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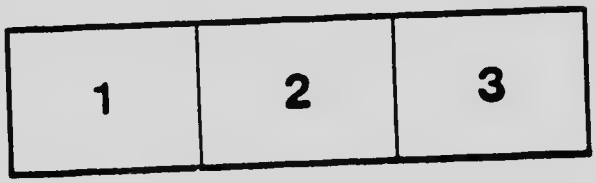

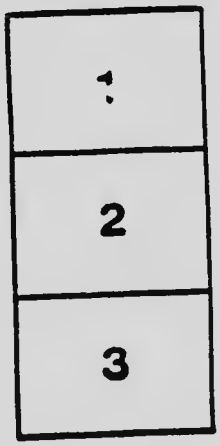

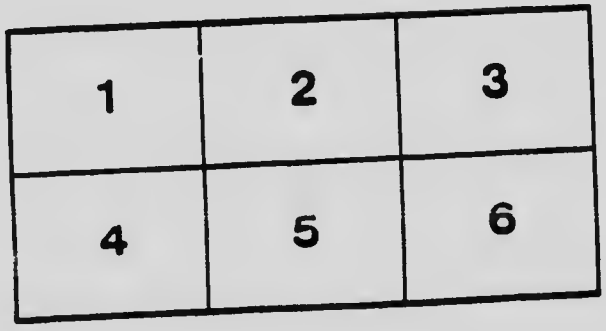

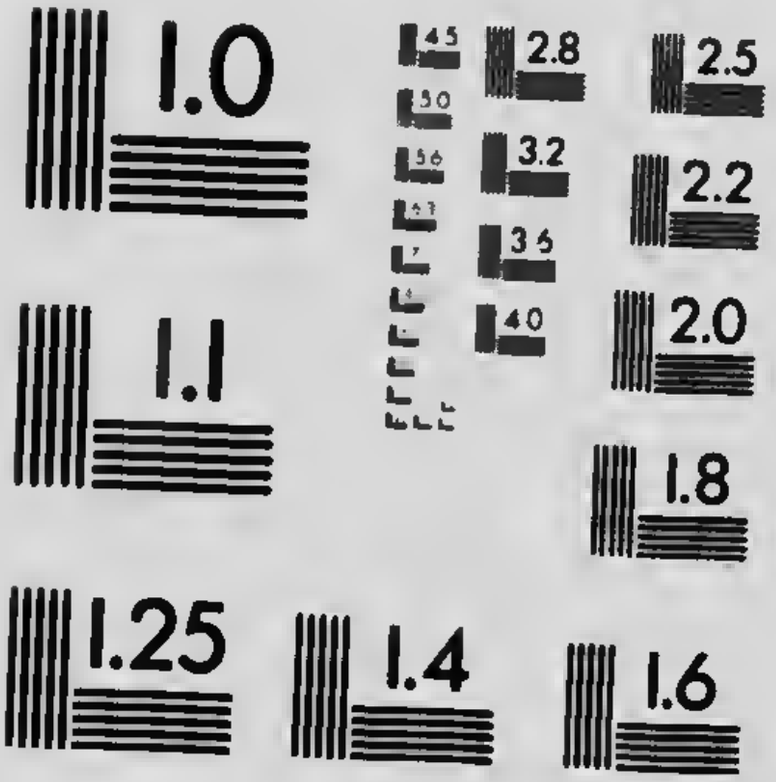

CANADA

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BRANCH

HON. W. TEMPLEMAN, MINISTER; A. P. LOW, DEPUTY MINISTER;
R. W. BROCK, ACTING DIRECTOR.

THE

GEOLOGY AND MINERAL RESOURCES

OF

NEW BRUNSWICK

BY

R. W. ELLS

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1907

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Deac. 1985

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9142—1½

A. P. Low, Esq.,

Deputy Minister, Dept. of Mines.

Herewith I beg to hand you a report on the Geology and Mineral Resources of New Brunswick. The report is accompanied by a map showing the mineral resources of the province.

Your obedient servant,

R. W. ELLS.

March, 1907.

PART I.

PHYSIOGRAPHY.

The physiography of New Brunswick has been extensively discussed within the last few years by several able writers, including Professor W. F. Ganong,[1] Drs. L. W. Bailey,[2] G. F. Matthew[3] and R. Chalmers,[4] Mr. W. J. Wilson[5] and others. In this brief introduction to the geology and mineral resources of the province it is not therefore considered necessary to give more than a mere outline of the leading features with a view to the better understanding of what may follow.

The province of New Brunswick is the largest of the three that constitute what are usually known as the 'Maritime Provinces.' At one time, with Nova Scotia, it formed what was called 'Acadia.' It is an integral portion of the continent, while the province of Prince Edward Island is entirely surrounded by water. Nova Scotia was in early Post-Tertiary times also an island, though now connected with New Brunswick by a narrow isthmus, only fifteen miles wide, between the headwaters of the Bay of Fundy and those of the Gulf of St. Lawrence. This isthmus consists in large part of marsh, but little raised above the sea-level, and its material has evidently been deposited largely by the action of the tides. Much of this marshy area has been reclaimed from tidal action by an extensive series of canals and dikes and is specially valuable as constituting the finest lands in the province for the production of hay. Reclamation is still going on by artificial methods.

The area of the province is 27,987 square miles. The population according to the census of 1901 was 331,120. New Brunswick, in its general outline, is nearly square, but the northwest portion projects westward between the province of Quebec and the state of Maine for some fifty miles, the River St. John for a part of this distance being the dividing line.

On the south side the province is bounded by the waters of the Bay of Fundy, which extends from the mouth of the St. Croix

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[1] W. F. Ganong, Canadian History Readings, pp. 74-104-129, 1900.
[2] Bulletins of the Natural History Society of N.B., 1896 to 1907.
[3] G. F. Matthew, G. S. Reports, 1877-8.
[4] R. Chalmers, G. S. Reports, 1884-1894-1899.
[5] W. J. Wilson, Canadian History Readings, p. 137, 1900.

on the west to the head of Cumberland bay on the east, a distance in a straight line of about 150 miles. On the east it is bounded by the waters of Northumberland strait, the Gulf of St. Lawrence and Chaleur bay, the latter forming the northern boundary of the east coast between Miscou island, which is the northeast point of the province, and the town of Dalhousie at the mouth of the Restigouche river. On the north the Restigouche divides it from the province of Quebec, as far as the mouth of the Patapedia, a distance of about fifty miles, whence the boundary between the provinces westward is broken to its connexion with the upper St. John. From a point about two miles west of Grand Falls the boundary between New Brunswick and the state of Maine is defined by a due north and south line, as far south as what is known as the Monument at the head of Monument brook, which is an upper tributary of the St. Croix river, whence it folllows that stream south to the Chiputneticook lakes, and thence by the St. Croix to Passamaquoddy bay on the Bay of Fundy.

The province is divided into fifteen counties, viz., Charlotte, St. John and Albert, bordering on the Bay of Fundy; York, Queens, Kings, and Sunbury in the interior; Westmorland, Kent, Northumberland, Gloucester and Restigouche along the Gulf of St. Lawrence and adjoining waters; Madawaska, Victoria and Carleton along the St. John river in the northwestern portion. The boundary between New Brunswick and Nova Scotia is along the Missaguash for the greater part of the distance between Cumberland bay and Bay Verte.

The southern portion, including large parts of Charlotte, St. John and Kings counties, is somewhat rugged, the surface diversified by a series of low mountains or hills which rarely exceed 1,200 feet in height. Of these the granite hills which extend across the greater part of Charlotte county are the most prominent in the area west of the St. John, while east of that river the range of crystalline and volcanic rocks, known in part as the Caledonia mountains, rises a few miles east of St. John city and continues into Albert county, terminating about six miles west of the Petitcodiac river. This hilly country extends northward along the St. John river for about thirty miles from the mouth, or nearly to the overlap of the rocks of the central Carboniferous basin.

The central portion of the province is occupied in large part by the Carboniferous rocks, forming an area of not far from 12,000 square miles. Throughout this area there are no prominent hill features, the elevation along the river being very gradual as far west as the city of Fredericton after passing the hilly country along the lower part of this stream. This comparatively low, basin-shaped country extends thence north along the Nashwaak to the Main South-

west Miramichi at Boiestown, which practically marks the northern limit of the Carboniferous formation in this area. The general level of the eastern part of the Carboniferous basin is rarely more than 250 to 300 feet, but in the northeastern portion, between Newcastle and Bathurst, ridges of this formation, indicating anticlinal axes, reach elevations of 500 to 600 feet.

The northern portion of the province, including that part north of a line drawn roughly from the vicinity of Woodstock on the St. John to Chaleur bay, contains the most strongly marked hill features. The country bordering the upper waters of the Tobique, the Miramichi and the Nipisiguit, in which are large masses of granite and other hard crystalline rocks, contains irregular chains of high hills or mountains, some of which reach elevations of not far from 2,700 feet above sea-level. The mountain features in this area have been carefully worked out in recent years by Dr. W. F. Ganong†, who has also spent much time in mapping the orographic details of the province generally. Several high peaks also occur in the area near the forks of the Upsalquitch and Restigouche, as Slate and Squaw mountains with elevations of about 2,000 feet, and at Campbellton in the Sugar Loaf with a height of 950 feet. On the Tobique river the Blue mountains are about 1,725 feet in height, and between this and the mouth of Portage brook on the Nipisiguit there are numbers of peaks with elevations between 1,600 and 2,500 feet above sea-level. To the north of this river the area occupied generally by Silurian rocks is very hilly, and, carefully traversed, may show the presence of masses of igneous rocks.

The rivers of the province are numerous, but small as compared with those of Ontario and Quebec. The St. John, taking its rise in the northern part of the State of Maine, is by far the largest with a length of 450 miles, and draining an area of the province of about 10,500 square miles. Along its course, which crosses the western portion of New Brunswick, there are a number of towns of considerable importance, including Edmundston, Grand Falls, Andover, Perth, Florenceville and Woodstock in the northern part, Fredericton, the capital city, about eighty-five miles by river from its mouth, Gagetown nearly midway to its mouth, and the city of St. John at its entrance into the Bay of Fundy. Numerous small villages are situated also along its course, and in the lower thirty miles above St. John it has in recent years become the favourite place of summer resort, many beautiful cottages having been erected along its banks. These are conveniently situated as regards communication with that city both by railway and by water.

† Literature.

The river is navigable for steamboats of good size at all times during the season, as far as Fredericton, a daily line of communication being maintained; while above this as far as Woodstock navigation is possible during a part of the summer. In high water, boats can run as far as Grand Falls, which is the first great natural barrier in the river. Above this last point boats can run for another forty to fifty miles, but the facilities for travel along this upper portion by railway, which skirts the bank of the river below Edmundston, have greatly lessened the travel by boats, for this portion.

This river is the great highway for the transport of lumber from its upper waters, both for the northern part of the province and for a large part of northern Maine, huge rafts being sent down to St. John every season. The lower portion especially is a favourite route for tourist travel, the scenery along its course being varied and of great beauty at many points.

Along the lower fifty miles of its course several large bays extend to the eastward, including Kennebecasis, Belleisle and Washademoak, and the Grand lake, a sheet of water about twenty-five miles in length with a breadth of three to six miles, connected with the St. John by the beautiful Jemseg creek. These are all navigable for small steamers, and regular lines of boats ply on these waters during every season.

Among other comparatively large rivers on the west which are tributaries of the St. John may be mentioned the Madawaska rising to the north in the province of Quebec, along the course of which the railway between River du Loup on the St. Lawrence and Edmundston is built, which connects the main line of the Intercolonial with the Canadian Pacific at the latter place. The Grand river, though not large, forms a convenient canoe route to the upper part of the Restigouche, and joins the St. John about twelve miles above Grand Falls; the Aroostook enters on the west side about fifteen miles below that town, but has its course mostly in the state of Maine. The Tobique enters from the east a few miles below this stream and is the principal tributary of the St. John from the east. It extends for some sixty miles in a direct line to the upper waters of the Nipisiguit, to which there is a portage of about three miles and from which there is water communication by canoes with Bathurst on Chaleur bay, a distance by stream of eighty-eight miles. This is a favourite canoe route between the west and east, and both streams are celebrated for the abundance and excellent quality of the trout and salmon which everywhere abound along the whole distance. The scenery along this route is among the finest in the province.

Farther south the Becaguimec and Keswick, comparatively small streams, are found. Opposite the city of Fredericton the

Nashwaak enters from the north and is a large and important stream rising near the upper part of the Main Southwest Miramichi. It is celebrated for the quantity and quality of its lumber. Farther east the Salmon river enters the upper end of Grand lake, the Canaan enters the head of Washademoak lake and the Belleisle and Kennebecasis enter the heads of their respective bays. On the west side of the St. John the Oromocto joins the river about twelve miles below Fredericton and with its two branches, the North and South, drains a considerable area in northern Charlotte and southern York counties.

The rivers entering the Bay of Fundy, with the exception of the St. Croix and St. John, are comparatively short owing to the belt of high lands which keeps a short distance to the north of the coast. West of St. John they include the Lepreau, the Magaguadavic, the Digdeguash and the Musquash, while east of that city they include the Black, the Big Salmon and the upper Salmon rivers. The Petitcodiac, however, which is in the southeastern part of the province, is a large tidal stream for some miles, and at high water vessels ascend as far as Moncton which is a shipping port; while the Memramcook, a few miles to the east, is also tidal, and at one time extensive shipbuilding yards were located near the head of the tidal waters of both these rivers. During low tide both rivers are practically empty with high mud banks, a feature caused by the great rise and fall of the tides along this portion of the Bay of Fundy. From data obtained from the latest published tide tables of the Department of Marine and Fisheries, it is seen that the rise of the tide increases in a marked degree as the bay is ascended, rising from twenty-five to twenty-seven and a half feet for spring and neap respectively in the western portion at St. Andrews to twenty-seven and twenty-three in St. John harbour, thirty and twenty-five at Quaco, forty-one and thirty-four and a half at Grindstone island at the mouth of the Petitcodiac estuary, and forty-five and thirty-eight at the mouth of the Petitcodiac, a rise only exceeded at a few points in Minas basin.

The rivers flowing into the Gulf of St. Lawrence are not navigable for crafts other than canoes beyond their tidal estuaries. They include from south to north, the Buctouche which rises in close proximity to the Canaan; the Richibucto heading near the upper part of the Salmon; with several minor streams between this and the Miramichi. The Main Southwest Miramichi is, next to the St. John, the most important as regards size. It traverses the greater part of the breadth of the interior of the province and heads near the lower part of the Tobique. It has a number of large branches, among which is Cains river from the south, while on the north are the Dungarvon, Renous, Little Southwest and the Northwest, the [illegible] joining the Main Southwest just below the crossing of the

Intercolonial railway near the town of Newcastle. All these rivers are important factors in the lumber industry.

Between this river and the Nipisiguit the rivers are small, but important fishing streams, abounding in sea-trout in their season. They include the Bartibog, Tabusintac, Tracadie and Pockmouche. They are navigable for canoes only for a certain distance according to the state of the water. The Southwest Miramichi and its branches abound in salmon and trout.

The Nipisiguit is an important river. Along its course immense quantities of lumber are floated, while as far up as the Grand falls, twenty miles from its mouth, it abounds in salmon and trout. The falls form an impassable barrier for salmon since no fishway has yet been constructed, though the upper portion would furnish the finest of spawning grounds for this fish. Above the falls to the head of the stream it is one of the best trout streams in the province. It has no large tributaries, the South branch, nearly sixty miles from the mouth, being the most important. This branch heads in the great range of granite hills to the south. Along the lower part near the Grand falls are extensive deposits of magnetite which have not yet been developed.

North of this river several streams, including the Tetagouche, the Nigadoo, the Charlo and the Jacquet rivers are found, none of which are navigable except for canoes in good water, but all abound in trout and salmon.

The Restigouche is the most northerly on this coast. The lower portion flowing into Chaleur bay is a tidal estuary, navigable for steamers as far up as the town of Campbellton, twelve miles above which place it is joined by the Metapedia from the north. Six miles farther west the Upsalquitch comes in from the south, an important stream rising near the Nipisiguit and forming a fine canoe route across this part of the province. Still farther west the principal tributaries from the north are the Patapedia and the Quatawamkedgewick, both Quebec streams. The tributaries from the south are unimportant. All these streams are celebrated for the abundance and quality of the salmon and trout.

The height of land or principal watershed of the province follows a very irregular course. From a paper published some years ago by Mr. W. J. Wilson† the following extracts may be given:—'From the Isthmus of Chignecto (which connects the province with Nova Scotia at the southeast angle) it runs northwesterly almost to the boundary of Kent county, separating the Kennebecasis, Canaan and Salmon rivers from those flowing into Northumberland strait. From this point it runs southwesterly separating Salmon and Cains rivers.

† Title, 'Canadian History Readings,' 1900.

Then northwesterly in a zig-zag course dividing the waters of the Miramichi from those flowing into the St. John. This course continues into Carleton county where it is only nine miles from the St. John river. The watershed then runs northeasterly between the Miramichi and Tobique waters into Northumberland county. It then curves round again to the southwest into Victoria and Madawaska counties where it is again only ten miles from the St. John which at this point forms the western boundary of the province. The height of land then runs northwesterly into Quebec.

This watershed or height of land is by no means a prominent and distinct ridge through all its course, for in its southern half it is not easily distinguishable. The small streams forming the headwaters of many of the rivers interlock, and it is impossible in passing over the country to determine to which slope they belong without following them for some distance. This is true in a large degree of all watersheds except in mountainous regions. Another watershed of some importance runs through Charlotte and York counties and separates the rivers emptying into the Bay of Fundy from those flowing into the St. John river. Its direction is northwest and southeast.'

Lakes.—While these are numerous none are of large size with the exception of Grand lake already referred to, the area of which is about sixty-eight square miles. The surface of this lake is scarcely above high tide level of the Bay of Fundy, and a small tide is found near its head about seventy miles inland. This is due to the peculiar phenomena of what is known as the 'Reversible falls,' which are situated near the discharge of the St. John into the tidal harbour, where during low tide the river waters are discharged seaward with a descent of fifteen to twenty feet, while at high water in the harbour the fall is inward, the harbour water being then from eight to ten feet higher than the normal water in the river itself. During certain stages in the tide the passage at the falls is smooth and shipping can pass up and down readily. At other times they are of course impassable. The effects of this inflow are felt as far inland as Fredericton. Grand lake lies near the centre of the great inland Carboniferous basin and the shores are generally low and somewhat level. This lake forms the outlet by schooners for much of the coal mined near its upper part in the Newcastle basin.

Among other lakes are those of the Chiputneticook chain on the St. Croix in Charlotte county, the Maguagadavie and Oromocto in southern York and the South Oromocto in the northeast corner of Charlotte, in which area numbers of small lakes occur. Many small lakes are also found around the headwaters of the south branch of the Tobique and the Nipisiguit and in the country drained by the Mira-

michi. The northern portion of the province shows but few lakes though thickly intersected by streams.

The agricultural capacity of a country usually depends to a large extent on the character of its underlying rock formations. In this respect large portions of the province are of necessity, owing to the presence of masses of granitic and other hard rocks, almost barren since the destruction of the original timber growth which at one time probably covered the greater part of the surface. Much of this timber in the central and northern plateau along the Miramichi was destroyed by great fires, especially by that known as the 'Miramichi fire,' of 1825, in which the soil of the mountain portion was practically burnt off, so that many of these hill ranges are now bare masses of rock interspersed with small shrubs or low bushes only.

The portions best adapted for farming are those underlaid by the slates and limestone of the Upper Silurian formations and by the red rocks of the Lower Carboniferous. Of these the former include a large part of the northern division from a line extending northeast from the vicinity of the town of Woodstock on the St. John river to the headwaters of the Tobique and thence across to Chaleur bay a few miles north of Bathurst. Other areas underlaid by these rocks are found adjacent to the lower St. John. Much of the northern area is still heavily covered by timber, unopened by roads, and consequently almost entirely unsettled.

On the red rocks of the Lower Carboniferous excellent farming lands are found about Bathurst on the north and in the valley of the Tobique; while in the southern part they occur along the valley of the Kennebecasis river, and in parts of Kings, Albert and Westmorland counties.

A large part of the great triangular area occupied by rocks of the Middle Carboniferous of the central and eastern basin, where these rocks are often greyish and sandy, is not largely productive, the resulting soils being light and hungry, but occasionally there are belts of reddish shale which are valuable from the agricultural standpoint. The rougher portions of the province are underlaid by masses of hard igneous rocks, comprising granite, diorite, &c., the decomposition of which is much slower than the comparatively soft sediments of the sedimentary series.

The geological features of the province will be found described in the accompanying report on this subject. They range from Pre-Cambrian, which includes all those of a date earlier than the earliest known fossiliferous Cambrian formations, upward into the upper or Permo-Carboniferous, with small isolated patches of Triassic sandstone and trap. The descriptions of the various economic minerals found in these several formations, with their general distribution,

will be found in the accompanying report on 'Mineral Resources.'

The animal and plant life of the province has been described quite fully by various writers. It is not considered necessary to reproduce the results of their studies fully in this paper.

Generally speaking the game animals include the three great divisions of the deer family, the moose, caribou and the red deer, which in the last few years, owing to careful preservation, have become very abundant in all parts of the province. The great area of wilderness lands about the upper waters of the Miramichi, the Tobique and Nipisiguit especially abound with these animals, though in the unsettled portions of Charlotte, Kings, Kent and eastern Queens they are also numerous. Black bears are plentiful and extensively hunted. Among smaller animals (Carnivora) the wild cat, loup cervier, several varieties of the fox, including the red, grey and black, are found in considerable numbers, the mink, martin or sable, otter, raccoon, fisher, ermine and the skunk are also abundant and are hunted for their furs. On the coasts seals of several kinds are frequently observed.

Among the rodentia, the beaver, which had some years ago become nearly extinct, has recently, owing to careful protection, again become fairly plentiful. Porcupines, rabbits (hares) and squirrels, especially the red, flying and ground varieties, the woodchuck and the muskrat abound, though in recent years the black and grey varieties of the squirrel appear to have practically disappeared. Of cetacea, whales are occasionally seen and are sometimes stranded in the shallow shores of the Bay of Fundy owing to the rapid retreat of the tidal waters, while black-fish, grampus and porpoise are also found.

The bird life is numerous. Lists of these were published in 1865, by Professor Hind, and later by Mr. Montague Chamberlain, the latter appearing in the Bulletins of the Natural History Society of St. John, 1882. Valuable papers relating to the physiography, history and general features of the province have also appeared in the bulletins of the same society, the results of the work and investigations of Professor W. F. Ganong.

GEOLOGICAL DIVISIONS IN NEW BRUNSWICK.

COMPARISON OF NOMENCLATURE OF REPORT, 1870-1, WITH THAT OF 1907.

1870-1.	1907.
Laurentian.	Pre-Cambrian, in part igneous and in part altered Silurian and Devonian.
Huronian: Kingston, Coldbrook, Coastal.	Pre-Cambrian with associated igneous masses.
Cambrian, St. John group.	Cambrian, Etcheminian, div. O at base Cambrian divs. 1, 2 and 3.
Mascarene series.	Siluro-Devonian.
Dark argillite series.	Upper Silurian, in part metamorphic.
Pale argillite series.	Devonian, not yet divided.
Devonian:	Bloomsbury division at base.
Bloomsbury,	Dadoxylon sandstone and shale.
Dadoxylon,	Cordaite shale and sandstone.
Cordaite,	Mispeck shales and conglomerate.
Mispeck.	Perry conglomerate, shale and sandstone.
Perry Sandstone group; Lower Carboniferous.	Upper division of the Devonian, including the 'Albert Shales.'
Lower Carboniferous.	Marine limestone, gypsum, conglomerates at base, shales, sandstone, &c. below the Millstone-grit.
Carboniferous: Middle, and Upper.	Millstone-grit, Upper or Permo-Carboniferous of the east coast, the productive coal measures of Nova Scotia being apparently absent.
New Red sandstone, or Trias.	Trias of the south coast.
Intrusive rocks.	Granite, gabbro, diorite and diabase, felsite, &c. of various age.

PART II.

GEOLOGY.

The literature pertaining to the geology of New Brunswick extends over a period of nearly half a century, and expresses the views of nearly a score of observers. It has become at length so voluminous as to be in a manner somewhat unintelligible to one not familiar with the province and the peculiar geological problems there presented. For this reason it has been deemed advisable to produce, in concise form, an epitome of the work done and the opinions held, from time to time, by those who have laboured in this field. This is especially necessary when we consider that no matter how interesting the subject but few persons have the time for careful perusal of all the reports bearing on this special field, many of which are now not to be obtained, having been long out of print.

In addition to a brief summary of the results obtained by earlier workers in this field the conclusions arrived at from latest study of the problems there presented will be given.

The systematic study of the geological structure of New Brunswick may be said to have begun with the appointment, by the L government, to the position of provincial geologist in 1838 of A. Gesner, a man of undoubted ability. The results of his labours were presented in a series of reports which may be said to constitute the basis of our knowledge in this direction. The first of these, appearing in that year, embraced the results of his examination of the country bordering on the Bay of Fundy, west of the St. John river, and along that stream as far up as Fredericton. This was followed, in 1839, by a report on the coast district east of St John extending to the head of Shepody bay, with a brief description of the Tormentine peninsula and the country along the Hammond river. His third season's work embraced generally the counties of St John and Kings with a very complete description of the Grand Lake coal-field. The fourth described the western portion of the province as far north as Woodstock, on the River St. John, with the country contiguous to that river, as well as the character of the coal fields lying along the Main Southwest Miramichi river, while the fifth included generally the area lying north of a line extending from Woodstock to Bathurst, on Chaleur bay.

Considering the state of geological science in that early day, the reports of Dr. Gesner contained a large amount of valuable information. It must be borne in mind that the nomenclature of the science was very limited. The grand formation which now comprises the fundamental rocks of our record, the Laurentian, had not then received its now world-wide designation, nor had the term Huronian been even thought of. The divisions into Primary and Secondary, Old and New Red Sandstone, coal measures and granitic rocks, composed the bulk of the geological scale.

There could, therefore, have been no attempt to separate the rocks of the older systems into such an arrangement as now exists. But Gesner evidently did a large amount of good work in the delineation of his areas of coal measures and new red sandstones, his Transition or slate and limestone group, and his volcanic rocks, though many of his boundaries were, of necessity, from the sparsely settled and, in consequence, comparatively inaccessible character of the country, far from correctly laid down, and the stratigraphical order, as given in his reports, is, in some cases, the reverse of what is now known to be the true position.

He pointed out also the presence of the two great areas of granitic rocks which traverse the province, one along its southern portion, the other diagonally across the northern half, extending south-westerly into the State of Maine, where these two areas evidently unite. They were considered by him as of Primary age, and included a large proportion of the felsitic rocks, with which, in some places, the granites are intimately connected. He held that these so-called Primary ridges were flanked by beds of Cambrian age, consisting of slates and hard-grained sandstone, styled by him greywacké, while to the north of the northerly belt the great Silurian fossiliferous area of slates and limestones was clearly indicated. Then, as now, the geology of the southern part of the province was found to be much more complicated than that of the northern portion. The igneous rocks were arranged into two belts, the one composed of true granite and syenite, with mica or hornblende, the representatives of the red granitic areas now recognized in Charlotte county and western Kings; the rocks composing the other comprised a large portion of the old Pre-Cambrian syenites and felsites of the present day, and were regarded as intrusive and as overflowing the schistose strata with which they are associated.

Resting upon the flanks of these intrusive ridges were two great series, one containing the limestones afterwards regarded as of Laurentian age, together with certain slates about St. John, and classed as the lower series; another portion, consisting of sandstones and slates and holding fossil plants and tree stems, was recognized as

an upper or newer division. These two groups, the lower of which was supposed to belong to the Silurian system, were held to pertain to the greywacké or transition series and to [illegible] the another area of schists, sandstones, conglomerates, &c., unconformably, which, from an apparent absence of organic remains, was styled Primary.

Concerning the rocks which underlie directly the great central Carboniferous area, the limestones were correctly placed in the lower portion of that system, but the associated red sandstone, conglomerates and marls, together with similar rocks in the valley of the Kennebecasis and Petitcodiac rivers, were regarded as of more recent age and referred to the horizon of the New Red Sandstone; while other red sediments on the St. John river, near Hampstead, were regarded as older and of the age of the Old Red Sandstone. The areas of soft red sandstones and shales along the Bay of Fundy, at Quaco and at other points east of St. John, were also regarded as of New Red Sandstone age.

Reviewing the reports of Dr. Gesner one can hardly fail to be impressed with his evident desire to convince the government, and through it the people, that the mineral resources of the province were practically limitless. This is more particularly the case in regard to the central coal basin and the iron ore deposits of Kings and Queens counties, and this feature has been ably criticized by the late Dr. Robb in his subsequent report on the coal-fields of the province, published in the report of Professor Johnson on the agricultural resources of New Brunswick, in which he clearly points out the unwarrantable exaggerations of Dr. Gesner as to the boundless stores of mineral wealth.

Doubtless many false hopes were raised by this unwise policy, and ground was given for much unprofitable controversy, before the true geological relations of the Carboniferous rocks were finally established. To his researches, however, we must ascribe the discovery of that wonderfully rich mineral deposit called generally 'Albert coal,' and concerning the true character and composition of which he appears to have had a just judgment, regarding it as an altered asphalt in the face of the combined opposition of the majority of the leading scientists of the day.

It is unfortunate that although Dr. Gesner spent the greater part of five years in his preliminary surveys of this province his labours ended without the publication of any geological map which might embody the result of the very large amount of exploratory work he evidently accomplished; and this is the more to be regretted since many of the points so graphically described by him lose, in consequence, very much of their actual value to the general reader.

Following Dr. Gesner, the next writer on the subject was the late Dr. Robb, of King's College, Fredericton (now the University of New Brunswick), who, in 1849-50, published a geological map which is embodied in the report of Professor Johnson, already referred to, and contributed a chapter to that work. Comparing this map with the reports just described it will be seen that a considerable advance has been made both as regards stratigraphy and nomenclature. The Primary and Transition groups are now arranged under the head of Cambrian and Lower and Upper Silurian, but no distinction was made in the red-coloured sediments, the whole being massed under one heading, though comprising areas which range from the Devonian to the top of the Upper Carboniferous. He, however, clearly understood the true position of the Lower Carboniferous sandstones and conglomerates as underlying the coal measures—from which arrangement Dr. Gesner dissented.

The belts of granite, both of the northern and southern areas, were indicated roughly, but much of what is now called Pre-Cambrian, embracing a great thickness of volcanic rocks, was included under the head of traps, syenites, feldspar-porphyries, &c.; while the Cambrian rocks were supposed to include, not so much the recognized Cambrian of the present day, as what are among the oldest of the Pre-Cambrian rocks, viz., the limestones, syenites and gneisses, with associated slates at one time regarded as a part of the Laurentian system. The limits of the central Carboniferous basin were outlined with considerable correctness, and the various coal crops clearly defined.

Dr. Robb also seems to have perfectly understood the general unproductiveness of this area, and to have vigorously confuted the exaggerated statements previously made concerning its economic importance.

In the northern portion of the province the boundaries of the great Silurian area north of the Tobique river, in so far as accessible, were quite correctly delineated, though, as communication was necessarily difficult, the various geological features were otherwise, for a great part of the area, largely conjectural.

Following the publications of Dr. Robb the next papers on the subject are brief articles by Messrs. Jackson and Taylor, bearing principally upon the disputed mineral of the Albert mine. These appeared in 1851, and were succeeded in 1852 by another, published in the *Geological Journal*, London, on the structure and geological relations of this famous deposit, by Mr. J. W., afterwards Sir William Dawson.

Perley's Handbook for Emigrants, while containing some information concerning the geological structure of the province, can scarcely

be said to have advanced our knowledge greatly; since the remarks there contained were taken largely from the works of previous writers. But in 1855 the first edition of the Acadian Geology contained two chapters relating to this province, the former of which, pertaining to the Carboniferous system, is a valuable contribution, and the conclusions there expressed as to the horizon of the central area, as well as the divisions of the southeastern portion in Albert county, have been very fully confirmed by the most recent investigations.

Concerning the older series of rocks developed about St. John sufficient work had not at that time been done to determine their true age. The richly fossiliferous Primordial or Cambrian slates of that city and of the Hammond River valley to the eastward had not then been studied; and only a few imperfect remains had been found, whose age could not be ascertained. As a consequence the Pre-Cambrian age of the rocks which unconformably underlie these at many points could not be established, while opportunities for comparison between the crystalline portion and the recognized Laurentian and Huronian of Ontario and Quebec, which, through the labours of Logan, Murray and Hunt, had now come into great prominence, were not sufficient to establish their true position on lithological grounds. The conclusions on this area then stated, in default of extended personal observations, were therefore of necessity largely those of Dr. Robb, who at that time, and in fact for some years later, was regarded as the standard authority on New Brunswick geology.

