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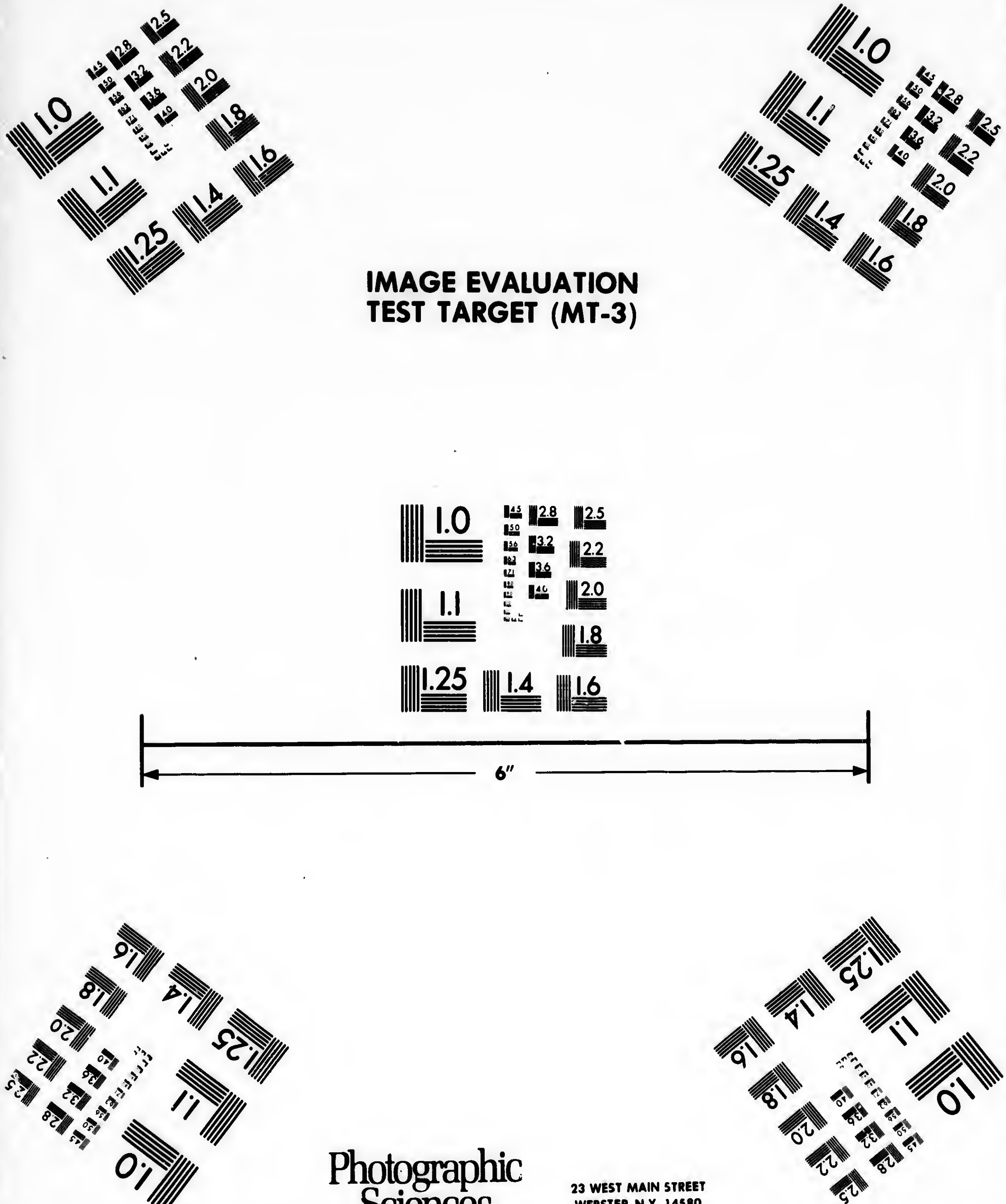

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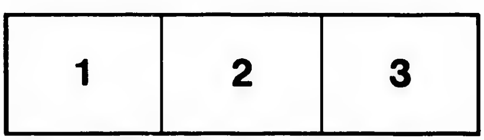
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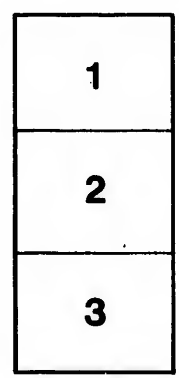
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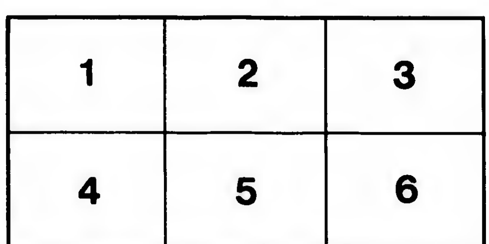
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A PRELIMINARY REPORT

ON THE

GEOLOGY OF NEW BRUNSWICK,

TOGETHER WITH

A SPECIAL REPORT

ON THE DISTRIBUTION OF THE

"QUEBEC GROUP"

IN THE PROVINCE.

BY

HENRY YOULE HIND, M.A., F.R.G.S.

(LATE PROFESSOR OF CHEMISTRY AND GEOLOGY IN THE UNIVERSITY OF TRINITY COLLEGE, TORONTO.)

Author of "Narrative of the Canadian Exploring Expeditions in Rupert's Land,"
"Explorations in the Interior of the Labrador Peninsula," &c. &c. &c.

FREDERICTON.

G. E. FENETY, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY.

1865.

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1865.

Fredericton, January 16th, 1865.

SIR,

I have the honor to present "A preliminary Report on the Geology of New Brunswick," including a Special Report (Chapters VIII. & IX.) on the probable distribution of the "Quebec Group" within its limits, according to instructions which I had the honor to receive from His Excellency the Administrator of the Government on the 9th July 1864.

With a view to avoid unnecessary recapitulation, I have so arranged the Reports, that the description of the 'Quebec Group' occupy their proper places in a general outline of the Geology of the Province.

In the Introductory Chapter I have given a brief and concise summary of the results of the season's work.

The following Maps accompany the written descriptions:—

I.—A General Geological Map of the Province, showing the probable limits of Formations.

II.—A Plan of the exposed Antimony Veins in Prince William Parish, on the property of the Brunswick Antimony Company.

III.—A Plan of the Letite Copper Mine, (Wheal Louisiana,) showing the structure of the Rocks in the Mascaben Peninsula.

IV.—A Plan of the Vernon Copper Mines, showing the structure of the Rocks on that part of the Coast of the Bay of Fundy.

V.—Section of the Carboniferous Outlier in the Valley of the Tobique.

I have the honor to be,

Your obedient servant,

HENRY Y. HIND.

The Hon. S. L. TILLEY,
Provincial Secretary.

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INTRODUCTORY CHAPTER.

The Geology of New Brunswick has formed the subject of four Reports by the late Dr. Abraham Gesner, written during the years 1839 to 1842 inclusive, twenty three years having elapsed since the date of Dr. Gesner's last official contribution to our knowledge respecting the Mineral resources of the Province.

In 1849 the late Dr. Robb contributed an admirable resumé of known facts connected with the Geology of New Brunswick to Professor Johnston, who was engaged by the Government during the same year to report on the Soils of the Province, and their capabilities for agricultural purposes. Dr. Robb's communication was accompanied by an excellent Geological Map, compiled, as he himself states, from the Reports of Dr. Gesner, Dr. Jackson's Reports on the Geology of Maine, Sir Charles Lyell's Travels in North America, and his own personal observations and enquiries.

In 1851 Dr. Robb, in conjunction with Professor Taylor, prepared a Report on the "Asphaltum Mine at Hillsborough," which all subsequent experience during the past thirteen years has shown to be a correct exposition, as far as it goes, of the Geology of the Albert Mine.

Dr. Dawson, of M'Gill College, Montreal, in conjunction with Sir Charles Lyell, has established the true age of the Albert Shales, and in his 'Acadian Geology' a portion of Albert County is especially noticed, and some of the rock formations on the coast of the Bay of Fundy.

Dr. Dawson has subsequently written some very valuable papers on "The Flora of the Carboniferous Period in Nova Scotia," and "The Flora of the Devonian Period in North Eastern America," in which important references are made to New Brunswick rocks.

In August 1863, Mr. G. F. Matthew of Saint John, published in the Canadian Naturalist and Geologist, a most creditable and able Paper, entitled "Observations on the Geology of Saint John County, N. B."; and in 1864, Professor Bailey, of the University of New Brunswick, communicated to His Excellency the Lieutenant Governor, a very interesting and well written "Report on the Mines and Minerals of New Brunswick." The same gentleman has also published in the Canadian Naturalist and Geologist for April 1864, a Paper entitled "Notes on the Geology and Botany of New Brunswick,"* with a Map of the country on the course of the rivers between the mouth of the Tobique and the mouth of the Nepisiguit.

These contributions to the Geological bibliography of New Brunswick, have been frequently referred to in the following pages, together with others which are enumerated either in notes of reference or in a list of works consulted, given at the close of the introductory Chapter.

* Read before the Natural History Society of New Brunswick 12th February 1864.

In May 1864, after an interview with Sir W. E. Logan, the Director of the Geological Survey of Canada, I addressed a letter to that eminent Geologist, soliciting his co-operation and that of Professor Hunt and Mr. Billings, in relation to the rocks and fossils of New Brunswick, partly with reference to my contemplated preliminary explorations, and partly in anticipation of any future action that the Government of New Brunswick might be disposed to take with regard to a complete Geological Survey of the Province.

The answer of Sir W. E. Logan, together with my communication to him, are appended,* and no words from my pen are necessary to show the vast advantage which must result to New Brunswick, from having the opinion of Sir William Logan and his associates on the rocks of the Province; but I should not do justice to my own feelings if I were to permit this public opportunity to escape me of expressing a grateful sense, as far as I am concerned, of the disinterested kindness of Sir William Logan, and the gentlemen of the Canadian Geological Survey, or to record my admiration of a zeal for Science alone which induces those gentlemen to undertake a laborious task, for which they ask no other recompense than that which Science herself can give.

In the preparation of my preliminary Report, I have frequently had occasion to scrutinize the labours of the late Dr. Robb; and here I venture to express, not only a very high opinion of the value of the work he has left behind him, but a strong appreciation of his trustworthy observations, and of his scrupulously conscientious record of facts. Through the kindness of his brother, Mr. Charles Robb, of Montreal, I have been permitted to peruse his manuscript notes on the geology of certain portions of the Province. Although many of these were made thirteen to sixteen years ago, and long prior to the important discoveries of the past decade, yet they manifest views, especially in relation to the once vexed question of the nature of Albertite, which he would probably long since have successfully developed, had the Almighty been pleased to have prolonged his life.

It now remains for me to state in general terms the results of the season's operations.

DISTRICTS VISITED.

I commenced my explorations on the 15th June, at Dalhousie; proceeding thence to Campbelltown on the Restigouche, and having engaged Indians there, ascended that river to the mouth of the Upsalquitch, which was traversed to its source, then crossed over to the Nepisiguit, and continued on down stream to Bathurst.

After spending a few days in the vicinity of Bathurst, I travelled across the country to Chatham, and thence to Fredericton.

In a letter addressed to the Provincial Secretary, I communicated some of the results of the exploration up the Upsalquitch and down the Nepisiguit,

* Vide Letters I. and II. at the close of this Chapter.

suggesting at the same time a further exploration of the Quebec Group of rocks which I had ascertained to have a breadth in the district examined of from thirty six to forty miles.*

His Excellency the Administrator of the Government in Council, was pleased to give instructions that the suggested sections across the Quebec Group should be made without delay.

From Fredericton I proceeded to Prince William, thence to Woodstock, and *via* the Shiktehawk and South West Miramichi, to Boiestown.

I then started *via* Woodstock for the Tobique, and having procured Indians and canoes, ascended that river as far as the mouth of the Gulquac, made a portage of twenty miles to Tobique Lake, explored the undescribed and unmapped Gulquac and Millpagos Lakes, and then portaged to Long Lake. Leaving the canoe at the head of that fine sheet of water, I took two Indians and made a portage of eight miles through forests innocent of lumbermen or indeed of "white men" of any description, to the Little South West Miramichi Lake, and descended the river issuing from that lake until I came to sedimentary rocks in place.

Returning to Tobique Lake, I went with "shoed" canoes down Campbell River, ascended the Serpentine as far as practicable, the water being unusually low, and returned to the Nictor or Forks of the Tobique *via* the right hand branch of the river. An ascent was then made up the Little Tobique for a few miles, and subsequently the main river was descended as far as Blue Mountain. Again, taking two Indians, and leaving the canoes in charge of a third, I made a traverse to the summit of Blue Mountain 1650 feet above the sea. The object of this traverse was to ascertain the southern limits here of the Carboniferous Outlier, which has converted the valley of the Tobique into a fertile and beautiful region, capable of sustaining an agricultural population of one hundred thousand souls. Slowly descending the Tobique to its mouth, I then leisurely ascended the Saint John, in canoe, as far as Little Falls, or within ten miles of the Canadian boundary line.

From Little Falls I proceeded to Quebec, thence to Montreal, where an opportunity of again examining the rocks of the Quebec Group in the Geological Museum was embraced. After remaining a week in Canada, I took the steamer from Quebec to Shediac, and from Shediac proceeded to Fredericton.

In October I visited King's County, making a section across Norton and Springfield, also, subsequently across Albert County, and from Hopewell Corners returned *via* Golden Mountain to Sussex Vale, and then proceeded to the Vernon Copper Mines, near the mouth of Goose Creek, on the Bay of Fundy. Returning thence to Fredericton, I spent two days in making up my notes, and then started a second time for the Prince William Antimony deposits, where I made a careful examination of the rocks and mapped the courses of the exposed veins, determining their relation and origin. I then crossed the country through the Harvey Settlement to Dumbarton

* *Vide* Letters III. and IV. at the close of this Chapter.

Station, on the New Brunswick and Canada Railway, and from this place proceeded to Roix Station, and made a section across the country to Saint George. After visiting the Upper Falls of the Magaguadavic, and making a section to the Lower Falls, I proceeded to the Letite Copper Mines, to which special attention was paid, and the probable origin of the Copper deposits in the Mascabin peninsula discovered, and the probable age of the rocks on Frye's Island; returning to Fredericton *via* Saint John. My last exploration, except in the immediate neighbourhood of Fredericton, was made in November, when the Vernon Mines on the Bay of Fundy were visited a second time, and four days spent on the coast, in an endeavour to trace the origin of the Copper deposits in that promising belt of rocks. This I found to be in certain copper-bearing intrusive traps which have a wide, and probably a very important distribution on that part of the coast.

In this general outline of journeys through the Province, every County of which I have visited except Kent, the lateral excursions from the main routes are not included.

The results of the season's work may be thus briefly expressed.

1. The QUEBEC GROUP, which is the great metalliferous formation of North America, has the following approximate breadths in the subjoined localities:—

1. Five miles from Bathurst,	... ...	20 Miles.
2. From Ramsay's Brook, southeasterly,	...	36 "
3. From near Nictor Lake, "	... ...	44 "
4. From the Tobique, "	... ...	43 "
5. From the Meduxnekeag, "	... ...	38 "
6. On the New Brunswick and Canada Railroad,		24 "

Time has not permitted me to obtain the necessary data, to determine the approximate breadth of this group in the southwestern part of Queen's, Sunbury, or King's County, nor even in the south part of Charlotte County, but of its presence there, valuable evidence is not wanting.

I have paid particular attention to the circumstances under which the Albertite in Albert County has originated, and venture to hope that I have succeeded in showing,—

1st. That Albertite is an inspissated Petroleum.

2nd. That it has originated from underlying Devonian Rocks probably of the same age as those yielding the vast stores of Petroleum in Canada and the United States.

3rd. That there is much probability that this valuable material will be found along the summits of two anticlinal axes (Ridges), one, extending from near Apohaqui Station, through the valley of Sussex Vale, to the County of Westmorland, on a general course N. 80° E., for a distance of fifty miles; the other anticlinal having a course nearly northeast, (magnetic), (N. 48° E.) from a few miles west of Shepody Mountain, through the Albert Mine, to and beyond the Petitcodiac River.

Along the eastern anticlinal the valuable bituminous shales which yield from sixty to ninety gallons of crude oil to the ton occur in great force.

The ascertained existence of the true Coal Measures within the limits of the Province, near and probably east of Grand Lake, is highly important, and a reasonable expectation may now be entertained that workable beds of coal will be found in the areas indicated in the Chapter on the Carboniferous Series.

The view formerly entertained with reference to the granitic belt passing through the Province from the frontier of Maine to the Bay of Chaleurs, a distance of one hundred and fifty miles, must be greatly modified. Instead of its being one broad belt, as represented on the Map constructed by the late Dr. Robb, it consists of a series of very narrow belts, (at least ten in number on the Miramichi,) with schists and metalliferous slates between them. The granite belts are of Devonian age, and it is, probably, not an intrusive rock, but consists of highly altered sedimentary strata, which have been brought to the surface by a series of anticlinal folds, with strata belonging to the Quebec Group on their flanks, and between the numerous narrow belts of which the entire formation is composed.

The same remark applies to much of the granite in Charlotte, King's and Saint John Counties. They are probably sedimentary rocks, highly metamorphosed, but bearing an intimate relation to the less metamorphosed or altered rocks on their flanks.

The copper-bearing Series of Saint George and the Vernon Mines are both important, though of very different geological ages. I have shown in the case of the Saint George Mines, that the probable origin of the copper is a hornblendic schist; but do not wish to be understood to say that the trap rocks of the series are not also copper-bearing. In the Vernon Mines, the copper-bearing traps, which are there intrusive, are the source of the metal, and they extend far beyond the limits of the area examined.

The antimony deposits of Prince William, on the property of the Brunswick Antimony Company, and on a series of Leases held by Mr. Hibbard, of Saint George, and gentlemen associated with him, are valuable; and a rather lengthy description of these deposits, their origin and probable extent, will appear, fully warranted by their prospective value to the Province.

The iron ores of Woodstock have been found to come up on the north side of the main granitic axis, in at least three different belts, extending over thirty miles, and probably, with intermediate breaks, as far as the Bay of Chaleurs. On the Beccaguimec and the Shiktehawk, each belt is associated with limestone beds. They are situated in a splendid agricultural and well timbered country. On the south side of the axis they have been recognized coming to the surface in two belts.

These ores, like the manganese and copper with which they are more or less associated, are true sediments. The copper deposits of Woodstock belong to the same class, and in view of their origin, I am inclined to think that they will be found commercially valuable. The veins which have been opened by Mr. Stephens, and partially opened by Mr. Connell, are segregations of the metal distributed through the country rock, which is apparently of the same age as the copper-bearing sediments of Canada East. Hence there is a probability that valuable beds will be discovered.

The gold which I have found to exist in the drift over a large portion of the northern Counties, and to a less extent in Saint John and King's Counties, will speak for itself. Too little, however, is yet known of the rocks of the Quebec Group in this Province to warrant the expression of an opinion as to its origin. A comparison with other countries where the same rocks occur, and are known to be auriferous, might apparently form the basis of reasonable conjecture; but gold has been found in quartz veins penetrating both Upper and Lower Silurian Rocks in Canada, and these rocks overlap one another from the Bay of Chaleurs to the Maine Boundary, and far beyond towards the Atlantic Ocean.

Although gold has been found in the drift derived from these rocks, it has not yet, to my knowledge, been discovered in quartz veins penetrating them.

I have much pleasure in expressing my obligations to many gentlemen for their courteous assistance and attention. Among others, to the Hon. John McMillan, of Campbelltown; Mr. Dugald Stewart, and Mr. Barberie, of Dalhousie; Mr. Busteed, of Bourdo; Mr. Byers, of the Albert Mine; Mr. Baldwin, of Bathurst; the Hon. Charles Connell, and Dr. Connell, of Woodstock; Mr. Stephens, of Woodstock; Mr. Woodward, of Saint John; Mr. M'Lellan, of Hopewell Corners; Mr. Frye, of Saint George; the gentlemen in the Crown Land Office; Mr. Wilkinson, of the Board of Works; Mr. Sanford Fleming, C. E.; Mr. Burpee, C. E.; Mr. Murdock, &c., &c.

To Dr. Brooke, of Fredericton, I am much indebted for an excellent series of Meteorological observations, which he has continued uninterruptedly for a period of seventeen years.

No. I.

From Professor Hind to Sir William Logan.

(Copy) *Montreal, May 30th*, 1864.

Dear Sir William Logan,—I have been commissioned by the Government of New Brunswick to make a preliminary Geological Survey of that Province during the present season, and am now *en route* to commence the work.

As there is every reason to believe that many of the formations in New Brunswick are repetitions of rocks which occur in Canada, and are of considerable economic value, I should be much obliged if you would allow me to send a complete series of whatever specimens I may collect in New Brunswick, to your address at the Museum of the Geological Survey, for comparison by yourself, Dr. Hunt, and Mr. Billings, with Canadian illustrations.

If you, Dr. Hunt, and Mr. Billings, will be so kind as to undertake the examination of what I may be able to send, and to communicate the results to me for the information of the Government of New Brunswick, I should be glad to know whether any expenses would be attached to the transmission of the specimens, provided they become the property of the Canadian Geological Survey.

There can be no doubt that it would be a matter of great importance to New Brunswick if a complete set of specimens, illustrating the rocks of the Province, were submitted to your inspection and judgment, and I venture to hope that it would also be of advantage to the Museum of the Geological Survey of Canada to possess the specimens for the sake of comparison and study.

I am, very truly, yours,

(Signed) HENRY Y. HIND.

Sir W. E. Logan, &c. &c. &c.

No. II.

From Sir William Logan to Professor Hind.

(Copy) *Montreal*, 30*th May*, 1864.

My Dear Sir,—In reply to your letter of this morning, I beg to say that we should be happy to receive a full collection of New Brunswick specimens, including minerals, rocks, and fossils, the expenses on the transmission of which, if the collection were permanently lodged in our Museum, we would willingly defray.

The possession of such a collection would enable us to institute a comparison between the Geology of Canada and that of her sister Colony, and in some degree to make available our ascertained results in forwarding your investigations and promoting the development of her mineral resources.

The rocks of New Brunswick are only an extension in part of those of Canada, with the addition of the coal formation, and from the descriptions of Robb, Bailey, Hitchcock, and others, as well as a limited personal examination by myself, it appears to me probable that the Quebec Group, which is so important in the Eastern Townships of Canada, for its economic minerals, will be found to have a considerable development in New Brunswick.

The rocks of this Group, I need not inform you, yield, in Canada, ores of Iron, Chromium, Lead, Antimony, Copper, Nickel, Silver, and Gold, with soapstone, potstone, hones, marbles, serpentines, cement stones, building stones, and roofing slates. They are a continuation of the gold-bearing series of Georgia, Carolina, and Virginia, and come up through Maryland, Pennsylvania, New Jersey, New York, and Vermont, into Canada, passing thence into Newfoundland.

By undulations they are repeated in New Brunswick on each side of a Granitic axis, which stretches from Deer Island on the coast of Maine, to Bathurst on the Bay Chaleur, and finally present themselves on the Atlantic Coast of Nova Scotia. It is of course very important to the interests of these Colonies that the limits of the Group should be traced out in them, as much in detail as possible.

In making serviceable in the investigation the experience and practice we have acquired on the Canadian Survey, we should be only carrying out a suggestion which has already been placed before the respective Governments of these Colonies, by the adoption of which the labour of the investigation would be shortened and the cost cheapened, while a unity of design would be given to the whole subject, rendering the results, both economic and scientific, intelligible to the world with much less study than would otherwise be required.

I am, my dear Sir, very truly, yours,

(Signed) W. E. LOGAN.

Professor Henry Youle Hind, Quebec.

No. III.

From Professor Hind to the Hon. the Provincial Secretary.

Fredericton, *July* 9*th*, 1864.

Sir,—I have the honor to inform you that I have just completed a geological exploration up the Upsalquitch River, in the County of Restigouche; also a portion of the country in the County of Gloucester, as far as the Nicadoo River.

The result of that exploration is of sufficient importance to induce me to make known to you, without delay, the character of the rock formations I recognized in position.

The rocks of the country south of the Restigouche, for about 20 miles, belong to the Upper Silurian Series, but south of a point on the Upsalquitch, near Ramsay's Brook, all the way to the Nepisignit; the Quebec Group of Sir W. E. Logan—a most important series of Lower Silurian Rocks—forms the country.

This Group I also found to exist all the way down the Valley of the Nepisiguit, to within seven miles of Bathurst, and as far west as the Nicadoo River. About two or three miles beyond the Nicadoo, I believe it to be overlaid by the Upper Silurian Series, mentioned as occurring on the lower portion of the Upsalquitch.

The Quebec Group has a breadth of not less than 36 miles between the Upsalquitch and the Nepisiguit, I presume that it extends about ten miles south of the Nepisiguit, until it is covered by the Bonaventure formation, or base of the Carboniferous Series.

The vast economic importance of the Quebec Group is stated in the letter addressed to me by Sir W. E. Logan, of which I had the honor to forward you a copy some days since.

I searched for gold in the drift and alluvial deposits of the Upsalquitch and Nepisiguit, and found minute particles on the upper portion of the Upsalquitch, and unworn and worn fragments of dimensions from one eighth of an inch in diameter, downwards, on the Nepisiguit. The washing process was carried on in a common tin dish.

As there is every probability that the Quebec Group stretches throughout the Province, from Bathurst to the Maine Boundary Line, and beyond, in a northeast and southwest direction, it is of the greatest importance to the interests of this Province that its breadth and general extension should be ascertained without delay, and I venture to suggest that I be instructed by the Government to make two or more Sections across the formation, in order to establish approximately its area.

I have only to remark, further, that the Quebec Group, being the great Metalliferous Rock Series of the American Continent, if found to be, as I suppose, largely developed in New Brunswick, will place the prospective mineral resources of this Province in a very prominent position before the scientific world.

The cost of the exploration I suggest, would be about $400; it could be accomplished in 50 days, and would, I think, establish the existence of the Quebec Group in New Brunswick, over an area exceeding one million acres.

I have the honor to be, Sir,

Your obedient servant,

HENRY Y. HIND.

The Hon. S. L. Tilley, M. P. P., Provincial Secretary, Fredericton.

No. IV.

From the Hon. the Provincial Secretary to Professor Hind.

(Copy) *Provincial Secretary's Office,*
Fredericton, N. B., 9th July, 1864.

Sir,—The Administrator of the Government in Council has had under consideration your communication of this day's date, proposing to make two or more Sections across the district of country designated therein, for the purpose of ascertaining the width and extent of the Quebec Group of Rocks;—

And I am instructed to request you to make the proposed examination, and report the results to the Government at as early a date as possible.

I have, &c.

(Signed) S. L. TILLEY.

Professor Henry Hind, &c. &c. &c.

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PRELIMINARY REPORT.

CHAPTER I.

LEADING GEOGRAPHICAL FEATURES OF THE PROVINCE.

Early Political importance of the "Highlands" of New Brunswick—Political importance of a Name—Origin of the name 'Acadia'—The Height of Land, or Highlands of New Brunswick—Elevation of the Highlands—Blue Mountain, view from—A night on Blue Mountain—Section from Miramichi Lake to the Restigouche—Mr. Sandford Fleming's Section—Section on the Royal Road, one hundred miles—Subordinate Mountain Ranges—Section from the Mouth of Goose Creek to Sussex Vale—Coast Section across the Basin occupied by the Carboniferous Rocks—Major Robinson's Survey—The Rivers of New Brunswick—The Saint John—Origin of name—Rise of—The Grand Falls—Height and descent of—General character of—The Restigouche—Early notice of—Mr. Richardson's Description of, to the Mouth of the Patapedia—The Coast Line—Bay of Chaleurs—Miscou Island—The White Whale—The Walrus—Bay of Fundy—The Tides—Depth of the Bay—The Cumberland Basin and Bay Verte Peninsula—Change of Coast Line.

The geographical features of a country are greatly dependent upon its geological structure. This is especially noticed in New Brunswick, where the mountain ranges lie almost altogether within the limits of the disturbed and ancient sedimentary rocks; the elevated plateaus and gently undulating plains distinguishing nearly the entire area of the comparatively undisturbed strata of the coal field.

For this reason it may be proper to glance briefly at some of the leading geographical features of the Province, limiting the observations made to the chief mountain ranges, the rivers, and the coast line. The introduction of a few historical notices may, in the judgment of many, enhance the interest which prominent physical peculiarities generally command.

EARLY POLITICAL IMPORTANCE OF THE "HIGHLANDS" OF NEW BRUNSWICK.

The highest continuous mountain range, or "axis of maximum elevation," as it is technically termed, between Canada and this Province, with its continuation into the United States, once formed a very important subject of enquiry on the part of the Governments of Great Britain and the United States of America.*

* Report of the British Commissioners to Survey the Territory in dispute between Great Britain and the United States of America, on the North Eastern Boundary of the United States.—Blue Book, 1840.

In the Report of the Royal Commissioners appointed to investigate and report upon the respective claims of Canada and New Brunswick to the Territory ceded to Great Britain by the Treaty of Washington,* the following remarkable passage occurs, which, by the way, has recently received additional strength from the disputes relating to the Straits of San Juan.—"The want of good maps, and correct information as to the topographical and physical character of the country, have been the principal cause of the constantly-recurring disputes which have now for more than half a century occurred in this part of North America, and rendered necessary Commission after Commission for inquiry and research."

POLITICAL IMPORTANCE OF A NAME.

It appears, however, far more singular, that a mere name, whose origin is still disputed, should have been instrumental in leading to the wars between England and France which terminated in the conquest of Canada.

The misunderstandings which arose in the construction of this expression, "all ACADIE, according to its ancient limits,"—ended in the war of 1756, and the annexation of all the possessions of France in North America to the British Empire.†

The interest in the word '*Acadie*,' has been recently revived under very different circumstances to those which first drew the attention of the entire civilized world to its origin and meaning, and which gave rise to interminable controversies, and finally led to sanguinary wars.

The Province of New Brunswick having formerly been wholly or in part included within the 'ancient limits of Acadie,' a glance at the origin of this word may not be out of place in a geographical sketch of the country it once in part represented.

In 1603, the Sieur de Monts received letters patent, in which the word "ACADIE," or "Cadie," is first used as the name of the country. His grant is from the "40me degré de latitude jusqu'a 46me," the 40th degree of latitude to the 46th,‡ thus including that part of New Brunswick which lies south of a line drawn between Fredericton and Bay Verte in the County of Westmorland.

The Boundary Commission consider the origin of the word "Acadie" to be as follows:—

"The obscurity which has been thrown in past times over the territorial extent of Acadie, that country of which De Monts received letters patent in 1603, was occasioned by not attending to the Indian origin of the name, and to the repeated transfer of the name to other parts of the country to which the first settlers afterwards removed. Even before the appointment of De la Roche, in 1598, as Lieutenant-General of the country, including those parts adjacent to the Bay of Fundy, the Bay into which the Saint Croix

* Blue Book, 1851, page 94. † Report of Commissioners on North Eastern Boundary.

‡ Fastes Chronologiques, quoted in Report of Commissioners on North Eastern Boundary, 1840.

empties itself was known by the Indians of the Moriseet tribe, which still inhabits New Brunswick, by the name Peskadumquodiah, from Peskadum, Fish, and Quodiah, the name of a fish resembling the Cod.*

"The French, according to their usual custom, abbreviated the Indian name, which we sometimes, in the old records, read Quadiac and 'Cadie,' and at length we find it taking the general designation of 'Acadie.'

"The English race have turned the original Indian name into Passamaquoddy, and the Indians of the district have long been by them familiarly called Quoddy Indians, as by the French they have been called *Les Acadiens.*"

That the word "CADIE," was at one time commonly used, may be inferred from its occurrence in the Relations of the Jesuits for 1671.—"Qui habitent les costes de Cadie et de la Nouvelle Angleterre."

Dr. Dawson, in his "ACADIAN GEOLOGY," gives a rather different version of the origin of this historic name:—

"The aboriginal Micmacs of Nova Scotia, being of a practical turn of mind, were in the habit of bestowing on places the names of the useful articles which could be found in them, affixing to such terms the word Acadie, denoting the local abundance of the particular objects to which the names referred. The early French settlers appear to have supposed this common termination to be the proper name of the country, and applied it as the general designation of the region now constituting the Provinces of Nova Scotia, New Brunswick, and Prince Edward Island."

FORMER LIMITS OF ACADIA.

The Jesuit Father, Hierosme Lallemont, writing from Quebec in 1659, says "Acadia is that part of New France which faces the sea, and which extends from New England to Gaspe, or more correctly to the entrance of the great River Saint Lawrence. This extent of country, which is fully 300 leagues, has but one name and one language."—*Relations des Jesuits*, 1659.

In a Map by Coronelli, dated 1689, published at Paris, the Peninsula southeast of the Bay of Fundy is called "Acadie," whilst the country north of the Bay of Fundy and watered by the Saint John River, is named "Etechemins," after the Indian tribe whose hunting grounds formerly extended over that part of the Province. Under the French these were frequently separate governments. By the Treaty of St. Germain in 1632, "*Canada* and *Acadia* were restored to France." By the Treaty of Breda in 1667, France was left with all her old possessions, as well as by the Treaty of Ryswick in 1697. The consequence of these frequent mutations was, that the French possessions east, west, and south of the Saint John, were occasionally placed under one and the same jurisdiction, which for the time went by the name of "Acadie."

* The Provincial name of this fish is "Pollock," and it still continues to frequent that Bay.

In 1702 war broke out again, subsequently to which came the Peace of Utrecht, in 1713, when France ceded to England for ever her rights to "all Acadie, according to its ancient limits." The misunderstandings which now arose in the construction of this expression, ended in the war of 1756, and the annexation of all the possessions of France in North America to the British Empire.*

The Abbe Ferland in his "Cours D'Histoire du Canada," states that the origin of this word is unknown, and he enumerates several compound words, being the names of places, of which it forms a part, such as Tracadie, Shubenacadie, Chykabenakdie.†

THE HEIGHT OF LAND OR HIGHLANDS OF NEW BRUNSWICK.

The height of land or "axis of maximum elevation," which formed so long the subject of dispute between the United States and Great Britain, and subsequently between Canada and New Brunswick, may be said to commence within the limits of the Province at the base of Mars Hill, an isolated twin-mountain situated close to the boundary line in the State of Maine, and about five miles from the River Saint John, in the County of Carleton. This conspicuous elevation rises 1650 feet above the sea, and it forms one in a range of numerous peaks which stretch in a northeasterly direction to the Bay of Chaleurs.

This height of land is the south branch of two great chains of highlands which come from the head waters of the Connecticut River. The northern branch lies altogether within the limits of Canada, and was formerly claimed by New Brunswick as its legitimate boundary. The southern branch, springing from the same source, traverses the State of Maine, and entering New Brunswick at Mars Hill,‡ pursues the course towards the Bay of Chaleurs already adverted to. These were the highlands formerly claimed by Canada as the southern boundary of that Province.§ The limits of the two Provinces ultimately agreed upon, do not require any particular description; they may be stated to form a line dividing the disputed territory between the highlands into two nearly equal parts.

ELEVATION OF THE HIGHLANDS.

The average breadth of these Highlands is about forty miles; the elevation of the most prominent peaks and notable points in this rugged region are given below. No Map of New Brunswick yet compiled can afford a correct idea of the geography of the southeastern portion of this Highland Belt. Innumerable lakes, with their connecting rivers, separated by high but narrow hill ranges, occur in the blank space on the Provincial Map, from

* Blue Book, 1840.

† "Cours D'Histoire du Canada," par J. B. A. Ferland, prêtre.—Professor d'Histoire à l' Université Laval.
Premiere partie 1534-1663.—Quebec, Augustin Coté, 1861.

‡ Latitude 45.50, longitude 68° nearly.

§ The area of the territory in dispute between Canada and N. Brunswick was about 10,000 square miles.

the head waters of the South West Miramichi to the Nipisiguit. The sources of some of the most important rivers in the Province are not laid down on this comparatively unexplored region, and there are very many lakes, still haunted by the beaver, seldom visited except by Indians, where even the adventurous lumberman has not yet penetrated, which cover a large area about the head waters of the different branches of the Miramichi, and the tributaries to the Tobique and Nipisiguit. As far, however, as the river courses have been laid down in this wild region, they are accurately delineated in Mr. Wilkinson's Provincial Map; and this Report will furnish the continuation of several important streams into the unmapped wilderness, about the head waters of the Gulquac, the right hand branch of the Tobique, and the Little South West Miramichi.

ELEVATIONS OF PROMINENT PEAKS IN THE HIGHLANDS.

Names of Mountains or Elevated Plateaus.	Locality.	Height in feet above the sea.
1. Mars Hill, ...	Boundary Line—5 miles from the St. John River.	1650
2. Blue Mountain, ...	Tobique River.	1641
3. Bald Mountain, ...	East of Blue Mountain.	2240 (?)
4. Nictau Lake, ...	Source of East Branch of Tobique.	772
5. Bald Mountain, ...	Near Nictau Lake.	2496
6. Three miles northeast of Nictau Lake,	"	1670
7. Ridge between Tobique and Nipisiguit,	Nipisiguit Lakes.	2092
8. Forks of the Tobique, ...		550
9. Mountain on a branch of the Nipisiguit,	Nipisiguit.	1718
10. A mile northeast from last station, ...	"	2043
11. Two miles from last station, ...	"	2145
12. High peak near same station, ...	"	2213
13. Valley in a dividing ridge between the Upsalquitch and Nipisiguit waters,	Upsalquitch and Nipisiguit.	1508
14. One mile and a half from last station,	"	1882
15. Three miles from last station but one,	"	2045
16. Ramsay Portage, ...	On the Upsalquitch.	271
17. Ramsay Camp, ...	"	841
18. Mountain two miles east of Ramsay Camp,	"	1048
19. Five miles from Ramsay Camp, east, ...	"	1432
20. Seventeen miles east of Ramsay Camp on the Upsalquitch, ...	... ...	1218
21. North side of Blue Mountains, ...	Blue Mountains.	1064
22. Near Big Hole Brook, ...	... ...	1318
23. Range of Hills on Middle River, ...	Middle River.	1539
24. Mountain ½ mile west of Upsalquitch Lake,	Upsalquitch Lake.	1707
25. Brook running into the Nipisiguit (Portage Brook), ...	Portage Brook.	1034
26. Conical Hill, near Upsalquitch Lake, ...	Upsalquitch Lake.	2186
27. Squaws Cap, ...	Upsalquitch—mouth of.	2000

Numerous other altitudes in the "Highlands" between Mars Hill and the Bay of Chaleurs may be found in the Report of the Commissioners on the North Eastern Boundary.

TABLE OF HIGH LANDS IN OTHER PARTS OF THE PROVINCE.

Names of Mountains or Elevated Plateaus.	Locality.	Height in feet above the sea.
28. Bull Moose Hill, ...	Springfield.	580 Gesner.
29. Chamcook, ...	Near Saint Andrews.	580 "
30. The Sugar Loaf, ...	Campbeltown.	730
31. Plateau above Fredericton, ...	Fredericton.	418
32. Head of Restigouche, ...	... ...	1036 Boundary Commis.
33. Ottellock Lake, ...	... ...	1200
34. Shog·noc River, ...	... ...	529 R. R. Sur.
35. Monument head of Saint Croix, ...	... ...	589
36. Chepnedcook Lakes, (foot of)	... ...	850
37. Nerepis, (source of)	... ...	600
38. Didgewash, (source of)	... ...	450
39. Dalhousie Hill, ...	... ...	750

ASCENT OF BLUE MOUNTAIN.

On the 18th August, accompanied by some Indians, I ascended Blue Mountain on the Tobique, reaching the summit just in time to witness the setting of the sun. The scene was one of rare beauty, and the sky being cloudless during the short summer night, the moon near her full, dawn slowly breaking into daylight without mist or cloud on the mountain tops, the most favourable opportunities were offered and gladly embraced to see this part of the Highlands of New Brunswick under conditions seldom enjoyed.

The first impression produced on glancing at this extraordinary scene, was a sense of extreme isolation in the midst of the vast wilderness of forest which lay like a troubled sea far beneath our feet. The detached peaks of many mountains seemed to occupy but a small part of the wide expanse open to view, while the remote ranges, in themselves extensive and formidable barriers, were reduced to rugged lines bounding comparatively small parts of the distant horizon. Such were the Salmon River Mountains, the Twin Mountains on the Gulquac, Moose Mountain, and Mars Hill, far to the southwest; as well as the bold dividing ridge between Long Lake and a Lake at the head of the Little South West Miramichi; and Bald Mountain to the northeast. Minor peaks and ridges limiting the broad valley of the Tobique, served but to give an irregular character to the great plain they diversified.

The clearings of the pioneer settlers on the Tobique, looked like white specks in a vast ocean of dark green. The contrast between the blue outlines of the mountain ranges to the west after the sun had dipped behind them, and the golden tints swiftly gliding up the sides of ranges lying to the east, was singularly imposing; the peaks of all those sufficiently elevated to catch his last receding rays being simultaneously lit up, and then passing into comparative gloom one by one.

The solemnity of a still and cloudless night on the summit of a high mountain in a wilderness country all can understand, but it is not so simple an effort to people in imagination the splendid valley which Blue Mountain overlooks, and through which the Tobique flows like a narrow thread, with a hundred thousand souls; and yet such, perhaps, even within the lives of some who may glance at these descriptions, is the probable future of this little known but most valuable tributary to the Saint John.*

From this mountain is seen the "lowest point" described by Major Robinson, overlooking the Tobique Valley, having an elevation 1,216 feet above the sea. It is situated eighteen miles from the Tobique, to reach which a descent of 796 feet has to be made. The summit level on the opposite ridge between the Tobique and the Restigouche is 920 feet above the sea, or 500 above the Tobique, at the place where his line of section crosses that river.

From the Three Brooks to the Two Brooks, eighteen miles, the line of proposed Government Great Road from the mouth of the Tobique to the Restigouche, skirts the foot of Sisson's Ridge, "one of the finest stretches of hardwood land in the Province."†

The morning mist rising from the Tobique pointed out its course to the narrows, through which it rushes in a deep gorge before debouching into the Saint John. The whole of the lower part of the valley has once been an inland lake of great extent, and, as will be shown when the Tobique is specially described, high falls probably existed at the spot where the narrows are now situated.

The subjoined Table shows the general character of this region for a distance of 78 miles, being a series of altitudes across the country from Miramichi Lake to the Restigouche, according to Major Robinson's survey.

SECTION FROM MIRAMICHI LAKE TO THE RESTIGOUCHE.

	Height in feet above the Sea.	Distance from Miramichi Lake.
Miramichi Lake, ...	750	0
Forks of the S. W. Miramichi, ...	797	11
Portage Road, ...	829	18
Mountain, (Beedle Brook Mountain,)	1084	22
N. W. Branch S. W. Miramichi, ...	926	24
Mountain, ...	1165	27
Height of land between Miramichi and Tobique waters, ...	1205	30
Source of the Odell, ...	1215	30½
Watershed between Odell and Wapsky, ...	1238	31
Levelling from near Boiestown in 1846, ...	1195	54
Do. the Tobique in 1847, ...	1189	and 18 from the
Barometric observations in 1847, ...	1168	Tobique.

* The settlers are already far in advance of the Government Road, and clearings have been commenced at the Nictau or Forks.

† Report of Messrs. Garden and Ferguson.—Journal of House of Assembly for 1858.

	Height in feet above the sea.	From the Tobique.
Beaver Brook, ...	849	15¾
Ovenrock Brook, ...	810	11¾
River du Chute, ...	630	10
Little Wapsky, ...	585	6
Tobique, ...	420	0
Branch of Two Brooks, ...	616	8 N.
Station 11½ miles, ...	935	11½
Cedar Brook, ...	776	15
Sisson Brook, (Tobique waters,)	844	19
Mountain Ridge, 23 miles north, ...	1177	23
Salmon River, ...	920	24¾
Height of land between Salmon River and Grand River,	1115	28½
Restigouche, ...	435	45

The levels obtained by Sanford Fleming, Esquire, Chief Engineer of the Inter-Colonial Railway, are considerably lower between the Restigouche and Two Brooks, in the Tobique Valley.* They are as follow:—

Between Restigouche and Grand River, ...	750	feet.
Between Grand River and Salmon River, ...	1080	"
Between Salmon River and Two Brooks, ...	840	"

The following Section on the Royal Road between Pickard's Mills on the Saint John to the Grand Falls,† one hundred miles in length, extends from the Carboniferous Rocks, which are distinguished by gentle undulations, across the central granitic belt, passes the head waters of the fertile valleys of the Beccaguimic, Munquart, and Shiktehawk, to the Tobique; thence through a fine country to Grand Falls. These two sections, compared with the one which follows across the Carboniferous Rocks, will show how subordinate are geographical features to geological structure in the surface outline of an extensive region.

SECTION FROM PICKARD'S MILLS TO THE GRAND FALLS.

	Distance.	Height above the Sea.
Pickard's Mills, Saint John, ...	0	0
Plateau north of Nashwaaksis, ...	6	416
Dividing Ridge between Nashwaaksis and Tay Creek, ...	15½	960
Tay Creek, ...	17½	750
Height of land between Branch of Nashwaak and Tay Creek,	25	1138
Branch of Nashwaak, ...	27	640
Hill north of Nashwaak, ...	33½	1266
Summit between Shiktehawk and Nashwaak, ...	41½	1550
Sources of Beccaguimic, Nashwaak, and Miramichi, ...	42 to 48	1450 to 1550
Shiktehawk, ...	56½	760
Summit between Shiktehawk and Monquart, ...	60	1660
Monquart, ...	62½	1000
Summit between Monquart and Trout Brook, ...	66	1540
Trout Brook, ...	68	1060
Do.	71¾	500
Tobique, ...	74½	316
Summit between Tobique and Little Salmon River, ...	85	1000
Little Salmon River, ...	90	366
Summit between Little Salmon River and Fall River, ...	96½	680
Fall River, ...	100	400

* I am indebted to Mr. Fleming for the above altitudes.

† I am indebted to the kindness of John Wilkinson, Esquire, C. E., for the above Section.

SUBORDINATE MOUNTAIN RANGES.

These are two in number, situated in the southern part of the Province, and stretching in a northeast by east direction through the Counties of Charlotte, King's, and Saint John, to Albert and Westmorland. They will be more particularly described in noticing the Geology of these Counties. None of the peaks attain such altitudes as some of those in the Highlands, but the plateau on which they are situated in Saint John County is elevated, so that they do not present such striking outlines as the bolder ranges in the northern part of the Province. A rough section was made in November of the present year from the coast of the Bay of Fundy to Sussex Vale, with an aneroid barometer. The altitudes are subjoined, but they must be regarded as only approximate.

Barometrical Section from the mouth of Goose Creek to Sussex Vale.

	Height in feet above the Sea.
Mouth of Goose Creek, ...	0
Two miles from Goose Creek, ...	950
Five miles from do.	1045
Shepody Road, ...	1083
The Chapel on the road to Sussex Vale, ...	1140
Altitude of hill range east of last station, (estimated,) ...	1340
Sussex Vale, ...	58

The hills west of the Chapel may be 100 feet higher, and from this point the descent to the valley of the Kennebeccasis is gradual.

THE BASIN OCCUPIED BY THE CARBONIFEROUS ROCKS.

The level character of many portions of this area is remarkable, and in striking contrast with the disturbed portions of the Province which have been briefly described.

Commencing at Bay Verte in the County of Westmorland, the elevation of the Carboniferous strata above the sea, on the line of Major Robinson's Railway Survey, is 109 feet; the utmost elevation the country attains between this point and Shediac (always on the surveyed line) is 185 feet; there is then a very gradual descent to the Cocagne River, but immediately after passing this stream, the country is broken, rising, before reaching Buctouche River, to 227 feet; near Coal Branch it is 259 feet, and between Harley Road and the Richibucto River the country is nearly level at an elevation of 170 feet above the sea, for a distance of ten miles, and one mile of that distance is absolutely level. There then succeeds a low dome shaped rise and fall from 78 to 277 and 71 feet. Extensive level spruce barrens succeed, which are 21 miles across, terminating at the South West Miramichi, the elevations of these barrens not exceeding 80 feet above the sea. Between the S. W. and N. W. Miramichi, the dividing ridge is 225 feet above the ocean, and in the valley of the N. W. Miramichi another level tract of country occurs for thirty miles, the land rising only from 150 feet to 215 feet in that long distance. A descent is then made to the Nepisiguit, where the Carboniferous strata terminate. The aggregate distance along the surveyed line, which is nearly straight, being 149 miles over the Carboniferous Series of New Brunswick. The route lies near the coast, varying from one to twenty miles distant; it exhibits, however, a remarkably level tract of country, and shows how few in number and how gentle in action have been the disturbances it has undergone.*

THE RIVERS OF NEW BRUNSWICK.

THE SAINT JOHN.

The River, *par excellence*, of New Brunswick, is the Saint John, called also the Wollastook from its original name in the Milicete language. On the authority of the Honorable Charles Perley, the word should be spelt Awollostook, and its signification is "the Big River."

One of the earliest historical notices of the River Saint John dates from 1598, when it was called "Riviere de la Grande Baie," or La Baie Francaise, as the Bay of Fundy was formerly designated. This occurs in the letters patent confirming the appointment of the Sieur de la Roche Lieutenant-General au Canada, Hochelaga, Terre-Neuve, Labrador, RIVIERE DE LA GRANDE BAIE (Saint John in the Bay of Fundy), Norembegue (the present State of Maine), et les terres adjacentes. (L'Escarbot). In the admirable Report by the late Dr. Robb, on the Agriculture of the Province, reference is made to the discovery of the Saint John by "Champlain, on Saint John Day, in the year 1604;" and in Monro's New Brunswick, there is a quotation from Haliburton's Nova Scotia, in which the name Saint John is stated to have been given to it because it was discovered on the 24th of June, the day of the Festival of Saint John the Baptist. Mr. Monro says also that this noble river was discovered by De Monts. It is clear from L'Escarbot, that the river was known previously to 1598. But in 1604 Sieur de Monts visited La Rivierè de la Grande Baie, and *changed* its name to the Saint Jean.

In the "Relations des Jesuites en Canada," allusion is made to the "Iron Mines on the River Saint John," so far back as 1611;† and in the same

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* Major Robinson's Survey:

The line is 630 miles long from Halifax to Quebec.

In passing the valley of the Tartigou River, and the watershed between the Saint Lawrence and the Restigouche, it attains an elevation of 763 feet above the sea.

Between the places where it crosses the Restigouche and Nepisiguit near Bathurst, the utmost height it reaches is 368 feet above tide, and this is the highest point reached in New Brunswick.

In Nova Scotia a ridge near Folly Lake, on the Cobequid hills, is 623 feet.

On a profile of this Survey, there is shown a tract of land absolutely level for a distance of five miles. This is situated on the Stewiacke River in Nova Scotia, 35 miles from Halifax, and 20 from Truro, its altitude is 33 feet above high water at Halifax.

Between Harley road and Richibucto River, for a distance of 8¼ miles, the country is nearly level, the actual fall towards Richibucto River being 1 foot in 1504 feet for five miles, level for one mile, and a fall of 1 in 3887 for the remaining distance.

The spruce barrens, with an altitude of 49 feet above the sea, through which the surveyed line passed for 18 miles, is perhaps the most extensive tract of level country in the Province.

† "Si le pays estcit habite ou pourroit profiter de ses mines; car il y en a vue d'argent dans la baie saincte Marie, au rapport du Sieur Champlain, et deux de beau et franc cuiure, l'une a l'entree du Port Royal, et l'autre a la baie des Mines, *une de fer a la Riviere S. Jean* et d'autres autre part."—(Relation de la Nouvelle France, 1611.)

record there is a brief description of the dangers encountered in passing the tidal falls which form so curious and distinguishing a feature at the mouth of this river. In 1652 Father Gabriel Druillettes voyaged to its source; and in 1659 the commerce or system of barter which existed between the Indians of the Saint John River and those of "Rigibouctou," is considered worthy of being mentioned in a letter by Father Lallemant on the Missions of Acadia.

The Indian name of the Saint John, as given on a Map by Father Coronelli, published in 1689, is Ouygondi, and the country through which it flows is represented as belonging to the Etechemins nation.* Dr. Dawson has Ouangonda, evidently of the same origin, and he names a fine Coniferous tree found in the Devonian Sandstone at Saint John, "*Dadoxylon Ouangondianum.*"

SOURCES OF THE SAINT JOHN.

The Saint John (South Branch) rises in the State of Maine (Lat. 46.2), 115 miles west of Woodstock, or more accurately, due west of the old Meductic Fort, a few miles below that town. It flows in a northeasterly direction through Maine to beyond the 47th parallel, and forms the boundary line between Maine and New Brunswick from the mouth of the Saint Francis to the Monument, three miles above the Grand Falls. After passing that point its course lies wholly within the Province.

The head of the south branch of the Saint John is 2,158 feet above the ocean. The source of the southwest branch, where the Monument is placed under the treaty of Washington on the boundary between Canada and Maine, is 1808 feet, and its northwest branch (in Canada) comes from an elevation of 2,358. This great river, with a course exceeding 400 miles, does not fall much more than the waters flowing into the Tobique or Nipisiguit, from the ridge (2,092 feet) which divides the valleys of those comparatively small rivers in the highlands of New Brunswick.†

Saint John Lake, on the south branch, is 1,075 feet above the ocean, and where the river first enters the Province, at the mouth of the Saint Francis, its waters are not more than 606 feet above high tide.‡

At the mouth of the Madawaska the general course of the river begins to trend towards the southeast, which is its course to the Grand Falls, 125 miles by the river from Fredericton, after which its waters flow almost due south for about 75 miles, until they again arrive at the same degree of latitude as that from which they started, a journey of more than 300 miles. This course, expressed in very general terms, may be described geologically as follows:—

From its source to the mouth of the Saint Francis it runs *with* the strike of the rocks, and from the mouth of the Saint Francis to the old Meductic Fort it runs diagonally *across* the strike of the rocks.

* Blue Book—North American Boundary.—London, 1840.

† The Boundary Commissioners give the height of the extreme source of the Saint John River above Lake Woolastaquaguam (Saint John Lake), as only 1,315 feet, but this measurement appears to be on the Portege road between the waters of the Penobscot and the Saint John, and not at the true source of the river or any one of its branches.

‡ Boundary Commission.

The due north Boundary line between Maine and New Brunswick, starting from the source of the Saint Croix River, (Lat. 45.48.8), after traversing the wilderness for 77½ miles, is intersected by the River Saint John 2½ miles west of the Military Post at the Grand Falls.

THE GRAND FALLS.

The exact altitude of the Grand Falls, and their elevation above the sea, has been invested with considerable importance in consequence of the position of this splendid cataract having been adopted by the Boundary Commissioners in 1839–40 as the standard point to which the barometrical altitudes throughout the country, east and west, should be referred. Every effort was made to determine their exact relation to the sea level; yet there exists a very marked discrepancy between the results attained by the Barometer, as hereafter described, and those taken in running the due north line.* On a Map embodying a section of the country on the course of the due north line forming the Boundary between Maine and New Brunswick, published under the authority of the United States Government, the altitude of the Saint John waters at the Monument, three miles above the Grand Falls, is stated to be 419 feet. The British Commissioner makes the summit of the Falls 296 feet 9 inches above the tide at Chapel Bar, a few miles above Fredericton, as follows:—

	Feet.	in.
Height of the basin at the foot of the Grand Falls, above the tide at Chapel Bar,	177	3
Perpendicular height of the Grand Falls, ...	74	0
Descent through Rocky Channel, ...	45	6
Total, ...	296	9

"The total height of the bed of the River Saint John above the tide at Chapel Bar, being 296 feet 9 inches."

As the distance from Fredericton to the Grand Falls is 125½ miles, and the ascent by the river is stated to be only 177 feet 3 inches,† according to the levels taken,‡ this would give a fall per mile of only one foot five inches.

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* See succeeding paragraphs for probable explanation.

† These are the levels reported by the Commissioners on the authority of a Surveyor, (*vide* Report.) There is, however, reason to believe that they contain very material errors.

‡ Levels (?) on the River Saint John from Fredericton to the Great Falls—

	Distance.	Height in inches.
From FREDERICTON to the confluence of tide below Chapel Bar, ...	4.47	0
Confluence of tide to French Chapel, ...	3.15	43
French Chapel to Cliff's Bar, ...	7.52	129
Cliff's Bar to the head of Bear Island, ...	5.70 }	227
Bear Island to Nacawakac, ...	8.54 }	
Nacawakac to Meductic, ...	4.68	55
Meductic to Eel River, ...	9.25	220
Eel River to Griffith's Island, ...	9.43	168
Griffith's Island to Macmullan's, ...	12.26 }	144
Macmullan's to Presqu'isle, ...	8.8 }	
Presqu'isle to Riviere du Chute, ...	14.77	375
Riviere du Chute to Tobique, ...	12.71 }	765
Tobique to GRAND FALLS,**	21.12 }	

** From Report of Commissioners.

The Commissioners say, in discussing their observations, "The difference between the two inferences above stated, viz., the greatest height of tide at Chapel Bar in the Bay of Fundy, 81.65 feet,* and at Bathurst in the Bay of Chaleurs, 6.9 feet, is 74.75 feet; and the same calculated by barometrical measurement, amounts to 77 feet, showing a total difference of little more than two feet between the two results."

It is, however, remarkable, that Mr. Graham ascertained the upper basin of the Grand Falls to be 419 feet above tide (probably the tide in Passamaquoddy Bay); the lower Basin to be 303 feet; consequently, the height of the Falls with the descent in the gorge, to be 116 feet; the Commissioners giving the total height of Falls and descent in gorge at 119 feet, in round numbers, a difference which unequal stages of water would readily account for.

The real explanation of this discrepancy has been afforded me by a gentleman occupying a position which entitles him to implicit confidence. The levels taken between Fredericton and the Grand Falls are not accurate. The summit of the Grand Falls is really more than 400 feet (419), ascertained by levelling from Passamaquoddy Bay; and the fall between the foot of the Grand Falls and Fredericton is 298 feet, instead of 177, and the fall per mile two feet four inches, instead of one foot five inches. The true altitude of the upper Basin of the Grand Falls being 419 feet. The levels taken on the Royal Road correspond with this estimate.

After taking the leap of 74 feet, the waters of the Saint John rush through a deep semicircular and very narrow gorge, one mile in length, to the lower Basin, which lies nearly due south of the upper Basin, and in the course which the river would have taken had it continued on uninterruptedly. The distance between the upper and lower Basin is only half a mile on the chord of the arc formed by the gorge. A deep ravine indicates the former valley of the river at a time when its waters flowed at a much higher level than at present. No less than five terraces mark its successive subsidences after the ancient valley in which it flowed was filled up, and partially re-excavated. The probable origin of the Falls will be discussed in a subsequent chapter.

THE SAINT JOHN BELOW THE GRAND FALLS.

Between Fredericton and Chapel Bar, soundings indicate a minimum depth of seven feet during the ordinary summer level; the maximum above Fredericton being 23 feet. At Chapel Bar, the head of tide, there was ten inches of water, with a circuitous channel,† when the river was surveyed, which was at a time when the waters were eighteen inches or two feet below their summer level.

* The Commissioners regarded Chapel Bar, *from its position*, being about 90 miles up and distant from the mouth of the River Saint John, to be equivalent to Cumberland Basin, in respect of the height of tide, which is based on the American Ephemeris for 1839, and appears to be excessive.

† Report of Commissioner for Exploring the River Saint John. Sept. 1838.—Appendix to Journals of Assembly.

The Bars of the Saint John are not permaneut, shifting from time to time, the greatest change taking place in spring; and floating ice is considered to be an important agent in producing them. Near Burgoyne's Ferry the depth is 60 feet, and at the foot of Long's Island 2½ feet.

The following Table shows the breadth of the Saint John at different places, the measurements being taken at low water:—

At Fredericton, ...	½ mile.
Cliff's Bar, ...	700 feet.
Nacawic, ...	475 "
Meductic, ...	550 "
Eel River, ...	550 "
Griffith's Island, ...	780 "
Presque Isle, ...	560 "
Riviere des Chutes, ...	420 "

Viewed as a whole, the River Saint John, from the Grand Falls to the Sea, presents peculiarities which will be more appropriately described in the Chapter on the "Surface Geology" of the Province; the remarkable tidal Falls at its mouth, with the great depths above and below them, together with the probable cause which has excavated these profound fissures, can then be fully discussed.

THE RESTIGOUCHE.

The "Restgouch" Indians are mentioned by Father Barthelemy Vimont in the Relations of 1642.—"You will see by the letter addressed to us from Miscou by the R. pere Richard, that we were not mistaken. He says in his letter that the people of the Bay of Chaleur, who are called 'Restgouch,' and others who live still further off, &c. &c."*

The Restigouche (Broad River) drains upwards of 2,000 square miles in Canada and New Brunswick. One of its affluents, the Wagansis, rises within ten miles of the Saint John, and is reached by a portage from the Grand River. Where Major Robinson's central line of Railroad crossed it, not far from the dividing ridge which separates it from Grand River, it is only 435 feet above the sea, and 45 miles from the Tobique.

The historical associations of the Restigouche are very interesting. Near the ancient Petit Rochelle, at the head of tide, a decisive battle was fought between the French under Bourdo and the English under Byron, in July 1760. And on the very pleasant farm of Mr. Busteed, many cannon balls are continually found, relics of Petit Rochelle, of the old French forts, and of the battle which took place there.

In 1858 Mr. Richardson, one of the officers of the Geological Survey of Canada, examined the Restigouche from its mouth to the junction of the Patapedia, which forms the boundary line between Canada and New Brunswick. His description, which contains some points of interest, is given below.

* Relation de la Nouvelle France en l'Annee, 1612.

THE RESTIGOUCHE RIVER TO THE MOUTH OF THE PATAPEDIA.

'About eight miles below the Matapedia the Restigouche meets the tide, and there are about two miles more to the head of the Bay Chaleur. For several miles above the Bay the River is from a mile to half a mile wide, and it is thickly set with low islands forming good meadow land. Above this, to the Matapedia, the breadth becomes contracted to less than half a mile, and in some places a considerable current prevails. From the Matapedia to the Petapedia the distance in a straight line is a little over twenty one miles, in a bearing about S. 65 W; but following the windings of the River, the distance given by the boundary Commissioners is thirty seven miles. About seven miles above the Matapedia, at a great bend to the right, a large tributary joins on the New Brunswick side. It is called the Upsalquitch, and is five chains wide at the mouth. About six miles higher up a tributary not more than ten feet across, called the Brandy Brook, joins on the Canada side, and while the distance by water from the Matapedia is thus thirteen miles, it is only six and a half miles over land. Above this, several other conspicuous bends occur; the bow at Cross Point, which is the most remarkable, is thirty one miles above the Matapedia by the River. In this curve, the distance by water is two miles, while across the land it appears to be not much over a hundred yards. As far up as Brandy Brook the hills stand somewhat back from the River, and rise with gently sloping sides, well covered with soil to the height of from 300 to 500 feet. Within a short distance of this both sides of the River are settled, but farther up the hills come close upon the River, and often rise up abruptly to heights of from 400 to 600 feet. It is thus only on flats at intervals of several miles, that sites can be obtained for settlement on its banks. The sides of the hills in this part appear to be thinly covered with soil, but farther back the land is said to be capable of cultivation.'

Above the Patapedia the Restigouche is wholly within the Province of New Brunswick. At its mouth the Patapedia is six chains wide, including a small island dividing it into two channels; but above this, the breadth does not exceed about fifty yards.

The upper country drained by this river is described as being valuable as an agricultural region, but little is known of it some distance from the banks of the river; and of its geology, above the Patapedia, we are still entirely without reliable information.

The Nipisiguit, Upsalquitch, Miramichi, Tobique, &c., will be noticed in the geological description of the country, to avoid repetition.

THE COAST LINE.

Seawards, New Brunswick is bounded by the BAY OF CHALEURS, the GULF OF SAINT LAWRENCE, and the BAY OF FUNDY.

The BAY OF CHALEURS, or the "Sea of Fish,"* is reported to be without rock, reef, or shoal. It is twenty five miles wide from Cape Despair to

* Micmac—Eck-e-tuan Ne-ma-a-chi—the "Sea of Fish."

Miscou Island, and seventy-five miles deep to the mouth of the Restigouche. The northern boundary of the Province follows the south coast of this magnificent Bay, and continues up the Restigouche as far as the Mistouche or Patapedia River.

Miscou Island was once celebrated as the chief seat of the Jesuit Missions on this part of the Gulf coast, comprehending the Indians of Gaspe, Miramichi, and Nipisiguit.* At the mouth of the last named river they had a station in 1645. In 1647 a chapel was built by them near where Bathurst now stands, and constant communication was held with Miscou Island, or, as it was then called, "*Ile de Saint Louis.*"†

The "Restgouch" Indians are mentioned in the relation of 1642 as being converted by the Missionaries of Miscou.

It is worthy of note that the white whale which at one time was common in the Bay of Chaleurs, and then deserted it for many years, is beginning to return again, and during the month of June of the present year (1864), I saw some hundreds of these remarkable animals sporting in the brackish waters opposite Dalhousie, near the mouth of the Restigouche.

The white whale (*Beluga borealis*) is found from fourteen to twenty two feet in length. It yields from 100 to 120 gallons of oil, which possesses the valuable property of retaining perfect fluidity at temperatures below zero, and is therefore very valuable for lighthouse purposes. Leather has been manufactured from its skin, which commands a sale at eight shillings the pound. The white whale (erroneously called the white porpoise), is caught in strong fish-pounds, at and near the mouth of the river Ouelle, a tributary of the Lower Saint Lawrence, at the Isle au Coudres, and at Point de Cariole on the north shore of the river. In the fall of the year they assemble, and migrate in a body to their winter quarters in the Gulf or Arctic Sea. They live from April to October in the brackish water of the Lower St. Lawrence, and then proceed slowly down the estuary, accustoming themselves to the salt water. Mr. Tétû, of Ouelle, who has been very successful in capturing the white whale, and in bringing its oil and leather into notice, informed me that he has seen the Saint Lawrence 'white with them;' and he has observed them passing towards the Gulf all day long over a space twelve miles broad.

The Walrus too, was once common on the coast of Miscou Island, and were slain in great numbers by the French about the middle of the 17th century, probably by the employees of the "Royal Company of Miscou." The late Mr. Perley notices an interesting geological fact in connection with the bones of the Walrus on Miscou Island. "On visiting the echouage," he says, "or place where the Walrus were formerly slain in such numbers, a little to the westward of Point Miscou, it was found that the ancient beach is now nearly a quarter of a mile from the sea; a long strip of sand plain, covered with coarse grass and a great abundance of cranberries, at this time

* Spelt by the Jesuits "Nepegigouit," signifying "troubled or rough waters."

† Relations des Jesuits, 1636.

intervenes between the present sea-beach and the former strand. This strip of recent formation is called the *Grande Plaine;* and the curving shore in its front is called by the fishermen *L'Ance a Grande Plaine.* On examining the ancient shore, near the outer edge of a belt of small spruce and fir trees, the bones of the Walrus which had formerly been slain there, were found imbedded in the sand in large quantities, and in good preservation, some of the skeletons being quite complete."*

The shores on the Gulf coast are generally low, and the indentations at the mouths of rivers wide, penetrating, in the form of narrow bays, many miles into the interior. This results from the soft character of the areanaceous deposits belonging to the carboniferous rocks, which form very nearly the whole of the Gulf coast of New Brunswick.

THE BAY OF FUNDY.

This remarkable body of water, originally called "Baie des Francais," and also "Mer de l'Acadie," exhibits various phenomena especially interesting in a geological point of view. The wonderful tides, so ably described by Dr. Dawson,† have been noticed by most travellers in New Brunswick and Nova Scotia with very different impressions, and some discordant enumerations of "facts." Some time since, the Fredericton Athenæum published a paper drawing attention to several absurd statements relating to the tides of the Bay of Fundy, which were thought to be prejudical to the interests of the Province.

These statements have appeared in works of acknowledged authority, and in some instances by writers of eminence. Sir John Herschel, in his "Outlines of Astronomy," paragraph 756, says, "At Annapolis, for instance, in the Bay of Fundy, *it is said* to rise 120 feet;" and Mr. P. H. Gosse, in his delightful volume "The Ocean," does not qualify the assertion with "it is said," but tells us that "the spring tides sometimes rise to the astonishing elevation of 120 feet."—(Introduction to "The Ocean.")

By the permission of Captain Shortland, R. N., the Officer in charge of the Coast Survey, I have been favoured with the following facts relating to the Tides in this remarkable Bay:—

* Report on the Sea and River Fisheries of New Brunswick.

† "The tide-wave that sweeps to the northeast along the Atlantic coast of the United States, entering the funnel-like mouth of the Bay of Fundy, becomes compressed and elevated as the sides of the Bay gradually approach each other, until in the narrower parts the water runs at the rate of six or seven miles per hour, and the vertical rise of the tide amounts to 60 feet or more. In Cobequid and Chiegnecto Bays, these tides, to an unaccustomed spectator, have rather the aspect of some rare convulsion of nature than an ordinary daily phenomenon. At low tide wide flats of brown mud are seen to extend for miles, as if the sea had altogether retired from its bed; and the distant channel appears as a mere stripe of muddy water. At the commencement of flood, a slight ripple is seen to break over the edge of the flats. It rushes swiftly forward, and covering the lower flats almost instantaneously, gains rapidly on the higher swells of mud, which appear as if they were being dissolved in the turbid waters. At the same time the torrents of red water enter all the channels, creeks and estuaries; surging, whirling and foaming, and often having in its front a white breaking wave, or "bore," which runs steadily forward, meeting and swallowing up the remains of the ebb still breaking down the channels. The mud flats are soon covered, and then, as the stranger sees the water gaining with noiseless and steady rapidity on the steep sides of banks and cliffs, a sense of insecurity creeps over him, as if no limit could be set to the advancing deluge. In a little time, however, he sees that the flat "hitherto shalt thou come, and no further," has been issued to the great Bay tide; its retreat commences, and the waters rush back as rapidly as they entered."—Acadinn Geology, pages 23-24.

	Height of Tide.
Point Lepreau, ...	25 to 21 feet.
Saint John, (outside of Harbour,)	28 to 22 "
Off Emerson's Creek, ...	31 to 23 "
Off Quaco, ...	31 to 21 "
Off Cape Enrage, ...	41 to 32 "
Mouth of Petitcodiac, ...	46 to 36 "
Off Apple River, Chignecto Bay, ...	39 to 29 "
Off Cape D'Ore, ...	41 to 31 "
Off Noel River, Cobequid Bay, ...	53 to 31 "
Off Black Rock, ...	36 to 31 "
Off Port George, ...	32 to 29 "
Off Brier Island, ...	22 to 16 "

At the extremities of narrow inlets the tides will exceed the maximum of these altitudes by a few feet.

The levels taken during the construction of the European and North American Railway have established the fact, that the level of high tide at Saint John is 10.70 feet *above* high tide in Shediac Harbour, and the level of the rails on the Shediac wharf is 6.70 feet *below* high water at Saint John.

ORIGIN OF THE BAY OF FUNDY.

The wildest theories have been advanced to account for the origin of the Bay of Fundy.* Although it is the most extensive Gulf on the eastern Coast of America, it is less than any of the great inland fresh water Lakes of the Saint Lawrence Basin. A straight line between Brier Island in Nova Scotia and Quoddy Head would pass through the Grand Manan, (formerly Menano; Relations, 1611,) and with this for its southwestern boundary, the Bay would be nearly as long as Lake Ontario, or about 180 miles. Its width varies from 50 to less than 30 miles, and towards its inner extremity it is divided by the Chignecto Promontory into Chignecto Bay and Bay of Minas, or as it was originally called the Bay of "Mines;" and under this name (Baie des Mines) it is mentioned in the early relations of the Jesuits, and allusions made to the Mines, elsewhere noticed.

Although the surface of the Bay of Fundy may approach that of Lake Ontario, its depth is considerably less, and if the southwestern entrance be excepted, the average depth of the Bay of Fundy will not be half that of Lake Ontario (500 feet or 83 fathoms.) The soundings in the Bay of Fundy, which were kindly permitted to be furnished to me, by Capt. Shortland, R. N., show that between Saint John and Digby, the greatest depth recorded is 43 fathoms, between Quaco and Port George 40, and between Martin's Head and Black Rock 29 fathoms. Near the entrance of Chignecto Bay there is 28 fathoms of water, but within the Minas Channel the lead shows 55, and in the Minas Basin 18 fathoms. Between Grand Manan and Brier Island it is 112 fathoms; but Lake Ontario is 720 feet deep in some places.

* See "Reports on the Sea and River Fisheries of New Brunswick," by M. H. Perley, for notice of these theories.

The Bay of Fundy is really nothing more than a shallow valley of denudation, and is a matter of surprise that, considering the tides to which it is subject, its depth should not be greater. It is probable too that a portion of the Arctic current once flowed through the Bay of Fundy, during a period of submergence of this part of the continent; yet the current does not appear to have materially effected its depth.

The levels on the line of the European and North American Railway, exhibit the singular character of the valley of the Kennebeccasis and its prolongation to Shediac Harbour. The dividing ridge is attained 97 miles from Saint John, where the altitude is 161 feet above the highest spring tides at Saint John. The summit, 12 miles from Saint John, is in the valley of the Kennebeccasis. During the submergence of the country below the level of 170 feet, the current in this valley must have been at times terrific; we see its effects in the bold escarpments and hills which distinguish the country about Sussex Vale. Borings at Lawlor's Lake showed soft material 100 feet below the present surface, which is 62 feet above high tide. This is, probably, a part of the ancient valley of the Saint John, or a deep indent from the sea.

The distance between the extremity of Cumberland Basin and Bay Verte is eleven miles. The highest land on this narrow isthmus is only 17 feet above the level of the highest tides in Cumberland Basin. This is on the Amherst and Bay Verte Road, four miles from the first Lock of the proposed Canal. Another ridge occurs two miles from Bay Verte, but this is only 14 feet above the high tides of Cumberland Basin, or 36 feet above the highest spring tides in Bay Verte. By the removal of these trifling obstacles the waters of the Bay of Fundy would flow into the Gulf of Saint Lawrence, and Nova Scotia would become an Island. If a ditch were dug to admit of the passage of the waters, they would rapidly widen it to a canal, but when they would cease their work of erosion and destruction, is a problem not easy to answer with present data.

CHANGE OF COAST LINE.

There are strong indications of a change in the relations of the coast to the level of the sea, taking place at the present day in the more northern parts of the Bay of Fundy. At the time of my visit to Albert County in the month of October, (1864,) the tides were unusually high, overflowing many dykes in the broad marshes of Shepody River. Several intelligent farmers and residents expressed the opinion that the tides were rising higher than formerly, or what may be really the case, that the land is slowly sinking.

The same physical change has been observed on a more extended scale in Nova Scotia, and was noticed some years since by Dr. Dawson;* submerged forests having been found by him in Cumberland County. Mr. Bell,† in a paper "on recent movements of the Earth's surface," states on the authority

* Acadian Geology.

† Transactions of the Nova Scotian Institute of Natural Science, 1863.

of Dr. Gilpin, that several hundred acres of dyke land in Annapolis, formerly in cultivation, are now given up to the sea.

In the great Tantamar Marsh, in the County of Westmorland, at its eastern extremity, large trees of different kinds, collections of shells and bones of fishes appear at different depths in the alluvium. On its northern border are patches of forest trees, some of which have been felled by the woodman's axe, but the stumps are now overflowed by the tides.* Relics of the early French settlers and many traces of the aborigines have been dug up at depths of five and ten feet beneath the surface. At Shediac and Bay Verte the gravestones of persons killed by the Indians in 1755, are now reached by the tide at high water, which washes the base of old Fort Moncton, and rises above its causeway.†

Two hundred and fifty years ago, (1612,) the Bay of Chignecto (called Chinictou, also Chignectou by the Jesuits, (1612,) and by Champlain, Baie des Genes,) was celebrated for its marshes or meadows, stretching as far as the eye could see.‡ At that time the Indians of this Bay were said to number from sixty to eighty souls, and to be sedentary on account of the abundance of game.

* Gesner.—Proceedings of the Geological Society, 1861. † Ibid. ‡ Relations, 1612.

CHAPTER II.

GEOLOGICAL SKETCH OF THE PROVINCE.

Nomenclature—Necessity for a uniform nomenclature—Nomenclature adopted by Sir W. E. Logan—The Sedimentary Rocks of New Brunswick—Economic materials they contain—The CENTRAL GRANITE BELT—The age of the Granite—Its character—Localities where it is seen—On the Nipisiguit—At Gulquac Lake—Long Lake Portage—On the South West Miramichi—Does not occur in the form of a continuous broad belt; but in several narrow belts—The Granite on the Saint John, occurs also in narrow belts—On the Frontier—Length and breadth of the Granite axis—Its importance—Geographical and Geological features compared—The Southern Granite Belt—Its mode of occurrence in the Southern Range—On the Magaguadavic—Breadth of the Granite in the Northern Belt—Occurs in Elgin Parish—Origin of the Granite—It is probably an altered Sedimentary Rock—Professor Hunt's views—Upper and Middle Silurian Series—Devonian Rocks—The Carboniferous Series.

NOMENCLATURE.

With a view to assist in preserving uniformity in the geological descriptions of British North America, I shall strictly adhere to the nomenclature adopted by the distinguished Chief of the Canadian Geological Survey, Sir W. E. Logan.* It is not, perhaps, generally known in this Province, that Sir Roderick Murchison, Director General of the Geological Survey of the United Kingdom, himself the discoverer and delineator of several great Rock Systems, (Silurian, &c.) has adopted the Canadian name Laurentian, first given by Sir William Logan to an ancient series of sedimentary rocks in Canada, to represent rocks of the same age which Sir Roderick Murchison has found to exist in the north of Scotland and some of the adjacent Islands.†

Mr. Alexander Murray, who is now making a Geological Survey of Newfoundland, will doubtless adopt the same nomenclature, and as the formations in Central British America have already been described in general terms according to the same plan,‡ it will result in a few years that a uniform

* This practice not only suggests itself as due to the exponent of British American Geology, but it is expressly recommended by Sir Roderick Murchison, in a letter with which the writer of this Report was favored by that eminent Geologist.

† "If this most ancient gneiss required a British name, it might indeed with propriety be termed the 'Lewisian System,' seeing that the large island of the Lewis is essentially composed of it, capped here and there by derivative masses of Cambrian conglomerate; but the term 'Laurentian' having been already applied to rocks of this age in North America by our distinguished associate Sir W. Logan, I adhere to that name, the more so as it is derived from a very extensive region of a great British Colony."—*Proceedings of the Geological Society, Nov.* 1859.

‡ Vide Geological Map of the country between Lake Superior and the Elbow of the south branch of the Saskatchewan, by the Author of this Report. "Narrative of the Canadian Expeditions." Longman, London. 1860. Also Blue Book, 1860. And Dr. Hector's Map of the country between Lake Superior and the Pacific.—Geological Society's Journal, Nov. 1861.

system of colouring can be given to a Map of British North America, with intelligible descriptions; and thus the almost inextricable confusion, to a foreigner at least, which has occurred in the delineations of the Geology of certain States of the American Union, will be avoided. There is no reason whatever, why rocks possessing local peculiarities of structure, composition, fauna or flora, should not receive special names, provided their relation to those great geological divisions of past time, with their well known local subdivisions, which are almost universally accepted, be clearly ascertained and prominently kept in view, in order that a stranger to the geographical position of the part of the country they represent and from which they derive their name, may not be subjected to the trouble and loss of time which a new nomenclature so often involves. Local designations are, indeed, sometimes absolutely necessary, and wholly unobjectionable if they specify peculiarities. But no one can substantially defend their application and use to such an embarrassing degree as now prevails in the different geological descriptions of some American States.

With reference to the nomenclature which has been adopted for the geological formations of Canada, Sir William Logan says—"In the names used we have been desirous of availing ourselves as much as possible of those which have been applied to well established groups of strata elsewhere, with a view of at once facilitating comparisons of equivalent masses, and of rendering homage to those whose labours have aided us in understanding our own rocks." For the subordinate groups of fossiliferous strata the nomenclature of the State of New York has been adopted, because the investigations of the able Geologists who conducted that survey had, in some degree, rendered the nomenclature classic in America; and it is only when a group has not been recognized among the rocks of New York, or when a mass there destitute of organic remains is replaced in Canada by one marked by fossils, that a Canadian name is introduced."*

CLASSIFICATION OF NEW BRUNSWICK ROCKS.

The Sedimentary Rocks of New Brunswick belong to the following Great Divisions:—

I. Recent and Post Pliocene.

* * * * *
* * * * *

II. Triassic?
III. Carboniferous.
IV. Devonian. — *Devonian Granite.*
V. Upper Silurian.
VI. Middle Silurian.
VII. Lower Silurian. — *Quebec Group.*

The valuable minerals belonging to each Group are as follow, as far as they are known; a special description will be given of the mode of occur-

* Geology of Canada, page 10.

rence of each particular mineral, in the Chapter relating to the Group in which it is found:—

I. RECENT and POST PLIOCENE.—Manganese; Bog Iron Ores; Ochres; Shell Marl; Kaolin; Clays for Pottery and Bricks; Moulding Sand; Blue Phosphate of Iron; Peat; Gold.

II. TRIASSIC.

III. CARBONIFEROUS.—Bituminous Coal; Albertite; Petroleum; Bituminous Shales; Limestones; Gypsum; Firestones; Sandstones; Grindstones; Millstones; Conglomerates; Flagstones; Building stones; Decorative materials; Sandstones for Glass.

