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SUMMARY REPORTS
OF THE
OPERATIONS OF THE GEOLOGICAL SURVEY
FOR THE YEARS 1887 AND 1888.

The following Summary Reports are reprinted from Part III. of the Annual Reports of the Department of the Interior, in which the reports and maps presented in this volume are referred to as well as others in course of preparation.

These will be issued during the season of 1889-90, and will together constitute Vol. IV., New Series, of the Reports of the Geological Survey.

1887.

As in previous years, the explorations of the Survey have embraced many parts of the Dominion, and have, during the past season, extended from Vancouver Island and the Alaskan and northern borders of British Columbia, to James' Bay and the Atlantic coast of Nova Scotia, as well as to portions of the provinces of new Brunswick, Quebec, Ontario and Manitoba.

Much new and valuable geological and geographical information has been acquired, and large and interesting additions have been made to the Museum collection.

The Annual Report for 1886, Vol. II., new series, has recently been issued. This volume of 977 pages, R. 8vo., with numerous maps and illustrations, is composed of thirteen parts, or distinct reports, giving, in detail, the scientific and the practical information, and the conclusions arrived at respecting the various portions of the country explored, or on the other subjects treated of. The parts are also published separately, and are sold at an average price of twenty-five cents each.

My own time, during the early part of the year, after my return from England, at the end of December, 1886, was fully occupied in the preparation of the Annual Departmental report, with the general executive details of the Branch, and in connection with the preparation of of the Annual Report, Vol. II, above referred to.

During the summer, between the 13th June and the 10th of October, I visited and examined varied places, between Gaspé Bay and Cape Rosier in Quebec, and Vancouver Island in British Columbia, where the work of the Survey is in progress, and where some personal observation was required, either for information on points of economic importance, or in connection with the working out of the geological structure of the region. Of these may be mentioned: the occurrence of petroleum at Gaspé; the relations of the graptolite bearing rocks of Cape Rosier, Matane and Bic to those of Point Levis, the Island of Orleans and Quebec; the cupriferous pyrrhotite mines of Sudbury; the silver mines and the iron ores of the vicinity of Port Arthur; the coal mines of Lethbridge and of Banff; the silver-lead mines of Illicillewaet, in the Selkirk Mountains; and the hot springs of Harrison Lake and of Banff.

As regards the Gaspé petroleum, no efforts appear to have been made to develop it since 1863, and beyond the fact of the recent discovery of ooings at a point higher up Silver Brook than where the first boring was made, there is no further information about it now than was given in the *Geology of Canada*, 1863, pages 402, 521 and 789, and in the report by Dr. T. Sterry Hunt, published in 1865, "On Petroleum, its Geological Relations considered with special reference to its occurrence in Gaspé." Three borings appear to have been made, the sites of which are marked on the geological map, $\frac{1}{4}$ sheet, 6 N. W., but as none of them exceeded 200 feet, a successful result was hardly to be expected. The development of the extraordinarily massive, cupriferous ore bodies in the vicinity of Sudbury was being actively prosecuted by the company. The manager informed me that 2,000 tons of the ore had been shipped to the Messrs. Vivians, of Swansea, Wales, and on their report depends the question whether the Sudbury ores can or can not be profitably worked. This ore-belt has now been definitely traced for eight miles, and outcrops of large bodies of ore have been found at intervals throughout. In view of the immense quantity of ore, the small cost of raising it, and the facilities for shipping it, a very low price per ton would leave a fair margin of profit.

The argentiferous galena of Illicillewaet occurs chiefly in quartz veins, cutting a series of black carbonaceous or graphitic slaty shales, and thin bedded limestones, often much folded, but showing an average dip of from 35° and 40° to E.N.E., and apparently flattening towards the summits of the mountains. Most of the veins are parallel with the stratification, though not infrequently passing from one bed plane to that of another. The openings on Kennedy & Corbyn's claim, No. 2, above the north fork of the Illicillewaet River, and about 5,300 feet above sea level, on a precipitous mountain

side, show a massive quartz vein in an almost vertical attitude, cutting the black slates which are here almost horizontal. The quartz is impregnated throughout with galena and some pyrites, and is said to be very rich in silver. A large pile of ore had been extracted, but as the only present access to this mine is by a steep zig-zag ascent 3,000 feet from the Canadian Pacific Railway, at Illicillewaet, and then by a similar descent of 1,000 feet on the other side of the ridge, ore very much richer than the bulk of this appears to be would be required to enable this mine to be profitably worked. The vein has more the appearance of a gash vein than that of a true fissure or fault vein, the slaty rock on either side of the vein being continuous, and showing no evidence of vertical displacement. Mr. G. B. Wright gave me a number of specimens from some of the other claims, and those that have been analysed by Mr. Hoffmann, have given from 247·92 oz. to 816·67 oz. of silver to the ton. In one only was a trace of gold found.

The great elevation—from 2,000 to 3,000 feet above the railway—at which most of the present openings are situated, must be considered a somewhat serious disadvantage, but there seems no reason why, by careful and intelligent prospecting, the same veins should not be discovered at lower elevations and in close proximity to the railway. No fossils have yet been found in these slates, but they closely resemble the black graptolitic shales described by Mr. McConnell, p. 22 D, Annual Report Geological Survey, 1886, and may be of Cambro-Silurian (Ordovician) age.

Samples were procured from the two hot springs at Harrison Lake, British Columbia, and these are now being analysed. That of Banff has also been analysed by Mr. Hoffmann. It will be interesting to ascertain the difference in the mineral contents of these waters—the one rising from the crystalline rocks of the coast range of British Columbia, and the other from the palæozoic limestones of the Rocky Mountains.

In my last summary report I stated “that the requirements of the Survey in respect to increased museum and office accommodation become each year more pressing.” I may now state that, as regards the office accommodation, the steps I recommended are being taken, and in a few weeks, four additional well lighted and commodious office rooms will be available. They are on the top flat of the adjoining building, which has been connected with the present offices, the communication being closed by double iron doors to minimize the risk of fire, a risk unfortunately always great in the present situation of the Museum, and one which, in view of the great and annually increasing value of the collections, and the impossibility of replacing them if destroyed, merits, I would respectfully submit, the serious consideration of the Government, with a view to its speedy removal.

Dr. G. M. Dawson, with Messrs. R. G. McConnell, B.A., and James McEvoy, B. Ap. Sc., as assistants, was engaged during the past season in an exploratory survey of the region of the head waters of the Yukon and its vicinity, including portions of the northern part of British Columbia, but for the most part in the territory to the north of the 60th parallel, which constitutes the provincial boundary. Dr. Dawson was placed in general charge of the expedition, which was carried out conjointly by the Geological Survey and Dominion Lands Branches of the Department of the Interior. He furnishes the following preliminary account of the work of the Geological Survey contingent—Mr. Ogilvie's report on his special work, in connection with the Dominion Lands Branch, appearing elsewhere:—

“The Yukon expedition was undertaken in consequence of the necessity of ascertaining the nature and extent of the developments of placer gold mining, which of late years has attracted an increasing number of miners into the almost unknown district bounded to the south by the northern line of British Columbia, and to the west by the eastern line of Alaska. On account of the remoteness and the isolated character of the region to be examined, and the known difficulties to be encountered in traversing it, much time and attention were devoted to obtaining, by correspondence and otherwise, all available information, and in making such preliminary arrangements as were possible. For assistance in these matters we are especially indebted to Mr. John Grant, M.P.P., of Victoria; to Mr. Robert Campbell, now of Manitoba, the original explorer of a great part of the region; to Mr. J. Wrigley, Commissioner of the Hudson Bay Company, and Mr. J. McDougall, of the same company.

“I must also express my sense of obligation to Mr. W. Ogilvie, D.L.S., in special charge of the instrumental measurement on the Lewis River and to the 141st meridian, for his ready and obliging co-operation, and to Messrs. R. G. McConnell and James McEvoy, of this Survey, for their efficient assistance, to which is due much of the success of the expedition in carrying out the pre-arranged programme of work.

“We left Ottawa on the 22nd of April, travelling by the Canadian Pacific Railway to Victoria, but, in consequence of irregularity in the sailing dates of the Alaskan mail steamers, were unable to reach Wrangell, at the mouth of the Stikine River, where our work may be said to have begun, till the 18th of May. Here Mr. McConnell stayed behind, for the purpose of getting Indians and canoes to enable him to make a micrometer survey of the Stikine from the end of the line measured by Mr. J. Hunter, in 1877, to Telegraph Creek, while I proceeded up the river by the first steamer of the season to Telegraph Creek, the head of navigation. From this place goods are carried by

pack animals to Dease Lake, the centre of the Cassiar mining district; and here again a delay of several days occurred, as the animals had not been brought in from their range or shod for the season's work at the date of our arrival. Finally, on June 5th, we reached the head of Dease Lake, and found the greater part of the lake still covered with ice. It was not till the 9th that we were able to reach the point on the shore near Laketon, at which two men, previously sent on in advance with an Indian packer, were sawing lumber for boats. Seven days were here busily employed in this work and in constructing three boats for the purposes of the expedition. On the evening of the 16th, a strong wind having broken up the remaining barrier of ice, we reached Laketon with our boats; Mr. McConnell, with a crew of five coast Indians intended for my work on the Upper Liard, having meanwhile joined us. On the 18th, having completed our supplies and outfit at Laketon, we left that place, and on the 23rd reached 'Sylvester's lower post' at the confluence of the Dease and Liard Rivers. Here Mr. McConnell, with one boat and two men was to separate from us for the purpose of surveying and geologically examining the Lower Liard. In consequence of the delays experienced I thought it advisable to instruct Mr. McConnell to make arrangements, if possible, to winter at Fort Simpson, on the Mackenzie, as this would allow him to spend at least an additional month in exploration in the autumn, besides enabling him to begin work to great advantage next spring, by descending the Mackenzie and crossing by the Rat and Porcupine Rivers to Yukon, thus obtaining a much more complete knowledge of the geology of the basin of the Upper Yukon than would otherwise be possible. This action on my part, I am happy to say, has since met with your approval, and advices have been received from Mr. McConnell since my return, to the effect that he had successfully accomplished the work on the Liard and had made arrangements to make his headquarters for the winter at Fort Providence.

"On leaving the confluence of the Dease and Liard, my own party included, besides myself, Mr. McEvoy, Messrs. L. Lewis and D. Johnson, engaged at Victoria, two Tshimsian and three Stikine Indians, all good boatmen. Two local Indians, hired as guides, and to help on the long portage, deserted a day or two after engaging, and from the lower post, to near the confluence of the Pelly and Lewis, for an interval of more than six weeks, we met with neither whites nor Indians.

"The ascent of the Liard and Frances Rivers to Frances Lake proved unexpectedly difficult and tedious, the water being swift throughout and three bad cañons having to be passed through. Frances Lake was reached on the 8th of July, and after spending a few days in examining and mapping the lake, making the observations necessary to fix its

position, and in the endeavor to find some Indian trail by which we might travel across to the Pelly, we began the work of portaging on the 17th.

"As we had been unable to discover any route now in use by the Indians, and no trace whatever remained of the trail employed by the Hudson Bay Company in former years, and as no local Indians could be found to act as guides or to assist in carrying our stuff, it was evident that the crossing of this portage (which had been estimated by Mr. Campbell at about 70 miles in length) would be a difficult matter, and that we might indeed find it impossible to carry over a sufficient supply of provisions for further work on the Pelly. We, therefore, constructed a strong log *cáche* on the shore of Frances Lake, and left there to be taken back to Laketon by the Indians when they returned, everything we could possibly dispense with. Had we been unable to effect the portage, there was in our *cáche* an ample supply of provisions to enable the whole party to return to the mouth of the Dease River. After a very toilsome journey, we were, however, so fortunate as to reach the bank of the Pelly on the 29th of July, with still nearly a month's provisions for four persons, the necessary instruments, and a small camping outfit, a canvas cover from which a canoe might be constructed, and the tools and nails for building a wooden boat, should that prove to be necessary. Our Indians, who had for a long time been very uneasy because of their distance from the coast and the unknown character of the country into which they had been taken, were here paid off, and to their great delight allowed to turn back.

"As a dangerous rapid was reported to exist on the upper part of the Pelly, it was decided to construct a canvas canoe in preference to building a boat, which it might prove impossible to portage past the rapid. Having completed the canoe, we descended the Pelly, making a portage of half a mile past Hoole's Rapid or Cañon, and reached the confluence of the Lewis branch of the Pelly (or Yukon) on the 11th of August. We had now reached the line of route which is used by the miners, and expected to find, at the mouth of the Lewis, a memorandum from Mr. Ogilvie, from whom we had separated in May. As we could not find any such memorandum, and as Mr. Lewis had not been seen on the lower river by a party of miners whom we met here on their way up the Lewis, we were forced to conclude that he had not yet reached this point. The same party informed us that few miners were during the summer on the Stewart River, where most of the work had been carried on in 1886, but that in consequence of the discovery of "coarse" gold on Forty Mile Creek, about 120 miles further down the river, all had gone there, and that Harper's trading post, where I had hoped to be able to get an additional supply of provisions should we fail to con-

nect with Mr. Ogilvie, had also been moved from the mouth of the Stewart to Forty Mile Creek. From the place where we now were we still had a journey of over 400 miles to the coast, with the swift waters of the Lewis to contend against for most of the distance. If, therefore, it should have become necessary to go down stream 220 miles to Forty-Mile Creek for provisions, so much would have been added to our upstream journey that it would become doubtful whether we should be able to afford time for geological work on the Lewis and reach the coast before the smaller lakes near the mountains were frozen over. I therefore decided to set about the building of another boat, suitable for the ascent of the Lewis, and on the second day after we had begun work, Mr. Ogilvie very opportunely appeared. After having completed our boat and obtained Mr. Ogilvie's preliminary report and survey sheets, together with the necessary provisions, we began the ascent of the Lewis, from the head waters of which we crossed the mountains by the Chilkoot Pass and reached the coast at the head of Lynn Canal on 20th September. I am happy to be able to add that the entire expedition was carried out without any serious accident or loss, notwithstanding the difficult nature of the country, and that, though circumstantial reports were heard in the spring of trouble between the miners and Indians on the Yukon, these proved to be entirely groundless.

"The geographical, geological and general results of the work are now in process of elaboration and will be made the subject of a detailed report at an early date. Mr. Ogilvie's instrumental survey, now doubtless completed to the intersection of the river with the 141st meridian, will form a sufficiently accurate base line for future exploration in the region. In addition to this, the geographical results include the completion of an instrumental survey of the Stikine to Telegraph Creek by Mr. McConnell, which is connected with Dease Lake by a carefully paced traverse by Mr. McEvoy. Thence, a detailed running survey was carried by the route previously outlined, following the Dease, Liard and Pelly rivers and connecting with Mr. Ogilvie's line at the mouth of the Lewis River, a total distance of about nine hundred miles. Taken in connection with Mr. Ogilvie's measured line, these surveys include an area of over 60,000 square miles, the interior of which is still, with the exception of reports received from a few prospectors and from Indians, a *terra incognita*. The same remark, with little qualification, may be applied to the whole surrounding region outside the surveyed circuit, but much general information has been obtained respecting the entire district which will facilitate further explorations. The whole region is more or less mountainous, though intersected by wide areas of flat or rolling country. The north-eastern margin of the belt of coast mountains may be said to be at Telegraph

Creek on the Stikine. A second important mountain range runs in a general north-west by south-east course to the east of Dease Lake and is cut through by the Dease River. To the east of this no high or well-defined range was met with till the vicinity of Frances Lake was reached. Here a range, which may be accepted as the western part of the Rocky Mountains proper, is found with a similar trend to the east, and in this the streams feeding Frances Lake and the Pelly River rise. On the lower Pelly and Lewis Rivers the mountains are less considerable and assume a direction approximating more nearly to east and west.

"The following heights, deduced from a series of observations at a few main points will serve to indicate the general elevation of the country —

	Feet.
Telegraph Creek, Stikine River (water level).....	540
Dease Lake	2,661
Confluence of Dease and Liard Rivers.....	2,100
Frances Lake.....	2,577
Pelly River at "Pelly Banks" (water level).....	2,965
Old Fort Selkirk, mouth of Lewis River (water level).	1,555
Lake Lindeman, head of Lewis River	<u>2,165</u>

"Till the observations made in the field have been laid down on the map it will be impossible to give with precision any account of the geological features of the region. The rocks in general are closely analogous to those met with in the corresponding region in British Columbia to the south. The coast mountains where crossed by the Stikine and by the Chilkoot Pass consist for the most part of granitoid rocks, with some included crystalline schists precisely similar to those found to the south in the same mountain belt, some details in connection with which are given in my last report on Vancouver Island.*

"To the east of the coast mountains, on the Stikine and Lewis Rivers, there are Palæozoic rocks resembling those provisionally classed in the southern interior parts of British Columbia as the C  che Creek series. They include limestones, quartzites, slates and schists, with a notable proportion of agglomerates and other materials of volcanic origin. In the vicinity of Dease Lake, and nearly on the same line of strike on the Pelly, important beds of serpentine occur, and the associated rocks in these and many other places are preponderantly schistose and slaty, running through numerous varieties, but closely resembling the rocks of the Cariboo and other goldbearing districts to the south.

* Part B, Annual Report Geol. Surv. 1886, V. II.

"These Palæozoic rocks are by far the most widely spread in the entire region so far as exploration has yet gone, but are interrupted by areas of granitic rocks which generally form ridges or mountain ranges, and these in some places are flanked by more or less important developments of crystalline schists which are probably, at least in part, altered portions of the Palæozoic. The most important granitic range met with in the inland region is that previously mentioned as crossing the Dease River.

"Fossils are by no means abundant in the Palæozoic rocks, but a small collection of graptolites, of Cambro-Silurian age, were obtained on the Dease River, and Carboniferous forms were observed in connection with the limestones in several places. It is quite probable, however, that rocks ranging from the Cambrian to the summit of the Palæozoic, and possibly extending also to the Triassic, may be included in this great series, of which the schistose and slaty members constitute the gold-bearing rocks of the country.

"Rocks which are probably of Cretaceous age occur in limited basins on the Stikine immediately east of the coast mountains, and beds holding Middle or Lower Cretaceous marine fossils have a considerable development on the Lewis River, where there are also plant-bearing beds referable to the horizon of the Laramie and probably of the same age as the so-called Miocene of the Alaskan coast and Mackenzie River. A few fossil plants which are probably Cretaceous in age were also found at one place on the Pelly River.

"The Miocene proper is represented in the Upper Liard valley by soft stratified rocks, associated with basalts, and basaltic overflows, probably of the same age, occur on the Pelly, near the mouth of the Lewis, on the latter river at the Cañon, and in the Stikine valley east of the coast mountains. In the last mentioned locality are some remarkable examples of superposed columnar flows overlying coarse gravel deposits. There is not, however, in the entire region examined, any wide basaltic plateau.

"Some features of special scientific interest occur in connection with superficial deposits and the evidences of glacial action, but these cannot be detailed here. It may, however, be stated that in both the Lewis and Pelly valleys traces of heavy glacier-ice moving in northward and north-westward directions, are often apparent. The grooving and furrowing is found equally well marked at the water level, and at the summits of hills several hundred feet in height, and appears to indicate the northward movement of a confluent glacier, in conformity with the general slope of the country. Terraces are of general occurrence and well developed, and often appear at considerable heights on the mountain sides. In connection with the distribution of placer

gold, the direction of ice movement in the glacial period is of special importance.

"As the main object of the expedition was the exploration of the Yukon basin, but passing notice could be taken of the Cassiar mining district. The rich placer mines in the vicinity of Dease Lake were discovered in 1872, and reached their maximum productiveness in 1874, in which year they are reported to have yielded about \$1,000,000. The yield in succeeding years has gradually declined, but about 150 men are still annually employed in the district. Much prospecting still remains to be accomplished before the possibility of the discovery of new rich creeks is exhausted. Promising deposits of quartz are known to occur, though nothing has yet been done towards their investigation and development. These seem to be worthy of special attention in consequence of the comparative accessibility of the district by means of the Stikine. It would be easy to construct a waggon road from the head of navigation on the river to Dease Lake, and a railway may eventually be expected to follow this route into the interior.

"Gold mining in the Yukon district may be said to have been initiated in 1880, though little was done in that year, except a certain amount of prospecting by twenty-five or thirty miners who entered by way of the Chilkoot Pass. Since then a yearly increasing number of miners have entered the country by the same route, and river bars have been worked with good results on different parts of the Lewis and its tributary the Teslin-too (Newberry of Schwatka, Hootalinqua of the miners), and on the Pelly and Stewart rivers. In 1886 most of the work was done on the Stewart, but in consequence of the discovery of 'heavy' or 'coarse' gold on Forty-mile Creek, as previously mentioned, nearly all the miners went to that place last summer. This is the first discovery of 'coarse' gold in the district, but it may safely be predicted that many more will follow. Prospecting has so far been confined almost exclusively to the larger rivers, and the mining to river-bar mining, but the fact has been developed that gold occurs in greater or less quantity on all the streams, and the extent of the gold-bearing river bars already known is, in the aggregate, almost unprecedented. The number of men engaged in mining on the upper Yukon last summer was about 250, of which about 100 are wintering in the country. The number likely to be employed next season can only be guessed at, as so much depends on the demand for labor on the west coast generally. It is not impossible, however, that at least 500 men will be at work.

"In comparison with the region now known as an auriferous one on the upper Yukon, the productive portions of the Cassiar mining dis-

trict are small, as profitable work there was practically confined to a few creeks, yet in 1876 the transit trade at Wrangell, in connection with the mining in Cassiar amounted in value to about a million dollars. This may serve as an index of the probable commercial results of a similar development of placer mining alone in any portion of the Yukon territory.

"The prospective value of the Yukon district and northern part of British Columbia as a mining region I believe to be great. This region includes—measured from the vicinity of Dease Lake to the intersection of the Pelly (Yukon) with the 141st meridian—a length of over 500 miles of the Cordillera belt of the west, which, wherever it has been examined, has been found rich in minerals and particularly in deposits of the precious metals. The width of this particular part of the Cordillera belt is also great, as it appears, so far as our explorations have gone, to extend from the coast to the eastern ranges of the Rocky Mountains in the vicinity of the Mackenzie River. This portion of the Cordillera region, together with that of the more southern part of British Columbia, gives an aggregate length of between 1,200 and 1,300 miles, almost exactly equal to the length of the same metalliferous belt contained by the United States, and in all probability susceptible of an eventual mining development equally great.

"The general climatic features of the region explored and their relation to its orography cannot be entered into in this preliminary note. It must suffice to say that the very humid conditions of the coast do not extend to the interior, which includes some tracts of very dry country, and in the mountains of which glaciers occur rarely, if at all. Wheat, barley and potatoes are grown, on a limited scale, at Telegraph Creek and in its vicinity on the Stikine, though irrigation is necessary. Farther north, summer frosts are probably almost everywhere too frequent to admit of the growth of wheat, but I feel satisfied that barley and rye, with other hardy crops may be grown as far north as the 63rd parallel in the Yukon basin. The country, though generally mountainous in character, includes large tracts of flat or slightly broken land, and is, in fact, one which may eventually support a population as large as that found in corresponding latitudes in Europe (as, for instance, in the province of Vologda in Russia). It is for the most part wooded, and produces much timber of very fair quality, while open hill sides and terraces with bunch grass and aspen thickets occur along the river valleys. Large quantities of fine furs are yearly exported from the Yukon district, reaching the coast by the Chilkat and Chilkoot Passes, Taku and Stikine Rivers, or crossing to the Mackenzie by the Porcupine and Rat Rivers.

"One of the most important features of the Yukon district is the facility which the various large rivers, converging to form the main stream, offer for travel and inter-communication. These afford means for prospecting and exploring the country, and the distances to which they may respectively be ascended by boat or canoe has not yet, in most cases, been determined. It may be stated, however, that the rivers navigable for sternwheel steamers in Canadian territory have an aggregate length (measured without reference to minor flexures) of considerably over 1,000 miles, in which but one serious break of about three miles occurs on the Lewis. This length will be added to when the upper reaches of the larger streams are examined beyond the rapids or cañons, which are, in the above estimate, considered as defining the head of navigation in each case.

"Over 120 photographs were taken along the route followed, representing the character of the country, and I am happy to say that nearly the whole of these have proved satisfactory on development. Meteorological observations were kept up as regularly as possible, and numerous observations for latitude and longitude were made. Such geological and botanical specimens as appeared to be of interest were brought back, but in consequence of the difficulties of transport the weight of these had to be kept down as much as possible."

Cost of season's exploration of both parties, \$4,832.46.

Mr. R. G. McConnell intended to send out a preliminary report on his examination of the lower part of the Liard River, above referred to, by the Hudson Bay winter packet, from Mackenzie River, but as this has failed to arrive in time to be included in this report, the following extracts from letters addressed to Dr. G. M. Dawson may serve to give an outline of his work.

In the first, sent back to the Pacific coast with his men, and dated Liard River, July 27, he writes:—

"I have now got down nearly to the mouth of the Nelson, and have just met some Hudson Bay men ascending the river. I am sending my two men back with them as the river is good from here, and I can drift down to Fort Liard, even if I cannot find an Indian to go down. I send them back from here because there is no chance of getting supplies either at Fort Liard or Nelson House, and if I took them on to Fort Simpson they could not get back this autumn, as the river is still booming and shows no sign of going down, and we have just about enough food left to last them to their *câche* at the Devil's Portage. I shot two moose on the way down and that kept our supply up. We had a bad time getting down, as the river is a regular cascade for over a hundred miles. Between the Little Cañon and forty miles below the Devil's Portage it falls over 1,000 feet, and as forty miles of this

is good water you may imagine the state of the rest. It would be bad enough if it had room to flow, but it is penned in by cañons, often less than 150 feet wide, every few miles, and then whirls and boils in an incredible manner. We worked our way by sheer muscle, carrying both boat and stuff through forests and over high hills. My men turned out well and worked without a grumble. As for myself, I have hardly a stitch of clothes left, as they were torn to pieces and left hanging on the brambles and roots along the many portages. I hope that you have worked your way through your many difficulties, and have got out to the coast again. But you have a tremendous task before you, which I can appreciate now better than in the spring."

In the next letter, from Fort Smith, Slave River, under date August 23rd, Mr. McConnell writes:—

"After leaving the men, I floated down alone as far as Fort Liard, and there got an Indian to take me down in a bark canoe to Fort Simpson. At Fort Simpson I found the steamer, and came up as far as this place in her. This is rather a hard country to winter in without sending in supplies beforehand, as the deer have deserted it, and the people have been on short commons since last March. I am making arrangements to stay at Fort Providence, as it is a good locality for fish, and one will always have something to fall back upon. It is, besides, below Slave Lake, the ice on which is the great impediment to getting down the Mackenzie early. * * I am going down Slave River in a canoe, and on the way I will go up Salt River to the ridge in which it heads. From the mouth of Slave River I purpose going up Hay River to the falls, about 100 miles. I may also go up Buffalo River if I have time. During the winter I will try to visit Horn Hills, and see the country about Fort Rae. I believe Sir John Richardson is right about the Palæozoic age of the shales between Fort Simpson and this place."

A box of fossils, sent out at the same time with the letter from which the above extracts are taken, has since arrived. The fossils show the presence of Devonian, Triassic and Cretaceous rocks on the Liard River.

Mr. Amos Bowman was occupied the whole season in preparing and in supervising the lithography of the maps of his field work in British Columbia during the seasons of 1885 and 1886, chiefly in the Cariboo district, the survey of which, as stated in my report last year, was undertaken in connection with the Provincial Government. It was then, December, 1886, anticipated that the work of reducing the measurements and preparing the maps for publication would have been completed early in 1887. It has, however, together with the preparation of the report on the district, occupied till the close of the year. Both maps and report will be published at an early date.

In Manitoba, Mr. J. B. Tyrrell commenced a geographical and topographical examination and survey of the Riding and Duck Mountain region. He was assisted during the season by Mr. D. B. Dowling. We had very little precise knowledge respecting this district, but were aware of the occurrence in it of salt springs, gypsum deposits and strong indications of petroleum. It was also thought possible that workable seams of coal or lignite and natural gas might be found there, and in view of its proximity to navigable waters and to railways, it was considered important that it should be thoroughly explored. Mr. Tyrrell reports as follows: "We left Ottawa on the 5th July and reached Brandon on the 14th, where the horses used last year on the Calgary and Edmonton survey had previously been brought by rail. Men and supplies having been obtained, the party left Brandon on the 15th of July, following the trail northwards to Strathclair, situated in range 21, township 17. Thence an odometer survey was made up the Little Saskatchewan River, across the Riding Mountains and down the Vermilion River to Lake Dauphin. From the trails, paced surveys were made of the beds of Ochre River and Edward's Creek, the banks of these streams being either too swampy or too much obstructed by fallen timber to admit of following them, except on foot.

An odometer survey was then made northward across Wilson River to Valley River, a track survey being at the same time made of the Wilson River and its vicinity. North of Valley River, one of the rounded gravel ridges, known to the Indians as "pitching ridges," was followed first with a buckboard and odometer and afterwards on horseback as far as Fork River, a fairly accurate sketch-map being at the same time made of the eastern face of Duck Mountain. Finding that progress would be very slow north of Fork River, we returned to Valley River and made an odometer survey of the cart trail leading westward along this stream, passing through the gap that separates the Duck from the Riding Mountains in a wide glacial valley leading down into the Shell River, from which the trail was followed and surveyed over the high ground southward to the village of Russell, a terminus of one of the branches of the Manitoba and North-Western Railway. From Russell, a similar survey was conducted across Silver, Bird Tail and Arrow Creeks to Shoal Lake, and thence to Little Saskatchewan River, returning by a more northern route to the point of starting. From Russell we proceeded northward with buckboard and carts to Asessippi, on the Shell River, from which point the vehicles were sent round to meet me higher up the river, while with saddle and pack horses I examined the lower part of the valley, and rejoined the carts about the south line of township 26. We then continued up Shell River, to within three miles of the confluence of the north and

east branches, generally in the bottom of the wide deep valley, but sometimes we were obliged to climb to the top of the bank where it was impossible, without great delay, to ford the stream. On the way, however, we left Shell River for a time and turned westward on an Indian cart trail to Angling Lakes, where Côté's band of Indians have several houses in which they spend the winter, being here in the centre of their hunting grounds. From this village, then quite deserted, a track survey was made of the stream that flows northward into the largest and most eastern of the Angling Lakes till it flowed out of the valley that separates the Duck and Riding Mountains. It was found to be the main branch of Valley River. Two pack trails leading northward from the Indian village were also examined, one being found to lead up the west branch of Valley River to its source, and the other to "The Lake that does not freeze," and the latter of which belongs to the drainage area of Shell River.