During the succeeding years to 1860 but little geological work appears to have been done, except in a desultory way; but about that date several young gentlemen of St. John, notably Messrs. Hartt and the brothers G. F. and C. R. Matthew, began the careful systematic study of the rock formations about that city. They were ably assisted by Professor L. W. Bailey, who had lately been appointed to the chair of Natural History in the University of New Brunswick, which had become vacant through the death of Dr. Robb. These gentlemen were fortunate in discovering a rich fauna and flora in many of the beds, both in the city itself as well as at various points to the east and west. The collected fossils were submitted to Sir J. W. Dawson, the principal of McGill College, and the recognized authority on fossil botany, who speedily determined the horizon of a portion of the strata as Devonian, while the fauna of another portion clearly appertained to a much older period. The results of these examinations were first made public in a paper read before the Natural History Society of Montreal, in 1861, and the Devonian character of the flora fully stated. In the same paper, however, the author stated that the associated slates and limestones, regarded by

Robb as Cambrian, but whose relations had not been clearly made out, might possibly belong, on stratigraphical grounds, to the Devonian or Silurian. These results were also communicated, in a much more extended form, in a paper to the Geological Society of London, published in 1862; in which also it was stated that the Devonian might possibly include what is now known to be Primordial, as well as the so-called Laurentian gneisses, limestones and associated rocks.

It will thus be seen that the geology of this section was an exceedingly difficult problem to decipher and one requiring great stratigraphical skill, as well as extensive knowledge of the obscure fossil forms that were being discovered from time to time, the horizon of which had not yet been accurately determined; and it was not until several years later that light began to break in upon this intricate question; for in the next publication on this subject, which was a communication from Mr. G. F. Matthew to the Canadian Naturalist in 1863, while re-casting the groups, as stated by Principal Dawson in the previous year, and giving them local names, he failed to see any real ground for the separation of the metamorphic portion, comprising the limestones, gneisses, &c., from the fossiliferous Devonian. He, however, gave the name of 'Portland,' to the lowest members of the group, from the fact of their being extensively developed in that suburb of St. John, and assigned them to the horizon of the lower Devonian, or possibly the upper part of the Silurian system.

To an apparently overlying series, embracing a considerable thickness of greenish grey slates, red, slaty conglomerates and shales, with red conglomerates, grits and hard grey sandstone, the name 'Coldbrook' was given, while a third division, styled the 'St. John group,' comprised a series of dark grey slates and sandstones, to a great extent the Primordial of the present day, in which were found a lingula and several other obscure fossils.

His succeeding group, the 'Bloomsbury,' while largely of volcanic origin, included in its upper part some five hundred feet of slates and conglomerates, apparently devoid of fossils; overlying which came the Little River and Mispec groups, largely composed of sandstones, slates and conglomerates of various colours, but distinguished in places by a great abundance of fossils, principally plants, though comprising also crustaceans and the remains of insects.

The apparent difficulty of separating the metamorphic portion from the fossiliferous and recognized Devonian, arose in great measure from the seeming interstratification of the various groups, and the complicated structure arising from the enfolding of newer strata with those of great antiquity, due to a series of anticlines which are often completely overturned, in conjunction with profound

faults; and it was not until the researches of another year by those indefatigable workers, Messrs. G. F. and C. R. Matthew, that the beds which the former gentleman had designated the St. John group, and which had for a long time been known to hold certain obscure traces of organic life, disclosed a new and entirely unexpected suite of fossils. These included brachiopods and trilobites, the latter in considerable variety, but generally of small size, which, on comparison with the published memoirs of Barrande on the Primordial of Europe, resulted in the establishment of a similar Primordial zone in New Brunswick, a discovery, the importance of which in relation to the elucidation of the geology of this section, can scarcely be overrated.

The credit of solving this difficult problem is largely due to the late Mr. C. F. Hartt, one of the earliest and most zealous workers in this field, who at that time was engaged in the Museum of Comparative Zoology in Harvard College. The results of his investigations on the fossils collected by the Messrs. Matthew in 1862, and by himself in the following year, were communicated in a preliminary paper to Professor Bailey in 1864, and published in the 'Observations on the Geology of Southern New Brunswick' by that author in 1865.

The discovery of the Primordial or Cambrian zone in the vicinity of St. John worked an entire revolution in the stratigraphy of that portion of the province. The puzzling admixture of the most highly metamorphic rocks with those entirely unaltered and abounding in fossils was again investigated, and by the aid of the new light a tolerably clear knowledge of the structure was obtained. The map accompanying the report just referred to, as compared with the hitherto recognized standard of Dr. Robb, shows many important changes in the various geological formations. One of the first corrections made was the transposition of the crystalline limestones, gneisses &c., from their former doubtful position to their proper place below the Cambrian, which was found to overlie them unconformably at various points; whilst their resemblance to recognized Laurentian rocks of Ontario and Quebec, which had already been pointed out by Sir William Dawson, rendered it exceedingly probable that they might occupy a similar position in the geological record. They were, therefore, so arranged, and have since been regarded by most geologists, as among the fundamental rocks of the province.

The lithological characters of the various rocks which compose these Azoic or Eozoic strata have been given in different papers on the subject. Their high degree of metamorphism was commented on by Sir William Dawson as early as 1861, and the descriptions of the several divisions of slates, limestones, quartzites, syenites and

gneiss were subsequently stated in Professor Bailey's report in 1865, under the heading of the 'Portland group,' and will be considered later.

Following the paper of Mr. Matthew in 1863, on the rocks in the vicinity of St. John, appeared one by Professor L. W. Bailey in the Canadian Naturalist, detailing observations made in 1863 during a canoe voyage across the northern part of the province, by way of the Tobique and Nipisiguit rivers. The paper is of special interest as giving us the first scientific account of the geology and botany of the country along these streams; since on the map of Dr. Robb, while the areas of Upper Silurian and Lower Carboniferous on the Tobique were laid down with tolerable accuracy, the boundaries of the formations on the other streams flowing east to Chaleur bay were largely imaginary. The great areas of felsites and other crystalline rocks about the headwaters of the Nipisiguit were noted by Professor Bailey, though their age was not determined, and the Lower Silurian aspect of the strata on the lower portion of this stream was pointed out. This was followed in the same year, 1864, by his 'Notes on the Mineral Resources of New Brunswick,' which, while giving nothing specially new in reference to the geology, contained much interesting matter concerning the mining industries, then in their infancy. It was in turn followed the next year 1865, by two reports on the geology of the province, the first by Professor Bailey on the southern portion already alluded to, and the second by Professor H. Y. Hind, also on its general geology, but more specially of interest in reference to the northern portion, and containing much information on the minerals of economic value. In both of these a marked increase in the nomenclature of the science is manifest. The researches of Prof. Hartt on the Primordial, already noted, led not only to the separation of a portion of the crystalline rocks as Laurentian, but made a still further stride by the removal of a second portion, lying stratigraphically between the Laurentian and the Cambrian, which was erected into a distinct group with the title of Coldbrook, and assigned to the Huronian system. This division was in time subdivided into an upper and lower, the former of which, consisting largely of reddish strata, was regarded as of purely sedimentary character, while the latter, composed largely of hard, greenish rocks, was held to be chiefly of volcanic origin, the thickness of the whole being estimated at 5,000 feet.

The recognized areas of Huronian rocks were, however, as yet very limited. The intricate stratigraphy of the south coast still prevented the separation of much of what is now known to be of that age from the position it had so long held as presumably Devonian or Silurian. From their apparently interstratified position among the plant bear-

ing beds of the former, at several points east of St. John, it was inferred that a great thickness of strata, highly metamorphic in character, and now known to be among the oldest in the province, constituted an integral portion of that series.

This belt, which has an extensive development in eastern St. John, Kings and Albert counties, has since been found to unconformably underlie rocks of Primordial age.

Another great group of rocks, also for the most part highly metamorphic, and designated by the term 'Kingston,' was brought prominently into notice in the same report. More difficult, apparently, of location than even the Coldbrook, its exact position could not, at that time, be determined by the New Brunswick geologists, and a suite of specimens was accordingly submitted to the inspection of Sir J. W. Dawson and Dr. Hunt of Montreal.

The lithological characters of the group were stated to be very like those found in the rocks of the Cobequid series of Nova Scotia, which were then regarded as of Upper and Middle Silurian age. It was also stated that possibly portions of the group might pertain to the Devonian system, from their resemblance to the supposed Devonian of southeastern New Brunswick, while the similarity of many of the rocks to older or true Plutonic masses was also pointed out. The true position of this group of rocks, which has a considerable development in the southern part of the province, will be considered later.

The Devonian of this area, as described in the report in question, has, since its publication, been greatly modified. It became evident, as the relations of the Huronian and Primordial were more fully understood, [illegible]nsiderable thickness of what was styled the Bloomsbury group, [illegible]hich represented the lower portion of the Devonian, possessed lithological characters very similar to much of what was now called Coldbrook, and that it was separable into two parts, the upper of which only,—embracing some 500 feet of sandstones, shales and conglomerates,—was referable to the Devonian; the lower portion, which was largely volcanic, being transferred to the Pre-Cambrian.

The Little River group, the second division, was also clearly separable into two, the Dadoxylon sandstone and the Cordaite shales; the former of which, consisting for the most part of hard grey sandstones, shales and grits, and representing a total thickness of about 2,800 feet, was characterized throughout by a wonderfully rich and important flora, of which large collections were made and carefully determined by Sir J. W. Dawson.

The second subdivision of the Little River group was, in 1865, held to embrace rocks of very dissimilar character. In addition to

fine shales and sandstones, holding the remains of Cordaites from which the formation received its name, it was thought that a great thickness of metamorphic rocks, chloritic and talcose schists, felsites, &c., presenting a marked resemblance to strata, which at a later period were recognized as Huronian, constituted, from their supposed position upon the Dadoxylon sandstone, an upper part of the same series.

This view was entertained for some years, or until the subsequent study of the formations on the east side of the St. John harbour disclosed the fact that the apparent position of the metamorphic upon the unaltered portion was due to an overturn, or possibly to a sliding fault. The error thus stated in 1865, and repeated by Professor Hind in his report in the same year, was again reproduced in the geological map which accompanied the second edition of the Acadian Geology in 1868; but it was soon afterwards discovered by the local geologists, and the metamorphic portion was separated, and established as a division of the Huronian, under the title of the 'Coastal group.'

The supposed highest beds of Devonian age were arranged under the head of the Mispec group. They consisted principally of reddish conglomerates and slates, the former holding fragments of felsitic rocks, red sandstones and slaty limestones in a reddish slaty paste. These were not found to contain fossils.

Passing to the consideration of the next system we find the general outlines of the Carboniferous indicated with tolerable accuracy. The observations appear, however, to be largely directed to the structure of the lower division; which, more especially in its eastern extension, included considerable areas of the middle Carboniferous. Sufficient opportunities for study were not afforded in this direction to admit of their complete separation. The various subdivisions of the Lower Carboniferous, as there laid down for the eastern part of Albert county, were verified on subsequent detailed examination, though certain sections elsewhere appeared at first view to present a somewhat different arrangement; more especially in regard to the true position of the bituminous or 'Albert shales,' which were later found to be unconformably beneath the marine limestone of the Lower Carboniferous.

In its distribution the Lower Carboniferous formation was found to constitute a well defined belt, underlying, throughout its whole extent, the Middle Carboniferous basin of the interior. It also comprised certain areas in eastern Albert and Kings counties which rested upon the flanks of what was then regarded as the metamorphic Devonian of the Caledonia Mountain range. West of St. John, however, its presence was not definitely noted, certain rocks in the vicinity of Lepreau village and harbour, which had been regarded by

Dr. Gesner as of New Red Sandstone and Carboniferous age, being found to pertain to a much lower horizon, representing the upper part of the Devonian system.

Concerning the structure of the central or Middle Carboniferous basin but few additional details were added to the views already expressed by the late Dr. Robb. Fossil plants were obtained at points about Grand lake, as well as in the vicinity of the Mirr michi river and Chaleur bay, which appeared to present what was at that time regarded as a mingling of forms, including some portions even of the Upper Carboniferous, while fossils from other outliers of the formation, distributed along the north side of the Bay of Fundy, indicated a Millstone-grit age. The discovery, however, by Mr. C. R. Matthew of the presence of a considerable area of micaceous slates, which are probably Devonian, in the very heart of the Grand Lake coal field, was very important, since it confirmed the view as to the apparent thinness of the measures at this point; while the fossils in the overlying rocks were of the horizon of the Millstone-grit.

The report of Professor H. Y. Hind to the New Brunswick government, (1865) contains a large amount of very valuable and interesting matter, relating not only to the geology, but to the mineral and agricultural resources of the province. A marked advance in geological knowledge is evident in connexion with the work, more especially in regard to the northern portion, concerning which area our information up to that time, owing to its largely inaccessible character, was very limited. A number of sections were made by Professor Hind along the various streams of the interior. The southern outline of the Upper Silurian was more clearly defined, both along the coast of Chaleur bay and on the Upsalquitch and Tobique rivers, as well as on the St. John, to the west. The great belt of metamorphic rocks of the interior, crossed by Professor Bailey on the Nipisiguit, was examined and classed by Professor Hind, principally on lithological grounds as the equivalent of the Quebec group of Canada, as laid down by the late Sir William Logan. The great areas of granite and syenite, both of the southern and northern portions of the province, were held to be intrusive and of Devonian age. No specially new facts bearing on the geology of the southern part of the province were advanced; the views of Bailey and Matthew in regard to the Devonian age of the metamorphic rocks of Albert and Kings being assented to. In the western area, however, the partly metamorphic belt underlying the Carboniferous basin on its northwestern side, and containing the antimony ores of Prince William,—rocks which had been regarded by Drs. Robb and Gesner as Cambrian, and by Matthew (see Appendix D, Report 1865,) as Lower

Silurian—was also classed by Hind in his Quebec group, and paralleled with the upper and slaty members seen on the Nipisiguit and other rivers in the northern part of the province.

On the lower Restigouche, between Campbellton and Dalhousie, Devonian rocks were recognized, skirting the shores, and associated with traps which present conspicuous hill features in this locality. Small outliers of Carboniferous conglomerate, near Dalhousie station, were also indicated, and their horizon was stated, in contradistinction to the early views of Dr. Gesner, who had regarded them as of the age of the Carboniferous and New Red Sandstone.

Following the report of Professor Hind the next contribution of note to the geology of the province was contained in the second edition of the *Acadian Geology*, 1865. The observations there given were based largely on the work of Dr. Robb, Professor Bailey, and Dr. Matthew. A large amount of additional information, relating principally to palæontological details, was also given, embracing the various formations from the St. John or 'Acadian group,' to the Carboniferous, both inclusive. The general distribution of the Laurentian and Huronian, the latter of which was still confined to the Coldbrook group, remained the same as in Professor Bailey's report, 1865. In the metamorphic rocks which surrounded the central Carboniferous basin, regarded as Lower Silurian, was included a large area in northern Charlotte county, and in the southern part of Sunbury and Queens, which was afterwards found to be of much more recent age. Following the determinations of Dr. Matthew the belt extending diagonally through the province from its southwest angle to the vicinity of Bathurst was also regarded as Lower Silurian, and not far removed in age from the St. John group. New and valuable matter relating to the Upper Silurian of Dalhousie and vicinity, with lists of characteristic fossils, was given, while to the same horizon was referred the Kingston group of the southern part of the province, which was also again paralleled with the Cobequid series of Nova Scotia. The accompanying map contained much new information, indicating a marked increase in our general knowledge of the structure of this interesting field.

In consequence of the passage of the Confederation Act in 1867, New Brunswick, at that date, came to a certain extent under the control of the Federal Government; and, in the ensuing year, the operations of the Geological Survey of Canada, which had been carried on continuously in Ontario and Quebec since 1843, were now extended to the Maritime provinces. In pursuance of this arrangement, Mr. C. Robb was sent to New Brunswick, to study more closely the structure of the country to the west and north of Fredericton, and along the upper St. John river, while Professor Bailey and Dr.

Matthew were assigned work in the southern part of the province. The results of these explorations appeared in two reports by Mr. Robb, in 1869 and 1870, and in a voluminous and exhaustive report by Messrs. Bailey and Matthew in 1871, reviewing the geological history of southern New Brunswick up to that date. This report, which evinces a great amount of painstaking research, has ever since been regarded as a standard work on the geology of this section, although modified in some respects as regards details of structure by later and more systematic explorations.

The first report by Mr. Robb made no attempt, in so far as related to the formations underlying the Carboniferous system, to decide the actual horizons of the rocks described, with the exception of the more northerly area, already regarded as Upper Silurian. The great metamorphic belt, regarded first as Cambrian and later as Lower Silurian, was divided into two parts, separated by the central granitic area. Their mineralogical and lithological characters were carefully given, and the discovery at one point on a branch of the Nashwaak river of a band of ochreous slates, holding fossils of Devonian age apparently intercalated with the metamorphic rocks, led to the supposition that this great formation might be newer than had hitherto been supposed. That the two bands to the north as well as to the south of the granite belt were of the same age was considered probable. The characters of the great central axis of granite were well described, and the highly altered condition of the various strata in contact with it was pointed out, the rocks in places having assumed a gneissoid structure and containing numerous crystals of staurolite, mica, &c. The extension of the metamorphic belt to the northeast beyond the Little Southwest Miramichi river was established, though fossils which might determine their actual age could not at that time be found.

Though no new facts tending to determine more precisely the position of these various groups in the geological scale were adduced in these reports, the large amount of topographical work done enabled Mr. Robb to construct a map of the three counties of York, Carleton and Victoria, upon which his observations of the two seasons were laid down. This resulted in a very great advance over the knowledge already possessed of that region, though the entirely unsettled character of the country east of the upper St. John prevented the accurate delineation of the several outlines of newer rocks, which occur at various points unconformably overlying the metamorphic series.

In the report by Professor Bailey and Dr. Matthew, which embraced a detailed account of the structure of the southern part of the province, the so-called Laurentian was divided into two portions, the lower of which consisted largely of gneiss and syenite of greenish,

grey and reddish colours with associated masses of diorite. The total thickness of this division was not definitely known. The upper was largely a calcareous series, resting upon the lower at many points, and was made up of crystalline limestone, quartzite and slate, and with limited beds of gneiss. The actual thickness of this division was also somewhat conjectural, but a section on the St. John river, near Indiantown, one of the suburbs of St. John city, gave 1,385 feet, while the lower portion, omitting a considerable thickness of granitoid gneiss, recognized in the western part of the county of St. John, but not seen in the river section, was estimated at 2,850 feet. This would give, for the whole of the supposed Laurentian rocks in this area, a probable thickness of over 5,000 feet. In a series of rocks, however, so extensively faulted and displaced as many of those in the vicinity of St. John, the actual measurement of their thickness is almost an impossibility.

Assisted by the extensive experience of Dr. T. S. Hunt, at that time an officer of the Geological Survey of Canada, the New Brunswick geologists then proceeded to attack the intricate problem of the metamorphic rocks, which, owing to their complex stratigraphy, had never been satisfactorily arranged.

Upon a more detailed examination it was conclusively established that rocks of Primordial age were, at several points east of St. John, unconformably placed upon what had so far been regarded as an integral position of the Devonian system, while the lithological characters of the latter presented many points of resemblance to those now recognized as of Huronian age. These discoveries, together with the fact that these supposed Devonian rocks were the possible continuation of the Coldbrook or Huronian belt of St. John and vicinity, led to their entire removal from the position they had so long held, on grounds both of stratigraphy and lithology, and to their being placed in the Huronian system, under the title of the Coastal group.

The importance of lithological characters being now recognized in the determination of certain horizons, especially when applied to areas of limited extent, attention was next directed to another great belt of metamorphic rocks which, under the title of the Kingston group, had, up to this time, been regarded as of possibly Upper Silurian age. This position had been assigned it on very much the same grounds that had affected the earlier position of the Coastal, viz., the supposed interstratification of its equivalents with fossiliferous Upper Silurian sediments which had been observed in eastern Maine. Subsequent examinations, however, proved the stratigraphical relations of the Kingston group to be entirely different. It was found at several points to underlie areas of primordial slates and, there-

fore, of necessity, to belong to a much lower position than had been supposed. At the same time the marked resemblance of the various rocks which composed the group to those of the Coastal and Coldbrook divisions was such that it was deemed most in accordance with the evidence at hand to include it also in the Huronian system. Thus, three great areas of metamorphic rocks, all presumably newer than Laurentian, had been established, though their relative positions to each other had not as yet been clearly defined. The Coldbrook group had, however, been divided into two portions, a supposed lower, including diorites with felsitic and chloritic rocks, largely a volcanic series, and an upper, consisting of argillites, sandstones and conglomerates, generally of reddish colours, which was considered to constitute the lowest member of the St. John group, since styled 'Etcheminian' by Dr. G. F. Matthew.

Since the arrangement of the formations, as given in the report now under discussion (1870-71), has been made to a large extent the ground work of the subsequent publications on the geology of southern New Brunswick, the consideration of the groups newer than the Huronian may here be profitably taken up. Of these, the first in ascending order is the Primordial Silurian, Acadian, or St. John group, which latter name it received when regarded as an integral portion of the Devonian system, from the fact of its being largely developed and first studied in and near the city of St. John. By the fortunate recognition of its contained fossils in 1863-64, Professor Hartt, as already stated, first established the position of certain doubtful metamorphic rocks as Pre-Cambrian, and thus afforded a satisfactory basis for future geological work. Six areas were now recognized as probably belonging to the Primordial horizon; concerning the most of which no doubt could be entertained, viz.,—

1. St. John and vicinity, with its extension eastward for nearly thirty miles along the valley of the Loch Lomond lakes until it reaches the Hammond river.

2. Limited outcrops about the lower part of Kennebecasis bay, seen on Long and Kennebecasis islands, and on Milkish head, as well as on the south shore of the bay itself.

3. The valley of the Long reach of the St. John river. In these three areas typical fossils are abundant.

4. An area of dark grey and black shales in Wickham, Queens county, resembling in lithological characters the rocks of the previous divisions, but in which no fossils could be detected.

5. A similar series of beds in the valley of the Nerepis river, likewise apparently devoid of organic remains.

6. An area in Charlotte county, near the head of Oak bay. Other areas of supposed Primordial age have, however, since been found.

In all these the lithological characters are very similar, but later explorations on the areas in question led, in subsequent reports, to the separation of divisions 4, 5 and 6, on the grounds of lack of fossil evidence, and they were placed in a newly erected group of doubtful beds, under the name Cambro-Silurian. The true relations of these beds to underlying rocks of Pre-Silurian aspect will be considered further on, when the general structure as at present understood, is discussed.

Next in order, among the many puzzling and doubtful formations discussed in this report, we may briefly glance at the Mascarene series.

This group of rocks, so-called from its recognized development along the shores of the Mascarene peninsula, on the east side of Passamaquoddy bay, comprises strata of very different character. Some of these very closely resemble Huronian rocks, such as diorites, fine-grained felsites, petrosilex, &c. They are intimately associated with, and, in places, apparently overlie a series of slates and sandstones containing fossil shells and remains of plants. Here then is presented a second problem, somewhat similar to that which so long remained unsolved near St. John. The intimate admixture of beds of such great diversity of character rendered the expression of any definite opinion as to the real age of this group exceedingly difficult, and it was accordingly described as an isolated series, without being assigned to any definite horizon. A re-examination was made in 1874, and in the report for that year it was stated to be of Upper Silurian age.

The parallelism of structure displayed in this group of rocks is so marked, when contrasted with the earlier apparent superposition of metamorphic Huronian strata on the Devonian, east of St. John, that the merits of the question may be here briefly stated.

The various strata exposed along this portion of the shore are arranged in five divisions; of which the lowest consists of hard, grey feldspathic slates and olive grey argillites, apparently non-fossiliferous, and having a thickness of about 400 feet.

Div. 2, in ascending order, comprises black and dark grey banded siliceous slates, with obscure plant remains, and with thin bands of conglomerate; thickness rather more than 600 feet.

Division 3 consists of grey sandy flags and slates with slate conglomerates, in all about 400 feet, the greater part of which contains fossil shells.

Div. 4, principally bright red and green slates, sometimes with a purple tinge, apparently without fossils; thickness 300 feet.

Div. 5, principally hard, red felsites, often porphyritic and of Huronian aspect; thickness unknown, probably over 300 feet.

The geological position assigned this series in report 1874-75, as a portion of the Upper Silurian, seems, from the characters of its various divisions, to be somewhat unsatisfactory. Thus, on page 88, it is stated that division 2, or its equivalent on Beaver harbour, contains plant stems, among which a *cyclopteris*, a *cordaite*, a *sphenopteris*, and the remains of ferns, were clearly recognized. The presence of these imparts a Devonian aspect to this portion; while the Upper Silurian fauna in the overlying beds would indicate an overturn or a line of fault at this point. Confirmatory evidence in this direction is afforded by bands of igneous rocks, which had for a long time been paralleled with the Coldbrook and Kingston groups, and it is very probable that, taking into consideration the crumpled character of the sediments of Beaver harbour, with the enfolding there of narrow belts of rocks holding Silurian fossils, we may have a similar condition of things in the Mascarene peninsula.

Ascending in the geological scale we find the outlines of the Upper Silurian considerably changed as compared with all previous reports. The separation of the Kingston group made a great reduction in its aggregate thickness. In Charlotte county the formation comprised several localities where characteristic fossils were found, such as the vicinity of Oak bay and the group of islands and promontories lying between Beaver harbour and the Western isles. Collections of these were made at various points, notably at Back bay on Frye island, and at Oak bay.

Farther east in Kings and Queens counties the fossiliferous areas east of the granite, and extending to the St. John river, were well defined. These were found to embrace slates, sandstones and conglomerates, with a considerable thickness of hard, quartzose beds, and occasionally felsites and diorites, the total thickness being regarded as about 5,700 feet.

Along the line between Kings and Queens counties these rocks were found to overlie unconformably a series of hard felsites and other rocks of Huronian aspect, which form prominent hill features in this area, the débris of which enter into the composition of the basal beds of the Silurian. The age of these strata in the vicinity of Beaver harbour, as determined by the fossils there obtained, is about that of the Niagara formation.

The Devonian system was, as contrasted with the report of 1865, also largely remodelled. The four divisions of Bloomsbury con-

glomerate, Dadoxylon sandstone, Cordaite shale and Mispec conglomerate, were retained, but the first was reduced by about 2,000 feet of trappean and other volcanic rocks which, from their character, were now referred to the Huronian system, while the Cordaite shales were reduced by the separation of the apparently upper and metamorphic portion, which was erected into the Coastal group as already described.

The total thickness of the four divisions of the Devonian was estimated at 7,500 feet, but as the area is somewhat affected by faults this estimate may not be accurately correct, owing to possible repetitions of certain strata. It does not include also the beds of the Perry sandstone group which, upon the authority of Sir William Dawson, from the evidence of contained plants, had been assigned to this system as its upper member several years before, and had also, in the report of 1865, been so described by Professor Bailey, but subsequently separated on the grounds of want of conformity to the underlying Devonian of Point Lepreau, and from a supposed resemblance to certain recognized Lower Carboniferous sediments in the vicinity of the St. John river. Various publications have appeared concerning the fossils of this group, among which may be mentioned those by Sir William Dawson in Can. Nat., 1861, on Pre-Carb. flora of Maine, etc.; Flora of Dev. period, in N. E. America, Geol. Soc., 1862; Observations on Dev. plants of Maine, Gaspé, etc., Geol. Soc., 1863; Fossil plants of Dev. and Up. Sil. of Canada, Geol. Sur., 1871. From the evidence, therefore, of its contained plants, and from its marked resemblance to much of the Upper Devonian conglomerate of the Gaspé district, it seems highly probable that this group should also be assigned to the Devonian rather than to the Carboniferous system. Its distribution is limited. It occupies the greater part of the peninsula between the St. Croix river and Passamaquoddy bay, underlying the town of St. Andrews, with several adjacent islands, and occurs in patches at the mouth of the Magagnadavic river, and as a considerable area about the village of Lepreau and on the peninsula which terminates in the point of that name.

Recent work by Dr. David White of the United States Geological Survey, on the plants of the Perry group, as developed in the vicinity of Eastport in Maine, has shown that they contain a well defined Upper Devonian flora. Within the last two years the continuation of the conglomerates and associated sandstones of this formation has been traced eastward through the islands of Kennebecasis bay where they contain a similar Devonian flora. Thence they have been followed to the northeast along the Kennebecasis valley almost continuously into Albert county, but are in places concealed for short distances by the conglomerates and limestones of the Lower Carboni-

ferous formation which are unconformably overlying. Near the centre of the Devonian basin, to the east of Courtney bay, a detached area of the Perry is found which overlies the other divisions of the Devonian system in this direction, so that at this place there is a continuous ascending series from the base or Bloomsbury division to the top or Perry, the upper part of which is seen on the north side of Kennebecasis island. The division known as the 'Albert shales' lies between the basal Perry conglomerate and the upper grey portion, and is thus a part of the Devonian series.

The Carboniferous system comprised three divisions, the Lower, Middle, and Upper, of which the first, having a thickness of several thousand feet, contained the limestones, gypsum, ores of manganese, and the peculiar mineral albertite, while the Middle and Upper were briefly described under the general term, Coal-measures, since the examination of this formation had not been carried on sufficiently to warrant a separation of its various members. The subdivisions of the Lower Carboniferous were, in the first edition of *Acadian Geology*, made to include the bituminous shales and associated conglomerates of the Albert mine, which were regarded as the lowest portion. This order of succession was, however, somewhat modified by Dr. Matthew from subsequent observations made along the line of railway near Norton, where the bituminous beds had an apparently higher position.

The distribution of the Lower Carboniferous series was given with considerable accuracy, and the presence of a volcanic, intercalated portion in a section along the St. John river, in the parish of Hampsted, was noted, trappean and feldspathic rocks occurring both near its summit and base. This volcanic feature is also well observed at other points, not only along the southwestern margin of the formation in Queens, Sunbury and York counties, but in outcrops at intervals in the very centre of the Middle Carboniferous basin about the upper end of Grand lake. As these rocks, however, had at this time not been particularly studied, many additional facts regarding them were brought to light on later investigations, and have been described in more recent publications.

The opinions stated in this report, 1870-71, regarding the Middle Carboniferous, confirmed those expressed by Dr. Robb in 1850, viz., that this formation was of no great thickness and was probably represented only by its lower member, as indicated by the presence of the outcrops of metamorphic slate, pointed out by C. R. Matthew, in what was supposed to be the thickest portion of the coal-field. The fossils collected were, for the most part, characteristic of the lower horizon, but in several cases appeared to indicate a higher

range, embracing Upper Carboniferous forms, which it was supposed might be derived from unconformably overlying patches of newer rocks, or more probably from a mingling of the flora of different horizons.

The deposits along the Bay of Fundy, described as of Triassic age, have, as in the case of so many other formations, been long a subject of dispute. Dr. Gesner, in his early reports, included not only the areas mentioned in the report under consideration as probably of this age, but also other deposits, some of which, like those of Lepreau and Passamaquoddy bay, have been seen to be presumably Devonian, while others, farther east, are now known to belong to the Lower and Upper Carboniferous formations. Dr. Robb, on the other hand, held that no rocks newer than Carboniferous existed in New Brunswick.

In many respects the limited areas which occur as outliers on the coast of the Bay of Fundy referred to in this report resemble and are probably the equivalents of the so-called Triassic of Nova Scotia; while other areas of soft red rocks, in the eastern part of the province, are of Upper Carboniferous age and similar to those seen in Prince Edward Island. The supposition has been confirmed by recent investigation.

The presence of plant remains in the sandstones at Quaco and Martin head, similar in character to those found in Prince Edward Island in what was formerly there regarded as Lower Trias, but now held to belong rather to the Permian, makes it very probable that more detailed study of these rocks will show that they also may be classed as the upper member of the Palæozoic series. In their stratigraphical relations there is nothing to indicate their higher position, since they rest generally on Upper Devonian sediments, while the occurrence of undoubted Upper Carboniferous beds in Westmorland county, similarly placed, and closely resembling these in character, tends to support the present view.

Triassic sandstones and shales are seen at several points on the Bay of Fundy coast, as at Martin head, Salisbury bay, and between Red head and Gardner creek, the last about twenty miles east of St. John city. Where associated with igneous rocks they appear to rest upon them. The large development of trappean rocks seen on Grand Manan is supposed to be of Triassic age, the western part of that island being composed largely of basalts, amygdaloids, and trap ashes, with limited exposures of red sandstone, which, near the contact, are impregnated to some extent with copper glance, supposed at one time to constitute a deposit of economic value.

There yet remain to be considered two groups mentioned in the report for 1870-71, which, owing to their great diversity lithologically, have ever been difficult of adjustment in the geological record.

These were described under the head of various Pre-Carboniferous rocks, and were divided into two portions, styled, from their prevailing colours, the 'dark and the pale argillites.' The lower members, which were generally dark-grey and often flinty in texture, were highly feldspathic, and so far as could be ascertained, were generally devoid of fossils; the upper, while usually of a lighter hue, had a greater preponderance of grey sandstones and shales and in places showed indistinct traces of plant remains. The lower series is found often in direct contact with the great granitic mass of Charlotte and Kings counties, the metamorphic action of which was evidenced by the alteration of the clay slates into schists, and by the production of crystals of staurolite, actinolite, mica, etc., in the adjacent beds. No definite fossil evidence could be found to locate this group in the scale of formations, though from the resemblance of its lowest members to the lower portions of the Mascarene series, it was supposed to be not far removed from the horizon of the Upper Silurian. The similarity of much of the upper group to the portion of the Devonian characterized as the Cordaite, together with the presence of plant remains, and its stratigraphical position between the dark argillites and the Lower Carboniferous, caused this portion to be regarded as probably belonging to the Devonian system. Both these series were, in the map accompanying the second edition of *Acadian Geology*, coloured as of Lower Silurian age.

