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GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

REPORTS

OF

EXPLORATIONS AND SURVEYS.

1880-81-82.

To the Right Honorable

Sir John A. Macdonald, P.C., K.C.B.

Minister of the Interior.

Sir,—I have the honor to submit for the information of His Excellency the Governor-General in Council, the customary Annual Report, relating to the progress of the Geological and Natural History Survey of Canada. These reports embrace a part only of the work of the three seasons named.

I have the honor to be,

Sir,

Your most obedient servant,

ALFRED R. C. SELWYN.

Ottawa, May, 1883.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., DIRECTOR.

REPORT OF PROGRESS

FOR

1880-81-82.

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REPORT A. (IV.)

Page 4 A, *4th line from bottom, for* "page 34," *read* "page 434."

REPORT B. (V.)

Page 14 B, *10th line from top, for* "page 49 C," *read* "page 49 G."

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Page 15 C, *14th line from bottom, for* "page 33 H," *read* "page 23H."

REPORT DD. (VIII.)

Page 2 DD, 1, 4, 14 *lines, &c., from top, for* "Breche á Manon." *read* "Brèche à Manon."
" 2 DD, *8th line from top, for* "Branpits," *read* "Beaufils."
" 3 DD, *14th line from bottom, for* "Mr. Lord," *read* "Mr. Low."
" 7 DD, *16th line, for* "*Cordaites angustifolia*," *read* "*Cordaites angustifolius.*"
" 7 DD, *44th line, for* "*Orthis aurelia* (?)" *read* "*Orthis Aurelia* (?)
" 8 DD, *7th line, for* "*Illoenus*," *read* "*Illaenus.*"
" 8 DD, *16th line from top, for* "Barry Cape," *read* "Barré Cape."
" 10 DD, *4th line from top, for* "p.p. 88–86," *read* "880–86."
" 11 DD, *22nd line from top, for* "Mr. Albert," *read* "Mt. Albert."
" 13 DD, *30th line, for* "*Modiolopsis Tethys*," *read* "*Sanguinolites Tethys.*"
" 14 DD, *2nd line, for* "*Spirifera Cycloptera*," *read* "*Spirifera cycloptera.*"
" 14 DD, *17th line, for* "*Phoetus phocion*," *read* "*Proetus Phocion.*"
" 17 DD, *21st line, for* "*Graptolithus flexilis*," *read* "*Dichograptus flexilis.*"
" 18 DD, *16th line from top, for* "Gros Rivière," *read* "Grosse Rivière."
" 19 DD, *5th* and *7th line from bottom, for* "Petite Cap," *read* "Petit Cap."
" 21 DD, *2nd line from top, for* "p. 69," *read* "p. 49."
" 21 DD, *2nd line from bottom, for* "Gros Mâule," *read* "Gros Mâle."
" 22 DD, *12th, 25th from top* and *3rd from bottom*, same correction.
" 22 DD, *4th line from bottom, for* "Abour Brook," *read* "à Rebours Brook."
" 24 DD, *14th* and *25th from top, for* "Ruisseau Vallée," *read* "Ruisseau à Vallée."
" 25 DD, *bottom, for* "*Graptolithus bifidus*," read "*Didymograptus bifidus.*"
" 25 DD, *bottom, for* "*Graptolithus pennatulus*," read "*Didymograptus pennatulus.*"
" 25 DD, *bottom, for* "*Graptolithus bryonoides*," read "*Tetragraptus bryonoides.*"
" 25 DD, *bottom, for* "*Graptolithus fruticosus*," read "*Tetragraptus fruticosus.*"
" 25 DD, *bvttom, for* "*Graptolithus Richardsoni*," read "*Dichograptus Richardsoni.*"
" 28 DD, *9th* and *15th line from top*, same correction.
" 28 DD, *13th line from top, for* "Anse du Tour," *read* "Anse du Four."
" 28 DD, *26th line from top, for* "*Dicthograptus flexilis*," read "*Dichograptus flexilis.*"
" 28 DD, *34th line from top, for* "*Dicthograptus rigidus*," read "*Dichograptus rigidus.*"
" 30 DD, *3rd line from top, for* "*Diplograptus annectaus*," read "*Didymograptus annectans*"

REPORT G.G. (IX.)

Page 37 GG, *6th line from top, for* "p. 52," *read* "p. 52 G.G."

SUMMARY REPORTS

OF THE

OPERATIONS OF THE GEOLOGICAL CORPS

TO 31ST DECEMBER, 1881,

AND

TO 31ST DECEMBER, 1882.

BY

ALFRED R. C. SELWYN, LL.D., F.R.S.,

DIRECTOR OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

1881.

The most important event in connection with this branch of the Department during the year, has been the removal from Montreal to Ottawa of the museum, and headquarters of the Survey, in accordance with the provisions of the Act, 40 Vict., Cap. 9, Sec. 7. Removal to Ottawa.

This work has necessarily occupied the greater part of the time and attention of the Director, and the museum staff, during the entire year. Most of the specimens are now unpacked and arranged in the cases, and the new museum rooms have been open to visitors since the 1st December. A very large amount of work, however, in numbering, labelling and cataloguing the specimens remains to be accomplished.

The total cost of the removal up to 31st December, has been $10,012.57, without taking into account the salaries of those members of the corps, the most of whose time during the year has been devoted to this work. To meet this expenditure a supplementary vote of $5,000 was granted, and the balance has been defrayed out of the general appropriation for the Survey.

The total number and weight of packages forwarded from Montreal between the months of November, 1880, and May, 1881, was 1,729 boxes, 101 barrels, 162 miscellaneous packages—gross weight, 282,585 lbs. in 1,992 packages. These comprised minerals, rocks, fossils, natural history specimens, books, office furniture and museum cases, &c. This work was conducted by Messrs. Weston, Willimott and White, assisted by Messrs. Broadbent, Curry, Holmes, Ward and White, jun.

The services of Mr. Broadbent have been retained to assist in the work of unpacking and re-arranging the specimens.

Archæological collections.

A very large collection of the manufactures of the Pacific Coast Indians, including implements of the chase, weapons, domestic utensils clothing, ornaments, &c., has been placed in the museum, and is now on view. This interesting and valuable collection has been acquired by the Indian Branch of the Department, through the exertion of Dr. Powell, in British Columbia, at a cost of $1,232.54, and it would be very desirable to obtain an equally complete collection of the manufactures of the tribes east of the Rocky Mountains and around Hudson's Bay. Such collections will eventually constitute the only historical record of the habits, manners and customs of the early inhabitants of the Dominion, and should therefore be well represented in the National Museum.

The time when it will be no longer possible to acccomplish this is at hand, and suggests the necessity of prompt action in the matter, unless Canada is to be forever dependent upon the museums of the United States for information relating to the life history of her own aboriginal races.

Recent Natural History collections.

During several years past considerable collections in recent natural history have been made by various members of the geological corps. These have been noticed in the annual reports, but there being no space available for their exhibition, they have, to a large extent, been placed in the custody of the McGill College and the Natural History Society of Montreal, with the understanding that if at any time required for the National Museum they would be transferred. In the Ottawa Museum one small room has now been set apart for recent natural history objects, and a section of the palæontological room for the exhibition of a very fine collection of shells loaned to the museum. There are already specimens on hand, or that could be purchased at a small expense, more than enough to occupy a much larger space than is at present available, and consequently if the recent natural history branch of the survey is to be carried out, additional accommodation for work-rooms and exhibition space is now required. This could be effected at

Extension of the Museum.

a comparatively small cost ($8,000) by extending the two museum galleries at right angles to the present building, one side resting on the wall already built, and the other on columns and arches; no basement or ground floor would be required, and a very small outlay for foundations. Two large museum rooms with necessary work-rooms could in this way be provided, giving an internal space of 80 feet long and 29 feet wide on each floor, equal to 4,640 square feet.

The field work of the geological corps during the past season has extended from the Rocky Mountains to the Atlantic coast of Nova Scotia. The working parties have been distributed as follows:— Surveys.

North-West Territories.
Basins of Hudson's Bay and Lake Superior.
Quebec.
New Brunswick.
Nova Scotia, including Cape Breton Island.

In the North-West Territories, Dr. G. M. Dawson, assisted by Mr. R. G. McConnell, examined a region extending from the 49th parallel to the Bow River, and from the Rocky Mountains eastward to the 111th meridian. The result of the work is summarized by Dr. Dawson as follows:— North-West Territories.

"This region has long been known to contain coal and lignite, and the exploration has been conducted with special reference to these. The chief economic result of the survey has been to prove the great extent and importance of the western coal fields. It has been found that both coal and lignite occur at several different horizons in the Cretaceous system, and many localities yield fuel of excellent quality.

"Several facts of importance and interest, from a scientific point of view, have been ascertained, and a large collection of fossils has been secured. Canoe surveys have been made of the Bow, Belly and St. Mary Rivers, and extended running, and odometer surveys in all parts of the area above defined. Notes on the general economic features of the country were made during the summer, and meteorological observations recorded regularly. These latter will be continued by Mr. McConnell, who remains at Calgary during the winter, and will thus be in a position to secure important collections of plants, birds and other animals in the early spring before he can resume field operations. It is proposed to devote another season to work in the same region before the detailed report and map are prepared."

Dr. Dawson left Montreal for the season's work on the 10th May, and returned on the 15th November. Cost of exploration, $3,560.00.

A considerable amount, $1,131.00 of this expenditure, was incurred in the purchase of horses, waggons and other equipments which are now available for further work in the spring.

Dr. Bell was requested to continue his exploration in the Lake Superior region, that portion being specially indicated which has Basin of Hudson's Bay and Lake Superior.

hitherto been but little, or not at all examined, lying east and south-east of Michipicoten, and in which there is reason to anticipate the discovery of valuable mineral deposits, which the construction of the Canadian Pacific Railway might render of immediate economic value.

With this object in view, Michipicoten was selected by Dr. Bell as the starting point. Dr. Bell left Montreal on the 18th June, and Sault St. Marie on the 14th July for Michipicoten, arriving there on the 15th July.

The Michipicoten River was ascended to the height of land, and a number of rivers and lakes lying between lattitudes 48° and 49°50′ north, and longitudes 82°30′ and 85° west, chiefly at the sources of the Moose and Albany Rivers, were surveyed and explored, occupying till the 13th September, when the party returned to the mouth of the Michipicoten River and proceeded by steamer to Sault Ste. Marie, arriving there on the 14th September.

On the 16th September, Dr. Bell sent his assistant with equipment and canoes to Prince Arthur's Landing, instructing him to engage men and "proceed inland immediately," Dr. Bell returning to Collingwood to obtain provisions, &c. Subsequently Dr. Bell reports that, "besides examining the line of the railway from Fort William to Selkirk, a careful exploration was made of the Wabigoon and part of the Eagle Rivers, of Lake Wabigoon, and the chain of lakes leading from it to Eagle and Vermilion Lakes, the chain of lakes thence by way of Bell Lake to Whitefish Bay, including the shores of this bay; Shoal Lake, and of those portions of Lake of the Woods not previously examined. A good collection of the rocks of the Lake of the Woods region was secured."

The above work occupied from the 19th September to the first week in November, and Winnipeg was reached on the 7th of November. Dr. Bell remained in Manitoba till the 28th November, occupied "in collecting information as to building stones, lime, brick-clays, sand, 'mineral soap,' salt, the water supply, &c."

A detailed report will be prepared as usual for publication in the annual Report of the Survey.

The cost of this exploration was $2,734.18, and occupied from the 18th June to the 3rd December.

It having been considered desirable that Mr. Cochrane should remain in the country during the winter, arrangements for his doing so were made towards the close of the season 1880; and the Hudson's Bay Company kindly provided him with comfortable winter quarters at their post on Reindeer Lake. The greater part of the winter was spent in preparing maps of his previous season's explorations, as well as collecting and arranging such other information relating to that region, as was possible.

Owing to the ice on Reindeer Lake being unusually late in breaking up, much time was lost in the spring, and it was not till the 12th July the explorations were begun. After many careful inquiries from the Indians, and much information obtained from officers of the H. B. Co., it was decided to explore that portion of the country between Du Brochet Post on Reindeer Lake, and Fort Chipewyan, on Lake Athabasca, and to return from there to Winnipeg *via* the Athabasca and Churchill Rivers, and the numerous lakes through which these rivers pass, to Frog Portage, and thence to Lake Winnipeg by Cumberland House on the Lower Saskatchewan.

Considerable difficulty was experienced in securing the services of interpreters, guides and men for the rivers and lakes on the proposed route, as it is now seldom or never used.

The distance between the two extreme points, by the route followed, was found to be 625 miles, of which a continuous track survey was made.

On this route the somewhat remarkable feature of a lake forming a watershed is presented in the large lake known by the Indians as Hatchet Lake, but which is marked on all maps as Wollaston Lake. This lake discharges by two outlets of nearly equal volume, the one on the east side being an affluent of Hudson's Bay, and the other on the west side, of the Mackenzie River, passing through Athabasca Lake.

A track-survey of about 800 miles was made between Fort Chipewyan and Cumberland House, by Ile à la Crosse and Frog Portage. The detailed report of this exploration, extending over two seasons, will be prepared for publication in the annual Survey Report.

Mr. Cochrane returned to Winnipeg on the 20th November, and leaving there on the 28th, reached Ottawa on the 3rd December. The cost of this exploration has been $1,226.94 for two seasons.

Mr. Arthur Webster has continued the work of exploration and survey on the south side of the St. Lawrence, in the region bordering the states of Vermont, New Hampshire and Maine, with a view to connect the work of the geologists in these States, and the limits of the several formations as defined by them, with our own. He has also paid considerable attention to the question of the probable extent and location of the auriferous deposits in this region. The country is for the most part densely wooded and sparsely settled, and in consequence, close and accurate geological examination is a very tedious and difficult undertaking. Mr. Webster's work extended from the 5th May to the 6th November, and cost $1,051.87. Quebec.

Mr. H. G. Vennor resigned his connection with the Survey on

30th April, 1881. During the seasons of 1877–1880, inclusive, Mr. Vennor was surveying and exploring in the Ottawa and Grenville phosphate region and in the counties of Argenteuil, Montcalm, Joliette and Berthier. Of the work of these four seasons, no detailed report or map has yet been furnished to the Director. It has, however, been promised, and the map, shewing the result of these four seasons' work, should be especially valuable.

Mr. Vennor's last report, embracing the work of 1875 and 1876, was published in the annual Report of the Survey for 1876–77.

New Brunswick.

In New Brunswick, explorations and surveys have been carried on during the year by Mr. Ells, over a large extent of country in the eastern and northern portion of the province, and have also extended to the southern shores of the peninsula of Gaspé, where surveys were made of the coast from Metapedia to Little Pabos, and of the rivers Cascapedia, Nouvelle, Bonaventure, Scaumenac, and Little Cascapedia, to a distance of about twenty miles from the sea.

In the counties of Northumberland, Kent, Westmoreland and Albert, geological examinations and topographical surveys were made to locate the outcrops of the coal seams in these counties, and to ascertain their probable economic value, and at the same time to connect the surveys in New Brunswick with those already made in Cumberland county, Nova Scotia. The work in the field occupied from the 25th April to the 12th November. Cost, $1,068.92.

In York county, on the north-east side of the River St. John, and extending into Carleton county, an area of about 7,000 square miles, was surveyed and examined by Mr. Wallace Broad. This work will afford the necessary data for the completion of the fourth quarter-sheet of the geological and topographical survey of southern New Brunswick. Mr. Broad spent two weeks in the Crown Lands office, Fredericton, making tracings of such plans as were connected with his work, or would afford additional information for the construction of the map. The field work commenced on the 25th April and terminated on the 12th November. Cost, $626.44.

Nova Scotia.

Mr. Hugh Fletcher has continued the work in Cape Breton, and reports as follows:—

"Early in the season a few days were spent in defining the limits of the Carboniferous and older formations in the neighborhood of Whycocomagh and the head of Lake Ainslie. Attention was then directed to the reported coal oil regions around this lake. No oil has yet been struck, and the money spent seems to have been thrown away. It is supposed that operations were commenced because of the finding of drops of petroleum which oozed from the dark, bituminous sandstone and shale on the lake shore.

The explorations were first carried on at the west side of the lake, where several stationary engines and derricks now lie idle and rusting; then bore holes were made on the east side, and also at McRae's bridge near Baddeck.

The sensational reports which have appeared in the Cape Breton and Boston newspapers, of the wonderful flow of petroleum from the wells, were altogether without foundation.

The very interesting region of the Mabou, Chimney Corner, and Broad Cove coal mines was next examined, together with the country underlaid by the Lower Carboniferous, gypsum, and limestone strata, the gneisses and felsites of Cape Mabou, and the traps and diorites of the Broad Cove Intervale (Strathlorne) which appear to be the same as those of south-west Margaree and Cheticamp, and to belong to the base of the Carboniferous system. The coal measures occupy small basins on the sea coast. In many places the seams of coal are in juxtaposition with large beds of gypsum, and all the measures hold crystals and veins of selenite. Fossiliferous black shales abound near Mabou and Broad Cove. A little coal has been extracted at Mabou. A great deal of money has been spent in developing the mines at Chimney Corner and Broad Cove.

The latter is by far the most important field, but the absence of suitable harbors retards the progress of coal mining on the northern shores of Cape Breton. An expensive wharf was built at Chimney Corner, and a breakwater at the mouth of Broad Cove River, but both are now out of repair. It is proposed to remove the bar at the mouth of Isaac Pond, and surveys have been made for this purpose. The water inside is deep, and a breakwater here would, it is thought, be less liable to be destroyed. The distance to Broad Cove mine is only a mile and a-half.

It has been necessary to make surveys of all the roads, brooks and lakes in the country, the only existing map being the admiralty chart of the coast on a scale of four miles and three-quarters to one inch. There are not even Crown land maps of the settlements in northern Cape Breton, and outside these is a *terra incognita*, but in which valuable veins of gold and silver have a reported existence.

This great unknown land may be said to be north of a line drawn from Margaree Harbor to the North River of St. Ann's, but within it, on the coast, are the thriving settlements of Cheticamp, Pleasant Bay, Bay St. Lawrence, Aspey Bay, Mills' Harbor, and Ingonish. Much of the interior is occupied by large barrens, over which roam herds of cariboo. On a small barren not far from Big Intervale Margaree, about 150 cariboo were counted one day towads the end of October. Moose, at one time also numerous, are now scarce. Along the shores of this northern region, and running into the bays and glens, is a narrow Carboniferous belt, through which the older gneissic and felsitic rocks of the interior come bluffly to the shore in capes and headlands.

The settlements are all on the Carboniferous belt. Inland there are Pre-Cambrian rocks, similiar to those described in the previous reports, as forming hills around Bras d'Or Lakes and elsewhere in Cape Breton. To these belong the Middle River gold bearing rocks, from which probably the gold was derived, mentioned by Mr. Campbell as being found in the Cheticamp and other neighboring rivers.

Galena occurs in many places in the Carboniferous limestone, and at South-West Margaree and Pleasant Bay it has been worked. Copper pyrites is found among the traps of Cheticamp, and in a diorite at Cape Rouge. Also in the rocks of St. Ann's Bay and the North River where a small vein has been worked which holds galena, zinc blende and copper ore. The copper mine at Coxheath has been sold to a United States Company, and now yields a large quantity of promising ore.

In October and November, some time was spent in a re-examination of the country around the head of Loch Lomond, where the Hon. E. T. Moseley, Esq., of Sidney, is now actively working some very important deposits of manganese ore. A large quantity has already been raised, and this mine promises to be of great value, some of the ore being valued at $100 per ton.

The northern part of Cape Breton Island is deserving a more careful exploration than it has as yet received. The difficulties of such an exploration have been much exaggerated. There are very few of the rivers and brooks that could not be ascended by wading during the low water of summer. In the lower part of their courses they cut deeply into the rocks, but the necessity of first surveying them to map the country, left but little time for a careful examination of the geology. It was found impossible to finish the survey last summer, owing partly to the wet season, and an early fall of snow, 5th October, which, although it disappeared from the lowlands, lay on the hills, and made the water of the large streams too cold to wade in. A few brooks remain to be traversed in Victoria county, between Ingonish and St. Ann's, and the Baddeck River has yet to be surveyed."

On the 5th November, Mr. W. Fletcher, B.A., assistant attached to the party was unfortunately drowned when crossing the North East Margaree River.

Last spring an arrangement was made with the Hon. S. H. Holmes, Attorney-General and Premier of Nova Scotia, by which the Provincial Government consented to share in equal proportion with the Geological Survey, the cost of a thorough topographical survey of the Nova Scotia gold fields. In accordance with this arrangement, the survey was commenced in June last, under the superintendence of Mr. William Bell Dawson.

The district covered by the season's work extends eastward from Halifax Harbor to Lake Porter. It comprises an area of about two hundred square miles, and includes the Lawrencetown, Montagu and Waverley gold fields with the intervening country. The survey is an instrumental one, made chiefly with theodolite and micrometer telescope, and embraces all the topographical details of importance, as well as the position of all "leads," shafts and workings. The information obtained is sufficient to enable large scale plans of these gold fields to be prepared, in addition to the general geological and topographical map to be published, on such scale as may be considered desirable. There is at present no map on which the position of leads can be marked or their probable course ascertained with any approximation to accuracy, and it is, therefore, thought that the survey, if carried out, will prove of much value to the gold mining interests of Nova Scotia, as it will afford a basis for mining operations not previously obtainable.

The cost of the survey to 31st December has been $1,500.

The liberal and enlightened action of the Nova Scotia Government in co-operating with the Dominion Geological Survey on the terms above stated, may be recommended for the favorable consideration of the other Provincial Governments who desire to expedite the geological survey of their respective territories, and thus more speedily acquire an accurate knowledge of the extent and value of their mineral resources, and the aid which accurate maps would afford in the development of them.

Palæontology and Natural History.

Up to the 1st of May most of the time of the Palæontologist and of Messrs. Foord and Weston has been spent in attending to the packing, not only of the extensive collections of fossils in the museum and store rooms, but also of office furniture and effects for removal to Ottawa. Before leaving Montreal the remarkable series of fossil fishes, collected by Mr. A. H. Foord, in 1880, from the Devonian rocks of Escuminac Bay, P.Q., was carefully studied, and a preliminary description of each of the species published in the *Canadian Naturalist and Geologist.* A more condensed description of the same specimens has also been published in the June number of the *American Journal of Science*, and has been reprinted verbatim in the August number of the *Annals and Magazine of Natural History*, London, (England). Fuller diagnoses of the species proposed in these papers, accompanied with illustrations, are in preparation for a forthcoming report. Since the removal to Ottawa most of the fossils intended for exhibition in the cases, have been selected, classified and re-arranged in the new museum. The nomenclature of each of the species exhibited so far, has been verified and revised. Those fossils which have been collected recently, and which require to be reported upon, have been unpacked and arranged in cabinets in the palæontologist's room. The fossils from the Cambro-Silurian deposits of the valley of the Red River, Manitoba, collected by Dr. R. Bell in 1880, have been critically examined and identified and a list of the species is published as an appendix to Dr. Bell's report. Report of Progress 1879-80, pp. 57-58 c.

During the past summer a new locality of fossil fishes has been discovered by Mr. R, W. Ells in Devonian limestone and breccia at Campbellton, N.B. These deposits have since been systematically explored by Mr. Foord. A provisional description of the fauna, as exemplified by the collection made from them by Mr. Foord, which consists of more than 200 specimens, has been published in the *Canadian Naturalist and Geologist* in advance of the publication, with illustrations, in the survey reports.

Mr. Foord has also made large collections of fossil fishes and plants from Escuminac Bay, P.Q.; of shells and corals from the Silurian rocks of the Nouvelle River, P.Q., and Cape Bon Ami, N.B.; of fish remains from the Mabou coal mines, Cape Breton, and of fish spines from the Gaspé sandstones of Gaspé Bay.

A small but interesting series of reptilian and fish remains from the tertiary deposits west of Manitoba has recently been received from Professor John Macoun; and some rare fossils from the Trenton and Utica formation of the immediate neighborhood of Ottawa, which were not previously represented in the collection, have been presented to the museum by Messrs. W. R. Billings, F. R. Latchford, H. M. Ami and J. W. H. Watts.

The number of specimens of fossils added to the collection during the past year is between 1,100 and 1,200, and of these about one-half have either been identified, or otherwise reported upon, and the rest have been subjected to a preliminary examination and partial study.

The Laboratory.

Consequent upon the removal of the Survey to Ottawa, and pending the fitting up of the new laboratory, the work in this branch was necessarily for a time suspended, and unfortunately after the fitting up had been completed, towards the end of August, the progress of the work has been very seriously retarded and interrupted, owing to the difficulty experienced in obtaining the requisite, steady, and sufficient supply of gas, and it is feared that this will continue unless the laboratory is supplied by a special pipe direct from the city gas works, involving a considerable expenditure.

A few analysis of technical importance have, however, been carried out, and several examinations of interesting minerals have been made. Much time has also been occupied in giving information, either personally or by letter, about minerals brought or sent for identification.

Owing to the packing up and removal of the library, and the illness and retirement of the Librarian, no exact record of the number of publications distributed, or of volumes received, is available. Amongst these, however, may be mentioned an almost complete set of the Proceedings of the Royal Geographical Society; a large number of the publications, maps and reports of the Geological Survey of the United Kingdom; and 11 volumes, 4to, of the Philosophical Transactions of the Royal Society of London. Many other valuable publications have been received in exchange for the reports of the Suvey, the distribution of which has been not less than in former years. The Library.

In September, Mr. A. B. Perry, Graduate of Kingston Military College, was temporarily appointed for three months as Acting Librarian, and during that time he arranged, labelled and numbered nearly all the books in the library, and made very considerable progress in the preparation of the catalogue.

The removal to Ottawa has necessitated the purchase of the books which, though the property of the late Sir W. E. Logan, have always formed part of the Survey library. Most of these are current publications, the earlier volumes of which were subscribed for by Sir W. E. Logan, while of late years the subscriptions have been paid from the Survey funds, thus making one portion of the series the property of the Survey, and the other the property of the Logan estate. Under these circumstances, and considering the difficulty of replacing these volumes, it has been deemed advisable to purchase them from the administrator of the estate.

The total number of volumes thus purchased is 715, and 41 maps in portfolios.

The surveying, mathematical, and optical instruments in use by the Survey, but the property of the Logan estate, have also been purchased. The total amount to be paid for these properties being—books, $1,500; instruments, $3,000. The valuation placed on them is very considerably less than was paid for them by Sir W. E. Logan. And as they were purchased for, and have always been used in the public service, the compensation to the estate was deemed a fair and equitable adjustment of the matter.

Owing to the work still in progress, the museum has not yet been announced as open to the public. It has, however, been visited by 296 persons during the month of December, a larger number than at any previous similiar period of its history, and a gratifying assurance that, when arranged and formally opened, it will be a popular institution. Visitors.

The foregoing summary of the operations of the Geological Corps was submitted for the information of the Government on the 31st January 1882. In the present volume detailed reports are given of some of the investigations named, also further information—Notes and Reports—relating to the work up to 31st December 1883, as summarized in the following report presented in January last for the information of the Government. It will thus be seen that this volume contains reports of portions of the work of the three seasons, 1880–81–82.

1882.

During the past year the explorations, surveys, and scientific investigations made by the staff of the Geological and Natural History Survey branch of the Department of the Interior have, as in former years, included portions of nearly all the Provinces and Territories of the Dominion, from British Columbia to Nova Scotia. Interesting and valuable additions have been made to our knowledge of the geography, geology, and natural history of the districts explored; and the general work of the survey in the field, having in view the construction of complete mineralogical and geological maps of the Dominion, has made satisfactory progress. The detail will be given in the usual Annual Report of the survey, which will be prepared when the collections and observations have been studied and arranged, and the measurements plotted, which, with the ordinary duties connected with the museum, will fully occupy the time and attention of the staff during the winter. In the meantime the investigations above alluded to may be briefly summarized as follows:—

British Columbia.

In British Columbia, Mr. Amos Bowman, who ably assisted Dr. G. M. Dawson in the western part of that province in 1876, has been engaged during the summer in working out details of the topography and geology of the southern interior east of the Fraser River. On the map of this region, published in connection with the report of progress for 1877-78, the main points of its geological structure were shewn for the first time, and the geography of the region laid down more completely than had before been possible. This map, however, left much to be desired, as this district, on account of its accessibility and comparative freedom from dense forest, is peculiarly suited to become a typical one, geologically, for the Province. It is, besides, that to be traversed by the Canadian Pacific Railway, and is known to contain coal and other economic minerals. The investigations of Mr. Bowman during the past season have added much to our knowledge of it; and the future prosecution of them will probably render desirable the preparation of a second edition of the maps at an early date. The expenditure on this exploration has been $1,800.00.

North-West Territories and Manitoba.

In the Report of last year it was stated that Mr. McConnell would remain at Calgary during the winter, to be in a position to resume as early as possible in the spring the surveys and explorations which were commenced in 1881, by Dr. G. M. Dawson, of the important coal fields of the North-West, situate in the Bow and Belly River districts, of which a preliminary report was prepared by Dr. Dawson and published in May, 1882.

During the past summer the examination of the country extending from the base of the Rocky Mountains eastward to the 111th meridian and from the international boundary northward to the 51st parallel, has been completed by Mr. McConnell.

After finishing the work on the plains, the remainder of the season, from the 1st August, was spent in the foot-hills and outer ranges of the mountains, where the line of junction of the newer coal-bearing rocks of the plains with the older rocks of the mountains was examined and defined. The principal topographical features of the foot-hills and outer ranges were sketched in as carefully as time permitted, the measurements being made either by odometer, pacing, or by rough triangulation. The disturbed formations adjacent to the mountains were also traced out and examined, and two barometric sections were made across the Porcupine Hills, north-west of Fort McLeod. Scabby Butte was also re-visited, and a large and interesting collection was made there of reptilian bones, probably of Dinosaurs, some of which are now exhibited in the museum. It is hoped that further research may lead to the discovery of enough of these bones to reconstruct the entire skeleton of one of those gigantic extinct reptiles, compared to which the mammoth would be a dwarf.

The most important coal seam in the region examined and described in the preliminary notes by Dr. G. M. Dawson, above referred to, occurs near the base of the Pierre shale formation. This seam has now been traced, varying in thickness from one and a half to five feet, from the international boundary to the Red Deer River—a distance of 175 miles. Several other seams were examined on the Red Deer River. The thickest, shewing six feet of coal, occurs not far above the summit of the Pierre shales, and is probably on the same horizon as the seam at the Blackfoot Crossing and at the Scabby Butte. A sketch survey was made of the Red Deer River, for about 100 miles, from the mouth of Rose-bud Creek down to Hunter's Hill; and, on the return eastward at the close of the season, all the formations cut by the South Saskatchewan River from the mouth of Bow River to Swift Current Creek were examined, the most important feature here being the occurrence of a thick coal seam exposed at intervals from Medicine Hat up the river for forty miles. This seam is supposed to be at a lower horizon than any of those observed further west, and may underlie them throughout the region examined. In any case, the evidence of the past season's work tends still further to confirm the opinion that the coal fields of the North-west may be regarded as practically inexhaustible. The measurements made by Mr. McConnell during the season were :—

1,000 miles by odometer,
275 miles by pacing,
450 miles by river (estimated.)

Total...........1,725 miles.

The season's operations extended from 1st May to 3rd November, the latter being the date of Mr. McConnell's return to Ottawa. Cost—$1,599.64. The equipment, consisting of one waggon, seven horses, three saddles, harness, tents, two carts, canvas canoe, buckboard, &c., were left in charge of Mr. James Scott, Fort McLeod, and will, for the most part, be available for another season's work.

Dr. Bell was requested to proceed to the Athabasca-Mackenzie region, and to there examine and survey that portion of the Athabasca River hitherto unsurveyed between the confluence of Lake La Biche River and the Clear Water River; and further to examine as much as possible of the great, wholly unexplored, region south of Athabasca Lake, and lying between the Athabasca River and the 108th degree of longitude.

The first part of the programme was successfully carried out, and some interesting details were obtained in relation to the lignite coal-bearing strata of the upper part, and the petroleum and salt deposits of the lower part, of the Athabasca River, all tending to confirm the opinion of previous explorers as to the great prospective importance of this region in connection with these valuable mineral deposits.

A track survey was made of Lake La Biche, and thence of the La Biche River and of the Athabasca, from the confluence of the latter to its mouth in Athabasca Lake, a distance of about 270 miles in a straight line.

Of the investigation indicated in the second part of the instructions, namely, that of the region south of Athabasca Lake, Dr. Bell states : "That, after consulting the officers of the H. B. Co. and others at Fort Chipewyan, I found that there was no route known across this region ; and, even if a route had been found, it would have been impossible to explore it, owing to the impossibility of obtaining supplies and reliable Indians." Dr. Bell therefore returned on the old route, by Methy Portage, Ile à la Crosse, and Green Lakes, to Carleton. At Ile à la Crosse a copy of a sketch map was obtained from Mr. Walter Francklyn, which he had made of his route from the Churchill River to Cree Lake, situate in the region in question. Mr. Francklyn also gave Dr. Bell much information about the country, and Dr. Bell procured from some intelligent Indians of the region, and others, various sketch maps and notes in regard to its geography. This information will no doubt prove useful in connection with future explorations.

From Methy Portage a track survey was made of the route to Ile à la Crosse Lake, and thence of the Beaver River to Green Lake, which was reached on the 4th of October. That portion of the route above referred to, between the Athabasca and the confluence of the Clear Water has already been frequently traversed and its features described in more or less detail, the latest account of it being that of Professor Macoun, published first in the Report of the Geological Survey for 1875–76, and since then (1882) in the same author's "Manitoba and the Great North-West." These accounts do not materially differ from that of Dr. Bell, except as regards the probable origin of the petroleum or "tar" deposits. Dr. Bell has, however, ascertained the interesting fact that the petroleum-saturated sandstones are of Cretaceous age, and of such extent and character as to lead to the idea that the sandstone itself might be utilized for fuel, or the petroleum might be profitably extracted from it. The saturated beds range from 100 to 150 feet in thickness and extend for many miles along the river. Dr. Bell believes the source of the petroleum to be in the underlying Devonian limestones, and not in the black shales mentioned by professor Macoun ; also, that the impregnation has taken plaace, as in eastern America, from below upward. Neither the eastern nor western limit of this tar-impregnated sand-rock of the Athabasca and Slave Rivers has yet been ascertained. On Peace River the only known indication of its occurrence is where the same Devonian limestones appear at the surface from beneath the Cretaceous rocks, as is recorded by Professor Macoun. (Geological Survey Report 1875-6, p. 88). Dr. Bell was assisted by Mr. Lawson. He left Ottawa on the third of July and returned on the eleventh of November, having travelled about 5,460 miles. Expenses $2,500, including salary of Assistant.

Mr. Cochrane was requested to make a survey and exploration of the country east of Lake Winnipeg from the 53rd parallel of latitude southward, including the Berens River and the upper waters of the Severn, returning, if practicable, by way of Trout Lake, Lake St. Joseph, and

District of Keewatin (East) of Lake Winnipeg.

Lonely Lake, the whole of this area never having been explored. Mr. Cochrane reports that he was unable to procure guides for the country on the east side of the Height of Land between the Berens and the Severn; and he did not therefore attempt the return route indicated in his instructions. A continuous track survey was, however, made of the Berens River from its mouth to the Height of Land, about 115 miles, as well as about 75 miles of one of the head waters of the Severn. The Pigeon River, which is connected with the Berens, was also surveyed for fifteen miles from its mouth. The Big Black River, about 65 miles north of the Pigeon, was then ascended and surveyed for about 82 miles, beyond which canoes could not be taken. At this point a portage was made, southward, into one of the tributaries of the Poplar River, which was descended and surveyed to its mouth in Lake Winnipeg. Mr. Cochrane then proceeded up the east shore of the lake to Norway House, with the intention of surveying and exploring the Jackfish (or Pike) River. This, however, was found to be impracticable, the water being too low to make the ascent. A sketch survey was then made of the lake shore from Norway House to the Grand Rapid Post at the mouth of the Saskatchewan. Leaving Grand Rapids on the 6th September the Saskatchewan was ascended to the outlet of Moose Lake, the shores of which were surveyed and examined. The field work commenced on the 1st July and terminated on the 15th October. Expenses, $985.46. No economic minerals of importance were observed, and the rocks on the eastern coast, and as far inland as the examination extended, consisted almost entirely of the ordinary varieties of grey Laurentian gneiss.

Ontario and Manitoba.

The Geological Survey work during the past season in Ontario consisted in examinations made, by the writer, of several of the principal mines on Lake Superior, and of the whole of the north shore of the lake from Kaministiquia River to Echo Lake, east of Sault Ste. Marie, including the whole of Thunder Bay, portions of Black Bay and Nipegon Bay and Straits, Michipicoten Island, Bachewanung Bay, and Goulais Bay. The entire distance—probably about 800 miles—was traversed in a small Mackinaw boat, and the shore line was pretty closely followed. Current River, Thunder Bay, was left on the 13th July, and Sault Ste. Marie reached on the 20th August. Remarkably fine weather was experienced, and but little detention from adverse winds. The average temperature for July between 6 and 8:30 a.m. was 60°. 95 and for August between the same hours 61°. 52. Many days it was so calm that sailing was impossible.

In the whole distance only seven mines and one stone quarry were found, at which work was being prosecuted. These were, from Thunder Bay, eastward :—

1. Pie Island.
2. Silver Islet
3. Free-stone Quarry, Isle Verte, Nipegon Bay.
4. Michipicoten Island.
5. Mamainse.
6. Do.
7. Echo Lake.
8. Garden River (east of Sault Ste. Marie).

The Silver Islet Mine is the only one which has yet yielded any profit on the working.

At Michipicoten Island, and at one of the Mamainse mines, very large sums of money are being expended; but the surface works, as has been so often the case in the past history of Lake Superior mining enterprise, are altogether too far ahead of the underground explorations, which in August last could not be said to have afforded more than a reasonable prospect of a profitable mine, more especially when considered in connection with the unsuccessful result of the previous somewhat extensive exploration of the same mining areas.

At No. 7, the Echo Lake mine, work has been suspended since the date of my visit in July.

The origin, geological structure, and age of the formations around the shores of Lake Superior are points upon which much discussion has arisen and various opinions have been expressed. To study these questions was one of the main objects of the present exploration, and also to ascertain whether any sound reasons existed for adopting the new names by which it has been proposed to designate the interesting groups of strata which there constitute the so-called upper and lower Copper-bearing Rocks. The result of the observations made will be given in the annual report, when the facts have been further considered. At present the impression formed is that the names referred to are not required, and that generally the views expressed by the earlier explorers are more nearly correct than those subsequently advanced, the latter being for the most part based apparently more on theoretical considerations than, like the former, on personal examination of the region. During the present exploration a number of rock specimens were collected, and about forty photographs of scenery and of interesting geological sections were taken.

In July, August, and September Mr. Weston made an examination of the formations from Sault Ste. Marie eastward along the northern shores of Lake Huron. The Huronian strata were carefully, but unsuccessfully, searched for fossils, a good suite of rock specimens was, however, secured, and a number of fossils was obtained from the Cambro-Silurian formations, chiefly of St. Joseph and La Cloche Islands, where we find the eastern limit of the Sault Ste. Marie or St. Peter sandstones. Expenses, $272.42.

Leaving Sault Ste. Marie again on the 27th August, the writer proceeded by steamer to Prince Arthur's Landing, with the intention of examining the country, thence to Winnipeg, along the line of the Canadian Pacific Railway.

This could not be carried out, as the trains, owing to a break on the line, were not running, and there was no certainty when traffic would be resumed. It was, therefore, decided to proceed, *via* Duluth, to Winnipeg, which was reached on the 2nd, and left on the 5th of September, for Portage La Prairie and Westbourne, where some days were spent in examining the country around the southern shores of Lake Manitoba. No rock exposures were found, the surface of the country being everywhere covered with a deep black soil, resting on a great, but varying, thickness of drift, which is well exposed in the banks of the White Mud River. Some worked flint chips and arrow heads were found at one point on the lake shore, a short distance east of the mouth of White Mud River. They were apparently washed up from the bed of the lake. On the 11th September I proceeded to Brandon, and thence, southward, across the plains to the Souris River. Several days were spent in the vicinity of Souris City and around the Brandon Hills. Thence the country was examined *via* the Tiger Hills, Rock Lake, and the Pembina River to Emerson, arriving there on the 3rd October and leaving again to return east on the 5th. Cost of season's explorations $1,179.34.

It seems very desirable that further explorations should be made in the Souris valley and the adjacent country. The Cretaceous rocks which crop out there are apparently nearly on the same horizon as those in which the lignite coals of the Bow and Belly Rivers occur. A careful search may therefore, very possibly, result in the discovery of workable lignite coal beds, either in the lower part of the Souris River valley, or between it and the valley of the Pembina.

It is unnecesary to dwell on the vast importance of such a discovery to all the inhabitants of this magnificent agricultural region; but from the general drift-covered and even character of the country, and from the strata being practically horizontal over such wide areas, there is little hope, even though they exist, of coal beds being discovered, except accidentally, without having recourse to boring. From the comparatively soft nature of the strata to be penetrated, this would not be a very costly operation; but, in any case, twenty or thirty thousand dollars judiciously applied would be money well spent in view of settling such an important question. It is proposed during the ensuing summer to thoroughly investigate the matter, so far, at least, as a careful examination of the surface and of all natural exposures will enable this to be effected. Attention has been called to the probable value for brick making of some of the smooth fine-grained Cretaceous shales which are cut by the Souris and Assiniboine Rivers, and the result of experiments made by Mr. Hoffmann on the samples submitted to him will be given in the annual report. They seem to show that we have, in these shales, an excellent material for the manufacture of the most refractory bricks, if not also for fine earthenware; and, if workable seams of lignite should be discovered associated with these shales, the manufactures referred to would be greatly facilitated.

Quebec and New Brunswick.

The explorations and surveys in New Brunswick were continued during the season by Mr. R. Ells and Mr. W. Broad, those of Mr. Ells having extended into the province of Quebec, around the north shore of the Bay of Chaleurs and the Gaspé Peninsula, from Cape Rosier to Métis. The examination included the valleys of the Restigouche and Metapedia, and of the Dartmouth and St. John Rivers of Gaspé. The St. Anne and the Magdalen Rivers were also ascended, and some observations were made in the Shickshock Mountains. This region is probably an important one, but the difficulties in the way of its exploration are very great. The rough and precipitous character of the numerous streams proceeding from it, and the dense forest which covers the whole of the intervening country, except the rugged summits which rise to elevations above the tree line, together with the entire absence of tracks or roads of any kind, are obstacles which have hitherto prevented the acquisition of any really accurate geographical or geological details concerning it; and, before these can be obtained, the requisite surveys and explorations will probably have to be undertaken during the winter.

It can, however, now be affirmed that this extensive mountain region has no connection with the Cambrian (Lower Silurian) formations of the *Quebec group*, but is a detached area of the Pre-Cambrian formations which constitute the chief mineral-bearing belt of the Eastern Townships, extending from the Vermont boundary north-eastward to a little beyond the latitude of Quebec. In the Shickshock Mountain area as yet only serpentine and chromic iron have been recognized, but as these everywhere accompany the deposits of crysotile or asbestus, and the ores of copper, lead, antimony, and iron, with some gold and silver, in the region to the south-west, it is not unreasonable to anticipate their discovery in this unexplored area of the Gaspé peninsula. It should therefore be more closely examined, and its physical and geological features more accurately determined. The measurements and observations made during the past season by Mr.

Ells in furtherance of this object were, from the causes already referred to, chiefly confined to the proximity of the coast, and to some of the more accessible of the river valleys. In the prosecution of this work between Little Pabos and Métis 300 miles of road were chained, 135 miles of road and 275 miles of shore line were paced, and interesting and instructive photographs of the scenery were secured. Collections were also made of typical rocks and of the fossils from the newer formations which surround and lie against the older nucleus of the mountains. The highest peaks of these attain to elevations ranging from 2,000 to 3,700 feet above the sea, and were graphically described, now nearly forty years ago, by Sir W. E. Logan. (P. 13, Report of Progress, Geological Survey, 1844).

Mr. Ells was assisted by Messrs. Low, Brumell, and Peers, and the cost of the season's exploration was $1,376.61, including the salaries of Messrs. Low and Brumel to the first of October, and of Mr. Peers to the 15th of September.

In western New Brunswick, counties of York and Carleton, Mr. W. Broad continued the surveys and explorations, in which he has now been engaged for four seasons, assisted during the past season by Mr. Robert Chalmers and by Mr. McInnes, B.A.

Mr. Chalmer's attention was devoted entirely to the superficial geology of the area, and a detailed report of this investigation will be prepared.

Mr. Broad and Mr. McInnes devoted their attention chiefly to the procuring the additional data required to complete the map, and in doing this surveys were made of the different branches of the Eel, Meduxnakeag, Nackawick, Keswick, and Mactagnac Rivers. The roads on both sides of the St. John River, between Woodstock and Victoria Corners, were surveyed with odometer, and the banks of the river between the points named were measured by pacing. Various small streams and wood roads were also traversed, and Mr. Broad states that the region in which he has been working, embracing about 4,000 square miles, is now surveyed with minuteness of detail not hitherto attained in any other part of New Brunswick.

The field work commenced about the 18th of June, and was continued to the 13th of November. The cost including salaries of Messrs. Chalmers and McInnes, the former to the 20th of September and the latter to the 31st December, was $1,071.79.

Nova Scotia.

In eastern Nova Scotia, the work was continued by Mr. Hugh Fletcher; but owing to the lateness of the season, very little was done in Cape Breton before the 7th of June. A detailed examination was then made of the manganese mines, extensively worked by the Hon. E. T. Mosely, in the lower Carboniferous rocks at Enoch, Loch Lomond, and also a further examination of the copper mines which are worked in the Pre-Cambrian rocks of the Coxheath hills, and which were described p. 123 F. of the Geological Report, 1879-80.

The Survey of the Baddeck and St. Ann's Rivers was then resumed, and finished about the end of August. On the lowland near the mouths of the rivers of this region, and along the "intervals" or alluvial flats which border them for many miles, Carboniferous strata occur, while the adjoining hills are composed of gneissic, granitic and felsitic rocks, making the structure of the country both physically and geologically similar to that of other portions of Cape Breton previously examined.

The remainder of the season was occupied in Guysboro and Antigonish counties, in continuing the work commenced in 1879-1880. In September heavy rains caused the suspension of the survey of brooks and lakes much earlier than usual; but nearly all the roads of Guysboro county, and many in Antigonish, were traversed by odometer or by pacing, and subsequently a preliminary inspection of most of the gold fields was made.

Near Guysboro there are deposits of specular iron ore like those described p. 122 F. Report of G. S. C. 1879-1880. The most important of these is worked by the Crane Iron Company, of Philadelphia. Three thousand tons of excellent ore have been taken out; but the distance from a good shipping place and bad roads renders its transport very costly. It sells in the United States for $7 and $8 per ton of 2,000 lbs., and is used as a lining for puddling furnaces.

The examination of this mine was greatly facilitated by the kindness of the manager, Mr. James Williams.

In November Mr. Fletcher spent some time at Albert, in New Brunswick, examining the curious copper deposits which occur there in so many places, in the form of grey copper ore replacing vegetable remains in the Carboniferous rocks, and also a yellow copper pyrites in rocks similar to those in which the Coxheath copper mine in Cape Breton is worked—probably Pre-Cambrian. One of these deposits in New Ireland seems to be well worth developing. Owing to litigation the work is now suspended.

Mr. Fletcher also visited and examined the coal seam on the Debert River, Londonderry county, but no definite information concerning it could be obtained. Many shallow pits have been sunk on the river flat, from which fragments of bright clean bituminous coal have been thrown out. The pits were all full of water, but there was no evidence to show that in any of them a solid seam of coal had been cut. Reports state the seam to be four feet thick, underlaid by a small seam of fire clay, and this by more coal. A seam of about the same thickness, opened years ago on the opposite side of the river, is stated to consist of black shale with only three bands of good coal, none of which exceeds four inches in thickness. This is probably the character of that found in the shallow pits above referred to. A brief examination was also made in December of some of the gold mines in Halifax county.

Mr. Fletcher was assisted by Messrs. John McMillan, Rodolphe Faribault, J. A. Robert, and M. H. McLeod. The field work continued from June to December; expenses, $1,315.00, including salaries of assitants, two to the 31st of August and two to the 15th of December.

The topographical survey of the Nova Scotia gold fields by Mr. W. Bell Dawson referred to in my last summary report as having been commenced in June, 1881, with the co-operation of the Provincial Legislature, was, it is to be regretted, not continued during the past summer, no funds having been provided for the purpose by the Local Government.

On the 12th June the plotting of the field observations was completed and plans were made of the Laurencetown, Montague and Waverly gold fields on a scale of 500 feet to one inch and also one sheet of the general map, embracing 18 by 12 miles, or 216 square miles, was prepared on a scale of two inches to the mile.

The surveys have extended beyond the limits of this sheet, and these have been plotted separately, to be included in the next sheet, so soon as the continuation of the field work will enable this to be prepared. The cost of the survey, as found by dividing the total expense by the area covered, is $16.75 per square mile.

Paleontology and Natural History.

With a view to exhibiting the whole of the species in the possession of the Survey, from each formation, a reclassification of the fossils in the museum has been commenced. This reclassification, which is being ably carried out by Mr. Tyrrell, has necessitated the opening of about one hundred boxes of specimens, from which many of the species have been selected, identified, labelled, and incorporated into their proper place in the collection. The rearrangement of the fossils of the St. John's, Potsdam, Calciferous, and Chazy formations has been completed, and much progress has been made in the reclassification of the Silurian and the rest of the Cambro-Silurian species. The nomenclature of all the Cambrian and Cambro-Silurian fossils, with the exception of those of the Hudson River formation, has been revised, and new labels for each species have been printed.

The graptolites and other fossils collected by Mr. T. C. Weston in 1877, and by Mr. R. W. Ells in 1882, from the coast between Matanne and Little Fox River, in the province of Quebec, have been studied by Mr. H. M. Ami, and identified so far as their state of preservation would admit.

A critical and microscopical revision of the Canadian *Monticuliporidæ* has been commenced by Mr. Foord, and the results of his investigations, which have been based on 284 thin sections skilfully prepared by Mr. T. C. Weston, will be published at an early date.

The Survey is again indebted to Principal Dawson for the preparation of the second part of his Report on the Devonian (Erian) and Silurian fossil plants of Canada. This Report, consisting of forty-nine pages of letterpress and four plates, R. 8vo., has been printed and distributed during the summer.

Two papers, one "On the Fossils of the Lower Cretaceous Rocks of British Columbia," and the other "On some supposed Annelid Tracks from the Gaspé Sandstones," have been prepared and were read by Mr. Whiteaves at the first meeting of the Royal Society of Canada in Ottawa. Papers were also prepared and read at the same meeting by Professor Macoun "On the Distribution of Northern, Southern, and Saline Plants in Canada," and by Dr. Bell, on the "Birds of Hudson's Bay."

At the meeting of the American Association for the Advancement of Science, held in Montreal last August, some of the most interesting fossils collected by officers of the Survey during the past three years were exhibited in the Geological Section. Before the same section, also, two papers were read, one "On the Recent Discoveries of Fossil Fishes in the Devonian Rocks of Canada," and another "On the Occurrence of *Siphonotreta-Scotica* (Davidson) in the Utica Formation, near Ottawa, Ontario." In the Biological Section a paper was read "On a Recent Species of *Heteropora* from the Strait of Juan de Fuca." Two of these papers have since been printed *verbatim* in the October number of the *American Journal of Science.* Assistance has been given to Professor W. Dwight, of Vassar College, Poughkeepsie, New York, in the preparation of a paper read at the same meeting, "On the Geology and Paleontology of the Wappinger Limestones of Duchess County, New York," by the comparison of suites of fossils forwarded from that locality with Canadian types in the museum of the Survey.

A collection of 200 specimens, from the Hamilton formation in the vicinity of Widder, Ontario, comprising many species not formerly represented in the museum, and some apparently new to science, has been presented to the survey by the Rev. Hector Currie. A catalogue of the species contained in this collection has been made and forwarded to Mr. Currie, together with a series of duplicates from other formations.

To the kindness of the Rev. J. M. Goodwillie, of Calamachie, Ontario, the Survey is also indebted for a series of rare fossils from the Niagara and Hamilton formations; and lists of the species presented have been made and mailed to the donor.

120 specimens of fossils from the Medina, Clinton, and Niagara formations have been presented by Colonel Grant, of Hamilton, Ontario. A slab about seven feet long, the finest specimen known of foot prints of *Sauropus unguifer* (Dawson) from Nova Scotia, was presented by Sandford Fleming, Esq., C.M.G. A cast of this unique specimen has been made and presented to the Redpath Museum, Montreal, and a smaller specimen, from the survey collection, of foot-prints of the same species was presented by request of the donor, to the University of Kingston.

Mr. H. W. Ami has presented 125 specimens from the Utica formation near Ottawa; and Mr. W. H. Billings has presented seven named species from the Trenton limestone, near Ottawa, not previously in the collection.

The principal collections of fossils made by officers of the survey during the past year are as follow:—

By T. C. Weston.—About 100 specimens of Carboniferous fossils from the S. Joggins, Nova Scotia, including two large stumps of *Sigillaria Brownii*, leaves of *Cordaites* slabs of *Anthracomya*, *Stigmarian* roots, *Calamites*, *Lepidodendron*, *Dadoxylon Lepidophloios*, *Spirorbis*, and scales and teeth of fishes. About 100 specimens of Black River and Trenton fossils from Gravel Point, St. Joseph's Island, Lake Huron.

By A. H. Foord.—Twenty-three specimens of fossil fishes from the Devonian rocks of Scaumenac Bay, P.Q., and 130 from Campbellton, N.B.

By R. G. McConnell.—About 100 specimens of molluscous and vertebrate fossils from Milk River Ridge, Highwood River, South Saskatchewan, and other localities in the Bow and Belly River districts, North-West Territory—all of Cretaceous or Tertiary age.

By A. H. Foord and H. M. Ami.—About 100 specimens of fossils from the Trenton limestone, near Ottawa.

By R. W. Ells.—Twelve specimens of graptolites from Matanne, three from the Marsouin River, and twenty-five from Gagnon's Beach, P.Q., 615 fine and rare fossils mostly from the Guelph Silurian limestones, have been acquired by purchase from Mr. Joseph Townsend, of Durham, Ontario.