Returning to this latter river, we were obliged to leave the carts at a point three miles below the confluence of the north and west branches and to use pack horses in continuing the survey towards the sources of some of the small streams tributary to the main river. Returning to the carts, we followed and surveyed an Indian cart trail northward across Big Boggy and Little Boggy Creeks, till it joined the old Pelly cart trail at the Indian village on Côté's Reserve. We then followed and located the latter trail northward to Fort Pelly, where we arrived on the 22nd of September. Having here obtained sufficient supplies to last till the end of the season, we followed a cart trail to the north-east, keeping north of Swan River for about forty miles, or till we reached the "Square Plain," making an odometer survey throughout the distance. I, however, branched off from this trail, and with pack horses followed a trail up Rolling River, till the stream became very small, and was flowing in a shallow valley through a country that appeared to be one interminable swamp. As the country was impassable for horses, I returned and made a paced survey down the bed of the stream to a short distance below the crossing of the old location of the Canadian Pacific Railway, where the river again flows in a defined but winding channel through a marshy, level tract of country.

Returning to Square Plain, Swan River was crossed and followed on its northern bank down to the mouth of Oak Creek, where the carts were again left, and with pack and saddle horses a track survey was made around the north end of Duck Mountain, following, during part of the distance, conspicuous gravel ridges that extend along the eastern face of the escarpment, at least so far north as the Valley of Swan River. In returning, the north-east point of the Duck Mountain was crossed, and also the head-waters of North and South Duck

Rivers and Pine River. Then passing around the north end of Big Lake, in which Rolling River takes its rise, the head of Favell River was reached. This river was then followed on a northward course to near its junction with Rolling River, returning thence to the carts at the mouth of Oak Creek.

While I was engaged as above described, Mr. Dowling was making pace and track surveys of Swan River and of the country lying north of it in the vicinity of the camp.

Below Oak Creek an odometer survey was made of the trail down to Swan Lake, and the river was followed on foot in many places, where there was any possibility of exposures of the underlying rocks being met with. From Swan Lake, the party returned to Fort Pelly by the old Hudson Bay Company's cart trail on the north side of Swan River, at the same time making an examination of the southern face of Thunder Hill.

The village of Russell was reached and the season's work completed on the 7th of November. Arrangements were made for the care of the horses and outfit for the winter before leaving for Ottawa, which we reached on the 14th November.

The surveys, which were checked throughout by latitudes taken with an eight inch sextant, will be plotted at once, and material will thus be furnished for an approximately correct map of a part of the country that, up to the present, has been almost entirely unknown.

Readings were taken regularly three times a day from a mercurial barometer, and numerous intermediate readings were taken from two aneroids, and as these will be compared with readings taken from a standard mercurial at Minnedosa, the height of which is known, it is hoped that the altitude of all important points can be determined with sufficient exactness to show the general slope of the country and the height of most of the important elevations.

The geological structure of these so-called mountains, as far as seen, is very simple. They are composed of practically horizontal dark-grey clay-shale, interbedded with bands of chalky limestones and bands and nodules of hard sandstone. These beds contain fossils characteristic of the Niobrara and Benton sub-divisions of the Cretaceous of Meek and Hayden's Nebraska section, and it is not improbable that some of the lower beds, which on Swan River were found to be sandstones and clays, represent their lowest, or Dakota Group, but no fossils were found to corroborate this, and no break or unconformity of any kind was found between any of the beds.

In some places, as on Vermilion and Ochre Rivers, the dark shales were found to contain a small quantity of mineral oil, and it is quite possible that borings may reveal reservoirs holding this oil in consider-

able quantities. No coal seams of any value, though carefully sought for, were found.

This subject and the geological structure of the district will be treated of in a detailed report to be prepared during the winter, after the observations and collections have been studied and the measurements plotted. About 1200 lineal miles of survey were made, and the observations covered an area of 3200 square miles of territory within the province of Manitoba.

The surface of the country is almost everywhere underlain by an irregular deposit of till, varying from a very thin crust to a massive bed several hundred feet in thickness. East of Duck Mountain its surface on the lower lands is generally level or slightly sloping, to the west it is generally more or less undulating, while on the summit of the mountain, and on the upper parts of its eastern slope there are many areas covered by moranic ridges, consisting of high drift knolls, thickly overstrewn with gneissoid boulders, between which are deep, rounded hollows, often holding small lakes of beautifully clear water.

Most of this latter country is practically valueless for agriculture, but considerable areas of it are covered with valuable forests, which by careful cutting could be made to yield a continuous supply of timber; but much of this rough land, especially that towards the north, is so thickly covered with boulders that it appears unable to bear more than a few scattered and stunted scrub pines. The undulating land to the south and west of the Duck and Riding Mountains is at present partly covered with groves of poplar, between which are more or less extensive areas of grassy prairie. This country is admirably suited for agriculture, since the soil is rich and well drained, and wheat can be raised with very little danger from early frost, certainly as far north as Big Boggy Creek, and perhaps as far as Fort Pelly. But perhaps the most fertile part of the whole district is that which lies between Dauphin Lake and the foot of Riding Mountain, where the underlying till is covered with rich layers of alluvial sand and clay. The land slopes gently towards the lake and is drained by several clear streams that flow from the face of the mountains. The area is partly wooded, the surface being covered with a rank growth of grass, weeds and rose-bushes, and dotted with groves of willow and poplar. Towards the north it is continuous with the swampy country lying between the gravel ridges east of Duck Mountain, though even here there are many rich meadows. Still further north, in the Swan River valley, meadow land again forms the greater portion of the surface, bearing a close growth of tall fine grass.

Near the headwaters of the Shell and Valley Rivers, between Rolling and Favell rivers, on the northern face of Duck Mountain, as well as

on some of the streams flowing from its eastern slope, there are some large areas covered with excellent white spruce averaging from 10 to 20 inches in diameter. Much of that on Shell River can be floated down into the Assiniboine River, where it can be sawn and distributed, but the rest must be floated into Lake Winnipegosis. From there it must be conveyed to Lake Manitoba before it can reach a market, but this will be a very easy matter when communication is once opened through the narrow neck of land in the vicinity of Meadow Portage. Of late years fires have been doing very great damage to the forests of this region, and it certainly seems advisable that some more stringent measures should be adopted to prevent the occurrence of the conflagrations that periodically sweep over such large areas throughout northern Manitoba.

Fossils were collected from the Cretaceous shales and limestones, and also a small but interesting collection was obtained from beds of pre-glacial or en-glacial age, near the summit of Duck Mountain. Numerous specimens of recent mammals, birds and insects were also collected.

Sixty-six photographs were taken during the season illustrative of the geology and general surface of features of the country examined.

Cost of exploration, \$1,741.16.

In April, correspondence was entered into with Major Powell, director of the United States Geological Survey, with a view to joint action in carrying out the survey and delineation of the glacial Lake Agassiz in its continuation into Manitoba. The terms of this joint action were agreed upon, and on the 6th May, Major Powell wrote expressing his "gratification at this inauguration of international work."

On the 11th September, Mr. Warren Upham, to whom the work was entrusted by Major Powell, wrote as follows:—"I have the honor to report the successful completion of the examination of the glacial Lake Agassiz in its continuation north of the international boundary in Manitoba, done under the auspices of your survey jointly for a detailed report to be made by me to you during the coming winter, and for my monograph on the subject for the United States Geological Survey. The cost of this exploration was \$344.88."

Mr. Upham's report will form part of the next Annual Report.

Mr. A. Lawson left Ottawa for the field accompanied by Mr. Smith as assistant on the 27th of May, to continue the exploration and survey of the country between the Lake of the Woods, Rainy Lake and Lake Superior.

The work was commenced in the vicinity of Rainy Lake, and during the months of June, July and August, Messrs. Lawson and Smith

were occupied in making the surveys and investigations necessary to complete the maps of the Rainy Lake and the Rainy River districts. These maps cover an area of 5,182 square miles. They will be similar to that of the Lake of the Woods, published with Part CC of the Annual Report, 1885, though on the smaller scale of four miles to one inch. The information for these maps is now in course of compilation in the office, and the maps will be prepared for publication, together with a detailed report, during the winter.

After completing the field work, and before commencing the survey of the intervening country east of Rainy Lake, it was deemed desirable to make a further general reconnaissance of the geological features of the Thunder Bay district and the vicinity of Port Arthur, where latterly mining interests have been rapidly developing. The remainder of the season was accordingly devoted to this work and to a visit to the Vermilion Lake and Gogebie iron ore districts in Minnesota, for the purpose of comparing the geological conditions which obtain there in connection with these deposits, with those of the Thunder Bay district, in many parts of which there are geological indications inducing the belief that valuable deposits of iron ore exist there like those above referred to. While Mr. Lawson was thus engaged, Mr. Smith continued the topographical work on the north side of Hunter's Island, in the vicinity of the international boundary.

Mr. Lawson's party was in the field four and a half months. Average strength five men. About 700 miles were measured by micrometer, log survey and compass triangulation.

Cost of exploration, \$1,608.97

Mr. A. P. Low, accompanied by J. M. Macoun as assistant, was engaged during the summer in making an exploration of the islands of James' Bay. No suitable craft for the work could be obtained at Moose Factory. A Lake Huron fishing boat was therefore purchased at Collingwood and sent to Missinabie station, on the Canadian Pacific Railway, situated on Dog Lake, at the head of the Michipocoten River. From here the boat was taken across the height of land and down the Missinabie branch of the Moose River to James' Bay, Moose Factory being reached 27th June. Leaving Moose 2nd July, the first island visited, called Charlton, lies near the southern end of the bay and about one-third of the distance across from the eastern shore. This island was found to be wholly made up of sand, clay and boulders, without any rock in place, and further investigation on the other islands visited showed that they were all of the same origin. Charlton Island is the second island in James' Bay in regard to size, being in shape an irregular oblique parallelogram, the diagonals being 18 miles from N.E. to S.W., and 12 miles from N.W. to S.E.

On the south side the shores are low and swampy, covered with a dense growth of black spruce and tamarac of small size; on the other sides the shores are high, and inland the island is a rolling plateau, with a light sandy soil, supporting a larger growth of white spruce and poplar. While on Charlton Island, a paced survey was made on the shore of Danby Island, which lies about one mile to the eastward. It was found to be roughly triangular in shape, each side being about two miles long. The whole island is low and flat, and covered with small black spruce and tamarac. On 11th July the party crossed to the Strattons, two small islands lying N. 65° E. from the north-east point of Charlton and ten miles distant. The western or larger is five miles long from E. to W. by about one mile and a half broad; the smaller is nearly round, with a diameter of one mile and half. The interior of the larger island has an elevation of seventy-five feet above sea level.

Little Charlton Island was next visited, distant eighteen miles from the Strattons in a N. N. W. direction.

From Little Charlton a northerly course was taken through the Tiders, several small low islands, the larger covered with low bushes, the smaller being merely sand and boulder shoals, stopping at Watson Island, which lies N. 33 E. from Little Charlton in latitude 52° 31' 07".

This island in form resembles a thin crescent, the greatest length being eight miles from north to south. With the exception of a few stunted white spruce, no trees grow on the island, its sand and boulder surface being covered with small arctic flowering plants, grasses and sedges. Continuing northward, Solomon's Temples, a number of low, sandy shoals, were passed, and the Twins, two large islands lying north and south, and separated by a channel five miles wide, were reached. These islands have the same barren character as Watson. After the Twins, Walter and Spencer, small islands lying to the eastward, were examined, and the mouth of the Big River reached 19th July. Here the party divided, Mr. Low going up the river, while Mr. Macoun explored the Lead and Bear Islands to the northward. The Big River was ascended fifty miles in an easterly direction. This is the largest river flowing into the east side of Hudson Bay, and is navigable with large boats for twenty miles from its mouth. It flows in a valley from one-third to one mile wide between cut banks from thirty to one hundred feet high.

The surrounding country is covered with a dense growth of trees in the following order as regards quantity: black and white spruce, tamarac, balsam and aspen poplar, balsam spruce and banksian pine; there are numerous outcrops of rock along the shores, the most common being a dark grey hornblende-gneiss.

Leaving Fort George, 2nd August, the bay was crossed by way of the Twins, and the island of Agoonski reached.

This is the largest island in James' Bay, being about seventy miles long from N. W. to S. E. by an average of ten miles broad.

Unlike the other islands, its coast line and interior are low and swampy and the interior is covered with small spruce and tamarac. From Agoonski the party returned to Moose Factory and thence by the Missinabie River reached the Canadian Pacific Railway 7th September.

The coast line and islands, as laid down on the Admiralty chart, do not agree with the Hudson Bay Company's chart, especially on the east coast, and further, neither the size, shape nor position of the islands visited by Mr. Low agrees closely with that given on either of the charts.

Mr. Macoun made several interesting additions to the collections of plants and insects.

Total cost of the exploration, \$3,179.00.

In December last Mr. E. D. Ingall visited the salt districts of Ontario for the purpose of investigating the present condition of that industry, and to gather statistics and other information relating to it. This work was continued by means of correspondence, after his return to Ottawa on the 5th of January. He was then engaged completing a report on the subject, and also one on the silver production of Canada, both of which are published in the Statistical Report on mineral production in Canada, Part S of the annual volume for 1886.

The preparation of the latter report, examinations for which were commenced in 1885, was much delayed last year by the preliminary work with Mr. Coste in connection with the arrangements for the collection of the mining and mineral statistics.

After the completion of this work, Mr. Ingall commenced the preparation of the maps and other illustrations to accompany his report on the silver mining district west of Port Arthur, and on the geological features connected with the very rich silver-bearing veins of that district. At the same time arrangements were being made to commence an exhaustive investigation and survey, during the approaching summer, of the apatite mining districts in Ottawa county, province of Quebec, with a view to the preparation of a monograph on the apatite deposits and their developments.

In pursuance of this plan it was decided to make an accurate delineation of the rocks associated with these deposits over an area of about 200 square miles, so outlined as to embrace the most important mines of the district, thus including parts of the townships of Portland, Der-

ry, Buckingham, and Templeton. Mr. Ingall was assisted by Mr. J. White, who on the 22nd June commenced the preliminary topographical measurements requisite for the construction of a map, on which to lay down the geological features and the position of the worked and the unworked apatite deposits. At the same time Mr. Ingall made a tour of inspection of the principal mines, and then returned to Ottawa to continue work in connection with his report on the silver bearing district above referred to, leaving Mr. White to continue the work in the field. This was unfortunately brought to a close on the 11th of August by a serious accident, in which Mr. White had his leg broken and was otherwise so seriously injured as to incapacitate him for any work during the rest of the season. Under these circumstances, Mr. Ingall disbanded the party, and has since devoted his time to the completion of his monograph of the Thunder Bay, Lake Superior silver mines, of which the publication is now in progress.

Cost of the work in the field, \$860.24.

Dr. R. Bell was engaged during the summer in an exploration of a portion of the large tract of but little known country on the confines of the provinces of Quebec and Ontario, including Lakes Temiscaming and Abbittibi, the Montreal River and the upper waters of the Ottawa. The chief objects of the exploration were to ascertain more precisely the northern extension and the distribution of the great mineral bearing belt of Huronian rocks which commences on the Georgian Bay of Lake Huron and crosses the Canadian Pacific Railway at and in the vicinity of Sudbury, also to investigate the question of the northern limit of the apatite or phosphate and mica bearing belts of Ottawa county, and likewise to make such additions as might be possible to the existing very imperfect geographical knowledge of the region to be traversed.

Dr. Bell was assisted in the field during the summer by Messrs. A. E. Barlow and A. S. Cochrane; by the former from the 16th July to the 1st October, and by the latter from 8th September to the 28th of October. The exploration extended from the 11th July to the 18th of October, when Dr. Bell returned to Ottawa.

Dr. Bell furnishes the following summary of the season's operations:—

“Although the watershed to Hudson Bay was crossed both in the eastern and in the western extension of the exploration, the country examined may be described as the Upper Ottawa country, as the waters used as the bases of our operations, both east and west of Lake Temiscaming, fall into the Ottawa River.

“Fort Temiscaming was selected as headquarters for the summer.”

The examination of the rocks of Lake Temiscaming was in continuation of the work of Sir W. E. Logan, in 1845, the result of which is summarized in chapters IV and XII of the *Geology of Canada*, 1863, and where also the succession of the Laurentian and the Huronian rocks on Lake Temiscaming is described. In the report for 1845 the rocks are more fully described, but they were not then known as Laurentian and Huronian.

Dr. Bell now states :—"This lake is surrounded by Huronian rocks and these were re-examined in the light of the knowledge of the Huronian system which has been gained since the time of Sir W. Logan's visit in 1845. The Silurian limestones, &c., of the islands and of the northern part of the lake were also examined and a considerable collection of their fossils was made. It is believed that the limits of the Silurian area at the north end of the lake can now be defined with tolerable accuracy.

"The course of the main Montreal River is singularly straight; its upward bearing is about north-west, and the distance from the mouth to the Great Bend, near which it divides into two branches flowing from the south, is 85 miles in a straight line. In 1875 I examined both these branches and the country thence to Lake Mattagami, in connection with a geological exploration, extending from the Wanapitai and Sturgeon Rivers, but the main Montreal River, below the Bend, had not hitherto been examined geologically. The rocks along it were found to belong to the Huronian system, except in two parts, namely at Bass Creek, two miles above the head of Elk Lake and just below the extremity of Sinclair's Line, or four miles below the junction of the East Branch, where Laurentian gneiss was met with.

"From the Great Bend of the Montreal River I crossed the height of land northward and descended the Frederick House River, a branch of the Abbittibi, to Paish-ko-tchagami Lake. All the rocks seen on this route also belong to the Huronian.

"On returning from this exploration I descended the Montreal River to its junction with the northern outlet of Temagami Lake, and made a track-survey and geological examination of the lakes through which it flows. The rocks on this route were found to consist principally of clay-slates, argillites and quartzites. At the time of my visit to Temagami Lake, Mr. Barlow was engaged in making a micrometer and compass survey of it, having begun this work on the 23rd July, and he completed it about the end of September, after which he made a similar survey of the route from Temagami Lake *via* Rabbit Lake to the foot of Lake Temiscaming. Temagami Lake was found to measure about thirty miles in its greatest extent, or from north to south, and nearly the same from east to west, but much of its general area is

occupied by peninsulas and islands. It is remarkable for having two outlets which discharge its waters, the one into the St. Lawrence and the other into the Ottawa. The southern outlet is a branch of the Sturgeon River, which flows into Lake Nipissing and thence by the French River into Lake Huron; while the northern outlet, as already mentioned, falls into the Montreal River and thence into the Ottawa. The rocks around Temagami Lake embrace felsites holding pebbles of syenite (which are the most abundant), quartzites, clay-slates, massive diorites and crystalline schists.

"After having made a geological reconnaissance of Temagami Lake, I returned to Fort Temiscaming by way of Rabbit Lake and the Mat-tabatchawan River, and found the rocks along this route to consist principally of felsites and clay-slates.

"The Rivière Blanche and the travelled canoe route from Lake Temiscaming to Abbittibbi Lake were explored geologically by the late Mr. Walter McOuat in 1872, * and during the present year Mr. E. B. Borron, on behalf of the Government of Ontario, made an exploration of the region lying to the southward of the latter lake and he has kindly promised to furnish me with notes of his geological observations. We are indebted to Mr. Edward Haycock and to Mr. David Beatty, P.L.S., for additional information on the rocks of the Rivière Blanche and neighborhood.

"The next division of the season's operations consisted of the exploration of the region between Lake Temiscaming and the source of the Ottawa. Accompanied by Mr. Cochrane I proceeded from this lake by way of Kippewa, Birch, Sasiganaga, Wolf and Grassy Lakes to the Grand Lac du Moine, and thence to Grand or Victoria Lake of the Ottawa. Laurentian gneiss was the only rock observed on this route all the way from the foot of Lake Temiscaming.

"From Grand Lake Mr. Cochrane was sent northward to ascertain whether or not the Huronian belt, which crosses the canoe-route between the height-of-land and Lake Abbittibbi, extends eastwardly to that longitude. In connection with this exploration he made a track-survey of the northern arm of Grand Lake, which has a length of about twenty miles, and thence across the watershed, and down the chain of lakes and streams which leads in the same direction to Shabogamog Lake. A track-survey and a geological examination were made of this lake, which proved to be over thirty miles long. Mr. Cochrane next descended the river flowing from this Shabogamog Lake for a distance of over ten miles, northwardly, where a series of rapids begins. It proved to be a large stream, fully equal to the Ottawa just below Grand Lake, and is apparently the head of the un-named river

* Report of Progress, Geol. Surv., 1872-73, pp. 112-135.

flowing into Hannah Bay, at the southern extremity of James' Bay. The height of land passes close to the northern extremity of Grand Lake, and soon after crossing it Mr. Cochrane found crystalline schists of the Huronian system, and further on they were met with here and there, alternating with Laurentian-like gneiss, as far as the outlet of Shabomagog Lake, beyond which the schists were continuous as far as he descended the river. There is little doubt these rocks form part of the Huronian belt, extending eastward from Abbittibbi Lake.

"On returning to Grand Lake, Mr. Cochrane, according to instructions, descended the Ottawa to Lake Temiscaming. The section of the river lying between Grand Lake and Lac des Quinze had been surveyed with the micrometer by Mr. Lindsay Russell, and it only remained for Mr. Cochrane to note the geological formations. The rocks along this division of the Ottawa proved to consist entirely of Laurentian gneiss. The Huronian schists, between Lac des Quinze and Lake Temiscaming were examined and reported on by the late Mr. McOuat, in 1872.

"Leaving Mr. Cochrane at Grand Lake to continue the explorations which have just been described, I proceeded up stream towards the source of the Ottawa. Grand Lake, the Ottawa River and the lakes upon its course as far as Barrier Lake, had been explored by Mr. Henry C. Symmes, P.L.S., in 1866, so that I only required to examine this section geologically, and throughout its whole extent the only rocks seen were gneiss.

"Above Barrier Lake, both a geological examination and a track-survey of the Ottawa were made to its source, which was found to be in a small lake at the head of the north-western and longest of the two branches into which it ultimately divides. This sheet of water, which is only about two miles long, had no name, and I called it Ottawa Lake, as an appropriate designation, and as following the almost universal rule which obtains in these regions by which the lake at the source of a river bears the same name as the river flowing from it. Laurentian gneiss continued to be the only rock observed all the way from Barrier Lake to Ottawa Lake.

"From Ottawa Lake I crossed the water-shed to Echaume Lake, one of the sources of the Gatineau River, and then descended that stream, which is constantly augmented by tributaries from either side as far as the river Désert, continuing to make both a track-survey and a geological examination the whole way. No rock but gneiss was met with in descending the Gatineau until reaching a portage about thirty miles below the Zigonse or principal north-east tributary of the river, where a white weathering coarsely crystalline light grey limestone made its appearance, and was afterwards traced, almost continuously,

down the river nearly to its mouth. This well characterized belt of limestone has evidently a great thickness. Thinner bands of a somewhat similar crystalline limestone were observed interstratifying gneisses, &c., in the lower part of the valley of the Désert. From this point I brought my canoe-men by stage to Ottawa, and thence sent them back to Lake Temiscaming *via* Mattawa."

The limestone above referred to by Dr. Bell was first noticed by Mr. J. Richardson in 1870, and is pretty fully described by him in the Report of Progress, Geol. Survey 1870-71, in which, on page 289, he says: "Without further examination it would be impossible to say whether these limestone which are so largely displayed along this portion of the Gatineau River form one or more bands. The thickness of this limestone in some parts cannot be short of five or six hundred feet and below the Big Eddy Portage may reach a thousand feet."

Dr. Bell further reports that while endeavoring to ascertain the nature, structure and geographical distribution of the rocks in the districts examined during the season, special attention was directed to the discovery of economic minerals.

"In this connection it may be mentioned that some days were devoted to an enquiry and examination into the alleged discovery of auriferous quartz veins in several places in the vicinity of Mattawa. The various openings where the discoveries were said to have been made were visited, and a number of specimens were collected. These have since been assayed by Mr. Hoffman, but without finding gold or silver in any of them.

"The glaciation of the fundamental rocks and other phenomena of the drift were studied, and many interesting facts noted, but these will be more appropriately recorded in the detailed report to be prepared. Numerous observations for latitude were made, which will be used to give greater accuracy to the maps of our track surveys. Notes were constantly kept in reference to commercial timber and to the distribution and the northern limits of the trees in the region visited. Considerable information was gathered on the natural history of the districts, especially with reference to food fishes; and collections of Coleoptera and Lepidoptera were made. The temperature of Lake Temagami and of other lakes was recorded three times a day by Mr. J. Fraser, a member of the party.

"Forty photographic views were taken to illustrate the various characteristic features of the scenery, points of geological interest and the general aspect of the country.

"As on all previous occasions, the Survey is again indebted to the officers of the Hudson Bay Company for their kind hospitality and assistance in promoting the work, and in this connection I may be

allowed to mention more particularly Chief Factor Colin Rankin, Mr. C. C. Farr, J. P., Mr. J. Mann, Mr. L. Christopherson and Mr. J. Turner.

Cost of season's exploration, \$2,036.87.

Mr. F. D. Adams left Ottawa on the 13th July, and spent the following three months and a-half in exploring and mapping in detail those portions of the counties of Montcalm and Joliette, which are included in the north-west quarter sheet of the map known as the map of the Eastern Townships.

The area examined by Mr. Adams has an extent of about 1,200 square miles, and lies immediately to the north of that explored by him in 1885. He now states that :

"The great mass of anorthosite underlying Morin, Abercrombie, Wexford and several other townships in Montcalm and in the adjacent counties, and the southern and western boundaries of which have already been determined, was still further examined, and its southern and eastern boundaries carefully traced. In doing so the unexpected fact was ascertained that the so-called massive and stratified varieties of this rock are in reality only different portions of one and the same mass. A number of small outliers of anorthosite were found in the gneiss to the east of this main area, resembling those found before on its western and southern sides. Four bands of crystalline limestone were also found east of the Lac Ouareau band and on the eastern side of the principal anorthosite area, some of which undoubtedly correspond to those found by Sir William Logan on its western side. As a result of this summer's work, I think it may be safely concluded that the rocks comprising the principal area of anorthosite above referred to, as well as most, if not all, of the smaller areas, are of eruptive origin.

"All localities, where minerals of economic importance were reported to occur, were visited and examined. These were for the most part deposits supposed to contain either gold or iron ore, many of which are associated with bands of pyritous rock near the contact of the anorthosite and gneiss. Several of them, now abandoned, had at one time been more or less extensively worked for gold. Specimens of these ores were collected, and it is proposed to assay them, in order to ascertain whether they really contain a sufficient amount of gold to warrant further efforts being made for their development. A large number of other specimens were also collected, some of which, it is hoped, may prove of economic importance, as well as of scientific interest.

"There still remains a large area to be examined within the limits of the map referred to, and until this is effected and the map can be

completed for publication, it is deemed desirable to defer the preparation of a detailed report on the geological structure of the district. A short report will, however, be prepared during this winter, dealing chiefly with the economic resources of those portions already examined, and which seem to be of more immediate practical importance.

Cost of season's exploration, \$563.00.

Dr. R. W. Ells, with Mr. N. J. Giroux as assistant, was occupied during the past season in continuing to the north-east the final examination and mapping of the geological formations on the south side of the St. Lawrence, in a part of the area comprising the north-east quarter sheet of the map of the Eastern Townships, extending from the county of Megantic north-eastward to the county of L'Islet. This work was, as stated, a continuation of that of the previous season to the south, which is described in the summary report for 1886, and in greater detail in part J of the annual report recently issued. The first two months were devoted principally to an examination of the gold-bearing rocks of the Chaudière district, and later the rocks along the southern side of the St. Lawrence were re-examined from St. Nicholas towards Rivière du Loup, together with some of the islands below the Island of Orleans. The object of this was to ascertain, and to map more accurately than has been hitherto effected, the distribution and the relative positions of the Levis formation and of the so-called Lauzon and Sillery formations along the borders of the St. Lawrence, where the rocks, over considerable areas, were in 1869 assigned to the horizon of the Potsdam sandstone, while other large areas of precisely similar rocks were still included in one or other of the sub-divisions of the so-called Quebec group. The reconnaissance examination which I have, from time to time, carried out in all parts of the region since 1874, had made it evident that an entire revision of the work of 1869 and previous years was now required, and this was commenced by Dr. Ells in 1885, and has since been ably prosecuted by him. The observations of the past season must now be carefully studied, and another season's work in the area will be required before the actual distribution of the formations can be fully ascertained and finally mapped, and the geological structure reported on, as there is still a very large area, probably not less than 1,250 square miles, in the counties of Bellechasse, Montmagny and L'Islet, that has been but little, if at all, explored. Much of it is thickly wooded and difficult of access; but as it is on the line of strike of the mineral-bearing belt to the south-west, it is not impossible that in some parts of it there may be a recurrence either of the asbestos, the iron ore, or the cupriferous deposits of that belt. In any case it is very desirable that the whole area should now be fully

and exhaustively explored, and its geological structure worked out before the map of it is published. This, is hoped, may be accomplished next year. A number of outcrops of serpentine, which are confined to the area south-west of the Etchemin River, were examined, with a view to finding workable deposits of asbestos, but though at several of these small veins of asbestos were observed, the mineral does not appear to occur in sufficient quantity to be of economic importance, and the altered igneous rocks with which it is associated to the south-west, chiefly in what has been called the volcanic belt, seem to disappear after the valleys of the Chaudière and Etchemin rivers are crossed.

On mining in the district, Dr. Ellis reports :—

“The output of asbestos at the mines of Coleraine and Thetford has largely increased during the past season, and preparations were being made to continue working during the winter. Several new mines have been opened at Thetford and near the Coleraine station which promise well.

“The Broughton Mine, situated on lot 14, range 7, Broughton, about half a mile west of the Quebec Central railway, is still being worked, though its present output is not very considerable. The asbestos at this mine occurs in an irregular vein along the contact between the serpentine and the black Cambrian slates, and differs from that obtained at the other mines of this mineral in character of fibre, and in its being associated with soapstone. It is, in so far as yet ascertained, confined to but one vein of any importance. Three shafts have been sunk in the line of outcrop, and some very excellent asbestos has been extracted, more especially from the upper portion of the vein. Very good indications of asbestos were also observed on lots 27, 28 and 29, range A, Coleraine, near the Poudrier road, the property of Dr. James Reed. Though but little work had been done, a number of veins of asbestos were exposed at the surface, varying in thickness from half an inch to an inch and a half.

