GEOLOGICAL SURVEY

OF

CANADA.

REPORT OF PROGRESS

FOR THE YEAR 1847–48.

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GEOLOGICAL SURVEY OF CANADA.

MONTREAL, 26*th March*, 1849.

SIR,

I have the honour to request you will do me the favour to place before His Excellency the Governor General, the accompanying Report of the progress made in the Geological Survey of the Province during the year concluding the 1st May, 1848, which, by permission, was retained beyond the period of its date, to allow the examination of certain test facts, bearing on the view taken of the physical structure of the Green Mountains of Vermont, in their prolongation into Canada.

I have the honour to be,
Sir,
Your most obedient servant,

W. E. LOGAN.
Provincial Geologist.

To the Honble. James Leslie,
Provincial Secretary,
&c., &c., &c.

TO HIS EXCELLENCY

THE RIGHT HONORABLE

JAMES, EARL OF ELGIN AND KINCARDINE, K. T.,

BARON BRUCE OF KINROSS AND OF TORRY,

ONE OF HER MAJESTY'S MOST HONORABLE PRIVY COUNCIL,

Governor General of British North America,

AND

CAPTAIN-GENERAL AND GOVERNOR-IN-CHIEF

IN AND OVER

THE PROVINCES OF CANADA, NOVA SCOTIA, NEW BRUNSWICK, AND THE ISLAND OF PRINCE EDWARD,

AND VICE-ADMIRAL OF THE SAME.

MONTREAL, 1*st May*, 1848.

MAY IT PLEASE YOUR EXCELLENCY:

My duty, as Director of the Geological Survey of the Province, requires that I should report to Your Excellency the progress which has been made in the investigation in the course of the past season.

The labors of my Assistant, Mr. Murray, have been devoted to an examination of part of the shores of Lake Huron; those of Mr. Hunt, to the chemical analysis of various minerals and mineral waters collected by himself on two different excursions chiefly, one to the Ottawa and one to the upper extremity of Lake Ontario, as well as of various substances obtained on the explorations both of Mr. Murray and myself. The Reports of Mr. Murray and Mr. Hunt I have now the honor to transmit to Your Excellency.

My own attention has been engaged in an examination of the country on the south side of the St. Lawrence, extending from the vicinity of Montreal and Lake Champlain to the River Chaudière; in which I availed myself of the aid of Mr. Hunt for part of the time it occupied.

Geographical Characteristics.

Between Montreal and Quebec the valley of the St. Lawrence has a general north-east course, and presents a flat surface on each bank of the river. On the north-west side this surface extends in breadth a distance varying from twelve to twenty miles, to the flank of a wide-spread, hilly, but not very elevated country, occupied by syenitic gneiss, interstratified with crystalline limestones, being a continuation of the metamorphic formation described in another Report as existing on the Ottawa. On the south-east side the plains exhibit a width of thirty to forty miles, and, with the intervention of a few moderate undulations in one or two places, reach the foot of a range of mountains, which stand on a breadth of twenty-five to thirty miles. This range is the continuation of the Green Mountains of Vermont, which, after entering Canada, lose much of the bold character they possess farther south, though they still offer, in the district under description, two or three isolated peaks attaining the height of about 4000 feet above the level of the sea. The opposite sides of the mountain belt run very nearly parallel to one another, and a valley, or continuous line of valleys, bounds it on the south-east side, with a gently-rolling surface by no means so even as the plains on the north-west, but presenting few extraordinary swells or abrupt protuberances. The breadth of this valley may be from fifteen to twenty miles; and to the south-east the land gradually rises into a more mountainous tract, extending to the Province line, which runs upon its ridge from the sources of the Connecticut River to those of the Chaudière.

These ranges of mountain and valley are parallel to one another and to the St. Lawrence, and the whole coincide with the strike of the formations constituting the district. The streams conveying the waters of the area to the great river, are first the Richelieu and the Yamaska, the main trunks of which run in a direct continuation of the valley of Lake Champlain, with a distance between them equal to about the greatest breadth of the lake, and go with the strike, while the eastern branches of the Yamaska, (including the most southern of them, bearing the name of the stream,) all of which have their sources west of the Green Mountain range, or among its peaks, run transverse to

the stratification. Next are the St. Francis and the Chaudière, about eighty miles asunder, the lower part of each of which makes a straight section across the measures, including the rocks constituting the mountain range, while their upper parts drain the line of valleys beyond. The upper part of the St. Francis and its tributary, the Massawippi, flowing in opposite directions along the foot of the mountain range, occupy about eighty miles of the line in the general strike of the formations, and join at Lennoxville, after being supplied by several transverse tributaries, which take their sources in the southern mountains. The Chaudière, springing in these mountains, overlaps the upper part of the St. Francis, flowing in an opposite course, and more southern but parallel line for some distance below Lake Megantic. It then turns up northward, and is joined by the Rivière du Loup, which flows across the measures in the same direction as the lower part of the Chaudière, and further on it meets another tributary called the Famine. This tributary is in the same relation to the rocks of the country as the upper part of the St. Francis and the Massawippi. Flowing in the strike, it takes its source to the eastward, in a level tract, which is also the source of the Mitaywaquon and constitutes part of the valley of the St. John River, to which this is tributary ; and it appears probable that the valley of the St. John, presenting a continuation of the line of valleys, will be found to display the same relation to the stratification as that portion of the depression to the south-west already mentioned. Between the St. Francis and the Chaudière, are the Bécancour, and the east and west branches of the Nicolet. These take their rise towards the south-east side of the mountainous belt of country. The course of the two Nicolets is in general transverse to the measures, more directly so in those parts which flow among the mountains ; that of the Bécancour is more irregular, being sometimes with and sometimes transverse to the strata for long stretches. The main source is about midway between the Chaudière and the St. Francis, but on leaving the hilly tract, the stream approaches to within twenty miles of the former, while its mouth is not much over the same distance below the latter.

These various tributaries of the St. Lawrence and their ramifications, by which the district is very abundantly watered, often spread out into small but beautiful lakes among the highlands,

giving, in association with mountain peaks, great picturesqueness to the scenery. This is particularly the case towards the south-western parts, where these lakes so bespangle the country that in one panoramic view from the summit of Orford Mountain, estimated at 4050 feet above the St. Lawrence, no less than eighteen of them can be counted, emptying into the Yamaska and Richelieu on the one hand, and the St. Francis on the other. The largest of these is Lake Memphramagog, which has a length of about twenty-five miles, by a breadth generally under one mile, but sometimes reaching two; it lies partly among the mountains and partly in the valley beyond, which obliquely crosses the upper extremity, and in one place the lake approaches to within six miles of Stanstead Plains. Each branch of the Nicolet is supplied with its lake among the mountains, the western in the Township of Tingwick, the eastern in the Augmentation of Ham, the position of each having the same relation, the one as the other, to the rocks of the district. The Bécancour displays a very beautiful chain of lakes in the Townships of Inverness, Halifax, and Ireland; while others, of a smaller size, on the north-west line of Wolfestown, appear at the sources of the stream, situated similarly in geological regard as those of the Nicolets. Several of these, with the addition of others, are taken in at one view from the summit of the White Mountain, a lofty peak near the division line between the Townships of Stuart and Neilson; but two of the most conspicuous the view comprehends are Lakes St. Francis and Aylmer, which, being expansions of the upper part of the St. Francis, are not among the mountains.

The plains on the north-west and the vale on the south-east of the mountain belt constitute two valuable tracts of country, of great agricultural capabilities. The soil of the former, though in some places light, is for the most part a strong calcareous clay, supporting, in its wild state, a predominating growth of soft wood, but when cleared, well suited to yield abundant crops of excellent wheat, for which the seigniorial farms along the St. Lawrence were celebrated before the practice of an inferior system of husbandry had caused exhaustion, and the Hessian fly had committed the devastating ravages which have almost wholly deprived the Lower Province of a wheat harvest for the last eight or nine years. The soil of the south-eastern vale is, with many

exceptions, generally a gravelly loam, seldom deficient in calcareous quality, and often very ferruginous; its timber is chiefly hardwood. It is well adapted for wheat; but the distance of the district from a market has turned the attention of its cultivators almost exclusively to the rearing of cattle, and its produce in hay and grass is uncommonly abundant. The intermediate mountain country is possessed of many fertile subordinate valleys, some of which are of considerable breadth; many of the mountains are round-topped elevations, of very moderate height, not deficient in soil; hill and dale are in a majority of cases clothed with hardwood, and when cleared have given some excellent farms.

The level surface of the plains on the north-west affords facilities for rail or plank roads in almost any direction, but the usual communications at present existing, though they give easy travelling in summer in the dry weather, become at the melting of the snows in spring, and in the rainy season towards the end of autumn, impracticable strips of deep adhesive mud. Among the hills and south of them, the roads, though more undulating, in general rest upon a good hard bottom, and when properly constructed in the first instance, and kept in moderate repair, are passable at all seasons. The number of them however is not great, and some which have perhaps been ill-chosen lines have, though originally made at great expense, been suffered to fall so far out of repair, as to become wholly or almost wholly obliterated; many are as yet mere tracks through the bush, and it is only the main channels of communication that are moderately good roads. This renders the examination of the country extremely laborious, and in following the strata, it oftentimes becomes requisite to traverse extensive tracts through the forest, where progress must necesssarily be slow.

Although the larger part of the district has been surveyed and divided into Seigniories and Townships, perhaps nine-tenths of it yet remain unreclaimed from its original wild condition. The greatest extent of clearing is on the bank of the Saint Lawrence, and the least in the central mountain belt, towards which, improvement proceeds from the Seigniories on the one hand, while on the the other, it advances from the State of Vermont; and of this state the whole area under description, in surface, soil, rocks

and minerals, appears to be a modified repetition, with a difference chiefly in latitude.

Sequence and distribution of Formations.

The more solid rocks of this region are so covered up on the plains by tertiary and alluvial clays, sands and gravels, and still so much concealed in most parts by primeval forest, that no one section examined across the formations, is sufficient to shew all the details in place. At the same time, the strata over extensive areas, are affected by such numerous and violent undulations, while they have also suffered great metamorphic action, that one season's work is not sufficient to unravel all the complications of the subject. It has been sufficient however to ascertain the general masses to which attention is to be devoted, and many of the subordinate materials holding economic value.

If a straight line be drawn from the city of Montreal to Canaan, on the Connecticut River, in Vermont, it will lie between the Granby and Farnham roads, conducting to Stanstead, until reaching Georgeville, on Memphramagog Lake; in its progress thence, keeping some distance to the north of Stanstead Plains, it will about strike the village of Barnston Corner, and quit the Province near the division between the Townships of Barford and Hereford. Such a line will run as nearly at right angles to the general strike of the formations, as a certain want of parallelism in some places, arising from the effects of undulations in the strata, will permit; and the facts seen on it, with the assistance of others gathered from some miles on each side, may be sufficient to shew, in section, the general character of the rock masses constituting the country on the south side of the St. Lawrence, from Montreal and Missisquoi Bay to the Chaudière. If this line were continued westwardly from Montreal, it would strike the Rivière du Nord, in the Seigniory of the Lake of Two Mountains, about north of St. Scholastique, and there come upon a formation of gneiss and crystalline limestone, which occupies the right bank of the stream, and is the same as that which has been described in a previous Report, as extensively displayed in the valley of the Ottawa.

Commencing with this formation as a base, the first rock found resting on it is a whitish quartzose sandstone, apparently

contemporary with the Potsdam sandstone of the State of New York; it occupies a narrow strip on the Rivière du Nord, and most probably will be found skirting the hills which bound the flat land on the north-east bank of the St. Lawrence; in this position it is mentioned by Mr. Ingall, in his remarks on the district traversed by the St. Maurice Expedition in 1829, as occurring above the Forges on the St. Maurice, at the Rapides au Grés. Above Montreal, as has already been stated in a previous Report, the same formation is found in a narrow belt on each side of the Ottawa at its mouth, running on the one hand from Rigaud to the Cascades, and forming on the other a few points in the vicinity of Mont Calvaire, which it probably surrounds, as well as the upper extremity of the Island of Montreal at St. Ann. It is the rock also of Isle Perrot, while on the south side of the Saint Lawrence and Lake St. Louis, starting with a breadth of five miles between the Cascades and the cove below St. Louis River, it crosses the County of Beauharnois, and entering the State of New York, gradually widening as it proceeds, it finally splits against the mountains of Franklin and Clinton Counties, in that State, into two branches, one turning up the valley of the Saint Lawrence, and the other sweeping round into that of Lake Champlain.

The next formation which presents itself on our line of section is a limestone which is arenaceous at the bottom, black and bituminous at the top, while in the middle it consists of thick, solid grey beds of excellent quality for building stone and for burning into quick lime. Kept at the surface by a small dip and several gentle undulations, it occupies about thirty miles of the line, and the summit approaches to within a short distance of the St. Lawrence, on the eastern side of the island of Montreal. With this side of the island the strike runs nearly parallel from Sault St. Louis to Bout-de-l'Isle, maintaining a direction a little to the east of north; further down the river it gradually assumes a little more easting, and the formation keeps wholly on the left bank, without, in any instance that I am aware of, reaching the margin before attaining the vicinity of the Grondines. In an opposite direction the summit of the formation crosses the St. Lawrence at Sault St. Louis, and gradually sweeping round the extremity of a trough with a deep curve towards the south, it

reaches the vicinity of St. John, where, affected by a dislocation or folding over an anticlinal axis, it turns up the Richelieu River, and keeping on the west side of the stream, enters the State of New York. On the islands of Montreal and Jésus the thick grey beds of the middle run in a line from the vicinity of Lachine and Caughnawaga to that of Terrebonne, keeping close behind the Montreal mountain, and perhaps runnning under it in their range, and they are displayed in various quarries extensively worked in the rear of the city. In these quarries the dip is always gentle, and occasionally almost imperceptible; the surface breadth of this valuable part of the deposit, in consequence appears to be considerable, stone of the character which characterises it, being found as far back as the village of St. Laurent, and above Lachapelle's Bridge, in the neighbourhood of Côte St. Louis or Bois-Franc. Some of the quarries in the rear of the city display a number of trap dykes of various thicknesses up to three feet, which run in several directions, and intersect one another as well as the limestone; and in some instances the limestone having been removed from among them, the dykes left standing up several feet above the bottom of the quarries, represent in a marked manner the various details of the cracks they once filled; on the old parade ground, on the Priests' Farm, and other places around the mountain, similar dykes are met with, and they are all probably connected with the great body of trap of which the mountain is composed. This mass, though apparently conformable or very nearly conformable in many places with the stratification, is perhaps an intercalated intrusion rather than an overflow; superficially it presents the form of an oval, or rather the frustrum of a wedge with the corners rounded off, the smaller end of which towards the north-east is about fifteen acres, and the larger to the south-west, about twenty acres wide, the length being about forty acres, extending from Mr. Lauzon's premises, on the Côte des Neiges road, to the terrace overlooking the old parade. The volcanic area would thus have an extent of about 700 acres; it consists of several varieties of trap, of which a detailed account has been given by Dr. Bigsby, in a paper published in the 2nd volume of the Annals of the New York Lyceum; that of the mountain summit, which overlooks the St. Catherines road, is light-grey in colour, being

composed of a preponderating quantity of white feldspar, with rather thinly disseminated black hornblende; in the summit overlooking the town, the hornblende appears to become more abundant than the feldspar, giving the rock a darker hue, and mica occasionally accompanies the other constituents; while that part which is in the vicinity of the Côte des Neiges road is augitic, forming black masses, which under the decomposing influence of the weather are disintegrated into a coarse, granular but fruitful soil; the position the whole mass occupies in the strata appears to be about the division between the grey and black limestones, but I have not yet been able to trace it to any visible interstratification with these rocks. A very important band of interstratified trap crosses the Papineau road about a mile and a half from the St. Lawrence, and it has been followed in the strike of the limestone for five miles to the northward, but southwardly it is lost beneath tertiary sands and clays in less than half a mile; if the band were carried farther forward in this direction it would come into place about ten acres to the east of the trappean precipice on that side of the Mountain, and it may be the means hereafter of assisting to establish the stratigraphical position of the mountain trap. The direct breadth of the band in the vicinity of the Papineau road, is between 200 and 300 yards; it is divided into thick layers, and exhibits two distinct escarpments running parallel to one another; it dips, with the stratification of the black limestone overlying it, at angle of about five degrees, which would establish a thickness of between fifty and eighty feet; the colour of the rock is in general a light-grey with a slight tinge of brown, and its composition appears to be an intimate mixture of hornblende and adularia, distinct crystals of both of which, of larger size than in the fine-grained matrix (the hornblende of a brilliant black) are disseminated through it. The rock is marked by white and reddish-white spots, composed of analcime and bladed crystals of feldspar or albite, associated with which, and also in separate crystals brown sphene occurs; with these are likewise found occasional crystals of brownish-green Heulandite, and this mineral is also met with colourless and transparent. The white spots sometimes shew small druses in their centres, in which small but well-defined crystals of these various associated minerals are exposed, now and then combined with acicular crystals

of black hornblende, and these druses give to the trap a slightly amygdaloidal character. In some parts of the band, as where it crosses the Côte de la Visitation road, about two miles northward of the Papineau Road, this variety of trap exhibits a distinct slaty structure, by a cleavage nearly vertical to the face of the layer, giving plates of one tenth to one quarter of an inch in thickness. In a quarry on Mr. James Logan's land, about four acres south of the Papineau Road, the white spots are fewer than in the localities mentioned; the rock there appears to possess more hornblende, rendering it darker in colour, and of this mineral there are occasionally large patches exceeding three or four inches in diameter, and sometimes reaching eight inches; the rock also holds large leaves of dark-brown mica, and large disseminated patches of magnetic iron-pyrites.

The calcareous formation which has been described is highly fossiliferous, and it corresponds in the lower part with the calciferous sandstone, in the upper with the Trenton limestone of New York; it is there succeeded by a fossiliferous deposit of black bituminous shale, with the title of the Utica slates, and a similar deposit follows the Montreal limestone on the line of section. This shale occupies a narrow strip on the east side of Montreal Island, and is exposed at Sault St. Louis, and several spots along the margin of the St. Lawrence, to Point St. Charles, reaching back to the third lock of the Lachine Canal; further down the Island it is concealed by tertiary and alluvial deposits, but it is seen at Longueuil on the opposite side of the river: it forms St. Paul Island, and it seems probable that the bed of the St. Lawrence is worn out of the formation for a considerable distance below Montreal. From Sault St. Louis it follows the subjacent limestone round to St. John, and running up the east side of the Richelieu, with a width extending beyond Henrysville, it constitutes all that point on Lake Champlain lying between the exit of the lake and Missisquoi Bay. Like the previous formation, it is cut by trap dykes, and interstratified with trap floors; instances of the former are seen on the Longueuil shore, opposite and below St. Helen's Island; and of the latter about a quarter of a mile forward from the Longueuil termination of the St. Lawrence and Atlantic Railroad, as well as at Point St. Charles, on St. Paul Island, and higher up the

stream. Where the outcrops of these floors come into the bed of the stream, and at any place cross its course, the unequal wear of the soft slate and hard trap leaves projections and steps in the bottom which frequently disturb the regular flow of the water and occasion leaps and rapids, interrupting the navigation of the river; the Sault Normand, out in front of Point St. Charles, appears to be of this description, the ledge occasioning it being probably connected with the trap at the point, and instances of minor importance may be seen near St. Paul Island and above it. It has been mentioned that the black shale is met with at the upper extremity of St. Helen's Island; the main body of the Island, however, which presents an uneven surface rising to a summit 125 feet (according to Bayfield's chart) above the river, consists of a peculiar conglomerate which I have not met with in any other locality, though the presence of large angular blocks of a similar rock, probably brought down by the river ice, and lying on the Montreal side above the vicinity of Point St. Charles, appear to indicate its existence elsewhere. It is composed of pebbles of various colours,—gray, green, brown, and bluish-black; they are hard, and seem for the most part of a silicious character; some however are partially calcareous, containing organic remains, and the chief part are probably derived from the Potsdam and calciferous sandstone; the matrix in which the pebbles lie appears to possess a considerable amount of calcareous matter, but still more of silicious, and strongly holding the pebbles together, makes with them a compact rock; under the hammer it exhibits a fracture which runs equally through pebbles and matrix, as if they were of homogeneous quality; and while freshly exposed surfaces are of a general grey colour, they soon turn, under the influence of the weather, to a rusty-brown. If the rock belongs to the formation it is probably very partial in its distribution.

The country between the St. Lawrence and the Yamaska presents an even surface, so covered by tertiary deposits that there are but few exposures of the older strata; it is in consequence difficult to assign the precise limit of the upper part of the Utica slates on the line of section, though it is probably not far removed from the bank of the St. Lawrence in Longueuil. On the railroad already alluded to the distance perhaps does not

attain a mile, and it certainly does not reach the point where this road crosses the Chambly plank road, about five miles from the river; as strata have there been laid bare, characterised by the fossils of the next succeeding formation, which in the nomenclature of New York is termed the Loraine shales. These fossiliferous beds, kept at the surface by undulations, probably occupy a considerable part of the interval to the Yamaska. There is a development of them through which the line of section would pass on both sides of the Richelieu where the rapids exist, above the basin at Chambly; the strata are there nearly flat, and consist of alternating layers of bluish and grey argillaceous and calcareous shales; the calcareous beds are at the same time arenaceous, and derive their lime from the presence of organic remains, among which are *Avicula demissa*, *Bellerophon bilobatus* and *Pentacrinites hamptoni*, figured by Emmons. Less than half way between the Richelieu and Yamaska, but some miles to the north of the line, there is another exposure of the same fossiliferous beds on the Rivière des Hurons, near the Village of St. Jean-Baptiste; a third locality is on the east side of Rougemont Mountain, precisely on the strike of a fourth locality at St. Hyacinthe, on the Yamaska, where the strata consist of dark greyish-blue argillaceous shales, interstratified with thin occasional layers of limestone; at Turcotte's Mill, lower down the stream, the same bluish argillaceous shales are associated with calcareous sandstones. Among the remains in these last two localities are the characteristic species *Pterinea carinata* and *Trinucleus caractaci*. In both places the measures are disturbed by undulations, causing slopes at high angles sometimes on one side and sometimes on the other of the strike, which remains pretty uniform, running with the general course of the river, and the limited areas of these exposures make it difficult to say what the average dip may be, either in direction or amount. It is not improbable that the Yamaska, the Hurons, and the Richelieu may run upon three parallel anticlinals, as there appears to be some evidence of higher strata than those holding the fossils, in the space between the rivers, around the mountains Rougemont and Belœil. These isolated mountains, with the addition of Montarville, and also Mount Johnson, appear to be composed of trap at the summit, resting on stratified rock at the base, but they have not been

sufficiently examined to be described in detail. At Chambly, about half a mile above the fort, there is an interstratified bed of trapof a trachytic character, being composed of a slightly reddish feldspar, with dingy-white spots or crystals of feldspar disseminated in it. A somewhat similar trachytic porphyry occurs in the formation, on the Chambly Canal, about half way between the two extremes; the feldspar of the matrix is of a lighter colour than in the other instance, approaching to buff, and the enclosed crystals of feldspar are larger and better defined; the rock contains analcime and chabazite, with calc-spar and quartz, in small druses. At St. Hyacinthe a dark compact two-feet greenstone dyke cuts the strata; small disseminated crystals of feldspar give it a porphyritic character, and these are associated with abundant small crystals of a dark green olivine.

On the line of section, dark-coloured argillaceous shales are met with on the Yamaska and arenaceous shales a little beyond it, both bearing the same mineral character as those at Chambly, but without fossils; but about two miles and a half beyond the stream, the interval being occupied chiefly by tertiary sands, a repetition of the Montreal limestone occurs in the Casimir range of that part of the Seigniory of St. Hyacinthe which belongs to the heirs of the late Hon. Louis Dessaulles. The undoubted part of the formation is composed of solid and massive grey and black beds well suited for burning, which occupy between one and two acres, but before reaching them there are seen a set of black shales, interstratified with dark-grey yellow-weathering calcareous bands, accompanied by nodules and patches of the same description, and with the massive beds, may have a breadth of ten acres. Proceeding northward, the same rocks are seen in a bend of the River Barbue in the Papineau range; the more solid beds have here a breadth of between two and three acres, with a dip to the east at an angle of 65°; they are much intersected by thin veins of white calcareous spar, and one of the beds appears to be a breccia, consisting of grey limestone fragments in a grey calcareous cement; above this there are strong beds of black limestone, which are much quarried and burnt, for the supply of lime in the vicinity, and they are followed by limestone interstratified with black shales or slates, the calcareous part gradually diminishing in qnantity towards the top. Farther northward, the formation

keeps about a mile and a half or two miles to the westward of Yamaska Mountain, and is seen on the road between the St. Elmire and Mountain ranges; it shews itself not far from the left bank of the Black River, about a mile from the village of St. Pie, where it is cut by trap dykes, and it is again met with about a mile on the road leading north-east from the village, whence it runs direct to St. Dominique. At this place the band assumes a greater breadth from a diminution of the slope; the general dip is about S. 65 E. < 15° to 17°; there are irregularities however, perhaps indicating undulations, and the inclination still pointing in the same direction sometimes reaches 30°; from the lowest to the highest beds, the direct horizontal breadth is very nearly one mile, two-thirds of which, on the St. Dominique road from St. Hyacinthe, are on the north-west, and one-third on the south-east side of the division between the sixth and seventh ranges of the Seigniory, though farther on, the rock wholly leaves the seventh, and part of it passes to the fifth range. On the St. Dominique road the limestone rises abruptly into a hill which is about seventy-five feet close upon the escarpment over the plain between it and the Yamaska, but falls more gently to the east; the lowest beds seen are grey and nodular, with thin leaves of bituminous shale running in irregular layers; these grey beds occupy a breadth of 250 yards; they yield yellowish lime, and in consequence are little resorted to for the material; but they are succeeded by thick layers of black limestone, on which there are several kilns, and these beds are considered by the inhabitants the best for burning, as they afford the whitest lime. As is the case in the Barbue deposit, the upper part becomes interstratified with black shale, which gradually increases in quantity, and ultimately predominates over the limestone. Fossils are met with in the more solid layers in all the localities which have been mentioned, but they are most abundant in the grey beds of St. Dominique, though it is difficult to obtain perfect specimens of the remains in them in consequence of the hardness and brittleness of the stone; the frequent presence, however, of various forms figured by Hall and Emmons, of New York, such as *Isotelus gigas*, *Leptena sericia*, *Orthis testudinaria*, *Favosites lycopodites*, and other species, leaves no doubt that the rock is the equivalent of the Trenton or Montreal limestone. Northward from the St. Dominique road the formation

is traceable for six miles, with a pretty equal breadth, but beyond this it becomes covered by tertiary deposits, and I have not yet been able to ascertain where it crosses the St. Francis River, the Nicolet and the Bécancour. The direction of the band however where lost, and the general strike of the measures farther on, make it probable that it is the same as, and may have an outcrop connexion with the limestone which is displayed on the south-east side of the St. Lawrence, in the Seigniories of St. Pierre les Becquets, and Deschaillons, and which crosses to those of Les Grondines, La Tesserie, La Chevrotière and Deschambault on the north-west. In an opposite direction from the line of section the band runs through the fortieth lot of the sixth range, and the forty-first of the fifth range of Farnham, and in the last locality it is fossiliferous. Between this and Bedford in Stanbridge, it has not been traced out; but it is met with at Bedford, where one of the beds is a calcareous conglomerate, and the deposit has been followed thence to Philipsburgh on Missisquoi Bay. The breadth of the band at Philipsburgh is about one mile and three-quarters, and the dip S. 68 E. $<5°$ to $20°$; the rock is here more crystalline than on the Barbue or in St. Dominique. In the lower part the beds are very silicious; thin veins of white quartz run with the strike, and small lumps and patches of the same mineral are d spersed through the layers; the internal colour of these beds is light-grey, but they weather externally to a yellowish tinge, and some of the layers are interstratified with black slate; this part of the deposit would yield very inferior lime, but higher up, towards the middle of the formation, the quality of the rock improves; massive beds appear, in some of which subordinate layers have become thoroughly cemented to one another, giving the rock a regular striped or barred appearance, while in others there is a mottled aspect, the colours in both descriptions being a dull white mixed with light-grey; there are some beds, however, of a uniform dark-grey and some of black. The texture of the rock in this portion of the deposit is very close, and being capable of receiving a high polish, it would yield, in almost any quantity, varieties of useful marble. Notwithstanding the highly crystalline character of this part, fossils are occasionally perceptible where the surface has been acted on by the weather. The upper portion of the deposit becomes silicious from the presence of sand in

the layers, and these sandy layers are also so ferruginous that though the interior colour is a light-grey, the weather converts a thick coating to nearly a brick-red. These arenaceo-ferruginous beds contain a large amount of fossils, which, in the weathered portion, appear as casts and impressions, the fossils themselves having been dissolved, leaving moulds merely of their forms.

The black shales which occur at the summit of the calcareous band in the Barbue and in St. Dominique, there is little doubt are a repetition of the Utica slates, and it is very probable they are followed by beds similar to those of Chambly and St. Hyacinthe, representing the Loraine shales. Both these formations succeed the limestone of Deschaillons, where it comes upon the St. Lawrence, and in the front of the Seigniory of Lotbiniére they display the fossils, which in New York peculiarly characterise them. On the line of section the rocks immediately succeding the limestone are concealed for about a mile and a half, and though a narrow exposure then occurs in St. George range of the St. Hyacinthe Seigniory, shewing clay slates with arenaceous and calcareous layers, accompanied by arenaceo-calcareous nodules, they are not observed to hold fossils, and the next two miles and a half to the Granby line being again covered up, little information is gathered from the whole distance. In the general strike of the space however, there are met with on the twelfth and sixteenth lots of the sixth and seventh ranges, as well as on the nineteenth lot of the eighth and ninth ranges of the Township of Grantham, an interstratification of dark-bluish shaly limestone bands, with black or dark-bluish shales or slates, which would probably come in somewhere in the concealed portions of the line of section. But between the two localities there appear to be rocks higher in the series than any yet mentioned. An exposure of these is met with on the Barbue on the road of the Seraphine range in the Seigniory already mentioned, about one mile distant from the position where a line from the Barbue to the Casimir limestone would cross the road. These higher rocks consist of strong coarse grey approaching to greenish sandstones with grains of transparent quartz and red or chocolate-coloured slates, banded with green; the exposure occupies about half a mile across the measures; it is terminated at both extremes by the sandstones, which have a breadth of eighty yards on the west, while on the

east there are two masses of about ninety and sixty yards respectively, with a covered interval of 170 yards between them; the intermediate 500 yards are partly occupied by the red slates, and partly concealed. These red slate no doubt are coloured by peroxyd of iron, but they have been ascertained by Mr. Hunt to be titaniferous. Though the dip of the whole appears to be to the east at a high angle, I am disposed to think that the sandstones flanking the slates are the same, and on opposite sides of a trough; as there is some reason for supposing that they converge northwardly and southwardly also, coming to a point in the former direction before reaching the Papineau range road. Between this road and that of the Séraphine range, about two miles to the east of the previous rocks, there is another exhibition of red slates, but no sandstones were observed to accompany them. Yamaksa mountain stands in the strike of the general space, which would comprehend these two exposures; none of the red slates were observed about the hill, though in one locality at the south end near the base there were found interstratified in blue slates, narrow light-green bands of precisely the same tinge and quality as mark the red slates elsewhere, but strong, coarse, grey and greenish sandstones occur in abundance; these were met with high up both sides of the mountain, while trap occupies the breadth of a mile and a half in the centre. Compact bluish slates, sometimes approacing the character of clinkstone, occupy lower parts of the western escarpment, and at the base there appears among them a brecciated band, containing cherty and calcareous fragments, while not far above there was met with a great patch of crystalline yellow-weathering limetone, fourteen yards wide and fifty to sixty long, accompanied by many nodules of the same quality; on the east side the sandstones reach the base of the hill, and in some parts in addition to being slightly micaceous, they are slightly plumbaginous. The dip on both sides of the mountain appears to be to the eastward at a high angle; on the east side, however, in one or two places, it points westward for short distances on the strike, and it is probable the trap may stand in a synclinal form. Several trap dykes cut the coarse sandstones transversely on the east side of the mountain; they are of various widths, from a few inches to three or four feet; their interior colour is light-grey but they weather to a drab; the presence of

small but distinct crystals of a greenish-white feldspar, gives them a porphyritic character, and in the middle of some of them there runs parallel to the walls an irregular course of calc-spar nodules, converting that part into an amygdaloid. A considerable mass of trap occurs at Drummondville, which is probably in contact with the strata belonging to this portion of the section. It does not like the trap of Yamaska rise into a hill, but it presents a breadth of at least 400 yards, constituting the rock of the falls near the village. It seems in general to be a compact greenstone of a grey or greenish colour; some parts of it however, bear an amygdaloidal character, with abundant small patches of white and pinkish calcareous spar, and one part presents the appearance of a brecciated bed, consisting of fragments of greenstone in a pinkish close-grained but highly crystalline calcareous cement.

The next set of rocks displayed on the line of section appears to consist of light-green slates, approaching to ash-gray, some of them spotted with bluish-gray, and interstratified with a few beds of iron-gray manganesian sandstone, weathering to a dark-brown, as well as some few bands of dark-gray clay slates, and thinner bands of black carbonaceous slate. These ash-gray slates are followed by titaniferous red slates with small and large green bands, and thus variegated they become interstratified with massive greenish sandstones, which appear in some parts to be strongly chloritic; sometimes the sandstones are partially red. Both the slates and the sandstones are in some instances slightly micaceous, and the sandstones are also very generally slightly plumbaginous, small distinct scales of graphite appearing disseminated in them. The sandstones, of which considerable masses occur without any interstratification of red slate, are in general rather fine-grained, but they very often become coarse, and frequently present the character of fine conglomerates with white quartz pebbles as large as buck shot. Both the fine and the coarse-grained are frequently calcareous, and when so are generally of a greenish colour. The red and green slates have a cleavage independent of the bedding, and some of the joints by which the red are cut, and flaws in the rock, hold manganese, while sometimes though rarely they present thin irregular seams of strongly titaniferous peroxyd of iron. Towards the base of this interstratification there

are some unctuous green bands, which appear to be a mixture of chlorite and carbonate of lime, holding chromium; and in some parts one or more thick massive beds of light grey or whitish limestone are met with in the immediate vicinity of the coarse-grained sandstone; but what the exact relation of these massive limestones may be in the sequence, I have not been able to determine satisfactorily. Indeed the area, in which the whole of these rocks have been observed, is so affected with undulations, that a difficulty of the same sort exists in regard to all the parts; there is little doubt they are equivalent to the sandstones and red slates a little to the westward, which have been already mentioned, and on the line of section such of them as are displayed, occupy a breadth of about three miles and a half. It is probable they lie in the general form of a trough, with several subordinate undulations of more or less importance; for the strata on the opposite sides converge southwardly, coming to a termination in Farnham, in the vicinity of the upper part of the Yamaska River. Diverging in an opposite course, they have a breadth of about five and a half miles on the Granby road, and about six and a half on the road between the second and third ranges of Milton. On the Granby road, what are supposed to be the lowest beds are seen in a quarry on the twenty-first lot of the ninth range of the Township; they are as followes, as they succeed one another in the direction of the dip, which is S. 65 E. $<70°$:—

	ft.	in.
Dark-grey or rather black clay slate, giving a white streak, with a few carbonaceous fucoid-like markings	0	10
Black carbonaceous slate or shale	0	7
Black clay slate, as before	0	8
Black carbonaceous slate	0	4
Dark-grey clay slate	0	2
Compact greenish or ash-coloured slate, with dark-grey or bluish spots and dashes in the direction of the dip; iron-pyrites is disseminated in small nodules, and there are joints in the rock at right angles to the strike	5	9
Dark-grey sandstones of a feldspathic quality, slightly micaceous, and weathering, for several inches at the surface, to a blackish-brown earthy condition; the rock holds a considerable quantity of manganese	6	0
Compact greenish or ash-coloured slate without spots or dashes	9	0
Black clay slate, breaking into rough, uneven fragments	3	3

Ash-coloured or light-grey approaching to greenish compact slates, spotted and dashed with dark-grey as before	6	0
Black carbonaceous slate or shale	0	7
Ash-coloured spotted slate, as before	6	4
Ash-coloured slates without spots	4	0
Greenish or olive-coloured slates	2	6
Black carbonaceous slate	0	6
Ash-coloured clay slates	2	0
Black carbonaceous slates	0	6
Light-grey or ash-coloured greenish slates, part of them in the middle, spotted and dashed as before	14	0
Light-grey or greenish slates of much the same aspect, but banded with dark-grey; calcareous matter is infiltrated into the cleavage-joints	40	0
	103	0

These beds appear to be repeated about two miles further on the road, after an exposure of red slate spreading over a superficial breadth of 220 yards; where the two bands reach the Milton road, there are about three miles and a half between them, the chief part of which displays red and green slates. It is thus probable they lie in a shallow trough subordinate to the larger one mentioned, in which the slates are much wrinkled, for the colours often indicate high angles of inclination in opposite directions, though the cleavage is always uniform. On the Granby road, the red and green slates are again met with on the twelfth and eleventh lots of the eighth range of the Township; and in the vicinity of the village there is a great development of the massive greenish sandstones, with which they become interstratified. This development occupies the breadth of half a mile; the slope of the beds appears for the most part to point to the south of east; but it is not improbable that this is in a great measure due to undulations and overturn dips, for what is supposed to be the southeastern outcrop limit of the sandstones presents such an attitude, the dip being S. 50 E. $<70°$; and while in other parts of the breadth the direction of the dip varies occasionally ten to fifteen degrees more to the eastward, the inclination sometimes increases to 80°, and sometimes diminishes to 45°.