IV. DEVONIAN.—Copper; Roofing Slates; Plumbago.

V. UPPER SILURIAN.—Limestones; Dolomites; Argillites; Honestones; Hydraulic Cement; Whetstones.

VI. MIDDLE SILURIAN.—Lead; Sulphate of Baryta; Limestones; Ochres; Copper Ores; Iron Ores.

VII. LOWER SILURIAN.—Copper; Antimony; Manganese; Iron Ores; Lead; Chromium; Nickel; Zinc; Gold; Potstone; Serpentines; Roofing slates; Marbles.

OUTLINE OF THE DISTRIBUTION OF FORMATIONS.

With exception of the rocks belonging to the Recent, Post Pliocene, and Carboniferous Series, the whole of the formations found in New Brunswick have been very much disturbed, but the direction of the forces which produced the disturbance appears to have been uniform rather than discordant; hence it results that over wide areas the strata are folded and curved with great regularity. This is particularly noticed in the grand belts of the Lower Silurian Series which stretch across the Province from the Saint John to the Bay of Chaleurs, in a northeasterly direction. The general direction of the strike of the rocks in these belts is to the northeast (N. 60 E.), and the dip at a high angle either to the southeast or northwest. These belts occur on both sides of a low range of Granite, stretching from the Atlantic coast of Maine to the Bay of Chaleurs, in either two or more broad or in numerous narrow parallel bands, which have apparently broken through the ancient Silurian Rocks, and determined in a great measure the subsequent geological arrangement of a large part of the Province.

The whole of this range of Granite would at the first blush seem to be of much more recent date than the rocks through which it has apparently crushed its way. It is our guide to the leading features of the Geology of the Province, and before alluding to those rocks which are clearly Sedimentary Strata, it will be advisable to describe the character of the great granitic masses, which have been so instrumental in giving them their present position. It is not necessary to enquire at present whether the thick sheets of Silurian Strata were crushed or squeezed into vast folds before the granite broke through them, it is sufficient for present purposes to consider the relation that rock bears to them, and to ascertain in the first place its Geological Age.

THE CENTRAL GRANITE BELT.

THE AGE OF THE GRANITE.

From near Bathurst, on the Bay of Chaleurs, to the islands in Penobscot Bay, on the Atlantic coast of Maine, a distance in an air line of nearly three hundred miles, there is a series of narrow belts, often joined into one, of so-called Devonian granite; that is, of granite apparently thrust up through the Lower Silurian strata which once covered the greater part of the vast expanse of country with one uniform sheet, at the close of the Devonian period, or just before the Carboniferous epoch commenced its existence.

The age of this granite is known from the simple relation it bears to the red sandstones and conglomerates of the Bonaventure formation near Bathurst, which lies here at the base of the Carboniferous series, and to the Devonian rocks of Gaspe; the nearly horizontal and undisturbed Bonaventure sandstones occupy the depressions and hollows in the granite, filling up every crevice and irregularity just as one may suppose sand, both coarse and fine, to cover with a uniform mantle the bottom of deep lakes, unruffled by streams, tides or winds. It is not to be supposed that the nearly horizontal sandstones of the Bonaventure formation, occupy the hollows in the granite with such perfect fidelity and regularity as the sand at the bottom of a deep and tranquil lake, but they preserve that position which they would take if they were deposited in a comparatively tranquil ocean, of which this granite was the floor. In the eastern townships of Canada intruding masses of this granite intersect the Devonian strata,* hence its age must be posterior to them; and in New Brunswick the base of the Carboniferous overlies it horizontally, filling its hollows, and is consequently newer than the granite, hence the exact age of this intrusive rock, if it be intrusive, is about the close of the Devonian Period.

In the Map prepared by Dr. Robb for Professor Johnston's Report on the Agricultural Resources of New Brunswick, the granite is made to occupy a uniform belt across the Province. Its true position differs from this delineation, in several important particulars. According to the observations I was enabled to make during the past summer, on the Nepisiguit, the source of the Little South West Miramichi, the upper waters of the South West Miramichi, and the Saint John River, its aggregate breadth has been overestimated, and a correct geographical position has not been assigned to it on any Map I have yet seen.

I crossed the belt at the localities above enumerated, and noted the limits of formations with as much precision as the nature of the country would permit without special research.

GRANITE NEAR THE BAY OF CHALEURS.

The granite is first seen near the coast on Middle River, about a mile and a half west of the Nepisiguit, and an eighth of a mile from the Harbour. It appears on the Nepisiguit at the Rough Waters, three miles from the mouth

* Geology of Canada.

of the river. Rough Waters is a classic spot, the river deriving its name from these rapids, which in the spring and fall are very magnificent. Here the Red Sandstones of the Bonaventure* formation, are seen lying in nearly horizontal layers upon the granite, which reveals itself as the floor of one of the earliest Seas belonging to the Carboniferous age. It is surely worth while to pause here for a few minutes and endeavour to realize what is the true significance of the expression "the floor of one of the earliest Seas belonging to the Carboniferous age." It means that we are gazing upon rock which formed the bottom of an ocean whose waves rolled over where we are now supposed to be standing, before any portion of the vast coal field of New Brunswick, Nova Scotia, and Cape Breton, was begun to be elaborated by the wearing down of already existing rocks; before a single plant had been called into existence, of the countless myriads which lie entombed in the coal deposits of this fourteen thousand feet thick mass of rock, which is called the Eastern Carboniferous area or coal field of America, as distinguished from the Western area, which occurs in Pennsylvania, Ohio, Missouri, and other western States.

If the rocks which have been formed since the ocean first rolled over the granite near Bathurst were removed throughout the eastern Provinces, and land and sea supposed to retain their present level, a considerable portion of New Brunswick, the whole, probably, of Prince Edward Island, and a large part of Nova Scotia and Cape Breton would be beneath the sea. This ancient bed of a former ocean can be seen within a few miles of Fredericton, on the road to Woodstock, where the outlying patch of the horizontal carboniferous sandstones repose on the granite near the Pokiok River.

Some conception of the vast lapse of time involved in these ideas may be formed, when it is considered that in Nova Scotia there are no less than seventy six seams of coal, each with their dirt bed, or bed in which a large portion of the plants forming the coal grew, succeeding one another. Each coal seam and dirt bed indicating a period of repose and the growth of interminable forests, in which insects, such as termites, cockroaches and scorpions wandered, dragon flies, weevils and locusts flew, and where numerous reptiles, all now extinct, luxuriated in the vast swamps and estuaries of the carboniferous period. Each coal seam was succeeded by long ages during which the waters covered the land, until in that vast lapse of time a thickness of no less than 14,750 feet of deposits was accumulated in Nova Scotia alone.

Two and a half miles above Pabineau Falls the granite is covered on the north side of the Nepisiguit with horizontal sandstones. It occurs here in the form of low domes. On the south side of the River the Bonaventure rocks come on the banks a short distance above the Pabineau Falls, which are themselves wholly in the granite, the sandstone flanking them on the south side. The granite is seen again at a point about half a mile above

* The "Bonaventure Formation" is the name given by Sir W. Logan to the base of the Carboniferous Series as it occurs in Canada.

Brandy Brook, where also the sandstones and conglomerates appear as cliffs 20 feet high, and on the east side capping a hill some 80 feet in altitude. The Rough Waters, more than two miles long, flow over granite with the horizontal conglomerates and sandstones filling the hollows between the low domes on each side, so that the breadth of the exposed granite is very small here. At the foot of the Rough Waters there is a felspar dyke containing red crystals of the same mineral.

The character of the granite near Bathurst, differs slightly from the same rock on the Saint John. At Rough Waters it consists of white felspar, black mica, and translucent quartz. On the Saint John, the white felspar crystals are generally much larger, the mica less in quantity, and sometimes difficult to discover.

The granite was not recognized on the Nepisiguit above the Grand Falls. In a Map accompanying a Paper read by Professor Bailey before the Natural History Society of New Brunswick,* and published in the April number of the Canadian Naturalist,† granite is delineated as forming the bed and banks of the river for several miles above the narrows, more than twenty miles from its mouth; and in his "Report on the Mines and Minerals of New Brunswick," it is stated that "Granite ridges appear in situ, and seem to have displaced and been thrust through the other strata. The violent eddies and rapid currents in this portion of the stream make careful observation very difficult."‡ I did not recognize any granite in this vicinity, and on reference to my notes, I find the following:—A quarter of a mile above Nepisiguit Brook greenish silicious schist occurs, with a strike N. 10 E. Dip 70 W.—300 yards below Nepisiguit Brook the same green silicious schist, with the same strike as before; half-mile below the great Bend ferruginous slates, with strike N. 40° E., Dip 75° W., showing disturbance, &c. These rocks will be described under the heading "Quebec Group," in a subsequent Chapter.

The granite probably pursues the course indicated by Professor Bailey, and the ridges of which he speaks may have escaped my observation, notwithstanding that special attention was given to the possible occurrence here of this rock, as represented on the Map constructed by the late Dr. Robb.

GRANITE AT GULQUAC AND LONG LAKE.

The next place where the granite was thought to be in position, but was not actually seen, is at Gulquac Lake, the head of Gulquac River, a sheet of water not laid down on the Provincial Map. In this remote lake there are a large number of huge granite boulders, not much worn; they resemble low domes in the lake, but did not appear to be in place. Since low ridges of a highly metamorphic schist were seen in the northern part of Gulquac Lake, it is probable that the granite is close at hand, and it may therefore be, pro-

* 12th February 1864.

† Notes on the Geology and Botany of New Brunswick, by Professor L. W. Bailey—Canadian Naturalist, April 1861.

‡ Page 10.

visionally, placed in this vicinity. Large boulders of the same rock were also observed in a northeast direction, on the Portage between Long Lake and a lake forming the source of the Little South West Miramichi, not laid down on the Provincial Map. The bed of a stream flowing into Long Lake from the elevated ridge separating this fine sheet of water from Little South West Miramichi Lake was composed of granite debris. The portage, although nine miles long, did not afford any opportunities for observing rocks in position, but large boulders were very numerous, and these almost altogether consist of white granite. To the north and south of these localities the sedimentary rocks are seen in place. Hence it is probable that a granite ridge passes through this portage, and is continuous with one near Gulquac Lake. These positions are about eight miles north of the northern boundary assigned by the late Dr. Robb to the supposed "Cambrian" belt which flanks the granite on either side.

ON THE MIRAMICHI.

On the northwest Branch of the South West Miramichi, low granite domes were seen about a mile and a quarter above the forks. They are succeeded by micaceous schists, with granite domes occasionally penetrating through them. Smooth white granite forms the bed of the river about two miles above the narrows on the South West, the channel of the river itself being full of granite boulders. Opposite Mount Alexander, and about three miles northwest of it, the granite has involved large masses and numerous fragments of schist, leading to the idea that it was in a plastic condition when upheaved. The same remark applies to the granite on the Saint John River, and elsewhere. At a point between Mount Alexander and the elevation on the east side of the river, as shown on the Provincial Map, a micaceous schist was observed in position, which continues for some distance. About a mile below Slate Brook, where a quartzose schist was observed, white granite again forms the bed of the river, but it is quickly succeeded by ferruginous schist. A ridge of granite containing parallel belts of schist, appears again about 1¼ mile below Slate Brook, after which no more granite is seen on this river, (the country being slates, &c.) until Snake Brook is reached; here there is a belt of granite about 400 yards broad, succeeded by ferruginous slates or schists. The granite appears again half a mile above "The Sisters," where it is succeeded by silicious slates, interpenetrated with numerous quartz veins. It crops out again, however, a few hundred yards lower down the river, when it is overlaid by a quartzite at the mouth of the Sisters, with a strike S. 60 E., dip S.W. angle 80°. Three quarters of a mile below "the Sisters" the granite appears in the form of low domes, the quartzites resting upon it with a strike N. 80 E., and a northerly dip at a high angle. This is the last anticlinal axis or ridge observed on this river, with the granite coming up in the centre.

It would seem from these observations that the great central granitic axis consists of a series of parallel ridges penetrating Silurian rocks; the ridges forming a number of anticlinal axes with the sedimentary rocks on each side of them. The breadth of country on this line of section over which the granite was seen in position, is considerably greater than represented in Dr. Robb's Map, from which our ideas of the leading features in the Geology of the Province have been derived hitherto, but it occurs in many narrow, parallel belts or stripes, and not in one uniform mass.

GRANITE ON THE SAINT JOHN.

On the Saint John, a small dome of granite is seen protruding through the horizontal strata of the outlier of Carboniferous rocks about one and a half miles east of Tilley's Hotel. West of the outlier it occurs as far as the Sheogomoc River, two and a half miles from Tilley's, where a micaceous schist or gneiss occurs. The schist contains black mica, it is easily separated by divisional planes at right angles to the strike, which is S. 70 E. Dip 65° S. The laminæ of the schist are contorted. At the falls of this river, a little above the bridge, white granite is seen in patches penetrating through and overlying the schist, it can also be seen overlying it in masses farther up the river, and it appears to have come through it in many places, giving to the schist the appearance of holding masses of the granite with sharp edges. About three quarters of a mile above the Sheogomoc, the laminæ of the gneiss or schist are beautifully apparent. Granite is again seen forming the bed of a brook a mile and a half from the Sheogomoc, but at Sullivan's Creek the strike of the micaceo-arenaceous rock is S. 10 E., dip 37 E. No more granite was seen on this section. The character of this rock in many parts of the region described, is very porphyritic, containing as it does large and well defined crystals of felspar; some of these crystals are an inch and a half long by half an inch in diameter, but few of them are perfect.

GRANITE ON THE BOUNDARY LINE.

This Belt of granite acquires greater breadth as it approaches the Cheputnecticook Lakes, forming the Boundary between Maine and New Brunswick, but it is probable that it alternates with several belts of schist or gneiss. On the western sides of these lakes, in Maine, which are also called the Eastern Schoodic Lakes, and consist of Cheputnecticook, Grand and North Lake, the granite has been recognized by Mr. C. H. Hitchcock, who supposes the greater part of the western shores of Cheputnecticook Lake, (called by Hitchcock, Chepedneck Lake,) to be occupied by granite. Bold bluffs of White granite were found on the west shore of Grand Lake, but the schists also appeared in place. The east side, however, of Grand Lake, is said to be underlaid by granite, and upon a hill between Grand and North Lakes the junction of the granite with mica schist may be seen.* This range of granite, Mr. Hitchcock suggests, may connect with the granite in Penobscot Bay, on the Atlantic coast. There are many reasons for supposing this conjecture to be correct.

*Second Annual Report upon the Natural History and Geology of the State of Maine, 1863.

The length of the granite axis in New Brunswick is one hundred and sixty five miles, and its aggregate breadth varies from one to twenty three miles.

Throughout the larger portion of its development it consists of a series of narrow parallel bands, with gneiss, or schist or slates between them, so that a very considerable portion of the country lying within the outer narrow bands, is occupied by altered sedimentary rocks, some of which may be valuable for the metalliferous ores they contain, the indications being both numerous and promising.

IMPORTANCE OF THE GRANITE AXIS.

The importance of this granite axis will be better understood when its relation to other rocks is explained. If the reader should place before him the Provincial Map of New Brunswick, or any other good Map embracing part of Canada and the State of Maine, with Nova Scotia, he would recognize certain river valleys, coast lines, and mountain ranges, which maintain a curved course from the southwest towards the northeast, and northeast by east; these are—

1st. The Saint Lawrence, pursuing a northeast course from Quebec to Bic Island, (south shore); from Bic Island its direction trends about 15° more to the east.

2nd. The Saint John River, from Lake Saint John, pursues a northeasterly course for about 100 miles.

3rd. The chain of highlands commencing west of Katahdin in Maine, passes north of Mars Hill to the head waters of the Tobique, and has a northeasterly course. The range then trends more to the east, until it reaches the Bay of Chaleurs.

4th. The Atlantic coast of Maine and the parallel coasts of the Bay of Fundy, have a northeasterly direction; Minas Channel and Basin trending more easterly.

5th. The Atlantic coast of Nova Scotia, from Cape Sable to Margaret's Bay, has a northeasterly course, it then trends more easterly, running parallel to the Saint Lawrence below Bic Island.

These are apparently geographical coincidences, but when the geological structure of the country is studied it will be seen at a glance that they are the result of some law operating uniformly over wide areas.

In a succeeding Chapter a great metalliferous belt of rocks will be described, which comes up on each side of the central granite axis. These rocks are called the "Quebec Group," by Sir W. Logan, who first discovered their relations in 1860, and has since described them as they occur in Canada and elsewhere.

The Quebec Group consists of an ancient series of strata lying near the base of the Lower Silurian System; they have been brought to the surface in Canada by successive foldings which have caused them to assume the form of a series of parallel ridges;* these, coming from Lake Champlain, follow the general course of the Saint Lawrence to Gaspe, and thence to Newfoundland.

The granite axis of New Brunswick has *apparently* uplifted and broken through the Quebec Group, (which had been previously squeezed into folds nearly parallel to the course of the axis,) and brought it to the surface on either side of a gently curving line, from the Bay of Penobscot in Maine, to the Bay of Chaleurs in New Brunswick, roughly parallel to the outcrop of the Quebec Group in Canada.

The next upheaval to the south occurs on a similar course, but trending a little more to the east in Charlotte, King's, Queen's, Saint John, and perhaps Albert Counties. In the first three of which, the Quebec Group has probably been recognized.

The last great fold in this direction to be noticed, occurs on the Atlantic coast of Nova Scotia, where the "Gold diggings" are situated in rocks belonging to the Quebec Group.

All of these foldings or plications which have aided in producing mountain ranges are, indirectly, the probable result of the gradual cooling of the earth's crust. The ocean beds too, are continually getting heavier by deposits, for which the wear of the coast and the debris brought down by rivers affords the material. That part of the crust of the earth forming the land is continually getting lighter; hence the beds of the oceans are always sinking as a whole, and the huge cracks which this occasions on the land are in part the origin of the mountain ranges near the coast, where volcanic vents and rents show a connection with that part of the fluid interior not rendered solid by enormous pressure. No volcano is found at a considerable distance from the ocean.†

* The Geological reader will understand that it is the endeavour of the writer to avoid as much as possible the use of technical terms, which are not supposed to be generally understood by the popular reader.

Sir William Logan describes the Quebec Group in the following words:—

"The Quebec Group would thus appear to be a great development of strata about the horizon of the chazy and calciferous formations, which were brought to the surface by an overturn anticlinal fold, with a crack and great dislocation running along its summit, by which the group is made to overlap the Hudson River formation." * * * "A series of such dislocations traverses eastern North America, from Alabama to Canada. They have been described by Professor Rogers in Pennsylvania and Virginia, and by Mr. Safford in Tennessee. The dislocation in question comes upon the boundary of the Province in the neighbourhood of Lake Champlain. From this it proceeds in a gently curving line to Quebec, running nearly parallel with the Philipsburgh and Deschambault anticlinal, and keeping just north of the fortress. It thence skirts the north side of the Island of Orleans, leaving a narrow margin on the Island for the Hudson River shales. From near the end of the Island it keeps under the waters of the St. Lawrence to within about eighty miles of the extremity of Gaspe, where it again comes upon the land, and appears to leave a narrow strip of the Hudson River or the Utica formation on the east."

"On the south side of the line, the Quebec Group seems to be arranged in long narrow synclinal forms, with many overturn dips."—*Geology of Canada.*

† See Herschel and Dana on this subject.

Now will be understood the expression which forms part of the introductory paragraph in the first Chapter of this Report, "The geographical features of a country are greatly dependent upon its geological structure." A tabular comparison between these parallel geographical and geological characteristics will be sufficiently striking.

PARALLEL GEOGRAPHICAL AND GEOLOGICAL FEATURES.

1st Geographical.	The course of the Saint Lawrence.
2nd Geological.	The Quebec group in Canada.
3rd Geographical.	The northeasterly course of the Saint John, and the Highlands of New Brunswick.
4th Geological.	The central series of granite belts, with the Quebec group on each side, stretching from the Atlantic to the Bay of Chaleurs.
5th Geographical and Geological.	The narrow granitic mountain ranges with the Quebec group on their flanks in Charlotte, King's and Queen's, &c.
6th Geographical.	The Atlantic coast of Maine and the Bay of Fundy.
7th Geographical.	The Atlantic coast of Nova Scotia.
8th Geological.	The Quebec group on the Atlantic coast of Nova Scotia.

A glance at the Geological Map will show that the great valleys between the anticlinal axes (ridges) just described, are occupied either by the coal formation and its outliers, or by other formations lying in parallel directions to the main ridges.

THE SOUTHERN GRANITE BELT.

This belt commences on the Atlantic Coast of the State of Maine, east of Penobscot Bay, and pursues its course in a northeasterly direction until it reaches the Boundary line. At or near the Boundary line it is divided into two subordinate belts or ranges, one of which crosses the Saint John at "Granite Quarry," and pursues a course towards Butternut Ridge, the limestone of which it has brought to the surface. The other ridge is seen four miles north of Magaguadavic Village, and crosses the Saint John above the City; it was recognized in position on a branch of the Coverdale (Little River), and probably extends to Shepody Mountain. The age of this Belt is the same as the Central Granitic Range, and it has brought up the Quebec Group of rocks on portions of the north side, and probably also on portions of the south side of the axis it represents.

On the road from Roix Station to the Village of Saint George, the granite has penetrated the schists in veins and patches,—and sometimes the patches of granite enclose masses of the schist. There is also a difficulty in distinguishing between the gneiss and the granite, and the impression produced at the time was that the gneiss gradually passed into a granite.

About ten miles from Magaguadavic Village the white granite was seen to involve pebbles of slate. It is here a very coarse granite, containing much milky white quartz, and large crystals of white weathering felspar. About three miles farther on the road towards Saint George, the crystals of felspar become pale rose red, and the granite is succeeded by a pale red felspathic schist, with a strike N. 80 E., and a vertical dip.

At the Upper Falls of the Magaguadavic the schist has a general strike N. 80° E., and a dip to the north; it is succeeded by white granite about a mile lower down the road to the Village of Saint George. Here the granite is very coarse, the quartz crystals being very large, though imperfect; the felspar pale flesh coloured, and weathering white, with a little mica. Three miles farther down the road there is a very coarse granitoid gneiss, with apparent strike N. 70 E., dip S.* The colour of the mass is rose red on fresh surfaces; it weathers grey.

The breadth of this granite belt on the Roix Station road and on the Magaguadavic, appears to be about four miles. On Little River, in Elgin Parish, it is seen with the gneiss resting on it.

ORIGIN OF THE GRANITE.

The remarkable manner in which this rock has involved within its mass fragments of schist; the singular minuteness with which veins of granite ramify through the schist, well seen on the Sheogomoc River; the parallelism of the alternating belts of schist and granite, and the slight disturbance which has occurred during the upheaval, all tend to establish the view entertained by Mr. C. H. Hitchcock, that these granites, as they occur in Maine, have been originally in a plastic state, due to the combined action of vapour of water and a low degree of heat. It is, however, very probable that the views which may be entertained of their origin point to a more precise link in their history than the mere supposition that they were in a plastic state during the time of their upheaval. They are indeed to be regarded more as metamorphosed or altered sedimentary strata than as intrusive rocks. They have probably been altered in position and belong to the class named by Professor Hunt, "Indigenous Rocks," and there are valid reasons for supposing that much of the granites of New Brunswick consist of altered sedimentary strata, changed by metamorphism into plastic felspathic sandstones and granitoid gneiss, then by a further metamorphism, partly into plastic granite and in part retaining traces of the stages of their metamorphism. Near the Magaguadavic, for instance, it was found impossible to find the line of demarkation between granite and granitoid gneiss, and between granitoid gneiss and true gneiss, so imperceptible were they blended one with the other.

Under these circumstances the granite of the central axis, as well as of the southern range, instead of being the agent by which the rocks were lifted up, would have only partaken of the general movement which affected the whole; a movement which we have seen extended from the Saint Lawrence

* The strike sometimes appears to be N. and S., dip W., but that given in the text is probably correct.

to the Atlantic coast of Nova Scotia, folding the strata in vast waves or undulations, at the close of the Devonian period.*

These grand uplifts must not be confounded with another series of earthquake movements which occurred during the earlier portion of the carboniferous epoch, and which are particularly manifest in the Counties of Albert and Westmorland; nor must they be associated with the subsequent gigantic movements of the earth's crust, called the Appalachian revolution, which extended from Alabama to Newfoundland.

Professor Hunt, of the Canadian Geological Survey, has devoted much attention to this intricate and important subject. His conclusions were advanced some years ago, and more recently embodied in the "Descriptive Catalogue of the Minerals sent by Canada to the International Exhibition for 1862." Subjoined is a valuable extract from that work, as well as one from the "Geology of Canada."†

And in a Chapter on the "Eruptive Rocks," in the Geology of Canada, "The general absence of granite from among these intrusive masses is a fact worthy of notice. * * * The granitic rocks of Shipton and of Saint Joseph on the Chaudiere, appear to be *indigenous* masses, belonging to the strata of the Quebec group; but the higher fossiliferous, formations to the east of the Notre Dame Mountains, are traversed in various places by veins and great masses of intrusive granite, whose characters and distribution have been described on pages 430 and 434.

* In describing the altered Devonian slates westward of the Nictaux River, in Nova Scotia, Dr. Dawson hints at a similar change into granite. "The beds of slate, in running against this great dyke of granite, change in strike from southwest to west, near the junction, and become slightly contorted and altered into gneiss, and filled with granite veins, but in some places they retain traces of their fossils to within 200 yards of the granite. The intrusion of this great mass of granite, without material disturbance of the strike of the slates, conveys the impression that it has melted quietly through the stratified deposits, or that these have been locally crystallized into granite *in situ*."—*Supplementary Chapter to Acadian Geology.*

† "The results of recent geological investigations in various parts of the world, lead to the conclusion that many rocks, formerly regarded as intrusive or exotic, are really sediments, altered *in situ*, or indigenous rocks. Such is the case with many granites, syenites, greenstones, amygdaloids, porphyries, and serpentines; all of which are represented among the altered strata of Canada. These sediments at the time of their metamorphism, were however in such a plastic state, that they were sometimes displaced and forced among the overlying and disrupted strata. It is not improbable that the intrusive granites, which are so abundant among the Devonian rocks to the south and west of the Notre-Dame Mountains, are the equivalents of the feldspathic sandstone and granitoid gneiss of the lower Silurian series. It is worthy of note, that intrusive masses are extremely rare in the Laurentian system, so far as known, except in one small area in the Counties of Grenville and Argenteuil, where a succession of eruptions of dolerite, syenite, and quartziferous porphyry, occurred before the commencement of the Silurian period. In the same way, the great masses of the Lower Silurian mountains are free from intrusive rocks. To the southeast of them, however, occur the Devonian granites just mentioned, and to the northwest, along the valleys of the St. Lawrence and Lake Champlain, are a series of intrusive dolerites, diorites, and trachytes."—*Geology of Canada, page* 669.—See also remarks on the same subject at the commencement of Chap. XX in the same work, by Professor Hunt.

"It is worthy of note, that the intrusive masses on the two sides of the mountain range are, so far as yet observed, entirely distinct in character; and that eruptive rocks are generally wanting among the Notre Dame Mountains, which consist chiefly of stratified rocks. It is also to be remarked, that the intrusive granites at their eastern base, are not unlike, in mineralogical characters, to the indigenous granites of the mountains; thus suggesting the view that these are possibly the source of the intrusive granites which break through the Devonian strata."

PLASTIC CONGLOMERATES.

The former plastic condition of the granites, as shown by the involved masses of schist, calls to mind the remarkable conglomerates in the neighbouring State of Maine, described by Mr. C. H. Hitchcock. The peculiarity of these conglomerates consists in the distortion and curvature of the pebbles they enclose. The pebbles appear as if they had been drawn out, curved and pressed together. Mr. Hitchcock considered that not only have the pebbles been elongated, flattened, and curved, since their consolidation into rock; but also that the elongated pebbles have been changed, by chemical action and prolonged pressure, into the siliceous laminæ of talcose and micaceous schists, while the cement has been converted into mica, the talc of talcose schists, and felspar.

The locality of this conglomerate is Weston and the north border of Washington County, Maine, close to the New Brunswick frontier. In travelling northerly it is first seen above the middle of No. 9, which borders on Grand Lake, one of the Cheputneticook Lakes, through which the boundary line runs. The strike of the conglomerate is N. 8° W. Dip 65° E.

It is argued that the elongation of the pebbles was due to pressure at a time when the rock was in a plastic condition.

The presence of graphite is sufficient proof that a great elevation of temperature has not accompanied the metamorphism of many sediments. A high temperature would have dissipated the carbon of the graphite. The thin sheets of this material which are found in the red and green slates at Woodstock; in the altered or metamorphosed rocks at the mouth of Goose Creek, on the Bay of Fundy; near the City of Saint John, and in the plumbagnious slates near the mouth of Musquash River, all of which belong to metamorphic rocks, afford sufficient proof that these strata have not been subjected to any considerable elevation of temperature, sufficient to oxydize the carbon they contain. The intercalation of crystalline sheets between fossiliferous beds, is another proof that heat is not essential in the metamorphosis of rock masses. On Frye's Island, fossiliferous limestone occurs between felspathic schists, and highly crystalline limestones. The opinions which necessarily associate high temperatures with the occurrence of crystalline rocks, or of rocks which have undergone metamorphic action, are now no longer tenable.

OTHER FORMATIONS.

Lying to the north and northwest of the Lower Silurian Rocks, brought to the surface by the granite just described, there are immense deposits of Upper Silurian Rocks, much disturbed in places by intrusive traps; and in other localities, as on the coast of the Bay of Chaleur and on the Restigouche, interstratified with volcanic rocks. This series covers nearly the whole of the Province to the north of the more ancient rocks.

On the coast of the Bay of Fundy there is a great series of Middle and Upper Silurian, and Devonian formations, most of which have been greatly altered by bedded volcanic rocks, and in some instances by intrusive traps.

The remaining portion of the Province, covering an area of about 6,500 square miles, is occupied by Lower, Middle, and Upper Carboniferous Strata. These sedimentary rocks will now be severally described in detail in the following Chapters.

CHAPTER III.

THE CARBONIFEROUS SERIES.

Area occupied by this Series—Possible extent of the true Coal Measures—Distribution of the Series in New Brunswick—The Central Area—The Tobique Outlier—The Bay of Fundy—On the Restigouche and Bay of Chaleurs—Details of the Eastern Coal Field—The Lower Carboniferous—The BONAVENTURE Formation—Its Distribution — The Copper Ores of Bathurst—Origin of—Dependence of their existence on the vegetable matter in the Sandstones—Section near Bathurst—Paucity of life in the Bonaventure formation—Absence of Coal—Improbability of finding extensive deposits of Copper in this Rock—The presence of the Metal depends upon the presence of organic matter—General origin of similar deposits—The TOBIQUE OUTLIER—Description of the Rocks on the Tobique—The Plaster Cliffs—Succession of Rocks in the Tobique Valley—Economic Materials in—The Limestones of the Tobique compared with others in the Province—Comparison between the Tobique Rocks and those of Albert County—Woodstock Conglomerate—Analysis of.

The Great Eastern Coal Field of America, the details of which are given further on, covers a large portion of New Brunswick. The Carboniferous area in this Province is estimated to extend over 6,500 square miles, a considerable part, however, being occupied by the Lower Carboniferous or unproductive Coal Measures. It will be shown in the sequel that recent examinations of the Flora of this Series show that the Middle Carboniferous or true Coal Measures occupy a larger and far more important area than was formerly supposed, and it is by no means improbable that productive seams of coal may be discovered in certain directions which will be described in the proper place.

The several parts of the Province where rocks belonging to the Carboniferous Series are known to exist, will now be briefly noticed, as well as a general outline of the Eastern American Coal Field.

If attention has been given to the description of the great folds or plications of the strata which were noticed in the last Chapter, and were there stated to have been the chief cause of the highlands, in the northwestern and southeastern part of the Province, it will be inferentially seen that a deep Sinus or Bay, like that drained by the Kennebeccasis, exists in the direction of the valley of Salmon River, and to a less extent along the valley of the South West Miramichi. It is thought probable that these supposed deep valleys, which would be the result of the folding of the strata, may be filled with Lower and Middle Carboniferous rocks, and covered by the upper portion of the Series. The reasons for this assumption will be amplified further on.

DISTRIBUTION OF THE CARBONIFEROUS SERIES IN NEW BRUNSWICK.

I. The great Central Plateau of triangular form, the apex being at Oromocto Lake, the extremities of the base at Bathurst, and the boundary between New Brunswick and Nova Scotia. The termination of this Plateau at Oromocto Lake is very remarkable. It appears to have been cut off abruptly by glacial ice. Vail's Hotel on the Magaguadavic is 230 feet above the sea, resting on Silurian slates. Rising abruptly from the valley of the river like a wall is seen the western edge of the Carboniferous Series, holding Lake Oromocto just within the rim of the narrow belt of Bonaventure rocks which fringe the Coal Measures. Oromocto Lake is 140 feet above Vail's, or 370 feet above the sea, but this west escarpment of the Coal Measures may be 100 feet higher. (See Chapter on Surface Geology for the probable origin of this escarpment.) The central area occupies a shallow basin containing probably one or two deep Bays, between the northeast granitic belt running through York, Northumberland, and Gloucester, and the northeast by east granitic belt runing through King's and Queens, in the direction of Butternut Ridge. Its mean elevation is about 450 feet above the sea. Connected with the central area is a deep sinus or indentation between the two granitic ranges in King's County, extending as far west as the Saint John. The entire development of the central area occupies part of Gloucester, Northumberland, and York, nearly the whole of Sunbury and Queen's, a large part of King's, and the whole of Westmorland, Kent, and a considerable portion of Albert County. An outlying patch covers parts of the Parishes of Prince William, Queensbury, and Dumfries.

II. The Tobique Outlier, extending from the foot of the Red Rapids to one mile and a half above Blue Mountain, a distance of 26 miles in an air line. The breadth of this Outlier is not known on the northwest side, but it probably does not exceed in the agregate 10 miles. Its northeastern boundary was ascertained in July last to extend 5½ miles up the north Gulquac, measured in a direct line. The area of the Outlier is probably not greater than 180 square miles, or 115,000 acres. The mouth of the Gulquac is 420 feet above the sea, which is about the mean elevation of the Outlier.

III. The Carboniferous Rocks on the Bay of Fundy, not at present forming a part of the central area. This Outlier extends from Emerson's Creek to Quaco.

IV. Mr. Matthew * describes a small area of Carboniferous Rocks on the east side of Saint John Harbour, in the rear of the plateau at Red Head, terminating in a bold cliff seventy feet high.

V. Dr. Gesner mentions an Outlier of the Carboniferous at Point Lepreau.

VI. On the Restigouche, there are small outliers at Point la Seine, also at Eel River, Huron Island, northwest of the mouth of Jacquet River, and in several places between Jacquet River and Bathurst.

* Observations on the Geology of Saint John County.

All of these now separate areas were at one time probably joined together, forming part of the Great Eastern Coal Field of America, which extends from the south shores of Gaspe in Canada, to the northeastern extremity of Breton Island, including part of Nova Scotia, passes under the Gulf of Saint Lawrence, and reappears on the southwestern extremity of Newfoundland. A portion of the bed of the Atlantic is probably composed of the rocks of this Series.

THE EASTERN COAL FIELDS OF AMERICA.

The following details will afford some idea of the Coal Fields of the Eastern Provinces of British North America—(New Brunswick, Nova Scotia, Newfoundland, and Cape Breton Island.)

General thickness of the Rocks of the Basin.

1.	Upper Coal Series—unproductive, ...	3,300 feet.
2.	Middle Coal Series—productive, ...	4,000 "
3.	Lower Carboniferous or Gypsiferous Series, ...	6,000 "

I. Central Coal Field of Nova Scotia and New Brunswick.

Area, 6,800 square miles; maximum thickness, 14,570 feet; number of seams of coal, 76; aggregate thickness of coal, 45 feet.

The principal known Coal Beds are at the Joggins in Nova Scotia—3½ and 1½ feet thick.

The Grand Lake seam in New Brunswick is 22 inches thick.

II. Colchester and Hants Coal Field, (N. S.)

Area, 200 square miles; Coal seams, under 18 inches.

III. Pictou Coal Field, (N. S.)

Area, 350 square miles; thickness of main Coal seams, 37½ feet and 22½ feet, separated by 157 feet of strata. A pillar of coal 36 feet high was sent to the London International Exhibition.

IV. Coal Fields of Richmond and Cape Breton.

Area, 350 square miles; productive measures cover 250 square miles; thickness 10,000 feet; contains numerous seams of workable coal, the main seam is 6 feet 9 inches thick.

Valuable Coal seams occur also at Lingan and Bridgport, one of which is nine feet in thickness.

V. Newfoundland Coal Field.

Two small Coal fields exist on this Island. The formation is similar to that of Nova Scotia, and the Lower Carboniferous contain red sandstones, red and green marls and gypsum, like the outlier on the Tobique. The thickest bed of coal is about three feet.*

The base of the Carboniferous Series, as developed in Canada and part of New Brunswick, constitutes the Bonaventure formation of Sir W. Logan. It consists of Red Sandstones interstratified with beds of a coarse calcareous conglomerate.† In Gaspé the Bonaventure formation attains its greatest

* The Coal Fields of Great Britain—by Edward Hull, B. A. † Geology of Canada.

development; the thickness of the series is there not less than three thousand feet. The only fossils which have been met with in this formation are certain large plants, converted into coal. It thins out in New Brunswick, although it is found at the rim of the basin throughout its entire development in this Province. But there have existed conditions in the Valley of the Kennebeccasis, which may have altered the character of the Bonaventure rocks there to a great degree.

The red sandstones and conglomerates which appear alone in Gaspe and the northern part of the Province, are in Westmorland, Albert and King's Counties, underlaid by a most important mass of bituminous shales whose thickness is probably not less than one thousand feet. These shales have been known in the Province under different designations, such as Caledonia Shales, Bituminous Shales, Albert Shales, Asphaltic Shales, &c. For the sake of uniformity they will be described in this Report as Albert Shales, because it is in these that the Albertite—a name first suggested to Sir Charles Lyell by the late Dr. Robb—of the celebrated Albert mines is chiefly embraced, although the same material is found in all kinds of rock as injected veins, and will be specially described in a succeeding Chapter. While, therefore, in Canada the base of the Carboniferous consists of red sandstones and conglomerates, in the southern part of New Brunswick the highly bituminous ALBERT SHALES form the lowest rock of the Series. On the first page of this Chapter, allusion is made to the deep Sinus or Bay forming the valley of the Kennebeccasis, and its eastern prolongation. It is in this Bay that the Albert Shales attain their greatest development.

THE LOWER CARBONIFEROUS.

THE BONAVENTURE FORMATION.

Skirting nearly the entire Carboniferous Series in New Brunswick, the conglomerates and sandstones of this formation may generally be recognized by the marked red colour they impart to the soil which overlies them, as well as by the intensely red aspect of the rock itself.

The occurrence of these rocks in the places represented on the geological map constructed by the late Dr. Robb, is in part hypothetical, much of the country where they are supposed to occur having never been examined, and some parts of it rarely visited, even by the lumberman. But from the marked regularity observed in the distribution of the whole series of rocks under consideration, it is probable that the general delineation of their outcrop is correct.

This formation was seen at Bathurst, by Sir William Logan, and described by him in the Geology of Canada. Here it reposes, nearly horizontally, upon granite of Devonian Age. The strata contain fossil plants, which about a mile above Bathurst, on the Nepisiguit, have been replaced in part by Sulphuret of Copper, which again has become converted into the Carbonate at the surface. This transmutation served as a sufficient foundation for the formation of the Gloucester Mining Company about 28 years since, but, owing to the irregular distribution of the organic remains * and the consequent uncertainty of the operations, the proprietors were induced to abandon the enterprize. The replacement of vegetable matter by ores of copper is by no means uncommon, and it has been described by Dr. Dawson as occurring to a certain extent in some of the lower beds on the Joggins Coast in Nova Scotia.† It is also stated by Sir William Logan, to occur in the Spanish Pyrenees, near Marc Auton and Hechos, where it has been successfully worked. A combination of coal and grey sulphuret of copper occupying the forms of vegetable remains, in a regular eighteen inch bed, seem there to crop out all around a considerable mountain.

The minerals have been introduced into the beds by water holding salts of copper in solution, in the form probably of blue vitriol or sulphate of copper. In contact with the carbonaceous matter of the fossil plants, the copper salt was deoxidized and deposited as a sulphuret.

SECTION NEAR BATHURST.

The following section of the strata occurs at and near the abandoned mine, on the Nepisiguit:—

	ft.	in.
Chocolate-red micaceo-arenaceous shale, with casts of shrinkage cracks, ...	30	0
White quartzose conglomerate, the thickest part of which is two feet, diminishing in one direction to two inches, in the space of 15 yards. The bottom is very white, and contains quartz pebbles, some of which are an inch in diameter, ...	1	0
Whitish-red argillo-arenaceous shale, forming a passage to the next bed below, ...	0	6
Whitish-red argillo-arenaceous shale in parallel layers; the bed thins out about 30 yards up the stream. It is charged with the remains of broken plants, some of which are replaced by vitreous sulphuret of copper, coated with a thin covering of green carbonate. Some are in part replaced by the copper ore, and partly converted into coal. Small nodules of the sulphuret of copper also occur, chiefly in the lower part, and traces of nickel are said to have been found in some of them. The greatest thickness of the bed is four feet; its average, ...	2	0
White quartzose conglomerate, similar to that of the summit. This does not thin out in the distance examined, about 50 yards, ...	4	0
Red Sandstone conglomerate with white quartz pebbles; of which some would weigh three ounces, ...	6	0
Red Shale, ...	6	0
Red Sandstone conglomerate, with quartz pebbles, some weighing a pound and a half,‡	10	0
	59	6

* Geology of Canada. † Acadian Geology. ‡ Geology of Canada.

At Rough Waters the strata are seen lying in a nearly horizontal attitude upon the granite, and filling the inequalities of its surface. They extend up this river as far as two miles below the Second Landing, where they cover up rocks belonging to the Quebec Group, and on the north side of the river they here form cliffs 20 feet high, consisting of brick-red shales and sandstones resting upon a coarse conglomerate. They come on the river again, (the intervening space being occupied by granite,) a short distance above the Pabineau Falls on the south bank, the opposite side and the bed of the river being granite. At Brandy Brook the sandstones and conglomerates are seen in cliffs 20 feet high, and on the east side they appear to form a hill about 80 feet in altitude. The Rough Waters, more than two miles long, flow over granite, but on either side the Bonaventure formation may be recognized reposing horizontally upon it, and filling all depressions. The breadth of the Bonaventure formation on the road to Chatham, from its northwestern boundary near Bathurst, is about 13 miles, including the Harbour of Bathurst, and this is probably the broadest portion in the northern part of the Province, assuming that the limestones and gypsum which overlie the red sandstones and conglomerates are not included in the formation. About 9½ miles from Bathurst, there appears to be an outlier or tongue of the Bonaventure Rocks, as shown by the steep cliffs of Little Bass River, and the red character of the soil.

Between the Nepisiguit and the South West Miramichi, the Bonaventure formation has not been traced, although it is laid down on the Geological Map of the Province accompanying Professor Johnston's Report, and where a section was made down the South West Miramichi this summer, the red rocks of the formation were not seen in position, although boulders were numerous. At the foot of the Island above Campbell, the grey sandstones and conglomerates overlying the red rocks have a very slight southerly dip, and rest on the tilted edges of Silurian Shales. That these strata do, however, extend all the way to Bathurst in the form of a narrow belt, is probable, as they are seen in many places between Campbell and the Saint John; they probably form a narrow belt about two miles broad, but in some places cover a wider area, for on Long's Creek, in the Parish of Kingsclear, they were observed a mile and a half below Essana's Mill, (about four miles from the Saint John), forming a coarse red rock, lying upon Silurian Slates. The pebbles were from six inches downwards in diameter, and the dip is to the south at an angle of 20°. (S. 10° E. angle 20 S.) They appear for some miles on the road to Harvey Settlement, which runs across them diagonally. Near the head of Oromocto Lake, when viewed from Magaguadavic Bridge (at Vail's), the bold cliffs of the denuded face of these rocks present a very fine appearance. In the Valley of the Kennebeccasis, and probably in other parts of the southeastern portion of the Province, where they are at the surface, the red conglomerates form the hills. It is a strong rock, and has resisted denuding agencies to a much greater extent than the softer sandstones which overlie it, hence the reasons why it not only marks the limit of the Carboniferous Series in New Brunswick with singular uniformity, but where it is exposed as a mass it forms imposing elevations or steep bluffs.

The same remark applies to this conglomerate on the Gaspe Shore, where the salient parts of the coast are composed of the conglomerate beds, while the re-entering angles correspond to the softer and less resisting red sandstones. Hence the zigzag line of the coast.*

It was suggested by Dr. Robb that the chief highlands on the Kennebecasis, from Milkish to the bluff, Mount Pisgah in Sussex and Studholm, and many hills on the coast of Charlotte County where outliers occur, were formed of this resisting rock.

LIFE DURING THE BONAVENTURE PERIOD.

The prevailing red colour is probably due to per-oxide of iron in the absence of organic remains; and it has been remarked by Dr. Dawson that the cause of the grey colour of certain sandstones may be traced to the presence of fossil plants, which have destroyed their original red colouring matter, the per-oxide of iron, just as in modern marshes on the Bay of Fundy, vegetable matter gradually converts the red into the grey mud, by de-oxydizing the red oxide of iron.

The period of Geological History embraced by the Bonaventure Formation must have been exceedingly barren in that part of the Continent where the red conglomerates and sandstones were deposited. But a series of strata upwards of 3,000 feet thick, almost destitute of animal or vegetable remains, was the prelude to the wonderful development of life which teamed in the oceans, swamps, and estuaries, of the succeeding age. It is probable, too, that deep secluded bays in the seas of this period, abounded in fish life, and their shores with a great variety and profusion of plants, for the Albert Shales, more than a thousand feet thick, in Hillsborough, which belong to the base of the Lower Carboniferous, are loaded with fish and plant remains, and the red conglomerates and marls surround and overlap them, though their thickness is comparatively insignificant.

NO WORKABLE COAL SEAMS IN THESE ROCKS.

In the Bonaventure Rocks, the paucity of fossil remains, independently of their lying at the base of the Carboniferous Series, would make any search for workable coal seams highly speculative; and although small seams from two to four inches thick have been found in various places, such for instance as in the outlier near Campbellton on the Restigouche, and as alleged, in the Harvey Settlement, (township of Manners-Sutton,) yet in the present state of our knowledge but slight prospects can be held out that remunerative seams will be discovered, or that any other result but disappointment will attend the search for *workable* coal in the strata of the Bonaventure formation *on the rim* of the Carboniferous Series in this Province. (*Vide* end of Chapter IV.)

* Geology of Canada.

In the deep sinus, now the valley of the Kennebeccasis, other conditions may prevail, and the Lower Carboniferous there yield workable beds, though the probability is against their occurrence; but it would be premature to express any decided opinion on the subject until the thickness of the formation and its rock characters in that remarkable indent are known. It has been stated on good authority, that there exist not far from Sussex Vale, two seams of coal, separated by a narrow parting of clay, the aggregate thickness of these seams being twenty inches.

In addition to what has been already stated with reference to workable seams of coal in the Lower Carboniferous in America, it may be urged that in Scotland the workable coal deposits belong to the Lower Carboniferous, which there, however, is of considerable thickness, whereas the rocks of the same age in the Valley of the Kennebeccasis and eastwards are comparatively thin.

The coal fields of Russia are considered by Sir R. I. Murchison to belong to the Lower Carboniferous period.* But they form an immense series stretching over a vast extent of country, and the greater part of the beds of coal are contained in the Carboniferous Limestone Series, as in the case of Scotland and Ireland.†

At the close of this Chapter a comparison is made between the Rocks of the Tobique Outlier and the Lower Carboniferous in Albert County. It will be there seen that the Albert Shales are supposed to be older than the Red Conglomerate of the Bonaventure formation, and to be at the very base of the Series.

OTHER MINERALS IN THIS FORMATION.

With reference to other minerals, the formation appears to be equally barren. Allusion has already been made to the Copper ores near Bathurst, but as these depend upon the abundance of vegetable matter in the sandstones to fix the salts of copper coming from much older rocks (the Quebec Group), in a state of solution, it is manifest that when the general absence of the de-oxydizing fossil vegetable is shown, the copper ore will not probably be found in quantity sufficient to warrant any large expenditure of capital or skill in search of it, for it will be understood at a glance that springs rich in copper salts might percolate through the sandstones for ages, but not a particle of copper would be arrested as soon as the supply of fossil vegetable matter became exhausted. If layers of vegetable matter, such as seams of impure coal, even three or four inches thick, were to be discovered in these rocks near Bathurst, it would afford some encouragement to trace them towards the locality where the copper ores were found. The clue to the copper ores will be the seams of impure coal—these once found, the metal may be looked for along their outcrop, with some prospect of success.

It is very probable that the substitution of a metallic mass for vegetable or animal matter has taken place to an enormous extent in the

* Russia and the Ural Mountains. † Hull—Coal Fields of America.

rocks of this Continent. Professor Hunt considers that the evidence presented by the copper deposits of the Quebec Group, (from which those of Bathurst originated), appears to show that not only copper, but iron, manganese, nickel, and chrome, which so often accompany copper throughout the ancient Silurian Rocks, were held in solution by the waters from which the sediments of the period were deposited, and that by the agency of organic matters they were reduced to the condition of a sulphuret, and precipitated with the sediments, either in a finely divided state, or more frequently in small nodules or patches, which became interstratified with the rocks of the series.* Hence it would appear, that the Bathurst Copper Ores are a second reproduction of a series of mutations which may be briefly described as follows:—The waters in which the sediments composing the rocks of the Quebec Group, underlying or surrounding the Bathurst shales and sandstones of the Bonaventure formation, were deposited, held salts of copper in solution, these were reduced by the vegetable matter contained in the ancient ocean and precipitated with the sediment in a solid form, and lay for ages as copper ores. Subsequently by the action of water and air, as the rock was exposed by denudation, a portion of the sulphuret again assumed a soluble form, to be a second time deoxydized when percolating through the organic matter contained in the shales and sandstones of the Bonaventure Rocks. This interesting and instructive subject will be again noticed in considering the origin of the iron ores of Woodstock, and the antimony of Prince William, &c. &c.

THE TOBIQUE OUTLIER.

The red conglomerate and sandstone of the Bonaventure formation cover horizontally the Silurian slates at an Island about nine miles from the mouth of the Tobique, and at the foot of the Red Rapids a fine section is exposed. The conglomerate holds a large number of green slate pebbles, with a less proportion of rounded and sharp pebbles of quartz. Between the Island and Red Rapids there is a protruding mass of this lower rock. The dips show a series of low undulations which continue to the northeastern extremity of the outlier. At the Island where the red rocks are first seen, the strata lie horizontally; at the foot of the Red Rapids the dip is E. N. E. $<$ 4°; half a mile up the stream the dip is W. S. W. at an angle of 5°, and a hundred yards farther on the dip is E. N. E. at about the same angle. There are seams of green shale between the red sandstones and shales or marls just above the head of the first rapid, and near the foot of the second rapid the rock loses its intensely red character and appears of a rusty brown, at times merging into grey. This is probably the limit of the Bonaventure formation, the succeeding rocks being more of the character of grits. These occur at Red Bank, eighteen miles up the river, where the strata are composed of minute angular particles of quartz firmly cemented together and possessing sufficient hardness and grit to make them serviceable as Mill stones.

* Geology of Canada.

Other layers are of sufficient fineness to admit of their being used as grindstones, being composed of fine white quartz grains. Above Three Brooks the bands of sandstone crop out on the bank with a north east dip of three or four degrees, and approaching the mouth of the Wapskehegan boulders of limestone become numerous. The red sandstone is variegated, and in it are found patches of a highly calcareous nature. The fine grained conglomerate of a pinkish colour, which occurs above Red Bank, is the same as that used by the proprietors of the Iron Works at Woodstock, in the construction of the new furnace, but the place where they have obtained their material is some miles further up the River. It has a pinkish cast, like some layers of the sandstone associated with it. It occurs in massive beds, and appears to be composed of angular grains of flint or quartz, with a few pebbles of slate.

Half a mile below the Wapskehegan, the pink sandstones disappear, and are overlaid by alternating red and green bands. The green are hard and calcareous, the red shaly and soft, approaching a red marl in composition.

LIMESTONES.

About a third of a mile above the mouth of the same river, silicious limestone appears in heavy bedded layers interstratified with red shales. A limekiln has been constructed at this spot, but is not now in operation. The limestone is pale sea green in colour, weathering dirty white; it occurs in beds from two to four feet thick, and dips to the east at an angle varying from three to five degrees. On the summit of a hill two hundred yards from the river, and about 120 feet above it, the limestone appears in heavy beds, and of a purer description than on the river, containing far less silicious matter. The rock is fissured at the surface, the crevices being two feet and less in diameter. The lime in a kiln constructed at the summit of the hill, is of good quality. The massive beds are not uniform in colour, being pale sea green streaked with red; patches of red are also not unfrequent. The limestone and shale appear to be about 140 feet in thickness. Half a mile above the outcrop of the limestone, a beautiful hard and white sandstone, with green specks in it, apparently succeeds the limestone. It is interstratified with an intensely red sandstone, dipping underneath the limestone. This must be a recurrence of the measures before described, the river here making a great bend to the northwest across the stratification.

GYPSUM.

The celebrated plaster cliffs, about 130 feet high, succeed the limestone. They consist of alternating bands of impure gypsum, greenish and red; red shale, and small seams of fibrous gypsum and amorphous alabaster, which also occurs in small dense masses, sometimes rose tinted, but generally pure white. The green and red varieties exfoliate; the red shales are fissile and underlie the gypsum. A careful measurement of the dip showed that the inclination to the southeast was 11 feet 8 inches in 360 feet of horizontal distance, or about 1 in 31½, or equal to a rise of 170 feet in a mile, which will give the gypsum a thickness of about 350 feet, if the inclination be maintained. Two hundred and fifty yards below the foregoing measurement, the dip was found to be E. $< 6°$.

About a mile above the plaster cliffs there is a remarkable exposure of tufaceous limestone. The surface is reddened by the debris of superimposed or interstratified red shales, but the limestone bands are four feet in thickness, and are weathered into the most fantastic shapes. The forms of the weathered surfaces assimilate those common in limestone caverns, showing numerous stalactitic prominences on the under side of overhanging bands. The tufaceous masses exhibited the impressions of leaves, roots and fragments of wood, which the calcareous substance has encrusted. The fine but highly silicious gritty conglomerate underlies this limestone, which is the continuation of the massive layers before described, coming up again on a synclinal slope below the gypsum, which appears to occupy the summit of the entire series in the valley of the Tobique.

CONGLOMERATE.

A mile and a quarter beyond the plaster cliffs the fine red quartzose conglomerate again comes into view, the lower beds being a coarse sandstone, the beds at the summit of the exposure a soft red sandstone, with pale yellowish green layers. Salt Brook, which flows into the Tobique a short distance above the plaster cliffs, has a brackish taste and medicinal properties; on examination it was found to contain a small quantity of sulphuretted hydrogen, a considerable percentage of sulphate of magnesia, (Epsom Salts,) to which probably its aperient effects are due, and some common salt. Below Sisson's Brook the country is well fitted for agricultural settlement, it equals the fine expanse of alluvial soil near the O'Dell (Otella) settlement.

Red sandstone again appears above Burnt Land Brook with an easterly dip of 4°. And a quarter of a mile above the brook, the heavy bedded crystalline limestones are seen interstratified with red and green shales. The upper layers are greenish, the lower grey. At Burnt Hill Brook the limestone layers were traced fifty feet above the river, but to a passing traveller, being externally red from the decomposing interstratified red shales, they look like beds of red sandstone; a blow with a hammer, immediately despels this illusion, and reveals the true calcareous character of the upper layers. There are some fine flats with superb elms in this neighbourhood. Half a mile below the Oxbow a low anticlinal axis occurs, the sandstone dipping west at an angle varying from 3° to 5°. Opposite an Island situated in a part of the river called the Oxbow, the banks show strata of alternating red, green, purple-red, and lavender-blue marls, with much shale of the same colours. It is only seen over a breadth of 20 yards. Three quarters of a mile above the Oxbow, the red sandstone and fine conglomerates come up on the west side of the low synclinal, the dip of the strata being east at a very low angle. About the same distance above the Gulquac, the pink quartzoze sandstone and conglomerate, before described as occurring near Red Bank, again come up, and it is from this locality that the materials for the formation of the Iron Furnace near Woodstock, were obtained. Equally good materials appear to exist nine miles lower down the river. The fine conglomerate occupies the bed of the river here, and on the left bank it is seen at an altitude of 40 feet above the water to be capped by alternating white sandstones, red shales and sandstones, and variegated sandstones, the whole having an altitude of about 100 feet; the strata here are slightly undulating.

Immediately below the Little Gulquac, the red conglomerate is seen overlying thick-bedded grey and pink conglomerates, dipping E., showing another low anticlinal axis; and a short distance higher up the river, red sandstone occurs in horizontal layers, terminating the southwest Carboniferous basin in the Tobique valley. This basin is separated by a few hundred yards of Silurian rocks from another but much smaller outlier, which begins about two miles above the North Gulquac, and extends as far as Irving's Brook, at the foot of Blue Mountain, a distance measured in an air line of about six miles. The upper basin contains only the red conglomerates and sandstones; it is separated on the river from the lower basin by an undulation, of which there are three between Red Rapids and Irving's Brook.

The following Table shows the order of succession in the Tobique Series of the Lower Carboniferous Rocks:—

TOBIQUE SECTION.

I. Gypsum.
II. Silicious Limestone.
III. Red and green calcareous Shales.
IV. Variegated calcareous Sandstone.
V. White and pink Grits and Sandstones.
VI. White Grits.
VII. Red Conglomerates and Sandstones.

The economic materials found in the above rocks are not unimportant; they contain—

1. Sandstones suitable for building purposes and for Grindstones.
2. Grits well adapted for Millstones.
3. Firestones.
4. Limestones.*
6. Plaster.
7. Ochres of good quality in the alluvial flats of the Islands.
8. Indications of Manganese in the rocks below.

* See analysis of one of these limestones on a succeeding page.

When the older rocks upon which these lower carboniferous strata repose are described, other and more attractive minerals and metals will be enumerated among the natural sources of wealth contained within the beautiful valley of the Tobique. Some of the settlers on the banks of this river report the existence of coal, but no specimens were seen, nor is it in the least degree probable that any productive measures will be found within the limits of this valley. A black gravel, cemented by black oxide of manganese, was noticed on the banks of the river; similar gravels were seen on the South West Miramichi. These are important only as indicating the presence of manganese in the rocks upon which the gravels rest. These are probably the same as those which occur on the Nepisiguit and Tattagouche, where manganese is abundant. The metal has been brought to the surface by springs, and its presence leads to the inference that wad or bog manganese will be found in the valley of the Tobique as it is in similar rocks near Sussex Vale, the origin in both cases being from older rocks below.

THE LIMESTONES OF THE PROVINCE.

The Limestones of the Lower Carboniferous Series appear to be all more or less silicious. Some layers on the Tobique contain too much silica to admit of their being used for building purposes; others on the Kennebeccasis are remarkably bituminous; and those which Dr. Gesner called "Lias," but which are really Lower Carboniferous, as in Norton, Sussex Vale, on Hammond River, and at Butternut Ridge, emit a fetid odour when struck with a hammer. Other varieties in the same basin are not sensibly bituminous. In many cases it is evident that the bitumen is of foreign origin, and not produced by the decomposition of marine animals in place.

The following analyses of limestones from these localities where the rocks under review occur, compared with one from the ancient crystalline limestone near Saint John, and another from L'Etang, will illustrate the wide difference which exists between the calcareous deposits of the different formations. The first three are taken from Professor Johnston's Report on the Agricultural Capabilities of New Brunswick, the fourth from Dr. Jackson's Report, the last column is by the writer. It will be observed that the specimen of Tobique limestone is more silicious than any of the others selected from Lower Carboniferous Rocks.

	Butternut Ridge.	St. John.	Near the Petitcodiac	L'Etang.	Tobique.
Carbonate of Lime,	91.28	98.25	94.08	98.00	82.62
Carbonate of Magnesia,	0.78	0.17	0.63	....	1.25
Alumina and Oxides of Iron,	0.54	0.33	0.68	0.40	0.97
Insoluble Silicious matter,	7.27	0.22	4.57	0.80	14.75
	99.87	99.67	99.96	99.20	99.59

In the last Chapter a Table is given showing the locality of all the known Limestone deposits in the Province, with some remarks on their peculiarities.

COMPARATIVE TABLE SHOWING THE SUCCESSION OF ROCKS IN ALBERT COUNTY AND THE TOBIQUE OUTLIER.

	Albert County.	*Tobique Outlier.*
Lower Coal Measures.	I. GREY SANDSTONES, GRITS, & COARSE LIGHT BROWN CONGLOMERATE. II. GREY CONGLOMERATE.	
	III. RED SANDSTONES.	
	IV. GYPSUM.	I. GYPSUM. Salt Springs.
	V. RED and GREEN MARLS. VI. LIMESTONE, (Cherty in layers.)	II. LIMESTONE, (Cherty in layers). III. RED and GREEN MARLS.
	VII. RED, DARK BROWN, and GREEN CONGLOMERATES, with beds of SANDSTONE.	IV. VARIEGATED CALCAREOUS SANDSTONES. V. WHITE GRITS, PINK & WHITE GRITS, both coarse and fine. VI. RED CONGLOMERATES and RED SANDSTONES.
	VIII. BITUMINOUS SHALES, or ALBERT SHALES.	
	DEVONIAN ROCKS.	LOWER SILURIAN ROCKS.

WOODSTOCK CONGLOMERATE.

In the vicinity of the Woodstock Iron Furnaces there is a remarkable outlier of ferruginous conglomerate, with a strike N. 35 E. and dip 50° southwesterly, resting unconformably upon the Lower Silurian Slates, which have a strike north and south, and a westerly dip at a high angle, about 200 yards west of the conglomerates. This conglomerate is stated by Mr. C. H. Hitchcock to occur again at a ferry about nine miles above Woodstock, dipping 25° N.W. Some of the strata are fine-grained, with impressions of raindrops. A few of the pebbles, according to the same authority, are encased in gypsum, and the conglomerate is considered to be of the same age as the Tobique outlier. Without expressing any opinion as to the age of this rock, the following analysis shows it to have been formed chiefly from the debris of the red ferruginous and manganesian slates which form the source of the ore of the Woodstock Iron Mines. From information obtained on the spot, it appears probable that a considerable area of this conglomerate occurs in Brighton Parish, from which its age may be determined. Near Woodstock it rests upon the Lower Silurian Slates unconformably, but inclined in the same direction; the underlying slates being tilted at a high angle with a westerly dip, the conglomerate dipping also westerly at an angle of about fifty degrees.

*Chemical composition of the Conglomerate Outlier near Woodstock.**

Peroxide of Iron, ...	7.857
Alumina, ...	4.371
Oxide of Manganese, ...	1.004
Lime, ...	4.046
Magnesia, ...	3.220
Potash, ...	.214
Soda, ...	.287
Sulphuric acid, ...	1.070
Phosphoric acid, ...	.880
Silica, ...	71.030
Carbonic acid and water, ...	6.011
	100.000
Metallic Iron, ...	5.500

* This analysis was kindly supplied by Norris Best, Esq., one of the Proprietors of the Woodstock Iron Works.

CHAPTER IV.

THE CARBONIFEROUS SERIES.—(Continued.)

The Central Triangular Area—Dr. Gesner's views—Dr. Robb's views—Mr. Henwood's opinions—Personal examinations—Dana and Dawson's subdivision of Carboniferous Rocks—Section in New Brandon—Lower and Middle Formation—Synopsis of the Flora of the Carboniferous Rocks of New Brunswick—The Flora of the Upper, Middle and Lower Rocks of the Series—Productive Coal Measures on Grand Lake—Probability of Coal being found in New Brunswick—Grand Lake Coal—Quantity raised—Section of Rocks from Oromocto Creek toward the Douglas Hills—True Coal Measures in the Valley of Salmon River—On the Richibucto—True Coal Measures probably extend from Grand Lake to the Gulf—The Valleys of the Kennebeccasis and Petitcodiac—Section in Albert County and Westmorland—Section north of Norton Station—Review of what is known respecting the Carboniferous Rocks of New Brunswick—Value of Gypsum and Limestone—Bituminous Shales—Life and Climate during the Carboniferous Period.

THE CENTRAL TRIANGULAR AREA.

A very considerable portion of this extensive area must still be regarded as a *terra incognita*. It is chiefly occupied by the "forest primeval," and large districts have not yet been topographically examined, except for timber berths. In the Government Map published in 1859, (Mr. Wilkinson's), which embodies so large an amount of geographical information, there are still left vacant spots which show the paucity of existing knowledge even as to the rivers which drain them. A glance at the Map will enable any one to point to such areas between the upper waters of Salmon River and Washademoak River, in the Parish of Brunswick, the north part of Salisbury, and the northeast part of Waterborough. Nor do many portions of this great basin appear to have been visited by a geologist. Sir William Logan, in 1843, walked * along the coast from Bay Verte to Bathurst, but he did not penetrate the interior. Dr. Gesner has given a highly coloured description of the "Coal Fields" of various Counties, but I find nothing in his delineations which would lead one to suppose that he had made a section across the entire Carboniferous area, so as to determine the sequence of the different formations, and establish the existence or otherwise of the Middle Carboniferous or productive coal measures. Dr. Gesner frequently describes in glowing

* It was in this year (1843) that Sir William Logan made that elaborate section of the Carboniferous Rocks at the Joggins in Nova Scotia, which Dr. Dawson has well described as "a remarkable monument of his industry and powers of observation." It may surprise some of my readers who are not fond of walking, when I state that Sir William Logan, in 1843, *walked* nearly the whole way from the Joggins in Nova Scotia, to the boundary of the Carboniferous Series near Bathurst, for the express purpose of examining the rocks exposed on the road to Canada. In his exploration in Canada he has *walked* probably not less than 25,000 miles, or equal to once round the Earth.

terms the amazing advantages which will result to New Brunswick on account of her immense deposits of coal, but he has not in his Reports pointed out the existence of a single *workable* bed of greater thickness than 22 inches. In the admirable resumé of what was known of the "Coal in New Brunswick in 1849," prepared by Dr. Robb, from his own observations and enquiries and the Reports of Dr. Gesner, the following conclusions are stated:—

"1. That though very many outcrops of common coal well adapted for blacksmith's use, are known to exist in the country, yet none of them exceed eighteen or twenty inches in thickness.

2. That though the beds of cannel coal reported to exist have a very considerable thickness, they hardly come up to the average standard of purity.

3. That the importance of the beds which are known has been over-stated, while the probability of finding others of greater thickness and improved quality, has been much exaggerated."*

Dr. Gesner did not stand alone in his sanguine views respecting the New Brunswick Coal Field. In the Transactions of the Royal Geological Society of Cornwall (1840), Mr. Henwood observes, that "the beauty and extent of these Coal Measures it is impossible to describe. In fact, we pass over nothing else, from Fredericton, on the Saint John River, to Miramichi, and thence to Bathurst, a distance of at least 150 miles. They consist of various beds of sandstone, shale, and conglomerate, with numerous thin seams of coal, few of which are more than a foot or two in thickness. The whole of this district is particularly rich in fossil flora."

My own examinations of the central area have necessarily been limited, and have, indeed, been confined to the district between Bathurst and Chatham; the neighbourhood of Boiestown; a portion of the country between Boiestown and Fredericton; the neighbourhood of Fredericton and Shediac; the Nerepis Road; Oromocto Road; in the Parishes of Manners-Sutton and Kingsclear; in Albert County; in the townships of Norton, Springfield, and part of Sussex, in King's County; and a few localities where an opportunity of making an observation on the rocks occurred, in journeying from one point to another within the limits of the Carboniferous area.

Under these circumstances, it is scarcely necessary to state that whatever information I may be able to offer respecting this large portion of the Province, relates almost altogether to the rim of the area; and as it is known that the rocks within it have been subjected to gentle undulations, which may have exerted a material influence upon them, it will be readily understood that where so large a portion is unexplored, conclusions respecting it must be in the main hypothetical, without they are based upon scientific data. For the purpose of explaining to the unscientific reader that the occurrence of carboniferous rocks to an immense extent, does not necessarily imply the existence of workable seams of coal, or, indeed, any coal at

* Report by Dr. Robb in Prof. Johnston's Report on the Agricultural Capabilities of New Brunswick.

all, it will be desirable to describe in general terms the opinions of Geologists as to the relation which the coal bearing strata, or coal measures in America, maintain with reference to the great mass of rock groups denominated the Carboniferous Series.

Dana* divides the American Carboniferous Rocks into three periods:—

I. Subcarboniferous Period.
II. The Carboniferous Period.
III. The Permian Period.

These are again subdivided in the following manner, showing the relation of the productive Coal Measures to the other Groups:—

I. Subcarboniferous Period.
  a. Upper.
  b. Lower, with *False Coal Measures.*
II. Carboniferous.
  a. Millstone Grit Epoch.
  b. Coal Measure Epoch.
III. Permian.

Dawson gives the following Synopsis of the Carboniferous Rocks of Nova Scotia:—

UPPER OR NEWER COAL FORMATION.

Greyish and reddish sandstones and shales, with beds of conglomerate, and a few thin beds of limestone and coal, the latter not of economic importance. Thickness, 3000 feet or more.

Characteristic Fossils.—Coniferous wood, Calamites, Ferns, &c.

LOWER OR OLDER COAL FORMATION.

Grey and dark coloured sandstones and shales, with a few reddish and brown beds; valuable beds of coal and ironstone; beds of bituminous limestone, and numerous underlays with Stigmaria. Thickness, 4000 feet or more.

Characteristic Fossils.—Stigmaria, Lepidodendron, Poacites, Calamites, Pecopteris, Equitsetum, &c. Erect trees *in situ;* remains of Ganoid Fishes, Cypris, Modiola, Spirorbis, Unio, &c. Reptiles, &c.

It is a general law, first noticed by Sir W. E. Logan, that the *Stigmaria Ficoides,* when found in an underlay, always indicates a true seam of coal.

LOWER CARBONIFEROUS OR GYPSIFEROUS FORMATION.

Great thickness of reddish and grey sandstones and shales, especially in upper part; conglomerates, especially in lower part; thick beds of limestone with marine shells and of gypsum. Thickness, 6000 feet or more.

Characteristic Fossils.—Productus, Terebratula, Encrinus, Madrepores, and other marine remains in the limestones; Coniferous wood, Lepidodendron Poacites or Cordaites, &c., in thin shales and sandstones; Fishes and scales of ganoid fish very abundant in the lowest beds; Trilobites, Reptiles, &c.

* Manual of Geology, by James D. Dana. Philadelphia: Theodore Bliss & Co., 1863. An admirable work, with which all students of Geology should be familiar.

In a recent paper by Dr. Dawson, a more uniform nomenclature has been adopted, and the terms Upper, Middle, and Lower Coal Formations, applied to the divisions of the Carboniferous Series. The "Lower Coal formation" is equivalent to the "Subcarboniferous" of Dana; the "Middle Coal Formation" is the "Coal Measure Epoch" of Dana, including the marine limestones and the principal coal beds. The "Upper Coal Formation" is applied to that part of the Series over the productive Coal Measures, but this does not include the Permian of Dana.*

All the evidence hitherto obtained with regard to the carboniferous rocks of New Brunswick, tends to show that at and near the rim of the central triangular area, the New Brunswick rocks belong to the Lower Carboniferous formation, and consequently lie below the Productive Coal Measures.

Towards the southeast portion of the area, in the neighbourhood of Grand Lake, the rocks are, according to Dr. Dawson, "on the horizon of the middle coal formation, though tending to the upper." This is an important fact, and with a knowledge of the dip and strike of the rocks, it affords not only a guide as to the direction in which the productive coal measures may be looked for, but it also shows that these productive measures will probably be found within the limits of the Province, the more especially as there is reason to believe in the existence of one or more deep bays or sinuses lying within the triangular area; and it is thought probable that these bays (resembling the Sussex Vale Bay,) may be in part filled with the middle carboniferous or productive coal measures. The origin of these supposed bays has been noticed on page 59.

I shall now proceed to describe what is actually known respecting the Carboniferous Rocks of the Province, and conclude the subject with a few deductions, which may serve to indicate the direction of future enquiry.

COAL FORMATION ON THE BAY OF CHALEURS.

At Salmon Beach, four miles from the entrance to the Harbour of Bathurst, red sandstones belonging probably to the Bonaventure Formation, dip to the northeast, and are succeeded five miles farther on by a succession of greenish-grey or drab sandstones, which also dip in the same direction at a low angle. As far as Point Dumai, 12 miles from Cranberry Cape, these rocks can be seen in the cliffs, which vary from twenty to one hundred feet in altitude, and the thickness of all the beds visible amounts to nearly four hundred feet.

In this section there are two seams of coal within 182 feet of one another, the upper one eight inches and the lower six inches thick. The roof of the upper coal seam consists of a dark bluish-grey argillaceous shale, and contains an abundance of ferns and other plants.†

These were submitted to Dr. Dawson, who considers them to indicate beds of the lower and probably *middle* coal formation. The beds include

* Synopsis of the Flora of the Carboniferous Period in Nova Scotia."—Can. Naturalist, vol. viii. 1863.
† Geology of Canada.

some species which, in Nova Scotia, are more characteristic of the upper coal formation. "This apparent mixture," says Dr. Dawson, "of plants of different horizons, may be a consequence of the comparatively small thickness of the New Brunswick coal formation."*

SECTION OF THE COAL MEASURES DISPLAYED IN THE CLIFFS BETWEEN CAPE CRANBERRY AND POINT DUMAI, IN THE COUNTY OF GLOUCESTER.

(The beds are given in descending order.)†

	Ft.	in.
Greenish-grey sandstone, much of it fit for *grindstones*. This composes Dumai Point, and approaching Grindstone Point it becomes interstratified with occasional layers of red shale, ...	50	0
Red arenaceous shale, becoming occasionally red sandstone, ...	15	0
Greenish-grey sandstone, ...	5	0
Red argillo-arenaceous shale, ...	15	0
Greenish-grey sandstone of an excellent quality for grindstones. This constitutes Grindstone Point, where grindstones are quarried,	45	0
Red argillo-arenaceous shale, ...	8	0
Greenish-grey arenaceous shale, in some places along the cliff becoming a sandstone sufficiently hard to resist the effects of the weather,	6	0
Red argillo-arenaceous shale, ...	17	0
Greenish-grey arenaceous shale, sometimes a sandstone, ...	3	0
Red argillo-arenaceous shale, ...	12	0
Green arenaceous shale, ...	2	0
Red argillo-arenaceous shale, ...	12	0
Green arenaceous shale, ...	2	0
Red argillo-arenaceous shale, ...	3	0
Greenish-grey arenaceous shale, sometimes becoming a sandstone,	4	0
Red argillo-arenaceous shale, ...	5	0
Greenish-grey sandstone, ...	5	0
Dark-grey argillaceous shale, with argillaceous iron ore in nodules,	2	0
Red argillo-arenaceous shale, ...	5	0
Grey argillaceous shale, ...	1	0
Greenish-grey arenaceous shale, in some places becoming a sandstone,	4	0
Grey argillaceous shale, with ironstone balls, ...	2	0
Greenish-grey arenaceous shale, in some places becoming a sandstone,	6	0
Green argillaceous shale, ...	3	0
Greenish-grey arenaceous shale, ...	3	0
Grey argillaceous shale, with nodules of argillaceous iron ore, ...	2	0
Greenish-grey arenaceous shale, in many places along the cliff assuming the hardness and consistency of a sandstone fit for building. In it *stigmaria* branches occur, and it is said that some time ago there used to be two upright columns, half imbedded in the rock, and at right angles to the stratification, well displayed. They were probably upright *sigillaria*.	5	0

* Synopsis of the Flora of the Carboniferous Period in Nova Scotia.

† Appendix to the fifth volume of the Journals of the Legislative Assembly of the Province of Canada. Sir W. E. Logan's Report.

Dark bluish-gray argillaceous shale, stored with abundance of impressions of ferns and other plants, among which was observed the branch of a Stigmaria, nine feet long, without leaves. On many of the plants a very minute convoluted shell is seen, and in the shale a small bivalve. In the distance of a mile along the face of the cliff this shale is sometimes six feet thick, and sometimes only one foot, and occasionally it is absent altogether, leaving the overlying sandstone in contact with the coal beneath, ...	5	0
COAL of a bituminous quality, with a thin seam of iron pyrites (a quarter to half an inch,) occasionally on the top, ...	0	8
Gray argillo-arenaceous shale of a tough crumbling quality, much resembling fire clay, abundantly filled with the leaves and branches of the *Stigmaria ficoides*, and having nodules of argillaceous iron ore,	3	0
Green argillaceous shale, ...	12	0
Greenish-grey arenaceous shale, ...	3	0
Red argillo-arenaceous shale, ...	10	0
Green and red shale with nodules of yellow limestone (with Stigmaria,)	2	0
Greenish-grey arenaceous shale and sandstone, ...	13	0
Red argillo-arenaceous shale, ...	3	0
Red sandstone and red shale, ...	9	0
Red argillo-arenaceous shale, ...	35	0
Red sandstone, ...	1	0
Red argillo-arenaceous shale, ...	5	0
Grey argillo-arenaceous shale, of a crumbly quality, much resembling fire clay, with nodules of limestone and remains of Stigmariæ, ...	3	0
Red argillo-arenaceous shale, ...	22	0
Greenish-grey arenaceous shale, sometimes sufficiently consistent to be called a sandstone.	11	0
COAL said to be of this thickness where bored to in this vicinity, ...	0	6
Greenish-grey argillo-arenaceous shale, with Stigmariæ, (underclay,) the thickness is not determined, the whole bed not being visible, say, ...	3	0
	397	2

FLORA OF THE NEW BRUNSWICK COAL FORMATIONS.

In a "Synopsis of the Flora of the Carboniferous Period in Nova Scotia," Dr. Dawson enumerates the species which he has recognized, as belonging to the different epochs of the Carboniferous Series in New Brunswick, from specimens sent to him by Sir William Logan, Mr. G. F. Matthew, Mr. C. B. Matthew, and Mr. C. F. Hartt.

The following List shows the relationship of these species to the several epochs of the Series, and the localities from which they were procured.

UPPER COAL FORMATION.—(*Unproductive Coal Measures.*)

1. *Sphenophyllum emarginatum.*—Grand Lake; Baie de Chaleurs.
2. *Sphenophyllum Saxifragifolium.*—Baie de Chaleurs.

Middle and Upper Coal Formations.

1. *Dadoxylon materiarium.*—Miramichi.*
2. *Alethopseris lonchitica.*—Grand Lake.

Middle Coal Formation.—(*Productive Coal Measures.*)

1. *Calamodendron approximatum.*—Coal Creek. One of the most common plants in the beds of bituminous coal.
2. *Antholithes rhabdocarpi.*—Grand Lake.
3. *Calamites Suckowii.*—Grand Lake, Coal Creek.
4. *Calamites Cistii.*—Grand Lake, Baie de Chaleurs, Coal Creek.
5. *Calamites nodosus.*—Grand Lake.
6. *Asterophyllites grandis.*—Grand Lake, Baie de Chaleurs.
7. *Annularia galioides.*—Grand Lake, Baie de Chaleurs.
8. *Cyclopteris obliqua.*—Grand Lake.
9. *Cyclopteris ingens.*—Grand Lake.
10. *Neuropteris rarinervis.*—Grand Lake, Baie de Chaleurs.
11. *Neuropteris gigantea.*—Grand Lake.
12. *Neuropteris Loshii.*—Baie de Chaleurs (?)
13. *Odontopteris Schlotheimii.*—Baie de Chaleurs.
14. *Sphenopteris munda.*—Grand Lake.
15. *Sphenopteris latior.*—Grand Lake.
16. *Sphenopteris gracilis.*—Grand Lake.
17. *Sphenopteris artemisifolia.*—Grand Lake.
18. *Sphenopteris Canadensis.*—Baie de Chaleurs (?)
19. *Sphenopteris obtusioloba* (?)—Baie de Chaleurs.
20. *Alethopteris nervosa.*—Baie de Chaleurs.
21. *Alethopteris Serlii.*—Baie de Chaleurs.
22. *Alethopteris grandis.*—Baie de Chaleurs (?)
23. *Beinertia Goepperti.*—Grand Lake, Baie de Chaleurs.
24. *Palæopteris Hartii.*—Grand Lake.
25. *Lepidodendron Pictoense.*—Grand Lake.
26. *Lepidostrobus sqiamosus.*—Grand Lake.
27. *Cordaites borassifolia.*—Grand Lake, Baie de Chaleurs.
28. *Cordaites simplex.*—Grand Lake.
29. *Cardiocarpum bisectatum.*—Gand Lake.

Lower Coal Formation.

1. *Cyclopteris Acadica.*—Norton Creek.
2. †*Lepidodendron corrugatum.*—Norton Creek.

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* In the neighbourhood of Fredericton, on the Nashwaak, and indeed over a wide area of country, the silicified trunks or fragments more or less complete, of this coniferous tree, are often found.

A fragment of a trunk of this species was found on the hill in the rear of Fredericton, behind the Hon. W. H. Odell's residence. It must have measured thirty inches in circumference when entire. The specimen showed a portion of the coaly bark and of the pith, but the mass was silicified.

† "This species is eminently characteristic of the Lower Carboniferous Coal Measures, and has not yet been found in the Middle Coal Formation. Fragments of bark resembling that of this species, occur in the coal formation of Baie de Chaleurs, along with leafy branches of *Lepidodendron*, which resemble those of the species, though I believe distinct."—(Dr. Dawson.)

PRODUCTIVE COAL MEASURES IN THIS PROVINCE.

