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REPORT

OF

MR. CHARLES ROBB,

ADDRESSED TO

SIR WILLIAM E. LOGAN, F.R.S., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY.

MONTREAL, 22nd April, 1869.

SIR,—Having, in the month of May last, been honoured with your instructions to visit and make a geological examination of certain parts of the Province of New Brunswick, I immediately proceeded thither, and have devoted to that object the remainder of the season suitable for field work.

The region indicated by you as that to which you deemed it desirable to bestow attention in the first instance, is that lying towards the northern base of the great coal area of the Province, comprising, in addition to the Carboniferous rocks themselves, an extensive belt of metamorphic and granitic rocks, the age and conditions of which had not been previously ascertained. I also understood it to be your desire that I should investigate incidentally, in the course of the season, the facts relating to the discovery or probable occurrence of economic minerals in the region referred to.

Of that part of the Province above indicated by far the greater proportion is still in the state of an unbroken wilderness, the settlements being confined for the most part to the banks and immediate vicinity of the river St. John and its principal tributaries. In order, therefore, to obtain, in the readiest manner, a key to the geological structure, I deemed it advisable to commence with the examination of the banks of the St. John River itself, which affords a transverse section of the formations; and of the more accessible districts on either side. Accordingly, my explorations of last summer and autumn have extended over the greater part of the counties of York and Carleton, and the south-eastern part of Victoria, in which

discoveries of gold had been reported, and lands leased for gold-mining purposes. The area over which my observations have extended may be estimated at 5,000 square miles; but for various reasons, which I shall state, the work must be regarded rather as a preliminary reconnaissance than a complete and detailed survey.

Geological
map.

In the accompanying map, which I have compiled from the most authentic available sources on a scale of two miles to an inch, and on the appended sections, I have recorded many of the details of my observations; and on the smaller map, reduced from the former to a scale of eight miles to an inch, I have indicated, by appropriate colouring, the general results.* In procuring the materials for the compilation of the maps, I have gratefully to acknowledge the courtesy and kindness of the gentlemen connected with the Crown Lands Department at Fredericton.

At an early stage in the course of this investigation it became evident that, in so far at least as regards the great area underlaid by the metamorphic and granitic rocks, the attempt to conduct a systematic and minutely detailed geological survey without a previous general reconnaissance, would, for various reasons, be beset with difficulties and attended with disappointment and loss of time.

1. Owing to the altered and contorted condition of these rocks the obscurity and difficulty incident to the investigation of all such regions is experienced here in full force. The lines of original stratification are either obliterated or so complicated with the superinduced planes of cleavage, foliation and jointing as, in the absence or very rare occurrence of fossils, to render the stratigraphical relations of their component parts extremely embarrassing and difficult to trace. The remarkable uniformity in mineral character and conditions, as shown in the river sections, is also extremely perplexing when it is attempted to determine the order of succession or thickness of the various members of the formation. This difficulty is further complicated, where differences in this respect do occur, by the gradual manner in which the rocks appear to blend with each other, and by the absence of well-defined and characteristic bands capable of being traced for great distances on the strike.

2. Although the transverse sections afforded by the St. John and Southwest Miramichi Rivers (which run approximately parallel to each other at the distance of about forty miles apart) are good and easily accessible, they are too far apart to be co-ordinated for the purpose in view, and in the intervening region, which is still for the most part a trackless wilderness, the rock exposures are few and their position uncertain and difficult to find.

3. In the absence of reliable topographical maps, and of landmarks of any kind in the interior of the country, the difficulty of bringing into posi-

* The smaller map is the one published with this Report.

tion any geological observations would be extreme. I am aware that in the progress of your surveys in Canada, you have encountered and overcome similar difficulties, on a large scale; but it appeared to me a matter for consideration how far, at the outset, I should be justified, under all the circumstances, in incurring the delay and expense of investigating minute local details, the connection of which would necessarily be so vague and obscure.

In consideration of all these circumstances, it has appeared to me that a comprehensive general view of the whole conditions of the case would be a necessary preliminary even to the institution of an intelligent and economical method of subsequent procedure, and would afford at the same time an opportunity of making special examinations of those localities, sometimes at great distances apart, where valuable minerals were reported to have been discovered.

Accordingly, my observations will be found, on the whole, to be more desultory and indefinite, as materials for a systematic survey, than they would otherwise have been, or than I could wish. I have, however, on all occasions striven to make them as accurate as possible in regard to position, by reference to the Crown Lands Surveys, and to all available landmarks, natural or artificial, such as prominent bends of rivers and streams, occurrence of islands, junctions of tributaries, mile-trees, roads, etc., and by bearings to all conspicuous elevations. In determining the line of junction of the Carboniferous and metamorphic rocks, I have followed, for the most part, the usual method of pacing, where points occur in the vicinity whose position is known with any degree of accuracy. In illustration of the mineral character of the various districts, I have collected a set of rock specimens and fossils, which are also herewith submitted.

The geological features of the region in question have been investigated to some extent and described in general terms by the late Drs. Gesner and Robb, and also by Dr. Dawson, Professor Bailey and Professor Hind, to whose labours I am indebted for much valuable assistance in the prosecution of my own.

For the convenience of classification I shall, in anticipation of the results to be hereafter detailed, divide the record of my observations into six distinct sections, corresponding with the geographical and geological lines upon the small map.

General divisions.

I. The section of country lying towards the south-east part of the county of York, and overlaid by the nearly horizontal unaltered rocks of the Carboniferous series.

II. The belt or band of metamorphic rocks immediately underlying the former, up to the south-eastern boundary of the great granitic area.