The following is a section of the lowest or most easterly beds seen, proceeeding across the measures in a south-east direction, which is supposed to be in descending order, the dip being as

above stated, S. 50 E. <70°, in immediate succession to a slope of 45°, and a previous one of 80° :—

	ft.	in.
Greenish sandstone, weathering whitish ; it presents solid massive beds, many of which are fine conglomerates, with white and a few reddish quartz pebbles as large as buckshot, and some of feldspar; the beds are often separated by bands of green slate, and they hold chlorite and small quantities of mica and graphite ; the graphite, and the chlorite, to which they owe their colour, being more abundant in the fine than in the coarse beds ; some of the beds are slightly calcareous...	60	0
Red slate, passing into green in the direction of the dip ; when the colours become blended the slate is grey, not distingushable from the grey clay slates in other parts of the formation ; there is a thin small patch of jasper or jaspery iron ore in one spot running with the stratification, and the joints of the rock hold snuff-brown earthy manganese	1	0
Green unctuous chloritic rock, holding 30.00 per cent of carbonate of lime and 0.10 per cent of oxyde of chromium, in addition to silica, magnesia, iron, and maganese.....	2	0
Measures concealed.....	30	0
Greenish sandstone with small scales of mica and graphite.....	6	0
Red slates, not very well exposed	18	0
Red slates, with a few inches of green slate at the top, which appears to be chloritic, and displays surfaces in the direction of the bedding, bright with numerous small scales of mica.....	6	0
Green compact slates	4	0
Green unctuous chloritic rock of a highly calcareous quality as before, weathering to brown exteriorly, and holding iron, manganese and chromium.....	1	0
Green slates; in flaws and cleavage joints there appears to be chlorite,	1	0
Greenish sandstone, with chlorite, mica, and graphite ; there is a band of red slate at the top.....	3	0
Red sandstone ; in the direction of the dip it becomes green and finer grained than at the crop ; it fractures in an uneven, splintery manner and holds some scales of mica and graphite ; a band of red slate lies in it toward the top, which is sometimes ten inches and sometimes one inch thick ; fragments of a completely red sandstone lie near the bed.....	3	0
	135	0

These sandstones, lying in a second trough, subordinate to the large one, should be flanked to the south-eastward by the ash-coloured spotted slates, grey sandstones, and black carbonaceous bands ; such however were not observed, but they may be concealed under the soil of a narrow alluvial valley which bounds

the section. On the west side of the general trough, the red titaniferous slates are traceable for twenty-five miles without intermission, from about the south-west corner of Granby, across the west side of Milton, to a point a little above the junction of the north and south branches of the Black River, in the south gore of Upton. They are again met with on the Saint Francis River, near the division line between Wickham and Grantham; and they appear to follow a general course parallel with the Saint Dominique and Deschaillons limestone, for they are recognised in the vicinity of Saint Nicholas and farther on, in the rear of Point Levi, opposite Quebec. On the eastern side of the trough, the sandstones with which the red slates become interstratified, have been traced to the south-western corner of Roxton, whence they appear to turn a little eastward, and, after reaching the fourth range in the vicinity of the ninth lot, they bend round, probably by a succession of undulations, to the middle of the south line of the Township, proceeding thence, on the west side of a narrow trough, towards Shefford Mountain. The east side of this narrow trough appears to run to the north-east corner of Roxton, and to cross over into Acton, in which the sandstones, as connected with those of Granby, are not yet known to reach more eastward than the seventeenth lot of the first range, from which they appear to be limited by a tributary of the north branch of the Black River, joining the main stream in the twenty-third lot of the sixth range. The interstratified red slates have been observed as far as the north-east corner of Roxton, but they have not been met with again in what might with probability be considered an analogous position that is to say connected with the same synclinal (little of the direct interval having been yet examined,) until reaching the fourteenth lot of the eighth range of Somerset, whence they have a run to the Red Rapid on the Bécancour, in the north corner of Inverness, associated with a twenty-feet bed of conglomerate limestone. The light-grey massive limestones, which have been mentioned as found in the vicinity of the sandstone, have been met in the forty-ninth, fiftieth and fifty-first lots of the twenty-first range of Upton, and in the twenty-sixth lot of the twelfth range of Wickham, where the band has a breadth of about thirty yards. These localities may possible be on one and the same outcrop; and the limestone is marked at both extremes of

the distance (seven miles) by the presence of copper pyrites. Light-grey limestone is again seen on the thirty-eighth lot of the seventh range of Acton, and the eighteenth lot of the ninth range of Wickham. These two localities also are possibly on the range of one outcrop, and the latter mentioned shows a breadth of about twenty yards; the rock is highly crystalline, and would yield good mottled grey marble in the upper part, but it becomes coarse at the bottom of the deposit, by the admixture of small white quartz pebbles. The dip is S. 68 E. $< 45°$, and at the distance of about 100 yards in its direction, there is a breadth of coarse greenish sandstone extending about fifty yards. Two additional localities, in which the rock may have an outcrop connection, are on the twenty-ninth lot of the sixth range of Acton, and the fourteenth lot of the ninth range of Wickham, and another locality in which a similar rock exists, is the twenty-seventh and twenty-eighth lots of the eighth range of Roxton. In the neighbourhood of Philipsburgh, the sandstones and the fine conglomerates of the group, in general more strongly calcareous, occupy the breadth of a mile on the road to Frelighsburgh, having between them and the Philipsburgh limestone the space of half a mile on the Rock River, for the red slates and the remainder of the strata supporting them, none of which were there observed to be exposed. The sandstones of this part appear to belong to an outlying patch extending into Vermont.

Succeeding this group of rocks, there occurs on the line of section a space of about five miles, occupied by dark-grey and black clay and carboneceous slates, with some bands of a lighter colour. These slates are interstratified in some parts, with thin grey sandstones; and in others with thin, black and dark-grey limestones, which are occasionally aggregated in sufficient quantity to be worked for lime burning. These beds bear a strong resemblance to the shales and limestones of Grantham, their mineral character being much the same, and occasionaly a feebler one (for no fossils are found in them) to the calcareous and arenaceous shales of the Yamaska and Richelieu, except that they are firmer and harder; and it seems not improbable, that this part of the section is a repetition of those measures. They present the same equality of geographical surface, while the intermediate greenish sandstones give a more undulating country, some of the swells of

which attain the height of about 600 feet above the St. Lawrence at Longueuil. These slates are met with on the Farnham, Granby, and St. Francis roads to Sherbrooke and Stanstead, and they have been traced from the Province line, with some interruptions, to the Township of Arthabaska and beyond it. The breadth which they have on the line of section, is pretty regularly maintained as far as the south-western part of Roxton, where they are interrupted by the turn that has been described, in the sandstones and red slates. The eastern limit of the space they thus occupy in this part, after crossing the Township of St. Armand, in which it keeps about a mile to the westward of Frelighsburgh, enters the Township of Dunham at the south-west corner; traversing this Township diagonally, and that of Farnham by Gale Mountain, it enters Shefford at the south-west corner, and runs thence to the north line of the Township, in the vicinity of the twelfth lot. If we pass over to the east side of the sandstones and red slates, which have been mentioned as prolonged from the middle of the north line of Shefford towards Shefford Mountain, the dark-coloured slates and limestones are again traceable from the south-eastern part of Roxton, across the north-western part of Ely, the south-eastern corner of Acton, and thence through Durham to the St. Francis, which the south-eastern limit of them crosses about three miles below the line between this Township and that of Melbourne. This limit, running thence through the whole length of Kingsey, and keeping about two miles and sometimes rather less from the division between it and Shipton, gains the Arthabaska road, which it follows through Warwick and Arthabaska, afterwards attaining the vicinity of the line between Halifax and Somerset, which it keeps to the continuous one of Inverness. From the Province line to Roxton the deposit appears to run on an anticlinal for about forty miles and from the south-eastern portion of Roxton to Inverness, on another and parallel one for seventy miles more; this however could scarcely be proved from the dips alone, which in general are at high angles, and though sometimes on one side and sometimes on the other of the strike, do not always coincide in direction with the results deducible from the geographical distribution of the strata, several of them being probably overturn dips; such as were considered to be of this character

generally pointed to the south-east, but they did not appear to do so in every instance. The anticlinal from the Province line to Roxton is shewn by the distribution of the sandstone in Granby and Shefford, and that between Roxton and Inverness by the Shefford sandstone, and the fact that the dark-coloured slates, and part of the limestones, are traceable round or nearly round what appears to be the extremity of a trough in the succeeding rocks, through a fortunate transverse gap on the west branch of the Nicolet, into a long and narrow anticlinal valley, which they occupy for the distance of about fifty miles, in a direction almost exactly parallel with the other two anticlinals. This valley runs under Danville and Richmond, in Shipton, and across Melbourne and Ely, the southern line of which last Township it crosses about the middle, proceeding thence across Stukely, to the north-east corner of Brome, where it points to Brome Lake, and the main geographical depression in Sutton. The limestones reach beyond the centre of Stukely, where the Black River flows through it, and the slates to the vicinity of Frostville; but neither appear to attain our line of section, which would pass by the southern extremity of Brome Lake. The breadth between these strata, from one side to the other of the double trough formed by the three anticlinal axes varies from six, to nine miles, and from the dark-coloured slates on one side to the southern extremity of Brome Lake on the other, would comprehend about the latter distance on the line of section.

The rocks that fill this space in the section, are first an extensive mass of trap, which occupies about one-half the amount. The mass may spread over an area of about twenty square miles, constituting the group of hills which go under the name of the Brome Mountains, of which Gale Mountain, though within the limits of Farnham, is one. Another mass of the same rock, in a position precisely the same in its geological relations, is met with in Shefford Mountain, a little to the north-east of the former, occupying about nine square miles. The trap is rather coarse-grained, and consists of white feldspar, with a sparing amount of black mica, and occasionally of black hornblende; without attentive inspection, the rock would readily be taken for granite, but the constant absence of the quartz is a marked feature; and the resemblance the mass bears lithologically to some parts of the iso-

lated mountains of Johnson, Yamaska, Rougemont, Belœil, and even Montreal, with the presence of some of the accidental minerals common to these, make it probable they are of the same age. In the Brome and Shefford trap, the mica or hornblende is in general evenly and regularly distributed; when the rock is closely examined it has a speckled aspect, but at a moderate distance it assumes a light grey colour, approaching to white. The mass appears to have regular planes of division, at small angles with the horizon, giving it a stratified semblance: it is often found split by natural causes into rectangular blocks, which may likewise be easily obtained of almost any required size, by the application of wedges, and it appears probable that these qualities would fit it for a good building stone; not however one of the very best description, for the long-continued action of the weather, and probably more immediate operation of frost, appear to disintegrate considerable exposures of it into a loose gravel on the surface, and from this circumstance it may be inferred that its durability might not be very great.

The effect that the great mass of trap in the Brome Mountains may have had in disturbing the strata in its vicinity, is not yet clearly ascertained, and there are certain rocks to the north-east and south-west of it, whose course it interrupts, that do not appear on the line of section, or if they are met with on it, will probably be found entangled in the trap. It will therefore, for the better understanding of the general character and arrangement of the masses filling the troughs formed by the three anticlinals, be preferable to present the facts that occur on two transverse sections, one on each side of the trap. The most convenient on the north-east, will be that afforded by the St. Francis, in the vicinity of Richmond and Melbourne, which will be about thirty miles from the Brome Mountains; on the south-west, a line from Nelsonville to Sutton Flats, about eight miles from the same point, will answer the purpose.

The rocks displayed on both sections, though stratified, are highly crystalline; but it seems to me they are to be considered not primary but metamorphic. Those between the neighbourhood of Nelsonville and Sutton Flats, in succession to the dark-coloured clay slates and limestones, taking some of the facts from the vicinity of Dunham Mills, about five miles from Nelsonville,

In the general strike of the stratification, are first a set of greenish clay slates, interstratified with dark grey bands; these slates appear gradually to become stronger and harder by the increased presence of silicious material disseminated in fine grains, though still interstratified with the softer and more aluminous quality. There then occurs a belt consisting of calcareous and silicious rocks; this belt has been traced in exposures, at intervals, from the Province line on the east end of the sixty-seventh lot of West St. Armand, by Cook's Corner and Lagrange's Mill, to the second lot of the ninth range of Dunham, and thence to the thirteenth lot of the seventh range. In this distance, the calcareous part of the deposit is found in some places divided into three bands, which are sometimes comprised in the breadth of 300 yards, and sometimes diverge to more than double the measure, the increase of separation being occasioned by the intervention of dark grey clay slate between the western and middle band; whether any of these bands are repetitions has not been ascertained. The amount of calcareous matter in them varies much in different parts of the run, and the rock in some places assumes the appearance of an obscure calcareous sandstone breccia. The limestones that result from them appear always to be very silicious, and when burnt yield a reddish or grey lime; where weathered the exterior surface is generally gritty and harsh to the touch, from the presence of minute grains of quartz, and its colour is always some decided tinge of yellowish-brown; internally the colour is generally light-grey, and very often a yellowish-white. The rock is always marked by a network of white quartz veins, of one to two or three inches in thickness, and sometimes more, which cut it in many directions. It usually contains a considerable amount of magnesia, often becoming a perfect dolomite, and in a grey variety of this on the second lot of the ninth range, garnets are met with; isolated cubes of iron-pyrites are common in the rock, and in a quartz vein, running with the strike close to the west side of the belt, at Cook's Corner (but in clay slate) copper pyrites occurred. The silicious rocks associated with the limestones, appear to be altered sandstones; they are of a greenish tinge and occasionally have the aspect of fine conglomerates with an imperfect cleavage independent of the bedding; some of the quartzose beds

are interposed between the calcareous bands, but the chief mass lies immediately to the east of them, and with the limestones constitute the first range of the bold land belonging to the hilly district.

At the distance of about a mile from the calcareous belt just described, another of the same quality in every respect occurs; and it also like the former, is associated with strong quartzose beds, forming with them another range of bold points, leaving a depression between the two. The belt has been traced from the Province line, on the forty-fifth lot of West St. Armand, through the thirty-seventh and thirty-eighth lots of the same Township, to the first lot of the ninth range of Dunham, and the second lot of the eighth range, where as well as in the previous lot, it is divided into two bands, comprised in the breadth of 150 yards, and whence it passes by the fourth lot of the eighth range to the eleventh lot of the sixth range, in the vicinity of Dunham Flats. The double-ridged elevation, in which the two belts of dolomite and quartzose rocks are thus far traced (upwards of ten miles) in a straight line, bearing N.E. by N. from the boundary of the province, here dies down; but another and parallel hill with about the same bearing, removed less than a mile to the south-east, takes up measures of a similar character from the eleventh lot of the fifth range, and carries them to the north-east corner lot of the Township, within half a mile of the trap of Brome Mountains. Where the Yamaska cuts through this hill, between the Churchville and Dunham road and the twenty-first lot of the first range of the Township, there are seen, on the sides and summit of the elevation, in a transverse distance of about a mile and a half, several parallel patches of the limestone; and though it is not easy to make out their relative geological arrangement with certainty, the structure of the hill appears to be anticlinal, while that of the previously mentioned one is probably synclinal.

The next three miles on the line of section, are occupied by a series of quartzose chloritic rocks, being apparently made up of grains of quartz and scales of chlorite in various proportions, and often becoming stong and massive from the abundance of the former material; their colour is green of several shades, and they have an imperfect cleavage, but the bedding being in general

obliterated, it is only by inference that their arrangement can be understood; they appear however to be altered sandstones, and in some parts of their distribution, to the south of the line of section, and towards their south-eastern limit, their original character is very distinctly marked, and the bedding visible.

To these altered sandstones succeeds a calcareous belt, of which the limestones externally resemble those of Dunham; they have the same decided brown colour in many places, evidently derived from the presence of peroxyd of iron, and are intersected by the same net-work of white quartz veins; they are however internally more generally whitish than grey, and are sometimes speckled with small purplish spots; chlorite and greenish-white foliated talc occur in the rock, and an abundance of veins of titaniferons peroxyd of iron, varying in thickness from half an inch to two inches, reticulate through it, much in the same manner as those of white quartz; small crystals of the magnetic oxyd are occasionally imbedded in the rock, and in the south-eastern corner of Dunham, octahedrons of chromic iron were also met with in it. The belt is divided into two, and cometimes three bands of nine to eighteen feet thick, comprised within the space of 180 yards; the intervals are occupied by dark-green strongly chloritic slates, and black and dark-grey talcose clay slates, in which beds of titaniferous specular iron, intermixed occasionally with the magnetic species, occur; the ore splits after the manner of the slates, and in the same direction, but in much thicker plates; it occasionally passes gradually into the slates on each side, by an increasing admixture of chlorite, while at other times the distinction between the ore and the enclosing chloritic strata is very well marked; thin leaves of talc and chlorite lie in the divisions between the plates, and the surfaces are in some places stained with green carbonate of copper, which is also met with in small veins of quartz, talc and chlorite, running with the stratification. About two miles beyond this calcareous belt, another of the same character occurs; it also is divided in some parts into three bands of five to fourteen yards wide, included in the breadth of about 100 yards; these hold the same minerals as before, and one of them is in parts so thickly loaded with octahedral crystals of magnetic iron, that the quantity appears occasionally almost sufficient to render such parts a granular ore, available for econo-

mic purposes. The interval between the calcareous belts is occupied by coarse chloritic and epidotic slates, with dark-grey and black talcose clay slates, and a great abundance of iron ore beds, chiefly of the specular but occasionally mixed with the magnetic oxyd. The chloritic slates are of various shades of green, from very dark bluish and blackish-green to ash-grey; the green bands are more abundant than the grey, and considerably more chloritic, and both are occasionally talcose, and perhaps sometimes a little micaceous from the presence of thin layers of talc and mica in parallel directions; the grey bands appear to derive their colour from an increased amount of very fine grains of white quartz, which are evenly mixed with the chlorite; and in this mixture as a matrix, the bands are abundantly marked by various sized and shaped spots or nodules of white granular quartz and crystalized pistachio-green epidote, sometimes several inches in diameter, and frequently elongated in parallel directions, the two minerals being as often unmixed in separate nodules, as mixed in the same nodule; in the latter case the epidote is generally within the quartz. In the grey bands, fine blackish-green lines of chlorite often run parallel to one another, and these are in many instances, pushed aside and contorted by the nodules of quartz and epidote, giving place to them as the fibre of the wood does to the knots in bird's eye maple. White feldspar is sometimes associated with the quartz and epidote, accompanied by actynolite in radiated crystallizations, and asbestus is met with in short parallel veins, cutting the epidote across the direction in which the nodules are elongated, and occasionally between the layers of slate; crystals of the specular and magnetic oxyds of iron are abundant in the chloritic and epidotic bands, the magnetic being more frequent in the chloritic; and in a vein running with the stratification, and consisting of white translucent quartz, white feldspar and dark green chlorite, cleavable forms of specular iron, with striated surfaces of great brilliancy, were in one place accompanied by rutile. Some of the chloritic bands in the neighbourhood of the dolomites hold a small quantity of chromium, but in what form is not quite certain; the talcose slates are either black, with a black streak and plumbaginous gloss, or grey with a white streak and satiny lustre; the one of which the quantity is small, is probably carbonaceous, and the other clay slate in altered condi-

tions; both species are very finely wrinkled on the cleavage surfaces, and in one part the grey is abundantly supplied with a mineral which appears to be phyllite. The iron ores are with some exceptions more or less titaniferous, and the number of localities, in which they are met with in this belt of rocks, through Sutton and Brome, is no doubt in a great degree occasioned by repetitions of the same beds through undulations; the thicknesses of the beds vary from one foot up to ten, and in one spot in Sutton, in consequence of three undulations in one bed, (which is thus repeated six times, in addition to the final outcrop, in the space of seventy yards,) there occurs an aggregate breadth of ninety feet of ore, which however is of rather too low a produce to be available; but within the distance of half a mile, across the measures from the same place, there occur two more localities, each shewing a breadth of thirty feet, in one of which the ore is of a good workable quality; the ore in all these beds is laminated, in fact it is an iron-slate, and where contortions occur, the slabs split off in forms shewing the bends that result from them; talc, chlorite and green carbonate of copper are frequently met with in thin leaves between the layers, and a thin irregular vein in one of the beds presented white sphene often with a tinge of green, associated with those three minerals, in addition to white quartz. These iron-slates are interstratified among the chloritic slates and partake largely of their mineral quality, but in a variable degree; the quantity of the metal in consequence varies in different parts of the range from 15 to about 50 per cent. The position of the grey and black talcose slates, among the chloritic, appears to be not far removed from the limestone bands on each side, and the chief bulk of the chloritic and epidotic rocks occupy the middle. Succeeding the eastern limestone belt, and before reaching the middle of the Sutton valley, in the supposed position of the anticlinal axis, there occurs a farther quantity of chloritic and partially epidotic rocks, some of which are strong and massive and rather quartzose, and shew small crystals of graphite; they may occupy about the breadth of a mile.

The section across the trough, where it is cut by the St Francis River, would span the distance of about six miles. The beds next in succession to the dark-coloured slates and limestones, consist of green clay slates of a harder and more silicious quality than

those supporting them, and they again pass at the top into dark-bluish-grey, both colours occupying about the breadth of a mile. These slates are followed by a belt of brown-weathering magnesian limestone, similar to those of Dunham and Sutton, interstratified with dark-purplish-grey sandstones, and accompanied at a short distance beyond by a band of red slates, the relation of which is ascertained in exposures removed about two miles to the south-west from the river; red slates are also met with within two miles of the Nicolet, probably in the same sequence, though the magnesian limestone has not been observed near them. On the line of section, at the distance of about a mile, the belt of dolomitic limestone just mentioned is followed by another with white quartzose beds, and near both the dolomites there are indications of titaniferous specular iron, of which loose fragments and small unworkable seams are met with. The exposures between the dolomitic belts appear to consist chiefly of hard grey and white sand-stones and fine conglomerates, some of which are so purely silicious as to afford material that might be fit for glass making. Half a mile then succeeds, so covered by sand as to show no stratification; and the following two miles and a-half are occupied by chloritic rocks, in which there are bands holding small patches of fine granular white quartz, and nodules of an epidotic quality are thickly disseminated throughout the whole mass, some of the nodules being six, eight and even ten inches in diameter. Some of the beds assume the aspect of fine quartzose conglomerates, or coarse sandstones with a chloritic base. These chloritic rocks are followed by a band of magnesian limestone with a brown exterior, with thin veins of titaniferous specular and magnetic iron (the former sometimes containing garnets,) and nodules of a strongly ferruginous red jasper. Beds of dark-grey talcose clay slate, some of them two feet thick, are associated with the limestone, which altogether may have a breadth of fifty yards, and is much intersected as before with white quartz veins, running in various directions. A slightly talcose coarse granular quartz rock, white and grey in colours then occurs, and occupies the breadth of about half a mile, becoming towards the south-eastern part interstratified with beds of dark-grey talcose clay slate. Another belt of magnesian limestone follows, bearing the same character-

istics as before; and the remainder of the distance to the dark-coloured limestones and slates, about a mile, is occupied by slates, which appear to be a fine mixture of quartz, chlorite and talc; they are in parts found fit for whet-stones, and their colour is in general allied to light-green. That the two double belts of magnesian limestone and interposed quartzose rocks are identical, and on opposite sides of a synclinal form, appears probable from their lithological resemblance, and from the fact that rocks of this character are traceable round towards one another, approaching the Nicolet, in the same way as are the dark-coloured slates and limestones on the outside of them. It seems also from the quality and strike of the strata, not improbable that the inner bands of the magnesian limestone are identical with those of the Sutton part of the southern section; while the talco-chloritic and epidotic rocks, which occupy the middle space between the dolomitic bands, constitute a ridge of high ground nearly the whole distance between the two sections, forming Tibbitts' Hill, Moorhouse Hill, and running to the Pinnacle Mountain in St. Armand on the one hand, and Brooker's Hill in Shipton on the other. It would seem also to be a consequence of the structure of the district, as far as described, that the talco-chloritic granular quartz rocks, their accompanying magnesian limestones, and associated quartzose chloritic and epidotic slates of the sections, represent the fine quartzose conglomerates and slightly calcareous chloritic sandstones of Granby with their chloritic limestones, the red titaniferous slates interstratified with which, seem to be obscurely seen in the slates of the same colour in the St. Francis section, and may perhaps be represented by the titaniferous iron slates in that of Sutton; and the analogies of the different localities are in some degree farther supported by the presence of chromium in or near the limestones in all.

The south-east belt of the Sutton dolomites, which have been described, would meet the general line of section on the road between the seventh and eighth ranges of Brome, about the fourteenth lot; the supposed anticlinal axis would intersect it near the southern part of Brome Lake, about the thirteenth or fourteenth lot of the ninth range. About a mile beyond this, another belt of magnesian limestone occurs at Knowltonville, on the twelfth lot of the tenth range. To the south-west, this has been traced by

the ninth lot of the ninth and the sixth lot of the eighth range of Brome, to the fourteenth lot of the eleventh range of Sutton, gradually approaching the previous belt in that direction. North-easterly from the line of section, the belt has been followed by the sixteenth lot of the eleventh range of Brome, the seventh lot of the second, and the first lot of the third range of Bolton, to Stukely Mills, and thence across the Granby and Outlet road, to the ninth lot of the third range of Stukely Township. Another locality in the bearing of these, still further to the north-east, in which limestone of the same quality is met with, is the thirteenth lot of the seventh range of the same Township; but it is not certain that it belongs to the same belt. In the neighbourhood of Knowltonville and across the corner of Bolton, this belt is associated with soapstone, which appears in general to be on the north-west side of it, some times two to three hundred yards removed; such is the case on the seventh lot of the second range of Bolton, where a breadth of twenty-five yards of the dolomite is exposed; it weathers to a yellowish-brown colour, and it is greatly intersected as usual by thin veins of white quartz, and marked by thin leaves and patches of a beautiful bright green foliated talc, irregularly running through it, the colour of which Mr. Hunt has ascertained to be due to oxyd of chromium. If this exposure were carried forward in the strike (N. 32 E.) to the sixth lot, it would be about the distance which has already been specified from a band of soapstone and serpentine, which has dark-grey glossy and finely wrinkled talcose clay-slate on both sides of it. The band is about thirty yards wide, and the serpentine, which is of a dark-green colour, occupies but one foot of the width, on the south-east side. The soapstone is a mottled grey, and holds many disseminated crystals of bitter-spar, and not a few of iron pyrites, and it is flanked on the north-west side by an agregate of the crystals of bitter-spar, forming a dolomite. On the Granby Road near Stukely Mills, the limestone is divided into three bands, which appear to dip to the north-west at a high angle. That on the north-west side, which is ten yards thick, has the usual brown colour of the dolomite, and presents the usual reticulation of white quartz veins; but the other two bands are a light grey externally and internally, in some parts nearly approaching to white. They are more highly crystalline than the

other, and their breadths are between forty and fifty yards each. The rocks which separate the whole are dark-green, and highly chloritic, as well as partially epidotic, and the intervals they occupy are about 145 yards between the western and middle bands, and 260 yards between the middle and eastern. Notwithstanding the uniformity of the dip, it appears not improbable the two grey bands may be due to a synclinal repetition; but the brown-weathering band was not met with on the south-east side to confirm the supposition.

Very nearly two miles beyond Knowltonville, another belt of dolomite presents itself on the line of section, on the tenth lot of the eleventh range of Brome, and the eighteenth lot of the first range of Bolton. It is found marked as the last by chrome-green talc, and associated with soapstone and serpentine. In one direction it has been followed at intervals to the Province line on the eighth lot of the first range of Sutton; and in the other, to the fourth lot of the fourth range of Bolton. In the last locality, it consists in one part of soapstone irregularly studded with crystals of bitter-spar, and mingled with patches of dolomite, twenty-five yards appearing to be its whole breadth; but to the north-eastward (on the strike) about 300 yards, it passes into a dark green slaty serpentine, bounded by a band of soapstone on the north-west side, the breadth of both augmenting to nearly fifty yards. The serpentine holds radiating asbestus, and crystals of magnetic and chromic iron imbedded in the rock, and picrolite in veins; and on the north-west side of the soapstone, there is a band wholly composed of actynolite imbedded in asbestus, with small quantities of talc and mica. Actynolite occurs in the dolomite of the eighteenth lot of the first range of Bolton; and in the twelfth lot of the seventh range of Sutton, the bed displays soapstone, holding much brown spar and crystals of pyrites with various replacements, as well as small disseminated octahedrons of chromic iron; on the south-east side of the soapstone there is a bright grass-green band of nearly a foot thick, composed of magnesite and talc, the latter deriving its colour from oxyd of chromium.

The rocks filling the interval between these dolomitic and steatitic belts consist chiefly of coarse quartzose chloritic slates, often thickly studded with crystals of the magnetic and specular

oxyds of iron; epidote appears to be by no means common, except on the north-west side; talc also is scarcer than in the previous chloritic rocks, and mica more abundant, particularly on the south-east side, and so also is feldspar or albite.

Succeeding the last-mentioned magnesian belt, the rocks which occupy the next five miles on the line of section, consist chiefly of coarse chloritic and micaceous slates. In many parts these slates become very quartzose, and they are frequently supplied with a small quantity of feldspar, giving them the character of gneiss; talc appears to be much less common than in the rocks to the westward; but one spot was observed, about two miles short of the total distance, where this mineral and calcareous spar became abundantly mixed as constituents in the rock, exhibiting green stains resulting from oxyd of chromium, and the feldspar greatly increased in quantity; by the analysis of Mr. Hunt, the rock here yields nearly 10 per cent of lime. The last two miles seem to hold more of the feldspar than the previous three, and small acicular crystals of black tourmaline are frequently disseminated in the rock, which at the end of the distance appears to become very quartzose, frequently losing its schistose character, and splitting into large solid blocks. The measures filling these five miles seem to expand southwardly, by a divergence of the strikes of the opposite sides, and on reaching the Province line they span a breadth of about double the distance between the valleys of Sutton and Potton. They constitute a mountainous tract, the greatest elevation being Sutton Mountain, the peak of which, rising to a height probably exceeding 4000 feet above the level of the St. Lawrence, is represented to be on the twenty-fourth lot of the fifth range of the Township. A valley on the east side of the main summit, in the run of the chrome-stained calcareo-talcose strata mentioned, divides the mass into two ridges, the eastern of which running through Potton, is alone prolonged into Bolton across the line of section, there forming Bolton Mountain, and dying down in Stukely. This mountainous area has as yet been but little examined.

The next rock met with on the line of section is a belt of highly magnesian character, consisting of serpentine, soapstone, and other allied minerals, which appear to have a definite place in the stratification, having been traced at intervals across Potton

and Bolton, in the valley of the Missisquoi, a distance of nearly twenty miles, keeping west of the stream. There are however several considerable intervals of concealment, and the exposures observed are not quite sufficient to determine with certainty, whether the rock lies in an uninterruptedly continuous bed or only in isolated masses, in a constant stratigraphical place. On the west side of the belt there appears a band which is quartzose, strongly chloritic, and distinctly but not very strongly calcareous, between which and the quartzose strata previously described, a green translucent compact silicious rock with a corneous aspect occurs, holding magnetic iron and veins of asbestus; both together occupy about 100 yards, and independent of them, the breadth of the serpentine is usually 150 to 300 yards. The belt consists chiefly of a dark bottle or blackish-green serpentine, with a very uneven exterior, weathering to a decided reddish-brown, or a decided white colour; thin veins of a pea-green serpentine occur, much softer than the dark-green, and thin reticulating veins of asbestus intersect the rock in various directions; considerable masses of the rock are sometimes of a light greyish-green, checquered by thin veins or seams of a darker colour, cutting and sometimes slightly dislocating one another in two rudely parallel directions, which not being at right angles divide the mass into irregular sub-rhombic prisms; picrolite is very frequently met with in irregular seams or veins, some of which are two or three inches in breadth, and the fibrous structure of the mineral running slightly oblique to the veins or with them, specimens may be obtained of two or three feet in length in the direction of the fibres; octahedral crystals of magnetic iron are often disseminated in the serpentine, and the mineral frequently runs in small beds or veins in the direction of the strike; chromic iron occurs in the same manner, and workable quantities of it have been found; iron pyrites is disseminated in small cubes. Soapstone is frequently associated with the serpentine, and was observed in some parts in considerable quantity on the west side of the belt, running with it; it seems also in some places to be present in the run of the belt, where the serpentine was not observed, and both with and without the serpentine, it occurs in workable quantities in beds of several feet; the colour is light-grey, and it is occasionally banded with pea-green. Veins or

beds of fine amianthus sometimes occur in the soapstone, of two to three inches thick, of a delicate greenish-white, affording beautiful specimens, and some portions of the talcose rock in such places, apparently disintegrated by frost and atmospheric agencies, have the softness of butter, and may be moulded into any shape. The soapstone seems occasionally to pass into an asbestiform talcose slate, fracturing into long fibrous splinters in the direction of the dip. The most northern spot at which an exposure of the serpentine, no doubt belonging to the belt, was met with, was on the seventh lot of the eighth range of Bolton; from this the general strike of the strata in the vicinity, as well as the direction of the course of the belt as displayed farther south, would carry it, by the first lot of the ninth range of Bolton to the twenty-first lot of the second range of Stukely, in which two localities no serpentine was found, but in its stead exposures of magnesian limestone, identical in its character with the dolomitic bands of Sutton and Brome; and in the more southern of the two localities, a highly feldspathic band which there accompanies the dolomite, displays a multitude of bright-green seams of talc not much thicker than paper, coloured by oxyd of chromium. Whether the serpentine passes into the dolomite, or has any immediate stratigraphical relation to it, could not be directly ascertained.

At the distance of a mile and a quarter from this belt of serpentine, another running parallel with it, and keeping on the east side of the Missisquoi, occurs on the line of section. The space intermediate between the two, appears to be filled chiefly with alternating bands of grey quartz rock, weathering white, and clay slate with glossy talcose surfaces; some parts of the quartz rock assume a granular texture, giving it the aspect of an obscure coarse-grained sandstone, or very fine conglomerate, and solid massive beds are occasionally separated by thinner bands of a more schistose character, holding mica. Interstratified with the talcose clay slates, are thin black apparently carbonaceous bands, having also glossy surfaces. It is difficult to say what proportion the beds of quartz rock bear to those of the talcose clay slates, as there are several intervals of concealment; but it is not improbable the latter preponderate. The strata in immediate succession to the belt of serpentine are not exposed,

but before reaching the eastern one, there are interposed between it and the alternating quartzose and argillaceous beds, about 270 yards of green-colored slates, which are chloritic, epidotic and partially talcose; a portion of the rock has on the exterior the aspect of being made up of large reniform or ovoid masses pressed on one another irregularly, the epidote occupying the interstices and obscurely serpentining over the surface, the arrangement of the pattern in marbled paper being illustrative of the appearance; the colours are various shades of obscure light-green. The rock has a species of waxy lustre and jaspery fracture, and fragments are imperfectly translucent on the edges; the texture is in some degree like that of half-baked porcelain, or clay imperfectly converted into jasper; in some parts of this there occur brecciated or conglomerate beds, made up of slaty fragments, weathering whiter than the matrix, which under atmospheric influences becomes a white with a dash of greenish-yellow, or an obscure and dirty sulphur-yellow; nearer the serpentine, the rock becomes more darkly green, more clearly chloritic and more distinctly epidotic.