From the foregoing list it will appear that in the immediate neighbourhood of Grand Lake, the PRODUCTIVE COAL MEASURES exist, although the flora shows that they are "tending to the upper formation." A great point is gained in having the age of these rocks sufficiently established to afford good ground for the belief that these productive measures may be found within the limits of the Povince, in such development as to make them of considerable value.

The supposed thinness of the New Brunswick Coal Field is opposed to the expectation that seams of workable coal will be found to occupy very wide areas, yet the structure of the country has been shown to support the view that in a bay or bays penetrating the Carboniferous area from the east, thicker seams than those which exist at Grand Lake (22 inches) may be sought for with a probability of success.

Before Dr. Dawson had an opportunity of examining the flora from Bay Chaleur and Grand Lake, he expressed an opinion unfavorable * to the existence of the productive measures in the Province, qualifying it, however, with the following words:—"The valuable character of the Albert Coal, however, and the well known fact that coal measures often vary materially in their productiveness, as we trace them from one locality to another, give some ground to hope that a Carboniferous area so extensive as that of New Brunswick, may not ultimately be found to be so unproductive as it now appears to be."

THE GRAND LAKE COAL.

The coal raised at Grand Lake from a twenty two inch seam, has hitherto been brought to market in a hap-hazard sort of way. There is no system whatever in mining it. Any farmer who finds the seam on his land, employs persons to dig out a certain quantity of coal, this is bought up by agents and shipped to Fredericton, Saint John and elsewhere. It sold at Fredericton at $6½ a chaldron at the commencement of the winter of 1864–5, and it appears that about 5,000 chaldrons were shipped from Grand Lake during the season.† The quality of the coal is good, now that more care is taken to separate the lumps of iron pyrites, with which some portions of the seam abound. An American Company has recently leased a tract of land on Grand Lake, and there is every probability that the supply will now be largely increased. The Blacksmiths of Saint John consider it very well adapted for their purposes, and prefer it to the imported coals. It has very little ash, and in a properly constructed grate it makes an excellent fire.

* "In short, so far as I can learn from my own limited observations, and the Reports of Mr. Gesner and Dr. Robb, they resemble the lowest parts of the Cumberland Coal Measures, or those upper members which overlie the workable coals; as if those alone had been deposited and the productive coal-measures left out."—*Acadian Geology*, 1855.

† I am indebted to Mr. Wetmore of Fredericton, for these facts.

Quantity of Coal raised at Grand Lake.

1828, ...	66	chaldrons.
1830, ...	70	"
1833, ...	138	"
1834, ...	687	"
1835, ...	3,537	"
1839, ...	2,143	"
1864, ...	5,000	"

Some idea of the amount of coal a persistent seam, easily accessible, is capable of yielding, even though it be only 22 inches thick, may be obtained from the following calculation.

Assuming that a chaldron or thirty six bushels of coal is contained in one cubic yard and a half, (really about $1\frac{1}{8}$,) allowance being made for waste and dressing, it would require at 18 inches thickness of seam, three square yards to supply a chaldron of dressed marketable coal. Each acre would, at this rate, yield sixteen hundred chaldrons, and *every square mile one million and twenty four thousand chaldrons.*

If the Grand Lake seam extends towards Coal Branch, on the Rigibuctou, and appears there with a thickness of 15 inches, as suggested by Dr. Robb, the total mass of coal on a length of 40 miles and a breadth of 15 miles, would amount to the enormous quantity of six hundred million chaldrons.

Some years since borings were made at the Salmon River Mines to the depth of 403 feet. In the section given in Dr. Gesner's Report, nine recurrences of coal are mentioned, all unimportant with the exception of "Bituminous Shale and Coal," eight feet thick at a depth of 250 feet; what this may mean the section affords no clue.

It being established that the productive coal measures exist in the neighbourhood of Grand Lake, it remains to be seen,—

1st. In what direction search must be made to find the area where they are developed to the greatest extent.

2nd. Whether the thickness of the series may not show them to be beyond or on the borders only of that part of the coal basin which is characterized by thick beds of workable coal.

The first of these enquiries can be provisionally answered by reference to known facts. The second is a problem, the solution of which can only be obtained by future investigation.

The following section may be suggestive as to the first enquiry, but it is to be regarded as a mere guide; neither time nor opportunity was available for making any more than cursory observations; a complete series would take as many weeks as days were given to those which follow.

The manuscript notes of Dr. Robb supply numerous observations on the dips and mineral character of the rocks, which will fill vacant spaces in the sections subjoined, or afford valuable hints, but it is a matter of regret that the localities of many cannot be easily identified, as they refer to the farms and houses of private individuals 16 and 17 years ago, and are consequently unavailable.

No. I.

OROMOCTO CREEK TOWARDS DOUGLAS HILLS ON THE NEREPIS ROAD.

	Kind of Rock.	Locality.
Lower Carboniferous.	1. Dark red or purplish argillaceous Sandstones, - - - - -	Oromocto Creek.
	2. Purplish platy Sandstones, -	Bridge at South Branch.
	3. Grey Grits and Sandstones, -	Brizley's Creek.
	4. Coarse grey Grits, - - - -	14 miles.
Bonaventure Formation.	5. Coarse Conglomerate and grey Grits. - - - - - -	Height of land.
	6. Red Sandstone & Conglomerates,	A mile south of height of land.
	7. Silurian Slates, - - - - -	Brook flowing to Nerepis.

This Section, coupled with other observations, appears to show that on the west side of the Saint John, the Lower Carboniferous or unproductive Coal Measures occupy the country.

From the dips recorded by Dr. Robb, it appears probable that Grand Lake, or part of it, occupies a synclinal axis, the anticlinal running in a north-easterly direction between Grand Lake and Salmon River on the one hand, and Washademoak Lake and River on the other. The direction indicated by these undulations would point to a narrow belt lying between those rivers, in the northern parts of the Parishes of Waterborough, Brunswick, and Salsbury, and the southern part of Harcourt, as the probable range of rocks of the age of the Productive Coal Measures, but whether they contain workable seams of coal of greater magnitude than those already known on Grand Lake, is a question to which no available data can supply a satisfactory answer. The presence of this synclinal axis at Grand Lake gives colour to the probable existence of a deep Bay or Sinus, in the direction of Salmon River, stretching towards the coast, and parallel to the Sussex Vale indentation.

Dr. Gesner suggests that "a sum of money would be well employed, in boring *at a judicious site*, in the neighbourhood of Gagetown, or on the *north side* of the Washademoak. The result of such an enterprize would be of the highest importance to the Province, and there could be no doubt of its final success."

With regard to Gagetown, the occurrence there of the same dark red or purplish argillaceous sandstones which are found on the Oromocto, as shown in section I, is opposed to the view expressed by Dr. Gesner, these rocks being, probably, below the productive coal measures.

As the Washademoak, from its mouth to its source, is some sixty miles long, the expression "north" of it is too indefinite to be of any service, although it is to the north of that river, that rocks of the age of the productive measures may be found.

Dr. Robb examined the coal on the Richibucto in 1849. He there found a seam 15 inches thick on Coal Brook. The coal cakes like the Grand Lake coal, and the dip is N. W. 10°. "Judging by the quality and thickness of the seam, it may yet prove to be the same as the one at the head of the Grand Lake, from which the sandstones pass continuously but in an undulating manner."* If the passage between the quotation marks is based on actual observation, it is most important. The rocks at Grand Lake having been shown to belong to the true or productive coal measures, the occurrence of these rocks for a distance of fifty miles, measured diagonally across the strike, follows from Dr. Robb's statement. This tends to show that a considerable area in that part of the Province belongs to the middle or productive coal series.

The mean altitude of the triangular area does not exceed 400 feet above the sea; and although the thickness of the carboniferous strata is not, perhaps, more than 1,000 feet, it has been subjected to gentle disturbances which have caused a number of low anticlinals, as already stated. At the mills, 18½ miles below Fredericton, the reddish-grey sandstones dip northwest at an angle of 9°; and on the south side of the brook above Smith's bridge, the grey sandstone under conglomerate dips northeast at an angle of 18°.—(Robb). Numerous other examples of undulations might be adduced, but those only possess value in relation to the occurrence of coal, where the age of the rock is known.

THE VALLEYS OF THE KENNEBECOASIS AND PETITCODIAC.

I have not recognized any rocks of more recent age than those belonging to the Lower Carboniferous, in the long trough-like indentation which stretches from the Petitcodiac to the Saint John; and although the true coal measures may be represented there, it is not likely that the area occupied by them will be large. Indeed, the supposed extent of country covered by the Carboniferous Series, as depicted on Dr. Robb's map, is much too wide. I crossed it in several places, and found the axis of older rocks running parallel to the Gulf, considerably broader than represented. Golden's mountain, for instance, lies wholly within the metamorphic belt; and the same rocks come within ten miles of Sussex Vale station, on the Dutch Valley road, before they are overlaid by the conglomerates of the Bonaventure formation. In various parts of this area there are rocks which may be included within the productive measures, but if so, they are outliers, and their dimensions must be small.

* Third Report, page 73.

In the Parish of Dorchester, County of Westmorland, the Middle or Productive Coal Measures appear on the Memramcook, forming the north extension of the already celebrated Joggins Measures in Cumberland County, Nova Scotia.

Their relation to the Joggins is seen in the following Section by Dr. Dawson*:—

No. II.

SECTION ON THE MEMRAMCOOK.

I. Upper Coal Measures.—	Upper sandstones and shales of south Joggins.
II. Middle Coal Measures.—	Coal Measures of the Joggins, and Millstone Grit or Lower Coal Measures of Dorchester.
III. Lower Carboniferous Marine Limestone.—	Limestones, Gypsum and Conglomerate of Dorchester and Petitcodiac.
IV. Lower Coal Measures.—	Fine calcareous and highly bituminous shales, with thin beds of sandstone. Abundance of the remains of fishes seen at Petitcodiac River, above Dorchester, Albert Mine, and other localities westward of that place.

The dislocation alluded to in Chapter V. occurring on the southeast coast of Shepody Bay, in Albert County, is situated in a synclinal fold, and the limestone which appears on Hayward's Brook is there at the surface, the probable upthrow being on the southwest side. The whole series of grey sandstone and red and green marl has been removed by denudation on the south side, and the limestone exposed. Had not this upthrow occurred, it is not improbable that the coal measures would have been found on the entire shore of Shepody Bay, whereas the Lower Coal Measures are only represented. The continuation of Shepody Mountain in a northwesterly direction, brings it to the head waters of the east branch of Turtle River, and here the mountain or rather table land of the older rocks has a mean elevation not less than 1000 feet above the sea, which is maintained to considerably beyond Salmon River, in Hammond Parish. In the ravines and gullies on the mountain side (which in some places resembles an escarpment) the red conglomerate and sandstones of the Bonaventure formation may be seen, while the hills north of the tableland, and in some cases forming part of it as it breaks away to the north, are composed of the grey sandstones and grits.

The middle coal formation may be found with productive measures in the southeastern portion of the County of Westmorland, but, I am not able to add from personal knowledge any new facts to those which have already been published by Dr. Dawson.

* Supplementary Chapter to the Acadian Geology, 1860.

About two miles southeast of Salisbury station, the red sandstones of the Bonaventure formation lie in a nearly horizontal position; and seven miles further on they were also seen to occupy the same position, showing that the disturbances which commence north of Weldon Creek did not extend far in that direction. The gypsum of the series is in position, and has been worked about two miles north of the station.

No. III.

SECTION NORTH OF NORTON STATION.

No higher rock than the red conglomerate covering the limestone, which appears so persistent throughout the lower carboniferous rocks in Albert County and the Tobique outlier, was recognized on this section. The series continues as far as the Bellisle River, where the narrow belt of older rocks appears stretching away towards Butternut Ridge.

The limestone would seem to underlie a considerable portion of the north side of the valley of the Kennebeccasis, being occasionally brought to the surface by low undulations. At Butternut Ridge it appears in great force, and according to Dr. Robb it has there been elevated in the form of several ridges running parallel to one another, and having a northeasterly course, which is the direction, as already noticed, of the anticlinal axis, bringing up the older rocks all the way from Saint Stephen, on the boundary line.

Silicious layers also occur in the limestone about seven miles northwest of Norton station, but on the whole it makes a white and strong lime. Some feeble veins of galena are seen in this rock.

REVIEW OF THE CARBONIFEROUS SERIES.

On reviewing what is known respecting the Carboniferous area in New Brunswick, the following conclusions appear to be worthy of acceptance:—

1. The entire rim of the central triangular area, the whole of the Tobique outlier, and the greater portion of the deep indent drained by the Kennebeccasis and the upper Petitcodiac Rivers, belong to the base of the Carboniferous Series, and consequently do not contain any workable seams of coal. They abound, however, in limestone and gypsum;* and the deep indent from Hillsborough to Norton contains a valuable deposit, and numerous favourable indications of other deposits of Albertite; also extensive and important beds of a highly bituminous shale, which may become valuable as a source of illuminating oil, and as a gas fuel for re-generating furnaces, and for metallurgical processes.

2. The country about and northeast of Grand Lake, is occupied by the Middle or Productive Coal Measures, but whether they contain workable seams of coal more than 22 inches thick, is a subject of future inquiry. The structure of the country leading to the inference that the productive Coal Measures will be found in force in the valley of Salmon River and the Richibucto.

* There are no less than six large areas of gypsum in Albert County.

3. A portion of the County of Westmorland contains the true Coal Measures, and it is not improbable that workable seams of coal may be found there.

4. What is known of the country near the coast north of Richibucto, leads to the inference that the Upper or unproductive Coal Measures are in place there, and consequently, that the probability of coal being found in workable quantities, is by no means great.

5. The interior of the central area, on a line drawn from the Bend of the Petitcodiac to the mouth of the Renous River, along the dividing Ridge separating the waters flowing into the Saint John from those flowing into the Gulf of Saint Lawrence, is geologically unknown, and no definite conclusions can be drawn respecting it; but, the dip of the rocks and the supposed absence of considerable undulations, with the occurrence of the "Lower Coal Measures tending to the Upper," west of this line, point to the inference that the Upper or unproductive Coal Measures are there in place. On the other hand it may be urged that a fault or dislocation would bring the Middle or productive Coal Maasures into place. There is however, no data upon which the existence or non-existence of a fault can be predicted. Hence the position of the central area remains still a *terra incognita.*

6. The borings which have been made at Grand Lake, and at New Bandon, show, if correctly registered (?), that no workable seams of coal exist below those which have been already discovered in those localities, as far as the borings have penetrated.

7. The thinness of the New Brunswick Carboniferous Series almost precludes the hope that what have been termed the "false coal measures," will be found in the Lower Rocks of the basin. In Pennsylvania these rocks (Subcarboniferous) have a thickness of about 5,000 feet, and they contain, both in the State named and in Virginia, a few thin workable seams of coal. In Montgomery County, Virginia, there is a layer of coal two, to two and a half feet thick in these lower, unproductive measures. But there is no reason to suppose that any rocks of the same age in New Brunswick contain seams of coal which approach that thickness, for with the exception of the Albert Shales, the general aspect of the red sandstones and conglomerates lead to the inference that life was scarce during their formation. It will be borne in mind that in America the productive or non-productive character of the different divisions of the Carboniferous Series is much more determined than in many parts of Europe, and the probability of workable coal being found is tolerably well indicated by the fossils of the rocks.

LIFE DURING THE CARBONIFEROUS PERIOD.

The enormous development of vegetable matter which we are able to recognize in the coal fields throughout the world, affords incontestible proof of the existence of most luxuriant plant life during the Carboniferous epoch; but, until recently, the evidences of the existence of air-breathing animals has not been so satisfactorily demonstrated. In 1841 Sir W. E. Logan discovered the first reptillian foot prints in the coal fields of Nova Scotia. It was already known that land snails and millipedes fed on the leaves and decaying vegetable matter of the luxuriant forests of that period, that insects flitted through the air, and that the seas teemed with fish and moluscous animals; but air-breathing reptiles were supposed to possess too high an organization to admit of their living in an atmo phere loaded, it was supposed, with poisonous carbonic acid, the chief food of vegetables. It has been the happy result of the long continued investigations of Dr. Dawson, to discover the existence of no less than eight different species of air-breathing land animals, which once swarmed, we may suppose, in the carboniferous marshes and swamps of Nova Scotia.*

CLIMATE OF THE COAL PERIOD.

The climate of the Coal Period has long been a difficulty. Many ingenious theories have been advanced to account for the presence of the Coal Series in the Arctic Regions, containing plants and animals which required a mild climate for their growth and development. The recent researches of Dr. Tyndall on Radiant Heat, have afforded a probable explanation of this phenomenon, which has been ably discussed by Professor Hunt.

The properties of gases with respect to radiant heat are most remarkable. Air scarcely absorbs any sensible quantity of radiant heat, but if air absorbs one ray, carbonic acid will absorb 90 rays; marsh gas, 403; ammonia, 1195; and olefiant, 970. Hence although ammonia is as transparent to light as the air we breathe, it is almost opaque to heat. But if the absorption be estimated at a low tension, that is to say when a small quantity of gas only is present, the difference becomes more apparent and striking. Thus at a tension of one inch, for every individual ray struck down by the air, oxygen, hydrogen, or nitrogen—ammonia strikes down a brigade of heat rays 7,260 strong—olefiant gas a brigade of 7,950, while sulphurous acid destroys 8,800 rays. This property is most important in its bearings upon climate. Aqueous vapor which always exists in the air, absorbs heat with great vigour. Regarding the earth as a source of heat, at least 10 per cent. of its heat is intercepted within ten feet of the surface by the aqueous vapour of the air. The removal, for a single summer night, of the aqueous vapour from the atmosphere which covers England, would be attended by the destruction of every plant which a freezing temperature could kill. The moisture of the air covers the earth as with a blanket at night, and where the air is dry as in the great desert of Sahara and the plains of Thibet, or the deserts of Australia, ice is frequently formed during the night by the direct radiation of the heat of the earth towards the planetary spaces, there being no blanket of aqueous vapour to retain it. So powerful is the effect of aqueous vapour in retaining heat that although the atmosphere contains but one particle of

* Five species of carboniferous reptiles have been found on the continent of Europe, three in Great Britain, and four in the United States.—(Air Breathers of the Coal Period.—Dawson, 1864.)

aqueous vapour to 200 of air on an average, yet that single particle absorbs 80 times as much heat as the 200 particles of air.

Bearing in mind that the atmosphere of the coal period contained an abundance of carbonic acid, from which plants drew their food, and limestones the acid combined with their base, we have at once an explanation of the uniform temperature of the earth. The carbonic acid mingled with the air, aided by aqueous vapour, prevented the heat rays of the sun from returning into space by radiation. The earth was covered as it were with "a dome of glass" which maintained at its surface the requisite temperature to enable plants and animals to live even in the Arctic Regions. The gradual absorption of this protecting shield of carbonic acid slowly but effectually changed the climate of the Arctic and Antarctic Regions, and arrested the growth of vegetation during the epochs succeeding the Carboniferous period.

CHAPTER V.

THE ORIGIN OF ALBERTITE.—THE ALBERT SHALES.

Geological age of the Albert Shales—They lie at the base of the Carboniferous Series—Disturbances in Albert County—Anticlinal and Synclinal axes—Faults—Section from Albert Mine to Cape Demoiselle—At Taylor's Mill Site—At the Big Cape—On the Tramway at Hillsborough Village—Bituminous Shales—ALBERT SHALES—Area over which they are found—Anticlinal axes in Albert and King's Counties—The Albert Mine—Character of the Mine—Observations in the Mine—Faults and Disturbances—An Overlap—Dr. Robb's and Professor Taylor's views—Dr. C. T. Jackson's views in 1850 and in 1851—Reasons why opinions were discordant—Professor Taylor's comparisons—Professor Bailey's views in 1864—Origin of Albertite—Albertite formerly a liquid—Crushed Albertite—Two periods of injection—Professor Hunt's views with regard to Bitumens—Albertite an inspissated Petroleum—Localities where Albertite is found—It comes originally from underlying Devonian Rocks—United States Commmissioner of Agriculture on Albertite—Albert Shales—A source of coal oil—Importance of the Albert Shales—Gas regenerating furnaces—Petroleum Springs in Albert and Westmorland—Conclusions with reference to Albertite—Composition of this substance.

GEOLOGICAL AGE OF THE ALBERT SHALES.

Two distinguished Geologists have pronounced their opinions upon the geological age of the Albert Shales.* They lie at the base of the Carboniferous Series, as developed in Albert County.† They are calcareo-bituminous shales, containing a great number of fossil fishes in a remarkable condition of preservation, every scale being in place, although the fishes are flattened by pressure; they also have their fins perfectly preserved. Some beautiful specimens are occasionally to be procured by breaking open the layers of shale taken out of the shaft, and are found larger than those which have been described. These fossil fish belong to the same genera with those found in the Joggins coal measures of Nova Scotia. Dr. C. T. Jackson discovered (1851) in the shales perfect stems of Lepidodendra, large flag-like leaves of plants, regarded as a species of Palm, stems of a fresh water plant, and numerous fishes, all indicative of the Carboniferous Series.

The Section subjoined is from Dr. Dawson's Acadian Geology.

1. Grey sandstone, often coarse and pebbly, with shales and conglomerate; Hopewell Ferry, &c. These beds, perhaps, correspond to the great sandstone ledges of Seaman's Quarries, Joggins. They may be traced through Albert County, to the southwest, for a considerable distance.

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* Sir Charles Lyell and Dr. Dawson. Dr. Percival, of New Haven, also agrees with Sir Charles Lyell and Dr. Dawson.—Acadian Geology. Dr. Robb was also of opinion that they belonged to the age of the "unproductive coal measures."—(Evidence at Trial.)

† Acadian Geology, page 196.

2. Reddish sandstones and shales.
3. Limestone and gypsum.
4. Red sandstone and conglomerate.
5. Grey and dark-coloured conglomerate.
6. Calcareo-bituminous shales of the ALBERT MINE, HILLSBOROUGH. These beds appear here to lie at the very base of the Lower Carboniferous Series.

Nos. 3, 4 and 5 of this Section remind us of the succession of rocks in the valley of the Tobique, where the strata are arranged in the following order: 1. Gypsum (the highest rock); 2. Limestone; 3. Sandstones and Conglomerates; 4. Silurian Slates.

In Albert County the gypsum is seen beneath the limestone, and the limestone resting upon the conglomerate. The newest rock here seems to be a light brown conglomerate.

The Joggins, celebrated for their unrivalled display of Carboniferous Rocks, are situated on the Nova Scotia side of Chignecto Bay, a distance of sixteen miles from the Albert Mine. Between these two localities the sequence of the rocks has been traced and described at some length by Dr. Dawson.

The coal measures of the Joggins dip to the southwest, and extend in the direction of the strike across Chignecto Bay to Cape Meranguin, where the lower coal measures appear. On tracing these to the northward, they become vertical and dip to the north, forming an *anticlinal* axis.

At Fort Cumberland the coarse grey sandstones still dip to the north, which continues as far as the east side of the Petitcodiac River. At Hopewell the same sandstones reappear, but with southerly dips, showing that the bed of the Petitcodiac here, or Shepody Bay, occupies a *synclinal* axis. On the west side of the Petitcodiac the rock shows alternating dips which will be noticed in succeeding paragraphs, but on the east side of the Albert Mine the dips are northeasterly, on the west side northwesterly, thus showing at and near the mine an anticlinal axis. Hence it appears that a series of disturbances has occurred in this district which may have very materially influenced the present distribution of the Albertite which has given to the Albert Mines so widespread a notoriety.

DISTURBANCES IN ALBERT COUNTY.

If a section be made across the County of Albert, from the Joggins, in Nova Scotia, to the syenite and older slates which form the continuation of the Shepody mountain, in a northwest by north direction, a series of anticlinal and synclinal axes will be found to run roughly parallel to one another in the following order:—

I. Chignecto Bay,..ANTICLINAL.
II. Shepody Bay,..SYNCLINAL.
III. Memramcook, mouth of,............................ANTICLINAL.
(Runs through the Peninsula.)

IV. South of Cape Demoiselle Road,....................SYNCLINAL.
V. Taylor's Mill Stream,..ANTICLINAL.
VI. Between Albert Mines and School House on Cape Demoiselle Road,....................................SYNCLINAL.
VII. ALBERT MINE,..ANTICLINAL.
VIII. Northwest of Albert Mine, one half mile......SYNCLINAL.
IX. Middle Branch of Weldon Brook.....................ANTICLINAL.

Five anticlinal and four synclinal axes appear to have been recognized in a distance of twenty two miles.

The general course of these axes is S.W. and N.E. They correspond in a remarkable manner with the course of the other anticlinals in this Province, which have already been described in preceding Chapters, (page 48.)

FAULTS.

Near the mouth of Danniell's Creek there is a fault and an upthrow on the south side, or a downfall on the north side.

At Big Cape on the Petitcodiac a fault throws the strata ten feet down on the south side.

At the Albert Mines the downfall appears to be wholly on the north side.

LOWER CARBONIFEROUS SERIES AS DEVELOPED IN ALBERT COUNTY.

On Shepody Mountain road, about three miles back from the coast, the grey sandstones overlie slates succeeded by syenite. On the coast at Danniell's Marsh, the sandstone capped by conglomerate has a northerly dip, but on Cape Demoiselle road about 1½ miles from its commencement, the grey sandstones dip south, shewing the existence probably in this neighbourhood of a synclinal axis and fault.

At Hayward's Brook, Red and Green Marls are seen resting on cherty limestone which lies on variegated conglomerate—all dipping S. E. The gypsum is recognized on Wilson's Brook in grand mural cliffs. These magnificent wall like precipices may be from 140 to 180 feet high and a quarter of a mile long. When the western sun shines upon the white and bluish masses of gypsum it affords a dazzling and most striking scene. The upper beds are white, the lower bluish, hard, and with a conchoidal fracture. The cleavage is vertical. The gypsum appears to have an easterly dip, and apparently underlies the conglomerate.

The following is a rough section of the Rocks from the Albert mine down the Cape Demoiselle Road to the Shore.

I. Bituminous Shales,.......................(South of Albert Mine.)
II. Grey Sandstone and Conglomerates.
III. Gypsum....................................Mill Stream.
IV. Conglomerate..............................Hayward's Brook.
V. Limestone, (cherty.)
VI. Green and Red Marls.
VII. Grey Sandstone.

FAULT, bringing number V. Limestone on the coast. Shepody Bay.

I did not visit the section exposed south of Edgett's, but Dr. Robb states that the house and farm is situated on a small *butte* of red conglomerate or breccia, made up in great part of angular fragments of a greenish slate, quartz, flint slate, porphyry and granite. It is difficult to detect any lines of bedding in it. On the beach near the exposure there is a considerable quantity of iron sand, which may have come from the conglomerate. This rock resembles in many particulars the red conglomerate at the base of the Carboniferous area in the valley of the Tobique. It dips to the south, and is succeeded by red sandstone and grey sandstone, containing calamites.

Dr. Jackson has the following Section at Taylor's Mill Site :—

I. Coarse Conglomerate.
II. Grey Limestone.
III. Gypsum.
IV. Red Marl.
V. White Gypsum.

The coarse conglomerate here described is evidently of the same age as that seen by Dr. Robb at Edgett's; it is stated to consist of pebbles of quartz, syenite, green metamorphic slate, trap rock, jasper and carbonate of lime.*

At the Big Cape on the Petitcodiac, the following Section may be seen :—

I. Red conglomerate, (calcareous.)
II. Greenish conglomerate.
III. Reddish Sandstone.
IV. Red Marl. Paint Rock.
V. Sandstone.
VI. Red Marl. Paint Rock.
VII. Sandstone, (Grindstone grit.)
VIII. Red Marl. Paint Rock.
IX. Green Marl.
X. Grey conglomerate.
XI. Grey Sandstone.

The grey grit resembles the rocks near Fredericton.

A short distance from the place where the grey conglomerates and sandstones reach the shore there is a fault, which throws the south side down about ten feet. The Red Marls or Paint Rocks as they are locally termed may be useful. The hard and homogeneous bands would make good "red chalk."

East of Edgett's, on the Petitcodiac, (about one mile,) Dr. Robb observed bituminous limestone, forming a bed about 12 feet thick, with cleavage joints filled in places *with bitumen.* Some of the pebbles of the neighbouring conglomerate were also coated with bitumen.

He also records on the opposite side of the Petitcodiac (Dorchester), after leaving the red conglomerate, dark coloured bituminous shales with fossil

* Report on the Albert Coal Mines, by Charles T. Jackson, M. D

ganoid scales, impure limestones, indurated marl, and a very impure coal. The dip was to the N. W. at an angle of 20°.

On Taylor's Mill Stream, the gypsum is seen in a great variety of hues and qualities. From hard grey massive rock to snow white alabaster it passes through all gradations of colour; from a high toned red to the most delicate shade of salmon. The cliffs at the quarry are from 80 to 100 feet high, and the locality is one well worthy of being visited on account of the singular and romantic appearance of the rocks. The section seen on the tramway to the Post Road is as follows:—

I. Gypsum.
II. Variegated Red and Green Marls.
III. Limestone.
IV. Conglomerate.

On the road from Edgett's to Steves' Brook, a mile north of Hillsborough, the dip of the rocks on the hill descending towards the brook, is to the north, (south of Hillsborough the dips are to the south), showing that an anticlinal axis is crossed, which is probably the main anticlinal passing through the Albert Shales near the Mines. South of Edgett's the dip is southerly, and north of Hillsborough the following dips were noted in October of the present year:—

Summit of hill in the centre of the village of Hillsborough, a coarse conglomerate, ...	Dip	S. 70° W.
Half a mile from centre of village, a fine conglomerate, ...	"	S. 30° W.
Sixty yards further down the hill, a sandstone, with small pebbles in some of the layers,*	"	S. 30° W.
Near the foot of the hill, a fine variegated conglomerate,	"	vertical.
Steves' Ravine—Petroleum Spring, ...	"	W. < 65°.
At the falls of Steves' Brook the rocks are composed of alternating red shales and red variegated sandstones, green and red, resting on cherty limestones. One bed of green shale is eight inches thick. The upper sandstones are slightly conglomerate. The mass is capped by a very coarse conglomerate, dipping, ...		N. W. < 8°

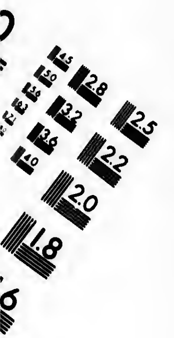
This rock appears to have been deposited after the disturbances in this part of the country, and perhaps the same remark may apply to the coarse light brown conglomerate capping the entire series in Albert County.

BITUMINOUS OR ALBERT SHALES.†

At the head of Turtle Creek the strike of these shales is E. and W. and dip N. at an angle of 50°. On the south Dividing Ridge the metamorphic slates are seen with a strike N. 60 E. and dip N. 30 W. at an angle of 54°. The bituminous shales are here observed to rest directly on the slates, and

* This sandstone resembles the firestone of the Tobique. The early settlers were accustomed to use it in the construction of their fireplaces.

† Called locally "Baltimore Shales."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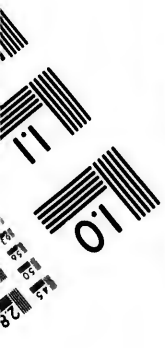
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the slates on syenite; these rocks resemble the pebbles in the red conglomerate forming the base of the Carboniferous Series in Albert County, and in other parts of the Province.

The area over which the Bituminous Shales are distributed is very considerable, for they have been recognized in patches from near Dorchester, in Westmorland, to Apohaqui, in King's County, a distance exceeding fifty miles.

A tabular list of localities where they appear at the surface, follows:—

KING'S COUNTY.

I. At Apohaqui, beds of Bituminous shale and seams of Albertite in sandstone. Further up the valley are thick deposits of bituminous shale and limestone.*

II. Ward's Creek.—Brownish bituminous shale or slate, extends for several miles towards Dutch Valley.

ALBERT COUNTY.

III. Baizeley's Farm on Turtle Creek.—Bituminous shales, called locally 'Baltimore Shales,' rest unconformably on metamorphic slates.

IV. Five miles N.W. of the mouth of Shepody River.

V. Frederick's Brook.—Bituminous shales, called locally 'Albert Shales,' and a distinction is popularly supposed to exist between the Albert Shales and the Bituminous or Baltimore Shales, which are here called also 'Brown Coal Shales.'

WESTMORLAND.

VI. Memramcook River—(Belleveaux Village) 4 miles north of Dorchester. —Bituminous Shales.

VII. Opposite the mouth of Stony Creek, near Ayre's.

These shales have been brought to the surface in patches along certain well marked lines of direction in Albert County, and in Albert and King's Counties; the one direction, that in Albert County, running in the same course as the Albert Mine anticlinal, namely, from S.W. to N.E. nearly, (Mag.) the other southwest by west to northeast by east, (N. 80° E. Mag).

Belonging to the first series are the exposures opposite Stony Creek, Westmorland, near the Albert Mine, and five miles northwest of the mouth of Shepody River. The second series, are four miles above Dorchester on the Memramcook, opposite Edgett's, in Dorchester, at Baizley's Farm, at the sources of Turtle River, in Mechanic's Settlement, at Cedar Camp, Ward's Creek, and near the Apohaqui Station.

Here then are two systems of anticlinal axes,—1st. The Albert Mine anticlinal, stretching through the County of Albert in a direction N. 48 E. (Mag.) 2nd. The northeast by east anticlinal, running up the valley of the Kennebeccasis and beyond it into Westmorland for more than fifty miles,

*Observations on the Geology of Saint John County, by Mr. G. S. Matthew.—Canadian Naturalist and Geologist, 1863.

with the shales in the centre, and the newer rocks flanking them on either side. Along the entire length of this anticlinal, Albertite has been discovered in one form or another.

THE ALBERT MINE.

It does not appear that anything was known about the occurrence of the mineral called Albertite in the year 1849, when Dr. Robb visited Albert County, in company with Professor Johnston, on a Geological tour, with a view to gather information and collect facts for a Report on the Agricultural Capabilities of the Province.

Under date 26th November, 1849, Dr. Robb writes: * "Dr. Gesner (III. 28) mentions the occurrence of a bed of coal at Frederick's Brook, a branch of Weldon's Creek, &c. &c." * * * "I visited" continues Dr. Robb "this place in October last (1849) and found on the land of Mr. J. Steves, near the head of Frederick's Brook, a good deal of brownish bituminous substance but no coal whatever." * * * "Mr. Steves showed me what had been regarded as coal, but it proved to be mineral pitch or hard bitumen; it had only been found, he said, in small rolled fragments in the surface drift of his fields."

The discovery of the existing Albert Mine was due I have been informed, to the bursting of a mill dam on a branch of Frederick's Brook, which exposed the brilliant and massive veins of Albertite, now the source of the mineral of the Albert Mine. The name "Albertite" was suggested to Sir Charles Lyell by Dr. Robb, at a time when the true nature of the mineral was still a matter of doubt. What was known of the Albert Mines in 1852, at the period of the trial,† is already familiar to the public, and need not here be repeated.

* Professor Johnston's Report.

† Report of a case tried at Albert Circuit in 1852, before His Honor Judge Wilmot, and a special Jury. Abraham Gesner *versus* William Cairns.—Copied from the Judges notes. Saint John, 1853. The scientific evidence advanced during this trial was of a singularly diverse description; it has, however, been paralleled recently in a trial in Great Britain, involving the mineral character of the so-called "Boghead coal."

The points of controversy are well noticed in the subjoined abstract as to the character of the material, taken from the Report above referred to.

Abstract of Points in Charging Jury, as to Character of Material.

I. Geological.

1. *General.*—Position of mines and surrounding strata.
2. *Special.*—1. Internal structure of mine.
   2. Structure of mineral.

II. Mineralogical.

Shewing the difference or resemblance between asphaltum and coal in,—1. Density; 2. Fracture; 3. Cleavage; 4. Odour; 5. Electricity; 6. Lustre; Charcoal dust.

III. Chemical.

Fusibility and Solubility,—1. Positive; Comparative.

At the time of my visit in October, 1864, when I descended the mine in company with the Manager, Mr. Byers, to the depth of about 750 feet, the following was the result of the experience of twelve years in working the mine, and also of my own observations:—

1. A Shaft sunk to the depth of 1000 feet still continues in the Bituminous Shales. This, however, does not afford a clue to their thickness, for they are tilted at high angles.

2. The relation of the Albertite to the adjacent rock is absolutely undefined, sometimes but rarely the strata are parallel to the vein, sometimes and generally inclined to it at a greater or less angle, sometimes they butt end on, and not unfrequently for some hundred feet the strata are inclined at different angles to the vein on opposite sides.

3. Faults or dislocations are several in number, but there appear to be three main or chief dislocations, and the vein in one dislocation actually PASSES BEYOND AND OVERLAPS BY MANY FEET THE VEIN IN ANOTHER DISLOCATION, coming to a wedge shaped termination at the extremity of the overlap where the vein ceases. This fact alone is a proof that the vein is not a bed.

PLAINTIFF'S EVIDENCE.	DEFENDANT'S EVIDENCE.
1. *General.*—An anticlinal axis. A vein not a bed. An injected mass thrown up. Strata distorted. No conglomerate above and below. No parallel strata of coal beds. No roof, no floor, no fire clay, no coal fossils, and lies beneath coal formation.	1. *General.*—No anticlinal axis. Is a bed —not a vein. A deposit, and not an injected mass. Strata are parallel. Has roof, floor, fire clay, and coal fossils, and is just where it ought to be, in the coal series above old red sandstone; and it would be a miracle if a coal bed were not there.
2. *Special.*—Amorphous. No vegetable structure. No cellular tissue. No lamination, and transmits light.	2. *Special.*—Has indications of vegetable structure. Distinct laminations. The evidence of its being amorphous only negative as to a few particles. Taylor in his cross-examination says, Cuban asphaltum—no shales, no fire clay, no fossils, no iron stone, lime stone, sand stone, or sulphuret of iron.
1. Density—less specific gravity than coal. Specific gravity 109. Asphaltum 100 to 120. Coal 120 to 175. 2. Fracture Conchoidal. 3. No cleavage, which coal has. 4. Odour like asphaltum. 5. Is negatively electric, coal not so. 6. Lustre brighter than coal. 7. No animal charcoal, which coal always has.	1. Some specimens of coal less than this. 2. Many kinds of coal conchoidal fracture, and many other substances, as flint, glass, &c. 3. Has distinct lines of cleavage. 4. Odour not at all like asphaltum. 5. Kentucky electric, and some asphaltum not electric. 6. Anthracite coal as lustrous—some pieces. 7. Several pieces of this shew charcoal.
It is fusible—melts by heat, and is the same after melted as before—is soluble in coal tar, in turpentine, in, naphtha, and in other menstrua.	Will not melt by heat without changing its character by throwing off gas. Every known variety of asphaltum melts at not exceeding 250; and after cool can be melted again. Known asphaltum softens in hot sun. Sun no effect on this. When apparently dissolved in coal tar, it is not dissolved, but only held in mechanical suspension.

4. In plans of the different levels which were kindly shown to me by the President of the Company by whom the Mine is now worked, and the originals of which were shown to me by Mr. Byers, these overlaps were visible on a plan of a level 623 feet below the surface.

5. On the plan of the "upper surface lodgement," 306 feet deep, there are shown two breaks or dislocations towards the south; in the second lodgment level, 470 feet deep, there are three dislocations to the north, and at the third level, 623 feet deep, there are three dislocations all to the south, including the overlap above described.

6. These dislocations occur in a horizontal distance of 1700 feet.

7. The Albertite occupies a great fissure already worked out, as I was informed, to the depth of 750 feet. In this fissure there are numerous "horses" or masses of rock which have fallen down. The PLACES FROM WHICH THE "HORSES" FELL, WERE FILLED WITH ALBERTITE, and by comparing "a horse" found below in the fissure with a cavity out of which the Albertite has been excavated above, there can be no doubt that the exact spot the "horse" once occupied can be pointed out.

8. The walls of the fissure correspond with one another,—that is to say, where an indentation is found on one wall, the corresponding protuberance can be discovered a little above or below it on the opposite wall.

9. The fracture does not appear to have been continuous, (or it may be that the fissure has not been traced continuously, and that it may yet be found), for the strata of opposing walls are still joined together in some places, but sharply curved and with a slight downfall to the northwest, the layers of rock arching over from the southeasterly wall to the northwesterly wall, and on this side the arch seems to extend lower than on the opposite or southeast side, as if the strata had been pulled down beyond the level of what may be called the abutment of the arch. Mr. Byers very kindly permitted one of the miners to take out from the roof of the lower level the crown of one of these arches, which is now in my possession.

10. The thickness of the vein varies from 17 feet to 0. thinning out and disappearing altogether in places, as at the overlaps, and minute fissures in the walls of the vein are filled with Albertite, these fissures running in every conceivable direction and at all angles to the main vein.

The evidence now afforded by the Albert Mine appears conclusively to establish the fact that the Albertite occurs in an irregular fissure running in a northeasterly course, of great depth, with a slight downthrow to the northwest; that this fissure occupies the crown of an anticlinal axis, which has been traced from near Shepody Mountain to beyond the Petitcodiac River, a distance of ten miles or more, and that the Albertite has been injected in a liquid or soft state under great pressure, so as not only to fill the fissure, but to force itself into all the minor cracks in the rock subordinate to the main fissure.

DR. ROBB'S AND PROFESSOR TAYLOR'S VIEWS.

So far this is the view in substance entertained by Dr. Robb and some others in 1852, and which all subsequent experience has only tended to confirm, and it is due to the memory of the late Dr. Robb, and his associate the late Richard Taylor, to reproduce their published opinions on the Albertite of Hillsborough. The following Report will show how clearly the views of these gentlemen coincided with those which the experience of twelve years now enables an unprejudiced observer to form :—

JOINT GEOLOGICAL REPORT ON THE ASPHALTE MINE OF HILLSBOROUGH, N. B., BY RICHARD C. TAYLOR AND JAMES ROBB.

Dorchester, N. B., 29th May, 1851.

The undersigned having examined the mine at Frederick's Brook, in the Parish of Hillsborough and County of Albert, in the Province of New Brunswick, found the mineral dug therein,—

1. To be placed almost vertically in the ground :
2. To vary from 1 to 14 feet in thickness, while its bounding walls diverge and converge accordingly :
3. To vary in its general course or strike :
4. To have its principal divisional planes always arranged unconformably to the bounding strata on either side—as in the case of the chapapote or asphalte of Cuba :
5. To come in contact with the edges much more frequently than with the planes of the contiguous rocks :
6. To be associated with rocks which for very considerable distances from the mine are highly impregnated with bitumen :
7. To have no proper "roof and floor," and no under clay or other subjacent bed containing *stigmaria*, or the ordinary vegetable fossil remains of the coal measures :
8. To give off several lateral ramifications, which both intersect and conform to the shale by which they are bounded :
9. To occur in bituminous, marly, [calcareous] shales, which, at the mine, are much disturbed and contorted.

From the facts above stated *we infer*,—

1. That the mineral mass is not parallel with the surrounding strata or measures, but that it cuts or intersects them :
2. That it is a true vein—occupying a line of dislocation of uncertain extent—and not a stratum conformable to the rocks in which it is contained, in the manner of coal seams :
3. That its origin is posterior to that of the shale wherein it occurs—and that it is not contemporaneous with them :
4. That the position of the vein in the rock, as well as the arrangement of the parts of the vein itself, are decidedly much more analogous to the case of asphalte in other places than to that of coal :
5. That it is asphalte, or a variety of asphalte, and not coal or a variety of coal.

(*Signed*) RICHD. C. TAYLOR, *Philadelphia, U. S.*
JAMES ROBB, *Fredericton, N. B.*

The late Professor Taylor, whose experience in all subjects relating to coal was of a most extensive and varied character, drew up the subjoined physical differences between coal and "a true Asphaltum vein," which may be valuable to those who are intending to prosecute the search for veins of Albertite either in King's, Albert, or Westmorland Counties.

PHYSICAL MARKS OF "A TRUE ASPHALTUM VEIN."

1. The absence of lamination in the mass.
2. Its brilliant conchoidal fracture and occasional tendency to assume a columnar structure.
3. The character and configuration of its surface markings.
4. Its small specific gravity; not equalling nor exceeding many of the resins.
5. The general prevailing uniformity in the entire substance or contents of the vein.
6. Its aspect, fracture, divisions, purity, and especially its almost entire freedom from foreign and earthy matters.
7. The absence of all vegetable traces in connection with the material of the vein.
8. The absence of all apparent organization in its composition.
9. Its apparent fused and liquid state originally, and its subsequent consolidation after cooling.
10. The practicable restoration of its characteristic surface markings, and its peculiar conchoidal fracture, after being once more rendered soluble, and again cooled and consolidated.
11. Its not soiling the fingers, in the manner of coal.
12. Its being strongly electric.

PHYSICAL MARKS OF COAL.

1. The lamination of its planes, which show the lines of deposit and develop the progress and mode of accumulation.
2. The rhomboidal subdivision and separation which almost all the unaltered bituminous coal seams exhibit.
3. Its irregular or indefinite cross fracture.
4. Its striated lines of horizontal deposition, as shown equally on all the sides of any portion of the mass.
5. The variable appearance presented by these strata, passing from dull, slaty lines or stripes to others which exhibit a highly brilliant, jet-like lustre, according to the greater or lesser amount of earthy impurities which prevailed at the respective periods of their deposition.
6. Its greater specific gravity; as influenced by the presence or absence of earthy matter.
7. The abundant accompanying traces of its vegetable origin.
8. The occasional presence of other organic forms, in close contiguity.
9. The impossibility to effect a solution of coal in manner of asphalte.
10. Whereas coal in a modified state, such for instance as anthracite, may still exhibit distinct traces of its original laminations of growth by means of the ashes which it leaves after combustion, the original aspect of its fracture, after fusion, can never be again restored, as has been shown to be practicable in relation to asphaltum.

DR. JACKSON'S VIEWS.

Dr. C. T. Jackson, of Boston, figured very prominently in the trial just referred to. The evidence he adduced in 1851,* stands in very unhappy contrast with the opinions he expressed in 1850.

In 1850 Dr. Jackson considered Albertite to be "a very beautiful variety of Asphaltum." "It is jet black, glossy, and free from smut. It breaks with a broad, conchoidal fracture, like obsidian, and presents a brilliant surface. It is a little softer than rock salt, which scratches its surface. Its specific gravity is 1.107. It softens and melts when exposed to heat in close vessels."†

* Report on the Albert Coal Mine.

† Vide Proceedings of the Boston Society of Natural History, April, 1850, p. 279.—Silliman's Journal.—British Colonist, May 2nd, 1850.

In 1851 Dr. Jackson calls the mineral "Albert Coal;" he states that "it is not fusible, hence cannot be used like Asphaltum for cement," * * * "and cannot be sold in the market as Asphaltum without fraud;"—that "it is a highly bituminous coal," and "that it is not Asphaltum."

In 1850 he gives substantial and positive reasons, based on experiments, why it *is* Asphaltum. In 1851 he gives substantial and positive reasons why it *is not* Asphaltum.

From what is now known of the properties of Petroleum, inspissated or hardened under different conditions, a vast number of the conflicting results obtained by Chemists of high reputation during the investigations incident to the celebrated trial, Abraham Gesner *vs.* Halifax Gaslight Company, would have been reconciled. At that day—now half a generation since—the experiments made to determine the character of Albertite were based upon a previous knowledge of the properties of certain materials—if these results were discordant, the material was called *coal*, but if in accord, asphaltum—it did not appear to be thought necessary, under the circumstances, to consider whether inspissated petroleum might not present under different conditions many of the chemical properties of coal, and *vice versa*.

Professor Bailey, Dr. Robb's successor in the University of New Brunswick, has revived in 1864 the idea that Albertite is a highly bituminous coal, but he does not give the slightest clue to the reasons which have induced him to express this opinion so confidently. "At the time" says Professor Bailey, "of the celebrated controversy upon the nature of the Albert coal, this fact was one of much importance.† One party contended that the Albertite was a mere deposit, and hence not coal, but asphalte; the other, that it occurred in true strata of the coal measures, and was therefore really a highly bituminous coal. The latter is, undoubtedly, the correct view; yet Mr. Byers informs me, that while in some portions of the mines the coal is in beds conformable with the natural stratification, in others it is directly at right angles to it."

While the opinion, whether the material be coal or Asphaltum, is immaterial as far as regards the tenure of the property, it is of vast importance as a scientific question, and in view of the interests of the Province. If it were coal, the mode of its occurrence would be directly opposed to the views of Geologists respecting the nature, origin, and disposition of coal, and no sound advice could be given towards prosecuting a search for it in any direction whatsoever. It would be an anomaly, or a geological accident, and as

* Report on the Mines and Minerals of New Brunswick—foot note, page 51.

† Many people appear to be of this impression, and to suppose that if it were shown that this article was anything else but coal, it would endanger the rights of the present owners; this opinion is sufficiently refuted by Mr. Justice Wilmot, who, in his charge, stated—"While I do not consider it important in deciding this case, whether the article be coal or asphaltum, for the reasons I have before mentioned, yet as so much trouble has been taken on either side in reference to this question, I shall ask you to say in your verdict which of the two you consider it." The jury said—"*We believe the material to be coal.*"—Report of the case.

such of little worth beyond its present known development. Viewed as an inspissated petroleum, which it will be shortly shown to be, its origin, position, and distribution, together with its chemical and physical characters, are perfectly in accordance with what would be expected in the present state of our knowledge of this substance, and we obtain without difficulty, by simple observation in the field, certain data to guide us in a search for other deposits of the same material.

ORIGIN OF ALBERTITE.

I shall now endeavour to show,—

I. That there were two periods of injection of the material which, upon consolidation, produced Albertite.

II. That Albertite is an inspissated or hardened petroleum.

III. That its source lies in rocks below the Albert Shales, and probably of Devonian Age.

TWO PERIODS OF INJECTION.

In the Report on the Albert Coal Mine, by Dr. Jackson, allusion is made to the crushed Albertite occurring *in situ* in the mines, and a diagram is given showing the supposed relation to the surrounding rocks. I have not seen any specimens of crushed Albertite (*in situ*) from the Albert Mines, but I have before me numerous specimens from another source, obtained during the present year. They were procured from a vein of Albertite found penetrating the grey sandstones far above the Bituminous Shales, about two miles east of the Albert Mines.* A portion of the sandstone adheres to some of the specimens, and it does not appear to be impregnated with bitumen, apparently a curious and indeed remarkable fact, but one which will be explained when the properties of petroleum are discussed.

These specimens are from a vein three inches thick, and they are composed of two layers of Albertite, one layer slightly crushed, the other uniform and differing in no particular from the best specimen from the Albert Mines. The thickness of each portion is about 1½ inches, and each shows the wall of the vein on the outer side, and the crushed portion shows in places an impression of a former wall, which is faithfully copied on the side of the unaltered or homogeneous portion of the vein. The explanation of the origin of these remarkable specimens, I conceive to be as follows: The crushed portion represents an original vein of Albertite occupying a narrow fissure into which it had been injected from below; a disturbance of the strata, accompanied by a slight downfall, occurred a second time, and the fissure was enlarged or widened, the Albertite occupying it being crushed by the disturbance.

After the fissure had opened a second time, it received a fresh injection of petroleum, which filled all the cavities, cemented the broken fragments of the old vein together, and formed upon solidification the vein as it now

* Lampsey's "New Discovery," 1861.

occurs, namely, with one half crushed, the other homogeneous. Other specimens from the same vein have been wholly formed of the crushed fragments, cemented together during the second injection.

When fractured, it is easy to distinguish between a fragment of the old vein and the new cementing material, there being a difference in the brilliancy of the black and in the nature of the surface. The fragments are also as easily distinguished as the crushed specimens.

Independently of any other evidence, the vein recently discovered would afford sufficient proof that the material with which it is filled was injected from below.

ALBERTITE AN INSPISSATED PETROLEUM.

It has been generally supposed that petroleum is confined to rocks of a certain geological age. Recent enquiries into the occurrence of this remarkable substance, have established the fact that petroleum is not only very widely diffused, but also that it occurs in rocks of almost all geological ages, often, however, in different mineral states or conditions. Naphtha, petroleum, rock oil, asphalt, and mineral pitch, are all forms of bitumen, some being solid and the others fluid at ordinary temperatures.*

At the base of the Lower Silurian rocks in Canada, (the Quebec Group) a black combustible coal-like substance, has been found at Quebec, Orleans Island, Acton, and many other places, in veins and fissures in the limestones, shales, and sandstones, and even in the trap rocks which penetrate them. Sometimes it is found in drops or buttons, at other times it lines fissures, in other cases it fills fissures several inches in diameter, so that it has been mistaken for coal, but it is always confined to veins and fissures in the strata, showing its deposition to have been posterior to the formation of the rocks. At Acton it fills irregular cracks and fissures, and sometimes forms masses of several inches in diameter. It is of a shining black colour, very brittle, breaking into irregular fragments with a conchoidal fracture. It varies considerably in its chemical characters. The volatile matter from a specimen at Quebec equalled 19.5 per cent.; from the Island of Orleans 21.0; from St. Flavien, 15.8; and from another locality, six miles from this, 24.5 per cent. "The resemblance of this substance to the altered insoluble bitumen from the Devonian corals at Bertie, taken in connection with the evidences that it was at once in a liquid state, are such that it can scarcely be doubted that the coaly matters in the Quebec Group have resulted from the slow alteration of liquid bitumen in the fissures of the strata."†

In all succeeding formations bitumens or petroleum exists; thus it is found in other lower Silurian rocks in many parts of Canada, as the Utica Slate for instance, the Birdseye formation, in the Trenton group, and Hudson River formation. In the upper Silurian rocks it is also abundant, but it is

* See an excellent paper on this subject by Prof. Hunt of the Canadian Geological Survey, in the 6th Volume of the "Canadian Naturalist and Geologist," entitled "Notes on the History of Petroleum or Rock Oil," August 1861. Also on the same subject, by the same author, in the "Geology of Canada."

† Ibid.

in the Devonian rocks that the most remarkable petroleum springs in Canada have been discovered. It may be here mentioned that some of the petroleum bearing strata are overlaid and underlaid by rock absolutely impermeable to petroleum; this probably arises from their being particularly permeable to water; the petroleum refuses to penetrate a moist rock, but when dried it becomes immediately impregnated with the oily substance.

ORIGIN AND FORMS OF PETROLEUM—PETROLEUM WELLS.

Terrestrial vegetation like that which has largely contributed to the formation of coal, is not essential to the production of petroleum, for it is found in those ancient rocks which do not contain a trace of the remains of land plants or animals. That it is essentially of organic origin there is no reason to doubt, and in many instances it is locally produced, for "the fact that intermediate porous strata of similar mineral characters are destitute of bitumen, shows that this material cannot have been derived from overlying or underlying beds, *but has been generated* by the transformation of organic matters in the strata in which it is met with." * * * * *

"In the great palæozoic basin of North America, bitumen, either in a liquid or solid state, is found in the strata at several different horizons. The forms in which it now occurs depend in great measure upon the presence or absence of atmospheric oxygen, since by oxydation and volatilization the naptha or petroleum, as we have already explained, becomes slowly changed into asphalt or mineral pitch, which is solid at ordinary temperatures. It would even appear that by a continuance of the same action the bitumen may lose its fusibility and solubility, and become converted into a coal-like matter."*

The wells in which petroleum accumulates, as well as the places where a "spouting" well is struck, lie on the line of an anticlinal axis abounding in fissures, into which the petroleum slowly filters from the surrounding rock, and by the pressure of carburetted hydrogen gas, or of volatile matter which it gives off, it is forced to the surface as soon as a communication is effected with the external air. These fissures are natural reservoirs of petroleum, and in the "oil region" it is quite common for the boring apparatus, on reaching a fissure, to sink suddenly several feet.

When a "flowing well" is said to cease, it is not to be understood that no discharge takes place from the iron pipe inserted into the bore or well; the discharge of petroleum ceases, but salt water, which often accompanies petroleum, takes its place and continues for a long time to flow with but little, if any, diminution of volume.

These fissures are frequently connected together by lateral fissures, so that on sinking in the vicinity of a continuously flowing well a neighbouring fissure may be struck which yields "oil," but at the same time causes an immediate diminution in the flow of some of those situated near it. The

* Notes on the History of Petroleum or Rock Oil, by T. Sterry Hunt, M.A., F.R.S., of the Geological Survey of Canada.

same source of supply has evidently been struck, and additional vent given to the oil, water and gas which occupy the net work of fissures freely communicating with one another. These fissures do not pursue a uniform course, and this circumstance often causes apparent anomalies in the results obtained by sinking wells where certain success would appear to be within reach of the operator.* The incident mentioned in the foot note may find a parallel in Albert County, where an attempt is now being made to strike the vein occupying the fissure at the Albert Mine, in the hope of reaching the same deposit of that valuable material. A line has been drawn through the axis or centre of the levels in the Albert Mine, and trials have been made both northeast and southwest on the course of the levels, but as yet without success. It does not appear that any notice has been taken in selecting the trial spots, of the law which governs the dislocations in the Albert Mine fissure; and it is not improbable that by following the

* Mr. Sandford Fleming, C. E., mentions a curious illustration of this uncertainty which occurred in Enniskillen, C. W. "Some time after the 'Shaw' well flowed so successfully, a second party bored the rock to the same depth about one hundred yards from it, and found a copious discharge of oil, but this second well had the immediate effect of reducing very materially the flow from the 'Shaw' well. When either was plugged up, the other yielded a full discharge; but when both were allowed to flow, each yielded only a partial supply. A third party, owning a small oil lot between the two wells, commenced boring on a line drawn from the one to the other, at the distance of about thirty yards from the 'Shaw' well; he naturally expected to rob both wells, whilst their owners (who by this time had formed a co-partnership,) had every reason to fear his certain success. All parties, however, were doomed to disappointment, as the third well proved an utter failure although the rock was bored to a much greater depth than the other two wells."—Notes on the present condition of the Oil Wells of Enniskillen.—Canadian Journal, May 1863.

In October 1864, there were about 250 Oil Companies in the United States, chiefly in New York and Pennsylvania, whose aggregate capital amounted to $88,000,000, (Gold at 210.) The Government tax is 20 cents per gallon on refined oil, and 10 cents per gallon on crude. The expenses of getting the oil to market are thus stated in the New York Herald of October 14, 1864:—

Crude oil sold at Story or M'Clintock's farm, October 8, 1864, per barrel of 41 gallons, ...		$7.00
Cost of barrel or package, ...		3.25
Cartage to Railroad depot at Franklin or to Titusville, ...		1.50
Freight to New York, ...		3.60
		$15.35
Rate in New York, October 11, 38 cents per gallon, ...	$15.58	
Barrel returned, ...	2.50	
		13.08
Net profit per barrel, ...		$2.27

The same paper states, that the aggregate operations of the 250 Companies represent $140,000,000. The enormous quantity of petroleum drawn from the deep-seated reservoirs in which it has so long remained hidden, must soon cause a considerable diminution in the supply; many of the most famous wells are even now rapidly diminishing in yield. Hence it appears probable that recourse will again be had to bituminous shales, and then the remarkably rich shales in Albert, King's, and Westmorland Counties, will acquire a value before unthought of.

apparently simple course of making trial pits on the course of the vein, as observed at any one of the levels, many unsuccessful attempts to reach the continuation of the fissure by boring will be made.

The Albertite, wherever observed in position, closely resembles in all important particulars the solid bitumens of the older rocks resulting from the alteration of Petroleum. It occupies fissures in several kinds of rocks on the line of one or more anticlinal axes, into which it has been injected from beneath under considerable pressure, leading to no other conclusion as to its origin, in the present condition of our knowledge of the subject, than that it is an altered or inspissated Petroleum, and that its source lies beneath the rocks whose fissures it now fills.

THE ALBERTITE ORIGINATED FROM UNDERLYING DEVONIAN ROCKS.

The remarkable state of preservation in which the fishes, ferns, lepidodendra and other plants which abound in the Albert Shales, exist, precludes the idea of its origin in that formation. It does not appear probable that the peculiar chemical transformation which caused the organic matter to become converted into petroleum instead of coal would not have extended to the beautifully preserved organic remains which exist so abundantly in the Albert Shales, if the petroleum had originated in these beds. It is much more probable that its source is to be found in the partially metamorphosed rocks, probably of Devonian Age, upon which the Albert Shales repose, and the discovery of Albertite in these partially altered rocks gives a very favourable aspect to this view,* if it does not altogether confirm it.

In Cuba the asphaltum which has been worked for nearly half a century, occurs chiefly in metamorphic slate. The differences between the asphalte of Cuba and Hillsborough are very slight and immaterial according to Professor Taylor, and in some veins it occurs in a compact form, in others it is cellular or spongy, as if this latter character was occasioned by the escape of gas during the process of cooling. The highest part of the deposit is porous, the lower portion, where the pressure has been greater, is compact.

Recently some remarkable discoveries of Bitumens in many different stages, from Petroleum to Albertite, have been made in the West India Islands; this part of America is probably destined to emulate if not to rival Ohio and Pennsylvania in the production of illuminating oils, or material from which illuminating oil can be manufactured.

"We do not know," says Professor Hunt, "the precise conditions which in certain strata favour the production of petroleum rather than of lignite or coal, but in the fermentation of sugar, to which we may compare the transformations of woody fibre, we find that under different conditions it may yield either alcohol and carbonic acid, or butyric and carbonic acids with hydrogen, and even in certain modified fermentations the acetic, lactic and propionic acids, and the higher alcohols like $C_{10} H_{12} O_2$.

* It is worthy of notice that Dr. Robb found the pebbles of the oldest conglomerate at the base of the Carboniferous Series in Albert County, cemented together by bitumen.

"These analogies furnish suggestions which may lead to a satisfactory explanation of the peculiar transformation by which, in certain sedimentary strata, organic matters have been converted into bitumen."*

The altered character of the slates underlying the Lower Carboniferous Series in the deep indent stretching from Dorchester to Sussex, does not militate against the supposition that the rocks to which these slates belong are the source of the petroleum; for it is well known that the metamorphism produced by intrusive rocks such as those which occur in the hill ranges bounding this great valley, is generally confined to within a few yards of the intrusive mass. This has been elsewhere shown to be the case with respect to the granite in Digby, Nova Scotia; and in by far the greater number of cases, the only apparent effect of the igneous rock upon the palæozoic limestones and shales, has been a very local induration.

The Petroleum Springs in Albert and Westmorland, which probably come from the underlying Devonian rocks, show that metamorphic action has not there changed in the least degree the character of the fluid, and these springs are situated at the mouth of the great indent between Butternut Ridge and Shepody Mountain, one of them being within five miles of the Albert Mine, and within a comparatively short distance, less than a mile, of Albertite in place.

If a line be drawn through wel lknown localities where Albertite in position has been discovered, it will be found to be nearly coincident with the north-east by east anticlinal described in preceding paragraphs.

LOCALITIES WHERE ALBERTITE HAS BEEN DISCOVERED IN POSITION.

I. Albert Mines, ... In calcareous Shales.	Albert County.
II. Barnett's Farm, (1864) in Sandstone,........ Two miles east of Albert Mines.	"
III. Half a mile from Petitcodiac River, east of Edgett's,	Westmorland.†
IV. Bellveau, about half a mile N.E. by N. of the last named place, ...	"
V. In the Mechanics' Settlement, 15 miles from Sussex Vale, and a few degrees to the south of west of the Albert Mine, in metamorphic Slate, ...	King's.
VI. Seams of Albertite were observed by Mr. R. C. Matthew, near Apohaqui, in 1862.‡	

The "Humbold's Mines," in Mechanics' Settlement, King's County, have been described by Mr. Simms, Civil and Mining Engineer. This gentleman reports:—"No. 1 shaft; sunk 11 feet; 4 to 6 inches of Albertite found; no shale, but the conglomerate and drift for some distance around is impreg-

* Dr. Sterry Hunt.—Contributions to Lithology.

† The two localities in Westmorland lie on the same course as the Albert Mine, or about N. 30° E. hence they belong probably to one and the same fissure.

‡ Observations on the Geology of Saint John County, by G. F. Matthew, Esq.

nated and cemented together with bitumen. Course of seam N. 80° W. Dip nearly vertical.

"No. 2 and No. 5, a small vein of 'coal,' running east and west, *through metamorphic slate rocks.* A leader of 'coal' is seen about 1½ inch thick, and occasional pockets or nests of 'coal' have been found.

"No. 3, a small seam of 'coal' about one inch thick, in the drift nearly east and west. The drift and gravel here, as in most places worked, being cemented with bituminous matter."

"On the south side of the hill there is a shaft sunk 20 feet in depth. After going down about 14 feet, a seam of coal was discovered. The seam is not of uniform thickness, but occurring in pockets of coal 7 or 8 inches thick, and occasionally nipped between the rocks in some places to about half an inch thickness, but the trace never lost. The course of the seam is N. 80° W. and dips very slightly to the south. About 15 feet from the surface, on the south side of the shaft, a small seam of 'coal' joins, dipping northward, and backed by a rock, apparently the wall rock of the mine. In this shaft, as in all the other places worked, no traces of shale have been found; the whole of the conglomerate is cemented with bitumen."

"At a small opening on the northern side of the same hill a seam of 'coal' is seen about ¾ of an inch in thickness, the course running nearly east and west, and dipping to the south."

In all the other places, with the exception of Mechanics' Settlement, the Albertite has been found in the shales, sandstones, conglomerates, or limestones of the Lower Carboniferous Series. According to Mr. Simms, it also occurs in the underlying metamorphic slates. At the first blush it would appear that the bituminous substance may have entered fissures in the slates from above, as it seems inconsistent with prevailing ideas respecting metamorphism that Albertite could resist the supposed degree of heat seemingly involved, without being dissipated; but it will be shown elsewhere that the condition of the slates is such as not necessarily to have required the aid of a considerable degree of heat to produce the alteration in structure they have undergone, and they do not offer any valid reason why the Albertite should not have its origin in or below them. The Albertite or Asphaltum of Cuba, it will be borne in mind, occurs in metamorphosed slate.

The United States Commissioner of Agriculture in a recent Report, in which he describes the conditions under which Petroleum is obtained in the United States and Canada, advances rather a novel view of the origin of Albertite, or as Dr. Wetherall, of Philadelphia, proposes to call it, "Melan-asphalt."

"Its position," says the Commissioner, "has been misinterpreted by several observers, who have reported it a volcanic injection of bitumen into a fissure of the earth many feet in width, by the force of which large pieces of the wall rock have been torn off and carried forward in the mass. It seems, however, pretty well made out, that it was originally a horizontal bed or lake of Petroleum, hardened and covered up by sand and clay deposits of carboniferous age, and afterwards upturned, bent over, and fractured, so as to assume its present posture. It is not properly a coal bed, therefore, but a mass of hardened coal oil, which can be, and in fact has been mined like a coal bed, and the product used wholly for making gas."*

The condition of the walls of the fissure, of the crushed Albertite in sandstone, and its occurrence in numerous veins in nearly horizontal conglomerates, and in limestone, and in slate, together with its wide-spread distribution, all tend to disprove the supposition contained in the preceding paragraphs, that a hardened lake of Petroleum had been tilted up on edge.

THE ALBERT OR BALTIMORE SHALES.

These bituminous rocks present many peculiarities. Some specimens which I took from the parent rock near the Albert Mines, resemble a fine calcareous mud stratified in extremely thin layers, each layer being separated by a coating of bitumen; I counted upwards of one hundred of these layers in an inch. The bitumen in the shales differs from Albertite; it ramifies through them in fine reticulating veins. The shales which occur near the Albert Mine, differ from the bituminous shales in which the Albertite is found in this respect, that they appear to be the uppermost beds of the formation, and to contain a much larger amount of bitumen; a ton of these shales would yield, upon distillation, from sixty to ninety gallons of crude oil. They seem to have been formed in a shallow tranquil tidal estuary, into which springs of petroleum were discharging themselves; they were subsequently much folded by pressure, and received an additional supply of bitumen by injection under pressure, hence the minute veins which ramify through fractures filled with Albertite.

It is a significant fact that the bituminous matter which is so abundant in these shales in New Brunswick, is almost entirely wanting in shales of the same geological age and position at Horton in Nova Scotia. The Horton beds contains incalculable numbers of fish; "every surface in some of the shales being thickly scattered over with their bright enamelled scales and sharp conical teeth."†

They must not be mistaken for the "Oil Shale" or "Oil Coal" of the "Fraser Mine" in Nova Scotia, which lies geologically far above the Albert Shales, and occupies a position within the true coal measures; nor with the "earthy bitumens" which are found within the same geological limits. These "oil coals" and "earthy bitumens" of the Coal Measures, are thought by Dr. Dawson, (than whom a better authority on this subject does not, perhaps, exist,) to be "a water-soaked vegetable soil, completely bituminized, and twisted, and slikensided, owing to the giving way under pressure of the roots and trunks under which it was interlaced."‡

These shales may yet become a source of considerable wealth to this portion of the Province. They can "make steam," and have been used by Mr. Byers, (experimentally) for that purpose, but the bulk of the ash is an objec-

* Report of U. S. Commissioner of Agriculture.—From the Journal of Board of Arts for U. C.

† Acadian Geology, page 215. ‡ Supplementary Chapter to "Acadian Geology."

tion to their use where coal is cheap. But, as a source of oil for illuminating and other purposes, and as a source of gas fuel, they will become very valuable, as the following statement will show :—

At Collingwood in Canada, oil has been distilled from Bituminous schist which yielded only eight gallons of crude oil to the ton. The cost of the crude oil was stated to be fourteen cents the gallon, when rectified it gave from forty to fifty per cent. of burning oil, and from twenty to twenty-five per cent. of pitch or waste. The remainder being a heavy oil fitted for lubricating purposes.*

The Albert Shales yield from 65 to 90 gallons crude oil per ton, or from 35 to 50 gallons fit for illuminating purposes. The Canadian manufacturers considered that if the discovery of petroleum had not materially lessened the price of burning oil they would have realized handsome profits; it is therefore probable that a shale which yields ten times as large a quantity of oil might be profitable notwithstanding the present enormous yield of petroleum both in the United States and Canada.

GAS FUEL FOR FURNACES.

As a source of gas fuel the Albert Shales will probably acquire very considerable importance. The Regenerative Gas Furnaces, the principle of which was discovered by the Rev. Mr. Stirling of Dundee, in 1817, and described by Faraday in 1862, at the Royal Institution of London, are likely to effect a considerable change in Metallurgical operations, and in all kinds of manufactures requiring an elevated temperature. The regenerative gas furnace has already been applied to a considerable extent in Germany for heating iron, having been worked out there under the direction of Dr. Werner Siemens, who has also contributed essentially to the development of the system. The furnaces at the extensive iron and engine works of M. Borsig, of Berlin, are being remodelled for the adoption of this system of heating, as have also been those at the Imperial factories at Warsaw.

"Another important application of the regenerative gas furnace is as a steel melting furnace, in which the highest degree of heat known in the arts is required, presenting consequently the greatest margin for saving of fuel. This application of the regenerative gas furnace is indeed rapidly extending in Germany, but has not yet practically succeeded in Sheffield, where it was also tried. It is, however, in course of application at the Brades Steel Works, near Birmingham. The arrangement of the reversing valves and the air and gas flues is similar to that in the glass furnace previously described."

"Other applications of the regenerative gas furnace are being carried out at the present time, among which may be mentioned one to brick and pottery kilns for Mr. Humphrey Chamberlin, near Southampton; for Messrs. Cliff, of Wortley, near Leeds; and for Mr. Cliff, of the Imperial Potteries, Lambeth; also to the heating of gas retorts at the Paris General Gas Works, and at the Chartered Gas Company's Works, London."†

* Geology of Canada.

† From a Paper by Mr. C. W. Siemens, of London.—Read before the Birmingham Institution of Mechanical Engineers, 1862.

This new application of impure combustibles is of sufficient importance to warrant the introduction here of a Notice of Gas Furnaces by Sir M. Faraday.

ROYAL INSTITUTION OF GREAT BRITAIN.

On Gas Furnaces, &c.—By Sir M. Faraday, D.C.L., LL.D., F.R.S.—Artizan, Sept. 1862.

Gas has been used to supply heat, even upon a very large scale, in some of the iron blast furnaces, and heat which has done work once has been carried back in part to the place from whence it came to repeat its service; but Mr. Siemens has combined these two points, and successfully applied them in a great variety of cases—as the potter's kiln—the enameller's furnace—the zinc-distilling furnace—the tube welding furnace—the metal-melting furnace—the iron-puddling furnace—and the glass furnace, either for covered or open pots—so as to obtain the highest heat required over any extent of space, with great facility of management, and with great economy (one-half) of fuel. The glass furnace described had an area of 28 feet long and 14 feet wide, and contained eight open pots each holding nearly two tons of material.

The gaseous fuel is obtained by the mutual action of coal, air, and water, at a moderate red heat. A brick chamber, perhaps 6ft. by 12 and about 10ft. high, has one of its end walls converted into a fire grate, *i. e.* about half way down it is solid plate, and for the rest of the distance consists of strong horizontal plate bars where air enters; the whole being at an inclination such as that which the side of a heap of coals would naturally take. Coals are poured, through openings above, upon this combination of wall and grate, and being fired at the undersurface, they burn at the place where the air enters; but as the layer of coal is from 2 to 3ft. thick, various operations go on in those parts of the fuel which cannot burn for want of air. Thus the upper and cooler part of the coal produces a larger body of hydro-carbons; the cinders or coke which are not volatilized, approach, in descending, towards the grate; that part which is nearest the grate burns with the entering air into carbonic acid, and the heat evolved ignites the mass above it, the carbonic acid passing slowly through the ignited carbon, becomes converted into carbonic oxide, and mingles in the upper part of the chamber (or gas producer) with the former hydro-carbons. The water, which is purposely introduced at the bottom of the arrangement, is first vaporized by the heat, and then decomposed by the ignited fuel and re-arranged as hydrogen and carbonic oxide; and only the ashes of the coal are removed as solid matter from the chamber at the bottom of the fire-bars.

These mixed gases form the gaseous fuel. The nitrogen which entered with the air at the grate is mingled with them, constituting about a third of the whole volume. The gas rises up a large vertical tube for 12 or 15ft., after which it proceeds horizontally for any required distance, and then descends to the heat-regenerator, through which it passes before it enters the furnaces. A regenerator is a chamber packed with fire-bricks, separated so as to allow of the free passage of air or gas between them. There are four placed under a furnace. The gas ascends through one of these chambers, whilst air ascends through the neighbouring chamber, and both are conducted through passage outlets at one end of the furnace, where mingling they burn, producing the heat due to their chemical action. Passing onwards to the other end of the furnace, they (*i. e.* the combined gases) find precisely similar outlets down which they pass; and traversing the two remaining regenerators from above downwards, heat them intensely, especially the upper part, and so travel on in their cooled state to the shaft or chimney. Now the passages between the four regenerators and the gas and air are supplied with valves and deflecting plates, some of which are like four way-cocks in their action; so that by the use of a lever these regenerators and air-ways, which were carrying off the expended fuel, can in a moment be used for conducting air and gas into the furnace; and those which just before had served to carry air and gas into the furnace now take the burnt fuel away to the stack. It is to be observed, that the intensely heated flame which leaves the furnace for the stack always proceeds downwards through the regenerators, so that the upper part of them is most intensely ignited, keeping back, as it does, the intense heat; and so effectual are they in this action, that the gas which enters the stack to be cast into the air is not usually above 300°F. of heat. On the other hand, the entering gas and air always passes upwards through the regenerator, so that they attain a temperature equal to white heat before they meet in the furnace, and there add to the carried heat that due to their mutual chemical action. It is considered that when the furnace is in full order, the heat carried forward to be envolved by the chemical action of combustion is about 4000°, whilst that carried back by the regenerators is about 3000°, making an intensity of power which, unless moderated on purpose, would fuze furnace and all exposed to its action.

Thus the regenerators are alternately heated and cooled by the outgoing and entering gas and air, and the time for the alternation is from half an hour to an hour, as observation may indicate. The motive power on the gas is of two kinds—a slight excess of pressure within is kept up from the gas-producer to the bottom of the regenerator to prevent air entering and mingling with the fuel before it is burnt; but from the furnace, downwards through the regenerators, the advance of the heated medium is governed mainly by the draught in the tall stack, or chimney.

Great facility is afforded in the management of these furnaces. If, whilst glass is in the course of manufacture, an intense heat is required, an abundant supply of gas and air is given; when the glass is made, and the condition has to be reduced to working temperature, the quantity of fuel and air is reduced. If the combustion in the furnace is required to be gradual from end to end, the inlets of air and gas are placed more or less apart the one from the other. The gas is lighter than the air; and if a rapid evolution of heat is required as in a short puddling furnace, the mouth of the gas inlet is placed below that of the air inlet; if the reverse is required, as in the long tube-welding furnace, the contrary arrangement is used. Sometimes, as in the enameller's furnace, which is a long muffle, it is requisite that the heat be greater at the door end of the muffle and furnace, because the goods, being put in and taken out at the same end, those which enter last and are withdrawn first, remain, of course, for a shorter time in the heat at that end; and though the fuel and air enters first at one end and then at the other alternately, still the necessary difference of temperature is preserved by the adjustment of the apertures at those ends.

Not merely can the supply of gas and air to the furnace be governed by valves in the passages, but the very manufacture of the gas fuel itself can be diminished, or even stopped, by cutting off the supply of air to the grate of the gas producer; and this is important, inasmuch as there is no gasometer to receive and preserve the aeriform fuel, for it proceeds at once to the furnaces.

Some of the furnaces have their contents open to the fuel and combustion, as in the puddling and metal-melting arrangements; others are enclosed, as in the muffle furnaces and the flint-glass furnaces. Because of the great cleanliness of fuel, some of the glass furnaces, which before had closed pots, now have them open, with great advantage to the working and no detriment to the colour.

The economy in the fuel is esteemed practically as one-half, even when the same kind of coal is used, either directly for the furnace or for the gas producer; but, as in the latter case, the most worthless kind can be employed—such as slack, &c., which can be converted into a clean gaseous fuel at a distance from the place of the furnace, so many advantages seem to present themselves in this part of the arrangement.

It will be seen that the system depends, in a great measure, upon the intermediate production of carbonic oxide from coal instead of the direct production of carbonic acid. Now carbonic oxide is poisonous, and, indeed, both these gases are very deleterious. Carbonic acid must at last go into the atmosphere; but the carbonic oxide ceases to exist at the furnace, its time is short, and whilst existing it is confined on its way from the gas-producer to the furnace, where it becomes carbonic acid. No signs of harm from it have occurred, although its applications have been made in thirty furnaces or more.

The following are some numbers that were used to convey general impressions to the audience. Carbon burnt perfectly into carbonic acid in a gas-producer would evolve about 4000° of heat; but, if burnt into carbonic oxide, it would evolve only 1200°. The carbonic oxide, in its fuel form, carries on with it the 2800° in chemical force, which it evolves when burning in the real furnace with a sufficient supply of air. The remaining 1200° are employed in the gas-producer in distilling hydro-carbons, decomposing water, &c. The whole mixed gaseous fuel can evolve about 4000° in the furnace, to which the regenerator can return about 3000° more.

The use of gas fuel in the smelting of iron ores has been further referred to in the Chapter on the "Quebec Group;" and the employment of the Albert Shales, as a source of gas fuel in the smelting of the Bog Iron ores of the Valley of the Kennebeccasis, and more especially of the almost pure magnetic ores of Springfield, suggested, as a promising field for the investment of capital, and the creation of local metallurgical industry.

In a subsequent Chapter the importance of the Albert Shales will appear in a more striking light, when viewed in relation to the manufacture of iron by the process of M. Chenot, who received the Gold Medal at the Paris Exhibition, for his discoveries in the use and application of gas fuel in the smelting of iron ores.

PETROLEUM SPRINGS IN ALBERT AND WESTMORLAND.

Natural petroleum springs have long been known in these Counties. Attempts are now being made to reach the source of supply by boring.

The following information respecting the depth of the borings was obtained from workmen at Steeves' Ravine well, in October of the present year:—

1. The Steves Ravine well.—The petroleum spring here has long been known. The oil occurs on the surface of the water in an excavation under the north bank of the ravine. Its odour and colour reminded me of the petroleum at the Enniskillen wells in Canada. The depth of the well was then, (October 15, 1864,) 186 feet. The sand pump brought up fresh water, and a very little oil.

2. The Dover well, about three miles north of Hillsborough, on the east side of the Petitcodiac, 106 feet down, with a strong flow of fresh water.

3. Cummins Well, Westmorland County, Dorchester Parish, about a mile from the Dover Well, 530 feet down; salt water in the pump, small show of oil.

4. Memramcook, about 140 feet down, very small show of oil.

An idea of the depth to which it will be necessary to bore before oil in remunerative abundance may be expected, will be gathered from the fact that the main shaft of the Albert Mines has already been excavated to the depth of one thousand feet, without a trace of oil being met with. It is not probable therefore, with this splendid test well in view, that the prospectors will be successful at a less depth than 1300 or 1500 feet, and it yet remains to be seen to what extent the Devonian Rocks, the probable source of the oil, are developed in that part of the Province.

The inflammable gas which is copiously evolved near the Albert Mine, and in several places in Albert County, is not necessarily connected with petroleum, as it is proceeds from rocks destitute of bitumen.

CONCLUSIONS WITH REFERENCE TO ALBERTITE.

As the question of an increased supply of Albertite is one of very considerable moment to the Province, it may not be an unnecessary recapitulation to state briefly and in order the conclusions which have been advanced in preceeding pages.

It is submitted that it has been shown—

1st. That the Albertite wherever it has been found in situ, occupies fissures produced by dislocations in the rocky strata, or exists as a cementing material in conglomerates, or occurs as an integral part of the rock, as in the Albert Shales.