Subsequently, in 1875, these Pre-Carboniferous rocks were arranged by Dr. G. F. Matthew under three heads, viz., Huronian, Upper Silurian and Devonian, with the proviso, however, that some portions, notably of the dark argillites, or lower group, presented strong resemblances to the Lower Silurian of the western part of the province. But later, in the general report accompanying the map of southern New Brunswick, (1878-79) they were re-arranged, the pale argillites being placed permanently in the Devonian, the doubtful or dark argillites classed as a new group, under the title of Cambro-Silurian, while a large area to the east of and between the granite ridge and the St. John river, in which typical fossils were found at various points, was called Silurian, certain areas of felsites which protruded through these fossiliferous sediments and formed prominent hills and ridges being, from their lithological aspect, regarded as Huronian rocks.

Resuming the regular history of New Brunswick geology, the next paper on the subject was by Professor L. W. Bailey, 1871-72. This dealt principally with the extension eastward of the Huronian system into Albert and Kings counties, more particularly with reference to the Coastal group, which was found to occupy the greater part of the country bordering on the Bay of Fundy in this direction, and was

regarded as constituting the mineral bearing, or copper belt of this area. Attention was also directed to the presence of a small deposit of supposed true coal-measure rocks at Dunsinane, on the railway between Sussex and Petitcodiac, (see also Report 1865, p. 157) which was thought might be similar in character to the coal area of Springhill, in Nova Scotia, a supposition, however, not verified by later examination of the district. The occurrence in eastern Albert of intrusive traps of supposed Triassic age was also noted, and this was considered important as tending to strengthen the view expressed the previous year as to the Mesozoic age of certain patches of red sandstone found at points along the coast in the vicinity. The intrusive character of the red granites, both of the great southern area in Charlotte county as well as certain masses in Albert and Kings, not only in Silurian sediments, but clearly intruded into older and possibly Laurentian rocks in the southwestern portion of the province, was well indicated.

The season of 1872 was devoted to an examination of the central or Grand Lake coal-field, with a view to determine more conclusively its economic value, by a series of borings, and thus to settle definitely the much vexed question as to the occurrence of workable seams underlying that, which, as a surface seam, had been worked to some extent for many years. No detailed study of this coal-field had been attempted since the time of Dr. Robb, whose views on the subject have already been stated. In the report on this area, 1872-73, the entire thickness of the formation above the Lower Carboniferous was estimated to be only 600 feet, which was divided into three portions of 200 feet each, assigned to the Millstone-grit, the Productive Coal measures, and the Upper Carboniferous, respectively. The general thinness of the formation was again conclusively shown by the presence of areas of older rocks at various places at and near the surface, and subsequently by means of the diamond drill, which penetrated the entire thickness of the Middle Carboniferous at the head of Grand lake, at a depth of little more than 200 feet. Borings carried on during the next three years, at different points, effectually proved the generally barren character of the measures, and disproved beyond a doubt the erroneous ideas entertained by many concerning the great economic importance of this area.

Later examinations of the Carboniferous basin over its entire extent, embracing an area of 10,000 to 12,000 square miles, have led to a modification of the views then expressed, and it has been satisfactorily established that with the exception of certain small outlying patches of Upper Carboniferous rocks, occurring for the most part along the shore of Northumberland strait and in the eastern part of Westmorland county, the rocks of the entire area belonged

to the horizon of the Millstone-grit, and were below the true productive measures of Nova Scotia.

The season of 1873 was devoted to the completion of the geological and topographical map of Queens and Sunbury counties, embracing not only the coal-field just described but the various formations bordering this area on the south, including the hitherto doubtful groups of the argillite series and the associated strata, supposed to be of Huronian age. The conclusions then arrived at, together with the map, were withheld for several years, pending further investigations, or until the appearance of the general geological map of southern New Brunswick in 1878-79, in which, however, the views expressed were very considerably modified as compared with those held in 1873.

In 1874-75 several papers on the geology of the province were published. In Charlotte county these related more particularly to the Mascarene series as developed about Passamaquoddy bay, and in the adjacent part of the State of Maine. From the facts then observed the age of the series was inferred to be Upper Silurian, but as this question has already been fully discussed in previous pages nothing further need here be said. The age of the pale argillites was, from the observations of the preceding season, proved to be, for the most part at least, Devonian while, concerning the lower or dark argillite group, satisfactory conclusions could not be arrived at.

Other papers appeared relative to the age and distribution of the iron ore deposits of Carleton county (R. W. Ells, 1874) and sundry facts were also given concerning the structure of the Grand Lake coal-field, derived from boring operations, by which the statements already made respecting the general barrenness of the measures were fully confirmed.

In this year, also, (1874) appeared a paper by Dr. Honeyman of Halifax, Nova Scotia, upon the various formations of the southern and eastern portions of New Brunswick, in which he paralleled the supposed Laurentian and Huronian systems about St. John, with the rocks of the Cobequid series in the adjoining province, and with his lower Arisaig group of Antigonish. In the northern part of the province he regarded the fossiliferous limestones of Dalhousie as probably of Niagara age, (the equivalents of his group, C. Arisaig) and recognized also the Lower Silurian, now Cambro-Silurian, aspect of the rocks on the lower Nipisiguit and Tetagouche rivers, in which graptolites were afterwards found, presumably of the horizon of Lower Trenton age, while the later age of the intrusive traps in the Dalhousie section, first pointed out by the late Sir Wm. Logan, was proved by the alteration of the contiguous beds and by the presence of Upper Silurian fossils contained in the trappean mass itself.

In 1875-76, a report on the Pre-Carboniferous formations of southern Queens and Sunbury counties, with various rocks in northern Kings, was presented, illustrative largely of the work done in 1873. These were now divided into three groups, the crystalline or older felsitic series, Coldbrook or Huronian, the dark argillites which were now considered to be Upper Silurian, though possibly containing areas of Lower Silurian, and the pale argillites, which were again asserted to be Devonian, from the evidence of the contained plant remains. The Upper Silurian, however, was now made to contain a considerable area of what was in 1870-71 regarded on lithological grounds as Pre-Silurian or Huronian.

In 1876-77 an interesting report by Dr. G. F. Matthew on the geology of Charlotte county was published. In this the aspect of certain supposed Pre-Silurian rocks in the southwestern portion was discussed, more especially in their development west of the lower part of the Digdeguash river. These, for the most part, highly crystalline rocks, consist of diorites, fine and coarse, hard schists, porphyritic and slaty felsites and gneissoid sandstone, which often present the appearance of fine-grained gneiss. They form an area of considerable extent and are intersected by intrusive granites which may be spurs from the main granitic mass of that district. They cross Oak bay and extend into Maine, and also form a conspicuous band on the St. Croix river, in the vicinity of, and for some distance above, St. Stephen and Calais. The fact that these volcanic rocks penetrate recognized Silurian strata in that vicinity was not apparently recognized at the time, and from their marked lithological resemblance to the Pre-Cambrian of St. John county they were regarded as also of Huronian or Laurentian age.

In this report, also, the dark argillites which have a considerable development in this country, forming an extensive belt which stretches diagonally across from the St. Croix river to its northeast corner, were considered as of Upper Silurian age. The rocks of this system were arranged in five divisions, the three lowest being paralleled with the divisions of that system, as stated in the report for the preceding year, whilst Nos. 4 and 5 of that series were supposed to represent Nos. 3 and 4 of the Kingston group. The latter was, by this arrangement, removed from the position assigned it in 1870-71 as a portion of the Huronian, to the upper part of the Upper Silurian, chiefly from its supposed superposition on the St. John group, as inferred from the presence of pebbles of black slate in the conglomerates near its base, which were held to be derived from beds of Primordial age.

The crystalline and Huronian aspect of the Kingston group, as a whole, can be well seen by reference to the sections given in New

river, Charlotte county; the character of the several divisions there seen being as follows:—

Green chloritic and granitoid rocks.
Dark, porphyritic, slaty felsite, with grains of clear quartz.
Grey clay-slates and diorites.
Chloritic and feldspathic slates and grits, with slate conglomerate

overlaid by about 11,000 feet, principally schists both micaceous and hornblendic, the latter predominating, crystalline felsites, and capped by chloritic and feldspathic gneiss.

No fossils were found in any of the strata, but it was distinctly stated that this group in Charlotte county constituted the mineral belt in the same way as the Coastal group to the eastward, which was also formerly considered to occupy nearly the same relative position as now assigned to the rocks under discussion. As, however, uncertainty still existed as to the true position of the Kingston group, the publication of the map and section accompanying this report was for the time deferred.

In the report for 1876-77 the relations of the great mass of red syenite and granite which forms so important a feature in the geology of this county, to the associated rocks, were also given. That they were clearly newer than the overlying Upper Silurian was evidenced by the metamorphism of the slates in contact, shown by the production of various crystals, as also by the presence of numerous faults and dislocations, and by the penetration of contiguous strata by numerous dikes and veins of granite, which, proceeding from the main mass, cut the adjoining beds with sharply defined lines of contact.

The same volume also contained a report on the Lower Carboniferous of Albert and part of Westmorland counties, by Professor L. W. Bailey and the author of this paper. This had particular reference to the distribution and economic value of the portion known as the Albert or bituminous shales, of special interest from their containing the remarkable mineral, albertite. In this paper, also, the Pre-Cambrian aspect of the rocks of the Caledonia Mountain range was pointed out. The divisions of the Lower Carboniferous there given were five in number, representing an exposed thickness of 4,150 feet, separable into two unconformable series by a break between the bituminous shales and associated conglomerates of the Albert Shale series and the sandstones and conglomerates of division 3, while the great masses of gypsum and limestone were regarded as being near the upper part of the formation.

The season of 1877-78 was devoted to further detailed work, prin-

cipally bearing on the relative positions of the various divisions of Pre-Silurian rocks in Kings, St. John and Albert counties, the results of which were stated in three papers by the writer, Professor Bailey, and Dr. G. F. Matthew respectively, with a supplementary report by the last on the superficial geology of the southern part of the province.

In the first of these, the structure of the Pre-Cambrian ridges was given as follows:—three main anticlines, situated to the south of Kennebecasis bay, extend from the vicinity of St. John northeasterly, and are roughly parallel to the north shore of the Bay of Fundy. In Albert county, and for some distance to the west, the two more southerly anticlines are apparently overturned; the contained syncline occupying the area along the Shepody road, and for some distance on either side. The most southerly anticline forms the crest of the mountain ridge in rear of Hopewell, whence, extending westerly, it crosses the Upper Salmon river some three miles below the Shepody road, and comes to the coast a short distance west of Martin head. On the Albert county-line it has a breadth of three to four miles, and is distinguished by the presence of syenite and gneiss, often greenish or protogine, with schists, felsites and dolomites,

The second anticline extends from the eastern part of the Caledonia Mountain range in the vicinity of the Albert mines, southerly through the southern part of Mechanic settlement, and reaches the Shepody road a short distance west of the Kings county line, on which road it can be traced for nearly eight miles. Farther west it can be seen on the Big Salmon river, about four miles from its mouth, beyond which it is apparently concealed by overlying sediments. This anticline in Albert county is flanked at one point by crystalline limestones, similar in character to those in the vicinity of St. John.

The third anticline comprises the syenite, gneiss and limestone of St. John and vicinity. Westward, it can be readily traced to its termination on the coast at Musquash harbour, although in places concealed by Devonian strata and drift deposits, while eastward it extends along the south side of Kennebecasis bay, appearing also in the islands and headlands of the southern extremity of the Kingston peninsula, uninterruptedly to a point about four miles south of Hampton station. It re-appears from beneath Upper Devonian beds, four miles farther east, and forms a narrow ridge, eight miles in length, when it again becomes overlapped by the Perry formation, and does not re-appear, but on the Kings county line an anticline, in the continuation of the one just described, brings up the Perry conglomerate and grey sandstone and probably indi-

cates the extension of this third axis which in this case is parallel with the second anticline of the Caledonia mountain.

A series of chloritic, talcose and feldspathic schists, ash rocks, purple grits, and conglomerates occupy the first syncline in Albert county. These are apparently unconformable to the rocks of the underlying anticlines just described, as well as to their supposed equivalents in Kings and St. John counties. They occupy a considerable area along the Shepody road, and the greater part of the coast of the Bay of Fundy, between Point Wolf and Melvin beach, about seven miles east of Quaco.

Along the northern side of the second anticline in Kings county these rocks, which constitute the Coastal portion of the Huronian, are to a great extent apparently replaced by a considerable thickness of brecciated, siliceous and feldspathic ash rocks and diorites, which, according to Professor Bailey (see his report on this group, 1877), compose the greater part of the Pre-Cambrian series to the south of the main Laurentian axis or anticline No. 3. These are regarded by him as older than the Coastal rocks which occupy the syncline just mentioned and which form the shore series. They are described in ascending order under two heads, the first or felsite petrosilex group consisting largely of the following rocks:—

Red and grey felsites, blue, grey, reddish and black petrosilex and breccias, diorites, and amygdaloidal ash rocks and ashy conglomerates.

Grey feldspathic sandstones and conglomerates, the whole representing the Coldbrook of former reports and now regarded as the oldest member of the Huronian.

The second or upper division consists of the following rocks:—

Chloritic schists, greenish, grey and purple ash rocks and amygdaloids, with purple conglomerates.

Pale grey pyritous and rusty-weathering felsites and feldspathic quartzites.

Hydromica schists, chloritic and feldspathic schists, grey clay-slates and purple conglomerates, with beds of hematite, styled Coastal in former reports, and now regarded by him as the upper member of the Huronian.

The third report, by Dr. G. F. Matthew, is confined to the Kingston group and principally to its development in the Kingston peninsula, where from the discovery of a small outcrop of fossiliferous ashy rocks and slates of Upper Silurian age along the south side of the Long reach of the St. John river, which at several points on the shore appear to have a dip inland, it was inferred that a large

portion of the rocks of this group were stratigraphically above the fossiliferous beds and consequently newer. He, however, at the same time, in tabular form, paralleled the Kingston of this locality and its extension westward into Charlotte county, under the heading Upper Silurian, with the recognized Huronian of St. John, in which the lithological resemblance of the two groups is such as to strike the most casual observer.

The Huronian character of the crystalline and metamorphic rocks of southern New Brunswick was next pointed out by Dr. T. Sterry Hunt, in his report to the Geological Survey of Pennsylvania, published in 1878, and subsequently in a paper read before the American Association for the Advancement of Science, (1879), in which the unconformity of these rocks to the supposed Laurentian of the St. John area was indicated, as well as their lack of conformity to the overlying Primordial slates. In the Supplement to *Acadian Geology*, (Sir Wm. Dawson, 1878) several allusions to this province also were made, the principal points of which have been already considered. In this year, too, the final report on the geology of southern New Brunswick appeared, accompanying the map of that area, which had been so long deferred. From a careful consideration of all the data in the possession of its several authors, which had been accumulating for years, the various geological lines were there laid down, and the most recent and probable views concerning the horizons of the different formations stated. As no subsequent publication on a large part of this portion of the province has since appeared, the position and arrangement of the geological systems as there expressed may be briefly stated, with some probable changes which may hereafter be made in certain groups, about which sufficient was not at that time known to pronounce definitely as to their exact age and relations.

It must be premised that in speaking of the geology of southern New Brunswick, that portion only is included which lies to the south of the great central Carboniferous area, in so far as relates to the Pre-Carboniferous rocks. The study of the northern and southeastern extensions having been taken up at a date subsequent to 1878, these areas will be considered further on.

The geological systems recognized at that date (1878-79), in that portion of the province now under consideration, are as follows:—

Laurentian.....	Lower.
	Upper.
Huronian.....	Formerly divided into Coldbrook, Coastal and Kingston.
Cambriar.....	Primordial Silurian, Acadian, or St. John group.
Cambro-Silurian.....	Formerly Middle Silurian.

Silurian.	
Devonian.	
Carboniferous.....	Lower.
	Middle or Millstone-grit.
	Upper of eastern Westmorland county.
Triassic.	
Intrusive rocks.....	Granites, syenites, diorites, diabases. Trappean rocks of Carboniferous and Triassic age.*

In the general geological map of the southern part of the province, 1878-79, the area coloured as Laurentian embraces principally that portion which, in 1860, was separated from the Devonian, under the title of the Portland group. West of St. John city it embraces the greater part of the county of St. John, extending across into Charlotte county, and terminates westward at Ragged head, which forms the southwestern point of Lepreau harbour. Though apparently divisible into two unconformable series it was not deemed advisable to colour these separately, but the limestones were designated, wherever known to occur, by a distinct tint, and thus the upper member was, to a certain extent, made conspicuous.

The anticlinal structure of the lower member was regarded as well marked, and its probable extension northeasterly has already been given. The limestones in the vicinity of the St. John river flank the axis on either side. These are well developed along the south side of Kennebecasis bay, and from South bay they extend at intervals for about four miles west of the river, where they apparently form a basin. Eastward they appear as outliers on the syenitic rocks beyond Rothesay, and at several points as far east as Norton. West of St. John they appear at Pisarinco and at Musquash harbour on the s[illegible] flank of the main anticline. The width of this supposed Laurentian area, comprising both divisions, is from six to seven miles.

In report 1870-71 it was stated that a belt of gneissic rocks, bearing much resemblance to those just described, extended from the head of the Long reach of the St. John river, along the north side of that sheet of water, to L'Etang harbour, forming an anticlinal ridge flanked by supposed Huronian sediments. On Frye island, near the southwestern extremity of this axis, syenitic rocks occur with crystalline limestone, in character somewhat similar t[illegible]hose which occur with so-called Laurentian rocks elsewhere, and the whole belt was con-

*NOTE.—The conclusions arrived at and stated in this report may be briefly summarized. Recent investigations in the southern part of the province, from the St. Croix river on the west to the Black river east of the city of St. John, have caused these opinions to be largely modified, and the recent changes will be also indicated.

sidered as probably a parallel ridge, contemporaneous with the belt just described. While, however, this view was held concerning the age of these rocks, the difficulty of separating them precisely from the overlying Kingston group, owing in large part to the wooded character of the country which they traverse, was such that it was thought best to include this series in the general Pre-Cambrian colour without definitely specifying its exact position. Lying off the coast in this direction the group of islands called The Wolves was found to be composed of greenish syenites and other rocks of the lower series in which, however, no limestones appeared.

Further west in the parishes of St. Patrick, St. Croix and St. Stephen, syenitic, dioritic and gneissic rocks are common. These in the vicinity of the St. Croix river present characters very similar to those of the fundamental rocks of the St. John area, and were at one time described as of the same horizon. They are intersected by large dikes and masses of intrusive syenite, some of which are of much later age than the rocks with which they are associated. In this locality, also, the authors found much difficulty in separating the newer intrusive rocks from the older portions, and all these areas of syenites, etc., of whatever age, were therefore included in the same colour, though the outlines of the newer are indicated on the map in a general way.

It must therefore be fully understood that in the area indicated as granite, west of the Digdeguash river, and for a mile or so to the east, a considerable portion might possibly be of Pre-Cambrian age.

In Albert county, also, attention was called in 1870-71 to the presence of rocks similar to those of the so-called Laurentian of St. John, and the supposition was then advanced that these occurred as ridges surrounded by Huronian strata. This view, in so far as the stratigraphical relations of the several groups were concerned, was confirmed in 1878, and the probable Laurentian age was indicated by the presence of crystalline limestones and dolomites. The older portions of these ridges, as we proceed westward into Kings county, speedily become concealed by the unconformable overlap of the Coldbrook and Coastal groups, from which, in lithological character, they are markedly different. They contain also a considerable area of coarsely crystalline diorites, holding magnetite, which in places become almost a pure hornblende rock.

A similar area of magnetic diorite in northern Kings county near the Scottish settlement was referred to in 1870-71, and was supposed to be of Laurentian age, as were several areas west of the St. John river, in the valley of the Nerepis. The dioritic rocks in Charlotte county, near St. Stephen, are also probably of this age. They contain serpentine and chromic iron in small

quantity and were supposed to underlie, unconformably, hard micaceous quartzites. East of St. John, near Dolin lake, bands of hard crystalline, feldspathic, sometimes dioritic, rock occur, associated with hypersthene and magnetic iron, which were considered by Dr. T. S. Hunt as identical with some varieties of norite rock of the Upper Laurentian or Labradorian series. They are associated with gneisses, also presumably of the upper division.

The limestones near St. John are in places serpentinous and have furnished indications of the presence of *Eozoon* structure. At Pisarinco, also, serpentine is found in talcose and chloritic rocks, associated with limestones, and at the falls of the St. John river deposits of plumbago of large extent are found in the slates and limestones. It is worthy of remark that in all the supposed Laurentian areas of Charlotte county no traces of limestone have as yet been found, except at Frye island and Lepreau.

The work of the last three years in Charlotte and St. John counties has caused a marked modification of the views formerly held as to Laurentian rocks of southern New Brunswick. Thus, as regards much of the granite, gabbro, diorite, and diabase it has been shown that the greater part at least of these are of comparatively recent date; that they are clearly intrusive through Silurian and sometimes Devonian sediments; that the crystalline limestone of Frye island is altered Silurian instead of Laurentian, the metamorphism being due in part to pressure and in part to large masses of intrusive rocks; that the crystalline limestones of Lepreau harbour and of Musquash village are altered portions of the Devonian (Bloomsbury), and that the crystalline limestones of St. John county, as seen on the east side of Musquash harbour and along the shore east of Pisarinco, are also locally altered and cut in all directions by masses and dikes of granite and diabase, which also cut the Bloomsbury division of the Devonian and other parts of that series of formations; that the crystalline limestones of St. John city and vicinity are not a part of the Laurentian formation (Grenville series of Quebec) but are associated with highly altered banded slates and quartzite which are similar in character (though sometimes more highly altered) to the lower portion of the Cambrian rocks of that city though as yet they have not yielded fossils; that the series of gabbros, granite and diabase rocks which were once regarded as representing the Lower Laurentian or Fundamental gneiss are in reality intrusive igneous rocks of later date than the slates and limestone with which they are now associated; and that a very close examination of these so-called oldest rocks could not determine any rocks of Laurentian age in the southern part of the province, at least at any observed point.

The history of the Huronian system, with the many changes

which have taken place in relation to its various groups, has already been somewhat fully stated, and we will, therefore, here present only the views held in 1878-79 regarding its distribution and mineral character.

The term Huronian does not appear on the general map, for the reason that, owing to the uncertainty as to the age of the several groups, some of which have just been described, it was thought best, until their true relations to the Laurentian or Huronian systems proper could be accurately worked out, to include these under a general term, Pre-Cambrian, since, in position, they were found to unconformably underlie at several points the fossiliferous Cambrian.

The former division of the Huronian into Coldbrook, Coastal and Kingston was exceedingly unsatisfactory, inasmuch as while they were all regarded as portions of the same system, their respective horizons could not with certainty be determined. Thus, in 1870-71, the Coldbrook is the first described after the Laurentian, leading to the inference that this group comprised the lowest members of the Huronian system, while at the same time its upper part was held to represent the basal beds of the St. John group, to the exclusion of the Coastal and Kingston. In the last report by Professor Bailey (1877-78) the Huronian south of the Kennebeeasis was divided into two groups only, the Coldbrook and Coastal, of which the latter is held to be the newer. The older is distinguished by the term 'felsite petrosilex group,' from the prevailing character of the rocks which compose it, while the newer is termed the 'micaceous and chloritic' or 'schistose group,' for the same reason. It is evident, from a consideration of the rocks of the Coldbrook, that they are for the most part of volcanic origin, the prevalence of breccias and brecciated agglomerates, diorites and ashy rocks, which make up the bulk of the group, presenting a marked contrast to the more slaty and schistose rocks of the Coastal, though the latter shows abundant evidence also of volcanic action in the presence of ashy and agglomerate rocks; it has also a considerable thickness of clay-slates, with purple grits and conglomerates. It is exceedingly doubtful, however, whether a separation such as has just been proposed, into an upper and a lower division, can be successfully made on stratigraphical grounds, owing to the difficulty of determining which group rests primarily on the supposed Laurentian, since in some places this position is held by the Coldbrook, while at others the Coastal is in direct contact. This difficulty becomes more apparent when we consider that the original Coldbrook, so named from the place where first studied, was at a later date regarded as Coastal. It is possible that both divisions may be contemporaneous, or that the Coldbrook or volcanic portion may be the more recent; this latter view receives a certain

amount of support from the stratigraphical evidence seen in the overturned syncline of Albert county, the rocks of which rest upon the basal ridges and are undoubtedly of the Coastal or schistose type, (see Rep. 1877-78). These occupy the southern portions of eastern Kings and St. John counties, and, while in their western extension they overlap the ridges just mentioned, they are in turn apparently overlaid by the volcanic rocks of the Coldbrook group, the Coastal not appearing at all in the northern portion of the main Pre-Cambrian area south of the Kennebecasis, unless we except certain doubtful and limited areas lying to the north and east of the Loch Lomond lakes.

There yet remains to be considered the third division of Huronian rocks, the Kingston group, which, also receiving its name from the place where first studied, namely, the peninsula lying between the Long reach and Kennebecasis bay, has a considerable development westward in Charlotte county. The various changes of opinion respecting the position of this group have already been stated, and we will, therefore, give the reasons, lithological as well as stratigraphical, which seem to us conclusively to prove that a portion of these rocks should be considered an integral part of the Huronian system. The character of the rocks which compose this group is well given in the report of Dr. Matthew, already referred to, for the Kingston area and for its extension westward, and is here presented for the sake of comparison:—

Compact, dark-grey diorite, and fine-grained, flesh-red felsite.

Hornblende and mica-schists, schistose diorite, and dark feldspathic slates, with grey argillites.

Fine-grained mica-schist, silico-feldspathic gneiss and schistose felsite. Chloritic gneiss and syenite, with thin beds of limestone, argillites, etc.

In addition, beds of slate conglomerate occur, and chlorite and epidote are found in veins of considerable size.

That the Kingston group is in part at least entirely distinct from and older than the Silurian was pointed out in 1870-71; but the Pre-Cambrian aspect is more clearly indicated if we glance at its structure as seen along the St. John river. By reference to the general report, 1878-79, it will be seen that the Pre-Cambrian rocks of southern New Brunswick are arranged in a series of approximately parallel anticlines, the synclines being occupied by fossiliferous Cambrian strata.

These anticlines were arranged in five divisions, of which Nos. 1 and 2 were considered of Laurentian age, No. 3, Coldbrook, No. 4, Coastal, and No. 5 Kingston.

This arrangement does not, however, necessarily indicate the true stratigraphical position of the various groups; for, while we have seen that the Coastal has not yet been definitely proved to be the upper portion of the Coldbrook, it is probable that the Kingston includes, in part at least, rocks common to both divisions 3 and 4, and possibly even lower.

The extension of the anticlines 1, 2 and 3 has already been given. Of the last two, which pertain to the Kingston peninsula, No. 4, beginning at Clifton on the south side, extends northeast past the head of Kingston creek, towards Dickie mountain, while No. 5, commencing near the western extremity, and well seen at Milkish creek, keeps along the north side of the peninsula, and crossing the entrance of Belleisle bay is probably continued along the north side of that sheet of water into the Scotch settlements.

A sixth ridge [illegible] Long reach on the north and forms the eastern extremity [illegible] ch, in Charlotte county, on the north, was stated to underlie Huronian sediments, and to be possibly of Laurentian age.

That all these ridges are, at least, Pre-Cambrian, was held to be plainly indicated by the presence of unconformably overlying areas of Cambrian slates, which occur in the form of basins of greater or less extent, the limits of which have been largely affected by denudation.

The most northerly of these, definitely recognized by fossils, is found on the west flank of the sixth ridge; but along its south side a much more important belt occurs, which occupies the greater part of the north shore of the Long reach from the mouth of the Nerepis to Jones creek, beyond which it is largely concealed by Silurian beds. It also appears in several small islands in the river and on the point at the mouth of Belleisle bay, where it overlies the more northerly of the two Kingston anticlines. It is quite possible that this basin of Cambrian rocks occupies the entire valley of the St. John river at this place, although its contact with the Kingston group along the south side of the reach is partially concealed by fossiliferous strata, which are possibly the prolongation southward of the Silurian area of Jones creek, since the overlap of the Primordial on the Kingston rocks is well seen at both extremities of the basin. It is probable also that the horizon of the two ridges of metamorphic rocks which extend on either side of the Long reach is not very different; although westward of the St. John river the Kingston group proper appears to occupy a syncline between the Lepreau axis and the older ridge north of L'Etang. This position would also correspond, on stratigraphical grounds with that assigned to it from lithological characters as largely representing Divisions 3 and 4 of

the Pre-Cambrian scale, but in this part of Charlotte county the Primordial has not yet been definitely recognized.

The presence of slaty conglomerates in the rocks of the Kingston group, the pebbles of which were at one time regarded as derived from Cambrian slates, has been recognized. The fragments may be derived from the bands of black and graphitic slates, which, at many points, form an integral portion of the rocks to the rear of St. John city and elsewhere.

In the areas coloured Cambro-Silurian, extending along the county line of Kings and Queens, belts of rock which very closely resemble those just described are found. They consist of hard felsites often porphyritic, with felsitic, chloritic and talcose schist, and fine and coarse diorites. After many ineffectual attempts to separate these satisfactorily from other slaty beds, with which they are intimately associated, the greater part of these areas was included, provisionally, in the metamorphic Cambro-Silurian system. These areas of igneous rock are in no place of great extent, but appear as crests of ridges exposed by denudation and protruding through the overlying strata.

In fact, the greater part of the formations of southern New Brunswick have been so intricately folded that the problem of deciphering their exact age has been a very difficult one; and it is to be presumed that with the accession of new light, derived from the study of similar rocks elsewhere, other important changes will be found necessary.

The views concerning the geology of the islands called the Western isles, in Passamaquoddy bay, have undergone the same changes as already described in connexion with the Pre-Cambrian rocks farther east. The group of The Wolves, consisting almost entirely of syenitic and gneissoid rocks, is probably the western prolongation of similar rocks from the mainland at Lepreau; while Campobello and Deer islands, together with the greater number of the smaller islands lying between these and the shore, represent, probably, the extension of what has been styled the Kingston group. Ores of copper and iron are common, in which respect the rocks resemble those of the metamorphic Coastal belt east of St. John, as well as in their general lithological character.

Recent investigations in this area (1903) have shown that the rocks of the islands in Passamaquoddy bay and in parts of the main land adjacent to the north, as at Letite, Frye island and elsewhere, consist largely of altered Silurian sediments, closely associated with dikes and masses of later intrusives, mostly diabasic in character, which have locally altered the Silurian slates and limestones, though the contained fossils can be seen at several points, but are generally much distorted.

From 1878 to 1903 no detailed examination was made of the Huronian rocks of Southern New Brunswick. In 1903 some detailed work was done in Charlotte county and has since been extended into St. John county and along the lower St. John river. While the exact position of the several divisions of the Huronian has not yet been definitely determined, sufficient has been learned to warrant certain changes in the distribution as defined in the published map of the district. Great portions of the Huronian are known to be igneous in character instead of sedimentary as was at one time supposed.

The Pre-Cambrian of Charlotte county has already been referred to in the notes on the Laurentian. In the St. John River areas, as in Kingston peninsula, the rocks are also largely igneous, consisting of felsites, both reddish and grey, which are cut by great masses and dikes of green diabase. On Kennebeecasis island, Milkish head, and on Long island, areas of Cambrian slates and crystalline limestones are found, but the relations of these are rather with what was formerly styled the Laurentian than with the Kingston division, and the contacts are more of the nature of intrusives than of overlying sediments. In the ridge north of the Long reach of the St. John river, composed also of felsites, diorites and hornblende schist, these are overlaid by the purple beds of the Etcheminian (Cambrian) and there are pebbles in the lower conglomerates derived from the rocks of this ridge. This is the belt of rocks which extends across into Charlotte county, coming to the coast west of Ragged head on the west side of Lepreau and extending thence nearly to Beaver harbour.

Along the south side of the Long reach, between Elmsdale and Carter point, the shore shows large ledges of diabase and granite rocks, all clearly igneous in character. These in the published map were coloured as Upper Silurian on the supposed evidence of fossils. A careful search during the past year failed to find any organic remains, as the rocks were volcanic. Along the shore occasional patches of altered slates are seen with the felsite, but no traces of Upper Silurian sediments were here seen.

As regards the Coldbrook and Coastal some changes were also noted. Portions of the former were observed to be intrusive in the Etcheminian, and the character of the rocks throughout was igneous. In the Coastal division east of St. John a part of this division which is highly schistose was separated and placed in the Devonian. This included a part between Cape Spencer, east of St. John, and the mouth of the Black river, and on the west it included a considerable area in Pisarinco peninsula between the east shore and Musquash harbour. Farther west it included a belt extending as far as Dipper harbour. In character these rocks resemble Pre-Cambrian schists.

but a re-examination showed them to be highly altered Devonian sediments. On the promontory known as Taylor island the red rocks of the Bloomsbury division are cut by huge masses of green and epidotic diabase, and masses of the red slates are caught in the igneous rocks. This series of igneous rocks of comparatively recent date extends along the south side of the post road from St. John to Lepreau and was, on the published map, coloured as Pre-Cambrian (Laurentian). Farther east of St. John the Coastal still remains as Pre-Cambrian, in large part underlying the Etcheminian Cambrian, and this belt of rocks extends from the vicinity of Black river to the east end of Caledonia mountain in Albert county. To the north of this certain areas, once coloured as Pre-Cambrian, can now with great propriety be styled intrusive rocks of much later date.