The breadth of the eastern band of serpentine is much the same as that of the western, perhaps it may occasionally exceed it; the exposures examined on it were more numerous than those on the other, and in all serpentine constitutes the chief mass. This however as in the western belt, appears to consist of different qualities, presenting different colours, which seem to run parallel to one another like strata, though none have been individually traced to any great distance. Gathering several of the facts from positions considerably removed to the north and south of the line of section, one of these quality is much harder than ordinary serpentine, and appears to be more silicious, being probably a compact intimate mechanical mixture of quartz and serpentine, or more likely quartz and diallage, and in one exposure an interposed bed of this was met with eight yards wide; crystals of schiller-spar are often imbedded in the serpentine, and in the northeastern part of the extension of this belt, subdivisions of it frequently pass into diallage rock. Beds of soapstone frequently appear, and seem in general to be towards the east side; magnetic iron and chromic iron often occur imbedded in crystals and small seams; of the former, interstratified workable quantities are met with,

and in one case a large mass of ore consists of an intimate mixture of ilmenite and the magnetic oxyd of iron; while the discovery of a boulder of chromic iron weighing six hundred pounds, probably derived from this band, leaves little doubt that workable quantities of this also will be found. A limestone (whether always of a dolomitic quality is not quite certain,) is frequently met with, either touching or very near the serpentine; this limestone is generally grey, and in a large number of cases it presents such an aspect, both externally and internally, as to leave little doubt that it is of a brecciated or conglomerate character; it is often spotted with chrome-green stains, and in once case cracks in it were found lined with nickel-green.

Near the line of section, a bed of grey weakly calcareous rock, with disseminated iron pyrites, bounds the serpentine on the east side, and the next important set of rocks in succession, after about 400 yards in nearly a fourth part of which, grey clay slates with glossy talcose surfaces are alone exposed, are silicious; they consist chiefly of beds composed in general of a white compact quartz, with a scaly fracture and waxy lustre, in which are imbedded in varying amount, crystals of diallage, of pyroxene, hornblende, or feldspar, the first mineral being probably more frequent than the rest; sometimes the rock is almost wholly free from them and has a corneous aspect, and on the contrary at others is so loaded with one or more of them, that they equal or surpass the quartz in amount; the crystals are occasionally large, and the rock has then a coarse-grained and mottled appearance; and they are sometimes so small as to be scarcely distinguishable; in this case the rocks, particularly when diallage is the mineral combined with it, has a uniform compact texture and green colour, causing it in some degree to resemble serpentine, from which it is easily distinguished by its greater hardness. In some layers it happens that in such a matrix as this, translucent grains of quartz, rather larger than buck shot, some angular and others rounded, will be imbedded, and occasional fragments of indurated shale of a jaspery quality will be included in others; small veins of asbestus will sometimes occur, and a small patch of serpentine will now and then present itself. Large masses of this silicious rock sometimes equalling 400 yards in breadth, and subdivided into layers, presenting a

variety of modifications from the various characteristics mentioned, are separated by bands of dark-grey pyritiferous clay slate, of greater or less width up to 300 yards, with very smooth glossy surfaces, as before probably due to the presence of talcose material. Some parts of the slate appear to hold fragments and nodules differing slightly in color from the general base, and weathering much lighter than it, and some parts of it are occasionally of a decided red color. These alternating rocks occupy about a mile beyond the last mentioned serpentine, and the strength of the silicious part, which has often the aspect of altered fine conglomerates or coarse sandstones, cause them to constitute a range of mountains, accompanying the serpentine as far as it has been traced, and presenting some of the highest peaks of the whole of the district, Orford or Victoria Mountain being one.

Before however pointing out the range these rocks take, it will be convenient to continue farther the enumeration of the masses that appear upon the line of section. The first is a band, of which about sixty yards are exposed transversely; it weathers to a yellow earth, deriving its colour from hydrated peroxyd of iron, probably resulting from the decomposition of iron pyrites finely disseminated; internally it has much the same aspect as the weakly calcareous rock to the east of the last band of serpentine, but contains much more lime, being an impure dolomite. In contact with this rock there rose from beneath the soil several large blocks of serpentine, crowded on one another for a short distance in the strike of the stratification, but it was impossible to determine with certainty whether they were wholly loose, or might belong to some associated mass *in situ*. The locality is on the twenty-eighth lot between the eighth and ninth ranges of Bolton, and in the strike farther north, on the twenty-first lot of the ninth range, the same dolomite rock is met with; still farther north, on the seventeenth lot, there is a bed of soapstone, not far from which is seen a considerable band of whitish and grey-speckled nearly pure magnesite rock, much stained with chrome green, while beyond this serpentine occurs. At the distance of a mile farther, on the line of section, there is another band of the same yellow-weathering description of impure dolomitic rock, and the intermediate space is occupied by the same alternation of grey glossy-surfaced clay slates, and corneous

quartz rock with its various imbedded minerals, the proportion of clay slates being rather larger than before, and the alternation continues for between 400 and 500 yards farther.

These rocks are followed by grey limestones, holding fossils, interstratified with calcareous slates. The breadth of the calcareous belt is about three-quarters of a mile, and it brings us to the west shore of Memphramagog Lake, at Potton Ferry. On the opposite side of the lake at Georgeville another belt of the same limestone occurs, which with a part concealed by the water, may have a breadth of a mile and a half. Between the two belts there is a space about three quarters of a mile wide, which on the line of section, is wholly covered by the lake; but the point of land immediately north of it, between the west bay and the body of the lake, is observed to be occupied by dark grey clay slates, with several bands of corneous rock (some of which weather yellow) running into a ridge. The two belts of limestone there is little doubt are equivalent rocks. and they are supposed to lie in the form of two distinct long parallel-sided troughs, the western one of which, in its northern prolongation, does not appear to reach the Outlet and Granby road, while the eastern one crosses it. In that direction the two belt-like troughs diverge a little, and approach in the opposite, the greatest measure across them both, including the intermediate space, being four miles and a quarter, and the least two miles. The dips of the stratification do not assist in making out the structure, for while the strata on both sides of the west trough are as near as possible vertical, those of the eastern, dip to the westward at a high angle. Grey clay slates banded with black, all with glossy surfaces, follow the Georgeville limestones, and prevail for nearly two miles; they are often marked by the presence of imbedded cubes of iron pyrites, and they are succeeded by two miles of talcose and chloritic slates, often presenting a very quartzose character, and then sometimes becoming micaceous; near the junction with the clay slates, some very talcose beds occur, and in the strike of these on Memphramagog Lake, there is a band of serpentine of a peculiar dingy light greenish-yellow or olive-green color, and more than usual translucency; some parts of it seem to have calcareous matter mixed with them, and the band may have a breadth of about fifty yards. The quartzose beds in

many places leave little doubt that they are altered fine conglomerates, particularly on the west side of the belt; but on the east, the rock is a fine-grained talc or mica slate, (the grain is so fine that it is difficult to distinguish which,) yielding excellent whet-stones. These rocks are again followed by limestones, in which though they are of a highly crystalline quality, well-defined fossils, among many that are obscure, have been detected in several localities.

These limestones, to the condition of which allusion will be made hereafter, lie at the southeastern base of the mountain tract, of which the talco-chloritic and quartzose belt constitutes a range of hills, shewing some bold points, the boldest being the Stoke Mountains. The line of division between this belt and the limestones is well marked; first by the East Bay of Memphremagog Lake, then by a deep dingle to Massawippi Lake, and by that lake and Massawippi River to the vicinity of Lennoxville. From this it follows the St. Francis as far as the third range of Westbury, whence it keeps the Quebec road to the line between the fourth and fifth ranges of Dudswell; here it curves round to the northwest, but again crosses the Quebec or Gosford Road, a little to the south of the line between the seventh and eighth ranges. Beyond this, the limestones have been seen near Lake Louisa, in the fifth range of Weedon, and the Stoke Mountain rocks, at Rice's Settlement on the Gosford Road, in the Augmentation of Ham, the distance between the two localities being seven miles transversely; but the junction of the two formations has not yet been traced with precision beyond Dudswell, though it is known to run in a general line up the River St. Francis, to the foot of St. Francis Lake, and thence to the Rivière de Famine, on the south-east side of which the limestone, holding well-defined fossils, is first met with in ascending the Chaudière.

Between Memphramagog Lake and Dudswell, the dip of the limestone appears in general to be north-westward, at very high angles, varrying from 50° to 90° immediately near the talco-chloritic quartzose rocks. The dip of these (which may provisionally be called the Stoke Mountain belt) appears to be in the same direction; so also does that of the clay slates, preceding them on the line of section. The dip of the Georgeville limestones has more of westing in it, but is still sufficiently near to that of the

other rocks to offer no contradiction to the semblance of a regular succession in the order of superposition of the whole. The organic condition however of the Georgeville and the Dudswell limestones, renders it probable they belong to one formation, and it would follow that the latter present an inversion of the strata, and that an anticlinal must run between the two. It would seem to follow also, that there must be some want of conformity between the clay slates and the Georgeville and Dudswell limestones; for the clay slates were not observed at all between the Dudswell rock and the Stoke Mountain belt, while between this belt and the Georgeville beds, which have been traced along Memphramagog Lake nearly fifteen miles, from the fifteenth lot of the first range of Stanstead to the vicinity of the Outlet, the clay slates constitute a wedge-shaped mass, gradually widening north-eastwardly from a point, to the breadth of nearly five miles, in which their strike appears to agree with that of the Stoke Mountain belt, rather than with the run of the limestones. The strike of the Potton Ferry limestones, and that of the glossy-surfaced clay slates with their associated corneous strata, to the west of them, do not show the same divergence; and it appears not improbable that the corneous belt and the Stock Mountain belt may have some proximate equivalence; for the strike of the latter being north-east and south-west, while that of the former is north and south, the two run together into one or into immediate sequence, on the west side of Memphramagog Lake in the vicinity of the Province Line, being assisted in their junction by what appears to be a great up-throw dislocation, making a clean section across the fossiliferous troughs, and bringing up the corneous strata into the Owl's-Head, a prominent mountain on the west side of the lake, standing very nearly on the anticlinal axis between the two.

The eastern band of serpentine of the Missisquoi valley in Potton, which bounds the corneous belt and extensively accompanies it, being of some importance in consequence of the economic value of the minerals with which rocks of this description are so often associated, has been traced for a considerable distance, with as much care and as little interruption as the circumstances of the district would permit. It enters the Province on the line between the sixth and seventh ranges of Potton, and holds to the seventh range across the whole of the Township,

running a little to the east of north; it enters Bolton also on the seventh range, and gains the line between it and the eighth, on the twentieth lot; it reaches the ninth range on the eleventh lot, and may possibly continue a little farther in the same line; but it is probable that in this neighbourhood it is carried round, by the effects of an undulation, to the next position in which it has been seen, which is upwards of a mile to the eastward, on the same numbered lot in the middle of the tenth range; thence gaining Orford Pond, it enters Stukely at the south-east corner, a little to the west of Orford Mountain, which consists in a great measure of the corneous rock. The serpentine is met with in a vast number of places, on the east side of Stukely and the west side of Orford Townships, comprised within a transverse distance of six miles and upwards, and so many of the exposures run in parallel directions, while some of them spread out to such great uninterrupted widths, (equal occasionally to the third of a mile), as, in addition to the fact that a certain prevailing sequence in the associated rocks is observed, renders it probable the distribution is due to undulations. Following what may be considered the western limit of these exposures, from the vicinity of the south-east corner of Stukely, it attains the ninth lot of the eighteenth range of Orford, with a belt of quartzose chloritic rock to the west side, and there entering Long Lake, it follows this lake through the whole length, coming out upon the twentieth lot of the second range of Brompton, and passing thence in a nearly straight line to the twenty-seventh lot of the first range of Melbourne, a little beyond which it strikes the Salmon River (the stream emptying Brompton Lake), on the line between the first and second ranges of Melbourne; from this it keeps the banks of the river until reaching the line between the fourth and fifth ranges, whence it runs to the St. Francis River, crossing it on the twenty-first lot at the upper end of an island three miles above Melbourne village, accompanied all the way by the chloritic and quartzose belt on the north-west of it; entering Shipton on the sixth lot of the fifteenth range, it maintains a direction crossing the lot lines at a small angle, and there are some evidences of it on the tenth lot of the seventh range, on the north-west side of Shipton Pinnacle Mountain. This mountain is composed of a coarse conglomerate, in which the pebbles, some of them two to

three inches in diameter, appear to be altered to several of the various qualities of rock met with in different parts; some consist of corneous quartz, and others of a mixture of corneous quartz and imbedded crystals of diallage; in that part of the rock constituting the matrix, there is much chlorite and epidote mingled with it in spots and patches; pebbles and fragments of more or less perfect red jasper (some of it resisting the knife,) are met with, and even patches of the same material in the run of the rock. There is a regular band of the jasper on the south-east side of the hill, which is a narrow ridge, as there is of the corneous quartz on the north-west, between the conglomerate and serpentine, while the previously-mentioned quartzose belt is still farther north-west. The conglomerate ridge is continued in a narrow chain of hills north-east of the Pinnacle, and the band of serpentine is met with about 400 yards to the north-west of it, on the eighth lot of the fourth range of the Township. The serpentine thence gains West Nicolet or Richmond Lake, on the twenty-seventh lot of the tenth range of Tingwick, where it is represented by an almost unmixed diallage rock, and its course nearly due east points for Ham Mountain; between Richmond Lake and this mountain it has not yet been traced, but it must attain its northern flank, probably after following a zig-zag course, through the influence of undulations, for it is met with again at the outlet of East Nicolet Lake, and Ham Mountain which is within three miles of it, is composed chiefly of corneous rock, being a repetition of Orford Mountain in almost every respect, with perhaps a small addition in height. From the outlet of East Nicolet Lake the course of the serpentine again becomes north-easterly, and it has been traced among the islands of the lake to the upper extremity, where it crosses the Quebec road; it thence attains Indian Pond and another small lake to the north-east, running between the two upon the south-east boundary line of Wolfestown, near to which line it keeps to the continuous line of Ireland, gaining on this Caribou Hill on Black Lake in the fifth range of the Township. From this it has not been followed across Thetford, Broughton and Tring; but it was again met with on the Rivière Bras, about two miles and a half below the point where this crosses the north-eastern boundary of the last-mentioned Township, being a spot about a mile above the

Great Rapid, and again at this rapid; it thence crosses the Chaudière and gains the lower fall of the Guillaume River, which it crosses; it is met with again near the north-west line of the Seigniory, about two miles from the south-west line of Cranbourne, and crossing the east corner of the Seigniory of St. Joseph, it enters Cranbourne in the second range, and has not been farther traced.

In thus following the range of the serpentine and its associated strata for 135 miles, it will be perceived that when they reach the vicinty of Ham Mountain, which is within two miles of the talco-chloritic quartzose rocks of Rice's Settlement, they stand in the same connexion with those rocks as they do in the neighbourhood of the Owl's Head, not far from our starting point on the Province line; and that the two positions are at the opposite extremes of a rude sub-elliptical area in the stratification, bounded by the serpentine on one side, and the Stoke Mountain belt on the other, about sixty-five miles asunder. The greatest transverse measure of the area, from the Gosford road where it enters Dudswell Township, to the anticlinal valley of Melbourne and Danville, near Shipton Pinnacle, rather exceeds twenty-five miles. Glossy-surfaced clay slates chiefly, (judging by the section afforded by the St. Francis River) appear to occupy the interior, but undulations, of which at least two considerable ones are known, bring in parallel ridges of the Stoke Mountain rocks in several places. The upper part of Memphramagog Lake, which lies in the eastern fossiliferous trough heretofore mentioned, runs nearly in the longitudinal axis of the sub-ellipse, but the facts ascertained in the general area are yet too few to enable me to describe its geological form with precision.

It will be observed also that in Shipton the band of serpentine appears to occupy the same stratigraphical position on the south-east side of the anticlinal axis that the upper band of dolomite does on the north-west; each has a belt of quartzose rocks below, and beneath these belts in Melbourne, there is another band of dolomite on the one side, while soapstone and serpentine were observed in two places in an analogous position on the other, and there are whet-stones in succession on both sides, followed by the dark-grey and black slates and limestones. Above the upper dolomite there are quartzose, chloritic and epidotic rocks,

and the same above the upper serpentine; in the latter case however the quartzose rocks are coarser, and they are accompanied by red jaspery slates; the red slates however are titaniferous and so is the peroxyd of iron of the dolomite associated with the chloritic and epidotic slates on the other side, while both the dolomite and the serpentine hold chromium. The nearest proximity of the bands of dolomite and serpentine in Shipton thus compared, is two miles and a half, and it will be observed that while one can be traced to the east side of the valley of Potton, the other runs to the west side of the valley of Sutton, the distance between them there attaining fifteen miles. It would seem to follow from this, that the Shipton anticlinal branches into two, one running to the valley of Potton; and in conformity with this, the dark-coloured slates and limestones are traceable up a tributary of the Salmon River for between eight and nine miles, to the twelfth lot of the eleventh range of Brompton, pointing to the north-east corner of Stukely and Potton valley beyond.

Sutton Mountain thus standing between two anticlinals, which run into one, might be supposed to possess a synclinal form; the strata however were observed to maintain dips, generally at high angles, in opposite directions from the axis of the mountain, with much constancy on the Sutton and Potton, the Brome and Boulton, and the Stukely roads, which the axis crosses; and the probability of this anticlinal form seems to be supported by one or two facts in Ely, which require further examination, indicating that another bifurcation may occur in the geographical distribution of the dark-coloured slates associated with the lower limestones, about the third lot of the third and fourth ranges of the Township. The anticlinal form of Sutton Mountain would appear to throw the two eastern belts of associated dolomite, soapstone and serpentine in Sutton valley, into the shape of a trough, and they would probably join northwardly a few miles beyond Stukely mills. As there would be a synclinal between the axis of Sutton Mountain and Potton valley, the serpentine on the west side of the valley may be expected to be repeated farther west; but whether the chromiferous calcareo-talcose rock, mentioned as occurring about two miles and a half from it to the westward, may indicate its position is yet to be definitely determined.

The dolomites and serpentines would thus appear to have about the same stratigraphical position in the rocks of the district, and the probability of their passing into one another, or being nearly associated, is farther supported by the fact that a belt is met with towards the Chaudière, in which both rocks occur more largely developed than elsewhere in combination; the breadth of the belt appears in some places to be about 400 yards, and in others it reaches 700, in which the dolomite and serpentine together make up between 50 and 100 yards, in four to seven bands, (some of which are probably repetitions), the serpentine never exceeding one; but the serpentine alone makes up nearly 100 yards in one locality, without any accompanying dolomite; the interstratified rocks are usually chloritic and talcose slates of a quartzose character, often very epidotic; iron ore in workable quantity runs with the belt in some places, and near the belt in one spot a two-feet vein of quartz, also coincident with the strike, holds beautiful specimens of variegated copper. This magnesian belt has been traced at intervals for a distance of twenty miles, from a point on the division line beween the Seigniories of St. Giles and St. Mary, about three miles from the south-east corner of the latter, to the fourth lot of the third range of Inverness; in its position it seems to correspond with the Kingsey dolomites, on the north-west side of the Shipton and Kingsey synclinal, but the interval between the localities (thirty-five miles,) is too great to permit me to speak with certainty; if such however should be the case, another belt may be expected corresponding with the dolomites on the south-eastern side of the same synclinal.

White quartz veins running with the stratification are often met with among the talcose, chloritic and quartzose slates, and the talcose clay slates; small quantities of copper pyrites have been met with in two or three, and traces of gold and silver in one in the vicinity of Sherbrooke.

Returning to the general line of section, the calcareous formation, which has been mentioned as succeeding the talco-chloritic quartzose belt of Memphramagog East Bay, and Massiwippi Lake, occupies a breadth of nearly twenty miles, and it consists of crystalline micaceous limestones, interstratified with fine and coarse mica slates. The limestones are much more abundant in

the first three miles of the distance than in the remainder, and in those three miles are usually of a dark-grey colour, and often approach a dull earthy black; these black beds being frequently separated by thin black calcareo-carbonaceous slates of a yielding, brittle character, with a satiny lustre in fresh fractures, resulting probably from the presence of very fine scales of mica. The black limestones weather to a deep brown, and the slates to a brownish-black, and it often happens that a considerable thickness of the exterior, sometimes equalling six inches or a foot, remains adhering together loosely in a disintegrated state. The grey limestones are of a rather more durable quality, and exposures of this description are met with, displaying 300 feet of thickness at once in an agg egation of beds; in some places the colour of the rock from a l ght-grey becomes in some layers a uniform yellowish-white or cream colour; the beds of this colour seem to be more compact than the general quality, and some of them, if the presence of thin filmy patches of what appears to be talc of the same color, do not deteriorate the stone, would probably yield excellent marble. In other places considerable crystalline masses of the rock exhibit a finely striped aspect, the colours being grey and white, running in the direction of the strike, and in such cases the rock appears to be fissile in the direction of the colours, from the presence of mica between the layers. The white, the banded and the light-grey are not so easily discoloured or disintegrated by the influences of the weather as the black, which usually holds a considerable quantity of iron pyrites disseminated through it in isolated cubes of various sizes up to half an inch, often thinly encased in white quartz.

The upper end of Massawippi Lake affords examples of the black beds; the vicinity of the bridge over the Burrows River on the Stanstead and Sherbrooke road, displays some of the grey; the striped quality is seen at Magoon's Point, on Memphramagog Lake, and the white varieties exist at Dudswell. In the latter two localities, organic remains were met with; in the first they consisted of encrinites, which were plainly visible on the weathered surfaces of the rock standing out in relief, and perceptible also in fresh fractures, notwithstanding the metamorphic condition of the rock, which is highly crystalline and finely granular, with mica running as has already been stated, in parallel planes.

The sections of the encrinital stems are rendered visible from the circumstance that they present smooth oval rings, resulting from a cleavage oblique to the direction of the stems, which rings are surrounded by the finely granular limestone, and display a finely granular spot in the centre. At Dudswell, in addition to the encrinital columns and disks, there is a great abundance of corals; they exist chiefly in the light-grey beds, and the eye is attracted to them by the white patches they present embedded in the grey. The whole rock is highly crystalline, but the corals appear more evenly and finely grained than the enveloping matrix, and free from mica, and on the weathered surfaces their structure is often plainly discernible, from deeply-worn lines running in the walls and divisions of cells, columns, and concentric layers. The genera seem to be *Cyathophyllum*, *Porites* and *Favosites;* one species of *Favosites* is sometimes found split in the direction of the columns, and there is no difficulty in determining it to be *F. gothlandica;* very beautiful specimens of this coral were met with in the Potton Ferry and Georgeville limestones. On the Rivière de Famine the rock is not so crystalline, and among the fossils are *Favosites gothlandica*, *Cyathophyllum cespitosum*, and *Atrypa affinis*. In all the localities mentioned, the fossils are found in what is conceived to be the inferior part of the calcareous formation, being that to the north-west.

The mica slates, which are interstratified in the more calcareous part of the formation, are usually of a soft and fine description, resembling clay slates with the addition of mica; but in the seventeen miles that follow, while the calcareous beds diminish in frequency, the mica slates become stronger and more quartzose, and very thick bands of this character ultimately prevail. The usual colour of the beds is grey; the limestones are sometimes very dark grey and are often silicious; they almost all weather brown, and usually exhibit a thick disintegrated coating, and their ruins constitute a considerable portion of the soil. Among the fine mica slates, a few black beds are sometimes met with, having waved surfaces, displaying chiastolite in cross fractures. The whole formation is very pyritiferous, isolated cubes of the sulphuret of iron being often thickly disseminated in all the beds, calcareous, micaceous, argillaceous and quartzose. That the strata are much affected by large undulations and minute corrugations,

there is not much doubt; but in the majority of cases the dip observed appeared to be towards the north-west, and usually at high angles of inclination.

In the remainder of the section to Canaan, which may occupy a space of about twelve miles, no calcareous beds are observed; mica slates predominate in alternating black and grey bands, the black holding more mica, the grey more quartz. Bands of light-grey or whitish quartz rock, weathering to an ochre-yellow, are interstratified in the slates, about three miles forward on the line, there constituting the ridge of a hill, and in the immediate vicinity of Canaan some of the strata exhibit a large amount of crystallized black hornblende, and small imbedded garnets; cubes of iron pyrites are met with in all the beds. The prevailing dip appears to be to the north-west, though there are probably many undulations, and the whole formation gives a bold rugged country, and appears to constitute the range of hills originating the head tributaries of the Connecticut and Chaudière Rivers.

The two formations which occupy the space between the Massawippi and Canaan, are in many parts pierced by considerable masses of a beautiful granite, consisting of white quartz and feldspar, with a rather sparing amount of black mica, very uniformly mixed, and the intrusive nature of these masses is clearly displayed by the granitic dykes proceeding from them in various directions. One of the largest masses, measuring about six square miles, occurs between Stanstead Plains and Memphramagog Lake, occupying the first to the sixth lots of the fourth, fifth, sixth, and part of the seventh ranges of the Township; it appears to displace the calcareous strata it penetrates, which were obeserved to dip from the granite in several places. On the fifth lot of the fifth range, on the east side of the road, within a short distance of the edge of the granitic nucleus, a great number of dykes of the same quality, some of them two and others three feet in breadth, running into a multitude of irregular reticulating branches (which are of various widths down to the eighth of an inch, and connect the whole together) are exposed, cutting the basset edges of the limestone beds, planed down to a horizontal surface; and in the face of an escarpment, which rises from the granite nucleus to this surface, a large dyke, of which the whole are probably ramifications, can be traeed down towards its

source. Intrusive masses of the same quality of granite were observed on the south side of Barnston and Barford and farther north in Hereford, in six different localities, in addition to several dykes of a few feet in width, which were traced for short distances; but in the immediate vicinity of Stanstead Plains, there is a granite dyke of seventy to one hundred feet in breadth, which was followed a distance of nearly four miles, from the fourth lot of the ninth range to the north side of the thirteenth lot of the eleventh range of the Township. It appeared to cut the stratification in the direction of the strike, which runs north or a little east of it; and it was traversed and broken by faults or cross courses in two places, in each of which it was heaved to the eastward (proceeding north) upwards of 600 yards. The direction of these important dislocations bore for the great up-throw fault of Owl's Head Mountain, probably constituting a continuation of it, and in conjunction with the intrusive granitic nuclei and dykes, together with the tilted and inverse attitude and contorted condition of the strata, they serve to illustrate the violent disturbances the rocks of the district have suffered at different epochs.

The facts which have been detailed in elucidation of the structure of the Green Mountains in their Canadian prolongation, would appear to make the plumbaginous sandstones and titaniferous red slates of the Seraphine range in the Seigniory of St. Hyacinthe, which are within a mile and a half of the Trenton limestone of that vicinity, equivalent to those of Granby; and these rocks, with their chromiferous calcareo-chloritic bands, to the dolomites and chloritic quartzose rocks of Kingsey, Shipton and Sutton; these again to the serpentine and quartz rocks of Potton, from which it would follow that the whole of the Green Mountain rocks, including those containing the auriferous quartz veins, belong to the Hudson River group, with the possible addition of part of the Shawagunk conglomerates. The fossils of the succeeding micaceo-calcareous formation of Memphramagog Lake and the St. Francis and Famine Rivers would seem to indicate that it is probably of an age not anterior to the Niagara limestone, or at most the Clinton group beneath, or to use more definite terms, that it is of the Upper Silurian series, of which the Clinton group appears at present to be considered the American base; and this sequence would accord with that displayed in the great Appalachian

trough, in its nearest approach to the Green Mountain range in the valley of the Hudson. A calcareous formation very fully supplied with Upper Silurian remains, has already been mentioned in prior Reports, as met with in Gaspé at intervals from the very extremity of that District to Matapedia Lake, a distance of about 150 miles. The geographical character of the intermediate 220 miles, the great similarity in the metamorphic condition of the Notre Dame and Green Mountains, and the continuous run of the recognised rocks of the Hudson River group, from Lake Champlain along the south bank of the St. Lawrence to Cape Rosier, render it probable that the Upper Silurian localities will be found to have a nearly direct continuous outcrop connexion; and as the micaceo-calcareous rocks of Memphramagog have I believe been traced thence by Professor Adams the State Geologist of Vermont, along the eastern flank of the Green Mountains, to the southern boundary of the State near Halifax, whence they proceed into Massachusetts, it seems probable the Upper Silurian group will thus be found continuous for perhaps upwards of 700 miles. In Gaspé an arenaceous formation succeeds the Upper Silurian, the conditions of which appear to resemble those of the Chemung and Portage group of New York, probably including the old red sandstone; and as this formation in Gaspé is found to possess a thickness of 7000 feet, and in its Western American development does not die away before reaching the banks of the Mississippi, it is not unreasonable to expect that they should follow the Upper Silurian zone, in its south-western course from the eastern extremity of Gaspé, and display a conspicuous figure, either in a metamorphic or unaltered condition, between it and the carboniferous areas of Eastern America, to one of which New Brunswick belongs, while another is met with in the State of Rhode Island, and in a metamorphic condition in Massachusetts. Whether the mica slates south-east of the micaceo-calcareous rocks on the line of section, be part of the Gaspé sandstones in an altered state, can until further investigation, be only conjectural.

MATERIALS CAPABLE OF ECONOMIC APPLICATION.

In the sketch which has been given of the rocks characterising the district under description, mention has been incidentally made

of various useful minerals. These are deserving of more particular notice, and there are others of some importance associated with the looser deposits of the surface that require to be pointed out. These various substances capable of application to useful purposes are the magnetic and specular oxyds of iron, bog iron ore and iron ochre, chromic iron, wad or bog manganese ore, copper ore, gold, granite and other qualities of stone suited for building, for mill-stones and whet-stones, roofing slates, serpentine, soapstones, magnesite, dolomite and common limestone, clay for common bricks and common pottery, and shell marl.

Magnetic and Specular Oxyds of Iron.

The localities in which the largest amount of these ores of iron was observed, were in the Townships of Sutton and Brome, and they occur chiefly in the vicinity of the two dolomitic belts occupying the two sides of the ridge west of the valley which has been described as running from the one Township to the other; in the whole of them the ores are almost all more or less titaniferous, sometimes strongly so. The specific gravities of the ores, in consequence, frequently appear to be disproportioned to their produces in metallic iron, the specific gravities of the different varieties of titaniferous iron (or ilmenite) being as great or greater than that of the pure peroxyd of iron, and from the presence of different varities of ilmenite, or their unequal mixture in the ore, it sometimes happens that a light ore will have a greater percentage of metallic iron than a heavy one. The produces of many of the beds will be found too low to render them available for economic purposes; but the ore being unequally mixed with chlorite, different samples from the same bed occasionally give very different results, and in any trial of the beds with a view of turning them to practical account, great care should be bestowed on an effective test of them for considerable distances on the strike.

The most southern locality reported to me is on the forty-fifth lot of Eastern St. Armand, in the occupation of Mr. A. L. Arms, being the lot next to Sutton in the south-east corner of the former named Township; the bed is on the west half of the lot, where five feet of its breadth were observed to be exposed, but as it ran under the surface soil on each side, and strata immediately limiting

the breadth were not seen, its whole thickness may be much greater; the rock in the vicinity is chloritic and epidotic slate; the dip of the strata is to the eastward at an angle of 84°, and no doubt that of the ore bed is the same. The ore is a finely granular peroxyd of iron mixed with chlorite, and the specimens obtained give a specific gravity of 4·44 with a produce of 34·73 per cent.; the yield of the bed would thus be 9·37 tons of pure iron for every cubic fathom. The bed was traceable for the space of thirty feet before becoming covered up in its course, but there is little doubt it would be found to continue with the stratification for a considerable distance.

There is a great display of the same description of ore on the seventh lot of the ninth range of Sutton, belonging to Mr. David Farnsworth, but it varies considerably in the percentage of pure iron in different beds or parts of the same bed, from a greater or a less admixture of chlorite; an exposure of a five feet bed, occurring about 250 yards from the south end of the lot towards the west side, holds so large a proportion of chlorite, that its yield of metallic iron does not exceed 15·90 per cent.; but about 100 yards farther north in the run of the bed, its produce seems rather to improve. About 100 yards to the west of this, another exposure is met with, perhaps a repetition of the same bed, presenting the crown of a sharp fold or arch, which spans a breadth of fifteen feet, and fifteen feet farther west there is another sharp fold, displaying eighteen feet; about thirty-four yards still farther west, there is a third fold which with what appear to be two dislocations, first an upthrow and then a downthrow, with a synclinal fold between them, keeps the bed at the surface for a breadth of fifty-seven feet, before it exhibits a final outcrop. That the three anticlinal folds belong to the same bed appears very probable; two of them are so sharp, as nearly to bring the under part of the bed upon itself, and the real thickness may therefore be considered to be about eight feet; the produce of the ore is 27·53 per cent., the specific gravity 3·90, giving 6·53 tons of pure metal per cubic fathom.

In the south-east corner of the next lot, being the sixth of the same range, in the possession of Mr. B. Mudget, there is another exposure of the ore, not much over a hundred yards removed from the ore of the previous lot, of which it may possibly be a

repetition; in the same manner as before, it exhibits an anticlinal fold, but giving a flatter arch which spans thirty feet, the thickness of the bed being about seven feet; the ore is of much the same quality as before. In the south-west corner of the same lot, and close by the line between it and the fifth lot, there is still another exposure of similar ore, exhibiting a six feet bed of which the produce is 23·83 per cent. and the specific gravity 4·13, yielding 5·99 tons of pure iron per cubic fathom. The average per centage of these two lots Nos. 6 and 7, derived from a mixed sample weighing between forty and fifty pounds, is 22·98 per cent., with a specific gravity of 3·13, equal to 4·37 tons of pure iron per cubic fathom, which is probably too low a yield to render the ore economically available.

On the succeeding lot, the fifth of the same range, belonging to the British American Land Company, but a few yards removed from the six feet bed above mentioned, a smooth-worn nearly vertical bluff of the ore is exposed, which has a breadth of twenty feet by a height of fifteen feet. The ore of the whole of the localities that have been described is of a thinly laminated or slaty character, as has already been stated, often splitting into curved plates where corrugations exist; and in the bluff in question, the laminæ throughout the whole face present a most complicated and fantastic set of contortions, but closely compacted together, in so smooth and polished a transverse section that it was not practicable to ascertain whether there was a tendency to separation in the lines of supposed deposit; a few parallel joints, independent of these lines, were observed, but giving thick plates. The specimens taken from the locality give a produce of 48·60 per cent. of pure iron, and the specific gravity being 4·17, the yield would be equal to 12·32 tons of the metal per cubic fathom, a quantity rendering the ore available for economic purposes. The ore is very feebly magnetic.

On the fourth lot of the same range, about fifty yards south-east from the western belt of dolomite, there are farther indications of similar ore, of which a bed of one to two feet was met with in chloritic slate; the produce is 22·98 per cent., its specific gravity 3·46, giving 4·83 tons of metallic iron per cubic fathom. Both the ore bed and the limestone, of which a band nine yards wide is seen, are cut by a transverse fault running northwest and

south-east, and heaved fifty yards to the north-west, on th south-west side of the fault; in the course of the fault, abou thirty yards south-east of the limestone, an oval or lozenge shaped intrusive mass of granite is displayed, measuring twenty yards in the direction of the fault, and ten yards across; it is composed of ferruginous quartz and feldspar, with black mica.

Iron ore was found associated also with the eastern belt of magnesian limestone in this range, where it obliquely crosses the southern part of the north half of the ninth lot, the property of Mr. Oramel Stutson. Three beds of the limestone are included in the space of 100 yards, the eastern of which is in one place twelve, and in another appears to be thirty-two yards wide; on the eastern side of it, the breadth of about four yards becomes heavily charged with small crystals of the magnetic oxyd of iron, constituting in a great bulk of specimens brought away, so much as 56·16 per cent. of the mass, making it an ore whose produce would be 38·67 per cent. of metallic iron; on the west side of this division of the dolomitic belt, there is an irregular bed of peroxyd of iron, with a breadth of one foot.

In the tenth range two beds of the specular ore were met with; one of them was in the north-east corner of the seventh lot, the breadth exposed being one foot; the produce in metallic iron of one specimen obtained is 19·07 per cent., a larger sample gave 39·06 per cent.; the specific gravity of the latter is 3·86, giving 9·17 tons of metallic iron to a cubic fathom. The other bed was at the north-east corner of the eighth lot, in the possession of Mr. A. Smith; the thickness is seven feet, and the produce of one sample is 19·42 per cent., that of a larger one, supposed to be nearer an average, is 32·13 per cent., which with a specific gravity of 3·86, would give 7.54 tons of metallic iron per cubic fathom.