“The gold mines of the Chaudière have not yet been developed on a scale commensurate with their importance. During the past season three companies have been engaged in mining operations, viz., the St. Onge Co., on Slate Creek, at St. George, Beauce; Messrs. Coupal & McArthur, on Mill Creek, near St. Francis village, and Capt. Richards on the Cumberland Stream, a branch of the Famine River. On the DesPlantes River also, Mr. Horace Sewell has been engaged in prospecting, with the object of finding the old channel of that stream, and claims to have been successful in locating it, though no work has yet been done to test it as a source of gold. At St. Francis, Mr. Coupal states that he has found considerable ‘coarse’ gold.

“During the past summer the old copper mine at Harvey Hill has

again been opened up, under the management of Mr. Chas. Lionais, but at the time of my visit the operations were confined principally to repairing the shafts and buildings. This mine has already been fully described in the *Geology of Canada*, 1863, pp. 724, 728, and no further information need here be given concerning it.

"Work has again been resumed at the South Ham antimony mine. This property is mentioned in the *Geology of Canada*, 1863, p. 876, and later in the *Report of Progress Geo. Survey 1881-82*, p. 399. It has lately changed hands, and is now owned by Dr. James Reed, who, within the present year, 1887, has driven a tunnel from the lower part of the hill in which the mine is situated, a distance of 304 feet, which has struck the vein at the bottom of the 100 foot shaft, with which also the other workings of the mine are connected. The mineral bearing lode, cut by the tunnel, is reported by Dr. Reed to be seventy feet in width, all of which he says will pay for extraction. The object of the tunnel driven by Dr. Reed is to drain the workings and to facilitate the extraction of the ore. Dr. Reed has already taken out about twenty tons of ore, and intends carrying on the work during the winter. The great difficulty in the way at present is the lack of a market, a difficulty likewise experienced at the antimony mines of Nova Scotia and New Brunswick. According to the '*Mineral Resources of the United States, 1885*,' the price of 50 per cent. ore was at that date \$10 per ton, the amount of crude antimony and regulus imported into the United States for that year being 2,668,302 lbs., valued at \$223,741, and of antimony ore 243,635 lbs., valued at \$8,783.

"Attention has again been directed to the iron ore deposits of Leeds. These ores, referred to in the *Geology of Canada*, 1863, p. 677, were subsequently examined by the late Mr. Chas. Robb, M.E., and are also referred to in "*Iron Ores of Canada*, p. 205, *Rep. Geol. Sur., 1873-74*," by Dr. Harrington, who says: 'The strata have been exposed by stripping for a distance of forty yards in the direction of the strike, and sixteen yards across it. In the latter distance three tolerably regular beds of ore were seen, respectively six, four and three feet thick, and all dipping to the north-west at an angle of $^{\circ}50$. The beds are separated by bands of chloritic slate, containing quartz and felspar. The ore is a fine-grained magnetite, more or less mixed with micaceous iron ore, and some specimens exhibit polarity in a marked manner.' Similar ores occur in the adjoining township of Inverness. The analysis of the Leeds ore, by Dr. Harrington, gave: metallic iron, 67.079; phos., .206; sulphur, .038. These ores are distant from the Quebec Central railway, at Robinson station, about ten miles, and from the Grand Trunk railway, at Bécancour station, from sixteen to eighteen miles.

"The field work was commenced on the 4th of June, and terminated on the 19th October—cost \$1,449.33."

Professor Laflamme, who was engaged for a short time during the summer in re-examining the country, and in continuing the revision of the geological boundaries on the north side of the St. Lawrence above Quebec, furnishes the following report:—

"A detailed examination was made of the country between the St. Maurice and the Batiscan Rivers, especially that portion of it which lies to the north of the boundary of the Cambro-Silurian rocks. The rocks observed here, as everywhere else in this region, belong to the Laurentian gneiss, which occurs in all its varieties. I, however, observed also three important bands of crystalline limestone in the parish of St. Tite. One commences at the southern extremity of Lake Roberge and runs westward to Lake Claire where it terminates. It is a coarse-grained limestone and encloses many fragments of gneiss, occurring as angular blocks regularly distributed through the limestone. The exposure is about five or six hundred feet wide, and about half a mile in length. The stone could, probably, only be utilized for burning into lime.

"The second band occurs about six miles to the south-east of the first. It is a fine-grained rose-colored limestone, susceptible of taking a fine polish, and consequently of being used as an ornamental marble. At the junction of the limestone and gneiss, there is a distinct appearance of bedding or alternating bands of limestone and of gneiss dipping south-easterly 75°. The exposure is about two acres in extent.

"The third band occurs about a mile to the south of the second, and the limestone closely resembles that of the Lake Roberge band, the crystals perhaps even larger. It likewise encloses many angular fragments of the surrounding rock. It could not be utilized as a marble.

All this northern country closely resembles the Saguenay district in the manner in which the deposits of clay "glaise," occur. These deposits are very irregular, and show much false bedding in most of the section made by the railway. There is no trace of quarternary fossils like those of the country in the vicinity of Quebec, and it seems that these deposits are all the result of the submergence of this part of the country by the fresh waters of the melting ice and snow of the glacial epoch. The country is generally fertile, but there is a larger number of extensive projections of Laurentian rocks, which interrupt the continuity of the clay deposits.

"East of Batiscan River the Laurentian rocks present the same general characters, as do also the arable lands. The general strike is north-east and south-west, and there is no trace of limestone bands in this region.

"I also made a further geological examination on the St. Anne River, but have nothing to add to what was stated last year.

"The Trenton limestones are very regular, with a scarcely discernable dip to south-southeast. About two miles above St. Anne's church they are covered by the Utica and Hudson River formations.

"In conclusion, I desire to draw attention to the work now being done in this part of the country in connection with the occurrence of natural gas.

"Already a number of wells have been bored, and though the result has not been what was at first anticipated, yet there is no reason why judiciously conducted researches should not some day be crowned with success. The discovery of natural gas in available quantity in the province of Quebec would be extremely valuable. We have no coal to work our minerals. Natural gas might replace it and give a fresh impulse to all our industries. Abundant sources of natural gas have been found in Ohio in the same formations, adding a certain degree of probability to the presence of gas in our Trenton and Utica formations.

"Cost of explorations, \$400."

From the above it might, perhaps, be inferred that natural gas had not been discovered in these formations, and, therefore, it may be well to quote the following passage from chapter xvii, p. 527 of the *Geology of Canada*, 1863, from which it will be seen that both gas and petroleum have long been known to occur over wide areas in Canada from the vicinity of Quebec to the Manitoulin Islands, and it has also long been known to occur in the Gaspé Peninsula:—

"The light carburetted hydrogen or marsh gas, which is so often a product of the transformation of organic matter at ordinary temperatures, is abundant in the palæozoic rocks of Canada and issues from many mineral springs. Those of Caledonia, Varennes and Caxton, in the Lower Silurian series, give off great volumes of this gas, which keep the waters in constant agitation. Many other less important instances of the same kind might be mentioned, while in the higher strata of western Canada this gas is still more abundant, as at the well known burning spring near Niagara Falls and in the region of the oil wells. In boring these, reservoirs of it are frequently penetrated from which the gas is liberated with explosive violence. In nearly all the oil wells there is a greater or less disengagement of inflammable gas; so that it would appear that the strata almost everywhere in that region hold, in a condensed state, portions of light carburetted hydrogen, which is discharged wherever a natural fissure or an artificial boring furnishes a vent.

"It was further stated *Op. cit.* p. 788: 'The possibility of its occur-

rence in available quantities in some parts of the Trenton formation should not be lost sight of.'

"During the past three or four years, attention has again been directed to this question, chiefly through the great developments that have during that period been made in Pennsylvania, Ohio and other states, and several wells have been sunk in the province of Quebec with a view to develop the indications of petroleum and natural gas, which, as already stated, were long ago pointed by the Geological Survey. The most important of these trials was made in the summer of 1885, and it seems desirable to quote here the detailed description of it by Mr. Obalski, as published, pp. 116-117, Report of the Commissioner of Crown Lands, Quebec, 1885."

GAS WELL NEAR ST. GRÉGOIRE, COUNTY OF NICOLET.

"These borings were effected on Mr. Hilaire Trudel's land (No. 501 of the Cadastre) at the south-east end of the concession of Bonsejour (Seigniorie Roquetaillade). The following table gives the depths reached and the nature of the rock encountered :—

	On the surface, 31st July, 1885, 1 foot of earth, good cultivatable soil, flow of odorless gas.
From 1 to 48 feet.	47 feet of blue loam, with thin layers of sand.
From 48 to 53 feet.	5 feet of white sand, with abundant emanations of odorless gas.
From 53 to 68 feet.	15 feet of heavy gravel, composed of pebbles of granite, sandstone, calcareous rock, &c., with abundant emanations of odorless gas and water.
From 68 to 75 feet.	7 feet of black sand, very dense, hard to penetrate; water, but no gas.
From 75 to 155 feet.	80 feet of solid rock, sandstone, somewhat calcareous, soft enough to be cut with a knife; oily ooziings.
From 155 to 215 feet.	60 feet of same rock, but harder and of a finer grain.
From 215 to 290 feet.	70 feet of red shale, wrongly called by the miners "soap-stone."
From 290 to 300 feet.	10 feet of same rock, lighter color.
From 300 to 316 feet.	16 feet of same rock, nearly black.
From 316 to 370 feet.	54 feet of blackish brown schist, not hard; abundant and sudden flow of gas, having a strong smell of kerosene.
From 370 to 475 feet.	105 feet of red shale; more abundant emanation of gas.
From 475 to 525 feet.	50 feet of red schist, somewhat greyish.
From 525 to 580 feet.	55 feet of red schist, softer.
From 580 to 640 feet.	60 feet, another flow of gas, more violent, throwing mud and stones from the bottom to a height of 60 feet in the air, and preventing work. This gas affects the sight and the lungs of the workmen; continuation of red shale.

From 640 to 680 feet. 20 feet of impure calcareous rock, apparently containing magnesia. Another vein of gas of the same nature.

From 660 to 720 feet. 60 feet of calcareous rock.

From 720 to 820 feet. 100 feet of oily calcareous rock.

From 820 to 860 feet. 40 feet of black schist, soft to the touch. New vein of the same gas.

From 860 to 1,115 ft. 225 feet of compact black schist.

1,115 feet.

Work suspended. The gas continues to flow with such force that it is impossible to close the orifice, so two pipes of $\frac{1}{2}$ -inch diameter are fitted to the main one.

"This boring has evidently passed through the Medina shales and sandstones which appear to be here 565 feet thick* and the remainder of the boring, 540 feet, seems to be in the Hudson River rocks. Below these the Utica, and the Trenton would be found, and as it is at the junction of the latter that the main gas and petroleum occurs in north-western Ohio it seems very desirable that the St. Grégoire boring should be continued till it reaches the Trenton limestone. The Ohio section shows the Medina only 80 feet thick with 305 feet of Clinton and Niagara on top, and at the base of the Medina there is a heavy flow of gas, as is the case at 640 feet deep, the base of the Medina, at St. Grégoire. Below this in Ohio are 430 feet of Hudson River strata and 275 feet of Utica shale, at the base of which, or a few feet lower in the Trenton limestone are, as above stated, the great petroleum and gas reservoirs.

"An all-important consideration in connection with the probable occurrence of these reservoirs is that of the geological structure of the district, and while for reasons in connection with this I have never had any faith in their occurrence on the north side of the St. Lawrence, I consider that the probability of such reservoirs existing on the south side, in the country between Lake St. Peter and St. Hyacinthe, is very great, especially along, or in proximity to, the central part of the line indicated by Sir W. E. Logan as the course of the Deschambault anticlinal.—Geol. of Canada, 1863, pp. 152, 205 and 272.

"At St. Grégoire, 550 feet of Hudson River strata have been penetrated. Between the Island of Orleans and the north shore of the St. Lawrence, Sir W. E. Logan estimated the thickness of the Hudson and Utica at 2,000 and 300 feet respectively. Supposing them to be equally thick at St. Grégoire the boring would have to be continued 1,700 feet before reaching the Trenton limestone. A little north of St. Hilaire, on the Grand Trunk railway, however, the Trenton limestone would probably be reached at a much less depth, as the axis of the anticlinal gradually rises in that direction, and the upper measures of the Hudson River and the Medina are absent.

* The thickness of the Medina formation at the west end of Lake Ontario is (Geol. of Canada, 1863, p. 312) as 614 feet.

"In any case the question may certainly be regarded as one of great importance in comparison with the small amount of money which would be required to thoroughly test it.

"As regards the question of manufacturing industries in connection with natural gas as a fuel, however, I may quote the following remarks by Professor Lesley.†

"The facts in reference to natural gas wells, briefly given above, point to the conclusion that gas wells have their regular life, and that the quantity of gas is a limited amount. If a single well is down and yielding gas, the pressure will remain constant and the supply regular for many years, but as soon as new wells go down in the immediate vicinity the total gas supply is sooner or later exhausted and all the wells cease yielding gas.

"The necessary result of this would be that natural gas as a fuel for iron puddling and other uses must be confined to the position of an economical adjunct to other fuels. That is, for works in all other respects well situated for successful iron working, with a cheap coal supply, immediately available upon a temporary or permanent ceasing of the gas supply, this natural gas can be brought in as a fuel and used with heavy saving of cost. But it is highly improbable that it could ever pay to locate works on a gas supply in a position where without the gas the works could not be successfully run. It is therefore as an economical adjunct, and not as a main source of supply that this gas must be regarded."

In New Brunswick, work was continued during the past summer by Professor Bailey and Mr. McInnes, assisted by Mr. J. W. Bailey. Professor Bailey's attention was first directed to the examination of the country on the upper waters of the St. John River, with a view to determine the limits of the Silurian System in that direction and its relations to the so-called Quebec group supposed to underlie and flank it on the northern side. With this object in view, an attempt was made to ascend the valley of the St. John to the north-west branch, where only a short interval separates the St. John waters from those of the Etchemin River flowing to the St. Lawrence: owing, however, to the dry season and the consequent low state of the water, it was found impossible to ascend further than the Seven Islands, and even this point was reached with difficulty, while the ascent of the Big Black and Little Black Rivers had to be abandoned.

Having obtained as much information as possible regarding the Silurian rocks in northern New Brunswick and in the adjacent portions of the province of Quebec and the State of Maine, it was considered advisable as a preliminary to the examination of the older rocks,

† Report L. 2nd, Geol. Survey of Pennsylvania, p. 171.

hitherto known as the Quebec group, to obtain somewhat greater intimacy with the latter in the localities where they were first observed and where their typical features can be best studied.

For this purpose Professor Bailey visited Rimouski and Bic, and then carried his examination inland, till, at the village of St. Blondin, he not only found the western edge of the Silurian rocks, but that there, and in the adjacent Bois Brulé Mountains, the beds were highly fossiliferous, and from them considerable collections were made. He then visited Quebec, where Dr. Ells was engaged in similar work, and with him made a boat trip down the St. Lawrence, thus acquiring a familiarity with the rocks of the so-called Quebec group which would not otherwise have been possible, and which will greatly facilitate his further study of the similar formations in New Brunswick.

During the latter part of the season, the cuttings recently made in constructing the Témiscouata railway were carefully examined, as was also the country in the vicinity of Témiscouata Lake. In the latter examination Professor Bailey was accompanied by Mr. Ami, who made a thorough exploration of the fossiliferous strata of Mount Wissick, Point aux Trembles and Lake Tuladie, and secured a number of interesting fossils, which must be critically examined before any precise correlation of the strata in which they occur can be made. The district was examined in 1849 by Sir W. E. Logan, and is described in the *Geology of Canada*, 1863, Chap. XVI, pp. 420-423, under the heading "Gaspé Series."

The attention of Mr. McInnes was devoted chiefly to making measurements and securing other data required for the completion of the quarter-sheet map, 17 N.E. of the New Brunswick series, on a scale of four miles to one inch. His observations extended also into the area, which will be included in the adjoining quarter sheet, to the north. A micrometer survey was made of the north side of the St. John River from Edmundston to the mouth of the St. Francis, and of the St. Francis River and lakes, in all about 100 miles. The region to the east of the inter-provincial boundary, in Restigouche county, was examined by ascending the Green River and crossing by a portage of about seven miles to the Quatawamkedgewick, and thence by the Restigouche and Grand Rivers to the St. John. The whole of this region was found to be occupied by strata of Silurian age. Large areas of good land are yet available for settlement in the valleys of these streams, along which there are many fine alluvial flats, with good soil on the uplands. About 250 miles of roads and streams, of which surveys were available, were traversed and examined during the season.

Mr. McInnes further reports that game, owing to the protection afforded it by law, is still fairly abundant in this region; that moose

and cariboo are numerous, and that red deer have latterly been coming in in considerable numbers from the adjoining state of Maine.

During the first part of the season Mr. J. W. Bailey was occupied in making an examination of the St. Francis River and its tributaries from their sources along the line of the Temiscouata Portage road to the junction of the same stream with the St. John. He also made a detailed examination of Temiscouata, Boundary, and other lakes as to depth, physical peculiarities, &c. Subsequently he accompanied and assisted Professor Bailey during the remainder of the season.

Mr. McInnes left Ottawa for field work on the 5th of July, and returned on the 11th October. Professor Bailey was in the field from 12th July to the 21st September.

Cost of season's explorations \$1,024.60.

The geological features of this region will form the subject of a detailed report and map, which will be prepared when the observations have been studied, the fossils determined and the measurements plotted. Another season's work in the field will, however, probably be desirable before the report and map referred to are published.

Mr. R. Chalmers left Ottawa on the 12th of May for New Brunswick to continue the examination and mapping of the surface deposits within the area embraced in the quarter-sheet maps Nos. 1 S.E. and 1 S.W., bordering the Bay of Fundy. In 1885 the area embraced in the quarter sheet maps 3 S.E. and 3 S.W. was surveyed and the report and accompanying maps are published as Part M. of the Annual Report, 1886. During the season of 1886 Mr. Chalmers made a detailed examination of the surface deposits in north-eastern New Brunswick, in the area covered by the quarter-sheet maps 2 N.W. and 6 S.E. These latter, with the report referring to them, are now waiting to be printed. Each of these quarter-sheet maps covers an area of 3,456 square miles. Mr. Chalmers has, therefore, now examined, making allowance for water areas, about 20,000 square miles.

During the past season the work in the field was continued to the 14th December. The cost being \$749.42.

Mr. Chalmers states "that the mapping of the different superficial formations was carried out in greater detail this season than had hitherto been attempted, the more settled condition of the country affording better facilities for doing so. All the important mountains and hill features, as well as the forest covered tracts, will be delineated on the map as accurately as time and circumstances permit. The representations of the hills and ridges in western Charlotte seemed to be absolutely necessary to exhibit the character of the surface deposits. In the vicinity of St. Stephen and eastward these ridges were found

to be capped with boulder-clay, while the valleys between them contain stratified materials.

"Observations with the aneroid barometer were regularly taken, based upon those of the meteorological stations at St. John and St. Andrew's, so that the heights in nearly every part of the area can be shown.

"The general character of the soil within the area under consideration is unfavorable to the successful prosecution of agriculture. Nevertheless, along the river valleys, and more especially in western Charlotte, there are excellent, well-cultivated farms. The land is good enough anywhere when once cleared of boulders; but owing to their abundance, the labor attending this is simply immense. At St. Andrew's there is a fine tract of land upon the Lower Carboniferous sandstones."

The maps and a full report will be prepared during the winter.

The explorations and surveys in Nova Scotia were conducted during the past summer, as heretofore, under the supervision of Mr. H. Fletcher, who left Ottawa for the field with his associates, Mr. E. R. Faribault, Mr. J. A. Robert and Mr. McMillan, on the 5th July. Mr. Fletcher's attention was devoted to the survey and examination, in which he was assisted by Mr. Robert, of that portion of Pictou county which lies between West River and the country that is described in Part B of the Annual Report for 1886, recently published. Mr. Fletcher reports having secured the services of Mr. Donald Fraser, of Springville, to trace the outcrops of the iron ores of the East River, and to describe the various workings on them.

Besides coal and iron ore, there are, within the area examined by Mr. Fletcher, workable deposits of gypsum, limestone, freestone, sand, brick clay and fire-clay. There is also a small deposit of bog-manganese in a brook at Glengarry.

The coal mines were not re-examined, but Mr. Fletcher states that "some alterations and some additions are now required in the map made by Sir W. E. Logan and Mr. Hartley, and published with the Report of Progress, Geological Survey, 1866-69.

"The iron ores of Pictou county, though not yet developed, must be regarded as next to the coal in economic importance. They are found at West River, Glengarry, Gairloch, Lorne, Bridgeville, Blanchard, Sutherland's and French Rivers, within a radius of seven miles and a half, and consist of limonite, red hematite, specular, spathic and bog ore, in such abundance, variety and purity as to astonish all visitors. The ores of the East River and Blanchard were worked sixty years ago, in a small way, by the General Mining Association. Since then

much money has been expended to develop the mineral resources of the district. It presents greater facilities for manufacturing iron profitably than are to be found in any other part of the Dominion, and it offers a field in which the investment of capital, by a company having enterprise and skill, would almost certainly result in the establishment of extensive and remunerative mining and smelting works, for the production of nearly all the grades of iron that are now imported. Pictou county is as favorably situated as are the best ore producing districts of Pennsylvania. There is a large market in the Dominion, as is shown by the value—nearly fifteen million dollars in 1886—of the iron and steel in various forms annually imported, much of which might be made in the country, labor being plentiful and cheap.

"The iron ores are in veins and in beds, varying in thickness from mere threads to one hundred feet. They crop out on hills and in bluffs, and the mines could be worked and drained by an adit to a depth, in most cases, of 200 to 300 feet, so that for some time to come neither pumping nor hoisting machinery would be required.

"The limonite, which yields 65 per cent. of metallic iron, is associated with manganese in quantity, thus strongly resembling the limonites that are brought to England from Spain to be used in the manufacture of spiegeleisen, manganeisen and steel. The percentage of iron in the other ores is variable, but all are of workable richness. The Pictou coal is free from sulphur and yields a firm, excellent coke. Limestone for flux is in close proximity and can be quarried cheaply in any required quantity."

A short and easily constructed branch railway would connect all the mines and the works with the Intercolonial main line, which now passes the coal mines, to an excellent shipping port on Pictou Harbor.

Cost of season's exploration \$1,500.

MINERAL STATISTICS.

Mr. Coste, Mining Engineer to the Geological Survey, has been engaged during the past year in collecting the material for, and in preparing a statistical report on the exports and imports and on the production of minerals in Canada in 1886, and, when the information was available, for some previous years also. This report, covering 85 pages, forms Part S of the Annual Report of the Geological Survey, Vol. II, new series 1886. It is also published separately and sold for twenty-five cents.

The articles relating to salt and silver were prepared by Mr. E. D. Ingall, Mining Geologist of this Branch.

Mr. Coste was ably assisted throughout by Mr. H. P. Brumell. He was further greatly aided, and the work was much lightened and expedited by the readiness evinced in all quarters to send in returns and answer enquiries, while but for the information afforded by the Department of Mines in British Columbia and by Mr. Gilpin, Chief Inspector of Mines in Nova Scotia, it would have been impossible to have completed the returns for those provinces.

Mr. Coste states that "about 2,000 forms and 400 letters were sent and 665 forms and 185 letters were returned. Plans of twenty different mines were secured and copied."

With a view to prepare for 1887 a more detailed and complete report on the mining resources and industries of the country than that now presented, the following places were visited during the summer by Mr. Coste in order to make personal examinations and enquiries:—

Port Arthur, Sudbury, Bristol Mine and places on the Kingston and Pembroke railway, Perth, Capelton and Montreal.

During these visits Mr. Coste observed "that in several districts the mining operations were being pushed with more vigor and success than during the previous year, especially in the Port Arthur silver district, along the Kingston and Pembroke railway line, at the Bristol iron mine, in the phosphate districts and at the Capelton copper mines. A wonderfully rich ore body was discovered in March of this year at the Beaver silver mine and in July was exposed in four different levels. Ninety to 100 tons of selected ore had been secured, which gave an average of \$1,500 to the ton; 1,400 tons of rock, averaging by assay \$40 per ton, had been treated in the mill, and had been reduced to about fifty tons of concentrates, averaging by assay \$1,000 per ton. On one day in July assays of the mill rock gave \$85 and the concentrates \$2,300 per ton.

In the district along the Kingston and Pembroke railway and at the Bristol iron Mines, Mr. Coste observed a marked "renewal of activity in the working of the iron mines by two strong companies."

"Some of the Canadian ores, it is true, contain a high percentage of sulphur, but so do the similar iron ores of New Jersey, in some instances as much as $\frac{3}{4}$ per cent., and yet these ores are mined in large quantity. In 1880, there were 112 mines being worked in New Jersey, which produced 739,369 tons of ore. An analysis of the average ore of the Sulphur Hill mine gave 2.527 per cent. of sulphur. This ore was used in the company's furnace at Chester, N. J., but was first roasted in Taylor's patent gas kilns, and it is stated that in a sample taken from 100 tons of the roasted ore only 0.786 per cent. of sulphur could be detected. *

* Tenth Census of the United States. Vol. XV, pp. 145-147.

These facts are given by Mr. Coste to show that there is no apparent reason why the same treatment could not be successfully applied to the sulphurous Canadian ores, and he states that the experiment is now being tried by the enterprising Ottawa capitalists who are working the Bristol mine, and who last summer erected two large Taylor-Langdon gas kilns to roast their ore before shipment. Should this prove successful it will probably lead to the further development of a number of large deposits of iron ore that have hitherto been neglected.

At the Capelton copper and sulphur mines some extensive new works were in progress both at the mines and near the railway station. At the latter, large new sulphuric acid works, nearly completed, and fitted with the best improvements, were being built by the present owners of the Albert, Hartford and Capel mines, Messrs. G. H. Nichols & Co., of New York. At the mine, also, extensive preparations for working on a larger scale were being made. These included the erection of a large crushing and concentrating plant, two new boilers, a pumping station three-quarters of a mile from the mine, a powerful hoisting engine, two air compressors and two shaft houses with corresponding well constructed skip roads. The old Albert, or present No. 1 shaft will also be repaired. It is now about 810 feet deep, and the vein is, on the whole, stronger in depth than it was nearer the surface. This is also the case in the Crown mine, which is further west on the same vein, and continues in active operation, the shaft having now reached a depth of more than 1,500 feet. Nearly 44,000 tons of ore were exported from these two mines (Albert and Crown) to the United States in 1886. The ore is an argentiferous iron and copper pyrites, very similar to, but holding a larger percentage of both copper and silver than that of the celebrated Huelva district in Spain, whence 550,000 tons were exported to England in 1886, valued at a little more than one million sterling.*

The cupriferous pyrites of the Eastern Townships contains as much sulphur as the Spanish pyrites and is, as stated, richer in copper and silver. If it could be introduced into England at the same price, about ten dollars per ton, there seems no reason why it might not compete successfully with the Spanish ores, and thus lead to the development of other valuable mines in the Eastern Townships.

In the phosphate mining industry Mr. Coste states "there is a renewal of activity in the Ontario district, where two promising properties are being worked by Capt. Boyd Smith, and by the Anglo-Canadian Company. In Quebec, Ottawa county, the mines continue to be actively worked and the production this year will probably be greater than in 1886." The introduction of Canadian phosphate in the

* Mining Statistics of the United Kingdom, 1886.

United States is likely to become an important feature of the industry, and to afford a large and profitable market.

Some hesitation and distrust is still noticed among many of the phosphate miners. This arises from the often irregular nature of the deposits, and from an idea, at one time somewhat prevalent, that most of the deposits were mere surface pockets. In this respect, however, there is no reason for supposing that the deposits of phosphate differ from those of iron ore or of any of the other associated minerals, and thus, while some of the deposits may be quickly exhausted, others will be permanent to the greatest depth to which mining operations can be profitably carried.

During the summer Mr. Brumell was requested by Mr. Coste to visit localities in the counties of Essex, Lambton and Brant, in Ontario. He also spent five weeks in New Brunswick, in King's, Queen's, Westmoreland, Charlotte, York, Sunbury and Northumberland counties.

Early in October he was sent to examine into a reported discovery of coal at Campbellford in Ontario. The report, as was well known it must, turned out to be unfounded, the country there being all occupied by the Trenton limestone formation.

On the 13th of October Mr. Brumell went to Lake Temiscaming, but owing to the steamer on the lake being disabled was unable to effect anything or to visit the mines.

Field expenses of Messrs Coste & Brumell \$1,088.40.

CHEMISTRY AND MINERALOGY.

The report furnished by Mr. Hoffmann on the work carried out in the chemical laboratory includes that in connection with the mineralogical section of the museum, to the arrangement of which much time and care has been devoted by Mr. Hoffmann, and, as a number of new specimens has been added to the collections, considerable extension and re-arrangement of the cases has been necessary.

Mr. Hoffmann reports as follows :—

“The work carried out in the chemical laboratory during the past year may be said to have an almost exclusive economic character. It included :—

“I.—Analyses of numerous specimens of lignites, lignitic coals and coals from the North-West Territory and British Columbia. Of the coals examined from the last named province, three were from seams of considerable thickness, and proved to be of very superior quality.

“II.—Analyses of iron and copper ores.

“III.—Analyses of mineral waters.

"IV.—Gold and silver assays. The number of these assays made in the laboratory during the period above specified amounted to one hundred and forty-eight, and exceeds that of any previous year.

"V.—Miscellaneous examinations, embracing chromic iron ore, clay, &c., &c.

"In the last summary report of this section mention was omitted of the following additions to the list of minerals previously known to occur in Canada, viz., cookeite, uraninite, monazite and smaltite. They have, however, been fully referred to in Part T, Annual Report, 1886. The second mentioned, uraninite or pitch-blende, constitutes the principal ore of uranium, and is of economic importance, being employed in chemical operations, for painting on porcelain, and glass staining.

"The number of mineral specimens received for examination amounted to six hundred and ninety-eight, as compared with five hundred and forty-six for 1886, and three hundred and thirty-nine for 1885. A large proportion of these were brought by visitors desirous of obtaining information in regard to their economic value, and this was in most instances communicated in the course of a personal interview. In many cases, however, a more than cursory examination was called for, and the results were subsequently communicated by letter. Notwithstanding that correspondence has been, as far as possible, limited to the writing of only such letters as were absolutely necessary for the conveying of information in regard to the results of examination, analysis, assay, or economic value of mineral specimens, it shows a marked increase over that of preceding years. Altogether the time devoted to visitors and correspondence has been very considerable. The number of letters written amount to two hundred and seventy-seven, as compared with one hundred and seventy in 1885.