2nd. That the Albertite, under all circumstances, has been injected from below.

3rd. That there were at least two periods of injection.

4th. That when it occupies fissures, these are on the lines of anticlinal axes.

5th. That it is an inspissated or altered petroleum.

6th. That its source lies beneath the Albert Shales, or in other words beneath the Lower Carboniferous Series.

7th. That it is consequently of Devonian or prior origin, and proceeds probably from rocks of the same age as those which yield the Petroleum of Pennsylvania, Ohio, and Canada.

8th. That it may with confidence be anticipated that a search made in accordance with the views which have been expressed respecting its origin, will result in valuable deposits being found over an extensive area between Dorchester in Westmorland and Norton in King's Counties; but this search must be continued along the lines of anticlinal axes which have been shown to exist within the limits specified.

The quantity of Albertite raised since the opening of the Mine in Albert County, is estimated to be about 170,000 tons. At $10 a ton (the minimum price at which I was informed it has been sold,) this would amount to one million seven hundred thousand dollars.

ANALYSIS OF ALBERTITE.

Results of the Analysis of Albertite by different Chemists.

References.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Volatile matters,..	58.50	58.80	58.65	55.55	61.10	65.20	56.50	54.50	56.50	58.48	59.75	61.53
Coke or Carbon,..	41.50	41.20	40.88	44.35	38.50	34.80	43.50	45.50	43.50	40.86	38.25	38.47
Ashes,..........	..	..	0.47	0.10	0.50	0.40	..	..	..	0.66	0.25	..
Water,..........	..	..	..	..	..	..	..	..	..	..	..	..
Totals,......	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Specific gravity,..	..	..	..	1.097	1.097	..	..	..	..	..	..	1.084

I. Dr. Jackson's 1st Analysis.
II. 2nd
III. mean.
IV. Dr. Wetherall, Philadelphia.
V. Prof. Penny, Glasgow.
VI. Mr. Outram, Halifax.
VII. Mr. C. T. Harris, New York.
VIII. do.
IX. do.
X. Dr. Chilton, N. Y.
XI. Mr. Booth, Philadelphia.
XII. Dr. Robb. Fredericton.

Calorific Power, ... 25
Total Carbon, ... 72
Carbon in volatile matters, 37.6
Outram.

53 per cent Gas. — Harris.

Formula (Wetherall) $C_{24} H_{15.9} O_{1.6}$

Coal,	76.2
Bitumen,	23.8
	100.00
	Penny.

According to the Analysis of Dr. Wetherall, of Philadelphia, the Albertite of New Brunswick resembles the Cuba Asphalte in a remarkable degree. The Barbadoes compact Bitumen is of similar composition.

	Cuba Asphalte.	Albertite.
Carbon, ...	82.339	86.087
Hydrogen, ...	9.104	8.962
Nitrogen, ...	1.910	2,930
Sulphur, ...	traces.	traces.
Oxygen, ...	6.247	1.971
Ash, ...	0.400	0.100
	100.00	100.00

	Cuba Asphalte.	Barbadoes Asphalte.
Bitumen, resolvable into tar and gas,	63.30	61.60
Coke or Carbon, ...	34.97	36.90
Ashes, ...	2.63	1.50
	100.00	100.00

CHAPTER VI.

THE DEVONIAN SERIES.

The Valley of the Restigouche—Upper Silurian and Devonian Rocks—Area occupied by the Devonian Rocks in this Valley—Devonian Rocks on the Bay of Fundy—Age of the Rocks—Extent of the Basin—The Devonian Rocks of Saint John—The Flora of the Devonian Rocks—The richness of this Series in Mineral Wealth—Iron Ores—Copper Ores—Origin of Petroleum—Source of the Albertite—Source of the Bituminous or Albert Shales—The Vernon Copper Mines—Origin of Metalliferous Veins—Segregated Veins—Gash Veins—True Veins—Origin of True Veins—Lead Ores Argentiferous Galena—Erroneous impressions which prevail with respect to the percentage of Silver in Argentiferous Galena—Description of the Vernon Mines near the Mouth of Goose Creek—Description of the Rocks on the Coast—Red Conglomerates, Epidotic Traps and Plumbaginous Slates—Green Conglomerate Slates—General arrangement of the Rocks—Intrusive Traps—Copper-bearing Traps—Newer Traps—The Sedimentary Rocks—Conglomerates and Porphyries—Steatitic Rocks—The Copper Lodes—The Peacock Vein—Fissure occupied by—Width of the Vein—Veinstone, Bitter Spar and Quartz—The Levels—The Green Vein—Occurs in a line of fault—Extension eastward of the Copper-bearing Traps.

The Restigouche forms for some miles the boundary between Canada and New Brunswick, and has been examined by the officers of the Geological Survey of Canada. The rocks in this valley, from the mouth of the Matapedia downwards, constitute a trough or basin in which the lower rocks belong to the Gaspe Limestones and are of Upper Silurian age, the upper rocks (sandstones and conglomerates) of Devonian age. Intrusive traps are very abundant in this neighbourhood, and have exercised a marked influence upon the present distribution of the sedimentary Rocks.

The Sugar-loaf, 750 feet high, near Campbeltown, is of trap which forms the greater part of the area between this hill and the Restigouche. On the River bank the Devonian conglomerate appears, and at Mission Point there is a sandstone which probably belongs to the same formation. Between Shaw's Brook and Point la Lime, intrusive traps composed of red felspar and black mica are interstratified with the conglomerate which runs along the beach to Point la Lime. Below this point there is a thin seam of carbonaceous shale associated with the conglomerate, with a bed of clay beneath it, which has led to the delusive hope that coal might be found in that vicinity. The same seam is again seen at Point Pin Sec resting on the clay bed, and overlaid by a mass of trap which has changed it to a hard black stone. A conglomerate bed again occurs further on in an easterly direction, from beneath which there appears, near Point Peuplier, a red slate which the Indians use for the manufacture of their pipes. The rocks seen along the shore towards Dalhousie are nearly all trap.* These conglomerates must not be mistaken for the small outlier of the Carboniferous Series, (Bonaventure formation) near Point la Lime on the south side of the Campbeltown road.

The siliceous conglomerates on the Restigouche resemble, in many places, a modern beach or ridge, whose pebbles are strongly cemented together. It occurs in beds a few feet in thickness, underlaid by shale and sandstone in which few pebbles are visible. In Campbeltown, near the residence of the Hon. John McMillan, a silicious rock crops out in shaly layers, which resembles the siliceous layers in the Section at Cape Bon Ami, described on a subsequent page.

The area here occupied by the Devonian rocks does not probably exceed five and twenty square miles, the greater portion of the valley of the Restigouche in New Brunswick, belonging to the Upper Silurian Series.

DEVONIAN ROCKS ON THE COAST OF THE BAY OF FUNDY.

The remains of a great basin formerly occupied by Devonian rocks are found on the coasts of the Bay of Fundy. Commencing in the State of Maine in the towns of Lubec, Perry, and Robbinstown, there is a narrow belt of Devonian Sandstones on the coast, forming the rim of the basin. It passes thence to Saint Andrews, and is stated by Hitchcock† to appear occasionally in the southwest part of the Province on Spruce Island, Indian Island, Friendship Folly, &c. On the western borders of Boyden Lake in Perry and Charlotte townships, (Me.) "this rock has undergone a change, being converted into silicious slates and trappean rocks." The dip is here northerly from 25 to 30 degrees. The same rocks were thought to have been seen on Bliss Island in November last, also a very small outlying patch on Frye's Island.

From near Point Lepreau, Devonian Rocks appear to form the coast as far as Emerson's Creek, when they are overlaid by Carboniferous Strata. In the rear of these they form a narrow belt which comes on the coast again in the neighbourhood of Salmon River. From near Mousheer's River to Point Wolf, rocks of this age occupy the coast, and a small patch occurs near the mouth of Upper Salmon River.

Mr. G. F. Matthew, of Saint John, has given an elaborate description of the Devonian Rocks in the neighbourhood of that City.‡

Mr. Matthew also describes a probable series of Devonian Rocks on the north side of the Kennebeccasis. "They may be the equivalent of the volcanic sediments described above (Bloomsbury Group—Lower Devonian), but their outcrop is so straight for a distance of thirty miles, that they may prove to be part of an older series brought up by a fault."

* Geology of Canada. † Geology of Maine, Scientific Survey, Vol. I. 1861.

‡ Observations on the Geology of Saint John County, by G. F. Matthew—Canadian Naturalist and Geologist, August 1863.

On the southeast side of the Bay of Fundy, in Nova Scotia, Devonian Rocks occur on the Nictau River, Moose River, Bear River, and thence to the extremity of the Peninsula.* They are overlaid near the coast by New Red Sandstone.

The conclusions deduced from these facts are as follows:—

1. A basin of Devonian Rocks, chiefly of the age of the Chemung and Portage Group of the New York Survey, occupies a large area now covered in great part by the waters of the Bay of Fundy.

2. The rim of this Basin is seen in the coast townships of Maine from Lubec to Robbinston, on many points and islands of New Brunswick from Saint Andrews to Lepreau, and near the coast from a short distance east of Lepreau to Saint John, and on the north side of the Kennebeccasis, to where it is overlaid by Lower Carboniferous Rocks. The southwestern rim of this basin is recognized in Nova Scotia from near Minas Basin to the extremity of the Peninsula. (Lower Devonian.)

3. The Carboniferous Series in the Valley of the Upper Kennebeccasis, and Petitcodiac, are probably underlaid by these Devonian Rocks, and the Bay of Fundy is in great part excavated in them, or in the superimposed Carboniferous Series. [See Chapter I.—Bay of Fundy.]

FLORA OF THE DEVONIAN SERIES.

The Devonian Rocks of the New Brunswick Basin are especially interesting on account of their well developed Flora.

Dr. Dawson has bestowed on specimens collected from different localities much attention, which has been productive of very valuable results.

The rocks which occur at Saint John he describes generally as the Saint John Series.†

The fossiliferous portion of the Saint John Series,‡ says Dr. Dawson, presents the richest known flora of the Devonian Period ever discovered. It far excels in number of genera and species the Lower Carboniferous flora as it exists in British America, and is comparable with that of the middle Coal Measures, from which, however, it differs very remarkably in the relative development of different genera, as well as in the species representing these genera.

"It is only just to observe, that the completeness of the following list is due to the industrious labours of an association of young gentlemen at Saint John, who, under the guidance of Messrs. Matthew and Hartt, have diligently explored every accessible spot within some distance of the city and have liberally placed their collections at my disposal for the purposes of this paper."

* Supplementary Chapter to "Acadian Geology."

† Quarterly Journal of the Geological Society. Nov. 1862.

‡ In "the Saint John Series," Dr. Dawson includes all Mr. Mathew's subdivisions.

LIST OF DEVONIAN PLANTS FOUND NEAR SAINT JOHN.

Dadoxylon Ouangondianum,		*Dawson.*
Sigillaria palpebra,	sp. nov.	
Stigmaria ficoides, (var.)		*Brongn.*
Calamites transitionis,		*Gœppert.*
" cannæformis,		*Brongn.*
Asterophyllites acicularis,	sp. nov.	
" latifolia,	"	
" scutigera,	"	
" longifolia,		*Brongn.*
" parvula,		*Dawson.*
Annularia acuminata,	sp. nov.	
Sphenophyllum antiquum,		*Dawson.*
Pinnularia displana,	sp. nov.	
Lepidodendron Gaspianum,		*Dawson.*
Lycopodites Mathewi,		"
Psilophyton elegans,	sp. nov.	
" glabrum,	"	
Cordaites Robbii,		*Dawson.*
" angustifolia,		"
Cyclopteris Jacksoni,		"
" obtusa,		*Gœppert.*
" varia,	sp. nov.	
" valida,	"	
Neuropteris serrulata,	"	
" polymorpha,	"	
Sphenopteris Hœninghausi,		*Brongn.*
" marginata,	sp. nov.	
" Harttii,	"	
" Hitchcockiana,	"	
Hymenophyllites Gersdorffii,		*Gœppert.*
" obtusilobus,		"
" curtilobus,	sp. nov.	
Pecopteris (Alethopteris) discrepans,	sp. nov.	
" (") ingens,	"	
" (") obscura ?		*Lesquereux.*
Trichomanites,	sp. nov.	
Cardiocarpum cornutum,	sp. nov.	
" obliquum,	"	
Trigonocarpum racemosum,	"	

MINERAL WEALTH OF THIS SERIES IN NEW BRUNSWICK.

The Devonian Series in New Brunswick is apparently rich in mineral wealth as far as it has been examined. In it are contained the important and extensive beds of iron ore at West Beach, described by Mr. Matthew in a paper read before the Natural History Society. The widely distributed deposits of copper ore at and in the neighbourhood of the Vernon Mines, near Goose Creek, are in this series, and it is very probable that rocks belonging to it underlie a considerable portion of Albert County and King's County, and from these rocks the petroleum, now in an inspissated or altered condition forming Albertite, has originated, as well as the Petroleum Springs which have been noticed in another place, (page 108.) Rocks of the same age, but without having undergone metamorphism, are the sources of the Petroleum in Canada, and in Pennsylvania.

The Bituminous or Albert Shales in the valleys of the Kennebeccasis and Petitcodiac, have also derived their bitumen in great part from these rocks. Under these circumstances a careful examination of this important series might lead to more valuable results than those which have been briefly adverted to.

The Vernon Copper Mines are now being worked energetically, and as they promise to become a source of wealth to the Province, and the rocks in which they are situated shew indications of valuable copper deposits both east and west of these Mines, a minute description of them and their geological relations, may be attended with advantage. The examination was made during the month of November in the present year.

As a preliminary to this description it will be advisable to make a few observations on metallic veins and the circumstances under which veins of different kinds originate.

ORIGIN OF METALLIC VEINS.

In expressing an opinion on the commercial value of any metalliferous deposit, it is essential to bear in mind various facts and conditions which experience has shown to be inseparable from mining operations. It is therefore proposed to glance briefly at the known laws which appear to regulate the distribution of veins and masses of ore in both stratified and unstratified rocks.

In rocks of sedimentary origin, metalliferous deposits when they occur in masses, are evidently of the same or nearly the same age as the strata in which they are found. As for instance the clay-iron stone deposits of the coal formations, the beds of hœmatite at Woodstock, &c. (see Chapter IX.), and it is in this form that iron and manganese are frequently found, whereas other metals, including also iron and manganese often occur in unstratified rocks. Some of the mountain masses of iron ore in the Laurentian Series of Canada belong to the stratified deposits, although there are eruptive masses of ore on Lake Superior and in Missouri. The form in which metalliferous deposits occur in the unstratified and often in metamorphosed rocks is that of mineral veins, which are of three kinds, segregated, gash and true veins.*

* See Professor J. D. Whitney on "the Occurrence of Metalliferous Ores."—Geological Survey of Wisconsin.

"Segregated veins, which are peculiar to altered crystalline, stratified or metamorphic rocks are usually parallel with the stratification, and not to be depended on in depth. Gash-veins may cross the formation at any angle, but are limited to one particular group of strata and are peculiar to the unaltered sedimentary rocks. True veins are aggregations of mineral matter, accompanied by metalliferous ores, within a crevice or fissure, which had its origin in some deep seated cause, and which may be presumed to extend for an indefinite distance downwards."*

True veins are supposed to have originated in faults, and may be indefinitely deep; gash veins probably originated in fissures produced by shrinkage, and are liable to give out on passing into another set of beds. True veins exhibit, first, persistence and depth; second, a peculiar gangue or veinstone forming the bulk of the vein, and often consisting of quartz, bitter spar, calcite, and heavy spar; third, a disposition of the mineral substances of which the vein is composed symmetrically, in parallel layers on the wall, with their chrystalline faces turned inwards and towards the centre of the lode or vein; fourth, well defined walls or sides of the vein, often polished or slickensided; fifth, they are usually independent of the stratification, and the vein stone changes frequently as they enter different strata.

The most productive deposits of Lead Ores appear to occur in Lower Silurian Rocks, or in Carboniferous Limestone. In Spain, and in the Western States, the lead districts are in Lower Silurian Rocks, in England in the Mountain Limestone. Both lead and zinc occur in heavy masses in unaltered rocks, but this is not the case with other metals. When lead occurs in the older chrystalline rocks, it is usually argentiferous and is worked for the silver it yields, and as a general rule the more chrystalline a rock is the more silver will lead ores found in it contain. When lead and zinc occur in the unaltered stratified rocks the deposits are usually irregular and cannot be relied on, but when they occur as true veins they are generally permanent.

ARGENTIFEROUS LEAD ORES.

The lead ores in New England are generally rich in silver, but they occur in such hard rocks and in so small quantities, that although the veins are frequently large and well defined they have not thus far been found capable of being wrought with profit.†

The ore at Warren, in New Hampshire, contains from 60 to 70 ounces to the ton of 2,000 lbs., and in Europe eight ounces of silver to the ton can be profitably separated.

It is a great mistake, however, to suppose that lead ores are necessarily argentiferous. The Galena of the Upper Mississippi Valley scarcely contains more than a trace of silver; and when we hear of lead ore containing "a good percentage of silver," we must receive the information with due allowance for looseness of expression, or with a suspicion that a want of correct information on the subject is far more probable than "a good per-

* Professor J. D. Whitney—Geology of Wisconsin. † Ibid.

centage of silver." A moment's reflection will show the absurdity of statements to the effect that certain lead ores contain three, two, or even one per cent. of silver. It has been already stated that eight ounces to the ton of ore pays for extraction in Europe. A ton contains 2,000 lbs., and eight ounces troy is two thirds of a pound. One pound in 2,000 lbs. would be exactly one twentieth per cent., and eight ounces to the ton is one thirtieth per cent. One per cent. of silver in lead ore would be 240 ounces to the ton, but as eight ounces pays for extracting, some idea may be formed of the value of a lead mine containing one per cent. of silver to the ton of ore.

THE VERNON MINES.

The Vernon Copper Mines, of which a description will now be given, are situated about two miles east of the mouth of Goose Creek, in the County of Saint John, near Martin's Head. The cliffs here are very precipitous, and the summit level or edge of the plateau is 660 feet above the sea.

DESCRIPTION OF THE ROCKS.

General Arrangement and Character.

The strike of the rocks on this part of the coast being nearly east and west magnetic, and the variation of the compass 20° west, a line of section at right angles to the strike would pass from Jim's Brook, (a small stream which tumbles over a ledge of rocks into the Bay of Fundy, 1½ miles from Goose Creek,) where it crosses the road to the Vernon Copper Mines, down its valley towards Mackerel Cove. For the purpose of representing the actual strike and dip of the rocks as they appear on the coast and in the valley of Jim's Brook, it will be necessary to diverge a few degrees to the west, and then to the east of a straight line at right angles to the strike.

At Mackerel Cove * red slates have a southerly dip, (S. 20° W.), for a few yards, and are succeeded by conglomerates and plumbaginous slates with a vertical dip, then by green, grey and black plumbaginous slates with a dip to the north, thus showing an anticlinal axis. About eleven years ago attempts were made to discover coal in the plumbaginous slates of Mackerel Cove, and a drift was made for a space of 90 feet horizontally, but of course without success, the rocks on this part of the coast being some thousand feet below the true coal measures. A red arenaceous conglomerate on the north side of the axis exhibits beautiful plumbaginous surfaces, hard, glistening, and intensely black. It is succeeded by green slates which gradually merge into a Diorite containing much epidote. These are followed by a few yards of an intensely red sandstone with slaty cleavage, which gradually becomes a fine conglomerate. A broad belt of Epidotic Trap now forms the coast for between two or three hundred yards; this trap appears again at the Point east of the mine, and probably at succeeding points on the coast in the same direction. The entire series of red, plumbaginous, and green slates just noticed, were thought to be recognized on Goose Creek, at the Mill-dam, and above it. They probably cross the peninsula in successive

* Mackerel Cove is about one mile east of the mouth of Goose Creek.

belts, between Mackerel Cove and Goose Creek. In a ravine near the Mill-dam, the plumbaginous slates have already attracted attention, and although it would be an absurd waste of labour and means to repeat the Mackerel Cove enterprise in search of coal, in what are probably Devonian Rocks, yet an impure plumbago might be obtained of questionable value.

The broad belt of Epidotic Trap has a very important bearing upon the geological structure of the coast for some miles to the east, and it will be noticed in subsequent paragraphs. Succeeding this trap is a very coarse red conglomerate dipping to the south. The beach is strewed with its debris and it shows much metamorphic action, the pebbles it contains being extremely hard and capable of receiving a fine polish. It is probable that some layers of this conglomerate, those near the trap, would afford an excellent material for the manufacture of ornamental tables, vases, &c. A narrow trap dyke succeeds the conglomerate, and is followed by slates and fine conglomerates as far as Jim's Brook, dipping to the north, showing another anticlinal axis or fold. About one hundred yards to the east of the brook and a little out of the line of section, the continuation of the last anticlinal noticed is well seen on the coast. A bright green sheet of trap comes up through the centre of the anticlinal, and is newer than another series of trap dykes, which are of a darker green, ferruginous and copper bearing.

Continuing up Jim's Brook on the line of section, reddish-grey conglomerates form the precipitous cliff down which Jim's Brook plunges for 228 feet. A trap dyke occurs here, which where it joins the slates, abounds in copper pyrites. This is called the Brook vein. The course of the brook changes after passing the trap, and runs in a deep gully for a distance of about 160 yards, in a northeasterly direction, over red and green conglomerates, dipping north; here the course changes again with another trap dyke, and continues for 300 yards in a direction N. 20° E., passing over beautiful green slates and two or three narrow belts of trap. These green slates are probably the same band which were found in excavating a cellar on the summit of the hill 350 yards from the coast. They are porphyritic, unctuous, and soft, being succeeded by still more altered and very hard slates. Some layers of the green slates have a compact texture and clean fracture; they would make good roofing slates if the mass of the rock retains the characters of some of the ledges exposed in the brook. The same slates cross the road to Goose Creek, due west of the Brook. Here they weather of a yellowish white colour, and would not attract attention without fresh fractures were exposed.

THE ROCKS ON THE COAST.

Returning to the coast east of Jim's Brook, red conglomerates highly metamorphosed are seen forming a sharp anticlinal. The conglomerates are jaspery and very hard; the bright green trap coming up through the crown of the anticlinal has already been noticed. Grey and reddish conglomerates dipping north, now occupy the coast, with occasional exposures of trap as far as the Point of rocks where a great mass of Epidotic Trap forms a well defined land mark, about 250 yards east of the main or Peacock vein. The several exposures of trap in this space are probably parts of a sheet which runs nearly parallel to the coast, and has resisted the action of the sea. The point upon which the house and store of the Vernon Mining Company is built is part of this sheet, the slates being found in its rear. Near Azor's Beach there is an anticlinal axis with porphyritic greenish slates on each side and a trap dyke between, the course of the slates being N. 70° E.

The general arrangement of the rocks north of the broad belt of Epidotic Trap which has been described as occurring near Mackerel Cove, at the Point of rocks and east of Azor's Beach, appears to be that of the north side of great anticlinal fold, the belt of Epidotic Trap, coming up from below and occupying the crown; the south side having been washed away by the sea. Minor undulations occur at Mackerel Cove, 300 yards west of Jim's Brook, 100 yards east of the same place, and about 150 yards west of Azor's Beach. The north side of this fold has been subjected to one or more cracks or dislocations, one being occupied by the Peacock vein, and another probably lying on a course nearly parallel to it and forming the valley of Jim's Brook, the Peacock vein being anticlinal and Jim's Brook synclinal. There is also, probably, a great fault, whose northern boundary is marked by the "Green vein."

INTRUSIVE TRAPS.

Epidotic Trap.

The general course of the Trap dykes is from east to west. The broad belt of Epidotic Trap on the coast is perhaps 200 yards in width. It forms the first point and some hundred yards of the coast east of Mackerel Cove. It has a rather coarse red conglomerate on one side and a fine red conglomerate on the other. It is next seen in force at the Point of rocks east of the house, with reddish conglomerate behind it at an altitude of 72 feet, and again near Azor's Beach.

Copper Bearing Trap.

In the rear of this great belt there is a series of narrow bands of intrusive trap which come up through the conglomerates and slates nearly at right angles to their dip. These are the Copper bearing Traps of this part of the coast.

The first band containing copper pyrites was seen at an altitude of 198 feet above the sea, 70 yards east of the Twin Pillars (east of the Epidotic trap near Azor's Beach). Its course would bring it out on the coast about 320 yards (estimated) east of the Point of rocks, where it was seen backed by yellowish green porphyritic slates dipping north. Two other narrow bands of a similar trap cross out on the coast between it and the Point of rocks, but no copper was seen in them. It is probable that the most westerly of these bands appears just in the rear of the Epidotic trap at the Point of rocks, where the distinction between the two kinds of trap is visible one being very epidotic, the other highly ferruginous and containing no epidote.

North of the Point of rocks another band of trap, 20 feet broad, is visible at an altitude of 229 feet. The fine conglomerates with slaty cleavage, are seen on both sides of this band, and are very porphyritic close to the trap. At an altitude of 350 feet, also about due north of the Point of rocks, there is a wall of trap having a course S. 70 E. and dipping S. at an angle of 78°. This is probably the same copper-bearing dyke which appears at the main pit of the "green vein," and also to the west of it in the gully between it and the upper pit of the green vein, and near the upper pit itself. The next copper-bearing trap of this Series, where the metal has been found, occurs at the Brook vein. Several other belts of trap running apparently parallel to those described may be seen in Jim's Brook, where the strata are exposed, and traces of copper were found in some of them. These copper bearing traps appears to form a set of rudely parallel sheets which come up through the conglomerates and slates, nearly at right angles to their stratification. The sheets face the coast line, and incline towards it at an angle, where observed, of about 78° S. The intrusive character of these traps is well exemplified east of the Point of rocks, where large masses of the conglomerates are seen involved in their mass, and their relation to the copper ores found in the veins is not difficult to trace.

NECESSITY FOR ASCERTAINING THE SOURCE OF THE METAL.

It is important to ascertain the true origin of the metal, as the future profitable working of the copper ores on this part of the coast materially depends upon a recognition and appreciation of this fact. In Canada "the distribution of copper through the rocks of the Quebec Group is very general, and seems to indicate that this metal was almost every where present in the waters from which these strata were deposited."* In a portion of the Acton Mine,† to which the Vernon Mine has been compared, but to which it bears no resemblance, except in the vein stone, "occasionally the variegated and vitreous sulphurets form the cement of a conglomerate rock, enclosing masses and grains of chert and of limestone." * * * "Sometimes the ores, as at Acton and Upton, are in the dolomites, or as in Ascott, in a chloritic limestone, while in many other localities they are found in micaceous or chloritic slates, or in steatite."‡

The reticulating veins of carbonate of lime which form so marked an object in the perpendicular cliffs of dark coloured calcareous slate near the mouth of Goose Creek contain copper ores, but these were probably derived from the trap injections which are so numerous in that vicinity. No copper has been found in the conglomerate of the Vernon property remote from a trap dyke, and specimens which have been analized appear free from a trace

* Geology of Canada, Prof. Hunt.

† These Mines occur in the "Quebec Group" of rock near the base of the Lower Silurian, the Vernon Mines are in rocks probably not older than the Devonian Epoch.

‡ Geology of Canada.

of the metal. The ores found in the upper portion of the Peacock vein, near the green vein, appear at the first glance to be wholly in the slaty conglomerate, but on a more minute examination, small calcareous and quartz veins are found, with layers of steatite in which the ores are contained. All the evidence so far gathered, tends to show that the trap is the chief source of the metal on this part of the coast.

NEWER TRAPS.

Narrow bands of a bright green trap which sometimes becomes a beautiful diorite, cut the older traps which have just been described near Jim's Brook. They occur here with the stratification, at the subordinate fold or anticlinal. At the same spot a band about two feet broad is seen at an altitude of about 250 feet above the sea, and may be traced to the gully near the Peacock vein, where it appears at a greater elevation. No copper has yet been found in these newer traps, and as they have only been recognized in the form of a few narrow dykes it is probable that they are not important.

An observer viewing this part of the coast from the sea, or even when making a superficial examination on the beach, would probably be misled not only as to the true relation of the traps and the conglomerates, but also as to the nature of the conglomerates themselves. The bold promontories caused by the hard epidotic trap appear at the first blush to run into the interior nearly at right angles to the coast, and it is only when the sedimentary rocks are seen in position in their rear, that the disposition of the broad but irregularly worn belt which produces them becomes apparent. So also with reference to the parallel bands of copper bearing trap, whose worn edges sometimes come on the coast; they must be examined in all their associations to discover the relation they bear to the sedimentary masses they penetrate.

SPECIAL CHARACTER OF THE SEDIMENTARY ROCKS.

The conglomerates vary from a very coarse pudding stone, best seen near Mackerel Cove, to a fine red, or greenish-grey schistose conglomerate in which the pebbles are nearly of the same colour as the matrix, small and few in number, but water-worn and pretty uniformly distributed. The coarse conglomerate, when altered by proximity to the traps dykes, is a very beautiful rock, and many rounded boulders on the beach which have originally come from high up the cliffs east of Mackerel Cove, would be valuable in the hands of a Lapidary. The fine red and green conglomerates, best seen high up the hill at the rear of the Peacock vein, are very magnesian, and in the vicinity of trap dykes remarkably porphyritic, containing crystals of yellowish felspar, and the enclosed pebbles are also porphyritic. The coarse conglomerate first described holds large pebbles of the porphyritic variety, showing not only that it is newer but that there has been no overlap on this disturbed part of the coast. The green slates on Jim's Brook may hereafter become valuable, as well as the fine red arenaceous rock near the black plumbaginous slates, for building and ornamental purposes. In the paste of all the fine conglomerates, magnesia appears to be a characteristic element, and the surfaces of most of them are very unctuous. The yellowish-green and brownish-red magnesian schists which appear to overlie the conglomerates or are interstratified with them, are fissile, very unctuous, glisten on fresh surfaces, and are porphyritic. Many of these layers which at first glance resemble a fine volcanic ash, show a conglomerate structure upon examination; holding small water-worn porphyritic pebbles. Some of the layers are, however, so steatitic that they resemble a fissile porphyrite soapstone; they can be cut with a knife, scratched with the nail, and yield when crushed under water a very fine, almost impalpable powder, and it is not improbable that by proper manipulation an excellent polishing powder could be cheaply manufactured from them. In the green or rather variegated variety (purple and green) of these metamorphosed schists or fissile slates, the magnesian portion resembles impure talc, it is lustrous, silvery, semi-transparent, and is not sensibly affected by dilute acid. These schists effervesce very feebly when immersed in an acid, in some specimens no effervescence can be recognized. Minute patches of chlorite occur in the green variety, but no copper has been detected in specimens taken remote from a lode or trap dyke, but copper has been seen in considerable and important proportions in these schists near a trap dyke.

THE COPPER LODES.

These are five in number and may be distinguished as follows:—

1st.—The Peacock Vein.
2nd.—The Green Vein.
3rd.—The Spur Vein.
4th.—The Brook Vein.
5th.—The Copper bearing Trap east of the Point of rocks.

1. The Peacock vein is a true vein occupying an irregular fissure produced by a crack and dislocation, with the downfall on the northwest side.

2. The Green vein is also a vein occupying a crack on a probable line of fault running N. 65 W., or nearly at right angles to the Peacock vein.

3. The Spur vein lies in a continuation of a fault whose northern boundary is marked by the Green vein.

4. The Brook vein occurs adjacent to one of the copper bearing sheets of Trap, but it has not been opened sufficiently far to admit of any opinion being expressed respecting its productiveness, but reasoning from what has been elsewhere observed here, it is a valuable vein.

5. The copper bearing Trap east of the Point of rocks is a valuable indication and guide for future investigation.

THE PEACOCK VEIN.

The manner in which the Peacock vein has originated may be explained in the following way. The first movement to which the strata were subjected, was such as to give them a northerly dip of 15 or 20 degrees. An irregular crack then occurred in a general horizontal direction N. 35° E., the strike of the slaty conglomerates being about E. and W. The downward direction of this crack was about 55° N. W. The crack represents then a thin irregular fissure subsequently filled with vein stone and ore, and forming a sheet which has a general strike N. 35° E., and a dip 55° N. W. The conglomerates on the west side of the crack have been made by this dislocation to dip 20° or 25° northwesterly, and on the east side of the crack they dip from 7° to 10° northeasterly, the downfall is on the western side. Suppose, for illustration, that a number of broad sheets of a slightly elastic substance were piled one on the other, and that then they were raised on one side so as to lie at an angle of 20 degrees to the horizon. The extremities being firmly fixed so that they should not move relatively to one another, we can conceive a force from beneath, or pressure at each extremity to bend them in the form of an arch. It is probable that they would crack about the centre of the arch; but if the force were not applied at right angles to their length, they would certainly crack in some other direction. It is easy to conceive that a force from below or a lateral force might be so applied that the sheets should crack at any desirable angle, supposing their structure to be tolerably uniform, and it is also easy to conceive that this crack could be made to take a sloping direction from the uppermost to the lowest sheet, by varying the direction of the pressure. The stratified conglomerates have been subjected to this kind of force, probably a lateral one which acted in a direction nearly at right angles to this crack, or from about southeast to northwest, or, as is perhaps equally probable, the crack occupied by the Peacock vein is *a subordinate lateral fracture* connected with the great undulation which first tilted the conglomerate slates and schists in a northerly direction.—(See page 119.) Whatever may have been the primary cause, we find the Peacock vein occupying a fissure, having a general course N. 35° E., and dipping at an angle of 55° in a northwesterly direction. This thin sheet is cut obliquely by several sheets of copper bearing trap.

The traps are supposed to be the original seat of the copper ore, and the Peacock vein was supplied with its copper from them, or from the source which gave it to the traps. Hence it is in the vicinity of these trap-dykes that the richest deposits of copper are to be looked for. It consequently becomes a question of primary importance to ascertain the easiest method of reaching these copper bearing traps where they intersect the Peacock vein.

If the direction of this vein were uniform, as well as that of the intrusive traps, it would be but a simple problem relating to the intersection of plane surfaces under different angles, but since both vein and traps vary in their courses by some degrees, an approximation can only be arrived at, but the general relation having been described, the details in particular cases can be worked out with difficulty.

The vein when it has been fully exposed varies in width from 1½ feet to 7 feet. Its course is uniformly N. 35 E. as seen on the denuded slope of the hill, to a few feet above the upper level, or about 120 feet above the sea. It then trends to the east and crosses the stairs at an altitude of 209 feet, after which it pursues a course N. 60 E, on the side of the hill, and intersects the Green vein at an altitude of 389 feet above high tide. It has not been traced beyond this point, probably on account of a fault which will be described hereafter.

THE VEIN STONE.

The vein stone consists chiefly of Bitter or Pearl Spar, a crystallized dolomite, composed of the carbonates of lime and magnesia; it is also interseamed with quartz. The Bitter Spar is often white, but sometimes rose coloured, owing to the presence of oxide of iron. The quartz is generally white and translucent, but sometimes rose coloured with the same material. Patches of chlorite occur in some parts of the vein, but generally, as exhibited at the levels, it is a massive seam of the dolomite, although crystals of calcite or calcareous spar are sometimes found. Bitter spar occurs in the copper bearing quartz veins at the Bruce Mines, Lake Huron. It there forms a wall of dolomite from a few inches to two feet in thickness. At the Vernon Mines the dolomite forms a solid wall or sheet fully 19 inches in thickness at the entrance of the upper level. It is remarkable that while the country rock contains abundance of magnesia, carbonate of lime scarcely enters sensibly into the composition of some of the red and greenish conglomerates through which the vein passes. In the copper mining district of Lower Canada the ores are very frequently met with in a gangue of Bitter spar and quartz.

COURSE OF THE LEVELS.

The crack occupied by the vein is very irregular, as will be seen by the following ascertained courses in driving the upper and middle levels:—

Upper Level,	... ...	103 feet above the sea.
N. and S.	... ...	23 " "
N. 85 E.	... ...	21 " "
N. 10 E.	... ...	40 " "
Middle Level,	... ...	69 feet above the sea.
N. 10 E.	... ...	24 " "
N. 20 W.	... ...	20 " "

By continuing the upper level on the same course, it is probable that a sheet of copper bearing trap will soon be reached, when a highly remunerative mass of the ore may be expected. In the neighbourhood of trap dykes this vein will be worked with the greatest success.

As already stated at an altitude of about 209 feet above the sea, the course of the exposed vein is N. 60° E. About 80 feet east of the steps on the course of the vein, the conglomerates dip N. W. by N., but at a distance of 280 feet east, they dip N. E. shewing the continuation of the crack and dislocation, although the vein is difficult to trace here. It is, however, well seen 300 feet east of the steps, and 286 feet above the sea; the eastern extremity of the wharf, bearing S. 30 W. There is near here a depression of several feet on a wooded plateau which may mark the site of a slide which has thrown the vein a little out of its original course and produced a jog, the altitude of the deepest portion of this depression is 360 feet above high tide. After crossing the depression the Peacock Vein shews well in the conglomerate, with leaves or seams of soft chlorite, but with little vein-stone. As it appears on the surface of a precipice here, it seems to run with the stratification. A few rods further on, in a northeasterly direction, the Peacock vein ought to cross the Green vein, but the actual point of junction is covered with debris and the north side is apparently shifted by the fault. This point, which is one of considerable importance, is situated (389 feet above the sea) in the first gully east of the House, and about mid way between the Upper and Lower Pit of the Green vein. It will, however, first have to pass through one of the sheets of trap which run with a general easterly and westerly course, and which is here seen to crop out just below the upper level of the Green vein.

THE GREEN VEIN AND SPUR VEIN.

This is the name given to a vein which occupies a fissure running N. 65 W. or nearly at right angles to the Peacock vein, and dipping S. $< 65°$. The Green vein on this course should cross the road leading to the head of the steps at an altitude of 453 feet above the sea, and about 300 feet from the head of the steps; but, on account of the rock being deeply covered with debris and clothed with forest growth, its course was not traced above the upper pit 409 feet above high tide, but it probably trends to the west and is seen again at the Spur vein. The strike of the slaty conglomerate on the north side of the fissure is about East and West, the dip north, on the south side the strata are much fractured, and this occurs both at the upper and lower pit, 40 feet lower down and 120 feet in a southeasterly direction, on the face of the steep hill. It suggests the idea that the Green vein may occupy a crack about 5 feet broad, produced by a surface slide of comparatively recent origin. This view is apparently sustained by the occurrence of a narrow valley or depression, before noticed, on the hill side some 10 feet deep, a little below the Green vein, (300 feet above the sea) and a few rods south west of the upper Pit, running in the same general direction as the Green vein.

On the other hand the Green vein may occupy a line of fault.

In support of this view it may be urged—1st. That the north walls of the Green vein are slickensided, so are also the walls of the disturbed masses on the south side.

2nd. The ore both at the upper and lower pit occurs between an irregularly arranged mass of shattered rock filling the fissure, with a thin wall of trap having a course S. 85° E. or nearly east and west, south of it, and a few feet below the lower pit there is a strong sheet of trap, of which a thickness of 14 feet are visible running east and west; the upper portion of this sheet has been worn away, but it still projects a little in the Gulley.

3rd. The valley or depression on the hill side to the southwest of the Green vein, has a direction corresponding to the fissure in which the Green vein is seated, and a very slight change in its course would carry it to the Spur vein west of the summit of the steps, where the rocks on *the south side* are folded or corrugated by pressure.

4th. There is a considerable proportion of quartz in the vein stone, and some excellent copper pyrites and grey copper, together with scales of specular iron near the trap.

5th. The occurrence of a fault here would account for the abrupt termination of the Peacock vein, which must be sought for more to the westward, and it would explain the origin of the valley without the supposition of a slide.

In the absence of more facts to establish the character of the Green vein, which the state of the hill side, covered by debris, moss, and forest growth, rendered it impossible then to procure, it can only be asserted at present that the impressions produced by what is already known, strongly tend to confirm the view that this vein occurs in a line of fault; that this fault, after passing the axis of the lower anticlinal occupied by the Peacock vein, trends more to the west and is seen again at the Spur vein, which is most probably the continuation of the Green vein.

The descriptions which have just been given of the general structure of the coast in this part of the Bay of Fundy, will suffice to show that no difficulties are likely to supervene in working the copper ores, which appear to have a wide-spread distribution, and to accompany, in fact, the copper-bearing traps their development here. Specimens of purple ore have been taken from veins near trap dykes, some miles to the east of Goose Creek, which promise remarkably well.

CHAPTER VII.

THE UPPER AND MIDDLE SILURIAN SERIES.

Their Boundaries in the Northern part of the Province—The upper part of the Series occurs at Cape Bon Ami—On the Upsalquitch River—On the Tobique—On the Saint John—The Middle, on the Bay of Fundy—Section at Cape Bon Ami—Honestones—Fossiliferous Limestones—Upsalquitch Lake—The Grand Falls—The Upsalquitch and Restigouche Rivers—Mountainous character of the Country—Swallow-tailed Butterflies—Wall of Trap—The Drift—Indian Superstition—Upper Silurian Rocks on the Restigouche—On the Upsalquitch—Argillites on the Tobique—Honestones—Uniformity in the Rocks on the Lower Tobique and Upper Upsalquitch—The Saint John—Hydraulic Limestones—The Grand Falls—Description of—The Gorge—Terraces—The Saint John above the Grand Falls to the Province Line—Upper and Middle Silurian Rocks on the Bay of Fundy—The Arisaig Series—Lead Ores on Campo Bello—Frye's Island—The Saint George Peninsula—Wheal Louisiana—Letite—Description of the Mascabon Peninsula—Section on the Peninsula—Trap and Slate Series—Hornblendic Slate—Fractures and Dislocations—The Main Fissure—The Mine—The Windlass Shaft—Subordinate Lodes—Frye's Island—Probably Middle Silurian—Barytes—Uses of—L'Etang—Limestone of.

A very considerable part of the Province is covered by rocks belonging to the Upper Silurian Series. It forms by far the largest portion of the area included within the Counties of Restigouche and Victoria.

On the Bay of Chaleur the boundary between the Upper and Lower Silurian may be provisionally placed close to Medisco River. It was seen as supposed, on the Upsalquitch at the Portage at Ramsay's Brook, near where a green conglomerate holding red and green slate pebbles forms the falls over which the river plunges. The boundary of this formation was next seen on the Tobique, about five miles from its mouth. Again between the Little and Big Shiktehauk, where a similar conglomerate was recognized, and finally near the North Branch of the Meduxnekeag. Between this point and the Bay of Chaleur, its outcrop, with the exception of a deep indent on the Saint John between Presquile and the Tobique, appears to form a curve roughly parallel to the outcrop of the Devonian Granite described in Chapter II.

The whole of the northern part of the Province not occupied by small Devonian or Carboniferous outliers already noticed, or by intrusive rocks, is supposed to be of Upper Silurian Age. It is, however, probable that Devonian outliers will be found on the upper waters of the Restigouche, in continuation of belts of rocks of similar age known to exist in the State of Maine.

The following brief descriptions of the Upper Silurian Series, as they occur at five points remote from one another, will serve to convey an idea of the great variety and in some cases of the economic value of different members of these extensive and important deposits:—

I. Cape Bon Ami, near Dalhousie.
II. The Upsalquitch River and Restigouche.
III. The Tobique River.
IV. The Saint John River.
V. Letite on the Bay of Fundy.

I.—Cape Bon Ami, near Dalhousie.

Near Dalhousie, in the vicinity of Mr. Dugald Stuart's fishing station, there is a beautiful series of Traps, trap ash, calcareous slates, and highly fossiliferous limestone, interstratified with one another. Proceeding from south to north, the section exposed may be roughly represented as follows:—

1. Trap.
2. Calcareous Shales.
3. Trap.
4. Calcareous Shales.
5. Trap.
6. Fossiliferous Calcareous Shales.
7. Trap.
8. Highly Fossiliferous Limestone.
*9. Trap.

On Mr. Barberie's Farm the calcareous (2) shales occupy the valley, resting on the trap to the southwest at an angle of about 45°. The trap overlaying these (3) is soft and weathers easily, crumbling into a fine earth which is used as a top dressing by the farmers of the neighbourhood. Veins of carbonate of lime and also of quartz ramify through the trap, which in some places is merely a volcanic ash, and shows a more or less distinct stratified arrangement.

No. 4 partakes of a shaly character, some layers are sufficiently hard and fine as to be adapted for honestones. It weathers buff and pale yellow.

No. 5 resembles a vesicula lava, hard, black in colour, but weathering red.

No. 6 consists of highly fossiliferous shales and limestones containing Favosites Gothlandica; Strophomena rhomboidales, &c. &c. Many layers are fissile and shaly, weathering buff; others are hard and silicious. It is from this layer probably, or its continuation, mentioned in the next paragraph, that the honestones and scythestones, exhibited by Mr. Barberie at the Provincial Exhibition for 1851, were taken. There are several layers here admirably fitted for the manufacture of these stones on a very extensive scale, and the quality is excellent.

* This Series is placed in the above form for the sake of comparison with another Series of about the same age on the south coast of the Province, (Letite.)

No. 7 is a massive trap. On this part of the coast a belt of very hard calcareous shale crops out on the shore, and is covered by high tide. It is succeeded by a conglomerate 14 feet thick, capped by honestone 36 feet thick, and followed by the heavy bedded trap, it is probably a continuation of No. 6, but separated from it by the waves of the sea having worn through the mass to the overlying trap.

No. 8 is a highly fossillferous limestone reposing on No. 7, filling the hollows. In and near the little stream which flows through the fishing house belonging to Mr. Dugaln Stewart, the fossils are very numerous, and many of them in an excellent state of preservation. Among them are—

Favosites	Gothlandica,
"	polymorpha,
"	basaltica,
Strophomena	rhomboidalis,
"	punctulifera,
Calymene	Blumenbachii,
Atrypa	reticularis,

with fragments of orthoceras, together with several species of orthis, spirifera, &c. A slab obtained by the writer and shown at the Provincial Exhibition, contained all of the above species, besides others.

No. 9. A highly ferruginous trap occurs as far as the point of Cape Bon Ami.

II.—The Upsalquitch.

Geographical Features.

Upsalquitch Lake, about two miles long by half a mile broad, forms the source of the River of the same name. It is a beautiful sheet of water surrounded by high conical mountains. The dividing Ridge which separates its waters from those flowing into the Nipisiguit is 1,508 above the sea. One of the conical mountains near this lake has an altitude of 2186 feet,* and another, half a mile west of the lake, an elevation of 1,707 feet. The Little Portage stream, between the Upsalquitch and Nipisiguit, is more than 1000 feet above the sea, (1034) but the Lake itself is only 750 feet higher than the same level. Some idea of the nature of the Grand Falls, which occur within eight miles of the Lake, may be obtained, when a comparison is made between the height of the River at Ramsay's Portage, where the Falls terminate, and the head of the Falls. At Ramsay's Portage the river is 271 feet above the sea; at the head of the Falls it is approximately 700 feet about six miles below Upsalquitch Lake. Hence, in a distance of about 1½ mile, the river is precipitated more than 420 feet. The cascades, some of which are very beautiful, are not marked down on the map, but what are called the "Great Falls" are placed near Borland's Brook, not far from the mouth of the river. Up these Falls there is no difficulty in dragging a canoe, they do not descend more than four or five feet.

* Boundary Commissioners Report.

The general course of the Upsalquitch is northwest, its length is about 44 miles, and it receives numerous important tributaries draining a large but mountainous tract of country. Two miles east of Ramsay's Camp, where the river is 271 feet above the sea, the hills are elevated 1048 feet, and a peak five miles east of the same place is 1432 feet, while within a few miles of the mouth of the river the Squaw's Cap rises 2000 feet above the ocean.

On the shores of Lake Upsalquitch innumerable swallow-tail butterflies were seen, and when clustered groups of from thirty to fifty were disturbed, the cause of their congregating so closely together was found to be a decaying fish bone.

Large areas of cultivable land in the immediate valley of the river cease near the junction of the northwest branch. Where the east branch comes in, a huge wall of trap some 300 feet high and many hundred yards broad forms striking scenery, and some distance above this place the river runs rapidly from side to side of a narrow valley between walls of the same intrusive rock. On Ramsay's brook there is a considerable area of good land, as well as on the nine mile Portage leading to Upsalquitch Lake, where the maple is found in small groves and interspersed with other forest growth.

The drift retains its coarse and apparently horizontal character for about 15 miles up the Upsalquitch, it then begins to show signs of a rearrangement of its materials, with layers of sand and gravel, but no large boulders. Above Ferguson's Brook it forms banks sometimes 30 feet high, and consists of coarse gravel reposing on fine sand not always horizontally disposed. At the Grand Falls the drift contains boulders of local rocks with a considerable quantity of sand, and at the outlet of the lake quartz fragments not much water-worn, are very numerous in the bed of the stream; they vary from half an inch to a foot in diameter, and masses of white quartz two feet in diameter are not unfrequent.

In walking up this stream I observed one of the Micmac Indians take a little crawfish and place it carefully on the bank, about two feet above the then level of the water. On enquiry, he stated that his object was to "get a freshet," so that we might go down the Nipisiguit without difficulty. "The little 'crab' would bring it, and make the water rise just as high as he pleased." He remarked that this was an old Micmac superstition, "and a very good one."

GEOLOGICAL FEATURES.

Mr. Richardson, of the Canadian Geological Survey, examined the Restigouche in 1857, from the mouth of the Patapedia to the Bay of Chaleurs. Allusion has been made in a previous Chapter to the existence of a small narrow basin of Devonian Rocks from the Matapedia downwards. Above this river the rocks belong to the Upper Silurian Series, (Gaspé Limestones). At the mouth of the Patapedia greenish arenaceous slates and sandstones, according to Mr. Richardson, appear to have a dip up the river, and to underlie the thin bedded limestones and dark grey shales beyond; they can be traced down the Restigouche to Cross Point, a distance of about four miles, where the beds associated with them are calcareous, and hold fossils consisting of fragments of trilobites and bivalve shells, but too much broken to be identified. The sandstones attain the neck of Cross Point, while the thin bedded limestones above them occur at the north part of the turn in the river. To this point the strike and the general valley of the river run about northeast; lower down they turn together, and the sandstones and their associated dark grey calcareous shales are every now and then seen for seven miles in a bearing nearly east. Here the river separates from them, and while they appear to continue in a pretty straight course to the junction of the Upsalquitch, the Restigouche makes a turn to the northeastward on the thin bedded limestones to Brandy Brook, and returns upon them southeastward to the sandstones at the Upsalquitch. From the Upsalquitch the Restigouche appears to flow on the thin bedded black limestones to the mouth of the Matapedia.

Calcareous shales, and slates with trap, appear occasionally on the Upsalquitch banks as far as Little Falls, where a beautiful section is exposed, in which there appears to be a silicious band, overlying contorted shales; these are underlaid by 40 feet of an ash-coloured crystalline mass forming the falls, and weathering light brown when exposed to running water. This overlies some 80 feet of fissile dark-coloured ferruginous shales, and 25 feet of a cream-coloured rock; of these last two there are four repetitions, the dip of the whole being south at an angle of 80°. Dark calcareous slates, with red silicious bands, are continually repeated for some miles up the river. There is a considerable development of Trap both above and below the Ox-bow, near Meadow Brook, where green and red argillites appear, which are quickly followed by highly fossilliferous limestone, holding numerous specimens of the chain coral, (Catenipora escharoides.)

Above Ramsay's Brook, and near the mouth of Hutchinson Brook, red slates appear in place, with a change in the strike; and on the portage just above, a well characterized conglomerate, supposed to belong to the Quebec Group, appears to mark the boundary of the Upper Silurian on the Upsalquitch.

III.—The Tobique.

The Rocks as developed about half a mile above the Narrows are both geologically interesting and economically important. They are provisionally placed among the Upper Silurian Series, the lower rocks appearing to come into place about five miles from the mouth of the river.

Above the Narrows there is a beautiful Series of red, sea green, and bluish black argillites with a calcareous band holding fossils, (*favosites Gothlandica.*)

There is also a silicious band of very fine texture admirably adapted for the manufacture of honestones. The argillites can be easily worked, and it is probable that the green variety, which is a beautiful material, may become of economic importance. This rock weathers buff-yellow. The strike of the whole Series is from N. 50 to 60 E. and the dip northwesterly. It will not escape the attention of the reader that red and green argillites, with a fossiliferous calcareous band holding the chain coral, have been described as occurring near Ramsay's Brook on the Upsalquitch; the occurrence of the same rocks near the mouth of the Tobique, at a distance of about 80 miles in an air line, shows remarkable uniformity in the distribution of the Upper Silurian Series here, the strike being such as, if prolonged, would carry the Tobique argillites to the Upsalquitch.

IV.—The Saint John.

The calcareous clay slates apparently belonging to this series, cross the Saint John with a strike N. 5° E. below Butternut creek. They consist of alternating bands of slate and limestone, the latter varying from one half to four inches in thickness. About one mile above Florenceville, on the east side of the River, they appear on the line of strike, but in proceeding up the Shiktehawk Portage road for 3½ miles, a hard quartzose schist with a strike N. 35 E., is followed by a conglomerate containing black, blue, and red slate pebbles. This is thought to belong to the lower rocks, and thus to mark the southern limit of the Upper Silurian Series.

On many parts of the Saint John between this place and the Grand Falls, the ribboned calcareous slates make their appearance, with a prevailing strike varying from N. 30° to 35° E., and so they continue with occasional local variation of strike due to trap dykes or dislocations, all the way to within half a mile of the Grand Falls. Many of the narrow limestone bands in this distance appear suitable for the manufacture of Hydraulic Lime. At the Grand Falls the spectacle presented by these calcareous slates is singularly imposing, not only on account of the grandeur of the scenery but geologically, in view of the remarkable foldings in the strata which the great gorge reveals.

GEOLOGICAL FEATURES OF THE GRAND FALLS.

When the Saint John flowed at a higher level the course of the stream was in a nearly straight line from the upper to the lower Basin. This is marked by a deep ravine which runs with a slight curve nearly across the peninsula now formed by the semicircular channel pursued by the torrent in its course through the gorge. The distance from the upper to the lower Basin is half a mile in a straight line, and the difference in level 120 feet. But in making this descent the waters of the Saint John plunge perpendicularly 74 feet, and then rush and foam through a rocky channel a mile long with a descent of 46 feet before they reach the quiet basin below.

The walls of this chasm, which vary from 80 to 150 feet in altitude, are on an average 250 feet apart, but in many places much less; they present most beautiful illustrations of lateral pressure folding massive rocks as if they were the leaves of a book. The strike of the rocks varies from E. and W. to N. 40 E. The thick calcareous bands, with their associated bands of slate, are twisted and contorted without perceptible fracture in the most striking manner. Numerous potholes of gigantic dimensions attest to the power of continually rolling stones confined within a limited space. This is well exemplified in a small whirlpool which has been locally designated the coffee-mill, into which sticks of timber are drawn at certain stages of water, and where never ceasing attrition soon rounds their extremities into hemispheres. During the time of my visit the water was 35 feet below the level to which stranded timber showed it rises during the freshets of spring.

The gorge is surrounded by a series of terraces four or five in number, which follow its sinuosities. The probable origin of these terraces, and of the present gorge, is discussed in Chapter X. The calcareous slates were not observed to present any other features worthy of special notice, beyond those already enumerated, but it is probable that an attentive study of their structure in this singularly favourable locality would reveal many interesting facts.

COUNTRY ABOVE THE GRAND FALLS.

Above the Grand Falls the country changes its character, particularly near the river banks, which are not only considerably lower, but show blue clay in horizontal layers. Above the mouth of the Siegas fine blue clay is seen to be overlaid by gravel and sand in banks 40 feet high, 30 of which are of clay.

Between the two Islands above the mouth of the Siegas, the ribboned calcareous slates similar to those at the Grand Falls were recognized with a strike N. 70° E. Half a mile below Saint Basil, the slates were of a dark blue colour with the same strike, and opposite Saint Basil there is a small area of beautiful ice polished rock, of similar character.

The Rocks of the Saint John from Little Falls to the Siegas, and from Little Falls to the Saint Francis, have been described by Sir W. Logan, under the heading, "Rocks of the Walloostook or Saint John River, and some of its tributaries." In the Chapter entitled "Distribution of the Gaspe Series,"* the following description will be found:—

"About half a mile down the Madawaska, where the rock comes close upon the river, the same grey greenish-weathering slate is seen, with thin light coloured slightly calcareous bands marking the bedding. The exposures on the river, all the way to Little Falls, at its junction with the Saint John, are not numerous. They consist pretty uniformly of the same slates and sandstones as before, the slates greatly predominating, and occasionally holding a small amount of calcareous matter. At Little Falls the color of the rock is grey internally, weathering generally to a dull obscure olive-green, sometimes so dark as to give it a chloritic aspect. The slate, which is micaceous, is interstratified with occasional hard compact bands, cleaving with difficulty, and possessed of sufficient grit to entitle them to the name of sandstones.

* Geology of Canada, page 426.

"Slates and sandstones, similar to those at Little Falls, are seen farther down on the Saint John near its tributary the Squesibish; where there is a transverse exposure of 200 or 300 yards. Here the slate internally grey, weathers greenish and is interstratified with bands of feebly calcareous sandstones, some of which are from four to twelve inches thick. The bedding is well displayed at this place, and a few contortions in the stratification are visible.

"Still lower down, and about a mile and a quarter above the mouth of another tributary, the Shiguash, a band of coarse conglomerate which crosses the road bears a strong resemblance to that of Black Point on Lake Temiscouta, and holds a great amount of large pebbles and small boulders of black limestone weathering to an ash grey. Some of the calcareous boulders are themselves of a conglomerate character, holding pebbles of a stratified rock, while their matrix includes organic remains. With the calcareous portions of this conglomerate band are mingled others of black jasper and of chalcedonic quartz, with these were observed several pebbles of a blackish green serpentine. The matrix is a hard calcareous sandstone, with grains of white and colored quartz; it is grey internally, and weathers to a yellowish tinge. Vertical beds of the conglomerate running N. 30° E. alternate with beds of sandstone similar in character to the matrix. A breadth of seventy five yards is visible, giving a thickness of 225 feet. As the strata above and below are concealed, the volume may be greater, particularly to the southeast, where the ground rises in a small hill for a quarter of a mile. At this distance the conglomerates are followed by calcareous slates, which at first are interstratified with a few bands of sandstone, resembling that associated with the conglomerate, but, farther on, display strongly calcareous beds, weathering to rotten stone.

"Sometimes the slates, without being themselves calcareous, are interstratified with slightly calcareous sandstones. These alternations are occasionally visible for about 500 yards, between which and the Shiguash, there are no exposures on the road. The examination in this vicinity has not been carried farther.

COUNTRY ABOVE LITTLE FALLS.

"Rocks similar to those of the lower part of the Madawaska and the Squesibish, prevail along the Saint John as far as the Saint Francis, and even to the Black River, twenty miles higher. Both the slates and the sandstones are in general micaceous, and occasionally calcareous. On the Saint Francis no traces have been found of Black Point conglomerates, or of the Jasper rocks of Pointe aux Trembles; nor have we been successful in meeting with the fossiliferous limestones of Mount Wissick, though the distance from Temiscouata is scarcely more than twenty two miles. The lowest exposure belonging to the Quebec Group on this river, consists of a coarse greenish chloritic sandstone, associated with green slates. It occurs just to the north of the Province line, at the foot of a lake called by the Indians Wollenabégeg; below this the country appears to consist chiefly of clay slate. The most calcareous ridge met with, occurs about three miles above another lake, which is called by the Indians Battewichcagameg. The rocks of this ridge, however, shew no fossils, and they do not hold a sufficient quantity of carbonate of lime as to entitle them to the name of limestones. A mountain on the northeast side of this lake displays some strong beds of sandstone, associated with bluish black or dark grey slates, both slightly micaceous, but the sandstones alone are somewhat calcareous. Similar micaceous sandstones sometimes holding a little carbonate of lime, prevail to the mouth of the lake.

"On the Black River, twenty miles above the Saint Francis, there occur the same grey micaceous slates and sandstones, occasionally calcareous. The sandstones weather greenish, and, where washed by the water, acquire a slightly reddish tinge. Large angular blocks of a calcareous conglomerate are occasionally met with; but the rock *in situ* does not occur below the Province line. Both below and half a mile above this line, calcareous slates occur, with black or dark grey coarse limestone bands; and half a mile above this there is seen a conglomerate, of which three exposures occur in a breadth of 300 yards. It holds boulders of a fine silicious conglomerate and of grey quartzite, with blackish vitreous quartz grains, and fragments of green slate. The matrix appears to be composed of this green rock in a comminuted state, with a fine grey slate.

"The fact that this conglomerate itself contains pebbles of an older conglomerate rock, resembling some portions of the Sillery series connects it with the conglomerates of Black Point on Lake Temiscouata, and with that near the Shiguash; which last encloses pebbles of serpentine. These characters suggest the probability that all these conglomerates may be newer than the Quebec Group, the sandstones of which were seen between three and four hundred yards farther up the Black River. They were examined for a distance of about a mile and a quarter, and resemble those of the Sillery series; being greenish, massive, and coarse grained with scales of mica and of graphite, and interstratified with occasional bands of red slate." *

UPPER AND MIDDLE SILURIAN ROCKS ON THE BAY OF FUNDY.

There are not many localities on the Bay of Fundy where the presence of the Upper Silurian Series is not involved in some degree of doubt. It is, however, probable that the well known development of these rocks on and near the coast of Maine in Cutler, Pembroke, Trescoll, and Lubec, continues at intervals on the coast as far as Lepreau Harbour, and then striking inland, stretches in the form of a narrow inland belt, toward the County of Albert.

In some parts of their development in the Bay of Fundy they are overlaid by outlying patches of the Devonian Series, as at Saint Andrews and on the Mascaban Peninsula, but of their continuity for more than one hundred and twenty miles there appears much probability.

* Geology of Canada.

In the Mascaban Peninsula (Saint George) they are interstratified with traps, and much altered, but on some of the adjacent Islands the limestones belonging to the series are fossilferous. The trappean series is largely developed westward, in Maine, and it points to a succession of volcanic disturbances alternating with periods of repose, which must have continued through long ages with remarkable uniformity. These rocks are supposed to be the equivalents of the Arisaig Series of Dr. Dawson in Nova Scotia, or the Lower Helderberg of the New York Survey.

The Upper or Middle Silurian rocks on the Bay of Fundy, particularly those which may be styled the Trappean Series, appear highly promising in a metalliferous aspect. In Maine, on the New Brunswick Frontier, they are stated now to yield remunerative returns of lead where mines have been opened; and on the Island of Campo Bello, which is of the same geological age, there appear to be some valuable indications of the same mineral. On Frye's Island, which will be noticed more at length in the sequel, lead ores occur in two places. On the Mascaban peninsula, also called Saint George's peninsula, but better known by the name Letite, copper ores are abundant, so that a special notice of the Letite Mines will not be considered out of place, as it is not improbable that what is there supposed to be a copper-bearing trap, has a wider distribution than is generally imagined by those whohave interested themselves in copper mining on the peninsula, and in its neighbourhood.

The name of the mine which will now be described, is the Wheal Louisiana, and as the study of the manner in which the metalliferous lodes are distributed, may serve as a sort of guide to other and similar enterprises, for which there is abundant room and apparently encouraging prospects, more details will be introduced here than would otherwise be considered to lie within the limits of a preliminary Report.

WHEAL LOUISIANA—LETITE.

General Geological Features.

The whole of the Mascaban Peninsula appears to have been subjected to a series of intermittent disturbances, which have not only changed in some degree the relative original position of sedimentary strata but have also altered their character. These disturbances are of a three-fold description, each of which will require a special notice on account of its bearings upon the metalliferous deposits which are largely distributed in a more or less concentrated form throughout the peninsula and neighbouring islands.

The mineral composition and sedimentary nature of the rocks establish the fact, that successive periods of repose were each succeeded by violent volcanic action at some distance from the strata under review. These consist of alternations of stratified talcose, chloritic, and clay slates, and bedded traps or greenstones. Intrusive diorites also occur in this neighbourhood, but while the bedded traps alternate with the clay-slates, the intrusive traps cut them at a low angle, but these intrusions, which are few in number, do not appear to have exerted here much influence upon the rocks of the peninsula. Some idea of the uniformity with which the periods of disturbance and comparative repose took place, may be inferred from the following section across the strata within a space not exceeding a mile in horizontal distance. It was roughly measured along the road and obliquely to the stratification. This section is given at length in order to point out another set of disturbances which are important in their bearings upon the disposition of the mineral veins found in this neighbourhood, and the mode in which they were filled, wholly or in part.

Section roughly measured along the road to the Wheal Louisiana.

Kind of Rock.	Breadth.		Remarks.
Slates,	79 yards.	Dip easterly.	Strike S. 20 E.
Trap,	168 "		
Slates,	80 "	Dip easterly.	Strike S. 20° W.
Trap,	64 "		
Slates,	30 "		
Slates and Trap,	150 "	Brook.	
Slates,	60 "		
Trap,	5 "		
Slates,	50 "	Dip East.	
Trap,	110 "		
Slates,	19 "	Dip vertical.	
Trap,	3 "	"	
Slates,	25 "	"	Anticlinal Axis.
Trap,	14 "		
Slates,	25 "	"	
Trap,	20 "		
Slates,	83 "	Dip West.	
Slates and Trap,	8 "	Dip vertical.	Anticlinal Axis.
Slates,	10 "	Dip East.	
Trap,	34 "		
Slates with quartz veins,	10 "		
Trap,	15 "		
Slates,	45 "		
Trap and Slates,	140 "	Dip Easterly.	Anticlinal Axis.
Slates,	70 "	Dip Westerly.	
Trap and Slates,	65 "		
* * * * *			
Slates,	30 "	Dip Northwest.	
Trap,	3 "		Anticlinal Axis at the MINES.
HORNBLENDIC ROCK,	23 "		
Slates,	31 "	Dip Southwest.	
Slates and Trap bands interstratified,	40 "		

Here we find, in a distance of about 1,300 yards, some fifteen alternations of slates and Trap,* with at least four anticlinal axes. It is probable that an exact survey would discover more alternations and perhaps more foldings; but the foregoing rough section is sufficiently near the truth to show

* Compare with Cape Bon Ami, near Dalhousie.

the extraordinary disturbances to which the rocks on this part of the coast have been subjected.

MINERAL CHARACTERS OF THE STRATA.

The slates vary much in their composition, they are generally laminated, with even fracture, but they are also frequently conglomerate and porphyritic, holding pebbles and fragments of trap, and sometimes they appear to consist of consolidated volcanic ash, and they are also occasionally talcose, cloritic, and magnesian. Vast beds of hornblendic schist also occur in the series, and in one of these the main lode of the Wheal Louisiana is in part situated.

This Hornblendic Schist presents itself in several different but closely allied forms. Sometimes it appears in one and the same belt as almost entirely composed of hornblende, then of hornblende and quartz, and again of hornblende crystals in a felspar paste, (Diorite,) the felspar weathering white and the hornblende standing out in large greenish black crystals. A considerable quantity of copper ore, and also specks of native copper, are diffused throughout the schist, and this rock may be a valuable source of the copper ore accumulated in the veins which intersect the series. The Diorites or greenstones of Lake Huron afford in abundance the ores of copper, and analysis shows the diffusion throughout the rock of the metals which are accumulated in the veins.* In and near the fissure to which allusion will soon be made, a thin bed of Actinolite occurs.

As will be observed from the foregoing section, the strike of the slates is not uniform, but there is a prevailing strike of about N. 70° E., which may be accepted as the general strike of the series, and this is also the strike of the rocks on Frye's Islands where the disturbances have not been so great.

Fractures and Dislocations.

At Wheal Louisiana the rocks have been upheaved and an anticlinal axis produced. A crack runs along the crown of the anticlinal, and taking a general course N. 55 E. it passes out of the Hornblendic Schist into the adjacent slates and traps, pursuing a slightly meandering course. A downfall or dislocation has taken place along the west side of this crack and thus produced a permanent fissure which is the seat of the main Lode of the Mine.

This fissure can be traced without any difficulty for some hundreds of yards southwesterly beyond the property of the Company. In Key's shaft, which intersects it, it is seen at the extremity of the first level 84 feet below the surface to form an open crack some fifteen feet high by two feet wide. It is also seen at the lower level 125 feet deep, where the part unoccupied by the lode is several inches in diameter. It is worthy of note that the fissure here is in the chloritic and talcose slates, having apparently passed out of the Hornblendic Schist, and, as it has been suggested that this

* Geology of Canada, page 595.

Schist is *one* of the sources of the Copper ores, it may prove to be a rule here that as long as the fissure is found in the Hornblendic Schist it will be productive, when it passes into the slates it may contain cavities which have never been filled with a metalliferous gangue. This fissure has evidently resulted from the following causes:—1st. The upheaval of the strata and the occurrence of a crack along the crown of the arch produced by the upheaval.

2nd. The downfall of the west half of the arched and fractured strata through many feet of space.

3rd. The walls of the fractured strata not coinciding after the downfall, produced a fissure of greater or less capacity in different parts of its horizontal and vertical extension, and of great depth.

The fissure has been partly or altogether filled with materials derived from the rocks in which it occurs. Some of its cavities, those in the hornblendic schist, have already been found full of copper ore, other cavities are lined with quartz crystals, carbonate of lime, bitter spar, and amorphous steatitic layers, also in places they are spangled over with crystals of sulphuret of copper, but still preserve a vacant space in which no metalliferous gangue has yet been deposited. The vein, where the fissure is filled, consists of quartz, calc and bitter spar, the quartz predominating; with patches of chlorite and aggregations of copper ore mixed with mundic and magnetic iron pyrites.

The surfaces of the rock coming together during the downfall are slickensided, and fragments of the mother rock or country are found embodied in the gangue. Small patches of native copper are sometimes seen to adhere strongly to the wall after the lode has been removed. This, however, has only been seen in the Hornblendic Schist, the lode coming from the smooth wall of the fissure in the rock with a clean surface. The subordinate transverse fissures, common under such circumstances, were also recognized, and these, so far as they occur in the Hornblendic Schist, may be productive of ore.

THE MINE.

Key's Shaft.

Key's Shaft has already been sunk to a depth of 125 feet. The upper level is 84 feet below the surface, and has been driven 47 feet in an easterly direction (E. 7° N.) In this level part of the fissure which carries the main lode is struck and is distinctly visible, forming the crack already described, some fifteen feet high, and from two to three wide. The lower levels have been driven at a depth of 125 feet, 43 feet in an easterly direction (E. 7° N.), and 36 feet on a southwesterly course—(W. 28° S. for 24 feet, and W. 22° S. for 12 feet). A jog throwing the lode six feet to the north here occurs, this may arise from unevenness in the line of fracture, the crack passing into a softer rock, or from some other cause changing slightly its course. The east wall of the lode in the western drift is trap, it soon, however, passes into the chloritic slate which presents slickensided surfaces with patches of chlorite. It is also worthy of note that the crack seems to have had a westerly slope for 84 feet, then it becomes vertical and so continues to the bottom of the shaft. The character of the gangue in the upper level differs in some slight but important particulars from the gangue in the lower drift. The quartz in the upper level for instance is very hard, in the lower level it becomes more friable and easily worked. The mundic (iron pyrites) increases in quantity on descending; chloritic slates with patches of chlorite are more confirmed in the lower levels, and the general aspect of the lode acquires a promising metalliferous character. Magnetic pyrites (pyrrhotine) occurs in abundance both in the upper and lower levels. Copper ore (pyrites) has not been found in large quantity in Key's Shaft, but from the improving character of the lode and the conditions under which it has been deposited, it is very probable that on sinking deeper the ore will be found to increase in quantity. It would be advisable to ascertain the precise position of the shaft with reference to the Hornblendic Schist. If it should be found that on sinking deeper on the line of the fissure, it approaches this rock, the prospects from this shaft will be still more favourable. The great obstacle to encounter will be water, and in order to drain this shaft, if deepened to 300 feet or more, a ten horse power steam engine will be required.

The Windlass Shaft.

This shaft which has not been sunk more than 16 or 18 feet, is situated directly on the crack as it appears at the surface. The crack here is wholly within the Hornblendic Schist, through which the copper, as already stated, appears to be more or less disseminated. Thin radiating leaves of native copper appear on the wall of the lode, and minute particles can be detected in the Hornblendic Schist itself. The crack here has a northwesterly dip, but it appears to leave this rock and pass into the slates and trap towards Key's Shaft, on approaching which the slates are much curved with a southerly dip, but when they arrive within 60 yards northwest of it, they dip northward.

Several barrels of excellent copper ore were taken out of the Windlass Shaft, which is at present nothing more than the lode removed from the crack. By following the course of this lode, which is the course of the crack both vertically and horizontally, it is probable that valuable "pockets," similar to the one already found, will be reached.

SUBORDINATE LODES.

Crossing the fissure at different angles there are numerous subordinate lodes holding more or less copper ore, but it has not yet been determined which are the older, nor is it known whether some of the lodes may not occupy transverse fractures. Of these lodes, six in number appear to cross the fissure within about 160 yards north of the main or Key's shaft. In consequence, however, of the slight meanderings to which they are subjected, it is impossible to state with any degree of precision the points of intersection, until an exact topographical survey of this area is made, and the courses of the quartzose lodes as they appear on the surface laid down correctly. It will be seen that where these lodes intersect the crack and line of dislocation, valuable deposits of copper ore may be looked for, and it is also apparent, on the supposition that the Hornblendic Schist carries the ore, that where the lodes intersect that rock they will be found to be rich in the metal.

FRYE'S ISLAND.

Frye's Island (called on the Admiralty Chart Cailiff Island) lying south-east of Mascaban Peninsula, is remarkably interesting in its geological aspect. Some of its limestones and grits on the eastern side are fossiliferous, containing *Favosites gothlandica, &c.* On the western side the limestone is crystalline. The lead veins have not yet been sufficiently explored or opened to enable an opinion to be expressed on their probable productiveness, but the minerals with which they are associated, fluor spar and sulphate of Baryta, the fine ochres on the walls of a trap dyke, the singular mode in which masses of quartz have accumulated over the smooth denuded surface of the limestone itself, and the fossiliferous character of some portions of the belt, all invest this Island with peculiar interest. It is a matter of regret that certain fossils which were collected there, together with specimens of the rocks, have not yet been forwarded.

Passing nearly through the centre of the narrow part of the Island there is a very peculiar Diorite, apparently running with the strike of the rock, but differing from any observed on Mascaban Peninsula. The interest of this locality is not diminished by what were supposed to be (at a distance) outliers of Red Devonian rocks, forming Bliss Island, also a small patch of the same red rock resting unconformably upon those of Frye's Island.

The absence of the specimens alluded to in a previous paragraph, militates against the use of copious notes taken during a day's ramble over the Island at the close of last October, the more particularly as the discovery of certain fossils creates a suspicion that the age of the rocks on Frye's Island may belong to the Middle rather than the Upper Silurian.

SULPHATE OF BARYTA.

The heavy spar or sulphate of baryta on Frye's Island is likely to become commercially valuable, the facilities for obtaining the material and for exportation being unusually good.

This mineral is extensively employed in the arts as a paint, both by itself and for mixing with other pigments as an adulteration, for which purpose it is fitted by its great weight. It enters into the composition of the cheaper kinds of white lead paint; sometimes, it is said, to the extent of seventy five or eighty per cent. For this purpose the native sulphate of baryta is crushed, and if necessary, boiled with dilute muriatic or sulphuric acid to remove any metallic oxide which may discolor it, after which, it is ground to a fine powder; an artificial sulphate of baryta is also manufactured by precipitation, and is sold under the name of 'permanent white' or 'blanc fixe.'

This is prepared from the native sulphate by igniting it with charcoal, by which a sulphuret of barium is formed; this, by the addition of muriatic acid, is converted into chloride of barium, from which the sulphate is precipitated by sulphuric acid, the pigment thus obtained is much finer than that prepared by simply grinding the mineral. It is used as a water color, and also in the manufacture of paper hangings, for giving a peculiar glossy surface. In 1861, about two tons a week of the precipitated sulphate of baryta were prepared by this process in South Lancashire. The consumption of the ground sulphate of baryta is very considerable. Many years since, about 4,000 tons of the mineral were sold annually in the United States, of which 1,500 tons were imported from England, and the remainder obtained from various parts of the country.*

L'ETANG LIMESTONE.

The limestone at L'Etang appears to be remarkably pure. After burning 100 parts yield 54.30 parts of quicklime.† When it is considered that 100 parts of pure carbonate of lime yield 56.4 of lime and 43.6 of carbonic acid, (Berzelius) the purity of the L'Etang lime is worthy of note, but it should be borne in mind that the analysis was only for practical purposes, and must not be regarded as chemically correct. On page 66 a Table of analyses of certain limestones is given, from which an idea of its purity when compared with other limestones in the Province may be obtained.

* Prof. Hunt, in 'Geology of Canada.'

† From a Comparative Table in "Geology of Maine," 1861.

CHAPTER VIII.

THE LOWER SILURIAN SERIES—THE QUEBEC GROUP.

The Metalliferous Rocks in Canada and the United States—Sir W. E. Logan's discoveries —THE QUEBEC GROUP—Importance of the Quebec Group—Economic Minerals of the Group—Age of the Group—How brought to the surface—Origin of the Metals it contains—The Quebec Group in NEW BRUNSWICK—Its Northern Boundary—Its prolongation into MAINE—Probable Breadth of the Quebec Group in New Brunswick Influence of the Granitic Belts on these Rocks—Its development on the Nipisiguit—Black Slates on the Nipisiguit and near Dumbarton Station—Copper Ore at the Grand Falls—Golden-hued Micaceous Schists—Feebly Auriferous Copper Ores on the Nipisiguit—Red Shales, with Iron and Manganese and Copper Ores, on the Nipisiguit—On the Campbell River—The Beccaguimic—The Shiktehawk—At Jacksontown, west of the Saint John—Near Boiestown—On the Tattagouche—Folds of the Strata on Campbell River—Probable limit of the Group about the Nictor—Upper Silurian Slates on the Nictor or Little Tobique—Jaspery Rocks on Campbell River—Red and Green Porphyries on the Serpentine—Ores of Metals on Campbell River—Iron, Manganese, Nickel, Copper, &c.—Diorites—Epidote—GEOGRAPHICAL DESCRIPTION of the Country south of Tobique Lake—Milpagos Lake—Gulquac Lake—Granite Ridges—Beaver Dams—Long Lake—Milnageo Lake—Portage to the Little South West Miramichi Lake—Miramichi Lake, (Little South West)—Granite Boulders—The Magaguadavic to Roix Station—Upper Falls of the Magaguadavic to the Lower Falls—Characteristic Strata belonging to the Quebec Group—GNEISS; ANORTHOSITES; DIORITES; EPIDOSITES; MICA ROCK; MICA SCHISTS; ARGILLITES; DIALLAGE ROCK; HORNBLENDE ROCK, with GARNETS; MAGNETIC IRON IN DOLORITE; COPPER PYRITES; OPHIOLITES, (Serpentines); STEATITES; CHLORITES; MAGNESITES; DOLOMITES; LIMESTONES; DEPOSITS of SILICA.

In Canada and in various States of the Union there have been discovered, from time to time, sedimentary rocks exceedingly rich in metalliferous wealth. The shores and islands of Lake Superior, and the northern shores of Lake Huron, have long been remarkable for their enormous deposits of copper.* The immense aggregations of ores of the same metal in Eastern Tennessee, and in Lower Canada, † are contained in rocks of the same geo-

* In 1861 the mines of Lake Superior yielded 7,500 tons of metal, being about twelve times greater than in 1851.

† Notwithstanding the enormous deposits of copper in many parts of Canada, it is only very recently that attention has been directed to this branch of mineral wealth. The following Table shows the Export of Ores and Copper from Canada since 1850 :—

Year.	Ores, Tons.	Copper, Tons.	Official Value.
1850,	272	62.44	$36,583
1851,	1,349	122.80	86,756
1852,	598	24.92	32,420

logical age, though known by different names. The vast lead deposits of Missouri,* associated with zinc, cobalt, nickel and copper, have long been known to belong to the most ancient sedimentary rocks; and from similar deposits the gold of the Appalachian range, from Virginia to Georgia, has been originally derived, as well as in Nova Scotia.

Sir William Logan was the first to show, in 1860, that all these different metal bearing rocks, some of which are more than a thousand miles apart, belonged to one and the same formation; and because this formation was well developed near Quebec, and first studied and understood there, Sir William named it the "Quebec Group."

THE QUEBEC GROUP.

Not only is the "Quebec Group"† the great metalliferous formation of North America, but its remarkable thickness and complexity, (7000 feet, or one mile and a third) coupled with the extraordinary manner in which it was deposited and brought to the surface, all unite to make it one of the most interesting and important formations of the entire geological series, with, perhaps, the single exception of the coal measures.

Its iron, copper, nickel, cobalt, antimony, lead, zinc, chromium, arsenic, titanium, silver and gold, which are all known to exist in remunerative quantities in this vast rock series, give it a special value which no other possesses, a value greatly increased by the association with these ores of metals, of serpentines,‡ roofing slates, soapstones, potstones,§ whetstones, magnesites,|| dolomites and building stones.

This great formation stretches from Gaspe to Alabama, then sweeps round through Kansas to Lake Superior where it reappears without any diminution of volume. Its age is that of the Chazy, Calciferous, and part of the Potsdam formations of the New York Survey, and it occupies a position near the base of the Lower Silurian System.

Table of Copper Exports continued.

Year.	Ores, Tons.	Copper, Tons.	Official Value.
1853,	1,639	61.60	94,325
1854,	1,731	——	103,328
1855,	1,708	1.96	91,627
1856,	1,106	——	82,834
1857,	2,869	3.36	240,942
1858,	2,158	2.24	191,949
1859,	3,403	61.	340,686
1860,	6,095	16.	465,525
1861,	7,364	18.	440,130

* In 1860 Missouri produced 4,164 tons of ore, valued at $356,660.