In the eleventh range, which is the most northern of the Township, a seven feet bed of the peroxyd was met with in the centre of the ninth lot, belonging to Mr. L. H. Smith; one sample has a produce of 21·78 per cent., another 39·90; the latter with a specific gravity of 3·96, would yield 9·61 tons of metallic iron per cubic fathom. On the seventh lot towards the south end, another exposure was seen, but the exact thickness of the

bed was not ascertained; the produce of the ore is 28·63 per cent., the specific gravity 3·79, and its yield would equal 6·60 tons of metallic iron per cubic fathom.

In a corresponding position with the last mentioned locality, not far removed from the western belt of dolomite, to which the ore holds the same relation here as it appears to do in the fifth and sixth lots of the ninth range of Sutton, peroxyd of iron is met with on the first lot of the third range of the Township of Brome, in the occupation of Mr. Reed Sweet. There appear to be three parallel exposures, which are all situated towards the east end of the lot; the most western is about five feet wide, and is limited by black slates with glossy surfaces on each side. About 200 yards to the east of this another band is seen, of which three feet are exposed; but where a band, supposed to be the same, is exposed a short distance to the south-westward in the strike, a breadth of eighteen feet has been quarried for ore, which was conveyed a distance of thirty or forty miles to the town of Troy, on the south side of the Province line in Vermont, and employed to assist the smelting of the magnetic oxyd procured from the serpentine in that vicinity; still further east, and about thirty yards from the east end of the lot, the third parallel exposure occurs; it has also been quarried for the same purpose as the previous bed; the true breadth of the bed is about five feet, but it presents the crown of an anticlinal fold, which doubles it up, and gives it an apparent breadth of ten feet; cracks occur in the curve, which are filled with white quartz, and thin irregular films of green carbonate of copper line these veins in some places, as they do other joints in the ore. The samples taken from these three exposures never having reached Montreal, it is not in my power to give their produces.

On the second lot of the same range of the Township, and probably in continuation of some of the above parallel exposures, a five-feet bed is met with, which gives a produce of 28·63 per cent of metallic iron; its specific gravity is 4·53, and its yield is equal to 7·88 tons per cubic fathom. The bed is cut by veins, holding quartz, blackish-green chlorite, with yellowish-white sphene, and thin patches of green carbonate of copper are found in spots on the walls of these veins and in narrow cracks or joints, which are partially faced with delicate flakes of talc.

On the fifth lot of the fourth range, on the property of Lieut. Budd, R.M., a little below the bridge over the Yamaska, after its junction with the Spalding, and just above the fall which there occurs, a bed of peroxyd crosses the stream; it is eight feet wide, but a band of chlorite slate about a foot in thickness, runs through the middle of it, and there are associated with the ore strings and patches or nodules of quartz. The ore is of a poor quality; its produce in metallic iron, in the specimens obtained, is 24·08 per cent, its specific gravity 3·05, giving only 4·46 tons of iron per cubic fathom.

On the sixth lot, on the line between the third and fourth ranges, by the side of the main road, there is an excavation in a bed of specular iron, the ore of which has been mined and transported to Troy for the same purpose as already mentioned. The excavation is ten feet wide across the strata; but the ore does not seem to exceed three or four feet. The produce of the ore, according to one specimen, is 54·60 per cent; a larger one, probably nearer the average, gave 44·38; its specific gravity is 4·29, and the bed would yield 11·58 tons per cubic fathom. In a thin vein of quartz, which runs with the bed, and seems to form a side or wall to the ore, stains of green carbonate of copper are seen, with flakes of talc; the bed of ore lies between two of the dolomitic bands of the western dolomitic belt, and one of the bands nearly touches the ore on the west side; other but minor beds of ore exist at no great distance, and are visible on the road. The strata are nearly vertical, and the following is a transverse section of the whole of the dolomitic belt, going from east to west:

	Feet.
Chloritic slate	10
Iron ore, peroxyd	1
Dolomitic limestone	18
Chloritic slate	90
Iron ore, peroxyd	1
Chloritic and glossy-surfaced clay slate	230
Iron ore, peroxyd	3
Dolomitic limestone	9
Chloritic and glossy-surfaced clay slate	180
Iron ore, peroxyd	0½
Dolomitic limestone	12
Iron ore, peroxyd	0½
Chloritic slate	10
	565 feet.

Another small excavation in a bed of the peroxyd occurs on the fourth lot of the fifth range, in the possession of Mr. Samuel Shepherd; it is near the west end of the lot, in the middle of its breadth; from this also ore was carried to Troy. The excavation which is about twelve feet deep, shews the rock on each side to be chloritic slate; the ore of which the structure is micaceous, lies in a laminated bed five feet thick, with thin divisions and patches of finely granular quartz, as well as chloritic, running in the direction of the plates. The yield of the ore in metallic iron is 30·97 per cent.; the specific gravity is 3·42, which would give 6·44 tons of iron for every cubic fathom; but the irregular distribution of the ore in the laminæ make it doubtful that the sample assayed is an average one. On the fifth lot of the same range, the property of Mr. Miller, also near the west end, a bed of the same description of ore was observed, of which two feet were exposed; being partially covered by the roots of a large tree, it was not practicable, without more delay than the occasion authorised, to ascertain the full thickness, but it is not improbable the bed may be a continuation of the previous one. The produce of the ore is 37·91 per cent., the specific gravity 4·41, and the bed would yield 10·16 tons of pure iron per cubic fathom.

All the localities which have been mentioned, it will be perceived, occur between the dolomitic belts on the west side of the anticlinal axis supposed to run through Brome and Sutton; the rocks which correspond with these on the east side, running through a tract, for the greatest part still uncleared of its forest, have not been so diligently searched for ore, and no localities of it there were mentioned to me by any of the inhabitants of the vicinity.

On the fifteenth lot of Western St. Armand, the property of Mr. Johnson Smith, on the west side of the Pinnacle Mountain, very beautiful specimens of a very nearly pure specular iron, with a micaceous structure, were met with; they occurred however in a transverse vein combined with quartz, cutting chloritic slates, which in some parts were of a very quartzose quality, shewing the character of an altered fine conglomerate, and were associated with black glossy-surfaced clay slates; the ore appeared to constitute a bunch in the vein, and though about fourteen inches thick in one part, it dwindled to nothing both ways

in a short distance, and did not seem to promise a quantity that would be economically available. I was informed that ore was to be met with on the twentieth or twenty-first lot of the first range of Sutton, but no specimen of it was shewn to me, and the locality, for want of a guide, was not visited.

Magnetic iron ore was met with on the second lot of the fourteenth range of Bolton, about two miles eastward of the serpentine of Orford Pond, on the road to the outlet of Memphramagog Lake; it consists of a collection of very minute octahedral crystals, abundantly disseminated in a very dark-green, or nearly black, and fine-grained chloritic matrix, with nodules of calcareous spar. There appears to be some confusion in the strata immediately near the ore, the most conspicuous mass being a breccia of chloritic slate and limestone, and the ore seems to occur in bunches entangled in the breccia one of the bunches, which had been mined to the depth of four feet, and appeared to have a breadth of three, could not be traced to any great distance; but I was informed that similar ore had been observed on the western pond of Cherry River, in the vicinity of the twenty-first or twenty-second lot of the fifteenth range of Orford, a position which would be in the general run of the stratification, and near which limestone, of the same description as that accompanying it in Bolton, occurs; specimens from the Bolton locality give 37·79 per cent of metallic iron, the specific gravity is 3·22, so that the yield per cubic fathom would be 7·00 tons.

Magnetic oxyd was also met with in the Township of Leeds, on the second lot of the tenth range, the property of Mr. Allan; it occurred in large loose angular blocks (some of them weighing a quarter to half a ton) near the band of serpentine which has been mentioned as associated in that vicinity with dolomitic limestone. Though the bed from which these blocks were derived was not discovered, it very probably was not far removed from the spot; and I have been informed that since my return from the district, a two feet bed of ore (said to be peroxyd) has been met with, in the vicinity of the run of the belt of associated serpentine and dolomite, on the fourth lot of the second range of Inverness, in the occupation of Mr. George, where the rocks in which it occurs are chloritic slates and talcose clay slates. The Leeds magnetic ore gives 47·10 per cent. of metallic iron.

Another locality in which the magnetic oxyd was observed, in workable quantity, was on the Seigniory of Rigaud Vaudreuil, about fifty miles from Quebec, up the Chaudière; the position of the ore is near the north-west limit of the Seigniory, about two miles from the south-west boundary line of the Township of Cranbourne, where it is imbedded in the belt of serpentine, of which the run through the Seigniory has been described; the serpentine of a blackish-green color, is seen on both sides of the ore bed, and again to the south-east of it, at the distance of 200 yards across the strike, and the ore bed appears to have a breadth of about forty-five feet; but though its direction seemed to coincide with the general run of the serpentine, which at the spot was N.E., it was not traced to any considerable distance, as it became covered up with soil and herbage and the standing trees of the forest, at a few yards from the spot where it was first seen. The limit of the ore bed on each side appeared to be nearly vertical, and a slope in the geographical surface crosses it, and exposes a face of about nine or ten feet in height; this with two feet more, that might be easily gained by a short ditch from lower ground to the foot of it, would give a workable quantity, about two fathoms in height, by about fifteen yards in breadth, which might with facility be quarried without impediment from water. It has been ascertained by Mr. Hunt, that the ore consists of a mechanical mixture of magnetic oxyd and ilmenite; after careful washing to get rid of earthy matter, the former constitutes about two thirds of the residue, with a produce of 65·00 per cent., and the latter about one third, with a produce of 28·22 per cent. of metallic iron, so that the produce of pure iron resulting from both would be 50·72 per cent.; the produce of the ore however as it comes from the bed is 34·72 per cent., its specific gravity 4·66, and a cubic fathom would yield 9·30 tons of metallic iron. I am not aware whether iron ore, containing so large a proportion of titanium, is anywhere practically applied for manufacturing purposes, or what peculiar treatment with fluxes might be required to render it available; but it is proper that it should be made a subject of inquiry and experiment in the first instance, by those who may be desirous of turning such ores to account.

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Bog Iron Ore and Iron Ochre.

Specimens of bog iron ore were obtained from two localities, said to be of some importance, one in the Township of Stanbridge, and the other in that of Simpson, but neither of them has yet been visited. The ore was observed in other localities, but the deposit in none of them appears to be of sufficent extent to deserve notice. The localities however are in the sixteenth lot of the ninth range of Ascot; the twenty-fourth lot of the third range of Stanstead; and in the Seigniory of Lotbiniére at the mouth of the Grande Riviére du Chêne. A deposit of iron ochre was met with in a narrow marsh, in a valley on the fourth lot of the fourth range of Durham, which was traced a distance 150 yards; with a breadth of ten yards, it had a depth of one to four feet.

Chromic Iron.

Oxyd of chromium, both by itself and in combination with the oxyds of other metals, is extensively used as a colouring material in dying and in calico printing, in pottery, porcelain, enamel and oil painting, and in glass staining, and in one of its combinations as a preservative of wood; and chromic acid is available as an agent to discharge colours in the first-mentioned art, in lieu of chlorine. In nature chromium occurs chiefly as an oxyd in combination with oxyd of iron, and chromic iron is thus the main source of the material as devoted to all its purposes. This mineral much resembles magnetic iron, except that it is not magnetic or but feebly so, and instead of a black gives a brown streak or powder; hitherto it has been found in serpentine and dolomitic rocks only, either in veins or imbedded masses or crystals, and all the known localities in which it has been met with, available for economic purposes, are not numerous; those mentioned by mineralogists are the Bare Hills near Baltimore in Maryland, in the United States, and in the continuation of the rocks composing those hills, into Pennsylvania and New Jersey; in Unst and Fetlar, two of the Shetland Islands, to the North of Scotland, and at Portsay in Banffshire; in the Department of Var in France; in Silesia and Bohemia; in the Ural Mountains in Russia; in those of Roraas in the rear of Drontheim in Norway; and in the Sharwarray Hills in the Presidency of Madras in

India. It is however from Baltimore, Drontheim, and the Shetland Islands, that Great Britain derives its chief supply, and the quantity which is annually consumed there may be stated as at present not exceeding 2000 tons. The value of the mineral is of course proportionate to the amount of oxyd of chromium it contains, which appears to vary from about 40 to about 60 per cent.; but the average proportion may be about 45 per cent, and with this yield, I am informed, it is in ordinary times worth £12 to £13 sterling per ton in the London market, where the highest percentages sometimes bring so much as £20 per ton.

Ore has been discovered lately, I understand, by Professor Adams the State Geologist of Vermont, in sufficient quantity to become economically available, in the serpentine of Jay and in that of the neighbourhood of Troy, which are continuations of the two ranges of serpentine, already described as occurring in Canada, in the Township of Potton. Having myself met with loose pieces of the mineral, in the vicinity of Memphramagog Lake, between six and seven years ago, I was prepared for the occurrence of it in the rocks of the Eastern Townships; and though specimens, from economic masses *in situ*, have yet been obtained from only one locality, the presence of it in a great many places, in disseminated crystals in the serpentine, which has such an extensive range through that part of the Province, and the discovery of loose blocks of the mineral, one of which weighs, as has been mentioned, six hundred pounds, leave little doubt that other available localities will be found. The Canadian locality in which the ore is known to occur, is the twenty-sixth lot of the seventh range of Bolton, where it was discovered by Mr. Batchelder of Troy, who subsequently purchased the lot of the British American Land Company; as stated by Mr. Batchelder, the bed is about a foot thick, and as analysed by Mr. Hunt, the ore gives 45·90 per cent. of oxyd of chromium; the six hundred pounds block gives 49·75 per cent of the same oxyd, and the dimensions of the mass shew that it must be from a bed at least eighteen inches in width.

Bog Manganese or Wad.

Several of the oxyds of manganese are used in various manufacturing processes, but the peroxyd of the metal is the most

important, as easily yielding a large quantity of oxygen gas, and thus affording the means of forming bleaching agents, so indispensible in the arts connected with the preparation and printing of cottons and other cloths, and in the preparation of rags for the manufacture of paper. There are two forms in which the great mass of the peroxyd is found in nature,—grey manganese ore or the anhydrous peroxyd, and bog manganese or wad, the hydrated peroxyd. Sir H. T. De la Bêche, in his Geological Report on Cornwall, Devonshire and West Somerset, in England, states the value of manganese raised in the two former Counties in 1837 at £40,000; but the mining of the English mineral, which I am informed can scarcely be worked profitably under £8 per ton, has been greatly interfered with lately by importations from foreign countries, particularly from Germany; the present foreign supply into the United Kingdom is about 8000 tons per annum, the average sale price of which in ordinary times is about £5 per ton. The anhydrous peroxyd is the more abundantly employed material, and is in general the more pure; it occurs in veins; the wad commonly contains a considerable quantity of oxyd of iron, silica and other impurities; it is a marsh deposit, found in situations similar to those yielding bog iron ore. The value of it of course depends upon the amount of pure peroxyd of manganese it may hold, which appears to vary from about 30 to 70 per cent, but I have not been able to ascertain the ratio of price in proportion to the quantity of peroxyd, farther than that for the various qualities of the different kinds of manganese ore, sold in the British market, the quantity ranges from £2 up to £8 per ton. The wad that has been met with in the Eastern Townships is not of the best description, and neither in quantity nor purity is it of much consequence, farther than that it shews the existence of such ore in the district, and the propriety of such researches as may end in the discovery of purer deposits. In Vermont manganese is found in several parts, both as vein and bog ore, and worked to profit, and it is quite reasonable to expect the same in the prolongation of the Vermont rocks into Canada.

In the Eastern Townships wad was met with in three localities; one of them is on the twenty-second lot of the twelfth range of Bolton, and another on the twenty-fourth lot of the fourth range

of Stanstead, both of them on clay slates. In the first locality the deposit, which did not exceed three to six inches in thickness, rested immediately upon the slates, filling up the interstices among the loose plates of the rock, and covering their edges with an even surface, upon a gentle slope at the foot of the hill; the extent observed did not exceed fifty to one hundred yards in length, by but a few yards in breadth; the yield of this, according to the analysis of Mr. Hunt, is 26 per cent. of the pure peroxyd. In the second locality the quantity did not appear to be of any greater importance.

The third locality is on the ninth lot of the tenth range of Stanstead; here the ore is met with near the surface of a deposit of sand, and it occurs in black porous nodules having the unequal sizes and shapes of potatoes, which are distributed irregularly over an area of about two acres, in aggregations occupying various sized forms up to two and three yards in diameter, and having sometimes the depth of a foot; after washing the sand from the nodules the yield of the ore of this deposit is 37 per cent. of the peroxyd.

Copper Ore.

It has already been stated that traces of copper pyrites and variegated copper were met with in several parts of the district, usually in the vicinity of the bands of magnesian limestone, which have been several times mentioned, and their supposed equivalents, and the massive whitish-grey limestones of Upton Acton and Wickham. The quantity however appears to be too insignificant in every case, to be worthy of farther notice, with the exception of three, where the ore, occurring in veins bearing the character of regular lodes, seems to be sufficient in amount to justify the risk of small crop trials, notwithstanding the promise of a profitable result cannot be asserted to be very encouraging. One locality is on the fourth lot of the second range of Inverness, in the occupation of Mr. George, where, on the south-east side of a valley not far from the position which would be in the direct run of the associated serpentine and dolomite of Leeds and Inverness, a vein of opaque white quartz occurs in chloritic and talcose slates, and coinciding in its direction with the strike of the measures, maintains with the valley a course a little to the north

of east. The quartz, with a mixture of chlorite, presents the thickness of about two feet, and the ore is disseminated in it in irregular patches and lumps, some of which would weigh upwards of a pound; but the patches at the out-crop, in the spot experimented upon, are so thinly scattered that notwithstanding the produce of the pure ore, which is variegated copper, is upwards of 60 per cent., the whole two feet of the lode do not yield more then 0·74 per cent., which would not give more than 90 lbs. of copper in a fathom forward by a fathom vertical.

The second locality is on the seventeenth lot of the seventh range of Ascot, about a mile from Sherbrooke, on the road between that place and Lennoxville, where a lode occurs, with an underlie to the eastward of 65°, running nearly north and south in the direction of the stratification, which is irregular at the spot, probably in consequence of an undulation; the veinstone is white quartz, and the lode includes patches of a rock similar to that in which it lies, which appears to be chloritic and talcose slate. The thickness of the lode is ten inches to one foot, and much of it is decomposed and presents the condition of a brown ferruginous earth, called *gozzan* by Cornish miners, which constitutes nearly the whole at the top, and lower down is irregularly mixed with the veinstone; the *gozzan* contains small quantities of copper pyrites, and where the veinstone is undecomposed, larger patches of the same mineral are displayed. On the west side of the lode the rock is reduced to the same brown ferruginous state as the crop, to such an extent in depth, that it is difficult to distinguish its original quality; it has however a slaty structure, and flakes of talc exist between the plates, and the rock close by it, as stated above, is chloritic and talcose slate. The yield of the lode, including the *gozzan*, as determined by a large crop sample, is 0·79 per cent. The pure ore is of the richest quality of copper pyrites and $1\frac{15}{16}$ lbs. resulting from the washing of 74 lbs. of the lode gives a produce of 30·34 per cent. This would be equal to about 50 lbs. of pure copper in a fathom forward by a fathom vertical of the lode as the result of the crop, and in addition to copper it holds traces both of gold and silver. The lode was followed a distance of about fifty yards, but a search for it on the side of a hill about one third to one half a mile farther southward in the direction of its run proved unavail-

ing; though several small quartz veins were met with, none of them appeared to contain copper.

The third locality is in the fifty-first lot of the twenty-first range of Upton, in the occupation of Mr. Ouimet. The lode in this instance appears to be transverse to the stratification; its course being from south-east to north-west. The rock which it intersects is the massive whitish-grey limestone, which has a breadth exceeding the distance specified. The breadth of the lode is from a foot to eighteen inches, and it is composed of a mixture of white quartz and calc-spar in which copper pyrites is rather sparingly disseminated; the crop is much stained by thin films of green carbonate of copper. A sample of about 24½ lbs. as near to an average as could be determined by the eye having been taken from the crop of the lode, it gave a produce of 3·84 per cent. According to this the yield of metallic copper in a fathom forward by a fathom vertical would be 300 pounds. The copper contains a trace of silver.

Gold.

It appears from the Reports of some of the State Geological Surveys of the American Union, from various papers which have come before the public in Silliman's Journal of Science and Art, and from the statements of Mr. James D. Dana and Professor Charles Upham Shepard in their works on Mineralogy, that the existence of gold in North America, occurring in more or less quantity in veins and alluvial deposits, has been traced at intervals, some of which are considerable, from Georgia, the Carolinas, Virginia and other Southern States, and even from Mexico to the Chaudière in Lower Canada. It is not improbable it may follow the run of one and the same geological formation through the whole distance, and will ultimately be traced to Gaspé. Along the whole line it seems to be associated with or in the vicinity of rocks, strongly characterised by magnesia, such as dolomite, serpentine, talc and chlorite slates, and at the same time marked by the presence of chromic iron, titaniferous iron and rutile. It is found in similar association in other countries, and the descripton of the Ural Mountains, for which we are indebted to Sir R. I. Murchison and his companions, shews that these characteristics are conspicuously displayed in that auriferous

region of Russia, where the gold is accompanied also by platinum, which is stated in Silliman's Journal for September last, to have been observed very recently in one of the gold mines of North Carolina.

What has already been said of the rocks of the Eastern Townships is sufficient to exhibit that the general types above alluded to are legibly imprinted on the Canadian prolongation of the Green Mountains, and the geological analogy between the Canadian strata, and those of the more Southern States is drawn still closer by the discovery of gold in the district under description, not only in alluvial deposit but also (in mere traces however) in a vein. In the different localities in which vein gold has been found in the Southern States, the metal appears in most instances to be in a matrix of white quartz, as a veinstone, sometimes associated with either iron or copper pyrites, or with galena or blende, and it is remarked that the pyrites is often found decomposed and converted into hydrated peroxyd of iron, strongly marking the crop of the vein. The metal however is not in all cases confined to the quartz vein; sometimes it extends into the rock, bounding the quartz on each side. But the gold, whether in the quartz or in the metallic sulphurets, or the hydrated peroxyd of iron, or the rock of the country, is always native, and it is disseminated in grains which, though sometimes visible to the naked eye, are most frequently so fine as not to be discernible in the matrix, notwithstanding it may be pure milk-white quartz, even with the assistance of a powerful magnifying glass, until the matrix has been bruised to a powder, and a separation effected by washing. "In far the greater number of cases, the eye detects "nothing but quartz, or sometimes metallic sulphurets of iron, "zinc or lead; and the observer, unless instructed in the case, "would never suspect the presence of gold, either distinct or in "the metallic sulphurets." The veins are of various breadths, from one foot and less to five feet and more, and the rocks in which they occur appear in general to be talcose slates, or clay slates not far removed from them. The veins seem in almost every case to coincide with the stratification both in strike and dip, thus assuming the semblance of beds. Professor Silliman, in his "Remarks on the Gold Mines of Virginia," (Journal, vol. 32, p. 98,) from which the above facts are taken, states that the expense

of working the auriferous quartz is 30 to 35 cents per 100 lbs., and the produce of the same 100 lbs., leaving out fractions and extraordinary results, from $1 and $2 to $10 in value, the gold being estimated at $4\frac{1}{2}$ cents per grain, which in round numbers may be said to equal 25 to 250 grains of gold to 100 lbs. of the vein. In Somerset County in Vermont, gold has been met with in a quartz vein with hydrated peroxyd of iron, coinciding with the stratification, in talcose slates, but it is not stated by Professor Hitchcock who has given an account on it in his Report of the Geology of the State of Massachusetts, that the quantity is of economic value.

The only locality of a vein with traces of gold, yet determined in the Eastern Townships, is in the vicinity of Sherbrooke, the metal being found associated with the copper pyrites in the vein which has already been noticed for the latter ore, on the seventeenth lot of the seventh range of Ascot. In the quartz gangue, the hydrated peroxyd of iron, the quality of the rock to which it belongs, and its conformity with the stratification, it agrees with the southern localities already mentioned. The quantity of the precious metal however appears to be insignificant. But it is to be remarked, that the gold in the matrix being invisible to the eye even assisted by a magnifying glass, the examination of the vein was not made with a knowledge of its presence, and it was only in assaying the copper obtained by smelting a washed sample of copper pyrites, resulting from 74 lbs. of the vein taken indiscriminately, that the existence of the gold was ascertained. According to this trial, 100 lbs. of the vein would yield $12\frac{1}{2}$ ounces of copper; 180 grains of which copper yielded 0·031 parts of a grain of gold. The 100 lbs. of the vein would thus give 1·03 grain of gold; and the value of the metal in a ton of the rock would be about $1. The 180 grains of copper yielded also 0.162 parts of a grain of silver; so that 100 lbs. of the vein, in addition to the gold, contains 5·40 grains of silver.

It is unnecessary to mention that these results are valueless in an economic point of view, and no allusion to them would have been made beyond a passing notice in stating the produce of the copper, did not the presence of the precious metal in a vein come in aid to illustrate the general character of the region, and in particular an alluvial auriferous deposit, where the quantity may

probably prove of more importance. This deposit is in the Seigniory of Rigaud-Vaudreuil, the property of the heirs of the late Charles Etienne Chaussegros de Léry, Esq. The spot is on a small stream called the Touffe des Pins, a tributary, falling in on the right bank of the Chaudière, about fifty-eight miles from Quebec. Mr. C. de Léry, one of the present proprietors, who six years ago exhibited to me the specimens of gold he had obtained, has informed me that the first piece of the metal was discovered about thirteen years ago by a daughter of one of the *censitaires*, and the fact coming to his knowledge, he himself made search, and found another piece in the bed of the stream. The discovery was communicated to the public, through Silliman's Journal, vol. 28, p. 112, in April, 1835, by Capt. F. H. Baddeley, of the Royal Engineers, whose zeal in Canadian geology is well known in the Province and elsewhere. The weight of the piece is stated in the Journal to have been 10·63 grains, but this was only a fragment separated from one of the pieces, the remainder of which now weighs 1056 grains. Subsequently to this, Mr. de Léry, from time to time, continued to meet with small lumps and grains, in and about the same spot in the channel of the brook, and up to the autumn of 1846, the value of the whole he had collected by hand, without any process whatever of washing, may have amounted to $130. The largest three pieces have been weighed by Mr. Hunt, and their weights are 1068 grains, 1056 grains, and 744 grains. Since that period, a slight examination has been made of the deposit, and last season, previous to my visit to the locality, which was late in the autumn, the alluvium had been washed experimentally in small quantities in several places along the banks of the stream with more or less success. But owing to freshets and other circumstances, the amount of work done was insignificant. One washing (the only regular day's work) of sixty bushels, by means of a rocker, or species of shaking-table, in common use in the Southern States, produced 440 grains of gold, which would be equal to about 7⅓ grains to a bushel, the weight of which bushel would be about 100 lbs. About 75 lbs. of gravel, washed in my presence by one of my own men, produced a quantity equal to about 2 grains to a bushel. The metal however is so unequally distributed, and so little has been done, that it would be premature to consider the above an average return.

I am informed by Mr. de Léry that it has been ascertained by the examination, that the deposit, in parts close upon the brook, presents indications of being auriferous for nearly two miles up the valley, which for that distance has a bearing to the north-east, coincident with the general strike of the stratification, and that in one place near the spot where the first discoveries were made a few particles of gold were found, on the south side of the valley, about fifty feet above the bed of the stream, and about 100 yards removed from it. He informs me, also, that a few particles were met with near the road, which is on the right bank of the Chaudière, on a small tributary brook, called the Ruisseau Lespard, also running with the stratification, about two miles below the Touffe des Pins, and one piece is reported to have been found higher up on the Chaudière, beyond the Seigniory. The total quantity obtained from the first discovery up to the end of October last year, equals a value of about $300. In an assay of a small piece of the gold obtained from Mr. C. de Léry, Mr. Hunt finds it to contain 13·27 per cent. of silver, so that the fineness of the gold would be $20\frac{1}{4}$ carats.

Distinguishing between the vein mines and deposit mines of Virginia, Professor Silliman remarks :—

"The latter contain only alluvial gold, or gold at least disen-
"gaged from rock or vein-stones; it is obviously not in its
"original connexion; it has doubtless proceeded from the des-
"truction of regular veins or beds, and of the rocks which con-
"tained them; the gold has either remained mixed with the
"ruins of the rocks and of the veins, or has been transported
"and scattered, sometimes far and wide, by the moving power
"of water, and buried at depths more or less considerable, in
"loose materials. Sometimes the gold is found immediately
"under the turf or sod; this happens most frequently on hills,
"but more commonly it is in lower situations, under several feet,
"or even yards, of soil, clay and gravel, and it is most abun-
"dant next the slate which underlies the whole of the loose ma-
"terials, and which slate is sometimes soft, being in a state of
"decomposition. When the slate rocks are solid, and their strata
"stand nearly perpendicular, the gold has been sometimes found
"in the crevices between natural layers of the rock; at the
"Whitehall mines, in Spotsylvania County, the gold extended

"downwards in this manner, sometimes to the depth of three "feet."..."The largest masses of gold have been discovered near "rivulets, or brooks, or runs of water, called in the language of "the country, branches. In such situations, pieces have been "found weighing several ounces, and in North Carolina, several "pounds. On a branch at the Whitehall mines, gold to the "value of $10,000 was found in the course of a few days, in a "space of twenty feet square, and $7,000 value of gold was "found in Tinder's mine, in Louisa County, in the course of one "week. It happens not unfrequently that the vein mines are "discovered in consequence of washing the earth, particularly in "the branches."

The deposit on the Seigniory of Rigaud-Vaudreuil is of the character above described. In Virginia it would, I presume, be termed a *branch*, and a full investigation of it would probably lead to the discovery of the vein from the destruction of which it is derived. The deposit occupies the centre of the valley in which it exists, which is deep and not very broad, and the amount of detritus varies considerably in different parts of its distribution, while the brook has cut down through it in many places, exposing the glossy-surfaced clay slate, and occasional quartzose bands on which it rests. The detritus is a gravel or shingle, of which the pebbles are derived from the various rocks composing the country, at least as far north-westward across the strata as the band of serpentine described as traversing the Chaudière in the north-west part of the Seigniory, the distance to which is six miles, and it is not improbable some of it may be derived from sources still farther in the same direction. One class of pebbles consists of talcose and chloritic slates, and glossy-surfaced clay slates; another, of the various qualities of the rocks which have been described, as mixtures of corneous quartz and diallage, or hornblende, or feldspar; a third, of vein-stone quartz, and a fourth of serpentine. In the smaller parts of the gravel are found grains of chromic iron and crystals of rutile. The serpentine pebbles are often in a decomposed condition on the exterior, giving an adhesive, unctuous, and partially ferruginous clay. A clay of this description is occasionally seen among the pebbles in a thin layer not far removed above the slates, and in some places a deposit of peroxyd of iron or of manganese, coating the pebbles and filling up

the interstices among them, runs in thin horizontal patches. The pieces and particles of gold are almost all found towards the lower part of the deposit, and many are discovered in the clefts of the slate, where the plates have been loosened by external causes; but the extent to which the plates have been so loosened is sometimes so small that it would scarcely be supposed they had been separated at all, yet scales of the metal will be found between them. Some pieces are found in the unctuous clay, and among the iron and manganese-coated pebbles, and the gold itself, is sometimes partially covered with a closely-adhering film of the hydrated peroxyd of manganese. The pieces of gold are all more or less rounded, their original sharp angles and corners, resulting from the mode in which they lie in the vein, having been worn away by attrition. In some of the largest, however, small portions of the vein-stone quartz remain firmly adhering.

Unless the gold were scattered to a considerable distance from its source, it would be expected that the *branch* or deposit would observe a general course in some degree parallel with the parent vein; and, inversely, the deposit running in a general line for a considerable distance parallel with the strike of the stratification, which coincides with the direction of the veins, it is to be inferred that the vein from which it is derived is not very far removed from the deposit. It is worthy of remark, that the positions of the gold-bearing vein of the vicinity of Sherbrooke and of the auriferous deposit of the Seigniory of Rigaud-Vaudreuil, bear directly for one another in the general strike of the stratification of the intervening country, and that they stand at an equal distance from the outcrop of what is considered the base of the Famine and St. Francis fossiliferous limestone. The general character of the rocks of the two localities is not unlike; there appears to be less chlorite on the Chaudière, and more talcose clay slate, but there is little doubt they belong to the same formation. The corneous rocks are much nearer the auriferous position on the Chaudière than on the St. Francis, but there is between the Touffe des Pins and the Famine a band of the same peculiar dingy olive-green translucent serpentine mentioned in the general description as occurring on the line of section not very far from the Georgeville limestone, the place of which serpentine on the St. Francis would be between Sherbrooke and Lennoxville, standing

there in the same relation to the auriferous vein, that it does to the deposit in the vicinity of the Chaudière. One or two small quartz veins run under the auriferous deposit of Rigaud-Vaudreuil, and it is not improbable that in these or other quartz veins that may be near, the source of the gold will be found. Those displaying hydrated peroxyd of iron should be especially examined.

Granite and other Stone suited for Building and Mill-stones.

The intrusive granites which have been mentioned as occupying various localities in Stanstead, Barnston, Barford and Hereford, would yield an inexhaustible amount of material of a very beautiful and probably enduring quality for building purposes. It presents an even mixture of translucent white quartz and opaque white feldspar, with a rather sparing quantity of brownish-black mica equally disseminated, and the regular arrangement of the constituents give, when viewed at a short distance, a uniform very light-grey colour approaching to white. It appears to me more pleasing to the eye than the celebrated light-grey granites of Cornwall in England and Aberdeen in Scotland, so much used for buildings requiring strength and durability, and it much resembles some of the best granites of Maine, Massachusetts and Connecticut. The feldspar has been tested by Mr. Hunt, who finds it to be potash feldspar, which is the variety belonging to the lasting granites, in opposition to soda feldspar, the presence of which generally leads to early decay, under atmospheric influences, and the probability of its durableness is further indicated by the fact, that the weather appears to exert little effect on the rock in those natural exposures in which it has been observed. It is free from pyrites, the decomposition of which so often injures the beauty of otherwise good stone; and as a further useful quality, it is capable of being split with facility by the application of wedges, into rectangular forms of almost any required size. Into such forms it is often found rent by natural causes. Many loose blocks of the stone are found scattered through the Townships in which the intrusive masses exist, and in that of Stanstead both the blocks and the parent rock are split up and used for under-pinning frame and brick houses, for door-lintels, window-sills and steps, and they would be

equally servicable for gate posts. The esteem in which such stone is held for building purposes is attested by the fact, that according to Sir H. T. De la Beche's Report, about 20,000 tons of it are annually raised and exported from Cornwall and Devon, the value of it before export being about 1s. 9d. a cubic foot, or 24s. 6d. a ton; the value of it in the English metropolis is 28s. to 32s at ton A considerable quantity of granite is exported from Maine, Massachusetts and Connecticut, and some of it has been carried for building purposes even so far as the Gulf of Mexico, a distance exceeding 1700 miles.

One of the localities in which the granite is met with in the Eastern Townships is on the nineteenth and twentieth lots of the fourth and fifth ranges of Hereford, on the intended line of the Saint Lawrence and Atlantic Rail-road. In addition to the localities already mentioned between Stanstead Plains and Memphramagog Lake, and the granite dyke near the village, others in which the rock is met with, are the first lot of the ninth range, the seventh to the fifteenth lots of the tenth and eleventh ranges, and the twenty-fifth to the twenty-seventh lots of the tenth range of Barnston, and the fifth to the ninth lots partly in the first and partly in the second ranges of Barford.

The trap of Brome and Shefford Mountains, much resembles the previous rock in its general colour, and in the fact that the colour is the result of brownish-black mica (sometimes hornblende) disseminated through a white base. It would in general probably be called a granite, but it is devoid of one of the essential constituents of that rock, having in no instance that has come under my observation displayed any admixture of quartz. It would probably be more easily quarried than the previous rock, as in addition to splitting with facility into rectangular blocks, it in many places was observed to possess a stratified semblance, shewing planes sometimes at very moderate angles with the horizon, dividing it into thicknesses of two feet and more. It is a strong rock, very probably capable of resisting great pressure, and perhaps some parts of the two mountains might be found to give a tolerably lasting material, but it would probably in general be inferior to the previous stone in durability, as in natural exposures it was in many places found to be decomposed into a loosely-adhering

gravel, for several inches on the surface, and its ruins constituted a large portion of the soil of the vicinity.