"The mineral specimens collected by Dr. G. M. Dawson in the Upper Yukon district are under examination, and the two mineral waters from Harrison Springs, B.C., collected by yourself will now shortly be submitted to analysis.

"Mr. F. D. Adams has, (with the exception of about three months and a half during the summer, when he was engaged in field work in the counties of Montcalm and Joliette, in continuation of work commenced in the season of 1885) in the capacity of assistant chemist, rendered excellent service, amongst other work conducted by him being that of the analysis of the water of one of the principal thermal springs at Banff.

"Mr. E. B. Kenrick worked faithfully and diligently as junior assistant chemist up to the end of August, when he left to accept a professorship at St. John's College, Winnipeg. The position occupied by him has since been filled by Mr. R. A. A. Johnston, an earnest worker.

"In the mineralogical section of the museum some of the specimens have been replaced by better ones of the same kind, and one hundred and twenty-six new ones have been added. These include the following presentations :

Allan, W. A., Ottawa :—

Crystal of apatite from the Emerald mine, township of Buckingham, Ottawa county, Q. This crystal weighs five hundred and fifty pounds, and has a circumference of seventy-two and a half inches. It is supposed to be the largest crystal ever found in any country.

Muscovite, with inclusions of garnet, from the Villeneuve mica mine, Villeneuve, Ottawa county, Q.

Native silver from mining location R. 238, north of Atik Lake, west of White Fish Lake, Thunder Bay, Lake Superior, Ont.

Chisholm, Duncan, Salt Springs, N. S. :—

Brick-clay and bricks from Salt Springs, Antigonish county, N. S.

Copeland, J. S., Merigonish, N. S. :—

Infusorial earth from Merigonish, Pictou county, N. S.

Daly, Thomas :

Phlogopite, from the township of Portland, Ottawa county, Q.

Egan, H. L., Ottawa :—

Magnetite, from the township of Litchfield, Pontiac county, Que.

Haycock, E. B., Ottawa :—

Uraninite, from the township of Villeneuve, Ottawa county, Que.

Monazite, from the township of Villeneuve, Ottawa county, Que.

Hanks, Prof. H. G., 543 Clay street, San Francisco, Cal. U.S.

A fine specimen of the new anhydrous sulpho-carbonate of sodium, "hanksite"; also well-crystallized specimens of glauberite.

Keefer, T. A., Port Arthur, Ont. :—

Zinc blende, from the Zenith zinc mine, north shore of Lake Superior, Ont.

Lemieux, Joseph, Ottawa :—

Hematite, from Iron Island, Lake Nipissing, Ont.

McCool, James, Mattawa, District of Nipissing, Ont. :

Apatite, from the township of Ferries, district of Nipissing, Ont.

McDonald, R., & Sons, Arnprior, Ont. :

Polished column and base of Arnprior marble, the stone having

been taken from their quarry in the township of McNab, Renfrew county, Ont.

Mackenzie, Alexander, Montreal, Que.

Gold-bearing rock, from the Crow's Nest mine, Guysborough county, N.S.

McLaurin, J. Templeton, Ottawa county, Que. :—

Phlogopite, from the township of Templeton, Ottawa county, Que.

McNeely, J. L. Carleton Place, Ont. :—

Hematite, from the township of Beckwith, Lanark county, Ont.

Copper pyrites, from the township of Beckwith, Lanark county, Ont.

Moore, Isaac, Ottawa :—

Copper pyrites, from the south-east side of Straight Lake, district of Algoma, Ont.

Murphy, W. H., Ottawa :—

Zinc-blende, from the township of Calumet, Pontiac county, Que

Poole, H. S., Stellarton, N.S. :—

Carboniferous conglomerate carrying native gold, from Gay's River, Colchester, N.S.

Altered bitumen, from the *falls measures* immediately overlying the Acadia seam at Westville, Pictou county, N.S.

Anglesite, from the Big Dome mine, Arizona.

Shea, Dennis, Bryson, Pontiac county, Que. :—

Zinc-blende, from the township of Calumet, Pontiac county, Que.

Toronto Stone Company, Toronto :—

A dressed cube of the dolomite, from Pelée Island, Lake Erie, Ont.

Van Horne, W. C., V. P. Canadian Pacific Railway. Montreal :—

Copper pyrites, from Sudbury, district of Nipissing, Ont.

Wild, General E. A., Port Arthur, Ont. :—

Silver glance, from the Rabbit Mountain mine, Thunder Bay, Lake Superior, Ont.

Wright, G. B., Victoria, B.C. :—

Silver ore from four different claims, Illicillewaet, Selkirk Range, B.C.

"Mr. R. L. Broadbent was, for the space of eight months, engaged in the prosecution of the work of permanent labelling of specimens in the mineral collection, re-adjusting the contents of some of the cases, and the maintaining of the same in an orderly condition. During the remaining months he was occupied in writing labels, under the direction of Mr. Whiteaves, for the biological section of the museum.

Mr. C. W. Willimott has labelled and catalogued a large number of the specimens which are exhibited in the yard of the museum. These specimens consist, in part, of such as cannot, by reason of their size or nature, be accommodated in the museum, and of others, such as building stones, &c., upon which it is desired to ascertain the action of atmospheric influences. He has also been occupied in making up mineral and rock collections for various educational institutions, &c.

"Collections of this description have been forwarded to:—

	Specimens.
Depart. de Obras Publicas Republica Argentina, for exchange..	119
James Edmunds, London, England.....	42
St. Joseph Philosophical and Theological Seminary.....	105
Halifax Teachers Class and Halifax Academy.....	105
Professor J. G. Bonney, London, England.....	41
Captain Douglas.....	4
Canadian Pacific Railway (for exhibition at the Liverpool Exhibition).....	75
Professor H. A. Ward, of Rochester, N.Y. (in exchange for specimens required for the museum).....	81
	<hr/> 533 <hr/>

"Collections for the following will be ready in a few days:—

	Specimens.
J. C. Tremblay, Chicoutimi.....	115
High School Board, Aylmer.....	115
University of St. Joseph, Memramcook, N.B.....	115
Christian Brothers training school, Clonmel, Ireland.....	115
St. John's College, Winnipeg.....	115
Canadian Institute, Toronto.....	115
	<hr/> 1,223 <hr/>

"Collections for the following have yet to be made up:—

W. Smith, Land and Works Department, B.C.
 Royal Military College, Kingston, Ont.
 College Bourget, Rigaud, P.Q.

"In the course of the summer, Mr. Willimott visited the townships of North Burgess, Ramsay, Darling and Ross in Ontario, and Oxford, Chatham, Grenville, Villeneuve, Wakefield, and Hull, in the Province of Quebec, for the purpose of procuring certain mineral specimens required for the making up of collections for educational purposes. Whilst so engaged, he collected many specimens superior to those already in the museum collection, which they will replace, and in addition some other highly interesting ones, such as tourmaline in various stages of alteration, a mineral which may prove to be lepidolite, as also specimens of the monazite and uraninite, of which mention was made at the commencement of this report."

PALÆONTOLOGY AND ZOOLOGY.

In this division Mr. Whiteaves reports as follows:—"The illustrated synopsis of the fossils of the Hamilton Formation of Ontario, with descriptions of some new species, to which reference was made in the Summary Report of last year, has been published and distributed. The fossils, collected by Dr. G. M. Dawson in 1885 from the Mesozoic rocks of the northern part of Vancouver Island and adjacent coasts, have been studied, and a critical list of the species, with descriptions of such as are believed to be new, has been prepared and published as an appendix to Dr. Dawson's report on the geology of that district. An interesting series of fossils, collected by Mr. J. B. Tyrrell in 1885 and 1886 from the Cretaceous and Larimie deposits of the valleys of the Saskatchewan and its tributaries, has also been studied, and a similar list of species, with descriptions of several new forms, has been printed as an appendix to Mr. Tyrrell's report on Northern Alberta. A paper, descriptive of the whole of the fossils at present in the Museum of the Survey from the Triassic rocks of British Columbia, has been written during the year, but its publication has been deferred in consequence of the recent receipt from Mr. McConnell of some additional species collected by him, during the summer from deposits on the Liard River. These are evidently of Triassic age, a description of these species being deemed essential to the completeness of this presentation of the subject. The generic and specific affinities of these fossils from the Liard River, however, have been for the most part ascertained, as have those also of a small but remarkable assemblage of species recently collected by Dr. Dawson from the Cretaceous rocks of the Lewis River, a tributary of the Yukon. A preliminary examination has been made of a series of Cretaceous and other fossils obtained during the year by Mr. Tyrrell from the Duck and Riding Mountains in northern Manitoba.

“Considerable alterations and improvements have been made in the upper flat of the museum. The more important of these consist of the construction of six large and new upright wall cases, three for the reception of fossils, two for recent shells, and one for birds. One of these new wall cases is now filled with the remains of vertebrata from the Post Tertiary and Tertiary deposits of Canada, which have been skillfully re arranged by Mr. T. C. Weston. To this series an important addition has been made during the year in the shape of a lower jaw, with several vertebræ, ribs and limb bones of a *Mastodon*, which was discovered some years ago in a peat bog near Woodstock, Ont. In two of the other new wall cases the larger fossils of the Carboniferous and Permo-Carboniferous rocks of the Lower Provinces are now displayed to much better advantage than heretofore, these specimens also having been judiciously re-arranged by Mr. Weston. Two others have been devoted to the exhibition of a number of recent shells, of large and comparatively large size, many of which have been recently acquired by exchange. The whole of the shells in these new cases, and in another of similar size, have been neatly labelled by Mr. R. Broadbent, under Mr. Whiteaves’ directions, the number of labels required for this purpose being 377. Mr. Broadbent, who has worked in this department for four months, has also labelled each specimen in the extensive series of recent mollusca from the Pacific coast of Canada now in the museum, so that the duplicates can be more readily distributed to educational institutions, and has placed upon exhibition in the cases a number of additional specimens. The last of the five new cases now contains 112 specimens of Canadian birds belonging to the family Oscinæ, very few of which had previously been exhibited.

“On the 31st of December, 1886, there were 44 mounted specimens of Canadian mammals and 142 of Canadian birds on exhibition in the museum. On the 23rd of December, 1887, the number of mounted specimens on exhibition was, mammals, 82 (including a fine example of a puma, shot in August last near Victoria, Vancouver Island); and birds, 352; many of which have been set up by Mr. Herring during the year. To most of these specimens a provisional label has been attached.

“The number of letters written is a little over 200; and for rather more than three months, in the absence of the Director on field work, the duties of Acting Director, as on several former occasions, have devolved on Mr. Whiteaves.

Mr. Weston reports that since the 30th of December, 1886, he has spent about three months in arranging, cataloguing and labelling several hundred ethnological specimens. He has also prepared about 150 microscopic sections of rocks from various formations. Between 13th June and 17th September, 56 days were devoted by him to field

work and to the examination of many fossil localities between Cape Rosier and Point Levis. In this exploration Mr. Weston was assisted by Mr. L. M. Lambe. A few days were subsequently spent in collecting fossils at Grimsby, Ont. Through the kindness of Mr. R. Thompson, of Grimsby, an unusually fine example of *Arthropycus* (or *Harlania*) *Harlani* was secured for the museum. The rest of Mr. Weston's time has been occupied in museum work in the palæontological department.

Mr. H. M. Ami reports that during the earlier portion of the past year he was engaged in determining, classifying and labelling the large series of Silurian fossils collected by Mr. Weston in 1886, at various localities on the Arisaig shore, at Cape George and at Lochaber Lake, and in Antigonish county, N.S., from rocks which range in age from the Medina to the Lower Helderberg. He has also determined the Graptolites collected by Dr. Selwyn at Matane, and has helped Mr. Whiteaves in the examination of some Devonian fossils from Western Ontario. He has prepared systematic lists of labels, which have since been printed, for the fossils of the Hamilton Formation of Ontario enumerated in Mr. Whiteaves' "Contributions to Canadian Palæontology," Vol. 1, part 2, and for the graptolites of the Lévis Formation. Collections from the duplicates in the museum have been selected and labelled by him and sent to the following institutions or persons:—(1) To Laval University, Quebec, fossils; (2) to Mr. W. B. Clark, of Johns Hopkins University, Baltimore, fossils, in exchange for other specimens; and (3) to the Rev. Hector Currie, of Thedford, Ont., recent shells in exchange for Devonian fossils. Small collections, for special purposes, have also been forwarded for examination to Messrs. G. F. Matthew, E. O. Ulrich and C. D. Walcott. During the month of September and part of October, Mr. Ami was engaged in assisting Dr. Ells and Professor Bailey in their field explorations of various parts of the Province of Quebec, by collecting fossils with a view to ascertain the exact geological horizon of the rocks from which they were obtained. Since his return from the field he has examined the somewhat extensive collections of Natural History specimens of various kinds, which Mr. D. N. St. Cyr brought to Ottawa for identification, on behalf of the Quebec Government. These collections are intended to form the nucleus of a museum in connection with the Department of Instruction at Quebec, and consist of a large series of Canadian fossils, mostly from the Province of Quebec, and numerous species of marine, land and fresh water shells, with other invertebrata, from the gulf or valley of the St. Lawrence, exotic shells and the like. These collections have since been named, labelled and catalogued by Mr. Ami, under the supervision of Mr. Whiteaves, and duly forwarded to Quebec.

As in previous years, the whole of the drawings required for the illustration of palæontological reports have been carefully and skillfully prepared by Mr. L. M. Lambe.

The following collections have been received during the year from members of the staff or from gentlemen engaged in the work of the Survey:—

Dr. A. R. C. Selwyn:—

About 60 specimens of graptolites from the shales of the Lévis formation at Matane, Que.

Dr. R. Bell:—

About 250 specimens of fossils from the Silurian rocks of Lake Temiscaming.

One skin of a black hare from Paish ko-tchagami Lake.

About 120 specimens of coleoptera and fifty of lepidoptera from the Upper Ottawa region, extending from Temagami Lake and the Montreal River to the source of the Ottawa River, due north of Ottawa.

One Star-nosed Mole (*Condylura cristata*) from Ottawa.

One Jumping Mouse (*Zapus Hudsonicus*) from the Albany River.

Dr. G. M. Dawson:—

One Field Mouse (*Arvicola riparia*) from Finlayson Lake, Liard River, N.W.T.

One Red Squirrel (*Sciurus Hudsonicus*) from the Yukon River at the confluence of the Lucas and Pelly.

One Northern Flying Squirrel (*Sciuropterus volucella*, var. *Hudsonicus*) from Chilkoot Inlet.

One Spotted Sandpiper (*Actitis macularia*) from the Cassair district, B.C.

One Northern Pacific Kittiwake (*Rissa tridactyla*, *pollicaris*) from Frances Lake, N.W.T.

A small series of fresh water shells, including some remarkable varieties of *Limnæa ampla*, from Frances and Finlayson lakes and the Lewis River.

Several specimens of graptolites from the presumably Cambro-Silurian shales of the Dease River, and thirty-five specimens of fossils from the Cretaceous rocks of the Lewis River.

Dr. R. W. Ellis:—

A series of about 50 specimens of fossils from the Lévis Formation at various localities in the province of Quebec.

Dr. R. W. Ells and H. M. Ami:—

Forty specimens of fossils from the Chaudière River, Q., near the railway bridge.

Twenty specimens of fossils from the Hudson River formation, near St. Nicholas, Q.

About twenty specimens of fossils from Point Lévis and South Quebec.

Several fossils from Champlain Street, and foot of Citadel Hill, Quebec.

About twenty fossils from the Montmorency River, and the same number from Bois Brûlé and St. Blondin, Q.

Prof. John Macoun:—

Fifty-six species of birds, represented by 90 skins, and two mammals, from Vancouver Island; also a large number of marine shells and other invertebrata, and of land and fresh water shells, from the same locality.

R. G. McConnell:—

An interesting series of fossils from the Triassic and Cretaceous rocks of the Liard River.

J. B. Tyrrell and D. B. Dowling:—

450 specimens of Cretaceous fossils, twenty-four of butterflies and three of mammals from Duck and Riding Mountains, in northern Manitoba.

Prof. L. W. Bailey:—

Fossils from the Beccaguimic River, N.B., from various places around Lake Temiscouata, Q., and from Bois Brûlé and St. Blondin, Q.

T. C. Weston:—

About 1,000 specimens of fossils collected at various localities between Cape Rosier and Point Lévis, Q., and about 300 specimens of forty species of Niagara fossils from Grimsby, Ont.

H. M. Ami:—

Collections of fossils from Pointe aux Trembles, Mount Wissick, Tuladi River, Tuladi Lake and other places near Lake Temiscouata.

W. McInnes:—

Silurian fossils from rocks south of Rimouski, Q.

H. P. Brumell :—

Five specimens of fossiliferous Trenton limestone from Campbellford, Ont.

The additions to these departments of the museum, by presentation and purchase, are as follows :—

By Presentation :—

Charles E. Fish, St. John, N. B. :—

Specimen of *Lepidodendron Sternbergii*, from the Millstone-grit of Newcastle, N. B.

J. W. Tyrrell, Weston, Ont. :—

One female "Blue" Fox, *Vulpes lagopus*, var. *fuliginosus* (trapped January 12th, 1886); one Arctic Fox, *Vulpes lagopus*, in winter coat; one Ringed Seal, *Phoca fasciata* (something under a week old); two Hudson's Bay Lemmings, *Cuniculus torquatus*; one Polar Hare, *Lepus timidus*, var. *arcticus*, in winter coat; all from Ashe Inlet, Hudson's Strait.

G. Seifert, Fabrique St., Quebec :—

Three specimens of the Fresh-water Pearl mussel (*Margaritana margaritifera*) with a number of pearls from the same species.

W. F. Whiteher, Ottawa :—

Skin of Kit Fox (*Vulpes velox*) from Antelope Lake, Assiniboia.

Prof. E. Hull, Director Geological Survey of Ireland, Dublin :—

Two specimens of *Oldhamia antiqua* from Carrick Mountain, Wicklow, and two of *Oldhamia radiata* from Bray Head, Wicklow.

H. Bartlett, Ottawa :—

Specimen of an Osprey (*Pandion haliaetus Carolinensis*) shot on the Rideau River near Ottawa.

W. P. Lett, Ottawa :—

One Sora Rail (*Porzana Carolina*) also shot on the Rideau River near Ottawa.

Sir William Dawson, C.M.G., &c. :—

Specimen of *Flustra serrulata*, Busk, from Murray Bay.

T. G. White, Ottawa :—

Four specimens of Wilson's Meadow Mouse (*Arvicola riparia*) from near Ottawa.

W. J. Bayley, New Edinburgh:—

One adult female of the Marsh Harrier (*Circus Hudsonicus*) shot at Britannia Bay, near Ottawa.

D. N. St. Cyr, Department of Public Instruction, Quebec;—

One young Harp Seal (*Phoca Groenlandica*) apparently about five or six weeks old.

Specimen of *Hippopus maculatus*.

H. L. Poole, Manager Acadia Coal Mines, Stellarton, N. B.:—

Fine specimen of *Lepidodendron personatum* from the coal measures at Westville, Pictou Co., N.S.

Percy Woodworth, Kentville, N.S.:—

Six specimens of insects and two foetal mice, from Digges Island, Hudson's Bay.

W. F. MacKay, Fort Albany, James' Bay:—

Three specimens of birds from the Albany district.

By Purchase:—

Head of adult Bull-walrus (*Odobæus rosmarus*) and skin of a White Wolf (*Canis lupus*, var.), both from Ashe's Inlet, Hudson's Strait. The walrus was shot on the 10th of April, 1886, was eleven feet long and weighed about 2,500 lbs. The white wolf was shot by an Eskimo in the winter of 1885-86, about 30 miles north of Ashe Inlet, or in Lat. 63° N., and Long. 71° 30' W.

Underjaw (with two teeth in place) vertebræ, ribs and limb-bones of *Mastodon* found in 1871 in a peat bog near Woodstock, Ont.

Specimen of an adult female Puma (*Felis concolor*) shot in August, 1887, near Victoria, V. I.

One Red Fox (*Vulpes vulgaris*).

One Kit Fox (*Vulpes velox*) from near Calgary, N.W.T.

One young Whooping Crane (*Grus Americana*) and one adult Franklin's Gull (*Larus Franklini*) both from Manitoba.

Remarkable colour variety of the Rough-legged Buzzard (*Archibuteo lagopus*) shot near Ottawa.

BOTANY.

On the work in this section during the year, Professor Macoun reports as follows:—"In January, February and March, I was occupied with correspondence and in examining and classifying a very large quantity of miscellaneous cryptogamic matter.

" My results have since been submitted to specialists, and their partial reports are now in my hands.

" The collection of Canadian Fungi, upwards of 600 species, now in the Museum, has been named by Mr. J. B. Ellis, of Newfield, N.J.

" Dr. Nils Conrad Kindberg, of Lusköping, Sweden, has examined the mosses, and has confirmed, or corrected my determination, and the list of Canadian mosses has been increased to nearly 600 species, many of them new, not only to Canada, but to science. The Hepaticæ or Liverworts are difficult to determine, but good progress is being made in this work. More than 100 species are now in the hands of Mr. Pearson, of Manchester, who is the highest authority in England on this class of plants.

" On the 8th of April, I left Ottawa for Vancouver Island, arriving there on the 15th. From that time to the end of August, I was occupied in collecting specimens of the flora of the island and in determining the distribution of its forest trees and the character of its soil as indicated by the vegetation.

" My researches extended from Victoria to Connox on the east coast, with frequent excursions to points in the interior. Crossing from Qualicum to Alberni I went in a canoe to Cape Beall on the outer coast. The islands in Barclay Sound were examined, and in prosecuting the examination of the country inland the following mountains were ascended :—

	Feet.
Mt. Erskine on Salt Spring Island.....	1,275
Mt. Finlayson near Goldstream, Vancouver Island.	1,350
Mt. Benson at Nanaimo.....	3,363
Mt. Prevost at Somenos.....	2,700
Mt. Arrowsmith near Qualicum.....	5,976
Mt. Mark at Horne Lake.....	3,080

Fifteen hundred species of plants were collected.

Since my return in September, I have been fully occupied sorting and determining the specimens collected during the summer, and in writing the fourth part of the Catalogue of Canadian Plants, a portion of which is now passing through the press.

During the year 1886-87 there were placed in the Herbarium 4,305 sheets of specimens, as follows :—

Canadian.....	752
American.....	1,807
European.....	750
Cryptogams.....	996
	<u>4,304</u>

From the herbarium 5,905 sheets of duplicate specimens were distributed either to individuals in exchange for specimens received, or to scientific institutions. Among the latter were the British Museum, McGill and Queen's Colleges in Canada, and the Harvard University herbarium in the United States.

Dr. Dawson has brought back from his last summer's field of labor on the Upper Yukon a valuable and interesting collection of plants and although but a cursory examination has been made of them, they show conclusively that the summer climate there is neither cold nor wet.

Mr. J. M. Macoun acts as botanical assistant during the winter and takes care of the herbarium, while during the summer he accompanies one or other of the exploring parties in the field, taking every opportunity to make botanical and zoological observations and collections. Besides the botanical work here recorded, Professor Macoun made valuable zoological collections during the summer which are referred to in the report on that section by Mr. Whiteaves.

MAPS.

British Columbia.—The map of the western part of Vancouver Island and adjacent coast, scale eight miles to one inch, has been published with Part B of the Annual Report, 1886.

Mr. Bowman during the year has completed the following maps and plans:—

	Area in Square Miles.
1. Revised map of the southern interior of British Columbia, scale 8 miles to 1 inch	28,914
2. Map of Cariboo district, scale 2 miles to 1 inch, about	2,720
3. Plans of eleven creeks showing placer mines and quartz ledges and embracing together about 249½ square miles, as follows:—	
(1.) Little Snowshoe and Keithley Creeks, scale 2½ inches to 1 mile	54
(2.) Sugar, Hardscrabble and Slough Creeks, 3 inches to 1 mile	49
(3.) Antler Creek, scale (about) 26 chains to 1 inch.	38
(4.) Cunningham Creek do 27½ do do .	34
(5.) Lightning Creek do 400 feet do .	17
(6.) Grouse Creek, scale do 25 chains do .	14
(7.) Island Mountain and Mosquito Creek, scale (about) 480 feet to 1 inch	3½
(8.) Harvey Creek, scale (about) 19 chains to 1 inch	3½
(9.) Williams Creek, scale (about) 400 feet to 1 inch.	12
(10.) Hixon Creek, scale 2½ inches to 1 mile	24
(11.) do do about 10 chains to 1 inch..	¾

North West Territory.—Mr. J. B. Tyrrell's map of the country between the Upper Bow and the North Saskatchewan Rivers is engraved, and accompanies Part J., Annual Report, 1886; scale 8 miles to 1 inch; area 45,000 square miles.

Manitoba and Western Ontario.—The map of the Lake of the Woods to illustrate Mr. Lawson's report on that region was published early in the year; scale 2 miles to 1 inch; area 3,456 square miles.

Mr. E. D. Ingall's map of Silver Mountain and vicinity is engraved; scale 20 chains to 1 inch; area 45 square miles. Also sketch map of Thunder Bay mining region; scale 4 miles to 1 inch; area 3,000 square miles.

Mr. Cochrane has continued the revision of sheet 115 in the field from 17th July to the 2nd September, having examined and corrected about 250 square miles. Copies were made of about 55 miles of the plans of the Wellington, Grey and Bruce railway: scale 200 feet to 1 inch.

Mr. Coste has a plan of the townships of Madoc and Marmora, county of Hastings, ready for publication. Scale 2 miles to 1 inch.

For two weeks during the summer Mr. Barlow was engaged surveying roads, range lines, &c., to aid in the compilation of the map of Carleton county. Scale 4 miles to 1 inch.

Quebec.—The south-east $\frac{1}{4}$ of the Eastern Townships map is completed and will accompany Part J Annual Report, 1886. Scale 4 miles to 1 inch. Area 4,500 square miles.

Professor Bailey and Mr. McInnes are working on $\frac{1}{4}$ sheets, 17 N. E. and 18 S. E.

The map of Ottawa and Pontiac counties remains as last reported.

New Brunswick.— $\frac{1}{4}$ sheet, No. 2, N. W., has been published. Scale 4 miles to 1 inch. Area 1,512 square miles.

Nova Scotia.— $\frac{1}{4}$ sheets, No. 4 N. E. and 4 S. E. are being drawn.

LIBRARY.

Dr. Thorburn reports that 5,075 copies of the various publications of the Survey were distributed during the year, including Annual Reports, special reports and maps. Of these 3,980 were distributed in Canada, the remainder were sent as exchanges to scientific and literary institutions and individuals in the United States, South America, Europe, India, China, Japan, Australia, &c.

The number of reports in French sent out was 563.

There were received as exchange during the past year 1,027 publications, including reports, transactions, proceedings, memoirs, periodicals, pamphlets, and maps.

There were added to the Library during the year 82 publications by purchase, besides 37 scientific magazines and periodicals on geological, mineralogical and natural history subjects subscribed for.

The number of volumes bound was 281.

The letters received in connection with matters relating to the Library and the distribution of the geological publications were 1,211, whereas those sent out during the same period were 1,315.

VISITORS.

The number of visitors to the Museum during the year from the 1st of January to the 31st of December was 17,575 or three thousand more than in any previous year.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The strength of the staff at present employed is 53, viz., professional, 36, ordinary, 17.

During the calendar year the following appointments were made to the permanent staff:—

Mr. Eugène Coste, Mining Engineer.
Mr. Amos Bowman, Field Geologist.
Mr. A. C. Lawson, do

The amount available for the fiscal year ended 30th June, 1887, was:—

Civil-list salaries, appropriation	\$40,650 00
General purposes, do	56,995 32
	<hr/>
	\$97,645 32
	<hr/>

The expenditure may be summarized under the divisions named as follows:—

Civil-list salaries	\$38,450 00
Wages, temporary employés	19,765 00
Exploration and survey	19,144 58
Indian and Colonial Exhibition	5,700 83
Printing and lithography	11,389 02
Purchase of specimens	865 05

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Purchase and binding of books, and purchase of instruments.....	525 83
Laboratory apparatus and chemicals.....	89 06
Stationery, mapping material and Queen's Printer.....	1,087 21
Incidental and other expenses.....	2,286 47
	<hr/>
	\$99,303 93
Less paid in 1886.....	8,837 48
	<hr/>
	\$90,466 45
Advance to field explorers and others on account	
1887-88.....	3,930 4
Unexpended balance civil-list appropriation.....	2,200 00
Unexpended balance of contingency appropriation.....	1,048 43
	<hr/>
	\$97,645 32
	<hr/>

The correspondence of the branch shows a total of 8,489 letters sent, and 5,505 received, from 1st January to 31st December, 1887.

ALFRED R. C. SELWYN,

Director.

1888.

During the summer, between the middle of July and October, I visited and examined certain places for the purpose of investigating questions in connection with the work of the Survey, and the discovery and development of valuable economic minerals. Among them may be mentioned the apatite and iron ore deposits near the village of Carp, in the townships of Huntley and Fitzroy, the borings for gas and petroleum at St. Grégoire and Maison-Neuve in Quebec, at and to the west of Collingwood in Ontario, and near Lake Dauphin in Manitoba. The whole of the month of August was devoted to the study of the great mineral bearing belt which occupies the shores of the north channel of the Georgian Bay of Lake Huron and extends from Sault St. Marie to Sudbury. Within this belt are situated not only the newly discovered nickel-copper and gold-bearing deposits in the vicinity of Sudbury, but also the old and now abandoned Bruce and Wallace mines, and a number of other promising deposits of copper ore, argentiferous galena and iron ore, which seem only to require energy and enterprise to convert them into profitable mines. The Vermilion or Tough gold mine near Whitefish station on the Sault St. Marie branch of the Canadian Pacific Railway was visited. Some of the rock obtained from the vein is mar-

vellously rich in visible free gold, but it is not easy to predict what the future of these mines will be. At the date of my visit, only one shaft, which strangers were not permitted to examine, had been sunk on the deposit, apparently a bed of quartz two to three feet thick running with the stratification, or about E.N.E and W.S.W., in a vertical attitude. Fine grained diorite, and altered greenish sandstone and schists of the usual Huronian type constitute the country rock, and on the summit of a ridge of this diorite, a few hundred yards to the south, a pit about 20 feet deep had been sunk in a fragmentary ferruginous mass which shows both free gold and films of native copper, while pyrrhotite, and yellow and purple sulphurets of copper occur impregnating the diorite as they do in the Stobie, Copper Cliff and Evans mines at Sudbury. The general geological features of this region appear to correspond very closely with those observed around the Lake of the Woods where also a number of gold-bearing quartz veins have been discovered, one of which, opened during the past year about seven miles S.E. from Rat Portage, opposite Quarry Island, has afforded a large number of specimens, even richer in free gold than those from the Vermilion Mines. The vein is a somewhat ferruginous quartz traversing a dioritic or hornblende schist near its contact with the granite mass of Quarry Island, and if the material can be got in quantity the owners have here an exceptionally rich mine. It is known as the Sultana mine, but does not appear to be the same vein as that described by Mr. Coste, p. 17 K, Geological Survey Report 1882-84, as the Sultana Lead, and of which he says, "I do not think it is auriferous."