The rocks of the St. John group, or Cambrian series, were, until 1865, as already stated, regarded as an integral part of the Devonian system. The early researches of Messrs. Hartt and Matthew on these rocks have been alluded to in former pages, but of late years their fauna has been particularly studied by the latter gentleman, whose investigations have brought to light many interesting facts relative to the palæontology of the group, the results of which have appeared, from time to time, in several papers contributed to the Royal Society of Canada and elsewhere. The lowest recognized portion of the Cambrian containing fossils consists of purple quartzose sandstones and conglomerates, with shales, the former apparently derived from the underlying groups. These are succeeded by red and greenish-grey argillites, often micaceous, whitish and grey sandstones, with grey and dark grey sandstones and shales, the latter of which are often fossiliferous, and contain a variety of trilobites, such as *Conocephalites, Microdiscus, Agnostus* and *Paradoxides*, all of Primordial type, together with *Lingula, Obolella, Discina* and *Orthis*. They lie in well defined basins upon the Huronian rocks. At least six of these Cambrian belts are known. Among the most important are the areas in the city of St. John and the great development which extends thence northeasterly past the Loch Lomond lakes towards the upper part of the Hammond river. Other areas consist of outlying patches, which have apparently escaped denudation, and which serve to illustrate the great dislocations by which, in many cases, these rocks have been affected. The smaller areas about Kennebecasis bay are overlapped by Upper Devonian sediments.

Though no fossils of value for determination have yet been found in the crystalline limestone and associated slate and quartzite which occur, in the western part of St. John city, and between that place and the Kennebecasis, the marked similarity between the slate and quartzite beds so associated, and those of portions of the Cambrian

proper, points strongly to the supposition that these rocks with the limestone bands or lenses, formerly supposed to be a part of the Laurentian series, may properly be placed in the lowest Cambrian system. The fact that these, as well as the Etcheminian division of the Cambrian, are cut by the same series of igneous rocks which were formerly regarded as a part of the Coldbrook Huronian, and have been altered along the contacts, makes the whole question, in the absence of characteristic fossils, difficult to determine definitely.

The Cambro-Silurian system, as at present understood, comprises all the formations between the Potsdam sandstone and the Hudson River or Lorraine shales, both inclusive. In New Brunswick the subdivision into intermediate groups has not yet been attempted the rocks of the series being entirely different in character from those found in Quebec and Ontario. The system comprises certain rocks known, for the most part at least, to underlie the fossiliferous Silurian, and to overlie the Cambrian. The characters of these have already been given.

In their distribution the rocks which were supposed to be of Cambro-Silurian age, in 1878-79, form a belt, principally of metamorphosed sediments, extending from the western boundary of the province diagonally across the county of Charlotte to its northeast corner, flanking on its north side the great granitic area for the greater part of the distance. Thence it extends to the River St. John, in the vicinity of Hampstead, and, reappearing on the eastern bank, continues along the county line of Kings and Queens for a further distance of twenty miles. The northern limit is fixed, for the most part, by the unconformably overlying interior basin of Devonian sediments; but to the west, at the head of Oak bay, and to the east of the granite area in southwestern Queens it is overlapped by strata of Silurian age. Much of the country occupied by these rocks is exceedingly difficult of access, and a more detailed examination has changed somewhat the outlines of the area as defined. Large portions of these rocks have recently been transferred to the Upper Silurian, which is the horizon at which they were placed more than thirty years ago.

Rocks of the Silurian system occur at several places in the southern part of the province. Along the coast of Charlotte they are found sometimes in small lenticular basins, which have been enfolded with areas of other rocks largely along the shores of Passamaquoddy bay; the association being intricate and often obscure, as in the case of the Mascarene series. Certain beds are, however, well defined by the presence of characteristic fossils, which are probably of the horizon of the Niagara formation. The fossiliferous beds are also well seen around the upper part of Oak bay, and from this place

they extend in a continuous belt along the south side of the granite area as far east as New river, a distance of thirty miles. In the southeastern part of the province they have not been definitely recognized; but along the St. John river, in the vicinity of the Kings and Queens county line, they form a considerable area, abounding in fossils at many points, and resting unconformably upon the rocks of the Huronian and Cambrian systems.

The Devonian system has a considerable development in the southern portion of the province, and contains many points of interest. It is noted for the abundance of the plant remains which have been obtained largely from one of the lower members, the Dadoxylon sandstone, and from its yielding the earliest remains of insect life yet known, at least in America. The flora, both from the formations in New Brunswick and from Gaspé, were carefully studied by the late Sir William Dawson many years ago, and the results have appeared in a series of papers, ranging in date from 1859 to 1882, which have been readily accepted as standards for the determination of the several divisions.

The rocks of the system have been divided into five groups, viz., Bloomsbury at the base, Dadoxylon, Cordaite shale, Mispeek and Perry. Of these the first is largely made up of igneous rocks which cut across and sometimes occur in large masses, associated with certain beds of reddish conglomerate, sandstone and shale. These sediments pass up into the Dadoxylon sandstone and shale, generally greyish, sometimes abounding in plant remains, the lower beds occasionally changed to a hard quartzite. Many of the plant remains are in a fine state of preservation, including in the shale beds several kinds of ferns, with insect wings and remains of crustaceans.

The Cordaite division consists of greenish-grey and purple-tinted shale and sandstone, in certain portions of which remains of Cordaites are abundant and well preserved, whence the name of the division. These rocks pass up without apparent break into the Mispeek division which contains numerous beds of conglomerate and is often purple tinted. Above all are the Perry conglomerate and snadstone series, generally reddish-brown in the lower portion, but gradually passing up into greyish beds of grit, shale and sandstone, with occasionally conglomerates which appear to constitute the upper part of the Devonian series. In these upper grey beds plant remains are often abundant, certain forms being similar to those found in the Gaspé series.

In certain places the Devonian rocks are much altered, passing into schists of Pre-Cambrian aspect, and occasionally they are cut by masses of diabase, with sometimes a great development of quartz in the form of veins and large masses; so that in this system we

have in the vicinity of St. John, on the east side of Courtney bay, a regular sequence of the different formations from the Bloomsbury division at the base to the upper or Perry group. The flora from this upper division closely resembles that from what is known as the Horton series as seen on the Avon river in Nova Scotia. In that portion between the red conglomerates and the upper grey shales is situated the series of bituminous shales, that in Albert county hold the peculiar mineral called 'Albertite' and known usually by the name 'Albert shale,' and which form a well-defined area extending from near the village of Hampton on the west into Westmorland county near Dorchester and Memramcook on the east.

Along the coast of the Bay of Fundy east of St. John the areas of the Devonian are somewhat limited, the principal being that already referred to east of the harbour at Courtney bay. Here the rocks occupy a true basin and extend from Little river on the north to Cape Spencer on the south. They are here in the form of a double syncline which extends inland for about eight miles. Farther east the upper or Perry division extends along the coast as far as the village of St. Martin, the rocks in places being much broken up and sometimes altered. Still farther east they again appear on the coast of Albert county and can be followed from Cape Wolf to Shepody mountain, both the Perry conglomerate and the upper grey plant-bearing shales and sandstone being well exposed, especially in that part between Cape Enrage and New Horton where the strata are highly tilted, sometimes reaching the vertical.

Inland the Perry formation occupies the shores of Kennebecasis bay and several islands there, and then continues eastward along the valley of the Kennebecasis river as far as Sussex, where it becomes covered in part by the unconformably overlying beds of conglomerate, limestone and gypsum of the Lower Carboniferous formation. The Perry beds again appear and have a considerable extent in eastern Kings and Albert counties where the Albert shale portion is well developed.

West of St. John the several divisions are also well exposed. The Bloomsbury red beds with the igneous epidotic masses show in the Carleton portion of the city, whence they continue at intervals to the village of Musquash, followed in ascending order by the other divisions into the Perry, which is well seen at Point Lepreau resting here upon the Dadoxylon sandstone. The intermediate divisions are highly altered about Piscarineo and in the portion west of Musquash harbour, becoming crystalline schists with masses of igneous rocks, often felsites or rhyolites.

The Perry rocks west of Lepreau show at a number of points on the coast of Charlotte county, but are especially developed about the

town of St. Andrews when they cross the St. Croix and pass into the State of Maine, where they have been recently studied, as regards their flora, by Mr. David White, of Washington, by whom their Devonian age has been declared.

The largest area in the southern half of the province is found underlying the central Carboniferous basin. This, beginning at the boundary of Maine, extends to the St. John river, and has in Charlotte county a breadth of about twelve miles, bounded on either side by rocks of Silurian age. That it underlies a very considerable portion of the Carboniferous central basin is seen from the occurrence at intervals, as about the head of the Grand lake and on Canaan river, of outcrops of Devonian slates, sometimes in the beds of the streams where they are unconformably capped by the Millstone-grit division. These Devonian strata have apparently participated in the series of disturbances which affected all the formations in the southern part of the province older than the Carboniferous.

In the western portion of the province outcrops of the conglomerates of Perry age are seen in Carleton county a short distance above Woodstock, whence they pass northeast and cross the St. John river two miles south of the village of Hartland. Here they spread out and form an area of considerable extent to the eastward, resting upon Upper Silurian rocks. These grey beds associated with these red conglomerates also contain plant remains similar to those which occur with the upper grey beds of the Perry in St. John county. It is also probable that a portion of the area along the Tobique river in the vicinity of Plaster Rock, and on several streams to the south, should be assigned to the horizon of the Perry division, but the details of this area have not yet been worked out.

The Carboniferous system is divided into three parts, viz., the Lower, the Middle and Upper. The Middle division in Nova Scotia is subdivided into two portions, the Millstone-grit and the Productive coal measures. Of these in New Brunswick, apparently only the first is represented, the coal seams known in the province belonging to this division and the true coal measures being absent.

To the Lower Carboniferous division belong the marine limestones and the gypsum deposits. These are usually regarded as constituting the base of the entire system; but with them are associated certain conglomerates, sometimes greenish and sometimes reddish, which rest upon the upper part of the Devonian. Above the gypsiferous measures other conglomerates with marly reddish shales occur, which directly underlie the grey Millstone grit conglomerate. As a rule the Lower Carboniferous beds are but little disturbed, their inclinations being at low angles, though thrown into undulations. In places near the base, intrusive masses of diabase and

rhyolite, sometimes porphyritic, occur, and some of the largest deposits of manganese in the province are found near the bottom of the series at the contact of the limestone with the old rocks, as at Markhamville and at Jordan mountain.

The general characters of the Carboniferous formations, as given from the time of Dr. Gesner, down to the publication of the general map in 1878-79, have been described in considerable detail in the preceding pages.

The total area of Middle Carboniferous rocks is about 12,000 square miles, throughout which great uniformity of character is apparent. Over the greater portion extends a thin seam of coal which crops out on Grand lake and on the Richibucto river, where it has been worked for many years, and at various other points along its entire border. This seam, while varying slightly in thickness, in no place, however, amounting to more than twenty or twenty-three inches, is very uniform in general character; and it is probable that all the outcrops noted pertain to the same seam, brought to the surface at intervals by a series of low anticlines which affect the measures throughout their entire extent, following generally a course parallel to the Pre-Cambrian ridges which surround the basin on the south and northwest. Throughout the counties of Kent, Northumberland and Gloucester, which comprise the area bordering on the Gulf of St. Lawrence, the character of the sediments is similar to that of the recognized Millstone-grit areas of the Bay of Fundy coast, though the horizontality of the beds is such that but little information can be obtained from surface examination as to the entire thickness of the formation. In eastern Westmorland the investigations of 1884 resulted in the discovery of many interesting facts in regard to the structure and thickness of the several formations comprised in this system.

The thickness of the Middle Carboniferous in the central basin, as given in the report for 1872-73, has also been considerably changed by the study of the rocks farther east. Thus the three divisions above the Lower Carboniferous were at that time regarded as follows :

Barren measures probably Millstone-grit	200 feet.
Productive	200 "
Upper Carboniferous	200 "

This view was modified in 1878, and the whole interior area was referred to the horizon of the Millstone-grit. The sections of this formation in the vicinity of Dorchester have shown that it has a thickness of at least 1,000 feet, and that it is directly overlapped by the Upper Carboniferous formation which extends thence over a considerable part of eastern Westmorland county, occasion-

ally broken by the presence of ridges of Millstone-grit rocks. Where the contact is not with the Millstone-grit the Upper formation rests directly on the Lower Carboniferous, which arrangement is also seen in the adjoining province, in the area lying south of Northumberland strait.

The westward extension of the magnificent Joggins section touches the coast of New Brunswick only in its lower part; the Productive measures, in which the Joggins coal seams are found, trending out into the bay, and being exposed on no part of the shore of the province. The general horizontality of the measures shows that the disturbances, which so profoundly affected the coal-fields of Spring Hill and Pictou, did not extend in this direction, while the apparent absence of the coal measures over any portion of New Brunswick, in so far at least as can be at present determined, leads to the assumption that this area was for a considerable period already permanently raised above the sea.

Several outlying patches of the Middle Carboniferous are seen at points outside the central area. In character of sediments they do not differ from those already described, and contain also a thin seam of coal. Among these may be mentioned that of Prince William, about twenty miles west of Fredericton, and at Dunsinane on the railway between Sussex and Petitcodiac.

Extensive traces of volcanic activity are manifest at many points, especially in the Lower Carboniferous formation. Thick beds of ash rocks, conglomerates and breccias, together with various traps, are found, not only around its border, but in isolated hills which, by the agency of denudation, now appear prominently from beneath the grey sandstones of the Millstone-grit in the very centre of the coal district. In places, these trappean masses are apparently overflows from dikes which have cut the lower beds of the Lower Carboniferous, and have altered these along the contact in the same manner as the sandstones of the Bay of Fundy have been affected by the trap outflows of the Triassic time.

The Triassic formation is well seen about the village of St. Martin on the north shore of the Bay of Fundy, about thirty miles east of the city of St. John. As exposed on the shore it consists of bright red, rather soft sandstone, which rests in part upon the Perry conglomerate and sandstone and in part on igneous rocks of St. Martin head. Inland, the sandstone becomes associated with pebbly conglomerates and with interstratified sandstone and shale. Traces of plant stems have been observed in these beds, but have not yet been definitely determined. The formation extends east from the village as far as Melvin beach, a distance of seven miles, and has a breadth inland to the foot of the mountain range of about two miles,

occupying a basin-shaped area, the northerly dips seen along the shore changing to the south near the contact with the underlying rocks inland.

Other small areas are seen in Albert county on the shores of Salisbury bay to the east, and to the west between Red head and Gardner creek where they also rest upon the Upper Devonian formation.

On the island of Grand Manan the Trias is represented principally by a large mass of trap or diabase, often columnar, sometimes ashy and amygdaloidal, resembling that of the North Mountain range in Nova Scotia. On the west shore of the island at low water small exposures of red Triassic sandstone are reported, similar to those just described.

Leaving for the present the consideration of the igneous rocks, which constitute an important element in the geology of this part of the province, we will now examine the structure of its northern and western portions.

The earlier investigations of Dr. Gesner and others have already been reviewed down to the year 1874. Upon the completion of the map of southern New Brunswick the examination of these sections was at once commenced, the northern part by the author of this paper; the western by Professor Bailey and Mr. W. Broad; while the superficial geology of the district was entrusted to Dr. R. Chalmers. Reports on the former area appeared in 1879-80, 1880-81, by the writer, and on the latter by Professor Bailey, 1882-83-84, and 1885. Investigations were also carried on for a short time in 1879, by Dr. G. F. Matthew, in Carleton county, the results of which were not published separately, but were subsequently embodied in the report by Professor Bailey on the area in question.

The difficulties encountered in tracing out the various formations were far greater in this section than in that already described, owing to the fact that, with the exception of narrow belts of settled lands in the vicinity of the St. John river on the west, and along the shores of Chaleur bay on the east, and for a short distance inland along the course of the principal streams, the country is an entire wilderness; the only means of access to its interior is by canoes along the various rivers which rise in close proximity to each other in the series of mountains constituting the watershed. Of these streams the principal flowing to the east are the Restigouche, Nipisiguit and the branches of the Miramichi; to the west the Tobique, and several other large branches of the St. John. From the explorations that have been thus carried on the following systems have been clearly recognized:—

Pre-Cambrian.....Comprising gneisses, syenites, schists of various kinds and felsites.

Cambro-Silurian	Which, as in southern New Brunswick, may also comprise limited areas of Pre-Cambrian, and even Cambrian rocks, at present not separable
Silurian	Limestones, slates and sandstones, often highly fossiliferous.
Devonian	Principally developed about Chaleur bay, and in Gaspé peninsula, but also as patches overlying the Silurian rocks inland.
Carboniferous	Lower or Bonaventure formation.
	Middle or Millstone-grit.
	Upper, along the shore of the Gulf of St Lawrence and Northumberland straits.

Volcanic or Igneous rocks.

In the study of the Pre-Cambrian areas of northern New Brunswick no attempt has yet been made to separate the divisions of the Pre-Cambrian; since, in the present largely inaccessible condition of the country, such separation must of necessity be very imperfect. Various rocks occur which approach very closely in character to the oldest rocks of St. John county, and which, apparently, form the lowest members of the Pre-Cambrian series, being clearly distinguished from the upper or schistose portion. Of the former are the gneisses and syenites, with certain felsites, which are extensively developed about the headwaters of the Nipisiguit river, whence they extend southwesterly, crossing the upper part of the south branches of the Tobique; but it is worthy of remark that in all the areas of these rocks yet examined in this portion of the province, no traces of the crystalline limestones which are so conspicuous in the older rocks of southern New Brunswick have yet been found. On the Tetagouche river beds of graphitic, and to some extent crystalline limestone, occur, which resemble somewhat those of St. John, but their intimate association with blackish slates that belong to the Cambro-Silurian graptolitic series near the mouth of that stream renders it probable that these may belong to that horizon, and that their alteration is due largely to local intrusions of dioritic masses, in the same way as is seen in the alteration of the fossiliferous Silurian limestones into marble near Chaleur bay.

In general, the Pre-Cambrian rocks of this section greatly resemble those of the recognized divisions already described. There is probably, however, a greater preponderance of true felsites, and a smaller development of the ashy or volcanic portions of the Coldbrook and Coastal groups, but felsitic, chloritic and talcose schists, epidotic rocks, gneises, etc., are common at many places

throughout the area in question. They occupy an extensive tract of country extending diagonally across the northern portion of the province, from a short distance above the Forks of the Main Southwest Miramichi, on the west, nearly to the mouth of the Jacquet river, on Chaleur bay. The greatest breadth of this area, on a line drawn across to the head of the Tobique river, is about forty-five miles, in which is included a breadth of twelve miles of intrusive granites. The principal area regarded as Pre-Cambrian is overlapped by the Silurian on the east, a short distance after crossing the Tetagouche river, on which stream its southern boundary is seen about sixteen miles from its mouth. The Silurian rocks here occupy an elongated basin, extending inland for some distance beyond the upper waters of the Upsalquitch river, bounded on the north by the prolongation of the felsite area, which can be traced continuously from the Tobique lake across the latter stream, and along the north side of the Jacquet river nearly to its mouth. On the upper part of the Upsalquitch, gabbros are associated with the gneisses that constitute the high hills in this vicinity; but along the watershed which divides the streams flowing into the Gulf of St. Lawrence, viz., the various branches of the Miramichi, and those into the Tobique, the Pre-Cambrian rocks have been broken through by a great mass of granitic and syenitic rocks, precisely similar in character to those of Charlotte county. The southern margin is also for some distance bounded by similar granites, which are extensively exposed on the upper part of the Main Southwest Miramichi and its tributaries.

On all the streams which flow east between the Nipisiguit and the Main Southwest Miramichi the rocks called Pre-Cambrian are easily recognized. Their intense degree of metamorphism, regional rather than local, distinguishes them from those of the overlying formations, while in many places there is a marked unconformity between them. The western boundary of the series is seen on Nictor lake, which is at the head of the Tobique river, in several islands and in the great peak known as the Bald mountain, whence a high chain of hills extends to the right hand branch of the Tobique, crossing it a short distance below the forks of the Campbell and Serpentine rivers, and continuing with a more southwesterly trend to the forks of the Miramichi. On the Nipisiguit its eastern boundary is seen a short distance below Indian falls, not far from the 47 mile post on this stream. The northeastern area is divided into three parts by basin-like overlaps of Cambro-Silurian and Silurian strata, presently to be described.

To the south, the Pre-Cambrian is overlaid principally by rocks of the Cambro-Silurian and Cambrian systems, and on the west by sediments of various ages, up to the Lower Carboniferous.

The Cambro-Silurian and Cambrian rocks resemble those of the areas already described under this head in previous pages. They consist of slates, grey, red, and black, with quartzose sandstones, sometimes schistose, and when in contact with the granites contain abundance of crystals of staurolite, mica; etc. Certain bands of the red and green slates are persistent for long distances, and can readily be traced from their northerly terminus on Chaleur bay southwesterly into the county of York. In character these slates of various colours, with their associated sandstones, resemble very closely certain beds of the Lévis and Sillery divisions of the Quebec group, and this resemblance is strengthened by the occurrence of graptolites, in some of the graphitic layers, similar to those found in that group. As in the southern portion of the province, certain areas of highly metamorphic rocks also occur, which lithologically closely resemble Pre-Cambrian; but as in the case of the more southern area, these are so intimately associated with other sediments as to render their separation impossible for the present. The alteration of many of these sediments is probably in part due to local intrusion of igneous rocks, and in part to the folding to which they have been subjected.

The rocks now considered of Cambro-Silurian, and in part of Cambrian-age, are in great part those described by Drs. Gesner and Robb as Cambrian, while in the map accompanying *Acadian Geology* they were comprised under the term Lower Silurian. To the southwest they occupy a large portion of the county of York, whence they extend into the adjoining state of Maine. In this direction they are directly overlaid by Carboniferous sediments of the central basin, the Devonian and Silurian being largely concealed, or, at best, represented only by detached outliers of very limited extent. Their northwest outline crosses the International Boundary into Maine, about two miles south of what is known as the Monument, at the source of the St. Croix river, whence, trending northeasterly, it crosses the St. John river a little to the north of Woodstock, and extends nearly to the headwaters of the Tobiquê. Recent investigation has shown that in this belt are included areas of fossiliferous Upper Silurian, more especially in that part between Canterbury and Benton on the line of the Canadian Pacific railway.

Areas of limestone which are sometimes crystalline and micaceous are found as an integral portion of the system in the western area near Canterbury. These resemble in some respects the crystalline limestones of St. John, and are associated with quartzites and schistose rocks. The occurrence also of somewhat similar limestones in the eastern area as a part of the same formation has already been referred to.

While then, the Cambro-Silurian and Cambrian rocks have a somewhat extensive development in this section of the province, their bulk is much reduced by the presence of large masses of syenite and granite of undoubtedly much later date. These have penetrated the surrounding beds, into which large dikes and veins are intruded in all directions, while huge pieces often have the appearance of having been torn from their original position, and of being now held in the igneous mass. Their action on the slates and sandstones is marked, not only by the generation of crystals of various kinds, but by a general alteration of the contiguous beds into schists and gneisses containing mica.

Two principal areas of these rocks are seen, the more southern flanking the south side of the Pre-Cambrian axis of the interior, and continuing to the shore of Chaleur bay, north of Bathurst, the other on the northwest side of the axis, terminating, as described, near the headwaters of the Tobique. These areas are distinctly unconformable to the underlying series. They are not, as a rule, rich in fossils, but at several points in the southern belt, notably on the Tetagouche and Miramichi rivers, different forms are found, including brachiopods, as well as graptolites. These, while in many cases too indistinct for perfect determination, present features more nearly allied to Cambro-Silurian forms than to those of any other horizon; but in the western belt, more especially on the North branch of the Becaguimec river, in Carleton, a wonderfully mixed fauna is found in a somewhat limited space. At one point on this stream, near Shaw's mill, strata, holding fossils which appear to belong to this system, are apparently interstratified with others containing Silurian forms, while in close proximity are beds filled with remains of *Psilophyton*. There would, therefore, in this locality, appear to be three systems represented, of which the Silurian forms seem to be near the base or junction with the Cambro-Silurian. This peculiar admixture of so many different horizons can probably best be explained on the hypothesis of intimate enfolding and subsequent denudation, by which narrow crests of older ridges are exposed. In addition to the fossils recently found at this place, several small outlying patches were noted, and first referred to, by Mr. C. Robb (Rep. Geol. Sur., 1869), and others were subsequently discovered by Mr. McInnes, in northern York; but these appear to be more closely allied to Lower Helderberg forms, and consequently quite distinct from the rocks of the principal Cambro-Silurian area upon which they rest at limited outlying patches.

The view taken by Professor Hind of this portion of the rocks in northern New Brunswick, as representing the Quebec group of Canada (see his Rep. 1865), has thus been fairly sustained by later

investigation, both on grounds of lithology and palæontology. The similarity also of the fossils of the Becaguimec area to those of the Lower Trenton group, to which horizon, a portion, at least, of the fossiliferous Quebec group belongs, is also evident, and leads to the conclusion that a repetition of these rocks, both in their fossiliferous and metamorphic stages, is found in this section of the province.

But by far the most extensive of the older geological systems in this area is the Upper Silurian. This occupies the entire country along the St. John river above Woodstock, extending across the Restigouche river into the adjoining province of Quebec, together with the greater part of the valley of the Tobique, where it is, however, to some extent overlapped by Lower Carboniferous sediments. Thence it extends to Chaleur bay; occupying, with the exception of the supposed Pre-Cambrian belt of Jacquet river, and sundry areas of diorite and trappean rocks, the remaining portion of the province to the north, and including the valley of the Restigouche and its tributaries, as well as a large portion of the Gaspé peninsula, where it rests upon the southern flank of the Quebec group.

The strata of this system are thrown into a series of anticlines, gouche river into the adjoining province of Quebec, together with the axes of which are well exposed on the various streams, and the beds are in places highly fossiliferous, the different formations from the Niagara to the Lower Helderberg, both inclusive, being already recognized. They are frequently penetrated by dikes and masses of trap, often of large extent, some of which, as at Dalhousie, are intercalated sheets between the fossiliferous limestone and shales, which have been altered along the contact. The Silurian here contains traces of plant stems, which are probably the oldest found in the province, and are associated with distinctly Silurian forms. The same association of plants in Silurian strata is found in the Gaspé limestone series near Gaspé basin, and was referred to by Sir Wm. Dawson in 'The Fossil Plants of the Silurian and Devonian, 1871.' It is also possible that the plant stems noted on the Becaguimec may be in the upper beds of the Silurian, though their aspect at this place is more markedly Devonian.

The rocks of the Devonian system occupy but limited areas in this section, and are, for the most part, confined to the vicinity of the upper portion of Chaleur bay. Several small outliers, have, however, been recognized in Carleton and Victoria counties, the fossils of which would place them near the base of the series. Of these, the former is found near the junction of the Becaguimec with the St. John, where certain black shales are exposed in a narrow band containing abundant remains of *Psilophyton princeps*, a characteristic

Devonian form (see Rep. Geol. Sur., C. Robb, 1870-71). This area is largely concealed by Upper Devonian conglomerate, and sandstone, which occupy a basin formed by the branches of the first-named stream.

In the section along the Upsalquitch river, a branch of the Restigouche from the south, a basin of Devonian sandstone and shale, with characteristic plants, was observed to rest unconformably upon Silurian rocks. Its extent inland could not be traced, as the surrounding country is densely wooded. As at other points, the sediments were intersected by trappean masses, the metamorphic action of which was quite evident and proved their more recent age.

On the Lower Restigouche, areas of Devonian rocks are found on both sides of the stream which forms the dividing line between the provinces of New Brunswick and Quebec. These, on the south side, extend at intervals from a point three miles above Campbellton, to within a couple of miles of Dalhousie. The shales and sandstones contain plant stems, descriptions of which are given in the report of 1879. In the vicinity of Campbellton, also, beds of brecciated limestone or calcareous breccia have yielded a comparatively rich fauna of Devonian fishes such as *Cephalaspis, Coccosteus*, etc., representing the lower part of the system, while on the side of the river opposite Dalhousie, other beds contain an abundance of fossil fishes, which have been described by Dr. Whiteaves, and appear to indicate its middle or upper portion. It is of interest to note that as early as 1842 these remains were recognized by Dr. Gesner, who, however, regarded them as reptilian in their character. He supposed the containing beds, from their lithological aspect, were portions of the New Red Sand-stone or Carboniferous formations, and it was not until 1879 that these interesting fossils were rediscovered by the writer and the true position of the beds established. The Devonian of this locality occupies a shallow syncline. The strata are penetrated by trap dikes, two periods of eruption being evident from the fact that the lower beds at Campbellton, in which the fishes were found, are composed largely of trappean débris, as also from the presence of pebbles of trap in the conglomerates elsewhere, and from the occurrence of fossiliferous strata overlying trappean ridges. Later intrusions of volcanic matter through the newer members of the system, both here and at various points in the Gaspé peninsula, are also common.

The Carboniferous system is represented in northern and eastern New Brunswick, principally by the upper portion of the Lower formation, styled the Bonaventure, and the lower or Millstone-grit portions of the middle division. The development of the latter over the great inland basin has already been referred to, and but little more

need be said concerning it. Along the south side of Chaleur bay a thin seam of coal occurs at several points, which has the same general character as in the interior. On the island of Shippigan, and on the mainland north of Tracadie, soft, red micaceous sandstone is seen, which probably represents a part of the Upper Carboniferous, but these areas are confined to a narrow fringe along the shore. A similar thin seam of coal is found on several of the branches of the Miramichi, and gives strong evidence that the formation has no great thickness at any point. The area is traversed by several low anticlines, of which four principal ones are recognized and described in Rep. Geol. Sur., 1882-83.

The more northerly of these extends between Bathurst and the Miramichi river, where it forms a ridge running northeasterly, with an elevation of between 500 and 600 feet. The second extends from the head of Grand lake to the vicinity of Richibucto head on Northumberland strait. This brings up the Devonian rocks of Coal creek.

The third passes to the north of Moncton, indicated by the ridges of Indian mountain, and reaches the shore a few miles north of Shediac; while the fourth, which affects the southeastern area only, is well seen in the Aulac ridge which extends to Bay Verte, and thence in a low rise runs through the Tormentine peninsula to its extremity.

The basin of Middle Carboniferous rocks is underlaid along nearly its entire boundary on the north, west, and south by the Lower Carboniferous. At one or two points, however, notably on the Dungarvon and Renous rivers and on either side of the St. John river, west of Fredericton, the lower members are concealed by the overlap of the Millstone-grit, directly upon the Silurian. The volcanic portion of the Lower Carboniferous, though considerably developed in the counties of York and Victoria, is apparently absent from the northern area where the rocks are sandstones and shales with conglomerates, which in the southern part of the province constitute the upper members of the gypsiferous division. They are well displayed along the south coast of Gaspé at intervals to the extremity of that peninsula, (where they received the name of the Bonaventure formation) as well as at several points on the shore north of Bathurst.

On Heron island, which is in Chaleur bay, about nine miles southeast of Dalhousie, the rocks of the Bonaventure formation are well developed. The shales here contain remains of plants which have never yet been described, while the sandstones show impressions of reptilian footmarks, which are the only ones of this age yet found in New Brunswick, though somewhat similar tracks have

been recognized at several points in Nova Scotia in strata of not much higher horizon.

IGNEOUS ROCKS.

The principal igneous rocks which have not already been sufficiently described in connexion with the various formations are the intrusive granites and syenites and those of the newer trappean areas.

Of these, the former are much the more important, not only from their very considerable extent but from their economic value. They have been roughly outlined from the time of the earliest report on the geology of the province, but it is only within the last few years that the details, more especially of the northern area which is much the larger, have been studied.

Generally speaking, these two great areas enter the province near its southwest corner from the adjoining state of Maine. Along the border in Charlotte and York counties they are separated by a considerable extent of slates already described. The southern belt extends entirely across the former county, and occupies a large part of western Kings and Queens, reaching, with some interruptions, to the St. John river. Farther east, in the latter county and in Westmorland, isolated outcrops protrude through Carboniferous sediments revealed by the denudation of the latter. That these are of earlier age than the overlying beds is proved by the débris of the granites being found in the lowest member of the Lower Carboniferous and Upper Devonian formations. Similar areas of granite are also associated with the Pre-Cambrian of the southern part of the province, but these are comparatively limited in extent as compared with the principal granitic mass. In character these rocks are very similar, being generally reddish and moderately coarse grained, often with large crystals of feldspar. In places, however, the texture is fine and the colour grey.