Both the true and the pseudo-granite above mentioned are used for mill-stones in the Eastern Townships to some extent, and though greatly inferior to the French burr, appear to afford a very serviceble substitute for mill purposes, as their cost does not I believe exceed one-fourth to one-third that of the French stone. It is probable the true granite, from the superior hardness of the quartz it contains, is a better material than the Brome and Shefford rock; the latter however is more scattered over the district in loose boulders than the other, and when these erratic masses are split and dressed for mill-stones, it is very probable, as there is very little difference in the aspect of the one kind and the other, very little distinction is made in the selection. But since leaving the district, I have been informed by the Honourable Mr. Knowlton that a better native material for the purpose of mill-stones than either of these rocks, is obtained in such a position on the sixth range of Bolton, where the road from Frostville to Potton Ferry crosses it, as induces me to suppose it must belong to one of the two very quartzose bands, between which the serpentine on the west side of the Missisquoi runs. Abundance of this stone might be procured in various places in the neighbourhood of the serpentine, and probably what has been called the corneous quartz might be of equal avail.

Flag Stones.

It is probable that the gneiss and mica state of Sutton Mountain will, when fully explored, disclose abundance of material fit for flag stones. The only section which has been examined across the strata composing the mountain is on the south road between the Sutton and Potton valleys, on which large loose slabs of mica schist were often met with, and they became most abundant in the vicinity of the nineteenth lot of the second range of Sutton, where plates were observed shewing a superficies of six feet by three, under six inches thick, and I was informed they might be obtained measuring ten feet by five; those which came under my inspection were a good deal shivered at the edges by the influences of the weather, and not quite flat and even on the surface, but the fissile nature of the rock was evident, and proba-

bly by diligent search, quarries giving smooth plates might be found.

On the west side of Memphramagog Lake at Potton Ferry, and on the east side, for some miles above the Outlet, there is a sandstone with a considerable portion of lime in it, which splits with facility into large slabs, and into thicknesses down to two inches; it would form an excellent material for pavements and other such purposes, and might be obtained to almost any required size up to six feet by three, and often ten feet by five. The stone has considerable strength, and appears to resist the influences of the weather well, except in regard to colour; in fresh fractures it is grey, but exposure to the atmosphere turns it to a uniform light-brown or drab; the opposite surfaces of the slabs are almost exactly parallel to one another, but they are a little rough and scaly, and would require a very small amount of dressing to make them perfectly smooth. The quantity of these stones is inexhaustible, and they might be obtained with facility on the lake shore.

To the east of the Quebec road in the sixth range of Dudswell, there is an aggregation of thin layers among the limestone strata, which would yield very excellent calcareous flagging; the colour is grey, the rock highly crystalline and capable of a polish, and being divided naturally into plates of two to three inches thick, it is resorted to for gravestones, and in consequence goes in the neighbourhood by the appellation of the tomb-stone bed. The limestone between Dudswell and Memphramagog Lake being in general micaceous, will very probably be discovered in many places to possess a fissile character, such as to fit it for flagging.

Roofing Slates.

Although from the great amount of clay slate prevailing in the district, it is very reasonable to expect the discovery of a quality fit for roofing, very little of any that has come under my observation appears to possess the requisite characteristics. Clay slate is found to be fit for roofing only when it has a uniform cleavage independent of the original bedding of the rock, and the original bedding is so far obliterated by consolidation as to afford no tendency to separation in it; the cleavage should be so regular and perfect as to cause the rock to

split with facility into thin even laminæ, and these should not be capable of absorbing water either on their surfaces or their sides and ends; on experiment, therefore, they should not increase perceptibly in weight after immersion in water. The laminæ should not disintegrate under the influences of weather, and while they are sound and compact they should be tenacious and not brittle, so that a hole could be struck through them by a sharp pointed instrument without causing them to splinter, and the same quality should render them susceptible of being dressed on the edge by a hatchet without any danger of their breaking up.

The only locality in which slates, in some degree possessing these qualities, were met with was on the fourth lot of the first range of Kingsey near one of the belts of dolomitic limestone. The slate band appeared to be narrow, and the material it affords softer than the best British roofiing slates. It shewed a dull glimmering surface, instead of an earthy one, probably from the presence of a small amount of talcose matter; but the slate does not go to ruin in the weather, it splits into thin laminæ, it does not absorb water, and can be easily dressed and pierced. Though the rock in general in the vicinity possesses a cleavage independent of the bedding, at the spot where the slate is found, the bedding and cleavage appear to coincide.

Marble.

It has already been stated that among the limestones of Philipsburgh there are many beds capable of yielding an almost inexhaustible quantity of useful marble; the rock is of a very close texture, capable of receiving a high polish, and the prevailing colour is a mixture of a dull yellowish-white and light-grey; the two tints are sometimes clouded into one another, giving the stone a mottled aspect, which is occasionally diversified by thin reticulating veins of white running through it, and sometimes the tints are arranged in close alternating bands, which would render the pattern too formal and ribbon-like in cross sections to be agreeable, but might produce a good effect in sections in the general direction of the bands, when these are slightly waved. The colour of the rock is sometimes a uniform ash-grey or dove colour, and from light-grey it ranges to smoky-grey, dark-grey

and black. The black is of a clouded character, and is sometimes variegated with reticulating white veins. Quarries were opened in one or two places on some of the best beds of the darker colours, and worked to some extent, the material being exported to New York, but they appear at present to be abandoned.

The whitish-grey limestones of Upton, Acton and Wickham are highly crystalline, and would take a good polish, affording a useful material, but the colours would not be very different from the mottled qualities of Philipsburgh, and the stone appears to have a greater amount of small silicious grains in it.

The Dudswell limestone would yield any quantity of grey coloured marble; but there are some beds on the twenty-second lot of the seventh range of the Township of a rich yellowish-white or cream colour, which would probably yield a handsome material; the stone yields easily to the chisel and is sufficiently compact to take a good polish; when fractured in a direction parallel to the planes of deposit, it shews glimmering spots in its surface, arising from the presence of thin partially distributed varnish-like films of talc or mica of its own colour. No practical trials however of its qualities have yet been made, to ascertain whether this may be a serious defect, or how far the stone is capable of resisting the influence of weather.

Serpentine.

The ranges of serpentine and some of their immediately associated strata would probably afford a large amount and variety of material for ornamental architecture and purposes of decoration where not requiring exposure to weather; this rock, when free from veins of talc and asbestus, is in general susceptible of a very high polish, and in the district displays a great diversity of the richest green colours, from light-green to almost black; some localities give blocks of an almost uniform green, others yield material in which different shades are arranged in clouds, flames, veins, and irregular forms, and on a lake which is on the Townline between Stukely and Orford, large blocks were met with displaying a brecciated green inlaid in white, resembling the celebrated *verd antique* The localites in which the rock may be found have been sufficiently indicated in the general description. It has not yet in any part of the district been quarried and

worked; practical experiments would be required to determine what might be available, and no doubt many fine varieties will be for the present inaccessible; but the St. Lawrence and Atlantic Railroad will cross one of the bands, at a point near which it is very extensively developed on the St. Francis, on the sixth lot of the fifteenth range of Shipton, and the twenty-first lot of the first range of Melbourne.

Soapstone.

A useful purpose to which this substance, which is a compact talc, is applicable, is as a lining for ovens, furnaces and fire-places; its sectile and refractory nature render it admirably adapted to such an object, and it is most suitable when most pure. It will be seen from what has been said of it in the general description of the rocks of the district, that in many of the localities in which it has been met with, it contains brown-spar, iron pyrites, chromic iron and magnetic iron, which according to their amount, greatly impair or totally destroy its value, rendering it more expensive to shape and more liable to crack and fuse. When pure it is serviceable as an ingredient in pastes to obviate friction, and it is employed to give a finish to the polish of marble and mirrors; it is the same material as French chalk, and is used in marking and removing grease stains from cloth; its powder mixed with oil is serviceable as a white paint, especially for out-door purposes; Professor C. U. Shepard, in his excellent Report on the useful minerals of Connecticut, states that two coatings of it form a good base for a third of common paint. It accompanies the serpentine and dolomite bands in a great many localities, and no doubt a large amount of good pure quality will be discovered; but the best bed met with, which is one of great purity, was on the twentieth lot of the fifth range of Potton, where, as in a considerable portion of the district, it is locally denominated free-stone. Its slow conduction of heat causes it to be used there as a foot-warmer on winter journies; a conveniently shaped piece of it is heated on the stove or in the fire, wrapped in a blanket or woollen cloth, and placed in the bottom of the sleigh under the feet. A considerable journey may be performed before the stone will become cold. The Hon. Mr. Knowlton of Knowltonville has applied an impure quality found near his residence, where it is mixed

with a considerable quantity of brown-spar, as a paving for his kitchen; the facility with which it is shaped into even-surfaced blocks fitting to one another, renders it an excellent material for such a purpose, and its impurity is rather an advantage t an otherwise in the case; too pure a quality would give too slippery a floor.

Jasper.

This silicious rock is much used for purposes of embellishment, and is cut into boxes, knife and fork handles, chimney ornaments and such like objects, the value of which consists altogether in the labour bestowed upon them; one of its commonest colours is blood-red. A bed of the rock of this colour was met with at Sherbrooke; in some parts it was about six feet thick, and it was traceable running with the stratification for some distance, passing occasionally into a jaspery iron ore, and shewing lines and spots of specular iron. At the surface it is not very sound, being apparently in a slight degree disintegrated by exposure to atmospheric action, and its texture does not seem to be quite so compact as jasper of the best quality. It is probable however that some parts of it, free from atmospheric injury, might be fit for ornamental articles.

Limestone.

The various localities in which limestone is met with, or may be expected, on the south side of the St. Lawrence between Lake Champlain and the Chaudière have been so far indicated in the description given of the distribution of the rocks, that it appears to be scarcely necessary to enter into farther details respecting them. It has already been stated that two species of calcareous rock were observed capable of useful application, the limestones proper, being those which, practically speaking, may be termed pure carbonate of lime, and the dolomitic limestones, those which with carbonate of lime unite a considerable quantity of carbonate of magnesia, pure dolomite being a mineral composed of the former and the latter in the proportions of 50 to 42. With the magnesian limestones of the Townships there is in general mixed a larger quantity of silicious grains and more iron, than with the limestones proper; they therefore, when burnt and slacked, give

darker coloured lime, and for the purpose of mortar do not permit the admixture of so much sand; they require besides more fuel and time in burning and slacking; the mortar resulting therefore is a more expensive material than that from the common lime; it however sets harder and gives stronger work. For agricultural purposes the magnesian lime is not so safe a material, nor one of such general application as the other, and unless thoroughly slacked by exposure for some time to the atmosphere, it may be pernicious. The application of a small amount of magnesia may sometimes be indispensable, but there is often enough even in those limestones called pure, to serve the purpose, and in the soils containing the ruins of those rocks with which dolomites are in general associated, there is usually a superabundance of magnesia; so that if there is a choice, it is in general advisable to apply the common lime as a manure in preference to the magnesian. But in the application of common lime, that resulting from the stone of one quarry, or one part of a quarry, may often be preferable to that derived from another. Phosphate of lime is well known to be in most cases of beneficial application to soils, hence the extensive use of bone manure, and it has been ascertained that in the composition of coral a small quantity of phosphate exists; it is a very indestructible material, and the analysis of Mr. Hunt has proved that in fossil coral the phosphate of lime still continues present; in agricultural use therefore a preference should be given to coraline limestones, and it becomes the interest of a skilful farmer to be able to distinguish corals among fossils.

Magnesite.

A not very common rock was met with on the seventeenth lot of the ninth range of Bolton; the breadth was considerable, probably twenty yards, and a large portion of it was marked by bright-green stains of oxyd of chromium; a part, of which one foot was seen, was free from the green stains, and the composition of this according to analysis is as follows:—

Carbonate of Magnesia	83,35
Carbonate of Iron	9,02
Silica	8,03
	100,40

It is thus a nearly pure carbonate of magnesia; such a rock as this is said by Dr. Ure to form a very excellent and beautiful mortar cement, and to have been advantageously used for such a purpose in India in the construction of terraces by Dr. McLeod. One of the uses to which magnesian limestone is applied is the manufacture of Epsom salt, which is a sulphate of magnesia and is the source of the carbonate and calcined magnesia of commerce; in pure dolomite the quantity of carbonate of magnesia is 45·66 per cent., and as the magnesite contains nearly double this proportion, it appears certain that it would be a more economical rock from which to obtain the sulphate; but I have not been able to obtain a sufficient number of statistical facts in connexion with the trade in these substances, to know whether the advantage to be derived from the substitution of magnesite for dolomite would compensate for a sufficient amount of transport charges, to render it profitably exportable, or to induce the establishment of a manufactury near the locality of the rock.

Whet-stones.

Stones fitted to give a sharp edge to steel instruments are of such indispensable utility, that in countries where they are not found native, they are sometimes imported from very great distances, and hence Newcastle in England is perhaps more extensively known over the face of the globe for its grindstones than for its coal. It is from the grits of the coal formation that the best grindstones have been obtained, and some of the sandstones of the New Brunswick and Nova Scotia coal fields are not inferior to the English. From Nova Scotia, grindstones constitute an important article of export, for the supply chiefly of the sea-board of the United States; but the locality nearest to Canada is on the south side of the Bay Chaleur in New Brunswick, where the stone is yet little quarried. The essential requisites of a good grindstone are a hardness greater than that of steel in the grains of which the stone is chiefly composed, uniformity in the size and distribution of the grains, (these being of a requisite fineness,) and a sufficient freedom in parting with them on friction, so that the grinding surface shall not become polished, and lose its bite of the metal applied to it. Throughout considerable stratified masses the English and British North American carboniferous

grits possess the grinding quality; and being naturally divided into beds of the required thickness, which are equally free on the edges and surfaces, and dress well in every direction, a circular form is given to them with advantage; they can thus be used as grinding wheels, and by a rotary movement a greater rapidity of grinding action attained, than by the same force applied in any other way.

In the Eastern Townships stones of a good grit are found in abundance in several places, but the structure of the rock is not such as to give plates capable of being dressed into a circular form with advantage; the grit is not so coarse as the Newcastle, and the rock is a fine mixture of talc and quartz, or perhaps in some cases mica and quartz, constituting talc or mica slates; they give whet-stones of very excellent quality. A band of the rock runs from Whetstone Island, in Memphramagog Lake, by Lee's Pond to the head of Massawippi Lake, a distance of nearly twelve miles; those from the island are in high esteem, and I understand that the stone has occasionally been carried from the locality by our enterprising neighbours on the south side of the Province line, brought back again to Canada manufactured into shape, and sold to a considerable profit. The band may probably be available much farther to the north-east. A rock which has been mentioned as an olive-green translucent serpentine occurring between the clay slates and the talco-chloritic quartzose belt east of Georgeville, yields hones capable of giving a very fine edge. One of the localities in which the serpentine is met with is on the fourteenth lot of the first range of Stanstead. There is a range of whet-stone on each side of the valley running from Melbourne to Danville; the stratigraphical position has been already alluded to. Good samples of the stone are procured on the sixteenth lot of the fifth range of Shipton; it is much softer than the Memphramagog stone, being more talcose. Another whet-stone locality is by the side of the great granite dyke which occurs near Stanstead Plains; the rock is probably a fine mixture of quartz and mica, and its quality may be in part due to the action of the dyke on the strata; no rock of the same quality was obtained in the micaceo-calcareous formation except near the granite dykes. The stone is of a yellowish-white, marked with spangles of grey talc of metallic lustre, and good samples of

it may be obtained on the fourth lot of the ninth range of Stanstead. Mr. Knowlton, of Waterville, or the Outlet as it is commonly called, informed me he had obtained hones of a superior quality on the west half of the fifth lot of the fourteenth range of Bolton, among the clay slates between the two Memphramagog limestone belts; but though diligent search was made for the bed immediately near the position in which it must occur, I did not obtain any sample that satisfied me I had found the true one indicated.

Clay for common Bricks and Pottery.

The tertiary formation, the deposits of which spread over the flat country between the St. Lawrence and the Green Mountains of Canada, afford an unlimited amount of clay for common bricks and common pottery; it all appears to contain more or less lime. Common brick clay is also met with in the valley to the south-east of the same mountains in many places, and there are some deposits of it in the vicinity of Stanstead Plains. The general level of the valley is upwards of 500 feet above that of the St. Lawrence, and its deposits are probably of a higher antiquity. No clay of a refractory quality has been met with for the manufacture of fire bricks or porcelain; material fit for such purposes however is mentioned by Professor Adams, as found in association with the rocks of the Green Mountains in Vermont, and it is not unreasonable to expect the discovery of the same in the Eastern Townships at some future period.

Shell Marl.

Of this well known valuable manure, three deposits were met with. One of them occurs on a pond about a mile south-east of Philipsburgh, on the 156th and 157th lots of St. Armand, on the lands of Mr. Street and Mr. Taylor. The marl is visible around the pond, and consists of the comminuted remains of fresh water shells, with a depth of several feet, resting on a deposit of marine shells of the tertiary age; the whole depth is in some parts seven feet, and the area of the deposit may be between thirty and forty acres.

The second deposit occurs on a pond on the land of Mr. Martin a little to the east of Stanstead Plains, being the fifth or sixth lot of the eleventh range of the Township. At the west end of

the pond there is a visible extent of the marl measuring about fifty by one hundred yards, being part of the margin of the pond; should it underlie the whole pond there might be an area of from fifty to one hundred acres.

The third locality is on the Seigniory of St. Hyacinthe, on the south side of the Granby road at its junction with the road to St. Pie, near the foot of Yamaska Mountain. The area which the marl occupies is about seven acres; it consists of the ruins of fresh-water shells, and its thickness is on the average about one foot. It is covered by a thin layer of peat, which might with advantage be mixed with it for use.

Stone Paints.

The application of soapstone to the purposes of a paint has already been mentioned. Professor C. U. Shepherd states that other allied qualities of stone are used in Connecticut in the same way, such as talc slate and serpentine. In the east end of the thirteenth lot of the ninth range of Stanstead an exposure was met with, which it is probable would afford a material adapted for such a use; it exhibits in a transverse section, alternating vertical beds of ochre-yellow and greyish-white colours, the latter belonging to a tender fine-grained talcose slate, resulting from the decomposition of a bluish-grey slate, the original colour of which is apparent in some parts less decomposed than others. The slaty structure is evident in both the white and the yellow bands, and it is perceptible that in the slaty cleavage of the yellow there are very thin white talcose partings, by the increased thickness of which the one colour passes into the other. The yellow bands derive their colour from the hydrated peroxyd of iron, but the decomposition of the rock extended too deep to permit its original quality to be seen; but the material they yield has been used, mixed with oil, for house-painting. A decomposed talcose slate is met with in the seventeenth lot of thirteenth range of the Township of Leeds, which is used as a white-wash instead of lime; the colour is a French-white or light ash-grey; it would probably mix well with oil.

I have the honor to be,

Your Excellency's most obedient servant,

W. E. LOGAN,

Provincial Geologist.

REPORT

OF

ALEXANDER MURRAY, ESQ., ASSISTANT PROVINCIAL GEOLOGIST,

ADDRESSED TO

W. E. LOGAN, ESQ., PROVINCIAL GEOLOGIST.

MONTREAL, *14th January*, 1848.

SIR,

In compliance with the instructions received from you at Montreal, on the 10th May last, my attention has been devoted during the past season to a geological examination of the main shores and islands of Lake Huron; and I have now the honor of furnishing you with a Report of the results of the investigation.

Having engaged four Indians at Montreal, we proceeded with as little delay as possible to Detroit, and there procuring the necessary supply of provisions, we continued our journey to Sault Ste. Marie, to avail ourselves of the use of the boat and canoes left at the place the previous season in charge of the Hudson Bay Company's agent, after the exploration of Lake Superior. A few days were spent at Sault Ste. Marie in refitting and repairing our boat, and making other arrangements for the summer's operations; and I have to express my thanks for the assistance and courtesy extended to me by Mr. Ballenden during my stay, as well as to Mr. Buchanan and others of the Company's officers, whose aid and kindness I experienced at a later season further down the lake, to the whole of whom the Survey is indebted for their attention, in safely forwarding the collection of minerals and fossils made during the season.

Leaving Sault Ste. Marie on the 7th June we were occupied until the middle of August in exploring portions of the north shore of the lake and of the Manitoulin Islands, parts of which, owing to the inaccuracies of the map supplied me, it became

necessary to survey topographically, for the purpose of exhibiting correctly the result of my inquiries. The principal of these measurements commenced at the north-west end of the island of La Cloche, and proceeded thence to and through the Petit Courant, along the Bay of Sheguenandod and farther, keeping to the west shore of the Manitouwaning Bay, to Manitouwaning. With this was connected a survey of a suite of lakes in the interior of the Grand Manitoulin Island, the largest of which, occupying a very extensive area, is more particularly mentioned in another part of the Report.

Having been instructed to survey the French River up to Lake Nipissing, on the 16th of August we left our boat at the Hudson Bay Company's Post at La Cloche and took thence three canoes instead, for the purpose; two of which being the same that had been employed the previous year on Lake Superior, had been forwarded from Sault Ste. Marie by Mr. Ballenden while the third was kindly supplied by Mr. Buchanan, the gentleman in charge. For the third canoe two additional Indians were engaged, who were acquainted with the coast and the French River, and who, acting as guides, saved much time and inconvenience, besides assisting materially in our admeasurements.

The measurements on all the surveys were chiefly effected as as in former years by the use of the micrometer telescope, and our bearings determined by prismatic compass; and by means of an excellent spirit level, the elevation of Lake Nipissing and various other points of importance, over the bed of Lake Huron, were ascertained. On our return from Lake Nipissing to La Cloche we resumed our boat, leaving the canoes under Mr. Buchanan's charge, and extended our examination to the eastern extremity of the Manitoulin Islands, and to the western coast of Georgian Bay, between Cape Hurd and Penetanguishene, at which latter place the line of section examined across the country from Lake Erie in 1843, had terminated.

GEOGRAPHICAL CHARACTERISTICS.

North Coast of Lake Huron west of the French River.

The greater portion of the immediate coast line on the north shore of Lake Huron, in so far as my observations extended, may be described as generally poor and rocky, in some parts wholly

destitute of vegetation, in others thickly clad with trees, which however are of stunted growth and of inconsiderable value. These marginal forests are chiefly composed of trees common to the colder and more mountainous parts of Canada, the species being balsam fir, spruce, red and white pine, white birch and poplar, predominating on dry parts, while white cedar and tamarack abound on the swampy and moister ground. But while the coast line exhibits this uninviting appearance, the interior in many places presents a very different character, especially in the valleys of the principal streams, where there are frequently to be seen extensive flats of rich and deep soil, producing maple, oak, elm, birch and basswood, besides occasional groves of both red and white pine of large size. Various places of this description have been cleared and cultivated by the Indians, and where such has been the case, as at Spanish River, notwithstanding the rude state of aboriginal agriculture, the crops of maize and potatoes are nearly equal in both quantity and quality to those usually seen in the more favored latitude, and under the more enlightened system of tillage in Canada West.

The principal streams, some of which are so favored, are the Thessalon, the Missisagui, the Serpent and the Spanish Rivers. The first two of them, taking their origin far in the interior, where the country is represented to be spotted with numerous small lakes, run in a south-easterly direction, and fall into Lake Huron within twenty-five miles of each other, the Thessalon nearly opposite the north point of Drummond Island, the Missisgui nearly due north from the west end of the Grand Manitoulin. The Serpent and the Spanish Rivers, whose mouths are fifteen miles apart, flow nearly due west for many miles of the lower part of their course, but rise a great distance to the northward, where they are connected, as the former two, with many small lakes. The exit of the Spanish River is about fifteen miles west from the Hudson Bay Company's Post at La Cloche, and the Serpent therefore will be about thirty from the same point.

To the westward of the Spanish River the coast is for the most part low, but precipitous and rugged; it abounds with safe and commodious harbours among its numerous islands and inlets, which can scarcely fail in many instances to become, in the course of time, of commercial importance. To the eastward of

the river the scenery is improved by the gradual approach of a high range of picturesque hills, coming out upon the coast about four miles westward of the Hudson Bay Company's Post at La Cloche. They are known there as the La Cloche Mountains, and one of their highest points was ascertained to be 482 feet above the level ot the lake. This part of the lake is thickly studded with islands, and the coast is much indented with extensive bays and inlets, which offer shelter and security, during any storm to which the voyager may be exposed; indeed, the whole coast from Sault Ste. Marie to the French River possesses advantages with respect to harbours that cannot be surpassed, but some of those which are of the safest description when entered, are dangerous and difficult to approach from the open lake, in consequence of the numerous reefs and sunken rocks lying concealed outside of them.

To the eastward of the Manitoulin group of islands another change occurs in the character of the scenery, and between Shebawenahning, an Indian trading post about thirty miles east from La Cloche, and the French River, the coast and islands are for the most part low rocks entirely destitute of vegetation. The La Cloche hills recede to the northward, and these being lost to the eye before we reach the French River, there extends to the horizon in the direction in which they vanish, a dreary and desolate waste of low broken country, while the water of the lake bounds the prospect to the south.

French River.

The French River is a continuous chain of long narrow lakes, which, lying at small elevations one over the other, are connected by short rapids or falls; these lakes are crowded with large and small islands, the channels among which are frequently contracted to a few yards in width, and thus acquire in many places a fluviatile semblance, and the waters of Lake Nipissing, after passing through these successive quiet intervals, join those of Lake Huron by four main outlets, about four miles apart from each other, which are included in a distance of fourteen or fifteen miles. From various points up these main channels, a multitude of narrow outlets break off, and the whole divide the land at the mouth of the river, into a perfect labyrinth of small islands. The

principal channel is the one farthest west, generally known as the North Channel, and it was through this, that our measurements and examination were carried; it joins the lake in latitude 45° 57′ north, and longitude 81° 7′ west, according to Captain Bayfield's chart, and a straight course from this point to the south side of the outlet of Lake Nipissing would bear by compass N. 75° E., the distance being fifty-nine miles. Following the bends of the channel there are three general courses; the first north-easterly for a distance of seven miles, the second nearly due east for thirty-three and a half miles, while the third turns again about two points to the northward of east and reaches Lake Nipissing in twenty-one miles. The variation of the compass was found by azimuths of the sun to be 1° 55′ W. at the mouth of the river, and 4° 25′ W. at a short distance from Lake Nipissing. Meridian altitudes of the sun were taken at various points for the purpose of correctly ascertaining the latitude, but from an injury that unfortunately befell our theodolite, which was not easily remedied, the result was not satisfactory.

Ascending the North Channel, three outlets are met with at the respective distances of six, nine and a half, and ten and a quarter miles, which are said to unite about two miles to the southward, and constitute the second main channel; two more outlets at the respective distances of twelve and twenty-four miles unite to form the third main channel, and the fourth separates in a single stream at the distance of twenty-eight miles.

The country through which the North Channel passes, is for the most part low and barren, affording little diversity of scenery; it is scantily clothed with timber, consisting of red, white and pitch pine, the first two of which sometimes appeared to attain a tolerable size, but were in no case that came under my observation, of sufficient dimensions to be of commercial value, and the last is always of diminutive size. The immediate banks of the channel are abrupt and precipitous, sometimes rising vertically for nearly seventy feet, but more frequently they are under twenty feet; from their rocky nature landing is often found difficult, and eligible places for encampment are exceedingly scarce; indeed, there were but three occasions on which we found on pitching our tents, a sufficiency of soil to admit our tent pins being driven into the ground.

After carefully levelling every part on the river where a current was visible, and making an allowance for those where no flow was perceptible, the total difference of height between Huron and Nipissing appears to be sixty-nine feet, and the following table will shew the successive steps in the rise, and the distances at which they occur from the mouth :—

	Distance. Miles.	Rise. Feet.
Rise in the first Fall, including the currents below, (a portage)	1	2.79
" Rapids above	2	0.51
" Rapids	$16\frac{3}{4}$	2.08
" Grand Recollet Fall and Rapid, (a portage)	21	7.81
" Current above the Fall		0 22
" Rapid	38	1.30
" Rapid	39	1.89
" Petite Faucelle Rapid, the distance is to the head, (a portage)	40	4.18
" Rapid du Buisson, (a portage)	$41\frac{1}{2}$	3 61
" Current above		0.42
" Grande Faucelle Rapid, (a portage)	$42\frac{1}{2}$	5.68
" Rapide du Pin, (a portage)	$43\frac{1}{2}$	2.50
" Chaudière Falls and Rapids, levelled across the portage to the height of Lake Nipissing, (a portage)	51	25.83
Allowance for imperceptible currents		10.18
Height of Lake Nipissing above Lake Huron		69.00
Height of Lake Huron over the Sea, according to the Michigan Surveyors		578.00
Height of Lake Nipissing over the sea		647.00

This result agrees very nearly with the estimate of Mr. W. Hawkins made in 1838, the details of which are as follows :—

	Ft. In.
1st or lowest Rapid	3.0
2d Rapid	6.0
3d Rapid	3.0
4th Rapid	2.0
5th Rapid	8.0
6th Rapid	3.0
7th Rapid	3.6
8th Rapid	3.0
9th Chaudière lower Falls	15.0
10th Chaudière upper Falls	10.0
	56.6
Allowance for imperceptible currents	10.2
Height of Nipissing over Huron	66.8
Height of the same as before	69.0
Difference	2.4

In ascending the river it was found necessary to make seven different portages, the positions of which are indicated in the table, but in descending, all these can be run by canoes with the exception of two; these are the Chaudière and the Grand Récollet, the former of which is about a quarter of a mile long, while none of the others exceeds a few yards.

There were indications in the water marks of both Lake Huron and Lake Nipissing, that they have sunk considerably below their ancient levels, and a corresponding fall could be traced in each successive lake of the chain between them. On Lake Huron the difference was ascertained by the spirit level to be 4·10 ft.; on Lake Nipissing the following measurements were carefully taken by a tape against a vertical rock.

	Ft.	In.
Spring mark of this year over the existing level	2	0
Old mark above the spring mark	3	9
Another mark supposd to be the old spring mark above the old summer mark	2	0

From this it would appear that the ancient average level of Lake Nipissing was 3 ft. 9 in. higher than the highest level it now attains during the freshets of the spring.

Lake Huron and the Manitoulin Islands.

A ridge of land which, proceeding from the vicinity of the Falls of Niagara, sweeps round the upper extremity of Lake Ontario, and running thence into the promontory of Cape Hurd and Cabot's Head, is represented in continuation by the Manitoulin Islands, divides Lake Huron into two parts, which may be called the south and the north. The south part constituting the great body of the lake, with a circumference exceeding 720 lineal miles has an area of about 14000 square miles; the north portion is again divided into two parts, the east and the west, the former of which, called Georgian Bay, extending from Nottawasaga to Shebawenahning and the eastern extremity of the Grand Manitoulin Island, with a length of 120 miles and a breadth of 50, has an area of about 6000 square miles while the remainder, called the North Channel, gradually narrowing as it proceeds westward, presents a surface, exclusive of the various islands with which it is studded particularly in the

eastern end, of 1700 square miles; the whole area of the water of the lake would thus appear to be 21000 square miles.

Only four of the islands which there serve to divide the lake go under the denomination of the Manitoulins; these are generally designated on maps, Drummond, Cockburn, Grand Manitoulin and Fitzwilliam or Horse Islands; but there are many others of minor importance which are links in the same chain, and exhibit similar geographical and geological features, and with St. Joseph and La Cloche Islands, it will be convenient for the present to suppose them included under the general name. The same formations which constitute the Manitoulin Islands constitute also the peninsular promontory of which they are an interrupted prolongation, and a uniform geographical character thus runs through the whole. That part of this promontory and of the islands, which faces the great body of the lake, presents a general line, leaving out coves and inlets, coinciding with the strike, which from a bearing of twenty degrees east of north, gradually bends round to half as many north of east, in a distance of 170 miles; from this line the land slopes gently up, for a varying breadth and to a varying height, (the breadth and height gradually diminishing, proceeding westward,) and then falls precipitously in escarpments in the opposite direction, which are deeply indented by many transverse ravines. The form of surface which is thus presented by this belt above the level of the lake is maintained below, and the result is, that while the lake on the shelving side is shallow, affording a dangerous approach to the land and few good harbours, on the opposite side it is deep, and good harbours for all sizes of vessels abound, the transverse ravines becoming sounds, long inlets and capacious bays with plenty of water and good shelter.

Such being the main general geographical feature of the belt, divers peculiarities prevail in particular parts, and these diversities occur on the abrupt rather than on the shelving side. Proceeding along the former, Drummond and Cockburn Islands present escarpments close upon their coasts, whose summits seldom rise higher than fifty or sixty feet over the level of the lake, but reaching Cape Robert on the Grand Manitoulin, our measurement made the cliffs 155 feet, and thus they continue to Barrie Island and the east side of Bayfield Sound. Beyond this they leave the shore, but re-appear again south of the Shegue-

nandod, an Indian village in Manitouwaning Bay, and are again seen at Wequamekong, near the Roman Catholic mission in Smith's Bay, and at Cape Smith beyond. In the neighbourhood of Sheguenandod and Wequamekong, from the foot of the escarpment mentioned, the land slopes upward northerly, rising to the edge of a second but less bold and well-defined escarpment, which is seen at La Cloche Strait and Point Peter, where it attains an elevation of 130 to 140 feet. The eastern extremity of the Grand Manitoulin Island and the line of coast between Cape Hurd and Cabot's Head are sections nearly transverse to the formations of the belt, and the islands that lie between them, in no case successively separated by intervals of water exceeding seven miles, are points shewing their connexion. All these islands present an abrupt escarpment to the north-east, and a gentle slope in a contrary direction. The same character is more grandly displayed in the coast between Cape Hurd and Cabot's Head, and it serves to illustrate the structure in other parts; the distance between the points is seventeen miles, and the edge of an abrupt limestone cliff is seen to rise gradually from the one to the other until it attains a height of 329 feet, standing almost perpendicularly over the water. South of Cabot's Head the coast continues to present bold precipices, sometimes upwards of 220 feet high, for the greater part of the distance to Owen's Sound; eastward of this it has a height of about 160 to 170 feet at Campbell's Cliff, between Cape William and Point Rich; the escarpment receding thence into the interior, and coming out again in Nottawasaga Bay can be traced along the shore to Beaver Brook, in the Township of Collingwood, farther on in which, leaving the water and striking into the interior in a south-easterly direction, the range to which it belongs, gains in height and becomes of sufficient importance to be dignified with the title of the Blue Mountains. Around the extremity of Nottawasaga Bay the land is low, but in the Peninsula which lies between it and Matchedash Bay, a feature of the same kind as characterises the Manitoulin belt is observed. From the south-west side the land gradually slopes up and falls in escarpments on the north-east at Point Adams and Point Gloucester, and the same form is carried out into the islands at the extremity of the peninsula from the

south-west side of Christian Island to the Giant's Tomb, whose bold north-eastern slope corresponds with that of Point Adams.

Along the bold shore of the south-western side of Georgian Bay, the water is very deep at a very short distance out from the land, as may be seen by a reference to Captain Bayfield's admirable chart of the lake; a mile out from Cabot's Head it is represented to be 460 feet, and in Dyer's Bay 500 feet, three miles out. Yet at every point and island, and sometimes also in the bays, it is observable that a fringe of reefs prevails close in upon the shore; the reefs all appear to be composed of loose blocks, and are probably in part derived from the destruction of the neighbouring cliffs, and they make it in many places dangerous, often for long stretches, to approach too near the land. This is the case nearly all the way from Nottawasaga to Owen's Sound, where in one part of the distance they extend out three miles.

Along the coast from Cape Hurd, places of shelter are not so numerous as they are along the Manitoulins, and they are sometimes dangerous to approach. There are several good harbours at Cape Hurd, though it is to be apprehended, from the irregular and rocky character of the bottom, they can scarcely be called good anchorages; there is a harbour also (called Wingfield's Basin on Bayfield's Chart,) at Cabot's Head, but its value is much diminished by the existence of a shallow bar across the entrance, effectually preventing the admission of large vessels, and rendering it at times inaccessible to even boats and canoes, especially when the wind is from the northward and westward. South of Cabot's Head the best harbours are Isthmus Bay and Melville's Sound, beyond which it is difficult to get shelter from north-easterly winds, except under the lee of the islands in Colpoy's Bay. Nottawasaga Bay may be said to be quite destitute of shelter, though formerly a good refuge for boats was readily found at the mouth of almost any of its streams; but the lake has within a comparatively short period receded, and the exits of these streams have become inaccessible. At the south end of Christian Island there is a capacious bay facing the east, which being sheltered on every side, and affording good anchorage and good camping ground, is in every respect an excellent harbour; and eastward of this there are safe coves and inlets both on the

main shore and on the islands, and no part is much exposed up to Penetanguishene.