The subject of natural gas in Canada was referred to in my last summary report. Since then I have informed quite a number of enquirers that almost in any part of the Ontario peninsula, more especially south and west of the outcrop of the Trenton limestone which extends from Port Hope to Collingwood, the chances of striking natural gas and petroleum are as good as they are in Ohio. I am informed that several borings are now in progress to test the question, and steps have been taken to secure an accurate record, and samples for examination, of the strata passed through in these borings.

Cost of season's work was \$852.60.

Dr. G. M. Dawson, assisted by Mr. J. McEvoy, was occupied during the past summer in carrying out a somewhat detailed geological examination of part of the southern interior of British Columbia. This region had been subjected to a general geological reconnaissance by Dr. Dawson in 1877, and a preliminary geological map and report were published as the result of the work. Since the completion of the

Canadian Pacific Railway, however, the importance of this particular portion of British Columbia has much increased, and Mr. A. Bowman was in consequence instructed to carry on work there in 1882 and 1883. Much of his time was devoted to topographical measurement and delineation, as the physical features of the region are very complicated and in some places hold a close relation to the geological structure. A map embodying the result of Mr. Bowman's geographical work was prepared and published last winter, and is a great advance on anything previously existing for the region covered by it, which is practically identical with that of Dr. Dawson's reconnaissance map of 1877. This map was regarded as the basis for a more detailed geological map, but from the complicated geological structure which Dr. Dawson's close examination during the past summer has revealed in some parts of the district, it may perhaps eventually be found desirable to complete the geological map on a larger scale. Dr. Dawson furnishes the following outline of his work, in connection with which he left Ottawa on the 14th of June, returning on the 30th of October :—

“ On beginning the work of the past season, I thought it probable that with the information already in hand it might be possible to revise the geology of the area covered by the map of 1877 and 1887, and to re-examine the various doubtful points within the area in the course of the summer. Before field work was begun, however, I arranged to meet Mr. Bowman, and on discussing the matter with him found that more than I had supposed remained to be done, and later, as the work progressed, unexpected complications of structure presented themselves, rendering necessary a close re-examination of certain parts of the district. There were also considerable gaps in the geographical outlines and topography of the map which we were obliged to fill, and it soon became evident that it would be better to go over a portion of the region in a somewhat detailed manner than to make disconnected observations over the entire area of the sheet. The operations were, therefore, practically confined to a district having an extreme length of about 130 miles with an extreme breadth of about 70 miles, which occupies the central portion of the map sheet above referred to.

“ The geographical and topographical part of the work was chiefly performed by Mr. McEvoy.

“ The geological observations have cleared up several points previously in doubt and have resulted in the definite outlining of the principal formations in the area covered, but much yet remains to be done before the present observations can be presented in a connected and satisfactory form, in combination with the facts ascertained by Mr. Bowman, as a supplement to those of 1877. I shall, therefore, here confine my remarks to notes on certain points which appear to have an immediate economic interest.

"The discovery of coal in the vicinity of Kamloops, which occurred last winter, has attracted some attention to the coal question in this interior part of the province, and was one, among other reasons, for the present re-examination of the district. The coals found in this region occur at the base of the Tertiary formation, in beds of ordinary sedimentary origin, while the upper portion of that formation is composed of volcanic rocks, largely basalts. Unlike most Tertiary fuels, however, these were found, in some places, to assume the character of bituminous coals. This is the case with one of the seams known for many years near the junction of the Nicola and Coldwater Rivers, and also with that of the Indian Reserve on the North Thompson. These localities, with others in which lignites occur, are described in the Report of Progress for 1877-78. The coal near Kamloops is also a bituminous coal, and though the seams so far found are quite thin, the locality appears to be worthy of examination on account of its nearness to the railway. The rocks in which the coal occurs form a local extension of the Tertiary basin which is somewhat wide-spread in the vicinity of Kamloops Lake, and even should no really workable bed be found at this spot, the mere occurrence of coal here points to the probability of the existence of thicker seams elsewhere in the basin. Excellent lignite, in seams of good thickness, has lately been found near Vermilion Forks on the Similkameen, but from the isolation of this locality can at present be of local use only. The lignite reported near Quilchana on Nicola Lake is of inferior quality and scarcely suitable even for local use.

"The work of the past summer has proved that the sandstones, shales, &c., with which the coal is associated really underlie but limited portions of the whole area covered by the Tertiary rocks, and appear to have been deposited in isolated basins, a fact scarcely realized before. This renders the thorough examination, by boring or otherwise, of the localities where either coal or lignite occurs very desirable. A further study of the region near the confluence of the Nicola and Coldwater Rivers indicates that this is one of the most promising places for coal mining which has yet been discovered in the region.

"While speaking of the Tertiary formation, it may be noted that important beds of trachyte occur in a number of places among its volcanic materials, and that in one of these, a few miles to the north-west of the head of Stump Lake, opaline silica and hyalite were found to be developed in small vesicular cavities. While nothing which can be classed as precious opal was actually observed, the locality would appear to be worthy of close examination, as the matrix is identical in character with that yielding precious opal in Hungary and elsewhere.

"The working of placer gold deposits has been in progress for many

years in a number of places scattered over this region, and though no extremely rich deposits like those of Cariboo have been discovered, a large amount of gold has been obtained in the aggregate, even without including that got along the Fraser and Thompson Rivers. Tranquille River, Cherry Creek, Mission Creek and the Similkameen River have been almost or quite continuously worked since their first discovery, either by whites or Chinese, and still continue to yield remunerative quantities of gold. The discovery of Granite Creek, a tributary of the North Similkameen or Tulameen, in 1885, with the late renewal of placer mining on a considerable scale on the Tulameen itself, seems to show that paying auriferous creeks may still remain to be found even in this comparatively well known part of the country. The area of good ground on Granite Creek was found eventually to be less considerable than at first supposed, and comparatively few claims are now being worked there, but several of the streams in this vicinity have since been worked with success. Of these Boulder Creek, a small stream running into Otter River, is at present the most important.

"The most interesting feature which has been developed in connection with mining on the upper part of the Similkameen and Tulameen and their tributaries is the occurrence everywhere of platinum in association with the gold. This association is mentioned in my report of 1877, in connection with the placers of Whipsaw Creek, where, however, both the gold and platinum are found only in fine scales. On the discovery of Granite Creek it was found that with the "coarse" or "heavy" gold obtained there, platinum of a similar character was also associated. In all about 1,400 ounces of platinum was sent out from this region in 1887. The close and constant association of the platinum with the gold renders it nearly certain that both are derived from a common source, to be found in the rocks of the immediate vicinity.

"Some attention has lately been paid to the search for lodes in the vicinity of the Tulameen, and a number of locations have been taken up, but nothing except a limited amount of preparatory work has yet been done toward their development. I may state, however, that the district appears to be worthy of attention by the prospector, as it presents very favorable indications, and the rocks often show evidence of solfataric action, being highly silicified and holding much pyrites in certain belts.

A specimen of ore collected by myself at the "Bonanza Queen" location has since been found by Mr. Hoffmann to contain 1.3 ounces of gold, and 5.1 ounces of silver, to the ton of 2,000 pounds.

"A remarkable indication of the existence somewhere in the Tulameen Basin of extremely rich ores is found in the discovery in sluice-boxes

on the river, about thirteen miles above Granite Creek, of small rolled pellets of pure silver-glance strung through with filamentous gold.

"In the vicinity of Stump Lake the principal mining developments are comprised within an area about five miles in length, with a variable breadth, running nearly north and south on the east side of the lake. A large number of mining claims have been taken up in this vicinity, and numerous prospect holes and small trial shafts have been sunk. The greatest amount of work has so far been accomplished on the property of the Nicola Mining Company, under the superintendence of Mr. W. Craib, and on the adjoining property of the Star Mining Company, under Mr. G. Henderson. A considerable amount of work has also been done on the Hepburn group of claims on the opposite side of the valley and further south than those first mentioned. Operations were temporarily suspended on the last mentioned claims at the time of my visit, but some of the richest ore, of which very satisfactory trial shipments have been made, has been obtained at this place.

"The metalliferous veins which have been found within the limited district above defined are very numerous. They vary from about ten inches to five or six feet in width and some of them have been traced for a length of several hundred feet. Though it is probable from the great number of veins which exist that no single one will be found to be continuous for a very great distance, a large supply of ore is already assured. Most of the veins run with very considerable uniformity in bearings a few degrees west of true north, or from N. 10° W. to N. 30° W. magnetic. There are, however, a few which diverge widely from this direction, and two or three which run nearly at right angles to it. The gangue is generally white quartz, and the principal metalliferous minerals present include iron and copper-pyrites, galena, blende and tetrahedrite. Assays made by Mr. Hoffmann, in the laboratory of the Survey, run from 15 to 406.5 ounces of silver, with 0 to 6 ounces of gold per ton of 2,000 lbs., according to the relative amounts of the various mineral constituents. The country-rock consists of altered volcanic materials, probably of Palæozoic age, and may be generally characterized as a diabase-porphyrite, the most characteristic material in this place being a rock of green and green-grey colour with coarse porphyritic crystals of plagioclase and pyroxene.

"On the whole, the prospects for the immediate development of an important mining district are here most encouraging. The occurrence of these ores in the green, altered volcanic rocks, which, under slightly varying forms, occupy so large an area of the southern interior of British Columbia, is a feature of peculiar interest, inasmuch as it leads to the belief that these wide-spread rocks become a metalliferous series where the other conditions are favorable. What these precise condi-

tions are, beyond the existence of fissures in which the segregation of metallic minerals has occurred, we are yet unprepared to say. Massive granite rocks occur a few miles to the west of the mineral belt of Stump Lake, and while a similar rock may underlie its surface at no great depth in the mineral belt, there is nothing to indicate that the ores partake of the nature of contact deposits.

"Another metalliferous locality to which some attention has been drawn, and which was visited during the summer, is situated near the lower part of Jamieson Creek, fifteen miles up the North Thompson. Very little work has yet been done here, though a number of claims have been recorded. The veins occur in a mass of greyish granite, which breaks through certain black micaceous schists or argillites, which form an important intercalation in the Palæozoic rocks, generally of volcanic origin, of this part of the province. The granite is highly siliceous in the vicinity of the veins, and these appear to have been produced contemporaneously with the intrusion of its granite. The gangue is quartz and it shows pyrites with a little galena, blende and tetrahedrite. Assays made by Mr. Hoffmann show from $\frac{1}{16}$ to 1 ounce of gold and $2\frac{1}{2}$ to 34 ounces of silver to the ton. Little can as yet be proved respecting the continuity of the veins in this district, and the area within which claims have been recorded is comparatively small.

The surface display of quartz is, however, considerable, and this, with the rich character of the ores, would appear to warrant some expenditure of a tentative character. The widest vein seen is from five to six feet. It may further be mentioned in this connection that fragments from similar veins were seen by us near the headwaters of Jamieson Creek.

"It is here only possible to mention some of the principal localities visited without entering into detail respecting them, and space cannot be accorded even to include mention of the numerous isolated "prospects" which have, of late, been brought to light. The mines of Cayoosh Creek and those of Rock Creek, though comprised within the area of the map first referred to, were not visited though encouraging reports have been received from both, and assays of specimens yield well in gold. At Cherry Creek also, a new company has undertaken a thorough examination of the very rich silver ore found there, but of which some difficulty has been found in following the vein. Some account is given by Dr. Selwyn, in the last summary report, of the deposits of argentiferous galena in the Selkirks, particularly near Illi-cillewaet. The exploration of some of these has been quietly but persistently carried on during the past summer. Work has also been in progress on the Monarch and Cornucopia claims at Mount Stephen, and prospecting operations in a number of localities on the eastern slope of the Selkirks.

"The Toad Mountain and Kootanie Lake districts have attracted much notice during the summer, and a large number of prospectors and miners have been at work there, with most encouraging results. Though I have not myself visited these localities, it appears certain that they require only to be brought within the reach of the railway to ensure a large output of argentiferous galena, some of which is of high grade. Some trial shipments have already been made, of which one of 22 tons, from the Silver King claim, sent with considerable difficulty to Butte, Montana, realized a gross amount of \$6,463, chiefly in silver.

"Amongst other items bearing on mining enterprise in the province in general, may be mentioned the establishment, which is in progress under the government of British Columbia, of a test mill in Cariboo, and the erection of a smelter, with a capacity of 50 tons per diem, by the British Columbia Smelting Company (Limited) at Vancouver.

"Of the various enterprises on the coast it is impossible to give particulars here, though it may be noted that Mr. Dunsmuir has commenced work on the opening up of a portion of the Comox coal field, while renewed efforts were in progress with a view of making a thorough test of the anthracite of the Queen Charlotte Islands.

"Notwithstanding the great activity in placer gold mining in British Columbia in the years following its discovery in 1857, and particularly after the finding of the phenomenally rich placers in Cariboo, in 1860, the subsequent development of metalliferous mining in its more permanent forms has been slow. This circumstance has been due to several causes, which need not here be discussed, but one of the chief drawbacks has always been the want of proper means of transport for heavy machinery and for ores. It is therefore extremely gratifying to find that, as an immediate consequence of the building of the Canadian Pacific Railway, that part of the country in its vicinity is rapidly beginning to evince its character as a rich metalliferous district, and to justify the confidence which those best informed on the subject have always felt as to its ultimate great value. The general knowledge which we now have of the geology of the province as a whole, is such as to show that, when similar means of travel and transport shall be extended to what are still the more inaccessible districts, these also will prove to be equally rich in minerals, and particularly in the precious metals, gold and silver.

"It is true that we have even in the southern part of the province to chronicle as yet merely the inception of "quartz mining," but so much has (even already) become known, and the deposits discovered in many cases carry ores of such high grade, that I feel no hesitation in stating my belief that the district is now on the verge of an era of

mining activity of great importance. The establishment of mining centres in different parts of the country, will react on all other industries, and in particular will supply just that local demand for produce which is required by the somewhat scattered character of the agricultural lands.

"I must also add that in comparing the degree of settlement, cultivation and progress of the ranching industry in the portion of British Columbia here particularly referred to, with that of these industries at the time of my previous work in the same district eleven years since, evidence is everywhere apparent of substantial progress. I was particularly struck with the fact that, even in the higher and more secluded valleys, settlers are now taking up land, and finding that crops may be successfully grown and stock raised, where in the more easy-going early years of the province no one would have attempted either. With this particular fact of evidence, it is worth calling renewed attention to the circumstance that in the further northern parts of British Columbia, particularly in the basin of the Nechacco and its vicinity, there exist relatively extensive tracts of low cultivable land. It would appear that the time has now almost arrived when the settlement of these may be undertaken with advantage."

Cost of season's work was about \$1,950.

On the seaboard of British Columbia, Mr. Amos Bowman commenced field work in New Westminster District on the 1st of April, continuing to the end of August. The area delineated comprises a rectangle of a degree of latitude lying north of the 49th parallel, and three degrees of longitude lying eastward from the Gulf of Georgia to the cañon of the Fraser. In this region are situated the cities of Westminster and Vancouver. It includes the delta of the Fraser, and also the much larger pleistocene delta of that stream. A considerable expanse of lignite-bearing Tertiary, and also of bituminous coal bearing rocks of Cretaceous age, occur in this region, the two series presenting a system of outliers and ranges flanking the higher coast mountains of granite.

In May and June the limits of the Tertiary were traced, first south of the Fraser, commencing at Mud Bay (Semihamoo) and thence eastward to the Chilliwack River Mountains. The same rocks were then delineated (and incidentally others) on the north side of the Fraser, especially in the vicinity of Westminster and Vancouver.

Workable beds of lignite and coal, in the older as well as in the newer series of rocks, are believed to exist, and will be developed when prospecting for them by boring, or drifting to depths beyond atmos-

pheric influence, is undertaken. In the adjacent United States territory the same rocks have been more extensively prospected, and in several places, where exploited, show every indication of the prevalence and continuance of favorable coal making conditions along the whole eastern or mainland side of the Puget Sound and Fuca Strait, from the southern extremity of the former as far northward as the valley of the Fraser—in other words, on the Westminster side of the trough as well as on the opposing Vancouver Island side. The older or Cretaceous series of rocks are extensively developed in Canadian territory in the Harrison Lake district, and in the south-eastern portions of the field described.

The quantity of Tertiary coal or lignite, which may be developed by means of judicious boring operations in the vicinity of Westminster and Vancouver, can only be conjectured by the experience at Bellingham Bay, which furnished one of the earliest examples of profitable coal mining on the Pacific Coast; the basin there and its rocks being continuous, it may be fairly inferred that the coal seams are so also.

Although coal has been found in very many localities north of the international boundary-line in the Tertiary delta of the Fraser, in only two instances have attempts been made, by sinking or boring, to ascertain the thickness of the seams at depths where they would be uninfluenced by atmospheric weathering, and in both instances without adequate capital—at Coal Harbour (Vancouver) by a boring, and at Sumas Mountain by an incline. The results, so far as they go, are by no means discouraging.

The quality of this Tertiary coal is somewhat superior to that of Mount Diablo in California, which has there served a most useful purpose.

The conditions now existing, which justify prospecting by boring operations, and mining lignite for local use, are its cheapness, and a local market greatly extended beyond that heretofore existing; which would enable it now to successfully compete for many purposes with coal transported from Vancouver Island.

Proximity to croppings of seams known and considered to be more or less promising, so as to test these at a distance from the surface, would be the first consideration in selecting sites suitable for boring operations. Otherwise located, a bore hole might be put down very widely astray, and might succeed only in testing a theory; but thus guided the bore could not fail to test the ground in association with the seam or seams in question to the depths explored.

The thickness of the measures desirable to be tested in the same connection will of course govern the depth of the bore in any given locality. The entire series exposed in the vicinity of Burrard Inlet is

not far from 3,000 feet in thickness. But all these beds, except some unknown, possibly underlying ones, come to the surface; those exposed nearest to the Inlet being at the bottom and those nearest to Fraser River at the top of the series. A bore near Port Moody, say at the terminus of the "North Road," would test the lower series; but could reveal nothing respecting the next overlying strata, which at that place have been removed by denudation. To test these it would be necessary to go as far up the coal ravine of the "Gravel Pit" (nearly opposite the north arm of Burrard Inlet, known also as camp No. 2, and the "Italian Camp," on the railway) as it would be possible to haul the boring machinery. The same rocks would be far below the surface at Burnaby Lake, and probably several thousand feet beneath the city of Westminster.

A very short incline, shaft or tunnel, might test the ground satisfactorily in one place, while a bore of several hundred feet might suffice at another; the choice being determined by the contract price. Sinking by shaft, necessitating pumping of water, would be undertaken only after the ground has been tested, and proved to justify that expense.

Boring for water, a question of present public interest, is quite another problem, if the water be looked for in the porous gravelly or sandy strata overlying the coal, as at Westminster. In a bore there, for an artesian well, a depth of from one to two thousand feet would have to be attained before any coal yet found could enter into consideration at all, and at such depth, even if found in that vicinity, it could not be profitably worked.

Cretaceous coal measures already referred to, lie probably too deep in the littoral district under consideration to be reached by boring, except possibly in certain localities along the south shore of Burrard Inlet, where a bore would probably go through some shore edges of the Cretaceous before reaching the underlying granite; such as opposite the valleys of the North Arm and of Pitt River, both of which may represent arms of the Cretaceous sea.

Any point between the smelting works and the terminus of the "North Road," would be suitable for a bore to search for the deep lying Cretaceous coal measures in this vicinity. That of the coal croppings on Hastings town site, half a mile west of Hastings, is as favorable as any other; and presents, in addition, the inducement of connected and interesting developments in the Tertiary series.

At Sumas Mountain, and at the Warnock-Kanaka Creek Mountain, the Tertiary coal, so far as known, lies near the bottom of the series. Kanaka Creeks presents a favorable locality for test by boring in the line of the ancient valley of the Lillooet River.

Two series of coal seams come to the surface on opposite sides of the city of Vancouver. The coal measures occupy the whole of Stanley Park, and also immediately underlie the city. By means of a bore of over 400 feet put down near Granville Hotel, Vancouver, nearly twenty years ago, some lower beds of the series coming to the surface in Stanley Park have been proved to be either noncontinuous or barren. But the seams which have given Coal Harbor its name more probably escaped the investigation of the prospectors altogether, from the circumstance that the locality selected appears to have presented only strata overlying the coal. The upper coal croppings of Brewery Creek, and other localities on the south side of False Creek, do not anywhere extend to the northward of False Creek. They could be conveniently intersected by a bore on the line of the False Creek trail to Fraser River, which could be so located as to reach the coal at any desired depth below the surface.

Cost of season's exploration was \$1,216.05.

Mr. R. G. McConnell, who left Ottawa on the 22nd April, 1887, and crossed from the Yukon to the Mackenzie River, where he passed the winter, as mentioned in the summary report for 1887, returned to Ottawa on the 15th of October last, and now furnishes the following statement respecting this exploration:—

“ I separated from Dr. G. M. Dawson at the mouth of Dease River, on the 25th June, 1887, and commenced the descent of the Liard the next day, accompanied by two white men, John McLeod and Louis Trépanier, and a couple of Indians who had agreed to go as far as the Devil's Portage, but became frightened at the first rifle and could not be induced to go farther.

“ The evil reputation of this river has not been exaggerated, and it requires careful steering and hard work to navigate it with safety. It is constantly interrupted with rapids and hemmed in by narrow cañons which render frequent portages necessary. The most dangerous part of the river is included between the Little Cañon and Hell Gate. In this distance of about one hundred miles it has a fall of over a thousand feet, and in high water is simply one long cascade.

“ The two longest portages are the Portage Brulé, two miles, and the Devil's Portage, which is four miles long and passes over a steep wooded hill 1,000 feet high. At the latter portage we were obliged to abandon our wooden boat owing to its weight and the impossibility of getting it across the portage, and rig up a small sixteen feet canvas boat with which we shot the remainder of the rapids. Escaping through Hell Gate the rapids are left behind, and from that on to near its mouth the river is free from any obstacles to navigation.

"Two days after reaching smooth water I met some Hudson Bay voyageurs going to Dease River, and I took advantage of the opportunity thus afforded of sending my men back to the coast, while there was still time for them to get out the same season. After the separation I drifted down alone to Fort Liard, and obtaining there, after a short delay, a bark canoe and an Indian boatman, proceeded to Fort Simpson where I arrived on the 5th August.

"At Fort Simpson I met Mr. Cummings who had charge of the Mackenzie River district in the absence of Mr. Camsell, the chief factor, and made arrangements with him for wintering at Fort Providence, a fur trading post belonging to the Hudson Bay Company, situated on the Mackenzie River, about forty miles below Great Slave Lake. From Fort Simpson I took passage on board the Hudson Bay Company's steamer "Wrigley" to Fort Smith on Slave River, and embarking there in a bark canoe with a couple of Indians I spent the remainder of the season on Slave River, Salt River, and Hay River, and in coasting round part of the north side of Great Slave Lake, reaching Fort Providence again about the 1st October, where I was hospitably received and treated during the winter by Mr. John Reid, the officer in charge.

"Exploratory work was necessarily suspended during the greater part of the winter, but rough traverses were made at intervals to Lake Bis-tsho, Fort Rae and other places in the vicinity of Fort Providence, and while staying at the post, the work of the preceding summer was plotted, and a complete set of meteorological observations recorded.

"I left Fort Providence on the 1st of May, travelling on the ice with dogs, and reached Fort Simpson on the 6th, where I remained until the river became sufficiently free from ice to allow travelling by boat.

"The river broke up on the 13th of May, but continued full of drift ice all the month. On the 28th of May, having had a boat built at Fort Simpson in the meantime, I left that post accompanied by two Indians, and spent about a month descending and examining the valley of the Mackenzie as far as the mouth of the Peel, and in ascending the latter river to Fort McPherson. Here a delay of a few days was caused by the non-arrival at the appointed time of the Mackenzie River boat, on which I depended for some supplies. The delay was, however, utilized in making a short trip up Rat River to the mountains, and being informed that neither boats nor canoes were to be had west of the mountains, but that the one I had used on the Mackenzie might be portaged across by taking it up Rat River and down a branch of Bell River on the other side, I sent five Indians to try and take it across.

"On the 12th of July, the Mackenzie boat not having arrived, and not knowing how long it would be delayed, I decided not to lose any more time waiting for it, and started across the mountains by the summer portage, reaching Lapierre's House on the 15th. This portage is about sixty miles long, and at the summit of the range attains an elevation of 2,500 feet. The walking is difficult and wide reaches covered with *Têtes des Femmes*, alternating with soft moss-covered muskegs, are met with all the way across. It is crossed by Indians carrying a load of forty pounds, besides supplies for the trip, in four days.

"Leaving Lapierre's House on the 16th July, with an ex-employé of the Hudson's Bay Company, whom I engaged to go to the coast with me, we reached Rampart House on the 20th and Fort Yukon, at the mouth of the Porcupine, on the 24th. From this point the coast and outside communication can be reached, either by descending the river to St. Michael's, or ascending it to the head of the Lewes, nearly 1,000 miles, and crossing the coast range by the Chilkoot Pass. The former is by far the easier route, as the lower Yukon possesses a strong steady current and is free from dangerous rapids, but as it lay altogether outside of Canadian territory, I decided if possible to try and ascend the stream. To do this in a short square-sterned boat, proved, however, to be a matter of no ordinary difficulty. In many places neither tracking nor poling was possible, and progression was only attainable by clinging to the overhanging branches and pulling ourselves up foot by foot. Fortunately the men worked well and we arrived at Forty-mile Creek after a laborious trip of fifteen days. At this place, which is the head-quarters of the miners on the Yukon, I had a suitable boat built, and the ascent of the upper part of the river was made without difficulty. We left Forty-mile Creek on the 14th August, and arrived at Chilkoot Pass on the 15th September, Juneau on the 21st, and Victoria on the 1st October. The total distance travelled from the time I left the coast at Fort Wrangell until I rejoined it again at the head of Lynn Canal, was 4,200 miles, 3,200 miles by water and 1,000 miles on foot.

"The general results of the exploration have not been worked up yet, but will be given in the next report of the survey. In the meantime it may be stated that the geographical results obtained include traverses of the Liard from Dease River to the Mackenzie, of the lower part of Hay River, and of Bell River and the Porcupine from Lapierre's House to Fort Yukon, and that, over the whole route travelled, in addition to the geological work, notes were taken on soils, trees, &c., and on the general capabilities of the country with regard to agriculture.

"During the past summer from two to three hundred men were engaged in working placer deposits on the Yukon and its tributaries,

but owing to continued high water these proved much less remunerative than in the preceding years and the total yield of the district would probably not exceed \$20,000. Mining and prospecting on the Yukon has heretofore been confined entirely to river diggings, and no attention has been paid to the extensive system of quartz veins and ledges, which are found all along the river from the boundary, up to White River, a distance of 150 miles, and which afford the greatest promise for the future. In the Mackenzie River valley the petroleum bearing beds were found to have a much wider distribution than expected, and although the distance from a market prevents the utilization of these at present, they will become exceedingly valuable in the future, when the supply of oil from more accessible regions is diminished or exhausted."

The total amount paid during 1887 and 1888, on account of the exploration in the Yukon and Mackenzie districts, was \$7,714.08, of which sum Dr. Dawson paid in 1887, in connection with his own and Mr. McConnell's explorations, \$4,426.25, the balance, \$3,287.83, being Mr. McConnell's expenditure for 1887 and '88.

Mr. J. B. Tyrrell, assisted by Mr. D. B. Dowling, was engaged during the winter of 1888 in plotting and compiling the surveys of the valleys of the Assiniboine and its tributaries, and of the Duck and Riding Mountains, for the purpose of making a map of that hitherto almost unknown district. A profile map on a scale of eight miles to an inch, with 100 feet contour lines has been made, and is now in the hands of the engraver, and will be published during the present winter. It will eventually form part of a larger map of north-western Manitoba, the publication of which must now be delayed for a year on account of Mr. Tyrrell's illness during the past season.

During the season of 1887, a number of enterprising gentlemen of Manitoba sank an eight-inch bore hole on the banks of Vermilion River to a depth of 300 feet in the hope of obtaining a supply of petroleum. Mr. Tyrrell was then consulted, and they were told that they would have to bore through Cretaceous shales to at least 420 feet below the surface, below which they would in all probability shortly strike the Devonian limestones. If petroleum was to be found, as far as there was any evidence to show, it would be in the beds immediately overlying this limestone. During the past summer the bore was sunk to a depth of 743 feet, the Devonian limestone having been struck at a depth of 422 feet, two feet below the depth stated by Mr. Tyrrell. Flows of salt water are reported from the well, but no petroleum or gas.

During the summer Mr. Tyrrell was engaged in continuing the work begun in 1887 in north-western Manitoba. The shores of Lakes Manitoba, Winnipegosis and small surrounding lakes were to be examined and as much of this work as possible was accomplished. The travelling in connection with the work in the west has, up to the present, been largely accomplished with the aid of horses and carts, but this summer most of the horses having been sold, two nineteen feet Peterboro' canoes were purchased and shipped to Westbourne, where they were awaiting the party on its arrival. Mr. Tyrrell reports as follows:—

“We left Ottawa on the 7th of June and proceeded at once to Winnipeg. Here a short time was spent in obtaining necessary supplies, which were at once shipped to Westbourne, whither Mr. Dowling had gone a day or two before to have all the camping outfit got ready for the summer, and if possible to obtain men. For this latter purpose, however, it was necessary to cross the lake to St. Laurent, where two canoeemen were obtained.

“On the 13th June I left Winnipeg for Portage LaPrairie, where Mr. W. R. Baker, General Superintendent of the Manitoba and North-Western Railway, kindly ordered a railway velocipede to be placed at my disposal. Proceeding by train westward to Minnedosa, I there obtained the velocipede and a man, and thus accompanied examined all the cuttings on the railway between Minnedosa and Langenburg, and the material thrown out of the wells at and between the different stations.