The northern area, while of greater extent, presents a similar aspect. Crossing from Maine through the chain of the St. Croix lakes, which form the boundary for some distance, it enters the province in a belt more than twenty miles in width, and extending northeasterly, crosses the St. John river midway between Fredericton and Woodstock. Fine sections are afforded by the river, which cuts directly through the belt, showing well the intrusive character of the rock by the number and nature of the dikes, which are sent off in all directions into the adjoining slates, as well as by the distinct local metamorphism, due directly to the presence of the granitic mass. Crossing the River St. John, the granite subdivides into two portions, the more southerly of which terminates near the New Brunswick railway, while the northern band crosses that line and continues to a

total distance of thirty miles from the river. North of this, to Chaleur bay, the granites occur in three distinct areas, of which the two central are of large extent, and are, for the most part, associated with Pre-Cambrian rocks, though also penetrating strata of Cambro-Silurian age, on the Miramichi river. On this stream the alteration along the contact, both of the slates and granite, is well seen, the latter, for several feet, becoming fine-grained and whitish in colour, while the former are in places shattered and contain crystals of various kinds. The second area occupies a great breadth of country about the headwaters of the South branch of the Nipisiguit, and on the Northwest Miramichi, forming an exceedingly hilly and broken surface, containing some of the highest peaks of the province. The third area occurs on the lower part of the Nipisiguit near Bathurst, and extends for some twelve miles up from its mouth, but is concealed on the lower portion for three miles by Lower Carboniferous beds, the base of which is made up of granitic débris.

From a consideration of the various points of contact the intrusive character of these granites is very clearly established; since, in no other way, can the peculiar phenomena seen be accounted for. There is, however, a marked difference in the character of the metamorphism resulting from the granite, as compared with that produced by the intrusion of the dioritic or trappean masses. In the former the alteration is more gradual, and extends over a much wider area as though continued for a considerable period, and probably under great pressure In the latter case the rocks in contact have frequently a baked or porcelainized aspect, as though exposed to a quicker but not so prolonged a heat. This may perhaps be more clearly expressed by regarding the granites as *intrusive* rocks proper, which have not reached the surface at the time of their intrusion, but cooled beneath the surface and were subsequently exposed by denudation, while the latter may be held as rather *extrusive,* coming to the surface along direct fractures or lines of bedding ,and cooling rapidly.

Of the other kinds of intrusive rocks some of the diorites and felsites doubtless are, as heretofore described, integral parts of the older formations. The metamorphosing action of the granite and diorite is seen in beds of Silurian age, so that it is evident its intrusion must have been subsequent to that period; while, as no pebbles or débris are found in any formation older than the Devonian, the age of these great masses cannot be far from the beginning of that era. Many of the older volcanic rocks of the Pre-Cambrian areas have an earlier date than the overlying Cambrian strata, since their débris enters largely into the composition of the basal beds of that system.

The areas of serpentine in the province are too limited to form

any particularly distinctive feature. Sufficient evidence, however, exists to indicate its connexion with the igneous rocks, probably as a product of alteration, as seen in the serpentinous diorites of western Charlotte county and elsewhere.

The trappean rocks, which are largely developed along the lower Restigouche, and along the upper part of Chaleur bay, are, like the granites, for the most part of Devonian age. In places, dikes of considerable size cut directly through sandstones and shales of this age, or throw them upwards into low anticlines, in the same way as the traps of the Bay of Fundy have affected the Triassic sandstone of that locality. In places, also, the conglomerates of the period are largely made up of trappean débris. It would thus appear that at least two periods of volcanic eruption occurred in this region, of which the earlier was probably the more extensive; since by it the huge mountains of Dalhousie, Campbellton, and the range along the north shore of the Restigouche to Tracadie Gash mountain, were brought into their present position, upon the flanks of which nearly horizontal beds of Devonian age have been deposited at various points.

There yet remain to be considered the great masses of felsitic rock of various ages, both of the southern portion of the province and of the great areas of the northern division. That the great bulk of these are true volcanic products is evident from their nature. Their character as amygdaloids, agglomerates and ashbeds, together with the existence of highly crystalline feldspar porphyries, trachytes, rhyolites and similar rocks, clearly establishes their eruptive origin. That they are, however, of different ages, is plain, since while some of these are undoubtedly of Pre-Cambrian age, and form what is known as the volcanic portion of the Huronian system, others are intimately associated with Silurian, Devonian, and Lower Carboniferous strata, either as great masses or as interbedded sheets. These latter are, however, as a rule more earthy than the older series, and their mode of occurrence clearly indicates their later age.

A large area of felsitic and other igneous rocks occurs on the Tobique river, the age of which is somewhat doubtful, and much of it is highly crystalline and porphyritic, and resembles the old Pre-Cambrian felsite of the interior; other portions are ashy. It is separated from the main area by a band of Cambro-Silurian slates, which may only occupy a basin-shaped valley in the older rocks, but the impenetrable character of much of the country renders it at present almost impracticable to determine its true horizon, and it is possible that it may in part pertain to the Lower Carboniferous outlier of this locality, with the rocks of which it appears to be intimately connected. Other areas of epidotic and dioritic rocks of uncertain position occur in

the vicinity of the St. John river, near Woodstock; they are associated with Cambro-Silurian and Upper Silurian strata.

SUPERFICIAL GEOLOGY.

The superficial geology of the province has, since the report of Professor Hind (1865), been more particularly studied by Messrs. Matthew and Chalmers, whose reports embody not only their own observations on the subject, but many of the notes collected by the other explorers in this field.

That by Professor Hind furnishes much valuable information concerning the origin of terraces, raised beaches, and lake basins, it also gives a list of glacial striae and ice grooves, from the particulars of which he infers that the ice might have had a thickness of 2,000 feet, as indicated by the markings found on the tops of some of the mountains. The varying courses of the striae are accounted for on the grounds that the direction of the ice sheet was influenced, to some extent, by the direction of the valleys and other leading topographical features. This peculiarity of local glaciers has been discussed at greater length in recent reports by Dr. Chalmers. The various lake basins were held to be due to the ploughing out of the softer portions of the underlying rocks through the agency of these glaciers.

The reports of Dr. Matthew go much more extensively into detail. In these the superficial deposits are arranged under three heads, viz.:

(1) Boulder clay or till, unmodified glacial drift, constituting the lowest member.

(2) Stratified sand and gravel, Syrtensian deposits, formed by marine action, and representing the remains of old shoals and banks.

Leda clay, estuarine deposits.

Saxicava sand and raised beaches, littoral deposits.

(3) Modern alluvium, shell marls, peat, etc.

The peculiarity of the boulder clay is its unstratified arrangement and its intermingling of sand, clay, and stones, which are often striated. As a general rule it was observed that the boulders were for the most part local, and only at rare intervals were stones found that had come from any considerable distance. Where observed in the southern part of the province, their course was generally from north to south or southeast, more especially in the southwestern and central portions, and good instances of upward transport were seen by their presence on the sides or tops of mountains, 500 feet or more above their starting point.

The colour of the boulder clay was found, as might naturally be supposed, to be affected in great measure by the colour of the rocks from which it was derived, more especially where these rocks were soft sandstones or calcareous shales, since the hard rocks resisted more effectually the degrading effects of the ice sheet. Wherever this clay is removed the strata beneath are, as a rule, found to be rounded and scored, showing that the deposit of the clay was subsequent to the smoothing of the rock. Two principal directions are visible in the striæ; to the west of St. John the prevailing course is to the south of east, while to the east of that city it is southwesterly, following to a great extent the principal hill features.

The beds of the second or Syrtensian group differ from the preceding in their stratified character, though there are, at certain points on the coast, indications of a gradual passage from the upper members of the boulder formation into the lower part of the stratified group. The various beds of the latter are arranged by Dr. Matthew under four principal heads, viz.:

The weather shoal, forming under the north side of the hill, or at the entrance to a valley.

The lee shoal, forming behind a hill, or at the outlet of a valley.

Centre shoals, formed in open spaces or enlargements of valleys, or on the higher lands.

Horsebacks, and eskers, formed of gravel and sand along valleys or ridges as connecting neighbouring hills, or opposing slopes of valleys.

The Leda clay may be regarded as an upper portion of the preceding group, since, in the southern part of the province, the beds of the former graduate upward into the latter. It may, however, be properly restricted to deposits of clay, which often rest upon the gravels of the Syrtensian group, and are generally distinguished by the presence of organic remains, in which, in addition to shells of various kinds, the remains of a *Phoca* and a *Beluga* have been found near the coast of the Bay of Fundy. This deposit is well recognized, not only in the southern part of the province, but in the Chaleur Bay area, both in New Brunswick and along the Gaspé shore, from which a large collection of fossil remains has been obtained. The deposit, however, changes its character in different places, from the admixture of sandy beds, and at times it is very difficult to distinguish between the Syrtensian, the Leda, and the Saxicava, owing to their occasional similarity.

To the Saxicava sand are attributed the upper members of the modified drift only. It is generally devoid of organic remains, having in southern New Brunswick produced only two species, a *Mya* and a *Macoma*. It was deposited in gradually shoaling water

as the land slowly rose from the sea, and, in this way, terraces of different heights were formed along the coast and river valleys. These terraces, more especially as seen along the St. John and other rivers in northern New Brunswick, have been recently described in detail by Dr. Chalmers, whose papers on the surface geology of these portions of the province are among the most important published on the subject. In many of these terraces the three subdivisions of the modified drift are seen, viz., the Sytensian gravel and sand at the bottom, the Leda clay in the central part, and the Saxicava sand at the top.

On the St. John river a number of sections were made, particularly of the part between Woodstock, and the St. Francis river, as well as along its tributaries, in some of which no less than seven distinct terraces were observed, with a total elevation for the uppermost of not far from 200 feet above the present level of the stream. The highest terraces are composed of stratified gravel and sand with water-worn pebbles; the lower contain the same materials as the upper, but are generally more water-worn, and have local beds of clay and silt. The materials of the kames, or eskers, and terraces are the same and are undoubtedly derived from the same source. Since it has been conclusively established that the valley of the St. John river is of pre-glacial age the mode of occurrence of these deposits is an exceedingly interesting question, and as Dr. Chalmers has evidently given the subject much study, and his views seem to satisfy most of the requirements of the case more fully than any previously advanced—with the proviso that they apply equally well to other river valleys—they are here presented.

'The river valleys, at the close of the glacial period, became very generally choked with drift, which, forming dams, would hold back the water, and constitute a series of lake basins along the river course. These dams, in some places, were from 150 to 200 feet above the present level, hence, the rivers would begin to flow at that height above their present beds. The gradual re-excavation of the drift would, therefore, as it went on, by the transportation to lower levels, result in the formation of the terraces, which would thus mark different levels of the river by the deposition of the materials from higher levels along the border of the lake-like expansions, and along the sides and bottoms of the current, which flowed in and through them; thus, by successive accumulation, forcing the channel from side to side as erosion and deposition went on.

'The kames are composed of similar sand and gravel as the terraces, and may be the remains of these left by denudation of beds once surounding them, and of which they formed a part. Their bases are often composed of till or boulder clay.'

The action of the glaciers, in following already defined depressions, is well seen at many points over the entire area of the province. Occasionally, two or more sets of striae occur, which often have courses at marked angles to each other.

Of these, the newer will almost invariably be noticed to run in the direction of a valley or, when near the coast, the course of some fiord or estuary. Excellent examples of this are seen in the vicinity of Sackville and Amherst, where the ice grooves and striae follow directly the depression between Bay Verte and the head of the Bay of Fundy, as also at Memramcook and Dorchester, where they follow the principal flexures of the Memramcook river. This peculiarity of direction is also noticed in both the adjoining provinces of Quebec and Nova Scotia. The older set of markings is, however, observed to keep a quite uniform direction, regardless of opposing hills, as if in many cases the propelling power of the glacier drove it resistlessly forward. If, then, we admit the existence of a widely extended ice sheet, which, in some parts of eastern Canada, appears to be quite clearly established, we must also admit a second and possibly a third ice era, during which local glaciers were shed from the height of land in whichever direction the most favorable outlet was presented, the course of which was largely affected by local conditions of configuration. In the northern area such evidences of local glaciers are visible in the striae which follow the outlines of the lower Restigouche and its tributaries. In Gaspé also, local glaciers were undoubtedly shed in both directions from the tops of the Shickshock mountains, modified by the lower hill ranges which lie nearer the coast. In Nova Scotia, striae on the north side of the Cobequids point towards the shore of Northumberland strait, while on the south side they have a westward course in the line of the Minas basin and channel.

The divergence of river beds is conclusively proved at several points, though whether these changes were all due to causes subsequent to the glacial period, may be questioned. Thus, at the Grand falls of the St. John river, 225 miles from the mouth, the present channel below the pitch forms a wonderful gorge cut through the Silurian rocks for nearly a mile to a depth of over one hundred feet, the old channel being blocked at what is now the town of Grand Falls by a great accumulation of clay and other drift material. So, also, near its junction with the St. John, the old valley of the Tobique has been dammed, and a new channel excavated through Silurian beds for nearly the same distance. The time necessary to produce a gorge of such a length in the comparatively hard rocks of these localities must have been considerable. Whether such was the cause of the present outlet of the St. John river has not been

conclusively proved, but appears highly probable, since huge dams of drift block up what appears to be an old outlet of the river in the direction of Manawagonish beach, a short distance west of its present mouth.

The views of Professor Hind (see Report of 1865) as to the glacial origin of many of the lake basins, do not, in all cases, seem to be fully sustained by the later investigations of Dr. Chalmers. The writer last named finds the depressions of some of the larger lakes in the southwestern part of the province to be pre-glacial, in the same way as the valley of the St. John river. The subsequent action of glaciers and glacial drift has, by heaping up mornines, modified existing conditions very greatly, either by forming entirely new basins, or changing very considerably those existing prior to the ice age. This peculiarity of morainic lake basins is well illustrated in many of the lakes of the St. Croix chain, along the boundary between New Brunswick and Maine.

Changes of level of the land are well shown by the presence of beds of marine or Leda clay at elevations, reaching, in some places, several hundred feet above the present sea level. This is also proved by the presence of old sea beaches at intervals along the coast of the Bay of Fundy, and now removed several miles from the existing shore line. That such changes of level have taken place in comparatively recent times is evidenced by the presence of tree stumps in the marshes about the upper part of this bay, now some twenty or thirty feet below high tide mark. These are found not only on the flats between Amherst and Sackville, along the shore, but in the several canals which have been cut for the purpose of improving the hay marsh. The partially submerged shell heaps on the coast of Charlotte county, which mark the sites of old Indian encampments, [illegible] probably at one time removed beyond the action of the [illegible] the gradual encroachment of the water, as well as [illegible] shell heaps are at a considerably lower level than [illegible] formed. On the other hand it is supposed by Prof. [illegible] others that the shores of the Gulf of St. Lawrence are [illegible] rising, as is evidenced by the shoaling of the waters in [illegible] and estuaries of the eastern coast, at the entrance to Miramichi harbour and the basin at Bathurst, since a marked difference in the depth of the water is now noted, as compared with the observations recorded within the last eighty or one hundred years. Some of these apparent changes of level may, to a certain extent, be due to the filling up of channels by sediment brought down by the rivers and redistributed by the action of the tides.

It might be supposed, by some persons, that the varied opinions

expressed at different times concerning the true interpretation of the geological structure of the province would have a tendency to reflect somewhat unfavourably upon the character of the work done by the several observers in this field. A moment's consideration of the subject will, however, serve to correct this impression, since it must be remembered that, in the elucidation of the structure of any country, the discovery of new facts from time to time naturally leads to changes in the interpretation of the various problems presented.

The earliest workers had the misfortune also to labour at a time when the science of geology was, comparatively speaking, in its infancy. With the increase of our scientific knowledge enlarged views will be unfolded, while the peculiar bias pertaining to each individual must, of itself, ever give abundant cause for difference of opinion. In the study of any subject the object primarily to be attained should be the truth, sinking personal feeling for the general good.

PART III.

MINERAL RESOURCES.

The last report issued by the Geological Survey Department on the 'Mineral Resources of New Brunswick' was prepared by Dr. L. W. Bailey, and printed in 1899. It was very complete, and contained many details as to the early history and development of the principal mining areas. While enumerating the various minerals found in the province, the statement is made that 'of all these, with the exception of building stone, limestone, brick clay, and gypsum, only four substances have been as yet the basis of successful mining operations, viz., coal, iron, manganese, and albertite; and of these coal, alone, is at present actually worked.'

This is certainly not a very encouraging showing for the mineral resources of a province as large as New Brunswick; and while large sums of money have been spent in the search for economic minerals, and in the attempt to develop certain areas, it is to be regretted that a large amount of capital thus employed has been rashly, not to say foolishly, invested. In many cases conditions have been found which were unfavourable to the enterprise displayed by the investors; and in some cases such investment might have been prevented had a proper examination of the areas in question been made by experts familiar with the geological and mineralogical conditions of the localities.

In writing of the mineral resources of the province two courses may be pursued, either—(1) to indicate every mineral occurrence as a possible or even probable source of wealth to the investor, or, (2) to give a true estimate of the actual value of such occurrences, as estimated by expert opinion, of the various supposed mining areas; to indicate certain lines of mineral development which, if properly followed out, would tend to return a fair profit to the investor, and to discourage on the other hand, as far as possible, the investment of capital in localities or areas where the venture would in all probability yield no return, and would entail the loss of all the capital invested. For, while it is the custom for many persons to decry expert scientific opinion as to the value or otherwise of any particular mining area, it will generally be found, in actual practice or in the summing up of the final balance sheet, that more attention to such advice would have resulted in better financial returns. The

scientific expert has acquired his knowledge by the study of both rock and minerals in the field, over wide areas, and of the conditions governing mineral occurrences; and the information thus obtained is practically on the same lines as that which makes the opinion of a competent lawyer or physician, or in fact of any kind of professional worker, of practical value. This view of the case is too often lost sight of entirely.

In the following pages the latter of the two courses suggested will be followed as closely as possible, consistent with the general welfare of the mining industries of the province; and in so far as known by close observation and actual experience the possible value of each mineral occurrence will be indicated.

Generally speaking, the minerals of any country are associated with certain rock formations which have in process of time come under a certain orderly arrangement of geological formations, as for example certain coal deposits which, while belonging to the general system known as the Carboniferous, are found in actual mining to belong practically to one division of that system known everywhere as the Middle Coal formation, which is again divided into the Lower or Millstone grit-formation, and the Upper or Productive measures. As a rule, the large coal beds belong to the upper of these divisions, as will be seen by reference to workings in the adjoining province of Nova Scotia, although smaller seams are also found in the lower or Millstone-grit division. As far as our experience extends, however the deposits of the lower, while showing at times a workable size, never reach the enormous dimensions which sometimes occur in the upper. Therefore we propose to give in brief a sketch of the several geological formations which have been recognized in the province from the study of its rocks during the last fifty years. It must be stated, however, that in some areas, owing to extreme alteration or other causes, the determination of the exact geological horizon is extremely difficult, and in some cases has not yet been definitely fixed.

The rock formations range from Pre-Cambrian as the oldest, to Triassic or the newest, excepting the Post-Tertiary, which comprises the sands, clay, and glacial drift generally. For some years it was supposed that the crystalline rocks about St. John, comprising areas of crystalline limestone, granite, granite-gneiss, etc., were the equivalents of the Laurentian of Quebec and Ontario, which are regarded as representing the oldest divisions in the world's history. A recent examination has, however, failed to establish this hypothesis, though they are among the oldest in the province. Most of the so-called granite-gneiss and other igneous rocks which occur with the limestones are intrusive in these, having cut them in every direction and changed them near the line of contact to a highly crystalline

condition. At points farther removed from these contacts the limestones are bluer and more slaty, the colouring being due in some cases to finely disseminated graphite. The limestone is also associated with green, gray, and black slates and with beds of hard quartzite, which closely resemble portions of the recognized Cambrian rocks of this district.

As a source of mineral supply these rocks yield little beyond an unlimited amount of excellent limestone for burning, and from the associated slates a small quantity of graphite which is separated from the slaty shales and used locally. The lime industry has for many years been a very important one about the city of St. John, but of late years the production has fallen off considerably owing to the closing of the American market, through the imposition of a practically prohibitive tariff on the manufactured article. These limestones form a marked geological feature at the narrows of the St. John river about Indiantown, and in the area between the city and the shore of Kennebecasis bay to the north. The graphitic slates are well seen near the Suspension bridge over the river in the west part of the city.

The Pre-Cambrian rocks of the province at present comprise what was formerly described under the term Huronian, in which three divisions were made. These were found to underlie, or were supposed to underlie, the fossiliferous Cambrian slates and quartzites, the lowest member of which has been styled the 'Etcheminian' formation, in the basal beds of which occur pebbles of an underlying series of igneous rocks; though a part of what was formerly called Huronian, Coldbrook, has recently been regarded as possibly the lower member of the Cambrian series.

The Huronian, as a whole, consists of schists, felsites, diabase, etc., the thickness of which cannot be determined since the series is essentially of igneous origin throughout. In the early reports on the geology of the province there were included in this series large areas of igneous rocks which have lately been found to be comparatively recent, as in the case of the gabbros near St. Stephen, with which occur the nickel ores of that place; and certain diabase rocks of Letite and other places in Charlotte county which contain small quantities of economic minerals such as copper, galena, pyrite, etc. These have been developed to a small extent; but so far as known do not occur in large quantity.

In the northern part of the province there are large areas of crystalline rocks which have been assigned to the Pre-Cambrian, and may belong to the Huronian system. As there is no positive means of determining this question as yet, owing to the fact that the overlying rocks, though presumably of Cambrian age in part, have not

yielded fossils to any extent, the age of the formation, which consists largely of igneous rocks such as felsites, diorites, and certain granitic masses, must be regarded to some extent as an open question. In some respects these closely resemble rocks of recognized Pre-Cambrian age near the coast east of St. John, which are there overlaid by fossiliferous Cambrian sediments.

The Cambrian rocks occur in well-defined areas as a series. Their age has been clearly demonstrated by the contained fossils, which have been studied in great detail by Dr. G. F. Matthew of St. John. They are well exposed about the city of St. John and form areas of considerable extent eastward, where they rest upon a great series of schists, felsites and other, generally speaking, igneous rocks, (all in a high state of alteration), which form the lofty ridges extending from St. John city into Albert county. The Cambrian rocks are usually slates, grey, green, and black in colour, with which are bands of conglomerate, quartzite and limestone. The slates are in places highly altered, thrown into folds and cut by quartz veins, with numerous faults and occasional intrusive masses of diorite. In age, they are apparently the equivalents of much of the gold-bearing series of Nova Scotia, but up to the present time no attempts to find gold in this New Brunswick series appear to have been made, unless indeed some of the quartz-veined slates of northern New Brunswick are a part of this system. Even here the search for gold appears to be confined to washing the sands from some of the brooks in the district. Small quartz veins abound in these northern slates, but no well-defined leads were seen in all our travels through this portion of the province.

The lowest fossiliferous division of the Cambrian appears to be a series of red and purple slates, conglomerates, and quartzite, which are seen about St. John city and to the eastward for some miles, occurring along the flanks of ridges of igneous rocks. This part of the system can generally be readily recognized. In the northern part of the province it is probable that rocks of this system occur in northern York, and form portions of the ridge of altered slates which crosses the province, appearing along the upper waters of the Miramichi river, and crossing the Nipisiguit river, where it is covered over by limestones and slates of the Upper Silurian formations.

The Cambro-Silurian rocks, which include the formations between the Cambrian and the Upper Silurian, are found at a number of places on both sides of the great Carboniferous central basin. Though not often fossiliferous, organic remains have been obtained at several points around the northern rim, as at Tetagouche on Chaleur bay, and on the Beeagnimee in the western part. In the southern part of the province they are not so readily recognized, and large areas which

were at one time placed in this group, provisionally, have since been assigned to the Upper Silurian. Of the Upper Silurian, or Silurian proper, large areas are known both in the southern and northern portions, where the great area between the Tobique and Nipisiguit rivers on the south and the Restigouche on the north are of this age, consisting largely of slates and limestones with occasional masses of intrusive igneous rocks. As a rule this formation is poor in economic minerals. The iron mines of Carleton, however, occur in these slates, and in southern Charlotte county they are much broken up by intrusive masses with which are small quantities of the ores of copper, nickel and galena. These form a soil of great value for agriculture, and are covered in the northern part by heavy forests of spruce and hardwood.

The Devonian rocks occur in considerable areas in the southern part of the province both to the east and west of St. John, and in the northern part overlying the Silurian. They contain quantities of fossil plants by which their horizon can be clearly determined, as also by their well established position between Silurian and Lower Carboniferous formations. In southern New Brunswick the system as a whole is divided into five groups, the uppermost of which is the Perry sandstone division, traceable eastward across the lower St. Croix river from the state of Maine, and extending at intervals for some miles east of St. John along the valley of the Kennebecasis river. These rocks were in the published map of the province, coloured as Lower Carboniferous, but the recent work done on these rocks has clearly shown them to belong to an older system. Another group of slates or shales known as the Albert shales, found in Albert and Westmorland counties, was also at one time regarded as belonging to the Lower Carboniferous division, but has, since the publication of the geological map of that area, been transferred to the Upper Devonian on good grounds. With this group is found the albertite and the bituminous shales now being exploited for petroleum. The remaining divisions of this system, comprising the Mispeck, Cordaite, Dadoxylon and Bloomsbury groups, include a great thickness of shales, sandstones and conglomerates, which often assume a schistose structure owing to alteration, and are penetrated by masses of igneous rocks at many points throughout their distribution.

The Carboniferous rocks are divisible into three groups, viz., the Lower, the Middle including the Millstone grit formation only, and the Upper or Permo-Carboniferous, which is found at intervals along the coast of the Gulf of St. Lawrence and Northumberland strait.

The principal minerals of the lower division are manganese and gypsum, while salt springs occur at several places.

The Millstone-grit division carries the coal-seams which outcrop at a number of points around the great central basin as well as in the interior. These have been worked to a limited extent for many years. The rocks are brown and grey shales and sandstones of purple and green-grey shades with occasional conglomerates, especially near the base. The principal quarries of building and grindstones occur in this formation, and beds of fire-clay sometimes accompany the coal seams.

The Upper or Permo-Carboniferous contains beds of brown freestone, which are worked at several points such as Sackville and Wood point where quarries of excellent stone are quarried. Thin seams of coal also occur, but these are of no economic value.

The Triassic formation occurs at a few points only along the north side of the Bay of Fundy. It consists of isolated outcrops of soft red sandstone and contains no minerals of economic importance. On the west side of Grand Manan island there is a great ridge of basalt which extends along its whole length and which sometimes contains traces of native copper similar to that found in the rocks of the North Mountain range of Nova Scotia.

Great ridges and masses of granite, both red and grey, are found both in the northern and southern portions of the province. These are comparatively recent, cutting formations as new as the Devonian. They are generally massive rocks, but sometimes a gneissic structure has been developed by pressure. Granites occur in connexion with all the formations from the Pre-Cambrian upward. They furnish large quantities of stone for building or monumental work, but rarely carry ores or minerals of value.

The Post-Tertiary or Pleistocene is the newest in the geological scale. It contains the peat bogs which are very extensive, the clays, sands and gravels valuable for bricks, pottery and for road material or for cement walls, and the deposits of Tripoli or infusorial earth and shell-marl which are found in a number of lakes in the southern part of the province. The mineral paints and the deposits of bog manganese or wad and of bog iron ore also belong to this formation, and have been utilized to some extent.

ECONOMIC GEOLOGY.

The ores comprise iron, manganese, copper, galena, silver, antimony, nickel and gold. Of these several have been mined quite extensively from time to time.

IRON.

The ores of iron comprise magnetite, hematite, specular ore and limonite or bog-iron. They are all found at widely separated points, are sometimes of good quality, and have been worked at intervals for nearly fifty years.

Hematite ores occur in beds of large size, interstratified with red and green slates, at several points in Carleton county. They have been known for more than sixty years and a blast furnace was erected as early as 1848 with a capacity of seven tons a day, a second furnace with a daily capacity of five tons being erected in 1863. These furnaces were in operation for some years, using charcoal for fuel, but the isolated position of the plant, at that time without railway communication nearer than some ten miles, interfered to some extent with the disposal of the output and the bringing in of supplies.

The ore is what may be called low-grade. It has also a considerable percentage of phosphorus and a high percentage of manganese as well as of silica. Methods of mining, handling, and of smelting have, however, changed very greatly within the last thirty years, while the demand for a workable ore of iron has increased so that it is possible that, by new processes and enlarged plant, combined with cheaper fuel, the disasters of former years may be changed and a profit from a renewed industry result, under proper management. No analyses of these ores made by this department are available, but several made in England, and furnished to Dr. Hind by Mr. Norris Best, the then manager, may be given as well representing their quality. The analyses are of eight samples, but the exact localities of these are not known.

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Perox. iron	49 357	47 858	39 285	67 857	42 587	27 143	50 000	35 714
Prot. "	1 412	2 140	1 140	1·070		trace.	2 400	5 100
Alumina	6 260	3 924	3 116	2 004	6 412	10·742	6.114	5 076
Oxide mang	4 784	6 110	5 872	0 976	2 140	5 172	3 742	6 840
Perox. "	..	..	..	..	8 740	..	..	..
Lime	2 014	1 004	1 120	0 887	1 074	5 964	1 146	0 762
Magnesia	3 911	5·016	4 602	2 940	5 107	2 057	4·072	4 216
Potash	0 886	0 972	0 702	0 744	0 217	0 884	0 214	0 887
Soda	0 692	0 671	0 512	0 631	0 202	0 772	0 216	0·642
Sulph. acid	0 798	0 596	1 274	0 588	0 977	0 842	0 572	0 764
Phos. "	1 324	0 977	1 389	0 064	0 880	1 924	1 062	1 762
Silica	22 021	16 842	25 964	5 630	22 420	34·214	19 842	25 600
Car. acid and water	7 621	13 890	14 964	5 609	8 974	10 286	10·630	12 673
	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Metal. iron	34 867	35·147	28 377	48 323	30 000	19 000	36·848	28 927
	Mean of the eight				32 683			

The principal ore beds are situated about six miles northwest of Woodstock. They have been described in the report for 1871, and their positions indicated on the accompanying map of the district. They occur in a number of beds which range in thickness from one to fifteen feet. The principal occurrences are at Moody hill, Iron Ore hill, Maple hill, and at Jacksontown, all on the west side of the St. John river. Other outcrops on the east side of the river are at Pole hill; near the forks of the Beccaguimec river; and near Glassville. It will be seen from the above assays that the percentage of iron is not large and the sulphur and phosphorus contents are high as well as the silica. Yet during the process of manufacture of the pig it was claimed that an iron of good commercial value was produced which found a ready sale. During the last period of working a considerable quantity of bog iron ore from the Maugerville deposit a few miles below Fredericton on the north side of the St. John river was mixed with the hematites of the district. No work has been done on these irons for some years, the necessity of building a modern plant, together with the lean character of the ores generally and the remoteness of a fuel supply other than charcoal, which can still readily be obtained, hampering investment. It might be desirable to have a fresh series of analyses made from carefully selected samples to see if certain beds do not contain sufficient iron for commercial working.

In the altered Devonian rocks of the southern part of the province small quantities of iron, generally of the specular variety, are found. Of these apparently the most abundant are situated at West beach and near the mouth of Black river a few miles east of St. John. An examination of these ores during the past season by Mr. J. A. Robert shows that they occur for the most part in purple schistose slates. They are intimately associated with quartz veins and are not sufficiently concentrated to be profitably extracted and no large ore-body was seen at either of these localities. The ores of West beach are more hematitic in character, but are also intersected with quartz and mixed with specular ore. Some years ago a small quantity was mined from this area and sent to the iron works located at Coldbrook, about three miles north of St. John city on the line of the Intercolonial railway, but the results of the tests made have not been published. The attempted development was not, apparently, successful, as no further work has been done at either of these places.

In Charlotte county, and in St. John west of Musquash harbour, similar occurrences of specular and hematitic ores have been recognized in altered Devonian rocks, but nothing of economic value has been found. Near the post road, about two miles west of the village of Lepreau, a large amount of money has been spent, principally in

boring, to find a body of magnetite which was located several years ago by a Swedish expert with the magnetometer. Although the instrument is said to have located a very large body or lens of this ore, subsequent attempts to find it with a diamond drill were unsuccessful though the holes were bored at several angles which were supposed would strike the ore mass, and were continued in some cases to over 900 feet. In none of these, in so far as can be learned, was any ore found, with the exception of one small vein which was traversed, and which is probably the downward extension of a small (one-inch) vein seen at the surface. Analysis of the ore made in this Department shows the quality to be good, but the amount is too limited to be of economic value. The rocks are mostly hornblende schists, cut by masses of diorite, and small grains of ore are disseminated through the rock mass. Work has been suspended at this location.

On Deer island also a small vein of ore has been reported for a number of years. It consists of magnetite mixed with diabase, but the size of the vein is too small to be worked. So far as known no body of iron ore has been found in the southern part of the province with the exception of the bog ore at Maugerville below Fredericton, where a deposit occurs in a fairly continuous bed extending along the north side of the river for several miles with a breadth of one-half to three-fourths of a mile. The ore occurs here in the soil forming flattened aggregations from six to twelve inches in diameter though sometimes of larger size. The deposit is the most extensive and valuable yet found in the province and was mined some years ago and sent to the Woodstock furnaces. A similar deposit is found at Burton on the south side of the river, but the extent of this has not yet been ascertained. It has been described by Dr. R. Chalmers in the Survey Report for 1882-84, p. 99.