III. The so-called central granitic area.

IV. The band of non-calcareous metamorphic slate and quartzite lying immediately to the north-west of the granitic area.

V. The north-western part of the county of Carleton, occupied for the most part by altered calcareous clay slate; and

VI. The Tobique valley and its tributaries, in the counties of Victoria and Northumberland.

N. B.—Throughout this Report the bearings are stated with reference to the astronomical meridian; the variation of the compass at the time of my visit was $19^{\circ} 20' W.$

I. THE CARBONIFEROUS AREA.

This formation, (in which for the present I include the lower red sandstones and conglomerates usually regarded as Lower Carboniferous), in so far as hitherto examined by me, is comprised between the southern boundary of the county of York and the unconformable altered slates to the north-west. This, however, constitutes only a portion of the northern rim of the great Carboniferous area. The line of out-crop, or junction of the two distinct series of rocks, which is rudely parallel to the strike or general direction of the older rocks, is delineated upon the map from my own observations and measurements at a great many points.

The Carboniferous (or more properly, perhaps, Lower Carboniferous) rocks, in the northern part of New Brunswick, consist of a series of sedimentary deposits, evidently composed of the debris of the more ancient metamorphic rocks; and rest unconformably and almost horizontally upon the upturned edges of the latter, filling up pre-existing hollows and bays, and but slightly altered in mineral composition, except where invaded, at intervals towards the base, by rocks of igneous origin. Owing apparently to these irregularities in the surface of deposition, and to the prevalence of other disturbing influences, it is difficult to give any exact definition of the component parts of this Lower Carboniferous series, their respective volumes, or even of the order of their succession.

The lowest member, resting immediately upon the metamorphic slates, and apparently dipping, at and near the line of contact, in conformity with their previously denuded surface, is a coarse dark red conglomerate, composed of rounded and flat pebbles, generally, though not always, water-worn, and consisting of slate, quartz, trappean, and older conglomerate rocks of all sizes up to eight inches diameter. Such of the pebbles as are of a softer or more permeable nature are stained red and sometimes green, doubtless from the penetration of ferruginous matter. The whole mass is cemented by a calcareous and arenaceous paste, sometimes, especially towards the base, with crystalline calcite. Wherever this red calcareous conglomerate

Lower Carboni-
ferous.

Lower conglo-
merate.

rests immediately on the metamorphic slates, the latter seem to partake of the same characteristics, becoming more or less tinged with red and green colours, and impregnated with calcareous matter; which appears both throughout the substance of the slates, and in veins and strings of calcareous spar, frequently associated with quartz, intersecting them. The calcareous impregnation diminishes in intensity as we recede vertically or horizontally, as the case may be, from the junction of the two formations.

Succeeding the red conglomerate, which generally becomes finer towards the summit, are red sandstones, also calcareous, but more sparingly so, with occasionally interposed thin and irregular layers of red shale, sometimes so free from grit as to make a good pigment. Both sandstones and shales are sometimes highly micaceous, and the calcareous matter seems gradually to diminish in quantity from the base upwards. No fossils have been observed in these red conglomerates, sandstones and shales, the aggregate thickness of which, from observations made at several points, I have reason to believe to be about 1000 feet.

Sandstones and shales,

Then follows, but only at irregular intervals, a coarse, silicious conglomerate, composed entirely of rounded white quartz pebbles with a cement consisting of fine grains of sand and feldspar, and totally devoid of lime; above which, in very considerable volume, repose coarse grey grits or sandstones and conglomerates, also devoid of lime, abounding with carbonized casts of calamites, cordaites and other obscure vegetable remains, and holding occasional thin seams of coal. These last mentioned rocks constitute, in that part of the region examined, the most prominent feature in the main Carboniferous area. Occasionally they are fine grained, and fit for grindstones; sometimes flaggy, in tolerably regular and thin layers, but generally very coarse grained and massive, extremely irregular in the size of the component particles, and partaking, even in the same beds, of the mixed character of sandstones and conglomerates. The paste is feldspathic, and sometimes shows the result of decomposition in the presence of small portions of kaolin among the particles.

Upper conglomerate.

Although the general colour of these rocks is grey, they are occasionally reddish, purple and yellow, and more rarely of a greenish hue, and sometimes stained black with oxide of manganese; these differences being apparently quite capricious in their modes of occurrence, depending rather upon local circumstances than upon the stratigraphical position of the beds exhibiting them. At the few spots where thin seams of coal have been discovered, they are overlaid by a correspondingly thin band of drab coloured arenaceous and micaceous shale, showing scanty and imperfect impressions of ferns and other coal plants, and rest upon a similar stratum, abounding in nodules of iron pyrites, but destitute of organic remains, so far as I could discover. I am not aware of any true stigmata underclays or

Coal seams.

other indications of productive and workable coal seams having been found in the region under notice. Near Thompson's Mills, at the mouth of the Nashwasis, about three miles north of Fredericton, two large prostrate-trees have been found imbedded in the solid sandstone, one measuring fifty feet long and two feet diameter at the base ; of these I have obtained fragments, but the species has not yet been identified.

General dip.

The attitude of the various strata above enumerated, which appear on the whole to be conformable, is nearly horizontal. From local irregularities, however, in the apparent surfaces of bedding, it is exceedingly rare to obtain an unequivocal observation of strike or dip by direct measurement, and from the want of continuity of the beds their precise attitude cannot be deduced from bearings and levels taken at moderately distant points. From a somewhat comprehensive series of observations, I believe I am justified in setting down the average dip, throughout the region explored by me, as E. 6° — 10° S. at an angle of 5° . This is at and near the rim of the area ; as we proceed towards the centre the strata become more and more nearly horizontal.

Soils.