“On this trip much useful information was collected, referring in the first place to the character, structure and mode of accumulation of the superficial deposits. The numerous small cuttings show that the surface is in part underlain by glacial till, in part by the sediment laid down in ancient lakes, and along the rivers, in places, by flood-plain deposits. In the next place the cuttings along the sides of the wide valleys of the little Saskatchewan, Bird Tail and Assiniboine Rivers show excellent sections of the underlying Cretaceous (Pierre) shales.

“On the banks of the latter river, near Millwood, these shales, which are of a dark blue-grey color, contain many, both large and small, nodules of limestone or calcareous ironstone. Some of these, when broken, are found to contain fossils, and from them an interesting collection of about twelve or fourteen different species was obtained.

“Returning to Minnedosa, I was requested by a number of gentlemen to go with them up the valley of the river, for a short distance, and examine a property, where a drift had been run into the side of the bank in the hope of finding coal. After making an examination of the bank, which consisted of dark grey Cretaceous shale, I was obliged to state that there was no indication of the presence of coal.

"Returning from Minnedosa to Westbourne, where Mr. Dowling was camped on the bank of White Mud River, we started in canoes down the stream to Totogan. From there we coasted along the west side of Lake Manitoba to Manitoba House, the shore being generally low throughout, and everywhere composed of alluvial sand and gravel.

"At Manitoba House we obtained another canoe, with an Indian, and proceeded to make an examination of the shores of the northern part of Lake Manitoba. Following the eastern side of the lake as far as the head of Fairford River, we descended this stream to St. Martin Lake.

"Sending Mr. Dowling with a patent floating log to make a survey of this lake, I set out on foot with some Indians, and travelled back from the lake to examine a deposit of gypsum which had been reported to exist in that locality. It was found to be a thick deposit of white, or in places crystalline and transparent gypsum, and to extend, apparently, in lenticular masses and bands, over very large areas. As this deposit is readily accessible it will be of great economic value in the near future, being destined to furnish Manitoba and the surrounding territories with land plaster and plaster of Paris, both of which must now be brought from Michigan, Iowa, Ontario, or more distant places. It can be quarried without difficulty, and can be readily removed by water; or if the proposed Hudson's Bay railway should be built on the east side of Lake Manitoba it will pass through this area and the quarries would then be within one hundred and fifty miles by rail from Winnipeg. Returning to Lake St. Martin, the shores and islands were examined, some of the latter being found to be composed of good, compact and generally coarse-grained granite (Laurertian).

"After having made the examination of Lake St. Martin we returned to Lake Manitoba, and examined its shores to Water Hen River, up which we proceeded to a trading post belonging to the Hudson's Bay Company.

"From here I sent Mr. Dowling on to Lake Winnipegosis to make a micrometer survey of its eastern and northern sides while I returned to Manitoba House by the west side of Manitoba Lake, making a survey with a patent log of the shores and islands as we passed along.

"Arriving at Manitoba House on Saturday evening, 21st July, I was much pleased to meet Mr. Whiteaves, palæontologist and one of the assistant directors of the Survey, who had arrived direct from Ottawa a few hours before. He had come out to join me for a few weeks for the purpose of studying the palæontology of the Silurian and Devonian rocks of Manitoba, as seen in the field.

"After obtaining an additional canoe, and necessary supplies for a month, we started northward together and examined all the principal

rock exposures around the lake, making a large collection of Devonian fossils, many of which are either new species or were now found for the first time in Manitoba. It had been our intention to examine some of the rocks in Lake Winnipeg, and for that purpose we started down the Fairford River on 10th August, but before we had reached Lake St. Martin, I was seized with an attack of typhoid fever and carried back to the mission at Fairford, where I was received with the greatest hospitality by the Rev. J. Bruce, the Episcopal missionary to the district. From Fairford I was removed to Manitoba House, and thence, by Westbourne, to the General Hospital at Winnipeg, which was reached on the 23rd August. Here I was obliged to remain for the rest of the season.

"Mr. Dowling, after he had left me at the Water Hen River on 18th July, proceeded up the east side of Lake Winnipegosis, surveying it with a compass and micrometer as far as Mossy Portage. Birch Island was also surveyed in passing. Close to this portage there is a meridian township line, which was run by Mr. Wm. Pearce, D.L.S., along the lake on the ice in the winter of 1880. From this line Mr. Dowling made a survey with a transit and micrometer of the north shore of the lake to the mouth of Overflowing River, where he connected with the termination of the survey made in a similar manner by Mr. J. L. Dufresne, D.L.S., in 1887.

"He next surveyed with compass and micrometer the Overflowing River for thirty-seven miles up from its mouth, the Armit or Red Deer River up to the lake, which was found to have an area of about a hundred square miles, and the river for twenty-two miles above the lake. He also connected the final point of Dufresne's survey of the Swan River with the chain survey of the higher part of that river made by Mr. Wm. Wagner, D.L.S., in 1878, on the ice. He then made a survey of the islands in Dawson Bay. Since I was unfortunately prevented from meeting him according to arrangement, he paid especial attention to the rocks met with, and made a good collection of fossils.

"He left off work on 11th October, and reached Westbourne on the 27th of the same month, where he left his canoe. After settling all outstanding accounts he returned to Ottawa.

"Twenty-seven photographs of different points of interest round Lake Manitoba were taken during the year.

"Three horses and a buckboard were sold during the year, and there yet remains with Mr. Sinclair, at Rosburn, Manitoba, one horse, with two carts and harness, and some old saddles and pack saddles. The two Peterboro' canoes taken out in the spring are still in good order and ready for another season's work.

"Cost of season's exploration \$1,923.44."

Dr. A. C. Lawson, assisted by Mr. Smith, was occupied during the early part of the year in completing his report of the southern part of the Lake of the Woods and Rainy Lake, which is now being printed and will form part of the Annual Report, Vol. III, for 1887-88. In June, on my recommendation, leave was granted to Dr. Lawson to proceed to England to attend the meeting of the International Geological Congress in London. The chief subject to be discussed at the Congress was the origin, age and character of the crystalline schists; an able paper on the subject was presented by Dr. Lawson for the consideration of the Congress, and has been printed in the report of its proceedings.

Mr. Smith continued the preparatory topographical measurements for the Hunter Island and Seine River sheet, which are in continuation of those of the Lake of the Woods and Rainy Lake, the former published with Dr. Lawson's report in 1885, and the latter now being engraved.

On this work Mr. Smith reports as follows:—

"Twelve weeks of the season were occupied in making log and compass surveys of the lakes in "Hunter's Island" and in the region north and north-east of it. As the main points of Hunter's Island had been previously fixed accurately by Mr. McAree's survey and the Minnesota township surveys, this more rapid method was deemed sufficiently accurate. The remaining four weeks of the season were employed in making a micrometer and compass survey of the Quetico Lake route from Pine Portage to the junction of the Quetico and Nameukan Rivers, tying the micrometer survey of last year, and in connecting this latter survey, at the most northerly point of Hunter's Island, with Pine Portage. Besides this, supplementary log surveys and time traverses were made in the adjacent country.

"The work involved in all about 140 miles of micrometer and compass lines, 500 miles of log and compass lines, and 60 miles of time traverses, and from points thus fixed, intermediate points and islands were determined by compass triangulation.

"The region covered extends from the provincial boundary line between the districts of Thunder Bay and Rainy River westward about 65 miles, and from the United States boundary northward about 40 miles, covering an area of about 2,600 square miles. This, with previous reliable surveys, completes the topography of the country included in the Hunter's Island sheet, and about one-fourth of that of the Seine River sheet to the north.

"This region, like all the Archæan countries of central Canada, appears rugged and hummocky, but few hills were observed over 200 feet in height above the lakes which they enclose, and soundings of the latter barely exceeded 80 feet. The numerous lakes form the most

important hydrographic feature of the country, the connecting rivers being short and broken by frequent falls or rapids.

"A very large proportion of the country has been swept by fire and few valuable timber areas are seen from the lake shores. Good farming land is of exceptional occurrence, the occasional and limited areas of drift being usually of a sandy and gravelly character.

"Nearly the whole of Hunter's Island is occupied by Laurentian gneiss and granites, with the exception of a narrow band of mica schists along the north side.

"There is also a broad band of schistose or slaty and trappean rocks containing beds of iron ore, crossing the south-eastern extremity of the island in a north-easterly direction. Dr. Lawson has not yet closely examined this band. Many mining locations have been taken up here within the last eighteen months, but no work has been done further than cutting out portages to facilitate the transport of exploratory machinery.

"To the north of Hunter's Island the gneisses are associated with mica schists, probably an eastward extension of the Couchiching series of rocks so largely developed on Rainy Lake.

"Many of the pegmatite veins cutting the gneiss contain large crystals of beautiful white mica, which in some places may possibly be developed, of sufficient size to be of economic value."

* Cost of season's work of Messrs. Lawson and Smith, \$1,065.48.

Dr. R. Bell, assisted by Mr. A. E. Barlow, continued the investigation and survey commenced the previous summer (1886) between the Montreal River and the northern shores of Lake Huron, with a view to further elucidate the geological structure of the Huronian system as developed in that region, especially in connection with the copper, nickel, argentiferous galena, iron ores, gold-bearing quartz veins and other economic minerals which characterize this system, and which apparently occur at intervals in all parts of its distribution.

Dr. Bell furnishes the following summary of the work accomplished:—"I left Ottawa for the field on the 17th of July and made Sudbury, at the junction of the main line of the Canadian Pacific Railway and the Sault Ste. Marie branch, my head-quarters for the summer. Mr. Barlow and party consisting of one assistant and three canoe-men were employed most of the season in making topographical and geological surveys of a number of the lakes around Temagami Lake (which had been carefully surveyed the year before) including Cross Lake on the Temagami River. In the autumn Mr. Barlow made some geological examinations in the Township of Broder and around Lake Panache,

principally with a view to the more exact determination of the boundary between the Huronian and Laurentian systems in that direction.

"The country immediately around Sudbury, which is important on account of the gold, nickel and copper deposits now being developed there, was first examined. Then the main line of the railway was followed on foot from Mark Stay to Straight Lake; and the Sault Ste. Marie branch from Sudbury to Mississagi River, with side explorations in the township of Denison and around Algoma Mills. Onaping Lake and River, and Vermilion Lake and a part of the river of the same name were also examined.

"In 1854-56, the late Mr. Alexander Murray surveyed Wahnapi-tæping Lake and the Wahnapi-tæ River below it, as well as a chain of lakes between the former and Sturgeon River. The shores of these waters were further examined geologically by myself during the past summer. Two traverses were also made between the above lake and Vermilion River, and a track survey of about twenty miles of Wahnapi-tæ River, above the lake. The section of the Sturgeon River, above the part surveyed by Mr. Murray, and below the point at which I struck it in 1875, was likewise examined geologically, so that the rocks of the whole of this stream, from its source to its mouth, are now known. I next made an exploration of the southern half of Obabika Lake and part of the surrounding country, Mr. Barlow having surveyed the northern part of this sheet of water during the present season.

"A number of points requiring further investigation in connection with the geology of Temagami Lake were next attended to, and I then proceeded to Lady Evelyn Lake, which stretches the greater part of the distance between Temagami Lake and Montreal River. The track survey which I had made of this sheet of water the previous year was improved in detail, and additional facts were ascertained in regard to its geology. About seven miles west of Wendabin's house, on this lake, a mountain rises to a height of upwards of 1,100 feet above its level, and afforded some good points of view for making a rough triangulation of the region to the west of it, which has hitherto been a blank on all maps. A track survey was also made of a river from the southwest, which enters Wendabin's Bay, and of two routes between it and Nonwakaming Lake, which lies between the northern outlet of Lake Temagami and Lady Evelyn Lake.

"The work above described will enable us to complete for publication the sheet which was compiled last winter, on a scale of two miles to one inch, measuring 30 by 34 inches, and embracing Lakes Temisaming and Temagami and a part of the Montreal River; and also one of the regular sheets, 18 by 12 inches, on the scale of four miles to one inch, belonging to the range of sheets next north of that which includes

Grand Manitoulin Island. This sheet embraces the country around Sudbury. Most of it has been surveyed into townships, and the greater number of these are now sub-divided into lots and concessions. The area which it represents is continuous with that shown on the Temagami and Temiscaming sheet.

"Geologically, these areas are occupied mostly by Huronian rocks. Whenever the boundary between the Huronian and the general Laurentian region traverses these sheets, it has been defined with sufficient accuracy. Within the outside boundaries of the Huronian, there are several detached areas of gneiss, apparently Laurentian, the limits of which were ascertained. One of these is in the townships of Denison and Creighton, and another in Snider and McKim. A gneiss area on the western side of Lake Wahnapietaping appears to be isolated as does also one on the south-west side of Lake Anima-nipissing, to the north-east of the main body of Lake Temagami. The two belts of gneiss which cross the Montreal River below the great Bend, may be connected with those to the north-east, discovered by the late Mr. McOuat, on the Blanche, but to the southward they are surrounded by Huronian strata.

"In addition to the large amount of data which was secured regarding the structure and distribution of the Huronian rocks, it is believed that the labors of the past season will throw considerable additional light on the nature and origin of these strata and the alterations which they have undergone. A large number of specimens were collected for study in the office, which, it is hoped, will develop many points of lithological interest.

"The modes of occurrence and the geological relations of the economic minerals of the districts examined were carefully studied. The metals which give most promise at present are the copper and nickel deposits which have been worked for the last three years near Sudbury.

"Early last spring the Government of Ontario having resolved to appoint a Royal Commission 'to enquire into the mineral resources of the province and the best means for their development,' did me the honor to request that I should act upon the commission, and with the approval of the Acting Minister of the Interior and of the Director of the Survey I accepted.

"Much of the data required by the Commission had already been ascertained by the Geological Survey, and my appointment resulted in greatly facilitating the enquiries of this commission, by enabling it readily to utilize whatever might be required of the vast amount of knowledge respecting the geology and the mineral resources of Ontario, acquired by the Survey during the past forty-five years, and embodied

in the Geological Survey reports and maps, which have been published during that period, and with which I was thoroughly acquainted.

"I accompanied the other commissioners only when they were in the vicinity of the district in which my work lay, except about 13 days at the close of the season. Altogether about 50 days were occupied at intervals between July and November, in the work of the Commission."

Cost of season's exploration, \$1,485.00.

Mr. A. S. Cochrane's work during the summer was in continuation of that of preceding seasons, the object being to obtain the data necessary for showing the geography of the western peninsula of Ontario, as accurately as possible, on the maps which are being prepared on the scale of four miles to one inch, to illustrate the geology of that part of the country. Respecting this work, Mr. Cochrane reports as follows:—

"I went over the ground carefully and marked in the hill features, rock exposures, positions of streams, and the natural features generally. The distances between side lines and concessions, the crossings of roads and railways, &c., were all checked by odometer measurements. The railway plans on large scales (200 and 400 feet to the inch) had all been reduced in the office during the winter, and with these on hand on the ground, I was enabled to locate all other features along them with accuracy on the map. The levels of all points which could be easily identified on the ground and fixed on the map, such as intersections of concessions and side lines, or of these with railway lines, &c., were determined by the aneroid barometer. I had with me copies of the official plans of the original Government surveys of all the townships, and it was interesting to note the changes which have been brought about by the clearing away of the primæval forests; for example, the old plans show a large amount of swamp lands in every township. Nearly the whole of these have now disappeared, and the lands which they occupied are the most fertile in the country.

"The work of the present season was confined to the area covered by the remainder of sheet 115 (of the general scheme) which had not been finished last year, and embraced part of the township of Osprey, the whole of the townships of Artemisia, Glenelg, Euphrasia and Holland and half of that of Sullivan. This completes the field work for the above sheet, and all the material is now on hand for compiling it for the engraver.

"The cost of the season's field work was \$380."

Mr. A. P. Low left Ottawa in May to continue the surveys and exploration of the eastern coasts, islands and rivers of Hudson Bay, on

which work he has now been occupied for several seasons, and though no important facts relating to the geology of this vast unexplored region have yet been elicited, considerable additions have been made to our previous knowledge of its geography and general physical character. There still remain, however, areas as large as the provinces of Ontario and Quebec, of which nothing is yet known, though there is reason to believe that, in some of these, further exploration would probably result in the discovery of valuable mineral resources and much interesting geological and geographical information.

On the work of the past summer Mr. Low reports as follows:—

“I left Ottawa on the 29th of May and proceeded by the Missinabie River to Moose Factory.”

“Here the boat used the previous year was stored; in it the party sailed across the foot of James Bay, and along the east coast to Fort George at the mouth of the Big River, arriving there on the 28th of June.

“Much delay was occasioned *en route* by the large quantities of ice in the bay, which, driven by the prevailing north-west winds, at times completely blocked the way.

“From Fort George the boat was sent along the coast to meet us again at Great Whale River, and the party turned inland to make a track survey up the Big River.

“This stream was followed for forty miles with but one short portage past a small chute, twenty miles from the mouth; beyond this, the river becomes very rough and flows between such steep, rocky banks that it is impossible to portage canoes past the obstructions; a portage route to the South Branch of the Bishop Roggan River was therefore followed through several of the many small lakes which occupy one-half the area of this part of the country.

“The branch was ascended to its head, and crossing the height of land, a small stream flowing into the Big River was descended to the main stream in a large lake forming a part of the main river, one hundred miles above where we had left it.

“Again, passing up stream, still greatly broken by falls and rapids, it was finally left by a north branch sixty miles above the lake. The river here is about three hundred yards wide with a current of three miles an hour; beyond this the guide said no portages occurred for a great distance, the river flowing smoothly along the surface of the interior plateau without a distinct valley.

“Following the branch through several small lakes, a short portage was made to the headwaters of the North Branch of the Bishop Roggan River. Having passed through more lakes drained by this stream, a crossing to the South Branch of the Great Whale River was effected.

descending this river the coast was again reached after a rough trip of about three hundred and fifty miles, including eighty-four portages.

"The country along the route is an exceedingly rough plateau, having an elevation of about twelve hundred feet above the sea, swampy throughout; many low, rocky hills rising above the general level, everywhere strewn with innumerable boulders, afford evidence of great ice action.

"The whole is covered with a small growth of black spruce and tamarac, while burnt portions generally support a small second growth of aspen, poplar and banksian pine, the latter becoming rare along the Whale River. On the bottom of the Big River valley were seen a few white spruce, balsam poplar and balsam spruce, of small size, seldom or never exceeding twelve inches in diameter three feet from the ground. The rock throughout is Laurentian gneiss, a pink hornblende variety predominating.

"Arriving at the mouth of Great Whale River, on the 26th of July, the party continued its course northward in the boat to Richmond Gulf; from the east bay of which a micrometer survey was commenced, starting with a portage of two miles past a fall of two hundred and sixty feet on a small river falling into the bay.

"This stream was followed sixteen miles, and then another portage made five hundred feet from the river valley up the surrounding hills to the plateau, and a direct route was taken through small lakes for fourteen miles to Clearwater River, which was ascended to Clearwater Lake, a total distance of sixty-three miles from Richmond Gulf. The country and rocks were found to be similar to those above described, the only trees being small, stunted black spruce and tamarac growing in clumps in sheltered parts of the valleys; everywhere else the vegetation consisted of arctic mosses, low shrubs and flowering plants, the whole having a very desolate appearance.

"Owing to the cold and wet season coming on, it was decided to proceed no farther, so the return trip was commenced on the 13th of August, and Ottawa was reached by Moose Factory and Mississauga on the 4th of October.

"Total cost of exploration, \$2,034.38."

Mr. E. D. Ingall was engaged during the summer in prosecuting the investigations and surveys, commenced in 1887, but then brought to a close by an accident as stated in my last summary report, for the preparation of a monograph of the phosphate deposits. Ottawa county, P. Q., was selected as the district in which the circumstances affecting the origin, mode of occurrence, and distribution of these deposits might best be studied.

Regarding the lines upon which Mr. Ingall is conducting the work, he says:—

“The Du Lièvre phosphate district has been chosen as the one in which to study the phenomena presented by these deposits, because the greatest number of mines are in active operation there, within reasonably easy reach of each other, and therefore it is there that the features brought out from time to time by their underground development can best be observed, so that not only can the surface features be studied, but the behavior in depth of the deposits can also be followed.

“The questions, also, relating to the rock formations associated with these deposits, are of great importance, and will necessarily receive attention, and an attempt will be made to work out their nature and relationships to the deposits and to each other, as well as their distribution, and thus aid further discovery. As all these points, relating both to the deposits and their associated rocks, will require very detailed and careful study to obtain the results aimed at, it has been decided to concentrate attention on a comparatively small area, comprising about 210 square miles of country, which has been so chosen as to include all the chief mines of this district.

“The elucidation of the nature and origin of these deposits, as a guide, where and how to seek for them, is of course the chief aim of such an investigation, and as this subject has already received considerable attention by many, both amongst and outside of the officers of our Survey, it is felt that only by such detailed and careful investigation can our knowledge on these points be advanced beyond the point at which previous observers have left it. It is also evident that the value of opinions and predictions as to the probable lasting qualities of these deposits, and other things of more immediate practical bearing on the future of the phosphate mining industry, must depend upon the extent to which we understand the true nature of the deposits, and it is therefore hoped that a thorough and careful investigation may advance us, at all events a few steps, towards this desirable goal; and also that when the monograph is completed, it may be found to provide in a compact form a large amount of information, which will prove not only useful to the general public, but also render available for intending investors, mining engineers, &c., such information respecting the general features of the deposits, &c., of the district, as shall materially assist them, in forming opinions as to the value of individual deposits upon which they may be called to pass judgment.

“One of the points which has been especially kept in view in the investigation is: Whether the mode of occurrence of the phosphate is such as to render the view probable, which has been advanced by many, and has tended to check enterprise, that the deposits are confined to

surface; or whether further investigation proving them to occur, either as portions of intrusive rock masses, or in connection with such, would not rather suggest a persistency in depth for which they have not been given credit by many.

"Again, the question arises as to whether all the deposits are necessarily similar in their nature, and whether some may not be filling fissures, whilst others are more of the nature above referred to.

"On these and many other matters connected with the occurrence of phosphate deposits, a certain amount of evidence has already been collected, but, in view of the number of very contradictory theories already advanced at various times, it is felt that it would be wiser to reserve any expression of opinion until the further study it is proposed to make shall give a sufficiently broad basis of fact upon which reliable conclusions may be founded, rather than to venture any premature suggestions or theories which would only be adding to the already too large stock of ill-based speculations on this subject."

In carrying on this work, Mr. Ingall has been assisted by Mr. James White, whose time has been taken up in conducting the topographical measurements necessary for the construction of a map of the area under study, on such a scale, that the details of the distribution and association of the different rocks may be delineated thereon.

Of the 210 square miles comprised, as stated, within the limits of this map, the lakes, rivers, roads, &c., over some 125 square miles have already been surveyed, leaving about 85 square miles to be done next season, when it is hoped to complete the work. These surveys have been plotted on a scale of 40 chains to the inch, and it is proposed to publish plans of special areas immediately surrounding the chief mines, on a scale of 200 feet to an inch, which will form the basis of special studies around these points. With a view to get a general idea of the geological features of the district under study, all the roads in the area, upwards of 200 miles, were travelled over and the outcrops examined. The rest of the season was taken up in commencing the special studies of the phenomena presented by the chief mining experiments, and in visiting the various mines from time to time to ascertain whether any new features had been brought out during their development. It will not be advisable to attempt to give a detailed report on the district till after another season's investigation has been completed.

Cost of season's exploration, \$1,289.78.

For about two months and a half during the past summer, Mr. F. Adams continued explorations in the counties of Joliette, Berthier, Maskinongé and St. Maurice, in the province of Quebec, with a view to securing additional data for the north-west sheet of the Eastern Town-

ships map. The south-east sheet of this map was completed and published last year, and the north-east sheet is now surveyed and will be ready for publication in the spring: each of these sheets covers an area of 4500 square miles, represented on scale of 4 miles to one inch, or natural scale of $\frac{1}{250,000}$. This season Mr. Adams examined an area of about 1,500 square miles, embracing a part of the Mattawin River and its tributaries, the headwaters of the River du Loup and such portions of the country to the south of these as had not already been examined. On this work Mr. Adams reports as follows:—

“All the northern portion of this district consists of Laurentian gneiss interstratified in places with thin bands of crystalline limestone. On the Cypress River, River du Milieu and on the Mattawin, to the west of the Ile de France, these gneisses dip at rather high angles to the west or south, but to the east of the Ile de France and on the headwaters of the River du Loup, they are flat or nearly so.

“In the southern portion of this district, especially in the township of Brandon, there are many intercalations of various varieties of anorthosite in the gneisses, which latter dip at rather low angles either to the east or west. All the areas of anorthosite now known to occur in the district have been examined, and mapped, and have proved to be either eruptive masses cutting through the gneisses, or masses interstratified with the latter, but probably still of eruptive origin. In the north-east corner of the district is a large mass of very coarse-grained basic red granite, which has already been mapped by Mr. McConnell. All localities where minerals of economic importance were known to occur, especially mica deposits, were visited and examined. Several supposed occurrences of gold were also examined and specimens collected, which have not as yet been assayed. One of these veins, near St. Alphonse, which was worked several years ago and abandoned, has recently been re-opened, and is now being worked to a considerable extent. The rock consists of a band or vein of crystalline limestone about 3 feet wide, flanked on either side by quartzose grey gneiss. The latter has been assayed in Chicago and is said to be rich in gold. Samples were taken for assay. A report on the district is now being written.

“I returned from the field on 5th November.

“Cost of season's exploration, \$378.79.”

Dr. R. Ells, assisted by Mr. N. J. Giroux, has, during the past summer, continued and extended the re-examination of the complicated geological structure in the valley of the St. Lawrence; on the south side, from Point aux Plateau, about 40 miles above Quebec, to River du Loup, and on the north side, from the mouth of Jacques Cartier

River to the vicinity of Cape Tourmente, including also Orleans and Crane islands and the other islands in the river between these. Several hundred miles of roads in the country on the south side were surveyed, and sections were made on the Etchemin and Bécancour rivers of 30 miles each. The report of this work, giving in detail the facts observed and the conclusions arrived at, will be prepared to accompany the north-east $\frac{1}{2}$ of the Eastern Townships map, when the measurements have been plotted, the observations studied, and the numerous fossils collected have been examined. The result will be to very greatly modify the geological mapping of a large part of this region, especially that of the south shore below Quebec, as published in the Report of the Geological Survey, 1869. It has now become more than ever plain that the Lauzon and Sillery slates and sandstones are not above but below, and older than the Levis formation; and that no such divisions as are indicated on the map accompanying the report referred to can be recognized on the south shore below Quebec.

The gold districts of the Chaudière and the asbestos mines of Thetford, Coleraine, &c., were also visited, for the purpose of noting the development during the year, and ascertaining the yield from the different mines. On this subject Dr. Ellis has furnished the following report, which, as being of more immediate interest and practical importance, is given in full:—

“The principal mining industries in the area examined by us are gold and asbestos. The former has been prosecuted more vigorously than in the previous year, four companies operating in the Chaudière district, viz., The Horace Sewell Co. on the DesPlantes, McArthur and Coupal at St. Francis, Capt. Richards on the Cumberland, and St. Onge Bros. on the Famine. All of these are supposed to be working in old river channels. The DesPlantes works consist of a shaft 30 feet deep, about 60 feet east of the stream and half a mile north of the bridge, near the mouth, at which spot a bed of well washed river gravel was struck, cemented by clay and resting upon altered slates and sandstone with diorites; coarse gold in good paying quantity is taken from this spot, though the high water in the river during the autumn interfered seriously with the work. At the time of my visit, but four men besides the foreman, Mr. Fenton, were employed. The bed of the DesPlantes at one time yielded a large amount of coarse gold.

“The most extensive workings in the district are now carried on at the Ruisseau Meul, a branch of the Millbrook, near St. Francis Village. A tunnel has been driven into the hill to a distance of 600 feet, in an old channel which at 400 feet was 30 feet below the adjoining bed of the brook, from which it was separated by slate reefs. The gravel of the old channel has yielded considerable coarse gold, nuggets from \$5

to \$15 value having been taken out during the past season. Drifting near the upper end of the tunnel is now being carried on, but much difficulty is experienced from quicksand. Neither here nor at the Des Plantes are there any appliances suitable for saving fine gold, and some changes in this respect will be necessary before satisfactory results will be obtained. From twelve to fourteen men were employed during the past season.

"Captain Richard's work on the Cumberland is yet largely exploratory, and no returns of gold taken out are to hand. Difficulty from quicksand is experienced here also in sinking shafts. No mining has been done on the Gilbert year, but on the Famine the St. Onge Bros. have driven in the east bank, about a mile above the road across the mouth, for several hundred feet in what they claim to be an old channel of that stream, and gold has been taken out in small quantity. The old workings on Slate Creek have been abandoned.

"The asbestos industry of Thetford and Coleraine continues to rapidly increase in importance. The formation of the new Bell Company of London during the past season, by which detached areas have been brought under one management, and the wonderful advance in the stock has incited fresh explorations, and several new openings have been started. Prospecting has been active during the past season, not only in Thetford and Coleraine, but in the great serpentine area of Wolfestown, and good indications of asbestos have been found at several new points. But the largest quantity and the best quality of fibre continues to be derived from the Thetford mines, though the very bad season of 1888 has reduced the output very seriously. The asbestos at these mines differ very materially from the greater part of that obtained at other points, both in Broughton on the one hand, and in Coleraine on the other. That from Coleraine and Wolfe is to a certain extent affected by a harshness and stiffness which pertains to a very considerable portion of the output, rendering the percentage of *firsts* much less than at Thetford. The fibre is also for the most part shorter, and much of it, especially near the surface, is discolored, probably from the percolation of surface waters charged with iron.

"Although large areas of serpentine exist at various points in the townships above named, a great part of them are, in so far as explorations have extended, apparently devoid of profitable veins of good asbestos; in some, short fibred veins of harsh and brittle mineral are found, but these have as yet no economic value, so that the really valuable areas are not very numerous. During the past season all the old mines were carefully examined as well as the new openings being made during the year. Among these last may be mentioned the Megantic Mine, one mile and a half from Coleraine station, first prospected in

1886, but now worked by Fenwick & Slater, of Montreal. A peculiarity of this mine, not noticed elsewhere so far, is the occurrence of considerable quantities of mica in veins with impure asbestos. The rock here is very much shattered near the surface, and the fibre is consequently discolored. Veins up to one inch and a half are found, and in the more solid portions the quality improves. The output from this place has been necessarily small, owing to the time spent in opening the mine, and the delays from bad weather; the quantity mined in four months to October 1st, being 39 tons, of which one-third may be classed as *seconds*, the rest as *thirds*. An average number of twelve men was employed.