Other occurrences of iron are found in connexion with the granites near St. George as small veins of specular ore cutting that rock; as nodules of hematite in slates on Coal creek at the head of Grand lake; as veins of siderite in limestone and slates at the north end of Grand Manan island; as bog iron on the Southwest Miramichi near the forks of the Clearwater; at Tracadie; in the settlements of Queensbury and Beaver Dam in York county; as small veins of magnetite in slates on the Charlotte road, six miles west of Gaspereau station on the Canadian Pacific, associated with diabase rocks; as hematite in beds of small but unknown extent in the slates near Oak mountain southwest of Fenton; and as loose pieces on Peabody farm about two miles south of Woodstock. These last may have been derived from the ore beds near that town. In none of

these localities is the quantity, so far as can be ascertained, of economic importance.

At present the largest known area of iron ore yet found in the province is located near the mouth of the Nipisiguit river about twenty-two miles from the town of Bathurst, and near the junction of a small stream known as Austin brook, about one mile above the head of the Grand falls. The rocks are altered slates, in part schistose, cut by masses of green diabase and the ore is a magnetite occurring in a large mass extending back from the river to the north for about two miles, with an exposed width in places of thirty to forty feet. Quite recently another body of similar ore was found in the vicinity. The quantity of ore in the whole deposit is very large. It is distant from the Intercolonial at Red Pine station about nine miles, but a branch line could be built at comparatively small cost. The assays of the ore in this Department are as under:—

Analyses of five samples from the Nipisiguit Iron Deposit.

Nos. 1 and 2. From bluff behind camp near Nipisiguit river.
No. 3. From northeast corner, one mile back from river.
No. 4. Bluff one-quarter mile back from camp on large outcrop.
No. 5. Second large outcrop east of camp.

	1.	2	3	4	5
Fe, metallic	55 20	51 20	46 00	18 30	59 20
Mn	0 14	0 32	2 17	0 91	1 62
Silica insol	15 40	18 20	21 60	26 40	9 00
Phos	0 039	1 25	0 923	0 43	0 959

Laboratory of Geological Survey, November, 1906.

M. F. Connor.

Analysis of two samples from new iron south of river.

	Lumsden man	Twin Tree L M Co's
Insoluble	31 00	14 00
Metallic iron	43 20	56 40
Manganese	1 15	0 90
Phos	0 82	0 68

November 27, 1906.

M. F. Connor,
Analyst.

The average of fourteen analyses, by the Dominion Steel Company of Cape Breton, from different portions of the deposit gave:—

Iron	50·85
Manganese	1·35
Phosphorus	0·783
Silica	17·8

The area, opened by trenching, shows fairly well at the surface, and has recently been proved in depth. In places near the contact with the intrusive masses there is a small amount of iron pyrite, but otherwise the ore appears to be almost free from sulphur, and if the expense of opening and getting to the railway is not too great the deposit should be economically valuable. Boring with a diamond drill has shown the iron ore to have a thickness of over 300 feet in one of the holes.

COPPER.

Copper is widely disseminated in the southern part of the province, occurring in both the sedimentary and igneous rocks, especially near the coast of the Bay of Fundy. It occurs in several forms such as the oxide (cuprite), sulphides (copper pyrite, &c.) and carbonate (malachite, &c.). Native copper also is found in small quantities in certain of the trap rocks of Grand Manan island, similar in character to the deposits at Cape D'Or and the North Mountain range in Nova Scotia.

The ore most widely distributed is chalcopyrite. It is found in connexion with felsites, diabase and other igneous rocks at a number of places, but usually in small quantities. Especially is this the case with the series of igneous rocks, many of which are altered to the schistose slate, which extends from the islands of Passamaquoddy bay in the south west part of Charlotte county eastward to Albert county. These rocks, while largely of the character of intrusives, have been so altered by pressure, among other things, that they have sometimes assumed the form of gneiss and schist, as have also the containing slates, resembling in this respect certain Pre-Cambrian rocks of the Huronian series. The intrusion of these igneous rocks into the slates and limestone is clearly seen at a number of points.

In certain areas along this coast these copper bearing rocks present some resemblance to the so-called copper bearing series of eastern Quebec. They are, however, in large part, of an entirely different horizon, especially in the western part of the area, though the presence of the copper ores may be due to the same general causes in both series.

A number of these copper deposits along the south coast of the province were opened some forty-five to fifty years ago, and large sums of money have been spent in a vain attempt to secure profitable returns from their development. It is perhaps not too much to say that of all the copper mines found in this group in the southern part of the province none have proved remunerative and, with the exception of one in Letite, all have long since been abandoned. The Letite mine, which was closed down for nearly forty years, reopened about five years ago.

Two causes seem to be against the profitable working of these deposits. In most of the occurrences the ore is a pyrite or pyrrhotite, occurring with quartz and a small quantity of calcite in irregular bunches. With this is often associated small quantities of chalcopyrite, but in no observed case is either the quantity or quality of the ore mass sufficient to warrant the expenditure of a large amount of capital in development. The usual statement of miners that the quality is sure to improve in depth is unfounded and certainly does not apply to these deposits so far as they have been worked. In some cases, as on Adams and Simpson islands, the quality of the ore (erubescite or peacock ore) is all that could be desired, and attempts to mine these have been made from time to time, splendid samples being obtained, but in these cases there appears to be no well defined body, the deposits being bunchy or pockety. The same remark applies also to much of the chalcopyrite. It frequently occurs near the contact of diabase with slaty rocks or felsites or along some small line of fault, and in quantity varies constantly, sometimes almost dying out entirely and sometimes reaching a thickness of some inches, but nowhere, in all this western district, can there yet be said to be a deposit of size and richness that can be worked at a profit.

The Simpson Island deposit at one time promised to be a valuable one, judging from the character of the ore extracted. This was largely a dark-grey copper sulphide which by exposure on the beach assumed the conditions of a pale green carbonate. The original location was on a vein of this ore below highwater mark, but owing to the impossibility of keeping the workings clear of water a shaft was sunk inland a short distance to intersect the vein. This attempt was not successful; though several small veins or stringers of the ore were found they were all too small to be profitably worked. The rocks of this island, like those of Adams island, are purple and green slates apparently of Upper Silurian age cut by green diabase, the ore occurring near the contact.

These dark-green, greyish and purple slates in places are altered to schists and cut by masses of green schistose diorite. They extend

into Letite peninsula where copper mining has been carried on at intervals for more than half a century. Here the old Letite and the Wheal Louisiana mine were located, and shafts were sunk forty-five years ago to a depth of over 100 feet with drifts along the course of the supposed vein, in which the ore found was chiefly small quantities of pyrite and pyrrhotite with but a small showing of chalcopyrite so that the mining was abandoned. Since the opening of this Louisiana mine several years ago the old shaft has been carried down to a depth of over 300 feet, apparently following a line of fault or contact between slates and diabase. The ore from this mine is largely a pyrite mixed with quartz and some calcite, the former in small quantity, and occasionally with a small percentage of chalcopyrite. The width of the so-called vein varies from one inch to over a foot, but the proportion of ore to the gangue is small throughout and so far as worked the conditions do not seem to greatly improve on those found in the original mine. The enlargements in this deposit may be due to small slips along the line of the fault forming a lens shaped structure.

This pyritous character is found in all the mines examined on the coast west of Martin head in St. John county, the chalcopyrite being usually in small quantity mixed with pyrite or pyrrhotite; but east of this place, at what was once known as the 'Vernon mine' and at others in western Albert county, the character of the ore is somewhat different. Bornite occurs in small quantity disseminated through quartz veins associated with calcite or chlorite. The whole series is intersected by diabase dikes and the ores are usually found near the contacts of these with the slates or schists. Fine specimens of ore can be found here but attempts to mine, some forty years ago, were not attended with success, while the resumption of mining at this place five years ago resulted in the expenditure of considerable capital, without profitable returns to the stockholders.

The deposits worked in the neighbourhood of the Upper Salmon river in Albert county have long since been abandoned. While excellent samples are obtained at a number of places it has been found practically impossible to locate any well-defined lode of ore which would give profitable returns from their exploitation.

One of the largest copper mines, so far as expenditure is concerned, is a few miles to the northeast of Dorchester. It was first opened in 1882-3 and having been sold to an American company at a large figure was worked for several years at a loss, when it was abandoned. After being idle for some time it was acquired about six years ago by another company by which a plant for crushing the rock and contained ore and separating by electrolysis was erected at large expense. This was found too costly in operating to be pro-

fitable, and the mine was again closed about three years ago, since which time it has been idle.

This mine is located in the lower part of the Millstone-grit formation, the rocks being greyish grits and fine conglomerates. In places plant remains are quite abundant and the organic matter of these has thrown down a deposit of copper from solution—apparently during the period of formation, which now exists in the form of carbonate, surrounding the plant stems which in places have been changed to coaly matter. Beautiful specimens can be obtained, but the quantity is limited. It has been stated that the sandstone itself carries from three to five per cent of grey copper ore throughout the mass, and that by crushing the rock this contained ore can be separated by electrolysis. The aspect of the rock, however, does not warrant the statement that such a percentage of copper exists, and although a large amount of money has been spent in the mining of the plant remains, and of the rock itself, which have been treated in an expensive plant, the financial loss from such treatment has been very large.

The mines are situated along the crest of a ridge of the grit which has been opened for a mile or more. At the northern end of this ridge a shaft was sunk in 1884 to a depth of about 100 feet; it passed through the grey grit into a bed of red argillaceous marl such as is found on the streams adjacent and along the roads. The disseminated ore in the sandstone is visible only by the aid of a magnifying lens. It seems scarcely possible that by any known process such a small percentage of copper can be profitably extracted, and certainly the results thus far obtained have been most discouraging to the investors.

Indications of the presence of similar ores are found at a number of places along the shore of the estuaries to the south, and also near the roads in the direction of Sackville. In Nova Scotia similar ores occur in the area north of the Cobequid mountains and unsuccessful attempts to mine these have been made in that province for many years.

Many years ago a similar deposit was found at the mouth of the Nipisiguit river near Bathurst. The remains of a fossil tree were found embedded in a reddish sandstone and shale, upon which green carbonate had been deposited, but with the removal of the fossil plants the copper was exhausted.

Among areas in the western part of the province may be mentioned that of Bull creek about three miles south of the town of Woodstock in Carleton county. Here, in a coarse intrusive grey granite, small veins of quartz occur carrying traces of pyrite and chalcopyrite. The ore is like that on the coast of Charlotte county,

and though attempts to mine it have been made from time to time, resulting in the expenditure of much capital, all such efforts have been unprofitable, owing to the very limited amount of ore contained in the area.

In the area to the north of Bathurst are several small streams flowing into Chaleur bay, where boulders of copper-bearing rock have been observed for many years, but as the country is generally densely wooded as well as partly drift-covered, the location of the ore body has never been found. The character of this district renders prospecting very difficult, and if any such deposit should ever be found it will probably be by mere accident. The rocks are slates and occasional limestones with masses of igneous rocks such as felsites, diabase and granite, most of which are more recent than the rocks with which they are associated.

A new locality for copper was seen last season on Jordan mountain in a dike of reddish felsite carrying a small proportion of greyish ore. The felsite cuts a greyish diabase and in one place has a breadth of eight feet, showing copper stains through the larger part of the mass. A small shaft has been sunk, but the showing of ore is not large and the actual value cannot yet be determined. Its occurrence is similar to the felsite ores of southern Charlotte.

NICKEL.

A deposit of nickeliferous pyrrhotite has been known for some years near the town of St. Stephen. The ore body is irregular, occurring apparently as pockety masses near the contact of altered slates and masses of a green-grey gabbro which are intrusive in the slates. Formerly it was supposed that these rocks were among the most ancient in the province. It now appears that the slaty portion is altered Upper Silurian, while the gabbro is newer. Their similarity to the nickel bearing rocks of the Sudbury district is not proven, since the latter are of Huronian age. An examination of the deposit near St. Stephen was made in 1903, in order to ascertain the actual economic value of this mass.

The result of the examination showed that the deposit of nickeliferous pyrrhotite occurred as a contact pockety mass for the most part in an intrusive gabbro which cuts Upper Silurian slates; that the deposit is limited in extent and that the percentage of nickel, being less than two per cent, is too low to be profitably extracted by methods now in use, and that no improvement in character could be found in any of the occurrences of the ore in the vicinity. In the Letite mine small amounts of nickel have also been recognized in the pyrrhotite, but here the amount of the ore itself is too insignificant

to render the deposit commercially valuable. Assays of the St. Stephen ore, made in this Department, gave:—

Nickel	1·72
Cobalt	0·16
Copper	0·31

Assays of selected samples from both the Todd and Carrell mines gave Mr. M. F. Connor of the assay office, nickel 1·38; cobalt, 0·21.

It would seem from these assays, which fairly represent the whole of the output, that the percentage of nickel in the pyrrhotite is practically too low to permit of smelting by ordinary methods employed at Sudbury. If, however, a process of concentration could be installed on the spot at an expense not too great for an apparently limited ore body, it is possible that a paying industry could be established, by shipping the resulting concentrates to the large works at Constable Hook, New Jersey, where the final separation and refining could be effected. It is as yet, however, a question whether the quantity of ore in sight is sufficient to warrant the expense necessary for the erection of such a plant.

ANTIMONY.

Antimony in Canada is a somewhat rare mineral. With the exception of the deposits which occur in Hants county, Nova Scotia, and which have been worked intermittently for some years, that at Prince William, situated about twenty-five miles west of Fredericton, is the most available at present. In the province of Quebec the mineral also occurs in the Eastern Townships in South Ham, but no work has been done at this place for some years.

The discovery of this mineral in the slates and quartzites of York county at Prince William was made some forty-five years ago, the ore occurring as stibnite or sulphide of antimony. Masses of intrusive rock, granite and diabase occur in the vicinity and have led to local alteration of the strata, with the production of quartz veins in which the mineral occurs. Some of these veins are mere strings of quartz, while in places they reach a thickness of several feet. Native antimony also is present in small quantity.

The mining of these ores and their reduction in a furnace to metallic antimony was carried on at this place for some years, an extensive plant having been erected by the Lake George Antimony Company. The smelting was discontinued after several years trial, in which it would appear that the general results were not very profitable, and afterwards the ore mined was shipped in the crude

state. In 1883 it is said that ninety men were employed, with a resulting shipment of twenty-nine tons, the shaft being sunk to a depth of 300 feet. Work was finally abandoned in 1890.

This ore apparently occurs as contact deposits or pockets, associated with some one of the intrusive masses. Whether a system of diamond drill borings would tend to locate other deposits at this locality is a matter for future testing under proper direction. The quality of the ore taken out is excellent, the percentage of the antimony as per analyses made by Dr. W. W. Bailey being as follows; from three samples:—

Antimony	68·91	70·1	69·00
Sulphur	28·86	28·84	27·28
Iron	0·85	·0	0·85
Gangue	0·81	1·50	1·50
	99·50	100·00	98·63

During the present year, 1907, work has again been resumed on this property and a considerable quantity of good ore has already been extracted. The prospects of successful development are reported as very favourable.

LEAD AND SILVER.

Veins of galena containing a small percentage of silver are found at a number of places both in the northern and southern parts of the province, and in rocks of widely differing character. Where tested, however, the results have been unsatisfactory.

In Charlotte county small veins of quartz, occurring in connexion with diabase dikes that cut altered slates and limestone of Upper Silurian age, are found on Frye and Campobello islands, and on the estuary of the Magaguadavic river about two miles below St. George village. At none of these places does the ore occur in economic quantity, and the several attempts made at development have long since been abandoned.

In St. John county, near Frenchman creek, on the east side of Musquash harbour, a pit has been sunk to a depth of twenty-nine feet in a whitish dolomite in which small stringers of galena mixed with a yellow zinc blende are found. The amount of ore is insignificant, but an analysis by this Department showed 25·08 ounces silver per ton of 2,000 pounds. On the west side of the harbour a small vein that occurs with granitic rock contained 14·218 ounces silver to the ton. The thickness of the vein of white quartz at the

latter place is from eight to twelve inches and the galena is mixed with chalcopyrite. The hardness of the rock and the small size of the vein are against its profitable development.

In Kings county small veins of galena of no value are found in the Lower Carboniferous limestone of Dickie mountain north of Norton, and near Wanamake's inn on Hammond river in Upham parish, occurring with chalcopyrite in quartz veins that cut diabase and felsitic rocks, the galena carrying 3·099 ounces silver to the ton. Near Quispamsis also, indications of galena with pyrite and blende occur in granite.

In Gloucester county argentiferous galena has been found in several places within a few miles of the town of Bathurst, viz., the Nigadu river, the north branch Elmtree river, and on Rocky brook, a branch of the Nipisiguit. Although considerable work has been done on the Nigadu and Elmtree deposits all mining was discontinued some years ago. The Nigadu workings were opened in 1879-80 and the percentage of silver as determined in the Survey laboratory was about five ounces to the ton. The ore from Elmtree gave an assay about seven ounces to the ton. In both cases the deposits are too small to be economically worked.

GOLD.

Various reports as to the occurrence of gold have been in circulation for many years, but so far as the examination of the rock formations has extended no well defined gold bearing district has yet been located. In Nova Scotia this mineral is found with quartz veins in the gold-bearing slates which have always been regarded as of Cambrian age; but while rocks of similar age occur at several points, more especially about St. John city, and for some miles to the east, that also carry quartz veins and are thrown into folds, their auriferous character has never been proved.

These characteristic Cambrian rocks of St. John are well c in certain parts by an abundance of fossils, a feature whic not belong to the Nova Scotia gold bearing series. It is, the impossible to correlate the series in the two provinces. Th John deposits are evidently much thinner than those of Nova Scotia, and while they are cut by diorites or diabase at several points there are not the same well-defined anticlines or large quartz veins as in the adjacent province.

The other areas of supposed Cambrian rocks extend across the northern part of the province from the Maine boundary in York county nearly to Chaleur bay. These are largely black and grey slates with occasional tints of red, and in some respects resemble

portions of the Silicry rocks of Quebec. They are in places intersected with small and gashy quartz veins, but though fairly well traversed over hundreds of miles they do not show well-defined veins of the mineral. These small veins are especially abundant on the Upper Miramichi waters. Masses of granite and diabase cut the slates of this area, but though numbers of quartz veins were broken up during the work in this district, no trace of gold was seen in any of them. There does not appear to be any well-defined reason, however, why in some portion of this slate area gold may not some day be discovered; but the district is difficult of access, being a perfect wilderness, and hard to traverse, so that a well conducted prospecting party has probably never been over large portions of the country. All the reports of gold have so far been from local panning along some of the brooks, and of some of these the gold found was apparently the result of 'salting.' Of this character, probably, was the reported finding of a gold field several years ago near the head of the Nashwaak.

Only in one case was gold in place obtained by washing by Dr. Chalmers of this Department. This was on the upper part of Campbell river (the Right Hand branch of the Tobique), although in the reports of Dr. Hind the presence of this metal is recorded from several points.

MANGANESE.

This mineral was mined many years ago to a considerable extent and became an important article of export. The principal deposit was at Markhamville where an ore of high grade was obtained which occured in pockety deposits, sometimes containing hundreds of tons of pyrolusite near the contact of Lower Carboniferous limestone with the Pre-Cambrian rocks of the so-called Coastal range, which includes large areas of igneous rocks. The limestone in which the ore occurs is usually greyish or buff coloured, with bands of shale, and the manganese (pyrolusite) occurs sometimes as veins with calcite, or as lenticular bodies in the limestone itself. The mines at Markhamville produced from 1868 to 1894, in which year the mining ceased, 25,024 tons, valued at $400,203. No attempts, so far as can be learned, have since been made to locate deposits of this mineral along the line of contact.

Among other localities in which manganese has been found and worked to some extent may be mentioned the Glebe mine, three miles northeast of Markhamville, and seven miles from the Intercolonial railway at Sussex, the ore occurring as nodules or thin layers, associated at times with calcite. Several shafts and tunnels were opened

but the actual mining continued for only a short time and was then abandoned. No returns of output are available.

On the east side of Jordan mountain, about seven miles northeast of Sussex, a deposit was discovered about twenty-five years ago. It is also a contact deposit occurring in Lower Carboniferous conglomerate near the contact of felsite and diabase, the conglomerate being made up of the débris of the underlying rocks. The ore is generally a fine-grained massive pyrolusite, but sometimes shows a crystalline structure. The main mass of the ore is near the base of the conglomerate and is exposed in a trench on the slope of the hill, but at the time of our visit last summer much of this trench was filled with débris. From Dr. Bailey's notes, however, we may assume that the ore extends for sixty-five feet with an average thickness of about six feet, and is apparently a lenticular mass conformable to the bedding rather than a true vein. Small stringers also occur penetrating the adjacent rock. The colour is generally iron-black or steel-grey with a dull lustre. Portions of the deposit appear to be low grade, while other portions are of fine quality. The following assays taken from Dr. Bailey's report are appended:—

Analysis by Prof. P. B. Wilson, Baltimore Md. November 7, 1887.

Mang. bi-oxide	86·08
Metallic mang.	54·57
Iron oxide	0·87
Silica	2·86

Analysis by Dr. Otto Wirth, Pittsburg, Pa., November 22, 1887.

Metallic mang.	52·88
Iron	1·18
Silica	9·70
Phosphorus	0·014

Analysis by Pennsylvania Steel Compa. . December 12, 1887.

Manganese	57·37
Silica	0·23
Phosphorus	0·015
Sulphur	0·61

The ore was hauled by team to Sussex station, I.C.R., a distance of seven miles. Work has been suspended for some years, but a number of tons are on the ground awaiting shipment.

The deposits at Quaco head, one mile southwest of the village of St. Martin, on the Bay of Fundy, occur in Lower Carboniferous shale and limestone associated with conglomerate. The ore is

chiefly pyrolusite, and the rocks are cut by dikes and masses of diabase. The strata are much disturbed and the ore is found in irregular veins of varying thickness and in nodules from an inch to several inches in diameter, the thickness of the ore-bearing bed being estimated at about thirty feet in places. Analysis of the ore by Dr. A. M. Comey shows for selected samples:—

	Compact Variety.	Porous Variety.
Manganese peroxide	71·54	65·00
Ferri oxide	2·19	1·75
Calcium	trace	trace
Phosphorus	0·02	0·04
Sulphur	0·00	0·00
Insol silicates	8·37	6·66
Manganese	58·20	57·15
Iron	1·53	1·23

Dr. Bailey remarks on this deposit 'The ore-bearing rocks can be traced on the promontory at intervals for almost a mile, to a place where an opening has been made on the farm of Mr. Molaskey. On the north side of the head small scattered nodules of manganese ore are found in the gravel drift that lines that part of Quaco harbour and extends inland over the Lower Carboniferous rocks. They have doubtless been derived from the latter rocks during deposition of the gravel, in the same way that the red sandstone just mentioned obtained its manganese contents at an earlier date.' Like the rest of the manganese mining of this province work has here been discontinued for some years.

On a small deposit of this ore, found on the east side of Salisbury bay in Albert county, near the contact of Triassic and Lower Carboniferous rocks, some mining was done thirty years or more ago. In the vicinity of Elgin, on the north side of Gowland mountain, large pieces of good ore have been obtained on the surface, but the source of these has never yet been found. It probably is at or near the contact of the slates and conglomerate of the valley with igneous rocks of the mountain.

On the west side of Shepody mountain a deposit of considerable extent was discovered and worked many years ago. It is at the contact of Lower Carboniferous shales, limestone and conglomerates on the north side of the mountain along the road from Hopewell to Albert mines. The mining was begun in 1866 by a Mr. Steadman of Hopewell who drove an adit into the limestone for a distance of about 500 feet. The ore was the black oxide and of high grade,

about 500 tons being reported as extracted. It was found both in veins and as beds, with an occasional thickness of five feet. Works were erected for the treatment of the ore on the ground, but owing to lack of capital, or lack of experience in its manipulation, were shortly after abandoned and the place has become a ruin. It is possible that further exploration on this line of contact would discover other deposits of the mineral.

The uncertainty of finding continuous beds of this ore militates against a persistent search. There is apparently no reason why the mineral should be confined to one portion of a contact between igneous rocks on the one side and Lower Carboniferous limestone on the other, especially where the ore occurrences are large and fairly continuous, but the expense of carrying on the exploration beyond the limit of the profitable areas has evidently been sufficient to deter investigation in many cases, even when such further exploration might have resulted in finding other and similar deposits.

The largest deposits of manganese in the province are of the variety known as wad or bog ore. This is more or less earthy and impure, occurring on the surface in beds of considerable extent at several points. Of these the largest at present known is in Albert county, at Dawson settlement, about five and a half miles northwest of Hillsborough. It is found principally on the north slope of a hill that rises from a small brook flowing into the Petitcodiac river. The upper part of this slope is wooded, but the lower portion is cleared, and when a thin covering of soil is removed an extensive deposit of a fine black powdery mineral is exposed covering the whole hillside. This has been proved in depth by boring and found to extend downward in places for twenty-five to thirty feet, the lower part sometimes being of a hard nature as if the mineral were in the solid condition. The estimated quantity of wad at this place is more than 170,000 tons. Analyses made by well known chemists give as the average of twelve samples:—

Metallic manganese	45·81
Metallic iron	9·95
Sulphur	0·03
Phosphorus	0·05
Silica	5·36

This ore is practically valueless for the uses to which pyrolusite is applied, and in its natural condition is of but small commercial importance. After trying in vain for some time to work the deposit, a scheme of briquetting was instituted which has apparently solved the problem of its utility. An extensive plant has been erected on

the spot, the manganese powder is wheeled in to the dryer, then conveyed to the mixer, and then to the machines for briquetting, whence it comes out in the form of cylindrical blocks about two inches in diameter and the same in length, of sufficient cohesiveness to stand transport by rail to place of destination. The raw material in its dry state is difficult to manipulate as the fine powder is very penetrating and fills the surroundings with a smothering dust. The prepared blocks were shipped to iron works at Bridgeville, N.S., where they found a ready mar[illegible] during the time of operation. Owing to several causes, financial and legal, the works were closed down about five years ago and have not as yet been re-opened though the property has changed hands. Outcrops of similar ores are found along the course of the brook, but no attempts at developing these have apparently been made.

BITUMINOUS COAL.

The history of the New Brunswick coal-fields has been written so frequently that it scarcely seems necessary to reproduce it here, in any considerable length. As regards the geological aspect of the question, the rocks that make up the Carboniferous system of the province are divisible into three parts, viz., the Lower, comprising limestone, gypsum, red conglomerate, shale or marl and sandstone both grey and red; the Millstone-grit, comprising purple and grey shale and sandstone with conglomerate holding white quartz pebbles near the base, the formation containing thin seams of coal, workable in places, of which at least two have been recognized; and a series of soft red, sometimes greyish sandstones and shales similar to the rocks of Prince Edward Island, found in small areas along the east coast of the province bordering on the Gulf of St. Lawrence and Northumberland strait, belonging to the Upper or Permo-Carboniferous. The productive coal-measures of Nova Scotia which, with the Millstone-grit, form the Middle Carboniferous in that province, are not apparently represented in New Brunswick.

The Millstone-grit rocks occupy a large area, approximately not far from 10,000 square miles, of roughly triangular shape, with the base on the Gulf of St. Lawrence. At a number of places around the margin of the basin, as well as at points in the interior, outcrops of bituminous coal occur. To the northeast these are seen on the south side of Chaleur bay, at New Bandon and near Caraquet, where the thickness is from six to ten inches; also on the Dungarvon river, one of the branches of the Miramichi, the thickness of coal being from ten to twelve inches. North of Fredericton it outcrops on the

Taxis and Nashwaaksis rivers; to the southwest on the Yoho and Oromocto rivers, with a thickness of four to five inches only; but no boring has been made in these localities so far as is known to determine whether a lower or thicker seam does not occur. Going east along the southern margin it occurs on Mersereau brook the thickness not being definitely ascertained, but apparently about one foot, and farther east in Clones, on a small stream, two seams are reported which according to the notes of Dr. Matthew gave a thickness of about three feet. On a subsequent trial by boring this thickness was greatly reduced. On the east side of St. John river on Long creek, south of the Washademoak near Cole island, the seam outcrops with a thickness of about ten to twelve inches, but is a dirty coal.

In the interior of the basin the principal outcrops are about the head of Grand lake, and on the Coal branch, a stream in Kent county flowing into the Richibucto river. At Minto, which is the present name of the mining centre in the Grand Lake district, and the terminus of the railway from Norton on the Intercolonial, two seams are found, one of twenty to twenty-four inches, the second from six to ten inches. Sometimes these approach so closely as to be worked as one, the parting of shale being reduced to about three inches. In the report for 1872-3 the measurements of these seams at a number of outcrops are given. Since that date mining in this area has developed very much and the thickness of the seams worked can be better ascertained. The thickness of thirty inches is found at King's mine, and practically on several areas adjacent. In the report referred to a measurement of coal near the steamboat wharf on the lake, on McMahon's property, as seen in a stripping for a length of forty feet, also showed thirty inches of coal. In the report on 'Mineral Resources, Bailey, 1897,' mention is made of the property of Robert Cox on the Emigrant Settlement road, where there was measured thirty-three inches of coal in two seams separated by a six inch parting. The seam as measured in King's mine was in two parts, the upper of twenty-four inches, a parting of three inch shale and a lower seam of six inches.

At most of the mines in this vicinity, while probably the two seams occur, the parting evidently increases in thickness so that usually only the upper seam is worked, varying from eighteen to twenty inches of good coal. But even with this comparatively small seam it is possible to take out a large amount of coal when properly and economically mined. It is estimated at King's mine that the coal per acre from the thirty inch seam totals nearly 4,000 tons, the coal being entirely removed. This gives about 1,500 tons per foot of seam per acre in mining.

In the Coal Branch area the seam ranges from sixteen to eighteen inches, which is the one at present mined, while in a boring one mile north of Moncton sixteen inches were passed through. Farther south at Dunsinane a seam of eighteen to twenty inches outcrops on Stones brook which has been opened up by adits to a depth of about seventy feet on the dip of the seam, and a number of bore holes have been put down which showed the presence of two seams with the aggregate thickness of the seams at Minto. Preparations are now being made for a further test of this side basin at Dunsinane.

It will be seen, therefore, that what may be called the principal seam extends over a wide area. It does not necessarily follow, however, that its continuity is unbroken throughout this whole extent, since in the series of low undulations which affect the coal-bearing strata some portions of the coal have probably come to the surface and have been removed by denudation. This is seen at the borings recently made at Pockmouche near Caraquet, where the small seam on the shore reappears inland a few miles south, and was opened in a shallow pit, while in a boring a few hundred feet north to a depth of over 700 feet no trace of the coal was found. Here the drill apparently passed through the so-called coal meaures for about half the distance down, then through the Lower Carboniferous formation and penetrated the underlying Devonian for nearly 100 feet of grey sandstone, representing portions of the grey sandstones of that age so well exposed on the Gaspé coast to the north.

The thinness of the coal-bearing formation as a whole is also seen from the borings made at various points such as at Minto (Grand lake) where the underlying Devonian slates were met at a depth of 260 feet from the surface and in the boring at the Bridge at 211 feet, this hole being started at about sixty feet below the surface seam. The Devonian rocks apparently occur as a ridge without a covering of the Lower Carboniferous at this place. Another hole bored near the outcrop of the coal and about two miles west of this one, reached the slates at practically the same depth below the coal.

At other places the thickness of the formation varies somewhat. Thus in the boring at Cocagne in Kent county the Lower Carboniferous was reached at about 850 feet in so far as the borings can be determined. In this boring a seam of coal of four inches only was reported a few feet from the surface.

At Dunsinane the thickness of the Millstone grit is about 400 feet; at Chatham about 300 feet; at Caraquet about 400 feet; at Three-tree creek south of Fredericton about 300 feet, no coal being found here; and at Moncton in a boring about one mile north, or near where the new railway yard is located, a seam of sixteen to eighteen inches was struck at a depth of 609 feet underlaid by a band

of coal and shale one foot thick, but no recognized base of the formation was reached, the hole being continued downward for only 140 feet farther. It will be seen therefore that the thickness of the so-called coal-formation in the province is quite thin, and that with the exception of the coals known as the 'surface seams' there is nothing as yet found to warrant the assumption that deeper lying seams exist.

For many years the coals exposed at the mines of Newcastle creek near Grand lake have been worked on a small scale. Until within the last five years when the railway was completed from Norton to Minto, where the principal mines are situated, the only means of transport to market was by woodboat on Grand lake in summer or by teams in winter to Fredericton, thirty miles distant. Up to that date no attempt appears to have been made at screening the output or at separating the slate and sulphur, the entire output being shipped to the market as run of mine. In addition to the original defects in the mining of the coal the methods of shipment necessitated the handling or shovelling from team to landing, then to barge, then the subsequent movement, until in all it was handled or shovelled and dumped six to eight times. As a consequence the coal was generally broken into small fragments, thoroughly mixed with dirt and other impurities and was universally regarded with disfavour for domestic consumption or as a producer of steam. With the advent of the railway a new era was inaugurated. Several of the mines were equipped with hoisting plants either by steam or by horse whim, the output was carefully screened and handled and inspected by an inspector appointed by the Intercolonial railway, and as a result the coal shipped to Norton station is of excellent quality, clean and bright, and furnishes a fuel for either domestic or steam purposes equal to any obtained from the Nova Scotia mines.