The grey grits and conglomerates being composed of materials little liable to disintegrate by the influences of the weather, especially towards the outer rim, have resisted denudation, and are generally found standing out in bold bluffs or more shelving ridges of various elevations up to 900 feet above tide level ; while the softer and more readily decomposed red and calcareous rocks at their base occupy lower ground, and partially influence the course of some of the rivers ; their ruins producing, as might be expected, good arable land. The grey sandstones, on the other hand, produce by their disintegration rather poor and meagre soils ; and the uplands overlying these rocks being either for the most part encumbered with loose blocks, or swampy from want of natural drainage, the progress of agriculture in such circumstances is necessarily slow.

The trappean rocks to which I have referred as associated with this group, occur only in connection with its lower members. The areas of these eruptive rocks, of which I have noted seven distinct localities in the region explored by me, are generally of very limited extent, but locally they appear to have exercised a considerable influence upon the character and distribution of the rocks penetrated and overlaid by them.

Carboniferous area.

Having thus indicated the general features and conditions of the Carboniferous rocks in this region, I shall proceed to give a few details of the more notable localities in which they were observed. It has been long known that the great Carboniferous area of New Brunswick has a triangular form, the base resting on the Gulf of St. Lawrence, and the apex situated a little

to the west of Oromocto Lake, near the boundary line between the counties of York and Charlotte. It is at this latter point that my observations commence, extending thence in a north-easterly direction to the county of Northumberland, at Boiestown on the Southwest Miramichi River. The river Magaguadavic skirts this line transversely just at the apex of the Carboniferous triangle, and seems to have excavated its channel in the soft calcareous and marly rocks at the base of the formation; the country beyond, to the west and north, forming a very extensive elevated plain, underlaid by the metamorphic rocks. The succeeding members crop out in bold bluffs, nearly 250 feet above and two-thirds of a mile from the river; the apparent dip being N. 70° E. $<15^{\circ}$. The section may be tabulated thus, in ascending order:—

	Feet.	
1. Red conglomerate and marl with impure hematite, to base of cliffs.....	60	Magaguadavic section
2. Red calcareous sandstone moderately fine-grained.....	45	
3. Purple sandstone, cut vertically and transversely in one place by a two-feet dyke of trap running east and west, which has to a small extent hardened and altered the rock in its immediate vicinity.....	30	
4. Reddish-grey coarse sandstone becoming conglomerate in irregular patches in the beds. The pebbles are of all sizes up to two inches diameter, chiefly of quartz and quartzite.....	30	
5. Yellowish coarse-grained sandstone with large quartz pebbles and obscure vegetable impressions.....	50	
6. Grey and purple coarse sandstone, occasionally stained black with oxide of manganese, to top of cliff.....	35	
Total.....	250	

Oromocto Lake, which is situated two miles eastward from the brow of the cliff, and is about sixteen square miles in superficial extent, is from 80 to 100 feet below the level of the escarpment referred to, and 370 feet above the level of tide water, while the general level of the great plain to the west is 250 feet; thus presenting the extraordinary phenomenon of a very considerable body of water supported at a height of 120 feet above the plain in the immediate vicinity, and yet draining through a very great area in the opposite direction. At Lister's Mills, ten miles north from the escarpment, and on the north-east branch of the Magaguadavic, the rocks at the base of the Carboniferous series present an interesting development of their peculiar characters where affected by trappean intrusions. Mottled red and green highly calcareous shales and conglomerates, some of the layers holding nodules of pure calcspar, layers of chert and strings of fluor-spar, occur mixed with rocks apparently of eruptive origin, and with others bearing much resemblance to the older metamorphic rocks.

The eruptive rocks which, to a limited extent, appear here, are situated at the south-western extremity of a lenticular shaped area about nine miles

in length by a little over one mile broad in the middle, occupied by rocks of a similar nature, attaining their greatest development at Bald Mountain and other bold bluffs at and near the foot of Cranberry (or Bear) Lake. This mass is flanked to the south by a considerable breadth of the red calcareous conglomerate and marl formerly described, forming the fertile tract of Harvey Settlement; and on the north by an extensive flat but elevated table-land, underlaid by the metamorphic slates; the water-shed between the streams flowing into the St. John River and Passamaquoddy Bay respectively. The eruptive mass appears to consist of a central and underlying part or nucleus of very hard and heavy dark red or purple compact quartziferous porphyry, holding a little calcareous spar, fluor-spar and traces of copper ore in cracks and crevices, overlaid and enveloped first by hard close-grained and homogenous yellowish-brown claystone, resembling overburnt pottery-ware, and then by a rock apparently identical in composition and equally close-grained, but finely laminated in purple and pink streaks, as if deposited from solution in water; the former being the more quartzose, and the latter the more feldspathic portion. The laminae run in the general direction of the length of the mass, and dip in opposite directions on either side of it, generally at an angle of 45° , but with many and violent contortions.* The conglomerate and marl of the lower member of the Carboniferous series appear to a very limited extent to the north of these rocks, but are chiefly developed in the opposite direction.

A good section of all these rocks is afforded by the railway cutting at the foot of Cranberry Lake; but as it intersects them longitudinally, or at a very oblique angle, it does not throw much light upon the structure, in so far as measurement is concerned. The following may be taken as an approximate estimate of the thickness of the various members of what are considered as belonging to the trappean mass, that of the sedimentary strata being here obscure:—

Thickness.