Collections of fossils containing about 182 species have been sent to Queen's College and to the Royal Military College, at Kingston, and twelve more are in course of preparation for distribution to other local educational institutions. A number of casts of tracks from the Potsdam formation has been presented to the museums of the Universities of Toronto, Kingston, McGill and Laval.

Early in the year, Professor John Macoun, of Belleville, was appointed Botanist and Natural History Collector to the Survey, and during the summer he was occupied in investigating the botanical features of the western peninsula of Ontario, from the head of Lake Erie to the Niagara River. Later, towards the end of July, he proceeded to Gaspé, and there investigated the coast and alpine flora of that interesting peninsula. The Shickshock Mountains were ascended, and the coast was carefully examined from Cape Rosier to Ste. Anne des Monts (about 200 miles), as were also portions of the shores of Gaspé Bay and of the Bay of Chaleurs. Specimens of the rarer species and of others not represented in the herbarium were collected; material, moreover, was obtained for a full report on the botany of the regions explored. Professor Macoun has been engaged during the autumn in classifying and arranging the herbarium, and has commenced the preparation of a complete catalogue of Canadian plants, the first part of which will be ready for publication during the ensuing year.

In November, Professor Macoun was instructed, at the request of the Minister of Marine and Fisheries, to make a collection for the forthcoming Fishery Exhibition of objects of marine natural history, especially sea weeds. After consultation, it was decided that the shores of Prince Edward Island, and of the south-western part of Nova Scotia, would afford the best facilities for the work. Accordingly Prince Edward Island was first visited, and then Halifax and Yarmouth. Professor Macoun left Ottawa on the 16th November, and returned on the 14th December. He succeeded in making a fair collection; but it is to be regretted that the work was not undertaken earlier, and at a season of the year when it would have been possible to attain results more complete and more commensurate with the importance of the object in view. Since his return, considerable time has been spent in arranging and preparing the collection for exhibtion.

Of the collections in recent natural history, alluded to in my report last year, two have since been purchased for the museum. The most important of these is the very fine collection of shells, the property of Mr. Whiteaves containing nearly 6,000 species, and upwards of 14,000 specimens, from all parts of the world; together with a fine collection of named Jurassic fossils, in which 598 species are represented by about 1,800 specimens—in all, upwards of 15,000 specimens, for the very moderate sum of $2,000. About 3,000 species are now temporarily arranged in trays, in the museum, preparatory to their being permanently mounted and labelled. The other collection referred to is one of Canadian birds and mammals, the property of Dr. Bell. It represents thirty species of birds, and thirteen species of mammals, and consists of fifty-six specimens. This collection is mounted and exhibited, and was purchased for $719. In connection with it, and with the considerable collection of bird's skins, already made by Professor Macoun, and now in the museum in drawers, and in view of further additions to the recent natural history collection, the services of an efficient taxidermist are greatly needed. I would also, in this connection, again call attention to the necessity of taking some steps to provide additional accommodation, either in the manner suggested in my report last year, or in any other which may be deemed more desirable.

Chemical and Mineralogical.

The work in this branch of the Survey during the past year has, apart from the analysis of one or two minerals possessing chiefly a scientific interest, consisted almost exclusively in the examination and analysis or assay of minerals of economic importance, including gold, silver, copper, lead, iron, manganese, and plumbago; also, the testing of certain clays in regard to their adaptability to brick making, and the partial quantitative analysis of some lake and river waters.

A series of analyses of the North-West lignite coals has been commenced, and is now in progress. This, when completed, will probably show, in a very interesting and conclusive manner, the intimate connection which apparently exists between the economic value of the seams and their proximity to areas which have been, either locally or generally, affected by movements of upheaval or depression producing heat and pressure.

Rather more than two hundred mineral specimens have been received for identification, or for an opinion of their economic value. In all cases the information asked for has been given, either personally or by letter.

The defective supply of gas in the laboratory mentioned in my last report has been remedied by the means then suggested, and no further difficulty in that respect has been experienced; and, with the exception of the apparatus for procuring distilled water, the fittings in the laboratory and in the assay room are now satisfactorily completed.

In 1881, Mr. Adams obtained, on my recommendation, six months leave, to visit Europe for the purpose of studying lithology, and acquainting himself with the latest and best methods in use for the microscopic examination of rocks. Since his return, in September, 1881, his time has been about equally divided between chemical work and micro-lithology; and he has examined and determined by this method a large number of the interesting crystalline rocks of the "Quebec Group," the character and geological relations of which could not be otherwise ascertained with certainty.

Mr. Hoffmann's time and attention has also been devoted to superintending the arranging, classifying and labelling of the mineralogical and stratigraphical collections, work which has been ably and industriously carried out by Messrs. Willimott and Broadbent; to complete this undertaking, however, a considerable amount of labour is still required.

Twenty names have been entered as having presented specimens to the mineralogical collections during the year. All such specimens, when in the museum, are labelled with the name of the donor.

Four papers were prepared by officers of the Survey and read at the meeting of the Royal Society of Canada in the Geological Section—by Dr. Bell, on "The Present Condition of the Mining Industry in Canada." And on "The Discovery of Zinc Blende on the North side of Lake Superior;" by Dr. G. M. Dawson, "Descriptive Notes of a general section from the Laurentian Axis to the Rocky Mountains;" and by the writer, on the "Quebec Group."

Twenty-one named collections of minerals and rocks have been made, labelled, catalogued, and distributed to educational institutions. These comprised in all 2,283 specimens. About 100 boxes of specimens have been opened, sorted, and classified, the useless specimens being rejected and the remainder, not wanted for the museum, repacked in such a manner as to be easily available for reference or exchange or for making up collections for presentation. This work was performed by Mr. C. W. Willimott, assisted by Mr. Brumell. In August and September, Mr. Willimott visited and examined several mining districts for the purpose of procuring specimens wanted for the museum collection, and also material for collections for distribution to educational institutions. At the same time statistics of all the mines visited were obtained, the details of which will be given in the annual report now in course of publication.

During the year ending 31st December last, 3,268 copies of the Survey publications have been distributed, a larger number than during any previous year. Of these 2,372 were distributed in Canada, 1,902 being in the English language and 470 in French. The remainder (869) were sent to scientific and literary societies in America, Europe, India, Japan, and Australia. In return for these, 435 publications, including books, transactions, memoirs, periodicals, pamphlets, and maps have been received. Many of these publications and a large number of other valuable books in the library are still unbound, and consequently it is only with difficulty, and at the risk of injury, that they are available for reference by the public or by members of the staff. Library.

Since the 20th May last, the Government contractor has only accomplished the binding of 138 volumes, at which rate of progress it will require four years to finish binding the books now in the library.

Thirty-three scientific magazines and periodicals have been subscribed for, a list of which is given in the Annual Report.

Eighty volumes have been added to the library by purchase.

There are now in the library about 4,500 volumes. The catalogue is being proceeded with, and will, it is hoped, be ready for printing some time during the ensuing year.

Visitors.

9,549 names have been entered in the register of visitors to the museum during the year, the largest number in any previous twelve months of its existence having been 1,652. This large increase of visitors must be regarded as exceedingly satisfactory for the first year of the establishment of the museum at the Capital; and I venture to express the hope that the future liberality of Parliament will enable the popularity and usefulness of the institution for practical, scientific, and educational purposes to be yet very largely increased.

Staff Appropriation and Expenditure.

The strength of the staff at present employed is thirty-eight of all classes, viz: professional, twenty-six; ordinary, twelve.

The appropriation for the current fiscal year ending 30th June next, was $60,000, against which the whole expenditure for the Geological and Natural History Survey, and for the maintenance of the museum, is charged, including the salaries and wages of all employés, which this year will amount to about $33,000.00.

The following changes have occurred during the year:—Dr. Thorburn was appointed Librarian on the 12th of April, 1882. Mr. A. Webster resigned on the 1st of October, after six months leave; and Mr. Wallace Broad was promoted to the vacancy. Messrs. Low and McMillan were appointed Assistant Field Geologists from the 1st of July, 1882; and Mr. Broadbent was appointed Museum Assistant (Mineralogical section) from the same date. Mr. Grignard was transferred, on the 5th of July, to the Dominion Lands branch. Dr. G. M. Dawson was absent in Europe, on leave without pay, from the 1st May to the 31st of December. While there he studied the process in use for the manufacture and utilization of lignite as fuel, a subject of considerable importance in connection with the development of the vast deposits of this material in the Canadian North-West. The result of Dr. Dawson's observations will be given in a future report.

Approximately stated, the expenditure during the six months, ending 31st December, 1882, has been, under the divisions named as follows:—

Salaries and wages	$16,474 91
Exploration and survey	13,480 42
Printing and lithography	633 46
Purchase of specimens	2,170 00
Purchase of books and instruments	332 62
Chemical and laboratory apparatus	101 84

Stationery	242 25
Fuel	598 95
Incidental expenses	596 24
	$34,630 69

The correspondence of the branch shows 1,445 letters sent and 1,938 received.

OTTAWA, January 1883.

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FROM JANUARY 1st, to DECEMBER 30th, 1882.

BY PRESENTATION.

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Department of Mines, Nova Scotia :—
Report. 1881.

Pickering College :
Announcement. 1881-82.

Entomological Society of Ontario :—
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Stipendiary Magistrates of Ontario :—
Report. 1882.

List of Members of the House of Commons. 1882.

Messrs. Murray, Stewart and Harvey, Halifax, N.S. :—
Statement of facts relating to Mt. Lloyd Copper Mine.

Extracts from Treatises on the Coal bearing districts of Notre Dame Bay, N.F.

Minister of Railways and Canals, Canada :—
Report. 1881.

Minister of Militia and Defence, Canada :—
Report. 1881.

Meteorological Report of Canada. 1880.

W. H. Smith, Ottawa :—
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Annual Report. 1881.

Dr. G. M. Duncan, Bathurst, N.B. :—
Discovery of Tripoli, or Polishing Powder, near St. John, N.B. 1881.

Silver Islet Harbour, as a Lake Superior Terminus of the Canada Pacific R. R.

New Brunswick Natural History Society.
Bulletin No. 1. 1882.

J. B. Goode, Yale Lytton, B.C. :—
A Vocabulary and Outlines of Grammar of the Nitlakapamuk, or Thompson Tongue. 1880.

F. de Saint Maurice :—

La Province de Quebec et la Canada au Troisième Congrès International de Geographie à Venise. 1881.

Canada Gazette....................................Volume XV., Nos. 50-53.
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Annuaire du Seminaire de Chicoutimi..........................No. 2. 1881-2

Prof. E. J. Chapman :—

A classification of Crinoids (23 copies). Pamphlet on the probable nature of the supposed fossil tracks known as Protichnites and Climactichnites.

B. J. Harrington :—

Pamphlet. Note on the Composition of Dawsonite.

Geographical Society of Quebec :—

Transactions.................................Volume I., Number 2.

Literary and Historical Society, Quebec :—

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Fifty-First Annual Report for the Year 1882.

Ed. Gilpin, Jr., A.M., F.G.S. &c. :—

The Gold Fields of Nova Scotia. 1882.

The Minerals of Nova Scotia, Dominion Exhibition. 1882.

Department of the Interior, Canada :—

Report. 1881.

Ottawa Field Naturalists' Club :—

Transactions..Number 3, 1881-2.

The A. A. A. S. Visit to Montreal :—

Hand-Book. 1882.

H. G. Vennor :—

Weather Bulletin...................................Volume 1, Numbers 6-9.

Inspector of Insurance for Ontario :—

Report. 1881.

McGill College :—

Annual Calendar. 1882-83.

Commissioner of Crown Lands, Ontario :—

Reports. 1869-81.

Newfoundland.

Alex. Murray, C.M.G., Director Geol. Survey :—

Report of Progress and Maps for 1881.

ENGLAND.

Royal Society, London :—

Proceedings...........................Volume XXXIII., Numbers 216-218.
" .... " XXXIV., " 220-221.

An account of the Botanical collection made in Kerguelens Land, during the transit of Venus Expedition. Volume (extra) 168 (Philosophical Transactions of the Roy. Soc., 1879).

Royal Geographical Society, London :—
Proceedings..Volume IV., Numbers 1-12.

Manchester Geological Society :—
Transactions ....Volume XVI., Parts 11-18.
" .... " XVII., " 1-2.

Plymouth Institution :—
Annual Report and Transactions.........................Volume VII., Part 3.
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Geographical Society of Cornwall :—
Transactions..Volume X., Part 4.

R. Etheridge, Jr., and P. Herbert Carpenter, M.A., Asst. Master Eton College :—
On certain points in the Morphology of the Blastoidea—with descriptions of some new Genera and Species.

P. H. Carpenter, M.A. :—
On certain points in the Morphology of the Blastoidea.

Professor T. R. Jones, F.R.S. :—
On some Leperditiæ. 1882.

Birmingham and Midland Institute :—
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University Library, Cambridge, England :—
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Botanical Society, Edinburgh :—
Annual Reports. First, Third, Fourth, Fifth, Sixth, Seventh and Eighth.
Proceedings. 1855.
Transactions.......................................Volume I., Part 1-2.
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" .... " VII.
" .... " VIII., " 2.
" .... " X., " 1.
" .... " XI., " 3.
" .... " XII., " 2, 3
" .... " XIII., " 2, 3.
" .... " XIV., " 1, 2.

Geological Society, Glasgow :—
Transactions.................................Volume VI., Part 2. 1878-80.

Glasgow University :—
Calendar..1882-83.

Royal Society, Edinburgh :—
Transactions..............................Volume XXX., Part 1, 1880-81.

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Royal Society, Edinburgh :—

Proceedings..1880-81.

Institution of Engineers and Shipbuilders in Scotland :—

Transactions..1881-82.

J. H. Balfour, M.D., and Chas. C. Babington, F.L.S. and F.G.S. :—

Account of Botanical Excursion to Skye and the Outer Hebrides. 1841.

W. S. Millar, C.E. :—

On the Dimensions of Cast Iron at various temperatures, with more especial reference to the Phenomena of the solid floating on the molten metal.

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Royal Dublin Society :—

Proceedings..............................Volume I., (2nd Series) Part 18.
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Report, from May, 1880, to January, 1882.

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Selections from Embryological Monographs, I. Crustacea, Volume IX., No 1. By Walter Faxon.

Michigan :—

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Geological Survey....................................Volume IV. 1880.

Graydon and Denton, Jersey City, N.J. :—

Rock Drills, Air Compressors, and Steam Pumps.

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Kansas City Review of Science and Industry........Volume VI., Number 4.

University of Pennsylvania :—

Contributions from the Laboratory to Mineralogy. By F. A. Genth. No. 20.

New York State Survey :—

Report. 1880.

Buffalo Society of Natural Science :—
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"Boulder County as it is."

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Walter McDermott, Chicago :—
The Frue Ore Concentrator, or Vanner.

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First Annual Report, Bureau of Ethnology, to the Secretary. 1879-80. J. W. Powell, Director.

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Historical Sketch of the U. S. Naval Academy. 1876.

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T. Egleston :—
The causes of rustiness and of some of the losses in working gold.
The formation of gold nuggets and Placer Deposits.

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Horatio T. B. Burchard, Director of the Mint, Washington :—
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Production of Gold and Silver in the United States. 1880.

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John D. Runkle, Ph.D. :—

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The dangers of impure ice.

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Preliminary Reports on the Building Stones, Clays, Limes, Cements, Roofing, Flagging, and Paving Stones of Minnesota. By W. H. Winchell.

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Geology of Frenchman's Bay, Maine.

Absence of the joint structure at great depths (from Geol. Mag., Sept., 1881.)

Extension of the Carboniferous Formations in Mass. By Prof. W. O. CROSBY and G. H. BARTON.

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INDEX
TO THE
COLOURS AND SIGNS
EMPLOYED IN THE MAPS AND SECTIONS OF THE
GEOLOGICAL SURVEY OF CANADA.

Further subdivision of formations can be denoted by additional small letters thus: $B\,2^a$ $B\,2^b$ $B\,2^c$ *indicating first, second or third division of Middle Huronian, &c.*
When required to designate different kinds of igneous rocks, initial letters in white can be used, as: Gr, *Granite.* Fel, *Felsite.* Ba, *Basalt.* Do, *Dolerite.* Di, *Diorite.* Dia, *Diabase.* Sy, *Syenite.* Tr, *Trachyte.* Me, *Melaphyre.* An, *Andesite.* Rh, *Rhyolite.* Ga, *Gabbro, and the age of such rock can be denoted by the letters,* A, &c., *assigned to the several systems.*

Signs connected with the Glacial Drift.

Roches moutonnées, (not striated.)
" " *striated, but direction of ice-flow not apparent.*
" " " *showing direction of ice-flow,*
Plane or flat surface. striated.
" " " " *where direction of ice-flow is visible.*

Signs indicating the Ores of the Metals and Minerals

Au. *Gold.* Ag. *Silver.* Cu. *Copper.* Sn. *Tin.* Pb. *Lead.* Zn. *Zinc.* Mn. *Manganese.* Fe. *Iron.* Bi. *Bismuth.* Pt. *Platinum.* Sb. *Antimony.* Mo. *Molybdenum.* Hg. *Mercury.* C. *Plumbago.* Ba. *Baryta.* Sr. *Strontia.* Ap. *Apatite.* S. *Salt.* K. *Kaolin.* Asb. *Asbestos.* Mi. *Mica.* Sp. *Soapstone.* Black lines, *Coal Crops.* Gold lines. *Mineral Veins.* Vertical blue bars, *Gypsum.* *Mine.* *Mineral Spring.*

Signs connected with Stratification

Horizontal. } *Strata.*
Vertical (longest line the strike.)
Contorted.
Dip. (angle and direction.)
Cleavage.
Anticlinal Axis.
General Dip of Undulating Strata
Undulating Strata.
Synclinal Axis. F. Fossils.

Interrupted lines — — — *show a doubtful or drift-covered Boundary.* White lines, *Faults*

Reference to Specimens in the Museum. R 10 *Rock.* M 12 *Mineral.* F 150 *Fossil*

Geological notes and geological references of all kinds are printed in red or white.

Alfred R. C. Selwyn, LL.D., F.R.S., F.G.S., &c.

DIRECTOR

1881.

Geo. E. Desbarats & Co. Montreal

GEOLOGICAL NOMENCLATURE

AND THE

COLORING AND NOTATION OF GEOLOGICAL MAPS

BY

ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S.

DIRECTOR OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

The scheme, the details of which are now given, for securing uniformity in Geological Nomenclature and in the coloring and notation of Geological maps and sections, was prepared for the consideration of the Geological Congress held in Bologna, in September, 1881. It has never been published, but as it has now been adopted for the maps and in the reports of the Canadian Geological Survey, I have considered it desirable that the explanation of it should find a place in the survey report for this year.

Though specially designed to meet the requirements of the Canadian Survey, embracing one half of the continent of North America and formations of every *Age* from the *Archean* to the "*Acrozoic*" * or *Human Period*, it is, I believe, applicable to all countries, and requires very little explanation. New or unknown terms have been studiously avoided, and the chief aim has been to give a definite and constant signification to terms already in general use, but hitherto with an ever varying meaning.

Absolute uniformity of procedure in the matters under consideration, however desirable in the interest of geological knowledge, will probably never be attained, but there seems no reason why in countries so closely connected as those of the United States and British North America, such perplexing differences as are now of constant occurrence,

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* This name denoting the summit or culminating point, was suggested by my colleague, Mr. J. F. Whiteaves. It is better than "*Anthropozoic*" suggested by myself or "Human Period" or "Age of Man," and I propose to adopt it, as it gives euphonious correspondence to the terminology used for the "Ages."—A.R.C.S.

should continue. In the mean time, those who are actively engaged in carrying on extended State Surveys, cannot await the deliberations and final conclusions of a general Geological Congress, but are compelled at once to adopt some plan suited to the requirements of their own work, and having, after due consideration, done so, to change it is exceedingly inconvenient, and except for some very weighty reason undesirable.

1. Stratigraphical Nomenclature.

The terms I would propose to use, and their relative importance, chronologically and geologically, are as follows:—

1. Age.
2. System or Terrane (I prefer the former.)
3. Group.
4. Formation.
5. Series.
6. Bed or Stratum.

1 and 2 are of universal application, and can be uniformly colored and noted on maps, &c.; 3, 4, 5 and 6 are all more or less local, and would generally require local names and special colors to define them, and this should be done by lines, dots or other devices in the color or shades of the color adopted for the system to which the subdivision belongs.

In the above scheme,

An *Age* comprehends one or more *Systems.*
A *System* one or more *Groups.*
A *Group* two or more *Formations.*
A *Formation* one or more *Series.*
A *Series* a collection of *Beds* or *Strata.*

The terms Primary, Secondary, Tertiary, &c., are objectionable, the first as making no distinction between the Palæozoic and the very distinctly older systems, and the last because required for the system succeeding the Cretaceous. So, also, is the use of all the terms, *Age*, *Epoch*, *Era*, *Period*, *Time.* These are all to some extent synonymous, and have no recognized or definite relation to each other as measures of time, like year, week, day; either of them might be adopted to denote the primary and largest or most comprehensive division of geological time. But whichever is adopted for this purpose, the others should be dropped. Considering the etymology and usual application of these terms, I consider *Age*, corresponding with the Greek *Eon*, in every respect the most suitable, notwithstanding its double signification, as the *age in which we live* and *his age is five years*, which, however, in practice, can never cause any confusion or inconvenience. Thus the *Ages* would be :—

1. Archean.
2. Palæozoic.
3. Mesozoic.
4. Cenozoic.
5. Anthropozoic or "Acrozoic" (summit or culminating point,) denoted by the Roman numerals I. to V.

The Systems :—

1. Laurentian.
2. Huronian.
3. Cambrian.
4. Cambro-Silurian.
5. Silurian.
6. Devonian.
7. Carboniferous.
8. Triassic.
9. Jurassic.
10. Cretaceous.
11. Tertiary.
12. Quarternary or Post-Tertiary. (Denoted by the letters A to M.)

The term Cambro-Silurian will probably be objected to. It is, however, advocated as being in Canadian stratigraphy convenient; as to some extent reconciling the conflicting claims of the eminent authors of the names, and further as indicating the stratigraphical and zoological continuity in the systems indicated.

We thus have five *Ages*, twelve *Systems*, and an indefinite and locally varying number of *Groups, Formations* and *Series*.

2. Coloring and Notation.

These, as proposed, are shown on the accompanying Chart or Index, and also in the published maps of a portion of the Canadian province of New Brunswick. In many respects, the colors selected appear to accord with those recommended by others, as expressed in the Reports of the several Commissions.

For large scale maps, where minor and purely local subdivisions of Groups and Formations or Series have to be represented, uniformity is impossible, and even in general or small scale maps tints will seldom correspond, and colors fade. I therefore consider the system of lines, dots or other marks in the color, and notation even more important in facilitating the reading and study of geological maps, &c., than the actual color.

I have supposed every system to be divisible into lower, middle and upper parts, these to be respectively indicated by vertical, inclined (left to right downwards) and horizontal lines, and further by figures 1 2 3 appended to the letter denoting the system. Any number of minor and local divisions can be indicated by the addition of a small letter (*a*) being always used for the lowest number, and so on in ascending order alphabetically. (See Chart.)

Crystalline stratified rocks of all *Ages* newer than the *Archean* would be defined by diagonal bars of the color used for the *System*, with (*m*) (Metamorphic) added.

Blue tints to be reserved for limestone strata and formations.

Deep Red tints (Carmine and Vermilion) to be used exclusively for *e*ruptive and *ir*ruptive rocks—the kinds being distinguished by white letters as shown on the Chart, and by bars, dots or other devices in the color.

If the age is known, the *System* letter can be added, thus—Fel. F. = Devonian Felsite.

All other geological references on maps, &c. (notes, letters and other conventional signs), should be printed in Red, and this can be usefully carried out on uncolored maps published to illustrate exploratory surveys.

For practical application see map of a part of the Canadian North-west Territory, published with Report for 1879–80.

All labels on specimens in museums should be colored to correspond with the color adopted for the System or Formation to which the specimen belongs, and the letter and number indicating the System and Subdivision should also appear on the label. If inconvenient to use the color, the letter and number alone would suffice.

I would likewise suggest that authors describing local formations under local names should after the name insert, in brackets, the letter indicating the *System*, and, if possible, the Subdivision to which the Formation, Group or Series belongs or is most nearly allied. Thus, in writing of the *Nipigon Formation*, I should add (C 1), and every one would know that a lower part of the Cambrian System was being described. So, in writing *Chazy*, I should append (D 1), indicating the lowest division in Canada of the lower part of the fourth or Cambro-Silurian System. The main features in the scheme may be recapitulated as follows:—

1. Definite colors for *Systems;* and for all subdivisions of systems, modifications of the same color by tints, lines or other devices.

2. *Age* colors to be the system colors combined in bars: thus, *Mesozoic Age* would be represented by any two or all (as required) of the colors used for the Triassic, Jurassic and Cretaceous Systems, with letters H. J. K. added, or the Roman numeral III. Or a single color might be used for each.

3. Vermilion and Carmine and other similar bright red tints to be used for igneous or supposed igneous, eruptive or irruptive rocks.

4. Blue to be used for limestone bands,—the System to which they belong being indicated by letter and tint.

5. All geological notes and references, letters, figures, etc., to be printed in red, except such as come on red-colored (igneous) areas; these to be in white. In the sample maps referred to, the printing of all the geological notes and references in red is not fully carried out, owing to a misunderstanding on the part of the printer.

6. Letters and numbers to be always used from 1 and A respectively in the ascending order of the Formation, Series or Beds.

7. No geological maps should be printed in less than two colors, *i.e.* black for the topography, and red or some other color in line, and various devices to represent the different Systems or Formations, with the same notation as used for fully coloured maps. On both colored and uncolored geological maps, the notation can often usefully be made to indicate what is not always apparent, viz., the formations which underlie that occupying the surface; thus, K. S. on E. 2 on B. would indicate Cretaceous (lower) on Silurian (middle division) on Huronian, or omitting names, 10th System lower division, on 3rd middle division, on 2nd.

8. In geological literature, the letter and number denoting the place in the geological sequence, of the formation named, should be added in brackets, as (C. 2^a) indicating the base of the middle divison of the 3rd system. By this means, local names entirely unknown to many readers would at once be intelligible to all.

9. Labels on specimens in museums should be colored and lettered to correspond with those of the System to which the specimens belong.

Ottawa, 29th August, 1881.

NOTES

ON THE

GEOLOGY OF THE SOUTH-EASTERN PORTION

OF THE

PROVINCE OF QUEBEC.

BY

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DIRECTOR OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

The region to which the following Notes refer extends from the boundary between Canada and the State of Vermont at Lake Memphremagog, north-eastward to the townships of Montmagny and L'Islet. It is limited to the south-east by the boundary between Canada and the state of Maine, and embraces a belt of country about 145 miles in length by thirty in width. or about 4,500 square miles.

Region described.

The greater portion of it is occupied by strata which belong to members of the Silurian (Upper Silurian) System. These consist of clay-slates, sandstones and limestones. The latter are exposed chiefly in the south-western half of the area, on the shores of Lake Memphremagog and in the vicinity of Dudswell, where some of the limestones afford excellent marble, specimens of which can be seen in the Geological Museum. The area has been already described in considerable detail by Sir W. E. Logan, in the XVIth chapter of the Geology of Canada, 1863. The rocks occupying it were then regarded as a part of the "Gaspé Series;" the limestones as being probably of Devonian age and the slates and sandstones beneath them as Silurian. The evidence on this point, owing to the badly preserved condition of the fossils, is still insufficient, but there seems in some localities to be such a mingling of Devonian and Silurian forms as to suggest the applicability of the name Devono-Silurian, proposed by Professor Edward Hull, or as I should prefer it, Siluro-Devonian, as being more euphonious and

Silurian and Devonian strata.

as indicating the upward direction of the passage. They rest everywhere along the north-western margin unconformably on and against the strata which form the great central axis of Pre-Cambrian age in the province of Quebec, and which were described by Logan as the "Altered Quebec Group." A ridge of these ancient sub-crystalline strata divides the Silurian area in the south-western portion, from the township of Ham to the shores of Lake Memphremagog and the Vermont boundary, and though rarely exceeding five miles in width, these older rocks form a prominent range of hills, some of which rise to 1,500 feet above the sea. This range known as the Stoke Mountains, has been described in the Geology of Canada, pp. 252 and 435, in such a manner as to leave little, if anything, further to be said respecting its physical or lithological characters.

Stoke Mountains.

The Geological relations of this belt correspond with those of the great central axis to the north-east, described in the Geological Survey Report for 1877-78, and again in more detail in a paper read by the writer at the first meeting of the Royal Society of Canada in May, 1882. The upper portion of this series was designated "the volcanic belt," from the association with it, especially on the south-east side of the main axis, of a grest variety of what were considered to be altered eruptive and irruptive rocks, but whether the strata forming this igneous belt are more nearly allied to the lower Cambrian than to the upper Huronian is not, fossils being absent, easily determined. In any case they are most certainly unconformably covered and overlapped to the north-west by fossiliferous beds of the Levis formation of the Quebec group, and to the south-east in the same manner, throughout their entire length, by the limestones, slates, and sandstones of the Siluro-Devonian trough above described; while between them and the more shistose rocks of the central axis by which they are underlaid, no unconformity has been detected; for these reasons, they are provisionally classed with the lower series, or as Pre-Cambrian probably upper Huronian.

Huronian or Lower Cambrian.

Microscopic examination of specimens.

Specimens of some of the most characteristic rocks of this belt have been submitted to a careful microscopical study by Mr. Frank Adams, Assistant Chemist and Lithologist to the Survey, and he has supplied me with the appended interesting notes respecting them. These seem to afford very decided support to the stratigraphical evidence and to conclusively prove that the rocks in question are largely of igneous origin and not ordinary altered paleozoic sediments. The evidence of a mixed volcanic and sedimentary origin is necessarily rather geological and physical than mineralogical, because of the excessive disturbance, denudation and alteration which has more or less affected the whole series. These causes have often almost obliterated original lithological and mineralogical characters, and therefore, notwithstanding that certain rocks are really of volcanic origin. That they are so is not easily proved either by chemical or microscopic examination.

The Siluro-Devonian area now under consideration was traversed and examined during the seasons of 1880 and 1881, by Mr. Webster late of the Geological corps, chiefly with a view of investigating its auriferous character, and determining the limits of the several formations, as stated in my summary report. In reference to the gold, Mr. Webster says:— "The drift appears to have come from the north-east and is found overlying a bluish-grey boulder clay, in which no gold has been observed. The gold drifts contain fragments of local rocks and foreign boulders of Laurentian and newer formations." Examination by Mr. Webster.

"Few true veins of quartz occur in the Silurian rocks, but there are great masses of milk-white quartz, sometimes of considerable extent, forming lenticular patches in both the slates and sandstones." Quartz veins.

"Visible gold has been stated to occur in quartz at several places in the Chaudière valley and in the neighbourhood of Sherbrooke, but upon examination, this supposed gold has in every case proved to be either iron pyrites or mica—up to the present time I have never seen gold in any of the quartz veins or masses which occur in this region. The altitude of the gold-bearing drift appears nowhere to exceed 2000 feet above the sea. Below this height "colors of gold" may be said to occur anywhere to the south-east of the great Quebec Anticlinal, and most abundantly on the upper waters of the Chaudière and the St. Francis Rivers. It has also been found on the Maine watershed." Gold.

"The following is a list of localities where "*colors*" have been found, apart from places where regular mining operations are being carried on:

1. In drift lying on Pre-Cambrian rocks:

List of auriferous localities.

Lake Massawippi, Black Point, Hatley.................... R. V. Lot 21.
Jack Brook....................................Ascot R. VIII. Lot 10.
Small brook between Sherbrooke and Lennoxville.
Mouth of brook on line between Ascot and Stoke.
Westbury.......................................Stoke R. VII. Lot 28.
South Halifax.......................................R. VII. Lot 3.
Ireland...R. III. Lot 4.
Do ....R. V. Lot 10.

In many places on the Bras du Sud Ouest River, Vaudreuil, Beauce.
On the Rivière des Plantes.
On the Colway and on a small stream to the north of it.
On the Rivière des Fermes.
On Mountain River.......................................Coleraine.
Also in the townships of Ditchfield, Clinton, Woburn and Chesham on the borders of Maine.

2. In drift lying on Silurian rocks:

Key Brook ....Brompton R. V. VI. Lot 28.
Magog River ....Sherbrooke R. IX. XIII Lots 17-22.
Dudswell...R. VI. Lot
Do ....R. III. Lots 14, 15.
" ....R. II. Lot 38.
" ....R. I. Lot 34.
Ditton..................................R. IX. Lots 17, 22, 23, 24.
" ....R. IX. Lot 2.
" ....R. XI. Lot 2.
In several places on Little Ditton River.
Ditton...R. VIII. Lot 60.
" ....R. VII. Lot 56.
" ....R. IV. Lot 52.
At the mouth of the Mountain Brook, Hampden R. II. III.
Along the Chaudière River and its tributaries from Lake Megantic to St. Joseph, fine gold can be found in almost every pan of earth washed from the bed rock."

View of Hydraulic Gold washing.

The view on the opposite page is from a photograph kindly given me by A. A. Humphrey, Esq., the Manager of the works represented. Should the enterprise prove successful, there is in this region a very large field in which similar operations might be undertaken.

" On the St. John and Daquaam Rivers, to the north-east, no gold was found, though carefully looked for. This may be owing to the swampy nature of the country and the few exposures of bed rock."

Granite areas.

" In the central or southern part of the region the sedimentary rocks are interrupted by six important masses of granite and some smaller ones. The areas occupied by these vary in extent from one square mile up to 100 square miles, some of them continuing across the border into the states of Vermont and Maine, where their distribution is still more extensive. Mr. Webster says " All these granite masses appear to be of similar character and consists of white quartz, felspar (orthoclase) and black mica." The southernmost lie on the boundary between Canada and Vermont; one extends west from Bebe Plain to the east shore of Lake Memphremagog, and further west another larger mass occupies fifteen miles along the boundary from Little Leach Pond eastward, but nowhere extends more than two miles northward. To the south in Vermont it covers a very large area, extending to and beyond the Grand Trunk railway at Island Pond. All these granite areas in Canada have been already enumerated and described under the head of " Intrusive Granites " in the Geology of Canada, 1863, p. 34. The limits of the several areas in Quebec have now been traced and will be shown on the Geological map of the province. Some of these, and their extension into the adjoining states have been described in the Geologi-

Artotyped by Geo. E. Desbarats & Co., Montreal.

From a Photograph taken by Mr. A. A. Humphrey.

HYDRAULIC GOLD MINING IN THE CHAUDIÈRE VALLEY, QUEBEC.

cal reports and maps of New Hampshire and Maine,* and it is therefore unnecessary here to enter into further detail of their distribution. The stratified rocks in contact with them are everywhere more or less disturbed and altered, the limestones are converted into graphitic schists or crystalline marble and the argillites into mica slates, chiastolite and staurolite schists, and are traversed by streaks and veins (dykes ?) of granite. This kind of alteration which may sometimes be observed apparently remote from any granite outcrop, has given rise to the supposition that the fossiliferous Silurian and Devonian strata of the Gaspé Peninsula and of Maine have on their south-eastern extension passed entirely into gneisses and mica schists; or in other words, that they have there suffered an intense regional metamorphism which has not affected them to the north-east; and this idea has been strengthened by the fact that sometimes the altered rocks mentioned come into contact, or rest upon, and often closely resemble the older, (probably Huronian and in some cases perhaps Laurentian) granitoid, gneisses and mica schists. There are thus in this region two distinct groups of micaceous gneissic and granitoid rocks. The one more or less local and due to the causes which gave rise to the great so-called intrusive masses of granite, which are of Siluro-Devonian age, and the other due chiefly to the much more ancient and extended movements which produced the regional metamorphism of the Huronian and Laurentian Systems, and occurred in the Pre-Cambrian ages. Various names have been proposed for these altered rocks as, Calciferous mica schist, Lyman, Lisbon, and Montalban, names, based apparently entirely on lithological and mineralogical characters, and not on a careful investigation and mapping of the structure and succession of the formations. In describing the alteration of the limestones in the vicinity of Lake Memphremagog, Mr. Webster says:—"The contact of the granite with the limestones and calcareous slates of Silurian or Devonian age is well seen on its northern edge in the IV, V, VI, and VII. ranges of Stanstead, where there are a great number of irregular dykes cutting and tongued in with the limestone beds. The latter are much altered at and near the contact. The dykes are from half an inch to four feet in breadth, and sometimes form a network holding the altered slates and limestones in what may be called the meshes."

Two groups of altered rocks.

Contact of granite and Devonian limestones.

Unquestionable proof is thus, here and elsewhere, afforded of the age of these granites. But the extent to which they have invaded and become mixed with the more ancient Pre-Cambrian micaceous and gneissic strata has not been clearly ascertained, though that they do so is certain and might easily be studied and worked out

Age of the granites.

* Atlas accompanying the Geological Report of New Hampshire. Geology of New Hampshire, Vol. I. 1881.

in the region south of Lake Megantic, or still more readily on the line of the Grand Trunk Railway between the townships of Barnston and Barford in Canada—where they are in contact with Silurian slates—and Island Pond in Vermont where we find them associated with a totally different set of rocks, which are probably Huronian and which there is at present no reason for separating from those which form what I have designated, the great Sutton and Danville Anticlinal—the lowest rocks of which appear in Sutton Mountain as mica schists and calcareous gneisses, often granitoid.

Post Devonian metamorphism.

The immense influence which the Devonian granite-forming epoch has had on the Pre-Carboniferous rocks of the region to the south-east of the great St. Lawrence, Champlain and Hudson River break, is certainly deserving of more careful consideration and study than it has yet received, and more especially so in connection with the alteration and metamorphism it has produced in large areas of Paleozoic, and perhaps pre Paleozoic, rocks. When these altered paleozoic strata come in contact, as they often do in Eastern Canada and in New England with the more ancient Huronian and Laurentian gneiss, granite, mica schist and other crystalline rocks, it is only possible to distinguish them or to define their respective limits by the most careful and minute stratigraphical work, such as the nature of the regions in New England and in the adjacent provinces of Canada, where these rocks are chiefly developed, renders almost impossible, or at any rate has never yet been attempted. Hence the maps hitherto published, representing the geological structure of these regions have necessarily been based almost entirely, so far as the crystalline groups are concerned, on lithological and mineralogical comparisons and considerations, producing petrological rather than geological maps, and as a consequence, though important and valuable aids to future investigation, they afford a very incorrect and imperfect idea of the true geological structure and the sequence and distribution of the several formations. Unfortunately, while careful, patient and minute observation in the field has been unavoidably limited and local, study in the laboratory and theoretical deductions therefrom have been unlimited and wide spread; but, as might have been expected, have not only afforded no satisfactory solution of the intricacies of Appalachian geological structure, but have on the contrary involved it in deeper mystery and complication. It is now evident that an entirely different system of procedure must be adopted before there will be any hope of definitely and satisfactorily solving the problems which have presented themselves to successive observers in this difficult field. On pages 577-78 of the Geology of Vermont, 1861, Dr. Hitchcock has clearly stated his conclusions respecting the age and relations of the granites and schists of Vermont. These rocks are the

Petrological maps.

Dr. Hitchcock on ages of Vermont granites.

southern extension of those of Canada to which the foregoing remarks specially refer. Dr. Hitchcock's conclusions were based on careful personal and extended examination in the field, and agree very closely with those of Sir W. Logan, and also with those of the writer whose conclusions are likewise based on similar careful examination of wide areas of Devonian granites in Australia and in eastern Canada. In these widely separated regions, whatever the causes may have been, the effects produced are identical.

Points to be investigated.

The most important points that now require investigation are:—The manner and extent in, and to which the Devonian granite-forming agencies have affected the formations which were previously in a metamorphic condition, and whether portions of the so-called Calciferous mica schists, and of the Coos groups of the New Hampshire survey which extend into Canada may not represent both palæozoic and pre-palæozoic strata of several formations, the normal conditions and character of which has been more or less affected and changed by the agencies referred to; and on the supposition that the granite itself has been formed from the rocks with which it is now in contact, to what extent it may itself differ, and show in this some constant relation to the normal differences observed in the several formations with which it is now locally surrounded. Theoretically in pursuance of this idea, the Devonian granites when in contact with Huronian rocks should materially differ from such as are in contact with the ordinary class of Devonian and Silurian sediments—hornblendic granite, syenite and other more basic forms prevailing in the former case, and the more acidic forms in the latter.

The investigations of the survey now in progress in Nova Scotia, New Brunswick and South-eastern Quebec will, it is hoped, together with the careful microscopic examinations being made by Mr. Adams, throw some light on these questions, and in the meantime it is quite useless to further speculate and theorize respecting them.

OTTAWA, May 1883.

APPENDIX.

NOTES

ON THE

MICROSCOPIC STRUCTURE OF SOME ROCKS OF THE QUEBEC GROUP.

BY

FRANK D. ADAMS.

The following notes are the result of a microscopic study of a collection of rocks from the Quebec Group submitted to me for examination by Dr. Selwyn. They are, with one exception, (that of the *Felspathic Sandstone* from Acton), from the middle and lower of the three divisions into which he has recently divided this Group,* and are, therefore, in Dr. Selwyn's opinion, probably of Lower Cambrian, or Huronian age. The nomenclature employed for the massive rocks is that of Professor Rosenbusch,† to whom my best thanks are due for much assistance kindly afforded me in this investigation.

Massive Rocks.

1. *Hornblende Granite—Shipton, Range XII., Line of lots* 7 *and* 8.

This rock is composed essentially of quartz, orthoclase, plagioclase and hornblende, with a little titanic iron ore. The hornblende, as is usual in granites, seldom has a good crystalline form. It is light green in colour, strongly pleochroic, shows in many places the characteristic cleavage and often occurs twinned. It sometimes contains little pleochroic "höfe" surrounding minute doubly refracting crystals. Its angle of extinction, as is often the case with the hornblende in granites, is large. The greatest angle measured was 24°, and this was in a section in the zone of the orthopin acoid and clino-

* Report of Progress, 1877-78, p. 3, A.

† Mikroskopische Physiographic der massigen Gesteine. Stuttgart, 1877.

pinacoid nearly but not quite coinciding with the latter plane. Many of these hornblende grains assume a fibrous form at their edge, but this is especially the case at the extremities of the elongated patches in which it often occurs. The rock is no longer fresh. The felspar, of which a very considerable proportion is plagioclase, is a good deal decomposed, and the hornblende is altered in a very peculiar and apparently hitherto unobserved manner. Three stages of the alteration can be clearly distinguished. 1st. The hornblende changes to a scaly mass having all the appearance of chlorite. This zone is not always present. 2nd. There is a zone of fine needles, generally in tufts with parallel extinction, and which have a brown or yellow colour. This colour, however, probably does not belong to the needles themselves, but is due to the separation of hydrated oxide of iron on the decomposition of the hornblende molecule. 3rd. Running out from these tufts are long and exceedingly fine hair-like needles which penetrate the quartz. These are colourless and probably the same as those of the yellow zone, but longer and finer. Dr. George Williams, of Johns Hopkins University, to whom I am indebted for information on several points connected with this rock, remarks the curious fact of the "constant relation existing between the hornblende and quartz; while the edge of a hornblende crystal in contact with felspar is quite sharp and fresh, or, at most, only fibrous; the edge of the same crystal in contact with quartz almost always presents the phenomena described." Dr. Williams considers that there has been a mutual reaction of these two minerals on each other in a way exactly similar to that so often observed between plagioclase and olivine in the Scandinavian olivine diabases*, in which cases a zone of silicates of undetermined character is formed along the line of contact between the two minerals. In this rock the yellow tufts of needles can often be seen along the junction of two quartz grains, in which case they have probably been formed by infiltration. Some quartz grains are so filled with the fine needles that they present exactly the appearance of decomposing cordierite, and might easily be mistaken for that mineral were it not for the fact that a uniaxial interference figure may be repeatedly observed. In some places the hornblende changes to a finely fibrous yellow mineral, probably chrysotile. The iron ore is present in small quantity, and is partially decomposed to leucoxene. Apatite is present in the usual long slender crystals.

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* Törnebohm—"Über die wichtigeren Gabbro-v.-Diabas Gesteine Schwedens," Neues Jahrbuch fur Mineralogie, p. 383, 1877. Törnebohm considers one portion of this zone to be composed of hornblende grains.

2. *Hornblende Granite—Orford, Range XV., Lot* 3.

Much decomposed, the hornblende, however, does not show the peculiar method of decomposition seen in the last specimen. Judging from the section, the rock must have been submitted to great pressure. The quartz grains are much broken and the section is traversed by several lines of fracture along which the constituents have been reduced to an aggregate of very small grains, and depositions of secondary minerals have taken place.

3. *Quartz—free Porphyry—Shefford, Range III., Lot* 24.

This rock occurs associated with chloritic schists, and is, so far as can be ascertained, comformable to these in strike and dip. In a section it is seen to be composed of a microcrystalline groundmass, holding numerous large crystals of felspar scattered through it. These felspar crystals have, under the microscope, a turbid appearance; they sometimes occur in simple forms, sometimes in twins, according to the Carlsbad law; and one or two of them in the sections showed an extinction parallel to a crystallographic axis, thereby proving that the felspar is really orthoclase. A few plagioclase crystals, like those of orthoclase much decomposed, but showing polysynthetic twins with very narrow lamellae, are also present in the section. No quartz crystals are present in either of the three sections of this rock which have been prepared, and it has accordingly been classed as a quartz-free porphyry, although some quartz recognizable by its uniaxial and positive character is present in the ground mass, so that, strictly speaking, it would probably occupy a position intermediate between the quartz and quartz-free porphyries, such rocks being by no means rare.* The rock is, however, a good deal decomposed, calcite being present in the ground mass, so that the quartz may be a secondary product. Disseminated through the groundmass, and in smaller amount in the imbedded crystals, there are numerous opaque black grains, generally irregular in shape, but sometimes occurring in little cubes; these are probably an iron ore. Associated with these grains, at a few places in the ground mass, there is a strongly pleochroic mineral, the colours changing from light yellowish-brown to a dark brown, and with greatest absorption parallel to a very good cleavage. Between crossed Nicols, extinction takes place when the plane of polarization of either prism coincides with this cleavage, so that the mineral is probably a magnesia mica. In a section the groundmass appears of a light brownish tint; the color being due to a yellowish-brown mineral which is finely dis-

* Comp. Rosenbusch, Mikroskopische Physiographie der massigen Gesteine, p. 129.

seminated through it, and which also occurs, though in much smaller quantity in the imbedded crystals, either in little patches or running along their cleavage lines.

4. *Quartz Porphyrite—Potton, Range X., Lot* 16.

The groundmass is microcrystalline. In it both plagioclase and quartz can be recognised; the former, by its polysynthetic twins, and the latter, by its axial figure. The imbedded crystals are numerous, and are principally plagioclase, sometimes showing a double set of twin lines. One or two untwinned felspar crystals are present in the sections. A few clear well-formed quartz crystals are also imbedded in the groundmass, and hold numerous cavities with moving bubbles. The felspar crystals also hold many cavities with bubbles; some of these bubbles can be seen to be in motion, while others, which are generally large in size, compared to the cavities, remain stationary. In addition to these quartz and felspar crystals, there are distributed through the groundmass, numerous masses which are apparently aggregates ot yellowish-brown rhombohedral crystals. They are composed principally of an untwinned carbonate, with yellowish-brown hydrated oxide of iron occurring around the edges of the masses as well as along the cleavage lines and in irregular shaped masses in the carbonate, which is also in some places traversed by minute acicular crystals. When a section of the rock is treated with dilute hydrochloric acid, the carbonate is dissolved out with effervescence, a portion of the oxide of iron also passing into solution. On treatment with the concentrated acid, all the oxide of iron goes into solution, leaving a dull greyish translucent mineral through which the oxide of iron had apparently been disseminated, and which on treating the etched side with fuchsine, absorbed the colouring matter and became deeply stained. The cavities, after the removal of the carbonate, are often seen to be lined with this mineral, while the minute acicular crystals which remain unacted upon by the acid, traverse them in various directions. These masses do not possess any general outline which would indicate their derivation from either hornblende or augite, although they have probably originated from the decomposition of some bisilicate. Scattered thickly through the groundmass and occurring also in the imbedded felspar crystals, there are minute lath-shaped crystals, generally ragged at the terminations. These are colourless, of a very faint greenish tint, doubly refracting; the interference colors being rather brilliant, and have a very good cleavage parallel to their length, and extinction parallel to this cleavage. When the section is treated with hydrochloric acid and then with fuchsine, these little crystals are found to have been attacked and stained. They are probably some hydrated variety of mica. A few grains of pyrite are also present in the sections.

5. *Gabbro—Between Lake Colombe and South East line of Wolfestown.*

This rock occurs associated with the serpentine. It is composed of diallage and plagioclase. The diallage is for the most part tolerably fresh, though in places it is decomposed. In addition to the prismatic cleavages, it has the usual perfect cleavage or "theilbarkeit" parallel to the orthopin acoid. In most of the crystals occurring in the section which show this cleavage, the axes of elasticity make an angle with it; but several grains were found which were cut in a direction approximating the base or an orthodome, and in which, consequently, the extinction almost or quite coincided with the cleavage. By examining the axial figure seen in such sections, the plane of the optic axes was found to be at right angles to the cleavage, thus proving that the mineral was really diallage and not a rhombic pyroxene. The plagioclase in the section is now entirely decomposed, principally to a dull translucent mass with aggregate polarization (saussurite?) Numerous very minute scales of oxide of iron are scattered through the rock.

It bears a very close resemblance to a gabbro from near the head of the Upsalquitch River in New Brunswick.

The following four rocks bear a general resemblance to one another. They are exceedingly decomposed; but little of their original constituents remaining intact. Being doubtful as to whether they should be regarded as igneous rocks, I sent sections of two of them, viz., that from Potton, Range VI., Lot 14, and that from Range X., Lot 24 of the same township, to Professor Rosenbusch, who was kind enough to examine them for me. Professor Rosenbusch gave it as his opinion, after a careful examination of the slides, that the rocks were not sedimentary, but were highly altered diabases.

6. *Altered Diabase—Potton, Range VI, Lot* 14.

The rock is very fine grained and of a dull greenish-gray colour. In my sections none of the original augite remains; in its place, there is a mixture of light green actinolite, often altered to chlorite, and some epidote. The original felspar is decomposed into a mixture of quartz, albite and calcite. The iron ore is altered to leucoxene. A little pyrite is present. Professor Rosenbusch observes that this kind of alteration is very common in the diabases, which occur in the form of beds in the metamorphic districts of the Harz, of the Rhein (Taunus), and of the Fichtelgebrige, and that the structure of the rock, which is still to be distinctly seen in places, shows that in this rock also we have an altered diabase.

7. *Altered Diabase—Potton, Range X., Lot* 24.

Very fine grained and of a dull greenish-gray color. What has been said of the last rock applies equally well to this. A large part of the actinolite is decomposed to chlorite. Some of the original plagioclase can still be recognised. A good deal of pyrite occurs scattered through the rock in cubic crystals.

8. *Altered Diabase—Potton, Range X., Lot* 12. (*Owl's Head.*)

A similar fine grained greenish-gray highly altered diabase.

9. *Altered Diabase?—Top of Adstock Mountain, Township of Adstock.*

Very fine grained, and even more decomposed than the other specimens. Consists largely of very fine fibrous light-green actinolite. Chlorite, quartz, plagioclase and leucoxene are also present in smaller amount. On treating a section of this rock with hydrochloric acid for thirty-six hours in the cold, and then with fuchsine, much chlorite occurring in little strings and patches, often running along the cleavage lines of the hornblende is seen to have been attacked and stained, while the greater part of the actinolite itself is still unattacked.

The hand specimen is traversed by small veins of white quartz. It is probably like the other three, a much decomposed diabase.

10. *Diorite—Adstock Mountain.*

A second specimen bearing the label Adstock Mountain.

It is rather coarsely crystalline, massive, and of a greyish-green colour, and is composed of hornblende and plagioclase. The hornblende is green or in some places brownish in colour, and is distinctly pleochroic. It is recognised by its biaxial character, its well marked cleavages, cutting one another at an angle of about 124°, and its small extinction angle of about 16°. It is often twinned. Much of the hornblende is decomposed to chlorite. In many cases the alteration appears to pass through an intermediate stage in which the hornblende assumes a very finely fibrous appearance. The fibres are generally approximately parallel, but do not as a general rule extinguish simultaneously. Individual fibres can often be seen to have an extinction inclined at a small angle to their longer axis. Some of these fibrous grains. show a distinct biaxial figure. The plagioclase is dull from incipient decomposition, but generally shows well defined polysynthetic twins, of which two sets are frequently present crossing one another. Although the two minerals have interfered with each other in crystallizing, both show in places good crystal forms. The felspar is perhaps upon the whole the better crystallized of the two. On treating an uncovered section with hydrochloric acid for an hour and a half, and then with fuchsine, decomposition products, occurring both in the hornblende and plagioclase in little strings and spots were found to have been acted on and stained. On treating the section with the acid for thirty hours longer, the undecomposed hornblende was still quite unacted on, but many of the hornblende crystals which had been, as above mentioned, altered wholly or in part to chlorite, were found to be stained by the fuchsine. The fibrous hornblende was found to be everywhere much mixed with chlorite.

Crystalline Schists and Serpentines.

The following five rocks resemble one another in composition, but present structural differences. They are evidently closely allied to a set of rocks from the Huronian series in the region south of Lake Superior described by Dr. Wichmann, and classified by him under the general heading, "Felspathic hornblende schist and rock." *

In these rocks from the Quebec group, however, the hornblende is almost invariably present in the form of actinolite, while in those from Lake Superior, it apparently as a general rule occurs in the ordinary prismatic form. It has recently been stated that the chlorite schist associated with the diorite at Dobschau, in Hungary, and out of which the latter is supposed to have been produced, has a micro-crystalline groundmass of a felspathic nature. The felspar of this groundmass is judging from flame reactions pretty rich in soda. †

These Canadian rocks are regarded by Dr. Selwyn as altered contemporaneous volcanic rocks.