The Manitoulin Islands and their corresponding peninsular promontory, which has not yet been fully examined, are covered with dense forests, which are frequently of the description usually indicating a rich and fertile soil. On many parts of the southern end of St. Joseph, and in the smaller islands of the Manitoulin group, but especially on the Grand Manitoulin, besides groves of stately pine that, under more favourable circumstances, might afford a considerable supply to the lumber market, there are extensive tracts of land, almost exclusively growing maple, elm, oak, ash, birch and basswood, of such character in point of size, as not to be greatly surpassed by the produce of the justly celebrated hard timber lands of Canada West. Several small settlements have been made on St. Joseph Island, the principal one of which is on the south side, where there is a small village known by the same name as the island; near it, a small stream enters a capacious bay, and affords a sufficient fall and an ample supply of water for milling purposes; a saw-mill was at one time in operation on it, which of late years has been abandoned. Cockburn, the Grand Manitoulin and Horse Islands, constituting an Indian reserve, Indian settlements alone have been made on it, the chief of which are at Manitouwaning, Sheguenandod and Wequamekong, all on the Grand Manitoulin. At the first mentioned place there is a regularly appointed Government Indian Establishment, under the agency of Captain Ironsides of the Indian Department, a gentleman to whom our party was much indebted for useful information and liberal hospitality. At Wequamekong, where there is Roman Catholic mission, the clearings are extensive, and many of the Indians have abandoned their wandering life and subsist on their farms, and this is the case too at Manitouwaning; but at Sheguenandod, although by far the finest tract of country that we saw is found there, the clearings are few and scattered, and the natives are more frequently to be met with in the woods or in their canoes, than in their houses or on their lands.

The Grand Manitoulin is a very important and very beautiful island. Its length is eighty, and its average breadth twenty miles; the forty-sixth parallel of north latitude passes through

three of its most northern points, and the eighty-second and eighty-third meridians of west longitude are at about equal distances from its west and east ends, the latter meridian passing through one of its most northern points at the broadest part, which measures thirty-three miles, and from which the island gradually tapers to the westward. The whole area of the island, exclusive of its numerous bays and inlets, cannot be less than 1600 square miles; the escarpments which have been mentioned run longitudinally through it, and some of them shew heights of 155 to 250 and 300 feet, and the most elevated points do not exceed 350 feet over the level of Huron. The amount of moisture which falls in this area must no doubt be considerable, and the interior of the island appears to be well supplied with streams and lakes. But there is a peculiarity belonging to at least one of these lakes which deserves to be noted. It lies within a few miles of Manitouwaning, and on sending my assistant Mr. Gilbert Burrows, and the chief part of my men, to La Cloche, to change our boat for canoes, in preparation to ascending the French River, I took the opportunity of making an accurate survey of it. A well-beaten Indian path, running a little to the north of due west for three miles, leads to the lake and enabled me to fix its position, and by means of the micrometer telescope and a conspicuous thirty-feet *blaze* effected by peeling to that measure, the stem of a straight vertical spruce, well seen from many of the main points of the lake, the task was soon accomplished. The form of the lake may be compared to that of an hour-glass, expanding at the ends which are seven miles wide, while in the middle of the length, which is ten miles in a N.W. and S.E. direction, it contracts to a breadth which in the narrowest part does not exceed one mile. The area of the eastern expansion is twenty-eight square miles, that of the western twenty-one square miles, and that of the middle part six square miles, making a total area of fifty-five square miles. Its rim is fringed to the water's edge by a thick growth of evergreens chiefly cedar, except on the south-western side, in some parts of which, precipitate ledges rise to the height of ten to forty feet; on this side too the land rises into an escarpment, while it slopes up gently on the other, exhibiting in these features a prevailing character already mentioned, arising from geological structure.

The eastern corner of the lake approaches to within a mile and a half of a sweep on the west side of Manitouwaning Bay, and on carefully levelling the difference of elevation between the two, it was found to be 155 feet, and a question of some interest connected with the lake (which constitutes its peculiarity,) is, the source whence it derives its supply of water. After closely examining its shores, only one small stream was found to run into a little bay on the south-west side of the narrow part, which from all that could be learned from the Indians, was its only visible supply; but while it thus appears to receive so scanty a tribute from the surrounding country it furnishes sufficient water for three large brooks which fall from it to the south, the west and the north. The first of these discharges itself into the main lake near Michael Bay on the south side of the island, after supplying several small ponds met with in its course; the second, which leaves the lake at its western extremity, feeds a succession of small lakes, and falls into Beaufort Bay; while the third, flowing to the north, supplies two more lakes, and eventually terminates at Sheguenandod Bay. While we were at Sheguenandod a rough survey was made of the lowest of these two lakes, and the middle one was seen from one of the heights in its neighbourhood; but for its form and size I am indebted to the Indian chief of Sheguenandod. The one we surveyed is nearly two miles in length, with a breadth exceeding half a mile; and from the chief's description, it is conceived the other is about the same size. Understanding that the lakes were unnamed, at the suggestion of Captain Ironsides, the title of Tecumtheh* was given to the largest, and that of Neewash to the lowest, after the two celebrated Indian warriors who bore those names; the third was called the Chief's Lake, in honour of the chief who favoured us with its description. It was observed on Tecumtheh Lake, that the level of the water at the time we saw it, which was in the early part of August, had the appearance of being higher than it must have been in the spring or some later period. The evidence of the fact was a well-defined water-line, which could be traced at about eight inches below the surface, marked by a slimy dark-

* The usual mode of writing the name of this celebrated warrier is, I believe, "Tecumseh" or "Tecumseth," but I have been informed by Captain Ironsides that the proper one is as that given in the text.

red coating, which covered the limestone pebbles of the bottom below the line, from which those above were completely free, these retaining the same colour and appearance they had when forming a part of the beach. Another large lake is said to occupy a portion of the island, between Beaufort Bay and Bayfield Sound; no satisfactory description could be obtained of its character, and there was neither time nor opportunity to make an excursion to it. The rock of the country being chiefly limestone, which is so frequently known to give subterranean passage to streams, it appears probable that these lakes may be related by such a communication, and there may be others in the same way connected with them, and thus the water of Tecumtheh Lake may result from the drainage of a considerable part of the island.

On concluding the examination of the coast at Penetangueshene, where, by the kindness of Mr. W. B. Hamilton, our boat was safely laid up against the winter, the opportunity was taken of my return homeward by Coldwater and Orillia, to determine the difference of level between Lakes Huron and Simcoe. There being a good road between the two places mentioned, the distance by which is fifteen miles, there was no farther difficulty in the operation than such as was occasioned by rainy weather.

The following is a list of the various bench-mark stations on the road, with their respective heights over Lake Huron.

	Feet.
Barr's Tavern, half way between Coldwater and Orillia,	363.85
Bridge across the North River which falls from Bass Lake, called the Wye on Bouchette's Map	250.24
Road near Bass Lake	282.96
Corner of Robertson's clearing, height of land	367.37
Surface of Lake Simcoe	125.52

A comparison of the result of these levels, with those taken by the Board of Works from Lake Ontario, proves highly satisfactory, as shewn by the following figures:

	Feet.
Height of Lake Huron over the sea, according to the measurements of the Michigan Engineers	578.00
Height of Lake Simcoe over Lake Huron, as above	125.52
Height of Lake Simcoe over the sea	703.52
Height of Lake Simcoe over the sea, as determined by the levels taken by the Board of Works from Lake Ontario	704.00
Difference	0.48

SEQUENCE AND DISTRIBUTION OF THE FORMATIONS.

The coast and islands of Lake Huron present greater advantages for the examination of the rocks, which constitute Western Canada, than perhaps can be found in any other part of the Province; for while the mainland on the northern and more eastern shores of the lake exhibits continuous exposures of the more ancient formations, the Manitoulin Islands, and the coast between Matchedash Bay and Sarnia shew in regular succession the whole of the fossiliferous groups from the lowest to the highest contained within its limits.

The older groups observed consist, firstly, of a metamorphic series, composed of granitic and syenitic rocks, in the forms of gneiss, mica slate and hornblende slate; and, secondly, of a stratified series composed of quartz rock or sandstones, conglomerates, shales and limestones, with interposed beds of greenstone; and of the fossiliferous groups following these, six formations were met with, which in the New York nomenclature come under the following designations:—

1. Potsdam sandstone.
2. Trenton limestone.
3. Utica slates.
4. Loraine shales.
5. Medina sandstones.
6. Niagara limestones, including the Clinton group.

Metamorphic series.

This series occupies the whole of the coast from Shebawenahning to the mouth of the French River, whence it constitutes the banks of this river to Lake Nipissing. Whether the rocks of this series compose the coast between the French River and Matchedash Bay, has not yet been ascertained, but they were met with on the north-eastern shore of this bay and its islands, to the mouth of the River Severn, where their limit strikes into the Township of Matchedash, as was stated in the Report I had the honor of addressing you in 1843.

In general character the rocks of this series are either granitic or syenitic gneiss, the constituents of granite prevailing in some instances, those of syenite doing so in others. Their prevailing

color on the north coast, and for several miles up the French River, is reddish, arising from the presence of red feldspar, and a pale flesh-colored quartz; in the other parts, and especially above the lowest seven miles of the French River, the general color is black or dark-grey, owing to the prevalence of black hornblende and black mica; feldspar occurs in most of the rocks, but in such various proportions, that in some instances it is nearly absent, while in others it forms the most abundant constituent. A parallel arrangement is observable in the constituents of all the varieties and in the varieties themselves, but it is particularly distinguishable where mica most prevails. When hornblende is the most abundant mineral, small red garnets are very frequently met with, which on close inspection give a speckled appearance to the rock.

When the rocks are chiefly composed of quartz and feldspar, with or without mica they are usually in thick beds; when hornblende and mica, prevail, the beds are mostly thin, sometimes slaty; the more massive beds are in many instances divided by thin layers of mica, generally black or of a brownish tinge. The thickness of the series it was not found possible to ascertain; its members were everywhere in a highly disturbed condition, and frequently very much contorted. On the lower parts of the French River, where the massive beds chiefly occur, the inclination appeared to be at a high angle towards the south-east, but further up the rocks were of a more slaty character, and where the thinner beds were frequently seen, we could discover a succession of sharp folds or contortions, which repeated the same beds for a distance of many miles. Near the crown of each undulation there was generally a crack, which extended at a pretty regular rate of inclination from the top to the bottom of the cliffs, and these cracks in succession might readily be mistaken for planes of stratification, and lead to great exaggeration in estimating thickness; whilst on the upper portion of the French River, it was frequently necessary to be cautious in regard to this peculiarity, especially when the thick bedded parts of the series were exposed, as the dip here became as uniformly westward as it had been to the eastward at the mouth; but having at the time become aware of the contortions, a close examination of the sequence of constituent bands, often convinced me, that what otherwise might

have been taken for enormous thickness, resulted in reality from frequent repetitions of the same masses. Veins of quartz were often observed to intersect this series, some of which were upwards of three feet wide, but in no instance did we perceive any metalliferous indications farther than the presence of iron pyrites.

Quartz Rocks and Sandstones, Conglomerates, Slates and Limestones.

The next series in succession in the ascending scale is a set of regularly stratified masses, consisting of quartz rocks or altered sandstones, conglomerates, slates and limestones, interstratified with beds of greenstone. Taken as one formation, these rocks form the whole north coast of Lake Huron, and either wholly or in part, many of its neighbouring islands between Little Lake George and Shebawenahning; but there is a great diversity of character, both in mineral quality and general appearance, in the different parts composing the group.

Classified as above, the division entitled the quartz rocks sometimes presents beds which are purely white in colour, closely compact in texture, and vitreous in lustre; at other times the layers are grey, greenish or brownish, granular, and occasionally micaceous; sometimes as sandstones they are fine-grained, at others become coarse, and occasionally pass into a beautiful conglomerate whose pebbles consist chiefly of blood-red jasper, sometimes mixed with others of greenish jasper and white quartz, and lie in a matrix of nearly pure white silicious sand. Both as quartz rocks and as sandstones, beds have sometimes a slaty cleavage from the presence of more or less mica between the layers. Besides the jasper conglomerates there are conglomerates composed of pebbles and boulders of syenite varying from a magnitude of one and two feet in diameter, down to a size no larger than pigeon's eggs, which are set sometimes in greenish quartz rock as a matrix and sometimes in a greenish slate, but most frequently in the latter. Under the denomination of slates are included various thinly laminated dark-green, blackish and reddish rocks, some of which are very chloritic, and some contain epidote. The limestones in fresh fractures are whitish, yellowish-buff, or bluish, and they weather sometimes to black and sometimes to yellow. On exposed surfaces both these colours alternate

in thin irregular layers, which being of different degrees of hardness wear unequally, the harder bands standing out in sharp relief while the softer are grooved out between them. The harder layers usually weather black and are very silicious, sometimes of the nature of hornstone, while the softer material weathers yellowish.

Numerous greenstone dykes traverse these rocks, which, throughout the whole space examined, bear a rude parallelism to one another. Their general course appears to be from west and east to north-west and south-east; they are generally fine-grained and frequently compact; in colour they are nearly black or very dark-green arising from the prevailing dark colour of the hornblende, which is one of the constituent minerals; they are sometimes spotted with small crystals of white feldspar, or larger crystals of the same mineral of a greenish tinge, and they appear frequently to contain epidote; iron pyrites occurs in most of the dykes and in some is abundant, and small specks of yellow sulphuret of copper are likewise by no means uncommon.

Great masses of greenstone, supposed to be interposed among the sedimentary beds, are also met with; their mineral quality varies but little from that of the dykes; magnetic iron, in greater or less quantity, appears to be disseminated through them as a constituent mineral. Some masses are coarsely grained, the fracture presenting elongated crystals of black or dark-green hornblende, mingled with aggregated crystals of white and red feldspar; the hornblende in another variety, is in smaller crystals, and is black; those of feldspar are likewise smaller and white, giving a dark-grey colour to the rock, and this appears to be the prevailing character, wherever the beds were seen extensively displayed. A third variety is very fine-grained, and is of a very dark-grey colour, the black hornblende being by far the most abundant constituent. Magnetic iron was found disseminated in all the varities, most abundant in the first, less so in the second, and least of all in the third; iron and copper pyrites were frequently disseminated through all.

In addition to the trap dykes, mineral veins intersected the formation; like them they are found to maintain a certain degree of parallelism, their prevailing direction being N. W. and S. E.; transverse faults were sometimes found to cut the veins; but

their presence did not appear to be marked by veins or dykes, and their existence was shown only by displacements. The mineral veins are usually composed of semi-translucent white quartz, associated often with dolomitic spar; many hold the yellow sulphuret of copper in small quantities, while others combine with it vitreous copper and variegated copper in workable abundance.

What breadth of country this series of rocks may occupy or what vertical thickness it may attain, there was no opportunity of determining. It was deemed advisable, in the first instance, to trace out the relation the series here to the superior deposits already in some degree known, before more particularly entering upon an examination of the series itself, and our observations were in consequence chiefly confined to the islands in the north channel, where the outcrop of the fossiliferous deposits terminate, and where they were frequently found in contact with the series under consideration. The visits made to the north shore were for the most part confined to places where veins holding metalliferous ores were known to exist, of which it was considered proper to obtain exact information, and the excursions made into the interior did not exceed the distance of two or three miles up a few of the streams, which were of easy access; but the spirit of mining enterprise, which at the present moment prevails, has sent a host of explorers over the district; and there can be little doubt that their researches will greatly aid to elucidate its geological features, and extend a knowledge of the mineral resources of the Province.

The different members of this series of rocks appear to be in so many cases interstratified with one another, that until a larger number of facts is collected, it would be difficult to make the relation of those portions that have been observed perfectly understood; and it therefore perhaps, for the present, will be sufficient to state some few points at which some of the most important examples of these were met with. The limestone part of the formation was seen for the first time on Echo Lake, a small sheet of water about two and a half miles, bearing a little to the east of north, from the most northern part of Lake George. The rock constitutes two prominent points, one on the east and the other on the west side, near the mid-length of the lake, and appeared to dip to the south

at an angle not exceeding 45°. It is overlaid by syenitic conglomerate and quartz rock, which are seen on both sides of the lake further down, and a range of hills, which must be imposed on them, is intersected by the discharging stream. Syenitic conglomerate underlies the limestone, and quartz rock follows it to the north.

Proceeding along the coast, white quartz appears to form its various points, and the many islands near it from the foot of Lake George to the foot of Lake St. Joseph, and the upper end of the north channel. A few scattered small red jasper pebbles were occasionally met with in it, but in no case forming a conglomerate. Many boulders however of the red jasper conglomerate were observed in the vicinity; but the only locality in which this beautiful rock was seen in place in any great mass, was on a small lake situated in the interior about three miles from the coast, and discharging by a small shoal rivulet, the mouth of which is about a mile and a half west of Portlock Harbour. The three large islands which are met at the west end of the north channel, two of them being those which assist in forming Portlock Harbour, and the third and largest, that on which Campment d'Ours is situated, (of which only the northern half is included,) consist chiefly of syenitic conglomerate, and this rock composes the main coast two miles farther east, and is succeeded by a reappearance of the limestone, which is displayed on a point three quarters of a mile above the French Islands, which are nearly north of the east end of St. Joseph's Island. The coast up to these islands and for a mile and three quarters beyond is greenstone, and this rock there constitutes part of the front of the Bruce Mines location, on the east side of which, at Eagle Point, quartz rock again makes its appearance.

Omitting several points which were touched at along the coast, and proceeding to La Cloche, the quartz rock was there found in a development which must be several thousand feet thick, constituting the range of picturesque mountains which run for many miles along the border of the lake, and the limestone is again seen to the north of these mountains on a lake about two miles from the coast at the Hudson Bay Company's Post.

On a cluster of small islands about midway across the North Channel, nearly due south from the Spanish River location, granite

was found breaking through the quartz-rock; it was coarse grained, having large crystals of feldspar and large leaves of mica, while the grains of quartz were small; the colour of the rock was red. On one of the islands, quartz-rock beds on opposite sides of the granite were observed to dip in opposite directions, north on the north side and south on the south side, at an angle of 70° or 80°; and in another of the islands the quartz-rock and granite were seen in juxtaposition, the former reclining on the latter. In this case the quartz rock was traversed by several trap dykes running slightly oblique to the strike, while granitic veins ran transversely through the whole, and were continued through a main body or nucleus of granite, the one granite being distinguishable from the other, notwithstanding the red colour of both, by the finer texture of the veins.

Fossiliferous Rocks.

The fossiliferous series, as before observed, is supported unconformably by the older rocks already described; in the North Channel they are seen to rest upon the tilted edges of the quartz-rock formation, while at Penetanguishene and Matchedash Bay, they repose upon the metamorphic or gneissoid series. Their attitude throughout the whole region seems to indicate a perfect state of quiescence from the time they were originally deposited; they horizontally fill up hollows in the older rocks, and while the irregularities of this ancient bottom are so great that different members of the fossiliferous group are found in contact with it in different parts, they are nowhere throughout the district affected by trap dykes, faults or other marks of disturbance.

Potsdam Sandstone.

This formation is not extensively developed on Lake Huron; it was observed on various parts of the River St. Mary, between the Sault Ste. Marie and Sugar Island, and it was again seen at the east end of the North Channel on the Island of La Cloche, as well as on a point of the long promontory that comes down towards the island from the mainland.

On the River St. Mary the colour of the deposit is generally red, or red and green, or red with green spots, and its character is for the most part that of a fine-grained sandstone. To the

eastward of the western extremity of Sugar Island, its boundary is generally concealed by drifted boulders or by overgrowing moss and forest trees; yet there is evidence in the character of the drift, that the formation extends to the eastern side of that island, and striking into the Island of St. Joseph, near its northern end, its basset edge runs nearly due east, and comes out again on the north coast of the latter, about two miles south of the Island of Campment D'Ours. At the east end of the North Channel, the formation is chiefly a red marl with green stripes and spots, containing thin beds of green slightly calcareous sandstone, and hard bands of red calcareo-argillaceous rock, varying in thickness from two to six inches; towards the top the beds become more and more calcareous and the green colour more prevalent in them, until they join the lower beds of the Trenton limestone. A narrow strip of the formation runs east along the south side of a quartz-rock ridge, through the Island of La Cloche, and then spreads out over a portion of the north-east corner of that island, and extends across to the peninsula of the mainland opposite, resting upon the tilted edges of the slates and quartz-rock formation.

We had no means of ascertaining the thickness of the formation above the west end of the North Channel; but at the east end it does not exceed forty feet. The only fossils that were seen in the strata, were met with in the upper beds near their junction with the Trenton limestone, where several specimens of orthoceratites, encrinites and fucoids were found.

Trenton Limestone.

A straight line from the Little Neebeesh Rapids on the River St. Mary, to the north-east point of the Island St. Joseph, will nearly mark the base of the Trenton limestone at the upper end of the lake. From this it can be traced eastward through the North Channel upon several of the islands, resting upon the upturned edges of the quartz-rock formation, until arriving at La Cloche Island, where it is found in conformable junction with the Potsdam sandstone. To the east of La Cloche Island it forms low belts round quartz-rock centres on islands and peninsular points from the mainland, to within a short distance of Shebawenahming, whence it strikes to the south-west; after a long sub-

aqueous course it emerges to leave Lake Huron in the vicinity of Matchedash Bay, where it rests upon the gneissoid rocks.

The lower members of the formation are dark brown or buff-coloured arenaceous limestones, frequently associated with beds of green calcareo-argillaceous shale. The higher portions of it consist of dark bluish, buff, and brownish-coloured limestones, which generally weather to a light-yellow, and where exposed to the action of the lake present cellular fretted surfaces. The beds at the top of the formation, where they come in contact with the Utica slates, are very bituminous, generally of a dark grey colour on fracture, weathering to a bright orange when exposed. The whole formation is very fossiliferous; in the lower portions of the series the most prevalent genera are *Orthoceras* (a large species), *Isotelus*, *Bronteus*, *Pleurotomaria*, *Sabulites*, *Cypricardia*, *Leptena*, *Atrypa*, *Lingula*, with encrinites, corals and fucoids, and most of the same genera are found in the higher parts.

A perfect section of the formation was obtained between protruding ridges of the quartz-rock, on La Cloche Island and the neighbouring point of the Grand Manitoulin, where the rate of inclination although inappreciable to the eye, is uniformly nearly south, descending at the rate of from thirty-five to forty feet in a mile. Taking the maximum as the rate of dip, the total thickness of the formation would be about 320 feet.

On a small group called the Snake Islands, which is very inaccurately laid down on the map furnished me, Bayfield's chart of the north shore of Lake Huron not being yet published, and of which islands we in consequence made a topographical delineation, the following section was measured to shew the want of conformity between the Trenton limestone and the subjacent rocks. From the western point of the largest island of the group, the N. E. point of Drummond Island bore 210¼° and the N. W. point of Cockburn Island 199½°. The bearing of the section line was N. 38 E., rather oblique to the stratification.

			Horizontal meas. chains.	Dip.
Limestone with Trenton fossils, on the larger island; the beds were nearly horizontal or gently undulating			18.00	0<0
Water of the lake			27.00	
Limestone as before, on the second island, nearly horizontal			2.25	0<0
Calcareous rock, being a bed consisting of quartz-rock fragments, cemented together by limestone holding fossils			0.20	0<0
	ft.	in.		
Quartz-rock of a compact texture, with thin bands of a slaty quality	8	8		
Green and buff coloured, thin bedded sandstones	8	8		
Measures imperfectly seen	81	0		
Bluish coloured quartz beds interstratified with pale green slaty beds and conglomerate bands with white quartz pebbles	13	0		
Pale green sandstones and compact quartz-rock in beds of two feet thick	9	5		
Bluish compact quartz-rock	15	0		
Bluish white compact quartz beds; here occurs a down-throw dislocation running oblique to the strata	12	0		
Thickness	147	9	11.80	178<37
Water of the lake			21.00	
Altered slates			1 00	183<23
Trap dyke, underlie, 22 <82			0.80	
Quartz-rock, slate and conglomerate			0.50	22<53

Utica Slates.

This formation is generally concealed by drift at the western end of Lake Huron, but indications of its presence were found on the Island St. Joseph, opposite the southern point of Neebeesh Island, and in some of the small islands between St. Joseph and Drummond Islands. The first good development met with travelling eastward, is on a group of islands nearly due north from Maple Cape, on the Grand Manitoulin, where it is seen to rest upon the Trenton limestone; on a small island in Shegue-nandod Bay, and likewise on the Island of Sheguenandod, it is again seen in contact with the Trenton limestone; but at the Indian village of Sheguenandod it reposes unconformably upon

the north side of a ridge of the quartz formation. It then can be traced across the point between Manitouwaning and Wequamekong Bays, beyond which it again appears at Cape Smith, and finally it strikes into the mainland in Nottawasaga Bay, where it once more marks the upper boundary of the Trenton limestone.

In mineral quality this formation is usually a jet-black bituminous shale, which on exposure weathers to a pale-yellow or buff colour, or decomposing under the influence of the atmosphere, becomes a mass of black bituminous clay. On Lake Huron, as in other parts of Canada and the United States, this formation has been frequently supposed to indicate the presence of coal, and many erroneous statements have been made with regard to it. Its position in the geological series has been frequently adverted to in former Reports, where it has been distinctly shewn to be lower than the true carboniferous rocks by many thousands of feet.

The characteristic fossils of the Utica slates are found in great abundance on some parts of Lake Huron. The number of species is not great, but different species appear to prevail in different localities: for example, at the islands opposite Maple Cape *Triarthus Beckii* and *Orthoceras* are nearly the only fossils; at Sheguenandod *Orthoceras* and *Graptolithus* are most abundant; at Cape Smith *Orthis testudinaria* and a small *Pleurotomaria* were in vast quantity; while in the Township of Collingwood, in Nottawasaga Bay, the beds were nearly a perfect mass of tails of one species of *Trilobite*. *Triarthus Beckii* is found in all the localities, and in addition to the genera enumerated, a *Lingula* is found in some parts.

Where the deposit rests upon the quartz formation, the beds are slightly turned up at the outcrop, dipping to the south 15°, but this does not extend above two chains from the ridge, where they assume the same horizontal attitude as was observed in the case of the Trenton limestone; the whole thickness on our line of section across the Grand Manitoulin is probably not over fifty feet.

Loraine Shales.

Except in the Island of St. Joseph, where it is generally concealed by drift, and on Sulphur Island, where it abuts against the

quartz-rock formation, this part of the series invariably presents a bold and lofty escarpment. Passing eastward from the northern points of Drummond and Cockburn Islands, where a portion of the formation is exposed, it is next seen at Cape Robert and Barrie Island, whence it continues through the Grand Manitoulin to the south side of Sheguenandod Bay; a high ridge marks its position between the bays to the eastward of Sheguenandod, and at Cape Smith it is found in contact with the Utica Slates. From Cape Smith the strike points directly for the high land of Lonely Isle. The formation is found in high cliffs on the main land at Cape Crocher, and to the east of Owen's Sound, whence it is easily traced to the Blue Mountains, in Collingwood, where it is again found in juxtaposition with the Utica slates.

The mineral character of the greater proportion of this deposit is a bluish or greenish-coloured argillaceous shale, holding thin beds of dark-blue argillaceous limestone, and of grey slightly calcareous yellow-weathering sandstone; near the top there are marls, which are sometimes red, at other times green, and sometimes a mixture of both; they hold very thin beds of dark-bluish argillaceous limestone, the whole being surmounted by beds of grey or bluish arenaceous limestone, which vary in thickness from six inches to two feet. Snowy gypsum is occasionally found in druses in the upper rocks, and in one place white gypsum and dark-brown sulphate of barytes were observed in the same cavity.

Fossils abound throughout the whole formation, among the most characteristic of which are a *Pterinea*, two species of *Cypricardia*, an *Atrypa*, with some univalve shells, as well as trilobites, corals, encrinites, and pentacrinites. In the upper beds the fossils are usually replaced by silica, and are beautifully developed upon surfaces that have been long exposed. The thickness of the deposit on the Grand Manitoulin was estimated at 200 feet.

Medina Sandstone.

The only part of Lake Huron where this group was seen in place was between Cabot's Head and Cape Montresor, and on the north-east point of Horse Island; but although it was no where exposed in sections on the Grand Manitoulin Island, there were indications of its presence upon Tecumtheh Lake, where a red marly clay was discovered to be washed up from the base of the Niagara limestones.

As seen on Lake Huron, this deposit consists of [illegible] h is partially striped and spotted with green, interstratified with red, green and variegated purely argillaceous bands, which never exceed six or eight inches in thickness. These bands appear to be entirely devoid of calcareous matter, and are carved by the Indians into tobacco pipes.

The only fossils observed in the deposit were a few fucoids near the junction with the superincumbent Clinton group. At Cabot's Head the formation was found resting upon the upper beds of the Loraine Shales, and supporting the Clinton group and Niagara limestones. The dip was found to be nearly due east, at the rate of 37 feet in a mile, and the total thickness 103 feet.

Niagara Limestones.

This group extends over the larger southern portion of Drummond Island, and nearly the whole of Cockburn Island, beyond which its northern boundary can be traced to the eastward, through the Grand Manitoulin, on the southern shores of Bayfield's Sound and Beaufort Bay, Tecumtheh Lake, and Manitouwaning Bay; the whole of Horse Island, and the group of islands between it and Cape Hurd are of the Niagara rocks. They cap the cliffs at Cabot's Head, and can be traced thence to the southward of Melville Sound, where, striking across the neck of the peninsula which runs out to Cape Crocker, they again appear at Cape Commodore, on the west side of Owen's Sound, whence they recede into the interior, and are no more seen on the coast.

At the base of the formation there are a set of green calcareo-argillaceous shales and thin-bedded limestones, which are supposed to be equivalent to the Clinton group of New York. A few species of fucoids were observed in some of these, and a small bivalve shell, supposed to be a nucula, was likewise detected. Resting on the green rocks, are beds of white or cream-coloured bituminous limestone, which weathers black or dark-brown; some of the beds are extremely massive, amounting in some places to twelve and even fifteen feet in thickness, and few in the whole aggregation are under two feet. The upper beds are bituminous and magnesian in mineral quality; they are cavernous in character, and present rough, irregular cellular surfaces after

long exposure to the air and water; some beds near the top of the group, hold black and white chert in large quantity, and fossil forms are sometimes filled by it; small quantities of gypsum are occasionally found in druses in the limestone, and more frequently calc-spar in variously modified crystals. The formation is intersected by joints which at Cabot's Head run in the bearings 85° and 151°, dividing the strata into rhomboidal masses. On some parts of the coast, the rock is worn by the action of the water of the lake into remarkable pillar-like shapes. This is particularly the case at Flower-pot Island, where one column was observed (the height of which we could not ascertain, as it was only viewed from the boat,) resembling a jelly-glass, being worn small near the base and enlarging symetrically toward the top.

The fossils met with peculiar to the Niagara limestone are chiefly corals, among which *Favosites Gothlandica* and *Catenipora* were frequently observed; some of the most massive beds appear to be entirely composed of coral of the most elaborate structure; one fallen mass was observed at Cabot's Head, which appeared to be all coral, measuring ten yards square on the surface, with an average thickness of five feet. The only bivalve shell that was met with abundantly was a *Pentamerus*, but spiral univalves and orthoceratites were occasionally found, and encrinites were plentiful among the higher beds.

The following section shewing the relation of the last three mentioned groups of rock, was measured at Cabot's Head in descending order:—

Thick bedded coraline limestone, (*Niagara*).....	.....228 feet.
Green shales and thin bedded limestones, (*Clinton*).....	55 "
Red marl and indurated clays, (*Medina*).....	.....103 "
Gray limestones, very fossiliferous to the water's edge, (*Loraine Shales*)	26 "
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The total thickness of the Niagara limestones on the line of section, on the Grand Manitoulin island, was found to be about 560 feet.

The total thickness of the series from the bottom of the Potsdam sandstone to the top of the Niagara limestone on the line of section across the Grand Manitoulin and La Cloche islands, is as follows:—

Potsdam sandstone	40 feet
Trenton limestone	320 "
Utica slates	50 "
Loraine shales	200 "
Medina sandstones	103 "
Niagara limestones, including the Clinton group	560 "
Total	1273 "

Economic Materials.

With the exception of the veins holding copper ore, not much of economic importance came under notice on Lake Huron. Specimens of specular iron were shewn me on more than one occasion, and I was informed that a vein of that description of ore existed in the neighbourhood of Penetanguishene, but as no opportunity occurred of our visiting the locality in which it was said to be situated, it is not in my power to offer any opinion respecting it.

On the northern shore of St. Joseph island near Campment D'Ours, there is a large quantity of very fine silicious sand, probably derived from the disintegration of the quartz rock beds, which appears suitable for the manufacture of glass. It is quite free from calcareous matter, but is slightly marked by spots of a very pale-yellowish colour, occasioned by the presence of a very small portion of the peroxyd of iron; but in a district where so large an extent of pure white quartz-rock is met with, there can be little doubt that a material fit for such an application would be by no means scarce.

Although stone fit for lithographic purposes has been found in the Trenton limestone formation at various parts east from Lake Simcoe, no rock of similar quality was observed in that formation on Lake Huron. The only useful purposes for which the beds of the Trenton group are adapted, are as building stone and for burning into quick lime; for the latter purpose most of the lower beds are too arenaceous, but good lime can be obtained from most of the higher parts of the formation.

Wherever the Niagara limestone exists, an excellent material for building purposes is procurable; its value in this respect has already been well tested on the Welland Canal and in other parts of Canada West, where the stone has been obtained from that formation. The stone which the same group affords upon Lake

Huron, is in no respect inferior in quality to the rocks at Thorold and Hamilton. Many beds likewise of the same formation burn into good lime; they are generally whiter in exterior appearance than the rest of the deposit.

That the north shore of Lake Huron is destined sooner or later to become a mineral region of importance, appears very probable. Although the whole district is covered by a dense forest, still in its original wild condition, already at the time of my visit, had the researches of the first explorers, only a short time previously commenced, been rewarded by the discovery of copper lodes, some of decided value, and others of considerable promise, and I have been informed since my return from the lake, that an additional number were subsequently brought to light.

The most important locality that came under my observation is situated on the main shore between the French and Palladeau Islands, about ten miles westward of Thessalon Point. On it exist the copper lodes, which have acquired for the spot the designation of the Bruce Mines. On the location there are at least two, perhaps three, and not at all improbably more veins with valuable metallic indications. Two of these are evident on that part of the ground which has been cleared close to the water's edge at the landing place, and another which is the one now worked, about thirteen chains to the north-east of it. This latter vein has been stripped of moss and underwood, and can readily be traced for upwards of a quarter of a mile; the width varies from three to six feet, and at every point exposed it is highly charged with ores of copper. The matrix of the lode is white semi-translucent quartz, which is enclosed within two well defined walls of greenstone, there the rock of the country. The run of the lode on an average is north-west and south-east, and it underlies to the north-eastward about 80°. The ore is for the greater part the yellow sulphuret, but variegated copper and vitreous copper likewise occur. Beautiful crystals of all the species are occasionally found in druses in the lode, with quartz, calc-spar and pearl-spar, and sometimes sulphate of barytes. Two transverse faults or *cross-courses* were observed, one of which throws the vein to the north-eastward, on the north-west side about twenty yards; the other cuts but does not displace the lode; where this latter occurs, the lode on each side of the fissure which crosses

it, is suddenly contracted to about eighteen inches in width, and while the ore on the east side was the yellow sulphuret, almost the whole of it was variegated copper on the west; the fissure itself held no metalliferous indications, but was filled with a clay called *fluccan* by miners. A considerable quantity of carbonate of copper, in a pulverulent condition, was found on the upper surface of the lode at this part, and several bushels of it had been collected within the space of eight or ten yards. Two shafts were in progress on the vein, one being down about forty-two feet, and the other about fifteen feet. At the bottom of each the ore appeared to be as abundant, and the width of the vein as great as on the surface. The most of the ore that was then out, was from the surface, having been worked in an open drift (or *stope*) for about 200 yards. An estimated quantity of 400 tons of ore was piled ready for transportation, part of which has since been taken to Boston, where I am informed it has been sampled and assayed, and found to yield a produce of 9·900 per cent. of copper tried in the dry way, and 11·50 per cent., in the moist way.

A supposed continuation of the lode at the landing, was observed at intervals for about a quarter of a mile; the breath varies from eight to ten and twelve feet, and perhaps more, with yellow sulphuret of copper disseminated through the whole at the surface; wherever a blast was put in, a promising description of ore was produced. The run of the vein is nearly parallel to the other, and its matrix and walls are precisely similar. Within a quarter of a mile north from the head of the bay, which is north-west from the harbour, and about a mile north-west from the landing a quartz vein about fifteen feet thick, well charged with yellow sulphuret of copper, occurs, which was supposed (the lode being unmapped,) to be a continuation of the one last mentioned, but subsequent examination, I am informed, induces the belief that it is not so, but a third and distinct vein.