	Feet.
1. Central mass of quartzose porphyry, (breadth).....	1800
2. Claystone, compact and close-grained, (thickness)	1250
3. Laminated and contorted quartzose and feldspathic rock, (thickness). ..	600

Within the limits of the trappean area described are four hills composed of these rocks; the highest of these, called Bald Mountain, is about 380 feet above the plain, with a steep mural face to the west, near the base of which at one point I observed the claystone trap overlying a coarse conglomerate, either of an eruptive or highly altered character. The other elevations are

* The central rock appears to bear a strong resemblance to an eruptive rock described and analyzed by Dr. Hunt under the name of *orthophyre* as occurring in the township of Grenville, Quebec. (See *Geology of Canada*, page 654).

about 220 feet in height, all very near each other, clustered around the foot of Cranberry Lake, and about the centre of the eruptive area.

A little coal is reported to have been found in the grey sandstone overlying the red conglomerate in Harvey Settlement, and hopes have been entertained in the locality that this might lead to workable deposits ; but in so far as regards the character and condition of the rocks here, there is little to justify such an expectation, since they are situated quite near to the base of the Lower Carboniferous, and appear to be devoid of the characteristic underclays which accompany workable coal seams.

About half-way between the St. Andrew's and Fredericton road, and the sharp bend of the St. John River at the mouth of Long's Creek, the junction of the metamorphic and Carboniferous rocks is well exposed near the house of Nicholas Barker ; where the former are seen dipping N. W. $< 80^{\circ}$, and the latter, now free from the influence of intrusive rocks, about S. E. $< 20^{\circ}$, both being highly calcareous towards the junction. The pebbles of the red conglomerate here, especially towards the base, are for the most part angular, composed of slaty and trapean rocks, and of all sizes up to six inches. The breadth of the conglomerate band and its associated red rocks is here over half a mile, and the thickness, assuming the dip to be uniform, about 1000 feet. Coal.

About five miles to the eastward of this point, where a section of the rocks is afforded at Kelley's Creek, the red rocks do not exceed one hundred paces in breadth ; beyond which they no longer appear to come to the surface, nor have they been observed by me in the whole distance thence to the main river, upwards of nine miles. The silicious conglomerate and coarse grey sandstone are observed in this interval in immediate contact, dipping in opposite directions at high angles, and both devoid of calcareous matter. The Fredericton and St. Andrew's road runs for this entire distance parallel to and a little south-east from the line of junction of these formations, occupying an elevated though irregular ridge of the grey grits, at an average height of 400 feet above the main river, the tributary streams running in opposite directions on either side of this ridge. On approaching the River St. John the country underlain by the metamorphic rocks becomes more rugged and mountainous ; and at and near Springhill, five miles from Fredericton on the Woodstock road, cliffs of these rocks rise to the height of from 300 to 500 feet, generally with steep mural faces to the north and east. The junction of the metamorphic and Carboniferous rocks on the right bank of the river, although concealed by the superficial deposits, I have good reason to believe to be about four and a half miles above Fredericton, near to which point the attitude of the Carboniferous rocks, where exposed, is ambiguous and perplexing ; in one instance I observed the grey grits dipping apparently at an angle of 65° to the S.E. Springhill.

In tracing the line of junction to the north-east we find evidence that on reaching the main river it coincides with its course, and runs under its bed for a distance of four and a-half miles ; that is, from the point above noted, to a little below the ferry at King's Clear, where it again comes out on the right bank ; and enclosing a circular area of about two and a-half square miles, crosses the river at Indian village to Keswick Bluffs, and thence skirts the right bank of the Keswick River for about five miles from its mouth. The line I have described forms, as will be seen by the map, a deep sinus or bay in the older rocks, which is occupied by elevated ridges of highly contorted and altered slate and quartzite. Near Springhill, at the mouth of Sutherland's Creek, and at a few other points along this line where exposures occur, these rocks are observed to become red and calcareous, probably from proximity to the red conglomerate and marl, which, however, do not actually appear in place on this side of the river until reaching the area at King's Clear, formerly regarded as an outlier of the formation. Here the strata lying at the extreme base of the Carboniferous series, are well exposed ; consisting chiefly of alternating thin beds of red conglomerate and marl, the latter occasionally holding nodules of limestone ; and the conglomerate, when in contact with the slate, being composed chiefly of angular fragments of that rock, which, in ascending, are gradually replaced by rounded and transported pebbles.

King's Clear.

On the opposite side of the river, which is here expanded to an average breadth of about one and a-half miles, and studded with large alluvial islands, the red conglomerates and sandstones are displayed in considerable force from Clarke's Mountain, opposite Springhill, to Keswick Ridge on the right side of the river of that name. Clarke's Mountain is a dome-shaped trappean mass or knob rising in a bold and picturesque manner from the brink of the river to the height of 280 feet. The rock is a mass of very hard and heavy close-grained blackish-green basalt or dolerite, with perpendicular joints running east and west, about eighteen inches apart, and another set dipping S. E. $<25^{\circ}$. At the river-bank it is seen reposing on nearly horizontal coarse red sandstone and conglomerate to the height of thirty-five or forty feet, and traceable about two miles up the river, where it attains a height of 350 feet ; giving a total thickness of about 1000 feet to the red rocks at this point, where the eruptive rock which caps them, with a steep face to the river for the whole distance from Clarke's Mountain, appears to terminate in a wedge-shaped point, giving place to the grey sandstone and conglomerate.

Clarke's Mountain.

The mineral character of the eruptive rock, in its continuation westward from Clarke's Mountain, is somewhat different from that found at the latter place, as above described, being of a lighter colour and inferior density, with less regularity in the arrangement of joints ; vesicular and amygdala-

loidal, the amygdulæ being composed of calcspar, green earth, and occasional zeolitic minerals. From the termination of the wedge-shaped eruptive mass northward, the grey grits and conglomerates form the continuation of these high lands; rising to an elevation of from 400 to 500 feet, and skirting the left side of the valley of the Keswick in an amphitheatre of bold bluffs, for several miles upwards from the main river.