11. *Felspathic Actinolite Schist—Pinnacle Mountain—East St. Armand.*

When a section of this rock is examined with the naked eye, it is seen to consist of a number of more or less rounded masses of an almost colourless transparent mineral, averaging about 0.1 inch in diameter, together with a few large magnetite crystals, imbeded in a green groundmass. When examined under the microscope these rounded masses are seen to consist, as a general rule, of a single crystalline individual, but often, especially in the larger ones, two or even more

* "Microscopical observations on the iron bearing (Huronian) rocks from the Region south of Lake Superior—Arthur Wichmann Ph. D."—Geology of Wisconsin, vol. III. p. 641.

† "Daten über den Diorit von Dobschau"—Ladislaus Nagy. (Földtani Közlöny 1880, X, 403). Noticed in the Neues Jahrbuch für Mineralogie, etc., I, 2, 1882, p. 236.

individuals are present. Each of these individuals contains a multitude of greenish inclusions, giving to the mineral, which is itself colourless, a green colour when seen in small fragments. These inclusions are heaped up in the central portion of the crystals, leaving a narrow zone immediately around the edge with comparitively few. When one of these rounded masses contains more than a single crystal, each individual has a heaping up of the inclusions about its own centre, leaving the lines of contact comparatively free from them, thus making it in many cases possible to distinguish the various crystals without the aid of polarized light. The inclusions are principally of two minerals. One occurring in irregular shaped, often elongated grains, with the high index of refraction, brilliant interference colours and characteristic pleochroism of epidote. The other generally in narrow elongated crystals with cleavage parallel to their long axis, and an extinction making a small angle with this cleavage, and which are actinolite. The colourless mineral itself is very clear and free from decomposition, when cut approximately perpendicular to an optic axis it always shows the revolving bar of a biaxial crystal, and many of the crystals show a set of parallel cleavage lines, sometimes crossed by a second less perfect set with an inclination varying with the direction of the section. Most of the crystals are untwinned, a number however show twins composed of two differently orientated parts, and some exhibit the polysynthetic twins of a plagioclastic felspar. It is therefore felspar, triclinic certainly in part and perhaps altogether. The impure felspar fuses at a little over 4, giving a strong soda flame. The green groundmass consists of actinolite crystals with epidote, a brown strongly dichroic mica, a small quantity of chlorite, and here and there a little quartz, distinguished from the felspar by its uniaxial character. The magnetite crystallizes in octahedra, generally very perfect in form, and occurs in the groundmass, often however penetrating into the felspar crystals. The rock also contains a considerable amount of calcite in large grains associated with, and sometimes occurring as an inclusion in the untwinned felspar. A section was treated with concentrated hydrochloric acid for an hour and a half without warming, the calcite having been previously removed by treatment with dilute acid. The magnetite was dissolved out and the brown mica somewhat acted on. By a longer treatment with the acid (thirty hours), all the mica, as well as the chlorite was etched, but all the other constituents were apparently quite untouched.

An attempt was made to separate the constituents of the rock using a solution of iodide of mercury in iodide of potassium, and thus ascertain by means of specific gravity whether more than one species of felspar was present. The magnetite, epidote and actinolite were easily obtained in an almost pure state, bnt the felspar was found to contain so many inclusions that it was impossible to obtain good results. Although the grains were of such a size that they passed through a sieve with 80 meshes to the linear inch, it was found that had they been half this size very few would have been free from the inclusions.

The rock has a green colour and in the hand specimen a rather distinct schistose structure.

12. *Felspathic Actinolite Schist—Sutton, Range II., Lot* 1.

Identical with the Pinnacle Mountain rock in almost every respect. Magnetite is however wanting in the sections, nor can any be seen in the hand specimen, and more quartz is present, occurring in the green groundmass, in aggregates of small clear uniaxial grains. The felspar masses are also somewhat larger, and the individual crystals of felspar even more crowded with inclusions. Many of them show lines of polysynthetic twinning.

13. *Felspathic Hornblende Schist—Top of Bear Mountain—Potton, Range XI., Lot* 2.

Consists of numerous felspar individuals together with some of hornblende, and of a greyish translucent mineral, imbedded in an aggregate of smaller grains. The felspar is often well crystallized. Almost every grain is twinned, the majority of them showing polysynthetic twin lines. As in the case of the last two rocks, they hold inclusions, which however are not so numerous and are very small. These are probably epidote and actinolite as before, bnt little bunches of a yellowish micaceous mineral are also present. It is therefore certain that in this rock a large proportion of the felspar is plagioclase, and I am inclined to think that the whole of it really belongs to a triclinic species. The hornblende is of a light green colour, and shows the characteristic cleavages, cutting one another at an angle of about 124°, and has a small angle of extinction. The large individuals often terminate in a bunch of fibres. The greyish translucent mineral above mentioned occurs in masses which are generally irregular in shape, and often elongated in the direction of the plane of foliation. They sometimes, however have a rude rhombic outline. On the thin edges where it is transparent, it is seen to be made up of minute rounded grains with high index of refraction and showing brilliant interference colours. They resemble some forms of leucoxene, a decomposition product of titanic iron ore which is in some cases at least, a form of the mineral sphene. A qualitative chemical examination of the rock was made, and a distinct reaction for titanic acid obtained, so that the mineral may be referred to this species. The finer grained aggregate in which these larger individuals are imbedded, consists of hornblende, generally in the form of actinolite, together with felspar, quartz, and chlorite. A mineral occurring in small irregular shaped brown leaves with elongated cross sections and often in the form of little bunches is also present. It is uniaxial and negative. The cross sections exhibit strong dichroism with almost total absorption of light passing through them parallel to their longer axis. It is therefore a mica probably allied to biotite. It is intimately associated with the hornblende. A good deal of epidote, together with a little pyrite and hematite also occur in small grains. The rock being schistose, a rude parallelism in the arrangement of the constituents is often to be seen in the sections. This is shown very well in the case of its long hornblende crystals which frequently curve around the felspar crystals giving an appearance somewhat resembling flow structure, and which is in many cases to be observed in crystalline schists, notably in the porphyroids.

14. *Felspathic Actinolite Schist—Stuckely, Range VII, Lot* 6.

A fine grained greenish-gray schist composed principally of felspar and actinolite, with a good deal of chlorite. The felspar is in the form of small clear biaxial grains, generally untwinned but often showing polysynthetic twinning, and forms a sort of groundmass of the schist, being frequently penetrated by the actinolite crystals. Large crystals of epidote and a large quantity of iron ore in irregular grains are scattered through the rock. The latter are usually much elongated in the direction of the foliation of the rock, and sometimes on very thin edges are seen to be transparent and of a deep red colour. This iron ore differs very much from that contained in the rock from Pinnacle Mountain, not only in its want of good crystalline form, but in the difficulty with which it is attacked by hydrochloric acid. The magnetite in the sections of the Pinnacle Mountain rock was entirely dissolved by treatment with concentrated hydrochloric acid for an hour and a half in the cold. The iron ore in this rock was but very slightly acted on by treatment with the acid for sixty hours in the cold, but was dissolved when the section was treated with hot acid for two hours. It is probably an ore rich in titanium, as numerous little bunches of irregular rounded grains of mineral resembling sphene are scattered through the rock and frequently clustered around its irregular shaped grains. The constituents of the rock generally have a parallel arrangement, and frequently in different layers one or other constituent predominates. The rock also contains irregular shaped secretions, giving to it a sort of amygdaloidal apppearance and which stand out from the weathered surface.

They have a more or less rounded outline, in a section are seen to have pretty well defined walls and are frequently elongated in the direction of the plane of foliation. Some of these are composed of chlorite and a triclinic felspar, while others hold well-crystallized epidote which frequently predominates to the almost total exclusion of the other constituents. The chlorite occurs in bunches of leaves arranged parallel to one another, or in radiating masses. The felspar sometimes assumes sheaf-like forms and presents a turbid appearance under the microscope, due to numerous small blackish inclusions and minute cavities. The felspar from one of these secretions, fused at about 4 to a transparent globule, giving a strong soda flame.

15. *Felspathic Actinolite Schist—Bolton, Range V, Lot* 28.

Very similar to the last rock, consisting principally of actinolite, felspar and epidote. The felspar, as before, forms a sort of groundmass, of very clear grains, sometimes showing polysynthetic twin lines. Although some of these grains look very much like quartz, I have not been able in a single instance to prove the presence of this mineral in the rock, since these grains whenever properly cut show the revolving bar of a biaxial crystal. The actinolite occurs in the form of long slender crystals, either separate or aggregated to mat-like masses, in which cases a little chlorite is also present. A small quantity of well-crystallized magnetite is present in the rock, and is much more readily attacked by the hydrochloric acid than the iron ore in the specimen from Stuckely, being completely removed from the section by treatment with the acid for thirty hours.

16. *Felspathic Hornblendic Schist—Bolton, Range XI, Lot* 3.

This rock is very distinctly foliated, consisting of thin alternate layers of a greyish and of a brownish colour.

The darker layers consist of irregular shaped grains of brown hornblende with a small quantity of felspar. The light coloured layers consist of felspar, with grains of clear green augite, and a little hornblende. Leucoxene, often with a core of ilmenite, also occurs in the rock, principally in the light coloured layers. The minerals do not possess good crystalline form. The hornblende is strongly dichroic and shows the cleavages characteristic of hornblende crossing one another at an angle of about 124°. The felspar is colourless, often a good deal decomposed, and generally untwinned, in many places, however, polysyntheic twin lamallæ can be seen. In sections the rock is seen to be traversed by numerous little faults running in a direction approximately at right angles to the foliation. Dr. Selwyn supposes this rock to be an altered tuff, and its microscopic characters do not oppose this view.

17. *Gneiss—Island in Lac Noir, Township of Coleraine.*

This rock is composed of quartz, orthoclase, plagioclase and a very light coloured mica. Both the quartz and felspar grains are much broken, faulted and twisted. The mica occurs in irregular strings and curved crystals having a rudely parallel direction, and generally running between the quartz and felspar grains, it also occurs as a scaly crypto-crystalline aggregate. It has one very good cleavage with extinction parallel to it, in some crystals no pleochroism can be observed, in others light passing through in a direction parallel to the cleavage assumes a very faint reddish tint, while that traversing the crystal at right angles to the cleavage has a very faint greenish tint. In some places it holds the pleochroitic "höfe" before mentioned as occurring in the hornblende of the granite from Shipton. It is perhaps some hydrated potass mica, and in many cases looks as if it were a secondary product. Although not a typical specimen of the species, the name gneiss is perhaps the most fitting for this rock.

18. *Serpentine—Range* 11. *Rivière des Plantes.*

The section of this serpentine contains a few remains of a rhombic pyroxene. These are slightly pleochroic, and have one very good cleavage to which the extinction is always parallel. Numerous little black needles are also inlaid parallel to this cleavage. In one or two cases where the mineral was cut perpendicular to an optic axis, the plane of the optic axis was found to be parallel to the cleavage, showing that these remains are really rhombic pyroxene and not diallage. This serpentine is therefore the product of the alteration of some rock of which a rhombic pyroxene was a constituent.

19. *Serpentine—Melbourne.*

The rock is of a dark green colour. In examining sections of it the alteration to serpentine was found to be complete, with the exception of a few irregular shaped remnants which occur in one of them. These have a well marked cleavage, or rather fibrous structure, in one direction with extinction parallel to it, and (the section being a thick one) a well marked pleochroism, the light passing through parallel to the cleavage being green, and that passing it at right angles to it of a reddish colour. They are probably bastite or some allied mineral derived from the alteration of a rhombic pyroxene, which was a constituent of the rock from which the serpentine was derived.

Clastic Rocks.

Of the following rocks the first is a true grauwacke, as the term is used in Germany, and although some of the others, notably, Nos. 25, 26, and 27, differ from it in several respects and might perhaps be more properly classed as highly felspathic sandstones, I have retained the name grauwacke in the case of Nos. 25 and 26, placing after it the name highly felspathic sandstone, and mentioning in the short description wherein they differ from grauwacke proper.

20. *Highly Felspathic Grauwacke—Potton, Range* VIII. *Lot* 15.

When a thin section is examined this rock is seen to be composed of numerous fragments of minerals, together with some rock fragments, united by a small quantity of a micro-crystalline cement. Many of these fragments are of quartz, these are generally angular, but sometimes somewhat rounded. A few of felspar, both orthoclastic and plagioclastic, are also present. There are also a large number of grains which are now decomposed to an aggregate, but which were originally felspar, since here and there a felspar grain may be seen partially decomposed to a similar aggregate. The quartz grains are not very rich in inclusions but sometimes hold the hair-like bodies often seen in the quartz of granites. A good deal of calcite, evidently a decomposition product, is scattered through the rock in little grains and strings. In addition to these mineral fragments there are a number of fragments of a very dark coloured, fine grained rock. These are very irregular in shape, sometimes much elongated, and often have a schistose structure. Between crossed nicols they are seen to be in places isotrope and elsewhere very feebly, doubly refracting, but contain little doubly refracting microlites as well as numerous opaque black granules. They are often penetrated by lath-shaped crystals of a mineral which is opaque or almost so, but by reflected light is of a dull yellowish colour and without metallic lustre. They also occasionally hold pyrite. These are fragments of a very fine grained grauwacke schist, and of argillaceous quartzite. The cementing material is probably derived partly from the decomposition of the felspar fragments, and is in part a product of the alteration of what was originally a muddy material deposited with the grains.

Most of the sections of this rock also contain minute crystals of zircon. These are in the form of square prisms, often terminated at one end by an obtuse pyramid. They are colourless, have a high index of refraction, polarize in brilliant tints and have an extinction parallel to the prism. On the square basal section they show the cross of a uniaxial crystal, which when tested with a quarter-undulation plate proves to be positive in sign. These zircons are sometimes without good crystalline form. Nearly all the sections also contain small oblong crystals of a brown or green colour. These are traversed by transverse cracks, have an extinction parallel to their long axis, and are dichroic, the greatest absorption taking place when the light passes through the crystal in a direction at right angles to the long axis. The ends of the crystals are irregular, in the larger crystals one end being almost invariably terminated by a somewhat fibrous development of the crystal, often lighter in colour than the remainder. These are tourmaline crystals. Grains of pyrite and minute crystals, probably apatite, are also present in most sections. A section of this rock was treated with concentrated hydrochloric acid for twenty-four hours and then with fuchsine. The rock fragments were unacted on with the exception of one in which numerous little points were found to be slightly coloured. The dull yellowish crystals penetrating them were also unacted on. Some of the decomposed felspar fragments were slightly but distinctly coloured, while the other felspar grains and the cementing material were unattacked.

Professor Rosenbusch, to whom I sent sections of this rock, states that it is similar to the felspar rich grauwackes which occur in the Vosges, for example, in the Devonian and Carboniferous, chiefly in the metamorphic districts designated by the older French geologists as the "terrain de transition modifié."

21. *Highly Felspathic Grauwacke—Shipton, Range VI. Lot* 11.

Resembles the last rock. The fragments in this rock, however, consist almost exclusively of felspar. They are more or less angular, the plagioclase grains being at least as numerous as those of orthoclase. Quartz grains are very few in number, if indeed any are present in the sections. A light green mineral is disseminated through the sections of this rock in strings and irregularly shaped patches. It is often pleochroic showing light green and greenish-yellow tints, and between crossed nicols shows aggregate polarization, with dull blue tints. It often occurs in little leaves and radiating spherulitic masses, and in some of the larger leaves a fibrous structure can be seen, in which cases extinction takes place parallel to the fibres. It thus has under the microscope the characters of a chloritic mineral, and has undoubtedly originated in great part at least from the alteration of the felspar, since in many places in the slides little vermiform processes of the mineral can be seen penetrating, well twinned plagioclase grains, and in some cases untwinned grains which are probably orthoclase. The alteration of plagioclase and orthoclase to a chloritic mineral (pseudophite) has already been described from several localties.* Numerous grains of leucoxene resulting from the decomposition of iron ore are also present.

* See Justus Roth—Allgemeine und Chemische Geologie, pp. 305 and 321.

22. *Highly Felspathic Grauwacke—Shipton, Range VI. Lot* 12.

Similar to the last mentioned rock from lot 11 of the same range. A very few quartz fragments are present in the sections.

23. *Highly Felspathic Grauwacke—Shipton, Range VI. Lot* 13.

Similar to the last two, but contains in addition to felspar fragments, a large proportion of angular quartz grains, as well as a few decomposed fragments of what was probably some rock. It shows evidence of having been submitted to great pressure. The quartz grains are much broken and in some places converted into a mass of rice-like grains. Very few of them extinguish simultaneously over the whole surface. They are, moreover often of an elongated shape, being sometimes as much as seven times as long as they are broad, which is unusual in ordinary clastic fragments of quartz. Those elongated fragments however occur with others not so elongated. The felspar grains as is the case in most of these rocks are much bent and faulted, phenomena which can be plainly seen in the plagioclase grains on account of their lines of twinning. Leucoxene occurs in numerous small irregular shaped masses, often with a core of undecomposed iron ore. Little folia of chlorite and of a colourless mica, together with little grains of epidote showing a high index of refraction and the usual pleochroism occurs in the cementing material.

24. *Highly Felspathic Grauwacke—Lac au Crapaud—Rolette, Range III. Lot* 7.

Resembles the last rock very closely, but does not contain any of the elongated quartz grains present in it. The quartz grains hold numerous hair-like bodies, and fluid inclusions, with moving bubbles. The cementing material contains a large quantity of a green chloritic mineral together with an almost colourless micaceous-looking mineral (muscovite?)

25. *Highly Felspathic Grauwacke or Sandstone—Between 2nd and 3rd south-west road. Augmentation of St. Michel.*

A rock composed of more or less angular grains of quartz, orthoclase, plagioclase and an iron ore, the latter partially decomposed to leucoxene cemented together by a small amount of a green chloritic mineral A few decomposed fragments of what was probably some rock are also present. The felspar grains are as numerous as those of quartz, and a few of them show the cross hatched structure usually seen in microcline. The cementing material in this rock is, as has been stated, a chloritic mineral, and is much smaller in amount than in most of the specimens before described.

26. *Highly Felspathic Grauwacke or Sandstone—River St. Anne, Shickshock Mountains.*

Resembles the specimens from Lac au Crapaud and Shipton, Range VI, lot 13, in composition, but is much fresher. Comparatively little of the chloritic mineral occurring in large quantity in both of these rocks is present. The cementing material is smaller in quantity, and is rich in the colourless micaceous mineral before mentioned. Much calcite in large grains is scattered through the rock, the hand specimen has a reddish tint due to disseminated hematite grains.

27. *Highly Felspathic Sandstone—Acton—Range XI. Lot* 36.

It is quite fresh and consists of fragments of quartz, orthoclase and plagioclase, held together by a very small quantity of a cementing material which appears to be partly microcrystalline and partly crypto-crystalline. This cement holds innumerable little red scales of hematite. The quartz grains preponderate, they are as a general rule angular, but a few are well rounded. Some hold numerous inclusions, while others are almost free from these. A number of other grains are seen in these sections, which are now decomposed to a chloritic mineral, but which were probably mica. A few little grains of tourmaline, epidote and sphene (?) are also present, as well as a good deal of hematite scattered through the section in irregular shaped masses.

28. *Felspathic Quartz Schist—Melbourne, Range VIII. Lot* 6.

This rock is seen by examining a section to consist of quartz grains, almost invariably angular but occasionally somewhat rounded, with a few of plagioclase and of a felspar which does not show any lines of twinning. Between these larger grains there are a great number of smaller ones of the same minerals. The rock is distinctly foliated, the plane of foliation being marked by little irregular strings and patches of a chloritic mineral. The quartz grains which preponderate very largely, generally hold hair-like inclusions, and some of them hold fluid cavities with moving bubbles. It is probably a clastic rock.

G.M.D., PHOTO., JULY [illegible]

A. Mortimer, Lith. Ottawa.

WEATHERED SANDSTONE ROCKS, MILK RIVER.

GEOLOGICAL SURVEY OF CANADA.
ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

PRELIMINARY REPORT

ON THE GEOLOGY OF THE

BOW AND BELLY RIVER REGION,

N. W. TERRITORY,

WITH

SPECIAL REFERENCE TO THE COAL DEPOSITS.

BY

GEORGE M. DAWSON, D.S., F.G.S.,
ASSOCIATE ROYAL SCHOOL OF MINES.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

Montreal:
DAWSON BROTHERS.

1883.

To Alfred R. C. Selwyn, Esq., LL.D., F.R.S., F.G.S.,

Director of the Geological and Natural History Survey of Canada.

Sir,—I beg to present herewith a preliminary report on the Bow and Belly River District, with special reference to the Coal deposits. A more detailed account of the region, with a geological map, is in course of preparation, and will be ready for issue in the next annual volume

I have the honour to be,

Sir,

Your obedient servant.

GEORGE M. DAWSON.

Ottawa, Jan., 1883.

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In submitting the following report, I may state that it is essentially a reprint, with additions and corrections, of a note published in May, 1882. This note was issued in advance of the ordinary annual report, on account of the importance of the coal deposits of the district, in connection with the rapid progress of settlement in the North-west Territory; the stage at which the examination of the district had then arrived having enabled the question as to its coal supply to be decided in the most favourable sense, and even rendered it probable that fuel for a large area of the North-west Territory may in the near future be derived from it.

As originally printed, this report embraced the result of my own work and that of my assistant, Mr. R. G. McConnell, B.A., in the summer and autumn of 1881. During the past season (1882) Mr. McConnell has continued the exploration of the same region, and some additional notes, the result of his work, are now incorporated. A map, on the scale of eight miles to an inch, which is intended to embody all the necessary details of structure, is now in course of preparation, and as this will be accompanied by a somewhat detailed description of the geology of the region, it is intended in the present report to give merely a short preliminary sketch of the stratigraphical relations of the beds, in so far as this is intimately connected with the occurrence of the coal seams. Work embraced in this report.

Outline of the Geology of the Region.

Limits of region.

The region embraced in this report, and of which the examination and field work for mapping has now been almost completed, extends from the Rocky Mountains eastward to the 111th meridian; is bounded to the south by the 49th parallel, stretches northward some distance beyond the 51st parallel, and embraces, to the east of the Palæozoic rocks of the mountains, over 20,000 square miles. It forms the southern part of the newly-created district of Alberta, and is drained chiefly by the Bow and Belly Rivers and their tributaries, though a portion of it lies in the Missouri basin and is drained by the Milk River.

Explorations in Rocky Mountains.

A portion of the Rocky Mountains has also been explored and mapped; but as the mountainous district must form the subject of a separate investigation, it will be necessary to state here, merely, that the South Kootanie Pass, the Crow's Nest Pass, and the eastern portion of the Bow River Pass, were the districts particularly examined. The most interesting feature of these explorations was the discovery that in the region of the Crow's Nest Pass, wide valleys based on Cretaceous rocks occur west of the first range, which is formed of the Palæozoic limestones, and that, in the Cretaceous rocks, an important intercalation of volcanic material appears, in connection with which traces at least of copper ores occur. It is possible that in some of these now isolated troughs of Cretaceous rocks, coal beds may yet be found, in the heart of the range. The existence of a seam was indeed reported about twenty miles west of the summit of the Crow's Nest Pass, but the locality has not yet been examined.

General attitude of rocks.

The rocks of the foot-hills and plains east of the mountains, are, so far as ascertained, entirely of Cretaceous and Laramie* age, overlain by boulder clay and other beds referable to the glacial period, and by alluvium. In the eastern portion of the district they are horizontal or very nearly so, being frequently affected by light undulating dips scarcely greater than may be supposed to have characterized the original surface of deposition. On approaching the base of the mountains this uniformity suddenly ceases, and the beds become more or less sharply corrugated, the disturbance being in some instances so great as to result in overturned folds. The belt of country affected by this disturbance constitutes the foot-hills. The exposures of the newer rocks nearest the actual margin of the Palæozoic, very often show comparatively light south-westerly or westerly dips toward the base of the mountains. A series of great faults with downthrow eastward must separate these

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* The term *Laramie* is used in a general sense for the Upper Cretaceous or Lower Eocene beds which overlie the Fox Hill Series (Cret. No. 5). It is not intended by its use to differentiate the beds so named from those of the Judith River and Fort Union series, with which they may be found to blend as the intervening district is more completely explored.

newer rocks from those of the mountains, and it is by a repetition of similar faulting in the mass of the range, that the isolated areas of Cretaceous rocks already alluded to have been introduced.

Width of disturbed belt

On the Bow River Valley, the width of the disturbed belt from the edge of the Palæozoic (which here falls back some miles from its general line) is about twenty-seven miles, on the Highwood River and its tributaries seventeen miles. On the North Fork of the Old Man it is about twelve miles in width, and on the southern branches of the same stream, including Mill and Pincher Creeks, about thirteen miles. On the Waterton (Kootanie), Belly and St. Mary Rivers, about eighteen miles. In the last named district, the limit of the belt of disturbed rocks, which has before run southward nearly parallel to the base of the main ranges of the mountains, changes its direction, in conformity with that of the mountains, to south-east. An approximate uniformity in the width of the region of upturned strata is thus maintained.

Change of composition near mountains.

Besides the disturbance above alluded to, the geology of the region in the immediate vicinity of the mountains is further complicated by the fact that the beds there change considerably in lithological character, the change being such as might be expected to occur on the approach to a shore line. Sandstones are much more abundant and coarser in texture, and in a few places conglomerates holding pebbles derived from the mountains, occur. One of the most abundant materials in these coarser rocks is the chert which is derived from concretions and irregular layers in some parts of the limestone series.

Great synclinal.

In the Belly River region, east of the belt of disturbed rocks above defined, the Cretaceous and Laramie beds form a broad, shallow synclinal, the centre of which is occupied by the Porcupine Hills. A series of reddish and purplish clay beds, which may be named provisionally the Willow Creek series, appears to be very persistent in the Laramie of this region, and affords the means of recognizing a definite horizon over a large tract of country. The width of the synclinal just alluded to, on the Old Man River and its tributaries—measuring from the base of the Willow Creek series on each side—is about forty miles. In proceeding eastward from this synclinal to the boundary of the district embraced in the season's work, the series is, generally, a descending one. The beds appear to have, as a rule, persistent light westerly or south-westerly dips, while the rivers have a considerable eastward slope; and though, as above stated, many minor undulations affect the nearly horizontal rocks of the plains, these are usually so light as to interfere little with their uniformity on the large scale. One important exception only has been noticed to this rule, where, a few miles above the mouth of the Belly, on the Old Man River, the estuarine and marine beds characteristic of the base of the Laramie are upturned at

Nearly horizontal beds.

angles of from 30° to 43°. Similar abrupt local disturbances are occasionally found in the west—as in several instances on the Missouri River—in connection with the intrusion of volcanic rocks, but there is no evidence here of such cause.

General arrangement of beds.

The general arrangement of the rocks may be represented as in the subjoined table, the subdivisions being in descending order. No attempt is at present made to state the thickness of the several subdivisions, as the map work and sections are not yet sufficiently advanced to render it possible to do so with an approximation to accuracy:—

LARAMIE.	Beds of the Porcupine Hills. chiefly thick-bedded sandstones, some shales.
	Willow Creek beds. Reddish and purplish clays, with grey and yellow sandstones.
	St. Mary River series. Sandstones, shales and clays of general greyish or greyish-green colours.
	Yellowish sandstones and shaly beds, with a mingling of fresh-water and brackish or marine molluscs.
FOX HILLS.	Yellowish sandstones, with some shales, irregular in thickness and character. Molluscs all marine.
PIERRE.	Blackish and lead-coloured shales, with occasional sandstone intercalations, especially toward the mountains.
NIOBRARA?	Belly River series. Sandstones, shales and sandy clays, generally of pale greyish tints. Marine and fresh water fossils.
	Series apparently underlying the last on the Bow and Belly, but on the stratigraphical position of which some doubt yet remains owing to the resemblance of its estuarine fauna to that of the Judith River. Brownish and yellowish sands and clays.

So far, no reason has been found to suppose that any Tertiary rocks newer than the Laramie have been found in this district, or indeed in any part of the Canadian North-west Territory.

Porcupine Hill series.

The beds typically developed in the Porcupine Hills have been examined by Mr. McConnell during the past summer. They consist chiefly of massive and often current-bedded sandstones, with occasional shaly layers. The beds seen on the upper part of the Bow River, near Calgary, doubtless represent the same stage in the Laramie. The thickness of beds shown in the Porcupine Hills is probably several thousand feet.

The relation of the Willow Creek series to the wide synclinal of the Porcupine Hills has already been referred to. The beds of this series are generally soft, and their outcrop follows the wide low valley which bounds the southern part of the Porcupine Hills to the west, and crossing Pincher Creek at the Police farm, runs south-eastward to the Waterton (Kootanie) River. In the vicinity of the upper part of Milk River, however, they are almost horizontal, and form the higher parts of the western portion of the plateau known as the Milk River Ridge. They also stand up prominently in the Belly Butte, near the confluence of the Belly River with the Waterton. The characteristic colouring and appearance of these beds constitute the only reason for giving them a separate provisional name, as they appear to be perfectly conformable with those above and below. Small, irregular, clayey nodules of peculiar appearance abound in some layers. Fossils are remarkably scarce, though a few fresh-water molluscs, similar to those of the underlying series, have been observed; and on the Old Man River, a few miles below the mouth of Willow Creek, the remains of a large chelonian were met with. These beds were not recognized on the Highwood or Bow Rivers, a fact not implying any break in the sequence of the Laramie formation there, but merely the absence of the peculiar colour, which enables the Willow Creek series to be defined in the southern part of the district. Willow Creek series.

The rocks which may be designated the St. Mary River series, cover a large portion of the region under description. They have been carefully examined at many different localities, and extensive collections of fresh-water molluscs, many of which are identical with those found in the Fort Union, Judith River and Laramie beds of the western states, have been made from them. These rocks are shown in excellent sections for many miles on the Upper Belly River, and the St. Mary, Waterton and Old Man Rivers and Pincher Creek. They are generally characterized by rapid alternations of sandstones and shaly or clayey beds, the stratification, as a rule, being regular. Greyish or greenish- or bluish-grey tints characterize the beds, though some of the sandstones weather to yellowish colours, and ironstone nodules are of frequent occurrence. At the base, these rocks show estuarine and marine conditions, and yellowish colours prevail. These latter beds have been separately designated in the table of formations, but there is probably no distinct character by which they may be separated from those above, except the passage from brackish-water to fresh-water conditions. The close relations of these with the upper beds is further illustrated by a section on Bow River, described below. In these transition beds, in the Belly River region, *Corbicula pyriformis*, *Corbicula occidentalis* and *Ostrea* are found in some layers in great abundance. St. Mary River series. Passage beds.

These fossils were observed in several places on the Upper Belly and St. Mary Rivers, and also on the Old Man River at the point already mentioned as showing a peculiar disturbance of the beds. The same zone runs northward to the Bow River and beyond, and at Scabby Butte includes large numbers of bones of dinosaurians.

Thickness and extent of the Laramie.

The whole of the beds so far described have been included under the general name of Laramie. The total thickness of the formation in this region is very great, several thousand feet at least, and much in excess of that of the Judith River beds as developed on the Missouri. Northward, on the Bow River, as the Willow Creek beds cannot be identified, it has been found impossible to carry out the subdivision which may be usefully retained for the region about the Belly and its tributaries. On the Bow, the Laramie extends continuously from the edge of the disturbed rocks of the vicinity of the mountains to a point about ten miles below the Blackfoot Crossing—a distance of over eighty miles. At the western edge of this region, the beds in their colour and general appearance closely resemble those of the typical St. Mary River subdivision, but eastward, sandstones predominate over shales and clays, the rapid alternation of beds differing lithologically is less marked, and the bluish and greenish-grey tints before observed are replaced by yellowish-grey and buff. The representatives of the brackish or marine beds described in the Belly River region were seen only near the eastern edge of the formation on the Bow. In a scarped bank about ten miles above the Blackfoot Crossing, the lowest layers near the river level are full of specimens of *Corbicula occidentalis* and a species of *Ostrea*, while a few feet higher, beds of similar lithological character, and perfectly conformable, are charged with *Unio* and *Vivipara*, and contain no brackish or marine forms.

Coal-bearing zone at base of Laramie.

The Laramie is, near its base, in the region now reported on, a persistent lignite- or coal-bearing formation. A few miles north of the 49th parallel, on the St. Mary River, a coal bed of excellent quality, eighteen inches in thickness, overlain by a bed holding *Corbicula occidentalis* and *Ostrea* occurs. It is described in my report on the Geology and Resources of the 49th Parallel (pp. 132, 172). Another coal outcrop, possibly of the same seam, and about a foot in thickness, is found on the Upper Belly River. The seam at the Indian farm near Pincher Creek, is probably again not far from the same horizon, though perhaps a little higher in the series. Coaly streaks occur in the sandstones at the disturbed locality on the Old Man River, which has already been referred to, and a lignite at Scabby Butte holds about the same position. Further north, the seam on the Bow at Coal Creek, between Morley and Calgary, and those in the vicinity of the Blackfoot Crossing, appear to occupy nearly the same stage. The thin seams near the mouth of the Highwood River may possibly be higher in the Laramie, and from the character of the St. Mary River subdivision throughout, it is not improbable that other coal- or lignite-bearing zones may occur locally. The character and surroundings of the more important seams now known are detailed on a subsequent page.

Fox Hill sandstones.

The Fox Hill beds, or their representatives in this district, appear to pass into the base of the Laramie upward, and below to blend with the Pierre, both lithologically and in their fauna. On the lower part of the St. Mary River, a massive sandstone, about fifty feet in thickness, which from its position at the top of the Pierre may be supposed to represent the Fox Hill subdivision, is well exposed. On the Milk River, near the crossing of the Benton Trail, and again north of the Buttes, yellowish sandstones occasionally holding marine shells (*Nucula cancellata*, *Liopistha undata*, &c.,) occur, and occupy the same position with regard to the Pierre shales. (See Plate I.)

Pierre shales.

The Pierre rocks, throughout this district, are not so homogeneous in character as further east, and frequently hold sandstone intercalations. The occurrence of the Pierre at the base of the West Butte has been described in my Report on the Geology and Resources of the 49th Parallel, already referred to. A further examination of this locality has since resulted in the discovery of additional fossils.

Distribution and character.

The Pierre is again seen with its characteristic fossils on the lower St. Mary River, and it has during the past summer been traced southward across the Milk River Ridge and Milk River to the 49th parallel. North-eastward it occupies a wide belt of country, owing to its low angle of outcrop, running on to the Bow River, a distance of eighty miles, and thence to the Red Deer River, a further distance of forty miles. On the Old Man River the upper part of the Pierre, for a thickness of about fifty feet, ceases to show its usual blackish or dark grey colour, becoming a sombre brown clay shale. On the Bow River the same appearance is found, but the beds so affected are several hundred feet in thickness, and there is also here toward the base of the Pierre a zone characterized by pale sandy clays and sandstone. A similar change, but even more pronounced, is found on the Red Deer River. The Pierre is, however, as a whole, the best marked and most easily recognized formation of the district. The most persistent coal-bearing horizon is included in its base, and has already been utilized in supplying Fort MacLeod, and for shipment to Benton on the Missouri by waggons returning from Fort MacLeod. A second coal seam occurs at the summit of the Pierre on Bow River, at Horse-shoe Bend. Details of these are given on a subsequent page.

Coal seams.

Sub-Pierre beds.

On both the Bow and Belly Rivers, and elsewhere, a series of pale, generally greyish and arenaceous beds at least two hundred feet in thickness are found underlying the Pierre shales. These have been designated as the Belly River series. On the Belly, a few large Unios and fragments of dinosaurian bones only were found in these Sub-Pierre rocks. Mr. McConnell has since, however, on Milk River Ridge not far below the Pierre shales, found, besides the unio above mentioned, several truly marine forms. On the lower parts of the Bow and Belly and on the S. Saskatchewan below their confluence, a series of beds containing estuarine fossils of Laramie (Judith River) type occurs. A more detailed account of this series is, however, reserved till some points as to the stratigraphy and fauna can be further investigated. In this series a seam of lignite, of good quality, but generally of small thickness, occurs on both the Bow and Belly Rivers. It is referred to again where, at one point on the Belly River, it becomes of possible economic importance. There is reason to believe that this seam is nearly on the same horizon with that of Medicine Hat, on the South Saskatchewan.

Beds on Lower Bow and Belly.

Equivalency.

The pale beds underlying the Pierre in this region represent, with little doubt, the Dunvegan sandstones of the Peace River section. (Report of Progress, 1879–80.) They are also evidently identical with those described by Prof. Cope as occupying a similar position on the Missouri (Bulletin U. S. Geol. and Geog. Survey, Vol. III., p. 568). This subdivision, which appears most probably to hold the position of the Niobrara in the Nebraska section, is therefore one of great persistence in the Cretaceous.

Notes on the more Important Coal Seams of the Bow and Belly River District.

Character of coals.

The fuels contained in the rocks described in the foregoing general notice, vary from lignites but slightly superior in quality to those of the Souris region, to materials containing a very small percentage of water, forming a strong coke on heating, yielding abundance of highly luminous hydrocarbons, and precisely resembling ordinary bituminous coals, though of Cretaceous and Laramie age. In describing them the term *coal* will generally be used, as it is impossible to draw a definite line between the two classes among the numerous intermediate varieties.

Seams on lower Bow and Belly.

The coal seam last referred to as occurring on the lower Bow and Belly Rivers, is seen in the banks for many miles at a height above the water, which varies in correspondence with the the light undulating dips by which it is affected. It is generally not more than a foot or eighteen inches in thickness though so persistent in extent, but at one point on the Belly River it thickens to three feet, forming a workable seam, which appears to be of good quality throughout. This locality is thirty-two miles in a direct line from "Coal Banks." No analysis has yet been made of this fuel.

As above stated, the coal near Medicine Hat on the South Saskatchewan, is supposed to occupy nearly the same position in the series as that just referred to, and though Medicine Hat is beyond the limit of the district described in this report, a short note on that locality may be of interest. It was examined by Mr. McConnell last autumn while on his way down the river. Coal at Medicine Hat.

Exposures of the seam were found to occur on nearly every bend of the river from a point about thirty miles below the junction of the Bow and Belly to Medicine Hat. The seam is, however, more variable in thickness and character than many in this part of the North-west, and at two places on the river scarcely a mile apart, changed from two feet in thickness of shaly impure lignite to six feet thick of very fair coal.

An exposure twelve and three-quarter miles above Medicine Hat gave the following section :—

	ft.	in.
Yellowish sandstone	10	0
Coal (fair quality, 100 feet above water level)	4	6
Shales	1	3
Sandstone	1	0
Coal (fair quality)	4	0
Shales	6	0

Higher up in the same section another seam about four feet thick was seen.

Three miles above Medicine Hat, the seam is again well shown in the side of the river valley at a height of eighty feet above the water level, and with a thickness of four feet. No analysis of this fuel has yet been made, but in physical characters it is to some extent intermediate between the Souris coals and those of the Bow and Belly Rivers.

The locality just referred to as "Coal Banks" is at the crossing of the Belly River by the trail to Benton. The coal occurring at this place is that which has been described as existing at the base of the subdivision of the Cretaceous known as the Pierre shales. It is one of the best in the district, and has been worked to a small extent for some years at this point by Mr. N. Sheran. The outcrop of this seam is now known to extend southward to a point on the St. Mary River six miles from Coal Banks, and thence south-eastward about twenty miles, where it reappears on the Milk River Ridge. North-easterly it runs to the Bow River about sixty miles, and thence to the Red Deer, forty-five miles further, giving a total length of outcrop, proved at a number of points, of about one hundred and thirty miles. "Coal Banks," Belly River.

General character of valley and sections.

The drift deposits average about one hundred feet in thickness in the region near Coal Banks, and it is consequently, in general, only in the river valley or in the larger coulées which flow into it that the Cretaceous rocks can be seen. The Belly Valley in this part of its course is about 300 feet deep, and averages nearly a mile in width. It therefore cuts about 200 feet into the Cretaceous rocks, and displays fine sections of these. There are in this vicinity several associated coal seams, of which one is workable and has been opened by Mr. Sheran. I may, for the sake of clearness, refer to it as the "main seam." It is more or less perfectly exposed at intervals along this part of the Belly for a distance of about twelve miles, or from the workings at Coal Banks to Big Island of the map. Above Coal Banks the measures are affected by a light anticlinal swell which brings up older rocks, and the outcrop runs round to the west, appearing on the river again at the mouth of the St. Mary. At the furthest point up the St. Mary at which the coal appears (about seven miles from the mouth of the river), it occurs in the following section, the second column being a continuation of the first, but at a spot about one hundred yards further down stream :—

Sections on St. Mary River.

	ft.	in.
Rusty ironstone layer	0	8
Blackish and rusty shale	5	0
Coal	0	3
Blackish shale	6	0
Coal	0	6
Soft carbonaceous shale	0	4
Coal	0	8
Soft, thin shale, highly carbonaceous in upper part	0	6
Ironstone shale	0	6
Blackish shale	3	0
Coal	0	8
Carbonaceous shale (some coal)	1	6
Coal (partly below water)	1	6

	ft.	in.
Coal	1	0
Shaly coal	0	6
Coal	1	3
Shale	0	2
Coal	0	9
Grey shale	4	0
Coal	1	4
Grey Shale (to water)	4	0

About two miles further down the St. Mary the coals are again seen, with the following development :—

Coal (rather shaly)	1	0
Coal	1	4
Shale	0	3
Coal	0	9
Shale	10	1
Coal	3	8
Shale (with obscure plant impressions)	6	0

GEOL SURVEY OF CANADA.

G.M.D., PHOTO., JUNE 18TH 81.

A. Mortimer, lith. Ottawa.

OUTCROP OF MAIN COAL SEAM, COAL BANKS, BELLY RIVER.

At the mouth of the St. Mary the main seam has a thickness of three feet six inches, but about eighteen inches at the top is rather shaly.

Where seen on Milk River Ridge the seam is only fifteen inches thick. Coal at Milk River Ridge.

On comparing the sections on the St. Mary with those at Coal Banks and on the Belly River to the north, it will be noticed that the coal at the first-mentioned locality is more divided by shales and less favourably situated for working.

On the part of the Belly River near Coal Banks, the measures have as a whole a light westerly dip, while that part of the outcrop between Coal Banks and Big Island forms a minor synclinal depression in its edge, across which the river cuts in a direction nearly coinciding with the main strike of the measures, and gives rise to a great display of coal on this part of the valley. The coal-bearing horizon, as above mentioned, lies at the base of the Pierre, and its position between the dark shales of this formation and the pale sandy beds of that underlying it, renders it easy to define the situation of the coals, even where their actual outcrop is concealed. For a distance of five miles north of the Coal Banks exposures, the dark shales just referred to occupy the river valley, while the outcrop of the coal is carried eastward to an uncertain distance by the light synclinal undulation above referred to. The gentle inclination of the measures shows that the coal might be reached at a moderate depth by shafts sunk through the dark shales in this part of the valley, from which it might with facility be worked up its slope to the eastward. The undulating character of the dips renders it impossible, however, to estimate the exact depth at which the seam would be found, though it is probably not over 500 feet below the river, midway between its southern and northern outcrops in the valley. It may also be worked on a smaller scale, but with great facility, by levels driven into the actual outcrops in the river banks. Position of coal at "Coal Banks."

Having thus briefly described the general mode of occurrence of the coal on this part of the Belly River, the following more detailed notes on the outcrops which occur will serve to show the actual character of the seam.

At Coal Banks, the coal has been extracted chiefly by quarrying along the natural outcrop, though during the summer of 1881 a small level was opened. The outcrop is situated in the front of a steep scarped bank facing the river, and the seam, which at the southern end of the bank is about 30 feet above the water, dips away below the water at the northern. (See Plate II.) The following section shows the mode of occurrence and association of the coal in the bank, but does not extend upward to the base of the drift deposits :— Details of outcrops near "Coal Banks."

Section at Sheran's.

		ft.	in.
	Finely laminated grey shale	8	0
	Coal (shaly below)	1	6
	Grey, thin-bedded shale	12	0
	Ironstone	0	3
	Grey shale	1	9
	Coal	0	8
	Grey shale and nodular sandstone, carbonaceous below	7	0
Main seam.	*Coal*	1	4 } Coal. 5′ 4″
	Shaly parting (often almost absent)	0	4
	Coal	4	0
	Carbonaceous shale	2	0
	Grey shale	2	0
	Ironstone	0	4
	Greyish and brownish shale	3	0
	Carbonaceous shale	3	0
	Coaly shale	0	8
	Grey shale	2	0
	Coal	0	4
	Carbonaceous shale (to water)	1	4

The dip at this place is about N. 83° W. (mag. variation 22° 46″ E.), at an angle of five to eight degrees.

On the opposite side of the river, at its next bend, the coal is again well shown. It is slightly undulating, and dips gradually away below the water level at the northern end of the bank. The part of the section designated above as the main seam is here as follows:—

	ft.	in.
Coal	1	6
Shaly parting (1 to 3 inches)	0	2
Coal	3	3
Total coal	4	9

About four inches in thickness at the base of the seam is here laminated in texture, but appears nevertheless to to be of good quality. The general dip is about N. 50° W. (mag.), at an angle of less than 5°.

Concealed interval. Section S. of Big Island.

From this point for a distance of five miles down the valley, the dark shales overlying the coal are alone seen. When it again appears, on the west bank of the river, the main seam shows the following section:—

	ft.	in.
Coal	1	6
Shale	0	3
Coal	4	6
Shale	1	6
Coal	2	9
Total coal	8	9

The lowest division of the seam at this place is apparently not represented in the sections previously described. The coal in it is somewhat laminated, but seems to be of good quality. The dip is here about S. 70° W. (mag.), at an angle of 5°.

About three miles further north, extensive exposures of the coal are again found in the scarped bank or cliff facing the river, at a height of about 100 feet above the water level. The dip is light and undulating, but on the whole westward, or away from the river. The main seam is here composed as follows:—

	ft.	in.
Coal	2	6
Carbonaceous shale	0	7
Coal	2	2
Carbonaceous shale	1	0
Coal	1	3
Total coal	5	11

The coal here appears to be of good quality throughout. North of this point on the river the main seam is not again found well exposed, though in several places the associated rocks are shown in such a way as to indicate that it outcrops below the drift deposits a short distance east of the river valley.

At the point at which the base of the Pierre should cross the Little Bow River, a seam of coal a few inches thick was observed by Mr. McConnell, but the exposures did not bring the main seam into view. Coal on Little Bow River.

This coal-bearing horizon appears again on the Bow River, opposite a considerable island, which I have named Grassy Island, about thirty-three miles in a direct line below the Blackfoot Crossing, in lat. 50° 25′ 15.″ In their general appearance, arrangement and thickness, the seams here exposed closely correspond with those on the Belly River. The subjoined section exhibits the relations of the coal at this place:— Continuation of seam on Bow River. Grassy Island.

	ft.	in.
Lead grey shale	25	0
Coal	1	6
Soft grey and yellowish-grey shaly sandstone	13	0
Carbonaceous shale, coaly streaks	2	3
Coal (good and sound throughout)	4	6
Dark grey shale and shaly clay	7	0
Coal	1	0
Carbonaceous shale	1	0
Coal	0	8
Soft shale and clay	8	0
Coal and carbonaceous shale (to water)	1	6

The beds dip westward at a very light and constant angle. The seam 4 feet 6 inches in thickness probably represents the main seam of the Belly River.

Composition of coal from this seam.

Some general facts regarding the composition of the coal of this horizon in the Cretaceous may be given. The analysis by Prof. Haanel quoted in my report on the Geology and Resources of the 49th Parallel (p. 179, No. III, in table) is of coal from this seam, but probably from that part of the outcrop near the mouth of the St. Mary River. The same remark applies to a specimen which was analyzed by Dr. Harrington. (Report of Progress, 1877-78, p. 49 C.) Prof. Haanel's analysis shows 6·69 per cent. of moisture and 6·31 per cent. ash. A specimen from Mr. Sheran's mine, collected and examined by myself, yielded the following result:—

Belly River outcrop.

Water	6·52
Volatile combustible matter	31·03
Fixed carhon	56·54
Ash	5.91
	100·00

The coal is compact, does not easily break up by handling or exposure, and is in every respect a very excellent fuel, though not yielding a coherent coke.

Bow River outcrop.

In correspondence with the increased distance from the mountains of the outcrop of the same seam on the Bow River, and the probable inferior degree of alteration to which it has been subjected, the coal is there found to contain more water, approximating in this respect to some of the Souris River lignites. From these, however, it still differs in its more compact texture and resistance to weathering and the regular vertical cleat or jointage planes by which it is traversed, which cause it to assume cuboidal instead of conchoidal forms on fracture. A preliminary examination of an outcrop specimen from this locality gave the following result:—

Water	12·37
Volatile combustible matter	32 33
Fixed carbon	46·39
Ash	8.91
	100.00

This seam, where it crosses the Red Deer River, has a thickness of about eighteen inches only.

Seam above Pierre shales.

The next recognized seam in ascending order is that at the top of the Pierre shales. As seen on the Bow River, at the point which I have designated as Horse-shoe Bend, it has a very light westerly or north-westerly dip, It is doubtless more local in character than the last, as it is not known on the Belly River, nor could Mr. McConnell find any corresponding seam on the Red Deer. The outcrop at Horse-shoe Bend is situated about fifteen miles east-north-east of the Blackfoot Crossing. The seam appears at a height of 135 feet above the water in a steep scarped bank on the south-east side of the river, and is exposed for nearly half a mile. It is 4 feet 4 inches in thickness, compact and hard where not long weathered, and in physical character resembles that last described. A preliminary examination of an outcrop specimen showed the following composition:— Horse-shoe Bend.

Water	13·67
Volatile combustible matter	37·16
Fixed carbon	40.50
Ash (reddish)	8.67
	100·00

Still following an ascending order in the series, the seam which has been known for some years at Blackfoot Crossing next claims attention. This is several hundred feet higher in the section than the last, and is distinctly included in the Laramie. It is probable that still another seam exists between this and and that described, but no sufficient exposures of it were found. Blackfoot Crossing coal seam.

Coal occurs in several places on the Bow River a few miles above the Blackfoot Crossing. The seams are too thin to work, but are probably on the same horizon with that described below. Throughout this region the beds are affected by gentle undulating dips, and though they have besides a very light general inclication westward, they may be considered as practically horizontal. Outcrops above the Crossing.

The outcrop from which a small quantity of coal has been extracted, and which has been referred to by several travellers, is situated six and a half miles eastward from the Blackfoot Agency buildings, on a coulée which runs northward to the Bow. The deposit here consists of two seams, the upper averaging 1 foot 8 inches in thickness, the lower 3 feet. They are separated by about a foot of carbonaceous shale. At this spot the bed may be traced about 500 feet in natural exposures, and is affected by variable dips which do not exceed 5° in amount. The thickness of the seams continues nearly uniform, and they would afford, say, 4 feet 6 inches of clean coal, the whole of which could be worked at once. The immediate banks of the coulée are about 80 feet high at this place, the upper two-thirds being composed of drift deposits, which rest on a worn undulating surface of the rocks below. The general surface of the surrounding prairie at this place is about 110 feet Outcrops on coulée E. of Crossing.

above the level of the coal, and no exposures of the coal or associated beds are found except in the river banks or coulées which cut deeply into the surface of the plain.

In following the coulée northward from the spot just described, the coal is frequently seen on the right or east bank for about a mile, after which the coulée opens into a wider valley with sloping grassy sides, and exposures cease. Owing to the slope of the bottom of the coulée toward the river, the beds are cut into more deeply near its mouth, and at the last exposure the seam is about thirty feet up in the bank. The upper seam is here not well shown, but the lower exhibits a few inches over four feet of good coal. In an exposure intermediate between this and the first, the upper seam is 8 inches thick, the shales 1 foot, and the lower seam 4 feet 4 inches. The seams are underlain by at least twenty feet of soft whitish sandstone. The same sandstone bed appears near the Agency buildings, where the Indian trail going eastward leaves the valley, but the coal seams here are wanting or very poor.

Outcrops on river E. of Crossing.

Between the Blackfoot Crossing and the coulée above described, the same coal-bearing horizon appears in several places in the banks of Bow River. The seams are here more favorably situated for working, and of greater thickness than in the coulée. The subjoined section shows their mode of occurrence at one point:—

	ft.	in.
Coal	1	8
Black carbonaceous shale	1	4
Coal	1	8
Shale	0	3
Coal	0	9
Shale	0	3
Coal	3	0
Shale	1	0
Coal	1	10
Total	11	10
Total coal	8	11

The coal is here underlaid by whitish sandstone for about 30 feet, or to the water's edge. Nearly opposite this exposure, on the south side of the river, the seam appears at intervals in the bank, at a height of about 40 feet above the water, for at least a quarter of a mile. It is affected by a series of light undulations.

Continuation on Crowfoot Creek.

At Crowfoot Creek, six miles north-east of the Blackfoot Crossing, a seam of coal eighteen inches thick appears, which is probably the highest in the group of beds above described, the section not showing the lower part of the series.

The natural exposures serve to prove the continuity in good workable thickness of this coal deposit over a tract of country several miles in extent, and its nearly horizontal attitude and moderate depth below the surface of the plains, would enable it to be proved by boring at a small expense over any desired area. Economic importance.

In texture, this coal is not so firm or well adapted for transport as those of the localities previously described, but its composition appears closely to resemble that of Horse-shoe Bend. Composition.

The following are analyses of the fuel from this place; the first from a specimen obtained by Prof. Macoun, the second from one collected by myself, and probably not subjected to such prolonged desiccation:—

	I*.	II.
Water	10·72	13·20
Volatile combustible matter	29·26	33.80
Fixed carbon	46·09	48·10
Ash	13·93	4·90
	100·00	100·00

This seam is probably continuous to the Red Deer River, and the same with that which occurs at the mouth of the Arrow-wood River, with a thickness of six feet. Continuation of seam on Red Deer.

Four coal-bearing localities on the head waters of the Oldman River appear to be of sufficient importance to obtain notice at the present time, but as the country toward the base of the mountains becomes more fully known, it is probable that numerous additional outcrops will be discovered. Coals nearer the mountains.

At the Government Indian Farm, south of Pincher Creek, a seam of coal occurs about one mile from the farm buildings, up the valley of the small stream on which they are situated. The rocks in the lower part of the valley belong to the St. Mary River subdivison of the Laramie, and dip toward the north-north-east (mag.) Their angle gradually increases from about 20° till the beds become nearly vertical where the coal occurs. Beyond this point the rocks are concealed, but the coal probably occupies a position very near the base of the Laramie. Seam at Indian Farm,

Near the coal seam, the beds have been much disturbed, and the coal itself is slickensided and broken throughout in such a way as to cause it to crumble easily by handling. The seam is two feet in thickness where exposed, but is said to have been considerably thicker where followed into the bank. The opening made on the coal had,

* By Mr. C. Hoffmann. Report of Progress, 1879-80, p. 12 H.

however, fallen in before the time of my visit. The seam should reappear on Pincher Creek about a mile above the crossing place of the road, but the rocks at this place are not well exposed.