In every respect the location appears highly favoured; the mineral indications are strongly encouraging; the harbour is excellent for boats and small craft, and the means of transporting the produce of its mines easy and convenient. In the harbour there is a small island, where vessels drawing ten feet water can lay alongside, take in and discharge cargo, and a wharf was being constructed, at the time of my visit, to join the island with

the mainland. A small stream enters the lake within about a quarter of a mile east of the present works, which (if it maintain a sufficient supply of water during the dry season,) has abundance of fall, and may be found of importance for the purpose of being applied to machinery and that of dressing the ores.

Another location was visited which is situated near the Spanish River; only one lode was observed holding the ores of copper, nor is it known to me that any others exist there. A party of miners were employed at the spot who had opened out the lode for a short distance along the surface, and had begun to sink a shaft. The run of the vein which is N. 65 W. and S. 65 E., seemed to correspond exactly with the strike of the slates which constitute its walls, and its underlie which is north-eastward, coincides with the dip of the strata; nevertheless its general character is that of a true vein. The width of the lode is about five feet, and in it there is a fair display of the yellow sulphuret of copper, in a matrix of white quartz and dolomite-spar; in druses acicular crystals of rutile were met with.

Other lodes were inspected on Echo Lake; they occur in a quartz-rock cliff, north of the limestone band which has been mentioned; the indications in them were not so promising as in those in the greenstone and slates.

I have the honor to be, Sir,
Your most obedient servant,

ALEX. MURRAY.

REPORT

OF

T. S. HUNT, ESQ., CHEMIST AND MINERALOGIST

TO THE

PROVINCIAL GEOLOGICAL SURVEY,

ADDRESSED TO

W. E. LOGAN, ESQ., PROVINCIAL GEOLOGIST.

MONTREAL, *April* 1848.

SIR,

Having in accordance with your directions made an examination of the rocks along the Ottawa with reference to their mineralogical character, I here submit the facts so far as observed, premising that the specimens collected have not as yet been carefully examined for want of time, and that some of them will probably prove on farther investigation to be not only new varieties, but in several cases new species.

The region thus examined is embraced in the crystalline limestones of the Ottawa, which underlie unconformably the Silurian rocks of the country and are interstratified with syenitic gneiss. The limestone is invariably highly crystalline and sometimes very coarse grained in its structure; at other times its texture is very fine, forming what is designated saccharoidal limestone, and occasionally the grain is so fine as to yield a marble fit for the artist. The color of the limestone is frequently reddish white or flesh-red, but these tints so far as I have observed, seldom prevail through any great extent; it is more often white, often intermixed with shades of grey. The rock is very generally micaceous, and presents small scales of gold or silver-coloured mica, and more rarely crystals of the same mineral of a deep malachite-green with an almost metallic lustre. As however the general features

of these rocks have been accurately described in your Report of this region, I will proceed at once to describe the characteristics of those examined by myself.

Leaving Montreal on the 14th of last June, I went by the way of Carillon to Lachute, on the Rivière du Nord. At the lime-kilns of M'Gregor, two miles from this, the limestone has been quarried to a considerable extent; it is white or grayish and rather coarsely crystalline, containing disseminated scales of mica and graphite, with tabular spar, brown tourmaline, pyroxene and quartz. None of the minerals except the quartz, appear to form veins or masses of any considerable extent, and the tourmalines although of a fine color were seldom met with in well defined crystals. Overlying the limestone near the kiln is a considerable extent (bed?) of coarse grained white or reddish-white felspar, occasionally containing sphene or pyroxene; the latter two often making up nearly the whole of the rock. They are associated with plumbago and small masses of magnetic pyrites; the sphene is in small clove-brown crystals, often brilliant and with drusy surfaces and rounded angles; they are generally but little modified, and present no well defined replacements. The pyroxene is dark-green and massive, seldom presenting well crystallized forms. Brown and black tourmaline are found both in the felspar and limestone, the black abundant, while the brown as before remarked is somewhat rare.

At the lime quarries of Mr. M'Gibbon on the ninth lot of the twelfth range of Chatham, the limestone is often coarsely crystalline, of a bluish color, but hard and not inclined to crumble by the action of the weather; some portions are very fine grained and compact, and being beautifully white, would make fine statuary marble, if found in sufficiently large masses free from quartz, which is frequently disseminated through it in small crystalline grains. A mineral was often found here, which on the weathered surfaces has a yellowish color and the appearance of chondrodite, for which it was at first mistaken, but similar appearances afterwards observed in the limestone of other localities, were found to be due to grains of a substance resembling serpentine, diffused throughout the rock, which resists the action of the weather better than the limestone, and at the same time assumes a yellowish-brown tint, but on breaking open the rock this tint is not perceived. The

nature of the foreign substance requires further examination. Graphite, mica and pyrites were also observed. The same limestone was examined at several places within about a mile of this; it is generally coarser grained, and contains large individuals of brown mica, white pyroxene and occasionally small quantities of graphite and pyrites.

From Chatham I proceeded to Grenville, and from this to the marble beds at Charlevoix' Mill near the falls of the River Calumet. Here a dyke of trap cuts through an ophitic limestone. The proportion of the serpentine is greater in the immediate proximity of the dyke, which is bounded on each side by a thin layer of pure serpentine, a fact which may tend to throw some light upon the agents which have been active in the changes that have resulted in the introduction of silica and magnesia into the rocks. In the seams of the limestone were found thin coatings of fibrous serpentine, approaching pierolite in character. As the locality has been already described by yourself, and presented nothing more of interest, I will dismiss it, reserving the discussion of any hypothesis which may be suggested by the subject, for another time.

About a mile east of this, on the land of Mr. Anderson, and on the thirteenth lot of the third range of Grenville, is a ledge of coarse crystalline limestone, which the proprietor had persuaded himself and his neighbours was gypsum or plaster of Paris. In accordance with this idea he was about to erect a mill for the purpose of grinding the material, and had already made preparations for it, when I to his great disappointment, undeceived him.

Overlying this limestone was a band of syenitic gneiss, which was rapidly disintegrating from the presence of a considerable quantity of iron-pyrites in a decomposing state disseminated through the rock. Mr. Anderson, the proprietor, had been induced to believe that he would obtain copperas from the place, and was quarrying with the hope of finding something of value, but the small quantity of the pyrites present, and its dissemination, forbid the idea of any economical value. Near this were two mineral springs to which the people attributed great medicinal powers; one of them was slightly chalybeate and sulphurous, and the other did not sensibly differ from ordinary spring water.

We then proceeded to the plumbago mine formerly wrought by the Hon. Mr. Harwood, on the south half of the tenth lot of the fifth range of Grenville. Here, in addition to the sphene tabular spar, plumbago, pyroxene and fel-spar, were found fine crystals of yellow idocrase. The peculiarities of this vein have already been described by yourself in your Report on the Ottawa, and any further notice is unnecessary.

About half a mile from this, on the north half of the same lot, is another deposit of plumbago, upon the land of Mr. Johnson. The vein has a course N. 27½ W. magnetic. It has scarcely been explored; an excavation of five or six feet at the foot of a hill in which the vein appears, being the whole examination made. The plumbago appeared to be in three *strings* from two to eleven inches wide, but I have since been informed that on digging down a few feet, the three unite in a vein eighteen inches in width, and quite free from any foreign substances. The specimens of the plumbago collected, seem quite soft and pure, and the locality is certainly well deserving of further exploration.

Accompanying the plumbago is a vein consisting chiefly of calc-spar and pyroxene. The calc-spar is beautifully white, and affords fine cleavable masses an inch or two in diameter, with a well-marked diagonal cleavage. The pyroxene often presents upon its cleavage planes, a peculiar bluish opalescence; it occurs in well-terminated crystals often half an inch in diameter, or in large cleavabe masses of a darker green color. Tabular spar is occasionally found in small masses of a delicate greenish-white and sphene in drusy-surfaced crystals of a light-brown color. Throughout the mass, crystals of zircon or hyacinth occur in considerable abundance; some have been found an inch in length and three-eighths of an inch in diameter, well terminated but dark-colored and only translucent. Smaller transparent ones are however met with of a fine hyacinth-red, which exhibit finely modified terminations and constitute gems of rare beauty. A further examination of this interesting locality will no doubt develope much of both scientific and economical interest.

From Grenville I proceeded to Bytown, and visited Blasdell's Mills on the Gatineau, some seven miles from its junction with the Ottawa. Here the rocks have been largely quarried in the construction of timber slides, and it was hoped the exposure

would present some things of mineralogical interest. The rocks are chiefly felspathic, often containing flesh-red felspar in large masses mixed with translucent quartz, and occasionally with mica. Some beds of quartz are met with, often containing rounded grains of pyroxene. This latter mineral is abundantly disseminated throughout the other rocks, and often makes up large portions of them; it occurs also in veins and nests, and sometimes lines seams, with small crystals; the colour varies from a light to a dark-green.

Calcite is found in patches in the felspathic and pyroxenic rocks, often of a reddish colour, but not very abundant; apatite in small imperfect crystals of a yellowish-green was observed in one loose mass, and masses of cleavable black hornblende in another, but neither of these could be found *in sitâ*. The only other minerals observed at this locality, were small portions of black tourmaline and iron pyrites.

Leaving Bytown I proceeded to Portage du Fort and thence to the Falls of the Grand Calumet; here the fine slides lately constructed by the government, have required a large amount of excavation in the limestone rocks, and it was anticipated that many interesting minerals might have been disclosed. The unusual height of the water however, precluded the possibility of examination in many of the situations which promised much of interest, and the principal part of the materials excavated during the labours of the previous winter, had been thrown into a pit, where they were at the time of my visit covered with several feet of water.

The beds of the white limestone, which is here abundant, are often fine grained and free from foreign materials, and as they cleave well, will doubtless be found serviceable for architectural purposes. The intermixture in considerable quantities, of serpentine, generally of light colours, characterises a large portion of the rock; iron pyrites is also abundant, sometimes in masses an inch or more in diameter. In deepening the slides the previous winter, beds of a coarse grained limestone were met with, containing a large quantity of pyroxene and mica. The pyroxene is greenish-white or greyish-green; the crystals, which are opaque and never brilliant, are fine prisms sometimes six inches in length and not more than a quarter of an inch in diameter;

some are smaller, and others an inch in diameter are met with. The prisms are often replaced upon the obtuse lateral edges, and sometimes upon the acute edges also; they are very frequently terminated. The mica is the binaxial species, having an oblique rhombic prism for its primary; the crystals have the acute lateral edges replaced; compound forms are also met with. The mineral occurs in very beautiful slender prisms, which when small are nearly transparent, and have a delicate olive-green colour; occasionally they are found an inch in diameter and three or four in length. The calcareous spar in which they were imbedded is generally flesh-red. As the principal part of the material which had been excavated, was covered with water, I was obliged to depend for my specimens upon the intelligent slide-master, Mr. M'Laren, who had reserved a considerable quantity of them.

One of the reverend gentlemen of the Seminary of this city, had obtained a few months previously, from one of the labourers at the slide, a fragment of limestone similar to that just described, in which were imbedded several magnificent crystals of idocrase of a rich hair-brown, brilliant, highly modified and nearly an inch in diameter; after some inquiry, I found the person who furnished it, and was informed that it was obtained at the same time with the pyroxene, but no specimens of it could be found among the few masses of the rock which were not submerged. An examination at low water would doubtless develop some more of this fine mineral which, for the size and beauty of its crystals, equals any specimens I have ever seen.

On the side of one of the cuts at the slide, appears a rock made up of felspar and crystals of dark green pyroxene, in which are imbedded small clove-brown crystals of sphene; but here, as at many other places, blasting was at that season considered by the slide-master as inadmissible, from the danger of impeding the passage of the slide with fragments. In several other places, nests of crystalline minerals were observed from above, but in such positions as to be quite inaccessible, while the water was in its present height. Some few imperfect crystals of brown tourmaline were observed in quartz, and masses of a coarse variety of this mineral were often seen in the limestone. Black tourmaline in imperfect crystals in a felspathic rock, was also seen abundantly in a cut by one of the slides, but here, as before, we were unable to blast the rocks.

A mass of white limestone was found near the second slide, containing light-green serpentine with brown mica, pyrites and minute prisms of apatite, besides chocolate-brown crystals of a species which will probably prove new; it somewhat resembles sphene, from which however it is distinguished by an inferior hardness and a different cleavage. It yet remains for examination. Neither this nor the same forms of accompanying minerals, were found except in this one mass, which was nevertheless evidently excavated from the neighbourhood.

My thanks are due both to Mr. M'Laren, the slide-master, and to Mr. Molloy, one of the contractors at the slide, for their kind attentions and the assistance furnished me while at the Calumet.

About a mile below the slides, a bed of serpentine occurs in the limestone; it is of greenish-grey colour and has an earthy fracture, and when recent is so soft as to be cut with a knife, a property which is taken advantage of by the Indians, to construct bullet moulds and calumets or pipes; hence the name of the island. The limestone from the Calumet down to the Portage du Fort presented nothing of interest; it was examined in many places and was either fine grained, with intermixed serpentine, or coarsely crystalline, with pyroxene and mica. At the Mountain Slide, a delicate white asbestiform tremolite was observed in a very fine grained white limestone.

Returning from the Portage du Fort, I stopped at the Island Portage, at the exit of Lac des Chats. The minerals observed here were brown tourmaline, of which imperfect crystals are found imbedded in quartz, often with iron pyrites, and cleavable masses of white translucent calcite. As at the Calumet, the rocks excavated in making the slide were principally under water. The railroad which runs across the island is cut through the rocks in some places. The sections exhibit principally syenitic gneiss, with patches of felspar and a little pyroxenic limestone.

From this I returned to Bytown, and crossed over to Hull, to examine the deposit of magnetic iron ore, as already described by yourself in your Report on the Ottawa. The one appears to form a bed of forty feet in width, bounded by syenitic gneiss on one side, and by crystalline limestone on the other. The latter often contains graphite, which in one place forms a vein an inch or two wide; the same mineral is often disseminated through the iron ore

in small scales. A hornblendic band in the syenitic rock, was observed to contain small grains of brilliant red garnet. Various reports were common among the country people of zinc, lead and other metallic ores, which were reported to have been found in this vicinity; but my examinations, with one of them for a guide, developed no other minerals than those above mentioned.

Leaving Bytown, I proceeded down the Rideau Canal to Oliver's Landing, and thence to Perth, designing to visit the interesting mineral region in its vicinity. This has already been explored to a considerable extent by Dr. Wilson of Perth, a gentleman who, notwithstanding the duties of an extensive country practice, has been able to devote considerable attention to the natural history of his district, and to enrich the mineralogy of the Province by the discovery of many very interesting minerals; and I may here express my obligations to him for his politeness and kind attentions during my examinations in his neighbourhood, accompanying me in many of my excursions, and often furnishing me with specimens from his own collection.

Our first excursion was to a locality of apatite or phosphate of lime, discovered but a short time previous by Dr. Wilson. It is found in the fourth lot of the eighth range of Burgess, in a bed of coarse crystalline limestone tinged of a flesh-red, and often embracing grains of pyroxene. The crystals are generally of considerable size, varying from half an inch to an inch in diameter. One immense crystal was found which measured twelve inches in length and nine and a half inches in circumference, and was terminated at one end. From its great size and its brittleness, it was impossible to remove it entire, but about one half was preserved. The apatite of this locality is translucent, and has a delicate celandine-green colour; the angles of the crystals are invariably rounded, and the terminations rarely distinct, the whole crystals looking as if they had been half-fused after their formation, a peculiarity which is also perceived in the crystals of this mineral from other parts of the same limestones, as for example in the fine specimens from St. Lawrence County, New York. The mineral is very abundantly disseminated through the rock, and frequently in rounded masses, in which no distinct crystalline faces can be observed. Associated with it, are beautiful crystals of rhombic mica, two or three inches in diameter; its

lustre is unusually metallic, and its colour nearly steel-grey ; the crystals frequently present the appearance of having been contorted after their formation, in such a manner as to separate the foliæ of the mica and admit of the introduction of thin laminæ of calcareous spar. One crystal was found enclosing a fine prism of apatite an inch and a half in length ; the principal axis of the prism was coincident with the basal cleavage of the mica. Overlying this rock was a limestone embracing a large quantity of pyroxene.

The attention of scientific agriculturists has within a few years, been much directed to the important part sustained in the vegetable economy by phosphates, and the great fertilizing powers possessed by phosphate of lime, particularly in the form of bone manure, are universally recognized. With a view of obtaining some cheaper source of this substance, some enterprising Englishmen have lately been exploring a deposit of native phosphate of lime in Spain. Under these circumstances, the limestone just described, which contains throughout it, a large supply of this important substance, is certainly well worthy of the attention of our agriculturists. The rock might be directly ground to a powder and applied to the soil, or previously burned to lime, when the united virtues of the phosphate and of quick lime would be rendered available to the soil. In two or three other places, the limestone has been observed to contain large quantities of this mineral disseminated, and doubtless in sufficient abundance to supply any demand. The phosphate of lime is largely contained in wheat; and the exhaustion of this ingredient is one great cause of the sterility of our worn-out wheat lands. In a grain-growing country like Canada therefore, the existence of such deposits as these will prove of great importance.

Not far from the locality of the apatite, on the land of Mr. George Holliday, on the second lot of the ninth range of Burgess, is a deposit of copper pyrites. It occurs in the crystalline limestone, but the explorations, which had consisted only in two or or three small blasts, had not developed any well-defined vein, although masses of the ore four or five inches in diameter had been obtained from the spot ; it seemed in *nests* or *strings* throughout the rock. The ore is a pure copper pyrites, granular, often crystalline and somewhat intermixed with calcareous spar.

Specimens from this locality, which I had formerly received from the Hon. William Morris, gave me upon an average 27·5 per cent of metallic copper. The richness of the ore is such as would certainly warrant explorations, and it is not improbable that the strings will be found to unite in one vein.

Among the masses of rock thrown out in blasting, were some consisting of silvery mica, with quartz, felspar or albite, and calc-spar, which contain imbedded masses of a delicate emerald-green and almost transparent pyroxene of rare beauty, and crystals of a dark honey-yellow sphene. The mica is often aggregated in masses of small crystals having a columnar arrangement; imbedded in this, and indeed disseminated throughout the rock, were a great number of small crystalline grains of a transparent mineral, varying in color from a light rose-red to a deep sapphire-blue. Their hardness, which is so great as to enable them to scratch readily the face of a crystal of topaz, shewed them to be nothing else than the very rare mineral *corundum*, which from its colors is referable to the varieties known as the *oriental ruby* and *sapphire*. The grains obtained were small, none indeed larger than a pepper-corn, but at the time I was on the spot they were not noticed, and the specimens were collected for the pyroxene, in only two or three of which I have since detected the corundum. It is probable that further examinations may develop larger and more available specimens of these rare and costly gems. It is in this crystalline limestone that they generally occur; and the corundum found in the State of New Jersey, is in the same rock and with similar mica. Those of the sands of Ceylon, which have supplied the market of the world with these gems, are derived from a similar crystalline limestone. I am indebted for this interesting fact to the courtesy of Major Lachlan, now of this city, a gentleman who spent many years of his life in India, and, ever alive to the interests of natural science, made a fine collection of the minerals and other natural curiosities of Hindostan and Ceylon. Among these is a fragment of white crystalline limestone, containing small crystals of sapphire, with grains of chondrodite. The latter mineral, which is quite characteristic of these peculiar limestones, is very abundant throughout those of New York and New Jersey, and although I have not yet observed it in place in Canada, I have seen a specimen in the hands of

Dr. Holmes of this city, which was broken from a boulder near Bytown, and which contains crystals of spinel, with chondrodite, in limestone. The existence of the mineral corundum is also interesting from another consideration: it is this substance in a coarse massive form, which constitutes the emery of the East Indies, so much valued as a material for cutting and polishing gems and articles of cutlery.

In company with Dr. Wilson, I then proceeded to examine the locality from which he had obtained the specimens described by Dr. Thompson of Glasgow, as *perthite*. It is nothing more than a reddish felspar which makes up a large portion of an intrusive mass of granite in the limestone. The perthite occurs in large individuals often three or four inches diameter. It is of different shades of reddish-brown, the colors being arranged in bands, and the surfaces of cleavage parallel to P, present golden reflections like the sun-stone. From the analysis of Dr. Thompson it would appear that this mineral, unlike other felspars, contains no potassium, which is according to him replaced by calcium, and it was upon this chemical difference principally, that he predicated its distinctness as a species. It has however been analysed by my pupil Mr. Hartley, in the Laboratory of the Survey, and the results show that it contains both potassium and sodium, and is indeed quite similar in composition to other felspars. This locality is in the third lot of the sixth range of Bathurst.

Not far from this place on the fourth lot of the same range, is a vein of heavy spar or sulphate of barytes in gneiss, about a foot wide; it occurs either massive or in thin bladed crystals. Small grains of copper pyrites are disseminated through it, but otherwise it is free from foreign substances, and it is worthy of attention as a material for paint. This mineral is very extensively used both in Great Britain and America for the adulteration of white lead, if indeed it may be called an adulteration which is universally known and admitted by all manufacturers and consumers of the article. Its great specific gravity and opaque whiteness render it peculiarly adapted for this purpose, and it is also often employed as a paint by itself, under the name of *permanent white*. As this is the only considerable deposit of heavy spar yet known in the country, with the exception of the enormous veins described as existing on the north shore of Lake Superior, it is

well worthy of attention. I was not able to examine the vein in person, but am indebted for the above account of it, to the accurate observations of Dr. Wilson, and the specimens kindly furnished me by him.*

On my return from the perthite locality, we examined a place which affords abundance of sphene. It is on the tenth lot of the sixth range of Elmsley, and the locality is a large vein of pyroxene with felspar, in which this sphene is found imbedded in imperfect crystals of a clove-brown. Near here, are beds of a rock which is made up of bright green pyroxene and black mica.

Having detected among the specimens in the possession of Dr. Wilson, some crystals of black spinel, I went to examine the place from which they had been obtained. It was on the tenth lot of the first range of Burgess, and imbedded in the flesh-red crystalline limestone, which for a mile or two often exhibits small crystals of the mineral; the best specimens were obtained from loose masses of the limestone scattered about the fields, although large crystals an inch in diameter but more or less coated with mica were found near the house of Mr. Ritchie, where the limestone had been quarried for burning. One of these was two inches in diameter and had its edges replaced; it was more or less intermixed with calcareous spar which was observed penetrating the crystal. In ploughing a field near there, a mass of crystals was found, completely separated from their gangue, and weighing eight ounces. They were about thirty in number, and exhibited various modes of composition in their aggregation; their diameters were from one-fourth of an inch to one inch. The faces were beautifully black and brilliant, and the larger ones exhibited cavities filled with small and brilliant octahedrons.

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* Note.—Since the above was written, I have collected the following information with regard to the price and consumption of heavy spar, for which I am indebted to Mr. Whitney of Newhaven, Conn., who manufactures it extensively at that place. The present annual consumption in the United States is about 4000 tons; of this 2500 tons are raised in the States and the remainder imported from England. The price of the manufactured article is about $30 per ton of 2240 pounds, while the crude material, according to its purity, is worth from $8 to $10 per ton. The process of manufacture consists in sorting and washing it, after which it is broken to a powder and digested with dilute sulphuric acid, to remove the earthy and metallic impurities which may be present, and finely ground to a powder.

Black tourmaline is frequently met with in the accompanying rock. The discovery of spinel in our limestones is one of much interest, although from the similarity which exists between the limestones of northern New York and of Canada, its presence was to be expected. Hitherto the only evidence of its existence, was the presence of one or two minute crystals found in a boulder with chondrodite, and in the possession of Dr. Holmes, to which I have already referred.

There were many other interesting minerals which had been observed by Dr. Wilson, and which I should have visited but that the localities were often such as could not be found without a guide, but with great difficulty, and the professional duties of Dr. Wilson prevented him from accompanying me. Among these were the *peristerite* of Dr. Thompson, so named from its beautiful bluish iridescence. It is white, often bluish or reddish, occurs in large cleavable masses, and appears to be nothing more than massive feldspar or labradorite containing disseminated grains of quartz. Cut specimens of this, which I saw in the possession of Dr. Wilson, were highly beautiful, exhibiting, when cut in the proper direction, a delicate celestial-blue opalescence. It forms a large mass, probably a vein or dyke, in the nineteenth lot of the ninth range of Bathurst. In the immediate neighbourhood of this, a beautiful white mineral occurs, which cleaves readily into regular forms, often two or three inches in length, that appear to be referable to the diclinate system, and to be probably nothing else than labradorite, although the colours of this mineral are generally dark. The face P presents a fine play of colours, which in polished specimens are exceedingly beautiful; the colours are blue, varying from light sky-blue to violet, pearly-white and gold, equalling in elegance the specimens from the coast of Labrador; it forms a beautiful ornamental stone. The mineral appears to be identical with that which constitutes the base of the peristerite.

Labradorite occurs also in the first lot of the third range of Drummond, where it forms large beds; the mass of the rock is a confusedly crystalline aggregation of the mineral, with quartz, containing imbedded large cleavable masses of it, often several inches in diameter. The colour is blackish-green, but when polished or moistened with water, and held in the proper light,

the before dark and dull surface glows with hues of "azure, green and gold," rivalling in beauty the plumage of the humming bird. This locality will furnish abundance of this rare and beautiful ornamental stone.

Fine black tourmalines are found in white translucent quartz in the eighteenth lot of the fourth range of Bathurst; crystals are met with an inch in diameter, having finely modified terminations. The *Bytownite* of Thompson is found abundantly in the tenth lot of the sixth range of the same Township; but its claim to be considered a distinct species is rather doubtful, and it requires further examination.

In the Township of Dalhousie, tenth lot and sixth range, are beds of fine white dolomite holding abundance of crystallized white hornblende. The *ferruginous silicate of manganese* of Thompson, which occurs in quartz on the second lot of the second range of Lanark, appear to be nothing more than a manganesian hornblende resembling the variety actynolite. The *raphilite* of Thompson appears equally referable to the same species, and to be an asbestiform tremolite somewhat peculiarly aggregated.

Ligniform asbestus occurs abundantly in the fifth lot of the seventh range of Lanark, apparently associated with serpentine, which is not uncommon in the limestone of this vicinity. Dr. Wilson also furnished me with a specimen of a mineral characterised by Dr. Thompson as *anthophyllite*, associated with satin spar. It deserves further examination.

A boulder of granitic rock found near the spinel locality at Bathurst, contained a mass of the very rare mineral spodumene; but the thoroughly worn and rounded form of the boulder, renders it probable that it may have been transported a long distance.

Such were some of the results of this tour; but as it was observed at the beginning, my various occupations since that time have prevented me from examining minutely or describing accurately, the minerals collected; the results of these will be deferred to a final Report.

EXAMINATIONS OF MINERAL WATERS.

After my return from the Eastern Townships, I proceeded, in accordance with your instructions, to collect some of the more im-

portant mineral waters of the Province, with a view of submitting them to chemical analyses. Some remarks as to the mode of collecting the waters, may not be out of place here, as showing the care taken to prevent any errors, and to transport the waters unchanged to the laboratory, where their analysis has occupied the winter season. Unless otherwise stated, they were always collected by myself from the spring, and put into large glass jars, holding about 100 lbs.; these were nearly filled, and being carefully stopped, the mouths were secured by a lute, which entirely excluded air, and prevented the escape of gases. For the determination of the gases, the processes directed by Fresenius, in his admirable treatise, were employed ; they consist in directly fixing upon the spot, the carbonic acid gas, by ammonio-chlorid of calcium, and the sulphuretted hydrogen, by a solution of chlorid of arsenic. Carefully-measured portions of the water being placed in bottles with these substances, the bottles were tightly sealed, and could thus be preserved until they were brought to the place of analysis. It is not the place in a report like this, to enter into a detail of the refined processes employed in researches of this kind ; it is sufficient to say that the most accurate and improved methods were resorted to, and that no pains were spared to make the results in every respect worthy of confidence.

In stating the composition of the waters, I shall first give the quantity of bases, acids and radicals in a thousand parts, and then in accordance with the general custom, shew how these may be united to form saline combinations; in following this course I have conformed to the general practice of chemists, rather because the results are more intelligible to the unscientific, and at the same time more readily compared with those of other analysts, than because the compounds thus calculated, represent the combinations actually existing in the water. The opinion is generally received among chemical philosophers, that there is really a partition of acids and bases in the solution. For example in the water of the " Intermitting Spring" of Caledonia are found chlorine and bromine, with potassium, sodium, calcium and magnesium. In calculating this I have represented the whole of the bromine as combined with the magnesium, while the potassium, sodium and calcium and the remainder of the magnesium

are supposed to exist as chlorides. In reality however, it is probable that the bromine is distributed among the four metals in a proportion which we have as yet no definite means of determining.

For greater convenience I have calculated also the amount of the different foreign substances in one pound avoirdupois; this equals 7000 grains, or very nearly a wine pint, which weighs 7291 grains. A weighed quantity was preferred for purposes of comparison, as from slight differences between the specific gravities of the mineral waters and of distilled water, as well as between the different waters themselves, it was difficult otherwise to institute an accurate comparison.

The analyses were all performed upon weighed portions of water in preference to using measures; and the weights, including the specific gravities, were determined by a delicate balance made to order by Deleuil of Paris, and sensible to the demi-milligramme, when loaded with 200 grammes.

THE CALEDONIA SPRINGS.

These springs are four in number; the waters rise through the strata of clay which overlie a rock equivalent to the Trenton limestone. Three of them, known as the "Gas Spring," the "Saline Spring, and the "White Sulphur Spring," are situated within a distance of four or five rods, and the mouths of the latter two, are not more than four feet apart. The fourth, known as the "Intermitting Spring," is situated about two miles distant, and is much more saline than the others. The first three are alkaline, the sulphur spring strongly so, while the latter contains in solution a great quantity of earthy chlorids. None of these waters are what are called "acidulous saline," a character which is due to the presence of large quantities of carbonic acid, and renders them pungent to the taste, and sparkling like champagne; to this the Seltzer and Saratoga waters owe their peculiar characters. The quantity of this acid found in these waters, is no more than is required to form bicarbonates with the bases present.

I.—*The "Gas Spring."*

The waters of this spring were collected on the 27th of September, 1847. The temperature of the air being 61.7° Fahrenheit,

that of the spring was 44.4. The dircharge was ascertained by careful measurement to be four gallons per minute, a quantity which is little subject to variation. The water in the well is kept in constant agitation by the escape of carburetted hydrogen gas, which is evolved in considerable quantity. It was roughly estimated at the time, to be 300 cubic inches a minute, but the discharge as I was informed, is often much more abundant.

The specific gravity of the water was found to be 1006.2. It is pleasantly saline to the taste, but not at all bitter; by exposure to the air it gradually deposits a white sediment of earthy carbonates. Its reaction is distinctly alkaline to test papers.

The examination of the unconcentrated water shewed the presence of chlorine, calcium and magnesium, but when the liquid is concentrated by boiling, the whole of these bases are pecipitated as carbonates, and the clear liquid is alkaline, yielding with a solution of chlorid of barium, a copious precipitate of carbonate which is dissolved by hydrochloric acid, leaving only a small quantity of sulphate of baryta. The alkaline liquid being evaporated to dryness, and the residue digested with alcohol, the solution gave evidence of the presence of both bromine and iodine; the saline residue was found to consist of salts of sodium with a small portion of chlorid of potassium. The precipitate of earthy carbonates contained traces of alumina, iron and manganese. On evaporating to dryness a quantity of the water with an acid, and treating the residue with water, a portion of silica was obtained.

The modes by which the quantities of chlorine, sulphuric acid, calcium, magnesium, sodium and potassium were obtained, need no particular description. The amount of the first two bases was determined first upon 1000 grammes of the water evaporated with an acid, and then, the same quantity having been boiled with the addition of distilled water until all the earthy salts were precipitated, the respective amounts of the calcium and magnesium, both in the precipitate and the filtrate, were determined, and those in the latter, regarded as corresponding to the chlorids and sulphates of those bases, in the recent water. The alkalies were separated by successive treatment with baryta and carbonate of ammonia, and the amount of potassium in the mixed chlorids was then determined by converting them into the platino-chlorids, and separating the sodium salt by alcohol.

The bromine and iodine were determined by evaporating fifty pounds of the water to a small bulk, separating the earthy precipitate, and finally evaporating the residue to dryness. This was treated with alcohol of sp. gr. ·835 until all traces of iodids and bromids were removed. The alcoholic solution was then evaporated to dryness, and the treatment renewed with alcohol of ·820; this process was repeated a third time, having previously ignited the residue to destroy any organic matters, and the solution being again evaporated to dryness, was dissolved in water, and the amount of iodine determined after the admirable method of Lassaigne, which consists in precipitating it as an iodid of palladium.

The bromids and chlorids remaining in the solution, were decomposed by a solution of nitrate of silver, and the mixed precipitate of chlorid and bromid of silver, after being fused and carefully weighed, was submitted in a state of fusion to the action of a current of dry chlorine gas, until the whole was converted into chlorid; from the loss, the amount of bromine was deduced by calculation.

The total amount of carbonic acid was determined by mixing measured portions of the water at the source, with caustic ammonia and a solution of chlorid of calcium; the proportion of carbonic acid in the precipitate thus obtained, was determined in the usual manner. The amount of carbonic acid required by those bases which were known to exist as carbonates in the water, was then deducted. The quantity of carbonate of soda was calculated from the excess of sodium over that required for the saturation of the chlorine, bromine, iodine and sulphuric acid, controlled by the amount of carbonate of baryta obtained by treating a solution of the solid residue of 1000 grammes of the water, with chlorid of barium; the two results closely agreeing.

1000 parts of the water of the Gas spring gave—

Chlorine	4·242810
Bromine	·011730
Iodine	·000461
Sulphuric acid (SO^3)	·002400
Soda	3·726400
Potash	·022100
Lime	·082880
Magnesia	·254600
Alumina	·004400
Silica	·031000
Iron and Manganese,	traces,
Carbonic Acid	·705000

These may be combined to form the following compounds—

Chlorid of Sodium	6·967500
" of Potassium	·030940
Bromid of Sodium	·015077
Iodid of Sodium	·000530
Sulphate of Potash	·005280
Carbonate of Soda	·048570
" of Lime	·148000
" of Magnesia	·526200
" of Iron and Manganese, traces,	
Alumina	·004400
Silica	·031000
Carbonic Acid	·349000
Water	991·873503
	1000 000000

Saline ingredients in 1000 parts, 7·7775.

A pound or 7000 grains contains—

Chlorid of Sodium	48·772500
" of Potassium	·216580
Bromid of Sodium	·105539
Iodid of Sodium	·003710
Sulphate of Potash	·036960
Carbonate of Soda	·339990
" of Lime	1·036000
" of Magnesia	3·683400
Alumina	·030800
Silica	·217000
Carbonic Acid	2·443000
Water	6943·114521
	7000·000000

Carbonic acid in 100 cubic inches, 17.5.

II. *The "Saline Spring."*

The spring thus named, is very similar to the last, but in reality less strongly saline. Its temperature was 45 F., that of the air being at the same time 60 F. The specific gravity is 1005·824. Its reaction is more strongly alkaline, but otherwise the results of its qualitative examination are similar to those given under the head of the "Gas spring." It contains no sulphuretted hydrogen whatever; some few bubbles of carburetted hydrogen are evolved,

but the quantity is very small. The discharge from this spring is about ten gallons per minute.

1000 parts of the water gave—

Chlorine	3·93830
Bromine	·01317
Iodine	·00123
Sulphuric Acid (SO^3)	·00220
Soda	3·52246
Potash	·04100
Lime	·06580
Magnesia	·25020
Silica	·04250
Alumina, Iron and Manganese, traces,	
Carbonic Acid	·64800

These may be combined in the following manner :—

Chloride of Sodium	6·44090
" of Potassium	·02960
Bromid of Sodium	·01696
Iodid of Sodium	·00146
Sulphate of Potash	·00480
Carbonate of Soda	·17620
" of Lime	·11750
" of Magnesia	·51724
" of Iron and Manganese } Alumina } traces,	
Silica	·04250
Carbonic Acid	·29200
Water	992·36084
	1000·00000

The pound of 7000 grains will consequently consist of—

Chlorid of Sodium	45·08630
" Potassium	·20720
Bromid of Sodium	·11872
Iodid of Sodium	·01022
Sulphate of Potash	·03360
Carbonate of Soda	1·23340
" of Lime	·82250
" of Magnesia	3·62068
" of Iron and Manganese } Alumina } traces,	
Silica	·29750
Carbonic Acid	2·04400
Water	6946·52588
	7000·00000

The amount of solid matter in 1000 parts of the water is by calculation 7·347; experiment gave 7·280, which is a close approximation. The carbonate of magnesia loses a part of its carbonic acid during the evaporation, and exists in the residue as a basic carbonate, and hence the slight deficiency in the result of experiment.