Three miles due east from this intrusive mass another of similar dimensions and mineral character occurs. This eminence, which flanks the Royal Road, on the south side of Nashwasis valley, and is called McLeod's Mountain, attains a height of 540 feet, and is capped by the eruptive rock to a thickness, at the only point where I could obtain an observation, of 170 feet, with a perpendicular face to the west. The rock is vesicular and uncrystalline, resembling not so much the basalt of Clarke's Mountain as its supposed continuation to the north-west. Here, too, as at the latter locality, it rests immediately upon soft red and green bedded marls with a dip to the S. E. $< 7^{\circ}$, overlying red conglomerate and shaly sandstone, and including angular fragments of the latter. Near Easty's Bridge, where the Royal Road crosses the Nashwasis, the eruptive mass seems to terminate in a very narrow band, at the river, where it is at least 300 feet below its lower surface in the mountain itself.

McLeod's
Mountain.

From the escarpment of the mountain the ground slopes to the south-east at a low angle, probably in conformity with the dip of the underlying grey grits, which flank the narrow coping of trap. Near the bridge the river divides into three branches, and on the north-east branch, about one and a quarter miles from the Forks, occur the Falls of Nashwasis. Here the brook, running in a picturesque gorge formed of nearly perpendicular cliffs of yellowish-grey sandstone, 100 feet apart, and about the same height, falls over coarse silicious conglomerate rocks, forming a cascade of forty feet high and fifty feet in width. Both the cliffs above, and the conglomerate forming the bed of the stream at the fall are copiously charged with carbonized impressions of obscure vegetable fossils, such as leaves and stems, the latter sometimes of considerable thickness, the bark being converted into coal, and the core replaced by sandstone; nodules of iron pyrites are also very abundant. Although such traces of carbonaceous matter abound, there seems to be nothing to justify the expectation, which has been entertained by some of the neighboring residents, that a workable seam of coal may be found here. Rumours were current also, when I visited the locality, of veins of manganese and even of more valuable ores having been found on McLeod's Mountain, together with great deposits of fine red ochre in the vicinity, but as they were not met with by me, I am unable to give any details. Just below the fall there is a considerable development of a pure white silicious conglomerate, composed entirely of large quartz pebbles, and without a trace of organic remains.

Falls of the
Nashwasis.

Fossil plants.

River Tay.

From the mouth of the Keswick, north-eastward as far as Tay settlement, a distance of fifteen miles, the hardness of the out-cropping edges of the grey grits and conglomerates, combined with the unequal effects of superficial denudations, produces a very marked topographical feature, forming a succession of nearly parallel ridges running north-east and south-west as far as the valley of the Nashwauk, and all of very considerable elevation up to 900 feet above tide-water. Most of the rock exposures observed by me in this district have been recorded on the large map, and need not be here repeated. In this interval the red rocks are nowhere conspicuously displayed, owing to the relief of the surface, the nearly horizontal attitude of the strata, and the soft nature of these rocks themselves. In the valley of the River Tay, however, they re-appear in considerable breadth, as might be expected from the fact of its cutting the formation transversely. At Boone's Mills, about eighteen miles from Fredericton, on the north branch of the Tay, and near the road between Car-digan and Tay settlements, fossiliferous and highly ferruginous grey grits occur in alternating massive and shaly beds, dipping S. E. $< 7^\circ$, with specular iron and impressions of large and small obscure fossil vegetable remains. A little farther north, at the bridge over the south branch, thin bedded micaceous red sandstones appear, dipping S.E. apparently $< 17^\circ$; this is at the junction of the red and grey rocks. Proceeding one and a-half miles northward on the road, we find at the bridge over the North Tay, the contorted and nearly perpendicular slate and quartzite of the unconformable metamorphic rocks, seamed with quartz veins, and slightly calcareous, but only so in streaks and blotches. On descending the stream (but ascending in stratigraphical order) the slates become gradually more calcareous, arenaceous and micaceous, and assume a red colour, till at a little over half a mile below the bridge, they are covered by the unaltered beds of red marl and conglomerate, dipping S E. $< 7^\circ$.

Tay section.

As the section afforded in the bed and banks of the Tay is tolerably complete and distinct, cutting nearly transversely to the direction of the Carboniferous rocks, extending for a distance of about ten miles from their base, and including two small seams of coal, I present the following tabulated details of it, in ascending order, commencing at the point indicated in the preceding paragraph:—

	<i>Feet.</i>
1. Coarse red calcareous conglomerate and marl.....	115
2. Red and green highly micaceous marl....	45
3. Calcareous red conglomerate with finer pebbles.....	90
4. Red sandstone.....	45
5. Measures concealed, but probably still underlain by the red conglomerate marl and sandstone which appear at the commencement of the section	700
6. Highly indurated red sandstone.....	90

7. Coarse grey grits in a cliff forty feet above river.....	70	
8. Alternating thin bands of red, grey and greenish sandstone, the grey rock highly micaceous.....	130	
9. Silicious conglomerate.....	43	
10. Grey flaggy grits, dipping apparently S.E. at an angle of 30°, but this may be due to false bedding.....	17	
11. Flaggy grey grits alternating with more massive beds.....	550	
12. Red and green calcareous crumbly shales.....	20	
13. Massive grey sandstone.....	50	
14. Flaggy grey grits overlaid by a coal seam five inches thick, but concealed under the bed of the river.....	30	Coal seam.
15. Green hard shaly rock containing impressions of calamites and ferns overlying the coal.....	10	
16. Grey grits thin and thick bedded, irregularly interstratified, and with obscure vegetable fossils.....	2000	
N.B.—This thickness is given on the presumption that in the four and a half miles intervening between the coal at C. Urquhart's on Tay Creek, and that at Alexander McLean's on the Nashwauk, there is no break, undulation nor change of dip, of the existence of which there is no evidence.		
17. Coal seam of four inches overlaid by green shale, with vegetable impression and grey sandstone to unknown thickness.....	—	Coal seam.
Total.....	4005	