"Near Black Lake several openings have been made along the track of the Quebec Central Railway, by Messrs. Johnston & Lomas. Only three to four men were employed, and the work was of a preparatory nature. The quantity of asbestos obtained was not stated. On lot 32, range B, Coleraine, work has been begun by Capt. Williams. At my visit in October, the average number of men employed was 15, and the output to date 29 tons, of which 4½ tons were *firsts*, the rest about equally divided between *seconds* and *thirds*.

"In this district also the Bell Company began operations on the north half of lot 28, same range, formerly the Hayden property. Very good surface indications are here visible, many small veins showing, while in the cut now going in towards the base of the hill, fibre an inch and a half to two inches long of good quality is found. The south half of these lots 28 and 27, belonging to Dr. Reid, has lately been sold to the Wertheims of Frankfort, Germany, who are putting in machinery preparatory to developing the mine. This property is the most elevated of any in the district, being not far from 600 feet above Black Lake Station. The surface indications are here very favorable, veins up to two inches and a half having been found. Prior to the sale about twelve tons were taken from this place, of which two tons were *firsts*, four *seconds*, and six *thirds*. It is now being worked by contract at \$25 per ton, ready for the market. On the north side of the Poudrier Road, in lots 27, 22, 29, range A, Coleraine, several openings have been made and good indications have been obtained. At the time of my last visit, veins of asbestos up to an inch and a half were seen with a number of smaller ones. On lot 26, also, an opening in the surface of the hill disclosed small veins. These areas are separated from those of Black Lake proper by masses of white granulite and dioritic rock, a belt of which, closely associated with the serpentine, extends from the shores of Black Lake to the rear of the Thetford mines.

"In the township of Ireland, on the west side of the great serpentine area, which extends north-east from Wolfestown, King Bros. have

started two openings on lot 24, 25, range III. The elevation of these by aneroid is about 500 feet above the surface of Black Lake, which is 200 feet below Thetford station on the Quebec Central Railway. The asbestos here is found principally in two knolls about one-fourth of a mile apart, and occurs at times in a series of thin veins from one-eighth of an inch upward, as many as twenty being sometimes found in a space of six inches. Many of these veins show a selvage of whitish weathering serpentine on either side, separated by a thin vein of asbestos from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch thick. Other veins of greater size are numerous, ranging in thickness to $1\frac{3}{4}$ inches; the aspect of the rock and the veins at this place strongly resemble in many respects those on the Belmina property in Wolfestown. The surface indications in so far as visible are excellent, but the mine has not been thoroughly opened, only two months work with a small force having been spent on it.

“ At Thetford, new openings have been made to the west of the Quebec Central Railway by Messrs. Ward Bros., by Mr. Johnston and by King Bros. These prove to a certain extent the serpentine area between the present workings and the Thetford River, and good indications of productive ground are found at all the locations, though the lower lying level of the ground may necessitate drainage works.

“ On lot 28, range VI, Thetford, good indications are found, as also on lot 32, R. C. Coleman, but no work has been done on either of these during the past year. Further north, on lots 16, 17 and 18, in range IV, Thetford, a belt of serpentine occurs which has been opened by Dr. Reid, who reports some very good veins of asbestos. Chromic iron, also, is found in this area, but the samples seen by us seemed too poor in chrome to reach the required standard. Noses of serpentine also occur on lot 13 range V, and on range XI, Broughton, from which asbestos has been reported, but, in so far as yet learned not in such quantity as to be economically valuable. The Broughton mine was also worked during the past season; the vein, of which there appears to be only one, in places reaches a thickness of 3 inches; at others it is split up into a number of thin strings of no value. The returns from this mine, have not been received.

“ The established mines in all the districts have been working during the past year, though the output has been greatly lessened by the very bad weather, especially during the autumn months. An attempt to obtain the output from each mine has been made, but has been only partially successful, several of the managers neglecting to forward the requisite information in time. Of the Thetford Mines, the output of the Bell Company mine, formerly the Boston Company, still far exceeds the others. The shipments for the season to 1st December being

1,350 tons, of which 930 tons were *firsts*, 105 tons *seconds*, and the rest waste or *thirds*. The quality of the asbestos from all the mines of this district is excellent, and the prices obtained are even higher than quoted in the report of 1886; *seconds* in some cases commanding \$75 per ton and *firsts* from \$80 to \$110. The output from King Bros.' mine for 1888 was *firsts*, 170 tons; *seconds*, 165 tons; *thirds*, 245 tons. Average number of men employed, 32; boys, 20. The returns from the other properties are not yet in, but there has been great activity in them all, and the output has been correspondingly large. Rock drills worked by compressed air have recently been introduced at the Bell mine.

"In the Black Lake district the principal mines in operation are the Scottish-Canadian, the Anglo-Canadian and the D'Auville. Mr. Penhale, the manager of the Scottish-Canadian, states that in the eight months ending 10th November, 400 tons were shipped from that mine, of which 40 tons were *firsts*, 110 tons *seconds*, and 250 tons *thirds*, but operations were hindered by scarcity of men and bad weather, so that the new workings could not be carried on. This mine is equipped with improved machinery, air compressor, rock drills, hoisting engines and dumping skips, with a new set of appliances for crushing the rock and separating the asbestos, more particularly in regard to the lower grades, to avoid the great expense of cobbing by hand. This machine was in operation but a short time, but is claimed by the manager to be a great success. Should this be the case, and the asbestos of short fibre be easily separated, it will largely enhance the profits of the industry, since many of the dumps, most of which now cover very valuable ground, can be profitably worked over and the refuse disposed of for ballasting or other purposes, while, under the present system of hand-cobbing, the shorter veins do not warrant the expense necessary for their separation. The Anglo-Canadian mine for the six months ending 15th November produced, according to Mr. Hopper, about 210 tons, the average number of hands, including cobbers, being 30 to 35. The principal pit at the mine has been sunk to a considerable depth, and Mr. Hopper reports veins at the bottom of very superior asbestos, resembling that from Thetford, from 3 to 7 inches thick. These veins have been uncovered since my visit. The percentage of *firsts* from this mine has, according to the manager, increased from 10 to nearly 20 per cent. Openings in the face of the knoll to the west of the principal pit are now being worked, the indications here being very good. The output of the Fréchette or D'Auville mine, which lies between the two just mentioned, is given by Mr. Hopper for the season to 1st December as about 300 tons.

"The cause of the difference in quality between a great part of the

output from the Black Lake mines and those of Thetford has long been a source of enquiry to the mine owners of those places. By some it is supposed to be due to the difference in level between the two places, the works of the Scottish-Canadian Company being from 250 to 300 feet higher than those of Thetford. Yet this can hardly be taken as satisfactory, since at the Reid mine, 300 feet higher, some excellent fibre is found. A more likely reason may possibly be the driving off of the contained water in the fibre, since asbestos is a hydrous silicate of magnesia, by the action of diorites or the metamorphism proceeding from the presence of the granites, which occupy a considerable area in the Black Lake district. If the soft silky fibre is heated it changes its character at once and becomes harsh and brittle. The serpentine near the contact with the granitic veins or masses is often very considerably shattered, as though the presence of the granite had exercised a marked influence on its condition. At Thetford the granite masses in the mines are limited to small and thin dyke-like veins, which have not produced any great effect upon the asbestos. It must, however, be said that the stiff-fibred mineral is not in all cases confined to the vicinity of visible granitic masses, and other causes may in such cases have produced a similar effect.

"A map of the asbestos region has been compiled from crown lands plans and our own surveys, using the survey of the Quebec Central Railway which has been furnished us from the Department of Public Works, Quebec, as a base line. All the mines have been indicated on it, both the old and the new openings, and it is hoped it will be of use to those interested in the asbestos mining industry. It is proposed to publish it with the detailed report on the district.

"The season's work extended from 31st of May to 29th of October.

"Amount expended, \$1,100.

"My assistant throughout was Mr. N. J. Giroux, C. E., P. L. S.

Professor J. W. Bailey, with Mr. McInnes, continued the survey and exploration in northern New Brunswick, and now furnishes the following statement respecting this work, from which it will be seen that only two $\frac{1}{4}$ sheet maps now remain to complete the general geological map of New Brunswick, the whole of which has been published on a uniform scale of four miles to one inch in consecutive $\frac{1}{4}$ sheets:—

"One main object of the several explorations was the obtaining of the necessary data for the completion of sheets 17 N.E. and 18 S.E. of the New Brunswick series of maps, being the last two illustrative of the geology of that province. Particulars of this work, which was chiefly carried on by Mr. McInnes, are given below.

" My own attention was more especially directed towards completing the observations, referred to in former reports, regarding the order of succession, equivalence and similar features, of the Silurian system as developed in northern New Brunswick, Quebec and Maine. With this object in view, and that the means might be had, of more directly comparing the Silurian rocks above the headwaters of the St. John River with those of the Gaspé Peninsula, the section afforded by the Metapedia Lake and River was first examined and further collections of fossils made.

" Attempts were then made to explore the somewhat prominent range of hills, forming a portion of the Notre Dame Mountains, which lie a few miles to the westward of Lake Metapedia, and which, from their altitude and comparative boldness of outline, had been regarded as probably containing Pre-Silurian strata, but these, as well as subsequent explorations by Mr. McInnes, failed to afford any evidence of the existence here of other than Silurian rocks.

" It was then proposed to make a revision of the section afforded by the Patapedia and Grand Metis Rivers (see *Geology of Canada*, p. 416) but the want of water when we were at work in this section prevented this being done. An exploration was, however, made of the Misgouegish, one of the chief tributaries of the Grand Metis, to within a mile or so of its source, and information was thus obtained regarding an extensive district of which but little was previously known. From the Grand Metis the northern edge of the Silurian plateau was carefully traced around, by way of Mount Commis and the Neigette River to Bois Brulé Mountain and St. Blandine near Rimouski. At several points, and especially at the last named, large and important collections of fossils were secured.

" The examination of the country lying between the Rimouski and Lake Temiscouata was then undertaken by Mr. McInnes, and my attention was next directed, in company with that gentleman, to the examination of the admirable section of the so-called Quebec group between Lake Temiscouata and Rivière du Loup, afforded by the newly made cuttings of the Temiscouata Railway. These were found to be largely through the rocks of the Sillery formation, alternating in a succession of folds with bright red and green slates, but we failed to find any fossils, though they were carefully searched for.

" Other work undertaken consisted of the exploration of the country bordering and lying between Pohenogamook Lake and Cabano Lake, of that lying between the eastern and western branches of Fish River, in northern Maine; the ascent of the Aroostook River to the Oxbow Plantations, and the examination of the country in the vicinity of Presqu'île. A visit was also made to the locality north of Frederic-

ton, in which obscure fossils had been found in rocks not previously known to contain organic remains.

"The results of these explorations will be given in detail in the report now in course of preparation.

"In addition to the work above described, the following surveys were made during the season by Mr. McInnes.

"Early in July a micrometer and paced survey was carried across the height of land south of the St. Lawrence, by way of the Quatawamkedgwick and Rimouski rivers. These two streams head quite close together; lakes at the sources of their right and left hand branches respectively are separated only by a low ridge, crossed by a portage 1,536 paces in length. Rocks of supposed Silurian age were found to extend from the Bois Brulé escarpment, nine miles back from the St. Lawrence at Rimouski, over the whole area traversed between that point and the St. John River. Grey calcareous slates, generally banded with more highly calcareous layers, are repeated again and again in a series of folds running roughly at right angles to the general course of the rivers followed. Hard siliceous sandstone, forming the crests of anticlinal folds along the main Rimouski River, seem to be the lowest members of this series. At one point just north of the Provincial boundary line, the strata were found to be fossiliferous, and a small collection was made, which will be further treated of in the extended report.

"Another traverse was made across this watershed by the Trois Pistoles, Boisbouscaché and Tuladi rivers. Here the older rocks (Cambro-Silurian) cover a much broader area; and slates and sandstones, thought to represent the Levis and Sillery formations extend southwards as far as Lac des Iles; beyond this point banded slates, similar to those along the upper part of Temiscouata Lake, were the only rocks seen.

"A survey, partly with micrometer telescope and partly paced, was made through the country lying between the St. John River and Temiscouata Lake. The route taken followed up Baker Brook to the lakes at its head, and thence by a portage of about four miles led to Long Lake which is drained by the Cabano River into Temiscouata Lake; this traverse was wholly within the Silurian area.

"During the season about 220 miles of lakes and streams were surveyed with the micrometer telescope and by pacing, and traverses were made of other streams of which surveys were already available.

"The field work occupied from 28th of June to the 16th November, and the expenditure was \$1,816.47."

Mr. R. Chalmers having been occupied during the early part of the year in the preparation of the report and maps relating to the work of 1887, left Ottawa on the 1st of June with instructions to continue the detailed examination and mapping of the surface deposits of southern New Brunswick, the special field of work being the area embraced in the geological $\frac{1}{4}$ sheet No. 1, N.E. Mr. A. H. Beers, of Montreal, joined Mr. Chalmers at Moncton as volunteer assistant. The work performed is summarized by Mr. Chalmers as follows :—

“ Commencing in the north-eastern part of the district we proceeded to examine it south-westwardly on both sides of the Intercolonial Railway as far as Sussex, which we made our headquarters for some weeks. Thence we traversed the surrounding country in all directions and made a large number of interesting notes. On the 18th July we proceeded to St. John and engaged a man and boat with the view of exploring the lower part of the St. John River valley, including Belleisle Bay, Washadamoak and Grand Lakes, &c. This occupied our time till 11th August. Returning to Sussex, we then started to examine the country to the south and south-west as far as Hampton. On the 27th August Mr. Beers left for home. I then commenced the exploration of the elevated tract in eastern King's and southern Albert, and the country bordering the Bay of Fundy. The frequent rains of September, October and November greatly hindered field operations, however, and although a considerable portion of the district referred to was traversed, I was unable to complete the work of the season as I desired. In November I visited Nova Scotia, making some observations on the dispersion of boulders from the Cobequid Mountains, &c., which are of interest when correlated with the facts respecting boulder distribution in New Brunswick. The unfavorable weather continuing, before closing field work, I proceeded to Restigouche a day or two to examine some more deposits which have just been opened up.

“ The work of the season has been, on the whole, interesting, and a number of new facts were discovered. Evidences of Post-Tertiary ice action are abundant in most places, but the courses of striae are somewhat diverse. The higher grounds which occupy the southern part of the district, and near the Bay of Fundy, form a plateau, ice movement and drift-transportation being southward or south eastward towards the coast. In the interior along the longitudinal valleys which lie parallel to the coast, the striae conform in a greater or less degree to these. In the north-western half of the area included in the map, where the country is low and flat not exceeding 300 to 350 feet in height, the general direction is south to south-east; while in the tract drained by the Petitcodiac River and its tributaries the ice followed the general north-eastward slope. In many places two or more sets of

striae are recorded upon the same rock surface. The erosion from ice appears to have been slight, judging from the great masses of decomposed rock undisturbed, and from the number of unglaciated areas. In some basin-shaped valleys in the interior, the ice seems to have been motionless, or nearly so, and to have produced striae around their borders simply by expansion.

"Decomposed rock and till constitute the great bulk of the superficial covering on hill summits and slopes, as well as on the larger part of the flat Carboniferous area. The thicker masses of till generally exhibit a rude stratification or bedding. Near St. John, lenticular masses of stratified clay occur in the till. One of these apparently occupies the bottom of a bank of till 15 to 20 feet in thickness. At Alma, well exposed sections show what have been called "upper" and "lower" till. But the two are really only one deposit, the upper part of which having undergone oxidation from exposure to the atmosphere for a long time, has assumed a yellowish or brown color. The oxidized portion seems, however, to contain less clayey material than the underlying bluish grey till. The whole deposit is made up of the debris of the underlying rocks.

"A considerable amount of data relative to lake basins, the origin of lakes, &c., were obtained. The lakes connected with the lower St. John are on the same level as its waters and are consequently tidal. All these are merely bodies of water ponded back by the narrowness of the St. John at its mouth, and by the obstruction which the tides, when at their flow, offer to the exit of its waters. Grand and Washadamoak Lakes and Belleisle Bay occupy the lower parts of the old valleys of the streams which now flow into their northern extremities. A rise of the land of 175 to 200 feet would enable the St. John to drain out its lower reaches and also these lakes.

"Several basins of extinct Post-Tertiary lakes were observed, notably Sussex Vale. Such of these as occur below the 200 feet level probably had only a brief existence. They originated as the land rose out of the sea, and before the present drainage channels had become established. As soon as the streams passing through them had sufficient time to cut down their outlets these lakes disappeared.

"Stratified gravel, sand and clay are abundant in all the valleys, more especially upon the Carboniferous rocks. The valley along which the Intercolonial Railway runs from Moncton to St. John is terraced with gravel and sand almost throughout its entire length. This valley, was, during the Post-Tertiary subsidence, a strait, and the highland tract between it and the Bay of Fundy was then an island. The terraces both in this valley and on the coast indicate a Post-Tertiary depression of the land of about 200 feet below its present level.

"Dyked salt marshes extend along the Petitcodiac valley and also skirt the coast at Little Rocher. Extensive fresh water flats occur along the St. John, forming all the islands and also wide intervals in parts of the valley. Others occur along the Kennebekasis, Petitcodiac, &c. They are nearly all under cultivation.

"Large portions of the area included in the map are still forest-clad, the northern area being entirely so. In eastern King's and Albert counties considerable tracts also are still covered by the original forest. The central and south-western parts of the district are extensively cleared.

"The agricultural character of the district is varied, depending in each locality largely upon the nature of the underlying rock. On the higher grounds near the coast the soil is stony and clayey; on the Carboniferous, gravelly and sandy, &c. The best land is in the valleys, more especially where lower Carboniferous rocks prevail, and along river banks and the margins of lakes. The country through which the Intercolonial Railway runs contains some excellent, well-cultivated farms. Sussex Vale is frequently called the garden of south-eastern New Brunswick.

"The materials of economic importance observed are infusorial earth at Pollett Lake, King's county, and Fitzgerald Lake, St. John county, referred to in previous reports. Brine springs occur near Sussex, and along Salt Springs Creek. At the former salt for dairy use has been prepared for a number of years. Clay and sand suitable for brick-making, &c., are abundant in many parts of the district.

"In November a short time was spent examining the glacial phenomena and drift deposits of the Cobequid Mountains and adjacent country in Nova Scotia by way of comparison with those of a like character in southern New Brunswick. It was found that the boulders had been transported in both directions from these mountains, *i. e.*, northward and southward. No striæ were observed, but transportation would seem to have been effected chiefly by ice, but to some extent also by the force of running water and gravitation. One fact especially noticeable is that boulders derived from the mountains become smaller and scarcer as we recede from them.

"On the 30th November I left the field for Ottawa."

Cost of session's exploration was \$845.91.

Mr. H. Fletcher left Ottawa on the 5th of June for Nova Scotia to continue the work in Pictou and Colchester counties, especially in view of making the additions and alterations referred to in the summary report of last year, as being now required in the map of Pictou coal fields as

published in 1869 by Sir W. E. Logan. This work was partly accomplished during the past year, as well as the survey of the western part of Pictou county and the eastern part of Colchester, required for completion of the geological maps of these counties. Respecting this work Mr. Fletcher reports as follows:—

“Along the northern part of Pictou and Colchester counties, from Big Island, Merigomish to Brulé and Tatamagouche, there is a wide belt of rocks described in the Annual Report, Geological Survey, Vol. 11, Part P., the conglomerate at the base forming Fraser's Mountains, Greenhill, Roger's Hill, Fitzpatrick Mountain, Dalhousie Mountain, the Biorachin and other high lands on its course. This conglomerate is overlaid by a great thickness of red shales and sandstones, these by grey and greenish sandstones from which good building stone and grindstones are quarried.

“Below these strata come the measures of the Pictou coal field, the limits of which were accurately determined by Sir William Logan and Mr. Hartley in 1869. Beneath them, in the eastern part of the district, are lower Carboniferous, Devonian, Silurian and Cambro-Silurian rocks; west of the East River of Pictou, only Lower Carboniferous and Devonian; while on approaching the eastern spurs of the Cobequid Hills, Silurian, Cambro-Silurian and Pre-Cambrian (?) strata are again found.

“Six collieries are in operation in the Pictou coal field, the Vale, East River, Albion, Acadia, Intercolonial (Drummond) and Nova Scotia (Black Diamond), having an aggregate annual yield of about 400,000 tons of coal. It has been supposed that the Permian rocks lying north of this field which hold plants and erect and prostrate tree stems, also include workable coal seams, and many boreholes have been put down to test these measures. The principal of these are: two near Pictou, 667 and 400 ft. deep; one at Logan's tannery, 1,000 ft.; two at Lyon's Brook, 500 ft.; one at Hardwood Hill, 700 ft.; three on Cariboo Island, 500 ft.; one on the East River, 750 ft. Only eight small seams of coal have, however, been cut on Cariboo Island, at the mouth of the Cariboo River, on the East River below New Glasgow, near the mouth of the Middle River and elsewhere, ranging from two feet downward and resembling and perhaps equivalent to, the small seams of Merigomish Island, Little Harbor, Small's Brook and Fraser's Mountain.

“Numerous attempts have at various times been made to work the rich grey sulphides and green carbonates of copper which are found in this formation in layers with lignite, pieces of jet, barytes, calcspar and other minerals impregnating large fossil tree trunks or in concretions; but none of them have proved successful, because the ores,

though containing sometimes 40 per cent. of copper, are not in workable quantity. The best known localities where these ores occur are on the banks of the Cariboo River, eight miles from Pictou, Toney River, at Durham on the West River; Scotch Hill; in Scotsburn Brook about 400 yards above the bridge at the church; and at River John. In the lower rocks traces of copper are found at Hopewell; on the East River; and on the Middle River near the mouth of McCulloch Brook.

"From the Permian formation valuable materials for building, grindstones and millstones are derived. From the Acadia quarries at Sawmill Brooks, West River, 1,200 tons of culvert and building stone were taken in 1888 by Mr. R. E. Chambers, and from the Granton quarry 350 tons of building and monumental stone, shipped principally to Halifax, and 110 tons of grindstone sent to Boston. The quarries at Pictou and at the Four, Six and Eight Mile Brooks of the West River also produced a large quantity of stone. Limestone fit for burning is found at Cape John, Cariboo, River John, Valley and elsewhere. Gypsum of good quality occurs in the neighborhood of Valley, and in very small quantity at Cape St. John. Barytes was exported from River John and from Brookfield, and is known to occur also at other points within the region examined.

"At Brookfield an important deposit of limonite has been opened by Mr. Chambers, and 1,000 tons extracted for shipment to Londonderry Mines. Limonite is also found at upper Stewiacke, and a promising deposit of red hematite at Newton Mills. The iron ore of Bridgeville has been largely worked during the summer of 1888 for transportation to Londonderry.

"A small seam of gold occurs in rocks underlying the Carboniferous limestone and has been opened near West River station at Riversdale, Salmon River, and the North River of Onslow, but is apparently nowhere of workable size and quality.

"At Manganese mines, near Valley, a quantity of black oxide of manganese is found in irregular veins, cutting a reddish slaty rock which underlies Carboniferous limestone.

"At Pembroke, Colchester county, galena, disseminated in a large mass of Carboniferous limestone and not in a definite vein, was unsuccessfully worked before 1877. At Smithfield a large body of sulphides of lead and iron was discovered in similar limestone at its contact with the underlying slates. Assays showed 100 ounces of silver to the ton of lead, and 5 dwts. of gold to the ton of ore. The property has attracted a good deal of attention, and it seems probable that, if the ore is in sufficient quantity, it may be profitably developed. In 1884, 100 tons averaging about 40 per cent. of lead were taken out, a small smelter erected and the ore successfully roasted in calciners.

"Several brickyards lie within the area surveyed and have long been in operation. A new one, lately established at the railway station of Sylvester, on an excellent deposit of clay, is capable of supplying a large demand for bricks.

"Deposits of infusorial earth are known to occur in the bottom of some of the lakes. But as the attempt to utilize the similar deposits at Folly Lake and at St. Anne's, in Cape Breton, have not been successful, nothing has yet been done to develop them.

"Through the kindness of Mr. S. H. Poole, manager of the Acadia Company's collieries, and of Mr. Robert Simpson, manager of the Inter-colonial colliery, and of Messrs. Harvey, Graham and John Sutherland, of the Nova Scotia mines, valuable plans were obtained of underground and surface surveys, and around the Pictou coal fields, and much information regarding certain parts was given by Mr. Poole, Mr. Alex. McBean, Mr. James Maxwell, Mr. Fergie, Mr. R. P. Fraser and others."

Mr. Fletcher returned to Ottawa on 22nd December. The cost of the season's exploration, including salary of assistants, was about \$700.

Mr. E. R. Faribault left Ottawa on the 31st May, to continue the examination and survey of the gold-bearing rocks of the Atlantic coast in Halifax county. He reports on this work as follows:—

"The district surveyed lies westward of that surveyed in 1887. It comprises the country watered by the two Little West rivers of Sheet Harbor and the Mushaboon, Tangier and Sheet Harbour rivers, an area of some 360 square miles.

"The sharp east and west folds into which these rocks were plicated to the eastward are found here again to continue their course is a westerly (magnetic) direction. They were traced with all possible accuracy, and the relation of the auriferous belts to the anticlinals has been carefully studied.

"The result of the work cannot yet be given in detail; but it may be safely stated in the interest of the mining community, that auriferous belts in Nova Scotia should be looked for only on or near to the anticlinal folds, and more especially on sharp ones. Hence the importance of accurately tracing and mapping these anticlinals to guide the prospector in the discovery of new auriferous belts, and thus prevent, if possible, the expenditure of thousands of dollars annually wasted in prospecting non-auriferous belts, because a few "sights" of gold, probably drifted from a distance, have been found in the vicinity. This consideration led me to devote two weeks last season in re-examining

the interior of the country, which is watered by the Sheet Harbour rivers, with the view of tracing out more accurately and studying more closely the various anticlinals affecting the strata.

"Four gold mining districts are now being worked in the region surveyed and examined: Tangier, Mooseland, Moose River and Caribou. In every one of these the auriferous leads are worked on each side of the anticlinal axes, and in no case are they more than 400 feet from them."

The country underlaid by these rocks and extending from Cape Canso to longitude $62^{\circ} 19'$, has been mapped on the scale of one mile to an inch, and is now waiting publication. This map covers eight sheets of 12 by 18 inches, and three more will be ready by next spring.

Mr. Faribault was assisted during the whole season by Messrs. John McMillan and A. Cameron, and part of the season by Messrs. A. P. Faribault and Jas. McG. Cruikshank.

Field work continued to the 1st of October, and the expenditure in connection with it amounted to \$1.025.

MINERAL STATISTICS.

Mr. Coste was engaged during the winter and the spring, assisted by Mr. Brumell, in preparing the report on the mining and mineral statistics of Canada for 1887. About 3,000 printed forms for returns of mineral production had been distributed, and later, about 3,000 letters were sent urging the transmission of the returns and seeking further information. Shortly after the close of the year, 1,500 returns and replies to letters had been received, and the full report was printed and issued in September last, and will form Part S. of Vol. III, Annual Report, 1887-88.

At intervals during the summer, Mr. Coste or Mr. Brumell visited a number of localities in Ontario and Quebec, with a view to investigate the occurrence of natural gas and petroleum in those provinces, especially in the formations that underlie the Devonian. In reference to natural gas Mr. Coste states as follows:—"A number of localities where natural gas had been reported were examined, and where possible the gas flow was measured and the logs of the borings and specimens of the drillings were obtained. Respecting wells bored several years ago, it was impossible to obtain any reliable information, and the loss of all such valuable data is very much to be regretted. The result of our investigation is that none of the wells yet bored in Ontario and Quebec produce more than 50,000 cubic feet of gas per diem, and very few even this much. The production of these wells, though small as compared with those of the United States gas region, are nevertheless of some value when in or near towns or villages."

"There seems no reason why further trials, especially in that part of Ontario between Lake St. Clair on the south-west and Lake Simcoe on the north-east, should not prove more successful, and yield as abundant a supply of gas or petroleum as do some of the Ohio wells."

In reference to petroleum, Mr. Coste states that no new oil wells of value have been bored, and that the entire production, 594,273 barrels in 1887, is confined to the county of Lambton and produced from about 2,700 wells, very few of which yield more than one barrel per diem. The average depth of the oil rock in Lambton is 490 to 500 feet from the surface.

Several wells have been bored in Essex county. One at Comber, 1,300 feet deep, is said to yield about one barrel of oil per diem. This oil is probably from the same formation as that of Findley in Ohio.

CHEMISTRY AND MINERALOGY.

The work carried out in the chemical laboratory during the past year has been entirely confined to the examination and analysis of such minerals and specimens, as were deemed likely to prove of economic value. Respecting this work Mr. Hoffmann gives the following details :

"It included :—

1. Analyses of lignitic coals.
2. Analyses of iron, copper, and manganese ores.
3. "Analyses of mineral waters—including analyses of the waters of the so-called "sulphur" and "potash" springs, Harrison Hot Springs, B. C., which were collected by Dr. Selwyn; analysis of a saline water from a boring at Otonabee, Peterborough county, Ont., and an analysis of a water from the boring at Maisonneuve, on the Island of Montreal. Of the foregoing the two first and the last mentioned, promise to prove of therapeutic value."
4. "Analyses of limestones and dolomites. A series of analyses has been commenced of such of these stones as occur in sufficiently extensive deposits—and with due regard to the accessibility of the latter—to be available for building material. On completion of the analyses of a series of the foregoing, the absorbing power (for moisture) and strength (resistance to a crushing force) of the same will also be determined. Dressed cubes of these stones are on exhibition in the Museum, showing their appearance under various "toolings" and when polished. Altogether, the information available in regard to them will be of such a nature as to very greatly facilitate the selection of a material for any special constructive work."

5. "Gold and silver assays. The greater number of the specimens examined were from British Columbia, and of these the results of assay were in a great many instances of a highly encouraging nature."

6. "Miscellaneous examinations embracing the testing of clays, in regard to their suitability for the manufacture of brick or pottery; the examination of pyrites with reference to its value as an ore of sulphur, and a variety of work of a like nature."

"There has been a steady increase, over former years, in the number of those seeking information in regard to minerals, as touching their identity or economic value. In most instances the desired information was communicated in the course of a personal interview; it not unfrequently happened, however, that a more than cursory examination was called for, or the estimation of a particular constituent deemed desirable, in which case the results were communicated by letter. The total number of specimens received—brought or sent—during the period in question, was seven hundred and sixty-five; and the number of letters written—for the most part in connection with same, and partaking of the nature of reports—two hundred and fifty-seven."