† The Taconic System of Emmons appears to consist of the Potsdam and Quebec Groups.

‡ A rock composed of silica or flint and magnesia, (silica, 43.6, magnesia, 43.4, water, 13.0,) soft enough to be scratched with a knife; colour, generally different shades of green. The Serpentines of the Quebec Group almost always contain oxides of nickel and chrome.

§ A dark or grey-green impure talc with an unctuous feel. || Carbonate of magnesia.

It has been brought to the surface in the United States, Canada, New Brunswick, Nova Scotia, and Newfoundland, by a series of undulations, or parallel folds, originating probably from lateral pressure coming in a south-easterly direction, similar to that which has given rise to the Appalachian chain of mountains, (See Chapter II.) These folds have broken through the upper crust, and exposed the surface of the Quebec Group.* To the south-east of the great fault (upthrow) in Canada, &c. which brought the Quebec Group to the surface, there is no evidence of Lower Silurian strata higher than those belonging to this group.† The same may be said of New Brunswick, as far as is known of its rock formations.

ORIGIN OF THE METALS OF THE QUEBEC GROUP.

‡ "The metals of the Quebec Group seem to have been originally brought to the surface in watery solution, from which we conceive them to have been separated by the reducing agency of organic matter in the form of sulphurets, or in the native state, and mingled with the contemporaneous sediments, where they occur in beds, in disseminated grains forming *fahlbands*, or as at Acton, are the cementing material of conglomerates. During the subsequent metamorphism of the strata these metallic matters being taken into solution by alkaline carbonates or sulphurets, have been redeposited in fissures in the metalliferous strata, forming veins, or ascending to higher beds, have given rise to metalliferous veins in strata not themselves metalliferous. Such we conceive to be in a few words the theory of metallic deposits; they belong to a period when the primal sediments were yet impregnated with metallic compounds which were soluble in the permeating waters. The metals of the sedimentary rocks are now however for the greater part in the form of insoluble sulphurets, so that we have only traces of them in a few mineral springs, which serve to show the agencies once at work in the sediments and waters of the earth's crust. The present occurrence of these metals in waters which are alkaline from the presence of carbonate of soda, is as we have elsewhere pointed out, of great significance when taken in connection with the metalliferous character of certain dolomites, which as we have shown, probably owe their origin to the action of similar alkaline springs upon basins of sea water.

"The intervention of intense heat, sublimation and similar hypotheses to explain the origin of metallic ores, we conceive to be uncalled for. The solvent powers of solutions of alkaline carbonates, chlorids and sulphurets at elevated temperatures, taken in connection with the notions above enunciated, and with De Senarmont's and Daubrée's beautiful experiments on the crystallization of certain mineral species in the moist way, will suffice to form the basis of a satisfactory theory of metallic deposits."

* For a description of the phenomena attending the formation of and subsequent foldings and bringing to the surface of the Quebec Group, the reader is referred to the "Geology of Canada," pages 296 and 233.

† Prof. Hunt—On some points in American Geology. ‡ Ibid.

THE QUEBEC GROUP IN NEW BRUNSWICK.

The supposed northern boundary of this formation within the limits of the Province, commences near the Medisco River on the Bay Chaleurs. The strike of the rocks would carry them to Ramsay's Brook on the Upsalquitch, and thence towards the head waters of the Tobique to the north of Nictau Lake.

A few miles from the mouth of the Tobique there are a series of silicious slates which appear to underlie unconformably a series of Upper Silurian argillites, green, red, and blue-black, and holding *Favosites gothlandica.* The strike of these silicious slates would carry them to the north of Nictau Lake, and this line prolonged in a southwesterly direction is supposed to form a rude but continuous curve, (see p. 127, Chap. VII.) which may provisionally represent the northern boundary of the Quebec Group, which has been brought to the surface simultaneously with the granite axis of Devonian age described in Chapter II.

The continuation of this boundary takes a southerly course and is supposed to cross the Shiktehawk about 3½ miles from its mouth, where a conglomerate occurs, described in Chapter VI. It crosses the Saint John below Presquile, and taking a southwesterly course it enters the State of Maine near the forks of the Meduxnekeag, pursuing its course towards the Atlantic Ocean on the north flank of the granitic axis, where it is represented on Mr. C. H. Hitchcock's Map of Maine as a belt of mica schist. On the south east side of this axis the Quebec Group is again brought to the surface, its eastern boundary being in great measure covered up by the Bonaventure formation or base of the carboniferous series, which in many places reposes upon it horizontally or nearly so. Until further investigations establish the contrary, all the sedimentary rocks, with the exception of the carboniferous, north of the granitic axis which comes in from the State of Maine at Saint Stephens, and proceeds in an easterly direction through Queen's County to and beyond the Saint John, may be considered as belonging to this group, although it is not improbable that there is a narrow belt of middle silurian rocks, on the northeast flank of the carboniferous series a few miles due west of Fredericton. The rocks on the north side of this last named axis, described by Hitchcock as mica schist, in its prolongation through Maine to the Atlantic Ocean, most probably belong to the Quebec Group.

The breadth of this group of rocks measured at right angles to the strike within the limits of the boundaries just described, will be approximately as follows, after deducting the granite axis:—

1. Five miles from Bathurst,	... ...	20 miles.
2. From Ramsay's Brook, southeasterly,	... ...	36 "
3. From near the Nictau "	... ...	44 "
4. From the Tobique, "	... ...	43 "
5. From the Maduxnekeag, "	... ...	38 "
6. On the New Brunswick and Canada R. R..	...	25 "

It has been already stated that this granite axis (Chap. II.) is really composed of numerous narrow belts, which come up between the schists of the Quebec Group, also that it has a much more northerly extension than represented by Dr. Gesner. On the South West Miramichi, there are no less than ten distinctly parallel granite belts, with belts of slate and schist between them. It is clear that this arrangement of the granite and slates may exercise a very important influence upon the rocks now under review, as it not only extends the area over which they may be found, but the metamorphic action exhibited by the granite may have effected a material change in the composition and crystalline arrangement of some of the strata.

THE QUEBEC GROUP ON THE NIPISIGUIT.

The rocks of this Group on the Nipisiguit have undergone more or less metamorphism. Between the Upsalquitch and Nipisiguit, they occur in the form of highly laminated talcose and micaceous schists, splitting easily into thin leaves on weathered surfaces; they are unctuous, ferruginous, some layers abounding in yellow mica, other chloritic, and others presenting a rich golden colour (micaceous,) when freshly broken. They are interpenetrated with quartz veins, and show also bunches of quartz. The same schist occurs just below the Devil's Elbow on the Nipisiguit, and appears at intervals more or less talcose and chloritic, from the 59th to the 47th mile from the mouth of the river. Green schists are seen near the mouth of 44 mile creek, and are succeeded by beautiful purple-red slates, supposed to derive their colour from manganese and iron ore, which are here associated together in the same manner as at Jacksontown, near Woodstock, and on the Tattagouche, where also copper ores occur. The pale sea green slates which come into place above and below nine mile brook are extremely beautiful, and superior in most particulars to the beautiful argillites of Upper Silurian age near the mouth of the Tobique.

Six miles further down the stream red slates appear in the form of mural precipices. These have the same strike as the purple-red slates just described. About a mile and a half above the Grand Falls, near an island, there is a narrow belt of intensely black slates, which present a slightly corrugated surface when split with the cleavage planes; these black slates resemble in every particular similar black slates, described further on, seen near the Dumbarton Station of the New Brunswick and Canada Railroad. The last named position of these slates shows them to be on the southeast side of the granite axis, although they have a northerly dip. The occurrence of these black slates at points so remote from one another (150 miles) is valuable, as affording additional proof to others which will be mentioned in the sequel, that these rocks of the Quebec Group are persistent throughout the breadth of the Province.

The black slates are succeeded by a highly silicious rock, which at the Grand Falls was seen to contain specks of sulphuret of copper, and to be of a more slaty character. The slates just below the Falls are porphyritic, but a cursory examination failed to detect in them any traces of copper. The anticlinal folds are very numerous down the whole extent of the River, until the granite appears in place.

Below the Falls, and close to the first Salmon Pool there is a belt of glistening talcose-micaceous schist, with an easterly dip (50°), which, when fresh surfaces are exposed and wetted, is of a brilliant and lustrous golden color, glistening in the sunlight with various hues, many of which are the rainbow colors produced by the decomposition of light. The rock is very beautiful, but extremely fragile. It is noticed here, because a rock possessing precisely similar characteristics occurs on the road between Fredericton and Woodstock, near Sullivan's Creek, with an easterly dip. At the Grand Falls, on the Nipisiguit, this rock occurs on the southeast side of the axis, as far as it is known there; on the Saint John it is found on the northwest side.

Four miles above Pabineau Falls sulphuret of copper mixed with iron pyrites is found in green slates, which appear to be a repetition of those already described. This ore at the surface is feebly auriferous. Some specimens have yielded a trace of gold.

The fissile micaceous schist described as occurring on the portage between the Upsalquitch and Nipisiguit, and for some miles down that River, appears again in Millpagos Lake, a beautiful sheet of water not shewn on the Provincial Map, situated at the head of the Gulquac River, about a mile due south of Gulquac Lake, which is also about a mile due south of Tobique or Trowser's Lake. In this remote Lake, which lies at the northern base of the same granitic ridge separating Long Lake from Little S. W. Miramichi Lake, the micaceous schist has a strike S. 70° E., dip W.

There still remains one more well marked rock on the Nipisiguit, which has been traced even with greater persistency than the black slates, the golden hued talcose-micaceous schists, or the fissile grey micaceous schists. This is the red slate with its bands of iron and manganese ores. On the Nipisiguit, red slates, similar to those which are found near Woodstock, are seen a little above Nine Mile Brook, about 31 miles from the mouth of the River. The River runs in the strike of the rock here, and the purple-red slates which occur five miles higher up the stream, are repetitions of the red slates, more deeply colored with manganese than iron. Indeed, it may be said that for a distance of six miles the River appears to flow on or close to the belt of red slates, with their iron and manganese ores. Ferruginous rocks, similar to these red slates were seen on the Quaquabs or Campbell River where they are much metamorphosed, but it is on the Beccaguimic, the Shiktehawk, and at Jacksontown that they occur in force. Those at Jacksontown are already well known, but those on the Beccaguimic and Shiktehawk have not yet been described. They are found in two broad belts, about a mile apart, and loaded with iron ores on the Beccaguimic. A more particular description will be given when noticing the Jacksontown, (Woodstock) iron ores. These slates again occur on the south side of the axis, within 10 miles of Boiestown.

The Tattagouche Rocks are probably repetitions of the same strata; they contain copper in addition to iron and manganese, but copper also occurs in Diorite within a few miles of Woodstock, belonging to the same series, and opened some years since by Mr. Stephens.

THE QUEBEC GROUP ON THE CAMPBELL AND SERPENTINE RIVERS.

Green porphyritic slates on Campbell River, resembling those of the Nipisiguit, are underlaid by quartzite; the same was observed on the Miramichi. About seven miles below the Tobique Lake, near a precipice 70 feet high, called Bull's Eye Rock, true gneiss was observed with the strike S. 60° E., it was followed by green ferruginous slate, which was again succeeded by a highly quartzose rock, by green porphyritic slates and by red slates. Many of the strata on this river so closely resembling those of Nipisiguit and Miramichi, leave scarcely any room for doubt that they all belong to the same series. The foldings of the rocks on Campbell River, near its junction with the Serpentine, are very striking. They are seen to form grand curves in the high banks of the river, which exceed 200 feet. The tops of these curves have been removed by denudation, probably glacial action, but the fine sweep of the strata can by a slight effort of the imagination be continued for more than a mile down the river, which exposes a beautiful section. A conglomerate similar to that seen on the Shiktehawk and on the Upsalquitch, is distributed in masses in the bed of the river about two miles above the junction of the Serpentine and Campbell River. This fact coupled with the occurrence of Banded slates, about a mile from the Nictor, similar to those seen on the Saint John, and which are supposed to belong to the Upper Silurian Series, creates the suspicion that the limit of the Quebec Group in this vicinity may be a short distance to the northwest of the Tobique, below the Nictor or Forks. The Diorites which occur between the Forks and Blue Mountain Brook, are supposed to be for the most part altered sedimentary deposits belonging to the Quebec Group. An exploration for a few miles up the Little Tobique River, rather tended to confirm this view, the slates there being calcareous, ferruginous, and banded like some of the Upper Silurian Slates seen on the Saint John. Hence the limit of this formation is provisionally shown on the map as indicated above.

About two miles above the mouth of Campbell River, on the left side of the river, there is a red jaspery rock with slaty cleavage, which may come on the river higher up in several places, as boulders both of the red and green variety were noticed in the stream, but the rock was hidden from view by drift. On the Serpentine, (right hand branch of the Tobique), below the Forks, there are excellent roofing slates; and at the Falls an exceedingly tough, green and red porphyry, whose surfaces, when ice polished, are remarkably beautiful.

The mountains of this part of the Serpentine are high, and the banks precipitous, sometimes appearing as bold precipices three or four hundred feet above the water level. The sands of this river are auriferous, but the particles of gold are very fine and the sand itself occurs in very small quantity. This river, however, as well as the Campbell, and the country between it and Blue Mountain, and northeast of Long Lake is exceedingly interesting and promising. Traces of copper were seen on Campbell River in trap, as well as iron, manganese, copper, antimony and nickel. It is not improbable that the iron and manganese may be associated with the red jaspery rock, which was thought to be metamorphosed red slate; the antimony and nickel, probably belong to a lower rock of the series, whose representative is found at the Prince William Antimony Mines, and on the other side of the granitic axis, a few miles north of Woodstock, where I was shown specimens both of antimony and manganese which were stated to have been obtained in the neighbourhood, but the finder, as I was informed, refused to name the locality until he had secured the land.

Throughout the whole of this region great beds and probably intrusive masses of Diorite are common. Some of these contain seams of green coloured epidote which have been mistaken for copper. In one locality above Blue Mountain on the Tobique, there are several traces of "prospecting" operations, which the Indians told me were undertaken some years since by persons from Saint John who expected to find "a copper mine." The Diorites in this neighbourhood contain traces of copper, but the operations seem to have been directed towards the veins of epidote.

Before glancing at the rocks on the section between the Tobique and the little South West Miramichi, it will be necessary to give a brief geographical description of a portion of the country which has not been surveyed or laid down on the Provincial Map. This area is situated south and southeast of the Tobique Lake and Long Lake.

GEOGRAPHICAL DESCRIPTION.

Milpagos Lake.

At the southern extremity of Tobique Lake there is a low portage, about one mile and a half long, leading into Milpagos Lake. This ridge is not more than 80 feet in altitude, and the course of the portage is S. S. W. A narrow stream flows from Milpagos Lake into Tobique Lake. The meaning of the word Milpagos is "a lake with many arms," an expression which scarcely characterizes this sheet of water. Its greatest breadth is not more than 300 yards, and its length is about a mile. At its southwestern extremity it receives a small tributary which flows through a lake a mile farther south, and is the true source of the right hand branch of the Tobique River. The dividing ridge south of Milpagos Lake is probably continuous with the ridge separating Long Lake from Little South West Miramichi Lake, and the Gulquac Lake from streams flowing into the Miramichi. The hills on the east side are from 300 to 400 feet above the lake, which at its upper extremity is very shallow and fringed with a broad belt of rushes, the breeding places of numerous families of ducks, and still the abode of many beaver. A greenish-grey chloritic and micaceous schist, with a strike S. 70° E. and dip W. at a high angle, forms a narrow ridge in this Lake. It resembles in some particulars the schist on the Upsalquitch Portage. The mountains in view are all in the form of long, low, narrow domes.

Gulquac Lake.

The portage to Gulquac Lake commences in the first open expanse of Milpagos Lake, and pursues a W. N. W. course for not more than one third of a mile, leading into a fine open sheet of water, three quarters of a mile long by half a mile broad, surrounded by a low swampy tamarac and spruce country. The pitcher plant was observed growing luxuriantly in the deep moss fringing this part of Gulquac Lake. A narrow portage, about 200 yards broad, leads into the main portion of Gulquac Lake, which is about two miles long and three quarters of a mile broad, on a due south course. The hills on the west side are from 250 to 300 feet high; on the east side the country is low.

From the number of granite boulders not much worn in the middle and towards the upper extremity of Gulquac Lake, it appears probable that ridges in this vicinity are composed of this rock. The Lake terminates in an extensive marsh lying at the base of the dividing ridge before mentioned. Its outlet leading into Gulquac River, is situated at the southwest extremity, and is closed by a beaver dam seventy yards long, 16 inches high on the Lake side, and two feet six inches on the River side; the waters of this Lake find their outlet during the summer months through the interstices at the upper portion of the dam, in the spring and fall they flow over it. The dam must be very old, as alders three inches in diameter have grown all across it, and their roots have no doubt added to its stability. It is composed of spruce branches, trunks of small trees, mud and stones; a fringe of stones from one inch to six inches in diameter being deposited on the Lake side. The dam is 2 feet broad at the top, 4 feet at the Lake surface, and six feet broad at the River surface. One part of the dam was strengthened with a large pine tree, which had evidently been blown into the Lake, and floated to its place by the beavers. The roots and branches were gnawed off close to the trunk, the marks of the teeth being clearly visible. The length of the tree was 33 feet, its diameter at the butt 20 inches, at the other extremity 12 inches.

Some of the houses were of large dimensions, the height of one being 10 feet, and breadth 16 feet. Two entrances were noticed under the water, and two covered up entrances 3 feet above the present water level, also two at the present level of the water. Near the house was a large heap of freshly cut willow branches, the commencement of their winter store of food, and at some little distance on the marshy ground the remains of last winter's store were visible. During the afternoon some of the beaver were seen feeding in the Lake, diving down among the water lilies, and bringing up portions of the roots. One was shot in the act of feeding in the deep water of the Lake, holding the water lily root between his four paws, and keeping his body in an upright position with his broad webbed hind feet. Several other beaver dams and houses were seen during this exploration, but none in which the wonderful instinct of this little animal was manifested in so marked a degree as in Gulquac Lake.

It was observed that the canoe might steal towards a beaver to within 30 or 40 yards, when feeding in the Lake, provided the approach were made in perfect silence, even though the animal was advancing at the same time. But the least noise, even the click of the trigger, was sufficient to cause them to dive instantly. The Indians with me remarked, that although the hearing of the beaver is perfect, his eyesight is very deficient, an observation which former experience leads me to suppose is correct. Although we did not deviate from our course for the purpose of hunting, or make any delay beyond what was required in effecting the portage from Milpagos Lake to Gulquac Lake, (half an hour,) the voyage through the last named piece of water yielded us one beaver, one mink, one muskrat, five ducks, four partridges, and a dozen and a half of trout, besides a passing glimpse of a cariboo, a bear, and several tracks of moose.

Long Lake.

Returning to Tobique Lake, we crossed over to Long Lake. The beach at the beginning of the portage is composed altogether of white granite debris; the portage which is 2½ miles long, passes through a swampy piece of ground to a beautiful bay in Long Lake.

This fine sheet of water is about seven and a half miles long, and two broad, but as it is laid down on Mr. Wilkinson's map, it requires no special description. It reminded me of lakes on the canoe route between Lake Superior and Red River. Proceeding to the head of Long Lake, we ascended a small river flowing over granite debris for the distance of a mile, passing the mouth of a small stream which comes from Milnagec Lake. Milnagec, which signifies "Full of Islands," is the name given to one of the feeders of Long Lake. It is situated about three miles W.S.W. of the head of Long Lake, and is stated by the Indians to be about 3 miles long and 1½ broad. The numerous Islands it contains have been the origin of its name.

Little South West Miramichi Lake.

Leaving our canoe on the bank of the stream 1½ mile from the head of Long Lake, we commenced a portage to Miramichi Lake, the head of the little southwest branch of that river, on the south side of the dividing ridge. The portage follows an old Indian path, over a low mountain, which may be 500 feet above the level of Long Lake. The forest is composed of spruce and birch. Three miles from the north end of the portage the path crosses a mountain stream flowing into Long Lake, and at about 4½ miles the summit level is attained which is probably 600 feet above Long Lake. The ascent is gradual, and the plateau covered with a very fine forest of spruce and birch. The descent to Miramichi Lake is also very gradual and through a very fine forest. The whole length of this portage is about 8½ miles. No rock was seen in position, but numerous unworn white granite boulders render it probable that this dividing ridge is granitic. A few unworn boulders of schist, much twisted and contorted, appear on the south side of this ridge, shewing the presence of belts of that rock running probably parallel with the granite as observed on the South West Miramichi. Arrived on the shores of Miramichi Lake the Indians began to construct a spruce bark canoe, which was finished and afloat in eight hours. Although it was only the 12th of August we were anxious to see if moose would respond to a call. Hardly believing that at this early period of the year any response would be made, and perhaps overcome with the fatigue of the portage, both the Indians and myself fell asleep on the beach, but were suddenly awakened by the splash and plunge of a moose which had answered the call, and approached through the shallow waters of the lake to within twenty yards of where we lay, when warned by a lull or change in the wind which enabled him to scent a suspicious object, he turned round and dashed away into the gloom before we had time to fire.

The head of Little South West Miramichi Lake is very shallow, and much grown up with rushes and water lilies. The main body is about two miles broad and two and a half long. It contains at least fourteen islands, all of them of white granite. The outlet of the lake forms the beginning of the Little South West Miramichi, a river which here is full of micaceous schist boulders and ridges of the same rock, resembling the schist of the Upsalquitch portage. At the rapids close to the Lake, we caught numbers of fine trout, weighing from two and a half to four pounds each. Leaving the Indians to fish, I walked a mile or so down the stream, but finding it choked with boulders, and the ledges of micaceous schist continuing without change, the examination of the river was not pursued any further. Besides the trout mentioned above, large chub are numerous in the lake; we shot several duck, and on the portage a dozen partridge, and saw numerous moose, cariboo, and bear tracks. From these observations it will be inferred that the tract of country described, is still rich in game, the lumberer not having yet reached either Long Lake Portage or the country about Milpagos and Gulquac Lakes. There is, moreover, a large vacant space on the Provincial Map, east of the area described, which the Indians allege has not yet been visited by "white men."

THE MAGAGUADAVIC AT VAIL'S TO ROIX STATION.

From the Magaguadavic to the Dumbarton Station of the New Brunswick and Canada Railroad, the Lower Silurian rocks appear at long intervals apart, the road generally lying through a low and uncleared country, but in the neighbourhood of the Station, they have a strike S. 60 E. with a dip to the N. E. at an angle of 40.° They present themselves here in the form of ferruginous schist beautifully laminated. About three quarters of a mile north of the Dumbarton Station, there are some immense unworn masses of a silicious schist, enclosing crystals of iron pyrites, and resembling in every particular a schist seen on the South West Miramichi. (See page 45, for a description of the South West Miramichi.) Many of these boulders protrude from a gravelly drift, and they appear to form part of a series of glacial moraines subsequently covered with river drift. On the west side of the Digdewash, about one mile above the Station, a remarkable schistose porphyritic rock occurs, with a strike S. 65 E., and dip N. E. at an angle of 80°. It overlays a blue talcose schist with a N. E. dip. This schist contains highly ferruginous bands with layers of hæmatite. It is followed by black slates which appear in place some distance to the west of the Station, but boulders from these slates were seen in great profusion over the summit and sides of the hills a little to the southwest. These black slates differ, as already stated, in no observed particular from similar slates seen on the Nipisiguit. The occurrence of ferruginous slates with layers of hæmatite above them, is also an exact counterpart of part of the Nipisiguit Series. Immediately in front of the Station the slates are much seamed with quartz layers, and quartz veins form a network between the layers. About five miles from Dumbarton ferruginous slates with bands of black slates were seen to form an anticlinal axis, and near Roix Road Station the blue slates, weathering grey, have a strike S. 50° W., with a vertical dip. It is also worthy of remark that near the Roix Road Station boulders of a conglomerate similar to that which occurs on the Shiktehawk were noticed. These boulders contain fragments of red, green, and black slate, emerald green silicious pebbles, a few quartz and jasper pebbles. Their occurrence here shows probably the proximity of the upper member of the Quebec Group; with these conglomerate boulders were also seen masses which were thought to be from a glauconite schist.

UPPER FALLS OF THE MAGAGUADAVIC TO THE LOWER FALLS.

Near the Upper Falls of the Magaguadavic, about eight miles north of the village of Saint George, a gneissoid schist, interpenetrated with reticulating veins of quartz was seen dipping north at a high angle, and the white granite of Devonian age on which it rested was recognized in position about a mile further down the stream. The granite here forms high cliffs facing the east, some of these escarpments are from 400 to 500 feet high, and from their summits a very extensive and beautiful view is obtained. Part of Lake Utopia with its islands is seen to the east, and Mount Pleasant, estimated at upwards of 1300 feet in altitude, is clearly distinguishable some twenty five miles to the north. The valley of the Magaguadavic lies at the feet of the spectator, while to the south the village of Saint George, backed by the hills lying between it and the sea, appears in delightful contrast to the nearer range of granite hills, from any one of whose summits the different objects enumerated may be observed. The granite is exceedingly coarse, the crystals of quartz being more than two lines in diameter, the felspar, though weathering white, has a pinkish tinge which increases on progressing southward until the rock viewed from a distance looks rose-red. In all particulars except the occasional occurrence of large crystals of white weathering felspar an inch and more long, the granite resembles the central range. When within about four miles of the village of Saint George, the rock assumes a gneissoid character with a strike nearly east and west, (N. 70 E.) and a dip to the south; it is in fact a porphyritic gneiss, in which the felspar predominates and the mica exists in very small quantity, the quartz crystals continuing large and well defined. The breadth of the granite probably does not exceed here three and a half miles. About two miles from Saint George, a Diorite succeeds the gneiss passing into a homogeneous slate. A mile north from Saint George the red felspathic schist, which appears for a long distance as a more or less precipitous escarpment on the road to Saint Stephen, here forms a magnificent "bluff." The rock is very strong, and seen from the road is a striking object. Its general colour is rose-red. And where partly covered with green moss and grey lichens it presents at a distance a picture of singular beauty, especially when lit up by the rays of the sun after a shower of rain. The contrast of the colours is so remarkable that this rock would form a favourite study for an artist in any country. The schist itself is not less interesting; it has an east and west strike and dips to the south; its upper portion is porphyritic and is probably a diorite. An intrusive green diorite appears on the southern exposure, but it was not traced to the summit. From this rock Lake Utopia is plainly seen, being not more than two miles from it. These green and red diorites resemble those on the Tobique and Campbell Rivers, and would probably form excellent materials for decorative arts. Some portions of the rock which had been submitted to glacial action, and the polished surfaces preserved by a thin coating of sand, were especially beautiful, deep red chrystals being imbedded in a light green or rose-red matrix.

FALLS OF THE MAGAGUADAVIC.

At the Falls of the Magaguadavic the slates have a general strike east and west with a southerly dip, but they have been subjected to some disturbance. The slates are succeeded by bedded diorites which from their hardness have arrested the retreat of the falls. Before the falls had reached the pool their retrocession must have been very rapid, as they then fell over fissile blue-black slates which appear just opposite the pool or basin below the mass of bedded Diorite over which the waters of the lower part of the falls plunge. These black slates have a strike nearly due east and west (N. 75° E.) with a northerly dip. They are first corrugated and very hard near to the Diorite, but they soon become fissile and expose large plane surfaces, and some bands are apparently fitted not only for roofing purposes but also for writing slates. The first band of slates is about 200 yards broad, this is succeeded by about 300 yards of Diorite, as exposed on the river bank; the slates then come in again with the same strike but a southerly dip, showing an anticlinal axis here. They are also blacker than before, and when wet appear intensely black; they present a rough surface when freshly fractured, like the black slates of the Nipisiguit and the black slates near Dumbarton. As both of these slates probably belong to that part of the Lower Silurian Series which is known as the Quebec Group, the resemblance of the black slates of the Magaguadavic to them is remarkable and suggestive. The lower bands of black slates easily break into rhombs, are ferruginous, and sometimes expose many square feet of plane surface with that peculiar roughness which distinguishes the black slates of the Nipisiguit.

CHARACTERISTIC STRATA BELONGING TO THE QUEBEC GROUP.

The great economic value of this series of rocks makes it desirable to supply as full a descriptive account of the strata which compose it as the limits of the present Report will permit. As the series in New Brunswick is merely a repetition of what has been carefully studied in Canada, it will be desirable to incorporate the results of many years study of the mineral characters of those rocks by Professor Hunt.

GNEISS.—Great masses of orthoclase gneiss * are met with in this series. They are generally fine-grained, and are more quartzose than those of the Laurentian system; with which the practiced observer will never confound them. The coarse-grained and porphyritic reddish and white varieties are never met with, and the gneiss is generally of pale greyish or greenish hues. In some cases, great portions of it are so destitute of marks of stratification, that but for their relations to the adjacent beds, they might be taken for intrusive masses. The mica is generally white or greyish, and in small quantity.
Often found reposing on the granite in New Brunswick.

ANORTHOSITE.—Rocks composed of triclinic feldspars, and representing the anorthosites † of the Laurentian system, are common in this series; they are, however, never coarsely crystalline, and are often compact. In some cases the feldspar approaches to albite or to oligoclase in composition. Through an intermixture of hornblende, these rocks pass into diorite.‡

DIORITE.—In the diorites of this series, the feldspar is sometimes the predominant element. One from Oxford was found, by analysis, to consist of sixty-four parts of albite, and thirty-six of hornblende; another contained seventy-four parts of a feldspar, which was near albite in composition, but contained as much potash as soda. Others of these diorites exhibit a predominance of hornblende, often mingled with a chloritic mineral, and constitute veritable greenstones; which, however, appear to be in all cases sedimentary rocks. They are frequently so finely granular as to appear at first sight homogeneous, while at others they are rather coarsely crystalline, or sometimes porphyritic, from the presence of large feldspar crystals.—*Common throughout the group in New Brunswick.*

EPIDOSITE (EPIDOTE AND QUARTZ).—Epidote is a characteristic mineral of great portions of this series. Sometimes it forms with quartz, a fine-grained compact rock, which is found in thick beds in the Shickshock Mountains. At others, the epidote is disseminated in nodules, in a fine grained silicious rock, which often becomes chloritic or argillaceous.—*Common on the Upper Tobique.*

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* ORTHOCLASE gneiss—Potash Felspar gneiss.
† Anorthosite—A Lime Felspar Rock.
‡ Diorite—A Rock composed chiefly of felspar and hornblende.

MICA-ROCK.—This soft grey schistose rock, a bed of which has been wrought as a variety of potstone, has nearly the composition of a hydrous mica, with only three per cent of alkalies, and fifty-one per cent of silica.—*Nipisiguit, Saint John River.*

MICA-SCHIST.—These mica-schists are very variable in their nature, and often highly quartzose; not unfrequently they have the aspect of what are called talcose slates, without, however, containing any magnesia, and owe their peculiar characters to a mica like that of the preceding rock, or to pholerite or pyrophyllite. Pholerite is sometimes found in a pure state, in fissures in the sandstones of this series; and pyrophyllite forms beds, resembling steatite, in the same formation in the southern United States; where it also occurs crystallized with quartz.

Localities.—*Devil's Elbow on the Nipisiguit, Saint John River, Upsalquitch Lake, Milpagos Lake.*

ARGILLITE.—The argillaceous rocks of this series present many varieties, from roofing-slates, and talcoid and plumbaginous shales, to others which are more or less chloritic or micaceous. Some specimens are remarkable from containing small oval masses of regular outline, consisting of orthoclase and quartz. Their exterior portion is generally of feldspar, the centre being filled with quartz; but sometimes the one or the other is wanting, and the kernels consist of quartz or of feldspar only. These oval masses, which are from one-eighth to one-half an inch in length, have their greater diameters parallel. The rock might be called an amygdaloid. Some portions of these argillites are penetrated by small veins with quartz, chlorite, and bitter-spar, intersecting these slates. *Compare the Red Slates in next Chapter.*

Localities.—*Valley of Shiktehawk, of Beccaguimic, Jacksontown, on Campbell River, on the Nipisiguit, on the Upsalquitch, on the South West Miramichi.*

IRON-SCHIST OR ITABIRITE.—Great beds of a rock made of scales of specular iron, with quartz and chlorite, are met with in the altered Silurian strata. They are sometimes rich iron ores, and at other times contain but small portions of the metallic oxyd. The specular schists often include a portion of titanic acid, which is occasionally seen in the form of rutile or of sphene, crystallized in veins, sometimes with feldspar. These rocks are apparently identical with the itabirite of Brazil.

Localities.—*On the Upper South West Miramichi, Campbell River.*

DIALLAGE ROCK.—Diallage is abundant, not only as a component of some ophiolites, but sometimes forming a rock, either by itself, or with a little mixture of an amorphous mineral, which approaches to pyrosclerite in its composition.

CHLORITOID-SCHIST.—Chloritoid is abundant in the quartzose mica-schists in this series.

HORNBLENDE ROCK, WITH GARNETS.—Beds of black crystalline hornblende rock, including small crystals of red garnet, occur with the serpentines of Mount Albert. In many other parts, hornblende in the form of actinolite, or a tough, fibrous variety allied to it, forms beds of great thickness.

MAGNETIC IRON IN DOLOMITE.—Magnetic iron ore is often found in these rocks, in irregular beds or masses in Serpentine.

COPPER PYRITES.—Copper is abundantly distributed in this formation. The ores are met with in quartzose, argillaceous, micaceous, and chloritic slates, in limestones, and in dolomites. The copper in these strata seems to have been a contemporaneous deposit from aqueous solutions. *Tattagouche—Nipisiguit, four miles above Pabineau Falls—At the Grand Falls—Campbell River—Woodstock.*

OPHIOLITE (SERPENTINE.)—Under the name of ophiolite we include those rocks which have serpentine for their base. The normal ophiolites are nearly pure serpentine, while some are mixtures of serpentine and carbonate of lime (calcareous ophiolites,) and others dolomitic and magnesitic ophiolites; containing respectively dolomite and carbonate of magnesia, often in large proportions. All of these varieties are met with in Canada, or in the adjacent State of Vermont. These compound ophiolites are sometimes porphyritic from the presence of diallage (the Italian gabbro). At other times, they have the aspect of conglomerates, exhibiting rounded or angular masses of pure serpentine of various sizes, imbedded in a dolomitic paste, itself more or less coloured by intermingled serpentine. A magnesitic ophiolite from Vermont has a gneissoid structure, due to the arrangement of the crystalline magnesite spar, with lamellæ of talc, apparently marking planes of stratification. The ophiolite of Mount Albert is marked with red and green bands, which have the aspect of sedimentary layers; and the relations of the ophiolite throughout this series, where its outcrop has been followed for hundreds of miles, are always those of an interstratified deposit, and never of an eruptive rock. It occurs with dolomite, magnesite, steatite, diorite and argillite, with each one of which it has been found in contact, and it seems sometimes to replace the other magnesian rocks. Its beds vary from a few yards to several hundred feet in thickness. The colours of these ophiolites are of various shades of green; generally much darker than those of the Laurentian series. A red colour sometimes occurs in patches and bands, or pervades the whole mass; this, in some cases, at least, is due to an intermixture of red hematite. Foliated and fibrous varieties (baltimorite and chrysotile) are frequently found in veins in these ophiolites. Chromic iron is also a characteristic mineral, in grains, or in interstratified beds or lenticular masses, often of large size. Magnetic iron occurs in these ophiolites, both in grains and beds, sometimes with ilmenite.

The analysis of the serpentine of these ophiolites show them to contain from seven to ten per cent. of protoxyd of iron, to which they owe their colour, besides small portions of oxyds of chrome and nickel. These two metals often occur in the magnesian rocks of this series, in the form of chromic iron and sulphuret of nickel; but are in many cases present as integral portions of the silicate. This is true, not only of the serpentines, but of the diallage and actinolite rocks, and many of the dolomites and magnesites. It would seem that chrome and nickel were constant accompaniments of the magnesian deposits of the present series. We have also detected these metals in the ophiolites of California, of Portsoy in Scotland, Cornwall, the Vosges Mountains, Mount Rosa and Corsica; while they are wanting in the Laurentian ophiolites of Canada, and in specimens of serpentine from Norway, supposed to be of the same formation.

STEATITE.—Talc slates or schistose varieties of steatite are not unfrequent. These are sometimes nearly pure talc, and at others mingled with hornblende, in the form of actinolite or with bitter spar.

CHLORITE, (POTSTONE.)—Sometimes beds of pure compact chlorite are met with in these rocks.

MAGNESITE.

DOLOMITES.—LIMESTONES.—Dolomites, or magnesian limestones, are abundant in this series, and frequently accompany the ophiolites or serpentines into the composition of which they often enter. These dolomites are generally ferruginous, often containing eight or ten per cent. of carbonate of iron, and sometimes as much carbonate of manganese. They are often mingled with a portion of clay, or of silicious sand, and very frequently become conglomerates, enclosing pebbles or rounded masses of pure limestone, and more rarely of sandstone, shale, or dolomite, in a paste of ferruginous red-weathering magnesian limestone. In some cases, these rocks have the composition of a true dolomite, in which the oxyds of iron and manganese replace a portion of magnesia. In others, the quantity of lime is not equivalent to the other protoxyd bases, and we have a passage to the magnesites already described; which are rocks consisting of carbonates of magnesia and iron, with little or no carbonate of lime. Tho foreign minerals of these rocks are few in number; chlorite, talc, hornblende, pyroxene and brown garnet are sometimrs met with, and a green chromiferous mica, probably allied to fuchsite, occurs in small scales, both in the magnesites and in the dolomites. With the ferruginous dolomites, are often interstratified beds of pure limestone, which frequently enclose concretionary fibrous masses, made up of concentric layers, like the recent deposits of travertine from calcareous waters.

The conditions under which these dolomites and pure limestones are associated, are such as to leave no doubt that they have been contemperaneous deposits and to forbid the notion of the formation of dolomite by any subsequent alteration of the limestones.—[See Geological Reports of Canada for 1857 and 1858.]

Deposits of Silica.—Deposits of silica, which are evidently of chemical origin, and which assume the form of hornstone or jasper, as they include more or less argillaceous or ferruginous matter, are not unfrequent among the mechanical sediments of this series. The two specimens of sandstone from the unaltered strata of the Quebec Group at St. Nicholas, are supposed to represent the granitic gneiss of the altered portions of the same formation. The cement in some of these sandstones, is a feldspathic matter, rich in potash; and the analysis of the rock, as a whole, gives a composition identical with the mixture of quartz, orthoclase, and mica, which constitutes this gneiss. The metamorphism of these aluminous rocks consists then, simply in the crystallization of the sillicates of alumina and alkali in the sediments, a reaction which has taken place at no very elevated temperature; the alkaline sillicates and carbonates, by which the waters of these sediments are impregnated, aiding the process. At the same time, the reactions between the sillicious and argillaceous matters, and the earthy carbonates, in the presence of these alkaline solutions give rise to chlorite, and epidote.*

* Professor Sterry Hunt.—Descriptive Catalogue of a collection of the Economic Minerals of Canada, and of its Chrystalline Rocks,—1862.

CHAPTER IX.

THE QUEBEC GROUP.—(Continued.)

Metalliferous Deposits in the Quebec Group of New Brunswick—Iron, Manganese, Copper, Antimony, Nickel, Lead, Zinc, Gold, Silver—Origin of the metallic deposits in this Group—Professor Sterry Hunt's Views—The Woodstock Iron Ores—Description of the Ores—Chemical Composition—Properties of the Iron—The Woodstock Iron Works—Opening for capital and enterprise in the working of these Iron Ores—Their extensive distribution—Their development on the east side of the Saint John—On the Beccaguimic—Their associations with limestones for fluxing, fuel for smelting, labour, and their occurrence in a fine agricultural country—Their occurrence on the Shiktehawk—Three undulations on the east side of the Saint John have brought the ores to the surface—Vast importance of these ores—Native silver in a jasper boulder on the Shiktehawk—Manganese and Copper Ores—On the Nipisiguit, Tattagouche, Campbell Rivers, Bull's Creek—Saint John—Professor Hunt's views respecting the origin of Copper in the deposits of the Quebec Group—Antimony Ores—The ores of Prince William Parish—Characters of the Dislocations—The Pits—Probable extent and richness of the ore—Nickel—Copper—Production and uses of Antimony—Lead Ores—Zinc Ores—Sequence of the strata in Canada—Island of Orleans Series—Phillipsburg Series.

METALLIFEROUS DEPOSITS AND METALS IN THE ROCKS SUPPOSED TO BELONG TO THE QUEBEC GROUP IN NEW BRUNSWICK.

I. Iron; II. Manganese; III. Copper; IV. Antimony; V. Nickel, VI. Lead; VII. Zinc; VIII. Gold; IX. Silver.

The manner in which the metals of this Group have originated is of much importance in attempting to form an estimate of the commercial value of any deposit. It has been shown in the preceding Chapter, according to Professor Sterry Hunt, who has paid especial attention to this subject, and the results of whose investigations form some of the most important contributions to Chemical Geology which have yet been given to the scientific world, that the metals seem to have been originally brought to the surface in watery solution, from which he considers them to have been separated by the reducing agency of organic matter in the form of sulphurets, or in the native state and mingled with the contemporaneous sediments, where they occur in beds, or in disseminated grains forming *fahlbands*, or, as at Acton, are the cementing material of conglomerates.

During the subsequent metamorphism of the strata, these metallic matters being taken into solution by alkaline carbonates or sulphurets, have been redeposited in fissures in the metalliferous strata, forming veins, or ascending to higher beds have given rise to metalliferous veins in strata not themselves metalliferous. The intervention of intense heat, sublimation and similar hypothesis to explain the origin of metallic ores, Professor Hunt conceives to be uncalled for.*

THE WOODSTOCK IRON ORES.

These ores are vast sedimentary deposits many feet in thickness, interstratified with red and green argillites, or with calcareo-magnesian slates, of a red or green, or mottled red and green colour. The ores vary in composition, being both red and black, the black is sometimes feebly magnetic, but it derives its colour more from the presence of manganese than from the black magnetic oxide. The red ore is an impure hæmatite, containing besides the peroxide of iron, some carbonate of the protoxide, and from one to six per cent. of manganese; it is often seamed with thin layers of graphite. The most characteristic of the earthy admixtures, are from two to five per cent. of magnesia, and from .064 to nearly two per cent. of phosphoric acid. The mean of eight analyses gave 32 68-100ths per cent. of iron from the ores worked at the furnaces. Some of the samples yielded as high as 48 per cent. of metallic iron, others as low as 19 per cent.; 32 per cent. appears to be about the general average as shewn in the accompanying Tables, when the extremes are thrown out and the mean of the remaining six analyses is taken.

The slaty ores are often concretionary,† showing layers of small circular or eliptical spaces regularly distributed in lines parallel to the stratification.

Table showing the Chemical Composition of Eight Samples of the Woodstock Iron Ores.‡

	1	2	3	4	5	6	7	8
Peroxide of Iron......	49.357	47.858	39.285	67.857	42.587	27.143	50.000	35.714
Protoxide "	1.412	2.140	1.140	1.070	—	traces	2.400	5.100
Alumina..............	6.200	3 924	3.116	2.004	6.412	10.742	6.114	5.076
Oxide of Manganese,	4.784	6.110	5.872	0.976	2.140	5.172	3.742	6.840
Peroxide "	—	—	—	—	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	0.206	0.642
Sulphuric Acid........	0.798	0.596	1.274	0.588	0.977	0.842	0.572	0.764
Phosphoric Acid......	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
Metallic Iron.........	34.867	35.147	28.377	48 323	30.000	19.000	36.848	28.927

Mean of the eight.................................32.683.

* On some points in American Geology. American Journal of Science, May 1861.

† Compare with "Argillite," page 157.

‡ This Table was kindly given to me by Norris Best, Esquire, one of the proprietors of the Woodstock Iron Works. The analyses were made in England by chemists of known reputation.

CHARACTER OF THE IRON.

The iron produced at the Woodstock Iron Company's Furnaces is of a very superior quality. Its colour is silver-grey; its density is equal to that of some varieties of the best hammered iron; it makes excellent steel, and possesses great toughness or resisting power.

The resistance in tons per square inch of—

Yorkshire Iron, is	24.50	tons.
Derbyshire "	20.25	"
Shropshire "	22.50	"
Staffordshire "	20.00	"
Woodstock "	24.80	"

The presence of phosphoric acid in iron without manganese, renders the metal "cold-short," that is, brittle when cold; but if the metal be alloyed with manganese, the two foreign elements combined appear to give it a high degree of ductility; manganese alone is not thought to improve the quality of the iron. It has been suggested that the Woodstock iron owes its great resisting power to the large quantity of carbon it contains; this view, however, is not in accordance with the experiments at Shoeburyness. The iron plates which contained the largest amount of carbon were the most easily fractured, a large percentage of carbon (0.23) causing brittleness. The composition of the plates* which afforded the greatest resistance to concussion, with regard to foreign substances, was as follows:—

	Carbon.	Sulphur.	Phosporous.	Silicon.	Manganese.
A...............	0.01636	0.104	0.106	0.122	0.28
B...............	0.03272	0.121	0.173	0.160	0.029
D...............	0.0436	0.118	0.228	0.174	0.250

A comparatively large amount of Carbon gives strength to resist tension and compression, but not concussion or the force of impact.†

While, however, the quality of the Woodstock iron is no doubt excellent, it seems probable that the estimation in which it is held by the Proprietors of the Works is a little too exalted, if the following statement in Professor Bailey's Report correctly expresses their opinions:—"The proprietors," says Professor Bailey, "believe the iron thus wrought to be superior to Swedish, Russian and East Indian pig iron, and draw their conclusions from the fact that one cubic inch of the Woodstock metal will weigh at least 22 per cent. more than either of the above, and is something like 26 per cent. heavier than the most of the Scotch brands."‡

* The hammered plates manufactured at the Thames Iron Works are made in the following manner:—"Scrap iron of the best description is carefully selected and cleaned, piled, hammered into a bloom, and then rolled into bars 6 inches broad, and 1 inch thick; these bars are cut up, piled, and again hammered into a slab; several of these slabs are put together, heated and hammered to the form required, and this process being repeated, the plate goes on gradually increasing to the length required."

† Fairbairn. ‡ Report on the Mines and Minerals of New Brunswick, page 58.

1. The specific gravity of common Scotch Iron, varies from 6.9 to 7.1.
2. That of pure iron is 7.8.
3. Of the best razor tempered steel 7.84.
4. Rolled and hammered iron 7.9.

An increase in weight equal to 26 per cent. would make the specific gravity of the Woodstock iron 8.82, or higher than that of copper, (assuming the specific gravity of the "Scotch brands" to be 7.0), and about 12½ per cent. higher than the best razor tempered steel. As this specific gravity for iron of any description manufactured or unmanufactured is wholly unprecedented, we may suppose that the above estimate is too high.

CAPACITY OF THE WOODSTOCK IRON WORKS.

The capacity of these works, with one furnace in operation (and one in process of erection), is stated to be six tons and a quarter of iron a day; the furnace continues in blast for about twenty-four weeks, six weeks being required for the necessary half yearly repairs, so that the actual producing time is about 43 weeks in a year, this would give, at 50 tons a week, the product of one furnace, about 2,150 tons per annum. Each of the British Iron Clad Frigates require from 800 to 1,050 tons of iron for plates, so that the two furnaces, which may be supposed to be in operation in the early part of 1865, would not be able to supply more than enough iron per annum to cover four first class frigates. At this rate it would take two or three generations to remodel the British Navy. Whenever the demand is made, however, and there is a demand for far more than can be supplied, there is ore and fuel enough for fifty furnaces, for on the east side of the River Saint John, the country is still an unbroken forest, except on the borders of the streams. Hitherto, the entire product of the one furnace in operation would be sufficient only to protect two frigates per annum, we must therefore receive the statement that "the British Government uses chiefly the Woodstock iron for the manufacture of the plates,"—*cum grano salis.**

No doubt it would be extensively used in the British and some foreign navies, if enough iron could be obtained with sufficient despatch. There is a splendid opening for the employment of capital in this direction, and ore and fuel in abundance for many years to come. The whole question is one of very considerable interest and will bear the strictest scrutiny.†

* C. H. Hitchcock—Second Annual Report upon the Natural History and Geology of the State of Maine, 1862, page 414.

† In a Report presented to the Woodstock Athenæum, February 11th, 1862, it is said—"The following statistics regarding the present works, and the extent of the iron beds have been kindly furnished by Mr. Norris Best, Manager of the Charcoal Iron Works at Upper Woodstock. The quantity of wood required for the operations of these works in 1864 is estimated at 12,000 cords, which will strip say 400 acres. Evidently with this consumption annually added to that necessary for the ordinary purposes of the County, wood must go up in price, and the expense of producing Charcoal Iron must be increased. But the present works furnish a very considerable addition to the business of the County, and would provide an item in Railway traffic of no small importance. The estimated production of pig iron for 1864 is 2,750 tons, employing at the mines and about the

DISTRIBUTION OF THE ORES.

The red and green slates with which this ore is interstratified are very widely distributed, as already stated, in a northeasterly direction, extending in fact as far as the Nipisiguit, a distance of more than one hundred and twenty miles. It is probable that owing to local disturbances there will be large breaks in these deposits, and the ores may not be found equally rich throughout the distribution of the red and green slates, but they are known to occur in inexhaustible quantities on the east side of the Saint John, where they appear in probably greater force than at Jacksontown, on the west side of the river, from which the Woodstock Iron Works are supplied.

The first Iron Ore Bed on the east side of the Saint John, seen this summer, was on the farm belonging to Mr. B. Thomas, No. 1, on the south side of the Beccaguimic. This is probably the same bed or one of the series which occurs at Jacksontown. The ore as it appears on the surface of the ground is very black, containing apparently a considerable proportion of Manganese. The red slates with hæmatite were observed in position with a strike N. 60° E. or from N. 50° E. to N. 60° E. The red and green slates have here a breadth of about one quarter of a mile, the dip is vertical where observed. The iron ore was seen to occupy more or less of 90 yards in this vertical section.

Two miles and three quarters from the Saint John, and within half a mile of the Beccaguimic, the red slates cross the road.

On the road to the Limekilns at Pole Hill, which is marked on Mr. Wilkinson's Map, red slates, which are probably another undulation of the same beds, cross the road about 250 yards from the Beccaguimic road.

On Mr. William Clark's lot, through which the Pole Hill road passes,

furnace and works seventy five men. Twelve teams, with their drivers, find constant employment in hauling the ore, while to cut the wood requires say one hundred and fifty men for twelve weeks; and to haul it some sixty teams and their drivers for the same length of time. The down freight of the pig iron for 1864 is estimated at $5,500. During the winter the iron, in order to keep up a regular supply for the English market, has to be hauled on sleds to the Houlton Road Terminus of the Saint Andrews Railway, a distance of nine miles, thence sent by Railway to Saint Andrews; and from that place shipped by schooner to Saint John; and every ton thus transported from Woodstock to Saint John, costs one dollar and twenty five cents additional. With a Railway communication between Woodstock and Saint John, the iron could be sent for two dollars throughout the year, and thus on one half the quantity produced there would be a saving in transport within the Province of one dollar and a quarter per ton. The up freight for the Works is estimated for 1864 at $4,500. Thus for 1864, from the works of the Iron Company alone, the proposed Railway would receive a traffic at present worth $10,000.

Mr. Best states to your Committee that if there were continuous Railway communication from Saint John to Woodstock, so that mineral coal could be delivered at the works at a rate of 1½ cents per ton per mile, it could be used profitably for iron smelting in this County; and that every description of iron, whether for the varied uses to which malleable iron is put, or for castings, could be produced in Carleton County and sent to Saint John at a price so low as to compete successively with English and Scotch irons. In fact, the result would be that three fourths of the importation of British and Foreign iron would cease."

about 5½ miles from the River Saint John, the red slates with black iron ore are seen in places on the west side of the road. These are, most probably, the Jacksontown beds brought to the surface by a third undulation.

A broad band of limestone deeply creviced, occurs within a mile to the southeast of these iron deposits. It is from this source that the lime for smelting purposes at the Woodstock Iron Works is obtained.

Limestone is said to be found also on Lot N, belonging to W. O. Clarke, on Gin Brook, this is probably the same bed as the one just noticed, brought to the surface by the same undulation which revealed the presence of the first belt of iron ore noticed on the Beccaguimic. The order being—

I. Red and green slates with iron and Manganese ores...Beccaguimic.
II. Limestone...Gin Brook.
III. Red and green slates with iron and Manganese ores...Cooke Lot.
IV. Limestone...Pole Hill.

A band of black iron ore crosses the Portage Road on the Upper Shiktehawk, about 7½ miles from the River Saint John; it has a strike N. 60° E. dip N. E. The red slates with which it is associated are near at hand, crossing the portage road a short distance in advance. The quantity of ore on this road is very considerable, but persons familiar with the country state that two or three hundred yards in the woods south of the road, the iron ores are much more abundant, and two miles from the same locality there is abundance of limestone.

The new settlement of Glassville must be situated on or near a band of these slates, for though not seen in position the debris was recognised at the bend of the North West Branch of the South West Miramichi.

IMPORTANCE OF THESE IRON ORES.

It appears clearly established that on the east side of the Saint John there are not less than three undulations which have brought up the red and green slates with their iron ores and associated beds of limestone. These immense deposits of ore occur in a country possessing an excellent agricultural soil, a splendid forest of birch, beach, spruce, and maple, and limestone in abundance. It will not fail to be noticed that these are elements of local industry belonging to the highest class. For the ore yields an iron of very superior quality, which has been thoroughly tested in the United States and in England, and if it be considered advisable to smelt it on the spot there is abundance of timber for fuel, lime for fluxing, labour for collecting the ore and preparing the fuel, and an excellent agricultural country as the basis of the whole industrial system. Now that this iron has met with so much favour in England, it is not improbable that it may yet be profitable to export the best quality of ore from those beds which are near to the Saint John. Under any circumstances it is probable that in a short time the abundance of fuel, either as coal, or gas from the highly bituminous shales of Sussex Vale, both of which are cheaply procurable in the lower portion of the river,*

* See Chapter VI. for a description of gas furnaces.

will render the construction of gas furnaces for obtaining iron of a very superior quality a matter of pecuniary advantage and provincial importance.

Red slates were seen on the southeast side of the axis, within ten miles of Boiestown on the Miramichi, but they were not specially examined for iron ores. Higher up the river the rocks are very ferruginous, but no details can be given respecting them.

FUEL AND ORE.

In Derbyshire (England,) the following is the proportion of ore and fuel consumed, and metal produced:—

Ore, ...	2 tons 12 cwt.
Mineral coal, ...	2 "
Metal produced, ...	1 "

In Staffordshire:—

Ore, ...	2 tons 7 cwt.
Mineral coal, ...	2 " 8 "
Metal produced, ...	1 "

In Dordogne, (France):—

Ore, ...	2 tons 7 cwt.
Charcoal, ...	1 " 8 "
Metal produced, ...	1 "

Woodstock, N. B.:—

Ore, ...	8 tons 6 cwt.
Charcoal, ...	126 bushels.
Metal produced, ...	1 ton.

This estimate is based on the statement kindly made by one of the proprietors, Mr. Norris Best, in a letter addressed to me under date 11th February 1865.

Mr. Best states that the average proportion of materials used during the past year has been as subjoined:—

Ore, ...	1180 lbs.
Limestone, ...	50 "
Charcoal, ...	20 bushels.

The average yield of the ores is assumed to be 30 per cent. of pure metal. (See Table of Analyses, page 161.)

Then 1,180 lbs. of ore will yield 354 lbs. of metal, or one ton of 2,240 lbs. will require 3.33 tons of ore, and 126 bushels of charcoal, which at seven cents a bushel, the price Mr. Best states he is paying on the 11th February, will cost $8.82, which is the actual cost of fuel, per ton, according to above data.

At Dordogne, the cost of charcoal for the production of one ton of iron is at the least $11.60 cents; and in France, generally, the average price of charcoal would raise the cost of every ton of iron to $14.80 for charcoal fuel alone.

For the further conversion of cast iron into wrought iron, there is required in England about one ton and one third of cast iron, and from two to two and a half tons of mineral coal are consumed, while the same amount of the cast iron of the Dordogne requires to convert it into a ton of wrought iron, one ton and a half of charcoal. In England, a ton of wrought iron requires about five tons of mineral coal for its fabrication. In France, a little over three tons of wood charcoal at $11.60 a ton, the minimum price of charcoal there.

It is clear that the price of charcoal in the vicinity of Woodstock will rise in the course of a few years, and then the question of a supply of fuel for smelting purposes will have to be vigorously met, or as in Canada, it will be necessary to move the furnaces where ore and fuel are still abundant, without the construction of a Railway enables coal to be delivered at a rate sufficiently low to admit of its being used for smelting purposes. But there are other parts of the Province where ores of iron and fuel exist in abundance together, and where gas fuel can be employed with advantage.

M. CHENOT'S PROCESS WITH GAS FUEL.

In 1857, Professor Hunt called attention to the new metallurgical processes of the late Adrien Chenot, which attracted in a particular manner the attention of the Jury of the Palace of Industry at Paris in 1855, who awarded to the inventor the Gold Medal of Honour. M. Chenot there exhibited a series of specimens serving to illustrate the processes which bear his name, and which have been the result of extraordinary labours on his part, continued through twenty five years.

M. Chenot employs gas fuel, generated from the poorest description of coal, or from any source capable of producing carbonic oxide. One mode of forming this gas fuel has already been described in a previous Chapter, in a notice of the regenerating gas furnace, page 106. According to Professor Hunt, the methods invented by the late Adrien Chenot for the reduction of iron ores and the fabrication of wrought iron and steel, constituted in the opinion of one eminently fitted to judge the case (M. Leplay of the Imperial School of Mines,) the most important metallurgical discovery of the age.

It can not fail to strike every unprejudiced reader that these facts are of the utmost importance to the manufacturing industry of this Province. It has been shown that in the valley of the Kennebeccasis, and eastwards towards Westmorland there is a great development of Albert Shales, eminently adapted for the manufacture of gas fuel; iron ores are abundant in the same valley, either in the form of bog ores or nearly pure magnetic ores in Springfield; under such conditions there is no reason why New Brunswick should not soon become an exporter rather than an importer of iron in all its multifarous forms.

The processes of M. Chenot are now (1857) being applied to the fabrication of steel at Clichy near Paris. The iron ore is imported from Spain, and notwithstanding the cost of its transport, and the high price of fuel and labour in the vicinity of the Metropolis, it appears from the data furnished by M. Chenot to the Jury at the Paris Exhibition, that steel is manufactured by him at Clichy at a cost which is not more than one fourth that of the steel manufactured in the same vicinity from the iron imported from Sweden. Near Bilboa, in Spain, at the works of Villalonga & Co., they are enabled to fabricate the metallic sponge at a cost of 200 francs, or $40 the ton, and the best quality of cast steel at 500 francs, or $100 the ton of 1000 kilograms, (2,200 lbs. avoirdupois) notwithstanding the high price of fuel. M. Chenot stated to Professor Hunt that the conversion of the ore to the condition of sponge is effected with little more than its own weight of charcoal.

THE SWEDISH GAS FURNACES.

The subject of gas furnaces in which any kind of fuel may be used, and for which, as already stated, the rich bituminous Albert shales are particularly adapted, has engaged the attention of the most prominent iron manufacturers in England, France, Sweden, and Prussia. In the United States the abundance and cheapness of mineral fuel has hitherto prevented attention being directed to this important improvement in metallurgical arts, and indeed in all those departments of industry which require very elevated temperatures. The Swedish gas furnace uses peat as the fuel, models of their improvements were exhibited at the International Exhibition in 1862. *The old furnace so commonly used for smelting iron ores, and the reverberatory furnace are really nothing more than clumsy and imperfect gas furnaces, where an enormous amount of heat is allowed to escape and more than twice as much fuel is used as the operation requires.* The following short description of the Swedish gas furnace may be acceptable, and when considered in connection with the brief details given respecting M. Chenot's process, and the Regenerative gas furnace of Mr. Siemens, described on page 106, the wide field open for industry in this Province will not fail to attract the attention of thinking men, the more especially when it is remembered that a nation's industry and manufacturing status is measured by its production of iron.

Improved Furnaces.—" In the Swedish department specimens of iron were exhibited made with peat as fuel; and in the Italian department steel was shown made in a gas-puddling furnace with the same fuel. The furnace in which peat is thus made available for metallurgical purposes, although not easily described without diagrams, is still so well worthy the attention of those interested in economizing fuel, that we make the attempt to render its structure intelligible to the general reader. We must assume, in the first place, that he is acquainted with the form and action of a common reverberatory furnace such as may be seen in operation in many parts of the country. Instead of the usual fire-place, there is what is called the "gas generator." This consists of a circular chamber of fire-brick several feet deep, and two or three feet in diameter, closed at the bottom, and having a hopper at the top, through which fuel is supplied. This chamber, at a certain height from the bottom, is in direct connection with the body of the furnace, so that flame may issue as freely from it as from the fire-place of an ordinary reverberatory furnace. In the sides of the generator, at a certain distance from the top, is a series of three or four small, round holes on the same level, and at some distance lower down is another similar series of round holes. These holes are for the passage of the air intended to support combustion in the interior of the generator, which is blown in either by a fan or some other convenient blowing-machine. Now, when the generator is full of incandescent fuel, and air is injected through the lateral holes, carbonic oxide gas is copiously produced and passes into the furnace, as there is no other place of egress, the hopper at the top being supposed to be shut. As it escapes from the generator, it is met with a current of heated air, or, as it technically termed, "hot blast," which is injected downwards from the roof of the furnace at or near its junction with the generator, either in several jets or one continuous sheet. The carbonic oxide while still hot is thus burnt, and the heat developed is sufficiently intense even to melt wrought iron by the hundred weight. The air which supplies the generator is also previously heated; and in the Swedish furnaces the apparatus for heating the blast consists of a series of cast-iron pipes fixed at the lower part of the stack. Hence only the waste heat of the furnace is employed for this purpose. It is usual to place a hollow cylinder of iron round the generator, so as to leave a closed space between its internal surface and the exterior of the generator; and into this space the hot blast is introduced, whence it passes through the two rows of holes previously described into the interior of the generator. The atmosphere of such a furnace can be rendered either reducing or oxidizing at will by regulating the amount of blast. At the bottom of the generator is a door, by means of which the ashes or clinker from the fuel may be withdrawn."*

PROBABLE CAUSE OF THE SUPERIORITY OF THE WOODSTOCK IRON.

Different ores of iron make very different kinds of steel, notwithstanding the most careful manipulation and scrupulous attention to the manufacturing process in all its stages. Until M. Chenot had investigated the subject, it was but very imperfectly understood, and the difference in the steel and iron produced was frequently stated to be due to the presence of some foreign body such as manganese or phosphorous, or silicon or excess of carbon. According to M. Chenot the nature of the ore has much more to do with the quality of the metal than the mode of treatment, and the *steel producing capacity* of any iron is MEASURED BY THE QUANTITY OF CARBON which it can absorb before losing its malleability and degenerating into cast iron.

The iron of Sweden and the Ural Mountains, after taking up six per cent. of carbon, yields a metal which is still malleable, while that of Elba with four per cent. becomes brittle and approaches cast iron in its properties. The ores of Sweden and the Ural are famous for the excellent quality of their steel; the ores of Elba yield a very superior iron, but are unfit for the fabrication of steel.

* Annual of Scientific Discovery, 1863.

It is a highly important fact that the Woodstock ores, which contain a considerable proportion of manganese, phosphorous, and silicious matter, should produce an excellent iron capable of being made into excellent steel, and we may, in the absence of definite experiment, conclude that it derives these valuable properties from the large amount of carbon it is capable of combining with, without degenerating into cast iron.

Hence, even should the price of charcoal rise considerably higher than it now is in the vicinity of the works, the remarkable quality of the ores will still yield a remunerative return; and it will become a question of simple arithmetical calculation whether it will be most economical to bring the ores to the fuel or the fuel to the ores.

MANGANESE.

The diffusion of the black oxide of manganese through the ferruginous beds which have just been described, will appear upon an examination of the table of analyses on page 161. Some of the ores it will be observed contained nearly seven per cent. of this metal, and from a cursory examination it appears not improbable that beds of ferruginous manganese may be found associated with the iron ores. On the South West Miramichi, the presence of manganese is indicated in several places by beds of black gravel in which the cementing material is the black oxide of this metal. Specimens of manganese were shown to me which were said to have been taken from beds on the east side of the Saint John, about 13 miles above Woodstock. On the Tattagouche, the black oxide of this metal is tolerably abundant, and the purple slates on the Nipisiguit show that the area over which it may be looked for with probable success is large and not inaccessible. Considerable quantities of manganese were formerly exported from the Tattagouche Mines. The development of these and several other mineral deposits in the Province is due to the energy and zeal of Mr. Stephens, of Woodstock.

COPPER ORES.

Judging from the wide dissemination of Copper ores in the Quebec Group of Canada, it appears at the first blush singular, that more extensive deposits of this metal should not have been discovered in rocks of the same age in New Brunswick; yet, when it is considered that the copper ores of Lower Canada have only recently been worked on a large scale, it is not surprising that a similar sparsely peopled area in New Brunswick, by far the greater portion, indeed, being still a thickly wooded wilderness, should have given but very little evidence of the presence of the metal in remunerative abundance. It is unfortunate that all the works which have been undertaken for the extraction of Copper in the rocks of the Quebec Group in this Province should have been temporarily abandoned.

Here, as in Canada East, the copper appears to have been originally deposited with the sedimentary rock in which it is found, being afterwards segregated in veins or bunches, or remaining diffused throughout the country rock.

On the Tattagouche the original matrix of copper appears to be the red slates, which also carry the iron and manganese ores; at the Falls of the Nipisiguit it is a porphyry; and lower down the river, some four miles above the Pabineau Falls, copper ores occur in green slates. On Campbell River they are contained in a diorite; at Jacksontown, the red and green argillites sometimes shows ores of copper. On Bull's Creek, they occur in a diorite, also in a green talcose schist, at Bedell's Cove, near Woodstock, the mother rock was not seen,* but the copper is associated with much iron pyrites. On the east side of the river, on Mr. Connell's farm, small quantities of sulphuret and purple copper have been found in a vein of iron pyrites penetrating a green silicious rock interstratified with green talcose and ferruginous slates.

In the neighbourhood of Woodstock copper ores appear to be widely disseminated, and from the appearance of the ores obtained from Mr. Stevens' mine on Bull's Creek, at Bedell Cove, and at Mr. Connell's vein, it seems probable that remunerative deposits will be found in that vicinity. But in order to form an opinion as to their commercial value, the rocks of that neighbourhood must be carefully studied in connection with the supposed origin of the copper deposits in these ancient sediments. (See page 145.)

CHANGES AT THE SURFACE OF A VEIN.

The change which is often observed to have taken place at the surface of metalliferous deposits is sometimes very considerable, and may penetrate to a great depth. In other instances the vein stone is harder than the country rock, and has resisted the decomposing influence of the atmosphere and water.

Among numerous illustrations which have come under my notice during the past season in this Province, the following are perhaps the best illustrations:—

I. The Antimony lodes of Prince William; these in most cases are persistent, and the lodes are stronger than the country rock, they have resisted decomposing influences, and stand out from the surface in the form of ridges.

II. The beautiful ochres on Frye's Island indicate a complete and deep decomposition of the veins, the influence of decomposing agents has penetrated many feet into the lodes.

III. Some of the copper lodes at the Vernon mines have been much decomposed, what is there termed the green vein shows decomposition to a considerable depth, the resulting ore is the green carbonate. It changes gradually to the sulphuret, and at a depth of 25 or 30 feet will probably disappear altogether, giving place to the sulphuret.

IV. The copper ores in the green slates above the Pabineau Falls on the Nipisiguit are replaced to a considerable extent by "gossan," but it is probable that at the depth of a few feet the gossan will gradually give place to copper pyrites. The same remark applies to some ores near Woodstock.

* These last named localities have been opened by Mr. Stephens of Woodstock.

The explanation of these changes is simple. Copper pyrites is composed of sulphide of copper and sulphide of iron, (two parts copper, one part sulphur, associated with two parts iron and three parts sulphur.) By contact with air and moisture, the copper pyrites is decomposed, the iron remains behind as an impure hydrous oxide or gossan. The copper is frequently removed from the surface by water after having been converted into the soluble sulphate, the sulphuric acid being derived from the oxidation of the sulphuret of iron, the original ore. At depths remote from atmospheric influences the copper pyrites remains intact, hence the reason why lodes which show much gossan at the surface gradually change in character, yielding more and more copper ore, until the gossan is altogether replaced by the original ore of the lode.

THE ANTIMONY DEPOSITS OF PRINCE WILLIAM.

The most important deposits of this metal are in Prince William Parish. It has been stated that this ore also exists on the northwest side of the granitic axis, about thirteen miles from Woodstock, but nothing is known of the extent of this deposit. Fine specimens of ore have been presented to me from a vein near Canterbury Station, on the Saint Andrews Railway, but the precise locality where the ores occur was not given.

From a trial survey which was made some years since as far as the Pokiok, for a Railway from Fredericton to Woodstock, it appears that the elevation of the Prince William deposits above the sea is about 460 feet. The survey crossed the road leading to Lake George, a short distance from them, at an elevation of 477.97 feet. The greatest altitude over which the Survey passed between Lake George and the Mines being 490 feet. Lake George is 442 feet above the sea, and about 400 feet above the Saint John River, where the ore is shipped.

As these deposits of Antimony are very remarkable and give promise not only of remunerative results to the present lessees, but of important advantages to the Province, leading to the expenditure of capital and the profitable employment of labour, I have given special attention to them, and have endeavoured to supply as full a description of the works now in operation, of the results which have already been obtained, and of the prospects in view, as the limits of a preliminary Report would permit.

The development of these deposits has been almost altogether confined, latterly, to the operations of the Brunswick Antimony Company, the works on a neighbouring lease, owned, I was informed, by Messrs. Hibbard & Co. of Saint George, having been for some time suspended, but for what reason I could not learn, certainly not on account of the paucity of the mineral on their property, as a cursory examination satisfied me of its existence over wide areas.

In the vicinity of the Antimony Mines in Prince William, the rock is a magnesian slate, interpenetrated with quartz veins. The roof or hanging wall of the lodes is frequently highly magnesian and contains thin layers of steatite or impure silicate of magnesia. The strike of the foot wall and occasionally of the roof wall does not coincide with the course of the vein as a general rule, although there are instances showing parallelism. The rock has been subjected to a series of dislocations, one set running roughly parallel to one another, the other set cutting the first at a small angle, but some time must elapse before a sufficient area of rock surface will be exposed to determine the general direction and relation of these dislocations with precision; but it is probable, however, that one set has a course of N. 50° W. and another set a course 10 to 20 S. which most nearly coincides with the prevailing strike of the rock. The cracks and dislocations to which reference is now made, are of the utmost importance in forming a judgment respecting the capabilities of these antimony deposits, for *the antimony lodes occupy the fissures caused by the dislocations.*

CHARACTER OF THE DISLOCATIONS.

It will be seen by an inspection of the diagrams which accompany this Report, that even with the very imperfect explanations which have as yet been made, the course of one dislocation can be traced without any difficulty for more than five hundred yards, and if it should result that what are now set down provisionally as parallel dislocations, are in fact continuous, the ascertained length will exceed five times that distance, or considerably more than a mile.

In Pit No. 1 there are apparently two veins inclined towards one another at a low angle, dipping N. E. and separated by a mass of rock, which is probably a slip or "horse" as it is technically termed.

The so called "roof vein" in this Pit is a thin sheet of antimony ore and quartz of unknown length and depth. Its thickness varies from a few inches to more than two feet. It dips to the N. E., and it changes its course in the space of twenty feet from S. 50 E. to S. 75 E. The so called "floor vein" in this shaft dips in the same direction at an angle of 55°, and meets or joins on the roof vein 68 feet below the surface, measured along the incline. Here the veins at the point of junction have respectively a thickness of one foot five inches and two feet, with a magnificent show of sulphuret of antimony, mixed with 'metallic antimony,' in parallel streaks from two to six inches in thickness. These two veins may be described as two sheets of rich metalliferous quartz filling two fissures which join together at a depth of nearly 70 feet on the incline below the surface, continue as separate sheets for an unknown horizontal distance in a southeasterly direction, but form one sheet at the present depth of the mine of unknown extent downwards, and but one sheet in a westerly direction where they have been traced for forty feet, five feet below the surface.

The dip of the 'roof vein' rock is 53° easterly, of the 'floor vein' rock 60° westerly, thus showing an *anticlinal axis* and a *downfall.*

The slickensided appearance of the surfaces shows the pressure to which the rock has been subjected during its displacement. It is also worthy of note, especially in relation to the origin of these veins, that not unfrequently rounded and angular pebbles are found in the ore. On breaking open masses I have succeeded in obtaining pebbles which appeared to belong to the country rock, and "horses" are by no means uncommon. These facts are important so far as they tend to show that the fissure in which the vein is segregated is probably of great depth and of very considerable horizontal extension. Above the roof vein there is a layer of steatite about two inches thick, it accompanies the vein all the way down to the bottom of the shaft.

The sheet of ore in the upper vein varies from four inches to two feet in thickness, and consists of sulphuret of antimony seamed with quartz, but masses or seams of the sulphuret, with a little 'metallic antimony,' occur in the vein from two inches to seven inches in thickness, sometimes also expanding into bunches eighteen inches in diameter. The country rock in this shaft is a silicious magnesian slate, the magnesian character preponderating in places so as to form an impure steatite, especially immediately above the vein rock.

Patches of Chlorite are seen in the quartz, which is also coloured red in spots by the decomposition of Iron pyrites. Minute veins of antimony penetrate the country rock as well as small quartz veins, and occasionally streaks of the brilliant oxy-sulphuret appear in small lateral fissures.

Pit No. II.

The fissures occupied by the veins opened at Pit No. II. intersect one another in two places. At the point of junction of the main vein and a transverse vein the shaft has been sunk 34 feet on the incline, which is at an angle of 45° to the N. E. But owing to the approach of winter, and a desire to increase the works in shaft No. 1, the miners had been withdrawn from it, and at the time of my visit it was full of water.

The veins, however, being covered with a sandy drift to a depth not exceeding three feet are easily exposed, and were seen for 100 yards on the main lode and sixty yards on the transverse lode. The antimony in these lodes varies from half an inch to 26 inches in thickness, and is a tolerably pure sulphuret.

Pit No. III.

At the third opening, or "Pit No. III," which, according to the mining Captain, is 490 yards from Pit No. I, the strike of the vein is N. 55 W. with a N. E. dip, at an angle of 35°. Here the conditions under which this lode has been made visible to the eye are most remarkable, and constitute a very singular and probably a very unusual feature in mining locations, south or east of Lakes Huron and Superior. Upon the removal of the shallow surface covering of loam or sandy clay, the country rock, together with the huge quartz veins which mark the lines of fracture and dislocations have been striated and polished by glacial action. The soft magnesian and chloritic slate is deeply scored with parallel or slightly divergent grooves, and the hard quartzose antimony veins are polished on the surfaces which have come in contact with the slowly moving glacial mass. For many miles around this neighbourhood the same glacial markings are visible. I have no doubt that Lake Saint George itself with the flat valley to the south of it, is a memento of the wonderful excavating power of glacial ice. The grinding down and polishing of the surface of the country, coupled with the almost entire absence of drift here, at least to a greater depth than from three to six feet, will enable the practical miner to trace out without difficulty the lines of dislocation and the antimony veins occupying them. Their position on the surface may then be laid down with perfect accuracy on a chart or map of the several properties, by any qualified land surveyor. None of the dislocations, as far as they have been exposed, appear to have been so affected by subsequent disturbances as to make the recovery of a vein, if lost, a matter of much difficulty or expense, and if a vein should be lost the plan will be to go at once to the surface, clean it from drift, and endeavour by aid of the glacial polishing to discover the extent and direction of the "jog."

The vein at the 3rd Shaft is very quartzose, and a considerable proportion of iron pyrites was observed here, which discolors the rock at the surface. Reticulating veins of quartz penetrate it, together with minute veins of antimony. The thickness of the lode varies from two to three feet, and some fine antimony ore was taken out in a blast during my visit, which dislodged a mass 22 inches in thickness, at a depth of 24 feet on the incline.

A "horse" is plainly visible occupying a portion of the fissure to the east of the pit, and the quartz is seen to surround it. The "horse," which is the country rock, must have fallen into the fissure before the metalliferous quartz was introduced. Another instructive and valuable fact is observed at this shaft. As the vertical strata approach the lode at the bottom of the shaft they are curved to the southeast, showing a movement in that direction from the northwest. The rock surfaces are slickensided by pressure. Immediately over the vein the soft impure steatite is visible from half an inch to two inches in thickness; it contains fragments of slate, and is overlaid by a crushed portion of the rock of variable thickness, from three to twelve inches; this is succeeded by the tilted edges of the magnesian slate. These observations show the prevalence of a lateral force acting subsequently to the filling up of the veins, and are worthy of being recorded, as the influence of this force may have operated more energetically at other localities, and occasioned faults or minor dislocations which might not be apparent or easily worked out without this guide.

Probable extent and richness of the Ore.

The reader who is familiar with the origin of dislocations in strata, will be at no loss to understand that the fissures which have resulted from them may be of very great vertical depth and extend over long horizontal distances. The cause, however, may on the other hand be local, and although the depth of the fissure may be great, its horizontal prolongation might possibly not extend over many hundred yards. In the present case the number, breadth and parallelism of the fissures, coupled with the fact that veins of ore have been discovered in one prevailing direction for considerably more than a mile, afford sufficient evidence of the great extent of tho antimony bearing veins in the area to which this report refers. Their depth too, the axis being anticlinal, with a downfall, doubtless extends through the Lower Silurian rocks in which they are situated, and these may be here, as elsewhere, of very considerable thickness, as the following observations show. About half a mile east of the mines a green talcose conglomerate holding black slate pebbles appears in position, this is thought to be one of the upper members of the Quebec Group. The talcose and chloritic slates in which the antimony veins occur appear to underlie this conglomerate, and as the entire series of which the Group is composed has been recognized during the past summer on the southeast side of the great fold which brought them to the surface, it is probable that the thickness of the series below the antimony slates is still several thousand feet. That this question is one possessing considerable interest, in connection with the probable duration of the antimony deposits in this vicinity, becomes manifest upon a review of the rapidity with which mining operations conducted on a large scale penetrate the rocks vertically. The Albert Mines for instance, though of recent origin, have worked out the Albertite on a horizontal distance of 1700 for a depth of 750 feet, and the new shaft now nearly completed will bring Albertite from a depth of one thousand feet.

With respect to the quality of the ore, it may be stated with confidence that it improves as the workings descend. The most common form in which it has been obtained until very recently was that of Stibnite or Grey Antimony Ore,* but in Pit No. 1, at a depth of 60 feet, there was found to be a considerable admixture of 'metallic antimony' with the sulphuret. This native antimony has a brilliant metallic lustre with the characteristic tin-white streak. It occurs in the lamellar form and gives a peculiarly brilliant appearance to the mass. It has been found in a vein full six inches in diameter, in which the native metal was mixed with the sulphuret with a very small proportion of quartz. It is remarkable that the deposit of antimony recently discovered in the Quebec Group of rocks in the township of Ham, Canada East, should also occur chiefly as lamellar native antimony.

NICKEL AND COPPER.

Associated with these antimony ores are small quantities of the green silicate of nickel, and on the surface the green carbonate of copper. Ores of nickel in small quantities are very common in the rocks of the Quebec Group, especially in the magnesian slates.

The production and uses of Antimony.

The quantity of ths metal produced from American mines is extremely small. The recently discovered ores in Australia, although of great extent and richness, are too far from the markets of the world to exercise any influence upon them.

* Composed of Antimony 74; Sulphur 26 in 100 parts.

The importations of antimony into Great Britain * during the years 1855 and 1856, the latest accessible returns were as follows:—

	1855.	1856.
Ores,	623 tons.	1,750 tons.
Crude,	639 cwts.	3,121 cwts.
Regulus,	11 "	1,004 "

Its uses in the arts are rapidly increasing, and it has been long employed in the manufacture of fine pewter, Britannia metal, type metal, stereotype metal, music plates, machinery bearings, particularly in cases of continuous revolution, as in the shafts of screw steamers, &c. It is also used for hardening bullets and shot, and to a small extent for medicinal purposes, &c. &c.

Now that an abundant supply of this metal can be obtained at a small cost from the deposits of antimony in this Province, it is probable that many new uses may soon be discovered.

FAVOURABLE CIRCUMSTANCES CONNECTED WITH THE DISTRIBUTION OF THE ORES.

The circumstances attending these deposits of antimony are singularly favorable towards their development. It may be advantageous to enumerate the most striking; they are—

1st. The geological position of the ores, or in other words their occurrence in the metal bearing group of North America.

2nd. Their occurrence on lines of fracture and dislocation, proving the veins to be 'true veins' of unknown vertical depth and horizontal extension.

3rd. The purity of the grey antimony ore and its gradual passage into lamellar native antimony as the veins deepen.

4th. The accessibility and the ease with which they may be reached from the seaboard.

The term regulus signifying "the little King," was first applied to antimony from the facility with which that metal alloyed with Gold. The alchemists had great hopes that antimony would lead them to the discovery of the philosophers' stone. The name is now applied to other metals in an impure state. Among the most important alloys of antimony are—

1. Two parts sulphide of antimony with one of iron, forming what was once called Martial Regulus. This alloy possesses magnetic properties.
2. Antimony and zinc—a hard brittle alloy.
3. 1 antimony, 10 tin forms a ductile compound.
4. 12 tin, 1 antimony, with a little copper, forms a fine pewter.
5. Type metal—4 parts lead, 1 part antimony, or 3 lead, 1 antimony.
6. Britannia metal—100 tin, 8 antimony, 2 bismuth, 2 copper.