At both of the above mentioned localities where coal has been found, the seams themselves are concealed, the former by a considerable depth of water in the creek, and the latter by a crumbling bank. Thus neither the quality nor conditions of occurrence of these coal seams have been accurately established; but there appears no reason to believe them to be of any economic importance, as no true underclays have been found in this section of country, and even the continuity of the coal beyond the spots where it has been found has not been ascertained. The following is a list of the plant impressions found by me in the shales forming the roof of the beds; they seemed to be for the most part common to both localities. I am indebted to Dr. Dawson, of McGill College, for their identification. Fossil plants.

Calamites cistii, *Neuropteris flexuosa*, *N. Loshii*, *N. tenuifolia*, (or an allied species,) *N. gigantea*, *Pecopteris arborescens*, *Annularia sphenophylloides*, *Alethopteris grandis*. At a few other localities in the valley of the Nashwauk traces of coal have been found, but apparently even less important than those included in the section.

Between Tay settlement and Stanley, on the Nashwauk, on the land of Robert Thorburn, an interesting exposure of the junction of the red calcareous conglomerate and underlying metamorphic slate rock, in vertical section, is afforded in a small ravine or gorge. The slate rock at and for some distance below the plane of contact is also calcareous, and seamed with strings of quartz and calcspar; in the same neighbourhood this rock was many years ago unsuccessfully burnt in a kiln for lime.

A similar conjunction to the last is well observed, though in horizontal

Nashwauk.

exposures, in descending the River Nashwauk, where, about a mile below Stanley Bridge, the slates, reddened and rendered highly calcareous towards the contact, are overlapped by the red conglomerate, sandstone and marl, which continue uninterruptedly in descending, for a distance of one and three-quarter miles, equivalent to a thickness of about 1000 feet; and terminate near the mouth of Cross Creek, there giving place to light-grey sandstone and conglomerate in massive beds. At Red Rock settlement and also at the month of Cross Creek, eruptive masses of trap protrude through the red conglomerate near the summit. At Nashwauk Bridge, on the Miramichi road, thin-bedded flaggy grey grits are seen on the bed and bank of the river, dipping S. E. $< 5^\circ$; and the same rocks are occasionally displayed at intervals along the Portage road to Boiestown. About ten miles from Boiestown the road skirts a considerable extent of red conglomerate, terminated towards the east by an eruptive mass of basalt similar to that at Clarke's Mountain, but more vesicular. It forms the height of land on the Portage, and is about three-quarters of a mile wide, terminating at Clear-water Brook, a tributary of the Taxis River; the other dimensions and precise form of the mass have not been fully ascertained.

South-west
Miramichi.

From Boiestown eastward for three or four miles, the right bank of the Southwest Miramichi River is flanked by an amphitheatre of the coarse grey sandstones rising to the height of 200 feet above the river, and dipping S. E. $< 5^\circ$; the line of this escarpment is considerably to the south of that of the bluffs at Keswick, Cardigan, etc. Near the mouth of the Taxis River, which flows into the Miramichi a little above Boiestown, a small seam of coal about three inches in thickness was reported. Four miles up the Miramichi from the mouth of the Taxis, the horizontal grey fossiliferous sandstones overlie red conglomerates and marls, dipping $< 67^\circ$ to the south-east. This high dip, of which some of the beds of the grey grits also seem to partake, may be due to a fault; in corroboration of which hypothesis the underlying metamorphic slate is unusually full of veins of quartz and calc-spar, as if much fractured; but on the other hand it is to be noted that with the observed horizontal breadth of the red rocks (400 yards) the thickness would closely approximate to that usually obtained for the red rocks, (1000 feet). The grey sandstones near this locality yield very fair though rather fine-grained grindstones; and some of the red marls might be found suitable for a pigment.

II. SLATE BAND SOUTH OF THE MAIN GRANITIC AREA.

The second district into which, for convenience of description, I have divided the region explored by me, is that lying between the northern

boundary of the Carboniferous area and the so-called central granitic band ; extending in length from Magaguadavic Lake to the Southwest Miramichi, and in breadth varying from nine and a-half miles on the St. John River to seventeen on the Miramichi ; these measurements being taken in straight lines at right angles to the strike. The rocks of this district consist of argillaceous and micaceous clay slates, with interposed bands of hard fine-grained, crystalline, quartzose, micaceous and feldspathic rocks resembling sandstone. These rocks, which doubtless consists of altered sediments, are generally of a light bluish-grey colour, but sometimes greenish and brown from the presence of iron in various states of oxydation. They are frequently traversed by small lenticular veins and strings of quartz, generally interlaminated, but often cutting the rocks in all directions. Occasionally they are more or less calcareous, and chiefly so at and near their junction with the newer rocks.