"Mr. F. D. Adams has (with the exception of a little over two months, when he was engaged in field work), as assistant chemist, applied himself with great diligence to the work in hand, the result of his labors being the analyses of the mineral waters aforementioned."

"Mr. R. A. A. Johnston, the junior assistant chemist, has proved himself a zealous and good worker. Apart from the gold and silver assays he has completed the analyses of numerous limestones and dolomites, besides doing a good deal of minor work."

"The work in the Mineralogical section of the Museum has progressed in a very satisfactory manner. The permanent labelling—which must by reason of additions be a more or less continuous work—has been almost completed to date. A manuscript catalogue of the scientifically arranged collection of minerals has been prepared, and will shortly be ready for printing, and considerable progress has been made in the preparation of a catalogue of the economic collection of minerals. The collection, which now numbers five thousand seven hundred and sixteen specimens, has, during the past year, been augmented by the addition of some two hundred specimens, including the following presentations:—"

Allan, W. A., Ottawa:—

Magnetite, from the township of Mulgrave, Ottawa county, Q.

Ami, H. M., of the Geological Survey, Ottawa:—

Calcite (nail-head spar) from the new quarries at Hull, Ottawa county, Q.

Colton, G. H., Pembroke, O. :—

Chlorite, from West Bay, Lake Nipissing, O.

Casey, T., East Templeton, Q. :—

Quartz and calcite, from East Templeton, Ottawa county, Q.

Craib, Wm., Nicola Milling and Mining Company, B. C. :—

Silver-ore, from the "Joshua" claim, Stump Lake, B. C.

do "Tubal" claim, do.

do "King William" claim, Stump Lake, B. C.

Egan, H. K., Ottawa. :—

Magnetite, from the township of Litchfield, Pontiac county, Q.

Gragg, Isaac G., Manager, Eastern Development Company, Lim. :—

Chalcopyrite, from the Coxheath copper mine, Cape Breton, N. S.

Henderson, G., Nicola Valley, B. C. :—

Silver ore, from the "Star" claim, Stump Lake, B. C.

Haycock, E. B., Ottawa. :—

Bog iron ore, from vicinity of Fort Natatchewan, Montreal River,
district of Nipissing, O.

Kilpatrick, S. J., Kingston, O. :—

Limestone from Wolf Island quarry, Wolf Island, Frontenac
county, O.

Keefer, T. A., Port Arthur, O. :—

Silver ore, "Native silver and argentite" from the Porcupine
mine, Loc. 96 T, township of Gillies, district of Thunder Bay, O.

Calcite, sphalerite and quartz from the "Rabbit Mountain" mine,
district of Thunder Bay, O.; and amethyst, with calcite carry-
ing argentite. An association of calcite, quartz and fluorite, and
sphalerite. Quartz with sphalerite and argentite. Galena, py-
rite and sphalerite in calcite. Galena, sphalerite and native
silver in calcite. Fluorite and quartz. Argentite, all from the
"Beaver" mine, district of Thunder Bay, O.

Kidd, W. J., Kingston, O., per T. C. Weston :—

Concretions from beach at Kingston, O.

Murphy, W. H. Ottawa :—

Sphalerite from Calumet Island, Pontiac county, Q.

Morris, W. J., Perth, O. :—

Hematite from the township of Darling, Lanark county, O.

MacNaughton, A. G. :—

Stibnite from West Gore, Hants county, N. S.

McKay, J., per Dr. G. M. Dawson :—

Argentiferous galena, from the "Acadia" claim, McDame's Creek, South Fork, Cassiar, B. C.

Parks, A., Sebastopol, Renfrew county, O. :—

Asbestos from lot 11, range 11, of Sebastopol, O.

Poole, H. S., Stellarton, N. S. :—

Anglesite from the Big Dome mine, Arizona, U. S. A.

Primrose, H. :—

Albertite from River John, west branch, Pictou county, N. S.

Warwick, F. W., Buckingham, Ottawa county, Q. :—

Mountain cork from the "Emerald" mine, township of Buckingham, Ottawa county, Q.

"Mr. R. L. Broadbent has been engaged in the permanent labelling of the specimens, which, as already stated, is now almost completed up to date,—in readjusting the entire collection of scientifically arranged minerals, which had become necessary by reason of the addition of a great many species not previously represented, and in the maintaining of the general collection in an orderly condition. The interest he has manifested in the work, and the diligence with which he has applied himself to the same, has in no small degree facilitated the work, and conduced to the marked progress made in this section of the museum."

"In the early part of the year, Mr. C. W. Willimott was engaged in making up collections of minerals, subsequently in re-sorting and arranging the contents of some two hundred and forty drawers of material employed for this purpose and which in the aggregate amounted to about two tons in weight. A great many species were found to be entirely unrepresented and in order to make good, as far as possible, this deficiency, he spent a portion of the summer months in visiting several of the mineral localities of the provinces of Ontario and Quebec, as also the coast line between Two Islands and Cape d'Or, Minas Basin, Nova Scotia. These visits resulted in the obtaining a large amount of fresh material, amongst which were a great number of handsome specimens, more especially of zeolites, and which as representing species not already shown in the collection or as serving to replace inferior specimens of the same species contained in it, proved a most desirable acquisition. Since his return he has been occupied in unpacking, sort-

ing and arranging this material, and more recently in making up collections of minerals and rocks for educational institutions, &c. Collections of this description have, in the course of the year, been forwarded to:—

	Specimens.
High School, Aylmer.....	115
University of St. Joseph, Memramcook.....	115
Christian Bros. training school, Clonmel, Ireland.....	115
St. John's College, Man.....	115
Canadian Institute, Toronto.....	115
J. C. Tremblay, Chicoutimi.....	115
Lands and Works Department, B. C.....	54
Royal Military College, Kingston (supplementary).....	30
W. C. Van Horne, C.P.R., Montreal (supplementary).....	28
Industrial School, Montreal.....	117
High School, Port Arthur, Ontario.....	117
St. François Xavier College, Antigonish, Nova Scotia.....	117
Bolton Institute, Bolton Centre, Q.....	109
Academy of Mount St. Vincent, Halifax, Nova Scotia.....	109
St. Hyacinthe College, St. Hyacinthe, Q. (supplementary)....	15
Dr. F. A. Gentl, Philadelphia, Pennsylvania, U. S. A. (in exchange).....	98
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	1,484
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PALÆONTOLOGY AND ZOOLOGY.

In these divisions Mr. Whiteaves reports as follows: "The letter-press of the illustrated paper on the Triassic Fossils of British Columbia, referred to in the annual report of last year, has been printed and distributed, and the lithographic plates to accompany it will soon be ready. The second and concluding part of a paper entitled "Illustrations of the Fossil Fishes of the Devonian Rocks of Canada," has been written for the current volume of Transactions of the Royal Society of Canada, and is now in type. It consists of twenty pages quarto of descriptions, and is illustrated by two full page plates, and by four of double the ordinary size. The greater part of the manuscript of another illustrated report, "On some Cretaceous Fossils from British Columbia, the North-West Territory and Manitoba," has been written and it is hoped that the whole will be ready for the printer early in the spring. The part written before the 31st of December, 1888, includes descriptions of the various species obtained by Dr. Dawson at the Rink Rapids of the Lewis River in 1887, as well as of those collected by Mr. McConnell, from the Rocky Mountains, three miles north of the east end of Devil's Lake in 1886, and from the Liard River in 1887. A preliminary examination has been made

of a large collection of fossils from the Niagara formation at the north end of Lake Temiscamingue, made by Dr. R. Bell in 1887; of a series of fossils from the Devonian rocks of Lakes Manitoba and Winnipegosis, collected by Messrs. Tyrell and Dowling in 1888; of various fossils from the Cretaceous rocks of Lake Labarge, the Rocky Mountains and the Porcupine and Yukon Rivers, collected by Dr. Dawson and Mr. R. G. McConnell in 1887-88; and of some Cretaceous invertebrata from Millwood, Manitoba, obtained by Mr. J. B. Tyrrell in 1888. During the months of July and August, I was occupied in collecting fossils, with Mr. Tyrrell, from the Devonian rocks at the north end of Lake Manitoba, when, as will be seen in the list of additions to the Museum, a large number of specimens was secured. In the upper flat of the Museum, a new upright wall case has been erected, which is now filled with the larger fossils of the Trenton group, all of which are now properly labelled. Some fine fossil plants from the Carboniferous formation of the South Joggins coast, including a trunk of *Dadoxylon* some five feet in height, and more than a foot in diameter, have been added to the collection during the year. New upright glass cases have also been made for the reception of some remarkable mammalian remains from the Tertiary rocks of the Cypress Hills, North-West Territories, and for a series of large dicotyledonous leaves from the Laramie deposits near Calgary, both collected by Mr. Weston during the past summer.

"In the small room devoted to the exhibition of mounted specimens of Canadian mammalia and birds, the wooden shelves in the wall cases have been entirely replaced by strips of glass. A large number of duplicate or inferior specimens of Canadian birds has been removed and their places filled, either with other species or with much better specimens, and nearly the whole series has been labelled in accordance with the check-list of North American Birds published by the American Ornithologists Union. The following is an estimate of the number of specimens and species of native vertebrata exhibited in the Museum in December, 1888.

Mammalia.

99 mounted specimens of	59 species.
8 mounted heads of	8 do
4 mounted skeletons of	4 do
27 separate skulls of	17 do

Birds.

448 mounted specimens of 300 species.

Turtles.

3 mounted specimens of 2 species.

"Among the more attractive of the zoological specimens received during the year may be mentioned a skeleton of the White Porpoise or Beluga (*Delphinapterus catodon*), prepared from a specimen caught in the Lower St. Lawrence, and secured for the Museum by Dr. B. J. Harrington, of McGill University, Montreal; an albino variety of the Grey Squirrel, shot at Lundy's Lane, Ont.; and a remarkable colour variety of the Bronzed Grackle, from the vicinity of Brandon, Manitoba. A commencement has been made of a collection of the eggs of Canadian birds, and those of some rather rare or local species have been received from Manitoba, the North-West Territory, British Columbia and Hudson's Bay and Strait. The series of recent mollusca from British Columbia, already in the Museum, has been much improved by the addition of several rare species from that province, kindly presented by the Rev. G. W. Taylor, formerly of Victoria, Vancouver Island, and some additions have been made to the collection of foreign shells. The number of official letters written during the year is 184, and throughout the months of September and October, the duties of Acting Director have been performed by the writer."

Mr. T. C. Weston reports that from the first of January to the latter part of June his time was occupied in Museum work in the palæontological and ethnological branches, and in making sections of rocks and fossils for microscopic examination. From the 28th of June to the 17th of September he was engaged in field work, in collecting fossils at various localities in the North-West Territory and at the South Joggins coast in Nova Scotia. The remainder of his time has been occupied in labelling and preparing fossils, &c., for exhibition in the Museum.

Mr. H. M. Ami has examined collections of fossils from upwards of one hundred localities in central Ontario, between Lake Simcoe and Belleville; from thirteen localities in the province of Quebec; from sixteen in New Brunswick, and from several at or in the neighborhood of Arisaig, N. S. With the view of ascertaining the exact geological horizons of the rocks from which they were collected, the species represented at each of those localities have been determined, as far as possible, and systematic lists of them have been made and placed upon record. He has written the manuscript of labels, which have since been printed, for the Cretaceous and Laramie fossils of northern Alberta described by the writer in 1887; for the Tertiary fossils of Skonun Point in the Queen Charlotte Islands; for the Laramie plants of the North-West Territory described by Sir William Dawson in 1887, and for the Cambrian fossils in the Museum, of which latter series he has re-classified and revised the nomenclature. From the duplicates in the Museum he has selected and labelled three sets of fossils, one of

which has been sent to St. Laurent College, Montreal; one to St. Francois College, Antigonish, N. S.; and one to the Manitoba College at Winnipeg. Some specimens of fossil sponges from the Museum have been loaned to Dr. J. G. Hinde for examination and study. From the 17th of September to the 18th of October, Mr. Ami was engaged in field work in the province of Quebec, under Dr. Ells, and succeeded in obtaining a considerable number of fossils. He has also collected a somewhat large series of fossils from the Chazy, Trenton and Utica formations around Ottawa.

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

Dr. Selwyn:—

Three specimens of *Prasopora lycoperdon*, Vanuxem (*P. Selwyni*, Nicholson) from the Trenton Limestone of Snake Island, Georgian Bay, Ont.

Dr. G. M. Dawson:—

Skin (since mounted) of the Hoary Marmot (*Arctomys caligatus*) from the mountains at the head of the Tulameen River, and about 300 specimens of plant and insect remains from the Tertiary rocks of British Columbia.

Dr. R. Bell:—

Specimen of a fresh-water shell from the Sturgeon River and one from the Vermilion River, Ont.

Professor Macoun:—

Eighty-nine specimens of birds from the neighbourhood of Ottawa.

Dr. R. W. Ells, N. J. Giroux and H. M. Ami:—

1500 fossils from various localities on both sides of the St. Lawrence from Béaucour River to Rivière du Loup (en bas) P. Q.

R. G. McConnell:—

500 fossils from the Devonian rocks of the Mackenzie and Hay Rivers; also seventy-five fossils from the Cretaceous rocks of the Mackenzie and Porcupine Rivers, and from the Yukon and Northern Rocky Mountain regions. About one hundred specimens of fossil plants from the Bear River Miocene, Mackenzie River.

Skins of an adult male of the Long-tailed Jaeger (*Stercorarius longicaudus*) of the Long-tailed Duck (*Clangula hyemalis*), of

the Surf, and Whitewinged Scoter (*Oidemia perspicillata* and *O. Deglandi*), all from the mouth of the Bear River, Mackenzie River.

J. B. Tyrrell:—

Fossils from the Cretaceous rocks at Millwood, Man., from the Hudson River formation at Stony Mountain, Man., and at Streetsville, Ont.

Skin of Franklin's Gull (*Larus Franklini*), a young loon (*Urinator imber*), and eggs of the Black Tern (*Hydrochelidon nigra Surinamensis*).

Twenty-five specimens of recent fresh water shells from the Assiniboine River, Man.

J. B. Tyrrell and J. F. Whiteaves:—

About 500 fossils from the Palæozoic rocks at the northern end of Lake Manitoba, and a small series of the recent Unionidæ of the same lake and the Fairford River.

T. C. Weston:—

Portion of a large skull, jaws, detached teeth, vertebrae and limb bones of various mammalia (nearly 300 specimens in all) from the older Miocene of the Cypress Hills.

300 fossil shells, &c., from the Belly River Series of Milk River Ridge, N.W.T.

Sixty specimens of dicotyledonous leaves, &c., from the Laramie formation at Calgary and the Red Deer River, N.W.T.

Thirty specimens of fossil plants from the Carboniferous rocks at the South Joggins, N. S.

H. M. Ami:—

300 fossils from the Utica, Trenton and Chazy formations about Ottawa, 100 nodules from Green's Creek, and fifty fossils from Glenora, Ont.

W. McInnes:—

Forty-five fossils from the Silurian rocks of the region between Rimouski and Lake Temiscouata, P. Q., and egg of the loon (*Urinator imber*).

J. Marshall:—

One Snapping Turtle, caught near Ottawa.

D. B. Dowling:—

150 fossils from the Devonian limestone of Lake Winnipegosis.

J. M. Macoun:—

Seventeen skins of birds and seven skins of mice from the Athabasca River.

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

By Presentation:

F. R. Latchford, Ottawa:—

Four specimens of *Limnæa ampla*, Mighels, from Brome Lake, P.Q.

Major A. Hamlyn Todd, Ottawa:—

Fine specimen of the Black or Silver Grey Fox (*Vulpes vulgaris*, var. *argentatus*) from the head of Lake Winnipeg. A vixen three years old, in winter fur and in the flesh.

W. H. Harrington, Ottawa:—

A White-footed Mouse (*Hesperomys leucopus*) caught in Gilmour Street, Ottawa; in the flesh.

Ruggles Wright, Hull, P. Q.:—

A nearly complete skeleton of a very young seal, probably *Phoca Groenlandica*, from the Post Pliocene clay at Hull.

Captain C. Berkeley Powell, Ottawa:—

Stuffed specimen of a beaver (*Castor fiber*) which was killed at White Partridge Creek on the Petewawa River in the winter of 1885-86.

T. G. Lear, Ottawa:—

Osprey (*Pandion haliaetus carolinensis*) shot on the Rideau River, in the flesh.

E. Browne, Ottawa:—

Specimen of the Hairy-tailed Mole (*Scapanus Breweri*) caught swimming in the Ottawa River between Britannia and Skead's mills; in the flesh.

E. H. Carter, Ottawa:—

Flying Squirrel (*Sciuropterus volucella*), shot at Aylmer, P.Q.: in the flesh.

J. A. Doyon, Ottawa:—

A sharp-shinned Hawk (*Accipiter velox*) shot near Ottawa; in the flesh.

Miles Spencer, Fort George, Hudson's Bay :—

Two eggs of the Willow Ptarmigan (*Lagopus lagopus*), one egg of the American Bittern (*Botaurus lentiginosus*), one of the Yellow-legs (*Totanus flavipes*), and three undetermined eggs, all from Fort George.

G. S. Cotter, Moose Factory, Hudson's Bay :—

A collection of butterflies and beetles from Moose Factory.

W. G. Kidd, Kingston, Ont. :—

A large trilobite (*Asaphus platycephalus*) from the Trenton limestone at the village of Wellington, Prince Edward county, Ont.

A. F. Grant, Ottawa :—

Skin of a Long-billed Curlew (*Numenius longirostris*) shot near Fort Macleod, Alberta.

Thomas Patterson, Ottawa :—

Slab of crinoidal limestone from Banff, N. W. T.

John Rutledge, Sydenham, Ont. :—

Antler of American Elk or Wapiti (*Cervus Canadensis*) ploughed up in what was once a cedar swamp, three miles from Sydenham.

Professor J. Fowler, M.A., Queen's University, Kingston, Ont. :—

An unusually perfect and well preserved specimen of *Lituities Americanus*, Emmons, from the Black River limestone of Wolfe's Island, near Kingston.

Dr. A. Jukes, Regina, N.W.T. :—

One atlas, one vertebra, three portions of jaws, four teeth and fragments of teeth and of limb-bones of various fossil mammalia from the "White River" beds of the Cypress Hills, N.W.T., also one specimen of a small *Inoceramus*.

Andrew Christie, Pincher Creek, Alberta :—

Skin of a Bushy-tailed Wood Rat (*Neotoma cinerea*) from Pincher Creek.

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

Fifteen specimens of six species of fossil shells and one calcareous annelid tube from the Post Pliocene clays on the bank of the Fraser River at New Westminster.

Rev. G. W. Taylor, Billings' Bridge, Ont. :—

Specimens of fourteen rare species of marine shells from the coast of British Columbia, one small crab from the same coast, and numerous examples of *Anodonta Nuttalliana* Lea, from Vancouver Island.

G. E. McMartin, St. Andrews, P.Q. :—

A Saw-whet or Acadian Owl (*Nyctale Acadica*) from the Little Rouge, a tributary of the North Nation River, P.Q.; in the flesh.

Dr. T. Tunstall, Kamloops, B.C. :—

One jade scraper and two stone hammers, from Lytton, B.C.

John Murray, Spence's Bridge, Thompson River, B.C. :—

Four flint arrow heads and one small stone paint pot, from the neighborhood of Spence's Bridge.

J. W. McKay, Kamloops, B.C. :—

Three flint arrow heads and four chipped flints, from Kamloops.

D. Armit, Manitoba House, Kinosota, Man. :—

Guard of a Belemnite, from Cretaceous rocks on the east bank of the Assiniboine, a little below the mouth of the Little Souris River; do., from rocks of similar age at Ochre River, Riding Mountain, Man., and a flint arrow head from Fort Ellice, N.W.T.

Dr. J. G. Hinde, Croydon, England :—

Specimens of *Syringolites Huronensis*, Hinde, from the Niagara Limestone of the Manitoulin Islands.

John Macoun, Ottawa :—

Pair of the Chickadee (*Parus atricapillus*); do. of the Red-breasted Nuthatch (*Sitta Canadensis*), a female Goldfinch (*Spinus tristis*) and two male Pine Grosbeaks (*Pinicola enucleator*), all from the neighborhood of Ottawa; skins, which have since been mounted.

E. G. White, Ottawa :—

Specimens of the Silvery-haired Bat (*Scotophilus noctivagans*) from Ottawa, in the flesh, and an American Crow (*Corvus Americanus*), also in the flesh.

Brother Secordian, Hull, P.Q. :—

Specimen of the Brown Bat (*Scotophilus fuscus*) from Hull; in the flesh.

W. E. Saunders, London, Ont. :—

Two small trilobites (*Phacops rana*) from drifted Devonian limestone at London.

John P. Esmonde, Ottawa :—

Necklace procured from a Blood Indian at the Blood Indian Reserve, twenty-two miles south of Fort Macleod.

B. K. Lowry, Maple Creek, Assa. :—

One vertebra of a buffalo with an iron arrow head imbedded in it, and another with a leaden bullet partly buried in it, both from the Cypress Hills.

By Exchange :—

From Dr. W. H. Rush, U.S.N., Philadelphia :—

Specimens of seventeen rare specimens of marine shells from Key West, the Bahamas, Yucatan Channel, Florida Straits, &c.

By Purchase :—

Large Beaver (*Castor fiber*) from Big Lake, Pontiac county, Ont., in the flesh.

Fine specimen of an Ammonite (*Placenticerus placenta*) from the Cretaceous rocks of the St. Mary River.

Skin (since mounted) of an Albino Grey Squirrel (*Sciurus Carolinensis*) shot at Lundy's Lane, Ont.

Remarkable color variety of the Bronzed Grackle (*Quiscalus quisculus æneus*) from the neighborhood of Brandon, Man.

Pair of Loucheux (*Kutchin*) Indian snowshoes, from Lapierre's house, Porcupine River, Yukon District, and a typical Loucheux knife.

Skeleton of the Star-nosed Mole (*Condylura cristata*) mounted by M. Jules Bailly, Montreal.

Molar of Mammoth (*Euelephas*), dug up in 1887 at St. Catharines, Ont.

One large Snapping Turtle (*Chelydra serpentina*) and a few fine stone implements of Indian manufacture, all from the county of Grey, Ont.

BOTANY, ETC.

The work in this section, under Professor Macoun, has made good progress during the year. Part IV, 248 pages R. 8vo. of the Catalogue of Canadian Plants, referred to in the summary report for 1887, as then passing through the press, was published early in the year and has since been distributed to scientific institutions and botanists in Europe and in America, and has been widely criticized in every case in the most complimentary terms.

During the first week in April, Professor Macoun made a list of all the mounted birds exhibited in the Museum, and found that there were 282 species, represented by 429 specimens. In the drawers 170 species were represented by 352 skins, 52 of which were of species not on exhibition in the cases. A list was then made out of all the birds known to Canada, which shows 564 species. This work was preliminary to that of the preparation of a complete catalogue of Canadian birds of the same character as the catalogue of plants, and Professor Macoun is now engaged on it.

Collections of plants to be examined and named were received during the year from Newfoundland, and from every province in the Dominion, except Prince Edward Island, in all over 1,500 specimens; these were all named and returned. Between January and the 15th of April there were mounted and placed in the herbarium by Mr. J. M. Macoun, 3,015 sheets of specimens, as under:—

Phænogams :—	
Canadian.....	850
European	775
United States.....	615
Cryptogams	775

During the same period there were sent to various museums, colleges and individuals 2,153 sheets of specimens, including 400 to McGill College, 300 to Columbia College, New York, 200 to the Department of Public Instruction, Quebec, and 200 to the British Museum. A large number of specimens received in exchange for those sent out, were mounted and placed in the herbarium which now contains 17,516 sheets.

Mr. J. M. Macoun left for the field on the 30th April with a Dominion land survey party. He collected plants and bird skins in the valleys of the Athabasca and Churchill rivers, returning to Ottawa on the 25th of November.

On the 18th of June, Professor Macoun left for Prince Edward Island. Twelve weeks were spent there studying its natural history and collecting specimens. Over 1,100 species of plants were secured, and valuable and interesting notes were made on the summer birds of the island. Returning on the 10th of September to Ottawa, Professor

Macoun then proceeded to Northumberland county, Ontario, where three weeks were spent collecting mosses and other material for Part V of the Catalogue of Canadian plants, the writing of which was then being commenced.

M. Pearson, of Manchester, England, has kindly given a report on the Hepaticæ—165 species—and Dr. Kindberg has examined and named nearly all the mosses, so that Professor Macoun is now in a position to complete Part V of the catalogue during the present winter.

Besides the collections of plants already mentioned, Dr. G. M. Dawson made an extensive one in the region around Kamloops, in British Columbia. Specimens of nearly 1,000 species, chiefly arctic plants, have been received from the British Museum in exchange. These are nearly all of the type species described by Sir W. Hooker in the *Flora Boreali-Americana* published in 1840. Most of the specimens were collected by Menzies, Douglas and Barclay on the Pacific Coast, by Drummond in the Rocky Mountains, and by Franklin and Richardson on the Arctic Coast.

MAPS.

There is now in course of preparation, and in various stages of readiness for publication, a large number of maps covering areas in all parts of the Dominion, amounting in the aggregate to 41,460 square miles. Some of these will require to be reduced for publication. They are as follows:—

No.		Scale.	Area in Sq. Mls.
1	Yukon district, N. W. T., and adjacent northern part of British Columbia	8 miles to 1 inch.	
2	Index map of above.		
3	Big River, Great Whale River, &c., east coast of Hudson's Bay	8 do 1 do	
4	British Columbia, part of southern interior.	4 do 1 do	
5	North-western Manitoba, preliminary map.	8 do 1 do	12,000
6	Western Ontario, Rainy River district.	4 do 1 do	3,456
7	do Hunter's Island.	4 do 1 do	1,450
8	Ontario, Madoc and Marmora township.	$\frac{1}{2}$ do 1 do	105
9	do Lake Temiscaming to Lake Huron.	4 do 1 do	180
10	do Preliminary map, Lakes Temagami and Temiscaming	2 do 1 do	3,828
11	do General map.	4 do 1 do	
12	do sheet 115 of same.	4 do 1 do	3,456
13	Quebec, N.-E. $\frac{1}{4}$ sheet (Eastern Townships map)	4 do 1 do	4,500
14	do phosphate deposits, Ottawa county.	$\frac{1}{2}$ do 1 do	210
15,16	do and New Brunswick, $\frac{1}{4}$ sheet, 17 N.-E. and 18 S.-E.	4 do 1 do	4,593
17,18	Nova Scotia, $\frac{1}{2}$ sheet, 4 N.-E. and 4 S.-E.	4 do 1 do	6,912
19,20	do parts of $\frac{1}{4}$ sheets 11 N.-W. and S.-W.	4 do 1 do	770
21	Various traverses in region of Mackenzie and Porcupine Rivers being reduced.		
	Nos. 1, 2, 3 and 21, are plans of routes of exploration by land, river and lake, of a total length of about 5,900 miles.		41,460

LIBRARY.

Dr. Thorburn reports that from 2nd January to 31st December, 1888, the total number of publications issued in connection with the Survey, including Annual Reports, parts of ditto, special reports and maps, has been 9,992. Of these, 6,567 were distributed in Canada, the remainder were sent to foreign countries, including Great Britain and Ireland, the Continent of Europe, the United States, South America, India, China, Japan, Australia, &c.

The number of reports in French distributed was 502.

There were received during the past year, as exchanges, 2,000 publications, including reports, transactions, proceedings, memoirs, periodicals, pamphlets and maps. Besides these, 56 publications were purchased and 40 scientific periodicals subscribed for.

There were 150 volumes bound during the year. The number of letters received relating to library matters was 1,927. The letters sent out by the Librarian were 1,119. There are now in the library about 7,500 volumes and 2,600 pamphlets.

VISITORS.

The number of visitors to the Museum during the year, from 1st of January to the 31st December, was 17,414, being a decrease of 161 as compared with the previous year.

In my summary report for 1875, I called attention to the question of opening the Museum on Sunday afternoon, and I then gave some very remarkable statistics of attendance, the result of this course having been adopted at the Australian Museum in Sydney, showing that on the 52 Sundays, afternoons only, the daily attendance was largely in excess of that of the 313 week days, the average being 986 on Sundays and 275 on week days; such a fact needs no comment, and I venture again to express a hope, in the interests of education and knowledge, that the time is not remote when a similar experiment will be tried in Ottawa.

There will, doubtless, be strong objections urged against such action, based chiefly, if not entirely, on the very erroneous, but unfortunately very prevalent idea, that a museum is a place of amusement, whereas it is essentially as much a place of instruction as is the church and Sunday-school; and the principal difference between the two, concisely stated, is, that in the Museum the *work*, and in the church and school the *word*, of the *Creator* is expounded. This admitted, there seems no obvious or intelligible reason why the one establishment should be closed and the other opened on the Sabbath.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The strength of the staff at present employed is 53, viz., professional 35, ordinary 17.

During the calendar year Messrs. Robert Chalmers and William McInnes were appointed as geologists to the permanent staff, and the following promotions were made:—

Professor John Macoun, from the 1st Class to Assistant Director.

Mr. Chas. W. Willimott, from the 3rd Class to 2nd Class.

The amount available for the fiscal year ended 30th June, 1888, was:—

	\$	cts.	\$	cts.
Civil List appropriation			44,800	00
General Purpose Appropriation			57,598	43
The expenditure may be summarized under the divisions named as follows:—				
Civil List Salaries	42,478	82		
Wages of temporary employes	16,671	55		
Exploration and survey	23,255	27		
Printing and lithography	11,655	28		
Purchase of specimens	2,091	85		
Purchase and binding of books, and purchase of instruments		967	48	
Laboratory apparatus and chemicals		324	87	
Stationery, mapping materials and Queen's Printer	1,294	12		
Incidental and other expenses	1,733	12		
	100,472	36		
LESS—Paid in 1887	3,930	44		
	96,541	92		
ADD—Advances to field explorers	3,479	42		
	100,021	34		
Unexpended balance Civil List Appropriation	2,321	18		
do of Contingency do		55	91	
	102,398	43	102,398	43

The correspondence of the branch shows a total of 7,662 letters sent, and 6,564 received, from 1st January to 31st December, 1888.

In conclusion I may again call attention to the inadequate Museum accommodation, referred to in previous reports, in the hope that some steps will be speedily taken to obviate this difficulty, which is constantly increased by the large annual additions now being made to the collections.

To raise the roof of the building and make a wide gallery around the upper flat supported with iron pillars, would be the least costly plan, and while much improving the external appearance of the building, would afford all the accommodation needed for some time to come.

ALFRED R. C. SELWYN,
Director.