The specific gravity of antimony is 6.7; it melts at about 840°, or at a dull red heat; the sulphuret has generally a specific gravity of about 4.96.

* Antimony was formerly mined extensively in Great Britain, but during the present century little has been produced. The grey ore from which commerce is supplied comes from Hungary and Borneo. Cornwall formerly produced a considerable quantity of the ore. Native antimony occurs in Canada East, Sweden, the Hartz Mountains in Germany, Dauphiny, Mexico, and, as recently ascertained, in New Brunswick.

LEAD ORES.

Galæna is not uncommon in this Group of Rocks, but no instance, to my knowledge, has been recorded where a vein occurs within the limits of the northeastern belt which promises remunerative results. There is a vein at the foot of Bradley's Island, on the Tobique, but it is not promising, so far as it has been exposed. It is not yet known what may be the precise age of the rocks in Hammond and Upham, where a large vein of Galæna has been traced continuously for about three miles, but the rocks are probably Middle or Lower Silurian, and if the latter, they will belong to the Quebec Group. In Canada, lead ores from this group, have yielded 32 ounces of silver to the ton, equal to five tenths per cent. Eight ounces of silver to one ton of lead ore will pay for extraction in England; this ore, therefore, might perhaps be profitably exported if it occurs in sufficient quantity—other lead ores in Canada, like similar ores in the United States, have yielded little or no silver. (See page 116.)

ZINC ORES.

Zinc Blende or Sulphuret of Zinc occurs in Prince William Parish. A vein in a gangue of quartz may be seen below the road in a gully on Marshall's farm, where an attempt has been made to blast the rocks in search of gold. No special examination has been made of this deposit with a view to see if it possesses economic value, but the impression produced by the specimens obtained was not favourable.

GOLD.

Mr. C. H. Hitchcock reports the existence of an auriferous belt which crosses the Saint Croix River above Calais. This is a part of the southern belt of the Quebec Group. The rock is a mica schist full of quartz veins and beds. Several pieces of bright flake gold were found in these veins near the Railroad bridge at Baileyville. On the New Brunswick side of this river, upon land belonging to Mr. Boulton of Saint Stephen, gold has been found in a black plumbaginous slate. The occurrence of gold in drift in many parts of the Province will be noticed in the next Chapter.

SILVER.

The boulders of jasper conglomerate which occur on the Saint John above Presquile, and are numerous on the Shiktehawk road, probably come originally from the northeast of the Shiktehawk. This rock promises well; but although the jasper rocks were noticed on Campbell River, and a jasper conglomerate on Blue Mountain, no rocks have been seen in place which approach the beauty of some of the boulders noticed on the Shiktehawk Portage. In one of these boulders a small fragment of native silver was seen, which appeared to form part of a vein running through the mass. The specimen (six inches in diameter) was unfortunately left on a birch stump not far from the Glassville Settlement, on the road to the north west branch of the Miramichi.

SECTIONS OF THE GROUP, SHOWING THE GENERAL ARRANGEMENT OF THE STRATA.

The importance of this great group of rocks will render acceptable a brief description of the order and sequence of the strata of which it is composed, as they occur in Canada.

The following is a section of the strata on the Island of Orleans*:—

SEQUENCE OF THE STRATA OF THE QUEBEC GROUP ON THE ISLAND OF ORLEANS.

1.	Green calcareo-magnesian shales, weathering to a yellowish or reddish brown, interstratified with thin bands of purplish grey argillaceous shale. Some of the magnesian shales are nearly grass green, and the surfaces of most of the green beds are marked with fucoid-like forms of purplish grey; the green shales hold about twenty per cent of dolomite. The mass is strong, and offers considerable resistance to wearing influences, ...	LEVIS FORMATION. MAGNESIAN SHALES.	100
2.	Grey argillaceous shale, much softer than the magnesian shale,		100
3.	Grey limestone conglomerate; the rounded masses are chiefly of grey limestone; the matrix in many parts weathers to a brownish color, and is probably dolomitic, fossils occur, some of them replaced by silica, but those as yet obtained in this locality are too obscure to be determined; the land in some parts appears to break into lenticular patches, ...	DOLOMITIC CONGLOMERATES.	10
4.	Green yellow weathering calcareo magnesian shale, with grey argillaceous bands of the same character as 1, ...		100
5.	Grey soft argillaceous shales, ...		200
6.	Yellowish-grey dolomites, weathering orange brown. It holds occasional masses of ash grey limestones, and in some parts of its thickness a multitude of pebbles of quartz as large as peas, and becomes towards the top a dolomitic sandstone, ...		70
7.	Grey, fine, soft, argillaceous shale, with compound graptolites (*Phyllograptus typus*) about thirty feet from the summit,	GRAPTOLITIC SHALES.	170
8.	Grey limestone conglomerate; the matrix in some parts weathers to a reddish-brown, being dolomitic, and contains a large concretion of carbonate of lime in concentric fibrous layers like travertine. The land holds fossils in some places, ...		35
9.	Grey, fine, soft, shale, with occasional bands of sandstone weathering brownish, none of them over six inches; the bands increase in number towards the top, ...		500
10.	Olive-green argillaceous shale, striped with purplish-grey bands,		400
11.	Olive-green arenaceous shale, with disseminated soft grains of a green mineral resembling glauconite, and approaching it in composition. In the upper part of the deposit, the shale contains so much grit as to become almost a sandstone; and within 100 feet of the top, it assumes a red colour, in one or two bands,	GLAUCONITE BEDS.	400
12.	Yellowish-white limestone conglomerate; matrix assumes a dolomitic aspect in some parts; the rounded masses or boulders are occasionally one or two feet in diameter, and some parts of the beds hold fossils, ...		10
13.	Grey, drab-weathering sandstones, in general slightly calcareous, interstratified with grey argillaceous shales; some of the sandstone beds towards the bottom are three or four feet thick, and	GREY SANDSTONES.	

* From the Geology of Canada—Sir W. E. Logan.

hold occasional calcareous pebbles. The sandstone becomes thinner ascending, and then the shales prevail; but these become by degrees, more and more arenaceous, and a band or two, about 200 feet from the top, assumes a red colour, ...	400	
14. Grey limestone conglomerate; the matrix weathering to a brown in some parts is probably dolomitic, ...	30	
15. Grey drab-weathering sandstones and shales, the sandstones slightly calcareous, ...	300	
16. Dark grey and green shales, with thin bands of quartzite, and occasional thicker beds of drab-weathering sandstone, some of them being lenticular masses; the dark shales appear in some parts to pass into black, ...	900	DARK SHALES AND QUARTZITES.
17. Red and green shales, the red prevailing, interstratified with occasional thin layers of grey, hard sandstone or quartsite, and a few of grey hard limestone; some of the bands of shale are deeper red than the general mass, approaching the maroon colour. Towards the top of the equivalents of these shales at Cape Rouge, occur a small *lingula* and *Obolella pretiosa;* the thickness of the deposit is from 1,500 feet to	1000	RED AND GREEN SHALES.
	5,025 feet.	

PHILLIPSBURG SERIES IN ASCENDING ORDER.*

A.

	Feet.	
1. Dark gray and yellowish-white dolomites, weathering grey and yellowish-brown, ...	400	
2. White and dove-grey pure compact limestones, ...	100	
3. Reddish-grey brown-weathering dolomites, and black dolomites, with some thin-bedded limestones, ...	200	
		700

B.

1. White and dove-grey pure limestones, with some yellowish weathering magnesian bands, ...	120	
2. Dark grey and black limestones, some of the beds magnesian, ...	120	
3. Dark bluish-grey thin bedded nodular limestones with thin layers of bluish-grey slate, probably magnesian; the surfaces of some of beds weathering into a red or yellow ochreous arenaceous earth,	150	
4. Black slaty thin bedded nodular limestones, with two or three thick beds of purer limestones towards the base, ...	300	
5. Black limestones, some of them massive, weathering bluish-grey, interstratified towards the bottom with black and dark grey yellow-weathering magnesian beds, ...	350	
		1,040

C.

1. Black and dark grey pure compact limestones, weathering lead-grey with a few bands of dove-grey. The beds are all massive, and afford abundance of a few species of testaceæ; the whole of which appear to have the peculiarities of being large-sized and thick-shelled, and occuring in numerous isolated patches, which vary in diameter from about three to ten feet. The fossils are several

* The details of Divisions A and B are given on pages 275, 279, of the Geology of Canada. Phillipsburg is in Canada East near the northern extremity of Lake Champlain.

undescribed species of *Murchisonia* and *Pleurotomaria*, *Ecculiomphalus Canadensis*, *E. intortus*, *E. spiralis*, several undescribed species of *Ophileta*, *Maclurea ponderosa*, several undescribed species of *Othoceras* and one of *Nautilus*. Toward the base, *Maclurea ponderosa* seems to be somewhat smaller than in the upper part of the deposit, and towards the top one or two beds appear to be of a partially conglomerate character, ... 150

2. Black slates or possibly thin bedded limestones, with a few thicker beds towards the top; the mass is altogether very imperfectly seen, 170

—— 320

D.

1. Black limestone conglomerate, composed chiefly of the ruins of the thick bedded limestones of division C. The enclosed masses vary in size from pieces of an inch in diameter, to blocks containing between fifty and sixty cubic feet, and are cemented together by a calcareo-magnesian paste. Of this, however, from the closeness with which the masses are packed together, there is but a very small quantity. The limestones are generally close grained, and black or dark in color, but there are mingled with them a few scattered blocks of a lighter colored yellow, weathering dolomite, some of them a foot in diameter. Many of the masses of limestone contain fossils, and the species are almost wholly confined to those already stated as characterising the parent beds C 1. There appears to be at least two principal bands of this conglomerate, each varying in thickness in different parts from about 50 to 100 feet. There is an interval between them of from 100 to 150 feet occupied by black slates holding round masses of limestone, which converts parts of the mass varying in thickness from ten to twenty feet into slaty conglomerates. In some parts, either the interval between the main two bands of conglomerates increases considerably, or there is a third band with similar slates intervening between it and the second. The whole is continued in a thickness of from 250 to 300

} *Conglomerates*

2. Black and greenish argillaceous slates, probably interstratified with occasional thin calcareous bands, and thin lenticular patches of limestone conglomerate, as well as more important bands of yellow-weathering dolomitic slates. The whole is terminated by a band of black limestone conglomerate, similar in character and thickness (from 50 to 100 feet) to those already mentioned, and containing *Maclurea ponderosa* in one of the few places in which the band has been seen. This whole mass of strata is very imperfectly exposed, and much uncertainty exists as to its true general character. Its thickness may be from 750 to 1000

} *Conglomerates*

3. Grey and black striped slates, some parts of which are calcareous, and weather slightly brownish. They are interstratified with occasional thin beds of black limestone, weathering lead-grey, as well as many strong and solid beds of brown weathering magnesian limestone, and brown weathering slates, some of the latter are marked by an abundance of fucoids resembling *Buthotrephis flexuosa* of Emmons. Occasional beds of sandstone, from one to three feet in thickness, are met with. About the middle of the mass, there has in one place been observed a bed of limestone conglomerate from five to ten feet thick, and other similar ones may occur in different parts of the vertical thickness, ... 1500

} *Dolomitic Slates.*

—— 2800

Feet, 4860

CHAPTER X.

SURFACE GEOLOGY.

General absence of thick deposits of Boulder Drift in the Province—Local origin of the Boulders—Absence of Laurentian Boulders—In Gaspe—Innumerable multitude of Boulders south of the Granitic Belt—General absence on the northern side—Boulders near Fredericton—Origin and course of these Boulders—The country of Boulders—The Labrador Peninsula—Agents in the distribution of the Boulders—Glacial Ice—Striations—General direction in this Province—Common over the entire Province—Glacial work—Lake George—Bear Lake—West of Oromocto Lake; down the Magaguadavic—Remarkable formation of the western extremity of the Coal Measures—Oromocto Lake Escarpment—Table of Glacial Striæ in New Brunswick—Progress of a Glacier—Thickness of the glacial mass once covering the Province—Agassiz on the thickness of the ice during the Glacial Period—Dr. Dawson's views—Probable elevation of the Continent during the Glacial Period—Glacial Lakes—Escarpments—Dr. Rink's experience in Greenland—Conditions under which Glaciers are formed—Zones of Moistures—Glacial Zones—Notice of Agassiz's theory of an Ice Cap—Glacial phenomena may be common to all geologic ages—Difference between Sea Coast escarpments and Glacial escarpments—Action of Glacial Rivers—Phenomena of Glacial Rivers in Greenland—Glacial Rivers excavate rocks and form escarpments—Escarpments may be formed at any level—A glacial mass cuts its way into a slope, forming an escarpment continually increasing in elevation—The valley of Lake Ontario excavated by Glaciers—Glacial Striæ show only the last record of the moving mass—Lake Basins and many escarpments show the work they have done—Remodelling of Glacial work—Lake Basins—Origin of certain Lakes in New Brunswick—Valley of the Saint John near Fredericton—BEACHES and TERRACES—Marine Terraces—On the Bay of Fundy—Post Pliocene Marine deposits—Modern elevations and depressions on the coast—Extensive upthrow west of the Saint John—Glacial Lake Terraces—Contour Lines at the Mouth of the Nerepis—Terraces opposite Gagetown—Contour Lines and Terraces near Fredericton—Alluvial Terraces—Boulder Clay in the bed of the Saint John—Sections of the alluvium on the Banks of the Saint John near Fredericton—Table of Drift Islands which have escaped denudation—Terraces of Lake Superior, &c.—Origin of—The GRAND FALLS of SAINT JOHN—Origin of—A Valley of erosion—The Tidal Falls at the mouth of the Saint John—Probably a valley of erosion—Early account of the "Falls"—"Horsebacks"—Action of Rivers on their banks—Influence of the motion of the Earth.

The general absence of deep deposits of clays, sands, and gravel, in other words of Drift, appears to be a prevailing feature in the surface Geology of the Province. On the upper Saint John, above the Grand Falls, there are banks of alluvial clays and sands exceeding fifty feet in thickness, and opposite Salmon River immense deposits of coarse gravel form the cliff like banks; so also on the Upsalquitch, extensive deposits of coarse gravel interstratified with fine sand are numerous, and the same features are observed on the Saint John nearly all the way to its mouth; these, however, are all of more recent origin than the true boulder formation, although it is probable that they consist in part of remodelled drift. Even on the dividing ridge between the waters of the Upsalquitch and Nipisiguit, the drift appears to be of local origin, and has been, on the portage at least, re-arranged, showing three or more distinct terraces. Nearly all the boulders observed during the past summer were of local origin, or could be traced to rocks in position some few miles to the north; and it may, with some degree of confidence be stated, that very few, if any, boulders deriving their origin from the Laurentian rocks of Canada have been seen during the past summer, even on the higher levels and in the most northern Counties of the Province, without an exception be made of the country about the upper Saint John near the Province line. In the Gaspe peninsula no foreign boulders have as yet been observed in the boulder formation; which there appears to be altogether composed of the debris of the rocks of the country.* This may arise from two causes,—1st. The direction of the ice flow, and subsequently of the drift currents;—2nd. The distance from the northern rocks taken in connection with the direction of the ice flow.

It must not be inferred from the foregoing remarks that boulders are generally absent in the Province, the contrary is really the case, but they are nearly all, if not altogether, of local origin; that is to say, the parent rock from which the boulders originated may almost invariably be found a few miles in a northerly direction from the spot where they lie.

THE BOULDERS SOUTH OF THE GRANITE.

Any one who has travelled on the southern edge of the numerous narrow granitic belts which stretch from the Atlantic coast of Maine to the Bay of Chaleurs, can scarcely fail to have been struck with the vast multitude of granitic boulders which cover the country for some miles in a southerly direction. But if he travel on the northern side of the belt, he will rarely find one granitic boulder. So also when descending some of the rivers, especially those which flow in a general direction from north to south, such as the different branches of the Miramichi, the number and magnitude of the boulders in the beds of those streams when passing through and a little beyond the granitic region, are truly astonishing. In the rear of Fredericton, the southwest side of the plateau and even part of the sides of the valley, are strewed with a multitude of boulders, these are chiefly derived from the sandstones of the Carboniferous rocks, but there are some trap boulders from the trap range in Douglas Parish, some red conglomerate boulders, from the Bonaventure formation on the north side of the River, and also a few of Silurian slate, and a few of white granite. All of these boulders, with the exception of some of the sandstones, must have crossed the valley of the

* Geology of Canada, page 939.

River Saint John, travelling in the direction of the valley of the Nashwaaksis, as will presently be shewn.

These boulders have been brought to their present position by glacial ice. It was formerly very generally supposed that floating ice was the chief instrument in the transportation of boulders, and that glacial ice played but a very small part in these wide spread phenomena, but proof upon proof has accumulated that floating ice is utterly incompetent to effect a tithe of the vast mechanical work apparently inseparable from those conditions always accompanying the true boulder drift.* That water and floating ice have played a great part in distributing the loose materials, previously disengaged by glaciers, over different parts of the globe there can be no question, but the first active agent was glacial ice, and subsequently water, or water and floating ice may have assisted in spreading the debris accumulated by the glacial masses.

CURRENTS INCOMPETENT TO PRODUCE LARGE BOULDERS.

Erratics or Boulders have been frequently adduced as evidence of the influence of currents, assisted by atmospheric agencies. Their rounded appearance has been attributed to weathering, or the attrition caused by running water, or the waves of the sea on a beach.†

It is well known that rounded boulders which would weigh *many hundred tons* are by no means uncommon. These are generally observed to be rounded or worn on all sides, showing that every part of them has been exposed to the grinding force. Sometimes the boulders are observed to be striated or scratched on one side only, thus affording sufficient proof of their origin. No one has ever seen torrents in our rivers sufficiently powerful to move boulders two or three feet in diameter—a *debacle* might cause motion for a short distance. But boulders *in* glacial ice can be seen at any time, not only in Greenland but in many glacial regions, and the actual process of rounding by attrition may be observed.

Mr. T. W. Taylor in his paper on the "*Fiords of South Greenland,*"‡ tells us that "the glaciers bring down with them boulders, sand, and much fine clay, the result of attrition; the *boulders are always rounded,* owing to the severe abrasion they have undergone by being transported over the rocks below, whilst under the enormous pressure of the vast thickness of continental ice."

Another important point connected with boulders is, that rounded masses are frequently to be met with in vast multitudes within a few miles of the parent rock and to the south of it, even when the parent rock is a low

* Under the term "true Boulder Drift" is meant the unmodified drift, that is to say Boulder Drift which has not been re-arranged since it was first deposited, whether by glacial ice or water, or both.

† Boulders of native copper have been found in the Lake Superior region; of copper pyrites in New Brunswick, and boulders of hæmatite and black magnetic oxide of iron of large dimensions are by no means uncommon.

‡ Proceedings of the Royal Geological Society, January 28, 1861.

glaciated ridge, scarcely rising above the general level of the country. This is observed south of a considerable part of the Granitic Belts of New Brunswick. It has been already remarked that all the boulders, and they are legion, of New Brunswick, are of local origin; it may be that on the Gulf Coast a few Laurentian erratics have been brought by ice, but in the interior those rocks are not represented even by erratics. All the large river valleys leading into the Atlantic, from New Brunswick and Maine, are probably in part due to glacial action; for glacial striæ and moraines have been observed in most of them, following the course of the valleys near the sea.

THE COUNTRY OF BOULDERS.

The country *par excellence* of Boulders, is the Labrador Peninsula. During an exploration of part of its interior in 1861, I had an opportunity of observing the extraordinary number and magnitude of erratics in the valley of the Moisie River and some of its tributaries, as far north as the south edge of the table-land of the Labrador Peninsula (lat. 51° 50′ N., long. 66° W.), and about 110 miles due north of the Gulf of Saint Lawrence. Boulders of large dimensions, 10 to 20 feet in diameter, began to be numerous at the Mountain Portage, 1460 feet above the sea, and 60 miles in an air-line from the mouth of the Moisie River. They were perched upon the summits of peaks estimated to be 1500 feet above the point of view, or nearly 3000 feet above the sea-level, and were observed to occupy the edges of cliffs, to be scattered over the slopes of mountain-ranges, and to be massed in great numbers in the intervening valleys.

At the "Burnt Portage" on the northeast branch of the Moisie, nearly 100 miles in an air-line from the Gulf of Saint Lawrence, and 1850 feet above the ocean, the low gneissoid hills for many miles round were seen to be strewed with erratics wherever a lodgment for them could be found. The valleys (one to two miles broad) were not only floored with them, but they lay there in tiers, three or more deep. Close to the banks of the rivers and lakes near the "Burnt Portage," where the mosses and lichens have been destroyed by fire, very coarse sand conceals the rocks beneath, but on ascending an eminence away from the immediate banks of the river the true character of the country becomes apparent. At the base of the gneissiod hills which limit the valley of the east branch (about three miles broad) at this point, they are observed to lie two or three deep, and although of large dimensions, that is from 5 to 20 feet in diameter, they are nearly all ice worn, with rounded edges, and generally polished or smoothed. These accumulations of erratics frequently form tongues, or spots, at the termination of small projecting promontories in the hill-ranges. I have several times counted three tiers of these travelled rocks where the mosses, which once covered them with a uniform mantle of green, had been burnt; and occasionally, before reaching the sandy area which is sometimes found on the banks of the river, I have been in danger of slipping through the crevices between the boulders, which were concealed by mosses, a foot and more deep, both before and after passing through the "Burnt Country," which has a length of about 30 miles where I crossed it. I extract the following note from my Journal of the appearance of these travelled rocks in the "Burnt Country":—

'Huge blocks of gneiss and labradorite lie in the channel of the river, or on the gneissoid domes which here and there pierce the sandy tract through which the river flows. On the summit of the mountains, and along the crest of the hill-ranges, about a mile off on either side, they seem as if they had been dropped like hail. It is not difficult to see that many of these rock-fragments are of local origin, but others have evidently travelled far, on account of their smooth out-line. From a gneissoid dome, I see that they are piled to a considerable height between hills 300 and 400 feet high; and from the comparatively sharp edges of many around me, the parent rock cannot be far distant.'

THE GLACIATED REGION ABOUT CARIBOO LAKE.

On all sides of Cariboo Lake, 110 miles, in an air-line from the Gulf, and 1870 feet above it, a conflagration had swept away trees, grasses, and mosses, with the exception of a point of forest which came down to the water's edge and formed the western limit of the living woods. The long lines of enormous unworn boulders, or fragments of rocks, skirting the east branch of the Moisie at this point were no doubt lateral glacial moraines. The coarse sand in the broad valley of the river was blown into low dunes, and the surrounding hills were covered with millions of erratics. No glacial striæ were observed here, but the gneissoid hills were rounded and smoothed at their summit; and the flanks were frequently seen to present a rough surface, as if they had recently been exposed by land-slides, which were often observed, and the cause which produced them, namely frozen waterfalls.

No clay or gravel was seen after passing the mouth of Cold-water River, 40 miles from the Gulf, and 320 feet above it. The soil, where trees grew, was always shallow as far as observed; and although a very luxuriant vegetation existed in secluded valleys, yet it appeared to depend upon the presence of labradorite-rock or a very coarse gneissoid rock, in which flesh coloured felspar was the prevailing ingredient.

BOULDERS IN OTHER PARTS OF THE PENINSULA.

Observers in other parts of the Labrador Peninsula have recorded the vast profusion in which erratics are distributed over its surface. There is one observer, however, well known in another branch of science, who has left a most interesting record of his journey in the Mistassinni country, between the Saint Lawrence, at the mouth of the Saguenay, and Rupert's River, in Hudson's Bay. Andre Michaux, the distinguished botanist, traversed the country between the Saint Lawrence and Hudson's Bay in 1792. He passed through Lake Mistassini; and in his manuscript notes, which were first printed in 1861, for private circulation, at Quebec, a brief description of the journey is given.—"The whole Mistassinni country," says Michaux, "is cut up by thousands of lakes, and covered with enormous rocks, piled one on the top of the other, which are often carpeted with large lichens of a black colour, and which increases the sombre aspect of these desert and almost uninhabitable regions. It is in the spaces between the rocks that one finds a few pines (*Pinus rupestris*,) which attain an altitude of three feet; and even at this small height showed signs of decay."

The remarkable absence of erratics in the Moisie, until an altitude of about 1000 feet above the sea is attained, may be explained by the supposition that they have been carried away by icebergs and coast-ice during a period of submergence, to the extent of about 1000 feet. I am not aware that any traces of marine shells or marine drift have been recognized north of the Labrador Peninsula, at a greater elevation than 1000 or 1100 feet. In the valley of the Saint Lawrence marine drift has not been observed higher than 600 feet above the sea. Glacial striæ were seen on the "gneiss-terraces" at the "Level Portage," 700 to 1000 feet above the sea. The sloping sides of those terraces are polished and furrowed by glacial action. Grooves half an inch deep, and an inch or more broad, go down slope and over level continuously. It is on the edge of the highest terrace here that the first large boulders were observed.

The entire absence of clay, and the extraordinary profusion of both worn and rugged masses of rock piled one above the other in the valley of the east branch of the Moisie as we approached the table-land, led me to attribute their origin to local glacial action, as well as the excavation of a large part of the great valley in which the river flows. Its tributary, the Cold-water River, flows in the strike of the rocks through a gorge 2000 feet deep, excavated in the comparatively soft labradorite of the Labrador series.

The descriptions which have recently been published* of different parts of the Labrador Peninsula not visited by me, favour the supposition that the origin of the surface features of the areas described may be due to glacial action, similar to that observed in the valley of the Moisie River.

SIR RODERICK MURCHISON ON GLACIAL ACTION.

The reader who is not familiar with the rapid progress which has been made during late years in SURFACE GEOLOGY, will do well to read the following extract from Sir Roderick Murchison's address, in which some of the geological influences ice is capable of exerting, are graphically described :—

"Our knowledge respecting the snow and ice clad region of Greenland† has been from time to time largely increased by the communications of our foreign member Dr. Rink. It is in part through his memoirs, as published in our volumns, that geologists have been enabled to reason upon what they believe to have been the former glacial condition of Scotland, and other tracts in Northern Europe, during a period antecedent to the creation of man. Independently, however, of any acquaintance with the condition of

* See 'Explorations in the Interior of Labrador Peninsula,' by the Author. Longmans, 1863.

† Greenland as it is.—Northern Europe as it was.—From the Anniversary Address of Sir R. Murchison to the Royal Geographical Society, May 25, 1863.

Greenland, as explanatory of ancient phenomena, my illustrious friend Agassiz, in the year 1840, boldly applied to the larger part of the northern hemisphere, and specially to Scotland, the doctrine which he had derived from a study of the effects produced by glaciers in the Alps. Wherever he found that the hardest rocks of North Britain had been ground down, polished, and striated by lines and furrows in the same manner as that by which the rocks beneath or on the side of existing glaciers are affected, there he contended solid ice had once advanced from the mountains to the sea-shore. This view, though supported vigorously by my dear friend and eminent master, the late Dr. Buckland, met at first with much opposition, though of late years it has been well upheld by much good evidence, patiently worked out by Professor Ramsay and various authors; and in the last years particularly by Mr. Jamieson of Ellon in Aberdeenshire, and by Mr. Archibald Geikie, of the Geological Survey. Now that the direct analogy of Greenland has been prominently brought forward, the bold theory of the great Swiss naturalist, who founded it on his knowledge of the Alps, has, to his great honour, been well sustained. Though once a sceptic as to a former spread of snow and ice over a large portion of Scotland, I have for some time been a firm believer in the application to that country of this portion of the theory of Agassiz.

"The manner in which the snow of the mountains descending and first forming "névé," the solid glaciers which advance to the shores of Greenland, and the mode in which huge masses of these glaciers are broken off and are launched into the sea, have been described by other authors, but by none more clearly than by Dr. Rink, whose long residence in Greenland has naturally given him favourable opportunities for observation. In his last memoir Dr. Rink has shown us, that though little water is apparent on the surface of the ice, yet that every glacier is a frozen mountain-river, which is greatly aided in its descent to the sea by a volume of water (about a sixth part of the whole icy mass), which flows either in interstices of the ice, or between the warmer subsoil and the thick cover of ice which prevents congelation. The proofs of the issue of large quantities of water from beneath the lofty ice-cliffs are seen by the issue of springs of fresh water, which rise like whirlpools at the external edge of the ice; and that some terrestrial living things are brought out in these agitated masses is proved by myriads of sea-birds being seen to hover over them, to obtain food in the brackish and muddy water.

"The occurrence of an unfrozen lake at a certain distance inland in one of the great glaciers, and the occasional sinking of its water, is accompanied by a corresponding rise of the springs in the sea, and the rise of its water by their diminution. At first sight I thought it possible that this existing phenomenon might in some degree serve, though by no means entirely, to explain the manner in which Mr. Jamieson, adopting the theory of Agassiz, has recently accounted for the so-called Parallel Roads of Glen Roy;* the

* See Quarterly Journal Geological Society, vol. xix (1863.)

lake on whose edges these terraces are supposed to have been formed having been held up by a glacier, the successive shrinkings of which let off at intervals the water from higher to lower levels. But looking to the Greenland case as the result of occasional and frequent openings of channels for the water, I see nothing in it which will account for the gravel terraces of Glen Roy at separate and distinct heights. In our Highland example, I believe with Agassiz and Jamieson, that the lacustrine waters were held up by a glacier; yet, knowing that each gravel terrace on their shores could only have been formed in tranquil periods, the distinct separation of the one from the other is to me a clear proof that sudden movements of the subsoil and rapid change of climate occasioned paroxysmal dislodgments of these icy barriers. In this way the successive subsidences due to the sudden collapse and removal of large portions of glaciers will as well account for the distinct separation of terraces which were accumulated during periods of quiescence, as the successive upheavels of the sea-shore (as I shall presently show) explain to us clearly how the heaps and terraces of gravel with sea-shells, which occur at different altitudes around the British Isles, were produced. * * * * * * * *

"But to return to the consideration of that glacial condition of the surface which geologists are pretty generally agreed upon as having been that which immediately preceded the creation of the human race. Believing, as I now do, that snow and ice formerly covered, during the whole year, my native Highlands, as well as the mountainous parts of England, Wales,* and Ireland, and, further, that glaciers descended from the higher grounds into the adjacent valleys and to the sea-board, transporting into the sea-bottom great blocks as well as enormous accumulations of clay and sand with striated fragments of rocks, constituting the "till" of Scottish geologists,† I must impress upon you that, in adopting this view, you do not embrace the largest portion of the operations of transport which took place in the glacial period. For, when the ancient glaciers advanced to the seas of that glacial epoch, they must (as is now taking place on the shores of Greenland) have launched from their cliffs huge icebergs, which were floated away by the prevailing currents, often to vast distances before they were melted. So in the present day numerous icebergs are wafted for hundreds of miles to warmer and southern seas, in which they disappear, and strew the surface of the sea-bottom with the blocks and pebbles with which they were loaded, to be mixed up with marine shells, sand, and mud."

ACTION OF GLACIAL ICE.

Whenever the loose covering of clay and sand is swept off the solid rock throughout the whole extent of this Province, glacial striæ are visible, in

* On this subject Professor Ramsay's excellent and original Papers should be consulted; particularly the general reader should peruse his Essay on the 'Old Glaciers of Switzerland and North Wales,' in the 1st volume of 'Peaks, Passes, and Glaciers,' and also published as a separate volume.

† See the very clear and able illustration of this subject, with a map shewing the various directions followed by the old glaciers, in the book entitled, 'On the Phenomena of the Glacial Drift of Scotland,' by Archibald Geikie. Glasgow, 1863.

other words, the rocks are seen to be polished, striated and sometimes deeply grooved. These striations are observed at all altitudes, but they have been obliterated over wide areas by atmospheric influences. During the past summer I saw them on the summit of Blue Mountain, 1650 feet above the sea. There, small surfaces of a very hard metamorphised conglomerate are beautifully polished and striated. They abound throughout the slate region of the Province, the slate receiving with ease and retaining with much persistency the markings produced by the slowly moving glacial mass.

The general direction of these striæ is N. 10° W., but there are often two sets to be seen, differing in direction by two or three degrees. The best place within a few miles of Fredericton for examining these striæ under very singular circumstances, is in Prince William Parish, at and near the antimony mines. On the road to the mines leading from the main post road the striæ are beautifully retained on the polished surface of a hard silicious slate. The country in that vicinity has been ground away and removed by ice to a vertical depth of some hundred feet, as has indeed, a considerable portion of, if not the whole, of the Province.

In Prince William, however, an observer can not only see the "tracks" of the glacial mass graven on the rocks, but he can also see the work it has accomplished in excavating Lake George. He can trace the course of the glaciers far beyond Lake George (442 feet above tide) and Bear Lake; see it in imagination sweeping past the edge of the Plateau of the Carboniferous series, which it has worn away to an escarpment west of Oromocto Lake, and as a glacial stream passing down the valley of the Magaguadavic to the sea.

The western extremity of the Coal Measures holds up Lake Oromocto. It has been denuded away by lateral glacial action towards the west, until we have the remarkable spectacle presented of a bold escarpment facing the west, holding up a Lake containing 10,000 acres, and 115 feet above the valley it overlooks. Lake Oromocto is 370 feet above the sea, the escarpment which overlooks the Magaguadavic is 394 feet, and the River itself flowing at the base of the escarpment is 256 feet above the same level.

GENERAL DIRECTION OF THE ICE FLOW IN NEW BRUNSWICK.

The polishing of some of the harder rocks is extremely beautiful, and shows that the action of the ice slowly moving over it must have continued for an exceedingly long period of time. It is not to be supposed that the ice had uniformly one direction, on the contrary, its direction may have varied through an entire quadrant under different conditions. When we look at glacial striæ we see only the last record of the moving mass, the last impression of its presence, but in what direction it moved, or with what effect at any period before the graving of its last striations, we can only conjecture.

In the following Table are given the direction and locality of some of these glacial striæ.

*Table showing the Direction of Glacial Striæ in New Brunswick.**

No.	Kind of Rock.	Locality.	Height above the Sea.	Direction.
1	Grey Grits,	Fredericton,	About 350 feet,	N. 10° W.
2	Siliceous Slate,	Prince William,	" 400 "	N. and S.
3	Grey Grits,	Four miles on Miramichi Road,		N. 10° W.
4	" "	Hanwell Road,†	" 400 "	N. 10° W.
5	" "	Maryland Road,	" 400 "	N. 10° W.
6	" "	" "	" 400 "	N. 10° W.
7	Red Sandstone,	" "	" 400 "	N. 10° W.
8	Greenstone,	Gagetown Road,		N. and S.
9	Conglomerate,	Near mouth of Keswick,		N. N. W.
10	Reddish Conglomerate,	Near Gagetown,		N. 22° W.
11	Conglomerate,	Oromocto Lake,	" 370 "	N. N. W.
12	"	Harvey Settlement,		N. and S.
13	Red Sandstone,	9 miles south of Saint Andrews,	" 60 "	W. by W.
14		Chamcook Lake Shore,		N. N. W.
15		On high land near St. Andrews,		N. by W.
16	Trap,	L'Etang,		N. 45° W.
17	"	Magaguadavic Falls,	" 100 "	N. W.
18	Granite,	East of Musquash Valley,		N. 20° E.
19	Slates,	Near Penitentiary, Saint John,		N. 30° E.
20	Syenite,	South Bay,		N. 25° E.
21	"	Mouth of Nerepis,		N. W.
22	"	Oxbow of "		N. N. W.
23	Grey Grits,	Old Woodstock Road,		N. 10° W.
24	Slates,	Spring Hill,		N. 10° W.
25	Purple Sandstones,	Gonish Road,		N. 10° W.
26	Metamorphosed Conglomerate,	Blue Mountain,	" 1650 "	N. and S.
27	Grits,	Opposite Fredericton,	" 350 "	N. 10° W.

An inspection of the preceding Table, although it is very imperfect, will show that the direction of the moving mass of ice was generally nearly due north and south. As the glaciers approached the sea they accommodated themselves to the sinuosities of the valleys through which they made their escape, and produced striations in different directions. At a greater elevation and more inland, what were on the sea shore mere ice-streams, would be in the interior a uniform or broad glacial mass. Suppose for instance that a mass of ice several hundred feet thick, like that which now covers in part the surface of Greenland,‡ once extended over the entire surface and

* Some of these observations were recorded by the late Dr. Robb.

† Between Fredericton and Hanwell, very numerous and uniformly N. 10° W.

‡ "To have a correct idea of the glacier accumulation in Greenland, we must imagine a narrow continent of ice flanked on its seaward side by a number of Islands, and in every other direction lost to vision in one continuous and boundless plain. Through the spaces between these apparent Islands, the enormous glacial accumulations slowly seek their passage to the sea, and send off an annual tribute to encumber, to cool, and to dilute the waters of the adjoining ocean. The average height or depth of the ice at its free edge in these intervals or valleys between the projecting points of coast is 1200 or 1500 feet, of which about one eighth or 150 feet will be above the water. In some of the valleys, however, the depth is upwards of 2400 feet. These phenomena can be seen at the present day in Baffin's Bay and Davis' Straits." "As we advance northwards along the coast

flanks of the granitic highland range to the north and northeast of the Saint John; during its slow movement towards the sea it would not only bring with it the materials it tore off the rocks over which it was passing, but it would also score and polish the rocks themselves. At that period the valley of the Saint John was probably, but not necessarily, filled with drift; the glacial mass passed over it towards the sea, scratching and polishing the rocks during its slow but irresistable journey; approaching the sea it would probably split into tongues, chiefly on account of its moving eccentrically, and thus covering a larger area owing to the figure of the earth; and by reason of climate these tongues would reach the sea as ice rivers, in process of time excavating for themselves deeper and deeper channels, which ultimately became "Fiords" or deep bays where the glaciers "calved," to use the term commonly employed in Greenland, and gave off their icebergs. An inland glacier having, as it were, once established itself in any determinate geographical position, would in process of time, assisted by its own glacial river, wear out a lake basin.*

PROBABLE THICKNESS OF THE GLACIAL COVERING.

Some idea of the former enormous thickness of the glacial mass which once covered a considerable portion, if not the whole of the Province, may be gleaned from the occurrence of those beautifully polished metamorphic conglomerates at the summit of Blue Mountains in the Tobique valley, 1640 feet above the sea. This would involve a glacial mass certainly not less than 2000 feet in thickness; but as there is no doubt that far more elevated mountain summits in the highlands are grooved and polished, it would be very unwise to attempt to fix a limit to the thickness of the glacial mass which once covered the Province from such data.

If we turn our eyes southwards, we find Mount Washington, which is over 6000 feet high, marked with glacial striæ nearly to its summit, the rough unpolished surface of its crown, covered with loose fragments, alone remaining unscored, showing that during the glacial epoch its summit was just raised above the surrounding ocean of ice.†

"In this region," says Agassiz, "the thickness of the sheet can not have been much less than six thousand feet;" and in another place in the same article—"In short, the ice of the great glacial period in America moved over the continent as one continuous sheet, over-riding nearly all the inequalities of the surface."‡

of west Greenland, and thus diminish the annual mean temperature both of the sea and of the atmosphere, we find the glacier approaches nearer and nearer the coast line, until in Melville Bay, latitude 75°, it presents to the sea one continuous wall of ice, unbroken by land, for a space of probably seventy or eighty miles."—Dr. Sutherland, *on the Geological and Glacial Phœnomena of the Coasts of Davis' Strait and Baffin's Bay.*—Proceedings of the Geological Society, 1853.

* See Professor Ramsay's paper "On the Glacial Origin of Lakes."—Journal of the Geological Society, August, 1862.

† Agassiz in the July number, (1864) of the Atlantic Monthly.

‡ Ice-Period in America—by Louis Agassiz.—Atlantic Monthly, July 1864, page 88.

If these are the conclusions advocated by Agassiz, in relation to America generally, north of the 44th parallel, we may accept as a very modest deduction the entombment of all the mountains in the Highlands of the Province under one glacial pall.

Dr. Dawson, the able and distinguished President of McGill College, Montreal, whose writings and authority have so frequently been quoted in this Report, does not agree with the views of glacialists as now understood. Dr. Dawson urges as a chief objection to the striation of a portion of the Saint Lawrence Valley—1st. "That the direction of the striation was from the ocean toward the interior, against the slope of the Saint Lawrence Valley;" and 2nd. When speaking of the supposed excavation of the great Lakes by means of ice, he says, "Glaciers could not have effected it; for even if the climatal conditions for these were admitted, there is no height of land to give them momentum."

"But," says Dr. Dawson, "if we suppose the land submerged so that the Arctic current flowing from the northeast should pour over the Laurentian rocks on the north side of Lake Superior and Lake Huron, it would necessarily cut out of the softer Silurian strata just such basins, drifting their materials to the southwest."* This conclusion is far from being borne out by the existing Lake Basins. An Arctic current could not have occasioned the vast subaqueous escarpments which exist on the north side of the Indian Peninsula and its Island prolongations in Lake Huron. There are three hundred feet of water close to many parts of the shore in that portion of the lake, a depth equal to that of the Bay of Fundy, notwithstanding its wonderful tides and never-ceasing currents. The vast depths of the great Canadian Lakes, from 700 to 1000 feet, surrounded by unbroken rocky rims, which hold their waters up, is another potent argument against the existence of currents, especially an arctic one, which is, comparatively speaking, a surface current, the warmer heavier water (39.5°) necessarily seeking the greatest depth and the colder current flowing over it. The geographical position of the axes of the great Lakes, which would be that of the current, is of itself a grave objection to the views urged by Dr. Dawson.

AN ELEVATION OF THE CONTINENT ALONE REQUIRED.

There can be no doubt that a submergence (which probably did not exceed 600 feet in this latitude) would account for some of the phenomena under review, but an ELEVATION of the northern portion of the continent, to the extent of as many hundred feet as some geologists suppose submergence to have taken place in thousands of feet, would explain all the glacial phenomena under consideration, as well as many others for which the hypothesis of submergence alone is wholly inadequate, such as the formation of elevated but local beaches and terraces, the formation of great escarpments increasing continually in altitude towards the west, the excavation of Lake Basins, &c.

* Proceedings at the Annual Meeting of the Natural History Society of Montreal, 1861.—"The President's Address."

This elevation would require to be of the same character as that which is now actually taking place in Sweden, and indeed on a small scale on the Atlantic coast of New Brunswick, Nova Scotia and the United States. A gradual elevation of the northern part of the continent, for a few feet in latitude 35° N., a hundred feet in latitude 40° N., 200 feet in latitude 45° N., 500 feet in latitude 50° N., and 1000 feet in latitude 65 or 70° N., would give the required slope.* The advocates of the Iceberg theory do not hesitate to assume that the continent was submerged to the extent of from 4,000 to 5,000 feet, in order to account for the scratches and Drift on Mount Washington and in the Catskills, yet a comparatively small elevation in the manner indicated above, would not only remove the difficulties with regard to slope, but it would also avoid the necessity for an assumption of which there is no real evidence in the way of Fossil remains, beyond a depression not exceeding in the valley of the Saint Lawrence six hundred feet.†

FORMATIONS OF ESCARPMENTS.

Most of the difficulties attending the formation of elevated beaches of small horizontal extent, at elevations varying from 900 to 1750 feet above the sea, disappear when viewed in connection with glacial Lakes. And that great enigma, the enormous parallel escarpments from 300 to 1000 feet high, and

* An elevation of this see-saw character has actually taken place within certain limits as shewn by marine shells. In Lake Champlain these are found at an elevation of about 400 feet, at Montreal 470 feet, and in the Arctic Regions they have been discovered at an elevation of nearly 1000 feet, on Cornwallis and Beechy Islands.

† In a recent Report on the Geological Survey of the State of Wisconsin by the distinguished American geologists, Professors James Hall and J. D. Whitney, the remarkable view is advanced by the latter, that there is an area of more than 3000 square miles in extent (long. 90° W. lat. 42° 50' N.) which has never been overflowed since the Upper Silurian epoch. Mr. Whitney says:—"If we consider the magnitude and universality of the drift-deposits in the Northern United States, and especially in Northern Wisconsin, we shall be more astonished to learn that throughout nearly the whole Lead-region, and over a considerable extent of territory to the north of it, no trace of transported materials, boulders, or drift can be found; and what is more curious, to the east, south, and west, the limit of the productive Lead-region is almost exactly the limit of the area thus marked by the absence of Drift."

The conclusions to which Mr. Whitney has been led by the study of this driftless region are briefly as follow:—

1. That since the Upper Silurian period this portion of Wisconsin has not been submerged, and that its surface has, consequently, never been covered by Drift.

2. That the denudation it has undergone has been effected by the simple agency of rain and frost.

3. That a large portion of the superficial detritus of the West [illegible] have had its origin in the subærial destruction of the rocks, the soluble portion of them having been gradually removed by the percolating water.

4. The entire absence of terraces indicates that the region in question has not been submerged in recent times. No organic remains other than those belonging to palæozoic times, except those of land animals and plants, have been found in the Lead-region.

On the railway between Milwaukie (Lake Michigan) and Prairie du Chien on the Mississippi, there is no point which rises higher than 950 feet above the sea-level; and the towns of Galena, Menomonee, and Dunlieth, in the Lead-region, are below the level of Lake Michigan.

from 300 to 3000 feet above the sea, and many hundred miles long, without any evidence of beaches on their slopes, appears best susceptible of explanation, by supposing them to be the result of glacial rivers wearing away the soft material of the stratified rocks in advance of the glacial mass, and simultaneously levelling the plains of the base of the escarpments. On the shores of the Bay of Fundy there are immense escarpments, but they contain in every sheltered nook ancient beaches to indicate their origin. Glacial escarpments have not, necessarily, any beaches or terraces showing the presence of a sea washing their shores.

In 1860* I described the remarkable parallelism which exists between great escarpments in America north of the 40th parallel of latitude.

1st. The Niagara escarpment.

2nd. The Riding, Duck, and Porcupine Hill escarpment, west of Lake Winnipeg.

3rd. The escarpment of the Grand Coteau de Missouri.

These are all roughly parallel to one another, and are many hundred miles in length. The lowest, the Niagara, varies from 600 feet to 1300 feet above the sea; the second, west of Lake Winnipeg, from 1600 feet to 2000; the third, the Grand Coteau de Missouri, from 2000 to 3000 feet and more above the ocean. They have all easterly, northeasterly, or northerly aspects, in relatively different parts of their lengths, and appear to have a common origin. If it can be shown conclusively, as Mr. Whitney believes, that the driftless area in Wisconsin has never been overflowed, these escarpments, as well as those of their great outliers in the "far West," can only be due to the same agent which excavated the basins of the great American Lakes, and we may look upon the symmetrical escarpments of the Grand Coteau de Missouri, the Riding Mountain and its prolongations, and portions of the Niagara escarpments, as the result of the action of glacial rivers undermining and washing away the soft strata of the sedimentary rocks, and excavating *in advance* of the glacial mass itself. They may represent different and closely succeeding glacial periods (the Missouri escarpment being older than that of the Riding Mountain,) with, however, a distinct geological interval between them. The close proximity of the isothermal curves in these latitudes to the general direction of the escarpments of the Grand Coteau and Riding Mountain is a very interesting and important feature in connexion with the cause which produced them.†

CONDITIONS UNDER WHICH GLACIERS ARE FORMED.

It is well known that glaciers can only be formed where there is a sufficiently low mean annual temperature and an abundance of moisture. On the shores of South Greenland there is, comparatively, a large annual precipitation, estimated by Dr. Rink at 12 inches per annum, and supplying

*See 'Narative of the Canadian Exploring Expeditions of 1857 and 1858,' volume ii, page 200, for a notice of these escarpments.

†From a Paper by the Author, read before the Geological Society of London, February 1864, (vide Proceedings for February.)

a vast glacier stretching continuously from the shore, inland. Advancing further up the Straits beyond the region of moisture, the region of glaciers, according to Captain Sir L. M'Clintock, is left behind. No icebergs were seen in the Archipelago of Barrow Straits; with high land and abundance of moisture there is an abundance of icebergs, but in the Archipelago of Barrow Straits, with a drier atmosphere, icebergs are not seen.*

It follows from these observations that a zone of moisture during the glacial epoch would in the north temperate regions be a zone of glaciers, and the boundary of these glaciers would necessarily follow an isothermal line. May not the escarpments described on a preceding page, represent a boundary of a zone of moisture, and the isothermal line which limited the ice masses? and may it not be ultimately shown that the glacial phenomena of the North American Continent have been limited at different periods to certain zones, which were zones of elevation and moisture, and that there is no necessity for conceiving with Agassiz that a continental cap of ice covered both poles, possessing the enormous thickness he assigns to it? Upon this view it does not appear to be improbable that glacial phenomena may be recognized in many preceding geological ages of the world; and the huge rounded boulders in some of the ancient conglomerates, belonging even to the Palæozoic Series, awaken the suspicion that glacial zones existed in those remote periods?

THE VALLEY OF LAKE ONTARIO.

The objection urged by Dr. Dawson, that the glacial mass would have to move up the slope of the Saint Lawrence Valley to explain, on the glacial hypothesis, the origin of the south west striations there, loses its force upon the legitimate assumption of a gradually increasing elevation of this part of the continent towards the north, and while this hypothesis accounts equally well with the iceberg theory for the distribution of the Montreal trap in the valley of the Genessee, and the dispersion of boulders throughout all parts of the Valley of the Saint Lawrence, as shown by Dr. Bigsby,† it affords at the same time a probable explanation of the original formation of the Niagara escarpment, especially of that elevated portion which constitutes the northern flank of the Blue Mountains, which is not less than 1400 feet above the sea level, and is nevertheless continuous with, and a part of, the escarpment to the east. That portion of this long wall of rock, (which stretches from the middle of the State of New York to Lake Superior), lying within the basin of Lake Ontario, has no doubt been greatly remodelled by the ocean during the subsequent period of subsidence to the extent of about 600 feet, but it seems probable that the Blue Mountain escarpment of Lake Huron, whose base is not less than 800 or 900 feet above the sea, should be the result, like the Riding Mountain and the Grand Coteau de Missouri, of the vast hydraulic power of Glacial Rivers.

* Discussion on Captain M. F. Maury's Paper on the Physical Geography of the sea.—Proc. of the Royal Geo. Soc. Nov. 26, 1860.

† Vide Dr. Bigsby, on Canadian Erratics.—Proceedings of the Geological Society—1851.

We thus connect all the phenomena of Striated rocks, Lake Basins, Escarpments, Inland Beaches, "Horsebacks," the formation and partial distribution of Boulders, and the unstratified Drift, with one and the same cause, simultaneously producing these varied manifestations of its power and evidence of its work.

GLACIAL RIVERS AND LAKES.

The great glacial mass which covers a large part of Greenland has its rivers, which are never frozen, uninterruptedly issuing from beneath the glacial covering and pouring their waters into the sea, both during summer and winter. The vast mass of ice appears to act as a cloak to the earth, so as to prevent its heat from being radiated into space. Hence, even in Greenland, the bottom of the glacier is apparently constantly thawing, owing to the heat of the earth, and the glacial rivers convey the products of the "thaw" under the ice to the sea.

Dr. Rink, who has resided many years in Greenland, as stated in a preceding extract, and studied glacial phenomena in its grandest development as it now exists, calculates the yearly amount of precipitation on Greenland in the form of snow and rain, at twelve inches, and that of the outpour of ice by its glaciers at two inches. He considers that only a small part of the remaining ten inches is disposed of by evaporation, and argues that the remainder must be carried to the sea in the form of sub-glacial rivers. He shows that copious springs of fresh water boil up through the sea in front of the glaciers that advance into it, and states that their positions are conspicuously pointed out by flocks of sea birds, which invariably hover over them in evident search of some food, whatever it may be, which they always find there.

Dr. Rink also specifies a Lake adjacent to the outfall of a glacier into the sea, which has an irregularly intermittent rise and fall. Whenever it rises the sea springs disappear; when it sinks they burst out afresh, showing a direct connection between the springs and a sub-glacial river. Arguing from what has been observed in the Alps, he concludes that an amount of glacier water equivalent to 10 inches precipitation on the whole surface of Greenland, is no extravagant hypothesis, and he accounts for its presence partly by the transmission of terrestrial heat to the lowest layer of the ice, and partly from the fact that the summer heats are conveyed into the body of the glacier, while the winter cold never reaches it. The heat melts the surface snow into water, which percolates the ice, while the cold penetrates a very inconsiderable portion of the glacier, whose thickness exceeds 2000 feet.*

The Glacial rivers, which flow continually from the continental mass of Greenland ice, and are the inseparable attendants of all glaciers wherever situated, enable us to see how an ice-stream advancing against a precipice

*On the discharge of the water from the interior of Greenland, through springs underneath the ice, by Dr. H. Rink of Greenland.—Proceedings of the Royal Geographical Society, February 23, 1863.

of soft rock will, by means of its river, undermine and carry away the debris laterally, and in advance of itself. It is like a gigantic hydraulic engine constantly playing against the wall-like surface of the rock, and sweeping off the abraded materials in a river flowing at its base. According to this view an escarpment can be formed at any level; it requires only two conditions,—1st. A slowly moving glacial mass; 2nd. *A rising slope.* We can conceive that the glacier does not ascend the slope, but it cuts away the rock in front of it by means of its rivers, and forms an escarpment continually increasing in elevation. Hence it appears probable that the greater portion of the valley of Lake Ontario, together with the valley of the Saint Lawrence, quite independently of the area occupied by the Lake Basin itself, was cut out by glacial ice acting in the manner just described. Glacial striæ it must be observed show only the last record of the receding masses, but we must look to Drift, to Terraces, to Lake Basins, to Boulders, and to Escarpments, for the work which they have accomplished.

The clean-swept floor of the level country at the foot of the great escarpments in the far West, also indicates the boundary of vast glaciers, which left their dirt-beds on the prairie country, even as far as the south branch of the Saskatchewan, where I observed the forced arrangement of slabs in *unstratified clay* in 1858.

The greater portion of this work was completed during the glacial period, when the land was elevated many hundred feet above its present level. Towards the close of the glacial period, and perhaps one of the agents which brought it to a close, occurred the gradual subsidence of the continent to a maximum extent of 600 feet in the latitude of Canada. During its subsidence and subsequent emergence, much of the work of the glacial period was remodelled, and some of it obliterated, the ocean having left traces of its own work in the form of marine and river beaches, and in the redistribution of many erratics, and the deposition of marine clays and sands within certain limits. These marine clays exists in Maine and New Brunswick to the ascertained height of 200 feet, but in the valley of the Saint Lawrence they have a much greater elevation.

The theory which has so long obtained a certain degree of popularity, that icebergs driven by oceanic currents, and grating upon the floor of the sea, grooved and scratched the rocks against which they impinged, has not received any additional strength from the announcement recently made by Captain Maury respecting ocean currents. "These currents," says that distinguished geographer of the seas, "are the most capricious things; they not only sometimes cease to run, but they occasionally turn and run backwards." He cited the Gulf Stream, which the officers of Her Majesty's Ships in sailing between Halifax and Bermuda, had observed actually running to the southward and westward.* The Gulf Stream is very capricious, and its northeasterly course is the resultant of a vast number of changes.

* Ocean Currents on the northeast coast of South America—By J. A. Mann, Esq.—Captain Maury on a discussion of the above Paper.—Read before the Royal Geographical Society, January 12, 1863.

The uniform constancy in the general direction of glacial striæ, where local causes have not operated, strengthen the suspicion that inconstant currents bearing floating ice can have had little to do with their origin.

THE SPITZBERGEN GLACIER.

The great Glacier of Spitzbergen described by Mr. Lamont * has a seaward face from 30 to 32 English miles, and protrudes in three great sweeping areas for at least five miles beyond the coast line. It has a precipitous and inaccessible cliff of ice all along its face, varying from 20 to 100 feet in height. It has of course no visible terminal moraine above water, but Mr. Lamont suggests that it may have some connection with an extensive submarine bank which lies opposite the whole length of the front of the Glacier, and extends for 15 or 20 miles to sea. The soundings on this bank may average fifteen fathoms, with a bottom of blueish clay. Several Glaciers on Spitzbergen were observed to be pushing before them vast heaps of mud and stones, and the bank just described was probably a submarine moraine. Its vast extent, the circumstances under which it is being produced under our eyes, consisting, as it no doubt does, partly of true glacial and partly of remodelled Drift, is suggestive as to operations of retreating or advancing glaciers in ages past.

LAKE BASINS.

There can be little doubt that nearly all the Lake basins in New Brunswick and Maine, like those of Canada, have been excavated by means of glaciers. Sir W. E. Logan has shown that the rock which is most characteristic of the innumerable lake depressions in the Laurentian region of Canada, is the comparatively soft chrystalline limestone, and there is every probability that the main erosive force has been glacial action. Prof. A. C. Ramsay, the local director of the Geological Survey of England, has shown that all the large lakes of Europe have been produced by the action of great glaciers, which by their slow grinding motion formed those depressions in the rocky strata which are now the basins of the lakes.†

It will be observed on an inspection of Mr. Wilkinson's excellent map of New Brunswick and Maine, that the lakes have a general uniform direction from north to south, or from northeast to southwest. There is a tendency among those which belong to the north and south class, to trend a few degrees to the east, this is also observed in the great Fiords on the coast through which the ice found its way to the sea.

The remarkable parallelism between Loch Lomond, Kennebecasis Bay, the Long Reach, with its continuation to Belle Isle Bay, Washademoak Lake, and Grand Lake, all point to glacial action, guided probably by previously existing valleys formed by anticlinal or synclinal folds, these lying in a course not far removed from the general course of the glacial

* Seasons with the Sea-Horses—by James Lamont, Esq. F. G. S.

† Proceedings of the Geological Society.

mass. It has not unfrequently happened that when a glacier entered an ancient valley, it followed the course of that valley as long as it did not deviate many degrees from its original direction, but if the valley deviated more than a certain number of degrees, the glacier left it, and pursued its course up hill and down dale without regard to obstacles not sufficiently formidable to divert it from the line of maximum descent. Hence we frequently find striæ leaving a valley and passing up the southern bank; this is especially the case near Fredericton, where the glacial masses have slowly progressed southwards in the direction indicated by the valley of the Nashwaak, pushed across the Saint John, then partially filled with drift clays, and thence over the plateau to the sea. They have been to a certain extent the cause of the gently sloping banks of the river here, which though they rise to the height of 400 feet above the level of its waters as it now exists, yet their elevation is attained after a long and uniform slope, broken only by terraces which mark the slow subsidence of the river or lake estuary during the period of the partial re-excavation of the valley. These terraces will be noticed in the proper place.

Glacial striæ are frequently observed to run under the waters of existing seas and lakes; in Lake Ontario, for instance, and on the Atlantic coast of Maine and the Bay of Fundy. They have even been observed to run under the waters of the ocean below low water mark. All of these phenomena belong to the close of the glacial period, after the uniform grinding down of the whole country, the formation of the great escarpments, and the excavation of the vast and deep Lakes of the Saint Lawrence Basin. They are among the last records of glacial action.

LIFE IN NORTHERN SEAS.

A strong argument in favor of the glacial origin of the unmodified drift is the absence of fossils. In England fossils, although much broken, are frequently found in the drift, but this shows that the glaciers which originated it terminated in fiords where marine life was abundant as it now is in the Greenland fiords; there, the vast masses of ice which are yearly given off do not appear to interfere with animal life. The northern seas abound with microscopic organisms, and Sir Leopold M'Clintock brought up several small star fishes from a depth of 1260 fathoms or 7560 feet, the nearest land being Iceland, which was 250 miles distant. In the iceberg region the sounding lead also showed abundance of marine life on the sea bottoms which could not fail to be occasionally disturbed by the grounding of icebergs.

TERRACES AND BEACHES.

There are three kinds of Terraces in various parts of the Province, differing from each other as to their origin, viz:—

1st. Marine Terraces or Ancient Coast Margins.
2nd. Glacial Lake Terraces.
3rd. River Bank Terraces.

The terraces on the coast of the Bay of Fundy, consisting of marls holding marine plants and shells, belong to the first class; the symmetrical terraces near Upsalquitch Lake are illustrations of the second, and the beautiful and singularly regular series visible on the St. John from the head of the Long Reach to the Grand Falls, are very imposing instances of river valley terraces.

MARINE TERRACES OR ANCIENT SEA MARGINS.

The estuaries of some of the smaller rivers on the Bay of Fundy, where they have been sheltered from denuding agencies, show well defined sea margins. A third of a mile up Goose Creek the following measurements were roughly taken with an aneroid barometer in November last. Although the altitudes of the several beaches may not be quite correct, yet they are sufficiently near the truth to establish their relations, and to point to certain results inseparable from them; their presence shows the difference between a precipitous coast line and a glacial escarpment.

TABLE SHOWING THE APPROXIMATE ALTITUDE OF MARINE BEACHES, NEAR THE MOUTH * OF GOOSE CREEK, BAY OF FUNDY.

No. of Beach.	Altitude above high tide in feet.
1	105
2	141
3	179
4	217
5	247
6	277
8	324
9	343
10	400
11	430
12	465
13	490

These beaches have been produced during the slow emergence of the continent after the Glacial epoch. It is not improbable that at the same time, most of the terraces on the banks of the rivers in the interior, lower than 500 feet above the sea, were occasioned by the same cause; in other words by simple drainage. We have only to conceive the valley of the river forming an estuary, and the estuary converted into a river as the land rose.

On the Atlantic coast of New Brunswick and Maine fossiliferous marine clays are found on the shores of most land-locked bays, and sometimes far up the broad valleys of rivers. They belong to the period when some of the lower river terraces were formed, and show the limits of tidal waters during that epoch. They are evidently of the same geological age as the deposits in the valley of the Saint Lawrence and Lake Champlain, (post-pliocene of Lyell,) and many of the fossils they contain are identical with living species. Mr. Hitchcock has shown that out of seventy species enumerated as being found in Maine, and eighty three in the Saint Lawrence valley, twenty five are common to both deposits. Beds of marl containing marine shells have been found above the Falls of the Saint John near the

* About one-third of a mile from the sea.

mouth of the river, on the shores of Grand Bay, the Kennebeccasis, Belleisle, and on the side of the main stream near the Reach, (Gesner.) On the coast these marl and clay beds are very numerous, occurring in all sheltered places, and from 10 to 40 feet above the highest tides. The beds of sand, gravel, clay, and marl, on the banks of the Saint John above Gagetown, consisting of remodelled drift, all appear to be of fresh water origin.

MODERN ELEVATIONS AND DEPRESSIONS OF THE COAST.

Near Point Blakeland, Bayfield notices on his chart of Miramichi Bay, a "Peat bank 10 feet high." Also near Grandoon Island, "cliffs of sandstone 15 feet, covered with Peat."

The soundings taken by Bayfield during 1848, in Miramichi inner Bay, show 2¾ and 3 fathoms where four and five fathoms are recorded on the old charts constructed by order of the Admiralty, previous to 1780, and published in that year by J. F. W. des Barres.

The Marsh inside of Hucklebury Island, Bayfield describes as filled with Eel grass and nearly dry at low water; the chart of 1780 shows three and two fathoms of water. . . . . .

Buctouche Harbour exhibits also great changes. The channel is very much diminished both in breadth and depth since 1780, the depth being about one half. These changes may be due in part to the debris brought down by the rivers, but there is ground for belief that the land is slowly rising north of Buctouche. The walrus bones on Miscou Island, alluded to on page 34, show a gradual elevation of that part of the coast, so also does the Harbour of Bathurst.

EXTENSIVE UPTHROW TO THE WEST OF THE SAINT JOHN.

The elevations and depressions which have just been noticed sink into insignificance when compared with a bold vertical movement of a considerable portion of the Province, which appears to have taken place long previous to the Glacial epoch. The known details of this movement are not sufficiently numerous to permit a general description of its effects to be drawn up, but they are susceptible of being traced over a wide area, so that some ideas may be gathered respecting its nature, which may serve as a guide for future enquiry.

The breaks in the continuity of the narrow belts of the Bonaventure rocks where they cross the Saint John in the Parish of Kingsclear and in the Parish of Hampstead, point to an important elevation of the whole of the Carboniferous rocks west of the Saint John. The sudden termination of the "granite" on the same river, according to Gesner, occurs at the Quarries. The granite and the slate are described as being cut off at the broad point of land between Belle Isle Bay and the Washademoak, and they are there, on the east side of the river, replaced by "trap."

The limits of this raised district are undefined to the west, but there appears to have been an upthrow of great extent, which may exercise an important influence on the geology of the country over which it prevailed.

The action of glacial ice has ground down to a uniform level the rocky strata on both sides of the Saint John, but data may be obtained by careful measurements about ten miles above Fredericton and a few miles below Gagetown, to determine the exact vertical limit of this remarkable upheaval.

GLACIAL LAKE TERRACES.

On page 188 a brief description from the pen of Sir Roderick Murchison is given of what are called by geologists, Glacial Lakes. The terraces already described as occurring near Upsalquitch Lake, on the Portage to the Nipisiguit, are most probably illustrations of this remarkable phenomenon.

The interior of the American Continent affords magnificent examples of Glacial Lake Terraces. At or near the head waters of the St. Lawrence, in the neighbourhood of Great Dog Lake, west of Lake Superior, a succession of these terraces are passed over having elevations above the sea of 945, 1109, 1197, 1398, 1417 and 1435 feet respectively. They appear on the sides of an immense sandbank and are several miles in length.

RIVER TERRACES.

In the following brief description of some of the most prominent river terraces in this Province, it should be borne in mind that the valley of the Saint John was excavated ages before the Glacial or Drift period. It was probably enlarged in certain parts during the glacial period, particularly near Fredericton, and in part filled with drift during the subsequent submergence, and re-excavated during the period of emergence with the formation of the terraces. Some of these terraces will now be noticed, previously to considering the question relating to the probable origin of the Grand Falls.

TERRACES AT THE MOUTH OF THE NEREPIS.

At the mouth of the Nerepis the contour lines of 50, 100, 150, 200, and 250 feet are parallel to one another, so also, as high as 300 feet, at Belleisle Bay, opposite Hog Island.

TERRACES OPPOSITE GAGETOWN.

The terraces opposite Gagetown, although not precisely represented by the contour lines of Captain Owen's Survey, are remarkably symmetrical, being parallel to one another at the most abrupt turns. They are represented at the following altitudes, all of which contour lines are roughly parallel to one another, and distant as follows:—

No.	Altitude.	Distance from one another.
1	20	0 yards.
2	50	110 "
3	100	180 "
4	150	260 "
5	200	330 "
6	250	385 "
7	300	330 "
8	350	400 "
Summit,	380 feet,	297 "

The elevation of 380 is attained in one mile and 60 yards. These contour lines are on the Jemseg River. Peters' Hill, in the flat or intervale opposite the town, is 57 feet high, it has escaped the denuding forces which re-excavated the valley.

TERRACES AT FREDERICTON.

The contour line of 50 feet above low water, showing the dimensions of the alluvial terrace upon which Fredericton is built, has a greatest breadth on the continuation of York Street of six furlongs, or three quarters of a mile; on Church Street, it is five furlongs, and opposite Government House the distance is the same. Opposite Kingsclear the contour line of 300 feet is 550 yards from the bank of the river, on the Poor House road it is 2,475 yards, and in the rear of Morrison's saw mill 770 yards.

The following table shows the distances of the contour lines given below, on the Poor House road, from the edge of the river, together with the altitude of the Terraces, as nearly as they can be distinguished.

On the Poor House Road.	Contour Line. Altitude.	Distance.
1	20 feet.	660 yards.
2	50 "	1300 "
3	100 "	1550 "
4	150 "	1925 "
5	200 "	1980 "
6	300 "	2475 "

TERRACES ON THE POOR HOUSE ROAD.

	Above River.
1st Terrace well defined, ...	131 feet.
2nd " near lower cross road, ...	247 "
3rd "	313 "
4th " near upper cross road, ...	345 "
Summit of hill, ...	418 "

SECTION ON THE COLLEGE ROAD, FROM THE SAINT JOHN TO NEAR THE SUMMIT.*

			Distance from River in Chains.	Height above River (March) in feet.
	River in March, ...		0	0
		Flats.	5	23
		Flats.	10	26
		Flats.	15	22
		Flats.	20	22
		Flats.	30	24
	Half a mile, ...		40	28
	Beginning of rise, ...		43.82	28
			50	41
			52.25	54
			55	80
	College Observatory—east window,		56	94
Terrace—	Three quarters of a mile, ...		60	126
			65	159
			70	181
Terrace—			75	208
	One mile, ...		80	237
		1 mile,	5	259

* Surveyed by Mr. Thomas McMahon Cregan.

Terrace— Cross Road, ...	1 mile,	9 chains,	270 feet.
	1 "	10 ...	280
	1 "	15 ...	298
Terrace— One mile and a quarter, ...	1 "	20 ...	316
	1 "	25 ...	328
TERRACE—	1 "	30 ...	338
TERRACE—One mile and a half, ...	1 "	40 ...	344
	1 "	45 ...	347
	1 "	50 ...	355
Swampy tract, from 1m. 55 ch. to 1 m. 60 ch.	1 "	60 ...	348
	1 "	70 ...	365
	1 "	75 ...	370
Two miles, ...	2 "	0 ...	375

Beside the upper terraces at Fredericton, which belong to the close of the Drift Period, and were formed during the gradual emergence of the country from beneath the ocean, there are several ALLUVIAL terraces in the great flat on which the city is built, which may be called respectively the Cathedral Terrace, the Burying Ground Terrace, and the Race Course Terrace.

The breadth of the Saint John, opposite York Street, is 825 yards; at low water its greatest depth is 19 feet, just in the middle of the river opposite the Market house; but there are several sections above and below, where the depth at low water does not exceed 15 feet, and a little higher than the Government House, the greatest depth recorded is nine feet, close to the south bank. On the opposite side of the river, (the continuation of York Street,) the contour line of 20 feet in 387 yards from the edge of low water, that of 50 feet, 440 yards, and of 100 feet, 620 yards. The valley of the river at an altitude of 100 feet above low water is about 2,990 yards broad, and at the summit level it is probably not less than four miles.

The bed of the River Saint John consists in many places of blue clay, which may be regarded as unaltered Glacial Drift. It is an extremely interesting problem to ascertain whether the boulders, slates or pebbles in the blue clay of the Saint John, have the arrangement which they would assume if they had dropped through water in the ordinary mode of deposition, or whether they have a forced arrangement, different from that which they would assume if water and floating ice had been instrumental in their distribution. In other words, it is desirable to ascertain whether any part of the blue or even yellow clay exhibits any evidence that it has once constituted the Dirt Band of a glacial mass, similar to some of the blue clay on the shores of Lake Ontario, which I described in 1855.

The Forced Arrangement of Blocks of Limestone, &c., in Boulder-Clay.

(From a Paper by the Author, read before the Geological Society of London, January 1864.)

The forced arrangement of blocks of limestone, slabs of shale, and boulders of the Laurentian rocks, in the Blue Clay at Toronto, formed the subject of a paper which I read before the Canadian Institute seven years ago. A minute description of this arrangement was published in my Report of the Assinniboine and Saskatchewan Exploring Expedition in 1859, to illustrate a similar arrangement of blocks of limestone and gneissoid rocks in the clay on the south branch of the Saskatchewan observed in 1858.

I concluded the description of this remarkable arrangement with the following hint at their origin:—" May not the plastic and irresistable agent which picked up the materials composing the Blue Clay, and then melting, left them in their present position, have been largely instrumental in excavating the basins of the great Canadian lakes."*

And, in 1860, in a "Narrative of the Canadian Expeditions," I remarked, "The wide-spread phenomena exhibiting the greater or less action of ice, such as grooved, polished, and embossed rocks, *the excavation of the deep lakes of the St. Lawrence basin*, the forced arrangement of drift, the ploughing-up of large areas, and the extraordinary amount of denudation *at different levels*, without the evidence of beaches, all point to the action of glacial ice previous to the operations of floating ice in the grand phenomena of the Drift."†

The following Sections show some of the peculiarities of the Saint John River alluvium.

ALLUVIAL STRATA EXPOSED NEAR FREDERICTON.‡

1. *Bank of River.*

Vegetable soil, ...	0 ft. 3 in.
Sandy soil, ...	3 " 6 "
Black ferruginous sand, Bog Iron Ore, gravel, yellow sand and black sand, all of variable thickness, ...	10 " 0 "
Yellow clay, ...	1 " 2 "
Total, ...	14 ft. 11 in.

BLUE CLAY of unknown depth forming the bed of the River, (Glacial Drift.)

2. *Front of the Legislative Buildings.*

Soil, ...	0 ft. 5 in.
Sand mixed with a little loam,	12 " 0 "
Total, ...	12 ft. 5 in.

BLUE CLAY forming bed of river of unknown depth, (Glacial Drift.)

3. *East side, near Brick Kiln.*

Sand, ...	9 ft. 9 in.
Yellow clay, ...	1 " 0 "
Total, ...	10 ft. 9 in.

Blue clay of unknown thickness, (Glacial Drift.)

4. *In front of Hermitage.*§

Soil, ...	1 ft. 0 in.
Ironshot sand, and gravel, ...	5 " 0 "
White sand and gravel, ...	8 " 0 "
Total, ...	14 ft. 0 in.

Marly clay forming bed of the river.

5. *Brook near Poor House.*

Soil, ...	0 ft. 5 in.
Sand, ...	3 " 5 "
Total, ...	3 ft. 10 in.

Yellow clay, unknown, (Perhaps Glacial Drift.)

6. *Ridge near Brick Kiln.*

Coarse soil, ...	0 ft. 6 in.
Sand, ...	10 " 0 "
Yellow clay, ...	12 " 0 "
Total, ...	22 ft. 6 in.

Blue clay, unknown, (Glacial Drift.)

* Report on the Assinniboine and Saskatchewan Exploring Expedition. By Henry Youle Hind, M. A., Toronto, 1859. Eyre and Spottiswoode, London, 1860.—(Blue Book.)

† Narrative of the Canadian Expeditions of 1857 and 1858, vol. ii. p. 254. Longman's 1860.

‡ Fredericton, Lat. 45° 57′ 18.7″ N. Long. 66° 38 W. is situated on an extensive "intervale" or flat, whose river edge is about 15 feet above the water in November. The character of the valley here is given in the text. It is 66 miles by road from Saint John, and 84 by water.

§ Dr. Robb.

The depth of the drift near the College is stated by Dr. Robb to be about 85 feet. The thickness of these deposits on the northeast side of the river appears to be considerably less than on the southeast side. Some of the wells on the Keswick are sunk through 7 feet fine gravel, 16 feet blue clay, and 4 feet coarse gravel resting on slates. In a well on a farm in the rear of Fredericton the rocks penetrated were as follows:—

Loose soil and sand, ...	2 feet 8 inches.
Yellow clay, ...	14 "
Dark clay, ...	4 "
Boulders and coarse gravel, ...	2 "

And in another well on the hill above the University—

Soil and sandy earth, ...	8 feet 3 inches.
Clay with small boulders and gravel, ...	7 "
Sandstone of the Carboniferous Series.*	

The depth of the blue clay forming the bed of the river is at least 60 feet.

TERRACES AT THE GRAND FALLS.

If we examine a plan of the Grand Falls after laying down the contour lines showing the different terraces, we can not fail to be struck with the following apparent facts :—

That previously to the glacial period the Saint John River pursued a straight course down the deep ravine to the west of the Portage road, possibly over falls. That this ravine extends from a little above the upper basin very nearly to the lower. It is apparently the former valley of the Saint John, now partially filled with drift.

The height of the upper basin above the level of the sea being 419 feet, it is clear that when the continent was submerged below that depth, the Saint John above the falls flowed directly into the ocean. During that period not only was the old channel partially filled up, but the glacial drift was rearranged over the tract of country near where the falls now are, and elsewhere. When the land began to rise again, the upper portion of the Saint John above the falls was a lake estuary in direct communication with the sea; the continued rising of the land converted this lake estuary into a river, which found its outlet, not by its old filled up channel, but by the course of the uppermost terrace, of which there are four, and all of which, be it observed, appear on Little or Falls River, showing that this Little River also cut its way through the rearranged drift. As the land rose, these terraces became successively developed in the ordinary process of drainage, until the river had re-excavated its ancient bed below the level of the ledge of rocks, when falls commenced and have existed since the Saint John cut out a channel for itself. The new falls began at the lower basin, near where, probably, the ancient falls once existed; the course of the excavated ravine

* In sinking a well near Bathurst, the workmen came to blue clay at a depth of 25 feet, some 200 feet above the sea. The blue clay, which was probably glacial drift, contained a very considerable quantity of bright iron pyrites. On Bull Creek, Woodstock, near the Saint John, there is a fine cliff of stratified yellow clay 60 feet above the stream,

was determined by the terraces, which, according to natural laws, the river had previously formed in the ordinary process of drainage. It is the terraces then which have determined the course of the gorge, not the gorge the formation and contour of the terraces. The gorge is simply a valley of erosion due to the action of running water, guided by a previously existing valley, and formed in the same manner and under similar circumstances as the gorge of the Tobique, or as the gorge of the Falls of Niagara. These valleys of erosion are every where to be seen, and water is competent to execute far more imposing monuments of its power, without calling in the aid of paroxysmal action, convulsions, or earthquakes.

The question will suggest itself to the reader, "why did not the Saint John follow its old channel direct from the upper to the lower basin." It is not difficult to frame a satisfactory answer to this question. The Glacial Drift now forming prominent hills near the falls, was once an unbroken barrier, holding up the lake-like estuary which at that remote period existed above the Grand Falls, and whose work is seen in the beautifully stratified fresh water marls, sands, and clays, on the banks of the river far above the Falls. The lowest point in this Drift barrier was on the course of the highest terrace, and this course was necessarily selected by the drainage waters of the estuary. Subsequently to the assumption of this new passage to the sea, the drift in the old valley has been gradually removed by the ordinary process of sub-ærial denudation, so as to mark its former existence by a depression of unmistakable origin.

DRIFT ISLANDS WHICH HAVE ESCAPED DENUDATION.

Islands on the Banks and Intervale (Flats.)

1. Island on the east bank opposite Robinson's Island, altitude of highest contour line, 150 feet.

2. Island in Gagetown Flats, altitude 51 feet.

3. Islands in Flats just above the mouth of Tenant's Cove.

   (*a.*) On east flat, altitude 50 feet, with an escarpment to the southeast.

   (*b.*) On west flats, altitude 350 and 380 feet, with escarpments to the southeast and northeast.

4. Island on Promontory, 250 feet high.

5. Island on east bank below Oak Point, 400 feet, with several Islands on west bank, 300 feet; escarpments on the river are common both a few miles above and below Oak Point and the mouth of the St. John, with terraces in the rear.

Terraces.

1. Terraces at Fredericton.
   Terraces opposite Gagetown.

2. On the Jemseg.

3. Round Oknabog Lake and opposite Long Island, highest contour line 400 feet. Distance from river ¼ of a mile.

4. Terraces have altitude of 400 feet northwest of Tenant's Cove, with an escarpment 400 feet high facing the east.

5. Terraces near the mouth of Belle Isle Bay have altitude of 350 feet.

Note.—Comparatively low terraces are numerous on the upper St. John. They are well seen at the mouth of the Tobique, and at Woodstock; they are also numerous on the Miramichi.

The foregoing Tables note some remarkable points on the River Saint John, between Fredericton and the sea, showing terraces, islands in the valley, and islands on the banks, which have partially escaped the denuding forces which excavated the bed of the river.

THE FALLS AT THE MOUTH OF THE SAINT JOHN.

The remarkable gorge in which these are situated is stated to be something more than a valley of erosion, although the gorges of the Magaguadavic, the Tattagouche, the Nicadoo, the Nipisiguit, the Upsalquitch, the Tobique, and numerous others belong to this class. With the exception, if it be one, of the gorge at the mouth of the Saint John, I have not seen any single instance in the Province which could not be explained by the action of ice and water, or generally, by erosion. On the supposition that the gorge of the Saint John at its mouth has been produced by a violent separation of the rock, (for it has been alleged that the salient and re-entering parts of the sides of this crack can be seen, and if the walls were brought together they would "fit,") it must be a crack or fissure, and if it be a crack which has allowed the waters of the Saint John to pass through their present channel, it will necessarily be of great depth, and in consequence of the strong currents to which it is subjected its depth will be constantly increasing. Soundings do not favour this view, for while the depth of water, according to Captain Owen's Survey, is 100, 114, 140, and even 160 feet between Navy Island and St. John, it does not exceed 87 feet in the Narrows above, and at the Split Rock it is not more than 119 feet in depth. At the Tidal Falls * the depth varies from 8 to 20 and 22 feet between the Mill and the Island; while in the small basin south of the Falls, 126 feet is recorded, and in the large basin above them, it varies from 122 to 204 feet deep, on a nearly due north and south course. The depth is also considerable opposite Indiantown, 195 feet being recorded; and in Grand Bay the depth continues great, varying from 104 to 180 feet.

These facts are certainly opposed to the view that the present outlet of the Saint John is the result of an earthquake fracture, but they favor the view that it is a valley of erosion, excavated subsequently to the Glacial Drift Period.

Nor has much change taken place within the last 254 years; for in the Relations of the Jesuits for the year 1611, there is an account of the voyage of le Sieur de Biencourt up the river, in which allusion is made, in the quaint old French spoken at that day, to the 'frightful difficulties' at the mouth of the Saint John.†

* In some parts of the Long Reach a depth of 126 feet is attained, but in general, soundings show a uniform depth of 70 feet for a long distance.