At present there are twenty-one companies or mine owners engaged in mining at Minto and vicinity. Of these, nine mine and ship their coal direct from the pit by railway with a minimum of handling, either to Norton or to Chipman, from which latter place it is shipped to St. John or Fredericton by schooner. The remaining twelve producers ship by water from the wharf on Grand lake by woodboat. This water shipment amounts annually to about 4,000 tons, is unscreened and handled in the old way, the coal being hauled to the landing in wagons, and consequently is unsatisfactory to the consumers. That sent by rail for the Intercolonial is screened, but a considerable portion of the rail coal is also shipped as run of mine. The value of the screened coal at Norton is $3 per ton; of the screenings the value is from 90 cents to $1.

The thickness of coal mined at King's pit, formerly Kennedy's, and

known as 'Rapids coal,' is, as already stated, thirty inches, made up of two seams, an upper of twenty-four inches, a three inch shale parting, and a lower of six inches. The whole is extracted, and in the mining about two feet of the shale roof is taken out to ensure height in the drifts. The railway is extended to touch the openings, of which there are in all nine, along the outcrop, but of all these King's mine is the only one at present using steam for hoisting.

The thickness of the worked seam at the other pits on this line of outcrop varies, those at the southern end working only the upper seam which ranges from eighteen to twenty inches. It is possible that in these cases the shale parting has thickened so that the lower seam cannot be utilized, unless indeed it has disappeared entirely. In the vicinity of King's mine, at Walton's, the seam aggregates twenty-eight inches; of which eighteen are good coal; and the levels were in for 150 to 200 feet during last summer, 1906, the daily average output being about twenty-five tons. At Coakley's mines adjacent to the south the thickness is given as twenty-six to twenty-eight inches with a parting of six inches from the bottom; at McDonald's the thickness of coal is twenty to twenty-four inches of which twenty inches are good coal and two to four inches at bottom are slaty. The remainder of this group of mines work on a seam ranging from eighteen to twenty inches thick. It does not seem to be established whether there is a lower seam under this portion of the field.

At King's mine the levels in August were driven west from the bottom of the shaft which had a depth of thirty feet, to a distance of about 800 feet, with cross drifts every thirty-five feet. The average daily shipment is 120 tons or six cars of twenty tons each for say 300 days. This includes the screenings. The run of mine coal sells for $2.35, and the amount of screenings is about 35 per cent. The pay of the men is by the box raised, at 18 cents, nine boxes to the chaldron of one and half tons. The mines of this group work all the year.

The second group of mines includes those that work intermittently. In places the surface, when not more than nine feet deep, is removed and the underlying coal quarried out, but for a deeper cover this is unprofitable. The seam usually ranges from eighteen to twenty inches, and the mines are worked when there is demand for the coal or when the owner is not otherwise engaged. The mines of this group are scattered over a wide area, extending from Newcastle bridge, and New Zion on the Fredericton road on the west, to Flower cove on the shore of the lake. Another outcrop which is found on the Little river about ten miles west of Newcastle, with a thickness of about fourteen inches, has not been worked to any great extent. Details as to the thickness of the coals in this district are

given in the report by Bailey and Matthew, 1872-73, in which the presence of the two seams is clearly indicated.

Prior to the opening of the railway to Minto the annual output rarely exceeded 10,000 tons of run of mines. With the improved plan of mining and facilities of shipment this has increased to between 40,000 and 50,000 tons for the year 1906, the amount in tons largely depending on the possibility of obtaining miners. Were men available the output could be largely increased, since there is practically an unlimited demand for the coal as now prepared for the market, and if a number of the principal mines could be brought under one management there would certainly be a marked improvement in many ways and a larger percentage of profits.

The only other place where coal-mining is now carried on in the province is at Beersville in Kent county. Here a seam of coal from sixteen to eighteen inches thick outcrops on the banks of the Coal branch, a tributary of the Richibucto river, the outcrops being about three miles apart on the stream. Mining on a small scale by the settlers was carried on here for some years and local supplies of coal were thus obtained, but about six years ago a company was formed to mine on the large scale, a branch railway of seven miles was built to connect with the Intercolonial at Adamsville, and the coal was gained in the regular way by adits and cross-drifts. Two of these have been driven, one to a depth of 1,300 feet, the other at the time of my visit (August, 1906) 700 feet with cross-drifts every twenty-five feet. The drifts are run in from the bank of the stream about twenty-five feet above water level and fifty feet from the top of the cliff, up which the coal is hoisted by a three horse whim which can raise a load of three tons up the incline to bank head, where it is loaded into cars for shipment by rail. The miners receive thirty-eight cents per box of 600 pounds for the mining, and in the period between March 1 and June 1, it is said that about 3,000 tons were raised in this way. The freight rate to Adamsville is forty cents per ton, and the value of the coal at the station is $3.10. The capping of the seam is a grey shale, about three and a half feet being removed in the mining; the underlying rock is a bed of fire-clay of two feet. The miners work in eight hour shifts of eight to ten men and mine on the average four boxes or 2,400 pounds per man. The price of the mining, therefore, is not very different from that at Minto. The coal splits readily into broad flakes, burns freely with a strong heat and makes steam rapidly. The output is not screened and the shipments to railway are run of mine. In character it resembles closely that from the Grand Lake mines.

At Dunsinane on the Intercolonial, about thirty miles southwest of Moncton, another coal basin occurs, separated from the southern

margin of the main basin by ridges of Lower Carboniferous and in places by igneous rocks. On the south also a prominent ridge of Lower Carboniferous sediments is seen, and the width of the basin of coal rocks is about four miles. Near a small brook (Stones brook) the coal outcrops in a seam of eighteen to twenty inches which has been opened by several adits to a depth of about seventy-five feet, and a number of tons have been removed that resemble in character the coal from the Grand Lake basin. This, when carefully mined, gives satisfaction.

Some years ago a series of borings was made, with a diamond drill, in this small basin, one of which was carried down to a depth of 1,300 feet. In several of these holes two seams were cut, the upper as seen in the drifts, and a lower of somewhat variable thickness according to the logs, but which showed a tendency to approach the upper and form one seam as in the case of the seams at Minto. Borings to settle this point are now in contemplation and if the dip of the seams is constant their junction should be a short distance north of Shives siding, in which case a seam with a thickness of two and a half feet may be found. If at a depth not too great this should be workable, owing to its proximity to the railway.

In view of a further possible development of the coal industry in this province it is advisable that a systematic series of borings at well selected points should be made, as was recommended some thirty years ago, but only partially carried out. For while there is no likelihood of finding large seams like those of Nova Scotia, judging from the results obtained from the borings made at widely separated points, it is quite possible, with judicious management, to obtain an output of some thousands of tons of excellent fuel, which in view of the railway construction now contemplated, should be able to meet fairly well all local demands, both for locomotive and domestic consumption, as well as for the several factories located in St. John and Fredericton, which now consume large quantities of the slack or screened coal, as also of the run of mines output. The eastern part of the province would, however, probably continue to derive its coal supply to a large extent from the mines of Springhill which are but a few miles distant.

As regards the occurrence of anthracite to which allusion is frequently made, and which has been supposed to occur in quantity at Lepreau and at Musquash, it may be said that at neither of these localities is the fuel obtained of sufficient value as a coal to warrant the expenditure of further capital in its development. A large amount of money has already been expended at both these places, but the deposits are rather of the nature of a highly carbonaceous shale, and the so-called coal is a graphitic carbon yielding a high

percentage of ash, (36 per cent) which remains after the carbonaceous matter is burned off, and this is accomplished only under a strong draft. At both places all work was abandoned many years ago, and the workings have fallen into decay. At Lepreau the so-called coal bed, which had a thickness of some four feet, was opened up by several shafts to a depth of 140 feet, while at Musquash a slope was sunk to a depth of over 300 feet without any improvement in the quality of the output. Several miles southwest of Musquash a number of holes were put down in this black shale with the same results.

An analysis of the coals from nine of the pits at Minto was furnished by Mr. W. H. Hunter, the present manager of the railway from Norton to Minto and is as follows:—

—	Connellsville, Pa.	Balkins.	Evans.	Kings.	Gibbons.	O'Leary.	Welton.	Coakley.	McDonald.	Kelly.
Moisture ...	1·10	0·60	0·80	0·60	0·58	0·72	0·65	0·74	0·67	0·6
Vol. matter ...	32·75	36·94	36·58	35·36	33·90	57·28	33·85	34·56	37·13	35·8
Fixed carb. ...	57·08	55·03	52·94	55·40	52·37	52·41	56·58	55·72	52·89	54·35
Ash ...	9·07	7·43	9·68	8·64	13·14	9·59	8·92	8·98	9·31	9·25
Sulphur ...	·85	4·48	5·81	5·63	6·09	2·99	5·25	8·46	4·72	3·92

Analysis of Grand Lake (Minto) coal made in Department of Geological Survey, 1906. M. F. Connor.

Moisture	0·46
Vol-Combustible	35·40
Fixed carbon	58·54
Ash	5·60
	100·00
Sulphur	2·97

Analysis of Dunsinane coal by Mason and Askwith, Halifax, N.S. Furnished by Mr. John White, from sample of No. 5 pit, 1900.

Vol. matter	39·20
Fixed carbon	55·60
Ash	5·15
	100·00

Analysis of Dunsinane coal by Mr. M. F. Connor, Geological Survey, 1906.

Moisture	1·28
Vol. matter	34·18
Fixed carbon	49·06
Ash	15·48
	100·00
Sulphur	7·90

ALBERTITE AND BITUMINOUS SHALE.

A great body of peculiar brownish and dark grey shales occurs in Albert and Westmorland counties and has long been known under the name of 'Albert shale.' It can be traced across the former county from Elgin on the west through Baltimore and the Albert mines and across the Petitcodiac river to the vicinity of Dorchester. Westward it is also found in that part of Kings county south of the Kennebecasis valley, but here the amount of bituminous matter is much less than in the eastern portion. These shales of Albert and Westmorland are peculiar in carrying a large percentage of bitumen which can be extracted by a process of distillation, and some forty years ago works for the extraction of the contained petroleum were in operation at Baltimore with a certain amount of success until the discovery of the great oil-wells of Ontario and of the United States so reduced the price of the raw products that the manipulation of these shale beds was rendered unprofitable and the works were closed.

These shales came into marked prominence many years ago through the finding at Albert mines of a great body, in vein form, of the peculiar mineral known as albertite, at that time regarded as a true coal occurring under peculiar conditions. This supposition as to its coaly nature was, however, soon abandoned and the material was regarded as a highly altered pitch or bitumen. It was mined for more than twenty years and yielded in all over 200,000 tons, which from the high price obtained, over $20 per ton, rendered it for some years one of the great mineral assets of the province and a source of great profit to its fortunate owners. This vein was mined to a depth of about 1,300 feet and in length for about half a mile and was practically exhausted twenty-five years ago, the lower portion changing into a brecciated mass of shale cemented by the albertite and thinning out to a few inches, while at either end it also became so thin as to be unworkable. Though the deposit was practically a hardened bitumen or pitch but slight traces of petroleum were found throughout the whole period of mining.

The age of these rocks was for many years regarded as Lower Carboniferous. The detailed study of the relations of the shales to the recognized Lower Carboniferous formations, comprising limestones, gypsum and other rocks, proved them to be unconformably beneath these rocks and of late years they have been regarded by all who have recently studied these deposits as belonging to the upper part of the Devonian system.

The large vein of mineral has not entirely been worked out, and it is known that other occurrences of a like nature occur in this area, though probably not of such great size. Thus, in the course of mining, it was found that the main vein, which was the one followed, deflected from its somewhat east and west course to a southeast course about midway in the line of workings. But recently another vein, which at the surface has a thickness of about two feet, has been found starting from the point of deflection and following the general direction to the east. This small vein has been proved to some extent, but if it develops the same conditions which affected the main vein, which occasionally reached a thickness of nearly seventeen feet, it would seem desirable that its development should take place.

In the western part of the area at the Albert mines, also, several small veins are known to occur, with a thickness in places of one foot, which have been opened to a limited extent. These are probably spurs from the main vein, but their proximity to the mass of crystalline rocks of the Caledonia mountain to the west will limit their extension in this direction. It is, however, possible that some of these veins will increase in size at certain points so as to render their mining profitable.

The Albert shales themselves are of special interest from the amount of bituminous matter they contain throughout their whole extent. They have a thickness of over 1,000 feet, but the exact figures are difficult to ascertain owing to the presence of folds and faults. As a series they are highly inclined, sometimes reaching the vertical. A number of sections were made at various points during our investigations in 1876, both of the eastern area on the Memramcook river, at the Albert mines, and as far west as Elgin. The same broken character was observed throughout and the amount of bituminous matter contained in the whole body of shale is estimated at from fifteen to thirty gallons of petroleum per ton.

At many points throughout the shale belt are beds of a dark, black or grey shale especially rich in bituminous matter. This rock has a woody aspect, breaks with a conchoidal fracture and on fresh surfaces shows numerous black streaks resembling hardened pitch. It has been found to contain from fifty to sixty-three gallons of oil per ton for the dark brown varieties, while some of the

greyish bands carry as much as eighty gallons as obtained by experimental distillation. The albertite itself yields over 100 gallons.

Of these rich shale bands at least five have been recognized, varying in thickness from one to five feet or even more. On the upper part of Turtle creek, in western Baltimore, the grey shale bands are found with a thickness up to seventeen and twenty feet according to measurements by Mr. W. Hall, late manager of the Spring Hill mines in Nova Scotia. Unfortunately it has up to the present been difficult to obtain definite data as to the actual economic value of these shales, but from the fact that splinters of this shale will readily kindle from the flame of a lighted match they are undoubtedly very rich in oil. The shale has a low specific gravity (1·50) and yields a large amount of gas of high candle power, burning with a strong yellow flame and with an intense heat.

In addition to the several varieties of oils which are obtainable from these oil-shales, the by-products are of considerable value, and should, in the manufacture, be a source of large profit. They include paraffin and other products such as naptha, benzole, aniline and sulphate of ammonia. As a steam producer it is claimed that the shales (oil-bands) give results equal to that obtained from high-grade coal either bituminous or anthracite, and though the percentage of ash is high its comparative freedom from sulphur, and the absence of clinker and slagging of the furnace bars, is such that the handling of the greater amount of ash is less troublesome than is the case with ordinary coals.

From tests made by the gas company at St. John the amount of gas obtained from the shale was 8,500 cubic feet per ton. Analyses of the shale bands have been made at the Standard Oil Company's works at Bergen point, with the following results:—the data obtained through the courtesy of Mr. M. Lodge, of Moncton, N.B.

Sample of the oil-shale from Baltimore.

Vol. carb. compounds	42·78
Fixed carb. compounds	17·45
Silica	20·88
Alumina	7·91
Iron	1·79
Calcium sulphate	7·56
Magnesia	1·11
Phos. acid	0·34
	99·82
Ash	39·70

Analysis of the grey and black shale of Baltimore by Ricketts and Banks, N.Y., 1893.

From the Grey bands—		
Moisture	1·10	1·54
Vol. matter	45·32	51·22
Fixed carb	1·29	3·03
Ash	50·69	44·21
Sulphur	1·70	.....
	100·00	100·00
Analysis of the Black bands—		
Moisture	0·36	0·64
Volatile	39·50	45·52
Fixed carb	3·60	5·05
Ash	56·10	48·79
Sulphur	1·04	.....
	100·00	100·00

From the known enormous extent of these highly bituminous shales, and their high percentage of bituminous matter, it would appear that if properly developed they should form one of the great mineral assets of the province. A comparison with some of the similar shales used for the manufacture of shale oil and by-products in Scotland, Belgium, France, New Zealand and Australia, shows that, taking the shale formations as a whole, the New Brunswick deposits are richer in bituminous matter than in any of those countries in so far as can be learned from obtainable data. In all these countries the shales are utilized on a very large scale.

Though no recent data as to the production of oil shale and oil are to hand for the Scotch industry, information obtained from Boverton Redwood's volume on Petroleum, 1896, furnishes the returns as late as 1894. These figures may be here given as bearing on the general question of the utilization of the New Brunswick shale deposits and as showing the enormous development the industry in Scotland has attained.

In Scotland alone, for 1894, the output of shale was 1,986,383 tons.

The average output for the ten years preceding was 1,888,339 tons.

The annual output varies somewhat from year to year. The specific gravity of the shale is about 1·75; twenty cubic feet to the ton.

The proportion of mineral matter in the shale is usually about 73 per cent, and sometimes as high as 80 per cent. The various oil shales exhibit marked differences in the yield of oil and sulphate of ammonia. The richer shales yield about thirty gallons per ton and in some cases as much as forty gallons, but the high yield is usually obtained at the expense of the solid paraffin and the quality of the heavy oils. The inferior shales yield about eighteen gallons of oil per ton, but a much larger amount of sulphate of ammonia. (from sixty to seventy pounds).

The total quantity of crude shale oil produced in Scotland during 1892 to 1894 is as follows;—

	Gals.
1892..	44,238,280
1893..	45,725,841
1894..	47,693,458

Taking the figures for the output of shale for the latter year:— the yield of oil per ton of shale is only twenty-four gallons.

The thickness of the oil-bearing shale bands mined in Scotland, according to the same author, is as follows for the eight principal seams:—

Dam or Raeburn shale..	2½ to 3 feet.
Mungle or Sewart..	2½ to 3 "

The Grey shale, thickness not stated, thin seams only.

The Fell shale, richest of the Scotch shales, produces from thirty-six to forty gallons crude oil, and yields from eleven to fourteen pounds amm. sulphate by the Henderson retort and from twenty-five to thirty-five pounds by the Young and Beilby retort.

The Wee, the Big, the Wild and the Curly shales, followed by the Broxburn shale which averages five and a half feet in thickness, produce twenty-eight to thirty-three gallons oil and from sixteen to twenty pounds amm. sulphate by the first, or twenty-six to thirty-two by the latter process.

The Dunnet shale, from six to sixteen feet thick, yields from fifteen to thirty gallons crude oil per ton.

The Barrack shale, average thickness of ten feet. Beneath this are the Pumpherston shales, which comprise the Jubilee, about eight feet, the Maybrick of six feet, the Curly about six and a half feet, the Big Plain eight and a half feet, the Wee Plain four and a half feet. Of these the Curly shales yield ten gallons crude per ton and sixty to seventy pounds amm. sulphate; and the average yield of

the Pumpherston shales is sixteen to twenty-two gallons crude with twenty-five to thirty-five pounds amm. sulphate to fifty to sixty pounds according to the process employed. The percentage of contained oil is also said to vary considerably in different parts of the workings. Most of these shales are now taken from considerable depths, some at least from 1,200 feet below the surface.

It would, therefore, appear from a comparison of the several seams in the two countries, both as regards quantity of contained oil and thickness of shale beds, as well as the facility of mining in New Brunswick, that the latter should have a marked advantage as regards general development.

The thick oil bands of the Albert shales are found in the eastern area at Taylorville on the Memramcook river, from which place considerable quantities were shipped forty or more years ago for distillation under the old process. They are found also near St Joseph college; at Bellevue, on the east side of the Petitcodiac river opposite Hillsborough and at Dover; at the Albert mines; on the east branch of Turtle creek in Baltimore; and on the West branch two miles west. They also appear in the Elgin area at Mapleton. In all of these places the oil shales outcrop and can be readily mined and there is a general resemblance throughout; but on the West branch of Turtle creek the oil-shale is of the grey variety instead of the black. At the Albert mines the dumps from the mining of the albertite are very large, aggregating some 120,000 tons, and these contain a large percentage of albertite, which was thrown away in the early days of the working, so that for distillation there is a very large amount of very rich material already at the surface. The locality is directly on the line of railway.

For many years borings have been made on these shales for oil. These have been sunk principally in the area between the Petitcodiac and Memramcook rivers, at Dover on the west and near St. Joseph college near Memramcook. The first attempt at boring in the shales appears to have been made about fifty years ago, the exact date not being obtainable. The hole was put down near the college, but though some traces of a black oil were obtained the results were not satisfactory and the borings were soon discontinued. Some twenty years later other attempts were made and several holes were sunk, some of which are reported as reaching a depth of over 1,000 feet and one is said to have been carried down for 2,200 feet. In this oil, in small quantity, was reported at 1,050 feet, but the attempt was abandoned at the depth stated with only small shows of oil and gas, and in none of the holes was sufficient success met with to warrant a continuance of operations. About six years ago a new company began a systematic search in order to settle the question of the occurrence

of oil in economic quantity, and a number of holes were bored both near the college and at Dover, as well as on the west side of the Petitcodiac river opposite. The borings were suspended at the close of 1904, in all some seventy holes being sunk, of which about twenty were near the Memramcook river, about forty-five at Dover and vicinity, and four or more in Albert county opposite, with several others whose location is not clearly indicated, making a total of seventy-six wells.

Most of these were sunk to depths of 500 to 800 feet, but one near Dover was carried down to a depth of 3,000 feet. While many of the wells proved to be barren, quite a number have produced oil in small quantity. Of these near the college practically 50 per cent are producers on a small scale, and are being pumped at intervals from a central station. The yield is exhausted in about four to five hours, and the amount obtained from the pumping is said to be about nine barrels weekly from eleven wells, but this contains a certain amount of water also. In the Dover area twenty-one wells are pumped for six days in the week with a stated pumping average of sixty barrels of thirty-five gallons capacity monthly. Here also the flow ceases in about five hours, the contents of the wells being then exhausted. In the deep boring neither oil nor water is said to have been found.

It will be seen from these results that the amount of oil as yet obtained is insufficient to pay the cost of extraction. From a study of the shales it is difficult to find sufficient data to warrant the statement that they will ever become great producers of oil by boring. The fact, clearly established, that the whole body of the shales, with their interstratified hard bands of sandstone and thin limestone, is highly tilted and faulted is opposed to this supposition of a great producing oil-area, and the conditions are entirely different from that found in all the producing oil fields of the world. The finding of small quantities of oil in some of the wells may be explained by the hypothesis that such oils reach the borenoles through lines of fault or by seepage in some way, since in none of these has there yet been found any indication of a subterranean oil reservoir, nor is it reasonable to suppose that in so broken a mass of sediment such a reservoir can exist which might ensure a permanent and large supply.

In this respect these shales are similar to the rocks found in the great so-called oil-basin of Gaspé, where hundreds of thousands of dollars have been spent during the last twenty years and many holes have been bored over a large area, some of which reached a depth of 3,700 feet. As in New Brunswick, small quantities of oil were obtained by pumping from some of the holes, but after a short time the

production of the oil ceased. These Gaspé explorations ended several years ago. Here also the strata while practically of the same horizon as those of New Brunswick or Upper Devonian, were tilted and faulted, and there were a number of well defined oil springs which were found near the line of the faults. Similar experiences were met with in similar borings near Lake Ainslie in Cape Breton and in Newfoundland on the west coast.

Of most of these borings no log has been furnished this Department and the thickness of the shale formation cannot therefore be indicated, but in some of the earlier holes it would appear that the drill passed through the bituminous shales and reached a series of red rocks at a depth of 550 feet, especially in a well bored a mile north of St. Joseph college, so that in this case probably the underlying red beds of the Devonian were reached. In regard to the deep well no log is available and it cannot be said what were the bottom rocks. Quite recently a new series of borings has been commenced in the Dover area.

GRAPHITE.

This mineral exists in but small quantity in the province as compared with the large areas of graphite bearing rocks which occur in Ontario and Quebec. Its occurrence as graphitic shale associated with crystalline limestone and diorite, near the Suspension bridge over the St. John river in St. John city, has been long known, and mining has been carried on at intervals for a number of years. While the separated graphite was not of the best quality, it was found to be suited for foundry facings, but the industry has never assumed large proportions, owing, probably, to the limited extent of the deposit. An analysis of the mineral made in this Department from samples obtained in 1878 gave as follows:—

Graphitic carbon	48·775
Rock matter	50·058
Hygroscopic water	1·167
	100·000

At present mining has been discontinued at the original spot, but another outcrop occurs in a limestone cutting with shales along the side of Douglas avenue about a fourth of a mile east of the bridge, from which a small quantity of the shale has been taken.

The presence of this graphite deposit was first recorded by Dr. A. Gesner in 1840. Some years after mining was commenced, and in 1853, it is reported (M. H. Perley) that 89,936 pounds were exported,

but the mine evidently closed down shortly after that date. It was reopened again in 1868 by Mr. Garrett, and the return of output for 1869 taken from the statistics in the Geological Survey report for 1871-72 is 6,000 barrels, valued at $12,000. No further returns were received from this property and mining seems to have been suspended for a time.

From Professor Bailey's report on the Mineral Resources of New Brunswick, 1897, it would appear that mining operations were resumed for a short time. A little later, probably about 1872, work was again commenced on this property, by Mr. S. S. Mayer, of Carleton, at a point about 600 yards east of the river, on the land of Messrs. Hazen and A. E. Botsford, but after the extraction of a few tons the location was sold to parties in the United States. The works were closed down shortly after, but later another attempt was made by Mr. W. F. Best and others to revive the industry, at a point about 200 feet east of the Mayer location. At this place the graphite was concealed at the surface, but on sinking a shaft it was struck in small quantity, showing at a depth of about fifteen feet. This area was regarded as a continuation of the deposit seen on the Mayer place, and the graphite is reported by Mr. H. Brumell, at that time on the Geological Survey staff, who examined the district in 1890, as occurring at the contact of crystalline limestone with a trap dike. Where first struck, at eight feet from the surface, the bed of graphitic shale had a thickness of only about two inches, but this rapidly increased and in the shaft it reached a width of eight to ten feet at a depth of fifty feet. A mass of trap with a thickness of two feet, which extended for fifty feet along the deposit, was struck at a depth of thirty feet from the surface. The dip of the hanging wall is to the south at an angle of 55 degrees. The graphite is associated in places with pyrite which breaks away readily and leaves the graphite comparatively pure. The output is said to have found a ready market at $7 per ton.

Small deposits of graphitic shales are found in Pisarineo peninsula, one at Mill creek on the east side which is worked to a small extent, the other near the mouth of Frenchman creek on the east side of Musquash harbour. At Little Lepreau, also, on the north side of Belas basin, graphitic shales occur which were at one time mined for fuel but which seem better fitted for some of the uses of graphite, resembling similar deposits in Massachusetts, where they are utilized for this purpose. Similar shales are found at Musquash on the property of Mr. Clinch.

A deposit of graphitic shales on Thorne brook in northern Kings county was opened some years ago, but was soon after abandoned.

Other occurrences have been noted in Charlotte county, but of these none have ever been utilized and it is doubtful if they would repay the cost of mining.

PEAT.

Peat is found in large bogs at many places throughout the province from north to south. They have been specially studied by Drs. R. Chalmers and W. F. Ganong. No attempt has apparently ever been made to utilize these bogs as a fuel supply, but some years ago a bog situated near Spruce lake, a few miles west of St. John city, was opened up by Mr. W. F. Todd of St. Stephen, preparatory to the manufacture of moss litter for which it was well suited. After a series of experiments a plant was put in operation which is said to have manufactured the raw peat moss from its original state, saturated with water, into a high grade finished article of litter in a few hours, but unfortunately the buildings were destroyed by fire in 1[illegible]5 and the industry has never been revived.

In Ontario and Quebec experiments have been carried on for a number of years to manufacture the peat under the surface moss into a compressed fuel in the form of briquettes. These efforts have been attended with a certain amount of success, and the demand for the finished product is in excess of the available supply. As yet, however, the industry has not assumed large proportions; but it is doubtful, in view of the supplies of coal from the mines of New Brunswick and of Nova Scotia, whether the manufacture of peat fuel in these provinces will ever reach sufficient proportions to make it a competitor with the supplies of coal proper. Lists of the bogs in New Brunswick are given in the Report by Dr. Chalmers, G.S.C., Vol III., 1887-88.

LIMESTONE.

Limestone is found at many widely separated points throughout the province. Owing to the limited local demand and the practically prohibitive duty against the import of the manufactured article into the United States, the industry, which some years ago reached large proportions from the burning of lime around the city of St. John, has languished, although the occurrence of limestone of excellent quality and in large areas around that city presents admirable facilities for the manufacture of the finished article at the lowest possible cost of production. The importance of this industry can be seen from the statement of the figures for export at different dates. Thus in 1881 the number of barrels shipped to United States ports was only 3,644 of the value of $1,822, while in 1890 it amounted to

286,584 barrels valued at $143,292. Since then the industry has declined, the value for 1897 being only $15,634. The figures of production for the last few years are not available in this Department. The great competitor with the St. John line in the United States market is Rockland on the east coast of Maine.

At present the principal quarries are operated near St. John and owned by Stetson and Cutler, Purdy and Green and by W. Lawlor and Son, the last at Brookville. Of other quarries once in operation, but at present closed down, are Messrs. I and F. Armstrong on Green head, first opened in 1828; Miller and Woodman, Green head; W. D. Morrow, Narrows of St. John river; and Mr. Stevens of South bay.

A peculiarity observed in all these quarries is the large number of dikes of epidotic green diabase which cut the limestone in all directions and often seriously interfere with the quarrying. Some of the larger dikes have masses of the limestone caught in the igneous mass, and the alteration of the limestone is most pronounced as the dike is approached.

Analyses of the limestone from several of these quarries have been made by Dr. Hoffmann of this Department with the following results:—

The quality of stone is excellent throughout.

I and F. Armstrongs' quarry, Green head.

Rock a dark bluish-grey, fine crystalline, massive, holding occasional specks of iron pyrite: after drying at 100 C,—Hygroscopic water = 0·09 per cent.

Carb. lime		95·60
Carb. magnesia		0·44
Carb. iron		0·13
Alumina	0·11	
Sol. silica	0·16	4·27
Insol. min. mat.	3·54	
Organic matter	0·46	
		100·44

Limestone from Stetson quarry, Indiantown.

Light and dark bluish-grey, banded, somewhat coarsely crystalline and massive; after drying at 100 C., Hygroscopic water = 0·04.

Carb. lime		99·05
Carb. magnesia		0·88
Carb. iron		0·13
Alumina	0·01	
Silica soluble	0·9	0·26
Insoluble mineral matter	0·14	
Organic matter	0·02	
		100·24

W. Lawlor and Son's quarry, Brookville.

Bluish-grey, somewhat coarse crystalline, massive.

After drying as before—

Carb. lime		98·39
Carb. magnesia		0·71
Carb. iron		0·05
Alumina	0·02	
Silica soluble	0·14	1·19
Insol. min. matter	0·82	
Organic matter	0·31	
		100·34

Crystalline limestone is also found in Pisarineo peninsula, on the east side along the shore to the south of Spruce lake and on the west side from Frenchman creek to Black beach. At this latter place the quantity is large, the quality excellent, and there are good shipping facilities, which would obviate the hauling necessary for much of the St. John lime. Abundance of wood for burning is found in the immediate vicinity. Farther west, crystalline limestone occurs on the south side of Belas basin, Lepreau, and in rear of Musquash village, but the outcrops in both these places are local and the formation cannot be traced far across country.

Other limestones, sometimes crystalline, are found in several geological formations. They have occasionally been utilized locally.

The largest of these so utilized is in Carleton county in Brighton, of Silurian age, which has been burned to some extent. In Albert county the Lower Carboniferous limestones were at one time burned for lime quite extensively, but though furnishing a good quality of the burned material the competition with the large kilns of St. John was against the continuance of the industry. Some of these Albert limestones are highly bituminous and it has been suggested that they might be used in the matter of sidewalk construction in towns. No attempt has ever been made in this direction.

GYPSUM.

The quarrying, calcining and export of gypsum is at present one of the leading industries in the province. The principal works and quarries now operated are situated at or near Hillsborough, in Albert county, a short distance from transport by the Petitcodiac river and by rail communication on the Salisbury and Harvey railway.

The raw material is found in great abundance as a part of the Lower Carboniferous formation both in this province and in Nova Scotia. Both the hydrous and anhydrous varieties occur, the latter, however, being of but small commercial value at the present time. The gypsum beds are usually found overlying a series of red conglomerates and limestone and are usually overlain by, and sometimes contain, beds of red marly shales. It varies in quality greatly, sometimes being white and clear, translucent, in which case it is styled alabaster; at other places it is crystallized in the form of selenite; sometimes it is deeply coloured, reddish or dark grey. The gypsum, while ordinarily massive, sometimes presents a well-banded or stratified appearance, lying in nearly horizontal beds of various colours and of varying thickness and purity, and the prevalent tints being white or grey. The so-called soft plaster alternates in the quarry with beds of the anhydrous variety, the contact between the two being usually sharp, and this necessarily adds greatly to the cost of extraction; while frequently the deposits are covered with heavy masses of red clay and soil which have to be removed in the mining. This alteration of soft or hydrous and hard or anhydrous plaster in the same beds is somewhat difficult of explanation, the transition being often so sharply defined. The former by analysis contains calcium 32·5, sulphuric acid 46·6, water 20·9, but the mineral is often quite impure owing to the presence of organic matter, clayey material, iron compounds and the carbonates of lime and magnesia. The different colours seen in rock plaster are apparently due in large measure to these

impurities. The hardness is 1·5 to 2·0, being easily scratched with the finger nail, thus distinguishing it from certain forms of limestone. Anhydrate has the same chemical composition except that it contains no water of crystallization and by the absorption of water this variety changes to the soft or hydrous variety; it is probably in this process of water absorption in nature that the alteration of the hard plaster to the soft is accomplished. Gypsum is also frequently associated with rock salt, and while this association has not been clearly recognized at any of the quarries worked in Albert county, the presence of salt springs which are found in the Kennebecasis valley, where they have been utilized for the manufacture of salt, is recognized in close proximity to well-known gypsum deposits which outcrop in this area.