These schistose and compact rocks, which alternate in irregular bands of various but generally no great thickness, seem to be only varieties of the same or a similar mineral aggregate, but of different structure. At one point, as I shall presently explain, I have found fossils apparently belonging to these rocks ; but, as the stratigraphical relations of these fossils are still very obscure, it is extremely difficult to discover the geological age, original conditions of stratification, thickness, or the succession of the component parts of the present series. I have observed in the same band of quartzite, (by which, for want of a better name, I shall in the meantime designate the compact bands) no less than four distinct planes of cleavage, or more strictly cleavage, lamination and jointing, along each of which the rock seems almost equally liable to split. Throughout the whole extent of these rocks they exhibit a series of sharp plications and occasional violent contortions, which greatly increase the difficulty of unraveling their structure. It is, however, probable that the planes of division between the compact and schistose bands are to be regarded as marking the original lines of stratification. From numerous observations, many of which are recorded on the larger map, the prevailing dip, when not affected by local contortions, is N. W. $< 60^{\circ}$ — 80° ; this seems in accordance also with the general structure of the country viewed comprehensively, and with the direction of the fossiliferous band at the only locality where I have observed it. Where the plications of the strata are so numerous and so sharp, the dip so steep and almost uniformly in one direction (indicating overturns) the bands of different characters so numerous, so thin, and so much alike, and the exposures so few and interrupted, it would be impossible, in the present state of our knowledge, to construct an accurate section, or to give even an approximate estimate of the thickness of the formation.

Joints and cleavages.

On the right side of the River St. John, the section of the country now

under consideration is for the most part an elevated and uncleared marshy flat, with no natural exposures of rock except on the ridge running from the Magaguadavic settlement to the antimony mines, and on the banks and in the immediate vicinity of the main river, where numerous minor ridges and valleys occur, running in the direction of the strike. Beyond what has been already stated in treating of the junction of the Carboniferous series, and the preceding general remarks upon the metamorphic rocks, there is nothing specially worthy of note on this side of the main river, with the exception of the antimony mines in Prince William parish, and the carboniferous outlier in the same parish and in that of Dumfries. Of the former I propose to give some account under the head of the economic minerals of this part of the province; and shall only remark here that the rocks of the locality are of the same general character as I have already described, except that they are unusually full of quartz veins, some of which contain also calcareous spar, and that they are talcose in their aspect.

Carboniferous
outlier.

The outlying patch of supposed Carboniferous rocks, situated about twenty-four miles from Fredericton, on the river road to Woodstock, and near to the antimony mines, is of a rudely elliptical form, the major axis being parallel to the river; it is of considerable extent, covering about fourteen and a-half square miles, being five and three-quarter miles long by three and a-quarter wide. It is chiefly situated on the right bank of the river, but a small portion extends to the opposite side. It seems to occupy a shallow trough or depression excavated in the older rocks, partly in the granitic and partly in the slate belt; the rocks of the outlier covering the junction of those underlyings. The newer rocks are nearly uniform in character and composition throughout, and consist of coarse grey grits and conglomerates combined in the same beds, and abounding in casts of calamites and carbonized impressions of various obscure vegetable forms. These rocks are apparently identical with those already described as occupying a very large area in the great Carboniferous field above the unfossiliferous red rocks; no traces of which are to be found in this outlier, which rises on the right bank to an average height of 420 feet above the river, shelving with a tolerably uniform slope towards its banks.

Although no distinction can be drawn between the sandstone and conglomerate here, in regard to stratigraphical order, the rocks show stratification, and apparently dip at a low angle, on the whole, from the exterior to the centre of the area. It is probable that the mass is of no great thickness; for at a point near its centre, and at no great distance from that of its highest elevation above the river, a fall on a branch of Jocelyne's Creek, which has cut thirty or forty feet from the present surface into the sandstone rocks, exposes at its base what appears to be a point of

the metamorphic slate protruding into the overlying sandstones. Where these repose immediately on the granite they are found, as in the case observed by yourself near Bathurst, to consist chiefly of the debris of the granite in the form of a highly micaceous sandstone, or "as if from the stratification and solidification of a layer of disintegrated granite." (See *Geology of Canada*, page 452.) A little coal is reported to have been dug up in making a superficial excavation in this outlier; but such a fact, when taken in conjunction with what is known of the general structure, is not sufficient to warrant the expectation of any workable deposit being found here. The extent of the outlier on the left bank of the river is extremely limited, not exceeding 200 acres.

At Keswick Bluff opposite the Indian village in King's Clear, the peculiar features of the slate formation are well exposed in a bold and steep cliff rising to the height of over 300 feet, close to the bank of the river, and extending nearly two miles in length. Here the alternations of schistose and compact structure in narrow bands, the varieties of cleavage and jointing, and the contortions and plications of the rocks may be well studied. At the base of the cliff a small patch of the calcareous red conglomerate appears, being doubtless connected with the area already described as having been met with on the opposite side of the river and at the mouth of the Keswick. Keswick bluff.

At Scotch settlement, near the junction of the granite, the quartzite becomes harder, the crystals of feldspar larger, and the whole more ferruginous than is usually observed, and some bands abound with large cubes of iron pyrites. Such characteristics appear to be frequently prevalent in the immediate vicinity of the granite; and here, as in many similar cases, I observed that next to the ferruginous bands, and still farther removed from the granite, the slates became more or less calcareous.

From Keswick Ridge and Scotch settlement northward as far as the River Nashwauk the country was not explored, and from its generally low and flat character, and being still for the most part a wilderness, appears unlikely to afford anything instructive. The rock exposures on the Nashwauk are not numerous, and present no features different from what I have already described, except that at a point about five miles above Stanley, where the slate and quartzite are much contorted, they are talcoid, ferruginous and slightly carbonaceous, penetrated in all directions by small strings of quartz, and by others of a peculiar white earthy mineral probably a kind of kaolin. Nashwauk.