The quantity of carbonic acid, above what is represented as combined with the bases, equals 14·7 cubic inches in 100 cubic inches of the water.

III. *The "White Sulphur Spring."*

This spring is situated very near to the last; the openings of the two wells being not more than four feet apart. Although it bears the name of a sulphur water, its claim to that title is very small. It has a feebly sulphurous taste and odor, and darkens slightly salts of lead and silver, but the quantity of sulphur existing either as sulphuretted hydrogen or as alkaline sulphuret is very inconsiderable, and cannot be quantitatively estimated by the ordinary processes.

Several bottles of the water were mixed with a solution of arsenic at the spring, but the precipitate of sulphuret of arsenic was scarcely perceptible; the quantity of the sulphuretted hydrogen was not equal to a cubic inch to the gallon. It is still, however sufficient to impart medicinal powers to the water, for the efficacy of this spring over all the others, in rheumatic and cutaneous affections is well attested. According to Dr. Stirling, who has been for many years a resident at the springs, and is a careful observer, the water was formerly much more sulphurous than at present; a thing not at all improbable, as it is well known that springs often change their character materially in the course of a few years.

The supply from this spring is apparently about the same as that of the "Gas Spring"; its waters flow into the same reservoir as those of the saline springs, and the two are used for hot baths. The mixture, after being heated for use, is without any odor of sulphur.

The temperature of the spring was found to be 46° F., that of the air being 60° F.

The specific gravity of the water at 60° F. is 1003·7; its re-

action is strongly alkaline, and the results of its qualitative examination show that it closely resembled the two preceding waters, except that traces only of iodine were detected in it.

1000 parts of the water of the sulphur spring gave :—

Chlorine	2·12500
Bromine	·00781
Iodine	traces,
Sulphuric Acid	·01030
Potash	·01450
Soda	2·12370
Lime	·11760
Magnesia	·14230
Iron	traces,
Alumina	·00265
Silica	·08400
Carbonic Acid	·59000

These combined in the usual manner, give as the composition of 1000 parts of the water :—

Chlorid of Sodium	3·84300
" of Potassium	·02300
Bromid of Sodium	·01004
Iodid of Sodium	traces,
Sulphate of Soda	·01833
Carbonate of Soda	·45580
" of Lime	·21000
" of Magnesia	·29400
" of Iron	traces,
Alumina	·00265
Silica	·08400
Carbonic Acid	·14100
Water	994·91818
	1000·00000

The quantity of carbonic acid over that required to form neutral carbonates, would in a gaseous state equal 7·2 cubic inches in 100 of the water. The amount required to form the above carbonates is ·449, and an equal quantity of carbonic acid would be necessary to enable them to exist as bicarbonates, a condition in which these earthy bases are generally regarded as being dissolved in mineral waters. The whole of these alkaline waters have, it will be observed, shewn a deficiency in the quantity of carbonic acid, and this is particularly marked in this last and most strongly alkaline of them all. This apparent

difficulty is at once explained by the fact that the whole, or a part of the carbonate of magnesia, exists in the form of a double carbonate of soda and magnesia, a compound which is readily soluble in water and much more permanent than the bicarbonate.

The large amount of silica which it contains, is an interesting peculiarity, and naturally connects itself with the strongly alkaline character of the water. As silica is capable of decomposing a solution of carbonate of soda, it is probable that a portion of the soda must really exist in the condition of a silicate. From the uncertainty which still remains as to the composition of these soluble silicates, it is impossible to calculate the portion of the soda which should be deducted from that represented as existing as carbonate, but an indirect experiment throws some light upon the question. 1000 grammes of the water were evaporated to perfect dryness, to render all the magnesia insoluble. The residue being then dissolved in distilled water, was mixed with a solution of chlorid of barium, and yielded a precipitate of carbonate, with a little sulphate, which contained an amount of carbonic acid corresponding to ·2540 of carbonate of soda, while the excess of soda above that required for saturating of the chlorine, bromine and sulphuric acid, equalled ·4558 parts of carbonate. The difference ·2018 corresponds to ·1179 of pure soda, which may be regarded as forming a silicate with the ·0840 of silica. With our imperfect knowledge of the silicates, especially the soluble ones, it is obviously useless to speculate farther upon the mode of combination in which these substances exist.

The amount of solid matters in 1000 parts of this water is 4·9406 parts, and the composition of 1 pound of 7000 grains is as follows :—

Chlorid of Sodium	26·90100
" of Potassium	·16100
Bromid of Sodium	·07028
Iodid of Sodium	traces,
Sulphate of Soda	·12831
Carbonate of Soda	3·19060
" of Lime	1·47000
" of Magnesia	2·05800
" of Iron	trace,
Alumina	·01855
Silica	·58800
Carbonic Acid	·98700
Water	6964·42726
	7000·00000

action is strongly alkaline, and the results of its qualitative examination show that it closely resembled the two preceding waters, except that traces only of iodine were detected in it.

1000 parts of the water of the sulphur spring gave :—

Chlorine	2·12500
Bromine	·00781
Iodine	traces,
Sulphuric Acid	·01030
Potash	·01450
Soda	2·12370
Lime	·11760
Magnesia	·14230
Iron	traces,
Alumina	·00265
Silica	·08400
Carbonic Acid	·59000

These combined in the usual manner, give as the composition of 1000 parts of the water :—

Chlorid of Sodium	3·84300
" of Potassium	·02300
Bromid of Sodium	·01004
Iodid of Sodium	traces,
Sulphate of Soda	·01833
Carbonate of Soda	·45580
" of Lime	·21000
" of Magnesia	·29400
" of Iron	traces,
Alumina	·00265
Silica	·08400
Carbonic Acid	·14100
Water	994·91818
	1000·00000

The quantity of carbonic acid over that required to form neutral carbonates, would in a gaseous state equal 7·2 cubic inches in 100 of the water. The amount required to form the above carbonates is ·449, and an equal quantity of carbonic acid would be necessary to enable them to exist as bicarbonates, a condition in which these earthy bases are generally regarded as being dissolved in mineral waters. The whole of these alkaline waters have, it will be observed, shewn a deficiency in the quantity of carbonic acid, and this is particularly marked in this last and most strongly alkaline of them all. This apparent

difficulty is at once explained by the fact that the whole, or a part of the carbonate of magnesia, exists in the form of a double carbonate of soda and magnesia, a compound which is readily soluble in water and much more permanent than the bicarbonate.

The large amount of silica which it contains, is an interesting peculiarity, and naturally connects itself with the strongly alkaline character of the water. As silica is capable of decomposing a solution of carbonate of soda, it is probable that a portion of the soda must really exist in the condition of a silicate. From the uncertainty which still remains as to the composition of these soluble silicates, it is impossible to calculate the portion of the soda which should be deducted from that represented as existing as carbonate, but an indirect experiment throws some light upon the question. 1000 grammes of the water were evaporated to perfect dryness, to render all the magnesia insoluble. The residue being then dissolved in distilled water, was mixed with a solution of chlorid of barium, and yielded a precipitate of carbonate, with a little sulphate, which contained an amount of carbonic acid corresponding to ·2540 of carbonate of soda, while the excess of soda above that required for saturating of the chlorine, bromine and sulphuric acid, equalled ·4558 parts of carbonate. The difference ·2018 corresponds to ·1179 of pure soda, which may be regarded as forming a silicate with the ·0840 of silica. With our imperfect knowledge of the silicates, especially the soluble ones, it is obviously useless to speculate farther upon the mode of combination in which these substances exist.

The amount of solid matters in 1000 parts of this water is 4·9406 parts, and the composition of 1 pound of 7000 grains is as follows :—

Chlorid of Sodium	26·90100
" of Potassium	·16100
Bromid of Sodium	·07028
Iodid of Sodium	traces,
Sulphate of Soda	·12831
Carbonate of Soda	3·19060
" of Lime	1·47000
" of Magnesia	2·05800
" of Iron	trace,
Alumina	·01855
Silica	·58800
Carbonic Acid	·98700
Water	6964·42726
	7000·00000

IV.—*The "Intermitting Spring."*

This spring has been already described, as situated about two miles distant from the others. It rises out of a bank of clay near the edge of a brook; a well has been sunk nearly thirty feet through the clay, and the water rises near to the surface. It is kept in almost constant agitation by the evolution of large quantities of carburetted hydrogen gas; the water from this cause, is kept constantly turbid by the quantity of clay diffused through it, and it is only after being allowed to stand for several hours in a quiet place, that it becomes transparent. The discharge of gas is not regular, some minutes often elapsing, during which only a few bubbles escape from time to time, after which a copious evolution occurs for a few moments, followed by another period of quiescence; from this peculiarity it is named the intermitting spring.

The temperature was found to be 50° F. at the bottom of the well; that of the air being 61°. The amount of water furnished by the spring could not be easily determined, as part of it escapes through the bank, but it is not large. At the time of my visit, the recent rains had diluted the spring with a good deal of surface water, and I accordingly availed myself of the politeness of the proprietor, Mr. Wilkinson, who allowed me to take as much as I required, from a supply which had been brought from the spring a month previous, and preserved in well-covered puncheons.

This was sensibly stronger to the taste than the water at the spring, and unlike the previously described waters, was disagreably bitter, as well as saline. Its specific gravity was 1010·939.

A qualitative examination shewed the presence of chlorine, bromine and iodine, with potassium, sodium, calcium, and magnesium; a large portion of the latter two exist in the condition of chlorids. No sulphuric acid was detected; but traces of iron and alumina. Baryta, strontia, fluorine and phosphates were sought for; but with the exception of slight traces of the latter, the results were altogether negative.

1000 parts of the water of the Intermitting Spring afforded,

Chlorine	8·36979
Bromine	.02059
Iodine	·00187
Potash	·01930
Soda	6·49360
Lime	1·44930
Magnesia	·55467
Alumina and Iron	traces,
Silica	·02250

These may be so combined as to give the following composition for 1000 parts of the water:—

Chloride of Sodium	12·250000
" of Potassium	·030500
" of Calcium	·287050
" of Magnesium	1·033840
Bromid of Magnesium	·023840
Iodid of Magnesium	·002057
Carbonate of Lime	·126460
" of Magnesia	·863230
" of Iron, Alumina }	traces.
Silica	·022500
Carbonic Acid	·501350
Water	984·859173
	1000·000000

The solid matter in 1000 parts, as determined by calculation, is 14·639 parts; the result obtained by directly evaporating a weighed quantity, and drying the residue at 300° F., was 14·500, the difference being due to a partial decomposition of the magnesian chlorid during the evaporation.

The carbonic acid of this water was not determined, as the fresh water, which was required for this purpose, was so much diluted as to be unlike the specimen analysed. If we regard the bases which were found to exist as carbonates as having been dissolved as bicarbonates, they would require the quantity of carbonic acid above given, ·501350 parts, which in a gaseous state would equal 25 cubic inches in 100 cubic inches of the water.

The composition of one pound of the water is in accordance with the above calculation, as follows :—

Chloride of Sodium	85·750000
" of Potassium	·213500
" of Calcium	2·009350
" of Magnesium	7·236880
Bromid of Magnesium	·166880
Iodid of Magnesium	·014399
Carbonate of Lime	·885220
" of Magnesia	6·042610
" of Iron, Alumina }	traces,
Silica	·157500
Carbonic Acid	3·509450
Water	6894·014211
	7000·000000

After I had collected the Caledonia waters and brought them to the Provincial laboratory, I left for Western Canada, to visit several springs there, one of which from its novel character, had become an object of considerable interest. I allude to the sour spring near Brantford. In addition to this, I collected specimens of water from a sulphurous spring at Charlotteville, and from two springs near Ancaster, one sulphurous and the other saline.

V.—*The Tuscarora "Sour Spring."*

This spring is situated in the Indian Reserve, in the County of Wentworth, about nine miles south of Brantford, and three miles south of the bank of the Grand River. The country for some distance around is thickly wooded, but in the immediate vicinity of the spring is a small clearing, upon a rising ground, on one side of which is the spring, in an enclosure some eight or ten rods square. In the centre of this, is a hillock six or eight feet high, made up of the gnarled roots of a pine now partially decayed. The whole enclosure is covered with crumbling rotten wood, and resembles a tan-heap ; upon digging down eighteen inches, the same material was found, apparently derived from the crumbling away of the trunk of the once huge pine, whose roots now occupy the centre of the enclosure. The whole soil, if it may be thus designated, is saturated with acid water, and the mold at the top of the hillock, as well as without the enclosure, is strongly

acid. Near the confines of this region, but in soil still quite acid to the taste, several plants were observed growing. They were the sheeps' sorel *(Rumex acetocella)*, the wild strawberry *(Fragaria Virginiana)*, two species of *Rubus*, the red raspberry *(R. Strigosus)* and *R. Canadensis*, besides several mosses, and a fern. The more acid parts were devoid of all vegetation.

The principal spring is at the east side of the stump, and has a round basin about eight feet in diameter and four to five feet deep; the bottom is soft mud. At the time of my visit (Oct. 18th) it was filled to within a foot of the brim; and as the guide assured me, unusually full, much fuller indeed than it had been five days previous, although no rain had fallen in the interval. There is no visible outlet to the basin; at the centre a constant ebullition is going on from the evolution of small bubbles of gas, which is found on examination to be carburetted hydrogen. The water is slightly turbid and brownish-colored, apparently from the surrounding decayed wood, which indeed forms the sides of the basin. It is strongly acid and styptic to the taste, and at the same time decidedly sulphurous; a bright silver coin is readily blackened by the water, and the odor of sulphuretted hydrogen is perceived for some distance round the place.

Within a few feet of this, was another smaller basin, two feet in diameter, and having about one foot of water in it; this was evolving gas more copiously than the other, and was somewhat more sulphurous to the taste, although not more acid. In other parts of the enclosure were three or four smaller cavities partly filled with a water more or less acid, and evolving a small quantity of gas. The temperature of the larger spring was 56° F., that of the smaller one 56° near the surface, but on burying it in the soft mud at the bottom it rose to 60.5°.

A large glass jar was filled with the water, and to three bottles into which a solution of arsenic had been previously introduced, were added thirty cubic inches of water; these were then carefully sealed and transported to the laboratory at Montreal.

Examination of the Water.—The specific gravity was found to be 1005·583. A solution of nitrate of silver did not sensibly affect it, shewing the absence of chlorine, but salts of baryta produced at once a copious precipitate insoluble in any acid, indicating that the acid present in the water was the sulphuric; the

usual tests applied to the recent water shewed the iron to be in a state of proto-salt, a condition indeed necessarily connected with the presence of sulphuretted hydrogen. When concentrated by evaporation with the addition of a little nitric acid, ammonia gave a copious red-brown precipitate; a portion of organic matter in the liquid interfered with the perfect precipitation of the iron, and hydro-sulphuret of ammonia was consequently added at the same time. The precipitate thus obtained after being thoroughly washed, was dissolved in hydrochloric acid, then boiled with nitric acid, filtered and precipitated by ammonia, with the previous addition of sal-ammoniac, and again filtered. The transparency of the filtrate thus obtained, was not disturbed by hydrosulphuret of ammonia, indicating the absence of manganese and other metals of this class, including zinc, nickel and cobalt. The precipitate was in part soluble in a solution of potash; the soluble portion was alumina, and the residue peroxyd of iron with a little magnesia. The alumina obtained from the alkaline solution was found to contain traces of phosphoric acid; by dissolving it in hydrochloric acid, adding tartaric acid, ammonia in excess and sulphate of magnesia, a slight granular precipitate of ammonio-magnesian phosphate was obtained.

The filtrate from the original precipitate by hydrosulphuret of ammonia, gave an abundant precipitate of lime, by oxalate of ammonia, and the filtrate from this precipitate yielded, when concentrated and mixed with ammonia and a solution of phosphate of soda, a granular precipitate of phosphate of magnesia and ammonia.

Another portion of this filtrate was evaporated to dryness, and ignited to expel the ammoniacal salts; the soluble salts in the residue were dissolved in water and mixed with a solution of chlorid of barium and excess of caustic baryta, and the mixture heated; to the filtrate from the precipitate thus obtained, were added carbonate of ammonia and excess of caustic ammonia, and the whole boiled and filtered; the solution was then evaporated to dryness and ignited, when a residue of alkaline chlorids was obtained. The presence of soda was shewn by the peculiar color imparted to the flame of alcohol when it was burned over the salt, and with chlorid of platinum, a bright yellow precipitate of platino-chlorid of potassium was obtained.

In a water so novel in character we might be led to expect some metal not usually present in mineral springs, and I have accordingly given the details of the qualitative analysis, to shew the measures taken to detect their presence. Arsenic, antimony, tin, lead and copper have all been recently detected in different ferruginous waters of Europe, but the presence of free sulphuretted hydrogen, which is found in the recent water of the present spring, is incompatible with their existence in solution.

1000 parts of the water yielded—

Sulphuric Acid, (SO_3)	4·63500
Potash	·03290
Soda	·02190
Lime	·31920
Magnesia	·05240
Alumina	·14000
Peroxyd of Iron	·19150
Phosphoric Acid	traces.

Representing the bases as combined with their equivalent of sulphuric acid, we have for the composition of 1000 parts of the water—

Sulphate of Potash	·06080
" of Soda	·05020
" of Lime	·77520
" of Magnesia	·15395
" of Iron, (proto)	·36385
" of Alumina	·46811
Phosphoric Acid	traces,
Sulphuric Acid (SHO_4)	4·28952
Water	993·83837
	1000·00000

The quantity of sulphuretted hydrogen present is small, being about one-half of a cubic inch in 200 cubic inches of the water.

The question of the origin of this spring presents such difficulties, that I will not attempt to theorise upon it; the fact that the spring issues directly at the roots of a not yet wholly decayed pine, is evidence that it has not existed for a very long period, at least in its present character; for as it has been remarked, no vegetable life exists for some distance around the place. Under the ordinary atmospheric influences I should conceive thirty or

forty years would be required to produce the state of decay which the pine exhibits, although both sulphuric acid and the sulphates of iron and alumina are powerful antiseptics, and would considerably retard the progress of decay. Apart from any consideration of this kind, there is not wanting evidence that the waters of the spring have materially changed their character within two or three years. In April, 1846, Professor Croft, of King's College, Toronto, published in the British North American Journal an account of the spring he had obtained from some one who had visited it, with a partial analysis of the water, such as he had been able to execute upon the specimen in his possession. He found in one pint (7680 grains)—

Sulphuric Acid, (average of three determinations,)	22.425 grs.
Peroxyd of Iron	3.950 "
Magnesia	1.584 "
Lime	3.685 "

No experiments were made to detect the presence of alkalies, nor was alumina sought for; it is probable that the alumina is included in the weight of the peroxyd of iron. The specific gravity was found by Professor Croft to be 1003·8.

For comparison I have reduced Professor Croft's results to the same standard as my own, and give them for 1000 parts; he found the iron as a per-salt, probably from the effect of exposure to the air. I have calculated that obtained by myself, as peroxyd, and added to it the alumina—

	Croft.	Hunt.
Sulphuric Acid	2·9069	4·6350
Potash	——	·0329
Soda	——	·0219
Lime	·4798	·3192
Magnesia	·2036	·0524
Peroxyd of Iron and Alumina	·5148	·3315

The water examined by Professor Croft contained much less foreign matter than that collected by myself, being in fact more dilute. The sum of the ingredients determined in the former is 4·1051 parts and in the latter 5·3281 parts in 1000. In the former, the sum of the bases is to the amount of acid, as 412 : 1000, and in the latter as 152 : 1000. The difference in the comparative quantity of sulphuric acid in the two, may be attri-

buted to the dilution by surface water, but the great change in the proportion of the bases to the acid, indicates some change in the internal economy of the spring. If we suppose the spring at its origin to evolve a dilute sulphuric acid only, it must take up the various other ingredients from the strata through which it passes; the lime and magnesia from the limestone, and the iron alumina from impurities in these, or from ferruginous and argillaceous rocks. The lime is to the acid in the first, about as 1 : 6 by weight, and in the second as 1 : 15; the magnesia in the first as 1 : 15, and in the second as 1 : 90. If we suppose the acid water to come in contact with a limestone bed containing, as is often the case, some magnesia, it would at first dissolve a large quantity of the lime and magnesia, and while some of the former sulphate would be deposited as gypsum, the water would run off saturated with the salt, but gradually, as nearly the whole adjacent calcareous matter had been converted into gypsum, the quantity of it in the water would be only the small portion dissolved by the spring in its course through its channels of gypsum. This readily explains the diminution of the proportions of these ingredients, as well as the increase of free sulphuric acid.

A similar spring to this, has been long known in the town of Byron, in the State of New York, and several others of the same kind have recently been discovered in the same region. These, as well as the Tuscarora spring, all rise from that portion of the Upper Silurian rocks designated by the geologists of New York as the Onondaga salt group, and characterised by the valuable deposits of gypsum with which it abounds.

A consideration of some of the peculiarities of these gypsum deposits in this connexion will, at the same time that it explains their formation, shew that there is ground for supposing an intimate relation between them, and the springs to which I have just alluded.

The investigations of Mr. Hall, in New York, and of Mr. Murray, in Western Canada show that the gypsum of these rocks occurs always in hillocks or dome-shaped masses, which vary in size from one foot to 300 or 400 feet in diameter, and are always near the surface of the formation. Sections of these masses, show them resting upon undisturbed strata of limestone, while the superior strata are thrown up and rest upon the flanks of the

intruded hillock, often very much broken, and, as Mr. Hall has remarked, in part consumed, so that one is at a loss to account for the disappearance of a large portion of the overlying strata.

Mr. Murray, in the report of his examination of this region of Western Canada in 1844, has described and figured many sections which illustrate these peculiarities. In one case observed by him, a slender cylinder of gypsum passes through several beds of limestone, and at last terminates in a cone of the usual form, which is entirely superior to the limestone formation, and surrounded by the clay of the region. The comparatively recent origin which this observation assigns to the gypsum deposits, is confirmed by the common experience of the people in Western New York, where it is a well known fact that since the settlement of the country, walls have been disturbed and raised from their foundations by a gradual elevation of the surface, beneath which, subsequent examination has shewn the presence of domes of gypsum.

In comparing these facts with what has been said above of the formation of gypsum by the action of an acid water upon the calcareous rocks, we recognize an agency fully adequate to their production, and capable of explaining at the same time the disappearance of the limestone and the local disturbance of the strata; for the crystalline gypsum which would be formed from them, occupies very nearly twice the bulk of an equivalent quantity of carbonate of lime.

To what extent the pressure at a great depth, may operate in preventing or modifying chemical changes we do not know, but it is easy to see that the acid once coming to a situation where it can act upon the limestone, will evolve carbonic acid gas, and form a calcareous sulphate, which, from its comparative insolubility, would be at once deposited in a crystalline form, while the water would pass off saturated with the sulphate, and at the same time carry with it the soluble sulphates of magnesia, alumina and iron, which would be formed from the other bases generally present in the limestones of this formation, and their accompanying shales. If the amount of acid were copious, or the supply of calcareous matter limited, the water might rise to the surface with free acid, as in the springs already noticed, and when the deposition of calcareous sulphate had extended so far as to protect the

adjacent strata from further action, the water would rise to the surface with a much smaller proportion of bases than before.

If on the contrary, the acid were entirely neutralized, the spring would present at the surface the character of an ordinary bitter mineral water, containing sulphates of lime and magnesia; two springs of this character are indeed found in the same formation not far from here, at Ancaster and Charlotteville. The ferrugino-argillaceous substance, known as *gypsiferous marl*, which surrounds these deposits, is probably due to the precipitation by the carbonate of lime, of the iron and alumina previously taken up by the water, for it is a mixture of these oxyds with carbonate and sulphate of lime.

The observation now required to confirm this theory is to find the carbonic acid gas which should be evolved from the decomposition of the carbonate. The small quantity of gas which rises from the Tuscarora spring is principally carburetted hydrogen, which is evolved by most of the saline and magnesian springs of this region, but it was collected at a time when, from the minute quantity of gypsum in solution, the action appears to have been at an end.

Charlotteville Sulphur Spring.

This interesting spring is situated a few miles west of Simcoe, in the third lot of the twelfth range of Charlotteville. It is on the west bank of a creek, on the land of Phillip Wilson, and about ten rods from a saw-mill. About twelve feet above the level of the creek, is a depression five or six feet deep, forming a natural basin about one rod in width and four rods in length, from N.E. to S.W.; it is oval in form, broader at the S.W. end, near which the spring rises. At the other end, the basin discharges itself by a little rivulet into the adjoining creek. The depth of the water at the time when I visited it, was from one to two feet, and the discharge, as it formed a little cascade before entering the creek, was roughly determined to be about 16 gallons per minute. Its temperature, as observed on the morning of the 19th October, when the air was 26° F. was found to be 45°, while that of the creek was 49°.

The water rises gently through several apertures in the soft mud of the bottom, occasionally accompanied by bubbles of gas.

In a still day the surface, with the exception of a small area about the source, is coated with a film of sulphur, which also covers the bottom of the basin. Leaves and sticks near the outlet, are found thickly incrusted with the same substance, or rather with a mixture of sulphur and carbonate of lime. The proprietor of the spring informed me that he was in the habit of gathering the substance thus deposited, and burning it under his bee-hives for the purpose of stupifying the insects while extracting the honey, perhaps the only economical application which can be made of the sulphur itself.

The specific gravity of the water is 1002·712; it is limpid and sparkling, its odor strongly sulphurous, and its taste pungent, with something like sweetness, leaving an impression of warmth in the mouth for some time. When mixed with a solution of chlorid of arsenic, it becomes quite opaque from the precipitation of yellow sulphuret of arsenic. A qualitative examination shewed besides, the presence of chlorids and sulphates, the latter in large quantities; the bases were potash, soda, lime, magnesia, with traces of alumina and iron; a large portion of the lime and magnesia were not precipitated by boiling. The carbonic acid was determined in the manner previously described, by the aid of chlorid of calcium and ammonia. For the sulphuretted hydrogen, three bottles were prepared by adding a solution of chlorid of arsenic; to each of these was added 30 cubic inches of the water; the whole was then agitated and allowed to stand a few minutes to permit the escape of carbonic acid, after which the bottles were carefully corked and sealed. This was done at the spring, and the bottles were then transported to the laboratory. When they were opened, the precipitate was collected on carefully weighed filters, dried at 212° F., and weighed. Its purity was determined by its complete solution in ammonia. From the average of these three, the weights closely agreeing, the amount of the sulphuretted hydrogen was calculated to be ·17763 parts to 1000 by weight, or ·[illegible]6 cubic inches to 100 cubic inches of the water.

To determine the state in which the sulphur existed, a portion of the water was digested for some time with pure magnesia and then boiled, carefully excluding the air; sulphuretted hydrogen was abundantly evolved, and after a few minutes not a trace of sulphuret could be detected in the liquid. This shews the sulphur to exist as sulphuretted hydrogen, and not as a fixed sulphuret.

The amount of carbonic acid in the water was found to be equal ·273 parts in 1000 of the water by weight.

1000 parts of the water gave—

Sulphuric Acid	1·22939
Chlorine	·06478
Potash	·02760
Soda	·20586
Lime	·64484
Magnesia	·19436
Carbonic Acid	·27300
Sulphuretted Hydrogen	·17763

These may be combined to give the following composition for 1000 parts:—

Sulphate of Potash	·05103
" of Soda	·47182
" of Lime	1·12670
" of Magnesia	·43510
Chlorid of Magnesium	·08783
Carbonate of Lime	·30500
" of Magnesia	·01798
" Iron ..... traces,	
Sulphuretted Hydrogen	·17763
Carbonic Acid	·15350
Water	997·17341
	1000,00000

Amount of solid matter by calculation, 2·49446 parts.

The great peculiarity of this water is the unexampled quantity of sulphuretted hydrogen it contains. The strongest of the celebrated Harrowgate Springs yields but 14 cubic inches of sulphuretted hydrogen gas to the gallon, while the Charlotteville contains in the same measure 26·8 cubic inches. This, added to its saline ingredients, cannot fail to give the water great medicinal virtues. The spring is not extensively known, but is used by some of the country people with great advantage in cases of rheumatism, and some remarkable instances were told me of obstinate cutaneous diseases cured by external application of the water. When taken in doses of a pint or more, it acts as a mild aperient; but its effect seems principally determined to the skin and kidneys, acting as a sudorific and diuretic.

I desire to call especial attention to this mineral water, which I am convinced will be found to be of great importance. I am not aware of any sulpurous water either in Canada or the United States which is comparable with it. The discharge is abundantly adequate for the supply of baths, and the location of the spring is such as to make it easily accessible; it is in the midst of a pleasant and fertile country, and but a few miles from Lake Erie and from Port Dover.

Ancaster Saline Spring.

This spring, which is known to the villagers as a "Salt Well," is about two miles west of the village of Ancaster, on the land of Mr. Robert Heslop. A well was sunk some years since, to the depth of thirty feet; and during the war of 1813–15, it is said a considerable quantity of salt was manufactured from it in a rude way. The water rises nearly to the surface, and at times a stream is said to flow from it; no outlet is visible, yet the spring, as I was told by the proprietor, fills up rapidly when the water is dipped out. The temperature was found to be the same as that of a neighbouring fresh spring, 48° F.; no evolution of gas is perceptible. The water is intensely bitter and saline to the taste; by boiling, a minute quantity of carbonate of lime is deposited, and the liquid contains chlorine, bromine, sulphuric acid, with potassium, sodium, calcium and magnesium. The specific gravity is 1029·1.

1000 parts of the water yielded—

Chlorine	20·21810
Bromine	·08910
Sulphuric Acid, (SO_3)	·45700
Soda	9·45200
Potash	·05800
Lime	5·59160
Magnesia	2·09900

These may be combined to give the following composition for 1000 parts of the water:—

Chlorid of Sodium	17·82800
" of Potassium	·05200
" of Magnesium	5·07370
" of Calcium	12·80270
Bromid of Magnesium	·10309
Sulphate of Lime	·77690
Water	963·32361
	1000·00000

Amount of saline matters, 36·67639 parts in 1000.

This water is extraordinary on account of the immense proportion of chlorid of magnesium and calcium which it contains; the sum of these exceeding the amount of common salt. With almost the same amount of solid matter, it contains less than two-thirds of the quantity of this salt, that is found in sea-water; in this respect it is quite unlike any water hitherto described. For the sake of comparison, I transcribe here Dr. Scheitzer's analysis* of the water of the British Channel. The specific gravity was 1027·4.

In 1000 parts were found—

Chlorid of Sodium	27·059
" of Potassium	·766
" of Magnesium	3·666
Bromid of do.	·029
Sulphate of do.	2·296
" of Lime	1·406
Carbonate of Lime	·033
Traces of Iodine and ammoniacal salts.	
Water	964·745
	1000·000

Amount of solid matters, 35.295 parts in 1000.

The Ancaster water contains a much greater quantity of lime and much less of sulphates, than sea water. The amount of earthy chlorids is so great, that this water would not easily afford a pure salt; and the difficulty of removing them is such, that as long as we have better sources, this would scarcely be eligible. The amount of bromine which it contains, is however consider-

* Philosophical Magazine, July, 1839.

able, and would be a secondary product of considerable value, as the process of extracting it from the residue is not expensive, and it commands a high price. The water, from the abundance of this substance and of the earthy chlorids, would probably prove efficacious as an external application in many diseases when these remedies are indicated.

Ancaster Sulphur Spring.

This source is situated about one mile and three quarters north-west of the village of Ancaster, by the side of the road to Flamborough West. The quantity of water discharged is but small, probably about two gallons per minute; it is quite limpid, and has a sulphurous odor; the taste is feebly saline and bitter. The temperature of the spring I found to be 50° F. that of the air being 56°, and that of a fresh water spring in the vicinity on the same day 48°. The specific gravity of the water is 1005·2.

A qualitative examination shews the presence of chlorids of sodium, calcium, magnesium and traces of potassium, the first two in large quantity; small portions of sulphate of lime, with carbonates of lime and magnesia, and traces of carbonate of iron and alumina. A minute portion of bromine was also detected in the concentrated water. The amount of sulphuretted hydrogen is small, being only about ·4 cubic inch in 100 cubic inches of the water.

Specimens of a chalybeate water from the vicinity of Hamilton, were at the time of my visit, furnished by Dr. Craigie of that place, to whose politeness I am much indebted. The water is very feebly chalybeate, and is not otherwise of interest.

VARIOUS METALIC ORES.

Copper.

I. The first specimen examined, was from a vein at Sherbrooke; the ore was pyrites in a gangue of quartz. 2000 grains of the finely crushed ore gave in the moist way, black oxyd equal to 13·01 grains of copper, or 0·65 per cent.

74 lbs. of this ore by washing gave $1\frac{15}{16}$ lbs. of nearly pure copper pyrites, which yielded 30·34 per cent. of metallic copper, equal to 0·8 per cent. of the ore.

A quantity of this ore being reduced in the usual way, a button of metallic copper weighing 180 grains was obtained; this was dissolved in pure nitric acid, and the residue being treated with aqua-regia, proto-sulphate of iron threw down a precipitate of metallic gold, which was weighed and then fused with borax before the blow-pipe into a globule; its weight was ·03 of a grain; the nitric solution gave with hydrochloric acid a precipitate of chlorid of silver, which equalled ·16 of a grain of silver.

II. Variegated sulphuret from Inverness. 212 lbs. of the ore by washing gave 4½ lbs. of ore, which yielded 34·93 per cent. equalling 0·741 per cent. of the unwashed ore.

This ore was examined for gold and silver without success.

III. Copper pyrites from the fifty-first lot of the twenty-first range of Upton. An average sample of this, weighing 24½ lbs., was crushed and submitted to assay; it yielded 3·84 per cent. of metallic copper, which afforded a trace of silver.

Gold.

A small mass of the native gold from Mr. de Léry's Seigniory, on the River Chaudière, gave for its composition—

Gold	86.73
Silver	13.27
	100.00

The gold found in nature is generally alloyed with silver, but it will be interesting to examine other specimens of the gold of this region, and determine whether this proportion of alloy is constant.

Manganese Ores.

The only ores of manganese examined, have been the earthy oxyd or black wad of the miners.

I. Specimen from a bed in the twenty-second lot of the twelfth range of Bolton; it is mixed with pebbles and other earthy impurities. An average sample of this, yielded by two trials, 26·2 and 26·5 per cent. of pure peroxyd of manganese.

II. Reniform masses from the ninth lot of the tenth range of Stanstead; it is more free from earthy matters than the last, but contains a large amount of iron. Two determinations gave 37 and 37·6 per centum of peroxyd of manganese.

Chromium.

This metal, whose various combinations are now so extensively used in the arts of painting, dying and calico-printing, is obtained for all these purposes, from the native combination of its oxyd, known as chromic iron. This valuable ore has been detected in two places in the Eastern Townships; one is in Bolton, where a vein of a foot in diameter occurs in serpentine; and the other is only known through a huge boulder found near the outlet of Memphramagog Lake, which from its dimensions, indicates a vein of large size, probably at no great distance. The ores from these two localities have been submitted to analysis, and prove to be rich in the oxyd of chromium.

I. Chromic iron from Bolton. This gives on analysis—

Sesqui-oxyd of Chromium	45·90
Protoxyd of Iron	35·68
Alumina	3·20
Magnesia	15·03
	99·81

II. Chromic iron from the boulder.

Sesqui-oxyd of Chromium	49·75
Protoxyd of Iron	21·28
Alumina	11.30
Magnesia	18·13
	100·46

Titanium.

This substance exists as titanic oxyd in the form of rutile, in Sutton Township and in the auriferous sands of the Chaudière River, but a more abundant source of it is found in the serpentine near the last-mentioned place. Here is a bed of iron ore forty-five feet in width, and apparently composed of magnetic iron. On carefully washing the ore from earthy matters, however, it is found to consist of two distinct substances, which may be readily separated by means of a magnet. The magnetic portion, which constitutes about two-thirds of the whole, is pure magnetic iron; the other, which is a brilliant black powder easily distinguished from the magnetic portion, is nothing else than titaniferous iron or ilmenite.

The result of a single somewhat imperfect analysis of this was—

Titanic oxyd	48·60
Peroxyd of iron	46·70
Magnesia	2·44
Insoluble matter	4·20
Water and loss	4·06
	100·00

Titanic iron appears to be mixed with several of the magnetic ores of the Eastern Townships, for in their analysis I observed small but variable quantities of titanium to be frequent, and in one or two instances the amount was considerable.

I have the honor to be,

Sir,

Your most obedient servant,

T. S. HUNT.