Analysis.

An analysis of the coal from this seam by Mr. Hoffmann is given in the Report of Progress for 1878-79, p. 12 H. It may be quoted here for comparison with those of the other seams, and illustrates the improvement in quality of the coals on their approach to the base of the mountains:—

Water	6·26
Volatile combustible matter	29·31
Fixed carbon	55·70
Ash	8·73
	100·00

Seams on Middle Fork of Old Man.

On the Middle Fork of the Old Man River, a few miles below the falls, and nearly north of the mill on Mill Creek, two seams of good coal occur in a scarped bank on the north side of the stream. The beds are each about three feet in thickness, and are folded in a very remarkable manner, illustrating the intensity of the force which has acted in crumpling the rocks near the base of the mountains. It is probable that these beds also occupy a horizon near the base of the Laramie. An analysis of the lower seam shows 56·38 per cent. of fixed carbon and 8·32 of ash.

The section in which these coal seams occur is as follows. The order appears to be descending, but the whole may not improbably be overturned:—

	ft.	in.
Grey to black, very fine shale, with occasional small fish scales and bones, becoming sandy and yellowish at base.	6	0
Ferruginous sandstone	0	6
Greyish soft sandstone or arenaceous clay, with some thin ironstone layers	10	0
Harder greyish and ferruginous sandstone, with some obscure plant fragments	6	0
Hard, flaggy, yellowish sandstone	2	0
Grey sandy shale and shaly sandstone	3	0
Coal	3	0
Soft black carbonaceous shale	0	9
Grey sandy shale	3	6
Grey sandy shale and sandstone	4	6
Grey flaggy sandstone, weathering rusty	2	6
Grey sandy shale and shaly sandstone	5	0
Coal. (Imperfectly seen, but at least 3 feet of good quality)	3	6
Carbonaceous shale	1	0
Grey sandy shale	4	0

	ft.	in.
Ferruginous sandstone	0	6
Greenish-grey sandstone	10	0
Grey and blackish carbonaceous shale	4	0
Greenish-grey, soft sandstone	6	0
Sandstone and arenaceous and carbonaceous shale, with general greenish-grey tints, (about)	80	0
	155	9

On Mill Creek, about four miles above the mill, a seam of coal outcrops. The measures are somewhat broken, and the seam appears to be rather inconstant in thickness. It is not improbable that it may yet be traced southward and northward and found to outcrop on other streams which cross the measures nearly parallel to Mill Creek. The coal is of excellent quality, containing 63·39 per cent. of fixed carbon, with 12·37 of ash. It has been used to a small extent for blacksmith's work at the mill. The following are sections of the seam on opposite sides of a break or fault which traverses the measures at the outcrop:— Seam on Mill Creek.

	ft.	in.
Coal (rather shaly)	3	1
Coal	2	0
Shale	1	4
Coal	2	0
Shale	1	4
Coal	2	0
Total coal	9	1

	ft.	in.
Coal (rather shaly)	2	0
Shale	1	0
Coal (apparently good throughout, with the exception of a few shaly partings, not equalling 4 inches in all)	6	0
Total coal	8	0

The geological horizon of the coal at Mill Creek has not been determined.

Lying also close to the foot of the mountains, about a mile and a half from the first limestone range on the North Fork of the Old Man, is a seam of coal about five feet thick, dipping westward at an angle of thirty-five degrees. Seam on North Fork of Old Man.

At the mouth of a stream which enters the Bow River from the north, between Calgarry and Morley, three miles and a half above the Jumping Pound River, I examined a seam of good coal which had a thickness in the natural exposure of about a foot. Seam on Coal Creek, Bow River.

At a point further up Coal Creek, the seam has since been worked to a small extent. Mr. McConnell visited this locality, and reports about three feet of good coal, with several feet of carbonaceous shales. The seam is evidently very variable, and becomes quite thin at a short distance from the spot just alluded to, along the strike.

General Remarks on the Coals and Lignites.

Great extent of coals.

Whether from an economic or purely scientific point of view, one of the most interesting results of the exploration of the Bow and Belly River country, is the determination of the fact that the coals are not confined to a single horizon or formation, but characterize several zones in the geological series of this region. The fuels found in the Laramie represent, at least in a general way, those known to occur in the same formation or its representative, the Fort Union Group, eastward on the plains to the Souris River. As far north as the Athabasca and Peace Rivers, fuels are now known to characterize the rocks of about the same age. The coal seam which has been referred to as attached to the summit of the Pierre shales, is not known to be represented elsewhere, unless indeed by a very thin seam near the same horizon on the Smoky River. (Report of Progress, 1879-80, p. 125 B.)

Relations with other known seams.

The coal at the base of the Pierre shales which has been worked at Coal Banks, on the Belly River, has not been recognized in a workable form beyond the limits of the district now described. The dark, highly carbonaceous beds at the base of the Upper Shales of Smoky River, are, however, at about this stage, and in one place a thin seam of lignite coal is locally developed (op. cit. p. 118 B.) A bed of lignite coal described by Prof. Cope on the Missouri as in some places of possible economic value must also be of nearly the same age. (Bulletin U. S. Geol. & Geog. Survey, Vol. III., p. 566.) It is further worthy of remark that this coal-bearing horizon at the base of the Pierre of the interior continental region is, as nearly as possible, equivalent to that at the base of the Chico Group, which yields the coals of Vancouver Island at Nanaimo and Comox.

An abundant supply of fuel.

The occurrence of workable coal seams at several different stages, and the proved continuity of some of them over great areas, guarantees an abundant supply of fuel in this district, a matter of great importance in a country which over extensive tracts is almost entirely destitute of wood. The quality of some of the fuels is such as to render them suitable for transport to a distance, and it is doubtless on this belt of coal-bearing rocks in the vicinity of the mountains that the railways of the North-west will chiefly depend for their supply.

As a good deal of misapprehension has arisen as to the character and

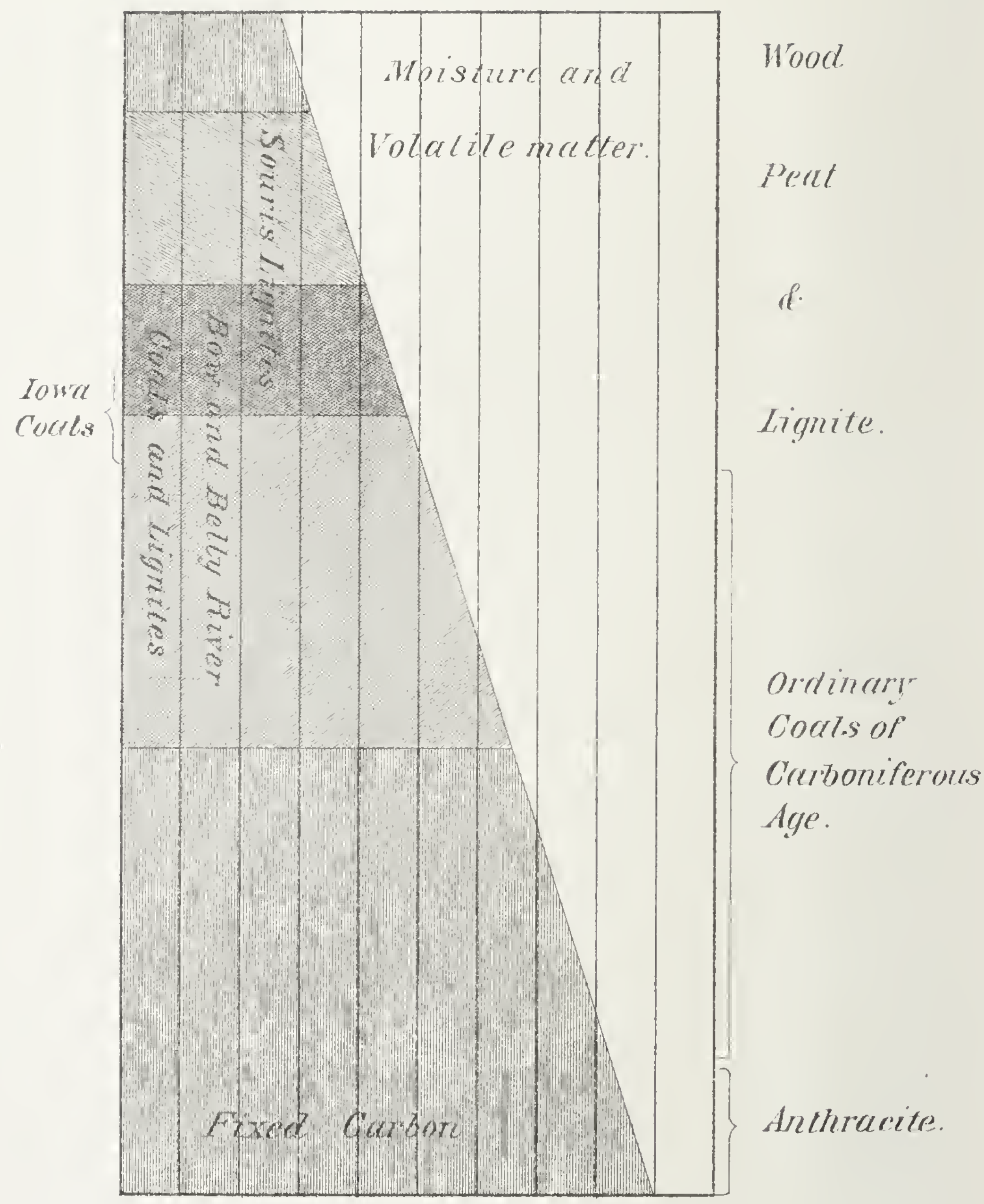

DIAGRAM ILLUSTRATING RELATIVE COMPOSITION

OF COALS, LIGNITES, ETC.

value of the lignites and coals of the North-west, the annexed diagram has been constructed for the purpose of illustrating, in a general way, their place in the scale of fuels. The fuels are here classed according to the amount of "fixed carbon," (charcoal or coke) which they yield. This method of classification, though by no means complete as regards the heat-giving capacity of a fuel,—as much also depends on the quantity of moisture and ash, and quantity and nature of the volatile combustible matter—yet approximates sufficiently to the truth to illustrate the heating value in a broad general way. The shaded portion of the diagam represents the fixed carbon graduating from twenty-five per cent. (charcoal) in wood to over ninety per cent. in anthracite, the complement to 100 per cent. being in each case made up by moisture and volatile matter. The spaces between the vertical lines represent ten per cent each. An inspection of the diagram will show how favourable a position the workable coals and lignite coals of the Bow and Belly River region hold, and how completely they bridge over the gap which is sometimes assumed to exist between coals and lignites. The fuels near which the lower line is drawn in the diagram for the Bow and Belly region, are those which are found in the disturbed belt near the base of the mountains, and, as before explained, appear to have been affected to a certain extent by pressure and possibly by heat, developed in connection with the folding of the beds. The upper line for the Bow and Belly coals, it will be observed, overlaps the lower line drawn for the lignites of the Souris district, showing that in regard to content of fixed carbon the better class of Souris fuels are about equivalent to the lower grades of those of the Bow and Belly. The brace on the left of the diagram indicates the range,—as regards the proportion between fixed carbon and volatile matter—of the carboniferous coals of Iowa. These are interesting not only on account of the greater quantity of moisture and volatile matter, which many of them hold as compared with ordinary carboniferous coals, but from the fact that they are likely to enter into direct competition with the fuels of the western region here reported on, in the Manitoba market.

Coals and lignites not distinctly separable.

Explanation of diagram.

The coals of the Bow and Belly district are, in fact, similar to the class of fuels now largely mined and employed on the western part of the line of the Union Pacific Railway, and much superior to most of the lignites and brown coals which give rise to important industries in various parts of Europe. The chief difficulty to be apprehended in connection with the extensive use of the lignites of the Souris River region is the fact that they yield so readily to the weather on exposure, and become more or less pulverulent, leading to a great waste during handling and transport. The writer has during the past summer had an opportunity of studying the methods of mining and overcoming

Comparison with other American and European fuels.

similar difficulties to that just referred to in several districts in Germany and Bohemia, which depend on lignites and brown coals for their fuel supply. The brown-coal of the Saatz-Teplitz basin in Bohemia, from which over a million tons were extracted in 1879, closely resembles in composition and even in physical character those of the Souris district. The thickness of the bed is there, however, so great, and the price of the fuel in consequence so low, that though much is lost from crumbling, no economic process to prevent this waste has yet been found applicable. The fuel, however, answers well for domestic and local manufacturing purposes, and is even employed in locomotives and transported to a considerable distance in the raw state. Brown coals, much inferior in composition and strength, worked in South Germany, are also used as they come from the mine for some industrial purposes, specially constructed furnaces being employed. For transport, however, they are generally compressed by steam machinery, either in the wet or dried state, into masses known as "briquettes," and thus treated constitute a very valuable fuel.

Modes of employing lignites and brown coals.

Processes of this nature will probably eventually be found applicable to the Souris lignites, rendering them of greater value, and suiting them for carriage to any distance. The coals and lignite-coals of the district specially referred to in this report are, however, for the most part independent of such aids, even for purposes of distant transport; and though their greater distance from the province of Manitoba must increase the cost of their delivery there, their character will probably be found to more than compensate for this disadvantage.

Estimated quantity of coal per square mile.

The quantity of coal already proved to exist is very great. The distances for which the outcrops of certain seams have been traced have been mentioned. Approximate estimates of the quantity of coal underlying a square mile of country in several localities have been made with the following results:—

Main Seam, in vicinity of Coal Banks, Belly River. Coal underlying one square mile, 5,500,000 tons.

Grassy Island, Bow River. (Continuation of Belly Biver Main Seam.) Coal underlying one square mile, over 5,000.000 tons.

Horse-shoe Bend, Bow River. Coal underlying one square mile, 4,900,000 tons.

Blackfoot Crossing. Workable coal in seam as exposed on Bow River. Underlying one square mile, 9,000,000 tons.

Note on Map.—The annexed map shows the positions of the chief natural exposures of coal and lignite in the Bow and Belly district, and the probable course of the outcrops of such of the seams as it has been possible to identify at a number of places. The edge of the Palæozoic rocks of the mountains, constituting the western border of the coal-bearing district, is marked by the red shading, but no attempt is made to indicate the general geology of the region, which will appear in connection with the detailed report on the district, now in course of preparation. The main outlines of the present map are based on the surveys of the Dominion Lands department wherever possible, but much of the topography and detail are from our own surveys.

Geological Survey of Canada.

Alfred R.C. Selwyn LL.D., F.R.S. & Director
1883.

Index Map of Coal and Lignite Outcrops, Bow and Belly River District.

To illustrate Report by GEORGE M. DAWSON, D.S., F.G.S., Assoc.R.S.M.

PHOTO LITH BY THE BURLAND LITH CO MONTREAL.

GEOLOGICAL SURVEY OF CANADA.
ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

REPORTS

BY ROBERT BELL, LL.D., M.D., C.E.

ON THE GEOLOGY OF THE

BASIN OF MOOSE RIVER

AND OF THE

LAKE OF THE WOODS

AND ADJACENT COUNTRY.

1881.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

Montreal:
DAWSON BROTHERS.

1883.

ALFRED R. C. SELWYN, ESQ., LL.D., F.R.S., &c.,

Director of the Geological and Natural History Survey.

SIR,

Herewith I have the honor to submit a report and map in regard to the geology of the Basin of Moose River and adjacent regions, and also a report and geological map in reference to the Lake of the Woods and the country lying to the eastward of it, in both of which districts I was engaged in pursuance of your instructions, in 1881. The maps, however, serve to illustrate, not only the field-work of this particular season, but also the results of the labours of some of the previous years in the areas which they cover, and which were described in the annual reports of the survey. A map of the Moose River, from the neighbourhood of Moose Factory to James' Bay, from a survey made by myself in 1877, is also herewith submitted.

I have the honor to be,

Sir,

Your obedient servant,

ROBERT BELL.

Ottawa, May, 1883.

VIEW UP THE VALLEY OF THE MICHIPICOTEN RIVER, FROM THE MOUTH.

I.

REPORT

ON THE GEOLOGY OF THE

BASIN OF MOOSE RIVER

AND ADJACENT COUNTRY,

BY

ROBERT BELL, LL.D., M.D., C.E.

Shortly after my return from making the geological examinations in the regions above indicated, a preliminary report was submitted and referred to in your summary report to the Minister of the Interior in February, 1882, pages 6 and 7. This work could not be fully described until proper maps of the surveys had been prepared, representing both the topography and geology of the regions indicated. The accompanying map of the basin of Moose River and the adjacent country shows, not only the results of the surveys and geological investigations made by the writer and his assistant in 1881, but also part of those made in 1870, 1875, 1876 and 1877, together with the results of a geological exploration of the upper Ottawa and Lake Abittibi region, made by the late Walter McOuat, of the Geological Survey, in 1872. These investigations are described in the Reports of the years indicated. The coastline of Lake Superior is from Bayfield's chart. The topography of the interior is principally the result of the work of the Geological Survey, but a portion of it is derived from surveys made for the Canadian Pacific Railway; and I would here beg to acknowledge our obligations to Messrs. Smellie, Ramsey, Carry and Poulin, engineers of this line, for information and maps relating to these surveys.

Geological map of the region.

Results of labors of 1870-75-76-77 and 1881.

The object of the explorations in this region in 1881, was to ascertain, as nearly as possible, the distribution of the formations in the country to the northward and eastward of the mouth of the Michipicoten River, where it was more imperfectly known than in other parts of the area represented upon the map. The present report will refer more particu-

Map represents an area larger than England.

larly to the geology of this district. The country represented on the map is 344 miles in length from east to west, and 224 miles in breadth from north to south, and embraces an area greater than that of England.

Age and distribution of the rocks.

The distribution of the rock-formations, as shewn on this map, is only provisional, but it is considered worth publishing the map to show the present state of our knowledge both of the topography and the geology of this great region, and also that it may serve as a basis to be improved upon in the future. In some parts, both the topographical and the geological lines will be found tolerably accurate, while it is believed that none of the geographical features marked in continuous lines are very far out of position. The junctions of the formations were correctly ascertained along the rivers and lakes surveyed or explored. In the case of the boundaries between the Laurentian and Huronian rocks, as these formations appear to be conformable to each other in this region, the course of the lines dividing them could often be inferred, with some degree of accuracy, by the prevailing strike of the two sets of rocks throughout a great thickness of the strata on either side of the observed contacts.

It will be noticed that a large part of the country represented on the map is occupied by Huronian rocks, which are generally rich in economic minerals. The prospect for the discoveries of metallic ores is increased in some districts by disturbances, and by the frequent intrusion of diorites, syenites and granites. This is especially the case in the region extending from the sources of the Montreal River eastward to the Abittibi Lake.

The present map will no doubt prove useful in many ways, now that the Canadian Pacific Railway is about to be built through the south-western part of the territory represented and other railways are projected to traverse various parts of it.

The work of 1881.

A short account will now be given of the investigations made in 1881, in the region under consideration. Having, in 1875, mapped the canoe-route between Lake Superior and Moose Factory, by way of the Michipicoten and Missinaibi Lake and River, this was used as a base for the operations of the present season. At Lake Mattawagaming, the third from Lake Superior, a leading canoe-route diverges to the northward, and this was adopted as a means of obtaining access to the country in that direction. In connection with the geological investigation of the region, a track-survey, checked by numerous latitudes, was made of the north-west arm of Lake Mattawagaming, Lake Wabatongwashene, Oba Lake and River, Kabinikagami Lake and the river of the same name to latitude 49° 35′.

At the same time Mr. C. Molson, B.A., Assistant Geologist, made a similar survey of Esnagami Lake at the head of the Magpie River, a

Artotype, Patented. G. E. Desbarats & Co., Montreal.

GRANITE HILL ON MICHIPICOTEN RIVER, FOUR MILES ABOVE LONG PORTAGE.

part of this river and of a canoe-route thence to Oba Lake, and also some further geological researches around Lake Mattawagaming.

The following is a brief statement of the geological results of the investigations in the basin of Moose River and the adjacent country, including the Michipicoten and Magpie Rivers. The canoe-route from Michipicoten Post to Moose Factory follows the Michipicoten River and the lakes on its course to Mattawagaming Lake, and thence through Dog Lake, just on the south side of the height of land, and separated from the last named lake by a narrow stream a few chains in length.

Geology of the vicinity of Michipicoten.

From Lake Mattawagaming another canoe-route branches to the northward and enters Lake Wabatongwashene, which may be regarded as the source of the Michipicoten River. As stated in my report for 1875, pages 335-336, Huronian schists, with diorites, syenites and granites prevail along the route between Dog Lake and the mouth of the Michipicoten River. Gneiss is there mentioned as occurring at the Cat Portage and the head of the Long Portage. These exposures appear to be at the junction of the Laurentian and Huronian systems, as indicated on the accompanying map. A variety of gneiss which may belong to the latter division was found at a southward bend of the river, about half-way from the mouth to the foot of the Long Portage. The strike was here south-westward. The dividing line between the Huronian area of Michipicoten and the Laurentian gneiss to the south-east of it, appears to have a north-eastward trend, from Cape Choyyé, on Lake Superior to Dog Lake, keeping mostly to the south-east of the Michipicoten River. It crosses Dog Lake, in a north-north-westerly course, and curving round, passes through the southern extremity of Wabatongwashene Lake, in a westerly direction, finally reaching the shore of Lake Superior in the neighborhood of Otter Head. It will be observed by the map that the granite and syenite areas along the Michipicoten River, referred to in 1875 (Report, page 335) and the granite of Burnt Point, mentioned in the Geol. Survey report for 1876, page 219, lie nearly in a straight line and close to the junction of the Huronian and Laurentian.

Granite areas.

This, as stated in former reports, is the usual position of these granite areas in the great region northward of Lakes Huron and Superior. The light-grey granite, which occurs about four miles above the Long Portage forms the steep hill, about 400 feet high, on the northern side of the river, represented in the accompanying illustration taken from a photograph.

Geology of a route northward from Lake Mattawagaming.

The geological features of the Michipicoten River were noticed in the report for 1875, pages 334–336, and I shall now add a description of the rocks of the route by which we travelled northward from the outlet of Mattawagaming Lake, where we turned off from the route to Missinaibi Lake. The rock of Little Stony Portage at the outlet of the former lake consists of fine-grained, massive, soft, greenish-grey, calcareous schist, with large veins of white quartz, which are seen in the river below the chute. Leaving this portage and going northward up the western shore of the lake, a hill of red syenitic granite is met with at a distance of two miles; and a similar granite is more extensively developed on the southern side of the lake directly opposite. With this exception, the rocks all along this side of the lake to its northern extremity, consists of green hornblendic, dioritic and chloritic schists. The strike varies much, being north-eastward in the southern part and north of west in the northern. Opposite Waboose Island, the hornblende schist contains pebbles, and at a point three miles further north, a soft, greyish-green schist, with calcspar in the joints, is, in places, full of large concretions of impure epidote, some of which have a ring-like form on cross section. Waboose Island consists of silicious green schist, running N. 35° W., vertical. Copper pyrites was found in a small quartz vein, cutting green schists, at a spot on the west shore, lying south-west of the north-west point of this island.

On the neck of land separating Lake Mattawagaming from Lake Wabatongwashene, the following rocks were met with in going from south to north in the order stated; bluish-grey, micaceous hornblende schist, coarse greyish-green hornblende schist, dark-grey crystalline diorite (in one place rendered porphyritic by spots of light, greenish-yellow felspar), grey "pepper-and-salt" gneiss, composed of quartz, felspar, green hornblende and black mica, and lastly hornblende schist; all followed to the northward by reddish gneiss. The general strike is a little south of west.

Lakes Wabatongwashene and Oba.

Oba River.

Proceeding northward through Wabatongwashene and Oba Lakes, and down the Oba River, Laurentian gneiss was the only rock observed after leaving the Huronian schists in the southern part of the former lake, until meeting with the two narrow bands of schists which cross Kabinakagami Lake. These have a general west-south-westerly strike and consist principally of hornblende schist.

At the inlet of the lake, much fine-grained magnetic iron is disseminated through the hornblende rock, which also holds strings and long lenticular patches of crystalline epidote, running with the strike. The larger patches are quartzose in their centres and are evidently concretionary. The hornblende schists of this belt are mostly compact and dark greyish-green in color. In some parts they are micaceous, and where they cross the southern part of the lake they are marked by iron-stained patches, and are flanked on the north-west side by soft, very fine-grained, grey gneiss, which has the calcareous character of the gneisses of the Huronian series, and contains specks of iron pyrites. Both belts are characterized by masses and bands, parallel to the stratification, of light-grey, felspathic granitoid rock.

A small island, situated a few hundred yards south of the outlet of Kabinakagami Lake, consists of rather coarse, greyish gneiss, dipping north-east, cut by a dyke of crystalline, greyish-green diorite, fifty or sixty yards in width, running N. 20° E. and S. 20° W. The relation of the great north-and-south dykes of the region north of Lakes Superior and Huron to the topographical features, has been pointed out in former reports. It is probable that the dyke, just referred to, has had something to do with the position of the outlet, and the course of the lake immediately above it and of the river for some miles below. In connection with this subject, it may be mentioned that a similar diorite, apparently forming part of a great dyke running down the centre of Oba Lake, was discovered upon an island in the narrows, about midway between its extremities.

Kabinakagami Lake and River

A fragment of dark-green serpentine, with rusty surfaces, was found on the small island near the outlet of Kabinakagami Lake. It resembles the serpentines of Lake Abittibi and Pigeon Lake, on the Montreal River.

A strong rapid, with a fall of thirty-three feet, occurs just where the Kabinakagami River leaves the lake. The portage past this obstruction is on the west side, and is 1145 paces in length. The rock at the rapid is a dark-green, fissile-hornblende schist, the strike of which varies from N. 45° W. to N. 80° W. At fourteen miles in a straight line below the lake, mica-schists, mostly coarse in texture and grey in color begin, and thence occupy a breadth of about one mile. They are vertical, and strike S. 80° W. Ten miles below this band, dark silicious mica schists make their appearance, and are found again three miles further down. These rocks, however, probably have a greater breadth to the southward than above indicated, since the strata for a number of miles before reaching the first exposure are concealed by a thick deposit of stratified sand. They may have a total breadth of seven or eight miles along the river. These two mica-schist bands appear to indicate the western extension of the great Huronian belt, which, coming from the eastward, crosses the Missinaibi between the Devil's Rapid and the junction of the Brunswick River, and which is largely made up of similar mica-schists.

Huronian bands.

An exposure of syenitic granite occurs at about a mile and a half below Kabinakagami Lake, and dark, greenish-grey crystalline diorite, apparently belonging to large dykes, was met with in several places as far as the river was descended. The point at which I turned back was found to be in latitude 49° 35′. With the exceptions above noted, the rocks found along this stream were entirely Laurentian gneiss, mostly of massive varieties. The stratification was usually much contorted, but the general strike was about east and west.

Although the Kabinakagami River appears to join the Missinaibi, as indicated on the accompanying map, some of the Indians we met with had an idea that it might join the Kenogami, a branch of the Albany at the place called Mammattawa. (See Geol. Survey Report for 1871 page 113).

Mr. Molson, in his track-survey of Esnagami Lake, the upper part of the Magpie River, and the canoe-route thence back to Oba Lake, found only Laurentian gneiss, which presented no characters worthy of special description.

Exploration from Missinaibi House towards Flying Post.

Having completed our labours in this direction, we proceeded to Missinaibi Lake, from which Mr. Molson was sent to make a track-survey of the Wi-a-sitch-a-wan River, which enters the south-east side of this lake, and of Little Missinaibi Lake at its head; while I descended the Missinaibi River to Flying Post Brook, about eight miles from its outlet; and leaving the river here, followed a canoe-route towards the Flying Post, as far as Trout River. This stream flows from the south and joins the Kapuskasing River, just below the outlet of the lake of the same name. It was followed for fifty-two miles in a straight line, and its course, as well as the lakes through which it passes, were carefully laid down. These topographical features are sufficiently well shewn upon the accompanying map and do not require any special description.

Kapuskasing Lake and River; Trout River.

Rocks between Missinaibi and Trout Rivers.

Between the Missinaibi and Trout River the rocks observed consisted entirely of Laurentian gneiss, having an average strike of about S. 60° W. It is mostly massive, but on Lake Tchi-tchi-ga-mog, eight miles south of Kapuskasing Lake, much of it is of a grey, slaty, micaceous character. Along the Trout River, different varieties of gneiss were met with as far as Trout Lake. Along this stretch of the river the direction of the dip and the angle of inclination changed frequently.

Rocks of Trout Lake.

Trout lake is five miles in length, in a north-and-south direction. Gneiss was observed on the north-west side of the outlet, but on the east side, silicious hornblendic schists appear to occupy the shore to a point half-way up the lake. Here a variety of red and reddish-grey syenitic granite, and of diorites are met with. Three miles south of the outlet, and one mile north of the inlet of the lake, the reddish granite is cut by veins of yellow-weathering pearl-spar, and it holds patches of grey amygdaloid in which the spots, consisting of white calcspar, from mere grains to the size of peas, are thickly disseminated. Along with the amygdaloidal patches, there are others of white calcspar, and light green apatite, the latter occurring in small thickly disseminated crystals in the calcspar, and as patches of a granular and very friable character associated with it. The amygdaloid also holds crystals and scattered masses of crystalline bright green fluorspar.

Schists.

Granite.

Amygdaloid Calcspar.

Apatite.

Fluorspar.

Syenitic granites, similar to those just described, are met with on the opposite side of the lake, and the mass to which they belong appears to have a general east-and-west trend. Between the inlet and the head of Trout Lake, a distance of about a mile, the rocks on both sides consist of rather coarse, dark-coloured hornblendic schists, with a general westward strike, and a dip to the north of 60° to 70°.

The country around Trout Lake is hilly, especially to the south-westward. The river, in entering its eastern side, passes down a steep rapid, with a fall of 144 feet from the head of the portage, which is three quarters of a mile in length; it continues rapid for another mile, but beyond this it is very tortuous with a smooth, moderate current. The elevation of the highest point we reached was ascertained by means of the barometer to be 254 feet above Trout Lake. The rocks in this interval consist of Laurentian gneiss, having a general strike a little to the south of west, and dipping to the north in most cases.

Huronian rocks in the vicinity of Flying Post.

From information derived from Mr. A. R. Ramsey, and Mr. B. R. Poulin, engineers of the Pacific Railway, and also from Mr. E. B. Borron, stipendiary magistrate, it appears that Huronian schists prevail around Flying Post Lake and Lake Mattagama, lying to the south of it. During the season of 1881, Mr. Borron, who was sent by the government of the Province of Ontario, explored the country from Missinaibi House to the Flying Post, and thence to Mattagami Post to the east, which I had reached in 1875 from the Montreal River, a branch of the Ottawa. In the summer of 1882, the same gentleman explored a canoe-route by way of the Mississagui River, from the north shore of Lake Huron to the Flying Post and thence by the Kakozhishk, or Ground-hog River to its junction with the Mattagami. Mr. Borron has a good knowledge of mining and geology, and made valuable notes on the rocks he met with on his journeys. These have been of assistance in laying down the distribution of the formations in the region referred to. We are also indebted to Mr. Borron for a copy of his "log," containing the courses and estimated distances along some of the routes which he travelled.

On his last named journey he crossed the height of land, a short distance east of longitude 83° W. and struck Lake Wakamagaming at the source of the Ground-hog River. In descending this stream he saw no rocks excepting Laurentian gneiss until reaching Cache Lake, the centre of which is near latitude 47°. 40′, longitude 82.° 46′ W. "A schistose rock, Huronian, here forms the shore." From Cache Lake, the river runs a little north of east to a point within about nine miles of the southern extremity of Lake Mattagama, "following nearly, as it appeared to me, the strike of the Huronian rocks at or about their junction with the Laurentian. The river then, finding a passage, turns north, crossing the Huronian ridges, and at the end of nine miles tumbles into a large basin at the south end of Lake Mattagama." (Mr. Borron's Report for 1882, page 23.) At page 30, he says: "I met with lead and

Veins with copper and lead ores.

copper ores on the north-west side of the eastern arm of Lake Mattagama, in the vicinity of Flying Post. The quantity of ore in the veins where exposed is not such as would justify, in my opinion, expensive mining operations, but sufficient, taken in connection with the size and general character of the veins, to warrant careful exploration in the reasonable expectation that larger deposits of these useful and valuable metals may be discovered."

Wi-a-sitch-a-wan River.

Little Missinaibi Lake.

On my return to Missinaibi House, I found that Mr. Molson had arrived there from his exploration a few days in advance of me. He had ascertained the following facts: The upward course of the Wi-a-sitch-a-wan River is S. S. E. for two and one half miles in a straight line, when the outlet of Little Missinaibi Lake is reached. The river is broken by a succession of rapids and falls throughout the whole of its short course. The main body of the lake, which is narrow, has a general south-eastward direction, and a length of about five miles. Two narrow bays extend at right angles from the north-east and three from the south-west side. The southernmost bays, on opposite sides, have the same general direction, and the distance between their extremities is over five miles. A stream enters the head of each of them. The upward continuation of the main river is at the south-eastern extremity of the lake, and its course is the same as that of its central part. It was followed for about six miles, and here, leaving the river, Mr. Molson explored the country, for five miles further to the south-eastward, the distance being ascertained by pacing.

Gneiss: Trap dykes.

Soil.

Throughout the whole of the country traversed from Lake Missinaibi, gneiss, with trap dykes cutting it, were the only rocks met with. At the Wi-a-sitch-a-wan Falls at the mouth of the river, the gneiss, which is grey and reddish-grey, and coarse in texture, runs S. 80° W., and is cut by a large dyke, having the same direction. Similar varieties of gneiss continued to and around Little Missinaibi Lake, the strike being from S. 10° E. to S. 40° E., averaging about S. 20° E. The dykes, of which several were seen cutting the gneiss, appear to run about S. 80° W. To the south-eastward of the lake, the strike of the gneiss is more variable, being from S. S. W. to W. N. W. The country just described was mostly of a rocky character, but Mr. Molson noticed some tracts of tolerably good soil. Near the Wi-a-sitch-a-wan Falls a light-coloured clay was observed between the ridges of gneiss.

Head waters of Michipicoten and Magpie Rivers.

Superficial Geology, Soil, &c. The country around the lakes at the heads of the Michipicoten, Magpie and Kabinakagami Rivers is generally hilly and broken. Some patches of fair land, mostly of sandy and gravelly loam, were found among the hills in the neighborhood of all these lakes. The valleys of the Oba and Kabinakagami Rivers are overspread with fine stratified sands which often contain much clay. On top of these deposits the soil usually appears to be good, but in some places it is of too light a character. Along the latter stream, the banks of sand sometimes attain a height of fifty feet and upwards, especially in the lower twenty or thirty miles examined. For a few miles above our turning point, a yellowish-drab clay, affording a good soil, was found on either side of the river.

Kapuskasing and Trout Rivers.

Coarse and fine sand.

In the country examined between the Missinaibi and Kapuskasing Rivers, much of the land is of a coarse sandy nature, broken here and there by ridges and knolls of rock, but in the valley of the latter stream there appears to be a considerable proportion of loamy and fine sandy soil of fair quality.

Enormous boulders.

On the east side of Trout River, about twelve miles above its junction with the Kapuskasing, two enormous boulders, each as large as an ordinary settler's house, were seen perched on a low hill a short distance from the water. From the outlet of Trout Lake, for a distance of about ten miles downward, the river which flows with a gentle current, is closely flanked on either side by sharp ridges and conical hills of gravel and sand rising to a height of about 100 feet. The ridges follow the course of the valley and behind them, long ponds and lagoons are situated, having generally openings of greater or less width connecting them with the river.

Ridges and conical hills of gravel and sand

NOTE.

In reference to the plan of the Moose River mouth, prepared by Dr. Bell, there appears to be some doubt of its accuracy, and in publishing it, I think it right to state what Dr. Rae, who lived there some forty years ago, has written me respecting it. The following are extracts from his letters to me dated London, 27th June, '83, and 20th Nov., '83 :

"I am glad you sent me the copies of the proposed maps of Moose River, in which I have put in very roughly the corrections required.

"There are, or were in my day, two Islands to the N. W. of 'Inner Ship Hole' called the Ship Sands, and these Islands were separated from the N. W. shore of the river by a deep and swift stream, which occupied about twenty minutes to paddle across in a canoe. Spring tides aided by a gale sometimes covered these Islands with several feet of water. If the Moose River is, as your map shows it to be, the islands where we camped must have been well inland on the main shore of the left bank."

Nov. 20th.—" In reply to your enquiry, I must say that it is possible by some convulsion of nature, that the north branch of the river may have ceased to exist, but in the usual course of things such an event was not at all likely. You may make this north branch even wider than I showed it in the rough sketch I sent you, unless the ship sands have greatly increased in width."

In the map now published, it will be observed that there is no *north branch* and that the main shore of the left bank comes close out to the "*Inner Ship Hole*" and includes the islands mentioned by Dr. Rae.

It may be, however, that Dr. Rae's recollection of it as it was forty years ago, and Dr. Bell's map of it as it is now, are both correct. A comparatively small elevation of the coast, aided by a silting up of the channel, effected by fluvial and tidal currents and wind, would suffice in the lapse of forty years to produce even greater changes in a river delta without any occurrence which could be correctly designated as a "convulsion of nature." Dr. Bell has already shewn * that there are other reasons for assuming that the shores of Hudson Bay are slowly rising, or, as he states it, that the water is receding.

ALFRED R. C. SELWYN.
Ottawa, 3*rd Dec.*, 1883.

*Report of Geol. Survey of Canada : 1877-78, p. 3 and 25 c.c.

80°45'
The water in James Bay in the vicinity of the mouth of Moose River is somewhat turbid and slightly brackish.
The rise and fall at spring tides is about ten feet; at neaps about six feet.
High water at full and change of moon XI½ o'clock.
Sea going ships come to the Inner Ship Hole from the direction of A. Elsewhere the water is shallow with sand and mud bottom.
The dotted line from the Inner Ship Hole indicates the channel followed by schooners to Moose Factory.
The head of tidewater is about eight miles above Moose Factory or twenty miles from the sea.
The continuous shore lines indicate the ordinary high tide mark. Extraordinary high tides occasionally flood back to the line of bushes.
A
North Bluff Beacon, 100 ft. high.
FLAT SHOALS
Nearly dry at lowest tide.
Beacon
JAMES' BAY
SHIP SANDS
Bushes
Trees
SHOALS
Nearly dry at lowest tide
The Big Stone
Boulders
HANNAH BAY
SHOALS
PARTRIDGE CREEKS
INNER SHIP HOLE
SANDS
Dry at low tide
SHOALS
CHANNEL
Magnetic North. Variation 15 West.
Ast. North
MOOSE RIVER
SANDY SHOALS
MIDDLEBORO SANDS
MIDDLEBORO ISLAND
MOOSE FLATS
PILGRIM ISLAND
MOOSE ISLAND
CHARLES ISD
MOOSE FACTY
PRINCESS ISD
SANDY SHOALS
MAIDMAN'S ID
Maidman's Creek
51°15'
SAW PIT ISLAND
HAZEY ISLAND
WILLOW ID
FISHING PT
BUSHY ISLAND
ISLAND
Doctor's Creek
Small boats may pass through this channel
SHINGLE ISLANDS
The banks of Moose River are well timbered with spruce, tamarac, balsam, banksian pine, white cedar, white birch, aspen, rough-barked poplar, etc.
The soil on Sawpit, Moose, Hazey and Middleboro Islands is grey clay with level surface. It produces good crops.
The clearing around Moose Factory is about a mile in length, and besides the establishment of the Hudson's Bay Company, an Episcopal Cathedral and the residence of the Bishop of Moosonee are situated here.
About eighty head of cattle are pastured on Sawpit Island.
Greenwich Observatory is in lat. 51°28'38" or 15 miles north of Moose Factory.
(Beyond the limits of this map.)
80°45'
Geological Survey of Canada.
Alfred R.C. Selwyn LL.D., F.R.S. & Director.
PLAN OF
MOOSE RIVER
FROM THE
NEIGHBOURHOOD OF MOOSE FACTORY
TO
JAMES' BAY
SURVEYED BY ROBERT BELL, LL.D., M.D., C.E.
To illustrate Reports of 1875-77-81
SCALE 8 MILES TO 1 INCH
Drawn by A.S. Cochrane
Reduced by A.P. Low, B Ap Sc.
51°15'

II.

ON THE GEOLOGY OF

THE LAKE OF THE WOODS

AND ADJACENT COUNTRY.

BY

ROBERT BELL, LL.D., M.D., C.E.

The geological explorations which had been made previous to 1881 in the country between Lake Superior, on the one hand, and Lake Winnipeg and the valley of the Red River on the other, had been accomplished by following the numerous canoe-routes leading through it in different directions, and examining the shores of the lakes and rivers, as well as by making short journeys inland from their banks. The Canadian Pacific Railway now traverses this region and passes through large tracts which are not easily accessible by canoe. It was so far completed in 1881 as to admit of our following the line throughout and thus enabling us to ascertain many new facts in regard to the geological structure and the geographical distribution, in these parts, of the Laurentian and Huronian systems. The cuttings along the track afforded excellent opportunties for examining fresh sections of the rock.

Geological examination of the line of the Canadian Pacific R. R.

Before proceeding with a continuation of the geological exploration of the Lake of the Woods, which had been begun in previous years (See Reports for 1872 and 1873), a cursory examination was made of the railway track from English River to Cross Lake. This work was performed by Mr. Molson in the section between Wabigoon Lake and Rat Portage, and in the other sections by myself. The same gentleman explored the Wabigoon and part of the Eagle River, whilst I made a track-survey from Wabigoon Lake to Lake of the Woods by way of the Three-fork River, Eagle, Vermilion and Bell's Lakes. This was followed by a geological examination of the northern part of the Lake of the Woods and of Shoal Lake and Whitefish Bay, with track-surveys of the parts travelled over.

English River.

In going westward from English River along the track of the Cana-

Butler. Bonheur. Falcon.

dian Pacific Railway, Laurentian gneiss continues to a point between Butler and Raleigh Stations. It is nearly all of dark-grey shades, and the prevailing strike is between W. S. W. and S. W. Between Bonheur and Falcon Stations, it is conspicuously banded or ribboned, the layers consisting of various shades of grey, with some of red. At the former station and for a short distance west the strike is S. 75° W., but for the remainder of the interval, about ten miles, it is S. 45° W., and the dip is to the south-east at an angle of about 70°. Between Gull River and Falcon Station, the gneiss, which is very dark and hornblendic, passing into schist, is very largely mixed with coarse and fine red felspathic granite. At two miles, and continuing thence for three miles west of Ignace Station, the rock is very massive grey gneiss, or possibly a granite, as no distinct stratification could be detected.

Huronian schists near Raleigh.

The last gneiss was seen at the Y, three miles west of Butler Station; and at about one mile and three-quarters east of Raleigh, dark-green, fine hornblende schist, which is considered Huronian, makes its appearance. The strike is north-westward, quite parallel to the railway track, and the dip is south-westward at an angle of 65° to 70°. A similar rock, with the same strike, was observed two miles west of Raleigh, while at four miles there is a dark, greenish-grey, silicious schist, and a lighter grey felspathic schist, all associated with a few thin, rusty, calcareous beds. Here the strike is more nearly north, but at one mile and a-half further west, where the felsitic schists are more largely developed, the strike is again north-westward. These rocks are followed immediately to the westward by dark-greenish silicious and chloritic schists, having the same strike. Next, slaty diorites were met with, becoming more massive in going westward, to a point three and a-half miles east of

Taché.

Taché Station, where they are succeeded by grey syenitic granite of medium texture, which has a breadth of a mile and a-half on the track. Green schists were observed at one mile west of Taché, beyond which the rocks for a number of miles are concealed by drift. In the neighbor-

Bois Brulé.

hood of Bois Brulé Station, the rocks, which strike north-westward, consist of soft, green schists, with strings of calcspar and quartz. Where the railway crosses the narrows of a small lake a mile or two west of this station, there is a cutting through dark, bluish-grey, soft and hard dioritic schists, with strings of brown-weathering calcspar. Quartz, epidote and iron pyrites also occur in these rocks. In another cutting, a short distance further west, the rock is a dioritic conglomerate. Between this point and Little Wabigoon Lake a variety of dioritic rocks were met with, consisting of massive and slaty forms, of various shades of bluish-green, grey, bluish, and greenish-grey. The dioritic schists generally contain much calcspar in the form of strings and spots. Slaty dioritic rocks running north-westward, or with the track, were observed here and there as far as Elm Bay on (Big) Wabigoon Lake, around the head of Little Wabigoon Lake, and in various localities along the track as far east as Taché, and as far west as Eagle River, there is a considerable thickness of stratified, drab clay, with an occasional reddish band. In some places the stratification of the clay was observed to dip at high angles. Small nodules of curious forms are sometimes found in it.

Wabigoon River to Rat Portage. Gneiss. Schists.

From the Wabigoon River to within about nine miles of Rat Portage, Mr. Molson found only Laurentian gneiss, with the exception of a narrow band of argillaceous slate near the north-east corner of Feist Lake, and a belt of hornblende schist, about one mile wide, with a northward strike, crossing the track opposite the end of Dog-tooth Lake. The strike of the gneiss varied much, but in the majority of cases it approached either a westward or a south-westward course. At nine miles before reaching Rat Portage, and continuing thence for two or three miles, a coarse grey syenitic granite prevailed. Between this and the village of Rat Portage, the rocks are principally fine-grained, somewhat calcraeous, hornblende schist, in which the jointing is well marked, but there are also felsitic, dioritic and silicious schists. The average direction of the strike is south-westward. A tough, greenish-grey, hornblendic rock, containing occasional patches of asbestus, occurs a short distance west of the outlet at Rat Portage. The line between the Laurentian and the Huronian systems, which crosses the Winnipeg River at Rat Portage, keeps near the railway to a point between Lake Lulu and Keewatin Mills, where it crosses it diagonally and continues thence in a westerly direction on the south side of the track.

Boundary between Laurentian and Huronian, north of Lake of the Woods.

Lake Deception to Cross Lake.

From Lake Deception to Cross Lake the Laurentian gneiss is generally dark grey and red, rather massive, much contorted and cut by numerous veins of red and grey granite; while from Cross Lake for some distance westward, it is reddish in colour, thinly bedded, and runs with great regularity nearly parallel to the railway, the dip being to the north at moderate angles. It is probable that a line of dislocation or disturbance, which may be connected with the granites of Lake of of the Woods and the Winnipeg River, runs north-westward through Cross Lake. The decomposition of the rock along this line, followed by the denuding agencies of the glacial period, have probably been the means of scooping out the deep channel of this lake, which caused so much trouble in attempting to carry the line of the Pacific Railway across it.

Probable dislocation.

Exploration from Wabigoon Lake by Eagle, Vermilion and Bell's Lake to Lake of the Woods.

Returning now to Wabigoon Lake, a short account will be given of the explorations by water which have been referred to. In descending the Wabigoon River to its junction with the Eagle River and in ascending the latter stream, Mr. Molson found only Laurentian gneiss, until coming to the outlet of Eagle Lake, where the Huronian schists begin. Their strike is here S. S. W.

In regard to the exploration from Wabigoon Lake by way of Eagle, Vermilion and Bell's Lakes to Lake of the Woods, the rocks will be mentioned in the order in which they were examined. Around Wabigoon Lake, green dioritic and chloritic schists prevail. I was shewn a small specimen of native copper in quartz, said to have been broken from a vein on an island in this lake. In the southern bay of the lake and along the Three-fork River, as far as the second small lake on its course, a massive, grey diorite appears to be the only rock. From this lake a portage, three quarters of a mile long, leads south-westward to a larger one, the waters of which eventually find their way into Eagle Lake. The northwest side of this lake is occupied with Laurentian gneiss. Lying to the south-east of Eagle Lake, proper, are two straggling sheets of water connected with each other by tortuous narrows, five or six miles long. The second and larger of these was called, for convenience, Hugh Osbourne's Lake. It is separated from the south-eastern bay of Eagle Lake by narrows only a few yards wide, and here the Huronian schists re-appear; the two straggling lakes mentioned being surrounded by hills of gneiss. Three miles north of the narrows by which we entered Eagle Lake, another narrow place was passed. Here the rock is a light-grey calcareous mica-schist on edge, and running S. 30° W. Along the south-east side of the lake, dark-grey diorites, for the most part of massive character, predominate, except in the last four miles before reaching the south-western extremity, where they are replaced by a grey syenitic granite of medium texture. At a mile and a-half north of the south-eastern extremity, a light-grey, slaty felsite was met with in a vertical attitude and striking S. 35° W. A narrow passage connects the western arm of Eagle Lake with the south-west end of Vermilion Lake. The rock at this place is a grey mica-schist full of iron pyrites. The ground is covered with red ochre resulting from the decomposition of the pyrites by bush fires and the action of the weather. The schists contain numerous short veins of red and white quartz (also holding iron pyrites), following the strike, which runs S. 45° W.

Three-fork River. *Lakes S.E. of Eagle Lake.* *Huronian rocks of Eagle Lake.*

Passing into Vermilion Lake through the passage already mentioned, at half a mile north of the western arm of Eagle Lake, Laurentian gneiss was again encountered and was the only rock met with along the route followed, until reaching the portage on Berry River, about a mile east of the head of Long Bay at the eastern extremity of the northern part of the Lake of the Woods. Here again schists and calcareous, light-grey micaceous quartzites were found, striking west, which proved to be connected with the large Huronian basin of this lake.

Laurentian gneiss of Vermilion and Bell's Lakes.

The gneiss all along the above route is of the ordinary greyish and reddish varieties, and requires no special description. The country visible from this chain of lakes on either side is mostly rocky and barren and nearly all the timber has been burnt off.

The shores and islands of Whitefish Bay were found to consist of Laurentian gneiss, except along the northern side and near Turtle Portage at the southern extremity. About a mile and a-half north of this portage dark-grey mica-schist and fine hornblende schist, running south-westward, are seen on both sides of the bay in contact with the gneiss. Gneiss of Whitefish Bay.

According to the late Dr. Bigsby, the shores and islands of Shebaskong Bay are occupied by a variety of schists, which are now included in the Huronian system, (see Journal of the Geological Society of London, Vol. 8). Green schists, with a westward strike, are seen in contact with the gneiss in the northern part of Whitefish Bay. Schists of Shebaskong Bay.

The subdivisions of the Huronian system, which is well developed around the northern part of Lake of the Woods and Shoal Lake, are explained more concisely and usefully for reference by means of the accompanying geological map and the notes upon it, than would be possible in any other way; and it is, therefore, unnecessary here to repeat these descriptions. At the time of our visit, no mining operations were going on at the Lake of the Woods, although some openings, in search of gold, had lately been made. Owing to the want of guides and the lateness of the season, it was found impossible to examine the various localities at which more or less work had been done. In 1879 I was presented by Mr. J. Dewe with a specimen from Hay Island, of white quartz, containing needle-like crystals of hornblende, with a little calcspar, which showed distinct specks of gold. It was assayed by Mr. Hoffman, chemist to the survey, and found to contain 37.318 ounces of gold and 1.431 ounces of silver to the ton of 2000 pounds [Report of Progress for 1878-79, page 33 H.]. We were shown specimens of copper pyrites in quartz and clay-slate, of galena in quartz and of magnetic iron associated with jasper, all said to have been found in the eastern part of the northern division of the Lake of the Woods. Huronian rocks of Lake of the Woods. Gold. Copper. Lead.

The botanical collection of the year, of which a list is given in the appendix, was made almost entirely in the region explored during the earlier part of the season. Lists are also given of the coleoptera collected, not only in the regions explored, but also of those which had been obtained at Oxford House, and a collection kindly made for me by Mr. William Isbister at Nelson River House, as well as of Mr. Cochrane's collections from the region which he traversed, between the Nelson and the Athabasca Rivers. We are greatly indebted to Dr. J. L. LeConte of Philadelphia for his kindness in having determined the species in all the above collections. His lists will be found in the appendix. Botanical and entomological collections.

APPENDIX I.

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CATALOGUE

By John Macoun, M.A., F.L.S., F.R.S.C.,

(*Botanist to the Survey,*)

OF THE PLANTS COLLECTED BY DR. ROBERT BELL ALONG THE MICHIPICOTEN RIVER AND IN THE SOUTHERN PART OF THE BASIN OF MOOSE RIVER,

In July, August and September, 1881.

The collection affords scarcely any indications of a boreal climate. The greater number of the species are the commoner plants of central Ontario. For the purpose of making a comparison between the two regions, the county of Hastings is selected because its flora is most familiar to the writer. The species found in this county are indicated in the fourth column of the catalogue. It may be observed that they represent largely the flora of rivers and river margins rather than the forest away from their banks. Many of the bog plants are absent, which indicates either a comparatively dry region, or that the bogs were not traversed. Plants peculiar to a dry limestone soil are absent. That the climate of the tract of country traversed is much warmer than that in the immediate vicinity of Lake Superior is indicated by the absence of many species which make their home there.

The species in this collection which have been found along the Georgian Bay or Lake Superior, but not in central Ontario, are the following. Those marked with a star are found on the lower St. Lawrence, and those with a dash extend westward to and beyond Manitoba.

—* Hedysarum boreale.
— Vicia Americana.
—* Potentilla tridentata.
Cratægus tomentosa var. pyrifolia.
—* Parnassia palustris.

— Saxifraga tricuspidata.
— Symphoricarpus racemosus, var. pauciflorus.
—* Lonicera involucrata.
— " parviflora var. Douglasii.
—* cærulea.
—* Viburnum pauciflorum.
—* Aster graminifolius.
—* Nabalus racemosus.
—* Vaccinium cæspitosum.
—* Pinguicula vulgaris.
— Mertensia paniculata.
Gentiana alba.
—* Halenia deflexa.
—* Comandra livida.
—* Indum erectum var. declinatum.
— Tofieldia glutinosa.
—* Streptopus amplexifolius.
—* Allium Schœnoprasum.
—* Eleocharis tenuis.
—* Carex capillaris.
—* Aspidium fragrans.
—* Woodsia glabella.
—* Stereocaulon paschale.