† La riuiere de S. Jean est au Norouest de Port Royal, y ayant entre-deux la Baye Francoise, large de 14 lieus. L'entrie de cest riuiere est fort estroite et tres dangereuse; car il faut passer au millieu de deux roches, desquelles l'une jette sur l'autre le courant de maree, estat entre deux auasi viste qu'un traict. Apres les roches suit un affreux et horrible precipice, lequel si vous ne passez a propos et quand il est comble doucement, de cent mille barques un poil n'eschapperoit pas, que corps et biens tout ne perist."

Between St. John and Portland there is a narrow and deep valley now occupied by a church, manufactories, and dwelling houses. In this valley, and above strata of clay, there are marl beds containing shells and decomposed sea weeds, identical with those still inhabiting the shores of the harbour. These beds are about 18 feet above the level of the sea, which at some former period surrounded the site of the city.*

The falls of the Saint John at its mouth are not "falls" in the ordinary acceptation of the term; they result from the narrow and shallow outlet through which the tide, which rises with great rapidity and to an altitude of 28 feet, has to pass. The outlet is not sufficiently broad or deep to admit the tidal waters with their rise, hence a fall inwards is produced during the flow; at the ebb, the tide recedes faster than the outlet of the river can admit of the escape of the waters accumulated within the inner basin, hence a fall outwards. Twice every day the waters are at a level on both sides of the gorge, and for half an hour or so these singular tidal falls are passable for vessels. A former outlet of the Saint John exists to the east of the City.

The following are instructions for going through the falls, which apply, we believe, to no other "falls" in the world:—

"The falls are level, or it is still water at about three and a half hours on the flood, and about two and a half on the ebb, so that they are passable four times in twenty four hours, about ten or fifteen minutes at each time. No other rule can be given, as much depends on the floods in the River Saint John, and the time of high water or full sea, which is often hastened by high southerly winds. For a few days in the spring of the year, the height of the water in the River Saint John renders the passage of the falls extremely difficult."

"Horsebacks."

The 'Horsebacks,' which are numerous in this Province, and consist of long raised beaches of gravel with boulders, were probably formed by glacial lakes; that is, they were washed up by lakes in the interior of a glacial mass, on those portions of the coast of the glacial lake which came in contact with the rocks over which the ice was moving. Hence the reason why these 'Horsebacks,' like the detached beaches of similar glacial lake origin, have only a certain limited length and terminate abruptly. There is a 'Horseback' near the Saint Andrews and Quebec Railroad, at M'Adam's Station, about 5 miles long. There are others on the Saint John above Woodstock, and elsewhere in the Province; and it may be that the barrier formerly existing at the Grand Falls was a 'Horseback.'

Action of Rivers on Their Banks.

Some years ago it was asserted that all rivers flowing from the north to the south had a tendency to wear away the right bank, and cut their beds in the rock to the right of their course, in preference, as it were, to the left.

* Dr. Gesner—Proceedings of the Geological Society, April 1861.

This subject has been investigated generally, with relation to the motion of Fluids and Solids relative to the Earth's surface, by Mr. W. Ferrel,* assistant in the Nautical Almanac Office at Washington. To those who are curious in such matters, it may be interesting to know that such great Flats as those of Fredericton, Gagetown, and elsewhere on the Saint John River, have probably been partly produced according to a general law which governs the motions of bodies on the earth's surface, and which may be thus briefly expressed:—

"In whatever direction a body moves on the surface of the earth, it is always deflected to the right in the northern hemisphere, and to the left in the southern hemisphere."

The motions of the atmosphere are materially influenced by this law, so are those of the ocean, but to a far less extent. The general eastward motion of the water of the northern part of the Atlantic, called the Gulf Stream, and the consequent depression of the water next the coast of North America, is the cause of the Greenland current.

The Gulf Stream flowing north is deflected towards the east, the Greenland current flowing south is deflected towards the west, hence they are preserved separate from one another as if divided by a wall.

When a railway train moves in a straight line at the rate of 40 miles an hour, at the parallel of 45°, the lateral pressure tending to throw it off the track, if it runs due north and south, is about one five thousandth part of its weight; if it moves from north to south, the lateral pressure is to the west, if from south to north, it is towards the east.

The equation deduced by Mr. Ferrel, by which the solution of problems similar to that just noticed may be determined, is as follows:—

Let v be the velocity of a body moving in any direction; F the deflecting force perpendicular to this direction; rn the lineal velocity at the equator, equal to 1523.2 feet in a second; then $n = .000072924 =$ angular velocity of the earth's rotation, r being the radius of the earth. Let $O =$ the polar distance in arc, and $g =$ gravity, or 32.2 feet. Then it is shown that $F = \frac{2v \cos. O}{289\, n} \times g$

In the case of a railway train moving at the rate of 40 miles an hour, v will equal 60 nearly at the parallel of 45°, and $F = \frac{1}{5188} g$ or the lateral pressure is equal to $\frac{1}{5188}$ of the weight of the train.

By making the necessary substitution in the case of a river flowing at the rate of one, two or three miles an hour, an approximation to the lateral force it exerts on its westerly bank, if it moves from north to south, will be obtained. The same equation may be applied by the curious to ascertain the lateral pressure of glaciers, which, although their movements are excessively slow, must, on account of their enormous weight, exert some lateral pressure, which may or may not be insignificant or immaterial, but it will always be a tendency to move *to the west* in the northern hemisphere.

* The American Journal of Science and Arts, January 1861.

If a glacier move at the rate of one foot per day, it will move $\frac{1}{86400}$ part of a foot in a second.

Putting this as the value of v in the equation—

$$F = \frac{2v \cos. O}{289n} \times g$$

where $n = .000072924 =$ the angular velocity of the earth's rotation, we have

$$F = \frac{1}{2,189,459,200} \text{ of its weight.}$$

Hence a glacier, in order to exercise a lateral pressure of 100 pounds due to the earth's rotation, must weigh upwards of 100 millions tons, if the equation can be considered applicable in this case.

ARTESIAN WELLS.

In some parts of the valley of the Saint John, the unbroken continuity of the blue clay would render the construction of Artesian wells, on the flats or intervales, an inexpensive and easy mode of obtaining a constant supply of Pure Water. If the water should fail to reach the surface on sinking through the blue clay to the probable layer of boulders below it, the dips of the sandstones belonging to the Carboniferous Series would generally ensure a supply; but it is yet a question which experiment alone can determine, whether borings for three or four hundred feet in the sandstones would not tap sheets of brine, or at least sheets of brackish water. The probability of obtaining a bountiful supply of fresh water within the limits of the Carboniferous basin, depends upon the locality; for these rocks have been subjected to gentle undulations, although their general dip is to the southeast at a low angle. There are, however, wide areas in which an Artesian well not more than 300 feet deep, and frequently far less, would pour forth a constant supply many feet above its outlet.

CHAPTER XI.

ECONOMIC MATERIALS IN THE DRIFT.

Bog Iron Ore or Limonite—Its formation—Its distribution—Importance of the Ore in Canada—The St. Maurice Forges—Wad or Bog Manganese—Principal Ores of—Its use in the Arts—Its use as a material for separating Gold from Quartz Sand, or Clays—Its use in the separation of Silver—Shell Marl—Kaolin for Pottery—Clays for Bricks and Pottery—Moulding Sand—Blue Phosphate of Iron—Gold—Its distribution in Auriferous Drift in Canada—In Glacial Drift—Mode of washing the Drift—The Hydraulic process—The Hydraulic process in California—Experiments on the River du Loup in Canada—Distribution of Gold in the Drift of New Brunswick—I. On the Upper Upsalquitch—II. The Nipisiguit—III. Campbell River and Long Lake—IV. The Serpentine—V. Blue Mountain Brook—VI. The Little South West Miramichi—VII. Springfield—VIII. Between Hopewell and Golden Mountain—IX. Dutch Valley Road—Conclusions—Miscellaneous Materials not in the Drift—Plumbago or Graphite—Dolomites—Origin of—Hydraulic Limestones—Composition of—Properties of—Grindstones—Probable Indian Relics on the Atlantic Coast—Professor Chadbourne's Account—Account in Sewall's Ancient Dominions—Mr. C. H. Hitchcock's Description—Mr. Morse's Account.

The Minerals of economic value found in the Drift are of considerable importance. They are Bog Iron Ore; Wad or Bog Manganese; Ochres; Shell Marl; Clays for Pottery; Silicious infusorial earth or polishing powder; impure Kaolin for the manufacture of superior articles of pottery; Blue phosphate of Iron for pigment; Gold, &c. These are generally found in the re-arranged Drift or Alluvium; also in the alluvial deposits in the valleys of rivers.

The most important metal found in the older or Glacial Drift is gold, derived from Palæozoic Rocks, partly by their decay and partly by the grinding process of glacial ice. The precious metal is also found in the re-arranged glacial drift or alluvium.

BOG IRON ORE OR LIMONITE—OCHRES.

The formation of this substance may be described as follows:—Water charged with organic matter, the result of the decay of vegetable substances, permeates ferruginous sediments or drift containing iron sand, and reduces the peroxide of iron to the state of protoxide which is soluble in water, and is brought to the surface by springs either as a carbonate of the protoxide of iron, or in combination with vegetables acids, (crenic, geic, and humic.) In contact with air these protosalts of iron absorb oxygen, the metal is rendered insoluble and is precipitated from the solution of the carbonate as a hydrated sesquioxide, or from the organic solution, as a compound of this oxide with the vegetable acid. While the purer limonites are nothing more than the hydrous sesquioxide of iron, the bog ores consist of variable mixtures of this with the organic compound, and some of the ochres are probably this combination in a nearly pure state.* The same process brings the manganese to the surface which is so frequently found associated with bog iron ores.

Dr. Gesner enumerates many localities where bog iron ores occur, some of these may become valuable for admixture with other ores of iron, or alone; the iron produced from them being generally of very superior quality. In view, however, of the enormous extent and excellent quality of the Woodstock ores, and the occurrence of excellent magnetic ores, noticed elsewhere, it is not very probable that the bog iron ores, without they are favorably situated, will be sought after for some years to come, although this variety has long been used in Canada.

"The Radnor Forges have within a few years been erected at Batiscan, in the Seigniory of Cap de la Madeleine, and are supplied with ore and charcoal from this and the adjoining Seigniory of Champlain. The crude ore is brought to the furnace, partly by the workmen of the Company, and partly by the farmers on whose land it is found. It is washed to free it from adhering earth, and then yields from forty to fifty per cent. of metal; about 2000 tons of cast iron being now produced annually from between 4000 and 5000 tons of ore. The number of workmen employed at the Radnor Forges varies from 200 to 400; a great many hands being required at certain seasons, to dig up and bring in the ore, and to prepare and transport the charcoal.

"The chief manufacture of the Company has, of late, been cast-iron wheels for railway cars, for which the metal appears well adapted. A pair of car-wheels, with an axle, of this manufacture, were sent by Messrs. Larue & Co. the proprietors of the Forges, to the International Exhibition of 1862, which were said to have run 150,000 miles. Wrought iron is also made at this establishment; and a rolling-mill has recently been erected here, which furnishes iron for the manufacture of scythes, and nail-rod iron."†

WAD OR BOG MANGANESE.

The application of Manganese to many manufacturing purposes, particularly those connected with bleaching and dyeing operations, is decidedly on the increase, and it is not improbable that a considerable demand for the oxide of this metal will grow out of its recent employment in the generation of nascent chlorine for the extraction of gold from auriferous rocks. This metal is rather extensively diffused in New Brunswick; and a special notice of its present application in the arts, with a brief description of Mr. Calvert's process for extracting gold, in view of its prospective value, will probably be acceptable.

The principal Ores of Manganese are—

1st. The grey or black peroxide, sometimes called grey manganese ore, and also *pyrolusite*. It contains 63.3 manganese, and 36.7 oxygen, in 100 parts.

* Geology of Canada. † Ibid.

2nd. Wad or Bog Manganese, or the hydrated peroxide. It differs, when pure, from the grey peroxide, in containing one atom of water.

In 1858 there were imported into Great Britain and Ireland, 24,171 tons of manganese, worth £193,368 sterling.

Manganese is now being largely used by the calico printer, and for the manufacture of bleaching powder; but it is the new application of the ores of this substance, in the production of nascent chlorine for the extraction of gold, that seems to promise the most rapid increase in the demand. The following process is due to Mr. F. C. Calvert, of Manchester, who communicated the results of his researches in a paper entitled "New Method of Extracting Gold from Auriferous Ores":—

"At the present time when the auriferous ores of Great Britain are attracting public attention, it may be advantageous to persons interested in gold-mining, to be made acquainted with a new and simple method of extracting gold from such ores, which presents the advantages of not only dispensing with the costly use of mercury, but of also extracting the silver and copper which the ore may contain. Further, it may be stated that the process can be profitably adopted in cases where the amount of gold is small, and the expense of mercury consequently too great. Without entering here into all the details of the numerous (about one hundred) experiments which I made some years since, before I finally arrived at the new method of extracting gold, which I have now the honor of communicating, allow me to state a few facts which are necessary to give a complete view of the subject. If 2.2 parts of pure and finely divided gold, obtained by the reduction of a salt of that metal, be added to 100 parts of pure sand, and placed in a bottle with a saturated solution of chlorine gas for 24 hours, only 0.5 of gold is dissolved. If the same experiment be repeated, but instead of chlorine water, a mixture of chlorine water and hydrochloric acid be used, 0.6 of gold is dissolved. If, instead of employing hydrochloric acid and chlorine gas, a mixture of sand, reduced gold, and peroxide of manganese, with hydrochloric acid, are placed in a bottle, 1.4 of gold is dissolved; so that it would appear that, under the influence of nascent chlorine, the gold is more readily dissolved than when the same gas is mixed in solution with hydrochloric acid, previously to being placed in contact with the auriferous sand. Still these processes leave a great deal to be desired in a commercial point of view, as more than a third of the gold remains undissolved. The same results are obtained if the chlorine gas be generated by another method, viz., by adding to the auriferous sand a mixture of chloride of sodium, sulphuric acid, and perozide of manganese. Being convinced, therefore, that nascent chlorine gas was a fit and proper agent for cheaply extracting gold from ores, and that it was probably only necessary to modify the method of operating, I allowed the mixture of hydrochloric acid and peroxide of manganese, or of sulphuric acid, peroxide of manganese, and chloride of sodium, to remain for twelve hours in contact with the auriferous sand; and, then, instead of washing-out the solution of gold, I added a small quantity of water, which removed a part of the acting agent, and this was made to percolate several times through the sand; by which method I succeeded in extracting from the sand, within a fraction the whole of the gold. I then repeated the last experiments with natural auriferous quartz, and easily extracted the two ounces of gold per ton which it contained. I therefore propose the following plan for extracting the gold on a commercial scale:—The finely-reduced auriferous quartz should be intimately mixed with about one per cent. of peroxide of manganese; and if common salt be used this material should be added at the same time as the manganese, in the proportion of three parts of salt to two of manganese. The whole should be then introduced into closed vats, having false bottoms, upon which is laid a quantity of small branches covered with straw, so as to prevent the reduced quartz from filling the holes in the false bottom. Muriatic acid should then be added if manganese alone is used, and diluted sulphuric acid if manganese and salt have been employed; and, after having left the whole in contact for twelve hours, water should be added so as to fill-up the whole space between the false and true bottoms with fluid. This fluid should then be pumped-up and allowed to percolate through the mass; and after this has been done several times, the fluid should be run off into separate vats for extracting the gold and copper it may contain. To effect this, old iron is placed in it to precipitate the copper; and after this has been removed, the liquor is heated to drive away the excess of free chlorine, and a concentrated solution of sulphate of protoxide of iron, or green copperas, must be added, which, acting on the gold-solution, will precipitate the gold in a metallic form. By this method, both gold and copper are obtained in a maketable condition. If silver is present in the ore, a slight modification in the process will enable the operator to obtain this metal also. It is simply necessary to generate the chlorine of the vitriol, manganese, and chloride of sodium process, taking care to use an excess of salt, that is, six parts instead of three, as above directed. The purpose of this chloride of sodium being to hold in solution any chloride of silver that may have been formed by the action of chlorine on the silver-ore, and to extract the metal, the following alteration in the mode of precipitation is necessary. Blades of copper must be placed in the metallic solution, to throw down the silver in a metallic form, then blades of iron to throw down the copper, the gold being then extracted as previously directed. I think the advantages of this process are, 1st, cheapness; 2nd, absence of injury to the health of the persons employed; 3rd, that not only is the metallic gold in the ore extracted (as is done by mercury), but it attacks and dissolves all gold which may be present in a combined state, besides enabling the miner also to extract what silver and copper the ore may contain."

Manganese deposits have long since been worked on the flanks of Shepody Mountain in Albert County; near Sussex Vale; at Quaco; and at the Tattagouche Mines in the County of Gloucester.

Wad or Bog Manganese is frequently found in the overlying drift in the neighbourhood of such deposits, having been brought to the surface in the same way as the iron of ochres, and some limonites or bog iron ores.

The total yield of the Nova Scotia gold fields for the quarter ended Dec. 31st, 1864, is officially stated to be 5,456 oz. 9 dwt. 5 gr., being in advance of any previous quarter. The total yield for the year 1864 is 20,022 oz. 13 dwt. 13 gr., against 14,000 oz. 14 dwt. 17 gr. for 1863.—The employment of manganese in separating the gold from the crushed quartz rock, will probably cause a rapid increase to take place in the production of the precious metal.

SHELL MARL.

This substance is extensively distributed in marshes, lakes and ponds throughout the Upper Silurian region in the northern part of the Province. It is a nearly pure carbonate of lime, and is valuable as a manure, as well as for the manufacture of lime. It originates from springs highly charged with the bi-carbonate, a soluble salt of lime; this becomes converted into the insoluble carbonate or chalk as soon as it reaches the air. Land shells abound in such waters, in consequence of their containing the necessary material with which small molluscous animals construct their habitations; hence it usually bears the name of shell marl, although the marl would not be one atom less in quantity if the shell-builders did not exist. These small creatures are numerous there, because the conditions for their increase are in the highest degree favourable.

KAOLIN FOR POTTERY.

Throughout the granitic region in the County of Charlotte, and particularly on the flanks of the felspathic range which runs through that County, there are several ponds and lakes which contain a whitish mud, composed altogether of impure kaolin. From personal experience, I am not aware of any very considerable deposit, but I have been informed on excellent local authority, that this material exists in great abundance, and in a comparatively pure state, in the form of an impalpable mud, covering the bottom of a lake lying within the limits of the felspar region in Charlotte County. As this is not only very probable, but of some economic importance, the more especially as efforts are now being made in St. John to establish extensive pottery works of the better sort, it is desirable that such deposits should become publicly known, and use made of them.

CLAY FOR BRICKS AND POTTERY, MOULDING SAND, &c.

When voyaging up the Saint John River in canoe during the past summer, the remarkable deposits of fine blue and yellow clays which appear in the form of high banks some miles above the Grand Falls, seemed to merit attention. The quantity is unlimited, and the quality of some of the layers appeared to be excellent. Other bands are too calcareous, and others too ochreous to serve for the manufacture of bricks or pottery. Layers of fine sand, suitable for moulding sand, are common on the Saint John, and an immense deposit was seen below Tibbits' Brook, near the mouth of the Tobique, and also in patches lower down the river, and about 20 miles above the Grand Falls, where fine clays suitable for pottery and bricks are abundant.

BLUE PHOSPHATE OF IRON—PIGMENT.

This beautiful mineral is found in considerable quantities in the alluvial clay-banks just alluded to, about 25 miles above the Grand Falls, near the mouth of Green River. The bank here is remarkable, and is worthy of a more minute examination that could be devoted to it. Being situated not far from the thickly settled Parish of Saint Basil, it may become a valuable source of industry to the Acadian settlers on the river banks. The whole of the alluvial terraces of this part of the Saint John, particularly on the east side, are rich in clays, sands, ochres, and blue phosphate of iron.

GOLD.

The interest which is naturally attached to rocks containing the precious metal, or to drift clays and sands throughout which it is distributed, may render an account of the manner in which gold is found in either form acceptable to the general reader, and with this view the following abbreviations from the "Geology of Canada" are subjoined:—

'The existence of gold in the sands of the Chaudière valley was first made known by Lieutenant, now General Baddeley, R. E., in 1835; and within the last twelve years repeated examinations have shown that the precious metal is not confined to that region, but exists in the superficial deposits of a wide region on the south side of the Saint Lawrence extending from the Saint Francis to the Etchemin River, and from the first line of hills on the northwest to the province line on the southeast. The source of the gold appears to be the crystalline schists of the Notre Dame range; and the materials derived from their disintegration, not only constitute the superficial material among the hills of this range, but are spread over a considerable area to the south of them. These same gold-bearing rocks may be traced south-westwardly, along the great Appalachian chain to the southern States of the Union, and are supposed to belong for the most part to the Quebec group. Native gold has however been found in small grains with galena, blende, and pyrites, in a well defined quartz vein, cutting slates which are supposed to be of Upper Silurian age, at the rapids of Saint Francis, on the Chaudière.* In Leeds, at Nutbrown's shaft, masses of native gold of several pennyweights are found with copper-glance and specular iron ore, in a vein of bitter-spar; and small grains of the metal have also been found imbedded

* In 1862, another quartz vein was opened about 100 yards from the last, and has yielded fine specimens of native gold, associated with arsenical pyrites. In 1863, native gold was discovered in a quartz vein with vitreous copper ore, at what is called the Chaudiere copper mine, in the rear part of the seigniory of Saint Giles. An assay of this quartz by Dr. Hayes of Boston yielded only 6¼ pennyweights of gold to the ton. Gold has also recently been found in a vein at the Halifax copper mines, by George Pierce, Esquire; and an essay of the vein-stone from this place gave about the same proportion of the precious metal as the quartz from Saint Giles. Traces of gold have also been found in a decomposing pyrites from Moulton Hill in Ascot, and it has recently been met with in Ditton.

in a white garnet-rock described elsewhere.* These latter localities belong to the rocks of the Quebec group, but the precious metal has rarely been found in place, and the working of it in Canada has been confined to the superficial deposits of cla sand, and gravel already mentioned. The occasional occurrence in these c. pieces of gold partially imbedded in quartz, shows that it was derived, in part at least, from beds or veins of this mineral, which are common among the talcoid slates of the region. The observations among the gold-bearing rocks of the Southern States seem to show that the precious metal was originally deposited in the beds of various sedimentary rocks, such as slates, quartzites, and limestones, and that by a subsequent process it has been, in some instances, accumulated in the veins which intersect these rocks. The formation of these veins would seem, from the one above described at Saint Francis, to be subsequent to the Silurian period. The same considerations apply to the copper and lead ores of the Eastern Townships.'

MANNER IN WHICH THE GOLD IS DISTRIBUTED.

'The gold is found very generally disseminated throughout the diluvial deposits over the region already designated in Canada, and is not confined to the river beds; the action which distributed the gravel over the surface being anterior to the formation of the present water-courses. When, by the process of washing, the heavier portions of the auriferous gravel have been brought together, they are found to contain abundance of black ferruginous ores, consisting of magnetic iron, hematite, both specular and compact, chromic iron and ilmenite; with occasional grains of garnet, rutile, and more rarely zircon and corundum. The gold is in grains, sometimes angular, but more often rounded, and varying in size from masses of half a pound weight to a fine dust, which last is separated by amalgamation from the black iron-sand.'

Mention is made in the Geology of Canada, (pages 518, 520,) of a quartz vein at Saint Francis, on the Chaudière; where small grains of native gold have been found imbedded in quartz, together with argentiferous galena, and sulphurets of zinc and iron, both containing gold, and with arsenical pyrites; much larger specimens of gold have since been found in quartz, about one hundred yards from the locality just mentioned. It is probable that this, and similar quartz veins, may be wrought with profit; but the gold hitherto obtained from this region has been from the superficial deposits of clay, sand and gravel which abound there, and appear to be derived from the breaking up of the rocks that contain the gold-bearing veins. These deposits probably belong in part *to the ancient glacial drift*, or boulder formation, and in part to newer stratified clays and gravels, which consist of the materials of this, modified and arranged by the subsequent action of water. On the Magog River, above Sherbrooke, particles of gold occur in a hard-

* This rock occurs with serpentine on the river Guillaume, the most northern tributary of the right bank of the Chaudiere in Vaudreuil. The next one, being in the southern part of Saint Joseph, is named on Bouchette's map the Riviere des Plantes.

bound gravel, 156 feet above the level of Saint Francis, near by. On the Famine River, there is met with an extensive deposit of clay, every where overlaid by sand and gravel. Along the banks of the river, a stratum of the oxyds of iron and manganese, in some parts six or eight inches thick, is seen near the top of the gravel, filling interstices among pebbles of the rocks of the region. Gold is found in this overlying gravel, as well as in the clay beneath; both of which deposits appear to belong to the modified drift. It is met with in similar conditions throughout the banks of stratified material on the Metgermet, which attain a height of fifty feet above the bed of the river. Gold also occurs still more abundantly in the recent alluvions found in the beds and along the flats of the streams which traverse this region, and in time of floods wash down the clay and sand from their banks, depositing the heavier portions along their course. In this way the gold is often caught in the fissures of the clay-slates, which frequently form the underlying rock, and are rich in alluvial gold.

The auriferous drift of Eastern Canada is spread over a wide area on the south side of the Saint Lawrence, including the hill-country belonging to the Notre Dame range, and extending thence south and east to the boundary of the Province. These wide limits are assigned, inasmuch as although gold has not been everywhere found in this region, the same mineralogical characters are met with throughout; and, in its continuation southward, in Plymouth and elsewhere in Vermont, considerable quantities of gold have been obtained from the alluvial deposits.

It would appear from the facts here given that the quantity of gold in the valley of the Chaudière is such as would be remunerative to skilled labour, and should encourage the outlay of capital. There is no reason for supposing that the proportion of the precious metal to be found along the Saint Francis, the Etchemin, and their various tributaries, is less considerable than that of the Chaudière.'

THE HYDRAULIC METHOD.

What is called the hydraulic method of washing such deposits is adopted on a great scale in California, and to some extent in the States of Georgia and North Carolina. "In this method, the force of a jet of water, with great pressure, is made available both for excavating and washing the auriferous earth. The water, issuing in a continuous stream, with great force, from a large hose-pipe like that of a fire-engine, is directed against the base of a bank of earth and gravel, and tears it away. The bank is rapidly undermined, the gravel is loosened, violently rolled together, and cleansed from any adhering particles of gold; while the fine sand and clay are carried off by the water. In this manner hundreds of tons of earth and gravel may be removed, and all the gold which they contain liberated and secured, with greater ease and expedition than ten tons could be excavated and washed in the old way. All the earth and gravel of a deposit is moved, washed, and carried off through long sluices by the water, leaving the gold behind. Square acres of earth on the hill-sides may thus be swept away into the hollows, without the aid of a pick or a shovel in excavation. Water performs all the labor, moving and washing the earth in one operation; while in excavating by hand, the two processes are of necessity entirely distinct. The value of this method, and the yield of gold by it, as compared with the older one, can hardly be estimated. The water acts constantly, with uniform effect, and can be brought to bear upon almost any point, where it would be difficult for men to work. It is especially effective in a region covered by trees, where the tangled roots would greatly retard the labor of workmen. In such places, the stream of water washes out the earth from below, and tree after tree falls before the current, any gold which may have adhered to the roots being washed away. With a pressure of sixty feet, and a pipe from one and a half to two inches aperture, over a thousand bushels of earth can be washed out from a bank in a day. Earth which contains only one twenty-fifth part of a grain of gold, equal to one fifth of a cent in value to the bushel, may be profitably washed by this method; and any earth or gravel which will pay the expense of washing in the old way, gives enormous profits by the new process. To wash successfully in this way requires a plentiful supply of water, at an elevation of fifty to ninety feet above the bed-rock, and a rapid slope or descent from the base of the bank of earth to be washed, so that the waste waters will run off through the sluices, bearing with it gravel, sand, and the suspended clay."

The above description has been copied from a report on the gold mines of Georgia, by Mr. William P. Blake, who has carefully studied this method of mining in California, and by whose recommendation it has been introduced into the Southern States. He tells us that in the case of a deposit in North Carolina, where ten men were required, for thirty-five days, to dig the earth with pick and shovel, and wash it in sluices, two men, with a single jet of water, would accomplish the same work in a week. The great economy of this method is manifest from the fact that many old deposits in the river-beds, the gravel of which had been already washed by hand, have been again washed with profit by the hydraulic method. He tells us that in California the whole art of working the diluvial gold-deposits was revolutionized by this new method. The auriferous earth, lying on hills, and at some distance above the level of the water-courses, would, in the ordinary methods be excavated by hand, and brought to the water; but by the present system, the water is brought by aqueducts to the gold-deposits, and whole square miles, which were before inaccessible, have yielded up their precious metal. It sometimes happens, from the irregular distribution of the gold in the diluvium in California, that the upper portions of a deposit do not contain gold enough to be washed by the ordinary methods; and would thus have to be removed, at a considerable expense, in order to reach the richer portions below. By the hydraulic method however, the cost of cutting away and excavating is so trifling, that there is scarcely any bank of earth which will not pay the expense of washing down, in order to reach the richer deposits of gold beneath.

The aqueducts or canals for the mining districts of California are seldom constructed by the gold-workers themselves, but by capitalists, who rent the water to the miners. The cost of one of these canals, carrying the waters of a branch of the Yuba River to Nevada County, was estimated at a million of dollars; and another one, thirty miles in length, running to the same district, cost $500,000. The assessed value of these various canals in 1857, was stated to be over four millions of dollars, of which value one half was in the single county of Eldorado. The Bear River and Auburn Canal is sixty miles in length, three feet deep, and four wide at the top, and cost in all $1,600,000; notwithstanding which, the water-rents were so great that it is stated to have paid a yearly dividend of twenty per cent.; while other similar canals paid from three to five and six per cent., and even more, monthly. The price of the water was fixed at so much the inch, for each day of eight or ten hours. This price was at first about three dollars, but by competition it has now been greatly reduced.

CAPITAL REQUIRED IN GOLD MINING.

From the foregoing statements, it will be seen that the great riches which have of late years been drawn from the gold mines of California, have not been obtained without the expenditure of large amounts of money and engineering skill. This last is especially exhibited in the construction of these great canals, and the application of the hydraulic method to the washing of auriferous deposits which were unavailable by the ordinary modes of working, on account of their distance from water-courses, or by reason of the small quantity of gold which they contain.

In order to judge of the applicability of this method of washing to our own auriferous deposits, a simple calculation based upon the experiments upon the Riviere du Loup will be of use. It has been shown that the washing of the ground over an area of one acre, and with an average depth of two feet, equal to 87,120 cubic feet, gave in round numbers, about 5000 pennyweights of gold, or one and thirty-eight hundredths grains to the cubic foot; which is equal to one and three-quarters grains of gold to the bushel. Now, according to Mr. Blake, earth containing one forty-fourth part of this amount, or one twenty-fifth of a grain of gold, can be profitably washed by the hydraulic method; while the labor of two men, with a proper jet of water, suffices to wash one thousand bushels in a day; which, in a deposit like that of Riviere du Loup, would contain about seventy-three pennyweights of gold. It is probable however that a certain portion of the finer gold dust, which is collected in the ordinary process, would be lost in working on the larger scale. It has already been shown that the gold in Canada is not confined to the gravel of the river channels, and the alluvial flats; but it is found on the Metgermet and Saint Francis Rivers, at from fifty to a hundred and fifty feet above their beds; and although its proportion were to be many times less than in the gravel of the Riviere du Loup, these thick deposits, which extend over great areas, might be profitably worked by the hydraulic method. The fall in most of the tributaries of the Chaudiere and of the Saint Francis, throughout the auriferous region, is such that it would not be difficult to secure a supply of water with a sufficient head, without a very great expenditure in the construction of canals; and it may reasonably be expected that before long the deposits of gold-bearing earth, which are so widely spread over the southeastern Canada, will be made economically available.*

GOLD WASHINGS IN RUSSIA.

Formerly the Russian mines were celebrated throughout the world for their productiveness. They are principally drift and alluvial washings, and the quantity yielded by the clays, sands and gravel does not generally exceed one grain of gold for 60 lbs. of earth, but sometimes the yield rises to double that average, but never exceeds it. The washings on the River du Loup yielded one and thirty eight hundreths of a grain of gold to the cubic foot of soil, hence it is probable that from this comparison, the Canadian Drift would be amply remunerative if the hydraulic method were employed, and as the Drift extends into this Province on the upper Saint John, it may be worth while to examine the glacial deposits there. Gold has been found in the drift over a large area in the valley of the Saint John, which runs through the State of Maine. Its source is probably the Quebec Group of rocks just north of the Boundary Line, or it may be that the auriferous quartz veins in the Upper Silurian Rocks have largely contributed to the productive clays in that region.

GOLD IN NEW BRUNSWICK.

In this Province there is a large area occupied by auriferous drift, but in consequence of its shallowness, it appears probable that it will not be found so rich as in Canada East, in those localities which are supposed to lie nearest the source of the gold. An exception to this may, perhaps, be found in the upper Saint John, whose waters are in direct communication with the source of the auriferous drift of Canada East.†

In this Province drift gold has been found in the following localities during the past Summer.

I.—*The Upper Upsalquitch.*

The drift on the shores of Upsalquitch Lake is feebly auriferous. The adjective is used in order to express what the writer himself ascertained, but it may be quite inapplicable when applied to the experience of more prospectors in this region. Very fine particles of gold were obtained by washing the

* Notes on the gold of Eastern Canada, being a reprint of portions of various Reports of the Geological Survey of Canada from 1845 to 1863.

† "It is not supposed that the limits of the auriferous district have been ascertained, but that it very probably extends much farther to the northeast, and attains the valley of the River Saint John; while to the southwest it is known to reach Vermont, and to be traceable at intervals through the United States, even it is said as far as Mexico. In its breadth, however, it does not appear to cross the range of mountains with which it runs parallel, and no traces of it have been met with on their northwestern flank."—(Geology of Canada, Report 1851.)

alluvial soil in a brook near an old lumberer's camp, about a quarter of a mile from the Lake. But the experiment was not considered decisive; the only means of digging were furnished by a large hunter's knife, and the only means of washing by a tin plate. Very fine black sand was obtained in considerable abundance. In order to make a fair trial of this part of the country, the drift should be taken from the surface of the rock on which it rests, and at least ten bushels of it thoroughly and carefully washed, as the gold will most probably be, like the sand, exceedingly fine. There is a very large proportion of quartz debris in the river where it issues from the lake; some of the larger fragments were broken and carefully examined, but without success.

II.—*The Nipisiguit.*

On the lower Nipisiguit, near the Grand Falls, I collected the sand and gravel which had been lodged in crevices on the side of a steep declivity down which a small stream sends a thin column of water in the spring and fall. I washed about one gallon of the sand and found several small grains, two filaments, and some very fine gold. If the gold, as I suppose, originates in the Quebec Group of rocks, the breadth of the series here north of the Grand Falls would not be more than three or four miles in the direction of the glacial grooves; thirty miles up the river it would be at least 18 miles broad in the direction of the glacial grooves, but there I made no attempt to wash for gold; had I been aware of its existence in the drift near the Grand Falls, I should certainly not have omitted to give the drift about the Indian Falls a fair trial.

III.—*Campbell River and Long Lake.*

I washed the alluvial drift on this river near the mouth of Long Lake fork, and found much black sand, with a few particles of gold.

IV.—*Long Lake Dividing Ridge.*

The sands in the bed of a small river leading from the height of land into Long Lake looked very promising, I washed two pans but found neither black sand nor gold; but the drift clay on the dividing ridge between the Long Lake waters and the Little S. W. Miramichi is auriferous. This, however, is essentially a granite boulder country; the substratum in the valleys being composed of huge boulders through which the small streams of water flow for miles without appearing at the surface.

V.—*The Serpentine.*

There is very little drift on this river; and the rocky banks below Campbell River are between 500 and 600 feet high for several miles down. The drift above the rise of the river is auriferous, but the alluvial drift gave no gold.

VI.—*Blue Mountain Brook.*

In a valley on the north side of Blue Mountain, near a Beaver dam, a quart of clay gave several small specks of gold. There being, however, no water conveniently situated for washing near at hand, I instructed an Indian to carry a tin can holding about one and a half gallons of earth until we came to water; the earth yielded several scales and grains of gold about one eighth of an inch in diameter. It was taken from as low a level in the almost dry valley of the brook as possible, and the stones were picked out. This is perhaps the most favourable specimen of auriferous drift I have met with in the Province, but it does not equal drift which I have washed on the River du Loup in Canada.

VII.—*The Little South West Miramichi.*

The drift from this river is feebly auriferous. The gold is very fine, as well as the black sand. Alluvial clay was taken from the immediate bank of the river, and may have been thoroughly washed by river action. The drift on the side of the hill showed more black sand, and perhaps a few more very fine particles of gold; but on the whole the washings were not encouraging.

VIII.—*Springfield, seven miles northwest of Norton Station.*

The gravel from a small brook in Springfield gave an unusually large quantity of the black sand, much of which consisted of the black magnetic oxide; there were also scales of specular iron, and two or three very small particles of gold. The large proportion of the iron sand is explained by the existence in this vicinity of an important bed of the magnetic oxide, the boulders of which are numerous throughout this part of the country.

IX.—*Between Hopewell and Golden Mountain.*

Two trials hastily made during very rainy weather late in the fall, showed that the Drift of this part of the country is slightly auriferous; but these trials are not considered sufficient or satisfactory.

X.—*Dutch Valley Road.*

Some fragments of iron pyrites taken from a vein penetrating an altered schistose rock on the road from Sussex Vale up the Dutch Valley to the Shepody Road, yielded traces of gold. I was subsequently shown some specimens of iron pyrites in which gold could be distinctly seen with the unassisted eye, which it was stated came from the same locality.

Conclusions.

Upon a review of the few attempts, properly conducted, which I have been able to make during the past summer in relation to the auriferous character of the Drift clays which cover certain portions of the country, the following conclusions appear to be just:—

1st. Experience shows that certain Drift clays in the Province are auriferous; but

2nd. No sufficient proof has yet been obtained to show that these Drift clays are so rich in the precious metal, as to make the working of them a promising speculation; and

3rd. Sufficient trials have not yet been made to admit of any definite opinion being expressed in relation to them, but enough is known to render a further and a systematic examination very desirable.

With capital to erect and conduct hydraulic operations to wash the Drift, there can be no doubt whatever that the clays in some localities would amply remunerate the outlay, but for the ordinary operation of slucing on a small scale, considered in relation to the geographical position of these clays, their remoteness from any source of supply, it would require more exact information than is at present available to warrant the expression of a favourable opinion. At the same time the fact must be taken into consideration and kept constantly in view, that the examinations were made only in the superficial deposits of clay, whereas coarse gold from its great specific gravity is found in the lower stratum and generally on or close to rock upon which the clays rest. These lower clays have in no single instance been reached, neither time nor labour being at my command to enable me to examine them. While therefore the ascertained presence of Gold in the upper Drift, is not yet, by itself, worthy of being regarded of much importance, as a source of the precious metal; it is of very considerable importance as showing—

1st. The probability that the lower and unmodified clays, constituting the original Glacial Drift, will be found remunerative when worked by the hydraulic process.

2nd. That the origin of the Drift establishes the fact that gold bearing rocks exist within the limits of the Province over wide areas, to the north of the localities where the fine gold in the superficial Drift has been discovered; and

3rd. That these gold bearing rocks probably lie within the limits of the Lower Silurian Series, and especially of that portion which has been described as the Quebec Group.*

The recent official Report of the Inspector of the Chaudiere District, (November 30th 1864,) Major de Bellefeuille, gives an encouraging account of gold discoveries in Canada. The labours of an average of 250 men extended over 116 days, were estimated to yield $116,000.

"As I remarked above," says the Inspector, "if the unfavourable weather the miners experienced in September and October be taken into consideration; also the small space from which that amount was extracted, viz: about three square *arpents*, it cannot but prove the immense wealth of this gold-bearing region. The success with which the few miners still remaining here meet, is but another proof of gold in this part of the Province; it's only a few days ago that one man took out, in one day, nine ounces, and the day previous, the same person had found a nugget of five ounces; that amount was found in a claim that had been, as they believed, well worked. Corroborating thereby what I heretofore mentioned, how imperfectly the mining was carried on."

* On the River du Loup in Lower Canada, Upper Silurian Rocks, penetrated by quartz veins, are supposed to be one source of the gold of that valley, and of the Chaudiere. Upper Silurian Rocks cover nearly the whole of the Province north of the Quebec Group, but it is not known whether they are penetrated by quartz veins.

The positive existence of gold in quartz veins penetrating the Upper Silurian Rocks over a wide extent of country, gives especial value to a large area in New Brunswick, north of the Quebec Group, where altered Upper Silurian Rocks occur.

"Quartz veins are to be found everywhere from the village of St. Francois to the boundary line. Gold has been detected in almost every vein; there is one particularly in the upper part of the first concession, not very far from the Gilbert line, produced by assay, viz: 22 dollars of silver and 15 dollars of gold per ton. This was taken from the surface,—the width of the vein being six feet,—and stripped to the length of 40 feet. Another very promising vein running northeast, intercepted by numerous small veins running due east and west, exists opposite the church of St. Francois on the eastern side of the village. It is supposed to cross the river and continue on the western side of the River Chaudiere."

"In the vicinity of the Famine, quartz has also been found. The mouth of the Du Loup has also brought out innumerable small veins running parallel to each other, in which gold has been found. On the Mill Stream and at the Grand Coulee, both tributaries of River Du Loup, quartz has been assayed, and found to contain gold.

"About the Metgermette and the Oliva, fine quartz is also to be met with. Not very distant from those two rivers, quartz was found on the Du Loup, which having been assayed gives 8 dwts. to the ton; this was also taken from the surface. Between the Portage and Kempt streams, tributaries of the Du Loup, two large veins are observed, they also contain gold. A short distance from the Monument River, a beautiful vein of quartz is to be seen from which gold has been extracted, by merely breaking the surface of the quartz with a hammer; the same results were obtained by Professor Hind,—I believe it was about the Metgermette—by merely crushing it with a stone.

"Quartz veins are to be opened and worked next spring at the village of St. Francois; the Devil's Rapids, where a crushing mill is to be erected. On the Oliva or Metgermette, there is another mill to be constructed. On the highlands of the Du Loup, and I believe on the Kempt stream, veins will be worked and that with profit. From the opinion I have heard expressed by several Professors of Geology, who have visited the mines, and particularly the quartz lodes during the season, I cannot but prognosticate great results to the country by the opening up of such lodes, and by the proper development of the mines which lay buried in this extensive and rich region. There is not the least doubt as to the presence of gold, and that in large quantities."

The quartz vein alluded to by the Inspector as having been found to contain gold by the writer of this Report, is situated on the Du Loup, near to the Metgermette, which river it probably crosses. A description of this vein, and of the mode in which the gold was obtained, together with a particular account of the auriferous character of an area containing 6,600 acres on the Du Loup, and embracing part of the Metgermette, is contained in a Report by the writer, on the River du Loup Mining Company's property.* The statements embodied in the above extracts from Major de Bellefeuille's Report, appear to show that gold is generally distributed in the quartz veins of the Upper Silurian Rocks on the Du Loup. Rocks of this age occurring in New Brunswick, north of the Quebec Group, (see Chapter VII.) suggest the possibility of similar auriferous areas being found in this Province.

* Boston, 1861. Report on the River du Loup Mining Company's location, by Henry Y. Hind.

MISCELLANEOUS MATERIALS NOT IN THE DRIFT.

PLUMBAGO OR GRAPHITE.

The occurrence of Plumbago or Graphite in many localities in this Province, coupled with the valuable process invented by Mr. Brockendon for purifying and preparing this material, make it desirable that attention should be directed to known deposits in New Brunswick. Although graphite or plumbago is widely distributed in small quantities, the following localities are worthy of special notice: Portland, Hammond River, Four miles north of Saint Stephen, Dorchester, Mackerel Cove, Goose Creek. Plumbago is known under the names of Graphite, Black Lead, and Carburet of Iron. Black lead pencils were in use in 1565. At one time £100,000 sterling was realized from the Borrowdale mine in Cumberland (England) in one year, the Cumberland plumbago selling at 45 shillings a pound. This source of supply is now nearly exhausted. Norway, Finland, Ceylon, the East Indies, Bohemia, and Canada, all furnish more or less of this material. The price of which has diminished on account of the discovery of a process by Mr. Brockendon by which impure varieties can be purified. Mr. Brockendon conceived the idea of solidifying the powder by pressure, without the intervention of any foreign adhesive substance, such as glue or gums.

The presence of air between the particles of plumbago proved in the first instance a fatal objection, the apparatus employed in the compression breaking at each attempt. By exhausting the air from the powder previously introduced into paper cylinders, under the receiver of an air pump, it was found that when subsequently submitted, without exposure to the atmosphere, to a heavy pressure, perfect adhesion of the particles took place, and a mass of plumbago or graphite was produced equal in beauty and solidity to the native minerals of Cumberland.

Ordinary plumbago is too impure to be submitted to this process without preparation. It is essential for the success of the operation that the foreign substances should be eliminated.

Mr. Brodie effects this by submitting the plumbago in coarse powder in an iron vessel to twice its weight of common sulphuric acid, and seven per cent. of chlorate of potash, and he heats the whole over a water bath until chloric oxide ceases to be evolved. By this means the compounds of iron, lime, and alumina present, are rendered for the most part soluble, and the subsequent addition of a little fluoride of sodium to the acid mixture, will decompose any silicates which may remain and volatilize the silica present. The mass is now washed with abundance of water, dried and heated to redness. This last operation causes the grains of plumbago to exfoliate, and the mass swells up in a surprising manner, and is reduced to a state of very minute division. It is then levigated, and obtained in a state of great purity, ready to be compressed by the method of Brokendon.*

* Vide Ure's Dictionary of Arts, Manufactures, and Mines. Last Edition.

Besides its use for the manufacture of pencils, this finely divided plumbago is advantageously employed for the glazing of gunpowder, and for the preparation of a paint.

DOLOMITES.

Dolomite is a mineral which in its purest state is composed of equivalent weights of carbonate of lime and carbonate of magnesia, these being in the proportions of 50 to 42, or in 100 parts of 54·35 of carbonate of lime, and 45·65 of carbonate of magnesia. This compound is distinguished from carbonate of lime by its greater density (which is from 2·85 to 2·90), and by its somewhat superior hardness. It is also much less readily attacked by acids than carbonate of lime, and at ordinary temperatures does not perceptibly effervesce with nitric or muriatic acids, unless reduced to powder. When calcined it gives a mixture of lime and magnesia, which is said to yield a stronger mortar than ordinary lime, but which slakes slowly and with but little evolution of heat.

A portion of the magnesia in dolomite is often replaced by protoxyd of iron, and more rarely by oxide of manganese. The dolomites containing carbonate of iron are generally yellowish or reddish on their weathered surfaces, from the change of a portion of the iron into hydrated peroxide, and those containing carbonate of manganese become brownish-black on the exterior from a similar cause.

Crystallized dolomites occur in veins and cavities in various rocks, and have received the names of *bitter-spar* and *pearl-spar*, the latter in allusion to the pearly lustre of the faces of the rhombohedron, which are generally curved.

Bitter Spar form the chief part of the vein stone of the Vernon Copper Mines.*

Dolomites may be produced by the mutual decomposition of bicarbonate of lime and sulphate of magnesia, yielding gypsum and bicarbonate of magnesia, which are successively deposited by evaporation. Hence the constant association of magnesian rocks with stratified gypsums. When bi-carbonate of lime which is abundant in sea water, is precipitated as a carbonate and mingled with carbonate of magnesia, they give rise to a double carbonate which constitutes dolomite.

HYDRAULIC CEMENTS.

The thin bands of limestone which occur in great profusion throughout the Upper Silurian Series as developed on the Saint John above Presqu'ile, and also many of the thin layers in the lower rocks near Woodstock, would yield a good hydraulic cement. The properties of this material are dependent upon an admixture of clay with the lime, and artificial compounds can be frequently prepared and used to a large extent.

* For an excellent description of the origin, distribution, and characters of dolomites, the reader is referred to an article by Professor Sterry Hunt, in the Report of the Geological Survey of Canada for the year 1857. Also, page 217 of the Report for 1858, where the origin of dolomites is discussed.

The Hydraulic cement employed in the construction of the Victoria Bridge consists of,—

Lime, ...	53.55
Magnesia, ...	2.20
Silica, ...	29.88
Alumina and oxide of iron, ...	12.70
Sulphate of Lime, ...	1.58
	99.91

This cement was found to set in from ten to fifteen minutes after mixing, with disengagement of heat.

Artificial mixtures are prepared by mingling carbonate of lime with clay and calcining the mixture; when natural admixtures of clay and lime occur, they are more advantageously employed than those prepared by artificial means, probably on account of the intimate mixture of the materials of which they are composed.

When a limestone contains ten or fifteen per cent. of clay, it becomes an hydraulic limestone; when the clay amounts to one third of the lime the mixture yields a mortar which hardens almost immediately under water. Dolomites and magnesian limestones generally yield with clay an equally good hydraulic cement.

GRINDSTONES.

The falling off in the manufacture of grindstones in the Province is remarkable. The number produced in 1851 was 58,849, against 42,476 in 1861, being a decrease of 16,373. This decrease has taken place in the County of Westmorland, which produced 33,080 less in number in 1851 than in 1861. In Gloucester an increase of 6,898 is recorded in the Census Tables.

PROBABLE INDIAN RELICS ON THE ATLANTIC COAST.

On various parts of the Atlantic Coast, and more especially on the coast of Maine, heaps of shells, interstratified with charcoal, and commingled with bones of existing animals have been discovered and described from time to time. The interesting discussions which have taken place in Europe respecting the antiquity of man in connection with the remarkable discoveries of his handy work in nearly all European countries, of an age far more remote than has generally been assigned to his existence on earth, invest with much interest whatever may tend to throw light upon this difficult but fascinating subject.

Relics of Indians, evidently of very great antiquity have been found at Newcastle, Trenton, Damariscotta, Goose Island, and many other places in Maine, and with less confirmation, on various parts of the coast of New Brunswick, in Charlotte County.

A few years since, Professor Chadborne of Bowdoin College, published, in the transactions of the Maine Historical Society, an account of a visit to the beds of oyster shells at Damariscotta. He considered them to afford indubitable evidence that the beds had been made by men. He drew the inference from the position of the piles of shells, the deposit beneath them, the arrangement of the shells in piles, the frequent occurrence of charcoal mixed with the shells even to the bottom, from the fact that fires had evidently been built among them near the bottom, turning a portion of them to lime, which is mingled with the charcoal, and finally, from the mixture of other animal remains, as common clams (*Mya arenaria*), thick shelled clams (*Venus mercenaria*), fragments of the bones of birds, the bones of beavers, with their teeth, and sturgeons plates.

The shells occur in small piles 10 or 15 feet in diameter, and apparently two or three feet deep. The deposit under the shells differs in no respect from the land in the immediate neighbourhood. The shells are entirely distinct from the soil and seem to have been thrown together in a heap. Fires appear to have been occasionally built upon the heaps, fragments of charcoal being numerous in layers.

In "Sewall's Ancient Dominions," a still more circumstantial account is given of similar deposits upon Sayers's Island. Here they are estimated to cover in the aggregate ten acres of soil, consisting of the debris of the bony skeleton of "man, beast, fish, and fowl," in every stage of decomposition from the dusty outline of crumbling earth crushed bones, to perfect skulls, joints, and teeth, in good preservation. The remains of *Mya edulis* or the common clam constitute the great deposit on Sawyer's Island.

Mr. C. H. Hitchcock states that two species of oyster occur in the Newcastle beds, *Ostrea borealis* and *O. Virginiana.* The latter shell, according to Mr. Hitchcock, has not been found living upon the coast of Maine, although it is thought to occur on Prince Edward's Island. The *O. borealis* is very rare upon the Maine coast, and the shell found in the Newcastle beds is *Venus Mercenaria* or the quahog, a scarce shell now upon the coast. It is supposed that those species are now nearly extinct, where they were once very abundant, and served as a chief source of food for the Indians.

In Casco Bay numerous piles of the Indian shell remains are found on many of the Islands; also about Mount Desert, they are common in small piles or heaps along the coast. At Trenton, one of the heaps is six feet thick.*

Two years since Mr. Morse gave an account to the Portland Natural History Society, of some excavations he had made at Goose Island, Casco Bay, in deposits of shells of *Mya arenaria* probably made by the Indians. Beneath the whole deposit and two feet from the surface of the shells, he came upon stones which rested in the old ground surface, under which, he found species of land shells not now living on the island, or of rare occurrence; among them were a few specimens of *Helix multidentata* hitherto rarely found in the interior of the State.

* 1st Report of the Geology of Maine.

NOTE ON THE ANTIMONY DEPOSITS IN PRINCE WILLIAM PARISH.

In a resumé of the favourable circumstances connected with the distribution of the ores of antimony in Prince William Parish, attention was drawn to "their occurrence on lines of fracture and dislocation, proving the veins to be 'true veins' of unknown vertical depth and horizontal extension," also, to "the purity of the grey antimony ore and its gradual passage into lamellar native antimony as the veins deepen." A recent excursion to the Mines of the Brunswick Antimony Company (March 1865), made for the purpose of ascertaining how far the progress of operations during the winter months had attested the correctness of the conclusions arrived at in November 1864, or might lead to modifications in the views then expressed, enables me to add some interesting facts in relation to the character of the fractures or dislocation in which the veins are seated, and to point out an important distinction in the kind of ore found in each vein.

In November last Pit No. 1 had been sunk to the depth of 68 feet, and the so-called "floor vein" and "roof vein" were described as joining together and forming one sheet at that depth. The miners have now reached a depth of 94 feet on the incline, and have made four Drifts, three to the west—No. 1, 20 feet; No. 2, 20 feet; No. 3, 40 feet; and one to the east (16 feet).

The deepening of the pit has revealed the following remarkable peculiarities :—

The two veins, instead of merging or blending into one vein at the depth of 68 feet, are seen to preserve a confluent course downwards at an angle of about 48 degrees. They do not blend together, there being a distinct line of demarkation between them, and on blasting or splitting off the "floor vein," it separates from the "roof vein" with a clean surface, having apparently a perfect cast of a former slickensided wall, which is reproduced on the lower surface of the "roof vein." Between the two veins there are occasionally thin stellar or radiating chrystaline forms of brilliant ore, probably native antimony.

The confluent veins were seen at a depth of 94 feet, to be respectively 16 inches and 8 inches in thickness, but the lower or "floor vein" varies much.

The "roof vein" is a decided conglomerate, holding, as stated in this Report, fragments of the country rock; the "floor vein" appear to be quite homogenous, and contains only the ore with quartz.

The ore in the roof, or conglomerate vein, consists now almost altogether of the sulphuret of antimony, with quartz and carbonate of lime. The ore in the floor, or homogeneous vein, contains the sulphuret mixed with lamellar native antimony and a little quartz.

This observation will probably establish the following facts :—

1st. The intersecting dislocations described in the Report and shown on the plan are of different ages.

2nd. The roof or conglomerate vein is the newest.

3rd. The distinction between the ores is a characteristic one and will be maintained.

When the snow which now covers the surface melts, there will be no difficulty in ascertaining positively which is the older vein; it will be found to be intersected or cut at the surface by the newer vein, and the glacial polishing of the rock will make this important enquiry easily and speedily clear to the miners.

The geological reader will understand at once the reason why the roof vein is supposed to be the newer; its conglomerate character, coupled with the cast of a former slickensided wall on the upper surface of the lower vein being the evidence upon which the supposition is for the present based.

The practical importance of this difference in the veins becomes manifest when the nature of the ores they carry is taken into consideration. The old vein, according to past experience at the mines of the Company, carries a homogeneous mass of rich sulphuret mixed with native antimony.

The newer vein, besides being of a conglomerate character, containing pebbles of the country rock, carries the sulphuret only, or with very little native antimony, it is of great thickness, but when compared with the older vein the ore is impure.

The ore in the old vein appears to be largely distributed in "pockets." The Drifts show that it thins out and expands again in the course of a few yards.

The origin of these veins of different ages is as follows:—The older vein occupies fissures formed by a fracture and downfall in the strata; after these fissures were filled with ore and vein stone, a second disturbance produced a second and larger fracture where seen, which in some places, following the line of greater weakness, occurs on the course of the old vein. Into this second fissure the fragments of the country rock fell from time to time during the process of filling, which probably occurred under different conditions to those which prevailed during the filling of the older or first fissure, hence the difference in the quality of the ore.

The importance of this distinction in the veins becomes the more apparent when the area over which they have been traced is taken into consideration. It will probably be most advantageous to concentrate labour on the old veins, and the observations here described will enable them to be easily found.

NOTE ON THE SALT SPRINGS OF SUSSEX AND UPHAM.

The manufacture of Salt is frequently a very valuable field for private enterprise, and in many countries a lucrative source of revenue to Government. In the State of New York, the celebrated Onondaga Salt Springs have reached an astonishing development within the last few years. The amount of salt inspected in 1861, on the Onondaga Salt Springs Reservation, in and adjacent to the City of Syracuse, N. Y., was 7,200,391 bushels, being equivalent to 1,440,000 barrels, of 280 lbs. each. The duties collected by the State amounted to $72,003, although the duty is only one cent a bushel. The disbursements for the support of the Salt Springs amounted to $45,000, and the dividend paid to the lessors of the salt vats reached 20 per cent. per annum. The salt trade of Syracuse is already enormous. This important article constitutes a large share of the return freight to the boats on the Erie Canal, and the vessels engaged on the great lakes in the transportation of grain and other western productions. The quantity of salt shipped from the Reservation, not forty miles from Oswego, amounted in 1858 to four hundred and twenty millions of pounds, or equal to the load of four thousand canal boats, with cargoes from fifty to one hundred tons. This quantity would ballast one thousand four hundred sailing vessels, with one hundred and fifty tons each. Canada obtains much of her salt from importations *via* the Saint Lawrence from Britain, but there is ample field and opportunity for manufacturing salt within her own boundaries. The shores of the Bay of Chaleurs and Gulf coast would probably afford many favourable localities for the establishment of salines; the heat of our summers of New Brunswick, which may be compared to those of the south of France, would produce a very rapid evaporation, while the severe frosts of the winters might be turned to account for the concentration of the water by freezing, as is practised in Northern Russia.

The value of the imported salt in this Province exceeded in 1862, twenty-one thousand dollars.

The Salines on the Gulf coast will probably attract attention in a few years, but at present the natural Brine Springs in the Parishes of Sussex and Upham, deserve more attention than they have yet received.

It is an important fact that some of the salt bearing strata in the State of Michigan are of the same geological age as the limestones, shales and conglomerates belonging to the lower carboniferous in the valley of the Kennebeccasis and Petitcodiac.

The "Napoleon Sandstone" of Michigan is one source of the vast supply of salt which is now being manufactured in that State.

The position of this rock in Michigan, according to Winchell, is as follows:

1. Carboniferous Limestone,	... ...		66 feet.
2. Michigan Salt Group,	... ...		184 "
3. Napoleon Group,	... ...		123 "
(*d.*) Shaly micaceous sandstone,	... ...	15	
(*c.*) Napoleon sandstone, highly saliferous in many localities,	... ...	78	
(*b.*) Shaly, micaceous sandstone,	... ...	15	
(*a.*) Clay and shale, more than	... ...	15	
4. Marshall Group,	... ...		173 "

Above the Michigan Salt Group (2), and the Napoleon Group (3), there are a series of strata called the "Parma Sandstone," which also furnish brine springs. These rocks lie just beneath the coal-measures.

The occurrence in the Parishes of Sussex and Upham of natural Brine Springs, from which salt has been manufactured, viewed in connection with the circumstance that the rocks in these Parishes are of the same geological age as the salt bearing rocks in Michigan, renders it probable that the source of the brine would be reached by boring, and a copious supply of rich workable brine obtained. The depth to which the strata would have to be penetrated would not be an obstacle, and there is always a probability that if borings should be made to an extent of 1000 feet, not brine springs only, but petroleum might be reached in part of Sussex and an adjoining Parish.

The following notice of the Michigan Salt Works will be found interesting:—

THE MICHIGAN WORKS.*

"The existence of salt springs in the lower peninsula of Michigan has been known from the time of its earliest settlement, and when in 1836 the State was admitted into the Union, the privilege was granted her of selecting 72 sections of salt spring lands. In the following year she organized a geological survey, principally for the purpose of ascertaining the number and distribution of the salt springs in the State. This survey led to erroneous conclusions, and the borings for salt which followed these conclusions were unsuccessful.

In 1859 a second survey was commenced and this led to the discovery and announcement, for the first time, that below the carboniferous limestone of Michigan occurs a series, 180 feet thick, of argilaceous shales, clays, magnesian limestones, and beds of gypsum; and that here is truly the origin of the brine. The strike of the outcropping edges of these strata describes an irregular circle, inclosing all the central portion of the State. The Michigan salt group of rocks underlies 17,000 square miles, in the form of a vast reservoir, constituting the most magnificent saliferous basin on the continent. The edges are sufficiently elevated to prevent the efflux of water which finds its way into it, and hence the saline particles have never been washed away. Beneath this series of shales is a porous sandstone—the Napoleon sandstone—which, within the circumference of the basin, becomes saturated with brine from above. From the nature of the case, it is evident that the strongest brine must accumulate in the deepest part of the basin.

Under this more intelligent guidance new borings were commenced and a well at East Saginaw reached the solid rock at the depth of 92 feet, and after passing through the coal measures, with their terminal and initial sandstones, pierced the carboniferous limestone, and found the Michigan salt group of strata 169 feet thick and eminently saliferous. In the Napoleon sandstone beneath, 109 feet thick, the reservoir of the brine was struck, and a supply, abundant in quantity, and of 90° strength, was obtained at almost exactly the point which geology had predicted. This well was 669 feet deep, terminating near the middle of the sandstone. Another was subsequently bored, 806 feet deep, extending through the sandstone and penetrating the underlying shales 64 feet.

This decided success was attained early in 1860. By July of that year a "block" had been erected and boiling commenced. Before the close of the year 4,000 barrels of salt had been manufactured, and no less than four other companies had commenced boring at different points along the river.

The following analysis will exhibit the strength and purity of Saginaw brines in comparison with those of other salt-producing regions:—

* Scientific American, 1862.

	Saginaw City.	East Saginaw.	Bay City.	Syracuse, N.Y.	Kanawha, V.
Specific Gravity	1.180	1.170	1.163	1.142	1.078
Chloride of Sodium	19.246	17.912	19.692	17.690	7.309
Chloride of Calcium	2.895	2.142	0.742	0.156	1.526
Chloride of Magnesium	1.804	1.522	0.482	0.119	0.374
Sulphate of Lime	0.534	0.116	0.155	0.573	——
Sulphate of Soda	——	——	0.116	——	——
Compounds of Iron	0.064	0.105	——	0.002	——
Other constituents	0.127	0.220	0.013	——	——
Total solid matter in 100 parts	24.170	22 017	21.140	18.540	9,200

As pure saturated brine has a specific gravity of 1.205, and contains 25.7 per cent of saline matter, it appears that the Saginaw brines approximate remarkably near to saturation.

The following Table exhibits further comparisons:—

Localities.		Weight of one gal. of brine.	Solid matter in one gal.	Pure salt in one gal.	Gals. required for 1 bushel salt.
Saginaw City,	lbs.	9.858	2.38	1.90	29
East Saginaw		9.775	2.15	1.75	32
Bay City		9.716	1.95	1.82	31
Syracuse		9.541	1.76	1.68	33
Kanawha		9.464	0.94	0.75	75

An intelligent writer in *Hunt's Merchants' Magazine* for September, to whom we are indebted for these interesting facts, states:—

It is now but two years since the first salt was manufactured in Saginaw valley; yet it is estimated that in this time the value of real estate has increased to the extent of three and a half millions of dollars in the Counties of Bay and Saginaw. At Carrolton, grounds suitable for salt lots, which, two years ago were bought at $20 an acre, are now held at $300 and $400 per acre. At Saginaw city, salt lands have risen from $30 to $200 and $300 an acre, Wood lands, from one to eight miles west and north of Saginaw city, which, as late as 1861, sold for $15 and $20 per acre, are now selling for $40 and $45 per acre. At Bay city, the increased valuation has been similar. And this is but the first impression of the creation of this new branch of industry in what is generally regarded as a Michigan wilderness."

CHAPTER XII.

THE AGRICULTURAL CAPABILITIES OF CERTAIN DISTRICTS. NOTES ON THE CLIMATE.

Importance of Limestone—Limestone Rocks produce good Soils—Progress of Settlement in the Laurentian Region of Canada is on the Crystalline Limestones—In New Brunswick the presence of a fine Hardwood Forest indicates the proximity of Limestone—Area of first class Land in the Province—Aids to Agriculture—Manures—Lime—Quantity manufactured in New Brunswick—In Maine—Gypsum—Some Localities where Limestone is found in the Province—Some Localities where Gypsum is found in the Province—Trap debris—Phosphate of Lime—Fish Manures—Its manufacture in France—In Newfoundland—Professor Hunt's descriptions—Manufacture at Gaspe—Value of the Fish Manure manufactured at Gaspe—Importance of the manufacture of Fish Manure on the Gulf Coast.

NOTES ON THE CLIMATE OF NEW BRUNSWICK.—The character of the Winter Season—Comparative Table, showing the mean opening of Rivers, Canals, and Harbours, from St. John to the Straits of Mackinaw—Duration of Navigation on the St. Lawrence, compared with the St. John—Table showing the mean Winter temperature of St. John, Quebec, and Montreal—Table of Annual means of Temperature, &c., at St. John, by G. Murdock—Table of Monthly and Seasonal means of Temperature at St. John, by G. Murdock—Table of mean results at Toronto—Table of minimum and maximum temperatures at Fredericton, by the Rev. Dr. Brooke—Comparative Table, showing the difference between some points in the Climates of St. John and Fredericton, by the late Dr. Robb—Table showing the mean annual temperature of St. John, Fredericton, Quebec, Montreal, and Toronto.

CONCLUSION.—The advantages of a systematic Geological Survey.

Intimately connected with the rock formations on which they rest, or which lie to the north of the area under review, are the soils which constitute the foundation of its agricultural capabilities.

It has been shown in a previous Chapter that the drift which covers the Province, as a general rule, has been derived from the grinding down of the rocks it covers more or less deeply. Hence when we find the drift shallow, and yet the land supporting a vigorous forest, we may in this Province infer that LIMESTONE lies to the north or underneath. Hence it is that on the Shiktehawk and Beccaguimec Rivers, where the drift is shallow, the vegetation is very luxuriant, in consequence of the limestone bands which accompany the red ferruginous and manganesian slates which form the most prominent rocks in the valleys of these rivers.

The progress of settlement in the great wilderness far in the rear of the Saint Lawrence and Lake Ontario, is a singular and most suggestive illustration of the value and importance of limestone rocks; for the settlements invariably follow the limestone, guided by the forest growth which it supports. This, of course, occurs only where the drift clays are shallow, and the surface soil has originated close by.

So in New Brunswick, the presence of a rich forest of hardwood throughout the vast area covered by the Lower and Upper Silurian rocks, will probably indicate the presence of limestone underneath or close at hand, and may yet prove an invaluable guide in the search for metalliferous deposits associated with the limestones, throughout the great unpeopled wilderness east of the Saint John, and south and north of the Tobique.

AREA OF SUPERIOR LAND.

The area of first rate upland soil within the limits of the Province was estimated by Professor Johnston to be about one million acres; it is satisfactory to know that further experience suggests the idea that this estimate is too low, and that in the then almost inaccessible river valleys, respecting which Professor Johnston could obtain no information, sixteen years since, without undertaking a journey through an unbroken wilderness, there is an available area of upland soil of a quality which will increase his estimate by at least one half, and an area of intervale and valley land which may be reasonably assumed not less than 3,000,000 acres, instead of 1,050,000, as estimated by Professor Johnston.

The same author estimates the second rate upland to have an area of about 6,900,000, and he considers the soil to be inferior to the preceding, but still "very good in quality."

The naked flats distinguished as bogs, heaths, barrens, cariboo plains, are regarded as occupying 5,000,000, and "not to be considered absolutely irreclaimable, but to be unfit for present culture or for settlement, until much larger progress has been made in the general improvement of the Province;" although many will be induced to concur to a certain extent in this view, yet it must be borne in mind that the experience obtained in Lower Canada shows that by drainage and a year's tillage, many of the bogs, heaths and barrens can be made most productive pasture lands, but the circumstances of location must be favourable to the first preliminary step, drainage.

MANURES.

Among the aids to agriculture which Geology is able to point out, are manures. In this Province husbandry is still in a rather backward condition, yet attention is occasionally devoted to the application of those mineral substances which *assist* farm yard manure in its operations, or supply materials in which the soil is deficient, or act by their presence alone.

LIME.

Lime is used in some Parishes, but only to a small extent. There can be no question that its application on many soils would be attended with immediate benefits. Where lime is not available, the shell marl described on page 217, might be advantageously used.

SOME LOCALITIES WHERE LIMESTONE ROCKS OCCUR IN THE PROVINCE.

SAINT JOHN COUNTY.—Several belts of crystalline limestone at and above the Suspension Bridge over the Saint John, near the month of the river. Limestone, sometimes beautifully laminated, very free from silicious and other impurities. Some belts stretch far to the northeast by east passing through Portland, forming part of the hill to the north of the Railway, and cropping out on the road to Hammond River. The graphite or plumbago in this range of limestone show that its metamorphism has not been accomplished by any considerable elevation of temperature, otherwise the graphite would have been oxidized. (See page 52.) An analysis of this limestone is given on page 66. Age, Silurian.

Quaco.—Carboniferous limestone.

Martin's Head.—Carboniferous limestone.

ALBERT COUNTY.—Four outcrops close to the gypsum which the limestone overlies, and in some localities underlies. LOWER CARBONIFEROUS.

WESTMORLAND COUNTY.—On the Memramcook, above Dorchester; the continuation of Butternut Ridge; near the gypsum; north of Anagance. LOWER CARBONIFEROUS.

QUEEN'S COUNTY.—South of Oknabog Lake, one mile. Strike of rock S. W. on the west side of the River Saint John. On the east side, E. N. E. to N. E. for several miles. Crystalline and fossiliferous. LOWER CARBONIFEROUS. In Wickham and Hampstead long narrow belts, northeast by east.

KING'S COUNTY.—Near the gypsum on Salmon River, and on Hammond River in Upham. In Norton, near the Railway Station, and seven miles northwest of it. In various parts of the valley of the Kennebeccasis. At Butternut Ridge, in several narrow ridges. (See Analysis.) LOWER CARBONIFEROUS.

RESTIGOUCHE COUNTY.—Abundant on the Coast, from Dalhousie to Belledune Point. On the Restigouche, black limestones. UPPER SILURIAN.

VICTORIA COUNTY.—Numerous narrow bands in the Upper Silurian slates which occupy the greater portion of this County. On the Tobique, underlying the gypsum. (See Analysis, page 66.) LOWER CARBONIFEROUS.

CHARLOTTE COUNTY, FRYE'S ISLAND.—Crystalline limestone of very superior quality continues to L'Etang, and thence northeast by east. (See Analysis page 66.) Limekilns at L'Etang, also on Frye's Island. SILURIAN.

CARLETON COUNTY.—Numerous narrow bands near and below Presqu'ile. Broad belts on the Beccaguimic, and south of the Shiktehawk. Numerous narrow bands interstratified with slaty layers are seen on the Saint John River at Sippral's, Victoria Corner. On north fork of Bull's Creek, Richmond Parish. LOWER SILURIAN.

Limestone beds appear to prevail all through the Lower Carboniferous indent, drained by the Kennebeccasis. They are not unfrequently associated with the valuable mineral gypsum, which, however, is not so widely distributed as the limestone, and occurs only in the Lower Carboniferous Series in New Brunswick.

In 1851 there were 35,599 casks of lime burnt in the Province; in 1861, the number of casks was 42,965, showing an increase of 7,366. Sunbury has hitherto produced no lime. Albert, Kent, Queen's, and York, all of which burnt a small quantity of lime in 1851, according to the census of 1861 yielded none. The increase in Saint John County was more than the aggregate increase of the Province, being 7,690 casks, against 7,366. In the adjoining State of Maine 400,000 casks of lime were burned in one Township alone in the year 1836, and 700,000 casks were even then estimated as the total produce of all the kilns in the State. This quantity is now exceeded by the amount thrown into the market annually from one locality alone. No better limestone for the manufacture of lime exists any where than in Charlotte County, and in the neighbourhood of Saint John.

In the Town of Rockland, Maine, about one million casks of lime are annually manufactured. One hundred sail of small vessels are employed in fetching wood for that purpose from the eastward, and it takes eighty sail of coasters to carry the lime to market. The lime of Rockland, before the war, was consumed all along the Atlantic Coast, from Calais to Texas.*

SOME LOCALITIES WHERE GYPSUM IS FOUND IN THE PROVINCE.

ALBERT COUNTY.—In at least six localities in the Parish of Hillsborough, forming the half of a circle, commencing a third of a mile west of Edgett's and appearing a little to the south of the road to the Albert Mines in three patches. Again south of the Mines, and in magnificent mural cliffs on Grass' Mill Stream, Shepody River, and Harvey Parish, on the bank.

WESTMORLAND.—Shepody Bay; on North River; near Anagance; about two miles north of Salsbury Station.

SAINT JOHN.—Near Martin's Head.

KING'S.—In Upham Parish; two patches on Salmon River, just above Smith's Creek, and below it; On Studholm's Mill Stream; north of Butternut Ridge.

VICTORIA.—Mouth of Wapskyhegan; on the Tobique, cliffs of impure Gypsum 130 feet high, (p. 63.)

The increase in the quantity of tons of gypsum produced in 1861, when compared with amount brought into the market in 1851, is 6,585 tons; the relative quantities being—

1851, ...	5,465 tons.
1861, ...	12,050 "
Increase, ...	6,585 "

To this must be added 1,000 barrels ground gypsum and 10,000 barrels calcined gypsum in 1861.

*Letter from Alden Ulmer, Inspector, to Prof. C. H. Hitchcock.—First Report on the Geology of Maine.

The debris of Trap Rocks which are not of a very ferruginous character is also found useful in localities where it is easily accessible, such as near Dalhousie.

PHOSPHATE OF LIME.

Phosphate of Lime or Apatite has not been found in sufficient quantity to render it commercially available.

FISH MANURES.

Among the most promising adjuncts to farm-yard manure, which should of course always form the groundwork of what is now called good husbandry, Fish Manures appear likely to secure a prominent place.

Professor Hunt has given special attention to the subject, and in an excellent article on Fish Manures published in the Report of Progress for 1857,* he discusses the questions relating to the manufacture of Fish Manures on the Gulf Coast.

"The use of fish as a manure has long been known; on the shores of Scotland, Cornwall, Brittany, some parts of the United States, and on our own sea-coasts, the offal from fisheries, as well as certain bony fishes of little value for food, are applied to the soil with great benefit. The idea of converting these materials into a portable manure was however I believe first carried into effect in France by Mr. Demolon, who seven or eight years since erected establishments for this object on the coast of Brittany and in Newfoundland. For the details of this manufacture I am indebted to the *Chimie Industrielle* of Payen. Concarneau, in the department of Finisterre, is a small town whose inhabitants are employed in fishing for sardines, and it is the refuse of this fishery which is employed in the manufacture of manure. The offal is placed in large coppers and heated by steam until thoroughly cooked, after which it is submitted to pressure, which extracts the water and oil. The pressed mass is then rasped, dried in a current of hot air, and ground to powder. 100 parts of the recent offal yield on an average 22 parts of the powder, besides from 2 to 2½ parts of oil. The manufactory of Concarneau employs six men and ten boys, and is able to work up daily eighteen or twenty tons of fish, and produce from four to five tons of the powdered manure.

"This manure contains, according to an average of several analyses, 80.0 per cent. of organic matters, and 14.1 per cent. of phosphates of lime and magnesia, besides some common salt, a little carbonate of lime, small portions of sulphate and carbonate of ammonia, and only 1.0 per cent. of water. The nitrogen of this manure, which is almost wholly in the form of organic matters, corresponds to 14.5 per cent. of ammonia, and we may estimate the phosporic acid, which is here present in an insoluble form, at 7.0 per cent. If we calculate the value of this manure according to the rules above laid down, we shall have as follows for 100 pounds:—

Ammonia,—14½ pounds, at 14 cents, ...	$2.03	$2.34½
Phosphoric Acid,—7 pounds at 4½ cents, ...	0.31½	

* Canadian Geological Survey.

This is equal to $47 the ton of 2,000 pounds; the manufactured product of Concarneau, however, according to Payen, is sold in the nearest shipping ports at 20 francs the 100 kilogrammes, (equal to 220 pounds,) which, counting the franc at $0.20, is equivalent only to $1.81 the 100 pounds, or a little over $37 the ton. This however was in 1854, since which time the price of manures has probably increased.

"Mr. Demolon in company with his brother, has also, according to Payen, erected a large establishment for the manufacture of this manure on the coast of Newfoundland, at Kerpon, near the eastern entrance of the Strait of Bellisle, in a harbour which is greatly resorted to by the vessels engaged in the cod-fishery. This manufactory, now in successful operation, is able to produce 8,000 or 10,000 tons of manure annually. Payen estimates the total yearly produce of the cod-fisheries to be equal to about 1,500,000 tons of fresh fish; of this, one-half is refuse, and is thrown into the sea or left to decay on the shore, while if treated by the process of Demolon, it would yield more than 150,000 tons of manure nearly equal in value to the guano of the Peruvian Islands, which now furnish annually from 300,000 to 400,000 tons. If to the manure which might be obtained from the cod-fish of the Lower Provinces, we add that of many other great fisheries, we are surprised at the immense resources for agriculture now neglected, which may be drawn at a little expense from the sea, and even from the otherwise worthless refuse of another industry. To this may be added vast quantities of other fish, which at other seasons and on some coasts are so abundant that they are even taken for the express purpose of spreading upon the adjacent lands, and which would greatly extend the resources of this new manufacture. The oil, whose extraction is made an object of economic importance in the fabrication of manure from sardines in France, exists in but very small quantities in the cod, but in the herring it equals 10 per cent. of the recent fish, and in some other species rises to 3.0 and 4.0 per cent.

"Mr. Duncan Bruce of Gaspe, has lately been endeavouring to introduce the manufacture of fish-manure into Canada; but he has conceived the idea of combining the fish-offal with a large amount of calcined shale, under the impression that the manure thus prepared will have the effect of driving away insects from the plants to which it is applied. He employs a black bituminous shale from Port Daniel, and distilling this at a red heat, passes the disengaged vapours into a vat containing the fish, which by a gentle and continued heat, have been reduced to a pulpy mass. The calcined shale is then ground to powder and mingled with the fish, and the whole dried. Experiments made with this manure appear to have given very satisfactory results, and it is said to have had the effect of driving away insects when applied to growing crops, a result which may be due to the small amount of bituminous matter in the products of the distillation of the shale, rather than to the admixture of the calcined residue. Coal-tar is known to be an efficient agent for the destruction of insects, and in a recent number of the Journal, *Le Cosmos*, it is stated that simply painting the wood-work of the inside of green-houses with coal-tar has the effect of expelling from them all noxious insects. Mr. Bruce caused several analyses of this shale to be made by Dr. Reid of New York, from which it appears that different specimens contain from 2·0 to 26·0 per cent. of carbonate of lime, besides from 1·4 to 2·0 per cent. of gypsum, 2·0 per cent. of iron pyrites, and from 4·5 to 6·7 per cent. of carbon remaining after distillation. The amount of volatile matter, described by Dr. Reid as consisting of water, naphtha and ammonia, was found by him in two different samples to equal only 3·5 per cent., of which a large proportion is probably water.

"I have examined two specimens of manure prepared by Mr. Bruce from the fish commonly known as the menhadden (*Alosa menhadden*). No. 1 was made with the Port Daniel shale, as before described; while for No. 2, this was replaced by a mixture of clay and saw-dust, which was distilled like the shale, the volatile products being added to the decomposing fish. The oil which rose to the surface of the liquid mass had been separated from the second preparation, but remained mingled with the first. Both of these specimens were in the form of a black granular mass, moist, cohering under pressure, and having a very fishy odour.

ANALYSIS OF EARTHY MATTERS.

	I.	II.
Phosphoric acid, ...	3·40	3·99
Sulphuric acid, ...	2·16	·15
Lime, ...	5·90	4·44
Magnesia, ...	1·20	1·15
Ammonia, ...	3·76	2·60

"If we calculate the value of the first specimen according to the rules already laid down, we have as follows for 100 pounds:—

Phosphoric acid, 3 4–10 pounds at 4½ cents, ...	$0·153
Ammonia, 3¾ pounds at 14 cents, ...	0·525
	$0·678

"At 68 cents the 100 pounds, this manure would be worth $13.60 the ton. The sulphuric acid is of small value, corresponding to 80 pounds of plaster of Paris to the ton, and we do not take it into the calculation. The somewhat larger amount of phosphoric acid in the second specimen, is probably derived in part from the ashes of the saw-dust, and in part from the clay. The value of this manure would be $10.88 the ton.

"In order to arrive at the real value of the animal portion of this manure, after the removal of the oil, we may suppose, since Dr. Reid obtained from the shales from 4.5 to 7.6 per cent. of fixed carbon, that with the 56.2 parts of calcined residue, there were originally 3.7 parts of carbon derived from the shales. This deducted from 23.7 parts leaves 20.0 of nitrogenized animal matter in 100 parts of the manure, yielding 3.76 parts or 18.8 per cent. of ammonia. This matter consists chiefly of muscular and gelatinous tissues, and Payen obtained from the dried muscle of the codfish, 16.8 per cent. of nitrogen, equal to 20.4 of ammonia. The 3.4 parts of phosphoric acid in the manure will correspond to 7.4 of bone-phosphate, and if to this we add for moisture, impurities, etc., 2.6 parts, = 80.0 in all, we should have for 100 pounds of the fish when free from oil and dried, the following quantities of ammonia and phosphoric acid:—

Ammonia,—12½ pounds at 14 cents, ...	$1.75
Phosphoric acid,—11⅓ pounds at 4½ cents, ...	0.51
	$2.26

"The matter thus prepared would have a value of $45.20 the ton, agreeing closely with that which we have calculated for the manure manufactured from sardines in France, in which the quantity of ammonia is somewhat greater, and the phosphoric acid less, giving it a value of $47 the ton.