Gypsum may be formed in two ways, either by the action of sulphuric acid or carbonate of lime, as is done in the laboratory, or by being deposited by evaporation. The Hillsborough deposits, according to the late Sir William Dawson, have been produced by the former method.* Limestone is very abundant in the Lower Carboniferous formation, and the sulphur could be derived either by the decomposition of iron pyrites or the decay of organic matter. On the other hand, the beds are usually interstratified with shales, sandstone and limestone which have been deposited in arms of the sea or in lake basins. The water, with salt and gypseous matter in solution, has, owing to evaporation, reached a sufficient degree of concentration to prevent the growth of organisms, since traces of these are rarely found in the gypsiferous formations, while the presence of iron oxide usually imparts a red colour. Thus in process of time the gypseous matter has formed beds of plaster sometimes of great thickness.

Analysis of the plaster from the Hillsborough quarries made by A. A. Breneman, N.Y., is as follows:—

Lime	32·45
Sulphuric acid	46·38
Water	21·05
Silica	0·25
Iron	trace
Magnesia	trace

The Hillsborough deposits were known and worked to some extent sixty years ago, but in 1854 the quarries in rear of the village were acquired by Mr. C. Tompkins and the shipment of the raw material to the mills in New Jersey was commenced. Later, a milling plant for calcining the crude output was erected near the point of

* See "Gypsum Deposits of New Brunswick," by L. W. Bailey, Roy. Soc. Can. Trans. 1906.

shipment on the Petitcodiac river, and the manufacture of plaster of Paris was carried on there. For some years the output as excluded from the markets of Ontario and Quebec, owing to the cost of transportation, but the opening up of the Intercolonial railway in 1876 allowed access to these provinces and a very large business is now carried on in this direction. Great quantities of the crude are still sent to the United States from Hillsborough in addition to the shipments of prepared plaster. Some idea of the growth of the industry may be obtained from the following figures, furnished by Mr. C. J. Osman, the managing director of the Albert Manufacturing Company. Thus, in 1877, the total sales in Canada were about 8,000 barrels, while in 1897 the Canadian trade had increased to 38,000 barrels; the shipments of crude gypsum to the United States increased from 5,000 barrels in 1877 to 59,334 in 1897 and in 1905 the figures were, mined 137,551 tons, for calcining 15,000 tons; the balance of 122,551 being shipped as crude.

Up to the present time the anhydrite has but little commercial value, being unsuitable for the manufacture of plaster of Paris. A certain amount is ground, however, and used, under the name of 'terra alba,' as a paper filler. It is equally adapted for land plaster as a fertilizer as the hydrous variety, and considerable quantities are now exported from the quarries in Nova Scotia, presumably for this purpose.

The price of crude gypsum delivered at the wharf in Hillsborough varies. For the lower grades, suitable for land plaster, including the discoloured rock, the price is 60 cents per ton; while for the higher grades used for the manufacture of calcined plaster it ranges from $1 to $2, and for the selected grades $2.50 per ton.* The quarries at Hillsborough are connected by steam road with the plaster mill and with the wharf at the Petitcodiac river.

Other large deposits of gypsum occur in Albert county, several of which are quarried. The Hillsborough Plaster Company located on Demoiselle creek took out about 5,000 tons in 1905, of excellent quality, and other quarries in the southern part of the county, as at Hopewell hill and Shepody mountain, have also been worked to some extent, but the figures of output are not to hand. Plaster also occurs in New Horton but has not as yet been opened up to any considerable extent.

The Albert Manufacturing Company is also opening additional deposits, one at Pink ledge, about one mile north of the end of Cape Maringouin on the east side of Shepody bay, where there is a deposit of large size and excellent quality from which shipments have already

* Much of this information is taken from an excellent article prepared by Mr. Osman for Dr. Bailey's report, 1899.

been made, and also on a deposit occurring at Martin head on the shore of the Bay of Fundy in eastern St. John county. In Westmorland county, two and a half miles west of Petitcodiac station, a deposit of gypsum, said to be forty rods in width and traceable for one mile, is found, in which a body of selenite occurs with a breadth of eight feet. This is also controlled by the Albert Manufacturing Company, but has never been largely mined. In Kings county quite extensive deposits are found near Sussex and in Upham near the road from Sussex to Quaco, from which about 500 tons were quarried during 1905.

In Victoria county, at Plaster Rock, heavy beds of somewhat impure gypsum associated with shales of the Lower Carboniferous formation occur. These are now connected by rail with the Canadian Pacific railway along the St. John valley. The mineral is well adapted for land plaster, and a mill has been erected in which it is ground and thence shipped in considerable quantity to the farms along the St. John river, as well as to Aroostook in Maine where it is highly esteemed as a fertilizer. During the season of 1906 work at these quarries was mostly suspended.

The total shipments of plaster from the province for 1905 aggregated 146,030 long tons in crude and manufactured, of a value of $232,586. Of these Plaster Rock shipped 819 tons, part of which was ground, the whole being used for land plaster.

One large element of expense in quarrying the plaster at certain places is the very heavy body of red clay which frequently overlies the mineral, and which is often allowed to fall into the pit instead of being removed by stripping before quarrying. This would seem to be an expensive way of removing such large masses of waste material. Another large item of expense in some of the quarries is the large percentage of anyhydrite which is practically of no value.

Granite, diorite, &c., occur over large areas and have been quarried for building stone, monumental work, &c., for more than thirty-five years.

GRANITE, &C.

Of the granites, both red and grey and the so-called black varieties occur. In age these are comparatively recent, since in many cases they cut rocks as new as the Devonian sediments, corresponding in this respect with certain similar granitic rocks of Nova Scotia.

Among the largest of these granite masses is that found in Charlotte county, which extends across the county from the St. Croix river northeast almost to the St. John river. The rock is generally red, but sometimes passes into grey. In different parts of the area are large masses of the black variety which is in reality a mica-diorite. This is found in the western area north of Boeabec, near the Magaguadavic river; and eastward near Welsford on the

line of the Canadian Pacific railway. This rock consists of labrador feldspar and hornblende with some magnetic iron; it takes a good polish, is very hard and tough, and is as a consequence a more difficult rock to dress and to finish properly.

The principal granite quarries in the province are situated near the village of St. George in Charlotte county and along the Magaguadavic river for some miles north. The principal quarries at present in operation are owned by:—

Milne, Coutts and Company.
Epps, Dodds and Company.
O'Brian and Baldwin.
Tayte, Meeting and Company.
Utopia Granite Works (H. McGrattan and Son).
Messenette and MacDougall.

The granite industry at this place was begun in 1872, by a New York company, and a plant for cutting and polishing was erected, which, however, in a few years, suspended work. Subsequently (1881), Milne, Coutts and Company acquired this plant and have continued the business to the present time. Exceptional facilities are afforded here for the manufacture of the stone owing to the supply of water for power furnished by the falls on the river, and the rough material can be brought from the quarries to the mills, either by scows down the Magaguadavic river or by teams.

The amount of rough stone produced at these quarries varies according to the demand. There is also a certain amount of stone known as 'black granite' brought from outlying points and at the works blocks of grey stone from the St. John River quarries (Spoon island) are dressed and polished.

The Spoon Island quarries are in a spur of granite which comes to the St. John river about three miles south of the village of Hampstead, opposite the lower end of Spoon island. The stone is a grey granite of excellent quality, and two firms are here engaged in quarrying, viz.: Allan Appleby and D. Mooney and Son. The output during the past season was about 2,500 tons.

Of the 'black granite' the output from the quarries near Beaubee in 1905 was about ninety tons.

In the York County belt, opposite the mouth of the Sheogomoc river, are the works of the Southampton Marble and Granite Company (Oldham Bros.). The output for some years has been used largely for monumental work, but no returns have been received by this Department. In the northern part of the province no granite quarries are now operated, though a good quality of rock is found at several places, as along the lower part of the Nipisiguit river.

Among other rock formations suited for stone as ornamental work but small indications have as yet been found in the province. The crystalline limestone of St. John does not appear to be very well adapted either for building or decorative work, while the small portions which are slighly serpentinous are equally unsatisfactory. In Ontario and Quebec, where serpentinous limestone and breccia occur in large quantity, but little use has ever been made of them. The serpentine of Pisarineo, which has sometimes been alluded to, has been worked out, it consisting merely of a pockety deposit with small threads of crysotile. That of Frye island and of Musquash is usually too much shattered to furnish blocks of large size, and is better adapted for lime burning, while the felsite of Chamcook, while furnishing beautiful hand specimens that take a fine polish, cannot be obtained in blocks of size sufficient for decorative purposes.

FREESTONE, MILLSTONE AND GRINDSTONE.

The great extent of the Millstone-grit formation in this province, with its widespread formations of sandstone and grit, furnishes an abundance of material for building and other purposes. At many places the quality of the stone, usually grey, is eminently adapted for building material, for which purpose very large quantities have been quarried and extensively shipped, as well as used locally. Some of the grey beds have a fine grit that especially adapts them for use as grindstones either for metal or for pulp wood.

For years a number of these quarries were in operation in south-east New Brunswick in the counties of Albert and Westmorland. Much of the grindstone was taken from ledges on the beach which were exposed at low water, the great rise and fall of the tides on this part of the coast, from forty to fifty feet, rendering it possible to extract the stone and then to float it to high water mark as the tide came in. At the extensive quarries on Grindstone island, and at Mary point, both grindstone and building stone were quarried on a large scale some thirty-five to fifty years ago. On the mainland at the Budreau and Rockland quarries large quantities were raised for both purposes but the large amount of waste and the increased cost of extraction became such that they have both closed down for the present, and with the exception of a few grindstones, which are taken out at Rockland, no work is now being done at either of these localities. At the present time the only quarries working in eastern New Brunswick are in Westmorland county at Sackville and at Woods point about three miles south. The beds which lie nearly horizontal are composed of a brownish sandstone of Upper or Permo-Carboniferous age. Mills have been erected at both places for sawing and

dressing the stone. At Sackville the output is a beautiful stone largely used for building purposes and occurring in blocks of any required size. The quarry is owned by Mr. Charles Pickard and turned out, last season, about 3,000 gross tons, valued at $12,000, besides 1,000 tons rubble. At Wood point, the quarry, owned by the Reid Bros., has, for the last eight years, mainly produced grindstones, the principal markets for which are in the United States and eastern Canada.

In the northern part of the province extensive quarries in grey stone were in operation for many years, especially in the Miramichi district where beds of the peculiar grit abound. At the present time all these old quarries are closed and the only one now worked is at the terminus of the Indiantown branch railway on the Miramichi, about twenty-one miles west of the bridge (Intercolonial) across the river. One of the most important of the old quarries on the lower Miramichi near Newcastle was the French Fort or Fish quarry, from which the stone for the Langevin block in Ottawa was taken. This stone is an olive green, works readily, and hardens, like many freestones, on exposure to the air.

The quarry at Indiantown is very similar in character. The formation is Millstone-grit and plant bearing beds are found between the beds of massive sandstone. The stone is also olive, and occurs in a high bluff which is easily reached, the beds ranging in thickness from sixteen inches to eight feet with a lower bed of over ten feet, the bottom not being reached. The layers are practically horizontal and regular and the stone dresses readily with a sharp edge. This quarry was opened about eight years ago. The quarry is equipped with steam derricks. The quarry is owned by W. Hood and Son of Montreal, and the output for the season of 1905 was about 20,000 feet of rough dressed stone valued at $8,000, and 700 tons of rubble. The output is hindered occasionally by the scarcity of labour. Part of the output is admirably suited for pulp stones of which twenty-five were made weighing about two and a half tons each. The stone finds ready sale in Montreal and the western cities of Ontario.

On the south side of Chaleur bay several quarries producing excellent grindstone are in operation. Of these the principal one is owned by Joseph Reed and Company, and has been in operation since 1844 when it was opened by Messrs. Sprague of Boston. It was taken over by the present firm in 1852.

The beds of grindstone grit have a thickness of about twenty-one feet, and this formation is overlaid by chocolate-brown shales. The beds are almost horizontal or dip southeast at an angle of one to two degrees. The quarry is opened on the beach and the water is kept out by a well-built dike, and by the aid of steam pumps. It is

operated for about five and a half months, but is flooded in winter in order to preserve the stone from the action of frost.

In addition to grindstones of all sizes a considerable quantity of scythe and other small stones is made. The yearly product is about 2,700 tons. Other quarries are found in practically the same reef which shows along the shore for some miles. These are Noel's at Clifton and a quarry at Grand Anse from which both grinding and building stone are produced. The latter was employed in the construction of the new Roman Catholic church at that place. Other small quarries are found, opened for local purposes apparently, but from which no returns are made to this Department.

Among these may be mentioned a quarry at Scotch settlement, at the head of Shediac river, known as McSweeney's, the output of which was used in the Roman Catholic church, Moncton; at Cocagne at the crossing of the Moncton and Buctouche railway, the stone being of both purple and grey varieties, and used in the Young Men's Christian Association building at Moncton; and a quarry along the line of the Canadian Pacific railway between Fredericton and Fredericton Junction where the stone for the provincial Parliament buildings was obtained, the output also being in two shades, grey and purple.

SLATES.

No beds of slate, of value sufficient to warrant the expense of opening, have as yet been found in the province, nor is there any indication that such beds exist, though the slate formation as a whole is of large extent. The great cost attendant on opening a quarry of slate, even in very favourable circumstances, and the comparatively small demand for the manufactured article, are such as to render competition with the large quarries of eastern Quebec or of Wales practically impossible.

Flag stones and hearth stones can be found at several places, but the demand for the former has greatly fallen off for sidewalks owing to the use of granolith or asphalt, while in the absence of blast furnaces there is at present no local demand for the latter. These were at one time obtained from red beds along the Tobique and Becaguimec valleys, and were used locally while the Woodstock iron furnaces were in operation.

CLAYS.

Both brick and fire clays occur, the former being used locally to some extent, but no attempt has yet been made to utilize the latter, which occurs in connexion with the coal seams both at Minto

and at Beersville. Brick yards are quite numerous about St. John, of which probably the principal are owned by Messrs. John Lee and Company, with yards on the east side of Courtney bay near the mouth of Little river. The output from these is about 2,000,000 common brick, 100,000 pressed and 10,000 drain tiles yearly, but in 1905 the common brick amounted to 2,800,000. Messrs. D. Mooney and Son also operate extensive brickyards at Fairville, the figures of recent output not being to hand.

The yards at Fredericton, owned by Messrs. Ryan and Son, in 1905 produced 1,400,000 common brick and 20,000 tiles. Those at Fairville, owned by Messrs. Mooney and Son, produced about 1,000,000 common brick.

Other yards are found at Bathurst, Chatham, Lewisville, Moncton, Newcastle, St. Stephen, Sussex, Marysville, Woodstock, &c., but of these no official returns are available. Recently a new deposit of clay marl was opened on the bank of the Salmon river about three miles from Harcourt by Mr. Van Buskirk and the first kiln was being prepared for burning in August last, 1906, the results of which have not been learned.

SILICA.

Silica and infusorial earth have been known for many years. Of the latter, deposits are found in the beds of several lakes, as in Pollet River lake and Pleasant lake in Kings county, and in Fitzgerald lake a few miles east of St. John. Of these the Pollet Lake deposit has to some extent been worked, the lake having been drained several years ago, and preparations are now being made to ascertain its commercial value. Fitzgerald lake was also drained and is being carefully tested, but only small shipments have as yet been made from either of these localities. Though of good quality the distance of several of these deposits from transportation facilities is such as to entail considerable expense in shipment of the raw material. This mineral is of organic origin, thus differing from ordinary deposits of silica.

Silica proper occurs in Charlotte county near Black harbour and has been utilized to some extent in the manufacture of polishing-powder, scouring soap and for fillings of wood, &c. The deposit is described in Dr. Bailey's report as occupying from one to two hundred acres with a thickness of about ten inches in places. It is practically a fine silt. Analysis by Messrs. Ledoux and Ricketts of New York is as follows:—

Silica	72·65
Alumina	17·93
Sesquioxide of iron	0·57

—with small quantities of lime, and magnesia and some contained water. This property is now owned by Mr. G. W. Gunong and others of St. Stephen.

MINERAL PAINTS.

Only few deposits of this substance are known and none appear to be utilized, or at least to but a small extent. A brown-red ochre is found near Edgett landing in Hillsborough, Albert county, which burns to a fine red powder, but the quantity of this mineral has never been ascertained.

On the Northwest Miramichi near Chaplin island the slates of the area are covered with a deposit of red ochre which fills the seams in the underlying rocks. It has been regarded by some as an iron ore of economic value, but the quantity is too small to be of importance, and it appears to be rather an exudation from the bank of red clay which covers this part of the country. No other occurrences are recorded.

MINERAL SPRINGS.

Saline springs occur at several points in the valley of the Kennebecasis river as at Plumweseep, four miles north of Sussex; at Salt Springs brook in the parish of Upham; to the north of Anagance near the head of Smith creek; and on the Tobique in Victoria county.

At the salt springs near Sussex the manufacture of salt by evaporation has been carried on for many years, though on a small scale, the output rarely exceeding 150 to 200 barrels per year. It is regarded as of special value for domestic and dairy purposes and sells readily for $2 to $3 per barrel. The evaporating plant is small and is run only during warm weather, though the supply of brine from the spring is sufficient for a much larger and continuous plant. It would seem possible with a well constructed modern plant to maintain an industry at this place equal to that in western Ontario, where the manufacture of salt by evaporation has assumed large proportions. In Ontario also the ground was well tested by boring, and heavy beds of salt were found at depths of more than 1,000 feet from the surface. In New Brunswick but little attempt has been made in this direction though a couple of holes were sunk some years ago, but these were merely shallow wells, the deepest recorded being only 330 feet. In view of the fact that the gypsums are abundant in some parts of this area it would seem advisable to thoroughly test the district with several holes sunk to a considerable depth to ascertain whether underlying bodies of salt do not exist in this part of the province.

Analysis of the Sussex brine from the Salina spring near Upham is as follows:—

	Per Mill.
Potassium chloride	19·963
Sodium chloride	1293·648
Magnesium chloride	22·315
Sulphate of lime	268·212
Sulphate of magnesia	11·336

The strength of the Sussex brine is given at 20 per cent. The manufacture and shipment of mineral waters has now reached considerable proportions. In Sussex on Mr. S. H. White's place a fine well was obtained (Artesian) by boring, the flow being through a four inch pipe, and a large plant for the manufacture of mineral waters of several kinds has been erected and is in very successful operation. The analysis of this water is as follows:

	Grains.
Potassium chloride	0·21
Sodium chloride	2·10
Sodium carbonate	25·35
Carbonate of lime	1·47
Silica	1·05
	30·53

Traces of hydrogen sulphide are found in this water and can be detected both by smell and taste. The waters of Upham are also quite extensively bottled under the name 'Malipu,' as also the waters from a spring in Havelock north of Petitcodiac, Kings county. No returns from any of these springs have been sent to this Department, though the industry promises to become a somewhat important one in a comparatively short time.

ROAD MATERIAL.

The supply of a good road material for use in city streets, as also in the country, has always been an important problem. For many years the softer rocks such as limestone, sandstone &c., were employed, but these speedily wear out and leave great quantities of dust in fine weather and of mud when it is wet.

In cities like Fredericton and St. John the presence of masses of igneous rocks has been recognized. In the latter city the green diabase found with the limestones, and the granite at many points around the city, should furnish an unlimited supply of good road material, while near Fredericton the basalt of Clark mountain is also available, and easy of access.

CONCLUSIONS.

It will be seen from the foregoing remarks on the various minerals found in this province that the actually profitable mining is confined to the non-metallic minerals at present comprising the coal, gypsum, building-stone, shale deposits, clay, &c., and sufficient has been said to show that in most cases these industries can be largely developed under proper attention to business requirements, and worked at a profit. As to the ore-deposits proper, but little can at present be said in their favour. Large sums of money have been spent in futile attempts to develop certain of these, much of which it is only fair to say might have been avoided had a proper examination of the territory by competent and disinterested persons been made. Of these large expenditures it is safe to say that only a very small proportion has been returned to the investors.

In the copper industry all attempts at mining have been disastrous, owing principally to the small amount of the mineral itself in all the occurrences as yet known, and to the broken nature of the deposits, since although there have been a number of occurrences of good ore, in no case have these been sufficiently extensive to make profitable returns on investment. The silver and galena ores are too poor in silver to render its extraction profitable, especially in view of the small size of the lead veins. The manganese ores were for some years worked profitably owing to the finding of large pockety masses of excellent quality, but of these the largest deposits and those of the highest grade, have long been exhausted apparently, or at least but small attempts have been made to find a further continuance of the same, while the uncertain pockety nature of the occurrence renders more difficult its profitable exploitation. The new discoveries in iron appear to indicate a possible profitable field for investigation if the cost of transport is not excessive. As regards the bituminous shale industry and the associated albertite there appears to be a promising field for the investment of capital skilfully applied, though the recent investigations of those in the search for oil have not as yet given promising results.

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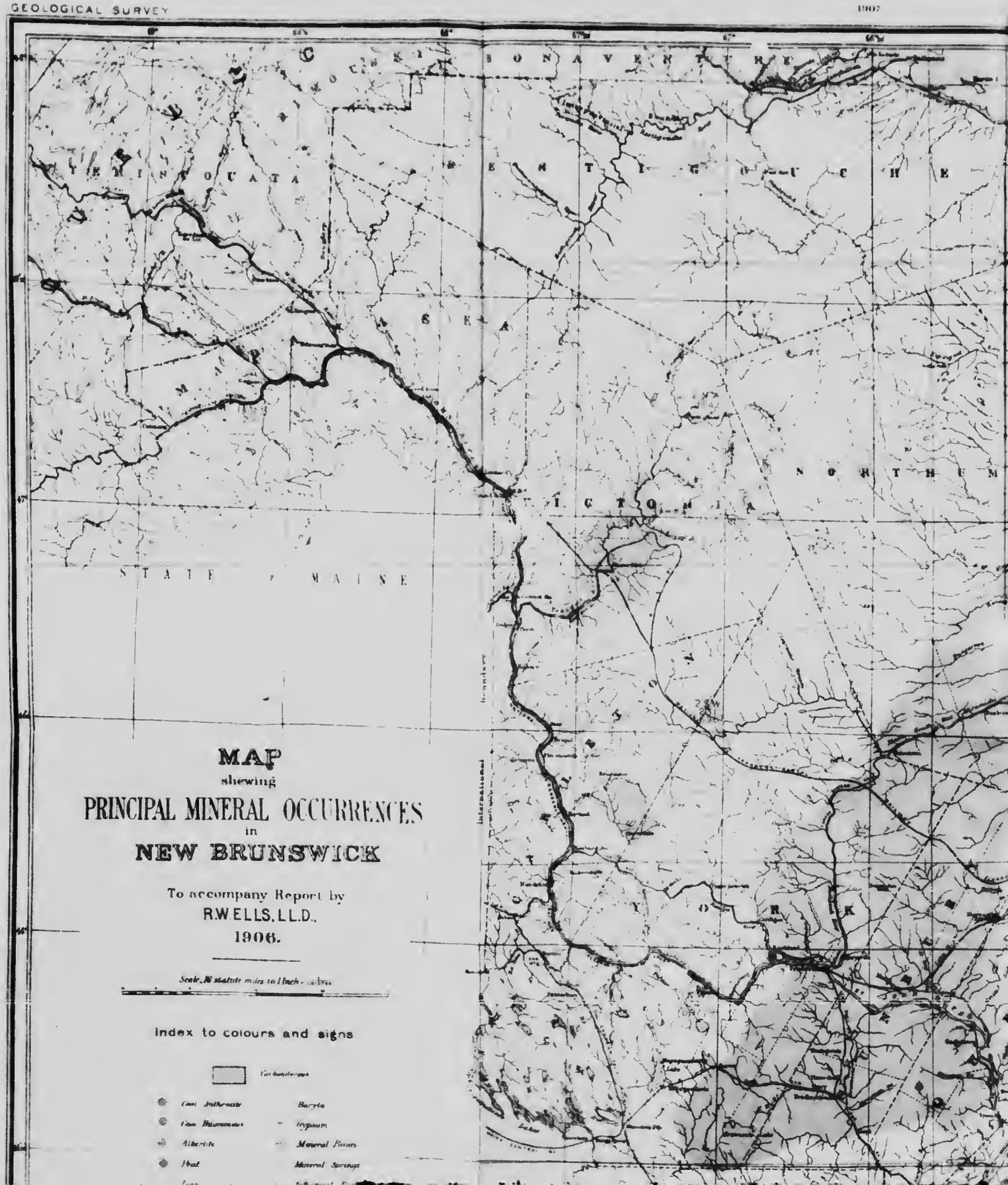

MAP
shewing
PRINCIPAL MINERAL OCCURRENCES
in
NEW BRUNSWICK

To accompany Report by
R. W. ELLS, LL.D.,
1906.

Scale, 16 statute miles to 1 inch.

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Albertite	Mineral Paint
Peat	Mineral Springs
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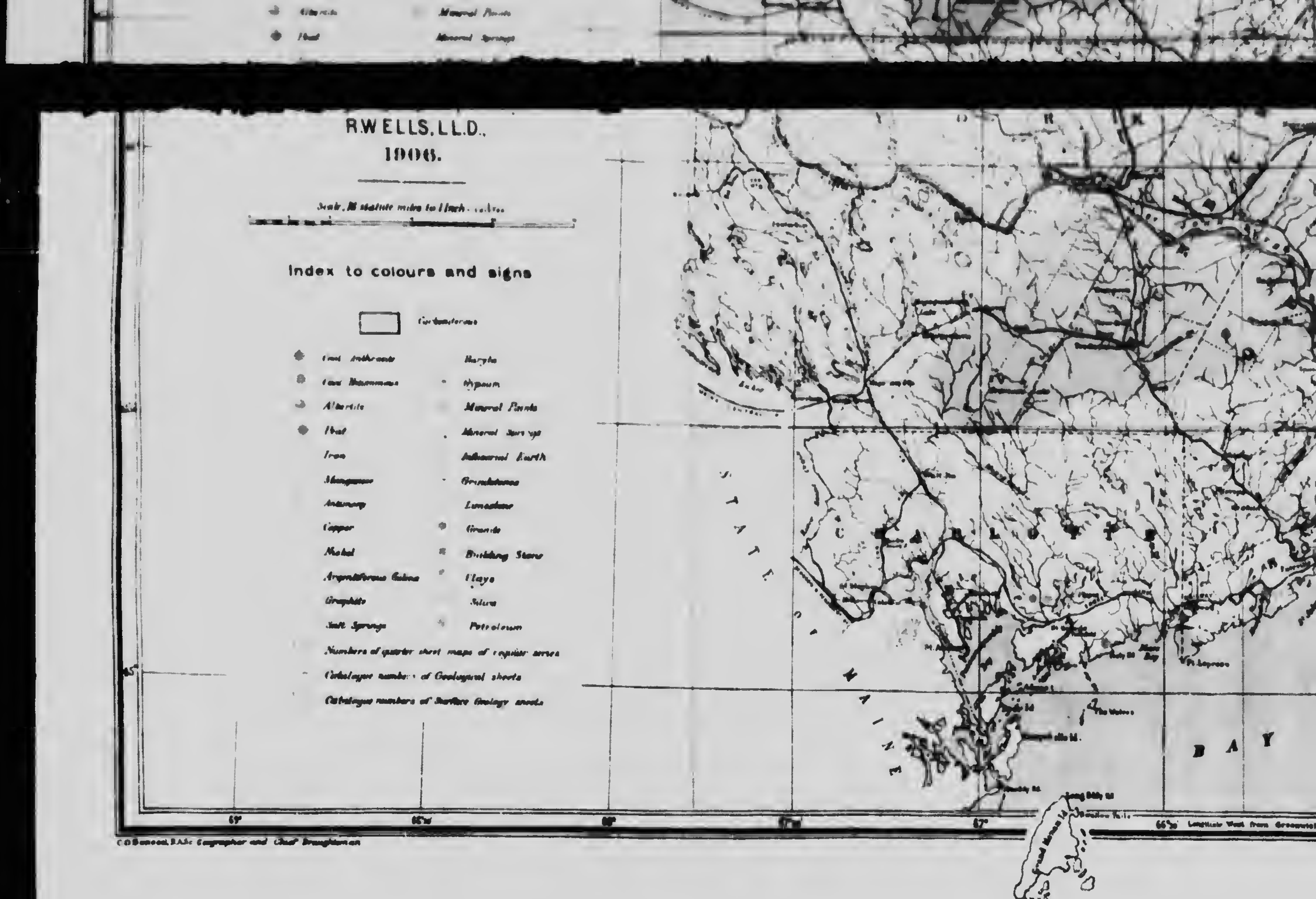
NOTE

The areas coloured Carboniferous along the bay of Fundy a[illegible] in the valley of Kenebecasis bay and river are in large part of "Perry" or Upper Devonian age. These formations have recently been separated in the field. The areas of Carleton and Victoria counties are also Upper Devonian in part.


R.W. ELLS, LL.D.
1906.
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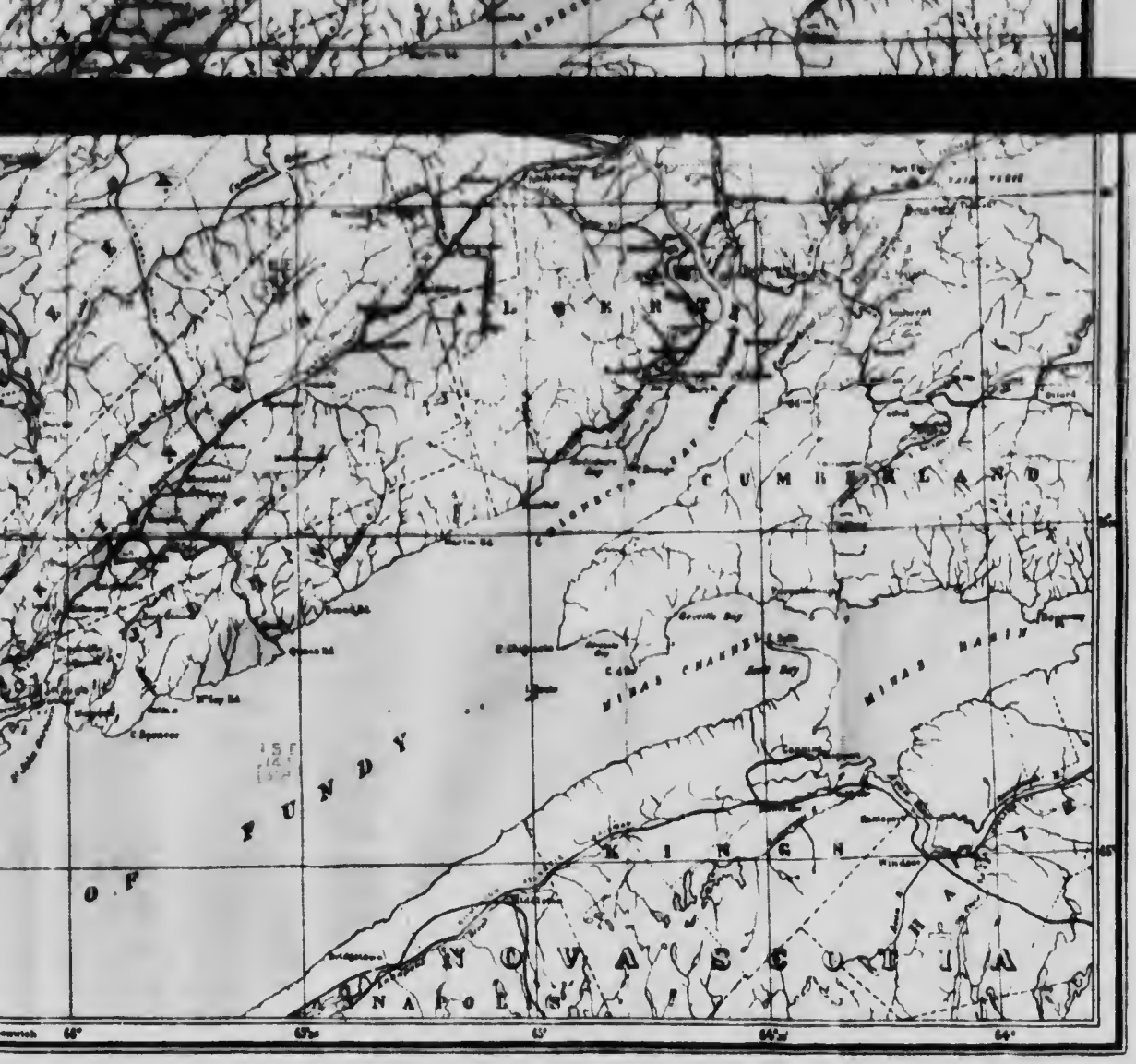
L U N E N
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