The foregoing list gives all the species in the collection which are not found in Hastings county, so that the western range of the species is the only point worthy of consideration. Many of these extend to and beyond the Rocky Mountains, and a few to the Pacific Ocean. It is a curious fact that Lake Superior seems to be the eastern limit of many western forms. At present no other cause can be adduced for it than the increased humidity of the air. Vicia, Parnassia, Saxifraga, Lonicera involucrata, Viburnum, Vaccinium, Mertensia, Comandra, Halenia, Streptopus, Allium, and Carex cross the Rocky Mountains, and are found in great luxuriance in northern British Columbia. A few reach the Pacific coast, and seem as much at home there as they do on Thunder Bay. Of these the Vicia, Lonicera, and Mertensia are the most common, and scarcely undergo the slightest change in fifty degrees of longitude. Many others, which do not appear in the list, could be cited as ceasing to grow at the western end of Lake Superior; and eastern species, especially shrubs and trees, have their western limit there. Much remains to be done in determining the geographical distribution of species, and no place will so well repay examination in this connection as the western end of Lake Superior.

Only two doubtful or unique forms were detected. These were a

Nuphar and a Hieracium. The former may be a variety of N. advena, but I am tempted to believe it is N. luteum, which has been lately found at Ottawa by Mr. J. Fletcher. The Hieracium is possibly a form of H. Canadense, but future collections must decide that, as the present specimen is too imperfect to determine this point.

The columns in the catalogue refer to the localities in which these plants were collected, as follows :

I.—Michipicoten River from the Long Portage to Lakes Mattawagaming and Wabatongwashene.

II.—Oba Lake and River, and Kabinakagami Lake and River.

III.—From Missinaibi House to Flying Post.

IV.—County of Hastings for comparison.

Nos.		I.	II.	III.	IV.
	RANUNCULACEÆ. (*Crowfoot family*).				
1	Clematis verticillaris, DC.	*			*
2	Anemone Pennsylvanica, Linn.		*		*
3	Thalictrum purpurascens, Linn	*			*
4	" Cornuti, Linn.	*			*
5	Ranunculus aquatilis, var. trichophyllus, Cham		*		*
6	" Flammula, L. var. reptans, Gr	*			*
7	" repens, Linn	*	*		*
8	Caltha palustris, Linn		*		*
9	Coptis trifolia, Salisb			2	*
10	Aquilegia Canadensis, Linn.			1	*
11	Actæa spicata, L. var. rubra, Gr		*		*
12	" alba, Bigel.	*		1	*
	NYMPHÆACEÆ. (*Pond Lily Family*).				
13	Brasenia peltata, Pursh		1		*
14	Nymphæa odorata, Ait		1		*
15	Nuphar advena, Ait.	*			*
16	" luteum ? Smith	*			
17	" luteum, Smith, var. pumilum, Gr		*	1	*
	SARRACENIACEÆ. (*Pitcher Plant Family*).				
18	Sarracenia purpurea, Linn		*		*
	FUMARIACEÆ. (*Fumitory Family*).				
19	Corydalis glauca, Pursh	*	*		*
	CRUCIFERÆ. (*Mustard Family*).				
20	Nasturtium palustre, DC		*		*
21	Cardamine hirsuta, Linn		*		*
22	Arabis Drummondi, Gray	*			*

Nos.		I.	II.	III.	IV.
	VIOLACEÆ. (*Violet Family*).				
23	Viola blanda, Willd	*			*
24	" cucullata, Ait	*			*
25	" canina, L. var. sylvestris, Reg			1	*
	DROSERACEÆ. (*Sundew Family*).				
26	Drosera rotundifolia, Linn	*			*
	HYPERICACEÆ. (*St. John's Wort Family*).				
27	Hypericum Canadense, Linn			2	*
28	Elodes Virginica, Nutt			2	*
	GERANIACEÆ. (*Geranium Family*).				
29	Geranium Carolinianum, Linn	*		2	*
30	Impatiens fulva, Nutt		*	2	*
31	Oxalis acetosella, Linn	*			*
	RHAMNACEÆ (*Buckthorn Family*).				
32	Rhamnus alnifolius, L'Her	*	*		*
	SAPINDACEÆ. (*Maple Family*).				
33	Acer spicatum, Lam	*			*
34	" rubrum, Linn	*			*
	LEGUMINOSÆ. (*Pea Family*).				
35	Trifolium repens, Linn		*		*
36	Hedysarum boreale, Nutt		*		
37	Vicia Americana, Muhl		*		
38	Lathyrus ochroleucus, Hook	*	*		*
	ROSACEÆ. (*Rose Family*).				
39	Prunus Virginiana, Linn		*		*
40	" Pennsylvanica, Linn	*			*
41	" pumila, Linn	*			*
42	Spiræa salicifolia, Linn	*			*
43	" opulifolia, Linn	*			*
44	Geum macrophyllum, Willis	*			*
45	" strictum, Ait	*	*		*
46	" rivale, Linn	*			*
47	Fragaria Virginiana, Ehrh	*			*
48	Potentilla arguta, Pursh	*			*
49	" anserina, Linn		*		*
50	" fruticosa, Linn	*		1	*
51	" tridentata, Ait	*			
52	" palustris, Scop	*			*
53	Rubus triflorus, Rich	*	*		*
54	" strigosus, Michx	*			*
55	Rosa blanda, Ait	*			*

Nos.		I.	II.	III.	IV.
	ROSACEÆ. (*Rose Family*).—(*Continued.*)				
56	Cratægus tomentosa, L. var. pyrifolia, Gr. Also at Sault Ste. Marie	*		(E)	
57	Amelanchier Canadensis, Torr and Gr	*			*
58	Pyrus Americana, DC	*			*
	SAXIFRAGACEÆ. (*Saxifrage Family*).				
59	Ribes hirtellum, Mx		*		*
60	" lacustre, Poir	*	*		*
61	" rubrum, Linn	*	*	2	*
62	Parnassia palustris, Linn		*	(25)	
63	Saxifraga tricuspidata, Retz			(W)	
64	Mitella nuda, Linn	*			*
	HALORAGEÆ.				
65	Hippuris vulgaris, Linn		*		*
66	Myriophyllum heterophyllum, Mx			1	
	ONAGRACEÆ. (*E. Primrose Family*).				
67	Circæa alpina, Linn	*	*		*
68	Epilobium angustifolium, Linn	*		(W)	*
69	" palustre, Linn	*			*
70	" " var. lineare, Gr	*			*
71	" tetragonum, Linn	*			*
72	" coloratum, Muhl	*			*
	UMBELLIFERÆ. (*Parsley Family*).				
73	Sanicula Marilandica, Linn	*			*
74	Heracleum lanatum, Michx	*			*
75	Cicuta bulbifera, Linn			1	
76	Sium lineare, Michx	*			*
77	Osmorhiza brevistylis, DC	*			*
	ARALIACEÆ. (*Ginseng Family*).				
78	Aralia nudicaulis, Linn	*			*
79	" hispida, Michx		*		*
	CORNACEÆ. (*Dogwood Family*).				
80	Cornus Canadensis, Linn	*		(W)	*
81	" stolonifera, Michx	*	*		*
	CAPRIFOLIACEÆ. (*Honeysuckle Family*).				
82	Linnæa borealis, Gronov	*			*
83	Symphoricarpus racemosus, Mx. var. pauciflorus (Robbins)	*			
84	Lonicera involucrata, Banks		*		
85	" parviflora, Lam, var. Douglasii, Gr	*	*	2	
86	" cœrulea, Linn		*		
87	" oblongifolia. Muhl	*		1	*
88	" ciliata, Muhl	*	*		*

Nos.		I.	II.	III.	IV.
	CAPRIFOLIACEÆ. (*Honeysuckle Family*).—(*Continued.*)				
89	Lonicera hirsuta, Eaton		*	1	*
90	Diervilla trifida, Mænch	*			*
91	Sambucus pubens, Michx	*			*
92	Viburnum pauciflorum, Pylaie		*		
93	" opulus, Linn	*			*
	RUBIACEÆ. (*Madder Family*).				
94	Galium triflorum, Michx	*	*	1	*
95	" trifidum, Linn	*		2	*
96	" asprellum, Michx			1	*
	COMPOSITÆ. (*Composite Family*).				
97	Eupatorium purpureum, Linn	*	*		*
98	Nardosmia palmata, Hook	*			*
99	Aster simplex, Willd			1	*
100	" æstivus, Ait		*		*
101	" cordifolius, Linn		*		*
102	" graminifolius, Torr and Gray		*		
103	" macrophyllus, Linn	*	*		*
104	" puniceus, Linn	*	*		*
105	Diplopappus umbellatus, Torr and Grey			1	*
106	Solidago lanceolata, Ait	*		1	*
107	" Virga-aurea, L. var. Alpina, Rig			(W)	
108	" Canadensis, Linn			1	*
109	" nemoralis, Ait	*			*
110	" latifolia, Linn	*			*
111	Achillæa millefolium, Linn	*			*
112	Antennaria plantaginifolia, Hook	*			*
113	" margaritacea, R. Br	*			*
114	Senecio aureus, Linn, var obovatus, T. & G	*			*
115	" " var borealis, T. & G			(W)	
116	Cirsium muticum, Michx	*			*
117	Hieracium Canadense, Michx	*	*		*
118	" ——— ?			1	
119	Nabalus racemosus, Hook		*		
120	Taraxacum dens-leonis, Desf	*			*
121	Mulgedium leucophæum, DC	*	*		*
122	Lactuca Canadensis, Linn	*			*
	LOBELIACEÆ. (*Lobelia Family*).				
123	Lobelia Kalmii, Linn				*
	CAMPANULACEÆ. (*Campanula Family*).				
124	Campanula aparinoides, Michx		*		*
	ERICACEÆ. (*Heath Family*).				
125	Vaccinium cæspitosum, Michx	*			
126	" Canadense, Kalm	*			*
127	" Oxycoccus, Linn		*		*
128	" Pennsylvanicum, Linn	*			*

Nos.		I.	II.	III.	IV.
	ERICACEÆ. (*Heath Family*).—(*Continued.*)				
129	Chiogenes hispidula, Torr and Gray......................			1.2	*
130	Arctostaphylos uva-ursi, Spreng.........................		*		*
131	Epigæa repens, Linn.......................................	*		1	*
132	Gaultheria procumbens, Linn..............................			1	*
133	Cassandra calyculata, Don..................................			2	*
134	Andromeda polifolia, Linn..................................		*		*
135	Ledum palustre, Linn..			(W)	
136	" latifolium, Ait...		*		*
137	Pyrola secunda, Linn..		*		*
138	" rotundifolia, Linn..		*		*
139	" elliptica, Nutt..			(W)	*
140	Moneses uniflora, Gray......................................		*	2	*
141	Monotropa uniflora, Linn....................................	*			*
	AQUIFOLIACEÆ. (*Holly Family*).				
142	Nemopanthes Canadensis, D C...............................	*			*
	PLANTAGINACEÆ. (*Plaintain Family*).				
143	Plantago major, Linn..		*		*
	PRIMULACEÆ. (*Primrose Family*).				
144	Primula Mistassinica, Michx...............................		*		
145	Trientalis Americana, Pursh	*			*
146	Lysimachia thyrsiflora, Linn................................		*		*
147	" stricta, Ait...	*	*		*
	LENTIBULACEÆ. (*Bladderortw Family*).				
148	Utricularia vulgaris, Linn...................................			2	*
149	Pinguicula vulgaris, Linn....................................		*		
	SCROPHULARIACEÆ. (*Figwort Family*).				
150	Mimulus ringens, Linn		*		*
151	Veronica Americana, Schw		*		*
152	" scutellata, Linn...	*		2	*
153	Melampyrum Americanum, Michx..........................	*	*		*
	LABIATÆ. (*Mint Family*).				
154	Mentha Canadensis, Linn....................................	*		2	*
155	Lycopus Virginicus, Linn....................................		*	1	*
156	" sinuatus, Gray...	*	*		*
157	Calamintha Clinopodium, Benth...........................	*			*
158	Brunella vulgaris, Linn......................................	*			*
159	Scutellaria galericulata, Linn..............................	*		(1w)	*
160	" lateriflora, Linn..		*		*
	BORAGINACEÆ. (*Borage Family*).				
161	Mertensia paniculata, Don..................................	*			

Nos.		I.	II.	III.	IV.
	GENTIANACEÆ. (*Gentian Family*).				
162	Gentiana alba, Michx............................			1	
163	Halenia deflexa, Griesb............................		*		
164	Menyanthes trifoliata, Linn............................		*		*
	APOCYNACEÆ. (*Dogbane Family*).				
165	Apocynum androsæmifolium, Linn............................	*			*
	OLEACEÆ. (*Olive Family*).				
166	Fraxinus sambucifolia, Lam............................	*			*
	POLYGONACEÆ. (*Buckwheat Family*).				
167	Polygonum tenue, Michx............................	*			*
168	" amphibium, var. aquaticum, L...............		*		*
169	Rumex orbiculatus, Gray............................		*	2	*
170	Fagopyrum esculentum, Mœnch	*			*
	SANTALACEÆ. (*Sandalwood Family*).				
171	Comandra livida, Rich............................		*		
	CALLITRICHACEÆ. (*Water Starworts*).				
172	Callitriche verna, Linn............................		*		*
	URTICACEÆ. (*Nettle Family*).			1	*
173	Urtica gracilis, Ait............................			E	*
174	Celtis occidentalis, Linn, Eagle Lake, Lat. 49° 45′, Long. 93° 15′				
	CUPULIFERÆ.				
175	Quercus alba, Linn. At Sault Ste. Marie..................				*
176	" rubra, Linn. On east side of Lake Superior, as far north as Agawa River; on west side as far north as the Kaministiquia River..................		*		*
177	" macrocarpa, Michx. In going west, this species is first met with at the east end of Eagle Lake...				
178	Corylus rostrata, Ait............................	*			*
179	Ostrya Virginica, Willd, around Lake of the Woods.......				*
	MYRICACEÆ.				
180	Myrica Gale, Linn............................	*			*
	BETULACEÆ. (*Birch Family*).				
181	Betula pumila, Linn............................			1	*
182	" papyracea, Ait............................	*			*
183	Alnus incana, Willd............................	*			*

Nos.		I.	II.	III.	IV.
	SALICACEÆ. (*Willow Family*).		*		*
184	Salix candida, Willd	*	*		*
185	" discolor, Muhl				
186	" livida var. occidentalis, Gray		(W)		*
187	" lucida, Muhl	*	*	1	*
188	" longifolia, Muhl		*		*
189	" myrtilloides, Linn		*		*
190	Populus tremuloides, Michx		*		*
191	" balsamifera, Linn		*		*
	CONIFERÆ. (*Pine Family*).				
192	Pinus Banksiana, Lamb			1	*
193	" resinosa, Ait			1	*
194	" strobus, Linn			1	*
195	Abies balsamea	*			*
196	" alba	*			*
197	Larix Americana, Michx	*			*
198	Thuja occidentalis, Hook	*			*
199	Taxus baccata, L. var. Canadensis, Gray	*			*
200	Juniperus communis, Linn		*		*
	ARACEÆ. (*Arum Family*).				
201	Acorus calamus, Linn		*		*
202	Calla palustris, Linn		*	(2w)	*
	TYPHACEÆ. (*Cat-tail Family*).				
203	Sparganium eurycarpum, Engelm			2	*
204	" simplex, Huds		*		*
205	" " var. angustifolium, Gr		*		*
206	Typha latifolia, Linn			1.2	*
	NAIADACEÆ. (*Pond-weed Family*).				
207	Potamogeton amplifolius, Tuck			1	*
208	" compressus, Linn		*		*
209	" gramineus, L. var. heterophyllus		*		*
210	" natans, Linn			2	*
211	" pectinatus, Linn			1	*
212	" Robbinsii, Oakes		*		*
213	" rufescens, Schrad	*			*
	ALISMACEÆ. (*Water-plantain Family*).				
214	Triglochin maritimum, L. var. elatum, Gr		*		*
215	Sagittaria variabilis, Engelm		*		*
216	" " var. obtusa, Gr		*		*
217	Alisma Plantago, L. var. Americanum, Gr			1	*
	ORCHIDACEÆ. (*Orchis Family*).		*		*
218	Habenaria Hookeri, Torr	*	*	1	*
219	" hyperborea, Lindl	*		2	*
220	" obtusata, Rich	*		2	*

Nos.		I.	II.	III.	IV.
	ORCHIDACEÆ. (*Orchis Family*).—(*Continued.*)				
221	Goodyera repens, R. Br.			1	*
222	Spiranthes Romanzoviana, Cham.		*		*
223	Corallorhiza innata, R. Br.	*			*
224	“ multiflora, Nutt.			1	
225	“ Macræi, Gray			1	*
226	Cypripedium pubescens, Willd.				
	IRIDACEÆ. (*Iris Family*).				
227	Iris versicolor, Linn.	*			*
228	Sisyrinchium Bermudianum, Linn.	*	*		*
	LILIACEÆ. (*Lily Family*).	*		1·2	
229	Trillium erectum, L. var. declinatum, Gr.	*			
230	Tofieldia glutinosa, Willd.	*			
231	Streptopus amplexifolius, D.C.	*			
232	“ roseus, Michx.	*			
233	Clintonia borealis, Desf.	*			*
234	Smilacina trifolia, Desf.	*		2	*
235	“ bifolia, Ker.				
236	Lilium Philadelphicum, Linn.	*			*
237	Allium Schænoprasum, Linn.	*			
	JUNCACEÆ. (*Rush Family*).				
238	Luzula parviflora, var. melanocarpa, Gr.		*		
239	Juncus effusus, Linn.	*			*
240	“ tenuis, Willd.		*		*
	CYPERACEÆ. (*Sedge Family*).			*	*
241	Dulichium spathaceum, Pers.	*		1	*
242	Eleocharis palustris, R. Br.	*			*
243	“ tenuis, Schultes.	*			
244	Scirpus validus, Vahl.	*			*
245	“ microcarpus, Prest.		*		*
246	“ subterminalis, Torr		1		*
247	Eriophorum Virginicum, Linn.		1		*
248	Carex adusta, Boot.	*			*
249	“ aurea, Nutt.		*		*
250	“ capillaris, Linn.	*			
251	“ Houghtonii, Torr.	*			*
252	“ lenticularis, Michx.	*			*
253	“ monile, Tuck.	*			*
254	“ polytrichoides, Muhl.	*			*
255	“ straminea, Schk.		*		*
256	“ tenella, Schk.		*		*
257	“ retrorsa, Schw.		*		*
258	“ irrigua, Smith.			1	*
	GRAMINEÆ. (*Grass Family*).		*	1	*
259	Zizania aquatica, Linn.	*			*
260	Phleum pratense, Linn.			1	*

Nos.		I.	II.	III.	IV.
	GRAMINEÆ. (*Grass Family*).—(*Continued.*)				
261	Agrostis scabra, Willd		*	1	*
262	Cinna arundinacea, Linn		*		*
263	Muhlenbergia glomerata, Trin	*	*		*
264	Calamagrostis Canadensis, Beauv			1	*
265	Glyceria aquatica, Smith			1	*
266	" fluitans, R. Br	*			*
267	Bromus ciliatus, Linn			1	*
268	Phragmites communis, Trin	*			*
269	Triticum repens, Linn	*			*
270	Danthonia spicata, Beauv	*			*
271	Aira cœspitosa, Linn	*	*		*
272	Trisetum subspicatum, var. molle, Gray	*			*
	EQUISETACEÆ. (*Horse-tail Family*).				
273	Equisetum arvense, Linn	*			*
274	" limosum, Linn		*		*
275	" hyemale, Linn			2	*
276	" scirpoides, Michx	*			*
	FILICES. (*Fern Family*).				
277	Polypodium vulgare, Linn	*			*
278	Pteris aquilina, Linn	*			*
279	Asplenium trichomanes, Linn			1	*
280	" Filix-fœmina, Bemh	*	*	1	*
281	Phegopteris polypodioides, Feè	*		1	*
282	" Dryopteris, Feè	*			*
283	Aspidium fragrans, Swartz			1·2	
284	" cristatum, Swartz			B.L.	*
285	" spinulosum, Swz. var. intermedium, Gr	*			*
286	" " var. dilatatum, Gr		*		*
287	Onoclea sensibilis, Linn	*			*
288	Cystopteris fragilis, Bernh	*			*
289	" bulbifera, Bernh	*		1	*
290	Woodsia Ilvensis, R. Br	*		1 BL	*
291	" ——— ?	*			
292	Osmunda regalis, Linn	*			*
293	" Claytoniana, Linn	*			*
294	Botrychium Virginicum, Swartz	*		2	*
	LYCOPODIACEÆ. (*Club-moss Family*).				
295	Lycopodium annotinum, Linn	*			*
296	" dendroideum, Michx	*			*
297	" clavatum, Linn	*			*
298	" complanatum, Linn			2	*
	MUSCI. (*Moss Family*).			1	*
299	Sphagnum cymbifolium, Ehrh			1	*
300	" recurvum, Beauv			1	*
301	Dicranum undulatum, Turner			1	*
302	Polytrichum commune, Linn			1	*
303	Mnium cuspidatum, Hedw		*		*

Nos.		I.	II.	III.	IV
	MUSCI. (*Moss Family*).—(*Continued.*)				
304	Funaria hygrometrica, Linn		*		*
305	Hypnum Crista-castrensis, Linn		*		*
306	" Schreberi, Willd		*		*
307	" splendens, Hedw		1		*
308	" triquetrum, Linn			1	
	HEPATICÆ. (*Liverwort Family*).				
309	Marchantia polymorpha, Linn	*	*		*
310	Madotheca platyphylla, Dumort		*		*
	LICHENES. (*Lichen Family*).			2	*
311	Usnea barbata, Fr			2	*
312	Parmelia saxatilis, Ach		*	2	
313	Umbilicaria Dillenii, Tuck		*	2	*
314	Sticta pulmonaria, Ach	*	*	2	*
315	Peltigera canina, Hoffm	*	*		*
316	Stereocaulon paschale, Lam		*		
317	Cladonia cornuta, Fries		*		
318	" cornucopioides, Fries		*		
319	" gracilis, Fries		*		
320	" furcata, Fries		*		

APPENDIX II.

LISTS OF COLEOPTERA COLLECTED IN 1881 BY DR. BELL AND OTHERS, IN THE LAKE SUPERIOR DISTRICT AND IN THE NORTH-WEST TERRITORIES,

east of the 112th Meridian and south of the 60th parallel.

BY DR. J. L. LECONTE, Philadelphia.

The species given in Lists i.-vii. were collected by Dr. Bell; those in viii. by Mr. William Isbister, and those in ix. x. xi. by Mr. A. S. Cochrane.

The only remark I have to make upon the collections examined is that *Aphodius fimetarius* is still extending its area towards the North-West. This European species was first found in Maine about 1835 by Randall, since which time it has extended towards Georgia on the south, and also into the Western States. It now appears in Dr. Bell's collection of last summer, made on the route from Thunder Bay to Lake of-the-Woods. This is, I believe, the first record of its appearance in the Lake Superior basin. It will therefore probably, undisturbed by enemies, diffuse itself over all parts of the continent, where proper food and endurable climate can be found.

I.—Sault Ste. Marie (between Lakes Huron and Superior), Lat. 46° 31′, *Long.* 84° 20′.

1. Cicindela longilabris.
2. " purpurea.
3. " vulgaris.
4. " duodecimguttata.
5. Patrobus longicornis.
6. Pterostichus lucublandus.
7. " orinomum.
8. " erythropus.
9. Amara impuncticollis.
10. " obesa.
11. Calathus impunctatus.

12. Platynus cupripennis.
13. " cupreus.
14. " obsoletus.
15. Chlænius sericeus.
16. Anisodactylus Baltimorensis.
17. Harpalus Pennsylvanicus.
18. " herbivagus.
19. " pleuriticus.
20. Stenolophus conjunctus.
21. Rhantus binotatus.
22. Leistotrophus cingulatus.
23. Philonthus æneus.
24. Silpha Americana.
25. Liodes globosa.
26. Dermestes lardarius.
27. Pediacus fuscus.
28. Epuræa rufa.
29. Nitidula bimaculata.
30. Coccinella trifasciata.
31. Anatis pullata.
32. Hister abbreviatus.
33. " depurator.
34. Dendrophilus punctulatus.
35. Saprinus Oregonensis.
36. " mancus.
37. " fraternus.
38. Platycerus depressus.
39. Onthophagus Hecate.
40. Aphodius granarius.
41. Serica tristis.
42. Lachnosterna fusca.
43. Trichius affinis.
44. Chalcophora Virginiensis.
45. Buprestis fasciata.
46. " consularis.
47. " maculiventris, form rusticorum.
48. Melanophila longipes.
49. Chrysobothris dentipes.
50. " trinervia.
51. Cryptohypnus abbreviatus.
52. Elater apicatus.
53. Agriotes mancus.
54. " fucosus.

55. Agriotes oblongicollis.
56. Dolopius lateralis.
57. Corymbites cruciatus.
58. Asaphes memnonius.
59. Cyphon variabilis.
60. Plateros canaliculatus.
61. Ellychnia corrusca.
62. Photinus ardens.
63. Photuris Pennsylvanica.
64. Podabrus puberulus.
65. Telephorus fraxini.
66. " scitulus.
67. Clerus undatulus.
68. Criocephalus agrestis.
69. Xylotrechus undulatus.
70. Desmocerus palliatus.
71. Acmæops pratensis.
72. Leptura chrysocoma.
73. " pubera.
74. " aspera.
75. Monohammus scutellatus.
76. " maculosus.
77. Chrysochus auratus.
78. Graphops marcassita.
79. Doryphora 10-lineata.
80. Chrysomela Philadelphica.
81. Prasocuris varipes.
82. Blapstinus moestus.
83. " interruptus.
84. Iphthimus opacus.
85. Upis ceramboides.
86. Tenebrio molitor.
87. " tenebrioides.
88. Hymenorus pilosus.
89. Isomira quadristriata.
90. Arthromacra ænea.
91. Corphyra lugubris.
92. Macrobasis unicolor.
93. Hylobius pales.
94. " confusus.
95. Baris confinis.
96. Dryopthorus corticalis.

II.—Mouth of Michipicoten River, Lake Superior. Lat. 47° 56′, Long. 84° 51′.

1. Cincindela longilabris.
2. Calosoma calidum.
3. Cymatopterus sculptilis.
4. Necrophorus vespilloides.
5. Silpha Lapponica.
6. Dichelonycha Backii.
7. Dicerca tenebrosa.
8. Buprestis maculiventris.
9. Monohammus scutellatus.

III.—Head Waters of the Michipicoten River, Lake Superior. Lat. 48° 30′, Long. 84° 00′, to Lat. 48° 30′, Long. 84° 10′.

1. Cicindela vulgaris.
2. " duodecimguttata.
3. Nomius pygmæus.
4. Pterostichus coracinus.
5. " orinomum.
6. Amara erratica.
7. Cymindis cribricollis.
8. Hydroporus inæqualis.
9. " sericeus.
10. Dytiscus Harrisii.
11. Acilius semisulcatus.
12. Cymatopterus sculptilis.
13. Hybius confusus.
14. Gaurodytes lutosus.
15. Gyrinus limbatus.
16. " borealis.
17. " pectoralis.
18. Silpha Lapponica.
19. Cocinella picta.
20. Buprestis rusticorum.
21. Pogonocherus penicillatus.
22. Monohammus scutellatus.
23. " marmoratus.
24. Donacia subtilis.
25. Galeruca sagittariæ.
26. Blapstinus moestus.
27. Pissodes strobi (very small).
28. " dubius.

IV.—From Missinaibi House, north-east of Lake Superior, to Flying Post. Lat. 48° 29′, Long. 83° 35′ to Lat. 48° 02′ Long. 82° 20′.

1. Platynus affinis.
2. " obsoletus.
3. Pterostichus coracinus.
4. " orinomum.
5. Dytiscus confluens.
6. Gyrinus confinis.
7. " affinis.
8. Silpha Americana.
9. Choleva basillaris.
10. Coccinella picta.
11. Ellychnia corrusca (very small).
12. Monohammus scutellatus.
13. Donacia proxima.
14. " hirticollis.
15. " aurea.
16. Graptodera bimarginata.
17. " (two species undetermined).
18. Penthe obliquata.
19. Stenotrachelus arctatus.

V.—Oba and Kabiuakagami Lakes and Rivers, north-east of Lake Superior. Lat. 48° 30′, Long. 84° 27′ to Lat. 49° 45′, Long. 83° 45′.

1. Pelophila rudis.
2. Nomius pygmæus.
3. Bembidium impressum.
4. Patrobus hyperboreus.
5. Pterostichus punctatissimus.
6. " coracinus.
7. " orinomum.
8. Amara impuncticollis.
9. Calathus ingratus.
10. Platynus metallescens.
11. " deceptivus.
12. " retractus.
13. Cymindis cribricollis.
14. Chlænius Pennsylvanicus.
15. Bradycellus cognatus.
16. Hydroporus rotundatus.
17. Dytiscus Lapponicus.
18. Cymatopterus sculptilis.

19. Agabus lutosus.
20. " parallelus.
21. Dineutus emarginatus.
22. Choleva basillaris.
23. Epuræa immunda.
24. Trichius affinis.
25. Buprestis maculiventris.
26. Chrysobothris trinervia.
27. Elater nigrinus.
28. Corymbetes virens.
29. " ochreipennis.
30. Celetes basalis.
31. Ellychnia corrusca.
32. Collops tricolor.
33. Leptura Canadensis.
34. Monohammus scutellatus.
35. Pogonocherus penicillatus.
36. Donacia pubicollis.
37. " aequalis.
38. Adoxus vitis.
39. Lina interrupta.
40. " scripta.
41. Galeruca sagittariæ.
42. Upis ceramboides.
43. Macrobasis unicolor.

VI.—From Thunder Bay to Lake-of-the-Woods, west of Lake Superior. Lat. 48° 25′, *Long.* 89° 10′, *to Lat.* 49° 25′, *Long.* 95° 00′.

1. Cicindela purpurea.
2. Bembidium picipes.
3. Platynus sinuatus.
4. " sordens.
5. Pterostichus lucublandus.
6. " patruelis.
7. Amara (Lirus) latior.
8. " erratica.
9. " interstitialis.
10. Bradycellus nigrinus.
11. Philhydrus perplexus.
12. Quedius lævigatus.
13. Silpha Surinamensis.
14. Ips quadriguttatus.

15. Coccinella picta.
16. Aphodius fimetarius.
17. " fœtidus.
18. Ellychnia corrusca.
19. Corynetes violaceus.
20. Donacia cuprea.
21. " flavipes.
22. Chrysomela Philadelphica.
23. Xyloterus bivittatus.

VII.—Oxford House, between Lake Winnipeg and Hudson's Bay. Lat. 54° 53′, *Long.* 95° 44′.

1. Notiophilus Hardyi.
2. Elaphrus riparius.
3. Carabus palustris.
4. " tædatus.
5. " Chammissonis.
6. Calathus ingratus.
7. Platynus sinuatus.
8. " metallescens.
9. " perforatus.
10. " obsoletus.
11. " quadripunctatus.
12. Pterostichus punctatissimus.
13. " orinomum.
14. " mandibularis.
15. Amara (Lirus) cylindrica.
16. " impuncticollis.
17. " interstitialis.
18. Harpalus pleuriticus.
19. Bembidium impressum.
20. " bimaculatum.
21. " nitens.
22. " nigripes.
23. " axillare.
24. Hydroporus alpinus.
25. Dytiscus confluens.
26. Gyrinus ventralis.
27. Tachyporus jocosus.
28. Creophilus maxillosus.
29. Olophrum rotundicolle [Sahlberg].
30. Porrhodites fenestralis.

31. Necrophorus vespilloides.
32. Silpha Lapponica.
33. Dermestes nubilus.
34. Attagenus megatoma.
35. Trogoderma inclusum ?
36. Pediacus fuscus.
37. Cryptophagus (not determined).
38. Anisosticta strigata.
39. Aphodius leopardus.
40. Dicerca tenebrosa.
41. " prolongata.
42. Buprestis Nuttalli.
43. " rusticorum.
44. Elater luctuosus.
45. Corymbites virens.
46. " spinosus.
47. " æripennis.
48. " metallicus.
49. Ellychnia corrusca.
50. Clerus undatulus.
51. Hadrobregmus foveatus.
52. Criocephalus agrestis.
53. Tetropium cinnamopterum.
54. Merium Proteus.
55. Hylotrupes ligneus.
56. Xylotrechus undulatus.
57. Rhagium lineatum.
58. Acmæops Proteus.
59. Leptura sexmaculata.
60. Monohammus scutellatus.
61. Pogonocerus penicillatus.
62. Gonioctena pallida.
63. Galeruca sagittariæ.
64. Graptodera (not determined).
65. Upis ceramboides.
66. Stenotrachelus arctatus.
67. Serropalpus striatus.
68. Hypomolyx pinicola.
69. Hylobius pales.

VIII.—Nelson River House, near Churchill River. Lat. 55° 50′, *Long.* 99° 30′.

1. Nebria Sahlbergi.

2. Pelophila rudis.
3. " Ulkei.
4. Carabus palustris.
5. " tædatus.
6. " Chamissonis.
7. Calathus ingratus.
8. Platynus ruficornis.
9. " obsoletus.
10. Pterostichus orinomum.
11. Amara (Stereocerus) similis.
12. " (Lirus) elongata.
13. " erratica.
14. " interstitialis.
15. " musculus.
16. Harpalus pleuriticus.
17. Dytiscus confluens.
18. Cymatopterus sculptilis.
19. Ilybius confusus.
20. Agabus punctulatus.
21. Gyrinus borealis.
22. Necrophorus vespilloides.
23. Silpha Lapponica.
24. Dermestes lardarius.
24. Hippodamia quinquesignata.
24. " tredecempunctata.
25. Coccinella trifasciata.
26. " quinquenotata.
27. Anatis quindecempunctata.
28. Dicerca prolongata.
29. Buprestis Nuttalli.
30. Melanophila longipes.
31. Elater nigrinus.
32. Sericosomus incongruus.
33. Corymbites virens.
34. " resplendens.
35. " ochreipennis.
36. Ellychnia corrusca.
37. Criocephalus agrestis.
38. Merium Proteus.
39. Xylotrechus undulatus.
40. Pachyta liturata.
41. Monohammus scutellatus.
42. Donacia hirticollis.

43. Donacia cuprea.
44. Adoxus vitis.
45. Gonioctena rufipes.
46. Gastroidea cyanea.
47. Galeruca sagittariæ.
48. Upis ceramboides.
49. Meloe angusticollis.
50. Lepyrus gemellus.
51. Hypomolyx pinicola.

IX.—From Cross Lake, on the Nelson River, to Cumberland House on the Saskatchewan. Lat. 54° 40′, *Long.* 98° 00′, *to Lat.* 54° 00′, *Long.* 102° 22′.

1. Notiophilus Sibiricus.
2. Carabus palustris.
3. Platynus cupreus.
4. Pterostichus orinomum.
5. Bembidium quadrimaculatum.
6. Gyrinus ventralis.
7. Pediacus fuscus.
8. Hippodamia tredecempunctata.
9. Buprestis Nuttalli.
10. Melanophila longipes.
11. Collops vittatus.
12. Merium Proteus.
13. Donacia magnifica.
14. " proxima.
15. " subtilis.
16. Cryptocephalus quadrimaculatus.
17. Galeruca sagittariæ.
18. Upis ceramboides.
19. Gonotropis gibbosus.

X.—From Cumberland House to Reindeer Lake. Lat. 54° 00′, *Long.* 102° 22′ *to Lat.* 58° 30′, *Long.* 101° 00′.

1. Carabus tædatus (form Agassizii).
2. Platynus obsoletus.
3. Pterostichus orinomum.
4. Amara littoralis.
5. Cymindis cribricollis.
6. Thymalus fulgidus.

7. Melanophila appendiculata.
8. Dinoderus substriatus.
9. Criocephalus agrestis.
10. Merium Proteus.
11. Gonocallus collaris.
12. Xylotrechus undulatus.
13. Acmæops Proteus.
14. Leptura sexmaculata.
15. " nigrella.
16. Monohammus scutellatus.
17. Lina interrupta var.
18. Hypomolyx pinicola.
19. Hylobius pales.

XI.—From the north end of Reindeer Lake to the west end of Athabaska Lake. Lat. 58° 30′, *Long.* 101° 00′ *to Lat.* 58° 30′, *Long.* 101° 00′.

1. Calathus ingratus.
2. Anatis 15-punctata.
3. Corymbites ochreipennis.
4. Hydnocera humeralis.
5. Donacia proxima.
6. " subtilis.
7. Upis ceramboides.
8. Carabus tædatus, var. Agassizii.

GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., Director.

REPORT

ON THE GEOLOGY OF

NORTHERN & EASTERN NEW BRUNSWICK

AND THE

NORTH SIDE OF THE BAY OF CHALEURS.

BY

R. W. ELLS, M.A.

1881.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

Montreal:
DAWSON BROTHERS.

1883.

Alfred R. C. Selwyn, Esq., LL.D., F.R.S., &c.,

Director Geological and Natural History Survey of Canada:

Sir,—I beg to present herewith a report on the explorations and surveys made, to the close of the season of 1881, in eastern and northern New Brunswick, and in the portion of the province of Quebec bordering the Bay of Chaleurs, as far east as Cape Maquereau, in Gaspé. Also a map, on the scale of four miles to one inch, of the country described in this report and in that of 1879-80, of which also further details are now given.

My assistants during the past season were Mr. A. P. Low, a student in the Faculty of Applied Science of McGill University, and Mr. T. D. Peers.

Mr. Peers was engaged during the greater part of the season in making topographical surveys in Westmoreland county, to connect with those of Nova Scotia. The publication of the result of this work, and of that of other surveys made in the county of Kent, must be deferred pending further investigation required to complete the $\frac{1}{4}$-sheet maps, in which these areas, and a portion of the province of Prince Edward Island, will be included.

In order to render this report uniform with those on New Brunswick already published, the dips of strata are given with reference to the magnetic meridian, the variation of which for the Bay of Chaleurs may be generally stated to be N. $23\frac{1}{2}°$ W.

I have the honor to be,

Sir,

Your obedient servant,

R. W. ELLS.

Ottawa, 1st May, 1882.

REPORT

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The present report refers chiefly to the areas included in the accompanying four ¼-sheet maps. These connect, about eight miles north of the latitude of Moncton, with those published in 1880, and correspond with them in all details of coloring, scale, &c. Each ¼-sheet represents 3,456 square miles. They are numbered as follows:—2.—S.E., 2.—N.E., 3.—S.E., 3.—S.W.

In the construction of the map we are much indebted to the several officers of the Crown Land Department, Fredericton, for valuable assistance in supplying us with tracings of important rivers. The coast line has been taken largely from Admiralty charts, corrected at various points by our own surveys. The Intercolonial and Kent Northern lines of railway are from reductions of the official plans. The roads in Kent, Gloucester and Restigouche counties, and along the north side of the Bay of Chaleurs, and various streams, are from surveys by ourselves. In the county of Northumberland, only the principal roads, measurements of which were necessary for tie lines, were surveyed, the minor details of roads, streams, &c., being filled in from the published county map by Roe and Colby, and from Crown Land plans.

Construction of map.

Great difficulty was experienced in constructing the map of the interior of the province, from its entirely unsettled and often unsurveyed character, and here the want of accurate tie lines is to be regretted. It is hoped, however, that from the material available from outside sources, combined with our own surveys, the topographical and geological lines have been laid down with a fair degree of accuracy, and that on the completion of the surveys now being carried on in the western portion of the province by Mr. Broad, a map of New Brunswick embodying all the known geological and topographical features will be the result. This map will be of great value to the Provincial Government; since the most favorable localities for settlement can be easily indicated on it, and the mistakes sometimes made in sending immigrants to sterile and unsuitable locations can be, to a great extent, avoided. The intimate relation between the geological formations of the country and the agricultural character of its soil is every day more clearly recognized; and therefore a carefully constructed geological map, rightly interpreted, is an approximately accurate index of the agricultural capabilities of the area it represents. Through the recent action of the New Brunswick Government in facilitating the construction of railroads, many parts of the country now entirely useless from their inaccessibility will be opened up.

Value of map as an index to character of soil.

In all our explorations, careful attention has been paid to the character of the soil in different localities. And it may be stated that in New Brunswick the finest soils are, as a rule, found on the Silurian or on the lower members of the Carboniferous systems. The rich and fertile districts of Carleton and Victoria counties may be cited as belonging to the Silurian system, while the beautiful valley of Sussex and the fine lands of King's and Albert counties result from the wear of strata which belong to the Lower Carboniferous formation. The soils formed from the Pre-Cambrian rocks, on the other hand, are generally hard, dry and stony, while the Middle Carboniferous (especially its grey sandstones), gives rise to a soil which is too light and sandy to be of much fertility, and which, when once exhausted, is with great difficulty restored to good condition. Some portions of the Middle Carboniferous, however, consisting of purple and reddish shales and sandstones, produce a soil of much greater strength and tenacity, often a stiff clay. This soil requires the addition of lime to make it easily and profitably worked. The Silurian soils, as a rule, contain in themselves sufficient lime; they are easily worked, and their fertility is very slowly exhausted. A knowledge of the distribution of the formations referred to may, therefore, prove of the greatest practical value to the immigrant and intending settler.

Character of soil dependent on underlying rock.

It is to be regretted that, for agricultural purposes, so large a portion of the province should be occupied by the grey and sandy portion of the Carboniferous system, and by granite and Pre-Cambrian crystalline rocks. In such districts the principal areas fit for agriculture are along the "intervals" or alluvial flats of the numerous streams, many of which are still uncultivated.

The systems described in the present report are—

G.—Carboniferous.	2. Middle. 1. Lower.	With their associated igneous and crystalline rocks: granite, diorite, felsite, diabase, dolerite, &c.
F.—Devonian.		
E.—Silurian.		
D.—Cambro-Silurian.		
A B.—Pre-Cambrian.		

G.—Carboniferous.

2. *Middle Carboniferous.*—The work of the past season, on this formation, was carried on principally in Kent and in the southern portion of Northumberland counties. The general character of the rocks of the Middle Carboniferous were described in the Report of 1879-80. The examinations during the past season tend to confirm the supposition then advanced that the Middle Carboniferous of eastern New Brunswick is chiefly composed of the Millstone Grit formation, the "Productive Coal Measures" being apparently wanting. Briefly stated, the geological structure of the eastern portion of the Carboniferous area, between the north side of the Bay of Chaleurs on the north and the head of the Bay of Fundy on the south, may be said to consist of four low, broad and shallow synclinal troughs, with their corresponding anticlines. Of these, the most northerly syncline is occupied principally by the waters of the Bay of Chaleurs, the southern margin or anticline being the high ridge that extends eastward from the vicinity of Bartibog station on the Intercolonial railway. The second syncline is occupied by the valley of the Miramichi River; the southern bounding anticlinal ridge, extending northeasterly from the head of Coal Creek in Queen's county on the west, reaches the coast in the vicinity of Richibucto Head. The third syncline contains the valleys of the Buctouche and Cocagne Rivers, and is probably bounded to the south by the prolongation of the ridge of Lower Carboniferous and Pre-Cambrian rocks seen in the Indian Mountain and Irishtown settlements, a few miles north of Moncton. The fourth syncline is probably bounded by the ridge extending from the head of Cumberland Basin at Aulac to Bay Verte. Other subordinate basins may exist, the evidences of which are not apparent.

Four principal synclinal basins in the Carboniferous of eastern New Brunswick.

The entire coast from Shippegan to Cape Tormentine is low and intersected by large estuaries, among which the principal are the

Character of coast.

Tracadie, Pokemouche, Tabusintac and Miramichi Rivers in Gloucester and Northumberland counties, and the Kouchibouguac, Kouchibouguacis, Richibucto, Buctouche and Cocagne Rivers in Kent county. In all these estuaries the tide flows inland from five to twenty miles in a direct line; while if we take the distance from the outer bars of the Miramichi to the head of tide at Indiantown and Red Bank, we have nearly seventy miles of tidal water. Great sandbanks extend in an almost continuous chain along the entire eastern coast, traversed by gulleys or outlets for the water brought down the various streams just mentioned, some of which are of large size.

Character of soil in Kent county.

The character of the soil on the areas occupied by the Middle Carboniferous rocks has already been described. (See page 2) The sandy portions are of small value for agricultural purposes, but the heavy clay areas can be made of great fertility by the application of lime, which, especially along the shore of Northumberland Strait, is now being supplied from the apparently inexhaustible beds of "mussel mud," composed largely of dead oyster shells. This mud is found in the estuaries of all the principal rivers, as well as at various points along the coast. When dug and exposed during winter, the shells speedily become disintegrated by the action of frost and other causes, and afford a natural lime fertilizer, which, applied to stiff soils, produces wonderful results, while light, sandy soils are but little improved by its application. Excellent ridges of farming land were observed in Kent county, where, among other localities, the valleys of the branches of the Nicholas and of the Kouchibouguacis Rivers may be especially mentioned. Large areas, however, are covered with sandy and peaty barrens, which abound with moose, caribou and bear, and support generally a scanty growth of scrubby spruce and pine, in marked contrast with the beautiful groves of maple and birch which distinguish the ridges of reddish soil. None of these soils, however, possess the value of those of the Lower Carboniferous, probably from the absence of lime in their composition.

Coal seam of Coal Branch, Richibucto River.

In my last year's report* (page 46 D) brief allusion was made to the occurrence of coal seams in this portion of the province. Since then, their various outcrops have been more particularly examined, and their probable economic value ascertained. The greatest thickness of coal observed was in the Coal Branch, a tributary of the Richibucto River, where at several points it shows a thickness of fifteen to eighteen inches, and resembles very strongly in character and mode of occurrence the seams on Coal Creek and Salmon River to the westward, with which it is probably connected, or at least is their equivalent,

* Report of Progress, Geological Survey of Canada, 1879-80.

brought to the surface at this point by the gentle swell of the central anticlinal. The coal has been locally mined for several years to a limited extent, and, like that of Grand Lake, is well fitted for blacksmith work. It is, however, too soft and impure for a good house coal, and the thinness of the seam will probably preclude its being mined to any great extent. Among other outcrops, one on the Buctouche River in Bishopland settlement was noted of ten inches, and near the Coal Branch station on the Intercolonial railway an extension of that first-mentioned is reported to have a thickness of eighteen inches, but is probably exaggerated. On the Dungarvon, one of the tributaries of the South-West Miramichi, an impure seam twelve inches thick was seen about twelve miles above the confluence of the Renous River; on the main South-West, a few miles below Doaktown, a seam from three to seven inches thick is said to exist. Other areas, as at Napan and Bay du Vin Rivers, reported to contain crops of coal, were examined, and the coal found to be merely the carbonized bark of probably drifted tree trunks imbedded in the grey sandstone.

Various coal outcrops in Kent and Northumberland counties.

It is not at all improbable that all these outcrops may be portions of one and the same seam; the generally horizontal character of the measures would tend to give great lateral extension to the strata, and in no place, except by faults, would the coal be carried to any great depth; while the low anticlinals would bring the seam near the surface at intervals. But though it would be of much geological interest to ascertain the thickness of the measures along the Gulf by boring, the surface indications do not point to the probable existence of deeper and thicker beds of coal than those already discovered.

Probably no lower seam.

Borings were made some years ago in Kent county for the purpose of obtaining oil, which was reported to occur at several points in springs. Examinations of these localities have led to the conclusion that these so-called oil springs were simply the ordinary mineral springs of the country, and that the oily appearance was due largely to the presence of iron pyrites, which abounds in certain beds of the greyer portion of the formation, and through decomposition often produces a thick, ferruginous scum on the surface of the water. This was the only substance having any resemblance to petroleum that we observed in any part of this area in which oil springs are reported to occur.

Boring for oil in Kent.

In the portion of the province occupied by Carboniferous rocks, no useful minerals other than coal are known to exist. Building and grindstones are quarried at several places, some of the strata being specially adapted for these purposes. The principal quarries are on the Miramichi River and on the south side of the Bay of Chaleurs.

Grindstones.

The stratigraphical position of the several coal seams observed may

Stratigraphical position of various outcrops.

be thus defined. The outcrops noted at Clifton and Shippegan belong to the most northerly, or Bay of Chaleurs, syncline; those of the Dungarvon, South-West Miramichi and Coal Branch to the second, or Miramichi, syncline; while the crops of the Buctouche and Cocagne belong to the third. In the fourth or more southerly basin, a small outcrop of coal from two to four inches thick is seen at Dupuis Corner, about ten miles east of Shediac.

Permo-Carboniferous rocks of Cape Tormentine and vicinity.

The eastern portion of Cape Tormentine peninsula is bordered by a narrow selvage of newer rocks, soft, reddish, micaceous sandstones, which resemble those seen on parts of Prince Edward Island. These extend from the vicinity of Cape Bald around the eastern end of Capes Tormentine and Jourimain, and up the Bay Verte for some six miles, and rest upon the grey beds of the Millstone Grit which occupy the peninsula, but do not extend inland more than half or three-quarters of a mile. Similar strata were also observed on the Nova Scotia shore near Tidnish Head. These rocks are very soft, and distinct in character from the ordinary purple and grey beds of the Middle Carboniferous, and are probably newer or Permo-Carboniferous in age.

Hemlock forest.

The settlements along the Gulf of St. Lawrence are for the most part confined to a belt along the coast from five to twenty miles wide. The disposition of the roads on either side of the several rivers indicates that the best settlement lands lie along their "intervals," the cross-roads serving more for inter-communication than for settlement. The uplands of the interior often produce immense groves of hemlock and spruce. The trees grow to a large size, and are now specially valued for their bark, which is stripped, and the bare trunk left to rot in the woods. The destructive effects of this practice will doubtless be felt before many years, especially in view of the rapid depletion of the more valuable kinds of timber which now form such an important article of export, but which are rapidly becoming exhausted in many localities, both from over-cutting and from the ravages of a small worm which has within the last two years begun to infest the spruce, and which rapidly works its destruction.

Destruction of timber.

Necessity for further examinations of the Lower Carboniferous.

1. *Lower Carboniferous.*—The additional work on this formation since the publication of the Report for 1879-80, has been principally along the north side of the Bay of Chaleurs, in the province of Quebec. No detailed geological examinations have been made in this area by the Geological Survey since 1844, and the discovery of the Devonian fish-bearing beds of the Lower Restigouche rendered necessary a closer examination of this locality in order to more clearly define the distribution of the Lower Carboniferous (Bonaventure) beds, and to ascertain the existence of further areas of Devonian rocks. Accordingly,

the coast and the adjoining country to the north have been explored as far east as the mouth of the Pabos River; and cross sections on the several streams made for a distance of several miles inland.

Distribution north of Restigouche harbor.

The red sandstones and conglomerates which form the high bluff at the mouth of the Scaumenac River, opposite Dalhousie, mark the western limit of the formation in this direction. They have a low, easterly dip, but are exposed for a distance of only a few hundred yards. Thence to Pirate Cove the shore is occupied by the *débris* of Devonian rocks. There, however, conglomerates crop out, which were at first supposed to be a part of the Lower Carboniferous formation, but their distinct dip and high inclination, ranging from 55° to 90°, together with their intimate interstratification with grey beds containing Psilophyton and other Devonian fossils, have now led to their separation. The upper beds re-appear, however, along the shore further east, and form the bluff above Fleurant Point or in the vicinity of Englishman's Brook, whence they extend eastward, and form the high ridge already described in the previous report, where they unconformably cap the red Devonian conglomerates just described, and also the sandy, grey, fish-bearing beds.

Unconformity of Devonian and Lower Carboniferous beds.

The unconformity of the two series is also well seen on the roads extending from the mouth of the Scaumenac to the Nouvelle, the dip of the older being N. 30° E. $<$ 65°–90°, while the newer or Lower Carboniferous beds have generally low dips of 10°–25°. These newer red sandstones and conglomerates occupy the extremity of Point Maguacha, and thence around to the mouth of the Nouvelle River, while the harder and older series extends across in a direct line to the same point. Below the mouth of the Nouvelle to Carleton, Lower Carboniferous beds are seen flanking the bold hills of Silurian slates or traps, and extend from the shore half a mile to a mile inland. Where exposed on the back road leading up to St. Louis Mountain, they dip S. 40° W. $<$ 25°–30°, but along the shore about two miles west of Carleton a bluff of these rocks shows at one point an abrupt dip of S. 10° W. $<$ 80°, changing, however, directly below to S. 10° E. $<$ 20°, whence it subsides, and the shore thence to Carleton shows nearly horizontal beds extending out under the water and dipping slightly seaward. From Carleton they can be traced eastward by occasional outcrops and by the bright red color they impart to the soil, to the Great Cascapedia River, where they have an exposed breadth of about four miles, with a southerly dip S. W. $<$ 10°, and they probably underlie all this area along the shore, although, owing to the great prevalence of *débris* and drift composed of Silurian and Devonian rocks, with sands and gravels, but few ledges appear between Carleton and the mouth of the Great Cascapedia.

Point Maguacha to Great Cascapedia River.

Between the Great and Little Cascapedia Rivers, exposures of rock in the settled portion of the country are also very few. The shore is occupied by beds of sand, gravel and marine clays, but the generally red color of the soil, with an occasional outcrop of conglomerate along the back concession roads, which extend inland for a distance of three to four miles, indicate that the Lower Carboniferous formation has here a breadth of nearly that extent. A small exposure of grey conglomerate is, however, seen about one mile back from the shore on the road leading north below Montgomery's mill, which serves to indicate the presence of Devonian rocks in this vicinity, and also the general thinness of the Lower Carboniferous formation. Between these two last-named rivers, the Carboniferous rocks rest apparently upon strata of Devonian age, but westward to the mouth of the Nouvelle they are seen at various points to lie against the flanks of the Silurian hills, overlapping the underlying Devonian beds. From the mouth of the Little Cascapedia eastward to Black Cape, the shore is occupied principally by Devonian and Silurian strata, but after passing the Cape, which is a rough headland of dolerite, we find two sets of conglomerates, both of which were in the Report for 1844 classed as of Lower Carboniferous age. There is, however, a marked difference in their character, composition and stratigraphical relations, the underlying set being hard, dark brownish-red, and with an abundance of large pebbles of Silurian fossiliferous limestone and trap of the vicinity, and having a dip of S. 50° W. $<$ 60°, while the overlying beds are the ordinary soft red sandstones of Lower Carboniferous age, and dip S. 10° E. $<$ 5°–10°. We have, therefore, on these grounds separated them, classifying the former as Devonian, while the latter remains as formerly described. These two sets of beds also appear on the Little Cascapedia; the overlying or Lower Carboniferous portion is seen in nearly horizontal beds about the mouth and for some distance—say a mile and a half—up stream, above which the banks for a mile or more are occupied by reddish clays, passing which, the second set of conglomerates is met with, which will be described under the heading of Devonian.