"Professor George H. Cook of New Jersey, in an analysis of the menhadden, obtained from 100 parts of the dried fish, 16.7 parts of oil, besides 61.6 of azotized matters yielding 9.28 parts of ammonia, and 21.7 of inorganic matters, etc., containing 7.78 of phosphoric acid.* If we deduct the oil we shall have for 100 parts of the fish, according to this analysis, 11.2 of ammonia, and 9.3 of phosphoric acid.

"By comparing these figures with the results calculated for the animal portion of Mr. Bruce's manures, we find:—

	Ammonia.	Phosphoric acid.
Manure from sardines, (Payen,)	14.5	7.0
Dried menhadden (Cooke,)	11.2	9.3
Manure by Mr. Bruce, ...	3.75	3.4
Do. do. (excluding shale,) ...	12.5	11.3

The proportion of phosphates is of course greater in the more bony fishes. In the manure of Mr. Bruce there are doubtless small amounts of phosphoric acid and ammonia, derived from the shale and the products of its distillation; but these do not however warrant the introduction of an inert material which reduces more than two-thirds the commercial value of the manure. The results which we have given clearly show that by the application of a process similar to that now applied in France and in Newfoundland, which consists in cooking the fish, pressing it to extract the oil and water, drying by artificial heat, and grinding it to powder, it is easy to prepare a concentrated portable manure, whose value, as a source of phosphoric acid and ammonia, will be in round numbers, about $40 the ton.

"We can scarcely doubt that by the application of this process a new source of profit may be found in the fisheries of the Gulf, which will not only render us independent of foreign guano, now brought into the Province to some extent, but will enable us to export large quantities of a most valuable concentrated manure, at prices which will be found remunerative."

* Report of the Geological Survey of New Jersey for 1856, p. 63.

NOTES ON THE CLIMATE OF NEW BRUNSWICK.

The suitability of the climate of any district for agricultural purposes is sufficiently indicated in old settlements by the crops raised with success. But this criterion does not necessarily convey correct ideas regarding the extremes of heat and cold, or the durations of the seasons. Throughout the settled portions of the valley of the Saint John Indian corn is grown, and wherever this crop ripens well a fair estimate of the character of the summer climate can be formed. The vegetables exhibited at the Provincial Exhibition show how admirably the summer temperature and rain are suited for the cultivation of root crops and common culinary vegetables, the fruits attested also the favourable character of the climate for their growth and proper development. These facts, however, tell nothing respecting the intensity of winter cold, the duration of the winter season, and the length of time during the year which can be given to outdoor operations. A long cold winter operates injuriously upon farming industry in so far as it compels stock to be housed and fed for a longer period than in a milder climate; but how far this may militate against the progress of husbandry in a district or Province, is not generally understood, and its supposed drawbacks are frequently very much overrated.

COAST AND INTERIOR CLIMATES COMPARED.

It has been shown by Albert Gallatin,* that on this continent inland places, remote from the sea, and under the same degree of latitude, have severer winters and hotter summers than those on the Atlantic coast. The same law appears to obtain in Europe.

Albert Gallatin compares Fort Snelling on the Mississippi, in lat. 44° 53′, and Eastport (Maine), lat. 44° 44′, with the following results:—

	Fort Snelling.	Eastport.
Mean annual temperature, ...	45.83	42.95
" Winter "	15.95	22.95
" Summer, "	72.75	62.10
Mean temperature of the coldest month, ...	13.58	20.68
" " ... of the hottest month, ...	75.47	64.55
Coldest day in the year, ...	—26	—13
Hottest day in the year, ...	93	91
Range between hottest and coldest day, ...	119	104

THE CHARACTER OF THE WINTER SEASON.

The River St. Lawrence is generally frozen between Quebec and Montreal every winter, and when there is no ice-bridge at Quebec, the communication between the two cities is open for steamers, generally on the 24th of April.

* Hale's Indians of North West America.

When there is an ice-bridge opposite the great fortress, the river is closed until the 27th of the same month. During a period of twenty years, from 1833 to 1855, the St. Lawrence has been frozen across at or near Quebec nine times without retarding the opening of the navigation for more than three days.

FREEZING OF CANALS AND RIVERS.

The following Table shows how far the seasons, from the Bay of Fundy to Lake Superior, affect navigation by the opening and closing of the Rivers and Canals*:—

		Opens.		Closes.		Average period closed in days.
1,	The Straits of Mackinaw,	April	14,	December	6,	129
2,	Port of Hamilton,	"	1,	"	28,	94
3,	" Buffalo,	"	14,	"	14,	121
4,	" Oswego,	March	20,	——		——
5,	" Montreal,	April	20,	"	11,	130
6,	" Quebec,	"	29,	November	24,	156
7,	" Bic,	March	16,	December	19,	87
8,	Erie Canal,	April	28,	"	7,	142
9,	Welland Canal,	"	8,	"	12,	117
10,	Cornwall Canal,	"	25,	"	8,	138
11,	Lachine,	"	28,	"	8,	141
12,	St. Lawrence River between Lake Ontario, Montreal, and Lachine,	"	26,	"	7,	140
13,	St. Lawrence between Montreal and Quebec,	"	24,	"	10,	135
14,	The St. John at Fredericton,	"	19,	November	26,	144
15,	The Kennebec, Maine,	"	6,	——		——

The geographical course of the Saint John, running from north to south, causes it to freeze earlier, or become choked with ice sooner than the Saint Lawrence, at Montreal, which runs from west to east.

PERIODS OF NAVIGATION.

The duration of the period when Navigation is closed, deduced from the foregoing Table, is as follows:—

	Days.
Quebec, ...	156
Fredericton, ...	144
Erie Canal, ...	142
Cornwall Canal, ...	141
Saint Lawrence River, ...	140

The Navigation of the Saint Lawrence for sea going vessels is of course dependent upon the opening and closing of the River at Quebec; hence the Saint John is really open 12 days longer than the Saint Lawrence.

* The first 13 localities are deduced from an average of 10 years. The Saint John, from an average of 28 years, and the Kennebec for 75 years.—Vide Appendix to the Journals of the House of Assembly, Canada, 1858.

Table showing the mean winter temperature of Toronto, Montreal, Quebec, and Saint John, for 1853–4, 1854–5, 1855–6:—

Mean Winter Temperature.

	1853–4.	1854–5.	1855–6.
Saint John, ...	18.72	21.46	19.88
Quebec, ...	11.03	13.37	12.75
Montreal, ...	13.22	12.15	13.96
Toronto, ...	23.8	21.06	19.6

From this Table it will be seen that the winter temperature of Saint John and Toronto are not unlike as regards intensity of cold.* They are both considerably warmer than either Montreal or Quebec; and if we select a station beyond the influence of the great lakes, yet within the limits of the peninsula of western Canada, we find the extremes of temperature exceed those of Saint John, and that the climate approaches that of Fredericton.

Stratford, at the junction of the Grand Trunk Railway, and Buffalo and Lake Huron Railway, is 1182 feet above the sea, and from its position in relation to the great lakes and its altitude, its climate may be compared with that of Fredericton, although it is two degrees and three quarters further south than the Capital of New Brunswick.

He who is disposed to grumble at the intensity of the cold in New Brunswick and Canada, let him read a generous and truthful article on this subject in Chambers' Edinburgh Journal, (January 1863,) in which some of the charms of the North American winter are portrayed, and some of its drawbacks drawn with a Painter's skill; yet the impression which remains is rather in favor of the cheery side, and the only change one would wish for in our winters here, when comparing them with the same season of the year in many other parts of the temperate zone, is that they were just a little shorter.

METEOROLOGY OF SAINT JOHN.

The following Tables by MR. G. MURDOCH, of Saint John, contain much valuable information respecting the climate on the coast of the Bay of Fundy.

They embody the condensed results of a series of Tables published, in part, in the Agricultural Report for the last season, and when compared with an elaborate Table for Toronto on the succeeding page, a fair idea of the difference between the climates of those distant Cities may be gathered.

* Smithsonian Report, 1860.

Table of Annual Means and Extremes of Temperature, with the dates when the latter occurred; also of Precipitation, Clouding, Wind and Thunder Storms, for the years 1861–2–3–4; from observations made at St. John, N. B., lat. 45° 16′ 42″ N., long. 66° 3′ 45″ W., height above sea, 135 feet, by G. Murdoch.*

	1861	1862	1863	1864	Mean.
Temperature—					
Highest, ...	79°.00	71°.00	83°.00	85°.00	79°.50
Date, ..	July 14th	Aug. 7th	May 22nd	June 14th	
Lowest, ...	—22°.00	—12°.00	—13°.00	—14°.00	—15°.25
Date, ..	Feb. 8th	Dec. 21st	Feb. 4th	Dec. 21th	
Yearly range, ..	101°.00	83°.00	96°.00	99°.00	94°.75
Greatest oscillation in one day,	34°.00	36°.00	34°.00	30°.00	33°.50
Date, ..	March 21st	Jan. 13th	May 22nd	June 14th	
Mean daily oscillation, ...	10°.07	10°.15	10°.78	11°.13	10°.53
Mean temperature— 6 a. m.	38°.22	35°.71	36°.40	37°.33	36°.92
10 a. m.	43 .65	40 .82	41 .36	42 .43	42 .06
noon,	45 .66	43 .04	43 .60	44 .38	44 .17
2 p. m.	46 .46	44 .24	45 .09	45 .80	45 .42
6 p. m.	43 .68	41 .84	42 .63	43 .00	42 .79
10 p. m.	40 .25	38 .97	39 .34	39 .30	39 .47
Mean of readings,	42 .94	40 .77	41 .39	42 .06	41 .80
Precipitation— Rain or Snow fell, ..	84 days	83 days	82 days	80 days	82.25
" "	80 nights	103 nights	80 nights	97 nights	93.75
Rain for year, ...	35.905 in.	43.018 in.	42.930 in.	39.920 in.	40.443 in.
Snow "	113.25 in.	83.75 in.	71.85 in.	86.60 in.	88.86 in.
Rain and melted snow,	48.730	52.948	50.177 in.	50.505 in.	50.59 in.
Clouding—average of three obs. Clear, ...	96.3 days	97.4 days	115.9 days	103.0 days	104 days
Wholly clouded,	183.7 "	192.9 "	184.7 "	190.0 "	187.9 "
Foggy, ...	39.0 "	35.9 "	43.3 "	23.7 "	35.3 "
Mean est'd clouding,	5.6	6.5	5.9 "	6.1 "	6.0 "
Wind, 2 p. m. E. to S. W.	180 days	197 days	209 days	202 days	197 days
W. to N. E.	185 "	168 "	156 "	164 "	168.25 "
Thunder storms, ...	5 "	7 "	4 "	12 "	7 "

*These observations for temperature have not been reduced, but they are the result of six daily observations.

Table of Monthly and Seasonal Means of Temperature; also of Precipitation, Clouding, and Wind; Deduced from observations made during the Years 1861-2-3-4, at St. John, N. B., lat. 45° 16′ 42″ N., long. 66° 3′ 45″ W., and height above sea 135 feet, by G. Murdoch.

Months.	Temperature.				Precipitation.					Clouding—Means 3 daily obs. 8 a.m. 2 p.m. 10 p.m.				Wind, 2 p.m.	
	4 years means 6 obs. daily, 6 a.m. 10 a.m. noon, 2 p.m. 6 p.m. 10 p.m.	4 years means of monthly maxima.	4 years means of monthly minima.	4 years means of daily oscillation.	4 years means No. days rain or snow fell.	4 years means nights rain or snow fell.	4 years means of rain fall in inches.	4 years means of snow fall in inches.	4 years means of rain and melted snow.	4 years means of No. of clear days.	of days wholly clouded.	of foggy days.	4 years means of estimated clouding.	4 years means of No. of days E. till S W.	and W. till N. E.
January,	20°.28	42°.5	— 8.7	11°.05	5.75	9.50	2.490	22.90	4.830	9.50	15.10	0.57	5.97	7.75	23.25
February,	22.37	42.5	—12.6	10.64	6.25	6.50	1.710	16.85	3.380	9.00	14.17	0.75	6.00	10.25	18.00
March,	28.57	44.0	— 2.0	16.10	8.75	6.25	1.546	25.03	4.675	9.07	14.70	0.90	5.60	11.75	19.25
April,	38.30	59.8	+17.5	11.58	6.00	6.25	2.810	7.37	3.618	9.10	14.15	1.53	5.72	15.25	14.75
May,	49.20	72.2	31.7	11.82	6.50	7.00	3.020	..	3.020	9.30	15.70	3.40	6.00	22.25	8.75
June,	55.53	73.5	41.8	12.73	4.75	6.50	1.917	..	1.917	10.17	11.70	3.77	5.53	24.00	6.00
July,	60.65	75.3	51.2	9.79	6.50	8.00	4.255	..	4.255	7.47	18.30	8.75	6.80	28.25	2.75
August,	60.91	73.5	47.8	10.11	6.50	7.00	4.224	..	4.224	7.92	17.70	6.75	5.90	21.75	9.25
September,	55.27	67.0	38.3	10.09	7.65	6.25	5.160	..	5.160	10.17	13.90	3.40	5.50	20.75	9.25
October,	47.85	62.3	28.0	9.30	6.65	8.75	4.335	..	4.335	7.25	17.50	2.90	6.90	17.25	13.75
November,	38.18	55.2	18.5	7.50	10.00	9.50	6.077	1.95	6.370	5.60	20.40	2.17	7.50	11.75	18.25
December,	23.74	48.3	— 5.8	10.51	7.75	9.00	2.915	14.75	4.687	9.10	18.60	0.75	6.50	6.25	24.75
Seasons.															
Winter,	22°.31	48°.0	—16°.0	11°.16	22°.0	22.5	6.697	50.94	12.398	26.5	49.7	1.70	6.0	24.0	57.0
Spring,	38.68	72.3	+ 2.0	11.51	17.5	22.5	7.349	32.40	11.307	25.5	43.0	6.50	5.8	49.0	44.3
Summer,	58.97	78.7	41.7	10.46	17.8	21.5	10.397	..	10.397	25.5	44.7	18.50	6.0	74.0	18.0
Autumn,	46.96	64.3	18.3	8.98	23.0	24.5	15.575	1.95	15.879	23.0	56.8	8.70	6.8	49.7	41.3

These observations have not been reduced, but as the temperatures are the result of six daily observations, they will very nearly represent true means.

When compared with the following Table for Toronto, some striking points of resemblance in climate will be noticed.

METEOROLOGICAL MEAN RESULTS FROM THE OBSERVATIONS OF 20 YEARS, (1840 to 1859 inclusive), PROVINCIAL OBSERVATORY, TORONTO, C. W.

Latitude. 43° 39′ 4″ North.
Longitude, 5h 17m 33s West.

Elevation above Lake Ontario. 106 feet.
Approximate elevation above the sea, 342 feet.

Months.	Temperature.					Rain.		Snow.		Total Moisture.		Wind.			Amount of Cloudiness.
	Mean.	Max'm obs'd	Min'm obs'd.	Monthly Range.	Daily Range.	Days on which rain fell.	Depth in inches on the surface.	Days on which snow fell.	Depth in inches.	Days on which rain or snow fell	Depth in inches on the surface.	Direction.	Mean velocity in miles.	Mean force in lbs.	
	°	°		°	°	d.		d.		d.		°			
January, ...	23.72	43.08	—6.56	49.64	13.76	4.4	1.480	11.3	13.51	15.7	2.831	N. 71 W.	7.61	0.70	0.70
February, ...	22.83	43.93	—5.34	49.27	14.90	4.1	1.043	11.2	17.30	15.3	2.773	N. 69 W.	7.51	0.78	0.69
Winter, ...	24.17	..	..	48.25	13.57	13.9	4.129	35.2	46.00	49.1	8.729	N. 71 W.	7.83	0.71	0.71
March, ...	30.07	52.32	3.64	48.68	14.74	6.0	1.553	8.1	9.25	14.4	2.478	N. 60 W.	8.11	0.66	0.59
April, ...	41.00	66.31	19.83	46.48	15.91	9.2	2.492	3.1	2.38	12.3	2.730	N. 29 W.	7.58	0.56	0.57
May, ...	51.38	75.02	31.78	43.24	18.57	11.5	3.305	0.5	0.08	12.0	3.313	N. 3 W.	6.36	0.43	0.53
Spring, ...	40.82	..	..	46.13	16.41	26.7	7.350	12.0	11.71	38.7	8.521	N. 36 W.	7.35	0.55	0.56
June, ...	61.27	83.76	40.59	43.17	19.15	11.7	3.198	..	..	11.7	3.198	W.	5.01	0.29	0.53
July, ...	67.06	87.49	48.31	39.18	19.97	9.5	3.490	..	..	9.5	3.490	N. 63 W.	4.73	0.29	0.44
August, ...	66.12	83.98	46.35	37.63	19.10	9.8	2.927	..	..	9.8	2.927	N. 59 W.	5.20	0.19	0.45
Summer, ...	64.82	..	..	39.99	19.41	31.0	9.615	..	..	31.0	9.615	N. 70 W.	4.98	0.26	0.47
September, ...	57.98	80.94	34.35	46.59	18.14	10.8	4.099	..	..	10.8	4.099	N. 59 W.	5.41	0.36	0.49
October, ...	45.27	66.71	24.99	41.72	15.88	11.3	2.557	2.0	0.94	13.3	2.651	N. 60 W.	5.76	0.37	0.59
November, ...	36.65	55.04	15.36	39.68	11.94	9.2	3.109	5.7	3.16	14.9	3.425	N. 75 W.	7.20	0.67	0.74
Autumn, ...	46.63	..	..	42.66	15.32	31.3	9.765	7.7	4.10	39.0	10.175	N. 67 W.	6.12	0.47	0.61
December, ...	25.97	45.11	—0.72	45.83	12.04	5.4	1.606	12.7	15.19	18.1	3.125	N. 70 W.	8.04	0.64	0.75
Year, ...	44.11	July	January	44.26	16.18	102.9	30.859	54.9	61.81	157.8	37.040	N. 60 W.	6.57	0.50	0.59
No. of years data,	20 years.	20 years.	20 years.	20 years.	20 years.	20 years.	19–20 years.	20 years.	17 years.	20 years.	19–20 Rain 17 Snow.	12 years.	12 years.	7 years.	7 years.

MINIMUM AND MAXIMUM TEMPERATURES AT FREDERICTON.

The Reverend Dr. Brooke, of Fredericton, has kindly furnished me with a condensed summary of meteorological observations taken by him daily at Fredericton for a period of seventeen years, or from 1847 to 1864 inclusive. These tables contain the monthly maximum and minimum temperatures, the mean temperatures at 7 a. m. and 2 p. m. The days on which the highest and lowest temperatures occurred, and the number of rainy, snowy, and cloudy days in each month. The extreme length of these tables necessarily forbids their being printed here in full, but some interesting extracts from them follow.

Table showing the lowest and highest temperatures recorded at Fredericton between 1848 and 1864 inclusive:—*

	Minimum Temperature.	Max. Temp. during the year.		Minimum Temperature.	Max. Temp. during the year.
1848,	February 28, —16	86	1857,	January 24, —30	86
1849,	" 14, —26	100	1858,	February 23, —14	90
1850,	" 7, —25	94	1859,	January 12, —30	88
1851,	" 9, —22	82	1860,	February 2, —22	88
1852,	January 20, —14	92	1861,	" 8, —27	90
1853,	" 28, —24	94	1862,	" 11, —16	80
1854,	" 10, —34	92	1863,	" 4, —20	95
1855,	February 7, —30	93	1864,	" 19, —30	90
1856,	January 2, —22	98			

On the 29th Dec. 1854, the unusally low temperature of 30 below zero was recorded; and on the 12th July 1849, the thermometer rose to 100 degrees.

The minimum temperatures in the above tables are frequently exceeded in Canada, east of Kingston. At Montreal "cold terms" are not unusual, and sometimes they well deserve the name which has been applied to them.

Dr. Brooke's register shows that on the 29th December 1854, the thermometer at Fredericton fell to 30 below zero, but at Montreal on the 22nd and 23rd December of the same year it fell to 36 below zero, and from 8 A. M. on the 22nd to 10 P. M. on the 23rd, it ranged from — 8.1 to — 36.

Again on the 9th, 10th, and 11th January 1859, the thermometer did not rise above zero during a period of 124 hours, 30 minutes, or more than five days. Mercury froze in the open air; and the mean temperature of the 9th was—27°8; the 10th—29°0; and the 11th—28°. At Fredericton the minimum temperature was 30 below zero, which occured on the 12th Jan'y.

At Quebec in the winter of 1853 and 4, the thermometer sank below the freezing point 189 nights, or rather more than half the year. There were during that winter 2 days in November in which it fell below zero; 7 in December; 20 in January; 17 in February; and 4 in March, making a total of 50 days during the winter upon which the thermometer was registered below zero.† Although the Saint Lawrence broke up on the 24th April, the ice did not pass out of the Saint Charles until the 5th May.

* These observations have not been reduced.

† Transactions of the Literary and Historical Society of Quebec, January 1855.

Comparative Table showing the difference between some points in the climates of Saint John and Fredericton* :—

Points of Comparison.	Coast.	Interior.
Mean Annual Temperature, ...	41°.39	42°.42
Maximum for the year, ...	88.00	98.00
Minimum, ...	—17.00—	—38.00
Maximum Monthly mean, ...	62.43	66.76
Minimum " "	20.52	14.79
Extreme range for the year, ...	105.00	136.00
Mean Monthly range, ...	41.91	51.97
Mean moisture, ...	39 inches.	37 inches.
Extreme highest, ...	?	42 "
" lowest, ...	?	32 "
Saint John open for Navigation, ...	always.	218 days.
Average duration of Summer, ...	——	204 "
Average period of the growth of crops,†		110 "

Table showing the mean annual temperature at Saint John, Fredericton, Quebec, Montreal, and Toronto :—

Saint John,‡	41.80
Fredericton,§	42.42
Quebec,‖	38.5
Montreal, ...	41.56
Toronto, ...	44.12

CONCLUSION.

THE ADVANTAGES OF A SYSTEMATIC GEOLOGICAL SURVEY.

In 1855 a Select Committee of the Canadian House of Assembly reported on the Geological Survey of Canada. During the investigation, a large number of witnesses were examined, with a view not only to arrive at a knowledge of the benefits resulting to the public from the survey, but also to ascertain the degree of estimation in which the labours of Sir William Logan, (then Mr. Logan) were held in abroad, and the prospective advantages which might reasonably be anticipated from the prosecution of the work on a considerably enlarged scale.

In their Report, the Committee state "the importance of an accurate Geological acquaintance with the country is so universally acknowledged, that it is unnecessary to do more than point out some portions of the evidence which show the immediate practical result; but as an apparent misapprehension exists in some quarters as to the objects of such a national undertaking, your Committee may be pardoned for making some additional observations.

* Fredericton 58 miles inland N.W., of Saint John, Latitude 45° 57′ 30″ N., Longitude 66° 38′ W.

† From Dr. Robb's Agricultural Report.

‡ The means for Saint John are the result of Mr. Murdoch's observations.

§ The means for Fredericton are the result of eight year's observations, but they have not been reduced. It is probable that the mean is about half a degree too high.

‖ Transactions Lit. and Hist. Society of Quebec, January 1855.

"The discovery of valuable economic materials speaks for itself, although, even here it may be doubted whether the relative importance of the minerals indicated is always justly appreciated, whether the crystalline limestones of the Laurentian Series have not been of more real value than some discoveries of a far more imposing character. But where the outline of some formation of no very obvious economic use is accurately traced for many miles, when minute and laborious investigations are carried on of the undulations, contortions and disturbances of other strata, with exact measures of their thickness and dip, and when the greatest attention is paid to the fossils they contain, some people are apt to think that the Geologist might be more usefully employed. They draw a distinction between practical utility and scientific interest. The ultimate object, however, of all science is practical utility; IT IS ONLY A SYSTEMATIC, instead of a DESULTORY SEARCH for valuable facts.

"The discovery of some useful material at a particular point would be an isolated fact, though, perhaps, of great importance to that locality; but combined with a correct scientific knowledge of the geology of the country, it would be not only available over an extensive region, but would be the contribution of a valuable truth to the whole world."

Mr. Hall, of Albany, a gentleman of world-wide reputation, author, among other valuable works, of the "Geology of the First District of the State of New York," and of those magnificent volumes devoted to the Palæontology of the entire State, submitted in evidence that a sound basis of scientific investigation is of the highest importance in leading to practical results. Mr. Hall said that he conceived that no practical or economic results of great value are likely to arise except those based upon scientific investigations. The great lead-bearing formation of the States of Wisconsin, Illinois, and Iowa was instanced. For many years a serious misapprehension existed in regard to the true position of the lead-bearing rock; and only so late as 1850 was it determined, by a proper examination of its organic remains, that instead of its being in the Niagara group, as formerly supposed, it belongs to a much lower series of rocks, viz., a Lower Silurian Limestone. This erroneous impression gave rise to fruitless searches for Lead ore in the Niagara limestone, which this late information will discourage. There are at this time multitudes of practical miners, who know at once, by the occurrence of certain Fossils, the presence of the Lead-bearing rock, and who would never think of searching for Lead ore in any rock where these Fossils do not exist.

During fifty years previous to the commencement of the Survey in the State of New York, *not less than one million dollars had been expended in abortive search for coal*, where a well-informed Geologist would have at once pronounced the undertaking useless, and certain to prove a failure.

During the last Session of the Canadian Parliament, (1863–4,) a further appropriation of $20,000 a year for five years was made for the continuation of the survey of that Province, such being the estimation in which this great national work is held in Canada.

A survey of New Brunswick should comprehend—

1. An accurate description, accompanied by a Map, of the limits of each formation, according to the plan already adopted by Sir William Logan, which is now well known in Europe and the United States. "UNITY OF DESIGN would render the results, both economic and scientific, intelligible to the world, with much less study than would otherwise be required." (See Sir William Logan's Letter, page xv, also Remarks on Nomenclature, pages 39 and 40.)

2. An examination of the mineral resources of each formation, showing their distribution and the probable extent to which they may be commercially valuable.

3. A collection of all the minerals found in the Province, with specimens of the rocks in which they occur, and illustrations, when practicable, of their uses in the arts, with a view to the formation of a Provincial Museum, in which all the minerals and fossils of the Province should be scientifically arranged and classified, and the localities where the rock which contains them mapped.

4. The publication of an Annual Report describing the year's operations, and particularizing the nature, extent, and probable commercial value of the minerals in the area examined.

On page xii of the Introductory Chapter, a brief notice is given of some of the results of a preliminary survey during the past year. It has been established that the great metalliferous belt of North America (the Quebec Group) occupies an area of upwards of four thousand square miles, or more than two and a half million acres. In the words of Sir William Logan,* "the rocks of this Group yield in Canada, ores of iron, chromium, lead, antimony, copper, nickel, silver and gold, with soapstone, potstone, hones, marbles, serpentines, cement stones, building stones, and roofing slates." The Chapters in this Report devoted to the Group (Chap. VIII. and IX.) as it occurs in New Brunswick, show that with the single exception of chromium, ALL OF THESE METALS and ECONOMIC MATERIALS have been found within its limits in this Province, and some of them to a far greater extent than they have been recognized in Canada. (ANTIMONY, the WOODSTOCK IRON ORES, MANGANESE). Hence it follows that a careful and systematic examination of this vast rock series promises very valuable results.

The ORIGIN OF ALBERTITE has been described, (Chapter V.) and the probability of its being found in workable quantities over a horizontal distance of fifty miles in one direction, and from ten to fifteen miles in another direction, pointed out.

The distribution of the highly bituminous ALBERT SHALES, and their value as a source of gas fuel for smelting and manufacturing purposes generally, is also noticed at some length in Chapter V., and it is of considerable importance that the area they occupy, their thickness and the extent to which they are available for the purposes described should be accurately determined.

* See Letter No. II. page xv.

The probable existence of workable beds of COAL, besides the Grand Lake seam is shown in the Chapters on the Carboniferous Series, (Chap. III. and IV.) As fossil fuel, whether in the form of coal or rich Bituminous Shales, lies at the foundation of modern progress, the existence of workable deposits in New Brunswick is of the highest importance. Canada, although more than twelve times the area of New Brunswick, possesses no deposits of coal, and no bituminous shales which can approach the richness of the Albert Shales, and no workable seams of Albertite.

The development of the COPPER-BEARING TRAPS on the shores of the Bay of Fundy is also a valuable subject of enquiry. These traps are noticed at length in Chapter VI.

Among apparently minor claims for a complete scientific survey of the Province, are the distribution of its LIMESTONES, the HYDRAULIC CEMENTS, materials for the manufacture of BRICKS and POTTERY, FIRE CLAYS, PLUMBAGO, MARBLES, SERPENTINES, ROOFING SLATES, WHETSTONES, HONES, GRINDSTONES, MILLSTONES, GYPSUM, SULPHATE OF BARYTA, SANDSTONE for GLASS, MOULDING SAND, all of which it will be seen by reference to the index, occur within the limits of the Province, and some of them in great abundance and of excellent quality.

The SOURCE OF THE GOLD in the Drift Clays of the Province is an important subject of enquiry, which has received additional interest from the recent confirmation of further discoveries of gold in quartz veins of Upper Silurian age in Canada, over wide areas on the River du Loup, and generally in the Valley of the Chaudiere and elsewhere. (Chapter XI.) The large area of country occupied by the Quebec Group in New Brunswick, would lead to the inference that the chief source of the gold is to be sought for in the rocks of this Group; but since altered Upper Silurian Rocks also occupy a considerable portion of the northern Counties, it is not improbable that these may have contributed to the auriferous Drift.

Lastly, in order to secure the introduction of Capital into the Province, and the establishment of manufacturing industry on a secure basis, it is absolutely essential that capitalists abroad should have some security for their investments.

The experience of many years sufficiently establishes the fact that unless plans for the development of metalliferous deposits, or for the working of economic materials, be based upon scientific research, showing " the reason why," it is only indulging in a fruitless expectation to suppose that foreign capitalists, or indeed any well-informed or reasonably cautious man, who has not an opportunity of judging for himself, will give them either countenance or support.

APPENDIX.

APPENDIX.

No. I.

ORIGIN OF THE NAMES OF CERTAIN RIVERS AND PLACES IN NEW BRUNSWICK.

[Hale's Vocabularies—Transactions of the Am. Ethnological Society—Relations of the Jesuits.]

The importance of understanding the origin of names assigned to a country, district, river, or place, is fully illustrated in the brief history which has been given at the commencement of the First Chapter, of the consequences which followed misapprehensions concerning the word "Acadia." In a historical point of view, names of places are always, or at least very frequently, suggestive, hence their origin and meaning is interesting. So many of the Rivers and Mountains of this Province still retain their original Indian appellations, that it is almost a part of a liberal education to be familiar with their meaning, and yet there are few who give more than a passing thought to this subject.

As means for obtaining a correct list of Indian names of places in New Brunswick are rapidly diminishing, the following is an attempt to arrange such as are known, with a view to their correction by competent authorities, and to fix indelibly the true meaning of Indian terms, before the only source from which we can obtain correct information passes away.

1. RISTIGOUCHE—Micmac, mentioned in the Relations of the Jesuits for 1642, and spelt "Restgouch." It signifies Broad River.
2. TITTIGOUCHE—Fairy River, (Robert Cooney). POKEMOUCHE; BUCTOUCHE—Fire River; MISTOUCHE.
3. NIPISIGUIT—Probably Milicete, (Etchemins). (The Micmac word for water is chabuguan, and for river chibuk). Mentioned in the Relations, and spelt "Nepigigouit." It means Rough Waters.
4. MIRAMICHI—Mentioned in Relations for 1646 & 1659—Happy Retreat (?).
5. MISCOU.—Mentioned in Relations for 1635, &c. Formerly called "Isle de Saint Louis."
6. CHEDABOUCTOU, (near Miramichi)—Father de Lionne died here. Relations, 1661. (Bouctou—Fire).

7. Asticou—A Micmac Chief. Relations, 1611.
8. Kadesquit—A part of Acadia where La Saussaye had projected an establishment. Relations, 1611.
9. Menano—Grand Manan. Relations, 1611.
10. Rigibouctou—River of Fire, Bay of. Relations, 1646.
" River. Relations, 1659.
11. As early as 1611, it was remarked by the writer of the "Relation de la Nouvelle France,"* that no trace remained of the origin of the words Norembegue, (the present State of Maine,) Acadia, (the country of the Souriquois or Micmacs,) and Canada.
12. Upsalquitch, (pronounced Ab-sat-quitch)—"The River that runs out small." Micmac.
13. Tabousintac—The place where two reside. (Cor.)
14. Maguadavic—River of Hills.
15. Nagotquo—Tobique River, (Milicete). Absegaguit nagotquo-sis quispem—Little Tobique Lake. Quis-pam-sis—Little Lake.
16. Saint Croix, (Island). Relations, 1611. Residence of de Monts on the coast of Norembegue.
17. River Saint Croix. Relations, 1611. Schoodic.
18. Autmoins—Name of the Micmac Conjuror. Manitousin—Ojibway.
19. Etchemins (canoe-men), originally Eteminquois—Milicete. The hunting ground of the Etchemins extended from the River Saint John to the Kennebec in 1611. Relations, 1611. Amaleates or the Maneus tribe—now Milicetes. Paris Documents, 1736. In Canadian Documents spelt Amalicite.
20. The Saint John—Called by L'Escarbot "the River of the Great Bay," 1598; by Champlain, Saint John, 1604; by the Etchemins or Milicetes, "Awollastook" or the "Big River"; by the Abenaquis, "Loshtook" or the "Long River"; also Ouygoudy.
21. "Cadie."—"A Map of North America, contained in the novus orbis of De Laet, published in 1633, distributes the country into the following divisions, commencing on the north: New France, Cadie, Norumbega, (comprising the territory between the Saint Croix and the Kennebec,) New England, New Netherland, Virginia, and Florida."—(Collection of the Maine Historical Society, Vol. II.)

The number of Micmacs or Souriquois was estimated at from 3,000 to 3,500 in 1611, by the Jesuit Missionaries. They spoke highly of the characters of the Souriquois and Etchemins—(Micmacs and Milicetes.) The number of Indians in this Province, according to the last census, was 1212, (625 males and 587 females).

* Relations, 1611—page 2.

MICMAC AND MILICETE NAMES FOR SOME COMMON THINGS.

	Micmac.	Etchemins or Milicete.		Micmac.	Etchemins or Milicete.
Man	tchinem	oskitap	Snow	wastouh	warst
Woman	epit	apet	Earth	keshwajowouyaw	takomiqu
Father	nutch (my)	mataqus	River	chibuk	sepe
Mother	kich	nikos	Stone	kundau	panapsqu
Son	unquece	n'kos	Tree	neepeejeesh	apas
Daughter	untouse	n'sous	Meat		wiyos
Head	unidgik	neneagan	Dog	lemuch	lumose
Hair			Beaver		quanbeadt
Ear	hadougan	chalkse	Bear		mowene
Eye	pouogul	n'siscol	Bird	tchipahit	cipsis
Nose	uchickun	nitou	Fish	nemeteh	n'mays
Mouth		neswone	Great	mechkilk	nukamkiqun
Tongue	willenonk	nyllal	Cold	tekayo	nedanbedatsi
Teeth	uabidul		White	uabeg	wapiyo
Hand	kpiten	petin	Black	m'katuey	muk saiwayo
Fingers	clooegan		Red	megoueg	maiquaik
Feet	ukkuat	n'sit	I	nil	nel
Blood	moldan	pocagun	Thou	kil	
House	uiguom	wannoji	He	negeum	wurt
Axe	tomehagan				
Knife	uagan		*numbers.*		
Shoes	whanjouonksnan		One	nest	naiget
Sky	mooshkoon	tumogat	Two	talu	nes
Sun	nakauget	asptaiasait	Three	chicht	nihi
Moon	topanakoushet	kisos	Four	neu	naho
Star	malakokoouich	psaisam	Five	nan	nane
Day	naakok	kisuok	Six	achigopt	gamatchine
Night	pishkceaukh		Seven	atumoguenok	alohegannak
Fire	bukteu	skut	Eight	sgomolchit	okemulchine
Water	chabuguan	somaquone	Nine	pechkunadck	asquenandake
Rain	ikfashak	suklan	Ten	ptolu	neqdensk

In 1855, "A Primer for young children, applicable to the Indian language as spoken by the Mee-lee-ceet Tribe in New Brunswick," collected and arranged by Mr. John Stephens, was published in Fredericton, under the patronage of the Honorable Mrs. Manners-Sutton.

The spelling of some of the words differs slightly from some of those in the vocabulary given above, others are identical, and others again, wholly diverse.

The Rev. S. T. Rand, Missionary to the Micmac Indians in Nova Scotia, has compiled a "First Reading Book," in Micmac, which was published in London in 1854, with phonetic abbreviations, and in the phonetic type of Fred. Pitman. The "Reader" contains 40 pages duodecimo. It is beautifully printed in large type on excellent paper. In 1853 the Gospel of Saint Mathew was also printed "fonetically in Mikmak." The words given by the Rev. Mr. Rand to represent certain objects, differ occasionally from those in the short vocabulary above.

No. II.

NAMES OF PLACES AND RIVERS DERIVED FROM THE ABENAQUIS LANGUAGE.

The language of the Abenaquis resembles in many particulars that of the Milicete tribe, and the names of some places in New Brunswick, and in the eastern and northern part of Maine, are derived from the language spoken by this tribe.

The Abenaquis proper, occupied the country between the Penobscot and Piscataqua rivers. Subjoined are some of their words which have become incorporated as it were with the English of the present day, so far as relates to names of places.*

AROOSTOOK.—Smooth river. Enters the Saint John above the Tobique.
ALLAGASH.—Bark camp. A hunting camp of the Indians on the lake.
ABENAQUIS.—East land men.
CASCO.—The Heron; also place of victory.
CHEPUTNATICOOK.—Saint Croix River, and Lakes.
KENDUSKEAG.—The place of Eels. Ossekeag; Passekeag.
KABASSAKEAG.—The place of Sturgeon.
MONAHAN.—Island. (Manan.)
MEGANTIC.
METAWAMKEAG.—A river with a smooth gravelly bottom.
MADUCTIC.—Falls of the Saint John.
MADUSNEKEAG.—Tributary to the Saint John at Woodstock.
MILLINOKET.—A lake with many Islands in it. (MILNAGEC.)
MOOSEBEC.—Straits of a River.
NORUMBEGUA.—Maine. Also MAVOSHEN or MAVOOSHEN, in Halkuyt's Voyages.
NICKETOW or NECCOTOH.—Where two streams meet. The forks.
OUY-GOUDY.—The Saint John.
PASCODUMQUOKEAG—From Pascodum (pollock,) oquen (catch 'em many,) keag (land.)
PASSAMAQUODDY.—Pos (great,) asquam (water,) aquoddie (pollock.)

Mr. C. E. Potter states in the Collections of the Maine Historical Society, that "AQUODDIE" has been Frenchified or corrupted into Acadia, Cadia or Cadie, and applied to the shore of the Bay of Fundy. It is an Indian word meaning a fish. See page 21 Chap. I. Mr. G. Folsom states that "the Bay of Passamaquoddy" is on the French maps named Pesmo-cadie.—(Collections of Maine Historical Society, Vol. II.)

QUISQUAMAGO.—High carrying place.
SCHOODIC.—The place where water rushes.
KENNEBEC.—A snake.
KENNEBECCASIS.—A little snake.

* Collections of the Maine Historical Society, Vol. IV.

KEERSAGE.—A high place; the same as Ktaadn or Katahdin.
NAUMKEAG.—From Namaas (fish,) kik or keag (a house, land, or place.) A fishing place.
NEQUAMKIKE.—Nee (my,) asquam (water,) kike (place.)
PENOBSCOT.—Penapse (stone,) auke (place.) Penobsquis.
SABASTICOOK.—Sebastis was an Indian corruption of the French, Jean Baptiste. The Indians formerly pronounced the words as they do at the present day *Che-battis.* Affixing the syllable cook, which signifies place, the word becomes Che-bat-tis-cook or really Jean-Baptiste's place, and hence Sabasticook.—(C. E. Potter.)

No. III.

ENUMERATION OF THE MAMMIFEROUS ANIMALS KNOWN TO EXIST IN NEW BRUNSWICK.

The following List is framed on the same plan as the one published in the Transactions of the Portland Natural History Society. It has been carefully revised by Mr. J. P. Sills of Fredericton, whose forest and field acquaintance with the mammiferous animals and birds of New Brunswick, as well as those of Great Britain, confers a special value on the information he has kindly communicated. The Portland Society's List is retained in its original form, as it is possible that some of the animals, not at present recognized, may yet be found to exist within the limits of the Province. The species not known to occur in New Brunswick are marked with a star, (*) those found in the Province or in the waters of the coast, and not enumerated in the Portland Society's List, are printed in italics. One mark thus, † indicates that the animal changes its colour during winter; two marks, thus, † † show that it sleeps during the winter season.

CHEIROPTERA.

†† Vespertilio Carolinensis, Geof., Common Brown Bat.
V. subulatus, Gm., Little Brown Bat.
* V. Noveboracensis, Say., New York Bat.

INSECTIVORA.

* Sorex Forsteri, Rich., Forster's Shrew.
* S. Richardsoni, Bachm., Richardson's Shrew.
* S. platyrhinus, Wagner, Eared Shrew.
* S. Thompsoni, Baird, Thompson's Shrew.
* Blarina talpoidea, Gray, Mole Shrew.
B. brevicauda, Gray, Short-tailed Shrew.
†† Scalops aquaticus, Cuv., Common Mole.
Condylura cristata, Ill., Star-nosed Mole.

CARNIVORA.

Felis concolor, Linn., Panther, Catamount, Indian Devil. Lunksoos

Lynx rufus, Raf., Wild Cat.

L. Canadensis, Raf., Loup-cervier.

Canis occidentalis, Rich, Gray Wolf.

Vulpes fulvus, Rich., Red Fox.

V. fulvus, var. argentatus, Silver Fox, Black Fox.

* V. Virginianus, Rich., Gray Fox.

† Mustela Pennantii, Erxl., Fisher, Black Cat.

† M. Americana, Turton, Pine Marten, Sable.

* Putorius Cicognanii, Bonap., Small Brown Weasel.

† P. Richardsonii, Bonap., Little Ermine.

P. Noveboracensis, DeKay, Ermine.

† P. vison, Rich., Brown Mink.

P. nigrescens, Aud. and Bach., Little Black Mink.

Lutra Canadensis, Sab., American Otter.

†† Mephitis mephitica, Baird, Skunk.

Procyon lotor, Storr, Raccoon.

Ursus Americanus, Pallas, Black Bear.

Phoca vitulina, Linn., Common Seal.

Stemmatopus cristatus, Gm., Hooded Seal.

Phoca Grœnlandica, Harp Seal.

* Trichechus rosmarus, Linn., Morse or Walrus.

RODENTIA.

* Sciurus Carolinensis, Gm., Gray Squirrel.

S. Carolinensis, Gm., var. nigra, Black Squirrel.

S. Hudsonius, Pallas, Red Squirrel.

Pteromys volucella, Cuv.?, Flying Squirrel.

* P. Hudsonius, Fischer, Northern Flying Squirrel.

Tamias striatus, Baird, Chipmunk, or Ground Squirrel.

†† Arctomys monax, Gm. Woodchuck.

Castor Canadensis, Kuhl., Beaver.

* Jaculus Hudsonius, Wagner, Jumping Mouse.

Mus decumanus, Pallas, Brown Rat. (Introduced.)

M. rattus, Linn., Black Rat. (Introduced.)

M. musculus, Linn., Common Mouse. (Introduced.)

Hesperomys leucopus, Wagner, White-footed Mouse.

* H. myoides, Baird, Hamster Mouse.

* Arvicola Gapperi, Vigors, Redbacked Mouse.

A. riparia, Ord., Bank Mouse.

Fiber zibethicus, Cuv., Muskrat.

Erethizon dorsatus, F. Cuv., Porcupine.

Lepus, Americanus, Erxl., White Hare.

* L. sylvaticus, Bach, Gray Rabbit.

RUMINANTIA.

Alce Americanus, Jardine, Moose.

Rangifer caribou, Aud. and Bach. Woodland Caribou.

Cervus Virginianus, Boddaert, Virginian Deer.

CETACEA.

Balæna mysticetus, Linn., Right Whale.
Physeter macrocephalus. Lacep., Sperm Whale.
Beluga borealis, White Whale.
Rorqualus rostratus, Fabr., Beaked Rorqual.
R. borealis, Knox, Northern Rorqual.
Globicephalus melas, Lesson, Black Fish.
Phocæna communis, Cuv., Porpoise.
P. orca, Fabr. Grampus.

No. IV.

ENUMERATION OF THE BIRDS KNOWN TO VISIT NEW BRUNSWICK.

This enumeration is framed on the same plan as the List published in the Transactions of the Portland Natural History Society. It has been revised by Mr. J. P. Sills of Fredericton. The birds not known to visit the Province have a star placed before them, thus, (*) those species which are not named in the Portland Society's List, but have been recognized in New Brunswick, are printed in italics.

INSESSORES.

Falco anatum, Bp., Duck Hawk.
F. columbarius, Linn., Pigeon Hawk.
F. Islandicus, Sabine, Jer Falcon.
F. sparverius, Linn., Sparrow Hawk.
Astur atricapillus, Wilson, Goshawk.
Accipiter Cooperii, Bp., Sharp-shinned Hawk.
Buteo borealis, Vieill., Red-tailed Hawk.
* B. lineatus, Jardine, Red-shouldered Hawk.
B. Pennsylvanicus, Bp., Broad-winged Hawk.
* Archibuteo lagopus, Gray, Rough-legged Hawk.
A. sancti-johannis, Gray, Black Hawk.
Circus Hudsonius, Vieill., Marsh Hawk.
* Aquila Canadensis, Cassin, Golden Eagle.
Haliæetus leucocephalus, Savigny, Bald Eagle.
Pandion Carolinensis, Bp., Fish Hawk.
——————— *North American Kite.* [Probably a new species.]
Strix pratincola, Bp., Barn Owl.
Bubo Virginianus, Bp., Great Horned Owl.
Scops asio, Bp., Mottled Owl. Screech Owl.
* Otus Wilsonianus, Lesson, Long-eared Owl.
* Brachyotus Cassinii, Brewer, Short-eared Owl. *Small Barred Owl.*
* Syrnium cinereum, Aud., Great Gray Owl.
S. nebulosum, Gray, Barred Owl.
Nyctale Richardsoni, Bp., Sparrow Owl.

N. Acadica, Bp. Saw-whet Owl.
Nyctea nivea, Gray, Snowy Owl.
Surnia ulula, Bp., Hawk Owl.
Coccygus Americanus, Bp., Yellow-billed Cuckoo.
C. erythrophthalmus, Bp., Black-billed Cuckoo.
Picus villosus, Linn., Hairy Woodpecker.
P. pubscens, Linn., Downy Woodpecker.
Picoldes arcticus, Gray, Black-backed Three-toed Woodpecker.
* P. hirsutus, Gray, Banded Three-toed Woodpecker.
Sphyropicus varius, Baird, Yellow-bellied Woodpecker.
Hylatomus pileatus, Baird, Black Woodcock.
Melanerpes erythrocephalus, Sw., Red-headed Woodpecker.
Picus Canadensis, Canada Woodpecker.
P. Phillipsii, Phillips' Woodpecker.
P. Martinæ, Maria's Woodpecker.
P. querulus, Red-cockaded Woodpecker.
P. Auduboni, Audubon's Woodpecker.
P. ruber, Red-breasted Woodpecker.
Colaptes auraratus, Sw., Flicker.
Trochilus colubris, Linn., Ruby throated Humming bird.
Chætura pelasgia, Steph., Chimney Swallow.
Antrostomus vociferus, Bp., Whip-poor-will.
Chordeiles popetue, Baird, Night Hawk.
Ceryle alcyon, Boie, Belted Kingfisher.
Tyrannus Carolinensis, Baird, King bird.
* Myiarchus crinitus, Cab., Great-crested Flycatcher.
Sayornis fuscus, Baird, Pewee.
Contopus borealis, Baird, Olive-sided Flycatcher.
* C. virens, Cab. Wood Pewee.
Empidonax minimus, Baird, Least Flycatcher.
Turdus mustelinus, Gm., Wood Thrush.
* T. Pallasi. Cab., Hermit Thrush.
* T. fuscescens, Steph., Wilson's Thrush.
* T. Swainsonii, Cab., Olive-backed Thrush.
T. migratorius, Linn., Robin.
Sialia sialis, Baird, Blue bird.
Regulus calendula, Licht., Ruby-crowned Wren. Common Wren.
R. satrapa, Licht., Golden-crested Wren.
Anthus Ludovicianus, Licht, Tit Lark.
Mniotilta varia, Vieill, Black and White Creeper.
Geothlypis trichas, Cab., Maryland Yellow-throat.
* Helmintherus vermivorus, Bp., Worm-eating Warbler.
* Helminthopaga chrysoptera, Baird, Golden-winged Warbler.
* H. ruficapilla, Baird, Nashville Warbler.
* Seiurus aurocapillus, Sw., Golden-crowned Thrush.
* S. Noveboracencis, Nutt., Water Thrush.
Dendroica virens, Baird, Black-throated Green Warbler.
* D. coronata, Gray, Yellow Rump Warbler.

D. Blackburniæ, Baird, Blackburnian Warbler.
* D. castanea, Baird, Bay-breasted Warbler.
D. pinus, Baird, Pine-creeping Warbler.
* D. Pennsylvanica, Baird, Chestnut-sided Warbler.
D. striata, Baird, Black Poll Warbler.
D. æstiva, Baird, Yellow Warbler.
D. maculosa, Baird, Black and Yellow Warbler.
D. tigrina, Baird, Cape May Warbler.
D. palmarum, Baird, Yellow Red Poll.
Silvia pensilis, Yellow-throated Wood Warbler.
Silvia autumnus, Autumnal Warbler.
Silvia nigrescens, Black-throated Gray Wood Warbler.
Helinaia Swainsonii, Swainson's Swamp Warbler.
Myiodioctes pusillus, Bp., Green Black-cap Flycatcher.
M. Canadensis, Aud., Canada Flycatcher.
Setophaga ruticilla, Sw., Redstart.
Pyranga rubra, Vieill, Scarlet Tanager.
Hirundo horreorum, Barton, Barn Swallow.
H. lunifrons, Say, Cliff Swallow.
H. bicolor, Vieill, White-bellied Swallow.
Cotyle riparia, Boie, Bank Swallow.
Progne purpurea, Boie, Purple Martin.
Ampelis garrulus, Linn., Wax Wing.
A. cedrorum, Baird, Cedar bird.
Collyrio borealis, Baird, Great Northern Shrike.
* Vireo olivaceus, Vieill, Red-eyed Fly-catcher.
* V. gilvus, Bp., Warbling Fly-catcher.
* V. Noveboracensis, Bp., White-eyed Vireo.
Vireo Flavifrons, Yellow-throated Fly-catcher.
* Mimus Carolinensis, Gray, Cat bird.
* Harporhynchus rufus, Cab., Brown Thrush.
* Cistothorus palustris, Cab., Long-billed Marsh Wren
C. stellaris, Cab., Short-billed Marsh Wren.
Troglodytes Americanus, Aud., Wood Wren.
T. hyemalis, Vieill., Winter Wren.
* Certhia Americana, Bp., American Creeper.
Certhia familiaris, Brown Creeper.
Sitta Carolinensis, Gm., White-bellied Nuthatch.
S. Canadensis, Linn., Red-bellied Nuthatch.
Parus atricapillus, Linn., Chickadee; Black-cap Titmouse.
Parus Carolinensis, Carolina Titmouse.
P. Hudsonicus, Forst., Hudsonian Titmouse.
* Eremophila cornuta, Boie., Sky Lark.
Pinicola Canadensis, Cab., Pine Grosbeak.
Carpodacus purpureus, Gray, Purple Finch.
Fringilla atricapilla.
Black and Yellow crowned Finch.
Chrysomitris tristis, Bp., Yellow bird.

C. pinus, Bp., Pine Finch.
Curvirostra Americana, Wils., Red Crossbill.
C. leucoptera, Wils., White-winged Crossbill.
Aegiothus linaria, Cab., Lesser Red Poll.
Plectrophanes nivalis, Meyer, Snow Bunting.
P. Lapponicus, Selby, Lapland Longspur.
* Passerculus Savanna, Bp., Savannah Sparrow.
Vireo Bartrami, *Bartram's Greenlet.*
Icteria virida, *Yellow-breasted Chat.*
* Poœcetes Gramineus, Baird, Grass Finch.
Coturniculus passerinus, Bp., Yellow-winged Sparrow.
Zonotrichia leucophrys, Linn., White-crowned Sparrow.
Z. albicollis, Bp., White-throated Sparrow.
Junco Hyemalis, Sclat., Snow Bird.
Spizella monticola, Baird, Tree Sparrow.
S. pusilla, Bp., Field Sparrow.
S. socialis, Bp., Chipping Sparrow.
Melospiza melodia, Baird, Song Sparrow.
M. palustris, Baird, Swamp Sparrow.
Passerella iliaca, Sw., Fox-colored Sparrow.
Guiraca Ludoviciana, Sw., Rose-breasted Grosbeak.
G. cærulea, Sw., Blue Grosbeak.
* Cyanospiza cyanea, Baird, Indigo Bird.
* Pipilo erythrophthalmus, Vieill., Ground Robin; Towhee.
Dolichonyx oryzivorus, Sw., Bobolink, Rice Bird.
Molothrus pecoris, Sw., Cow Bird.
Agelaius phœniceus, Vieill., Swamp Blackbird; Red-winged Blackbird.
Sturnella magna, Sw., Meadow Lark.
Icterus spurius, Bp., Orchard Oriole.
I. Baltimore, Daudin, Baltimore Oriole.
* Scolecophagus ferrugineus, Sw., Rusty Blackbird.
Quiscalus versicolor, Vieill, Crow Blackbird.
Corvus carnivorus, Bartram, American Raven.
C. Americanus, Aud., Crow.
Cyanura cristata, Sw., Blue Jay.
Perisoreus Canadensis, Bp., Canada Jay.
Ectopistes migratoria, Sw., Wild Pigeon, (*Passenger*).
Zenaidura Carolinensis, Bp., Common Dove.

RASORES.

Tetrao Canadensis, Linn, Spruce Partridge.
Bonasa umbellus, Steph., Ruffed Grouse, or Partridge, (*Pheasant*).
* Lagopus albus, Aud., White Ptarmigan.
Ortyx Virginianus, Bp., Quail.

GRALLATORES.

Ardea herodias, Linn., Great Blue Heron.
* Ardetta exilis, Gray, Least Bittern.
Botaurus lentiginosus, Steph., Bittern.

* Butorides virescens, Bp., Green Heron.
* Nyctiardea Gardeni, Baird, Night Heron.
Ardea Occidentalis, Great White Heron.
Charadrius Virginicus, Borck, Golden Plover.
* Aegialitis vociferous, Cassin, Killdeer.
* A. semipalmatus, Cab., Semipalmated Plover.
A. melodus, Cab., Piping Plover.
* Squatarola Helvetica, Cuv., Black-bellied Plover.
* Strepsilas interpres, Ill., Turnstone.
Philohela minor, Gray, American Woodcock.
Gallinago Wilsonii, Bp. Wilson's Snipe.
Macrorhamphus griseus, Leach, Red-breasted Snipe.
Tringa canutus, Linn., Gray Back.
T. maritima, Brunnich, Purple Sandpiper.
T. subarquata, Temm., Curlew Sandpiper.
T. alpina, Cassin, Red-backed Sandpiper.
* T. maculata, Vieill., Jack Snipe.
T. Wilsonii, Nuttall, Least Sandpiper.
Calidris arenaria, Ill., Sanderling.
Ereunetes petrificatus, Ill., Semi-palmated Sandpiper.
* Symphemia semipalmata, Hartlaub., Willet.
* Gambetta melanoleuca, Bp., Tell-tale; Stone Snipe.
G. flavipes, Bp., Yellow Legs.
* Ryacophilus solitarius, Bp., Solitary Sandpiper.
Tringoides macularius, Gray, Spotted Sandpiper.
Tringa Pectoralis, Pectoral Sandpiper.
* Philomachus pugnax, Gray, Ruff.
† Limosa Hudsonica, Sw., Hudson Godwit.
Numenius longirostris, Wilson, Long-billed Curlew.
N. Hudsonicus, Latham, Hudsonian Curlew.
* N. borealis, Latham, Esquimaux Curlew.
* Porzana Carolina, Vieill, Common Rail.
* Fulica Americana, Gm., Coot.

NATATORES.

Anser hypoboreus, Pallas, Snow Goose.
Bernicla Canadensis, Boie, Canada Goose.
B. brenta, Steph., Brant.
* Anas boschas, Linn., Mallard.
A. obscura, Gm., Black Duck.
Dafila acuta, Jenyns, Sprig-tail; Pin-tail.
Nettion Carolinensis, Baird, Green-winged Teal.
Querquedula discors, Steph., Blue-winged Teal.
* Spatula clypeata, Boie, Shoveller.
Chauleeasmus streperus, Gray, Gadwall.
Mareca Americana, Steph, Baldpate; American Widgeon.
Aix sponsa, Boie, Summer Duck.
* Fulix marila, Baird, Big Black-head, *Scaup Duck.*
F. collaris, Baird, Ring-necked Duck.

Bucephala Americana, Baird, Golden Eye.
* B. albeola, Baird, Butter Ball.
Histrionicus torquatus, Bp., Harlequin Duck.
* Harelda glacialis, Leach, South Southerly.
Melanetta velvetina, Baird, Velvet Duck.
* Oidemia Americana, Swains, Scoter.
Somateria mollisima, Leach, Eider Duck.
* Erismatura rubida, Bp., Ruddy Duck.
Fuligula perspicillata, Surf Duck.
Mergus Americanus, Cassin, Sheldrake.
M. serrator, Linn., Red-breasted Merganser.
Lophodytes cucullatus, Reich., Hooded Merganser.
Sula bassana, Briss., Common Gannet; Solan Goose.
Graculus Carbo, Gray, Common Cormorant.
Thalassidroma Leachii, Temm., Leach's Petrel.
T. pelagica, Bp., Mother Carey's Chicken.
Puffinus major, Fabor, Greater Sheerwater.
P. anglorum, Temm., Mank's Sheerwater.
* Stercorarius pomarinus, Temm., Pomarine Skua.
S. parasiticus, Temm., Arctic Skua.
Larus marinus, Linn., Great Black-backed Gull.
L. argentatus, Brunn., Herring Gull.
L. Delawarensis, Ord., Ring-billed Gull.
Chroicocephalus atricilla, Linn., Laughing Gull.
C. Philadelphia, Lawrence, Bonaparte's Gull.
Rissa tridactyla, Bp., Kittiwake Gull.
Sterna Wilsoni, Bp., Wilson's Tern.
S. macroura, Naum., Arctic Tern.
Colymbus torquatus, Brunn., Loon; Northern Diver.
C. septentrionalis, Linn., Red-throated Diver.
Prodiceps griseigena, Gray, Red-necked Grebe.
P. cornutus, Latham, Horned Grebe.
Podilymbus podiceps, Lawrence, The Pie-billed Grebe; Carolina Grebe.
Alca torda, Linn., Razor-billed Auk.
Mormon artica, Ill., Puffin.
Uria grylle, Latham, Black Guillemot.
U. ringvia, Briinn., Murre.
Mergulus alle, Vieill., Sea Dove; Dove Kie.
Pelicanus Americanus, White Pelican.
Larus Sabini, Fork-tailed Gull.
Larus eburneus, Ivory Gull.
Larus leucopterus, White-winged Silvery Gull.
Lestris Pomarine, Pomarine Jager.
Procellaria glacialis, Common Fulmar.
Puffinus cinereus, Wandering Sheerwater.

WINTER BIRDS.

The following species may be found in the Province during the winter season :—

1. All the Owls, with the exception of the Snowy Owl.
2. All the Woodpeckers, with the exception of the Golden and Gray.
3. Grosbeak, Nuthatch, and Titmouse, two species each.
4. Crossbill, two species; Snow Bunting, two species; Snow Birds, only seen in winter.
5. Chipping Sparrow, remained all winter (1864-5)—a very rare occurrence.
6. A Field Sparrow was also seen by Mr. Sills, at Lake Yoho, on the 20th January, 1865. Very rare occurrence.
7. Moose Bird, or Whiskey Jack.
8. Crow.
9. Blue Jay.
10. Spruce Partridge.
11. Birch Partridge.
12. Ring Necked Duck.
13. Red Linnet, retaining its colour summer and winter.

Twenty-eight species in all.

NORTH AMERICAN KITE.

Description of a Kite not recognized in Audubon's "*Birds of America*," killed in Cardigan, York County :—

Length of body,	...	...	...	10	inches.
" tail,	...	...	...	7	"
Legs (from body),	...	...	...	7	"
Extended wings,	...	...	...	34	"
Expanded foot,	...	...	...	3	"
Beak,	...	...	...	1	"

Head very small; colour of body pale chestnut; back and wings very dark brown; back of tail, brown-gray; tips of wings, do.; legs, bright yellow; beak, blue and small; weight, very light; floats rather than flies; lives on mice and small birds.

No. V.

ENUMERATION OF THE FISHES OF NEW BRUNSWICK.

[From the Reports of the late M. H. Perley, Esq.]

I. *The Perch Family.*

1 The American yellow Perch,..................*Perca Flavescens.*
2 The Striped Basse,..................*Labrax Lineatus.*
3 The White Perch,..................*Labrax pallidus.*
4 The common Pond Fish,..................*Pomotis vulgaris.*

II. *The hard-cheeked Family,* (*Sculpin.*)

1 The common Bullhead,..................*Cottus Virginianus.*
2 The Greenland Bullhead,.................. " *Grœnlandicus.*
3 The two-spined Stickleback,..................*Gasterosteus biaculeatus.*
4 The Norway Haddock,..................*Sebastes Norvegicus.*

III. *The Mackerel Family.*

1 The Spring Mackerel,..................*Scomber vernalis.*
2 The Fall Mackerel,..................*Scomber grex.*
3 The Tunny, or Albicore..................*Thynnus vulgaris.*
4 The Sword Fish,..................*Xiphias gladius.*

IV. *The Goby Family.*

1 The Wolf Fish,..................*Anarrhicas lupus.*

V. *Fishes with wrists in their pectoral fins.*

1 The American Angler,..................*Lophius Americanus.*

VI. *The Wrasse, or Rock Fish Family.*

1 The Sea Perch or Cunner,..................*Ctenolabrus ceruleus.*
2 The Tautog, or Black Fish,..................*Tautoga Americana.*

VII. *The Carp Family.*

1 The common Sucker,..................*Catostomus communis.*
2 The yellow Shiner,..................*Leuciscus chrysoleucas.*
3 The Roach, or Red-fin,.................. " *cornutus.*
4 The Roach Dace,.................. " *pulchellus.*
5 The shining Dace, or Shiner,.................. " *argenteus.*
6 The Chub,.................. " *cephalus.*
7 The Brook Minnow,.................. " *atronasus.*
8 The striped Killifish,..................*Fundulus fasciatus.*

VIII. *The Sheat-fish Family.*

1 The common Cat-fish,..................*Pimelodus catus.*

IX. *The Salmon Family.*

1 The Brook Trout,..................*Salmo fontinalis.*
2 The Great Gray Trout,.................. " *ferox.*
3 The Salmon Trout, (White Sea Trout,)... " *trutta.*
4 The Salmon,.................. " *salar.*
5 The Smelt,..................*Osmerus viridescens.*
6 The Capelin,..................*Mallotus villosus.*
7 The White Fish, (Gizzard Fish.)..................*Coregonus albus.*

X. *The Herring Family.*

1	The common American Herring,	*Clupea elongata.*
2	The Britt,	" *minima.*
3	The Shad,	*Alosa sapidissima.*
4	The Alewive, or Gaspereaux,	" *tyrannus.*
5	The Mossbonker,	" *menhaden.*
6	The Shad Herring,	" *mattowaca.*

XI. *The Cod Family.*

1	The Bank Cod,	*Morrhua vulgaris.*
2	The American Cod,	" *Americanus.*
3	The Tomcod,	" *pruinosa.*
4	The Haddock, or Hake,	" *æglefinus.*
5	The Hake,	*Phycis Americanus.*
6	The Silver Hake,	*Merlucius albidus.*
7	The Pollack,	*Merlangus carbonarius.*
8	The Torsk, or Cusk,	*Brosmius vulgaris.*
9	The Fresh Water Cusk,	*Lota maculosa.*

XII. *The Flat-fish Family.*

1	The Halibut,	*Hippoglossus vulgaris.*
2	The common Flounder,	*Platessa plana.*
3	The Sand Flounder,	" *pusilla.*
4	The Fleuk,	" *limanda.*

XIII. *The Lump-fish Family.*

1	The Lump-fish,	*Lumpus vulgaris.*

XIV. *The Eel Family.*

1	The common Eel,	*Anguilla vulgaris.*
2	The Sea Eel,	" *oceanica.*
3	The American Sand-launce,	*Ammodytes Americanus.*

XV. *The Sturgeon Family.*

1	The Sharp-nosed Sturgeon,	*Accipenser oxyrinchus.*

XVI. *The Shark Family.*

1	The Thresher Shark,	*Carcharias vulpes.*
2	The Basking Shark,	*Selachus maximus.*
3	The Dog Fish,	*Spinax acanthias.*

XVII. *The Ray Family.*

1	The Skate,	*Raia lævis.*
2	The Hedge-Hog Ray,	" *erinaceus.*

XVIII. *The Lamprey Family.*

1	The Lamprey,	*Petromyzon Americanus.*

In all eighteen families, comprising forty genera, and sixty-two species of Fish.

No. VI.

FOSSILIFEROUS MARINE CLAYS OF MAINE AND THE SAINT LAWRENCE COMPARED.

[From Notes on the Geology of Maine, by C. H. Hitchcock, Esq.—Proceedings of the Portland Natural History Society.]

The occurrence of fossiliferous Marine Clays on the coast of New Brunswick is noticed in the Chapter on SURFACE GEOLOGY, page 201. The following table drawn up by Mr. C. H. Hitchcock, from materials supplied by Mr. Fuller, and the published list of Dr. Dawson, will be valuable to the Geologist in this Province. The age of the clays is that part of the Post Pliocene period which belongs to the Terrace epoch.

The occurrence of coarse drift over stratified clays containing fossils at Portland, Brunswick, Bangor, &c., appears to show that a temporary local extension or increase of existing glaciers took place towards the close of the glacial period, or perhaps a change in the location of an ice-stream, owing to the filling up of a fiord with debris, as now occurs in Greenland.—(See Mr. Taylor's paper quoted, page 184.)

MAINE SPECIES.

VERTEBRATA.

Vertebræ of Whales, two species.
Specimens of fish in concretions, possibly the same as one of the St. Lawrence species.
Scales of large fish, such as the Rays.
Teeth of shark, Carcharias.

ARTICULATA.

Cancer irroratus, Say.
Hyas coarctata, Leach.
Bernhardus streblonyx, Dana.
†Cytheridea Mulleri.
Bairdia?
Nereis.
†Spirorbis spirillum, Lam.
Balanus balanoides, Linn.
†B. crenatus.

MOLLUSCA.

Terebratulina septentrionalis, Couth, (Dawson.)
Ostrea borealis, Lam., (Mighels.)
†Pecten Islandicus, Ch.
P. similis? Laskey.
Nucula antiqua, Migh.
†Yoldia pygmæa? Muenst.
†Leda Portlandica, Hitch.
Yoldia limatula, Say.
Leda tenuisulcata, Couth., (Nucula Jacksoni.)

ST. LAWRENCE SPECIES

VERTEBRATA.

A. Delphinus, (Cetacean).
Mallotus villosus.
Cyclopterus lumpus.
Remains of a Seal.

ARTICULATA.

†Balanus crenatus.
B. Hameri, Ascanius.
B. porcatus, Dacosta.
†Cytheridea Mulleri.
Spirorbis sinistrorsa.
†S. spirillum.
Serpula vermicularis.

MOLLUSCA.

Rynchonella psittacea, Gm.
†Pecten Islandicus, Ch.
Leda minuta, Moll.
†L. Portlandica, Hitch.
†Yoldia pygmæa, Muenst.
Crenella glandula, Tott.
†Modiolaria nigra, Linn.
†*Mytilus edulis, Linn.
†Serripes Grœnlandicus, Ch.
Cardium Islandicum, Linn.

MAINE SPECIES.

Mollusca.

*†Modiolaria nigra, Gray. (M. discors of Dawson's papers.)
†*Mytilus edulis, Linn.
Cardium pinnulatum, Con.
†Serripes Grœnlandicus, Ch.
Cryptodon Gouldii, Phil.
†Astarte semisulcata, Moll, (A. Elliptica, of Dawson's papers.)
†A. lactea, Br. and Sow, (A. arctica, of Dawson's papers.)
†A. striata, Leach, (A. compressa, Mont.)
Mactra polynyma, Stm.
Macoma subulosa, Spengl.
†*M. fusca, Say.
*Solen ensis, Linn.
†*Mya arenaria, Linn.
†*M. truncata, Linn.
Cyrtodaria siliqua, Spengl.
†*Saxicava distorta, Say.
S. arctica, Linn.
Thracia Conradi, Couth.
T. truncata, Migh.
Lyonsia arenosa.
Pandora trilineata, Say.
Pholas crispata, Linn.
Bulla occulta, Migh.
Cemoria noachina, Linn.
Margarita cinerea, Couth.
Aporrhais occidentalis, Beck.
Natica pusilla, Say., (N. Grœnlandica.)
†N. clausa, Sow.
Bela pleurotomaria, Couth.
†*Buccinum undatum, Linn.
†B. ciliatum, Fabr.
B. Donovani, Gray.
†Fusus tornatus, Gould.
*F. decemcostatus, Say.
Trophon clathratus, Linn.
†Trichotropis borealis, Br. and Sow.
†Lepralia hyalina, Linn.
L. (undetermined.)
L. variolosa.
L. Bellii, Dawson.
Tubulipora, (undetermined.)
Membranipora, (undetermined.)

ST. LAWRENCE SPECIES.

Mollusca.

†Astarte semisulcata, Moll.
†A. lactea, Br. and Sow.
†A. striata, Leach.
A. Lawrentiana, Lyell.
Tellina calcarea, of Dawson's papers.
†*Macoma fusca, Say.
†*Mya arenaria, Linn.
†*M. Truncata, Linn.
†*Saxicava distorta, Say.
Diaphana debilis, Gould.
Cylichna orysa, Tott.
Amicula Emersonii, Couth.
Lepeta cæca, Mull.
Margarita helicina, G. Fabr.
*Rissoa minuta, Tott.
*Lacuna neritoidea, Gould.
*Littorina palliata, Say.
Scalaria Grœnlandica, Perry.
Turritella erosa Couth.
Menestho albula, Moll.
Velutina zonata? Gould.
Amauropsis helicoides, Johnst.
Lunatia Grœnlandica, Mull.
*Natica heros. Say.
†N. clausa, Sow.
Bela turricula, Mont.
B. harpularia, Couth.
†*Buccinum undatum, Linn.
†B. ciliatum, O. Fabr.
†Fusus tornatus, Gould.
F. borealis.
Trophon scalariformis, Gould.
†Trichotropis borealis, Br. and Sow.
T. arctica.
Admete viridula, O. Fabr.
Limnæa umbrosa, Say.
L. stagnalis.
Cyclas.
Planorbis.
Hippothoa catenularia, Fleming.
H. divaricata, Lameur.
Tubulipora flabellaris, Fabricius.
†Lepralia hyalina, Linn.
L. pertusa, Johnston.
L. quadricornuta, Dawson.

MAINE SPECIES.	ST. LAWRENCE SPECIES.
RADIATA.	RADIATA.
†Echinus granulatus, Say.	†Echinus granulatus, Say.
Undetermined starfish.	Ophiocoma (undetermined.)
Nonionina scapha, Fichtel and Moll.	Asterocantheon polaris, Moll.
†N. crassula, Wacke.	Tethæa Logani.
†Biloculina ringens, D'Orb.	Polystomella umbilicatula, Walker.
Polystomella striatopunctata, Fichtel and Moll.	†Nonionina crassula, Walker.
	Polymorphina lactea.
	Miliolina seminulum, Linn.
	Entosolenia globosa.
	E. costata, Williamson.
	E. squamosa.
	†Biloculina ringens, D'Orb.
NO PLANTS.	PLANTS.
	Populus balsamifera, Linn.
	Potentilla Norvegica, Linn.
	Thuja occidentalis, Linn.
	Algæ.

"The specimens among the mollusca marked with an asterisk are littoral species, or those which live on the shore between high and low water mark: the rest are deep water species. Seventy species are enumerated in the list above as belonging to Maine, and eighty-three as found in the St. Lawrence valley. Twenty-five species, marked with daggers, are common to both deposits.

"It is a curious fact, that in the collections of the Canadian Geological Survey, the group of shells obtained by Bell and Richardson in dredging on the north coast of Gaspe, in about 60 fathoms, is almost precisely that of the shells grouped in these clays about Portland."

No. VII.

TABLE showing the value of the Imports and Exports, being the Produce and Manufacture of the Colony, of Minerals, Ores, and Metals, manufactured and unmanufactured, during the years 1861, 1862, and 1863.

	1861.		1862.		1863.	
	IMPORTS.	EXPORTS.	IMPORTS.	EXPORTS.	IMPORTS.	EXPORTS.
1 Bricks, Building,.........	$1,136	...	$1,468	$745	$1,204	$184
2 Copper and Patent Metal,	39,573	...	57,495	...	144,251	...
3 Coals,.....................	96,097	$250,313	93,031	118,274	110,390	169,616
4 Cement,.....................	1,417	...	1,068	...	1,452	71
5 Charcoal,....................	263	...	...	...	49	...
6 Earthenware,..............	29,391	...	29,298	...	39,429	20
7 Fire Bricks and Tiles,...	2,697	1,868	2,707	...	5,016	...
8 Fire Clay,....................	24	14	...	...	564	...
9 Gypsum,....................	96	13,399	247	12,282	390	13,581
10 Iron Anchors, Chain Cables, &c., ...	59,687	...	79,508	...	116,141	...
11 Bolts, Bars, Plates, Sheets &c. and Railroad Iron,	254,618	3,100	203,299	1,285	316,679	4,937
12 Nails and Spikes,.........	21,003	4,361	15,275	...	39,647	...
13 Wrought & Cast Iron, &c.	10,359	...	16,023	19,880	11,418	4,725
14 Iron Castings, &c., ...	9,832	...	7,467	...	10,435	...
15 Iron, old and Scrap,......	...	...	...	...	...	10,768
16 Iron, Pig,..................	35,508	9,580	27,091	7,046	54,182	21,920
17 Iron Blooms, ...	...	...	...	3,440	...	...
18 Iron Ore,....................	825	48	825	...	7,824	500
19 Lime........................	49	10,055	72	7,052	122	9,345
20 Lead........................	3,939	...	6,938	...	6,792	...
21 Marble Manufactures,...	1,517	1,436	862	260	2,343	720
22 Marble, unwrought,......	3,765	...	5,278	...	2,670	...
23 Salt,........................	20,404	...	21,579	...	14,610	...
24 Slate........................	1,246	...	...	...	1,627	...
25 Stones, Burr, Grindstones and Building Stones,	3,247	38,437	...	30,646	904	40,393
26 Steel, Bar and Sheet, ...	11,509	387	10,697	...	13,226	...
27 Zinc,........................	1,943	...	4,345	...	4,516	...
28 Limestone.................	...	373	...	399	...	1,610
29 Manganese, ...	...	1,260	...	5,239	...	3,124
30 Oil, Coal and Mineral,...	...	3,981	10,236	...	31,080	9,671
31 Oil, Crude, (Coal,)	...	4,074	...	...	...	...
32 Tin, ...	...	...	33,774	...	28,351	...
33 Copper Ore,..............	...	...	...	2,140	...	...
34 Antimony..................	...	...	...	...	...	30

No. VIII.

MINING LICENCE.

NEW BRUNSWICK TO-WIT:

By His Excellency The Honourable Arthur Hamilton Gordon, C. M. G. Lieutenant Governor and Commander-in-Chief of the Province of New Brunswick, &c. &c. &c.

To all to whom these presents shall come:

Whereas

in this Province, has applied for Licence to dig and raise Coal and other Minerals from the Land hereinafter mentioned, having represented that the owner thereof

Now know ye, that in pursuance of authority contained in the Act 18th Victoria, Chapter 76, entitled "An Act Relating to Mines and Minerals," Licence is hereby granted to the said

Heirs, Executors, Administrators and Assigns, for the period of years from the date of these Presents, to dig and raise Coal and other Minerals from that tract of Land situated

Subject always to the Rules and Regulations hereunto annexed, and the payment of the Rent or Royalty at the times, and in the manner therein mentioned, provided nevertheless that the Licence herein granted, shall only continue during the existence of the legal title or interest to dig Coal and other Minerals therefrom of the said or Heirs, Executors, Administrators and assigns.

Surveyor General.

Given under my hand and Seal at Fredericton, the day of in the year of our Lord one thousand eight hundred and

By His Excellency's Command.

GRANTED LANDS.

RULES AND REGULATIONS.

1st. Every Mining Licence to be exempted from payment of Royalty for three years from its date.

2nd. The Rent of Royalty upon Coal to be one shilling per chaldron, (with the exception of that to be raised from lands formerly under lease to Berton, Maynard, and Scyphers, where the rate is to be two shillings per chaldron). Upon Shale sixpence per chaldron, and upon all Metallic Ores except Gold and Silver 2½ per cent. upon the value thereof when raised or dug.

3rd. On payment of a fee of five dollars, Licence to be granted to the owner of the soil, or his assignee, for Coal or Shale for a period not exceeding twenty-five years, and for other minerals for a period not exceeding fifty years.

4th. The Rent or Royalty to be paid quarterly on the first day of February, May, August and November in each year after the third, to the Receiver General, or an agent for that purpose to be appointed by the Lieutenant Governor. The statements on which such payments are to be made to be on oath.

CROWN LANDS.

MINING REGULATIONS.

1st. That the right of Mining within a tract of one square mile, for the term of twent[illegible]e years, be put up at a fixed rent of one shilling per chaldron on Coal, and five per cent. on the value of all other minerals raised, to be paid quarterly, on the first day of January, April, July, and October, in each year, to the Receiver General, or an agent for that purpose to be appointed by the Government.

2nd. That the upset preference price paid on each lot be five pounds.

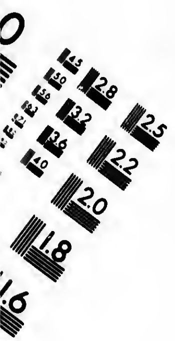
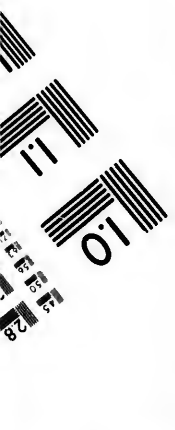
3rd. That the preference money be paid and the ground selected within one hour after the time of sale, after which other lots will be offered, if required, in like manner.

4th. That if the lessee shall not actually raise Coal or other mineral to the value of one hundred pounds from his ground, within any one year after the first, during the continuance of his lease, the same shall become forfeited.

5th. That the lease contains a clause of renewal, or that the Government may resume and take the improvements at a valuation to be made by arbitrators mutually chosen by the Surveyor General for the time being, and by the lessee or his assigns.

IMAGE EVALUATION
TEST TARGET (MT-3)

6"

SUPPLEMENTARY LIST OF AUTHORS REFERRED TO.

M. H. PERLEY—Reports on the Sea and River Fisheries of New Brunswick.

SIR RODERICK I. MURCHISON—Russia and the Ural Mountains. Addresses before the Geographical Society, &c. &c. &c.

Sir WILLIAM HERSCHEL—" On Volcanoes."

Mr. C. W. SIEMENS—On Regenerative Gas Furnaces.

Sir MICHAEL FARADAY—On Gas Furnaces.

Mr. T. W. TAYLOR—Fiords of South Greenland.

Dr. RINK—On Ice Phenomena in Greenland.

LOUIS AGASSIZ—Ice Period in America.

JAMES LAMONT—Seasons with the Sea-horses.

Captain MAURY—Ocean Currents.

URE's Dictionary of Arts, Manufactures, and Mines—Last Edition.

Scientific American.

HALE's Indians of North West America.

ERRATA.

Page 2, line 9, for *description* read *descriptions*.
" 24, " 5, for 580 (Chamcook) read 637.
" 32, " 27, for 2000 read 6000.
" 78, four lines from bottom, insert * reference on opposite page.
" 96, sixteen lines from bottom, insert * reference to foot note.
" 102, seven lines from bottom, for *Simms* read *Lunn*.
" 103, line 23, for *Simms* read *Lunn*.
" 104, " 15, after the word differs, insert *in no particulars*.
" 129, " 9, for *Dugaln* read *Dugald*.
" 203, second line from bottom, for 380 read 350.
" 204, line 27, for 2nd read 3rd.
" 247, erase reference, (*Smithsonian Report*, 1860), and * line 10.

GENERAL INDEX.

C

D

PAGE

M