Black Cape conglomerates.

Little Cascapedia River.

Distribution eastward of Black Cape to Grand Pabos.

Returning to the shore east of Black Cape, the red beds of the formation under consideration are now seen extending eastward along the coast, without interruption, except by occasional banks of marine clays and sands, to within two miles and a half of the entrance to Port Daniel Bay. At several points, however, as at New Carlisle, Shigawake Point, Cape Loup Marin and eastward, the shore at low water, and sometimes a few feet of the lower part of the cliffs, are seen to be composed of Silurian slates and calcareous beds, upon which the red beds under discussion rest unconformably. As seen from the water, the stratification of the Lower Carboniferous along this part of the coast is very nearly horizontal. At times a slight inclination of two to four degrees south-easterly is noted, but the beds are entirely undisturbed. East of Port Daniel to Grand Pabos post-office, the exposures of Lower Carboniferous rocks are very limited. A small area, with an exposed breadth on the shore of 150 paces, is seen on the east side of the harbor. At Herrington Cove, two miles below the eastern entrance, another small exposure is seen in a depression in the cliff, and a third near the contact of the Silurian and metamorphic rocks at Pointe-aux-Bouleaux, about two miles west of Cape Macquereau. These various exposures are in the Report of 1844 described under the head of upper conglomerates and sandstone; now, the siliceous conglomerate of the Bay of Chaleurs is known to be of Devonian age, and to be associated with the beds which yield Devonian fishes.

Distribution of formations on the Miramichi and its branches.

Lower Carboniferous strata were recognized on the Renous River, a branch of the Main South-West Miramichi, where they have an exposed breadth along the stream of two and a half to three miles; but on the Dungarvon, a few miles farther south, they are not visible, the grey beds of the Millstone Grit overlapping them and resting directly upon the Cambro-Silurian of this locality. With this exception, they have now been traced in a continuous belt from Bathurst south-westward to the St. John River, a few miles above Fredericton; their distribution in that area will be described in the report accompanying the map of that locality in preparation by Mr. W. Broad.

F.—Devonian.

Discovery of Devonian fishes at Campbellton.

During the past season, the extension of this system was further defined along the north side of the Bay of Chaleurs. The examination of the brecciated limestone and associated beds of Campbellton, which, as stated in the Report of 1879-80, probably marked the base of the system, resulted in the discovery of several Devonian forms hitherto unknown in Canada, among which were Cephalaspis, Coccosteus, &c., besides other remains. Immediately after their discovery, Mr. Foord, Assistant Palæontologist to the Survey, visited the locality and secured a full and interesting collection. The following genera and species from this collection, most of which are new, have since been identified and described by Mr. Whiteaves in the *Canadian Naturalist*, Vol. X., No. 2.

Fossils from Campbellton.

Fishes.

Coccosteus Acadicus.
Cephalaspis Campbelltonensis.
Ctenacanthus latispinosus.
Homacanthus. Sp. undeterminable.

Crustacea.

Pterygotus. Sp. undeterminable.

Mollusca.

Cyclora valvatiformis.
Cyclora turbinata

Difference between the Campbellton and Scaumenac Bay beds.

The Devonian fauna and flora of the Campbellton area differ markedly from those of Scaumenac Bay, and indicate that, while the former is characteristic of the lower portion of the system, the latter is closely connected with the upper portion. During the past season, additional collections have been made by Mr. Foord from the beds at Scaumenac Bay. From this locality the following genera and species have been identified and described by Mr. Whiteaves:

Fossils from Scaumenac Bay.

Pterichthys Canadensis.
Diplacanthus.
Acanthodes.
Phaneropleuron curtum.
Eusthenopteron Foordi.
Glyptolepis microlepidotus? Agassiz.
Cheirolepis Canadensis. Sp. nov.

Measures wanting.

The gap in the continuity of succession of the various divisions of the Devonian system, thus indicated by the fauna and flora, is fully confirmed by the apparent unconformity of the two sets of beds, the lower one being inclined at high angles, often vertical, and in places apparently overlaid by almost horizontal measures, the other apparently undisturbed, and dipping at low angles of 7° to 15°.

Relations of the conglomerates to the psilophyton beds.

The red conglomerate beds of Pirate Cove, which, as already stated, resemble the beds of Lower Carboniferous age, were more closely examined, and found to be Devonian. They were traced through to the Nouvelle River, and found to underlie unconformably the red, soft beds of the Bonaventure series. They were also observed to be closely connected and interstratified with the grey siliceous conglomerates and psilophyton beds so largely developed in this locality. Opposite the mouth of the Nouvelle, they were again seen on the post road, dipping N. 10° E. $<$ 40°, the dip at Pirate Cove being N. 5° W. $<$ 80°. They are, however, directly succeeded and concealed by the Lower Carboniferous beds.

Between this point and the Great Cascapedia River, the typical Devonian conglomerates and fish-bearing beds of Scaumenac Bay and

Campbellton were not noted; but lying on the flanks of the trappean and Silurian hills, ledges of greyish quartzose sandstone are seen at intervals, and may represent the Devonian system in this direction. These beds crop out on the road leading back to St. Louis Mountain, near the Shoolbred post-office, in a small exposure, associated with trap at the entrance of the gorge, resting on calcareous and slaty Silurian rocks, dipping S. 40° E. < ? About three miles farther east, at a distance of 460 paces from the post road, showing reddish Lower Carboniferous soil, a low ridge of apparently altered quartzo-felspathic sandstone is seen, separated by about 200 paces from the front of the Silurian escarpment, which in this vicinity rises abruptly for nearly 1000 feet. These quartzose sandstones appear at intervals for several miles, but no fossils to indicate their exact age were found. East of the Carleton Mountain range, however, in the valley of Green Brook, about two miles and a half north of Maria post-office, ledges of fossiliferous grey sandstone of Devonian aspect occur, dipping S. 50° W. < 60°: these apparently sweep around the western extremity of another great trap ridge which extends thence, with a break at the Irish Settlement road, to the Great Cascapedia River.

Distribution between Seaumenac and Great Cascapedia River.

Fossils at Green Brook.

In these sandstones and shales of Green Brook, crinoid stems, corals, brachiopod shells and psilophyton stems were observed. The beds have a different strike from the ordinary Silurian strata, and though not apparently associated with the typical grey Devonian conglomerates of the lower Restigouche, rest upon purple trap conglomerates, which resemble in character some of the beds lying at the base of this system in the vicinity of Campbellton and elsewhere. Farther east on the Irish Settlement road, and flanking the eastern spur of this trappean ridge, are ledges of reddish and greenish felspathic and grey ochreous sandstones of Devonian aspect, with reddish and grey conglomerates of the usual type, in which the dip was not discernible, but a short distance north, beds of Silurian limestones and shale dips S. 10° W. < 65°, and probably mark the southern limit of the Silurian in this direction. The presumed Devonian beds just described doubtless mark the basal members of the system as developed in this portion of the Bay of Chaleurs.

Devonian fossiliferous beds rest upon the trap hills.

The Devonian strata probably extend in an unbroken belt, underlying the Lower Carboniferous sediments, to the Great Cascapedia, as they reappear again in considerable force on the eastern bank of that stream, about four miles from its mouth, with a dip S. < 7°. These beds may be traced up the river for several miles, where the lower members, which consist of grey siliceous conglomerates, very closely resembling the beds of Fleurant Point, rest on calcareous and slaty Silurian beds. No characteristic fossils were found here, but this is probably due to the coarseness of the sediments, the finer shales being apparently wanting, or at least not exposed to view.

Little Cascapedia River and eastward.

Between the two Cascapedias the surface is largely covered by drift, though on the roads leading up the west bank of the Little Cascapedia several small outcrops of Devonian rocks are seen, as well as along the back concession roads. They dip uniformly at a low angle southward. On this stream, in the vicinity of Brulé brook, hard dark-red conglomerates dip S. $< 2^{\circ}$—4°, and are probably the representatives of the Devonian in this direction, as they are intermediate in position between the calcareous slates of the Silurian farther up and the Lower Carboniferous softer beds about the mouth of the stream. Farther east they are also associated with grey sandy beds holding psilophyton. In these localities the dip is low, not more than 7° to 10°, but on the eastern side of Black Cape, hard red Devonian conglomerates, already referred to under the section, Lower Carboniferous, are seen on the shore as well as along the Post roads in the vicinity, dipping on the shore S. 50° W. $< 60^{\circ}$ and on the roads S. 20° W. $< 40^{\circ}$. The exposed breadth on the shore is about 600 yards, but on the road it is nearly three-fourths of a mile, and extends northward along the road leading to the back concession for nearly a mile inland. East of this the rocks of this system were not definitely recognized, although certain beds underlying the Lower Carboniferous of the Bonaventure River and developed along the back roads to the west of that stream have a lithological resemblance to the grey beds described. They contain, however, abundance of crinoid stems, and more probably are the equivalents of the upper part of the Silurian. It has not yet been possible, owing to the difficulty of penetrating the interior, to ascertain the relations of the Devonian basin of the lower Restigouche and the upper part of the Bay of Chaleurs to that of Gaspé, but it is probable that they form two separate and distinct basins, with ridges of Silurian and older rocks intervening.

Devonian basins of the Bay of Chaleurs and of Gaspé are probably not connected.

E.—Silurian.

The rocks of this system have their greatest development in the northern portion of New Brunswick and the central and southern portion of the Gaspé peninsula. Their general distribution in the former province has been briefly described in the report of 1879-80, but during the past season further explorations have been made in the province of Quebec, along the north side of the lower Restigouche, and on the various rivers flowing into the Bay of Chaleurs.

Intrusive rocks north of Bathurst.

On the coast north of Bathurst, their bulk is much reduced by the presence of large areas of intrusive dolerite (diabase) and felsite, which have burst through the rocks of this system in many places, often reducing the Silurian beds to narrow wedge-shaped areas or patches enclosed by the trappean masses. It has, however, been found to be impossible to determine the exact distribution of these rocks, since the country lying between the coast of the Bay of Chaleurs and the Upsalquitch River to the west is densely wooded and entirely unoccupied. Even the few portage roads that extend a short distance inland are impracticable, except in winter or during the driest weather. Under such circumstances, the tracing out of the various Silurian bands cannot be accurately done at present, but from our observations on the Upsalquitch River, it is evident that the huge masses of trappean rocks seen near the coast do not, as a whole, extend across the entire distance to the river. Minor dykes and spurs, however, probably connect the two localities, as these are seen cutting the Silurian slates on the Upsalquitch. The greater part of the surface is low, or, at least, is not broken by any elevation of considerable extent.

Character of country between the Bay of Chaleurs and the Upsalquitch River.

On the north side of the Restigouche the Silurian system has a much broader and more extended development. After passing the trappean ridges that form such prominent features from Campbellton almost to the Cascapedia River, the slates and limestones which form the bulk of the formation can be traversed across their strike for quite fifty miles, and it is evident from the direction of the several beds on the opposite shores that they extend directly under the waters of the bay. They have at no point any very great elevation, but after ascending the somewhat bold escarpment which fronts the shore they form a series of table lands from 1,000 to 1,200 feet high, frequently deeply furrowed by the numerous streams that intersect this portion of the province. Of these the principal flowing southward are the Patapedia, Metapedia, Scaumenac, Nouvelle, Great and Little Cascapedias, Bonaventure, Pabos and Grand Rivers. All of these, with the exception of the Pabos, have been examined, and in all, the rocks of this system are well developed.

Extent of the Silurian, north of the Bay of Chaleurs.

Enquiries as to the character of the country inland lead to the supposition that on the summit of these table lands, the soil is in many places well adapted for cultivation. It is to be feared however that, as in northern New Brunswick, their elevation is such that early frosts may materially affect the successful carrying on of agricultural pursuits.

Along the north side of the bay, Silurian rocks do not appear on the coast from the western terminus of the trappean ridge below Metapedia till we pass the mouth of the Little Cascapedia. Here, however, about one mile below the entrance of the river, they come out boldly upon the shore and form a cliff of moderate elevation for nearly two miles, or till they meet the intrusive traps of Black Cape. At their western exposure the rocks are limestones, hard and bluish, and contain, with a dip of S. 55° E. $<$ 40°, abundance of crinoids and

Contact of Silurian beds with the trap of Black Cape.

corals. In a fourth of a mile the dip changes to S. 40° W. $<$ 40°, evidence of the disturbing influence of the trap dykes in this vicinity being apparent in the partial altering of the limestone and the baking or hardening of the sandy beds. In the next half mile the dips vary considerably, but thence on to Black Cape they dip regularly S. 10° W. $<$ 45. Small patches of these rocks are observable in the mass of trap at this point as though they had been caught in its upward thrust. Portions of these Silurian rocks are exceedingly rich in fossils, corals, crinoids and brachiopods.

Black Cape to Cape Macquereau.

Below this to Shigawake Point, these rocks do not approach the shore with the exception of a small exposure at the town site of New Carlisle, where beds of red calcareo-arenaceous shale with a few thin bands of limestone are seen occupying the lower portion of the cliff in front, as well as the main road leading inland from the centre of the town, on which at a distance of one mile from the post road they are overlaid by Lower Carboniferous conglomerates dipping N. 15° E. $<$ 10°, the Silurian slates on the road having a dip of S. 50° E. $<$ 5°. At this place also they are cut by numerous dykes of trap, dolerite or diabase, which, spreading out, occupy a large portion of the town plot of Carlisle from the Catholic church east to the post office. At Shigawake Point, about 400 paces below the mouth of the river, sandy shales with calcareous beds come out in the lower part of a low bluff and extend for 750 paces, having a dip of S. 20° E. $<$ 60. At Cape Loup Marin similar beds appear, capped by Lower Carboniferous sediments, and thence extend almost without interruption to within two miles of Cape Macquereau or to Anse à la Vieille. At this point the contact of the Silurian with the metamorphic rocks of the cape can be well studied, the former dipping S. 30° W. $<$ 35°, while the latter dip N. 30° E. $<$ 85°-90°. A full description of the Silurian rocks along this portion of the coast is given in the Report by Sir William Logan, 1844, page 51-55, the details of which it is unnecessary to repeat here.

Port Daniel.

At Port Daniel and vicinity they do not extend very far inland. In the immediate neighborhood of the harbor, the most conspicuous members of the system are shown in the great cliffs of encrinite limestone which form the entrance. They are also seen to extend north-easterly in two or more parallel ridges from the upper part of the bay, one, the most northerly, keeping a few hundred yards to the east of the road that goes up along the side of the large lagoon; the strike of this ridge is north-east, the dip varying from S. to S.E. $<$ 50°-90°. On the east branch of the Port Daniel River the limestones are underlaid by beds of greenish-grey grits, dip S. $<$ 60°, which resemble very closely the bedsof the Nigadoo in New Brunswick, and which probably mark the lower strata of the Silurian or the upper portion of the Cambro-Silurian.

At the distance of 1,500 paces farther up stream, ledges of dark grey and black slates occur with a dip apparently unconformable to the underlying greenish grits just mentioned. These are doubtless the bituminous and graptolitic beds mentioned by Sir W. E. Logan as occurring in the middle branch and mark the limit of the Silurian in this direction. It is probable, however, that the grey and brown grits mentioned as overlying the black slates may be, as stated, above the upper beds of the Cambro-Silurian, in which case the black graptolitic slates of the Port Daniel River would be the probable equivalents of the graptolitic slates of the Tête à Gauche at the railroad bridge and referred to in the preceding report as of presumably Hudson River age.

Graptolitic slates of Port Daniel.

D.—Cambro-Silurian.

The rocks of this system in the Gaspé peninsula have in preceding maps and reports been distinguished under the general heading of the Quebec group. During the past season the examinations of them were principally carried on in the vicinity of Cape Macquereau and thence eastward to Grand Pabos post office. In addition, a brief excursion was made on the Dungarvon and Renous Rivers, tributaries of the Main South-West Miramichi, where the breadth of this system was ascertained and the eastern limit of the central granitic axis fixed. The results of this exploration will be shown on the map sheets illustrating the geology of the eastern portion of the province of New Brunswick.

Explorations over this system.

In the vicinity of Cape Macquereau two sets of rocks are apparently developed, one of these has already been mentioned as occurring on the streams that flow into the head of the Port Daniel lagoon and has been referred to this system, as it evidently underlies the basal beds of the Silurian seen there. The other set is much more highly metamorphic and in addition has a different strike. It will be described under the heading Pre-Cambrian, in which system it has been provisionally placed.

Two sets of beds at Cape Macquereau.

The rocks which it is now proposed to classify as Cambro-Silurian have been described by Sir Wm. Logan, report 1844. They do not appear on the shore west of the Cape Macquereau lighthouse, but on the coast to the east, about two miles from the end of the cape, a series of beds distinct to a large extent, both in lithological character and stratigraphical position, from the more crystalline strata of the cape, are seen. In the vicinity of the Mahy Islands, where these Cambro-Silurian rocks are first well observed, they dip S. 20° E. $<$ 55° along the shore, the dip on the Islands being more easterly, or E. 10° S. $<$ 40°. The metamorphic rocks of the Cape, however, have a quite regular strike of W. 30° N., with dips of 75° to 90°.

East from the Mahy Islands to Grand Pabos the rocks consist largely of felspathic slates, brown and ochreous, dark green, splintery slates and shales with calcite, and brown and grey sandy schists. In addition, thin beds of purple and grey slates are found, with green chloritic and epidotic rocks. A few beds, slightly talcose, occur, but the great bulk of these sediments seem to belong to a newer series, being much less crystalline in character and much more sandy than the metamorphic rocks in the vicinity of the lighthouse.

Characters of the two sets distinct.

The apparent want of conformity mentioned as occurring along the shore is also evident on the East Branch of the Port Daniel River, where the black slates and associated beds, though a good deal disturbed, appear to strike almost at right angles to the felspathic gneisses which occur farther up the stream and which we have connected with the crystalline felsites of the cape. They are therefore for these various reasons provisionally divided into two series, though the exposures in this locality are not of sufficient extent to as yet warrant their complete separation.

Development on the branches of the South-West Miramichi.

In the province of New Brunswick, the explorations on this system were confined to the Dungarvon and Renous Rivers, the latter a branch of the Main South-West Miramichi. On the former the first exposures of Cambro-Silurian were seen after passing the Carboniferous sandstones about two miles below King Brook, a small branch from the south, where hard green chloritic slates with softer bands occur, dip S. 10° E. $< 65°$. These resemble the beds seen farther north on the Nigadoo and elsewhere. Above this the band of black irony slates which forms so marked a feature in this group, is met with, dip S. 20° E. $< 50°$, associated with green grits. Further up, above the mouth of the Little Dungarvon, purple quartzites similar to those observed last year on the Main South West were seen, and these continue up to the contact with the granite near the mouth of McConnell Brook.

Above the Upper Falls on this stream the granites, which are of the usual coarse red variety of the interior, are associated with bands of gneissoid rock; but the exposures are too limited to enable us to separate the two series. Passing to the Renous River, rocks of this system were first met with about a mile and a half below the mouth of the Little South Branch. Thence to the Upper Falls no granite was seen in situ, although some granitic debris was observed on the portage road up the river. It is not probable, however, that the granite appears in mass on the stream below the Upper Falls, but crosses above and sweeps round by the head of the river northward to the Little South-West Miramichi.

The principal rocks of Cambro-Silurian age, on the Renous, are bluish grey and purple slates, with softer gritty and slaty quartzose rocks in its upper part, dipping S. 25° E. < 60°, in which respect they resemble the beds seen on the Dungarvon to the south.

A. B.—Pre-Cambrian.

The general distribution of this system has been given in preceding reports, and the only additional areas which are now classed under this head are the rocks of Cape Macquereau and Port Daniel River. As developed on the upper part of this stream, they consist principally of hard rubbly felspathic and micaceous gneissic rock with quartzose micaceous, talcose and chloritic schists. They are, as already stated, quite distinct lithologically and stratigraphically from the black slate (Cambro-Silurian) series of the river; the strike of the latter being south-west, while the older series strike north-west.

As first seen along the shore, about a mile and a half to two miles west of Cape Macquereau, these Pre-Cambrian rocks are directly overlaid by Silurian strata. They consist of hard dark reddish felspathic schist, including some thin bands of talcose schist. Some of the micaceous schists hold disseminated grains of clear quartz. About the end of the cape the rocks are hard grey quartzites with crystalline felspathic and talco-chloritic schists. They have a strike N. 60° W. and dip at angles of 75° to 90°, and they unconformably underlie the softer brown and grey sandy beds seen along the coast farther east. As a series they very closely resemble portions of the recognized Pre-Cambrian rocks of southern New Brunswick. Cape Macquereau.

The evidence at present at our disposal, therefore, shows that a marked difference exists between the two groups that make up the area known as the Quebec group at this point. The lowest portion, however, at and in the vicinity of Cape Macquereau, may not be older than the basal part of the Cambrian, but from resemblance to Pre-Cambrian beds in New Brunswick and the lack of typical Cambrian such as is there recognized, it has been deemed best for the present at least to separate the older portion under the heading Pre-Cambrian, and it has therefore been provisionally assigned to that system.

Eruptive and Irruptive Rocks.

The general distribution of these rocks in northern New Brunswick and about the lower Restigouche was given in last report. During the past season their distribution along the north side of the Bay of Chaleurs was more particularly noted. In this area the dolerites or diabases extend in an apparently unbroken belt from their first outcrop about four miles below the mouth of the Metapedia to the Nouvelle near the upper bridge, where they are in contact with fossiliferous Distribution north of Bay of Chaleurs.

Silurian strata. They form prominent features in the landscape, various peaks rising from 1,000 to 1,700 feet above sea level. At the Nouvelle they are cut off by the river, but almost immediately reappear on the eastern side, though in much diminished bulk, and extend along the north side of this stream to a point opposite its mouth, keeping at a distance of one-fourth to a mile to the north. Another break occurs here, but similar doleritic rocks appear again after an interval of several miles, forming a ridge of about six miles in length, in which the peak of Tracadigash, or Carleton Mountain, is the most prominent point, having an elevation of some 1,700 feet.

The valley of Green Brook makes another break here, after which the trappean hills rise again into a lofty ridge of about four miles in length, and reach to within a short distance of the Irish settlement road. The most easterly spur of this range comes in on the road up the west side of the Cascapedia and extends to the river bank; to the eastward of which, with the exception of Black Cape and the trap dykes of New Carlisle, these rocks have not been seen.

Relation of traps to the Silurian and Devonian rocks

The outline of these trappean hills is generally parallel to the shore. The age of the igneous rock is very clearly defined by its stratigraphical relations to the Devonian and Silurian beds with which it is in contact. Wherever found with the latter, it cuts them or occurs as interbedded sheets, whereas the Devonian beds which are in contact with it are, *as a rule*, not cut through or broken up by it, although some of the lower members are highly inclined at detached points, but probably from other causes. Minor periods of igneous activity have however occurred, during the deposition of the Devonian, as is evidenced by the occurrence of occasional thin sheets of trap along the bedding planes, as well as by that of beds of trap conglomerates which are found closely associated with the lower members of the system. The presence also of the Devonian fishes of Campbellton, characteristic of the basal part of this system in the brecciated rocks of that locality, shows that at this time there were disturbances of this nature. The upper part of the Devonian, however—viz., the fish-bearing beds of Scaumenac Bay—shows no evidence of igneous disturbance; but the basal beds of this portion frequently contain pebbles of trap in their conglomerates, while the beds dip generally at low angles of 10°-20°. At Point à la Garde, also, the Devonian beds are seen to form a low anticlinal over a spur from the trappean hills, the basal beds of which consist of trap conglomerates, the pebbles being rounded masses of trap cemented by trappean matter, and at other points these beds conform to the general outline of the various spurs and depressions that exist along the north side of the lower Restigouche.

At Black Cape also the trappean rocks are seen to have burst through

This Pillar was destroyed twenty years ago by Men-of-War using it as a target.

A. Mortimer, Lith., Ottawa

Sketched in 1844 by Sir W. Logan. A. H. Foord, del.

PILLAR OF TRAP. (*Dolerite.*)

Bon Ami Cape. Bay of Chaleurs.

the Silurian beds and hold pieces of the latter in their mass. The lower beds of the Devonian, on the other hand, in addition to large masses of fossiliferous Silurian limestone, include fragments of trap and are thus evidently of later origin than the latter. Black Cape.

At New Carlisle also the Silurian shales and calcareous bands are cut by frequent dykes, generally of small size, which spread out and occupy a large portion of the town site. Here the Devonian beds are wanting. New Carlisle.

On the New Brunswick side, the traps of the Bay of Chaleurs were still further traced south of Dalhousie, along the Benjamin, Louison, and Charlo Rivers. They were here found to have a breadth of from eight to ten miles, and to contain in places narrow wedge-shaped basins of Silurian slates, limestones and conglomerates. The dark brown felsite conglomerate, described in report 1879-80, page 20D, is an apparently well stratified rock in places, and though frequently intersected by or interstratified with beds or dykes of trap, has been for the present classed as of Silurian age.

The western limit of these trappean masses towards the Upsalquitch has not yet been definitely determined owing to the impracticable character of the country, and the connection of the large area on the Charlo and Louison Rivers with the quite extensive outcrops seen on the Upsalquitch above the forks of that stream has not been traced, the country intervening being generally low and swampy.

The somewhat extensive development of the trappean rocks, as will be seen by the map, greatly reduces the breadth and area of the Silurian beds, which strike across from the Upsalquitch to the Bay of Chaleurs. This reduction has been effected in places, probably by the folding and crumpling of the various members of the Silurian in their vicinity, the evidences of which are visible in the frequent exposures along the shore of the bay as well as on the Upsalquitch River, where sharp folds occur at short intervals. The general breadth of the trappean masses on the lower Restigouche is from eight to ten miles. This taken with the breadth of the Charlo area, which is about the same, and the areas further south in the vicinity of Belledune and Elmtree, would give a total width for these igneous rocks of not less than twenty-four miles. Area of trappean rocks about the upper part of the Bay of Chaleurs.

As might be expected, the presence of such a bulk of rocks of this nature has had a marked influence on the character of the country, the surface of which is in general rough and the soil poor and scanty; and these facts doubtless account for the sparsely settled condition of this portion of the province. Where the surface is underlaid by the calcareous and argillaceous Silurian rocks, however, the soil is excellent and the settlements are therefore, as a rule, confined to such areas. Character of soil.

Surface Geology, Soil, &c.

The general superficial features of much of the country to which the present report and accompanying map relate have already been described in former reports. It is not, therefore, deemed advisable or necessary to describe them here. In the area more particularly examined last year, especially in the county of Kent and on the south side of the Bay of Chaleurs, rock exposures are not numerous. In the former area the surface is largely covered by sandy or clayey deposits, as the underlying rock happens to be a grey sandstone or reddish shale. At several points, where the rock has been laid bare, glacial striæ are seen. These, near Weldford station, according to Mr. Dunn of that place, run north and south. For the character of the soil see p. 4 D.

Soil in Kent Co.

In the portion lying along the north side of the Bay of Chaleurs, drift deposits are abundant. At many points high banks of well stratified gravels, sands and marine clays are seen, some of which, in the vicinity of Maria Capes, have a height of fifty to seventy feet. Farther down, below the Cascapedia and the Bonaventure Rivers, the shores are often lined by marine clays of considerable thickness, holding abundance of shells of the usual types, already mentioned in former reports. Local deposits of shell marl exist in many of the lakes lying at the foot of the hills back of the towns of New Carlisle and Paspebiac, (these are mentioned in the Geological Survey Report, Logan, 1844,) as well as in beds of lakes on back concession roads in New Richmond. In the Irish Settlement, west of the Cascapedia, several lakes occur, known locally as the Blue Lakes, from their peculiar color. The blue tint is supposed by the settlers in that vicinity to be due to some peculiarity of the water, which, however, on examination, was found not to be the case, as it is singularly clear, but to the bottom of the lakes being occupied by a greyish or bluish-grey marl or clay. The soil of much of this area is of excellent quality. It is underlaid by Lower Carboniferous and Silurian rocks. The belt of level land is, however, narrow; the bold escarpment of the Silurian and trappean hills rising at a distance of half a mile to three miles from the shore. Doubtless, much good land will be found on the summit levels, which are said to be very extensive. In our exploration of the Dungarvon and Renous Rivers several ridges of fine land were crossed, lying on rocks of Cambro-Silurian age; and it may be generally stated that on this system between the Main South-West and the North-West Miramichi Rivers a belt of country with a soil admirably adapted for settlement exists. These ridges were met with between the Bartholomew and Dungarvon Rivers in the vicinity of the portage road from Doaktown; also between the Dungarvon and Renous; and between the two branches of the latter river, about the head of Moneghan

Marine clays of Bay of Chaleurs

Blue Lakes.

Fine ridges of land in Eastern New Brunswick

Brook. Further north fine ridges were seen between the North-West Miramichi and the north branch of the Sevogle, as well as between the branches of the latter stream. These ridges are generally covered with a good growth of rock maple, yellow birch, beech and other hard woods, often of large size. The soil is frequently a rich black loam, apparently of considerable depth and admirably suited for cultivation. Farther inland, about the heads of these streams, the country becomes rougher, and the soil diminishes in depth and richness. At present, however, the generally inaccessible condition of this area renders it practically useless, but upon the construction of roads along the valleys of the various streams areas will be opened up which will doubtless be of great value for settlement.

Hard wood forests.

Economic Minerals.

Coal.—Although indications of coal are found at various points, and mining it has been attempted at different times, the work so far has not been attended with much success. During the past season examinations were made over a large part of the Carboniferous basin in the hope of finding seams of paying size, but so far without having our hopes realized; and it is to be feared that in the eastern as in the central and western portions of the Carboniferous basin, thicker and workable beds of coal do not exist. It is probable that the great bulk of the middle Carboniferous sediments of the province are confined to its lower portion, or are of Millstone Grit age, which, while it sometimes produces workable seams, as a rule does not yield coal in quantity sufficient to be of great economic value. The Carboniferous basin of New Brunswick has now been pretty thoroughly examined, and borings at different points have been made to determine the existence of lower and thicker seams, but without success.

Middle Carboniferous of Eastern New Brunswick.

Probably Millstone Grit.

Among the outcrops to which reference has been made, the most extensive in the eastern portion of the province occur in Kent county. The thickest, however, do not exceed eighteen inches, which, considering the poor quality, is not of sufficient size to be worked profitably. This locality is on the Coal Branch, a tributary of the Richibucto River, above Foord's mill, and about six miles from the Coal Branch station, on the Intercolonial railway. Other outcrops which may be of the same seam are seen at different points, the principal of which are described—see page 5 D.

Coal seams in Kent County.

Argentiferous Galena.—The deposit mentioned on p. 45D, report of 1879-80, as occurring on the Nigadoo River, has since been opened to a considerable depth, but has not as yet fulfilled the expectations of the proprietors of the mine. An analysis of the ore has been made in the

Nigadoo and Elm Tree Rivers.

laboratory of the Survey from samples that fairly represented its quality, with a result of rather more than five ounces of silver to the ton. This percentage may vary slightly either way. Another locality since opened up is on the Elm Tree River, about four miles from the mouth. The country rock at these localities is a hard metamorphic slate. The vein at the latter place is much better defined than on the Nigadoo, and has a width of from six to seven feet, often brecciated and porphyritic, carrying galena, blende, iron pyrites and sulphuret of copper, associated with quartz and calcite. The rocks are a good deal broken up, and the metamorphism may be largely due to the local intrusions of trap rocks, which form such extensive ridges in this area. Sufficient work has not yet been done to determine the actual value of the mine, a shaft having been but lately started.

Argentiferous galena.

As the strike of the rocks at the Nigadoo mine would run directly to the Elm Tree, it is possible that the two may be portions of one vein much broken up, the character of the country rock being similar as well as the quality of the ore. These deposits occur in rocks very near the base of the Silurian system, possibly transition rocks between the latter and the Cambro-Silurian. The locality on the Elm Tree River is to be developed at the first opportunity, and, it is to be hoped, with satisfactory results, as it is probable the opening of other similar mines in this area will depend largely upon the success met with in this case. An analysis of the ore from the Elm Tree mine, made in the laboratory of the Survey, gave a little over seven ounces of silver to the ton.

Analysis of silver ore.

Gold.—Nothing further has been discovered under this heading, with the exception that on one of the branches of the Miramichi a small piece of gold-bearing quartz is said to have been found fixed in the end of a saw log which had come down the stream, in which case it might have been knocked off some one of the many quartz veins that intersect the slates and schists of the upper portions of these streams. The locality is not definitely known, but it goes to establish the probable occurrence of gold in small quantities in this portion of the province. Persistent and long-continued search has, however, up to the present failed to find gold-bearing quartz veins, in so far as we have been able to ascertain.

Gold quartz of Little South-West Miramichi.

Apatite.—Apatite in quantity sufficient to be profitably worked was reported to occur in the trap rocks of Black Cape, New Richmond. The locality was visited and specimens obtained, of which an assay was made by Mr. Hoffmann. The result, however, was very unsatisfactory, the amount of tribasic phosphate of lime being only about the half of one per cent.

Black Cape.

Copper Ore.—Towards the close of the season a few days were spent in the examination of the ore deposits of Westmorland and Albert counties. Of these the former is especially interesting, in view of its occurrence in Carboniferous sediments. The locality is about two miles north of Dorchester, and the ore is found in the basal portion of the Millstone Grit, or very near its contact with the red marls of the Lower Carboniferous. The ore is found both as carbonate, frequently cementing the pebbles and filling the paste of the grey quartzose conglomerate, which forms the base of the Millstone Grit, and also as grey copper ore or glance, which occurs apparently in pockets in the overlying or gritty beds. As might be expected, the carbonate appears to be most plentiful in the vicinity of plant remains, the organic matter of which has undoubtedly precipitated the copper from solution. In the various openings which have been made for nearly two miles along the face of the escarpment that runs north from Dorchester Corners, the ore is seen in lenticular masses varying in thickness from a few inches to several feet, and should it prove to be continuous on the dip to any extent, would be of great value, as the quality of the ore is good and the mine very easy to work, both from the nature of the rock and the facilities for drainage. The rocks, sandstones and conglomerates dip uniformly S. 5° 10° E. < 35. Active operations were commenced at this locality in the fall of 1881, but are now suspended, pending new arrangements by the company. The occurrence of copper ore in this formation is quite common, but the quantity is generally too limited to be profitably worked. Dorchester copper mine.

The only other deposit of copper ore known in this area is that seen on the Beech Hill road, about a mile and a half east of Memramcook Corner, where the ore is associated with purple fluor spar and baryta; the whole forming a vein of two to six feet wide, and extending for several hundred feet. The quantity of ore is very limited, and the baryta is too impure to be of any great economic value. Operations carried on formerly at this locality have long since been abandoned. Memramcook copper and baryta mine.

A second deposit of copper ore was examined in Albert county. It occurs on a small branch of the Upper Salmon River, about two miles west of the road leading from Hillside P. O. to the New Ireland road, and about eight miles south of Elgin Corner. The location is known locally as the Goodfellow Mine, and consists of a vein which is tolerably well defined, carrying copper sulphuret with a little peacock ore and carbonate, with iron pyrites in a quartz and calcite gangue, mostly the latter, and situated in the talco felspathic and chloritic schist of Pre-Cambrian age. The breadth of the lead is from fifteen to twenty-five feet, and it has a direction nearly east and west. The quantity of sulphuret of copper in some portions is considerable, but sufficient work Albert County copper mine.

has not yet been done to determine its true value. Another deposit, similar in character, in rock of the same kind occurs on the head waters of the Coverdale, about five miles north-easterly, but this also has not been sufficiently opened to ascertain its value.

GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

REPORT

ON THE

GEOLOGICAL FORMATIONS

IN THE

GASPE PENINSULA

1882

BY

R. W. ELLS, M.A.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

Montreal:

DAWSON BROTHERS.

1883

ALFRED R. C. SELWYN, ESQ., LL.D., F.R.S., &c.,

Director of the Geological and Natural History Survey.

SIR,

The accompanying report on the Geology of the Gaspé peninsula, in continuation of the work of the past season, is herewith submitted. The examinations were for the most part confined to the vicinity of the coast, but several excursions inland were also made, principally on the Rivers flowing into Gaspé Bay. My assistants during the past season were Messrs. A. P. Low, T. D. Peers and H. P. Brumell, the two former of whom had been with me during the previous year. In addition to the geological investigations, a large amount of topographical work was done, including a chained survey of the post road from Little Pabos to Gaspé Basin and thence along the south shore of the River St. Lawrence to Grand Metis, whence connections were made with the Intercolonial railway at Little Metis and Sayabec stations. The back concession roads and others connecting with the shore, as also the entire coast-line were measured by pacing and the various rock exposures carefully examined.

Our thanks are especially due to Mr. Joseph Eden, Harbor Master of Gaspé, to Messrs. J. and E. Collas, and to H. Bouthillier, Esq., for various favors.

Many new facts were obtained in regard to the distribution of the several formations, more especially affecting the Lower Carboniferous and Devonian, and the relations of the various members of the so-called Quebec group, to which particular attention was directed, have been, we trust, more clearly defined.

I have the honor to be,

Sir,

Your obedient servant,

R. W. ELLS.

Ottawa, May, 1883.

REPORT

ON THE GEOLOGY OF THE

GASPE PENINSULA,

1882.

BY

R. W. ELLS, M.A.

The Geological systems and formations described in this report are :—

G.—CARBONIFEROUS. 1. LOWER.		(Bonaventure.)
F.—DEVONIAN.		(Gaspé sandstone series.)
E.—SILURIAN.		(Gaspé limestone series.)
D.—CAMBRO-SILURIAN.	}	(Quebec group.)
C.—CAMBRIAN.	}	
IGNEOUS ROCKS.		

G.—CARBONIFEROUS.

Distribution of of Lower Carboniferous rocks.

1.—*Lower Carboniferous.*—In the report for last year it was stated that the rocks of the Quebec group (Cambrian and Cambro-Silurian) were concealed at a distance of a mile and a half east of Grand Pabos bar and just west of the Grand Pabos, P.Q. At this place the Lower Carboniferous beds, which have been wanting for about seventeen miles, are again developed in considerable force, and consist of nearly horizontal, soft, red sandstones and conglomerates of the usual type. These extend eastward, and at the Little Pabos River have a breadth of about two miles and a half, resting upon fossiliferous Silurian slates and limestones. Thence they cross the river and form a continuous area along the shore to near the Grand River, where on the road up the west side, at a distance of three-fourths of a mile from the mouth, they are again seen to overlap the slates. The Silurian strata then occupy both banks and form cliffs of considerable height. Between the Grand River and Breche â Manon Brook, another Carboniferous area of small extent is found, the Silurian strata coming out to the shore again at the latter stream; but from Breche â Manon eastward the rocks under consideration extend uninterruptedly to White Head at the west side of Percé Harbor. The northern boundary cannot be traced continuously, but at various places on the back concession road, the junction with the Silurian, and further east with the Devonian on the Branpits Brook and at other points between that brook and Percé village, can be easily perceived, and clearly indicates that inland the Lower Carboniferous has a very limited development. At several points along this part of the coast it is seen to rest unconformably upon the Silurian or Devonian strata, which occupy the beach and form the lower part of the cliffs. Notable examples of this occur in the vicinity of Breche â Manon and at White Head, at which latter place slates and limestones come out to the shore and occupy the entire headland for several hundred yards. East of this point another small patch of these rocks rests upon Devonian strata and extends back from the shore for about half a mile, but a larger and much more important area is that of the Percé Mountain, where the red sandstone and conglomerates described by Sir W. E. Logan (Report, 1844) are seen to constitute the upper part of that elevation and to rest upon another set of conglomerates somewhat similar in character, but unconformable in position, and presumably belonging to a lower horizon.

Unconformable junction with Silurian and Devonian.

The only other deposit of this age, observed by us on the mainland, is found on the north side of Mal Bay, extending for a distance of a mile and a half up the Mal Bay River, where, as at Percé, they are seen to rest unconformably upon Devonian beds. The same relative position is seen to the east, at Grand Briant Brook, where the lower beds terminate. They extend about one mile and a quarter inland, where they rest upon reddish beds, presumably of the Gaspé sandstone series.

Mal Bay and Grand Briant Brook.

The surface of Bonaventure Island, three miles southeast of Percé, is also occupied by Lower Carboniferous rocks, and the name given to the formation by Sir W. Logan, was derived from it. In the cliffs at the northeast end of the island, conglomerates are seen like those which form the base of Percé Mountain. They are undoubtedly connected with these beneath the intervening water, and they hold a similar unconformable relation to the beds which rest on them.

Changes in the distribution as described 1866.

It will be seen from the foregoing and by reference to the Geological Map (1866), that important changes have been made in the described distribution of the Lower Carboniferous of this area. These changes have been based on lithological and stratigraphical evidence, which shews that much of the conglomerate formerly styled Bonaventure, underlies unconformably the typical Bonaventure beds, while in its composition it exactly resembles the Devonian conglomerate of the upper part of the Bay of Chaleurs, which was also formerly regarded as of this age, but which is now, from the discovery of distinctive Devonian fossils in interstratified beds, plainly recognized as belonging to a lower horizon.

The characteristics of the rocks of the Bonaventure formation have been fully described in former reports, and the changes referred to in the distribution will be shewn on the maps now being prepared.

F.—Devonian.

The Gaspé series as described in former reports.

In former reports of the Geological Survey, on the Gaspé peninsula (1844–1857 and 1863), the rocks which we now propose to discuss under the head of Devonian, were described as the Gaspé series, and divided into two groups, the Gaspé sandstones and the Gaspé limestones; the former of which were considered to be of Devonian age, while the latter were assigned to the horizon of the Lower Helderberg. It is evident, however, that a portion of the latter can, on palæontological grounds, be now included in the Devonian also (see Vol. II., Part I., Pal. Fossils), while, in the upper part of the system, we propose to include a considerable thickness of conglomerates, which in former years were regarded as a part of the Bonaventure or Lower Carboniferous formation. The reasons for this change are founded, as already stated, on both lithological and stratigraphical evidence.

The most easterly exposures of Devonian rocks described in my last report (1881), are in the vicinity of Black Cape, New Richmond. Below this point, if they exist at all along the north side of the Bay of Chaleurs, they are concealed from view by the nearly horizontal beds of the Lower Carboniferous. A small outcrop of sandstone and conglomerates of Devonian aspect was, however, noted by Mr. Lord, on the Bonaventure River, as occurring between the Lower Carboniferous and Silurian rocks, which would tend to shew that, for a part of the distance at least, Devonian sediments had been deposited in this direction.

Upper beds of the Devonian rear of Cape Cove.

As we approach Percé, we find on the back concession road, in rear of Cape Cove, in the beds of several of the brooks which have cut channels of considerable depth, ledges of hard grey and brown quartzose sandstone in a nearly horizontal position, which doubtless belong to the upper portion of this system, and it is very probable that in the rear of Percé and about the heads of the streams which flow into Mal Bay, these rocks have a considerable development, the newer measures being confined to a narrow strip of from one to two miles in width along the shore.

In the Irishtown settlement, about two miles and a half west of the junction of the back concession road with the post road, near the village of Percé, the Devonian rocks are seen to approach nearer the coast. High hills of conglomerate, with beds of hard grey and brown sandstone, are observed in close contact with the soft red beds of the Carboniferous, while the numerous springs which are seen to issue from the side of the hill for a distance of over a mile along the road, indicate the line of junction between the two formations. The marked difference also in the aspect of the two sets of beds, serves easily to define them. The older conglomerates are the same as those which form the basal portion of Percé Mountain, and those about the upper part of the Barachois of Mal Bay, and which underlie the Bonaventure, developed about the mouth of that River and along the coast to Grand Briant Brook, and have been already briefly alluded to in our remarks on the Lower Carboniferous.

Two sets of Conglomerates different in aspect.

Percé Mountain.

On the road from Percé to Mal Bay, which passes over the western spur of the mountain, the rocks of this system are seen in considerable variety. The conglomerates just described, which we have now assigned to its upper portion, are continuously exposed to the point where the road suddenly turns down the northern flank, and the line of contact or overlap of the Bonaventure, is seen about two hundred yards to the right, in a depression down which flows a small brook to Percé Harbor. At the highest part of the road, large ledges containing abundance of limestone pebbles, which hold fossils of Silurian age, dip N. 55°. E. <30°. Descending the mountain to the north, outcrops of grey fossiliferous limestone and shale are noted, which are probably the continuation under the mountain of the beds seen at Mount Joli, presently to be described. Further north, towards Mal Bay, the road is strewed for some distance with blocks of grey Devonian sandstone, and grey and black sandy shales, which belong to the first beds seen on the shore section south of Mal Bay beach, and which unconformably overlie the calcareous slates, limestones and sandstones of Percé rock and the Blowhole cliffs. The last exposures seen on the road to the south of the beach, are fine reddish brown conglomerates, which dip N. 20°. E. < 80°.

Three series of Devonian strata.

It would appear, therefore, that in this limited area we have three sets of Devonian strata exposed: the upper, consisting principally of conglomerates, with interstratified beds of sandstone; the middle, of sandstones and shales, with some conglomerate beds; and a lower, largely calcareous, and containing considerable beds of limestone. The relations of these we will now consider.

Crossing the Barachois of Mal Bay, we find a considerable area of conglomerates, developed along its north side and extending eastward to Point St. Peter, a portion of which have already been described under the head of Lower Carboniferous. The lower beds first come into view on the road up the north side of the Mal Bay River, about one mile and a half west of the ferry, and consist of hard brownish-grey and grey conglomerates and sandstones, the former containing abundance of pebbles of limestone, jasper, white and yellow quartz and felspar. They are undoubtedly the equivalents of those which form the lower part of the Percé Mountain, towards which they dip in a direction S. 35°–75°. E. < 5°–10°. These in turn overlie the sandstones and shales of the Gaspé series proper, which are developed on Mal Bay River for several miles, and form a basin of considerable extent, bounded on the south by the Percé anticlinal. Eastward, towards Point St. Peter, these rocks are first met in a small cove, just beyond where the road strikes across the peninsula to Anse à Brillaut, whence they continue to the end of the Point, and occupy its entire extremity as far west as Point Jaune on the north shore. These beds are described in the Report of 1844, under the head of Limestone Conglomerate, and a detailed section is given in the appendix to that report, pp. 80–82, in which the thickness, as exhibited along the coast, is stated at 2766 feet. Estimated thickness in the report of 1844.

It will be seen by reference to this section, that a marked similarity exists to many of the beds which constitute the upper portion of the Gaspé sandstone series, though the latter lacks the heavy beds of conglomerate, which form an important feature of the series under consideration.

The dip of the strata, on the north side of Point St. Peter, is constant in direction, being S. 85°. E. < 10°–20°.; and at its extremity they pass under a small island lying half a mile distant, and which probably marks the contact with the Bonaventure formation. If we suppose the space between the mainland and this island to be occupied by the conglomerates under discussion, we may add a further thickness of 250 to 300 feet to that already given for the shore section. This would give for the upper member of the Devonian, an entire thickness of about 3,000 feet. Several faults, however, of greater or less extent, render accurate measurements very difficult. Thickness of the upper members of the Devonian.

The middle portion of the Devonian, known here as the Gaspé sandstone series, has a much greater development, and comprises the bulk of the sediments which belong to this system. It is distinct in lithological characters from the series just described, in having a great preponderance of grey sandstones and shales, as well as an abundance of contained fossil plants. The descriptions of the various members of the series are given in the Geology of Canada, 1863 (pp. 394–96), and elaborate sections, with detailed measurements, are contained in the Report of Progress for 1844. From these, their entire thickness is estimated at 7,036 feet. They occupy the whole area of Gaspé Bay, from the contact with the limestone series, on the north side, at Little Gaspé, to the overlap of the upper conglomerates at Point Jaune, on the south shore, about two miles and a half west of Point St. Peter. Here the two series are brought into contact by a fault, the extent of which cannot be accurately estimated, but judging from the character of the beds on either side, it cannot be very great.

Faults.

Most southerly exposures of the Gaspé sandstones.

The most southerly exposures of the Gaspé sandstones are seen on the coast between Percé and Mal Bay. About half way between these two points, grey and brown sandstones, fine conglomerates and soft red and grey shales, the coarser beds containing abundance of plant stems, often of large size, with the bark turned to coal, are seen in unconformable contact with grey calcareous shales and limestones of a lower series, on the one hand, and with the hard, dark red conglomerates just described, on the other. These are undoubtedly the equivalents of the upper part of this series, as seen on the south side of Gaspé Bay, and have a quite regular dip of N. 20°–30°. E. $<$ 60°–70°. An anticlinal structure is evident along this part of the coast, by which the lower or Gaspé limestone series is brought to the surface, since on the post-road, a short distance inland, grey shales and limestones are seen to dip S. 25° W. $<$ 40°. The exposures of the sandstones and associated beds terminate on the shore just before reaching the Mal Bay River, about three miles from its mouth; the intervening area being occupied by the alluvial island and the waters of the Barachois.

The rocks of the series have a considerable development on the several rivers that flow into Gaspé Bay, where they lie in shallow basins, bounded by the anticlinals, which bring into view the strata of the lower or Gaspé limestone series. These basins are at least four in number, the dividing anticlinals being known as the Hildemand, the Tar Point, the Point St. Peter, and the Percé, the most southerly yet recognized. On the south side they rest upon rocks of the Silurian system. The whole formation may therefore be said to occupy a geosynclinal basin the western limit of which has not yet been traced, but which will probably be found to be continuous with the basin recognized on the Cascapedia River and thence extending to the Metapedia. Further explorations about the head waters of the York and Bonaventure Rivers will be necessary to determine this point.

Four basins with intervening anticlinals.

Fossil plants.

As already stated, this series is distinguished from the lower by the abundance of plant remains, among which, from various places around Gaspé Bay, the following have been determined by Dr. J. W. Dawson :—

Prototaxites Logani.

Lepidodendron Gaspeanum.

Lepidophloios antiquus.
Leptophleum rhombicum.
Psilophyton princeps.
" *robustius.*
" *elegans.*
" *glabrum.*
Nematoxylon crassum.
" *tenue.*
Stigmaria areolata.
" *minutissima.*
Didymophyllum reniforme.
Calamites inornatus.
Annularia laxa.
Arthrostigma gracile.
Cyclostigma densifolium.
Cordaites angustifolia.

Such full descriptions of this formation have already been given in the Geology of Canada, 1863, pp. 394 to 404, and pp. 880-86, as well as in other earlier reports, that further descriptions here are considered unnecessary. Descriptions in the Geology of Canada, 1863.

The lower division of the Gaspé rocks in the reports previous to 1872 was styled the Gaspé limestone series and assigned to the horizon of the Lower Helderberg or upper part of the Silurian system. In Vol. II., Part I., Palæozoic Fossils, however, published in that year, the strata which composed the series were divided into eight parts, the entire thickness being estimated at 2,010 feet, of which the two lower members, representing a thickness of 160 feet, were stated to be probably Silurian, while the two upper members, aggregating 800 feet, were Devonian about the horizon of the Oriskany. The remainder, or 1,050 feet, were considered to constitute transition beds. During the past season, however, a considerable collection of fossils was made on the upper part of the Griffin Cove River, at the peaks of the Ruisseau de la grand Carrière and for a short distance below. The strata here are very near the contact with the rocks of the Quebec group, and the fossils are from the lower division of the limestone series. Among them Mr. Ami, of the Palæontological department of the Survey, has recognized :— Gaspé limestone series.

Zaphrentis cingulosa.
Strophomena punctulifera.
" *inequiradiata.*
" *perplana.*
Orthis aurelia (?).

Atrypa reticularis.
Athyris (Merista) arcuata.
Lingula Lucretia.
Spirifera cycloptera.
Pleronitella (allied to *P. venusta*).
Orthoceras. Sp. undet.
Illoenus (*pygidium*).
Dalmanites Anchiops.

Exposure near Percé.

The first exposures of the rocks of this series are found in the vicinity of Percé. They probably constitute White Head, to the west of Percé Harbor, where they unconformably underlie both the Lower Carboniferous and the Upper Devonian conglomerates, though the paucity of organic remains leaves the exact age of the strata at this point somewhat uncertain. But at Mount Joli and along the shore north, for some distance, they are well seen in the high cliffs that form the Murailles and Barry Cape. They also form the detached mass known as Percé Rock. Inland they were recognized on the post road to Mal Bay, after descending the Mountain. In places along this part of the coast these strata are brought into view through the wearing away by the action of the sea, of the overlying sandstone series just described. The rocks thus exposed consist of grey calcareous shales, slates and sandstones, with bands of hard quartzose rock and reddish and grey limestones, the latter often veined with calcite. Though much disturbed in places, these strata have generally nearly vertical positions. They dip on the seaward side N. 20° E. < 60°-90°, and along the road S. 25° W. < 40°, showing clearly the presence of an anticlinal by which these lower strata are brought into view. This anticline is also well marked at several points along the coast, as well as at Mount Joli, where its extension carries it seaward to Percé Rock, separated from the mainland by several hundred yards. This rock received its name from the fact of its being pierced or perforated by two holes, doubtless worn in the strata by the restless surge which comes in with terrific force at this place during an easterly gale. The arch of the outer wall fell in 1847. The Rock consists principally of hard brownish-red limestone with some shales and fine conglomerates in a nearly vertical position, and resembling in character the beds seen along the coast towards the great Blow-hole. They abound in fossils, brachiopods, tribolites, &c., in a collection of which the following species have been recognized :—

Anticlinal axis.

Percé Rock and the Blow-hole.

Strophomena Blainvillei.
" *Tullia.*
Zaphrentis cingulosa.

Zaphrentis corticata.
Chonetes Canadensis.
" *Dawsoni.*
" *Antiopa.*
Orthis musculosa.
Spirifera cycloptera.
" *Gaspensis.*
Platyostoma ventricosum.
Platyceras tortuosum.
Anodontopsis ventricosa.
Leptocoelia flabellites.
Orthoceras, sp. undet.
Dalmanites Anchiops.

These specimens were collected mostly from the Split (Percé) Rock and from the shore adjacent, but from the coast two miles north or near a high cliff known as the Blowhole a few fossils were also obtained, among which were recognized:— Fossils from Split Rock.

Spirifera arenosa.
" *cycloptera.*

From a comparison of the forms found at Percé, with those described from the Griffin Cove River the parallelism of the beds at the two localities is manifest. It will also be observed that most of the species are typical Devonian, and belong to the lower portion or probably the basal members of the Oriskany formation.

On the coast between Mal Bay and the north side of Gaspé Bay no strata are seen similar to those under consideration, but on the several streams flowing into this portion of the gulf they have been recognized, being brought up by the various anticlinals already mentioned. Their greatest development, however, is on the north side of Gaspé Bay, where they form the bold headlands of Cape Gaspé and Ship Head, which tower 600 to 700 feet perpendicular above the tide, forming the extremity of the cove finger-like projection which extends east from Cape Rosier Bay. They are seen in contact with the upper sandstone series at Little Gaspé as well as in the Dartmouth River to the head, where there appears to be a gradual passage of the beds of the latter into the lower portion. Further west they have been recognized in the Magdalen River south of the great bend at the Terrace Mountains. Their surface breadth in the road leading across to Griffin Cove is one mile and a half. By the extension of the Tar Point anticlinal westward these rocks can be traced to the southern slope of the Shickshock range, where their development needs to be further studied. Cape Gaspé and Ship Head.

The four anticlinals mentioned as existing in the Gaspé Devonian

Extent of the four anticlinals.

basin were traced for a great portion of their extension from the coast to the upper waters of the Dartmouth and Douglastown Rivers by Dr. Bell, and their positions are described in the Geology of Canada, 1863 (p.p. 406-410 and 83-86). No new facts were obtained on the subject except that the fourth or Percé anticlinal was more exactly defined, so there appears very little doubt it is the same as that observed to continue along the valley of the Douglastown River. There is also evidently a break in the continuity of the Tar Point anticlinal when it crosses the Douglastown River. Since all the strata in that stream from the crossing of the Point St. Peter anticlinal at the bend, thirteen miles from the mouth, to the head of the Barachois, dip uniformly north-easterly, the last recorded at the head of the island being N.15° E.$<$20°. It therefore evidently dies out in the distance between this river and the York, yet is brought prominently into view again on the coast at Tar Point by the extension of the trap dyke at that locality.

Tar Point trap dyke.

In regard to the eastern termination of the Point St. Peter anticlinal some doubt exists. The conglomerates which form the extremity appear to have an anticlinal structure, but the lower members of the system in the sandstone series proper do not come into view at this place. The crest of the anticlinal has, therefore, probably sunk below the sea level some distance before reaching the coast. A more marked anticlinal structure is apparent in the upper part of the sandstone series about two miles and a half north of Point Jaune, which latter place marks the contact of the sandstones and conglomerates, the opposing dips of which are S.70°E. and N.20°E., the angles, however, being low, not more than 5° to 10°. This, therefore, may only be a local disturbance, and was evidently so regarded by Sir W. Logan in his examination of this part of the coast, as he includes all this stretch in his séction. The Portage road across the peninsula from Mal Bay to Anse â Brilliant shows but few ledges, but at one point about two miles from the southern extremity of the road red sandy shales with grey Devonian sandstone were observed to dip S.25°–30°E.$<$5. These beds evidently extend underneath the conglomerates that cap the extremity of the point, and tends to support the opinion that the axis of this anticlinal follows the line of the Point St. Peter peninsula and reaches the coast near its end.

Contact of sandstones and conglomerates at Point Jaune.

Survey of St. John and Douglastown River.

In order to complete if possible the survey of the St. John and Douglastown River, which had already been measured by Mr. Murray in 1845 as far as the forks, a distance by the river of forty-eight miles, or in a direct line from its mouth thirty-eight miles. An excursion was made to that point. It was found, however, after reaching the fork, that owing to the low state of the water, and the impossibility of traversing the wilderness without a larger force of men, further progress in that direction was impossible. Above this point Mr. Murray says (Reports 1845-46, p. 107-8) "the valley takes a north-west direction, and I was informed by the Indians who were acquainted with the country that the river branches off into several small streams at a distance of three or four miles above the point we reached, ultimately terminating among the mountains near the sources of the Bonaventure and Southwest Rivers of Gaspé (York). Where we stopped the river had a breadth of sixty feet, but increasing in its downward course proportionately with the supply from its tributaries, it was at a short distance above the jam (near its mouth) upwards of 300 feet across. The estimated fall in the whole measured distance was thirteen feet per mile, the height of the highest point being 643 feet above the sea level.

There are four considerable tributaries to the St. John, two joining it within the first seven miles from the mouth, the other two at the respective distances of thirty-nine and a quarter and forty-six and a quarter miles from the entrance, and all coming from the sonth, besides many smaller ones falling in on either side. The two upper forks are supposed to take their rise very near the upper N. E. branch of the Bonaventure, and the lower of the two sweeps past the western base of a mountain known by the Indians as Mt. Alexander, and one of the high points fixed in our triangulation from Mr. Albert.

Tributaries of the St. John River.

The lower part of the river for a distance of thirteen miles flows through a level country, producing white pine, spruce, and a species of larch frequently of considerable size and of valuable quality, balsam, fir, cedar, and three varieties of birch, white maple, elm and ash in less abundance.

To the south this flat country is bounded by a range of hills, which, commencing at the sea coast near Mal Bay, run in a north-west direction, and gradually approaching the river strikes it thirteen miles from the coast. On the north side of the river the country continues to maintain its level character across to the south-west on River York, and, appearing to be covered with a good soil of sandy loam, it is doubtless well qualified to be brought into a state of cultivation, and might probably become as valuable an agricultural tract as any in the peninsula.

Level country fit for cultivation.

The whole of the upper part of the stream flows through a mountainous region. In some places extensive alluvial flats occur between the river and the mountains, while at others the valley contracts to a deep narrow gorge, the hills rising precipitously from either bank to a height occasionally of 300 to 400 feet. The hills increase in elevation with the height of the stream, and the highest one ascended measured

Mount Alexander.

845* feet above the level of the sea. From the hill directly above the point where our survey terminated Mount Alexander bears due south. From its long and straight roof-like top, as well as superior elevation, it was easily distinguished as one of the most conspicuous points seen in our eastern horizon from Mount Albert.

The upper part of this stream, from the Forks to a point about thirteen miles from its mouth, runs on the strike of the Gaspé limestone series, and nearly the course of an anticlinal, which is doubtless the western extension of that which comes to the shore at Percé. The rocks displayed along the river are blue and grey siliceous limestone, blue and grey thin-bedded limestone, and grey calcareous shales; the thin-bedded limestones are frequently nodular and shaly. The only fossils detected by Mr. Murray in these rocks were fucoids, probably Caudagalli. This would tend to place them on the horizon of the Oriskany formation. The lower thirteen miles are occupied by grey sandstones of the Gaspé sandstone series with plant stems.

The Dartmouth River.

The Dartmouth River was also ascended to a point four miles above the Upper North Fork. On this stream the line of separation between the sandstone and the limestone series cannot be clearly defined, the former, which occupies the lower part of the river to the Falls, about three-eighths of a mile above Lady Steps Creek, has a regular dip 20°-25° W. $<$35°-40°, and gradually becomes more calcareous. At the Falls the beds contain plant stems, but 100 yards below the second island above the Falls, ledges of hard grey limestone contain abundance of fossils similar to those found on the Griffin Cove River and already mentioned. The dip of these lower beds, which represent the limestone series, is S 15° W $<$60°. A short distance further up these rocks rest upon black calcareous shales and green-grey sandstones of sillery aspect.

Sillery and Levis rocks.

Thence up stream the river is occupied by calcareous shales, black and grey in color, with bands of limestone, conglomerate and sandstones, resembling the Levis formation, of which they are the undoubted equivalent; but at a point two miles and a-half above the Upper North Fork, greenish grey Sillery sandstones are again overlaid by fine grained limestones and shales in thin bands, containing fossils identical with those noted lower on the stream, and clearly showing the westward extension of the Devonian basin. Above this it was found impossible to proceed owing to the low state of the water, but an attempt will be made during the coming season to complete the traverse of the upper part of this stream, from the Fork River northward.

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* The height of this hill should probably be given at 845 feet above the level of the stream as measured by Aneroid last season.

This series is exceedingly rich in fossils, large collections of which have been made at different times by various members of the survey. Those pertaining to the lower portion have already been mentioned on pages 8–9 D D, and for the sake of comparison other forms, which have been determined principally by Mr. Billings, are given. Fossils.

From Cape Gaspé and Bon Ami Cape, which may be taken as representing the middle divisions, or, as they have been regarded, the transition beds, we have the following:—

Zaphrentis rugatula.
Dictyonema splendens.
Strophomena varistriata.
" *punctulifera.*
Modiolopsis varia.
Pleurotomaria princessa.
Sanguinolites Tethys.
Lingula Lucretia.
" *Artemis.*
Pentamerus galeatus.
Crania bella.

From the upper members of the series at Indian Cove, Grand Grêve, and Little Gaspé, we have:—

Philipsastrea affinis.
Polypora Psyche.
Zaphrentis incondita.
Strophomena magnifica.
" *rhomboidalis.*
" *Galatea.*
" *magniventra.*
" *inequiradiata.*
" *Irene.*
Modiolopsis Tethys.
Chonetes melonica.
" *laticosta.*
Leptocœlia flabellites.
Orthis Livia.
" *Aurelia.*
" *Lucia.*
Rhynchonella excellens.
" *Dryope.*
" *pleiopleura.*
Eatonia peculiaris.
Ptilodictya tarda.

Rensselaeria ovoides.
Spirifera Cycloptera.
Spirifera superba.
" *Gaspensis.*
" *raricosta.*
Goniophora mediocris.
Mytilarca nitida.
Leptodomus Canadensis.
Anodontopsis ventricosa.
Cypricardinia distincta.
Murchisonia Hebe.
Platyostoma affinis.
Pleurotomaria Lydia.
" *Voltumna.*
" *Delia.*
Bellerophon plenus,
Phoetus phocion.

From the vicinity of Gaspé and the York and Dartmouth Rivers we have from the basal beds of the Gaspé sandstone:—

Strophomena Blainvillei.
Grammysia Canadensis.
Mytilarca "
Modiomorpha inornata.
Murchisonia egregia.
Leptocoelia flabellites.

By comparing the fossils from the several localities, it will be seen that the majority are of Devonian types, and that the series as a whole belongs much more closely to this system than to the Silurian, though, in the basal beds, forms common to both horizons are found.

The various members of this system have been so minutely described in preceding reports, 1844 and 1863, that, with preceding details as to distribution, further remarks are considered unnecessary.

Petroleum.

In regard to the existence of petroleum in the area under consideration, no new facts have been ascertained since the abandonment of operations by the Company, some years ago. Several of the most important oil springs were examined during the past season, but the surface indications are so slight that no satisfactory opinion can from their mere inspection, be pronounced. The unsuccessful results of the boring operations, in which a very large sum of money was expended, prove quite conclusively the difficulty of striking subterranean oil reservoirs in this locality. It is possible that here, as at Lake Ainslie, in Cape Breton, and at Beliveau, in New Brunswick, there exists a substratum of rock to some extent impregnated with oil, which may escape to the surface in small quantities along various vents. At both the latter places, but more especially at Beliveau, outflows of oil, equal if not superior to any yet observed in Gaspé, are found, but though very large sums of money have been expended in putting down bore-holes, some of which reached a depth of more than 1,200 feet, no satisfactory results were obtained.

The only other indication of mineral wealth observed by us was the occurrence of galena in small quantities at several points, notably at Indian Cove and Little Gaspé. These localities have been investigated by a company from Halifax, and small excavations made on the vein. The quantity of ore is, however, small, and the operations have been abandoned. Specimens of the ore from Little Gaspé have been collected for assay. Galena.

E—Silurian.

The rocks of this system in the area under consideration have but a limited development, being confined principally to a few exposures along the coast, between Little Pabos and Cape D'Espoir. At the places where seen they form the beach, and a few feet of the lower part of the cliff, being overlaid by the Lower Carboniferous beds which have already been described. Their first outcrops are observed in the Little Pabos River and on the roads which extend along either bank, about one mile and a-half from its mouth. The strata there consist of greyish limestones and calcareous shales, containing corals and other fossils of Silurian aspect. These beds strike south-easterly towards the mouth of Grand River, on which stream they form high bluffs about the lower part, and extend inland as far as it has been examined. They are again concealed from view for a short distance below this river, but in the vicinity of the Breche à Manon Brook they are well exposed in the road leading down to the bridge, as well as on the shore for several hundred yards. East of this, along the coast, they have not been recognized, but on the back concession road below this stream, the contact of these rocks with the Lower Carboniferous is seen for several miles. In the rear of Cape D'Espoir they apparently pass beneath the Devonian strata, which extend thence to Percé. Distribution of the Silurian strata.

The limestones in the eastern part of the Gaspé Peninsula, which in former reports were stated to belong to this system, under the head of the Gaspé Limestones have already been fully discussed in my remarks on the Devonian. Of these Gaspé limestones it is now con- Gaspé limesone.

sidered that only the two lower members, representing a thickness of 160 feet, can with propriety be assigned to this system, while the preponderance of fossils of Devonian aspect, even in the basal bed, renders it probable that the whole may ultimately be transferred to the Devonian system. Further examinations with a view to determine this point will be made during the coming season.

D—Cambro-Silurian—(*Quebec Group*).

Detailed descriptions of the various rocks which compose this group have already appeared in various reports and papers, among which may be mentioned those by Sir W. E. Logan, 1844; Murray, 1845–6; Richardson, 1857–58; Geology of Canada, 1863; Selwyn, 1877–78; and Dr. T. S. Hunt; Second Geological Survey of Pennsylvania; Azoic Rocks E. 1878. The explorations of the past season have, however, thrown new light on some points, and will explain certain peculiarities of structure and apparent anomalies of fossil evidence to which attention has not heretofore been specially directed.

Distribution of the Quebec group in the Gaspé Peninsula.

The general distribution of the Quebec group in the Gaspé Peninsula has been shewn on the Geological Map of Canada, 1866. The strata which have been assigned to it, can be easily traced from their most easterly exposure, about two miles and three-fourths south of Cape Rosier, where they are overlaid by the Gaspé limestone series, to Point Levis, and they are easily recognized on the various streams flowing into the St. Lawrence, in nearly all of which the unconformable overlap of the Silurian beds can be observed; and it is interesting to note that in almost every case, these newer rocks rest upon what has generally been regarded as the lower or Levis portion of the group, which in turn is seen to be above, instead of as formerly supposed, below the Sillery.

Oultiers of Utica and Hudson River.

It must be mentioned that attention was called by Mr. C. Weston, in 1878, to some new features, shewn by the fossils, principally graptolites, which he collected that year at various points from Cape Rosier to Metis. These included a number of forms peculiar to the horizon of the Utica slate, or Hudson River, and proved that in this area, as in other areas to the southwest, which had till 1876 been regarded as Levis or Lauzon, strata of much more recent age existed. The examinations of the past season have not only further confirmed this supposition, but have enabled us to locate, definitely, some at least of the areas of the newer rocks, the position and details of which will be given in our description of the coast.

By reference to the geological map of Canada (1866), it will be seen that, between Cape Rosier and Metis, four formations are represented, namely, the Levis, Lauzon, Sillery, and Hudson River, the latter of which is represented as beginning at Little Fox River, and extending to the Marsouin River. This line is evidently wrongly placed, since, for a distance of over twelve miles below the former stream, the strata, which are highly fossiliferous, hold characteristic Utica slate species, while in the other direction the same forms were observed in the rocks of the beach at and for a mile above the mouth of the Marsouin.

Formations between Cape Rosier and Metis.

The most easterly exposures of this formation are seen on the south side of Cape Rosier Bay, where, as already stated, they underlie the Gaspé limestone series. Thence, west from the Cape for about three miles, or to within a short distance of Marin Brook, the coast is occupied by red, green, grey, and black shales, with interstratified bands of hard grey calcareous sandstone and buff weathering dolomitic limestones. In the immediate vicinity of the lighthouse, beds of conglomerate, containing pebbles of limestone, grit and shale occur, the whole presenting a marked resemblance to the recognized Levis beds of Orleans Island.

Levis rocks, Cape Rosier.

From the associated black shales Mr. Weston obtained a variety of graptolites, among which the following characteristic Levis species have been recognized :—*Dictyonema irregulare, Graptolithus flexilis, Loganograptus Logani.*

In the pebbles from the lower band of conglomerates fragments of trilobites similar to those from Point Levis were also noticed.

About 800 paces below Marin Brook, the red shales which form so conspicuous a feature between this point and Cape Rosier suddenly terminate, and are seen to overlie another set of beds, consisting of grey and black slates with hard grey sandstones, the contact indicating a line of fault, the extent of which cannot be determined. The dip of the red shale at this place is S.20°W.<30°, while that of the underlying black and grey beds is S.45°W.<70°-80°. This lower series can be traced to the westward for a long distance, and though stratigraphically it should belong to a lower horizon than the formation just described, as indeed was supposed till quite recently, it has been found to contain a plentiful fauna, principally of graptolites, which belong to the horizon of the Utica slate or Hudson River. A considerable collection was made at several points both below Griffin Cove as well as at its north-west point, among which the following species have been recognized :—*Dicranograptus ramosus, Climacograptus bicornis, Didymograptus sextans, Cœnograptus gracilis, Leptobolus.* (?)

Utica slate fossils.

The presence of these fossils in the black slates of this area readily fixes their position, and shows that the line of separation between he Levis and Hudson River formations, as drawn on the general map

Line between Levis and Hudson River strata.

(1866), requires to be corrected. It is needless to state, however, that at that time the existence of these fossils was unknown at this locality.

Several compound forms were also obtained from this place which at first sight were thought to belong to the Levis and to indicate a mingling of the different horizons, but a careful subsequent examination showed these also to belong to the age of the Utica.

Fault.

Between the fault which we have taken as marking the contact of the two formations and Griffin Cove, the strata, which are largely black and bituminous, dip S.20°W. to N.30° E.<85°-90°. Associated with the soft black and grey shales are beds of hard dark cherty felspathic slate, which will be seen to form a conspicuous member of the formation now under consideration. From the first outcrop of these hard beds in the beach below the Cove they can be traced on their strike westward across the mouth of the Griffin River, where they form a ridge lying between the post road and the portage across to Gaspé. At Gros Rivière, about half way between this Cove and Fox River, they are again seen, as well as at Fox River, where at the branch road up the river, they form a considerable hill. These are the same hard cherty beds mentioned in former reports as occurring at the Marsouin River, and they are also noted by Sir W. E. Logan (Geology of Canada, 1863, p. 267) about two miles above Cap Rouge. At all these places they are found to be intimately associated with strata which hold fossils of the horizon of the Utica, and attention is particularly called to these beds since they enable us to locate more definitely the line of contact between the Utica and the Levis both at the Marsouin and at other localities. From Griffin Cove to Great Fox River black shales and limestones with bands of buff weathering dolomites, the former veined with white calcite, dip generally S. 40° W. < 35°-60°, and in the vicinity of the latter place the bituminous portion contains graptolites similar to those just described, while the grey sandy and calcareous beds contain fragments of crinoids and small corals. On the west side of Fox River the same character is maintained but the strike becomes more westerly, following the trend of the shore, the dip being S. 30° W.<40°-80°. Near the outside of Fox Cove two small local folds are observed in the strata, but these do not apparently affect the regularity of the measures.

Cherty beds at contact of formations.

Section at Griffin Cove.

A section made across the strike at Griffin Cove River gives the breadth of this formation there at four miles. The line of contact with the beds of the Gaspé limestone series is seen a short distance below the forks with the Ruisseau de la Grande Carrière. The upper members of the Quebec group are fine conglomerates with white quartz pebbles, and red, brown and grey shales, which dip generally S.25°W.<

50°. Further down, ledges of limestone conglomerate and black shale of Levis aspect occur which show an anticlinal structure, having a dip N. 20° E. $<$ 75°. This, however, soon becomes reversed to S. 25° W. $<$ 85°, below which the stream flows through swamps and exposures are wanting. On the road, however, the interval between the exposures of Levis conglomerates on the stream and the coast, shows ledges of hard greenish-grey sandstone or fine conglomerate, with fine grey, black and reddish shale, probably of Sillery age. These would underlie the Levis conglomerates above mentioned, and be in turn apparently underlaid by the black Utica shales of the Cove.

On the Great Fox River, for three miles from its mouth, exposures are rare. The small branches from the west show fragments of greenish grey grit with fine bluish grey and red shales, but at a distance of four miles the characteristic Sillery or Pillar sandstone is found in place, with reddish and grey shales, which extend for several hundred rods. The contact with the Levis conglomerates in this direction was not seen, but it is probable they overlie the beds just noted further south, as they form the upper beds of the formation on the Dartmouth River to the west. The contact of Levis or Sillery beds with the Utica is also concealed on this stream. Great Fox River.

Westward from the great Fox River, black bituminous shales with buff weathering dolomite bands and grey calcareous sandstones continue along the coast. These are like the beds of Griffin Cove, and like them contain graptolites with obolella, and crinoid stems.

As already mentioned, the line is drawn on the General Map at Little Fox River, between the Levis and Hudson River formations. From the facts obtained at this place and below, it is evident that no grounds for such separation exist. The crumplings in the strata are local and do not show any evidence of great displacement, while the character of the fauna is the same for several miles both below and above this stream. It is possible, however, that a fault exists here which may bring the higher members of the Utica or Hudson River into view; as a short distance above this point, hard grey sandy beds with curiously knobbed surfaces are seen in force, interstratified with splintery black shales. These sandstones hold imperfect remains of brachiopod shells as well as graptolites, among which Diplograptus pristis is very common. These are also found abundantly at Petite Cap, one mile and a half above Little Fox River. Little Fox River.

Between Petite Cap and Anse à Vallon we pass three principal points, Cape Barré, Cape Serpent and Point Jaune. At all these places dark grey and black shales with hard grey sandy beds, having the peculiar knobbed surfaces noted above, are seen. Their strike is constant, following the bend of the shore, which at this locality is N. 50° W. Coast between Petite Cap and Anse a Vallon.

The angle of dip for half a mile beyond Cape Serpent ranges from 25° to 50°, when it suddenly rises to 80°–90°, which high inclination is maintained to within a short distance of Point Sèche.

About three-fourths of a mile below this point the dip changes to N.E. < 80°, showing a sharp anticlinal structure. Twenty chains below the Point a well-marked syncline occurs; the dip on the opposite sides being N. 20° E. < 65° and S. 20° W. < 35°. This is again seen in the west side of the Cove above the Point; the opposing angles being 45°, and at fifty chains beyond the entrance another flat anticline is observed, the previous dip having decreased to angles of 4° and 7°. For thirty chains more the dip continues low and then suddenly increases to angles of 30°, forming another well-defined syncline. This is on the shore at Little Cloridon Cove, and it is again seen further west below the mouth of the Great Cloridon River, the strike of the strata keeping regularly along the coast.

Great Cloridon River.

West of the mouth of the great Cloridon River, the strata again dip S. 20°. W. < 45°–50°, rising half a mile beyond the point on the west side of the cove to 80°–90° for a short distance, and continuing with a higher inclination to the southwest as far as Little Valley River. The rocks from Anse à Vallon to this place are for the most part hard, grey sandstones, the black and grey shales being in thin bands with a few interstratified beds of buff weathering limestone; the heavy beds of black bituminous shales and limestones, which form so conspicuous a feature between Griffin Cove and Fox River, having become greatly reduced. As, however, the strike of the beds continues to conform with the outline of the shore, but a small thickness of the measures is exposed.

Utica fossils.

At intervals, for the whole distance, graptolites are found, the predominating type being Diplograptus pristis, which is abundant in some of the sandy beds. A compound form was also observed by Mr. Weston, at Anse à Vallon and at Grand Etang, with fragments of corals, crinoids and brachiopods, the examination of which shews them to be of the horizon of the Utica. Similar forms were found at Cloridon, there being very little change in the character of the strata at all these places.

Westward of Little Valley, the angles of dip gradually decline, and at about two miles above Great Valley River, the strata dip S. 5°. W. < 60°. Beyond this, the inclination speedily becomes less steep, with angles of 20°–35° to the mouth of the Magdalen River. The rocks continue to be similar in character for this distance, and hold the same fossils as noted lower down the coast; the Diplograptus pristis being especially abundant. No evidence of anticlinal structure is seen from the Great Cloridon to this river, the rocks having a uniform southerly dip all the way.

From Photo. by R. W. Ells. Geological Survey, 1883.

Artotype—G. E. Desbarats & Co., Montreal.

GRAND FALLS OF THE MAGDALEN RIVER, SIXTY FEET HIGH, FOUR MILES FROM THE MOUTH.

The rocks belong to the Upper or Hudson River division of the Cambro-Silurian (D. 4.) and the surrounding hills, are eight to twelve hundred feet high. A portage road over the hills has been made to pass this portion of the stream.

The section made by Mr. Richardson, from the Grand Etang to the Dartmouth River (see Report of Progress, 1857, p. 69), gives a surface breadth, for the rocks under discussion, of about two miles. In that report they are classed as division A, which was then supposed to constitute the lowest member of the Quebec group, as their apparent stratigraphical position indicates. They are overlaid by greenish grey sandstones, holding pellucid grains of quartz and small films of black shale: these are the representatives of the typical Sillery sandstones. They are in turn succeeded by black and grey shales and beds of dolomitic limestone, associated with red shale and sandstones; and, further south in the valley of the Dartmouth, by Levis limestone conglomerates, and are without doubt the extension westward of the beds of Cape Rosier; in this river they have been traced from their first exposures about one mile and a half north of Ladysteps Brook, beyond the upper north fork where the stream makes its sharp bend to the east. Sections by Mr. Richardson, 1857.

Another section further west, measured by Mr. Richardson, on the Magdalen River (see Report, 1857), gives a similar arrangement of formations. The Utica, or Hudson River beds, near the mouth of the stream, are marked by characteristic fossils, both brachiopods and graptolites, among the former, Orthis testudinaria and Leptœna sericea, being abundant, and are well exposed for over four miles across the strike, or for about one mile above the Grand Falls, above which the river banks are flat as far as Porcupine Bluff. Here strata of Levis and Sillery aspect apparently overlie the Utica, though the contact is concealed, and consist of green grey sandstones, with red and grey shales, south of which and resting upon them, are the conglomerate limestones and associated beds of the Levis formation, which are in turn unconformably overlaid by the Gaspé limestone series. Levis strata overlying Utica.

West of the Magdalen River, the rocks resemble in character those seen along the coast to the east, being for the most part black and grey shales, with buff weathering dolomites and interstratified beds of hard grey sandstone. These differ from the typical sillery or pillar sandstone, in the absence of the grains of clear quartz and films of black shale, as well as in their being more compact and homogeneous. At a distance of one mile west of the lighthouse at the mouth of the river, a well-defined synclinal is observed with opposing angles of 50° and 75°, which is again brought into view half a mile further on in a small cove. Thence upward to Marsh Bay, the beds strike regularly along the shore with a dip S $<$50°-75°, but shew an anticlinal structure half a mile east of Marsh Bay Beach. One mile west of this place the strata are again reversed, forming a synclinal with angles of 75°, and another local syncline occurs one mile and a half east of Gros Mâule River. Marsh Bay.

At this river, and for several miles above and below, the heavy black bituminous shales of Griffin Cove are again strongly developed, and form bold and high cliffs. They contain abundance of graptolites, a large collection of which was made in 1878 by Mr. Weston. Among these may be mentioned:—*Climacograptus bicornis, Dicranograptus ramosus, Diplograptus pristis, Cœnograptus gracilis, Graptolithus scalaris, Orthoceras.*

No mingling of Utica and Levis fossils.

It will be seen that these species are all of the horizon of the Utica, but in Hall's "Graptolites of the Quebec Group, Dec. 2, 1865," several forms peculiar to the Levis formation are mentioned, probably in error, as having been found at this place. Since then, however, it has been ascertained that the Levis forms marked Gros Mâule were wrongly marked, and that they belonged to another locality. This gave rise to the supposition that at this place there was a mingling of the faunas of the two horizons, but it may be said, after careful examination, that no other fossils than those of the Utica slate could be found. The lithological character of the rocks also clearly distinguishes them from the Levis beds, and taken in connection with the stratigraphy, indicates that the Utica and Hudson River are continuous from below Griffin Cove to this place. And we may here remark that, at no place where fossils have been collected, do we find any mingling of the two faunas in the same bed, though in some localities the association of the strata of the Levis with the Utica is very intimate, as will be seen as we proceed further up the coast.

Gros Maule to Marsouin River.

Between Gros Mâule and the Marsouin River an anticlinal structure appears to follow the bend of the shore line for the greater part of the distance. The inclination of the angles being often very low, and the shallow synclines coming to the shore obliquely from the river. Beautiful exhibitions of contorted strata are visible at several points, among which may be mentioned the west side of Mont Louis Cove and the Grand Matte, the disturbances along this part of the coast presenting the aspect of a crumpled anticlinal. No change in the character of the rock is apparent, the interstratified beds of hard grey sandstone having the same peculiar knobbed surfaces as were noted in the vicinity of Little Fox River, and at other points to the east. They contain abundance of Diplograptus pristis, and there is no doubt that the rocks all along this part of the St. Lawrence belong to the same horizon.

Fault at the Marsouin River.

Just below the mouth of the Marsouin River evidences of a fault are apparent. Hard grey sandstone with partings of grey sandy shale, extend almost the whole distance from Abour Brook, and apparently overlie the black graptolitic beds of Gros Mâule. These sandstones contain D. pristis, and are possibly a portion of the Hudson River formation. At the mouth of the Marsouin they dip N 65°W<40°, and at the

From Photo. by R. W. Ells. Geological Survey, 1883. *Artotype—G. E. Desbarats & Co., Montreal*

GORGE AT THE MOUTH OF THE GRAND MATTE RIVER, FIFTEEN MILES WEST OF THE MAGDALEN RIVER

The hills are ten to fourteen hundred feet high, and shew beautiful cliff sections of the contorted strata belonging to the Levis formation (C. 3.)

entrance of the Cove just above, hard dark cherty felspathic slates of a lower horizon dip S 25°W <30°, and constitute also the ledgy islet at the mouth of the River. It was at first thought that the want of conformity marked the line of the great fault between the Utica and Levis formations, but from the fact that the hard cherty shales have been found at various points to form an integral part of the Utica and that black graphitic shales, with other beds holding abundance of Utica fossils, continue to occupy the shore for a further distance of over one mile from the mouth of the river, it is evident that this fault is local. The contact of the Utica with the Levis can, however, be seen on the shore at the distance mentioned, the latter strata of red and green shale with their conglomerates constituting the cliff, while the former beds occupy the shore, and gradually pass under the waters of the St. Lawrence. As at other points the beds of the Levis apparently rest upon the Utica, which, at their contact, has a dip S<50°-60°.

From the black graphitic shales west of the Marsouin, the following fossils of Utica types have been obtained :—

Dicranograptus ramosus.
Diplograptus pristis.
" *mucronatus.*
Graptolithus tenuis.
Leptobolus insignis.

Coast section from Cape Rosier to the Marsouin River.

Briefly, then, the section along the coast from Cape Rosier to the Marsouin River confirms the existence of two distinct formations, entirely separable on palæontological if not always on stratigraphical, grounds; of which the lower contains characteristic compound graptolites peculiar to the Levis, and in which no distinct fossils of the horizon of the Utica or Hudson River have been recognized. This older series, while it has an exposed area along the coast of only three miles and a half west from Cape Rosier, is continuous the whole way at a distance of from one to four miles inland. The newer formation, beginning in the vicinity of Marin Brook, occupies the shore continuously to the Marsouin, and while it contains none of the fauna of the Levis beds, it holds, at nearly every point for the entire distance, an abundance of graptolites and other forms peculiar to the horizon of the Utica or Hudson River. It is worthy of remark also that in every observed contact the Levis beds appear to be superimposed upon the Utica, as on the Island of Orleans. Westward of the Marsouin, until the present season, no rocks of recognized Utica slate age had been definitely located, although such areas have lately been supposed to exist, but during the examinations of the past season these were found at several localities. Also the discovery of fossils of the newer series at various

Apparent super-position of the older series.

points between St. Anne and Metis in rocks which have been regarded as belonging to the typical Levis and Lauzon formations, opens up the question as to how much of the so-called Levis in this north-eastern area may now be considered as belonging to a more recent formation. The distribution of these areas will now be considered.

Passing the mouth of the Marsouin River we find the beach as stated for a distance of 100 chains, occupied by the rocks just described, while the cliff is composed of red, green and grey shales resembling the strata seen to the south of Cape Rosier. The beds of the beach, which dip S. 25° E. $<$ 60°, are seen to pass under the waters of the River at this distance, the last beds exposed being hard cherty felspathic slates like those of Fox River, upon which the older rocks rest unconformably, the angles of dip at the contact being 40° and 70°. Thence up the coast to Ruisseau Valleé, about six miles, strata of red, green and banded shales, with buff weathering limestone and occasional beds of green-grey sandstone containing small grains of clear quartz and films of black shale occur, the latter being similar to the pillar sandstone in the vicinity of St. Anne's. All these strata resemble what have been called in earlier reports the Sillery and Lauzon divisions.

The structure of this part of the coast is very simple. At two points a synclinal with associated anticlinal occurs, the first at a distance of two miles from the contact mentioned above, the other 100 chains west of the River Martin, but from the run of the strata it is evident that both these exposures are on the same axis.

Ruisseau Valee.

West of the Ruisseau Valleé, grey grits and shales with a few limestone bands strike out to sea at a moderate angle for two miles, where a sharp synclinal with an equally abrupt anticlinal is seen. These can be traced up the shore for several miles, or to within four miles of the St. Anne's River, in which distance the anticlinal axis, which curves along the shore, is crossed by the coast section no less than seven times. The rocks are principally sandstones of Sillery aspect, or what have been described in former reports as Pillar sandstones, from the peculiar pillar-like masses which stand up from the beach between the Ruisseau Castor and Potato Brook. A short distance below the latter stream the sandy beds again strike out to sea with a dip of N.10° E. $<$80°, and give place along the beach to red, grey and green shales with dolomite bands, which are apparently a portion of the sandstone series, since they conform in dip and direction. Above the brook the dip becomes reversed to S. $<$ 75°, and between this and Little St. Anne Point the strata are a good deal disturbed. At this point the rocks, which consist of broken grey limestones with shales of various shades, contain an interstratified band of conglomerate limestone, which marks the first exposure of this kind along the shore since leaving Cape Rosier.

From Photo. by R. W. Ells. Geological Survey, 1883. *Artotype—G. E. Desbarats & Co., Montreal.*

COAST BELOW RUISSEAU CASTOR, TEN MILES EAST OF STE-ANNE DES MONTS.

The high hills are composed principally of the Sillery Sandstone division of the Quebec group and terminate on the shore in abrupt cliffs eight to twelve hundred feet high.

Thence up to the mouth of the St. Anne River the purple grey and clouded shales continue.

Aspect of the beds above the Marsouin River.

The aspect of the various beds seen above the Marsouin, is that of the Lauzon and Sillery divisions, but at a distance of one mile and a half west of the great Ste. Anne River, a set of beds which are typical Levis in character, come in on the shore and form also two prominent but local ridges about half a mile inland. These consist of limestone conglomerate often coarse, with associated beds of hard, greyish quartzite, or quartzose sandstone, and thin red, black and grey shales. These have been correlated by former observers with the beds of Point Levis and Bic, of which they are apparently the equivalents. From the pebbles of the conglomerate, Salterella has been obtained. The ridges mentioned have a superficial breadth of about ten chains, of which the larger part is occupied by soft shales, separating the harder and conglomerate portions, and they extend along the strike for about twenty chains, sinking down quite abruptly at either end to the level of the terrace from which they rise; the strike of the beds is about N. 70° W., the angle of dip being N. 20° E. $<$ 60°.

Due north from these outcrops, the shore at low water presents similar beds. These shew, at the outer margin, an anticlinal structure in the conglomerate and grit portion, with opposing dip of 75°, and are overlaid shoreward by a series of slates and arenaceous limestone of the character just described. They present a marked resemblance to the beds seen at Cape Rosier, of which they are the undoubted equivalents, and can be traced up the shore for about three-fourths of a mile, where they give place to grey, green, and purple clouded shales, which thence occupy the coast towards Cape Chat. The limestone conglomerates are very irregular in their distribution, and cannot be traced for any considerable distance in their strike, often abruptly terminating by faulting or thinning out; evidences of both being frequently visible. The black associated shales contain frequent nodules, which are hard and cherty and often calcareous: cracks in these contain the same carbonaceous matter found in the beds on Orleans Island at Point Levis and elsewhere. Among the fossils collected from these beds the following typical Levis forms have been recognized:

Calcareous nodules in the black shales.

Levis fossils.

Graptolithus bifidus.
" *similis.*
" *pennatulus.*
" *bryonoides.*
" *fruticosus,*
" *Richardsoni.*
Phyllograptus Anna.
Thamnograptus Anna.

Cape Chat sandstones.

This locality is about three miles west of St. Annes, des Monts River. Thence up to the point below the Cape Chat River, red, green and grey shales, often confused, occupy the shore, and are similar to those described as holding graptolites of Levis types. They all have a southerly or southeasterly dip, with angles from 35° to 60°. At the point two miles below Cape Chat River, sandstones of typical Sillery aspect, with interstratified grey and black shales again come in and apparently underlie those just described. These beds are better seen above the mouth of the river, and between that place and Cape Chat, are strongly developed. They present a curved structure, and strike seaward at their upper exposure, beyond the lighthouse, with a dip S. 10° W. $<$ 35°–60°, directly underlying banded red, green, and black shales.

It may be well to mention that, in the sandstones now under discussion, the characteristic fossil *Phyllograptus typus*, so common in beds at Point Levis, associated with the conglomerates, has been found by Mr. Richardson, shewing that these rocks are of the same horizon.

The shales referred to in the preceding paragraph are, however, only an interstratified belt with the sandstones, to which they conform in dip, and have an exposed length of only a few chains, the coast above being occupied by interstratified beds of Sillery sandstone and shales of various colors as far as Little Michaud Bay. Sharp foldings are seen in the rocks at Little Capuchin Bay, as well as on the point between this and the Great Capuchin, and about three fourths of a mile below the former place the interstratified black shales were found to contain both *Dictyonema* and *Graptolites*, among which *Loganograptus Logani* and *Callograptus* were recognized. At Great Capuchin, on the west side of the Cove, the Sillery sandstones are in contact with deep red shales, which are mentioned by Mr. Richardson (Report 1857, p. 142) as containing copper ore in small quantity, and then supposed by him, apparently for this reason only, to form the eastern extension of the copper-bearing beds of the Eastern Townships. The beds at the contact with the red shales have a vertical position, while the general dip of the sandstone across the point is only 40° to 55°.

Copper ore supposed to indicate the position of the strata.

Sillery sandstones, Little Michaud Bay.

The Sillery sandstones are strongly developed along the shore to the east side of Little Michaud Bay and terminate about 200 paces east of the bridge over that stream, west of which along the beach no exposures are seen for half a mile, the dip of the last beds of the sandstone being S. 25° E. $<$65°. The next beds seen after passing the sandy beach are soft black and dark grey shales with hard grey bands like those seen about Griffin Cove. These are found to contain an abundance of graptolites, among which Mr. Ami has recognized :—

Dicranograptus ramosus.
Diplograptus pristis.
Didymograptus divaricatus.

From Photo. by R. W. Ells. Geological Survey, 1883. *Artotype—G. E. Desbarats & Co., Montreal.*

SANDSTONE PILLAR ON THE COAST, EIGHT AND A HALF MILES EAST OF STE-ANNE DES MONTS.

The name "Pillar Sandstone" applied to the Sillery division in the Reports of 1845 and 1859, was derived from these pillars of which there are several in the vicinity.

The exposures of these shales are, however, limited to a superficial breadth of not more than fifteen chains, the dip is S. 40° E. $<$ 80°, and they occupy the inner portion of the west side of the Little Michaud Cove, being underlaid seaward by red, green and grey shales of Sillery aspect. The occurrence here of this band of Utica or Hudson River shales is very interesting, and is doubtless due to the intimate infolding of these beds in the older formation. Great and Little Michaud Coves.

Beyond the shales and limestones along the east side of the Great Michaud Cove, which are probably the extension of the fossiliferous strata just described, heavy beds of quartzose sandstone and limestone conglomerate, similar to those seen at St. Anne, form a prominent ridge about 200 paces back from the shore and extend towards the Great Michaud River; they have a southerly dip at a high angle, and, from the pebbles, fragments of trilobites, which are like those from the conglomerates of Bic, and *Salterella* were obtained by Mr. Weston

The western side of Great Michaud Cove brings into view a repetition of the conglomerate limestone and associated grey and black shales. These beds are like those seen above the Ste. Anne River, and the interstratified slates contain typical Levis fossils. It is interesting to note that the pieces of shale which enter into the composition of this conglomerate, also contain graptolites, among which *Tetragraptus bryonoides*, or an allied form, has been recognized. From the end of the Grand Michaud Point to Les Islets about two miles west, beds of grey and brownish grey, calcareous shales with dolomitic bands and, in their lower portion, heavy beds of coarse oolitic limestone are found. All these beds have a southerly dip at angles of 30° to 40°, rising at one place about one mile west of the point to 80°, where a sharp fold is visible in the grey calcareous shales. At Les Islets, coarse conglomerate limestone with heavy bands of grey or brownish grey quartzose sandstones are largely developed, with interstratified beds of grey and dark grey shales, and continue to form a very rough coast for several miles, or to the mouth of the Gros Roches Brook. The dip is generally to the south-east at angles of 30° to 45°, rising at one point to 80° about midway between the two places where indications of an overturned anticlinal are visible. A section given by Mr. Richardson (See Report for 1858, p. 144–6) makes the thickness of the measures on the east side of the axis to be 667 feet. Les Islets. Section by Mr. Richardson, 1858.

All these conglomerates and associated rocks present a marked resemblance to rocks in the vicinity of Bic and other points farther west. The pebbles frequently contain *Salterella*, while the interstratified shales contain graptolites of Levis types. Among these the following species were collected by Mr. Weston, principally in the vicinity of Grand Michaud Point:

Dichograptus ramulus.

Tetragraptus quadribranchiatus.
" *fruticosus.*
Dendrograptus.
Callograptus.

Although these beds are apparently higher in position than those west of Les Islets, the occurrence of similar Levis fossils in the shales of the latter, shews them to be of not very different horizons. Thus, the evidence is entirely opposed to their being of Potsdam age.

Gros Roches Brook.

West of Gros Roches Brook, beds of red, green and black variegated shales, with bands of limestone and green, grey sandstone again come in, apparently underlying the conglomerates just described. These resemble the typical Sillery, and extend for about two miles, or almost to Anse du Tour, where heavy beds of sandstone occupy the shore in force, and extend thence to Whale Point. The shaly portion west of Gros Roches, shews evidence of crumpling, which, however, may be only local. Rounding Cape Whale Point, these red and green shales with interstratified beds of green sandstone, extend for a short distance, evidently as a part of the Sillery series, the sandy portion of which is again rapidly developed, and continues without interruption to Long Point about four miles farther. In this stretch there are several interstratified bands of red shale, but after passing to the west side of Long

Fault.

Point, a fault brings in the crumpled limestones and shales of the Levis formation, the latter containing:

Tetragraptus fruticosus.
Dicthograptus flexilis.
Dictyonema.

Associated with these are beds of conglomerate limestone and hard

Great and Little Matanne Rivers.

quartzose sandstone, like the rocks of Les Islets. This series extends up to the great Matanne River, half way between which and Little Matanne, beds of blackish grey shale, with dolomite bands, contain graptolites and other fossils, among which the following species have been determined:

Dicthograptus rigidus.
" *flexilis.*
Dictyonema irregulare.

Fragments of trilobites were also obtained from associated strata, but these were not perfect enough to be determined.

These beds apparently all overlie the so-called Sillery sandstones, and as the same stratigraphical relations of the two divisions of the formation are exhibited at nearly every observed contact, it is evident that the supposed lower position of the graptolite shales can only be maintained by the assumption that the whole group has been completely overturned, of which there is no evidence.

Above the Great Matanne no exposures are seen on the beach for four miles, above which, to the mouth of the Tartigo River, shales of various colours with beds of green-grey sandstone again occupy the shore. These have a general south-easterly dip at various angles, and apparently underlie the heavy masses of coarse limestone conglomerate and hard sandstone, which constitute the prominent ridges about two miles inland on the Great and Little White Rivers, and large blocks of which are seen on the coast near the mouth of these streams. The shales at several places contain abundance of graptolites and other fossils of Levis types. *Dichograptus flexilis* and *Dictyonema* were collected about one mile and a half below the Little White River, and at about one mile and a half below the Tartigo, a *Dictyonema* and *Thamnograptus Anna*. Fossils.

Just at this place, however, black bituminous shales with grey sandy and dolomitic beds occur, and form a narrow selvage for a short distance along the shore, and apparently dip under the fossiliferous Levis beds just described. These shales resemble lithologically those of Griffin Cove, and like them have yielded graptolites of Utica species. In a collection made here by Mr. Weston, Mr. Ami has recognized :

Climacograptus bicornis.
Didymograptus sextans.
Dicranograptus furcatus.
Retiograptus, sp. indet.

These beds extend along the shore about fifty-five chains, above which, to the mouth of the Tartigo River, large masses of red and green shales are exposed on the flats at low water, and include near the mouth of the river thin bands of conglomerate, the whole series dipping S 65°E <35° 40°. Tartigo River.

It has been found impossible to trace the bands of conglomerate and hard sandstone referred to for any considerable distance continuously owing to the irregularity of their outcrop.

Above the mouth of the Tartigo River, black shales with buff weathering bands again reach the shore, and form almost continuous exposures for two miles and a half; the gritty and calcareous bands, containing *encrinites* and fragments of *Stictopora acuta* while the shales are exceedingly rich in fossils, principally graptolites. At Gagnon's Beach they yielded :

Cœnograptus gracilis.
Climacograptus bicornis.

Dicranograptus ramosus.
Diplograptus pristis.
" *annectaus.*
" *sextans.*
Graptolithus scalaris.
Orthoceras lamellosum.

The strata from which these species were obtained resemble precisely those of Griffin Cove, not only in the character of their various rocks, but in the presence of the same hard cherty felspathic slates which form so marked a feature there and elsewhere. These areas of highly fossiliferous shales which are now for the first time definitely located and recognized as of Utica or Hudson River age, though closely associated in the manner described with Levis rocks, are exceedingly interesting and important, and it may be presumed that further examination of the Quebec group, on the south shore of the St. Lawrence, will reveal, as it has done to the south-west, the existence of other similar outliers.

Two miles and a half west of the Tartigo River the newer strata dip, apparently, under red, grey and banded slates similar to those below that stream which thence extend to MacNider Bay. In this distance are included bands of conglomerate limestone and other rocks, the whole resembling the strata at Les Islets and Gros Crapauds. They have a general strike along the shore but exhibit several anticlinal folds, and at the upper part of MacNider Bay are seen to rest upon the green grey Sillery sandstone, both series dipping south-easterly at angles of 50°-70°.

Little Metis River.

From MacNider Bay to within a short distance of the mouth of Little Metis River, the Sillery sandstone and associated red and grey shales occupy the shore, but from the upper hotel to the mouth of the stream hard whitish weathering quartzose beds with thin bands of limestone conglomerate of Levis aspect rest again upon the sandy beds, the dip of the upper portion being S. 30° E. $<$ 50°.

Between the mouth of Little Metis River and the lighthouse at the Point on the north-west side of the Cove, the Sillery sandstones are largely developed. They occupy the shore west from the point to the beginning of the Cove east of the Great Metis River at which place they underlie red, grey and banded slates, which extend thence to the mouth of the latter stream where they are again intimately associated with limestone conglomerates of the Levis formation. This point marks the western limit of our observations along the coast.

It will be seen from the facts here presented and from the inspection of the accompanying map that several important changes have been made in the distribution of the various formations. The intimate association of the red and green shales of the Lanzon with the green-grey sandstones and other beds of the Sillery make it evident that in this area at least the separation of these two formations is not possible, while the evident superposition of the Levis division upon the Sillery at so many points renders it probable that the latter may form its basal portion. Further examination of the conglomerate limestones, with special reference to their contained fossils, will probably throw new light on this point; the presence of graptolites in the pieces of shale which help to make up these conglomerates shews that a part of these rocks at least are newer than some of the fossiliferous shales of the Levis. The impossibility of tracing in detail the different divisions for any great distance in a country covered by dense forest and accessible only by a few streams, on which even continuous outcrops are not found, is apparent, while the numerous dislocations and disturbances of the strata, render the accurate portraying of the different members, from their strike alone, except by actual exposures extremely unsatisfactory You have therefore deemed it best to include the whole group in one system, under the heading Upper Cambrian, notwithstanding it includes numerous outliers of Cambro-Silurian formations — Utica and Hudson River, — but presents no evidence of any Potsdam or Lower Cambrian strata.

Changes in the supposed distribution of the formations.

Classification of the formations.

*The line of the great fault between the Utica or Hudson River and the older portion has been clearly defined at several points along its eastern extension, while the detached areas or outliers of the upper rocks, which are generally of small extent, appearing to form an integral portion of the Levis, is fully explained by supposing them to have been caught up and infolded with the older strata in some of the great crumplings and apparent overturns which have affected the whole region to the south-east of the great St. Lawrence and Champlain break.

Explanation of the outliers of newer rocks.

Igneous Rocks.

The various exposures of trappean rocks, which are seen to cut the Devonian strata under consideration, have been fully described by Sir W. E. Logan (Report 1844, p. 40). Five are there mentioned, all of which have the aspect of true dykes. Three of these occur on the north side of Gaspé Bay, of which the most easterly is one mile and a quarter west of the outside point of Little Gaspé Cove; the second, 300 yards above Little Cape Oiseau, and the third, 300 yards above the

Trap dykes.

* These remarks must not be taken as applying to the metamorphic area as displayed in the Shickshock range, that area not having yet been closely examined.

same point. The fourth occurs at Anse Cousin, one mile and three-quarters above the bluff on the upper side of the entrance to the S. W. arm. The fifth is that seen at Tar Point, and is chiefly remarkable for the presence of petroleum which occurs, sometimes solid and sometimes liquid, in numerous drusy cavities, disseminated through the trap, and which are often lined with chalcedony. None of these dykes have an apparent breadth greater than ten to twelve yards; and from the fact of their having indurated or otherwise altered the sandstone strata with which they are in contact, it is evident that their age is subsequent to the deposition of this portion of the Devonian.

Petroleum.

Another trap dyke, observed by us last season, is on the back concession, near the western boundary of the township of Percé. The exposure here has a surface breadth of 260 paces, and is surrounded by sandy slates, presumably of Silurian age, but largely concealed by the overlapping Lower Carboniferous sediments. The trap is of a hard, steely grey color, heavy and crystalline in character, and forms a knob over which the road passes with an abrupt descent on its eastern side.

GEOLOGICAL SURVEY OF CANADA.

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NOTES

ON

SOME OF THE MINES

IN THE

PROVINCE OF QUEBEC.

BY

CHAS. W. WILLIMOTT.

1882.

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NOTES

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Copper.

Harvey Hill Mines.—These mines are situated on the 17th lot, in the 15th range of Leeds, in the county of Megantic. Before they were closed in 1879, the Company's attention was directed more especially to the Kent shaft, and the Fanny Eliza vein described in the Geology of Canada, 1863, p. 728. Of the two levels that have been driven, only in the one at 180 feet, has any further work been done since the publication of the report of 1863, pp. 725–729. This level has been extended to 150 feet to the west; from it an incline at an angle of 45 degrees has been sunk for a distance of 600 feet; some very rich pockets and lodes have been met with. The Fanny Eliza vein has yielded an ore of 50 per cent.

These pockets are filled with quartz and dolomite, mixed with a beautiful variety of purple copper. Sometimes the pockets hold ore only, with imbedded rounded crystals of quartz. In some instances the ore is replaced by reticulating masses of chloritoid, and in rare cases the two minerals are associated.

At the time of my visit, in August, 1882, three men employed by a New York Company, (the present owners) were taking the water out of the shaft with a hand windlass. This work had then occupied them ten months.

The manager states that it is the intention of the Company to commence mining next year, as soon as the snow is off the ground. They intend to sink new shafts, and should the result prove satisfactory, they will erect smelting furnaces.

On the next lot No. 18, in the same range, a small opening has been made in the hydro-mica schists to the depth of six feet, on a vein of vitreous ore, (chalcocite) in a matrix of decomposed bitter spar. This vein is traversed by bands of chlorite, often arranged in alternate layers with quartz, and resembling the structure of Eozoon limestone. The ore is reported to have yielded on assay 8 ozs. of silver to the ton.

Ascot Mine.—This mine, situated on the 8th lot of the 8th concession, in the township of Ascot, has now become the property of the Sherbrooke Mining and Smelting Company, who are determined to resume operations on a more extensive scale.

The shaft which is about 150 feet deep, was being emptied of water when visited in 1882.

The ore, yellow sulphuret, is derived from a two feet bed in chloritic mica schist. It is stated to average about 7 per cent. of metallic copper.

Hepburn Mine.—This mine, situated about 3000 feet to the S. W. of the Ascot Mine, is also the property of the Sherbrooke Mining and Smelting Company. A shaft has been sunk to the depth of 156 feet. At sixty feet, a level has been driven thirty feet, from this a north and a south cross-cut was made; the latter was carried 110 feet, at which distance a bed of yellow sulphide, twenty-four feet thick was cut, averaging about 7 per cent. metallic copper. The north cross-cut was carried 125 feet where another bed of yelllow ore was cut, said to be twenty-seven feet thick.

No ore has been raised, the object of the Company being to develop a large reserve.

About twenty men are employed at this mine.

Suffield Mine.—This mine, situated on the 3rd lot of the 13th concession of Ascot, is also the property of the Sherbrooke Mining and Smelting Company. A shaft has been sunk 200 feet; at the depths of eighty-five feet, and 200 feet, levels have been driven to the east, the former 300 feet and the latter 100 feet, connected by a ventilating winze.

The amount of exposed ore is about 40,000 tons, 3,500 to 4,000 tons have been taken out and will be concentrated and smelted at the mine.

Mr. Stewart, the Company's obliging superintendent, informed me that with the present appliances they can take out seventy-five tons a day. The drilling is done by an air compressor driven by an engine of sixty horse-power. The drills which have a stroke of $3\frac{1}{2}$ inches and make 500 blows to the minute, penetrate eight feet in 45 minutes.

The bulk of the ore is of a very fine texture, and varies in color from a steel grey to a pale yellow. It resembles portions of the Hartford mine ore described by Dr. Harrington as tetrahedrite. (*Geol. Survey Reports*, 1877–78, p. 52.)

Iron pyrites is frequently associated with it, both in granular masses and large cubes.

Assays of ore made by John Massey & Co., London, England, gave silver varying from 8 ozs. to 235 ozs. to the ton, and from 4 to 29 per cent. of metallic copper.

Sixty men are employed at this mine.

Iron Ore.

Leeds.—On the 10th lot of the 15th range, in the township of Leeds, the magnetic iron ore, described in the Geology of Canada, 1863, p. 677, has since been found in situ and traced a considerable distance. Several tons of the ore were shipped some time ago to the St. Maurice Forges on trial, and proved to be of good quality.

St. Armand.—On the 43rd lot of St. Armand east, a small opening has been made, on what appears to be at first glance, an epidotic dyke, or it may possibly be a thin vein. It is almost vertical, and is flanked on either side by epidotic amygdaloid and chloritic schists. These epidotic rocks, hold small shining plates and crystals of specular iron, to the extent of about 5 per cent. I need hardly say this enterprise did not prove remunerative.

S. Ham.—On the 1st range, between the 22nd and 24th lots, a bed of magnetite occurs. It is about eleven feet wide and overlaid by serpentine.

Wakefield, Quebec.—On the north half of lot 7, in the 1st range of Wakefield, a vein of magnetite was met with, about 4 feet in width. There are numerous detached crystals on the surface which have been derived from the disintegrating limestone that forms the walls of the vein.

Magnetite occurs also on the south half of the same lot in veins, and patches distributed through a pyroxene rock.

Antimony.

S. Ham, Quebec.—At the antimony mine of South Ham, situated on the 28th lot of the 1st range, on the property of Mr. W. Russell, of Quebec, when visited in August, some preliminary work was being done by a small gang of men, who were employed removing detatched pieces of rock from the bottom of the shaft, which had caved in through unskilful working, having caused the timbers to give way. It is the intention of the owner to sink 10 fathoms deeper. 15 yards off, a double shaft has been sunk to the depth of 100 feet, in black argillaceous slate, holding disseminated grains and crystals of native antimony. Pockets of the sulphide (stibnite) are occasionally met with.

Two or three levels have been driven short distances, but with what result I was unable to ascertain; judging from what had been excavated, none of the ore would average more than 5 per cent., exclusive of some very rich pockets said to have been extracted.

Two hundred yards east of this shaft another opening has been made to the depth of 12 feet, and judging from the dumps of extracted minerals, some very rich pockets of native antimony have been taken out; the presence of the sulphide is marked only by small acicular crystals that are sometimes met with in cavities in the wall rock.

The minerals of antimony that have been noticed at this mine are:—

1. Native Antimony distributed through a great thickness of argillaceous slate, in disseminated grains, and small crystals; the latter, however, are confined to the veins. This deposit may be regarded as an interstratified bed, alternating with other rocks of a more micaceous nature. A highly lustrous variety of native antimony fills some of the pockets, which abound in the region of the slates. It is invariably associated with the oxysulphide (kermesite) in diverging masses and capillary tufts. The color of the latter varying from dark cherry-red to almost white.

2. A granular variety of valentinite intersected by small crystals of the same mineral, sometimes accompanied by rounded crystals of quartz, constitutes the filling material of some of the veins, and like the native metal is associated with kermesite, in, however, a more advanced state of decomposition. Besides the massive variety, small but well defined crystals of valentinite and senarmontite may frequently be seen lining cavities near to the walls of the vein. In breaking some specimens of the native antimony, obscure diverging blades were noticed, and it appears that the kermesite, and the native metal also, has been derived from the sulphide.

The passage of the sulphide to kermesite is shewn by the latter when fractured often exhibiting included portions of sulphide. This accounts in some measure for the sulphide which elsewhere appears to be the most abundant form being here comparatively rare. The bedded material averages about 5 per cent., and has to be concentrated to 8 per cent. before it is marketable. This is accomplished by first passing the ore through a set of stamps, a stream of water then carries the crushed material on to a rubber belt about four feet wide, revolving at a slight inclination, by which the heavier particles are carried under, to the receiving trough, whilst the lighter portions pass off with the water. I have no doubt that a great deal of the oxide must be lost, and also portions of the native metal. On examining some of the slime numerous shining particles of antimony could be seen. A large commodious building has been erected, wherein is stationed an 18 horse power engine.

Nickel.

Orford Nickel Mine.—This mine is situated on the 6th lot in the 12th range of Orford. Mining operations have apparently been suspended some time. The general aspect on approaching the mine conveys some idea of the misdirected enterprise of the proprietors. Numerous substantial houses have been erected, also a commodious store, powder-house, smelting-furnace, &c.—all now deserted, with the exception of one house, used by the caretaker. This group of houses forms quite a village, and were they situated in a more frequented locality, would in all probability prove more remunerative than the mine.

Two small shafts have been sunk on what appears to be a large calcite vein, enclosing small transparent green crystals of chrome garnet, and often penetrated by long filaments of pyroxene, of a greenish or yellowish color. The latter mineral often occurs in long fibrous masses cleaving with great facility parallel to the fibres; it also assumes reticulating shapes, the intervening parts being filled with dogtooth spar and dolomite.

The chrome-garnet also forms large granular masses, holding, sparingly disseminated, small brass-like grains and crystals of millerite. The largest crystals, however, are generally found penetrating a beautiful cleavable variety of calcite, and often exceed three inches in length. Cavities are of frequent occurrence in the massive portions of the chrome garnet, and are usually filled with small dodecahedrons of transparent green garnet and minute crystals of chromite.

Gold.

Gold Mine, Garthby.—An opportunity was taken to visit the so-called gold mine on the property of Mr. Elzear Deblois, marked on the town plan No. 1, in the 15th range of Garthby.

Some promising specimens of native gold in a ferruginous-looking quartz, occasionally holding some cubical pyrites, are shown by the proprietor, who assured me they were taken from a vein at the back of his house. On examining the vein, it was found to be highly crystalline, exhibiting many modified forms of quartz. It was not visibly auriferous, and it also presents other points of difference, with the specimens shown as coming from it.

Graphite.

On the south half of lot 7, in the 1st range of Wakefield, a fine granular variety of graphite occurs, filling pockets in a fine-grained crystalline limestone.

The residents of the neighborhood are in the habit of using the crude material for polishing purposes. Whether this can be extracted to advantage must be decided by a trial. The outcrop, which is about two feet, dipping at a high angle, does not present any encouraging feature, although there is every reason to suppose the mineral is distributed to some extent throughout the entire band. This might easily be proved by a short adit level. A serpentinous mineral, which may probably be referred to rensselaerite, forms lenticular patches in the same band, and like the limestone is also graphitic, although in this instance, in broad scales.

A mineral, probably aragonite, occurs in connection with this limestone. It stands out in relief on the weathered surface, and consists of conical groups of long fibres, weathering to a yellowish-brown colour.

Asbestus.

This mineral is now causing some excitement in the Eastern Townships, augmented by the gradual increasing demand for it.

There appear to be unlimited quantities of it distributed throughout the entire serpentine belt, which attains its greatest prominence in the townships of Thetford and Coleraine. The existence of asbestus is generally made apparent by the whitish shining substance found coating the serpentine arising from the decay of the outcropping veins. But this must not be taken as always indicating the presence of workable veins. The serpentine may be devoid of asbestus for several feet adjoining other masses intersected by numerous veins of it. Asbestus veins are apparently confined to certain masses, through which they pursue parallel courses. Not unfrequently two small veins are seen to converge into one.

At the Thetford mines, and elswhere, there are large blocks of serpentine without a trace of asbestus.

The veins are occasionally associated with grains of magnetite and chromic iron. Cobbing is then resorted to as the best means of separation. The magnetite forms rather conspicuous masses between the veins of asbestus in King's mine in Thetford, and sometimes it entirely replaces the latter.

Boston Company's Mine.—At the Boston Asbestus Packing Company's mine, on the 27th lot in the 5th range of Thetford, I was informed by Mr. Sheridan, the company's Manager, that although the output was fully up to expectations, the demand was much greater than they could meet. The features at this and the neighbouring mines are very similar; a massive serpentine, varying in color from a dark green to almost white, cut by numerous veins of chrysotile (Asbestus) from a quarter of an inch to four inches in width, which are comparatively free from foreign matter.

When visited in the month of August, this mine was about seventy feet deep and covered a great deal of ground. About seventy-five tons of very fine asbestus were awaiting shipment to Boston. A portion of a four inch vein, that could not weigh less then two hundred pounds, lay on the heap.

The average daily output during the summer months, was two tons. Seventy-five men employed.

Johnson's Mine.—This mine situated on the 27th lot in the 6th range of the same township, has been opened by a trench of about fifty yards long, which not only affords ample gang-way room, but also serves for drainage purposes. In cutting this trench a wedge shaped mass of felspathic rock was encountered in the serpentine. As at the last mentioned mine, the work is progressing most favourably, and when visited, the fifty men employed had raised ready for shipment about sixty-five tons of first class asbestus. The daily output averages about two tons.

King's Mine.—King Bros. mine is situated on the 26th lot in the 5th and 6th ranges of Thetford. This mine had commenced operations, but a short time previous to my visit. The veins near the surface are small, and the fibres of crysotile are much broken by small penetrating veins of magnetite. They, however, seem to improve in depth both in quality and size. Twenty men are employed, whose aggregate daily output, would amount to half a ton. Twenty tons have been extracted and are ready for shipment.

Wards Mine.—This mine is situated on the south half of lot 27, in the 5th range of the same township. A gang of twelve men has just commenced operations, but owing to the necessity of procuring a permit to tunnel the railroad track, were not making much progress.

Wright's Mine.—This mine recently opened, is situated in the township of Wolfstown. It was not visited, but I learned that about four tons had been extracted. Twenty men being employed. The average daily output is about one quarter of a ton.

Big Island Pond.—This mine, situated on Big Island, in Lake Nicolet, in the Township of South Ham, is the property of Mr. W. Russell, of Quebec. The serpentine rocks at this point rise rather abruptly to the height of seventy feet, forming cliffs on the western side of the island.

Several openings have been made at the most promising points, revealing in every case, veins of asbestus or crysotile in more or less abundance. The mineral on this island, presents many points of difference, both in quality and extent, with that from the township of Thetford and elsewhere, and may be said to comprise four varieties :

First. Small veins rarely exceeding half an inch in width, the fibres not easily separable. This, however, does not detract from its commercial value.

Second. Apparently occupying a position at right angles to the veins above noticed, is a coarse fibrous mineral, resembling rope, and evidently derived from the associated picrolite. The extreme length which these fibres may attain could not be determined, but judging from exposed portions it cannot be less then three feet.

Third. Veins somewhat resembling the latter in aspect, but much finer in texture. The fibre can be separated with great facility, though firmly attached at one end to the parent rock.

Fourth. A steatitic asbestus rock, resembling "Mountain Leather" forms important masses, enclosing small concretionary pellets of asbestus, the centres of which contain a nucleus of serpentine. Very little has yet been done on the island, to develop these asbestus veins, perhaps, owing to the difficulty of transport across the lake, which, however, would probably be more then counterbalanced by the magnificent returns, this locality promises to afford.

Apatite.

The prospect of apatite mining cannot be said to be on the decline, and a trip through the apatite region will soon dispel any doubts in this respect, that rumour may have given rise to. Apatite lands are still in great demand, and although exhorbitant prices are often offered; they are nevertheless refused. The importance of this industry to the Gatineau district, is daily becoming more apparent, and the construction of the Gatineau Valley railroad will, by affording easy transport render it still more profitable.

I had time to visit only a few of the productive mines in the townships of Templeton, Hull and Wakefield. These will be referred to separately.

Haldanes Mine.—This mine is situated on the 12th lot in the 1st range of Wakefield, but was not visited. Specimens from it were given me, some of which were of a dark green granular variety, very much impregnated with iron pyrites, while the granular variety of a lighter shade contained no pyrites.

Moore's Mine.—This mine is situated on the 17th lot in the 1st range of Wakefield, on the property of Mr. Thos. Lawlor, the mining rights being secured by Mr. Isaac Moore of Ottawa. Nothing appears to have been done to develop the apatite on this lot, with the exception of some prospecting, exposing a few small veins; one about four feet wide was greatly mixed with pyroxene and crystals of tourmaline.

Moore's Mine.—This mine is also the property of Mr. Isaac Moore, and is situated on lot eighteen, range two of the same Township. At this mine an almost vertical stratum has been stripped for about fifty feet along the strike, exposing numerous veins and pockets of apatite in pyroxene and limestone. The veins hold fine crystals of black mica, often accompanied by crystals of pyroxene of 50 lbs. weight, with their terminal and lateral planes well preserved, although somewhat dulled by an incipient decomposition. An interesting vein of about two feet wide occurs at this mine, filled with crystals of apatite varying in size from one ounce to several hundred pounds. In following the vein, a cavernous *vug* was struck, with an entrance of five feet, the overhanging wall being covered with long handsomely formed crystals of pyroxene. The spaces between these crystals are best accounted for, by an examination of the material forming the floor of the cave, and which consists of disintegrated particles of apatite and an occasional crystal of pyroxene, liberated by the decomposition of the apatite rock.

A few yards from this cave in a depression where the rocks become more horizontal, several pits have been sunk with very satisfactory results, on what appear to be bedded masses of apatite alternating with other rocks, as pyroxene and a translucent variety of scapolite. In one instance, a vein of quartz was seen cutting the stratification with inclusions of apatite and pyroxene.

About 120 tons of apatite had been mined, and was ready for shipment. At the time of my visit, the average daily output with nine men employed, was four tons.

I have since learned that two hundred tons more have been extracted, making the total 230 tons for the year 1882.

The bedded masses are generally of the fine granular variety, although the veins are sometimes filled with the coarser varieties.

Wilson's Mine.—This mine is situated on lot 17, range 2, of Wakefield. An irregular vein of apatite has been followed about 40 feet. It is about 12 feet wide, with a tendency to pinch out, in which case a bed of ferruginous-looking apatite, running with the stratification, may become available although the removal of the overlying rocks would be attended by a great amount of labour and expense.

The apatite from the vein consists of two varieties, the cleavable and the granular, varying in color from a bright red to a dull green. The grains of the latter variety are so strongly coherent as to admit being mined and shipped with less loss than some of the varieties known as sugar phosphate.

When visited in September about one hundred tons of first quality apatite had been taken out and were ready for shipment. Eight men were employed in the mine.

Moore's Mine.—This mine also belongs to Mr. Isaac Moore. It is situated on lot 12, range 16, of Hull. Several openings have been made at various points on this lot, the result of which was not of a nature to encourage further investment. The aggregate output of the several pits might possibly amount to 30 tons. The veins of apatite that were noticed were usually very small, sometimes intermingled with pyroxene.

Crystals of apatite are also abundantly interspersed throughout the pink calcite veins that intersect the rocks of the neighborhood. The overlying rock at this mine consists of orthoclase, studded with imperfect crystals of titanite and pyroxene, having a thickness of about 30 feet.

In connection with the above may be mentioned a band ot pink limestone, occurring a short distance east of the apatite openings, enclosing fine crystals of a greenish-black hornblende, sometimes three inches in length and an inch in diameter. Immediately overlying this is another band of whitish limestone holding disseminated plates of graphite.

Close to the last mentioned place a small pit has been sunk, for what purpose, I am unaware, revealing several feet of scapolite, apparently forming a bedded mass. The associated crystals, although attaining an immense size, are usually very much defaced.

Apatite Mine.—On lot 7, range 7, of Templeton, a pit has been sunk through an orthoclase rock, studded with crystals of titanite, striking a bedded mass of apatite, presenting a 15 feet face and still not limited. The apatite for the most part is a coarse cleavable variety, often very much impregnated with pyrites. Veins of calcite may be seen cutting the stratification, holding rounded crystals of pyroxene and apatite. Scapolite and hornblende, are also of frequent occurrence, filling cavities.

About 50 yards east of this opening another has been made, in what appears to be a bed of greyish-white scapolite rock of considerable thickness, cut by small veins of apatite, and there are also pockets of a lamellar variety of pyroxene and apatite, which are somewhat conspicuous. Over one hundred tons of very fine apatite had been mined and were ready for shipment. Four men were employed in the mine.

Post's Mine.—This mine is situated on the east half of lot 9, range 10, of Templeton. The opening visited consists of a trench about 50 feet long, and from 30 to 70 feet in width. The amount of apatite that has been raised was not ascertained, as all work was suspended.

On examining the dumps, the mineralogical characters of the rock did not appear to differ from those shewn by many of the other apatite localities, with the exception of the occurrence of chabazite and prehnite, the former in semi-transparent penetrating twins, and the latter in greyish-white mamillated groups, the individuals of which are strongly coherent. I have since learned Mr. Post is carrying on operations farther east, but with what success has not been ascertained.

Jackson Rae Mine.—This mine is situated on the west half of the same lot, and comprises a number of openings, the most extensive of which is a tunnel. On descending the slope to the mine, the eye is at once attracted by the numerous veins and patches that intersect the standing walls, and many of them crossing the stratification.

Amongst the associated minerals at this mine may be mentioned a massive iron pyrites, often enclosing grains of apatite, and in one instance a thin film of pyrites completely enveloped a crystal of apatite. Mr. Mason, the company's manager, presented me with some interesting specimens of apatite, of a dark bottle-green color. They were in nuggets and rounded crystals, shewing deep indentations or cavities. They were probably derived from some of the calcite veins.

At the time of my visit about twenty men were employed, and the apatite heaps would aggregate about 100 tons. At another opening on this lot, known as the Spring Mine, a beautiful variety of sea-green color occurs, but to what extent this has been worked I failed to learn.

Murphy's Mine.—This mine is situated on the south half of lot 10, in the 10th range of Templeton. At the time of my visit work had been suspended.

Several pits have been sunk, at various depths, in the pyroxene strata, and any comment on the same would be a superfluous repetition of the descriptions already given.

Mica.—A thick calcite vein was cut in one of the pits. It holds large plates of mica, often two feet square, and perfectly free from cracks or folds. Plates of this mineral have been subjected to the heat of an ordinary coal stove, for three months, without any perceptible swelling or parting, but their transparency is slightly marred owing to their becoming tinged by the flame. This vein may yet become of economic importance.

Scapolite.—A beautiful pink translucent scapolite was noticed amongst the debris from the mines. It appears to assume this color only on exposure, as freshly fractured specimens are colorless.

Mr. A. McLaurin's Property.—This property is situated on the south half of lot 8, in the 12th range of Templeton. The pyroxenic rocks crop out in many places on this lot, and are occasionally cut by veins of pink calcite, holding prisms of mica and of apatite. The more workable deposits, however, are confined to veins in the pyroxene, which vary very much in width. It is the intention of Mr. A. McLauren to commence operations in the fall.

Breckin's Mine.—This mine is situated on the 23rd lot, in the 13th range of Templeton. At the time of my visit work was suspended at it, owing to other exposures in the neighborhood, affording more encouraging prospects. The apatite, visible, occurs in spurs and small lenticular patches, and may prove more abundant at a lower level. The associated minerals noticed were titanite in large imperfect crystals, scapolite, prehnite, pyroxene, fluorite, idocrase, natrolite (?) and zircon.

Blue Apatite.—On the south half of lot 7, in the 1st range of Wakefield, small sky-blue crystals of apatite occur, associated with prisms of silvery mica, in a disintegrated limestone.

Barite.

Barite.—Barite occurs on lot 12 in the 12th range of Templeton. A small opening has been made in a gneissic rock, on, what is probably, a bedded vein of a lamellar variety of barite. The upper portion of the deposit, is greatly mixed with calcite, also, occasionally by brownish red geniculated crystals of rutile, which mineral appears to be more frequent, in a yellowish brown barite, that occurs near to the overlying gneiss.

A small quantity of the mineral has been taken out, and consists for the most part of an admixture of calcite and barite, constituting a very inferior article. These impurites are less frequent in the lower portion of the bed.

Garnet.

Garnet Mine.—An opening has been made in a band of crystalline limestone, situated on the north half of lot six, in the first range of Wakefield, and better known as McBryde's Mine; crystals of Garnet of various modifications, from the dodecahedron to the elongated trapezohedron, occur in some abundance, also in clusters and crystalline aggregates of undeterminable form, from almost colorless to white, and from translucent to opaque. One of the most common forms being that of a rhombic dodecahedron of a hair brown color. The lateral planes sometimes measuring two inches, and an inch and a half in diameter.

These crystals are associated with zinc-blende, galena, pyrite, idocrase and graphite. The pyrite often forms a considerable propor. tion of the whole mass.

Mullin's Mine.—Another opening has been made on lot fourteen of the first range of the same township, where work, I am told, has been carried on for four months, but with what object in view, I failed to perceive. The rock is a very crystalline limestone, interbedded with masses of wollastonite. This latter mineral being sometimes intermingled with the limestone forming granular masses, enclosing rude crystals of a wine colored garnet of large dimensions: their structure is decidedly granular, and they shatter under the least concussion, and are consequently useless for ornamental purposes.

Idocrase.—These crystals are accompanied by large translucent brown prisms of idocrase, often two inches in length, and one inch in diameter, with their angles more or less bevelled.

Wollastonite.—Wollastonite also occurs on the south half of lot seven in the first range, filling a vein with a sky blue calcite, and a mineral resembling idocrase.

Tremolite.—Tremolite in reticulating masses of a light green color, occurs on lot seventeen of the first range of Wakefield, enclosed in a pink calcite. The bladed individuals are often semi-transparent, and deeply striated longitudinally. They are accompanied by crystals of pyroxene.

Scapolite.—Scapolite may be mentioned in the same connection forming beds of some thickness, the unweathered surfaces of which are covered with crystals of the same mineral. Although the faces are somewhat rough, owing to partial decomposition, their crystalline form is perfect.

Titanite.—To enumerate all the localities where titanite occurs would be both endless and useless. Suffice it to say, it is one of the most commonly associated minerals of the apatite rocks, either distributed in crystals or forming lamellar and granular masses in pyroxene.

On lot seven in the first range of Wakefield, it occurs in crystals in such abundance as to make up more than three-fourths of the whole mass, and even the remainder is sometimes thickly studded with minute crystals. The titaniferous mass is again cut by calcite veins, also studded with crystals of titanite. More perfect crystals, however, occur under similar circumstances about two hundred yards north of the latter place, of a clove brown color, and often measuring three inches across.

Haldane's Mines.—Since writing the foregoing, I have been furnished with more details respecting this flourishing mine, owned by Messrs. Haldane and Sons, of Aylmer, and on their authority the following statement is based :

They have now sixteen openings on veins of apatite, traceable from twenty to 100 feet across the lot; their width varies from two to ten feet. Among the most promising exposures that have been worked, may be mentioned a vein of red apatite, ten feet in width which has been stripped for a distance of forty-two feet, and tested to the depth of fifteen feet. Another opening known as the "Big Pit" has been sunk 125 feet, and has yielded since it was first opened about 1,800 tons of dark greenish apatite. The vein in the bottom of the mine is said to shew as well as ever.

A number of other veins in the neighborhood of the Big Pit mine, have afforded several hundred tons of a pale green apatite. About 100 yards south of the "Big Pit" mine, another opening has been made on a vein of red apatite, from which about eighty tons of 86½ per cent. phosphate have been extracted. A tunnel has been driven about sixty feet following a vein of bluish green apatite, from which 100 tons have been taken.

Messrs. Haldane expect to have 600 tons ready for shipment in the spring. Fifteen men are employed in connection with the mines. And during the four years of possession, twenty-five acres of land have been cleared and some substantial buildings erected.

GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

CHEMICAL CONTRIBUTIONS

TO THE

GEOLOGY OF CANADA.

FROM THE

LABORATORY OF THE SURVEY.

BY

G. CHRISTIAN HOFFMANN, F. Inst. Chem.

Chemist and Mineralogist to the Survey.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

Montreal:

DAWSON BROTHERS.

1883

ALFRED R. C. SELWYN, ESQ., LL.D., F.R.S., F.G.S.,

Director of the Geological and Natural History Survey and Museum.

SIR,—I have the honor of herewith laying before you my Report upon the work carried out in the Laboratory of this Survey during the past year. It embodies only such analyses and examinations as were deemed likely to prove of general interest. Of these, such as were conducted by Assistant Chemist, Mr. Frank D. Adams, have, in all instances, been duly credited to him.

The results of an examination of a series of coals, from the North-west Territory, is in course of progress, and I trust to be in a position to hand you the results, in the form of a separate report, at an early date.

I have the honor to be,

Sir,

Your obedient servant,

G. CHRISTIAN HOFFMANN.

OTTAWA, December 30, 1882.

CHEMICAL CONTRIBUTIONS

TO THE

GEOLOGY OF CANADA.

FROM THE

LABORATORY OF THE SURVEY,

BY

G. CHRISTIAN HOFFMANN, F. Inst. Chem.

MISCELLANEOUS MINERALS.

SAMARSKITE.

This interesting mineral—not hitherto met with in Canada—was found just beyond the north-western limits of the township of Brassard, county of Berthier, P.Q. Samarskite from Berthier county, P.Q.

It consisted of irregular-shaped fragments without the slightest indication of crystalline form. Lustre, sub-metallic, shining. Color, brownish-black, almost black; in parts iridescent. Opaque even on the thinnest edges. Brittle. Fracture, uneven. Streak, greyish-brown. Hardness, about 6. Fuses between 4 and 4·5. Specific gravity, 4.9478. In the closed tube decrepitates and gives off a little slightly acid water. Readily and completely decomposed by heating with concentrated sulphuric acid. Analysis gave:— Analysis of.

Columbic acid. } Tantalic Acid.. }	55.41*
Tungstic Acid	—
Stannic acid	.10
Yttrium oxide†	14.34
Cerium oxides†	4.78
Uranium oxide (UO_3)	10.75
Manganous oxide	.51
Ferrous oxide	4.83
Lime	5.38
Magnesia	.11
Potash	.39
Soda	.23
Fluorine	trace.
Water	2.21
	99.04

* Apparently in great part, if not almost entirely, columbic acid.

† The presence or absence of other members of this group was not ascertained.

A gramme of the finely pulverized mineral, decomposed by heating with sulphuric acid, with careful exclusion of air, decolorized an amount of potassium permanganate corresponding to 4.79 per cent. ferrous oxide. The water was expelled by ignition and collected in a chloride of calcium tube.

INDURATED CLAY.

Indurated clay from Manitoba.

From Souris City, Souris River, Manitoba.

Structure, compact. Color, light bluish-grey. Lustre, dull. Smooth, but meagre to the touch. Adheres strongly to the tongue. Tough. Somewhat sonorous. Hardness, about 3. Fracture, irregular, occasionally imperfectly large conchoidal. May be ground, with tolerable facility, to a soft impalpable powder, which forms with water a more or less plastic paste. Geological position, Cretaceous—(Pierre formation.)

This specimen was collected by Dr. A. R- C. Selwyn, who at the time of handing it to me expressed the opinion that it would, in all probability, prove an excellent material for the manufacture of building brick; a supposition, the correctness of which has been fully borne out by actual experiment.

For the purpose of brick making, this material requires—agreeably with the present experience—no admixture whatever. In the following experiments it was simply ground to powder—which it readily admits of—mixed into a stiff paste with water, well pugged and then the moulding of the bricks proceeded with. By employing the material in a fine state of division, and forming the bricks under pressure, an article of very close texture may be ensured. The bricks after having been thoroughly dried, were finally burned in the muffle of a cupelling furnace, at a full-red heat. On examination they were found to have retained their form well, having neither warped nor cracked; they were firm and tough; the color, a very pleasing one, may, perhaps, be best described as a very pale brownish-yellow. They were in no wise affected by protracted and repeated immersion in water.

Its adaptability for the manufacture of building and fire brick.

Other of these bricks were inserted in covered crucibles, and these latter placed in an air-furnace, the temperature of which was gradually raised, until, at the expiration of an hour, a white heat had been attained, at which temperature it was maintained for an additional two hours. On opening the crucible the bricks were found to have retained their original form intact, they had neither warped nor cracked, their edges remained perfectly sharp and showed no indication of having undergone even the most incipient fusion. Color, a very pale reddish-brown.

The foregoing experiments tend to show that this clay is well adapted for the manufacture of an excellent building brick, and further, lead to the inference, that it could also be advantageously employed for the manufacture of a good class of fire brick.

It should be stated that this material is readily accessible, and occurs in practically unlimited quantity.

An analysis of this clay, and further experiments in regard to its employment as a refractory material, will be carried out in the course of a contemplated early investigation bearing directly upon the subject of our fire-clays.

BITUMINOUS SAND-ROCK AND MINERAL-TAR OR MALTHA.

Bituminous sand-rock and mineral-tar from the North-west Territory.

From the Athabasca or Elk River—North-west Territory. With reference to the geological position and general mode of occurrence of the above, Dr. R. Bell informs me:—

"That the deposit is of Cretaceous age, but rests directly upon limestone of the Devonian system. The bedding of the latter undulates gently, while the asphaltic sand lies in thick horizontal layers upon its surface, and in some cases fills fissures in the upper part of the limestone. The asphaltic matter has no doubt resulted from petroleum rising up out of the underlying Devonian rocks, in which evidence of its existence can be detected. In descending the Athabasca River it was first observed a few miles above the junction of the Clearwater branch, below which it becomes more conspicuous, forming the whole banks of the stream, with the exception of a few feet of limestone at the base, for a distance of many miles. These banks are sometimes about one hundred and fifty feet in height, and frequently maintain an elevation of about one hundred feet for considerable distances. Except where they have been long exposed to the weather, they generally look as black as coal. A thick tar is often seen draining out of the deposit, and in numerous places on the ground at the foot of either bank, or on terraces lower than their summits, this tar collects in pools, or flows in sluggish streams to lower levels among the peaty materials in the woods. The surface of these accumulations of tar is usually covered with a hardened pitchy crust. The boatmen on the river break through this crust in order to collect the underlying tar which they boil down and use for pitching their craft. Some parts of the banks are rendered plastic *en masse* from being over-saturated with the asphalt, and in warm weather they slide gradually down into the bed of the river incorporating the boulders and pebbles in their course."

Mode of occurrence.

BITUMINOUS SAND-ROCK.

Bituminous sand-rock.

From the Athabasca River, about six miles below its confluence with the Clearwater. Collected by Dr. R. Bell. This specimen was compact

Bituminous sand-rock, cont.

and homogeneous in appearance, and of a dull, dark brownish-black color. Specific gravity at at 60° F. 2.040. At the temperature of 50° F. it is quite firm, barely, if at all, yielding to pressure, and does not soil the hand; at 70° F. it gives somewhat to the touch, and is slightly sticky; at 100° F. it becomes quite soft and eminently soils the fingers. It is scarcely act.d on by alcohol in the cold, and but very slightly at a boiling temperature; but ether, oil of turpentine, kerosene, benzine (petroleum spirit), benzol (coal-tar naphtha) and bi-sulphide of carbon, more especially the last two named, readily dissolve the bituminous matter, with formation of dark brown colored solutions, and leaving a pure or almost pure siliceous residue in the form of sand, of which apparently the bitumen had constituted the sole binding medium.

Analysis of.

The composition of this specimen of the rock was found to be as follows:—

Bitumen	12.42
Water, mechanically included	5.85
Siliceous sand	81.73
	100.

The sand consisted of colorless transparent quartz, not unfrequently presenting the bright glassy lustre of broken quartz crystal, the surfaces were, however, for the most part, more or less dulled by abrasion: it contained a few flakes of silvery mica, and, as Mr. Adams—to whom I handed a small quantity for microscopical examination—informs me, an occasional fragment of felspar. It is on the whole exceedingly fine, 52 per cent. of the same passing a sieve of ninety meshes to the linear inch; 16 per cent. one of seventy-five meshes; 15 per cent. one of sixty-six meshes, and 9 per cent. one of fifty meshes, leaving a balance of 8 per cent. as rejected by the latter.

Subsequent to the foregoing examination Mr. A. S. Cochrane, of this survey, handed me a specimen which he collected, and which differs from the above, in that it does not appear to contain so much water and the bituminous matter partakes more of the nature of asphalt. At the temperature of 65 F. it is quite hard, fragments may be chipped off with a hammer, and it is reducible in a mortar to a non-coherent pulverulent condition; at 100° F. it barely yields to pressure, and is only slightly adhesive: at 150° F. it gives to the touch and is somewhat sticky; at 200° F. it is quite soft, and may be readily moulded.

MALTHA OR MINERAL-TAR.

Maltha or mineral-tar

From the right bank of the Athabasca, about twelve miles below its confluence with the Little Red River. Collected by Mr. A. S. Cochrane.

This material also occurs at several other points further down the river, and is identical with that referred to in the prefatory remarks.

The sample in question had a pitchy-black color, in thin layers and by transmitted light, rich dark reddish-brown. The specific gravity at 60° F. was found to be 1.023; at this temperature it has the consistence of a soft extract, and will barely flow; at 70° F., flows, but sluggishly, whilst at 100° F. it has the consistence of treacle.

As regards the utilization of these substances,—the most appropriate application of the former and that for which it would appear to be admirably adapted, would be for asphalting purposes. It has one of the most important qualifications of a good bituminous concrete, viz., intimate combination of the mineral and organic constituents, and this in a degree which no artificial preparation of the kind could be expected to possess. It will, in all probability be found, that a very slight treatment will render it suitable for employment in the construction of roads, foot-paths, court-yards, *et cetera*; for asphalting the flooring of granaries, basements of warehouses and the like, and further as a roofing material. Should it be deemed more expedient to separate the bitumen, this may be effected by simply boiling or macerating the material with hot water, when the bituminous matter, entering into fusion, will rise as a scum to the surface and may be removed by skimmers, whilst the sand falls to the bottom of the vessel.

Economic uses of the Bituminous sand-rock.

Extraction of the Bitumen.

An experiment was made in order to ascertain the greatest state of purity to which the bitumen could be brought by this method; it was found, that of the 81.73 per cent. sand, 69.26 per cent. had been removed, the extracted bitumen containing 50.1 per cent. sand, and—owing to the extreme fineness of a portion of this latter, as already mentioned—it may be questioned if the purification, by this method, could be pushed much beyond this.

The sand separated by this process, when carefully conducted, is free or almost free from bitumen, and might, after being heated to redness in a reverberatory furnace—to destroy any little adhering bitumen—be advantageously employed for the manufacture of one of the better qualities of glass.

The above treatment requires but the simplest of appliances and might be readily carried out on the spot.

Economic uses of the Maltha.

The amount of maltha at my disposal was far too small to warrant any attempt at its distillation. Should it occur in sufficient quantity, it might possibly, amongst other uses, be advantageously employed as a crude material for the manufacture of illuminating and lubricating oils and parrafin.

NATURAL WATERS.

Lake and river waters from North-west Territory.

The following lake and river waters from the North-west Territory, were collected at the instance of Mr. A. S. Cochrane, whilst conducting a survey in the section of country in question, and handed to me by him for examination.

Mr. Frank D. Adams has conducted a qualitative analysis of these waters, and also estimated the amount of total dissolved solid matter contained in them. The results obtained by him were as stated below.

Examination of water from Reindeer Lake.

1.—Reindeer Lake.—This water was taken from an open space between the islands, about ten miles above the outlet of the lake. Date of collection, July 25th, 1881.

There was a small quantity of flocculent suspended matter of a yellowish-brown color. After filtration the water had a faint brownish-yellow tinge. The specific gravity at 15.5° C. was found to be 1000.04, and the total dissolved solid matter dried at 100° C., amounted to 2.02 grains to the Imperial gallon.—It contained:

Potassa and soda....	A very small quantity, potassa predominating.
Lime	A slight trace.
Magnesia...........	A trace.
Silica	A very small quantity.
Carbonic acid.......	A mere trace.
Chlorine	A trace.

Examination of water from Churchill River.

2.—Churchill or English River.—This sample was taken from the centre of the river, about six miles above the Kettle Falls. Date of collection, July 28th, 1881.

There was a large quantity of flocculent suspended matter of a light brown color. After filtration the water had a pale brownish-yellow tinge. Its specific gravity at 15.5° C., was 1000.17. The total dissolved solid matter—dried at 100° C.,—amounted to 7.96 grains per Imperial gallon.—It contained:

Potassa and soda....	A rather large quantity, potassa predominating.
Lime..............	A small quantity.
Magnesia	A very small quantity.
Silica..............	A somewhat large amount.
Carbonic acid.......	A very small quantity.
Chlorine	A small quantity.

Examination of water from Saskatchewan River.

3.—Saskatchewan River.—Taken from the centre of the river, about a quarter of a mile below the junction of the Big-Stone River. Date of collection, August 3rd, 1881.

There was a large amount of brownish-black colored flocculent matter in suspension. After filtration, the water had a pale brownish-yellow color. The specific gravity at 15.5° C., was found to be 1000.33, and the total dissolved solid water—dried at 100° C.,—amounted to 16.60 grains per Imperial gallon.—It contained : Examination of water from Saskatchewan River.

Potassa and soda....	A rather large quantity, potassa preponderating.
Lime..............	A large quantity.
Magnesia	A rather large quantity.
Ferrous oxide......	A trace.
Silica	A somewhat large amount.
Sulphuric acid.....	A somewhat large amount.
Carbonic acid......	A large amount.
Chlorine...........	A very small quantity.

Of the foregoing waters that from the Reindeer Lake, is remarkable for the small amount of dissolved solid matter which it contains; in this regard it would take rank with the waters of Bala Lake, Merionethshire, Wales, and Loch Katrine, Perthshire, Scotland, the former of which contains 1.953 grains (Frankland and Odling), and the latter 1.981 grains (Wallace) of solid matter to the gallon.

IRON ORES.

HÆMATITE.

1.—From near the head of Loch Lomond, a quarter of a mile north-west of the L'Ardoise road, and a quarter of a mile south-west of McVicars road, Cape Breton county, Nova Scotia. Mr. Hugh Fletcher informs me that it is a contact deposit, and the geological position, Lower Carboniferous. Iron ores—Analyses of

Structure, compact. Color, steel-grey, in parts red. Determinations—by Mr. Frank D. Adams—of the more important constituents, gave the following results: Hæmatite from near Loch Lomond, Nova Scotia.

Ferric oxide..................................	83.645
Ferrous oxide..................................	7.640
Manganous oxide..................................	.285
Phosphoric acid..................................	.077
Sulphuric acid..................................	.194
Water, hygroscopic..................................	.341
Insoluble residue..................................	7.768
Metallic iron, total amount of....................	64.494
Phosphorous..................................	.034
Sulphur..................................	.078

Should this deposit prove at all extensive, and the ore equal in quality to the above sample, it cannot fail to prove of importance.

MAGNETITE.

Iron ores—Analyses of, cont.

2.—A specimen of magnetite from the thirteenth lot of the sixth range of Bagot, county of Renfrew, Ontario, was examined by Mr. F. D. Adams, and found to contain:

Magnetite from county of Renfrew, Ont.

Metallic iron	45.87
Titanium dioxide	trace
Insoluble residue	28.56

The object of the enquiry did not call for a more extended examination.

He has also examined samples of magnetite from other lots and ranges—in this township, in order to ascertain if they contained titanium dioxide or no, and with the following results: specimens from lot five, and the east half of lot ten of the twelfth range, as also a specimen from the twelfth lot of the seventh range, were found to be quite free from the same.

Magnetite from Thunder Bay, L.S.

3.—A very fine crystalline, dark steel-grey colored magnetite from location seven, Thunder-Bay, Lake Superior, was found to contain:

Metallic iron	49.02
Insoluble residue	24.61

This specimen was perfectly free from titanium dioxide.

Magnetite from county of Frontenac, Ont.

4.—Magnetic iron ore from the seventeenth lot of the eleventh range of the township of Olden, county of Frontenac, Ontario.

Massive, structure, coarse-crystalline. Color, greyish-black-lustre, metallic. A partial analysis gave as follows:

Ferric oxide	68.146
Ferrous oxide	28.975
Water, hygroscopic	.059
Insoluble residue	1.364
Metallic iron, total amount of	70.238

This specimen was perfectly free from titanium dioxide.

CLAY IRON-STONE.

Clay iron-stone from North-west Territory.

The following seven specimens of clay iron-stone from the North-west Territory, were collected by Dr. G. M. Dawson, by whom they were submitted to me for examination, accompanied by the following notes in regard to their geological position and general mode of occurrence, in that section of country. He says:

Clay iron-stone from North-west Territory—General mode of occurrence of.

"It may be stated generally, that iron-stone occurs in greater or less abundance at all horizons of the Cretaceous and Laramie or Fort Union beds, whether of marine or fresh water origin, throughout the North-west Territory.

Notwithstanding this general distribution, however, no locality yet observed is capable of yielding this ore in such great quantity as to justify a belief in its immediate commercial value.

The iron-stone occurs either in nodular masses, following certain layers of the shales, sandy-clays and clays of the formations above referred to, or in more or less regular nodular sheets intercalated between the beds. To those localities in which a considerable number of iron-stone bearing bands occur in proximity in a moderate thickness of beds, the greatest importance attaches, and in some of these it may eventually be proved profitable to work over the entire banks for their extraction. The analyses so far made tend to shew the high position which these iron-stones hold among ores of the same class, both as to percentage of iron and freedom from injurious elements.

In the Pierre shales exposed in Pembina Mountain and its vicinity, the iron-stone so far discovered is of inferior quality, and the ore is not abundant. Further west, in the Lignitic (Fort Union) formation of the Souris region, iron-stone is much more abundant and often occurs on the surface in large quantities, where it has been left as the soft containing beds were denuded away.

In the region drained by the South Saskatchewan and its tributaries, the Pierre shales contain a much larger proportion of iron-stone than they do in their eastern exposures, and in some places may yet prove to hold deposits of economic importance. Numbers 5 and 8 of the present series of analyses are of ore derived from this subdivision of the Cretaceous, the former occurring in nodules of large size and in considerable abundance in scarped banks on the Bow River, the latter in the immediate vicinity of the main coal seam on the Belly River, but in a layer only a few inches thick. Number 7 is also probably from this horizon, and occurs forming a series of beds each a few inches in thickness, which are intercalated in black shales in such great number as to form a considerable proportion of the whole. The locality is near the mouth of Kananaskis River, a short distance from the Bow River fall. Specimen number 9 is from a series of pale sandstones and sandy clays which underlie the Pierre shales, and contain in some exposures very large quantities of iron-stone nodules, remarkable from their great size and septarian character.

Clay iron-stone from North-west Territory —Analyses of

The iron-stone of this subdivision of the Cretaceous was observed to be most abundant in the high scarped banks between the mouth of the St. Mary's River and Coal Banks on the Belly River. Numbers 10 and 6 are derived from a series of beds, the precise stratigraphical position of which is yet open to some doubt. They contain estuarine fossils, and occasionally many large nodules and nodular sheets of iron-stone. The locality on the Bow River from which the specimen numbered 6 was collected, is one of those which appear most promising; here the iron-stones are very abundant and often several tons in weight. The stratigraphical position of the specimen numbered 11, is uncertain, owing to the extreme disturbance which the beds in the immediate vicinity of the mountains have suffered"

From Bow River.

5.—Bow River, eight miles above Grassy Island.

Structure, very fine granular. Color, ash-grey with a brownish tinge. Streak, ash-grey. Fracture, imperfectly conchoidal. Weathers purplish-brown.

A partial analysis of this ore gave:

Ferrous oxide	40.347
Ferric oxide	.878
Water, hygroscopic	.856
Insoluble residue	16.121
Metallic iron, total amount of	31.996

Erom Bow River.

6.—Bow River, twelve miles above Prairie Island.

Structure, compact. Color, ash-grey. Streak, pale ash-grey. Fracture, large conchoidal. Weathers, reddish-brown.

A partial analysis of this specimen gave:

Ferrous oxide	28.818
Ferric oxide	.818
Water, hygroscopic	.938
Insoluble residue	13.935
Metallic iron, total amount of	22.987

From Kananaskis River.

7.—Kananaskis or Rapid River, near its confluence with Bow River.

Structure, very fine granular. Color, dark bluish-grey. Streak, dark-grey. Fracture, imperfectly conchoidal. Weathers, brownish-red.

A partial analysis gave: Clay iron-stone from North-west Territory—Analyses of, cont.

Ferrous oxide	13.786
Ferric oxide	.772
Water, hygroscopic	.473
Insoluble residue	66.966
Metallic iron, total amount of	11.263

8.—Belly River, at "Coal Banks."

Structure, very fine granular. Color, brownish-grey. Streak, ash-grey with a slight brownish tinge. Fracture, imperfectly conchoidal. From Belly River.

A partial analysis gave:

Ferrous oxide	41.458
Ferric oxide	.328
Water, hygroscopic	1.042
Insoluble residue	10.294
Metallic iron, total amount of	32.475

9.—Belly River, about seven miles below "Coal Banks."

Structure, fine granular. Color, pale reddish-brown. Streak, brownish-grey. Fracture, irregular. Weathers, dark reddish-brown. From Belly River.

A partial analysis gave the following results:

Ferrous oxide	30.730
Ferric oxide	1.398
Water, hygroscopic	1.272
Insoluble residue	23.754
Metallic iron, total amount of	24.880

10.—Belly River, about seventeen miles east of the mouth of the Little Bow River. From Belly River.

Structure, compact. Color, pale brownish-yellow. Streak, light grey. Fracture, large conchoidal. Weathers, brownish-yellow.

A partial analysis of this specimen gave:—

Ferrous oxide	30.302
Ferric oxide	1.487
Water, hygroscopic	1.445
Insoluble residue	12.120
Metallic iron, total amount of	26.165

11.—Mill Creek, at coal outcrop, about four miles above the mill. From Mill Creek.

Structure, fine granular. Color, dark grey. Streak, ash-grey.

Fracture, irregular. Weathers dark reddish-brown. A partial analysis of this specimen gave :—

Ferrous oxide	37.985
Ferric oxide	.811
Water, hygroscopic	.634
Insoluble residue	22.511
Metallic iron, total amount of	30.112

MANGANESE ORES.

Manganese ores—Analyses of.

1.—From the Glenmore or Morrison mine, Salmon-River road, about two miles east of the head of Loch Lomond, Cape Breton county, Nova Scotia.

Pyrolusite from near Loch Lomond, Nova Scotia.

This specimen consisted almost exclusively of pyrolusite; a partial analysis of the same—after drying at 100° C.—afforded Mr. F. D. Adams, the following results :—

Manganese dioxide	91.84 per cent.
Ferric oxide	.12 " "
Insoluble residue	2.91 " "

Bog manganese from Boularderie Island, Nova Scotia.

2.—Bog Manganese, from the vicinity of Big Harbour, Boularderie Island, Cape Breton, Nova Scotia. The deposit is stated to be an extensive one.

This sample was in the form of porous friable lumps, varying in color from dark-brown to brownish and bluish black. A partial analysis, by Mr. F. D. Adams, gave the following results :—

Manganese dioxide	25.42 per cent.
Water	33.52 " "

Judging from specimens, collected in previous years, from this locality, I am disposed to regard the one in question as a picked and not an average sample of this deposit.

GOLD AND SILVER ASSAYS.

The following assays were all conducted by Mr. Frank D. Adams:—

PROVINCE OF NOVA SCOTIA.

Gold and Silver assays.

1.—From a large brook, a little above the Salmon River road, seven miles from the head of Loch Lomond, and six miles from Mira.

The specimen, a single fragment, weighed four and a half ounces; it consisted of a breccia through which was disseminated galena in a very finely divided state: the galena apparently constituted but a small proportion of the whole. Assays gave.— Gold and Silver assays, cont.

Gold.. None.
Silver.....................2.879 ounces to the ton of 2,000 lbs.

Province of Nova Scotia.

2.—Canso road, nine and three quarter miles west of Canso, Guysborough county, Cape Breton.

The sample weighed a little over four pounds; it consisted of an association of copper pyrites, arsenical pyrites and iron pyrites in a gangue of greyish, translucent quartz. It was found to contain:—

Gold..trace.
Silver.................. 0.379 ounce to the ton of 2,000 lbs.

3.—This specimen was taken from an opening about two hundred feet distant from that of the preceding specimen.

It consisted of mispickel associated with a small quantity of a greyish translucent quartz.

It contained only traces of gold and silver.

PROVINCE OF NEW BRUNSWICK.

Province of New Brunswick.

4.—Elm-tree River, Gloucester county.

The specimen, a single fragment, weighed somewhat over three and a quarter pounds, and consisted of a coarsely crystalline galena, associated with copper pyrites and a small quantity of zinc blende, in a gangue of greyish, subtranslucent quartz—the latter constituting 49.8 per cent. by weight of the whole. Assays gave:—

Gold.. trace.
Silver.. ....7.197 ounces to the ton of 2,000 lbs.

5.—From the so-called "Nigadoo Silver-mine," Gloucester county.

A fine crystalline galena, associated with a little zinc blende, in a more or less weathered rocky gangue. The metallic sulphides constituted but a small proportion of the whole. It contained:—

Gold.. trace.
Silver..................5.811 ounces to the ton of 2,000 lbs.

PROVINCE OF ONTARIO.

Province of Ontario.

6.—From a small island in the Ottawa River. near Fitzroy Harbour, township of Fitzroy, Carleton county.

A coarsely crystalline galena, associated with a trifling amount of calcite. It was found to contain:—

Gold.. none.
Silver................. 0.493 ounce to the ton of 2,000 lbs.

Gold and Silver assays, cont.

Province of Ontario.

7.—Another specimen found in close proximity to the foregoing, likewise a coarsely crystalline galena, but of a much darker color than the generality of specimens of this mineral; gave an assay:—

Gold.... .... None.
Silver.................. 0.751 ounce to the ton of 2,000 lbs.

8.—From Hastings county.

The specimen, which weighed thirteen and a half pounds, consisted for the most part of a coarsely crystalline aggregate of quartz. felspar and mica, carrying a little iron pyrites; the lesser portion consisted of a more or less weathered, finely granular, highly quartzoze schist.

It contained neither gold nor silver.

9.—From near the Duncan Mine, W$\frac{1}{2}$B, Thunder Bay, Lake Superior.

A greyish siliceous rock carrying small quantities of galena and zinc blende, and a little iron pyrites; the metallic sulphides constituting but a very small proportion of the whole. This sample was found to contain:—

Gold... None.
Silver........... ...... 0.343 ounce to the ton of 2,000 lbs.

10.—From location 20, township of McIntyre, Thunder Bay, Lake Superior.

A coarsely crystalline calcite, associated with quarts, and carrying small quantities of zinc blende and galena, with here and there a speck of copper pyrites.

It contained neither gold nor silver.

11.—From Pie Island, Lake Superior.

A very finely crystalline galena associated with a little zinc blende, in a gangue consisting of quartz and a highly siliceous rock; the metallic sulphides constituted but a small proportion of the whole. It contained:—

Gold................................ .... distinct trace.
Silver..................2.249 ounces to the ton of 2,000 lbs.

12.—From the same locality as the foregoing.

It consisted of finely crstalline galena associated with zinc blende, in a gangue of similar composition to that of the foregoing specimen. It was found to contain:—

Gold.. None.
Silver.................. 0.343 ounce to the ton of 2,000 lbs.

13.—From the same locality as No. 11.

It consisted of zinc blende in a gangue closely resembling that of the two previous specimens. The zinc blende constituted about one-third, in bulk, of the sample; it contained precisely the same amount of silver as the preceding specimen, viz: 0.343 ounce to the ton of 2,000 lbs. Gold and Silver assays, cont.

NORTH-WEST TERRITORY.

14.—This and the three following specimens came from the Rocky Mountains, western part of the district of Alberta. North-west Territory.

This specimen consisted of an impure reddish-grey coloured dolomite.

It contained neither gold nor silver.

15.—An impure reddish-grey coloured fine granular quartzite, with which was associated a small quantity of galena. It contained:—

Gold	None.
Silver	0.466 ounce to the ton of 2,000 lbs.

16.—Consisted for the most part of copper pyrites, associated with more or less green and blue carbonate of copper. Assays gave:—

Gold	0.364 ounce to the ton of 2,000 lbs.
Silver	28,619 " " " "

17.—This specimen consisted of chalcocite, more or less seamed and coated with green carbonate of copper.—A valuable copper ore.—It contained neither gold nor silver.

MISCELLANEOUS EXAMINATIONS.

The following determinations were carried out by Mr. Frank D. Adams:—

1.—Zinc. According to Dr. R. Bell, an extensive deposit of sphalerite occurs nine miles and a half north of the mouth of White Sand River, which latter enters Lake Superior opposite to Simpson's Island, and consequently about the middle of the north shore of the lake. Miscellaneous examinations. Estimation of zinc in blende from White Sand River, L.S.

A specimen from this locality was found to contain:—

Zinc	54.26 per cent.

2.—Nickel and cobalt. A specimen of pyrrhotite—associated with a little chalcopyrite and sphalerite, with a small quantity of intermingled chlorite—from Pie Island, Lake Superior, was found—after drying at 100° C.,—to contain:— Estimation of nickle and cobalt in pyrrhotite from Pie Island, L.S.

Nickel	0.562 per cent.
Cobalt	0.138 "

Miscellaneous examinations, cont.

3.—Nickel and Cobalt. A mineral specimen from Mr. Thompson's farm, St. Stephen, Charlotte county, New Brunswick. This consisted of pyrrhotite in association with chalcopyrite and a little magnetite, in a gangue of greenish-grey serpentine; the pyrrhotite constituted approximately about one-fourth by weight of the whole. The pyrrhotite carefully freed from the associated minerals was found—after drying at 100° C.,—to contain :—

Estimation of nickel and cobalt in pyrrhotite from St. Stephen, N.B.

Nickel	0.923 per cent.
Cobalt	0.394 "

Estimation of phosphoric acid in trap from Black Cape, P. Q.

4.—A highly decomposed trap from Black Cape, New Richmond, Bonaventure county, P.Q.—was examined for, and found to contain, an amount of phosphoric acid, equal to 0.594 per cent. of tribasic phosphate of lime.