In ascending Rocky Brook, a large tributary of the Nashwauk, which joins the main river nine and a half miles above Stanley, the exposures—as the name imports—become more frequent; their general character and prevailing apparent attitude, remaining unchanged. At the Stairs, about

two miles from its mouth, the brook falls in a succession of cascades of no great height in a rocky gorge overhung by lofty perpendicular cliffs. Immediately above this point a small tributary joins the main brook, flowing in a south-westerly direction, and about three-quarters of a mile up this creek, occur the only fossil forms which, so far as I know, have hitherto been found in these rocks.

Fossils.

The discovery of fossils at this locality, which is situated in the depths of a pathless forest; seldom visited except by the lumberer; was accidental. The fact of their existence was first brought to light by Mr. Edward Jack, Civil Engineer and Land Surveyor, by whom they were observed in the course of his professional avocations, but who seemed to have been under the impression that they were only drift fossils. Mr. Jack, however, in the autumn of 1867, communicated the fact in a short note to the Natural History Society of St. John. Very shortly after my arrival in the Province, hearing of the matter from Dr. Leith Adams of the 22nd Regiment, then stationed at Fredericton, who had visited the place, and suspected that the fossils might belong to the underlying rock, I visited the spot in company with him, and succeeded not only in obtaining numerous specimens of the loose and extremely friable forms which had been previously observed, but in tracing them to their parent bed in the solid rock.

The fossiliferous layer, which so far as I could discover, does not exceed two inches in thickness, standing nearly vertical, and in conformity with the general attitude of the strata, is a hard close-grained argillo-micaceous and slightly calcareous rock, evidently an indurated shale, scarcely distinguishable, on unweathered surfaces, from the ordinary slate and quartzite of the country, but in the joints and laminæ shewing the presence of much iron by a thick brown rusty coating. The entire rock, through long exposure, becomes a brown pulverulent mass, and it is to this weathering alone that we are indebted for the exhibition of the fossil forms, many of which are in a sufficiently good state of preservation for identification, and are tolerably free from distortion. Although it is only under such conditions that the forms are visible, the entire mass of the band is probably filled with them.

List of species.

The following is a list of the species which have been recognized and determined by Mr. Billings:—*Chonetes Canadensis*, *Leptocælia flabellites*, *Renssællaria ovoides*, *Strophomena perplana*, *Streptorhyncus* (undetermined species). This assemblage of fossils is characteristic of that part of the Gaspé limestones which constitute a passage between the Upper Silurian and Devonian series. (See *Geology of Canada*, pages 393 and 933).

As the discovery of these fossils is an isolated fact, unsupported by similar evidence in other parts of the region now under notice, and as the relations of the rocks enclosing them to the rest of the formation have not yet

been fully determined, it would be premature to assign to the whole the same geological age as that established for the fossiliferous stratum above described. It seems highly probable, however, that this discovery may lead to some modification of the views hitherto entertained by geologists with regard to the age of this schistose belt, which occupies a very large area in the Province.

On the same brook, 150 yards above the fossiliferous band, although probably closely adjoining it in stratigraphical order, an exposure of highly carbonaceous black slates appears in the bed and banks ; but as this exposure was very limited I could not discover their precise relation to the other strata adjacent. The black slates are soft and fissile, with glossy surfaces, staining the hands when touched, shewing various planes of cleavage, and traversed in all directions by thin strings of a peculiar white earthy mineral resembling a sort of clay or kaolin, apparently the same as that mentioned on a previous occasion as occurring about five miles above Stanley on the Nashauk River.

On the Southwest Miramichi the line which I have marked as the boundary between the granite and the slate, is only applicable in so far as regards the area underlaid by the main band of the former rock. Several smaller patches of granite and gneiss were observed within the breadth assigned to the latter ; but as these were only seen in the bed and precipitous banks of the river, I am not prepared to state to what extent they pervade the rugged and mountainous country on either side.

I have already, in treating of the Carboniferous rocks of the Miramichi, indicated the point, at (Campbell settlement,) at which they overlap the slate and quartzite, and have referred to the manner in which the latter rocks are apparently affected at the contact of the former. In ascending the river, the slate and quartzite occupy an uninterrupted breadth of six and a-half miles, nearly across the strike, presenting no features different from those already noted in the general description of these rocks, except that the prevailing dip seems to be S. E. at a high angle. Above this point the course of the river becomes exceedingly tortuous, running for the most part in a deep gorge, and the changes of rock are frequent, although, in most instances, not sharply defined ; thus rendering any attempt at exact measurement difficult and unsatisfactory. I shall therefore, on the present occasion, merely indicate in a concise manner the nature, localities and approximate thicknesses of the various descriptions of rock met with. The point of departure from which the distances are estimated is the junction of the two great divisions of the rock formations at Campbell settlement ; the distances themselves, and the thicknesses of the various bands being measured in a straight line across the strike of the rocks.

At the point above indicated, near Lower Birch Island, (six and a-half

miles from Campbell,) there occurs what I take to be a dyke, ten or twelve feet wide, composed at the surface of a soft brown-weathering, argillaceous rock with much iron and manganese, apparently cutting the rocks, and with a course a little E. of N., succeeded by a band of red and green slate about 1000 feet in aggregate thickness, also much stained with oxide of manganese, and apparently dipping S. E. $<75^{\circ}$. At the mouth of Trout Brook, (seven miles) a very hard green, highly feldspathic quartzite, which appears to have the same dip as that above noted. At seven and a-half miles, a band of very hard close-grained cherty rock resembling Lydian stone, four feet wide, holding much iron pyrites and imbedded in light green micaceous and ferruginous slate. At Falls Brook, (seven and three quarter miles,) there is a band of highly ferruginous soft, black, but rusty-brown weathering slate, the attitude of which is vertical, and the breadth about 450 yards. The fall is about a quarter of a mile from the main river, the brook running on the strike of the rocks, which, apparently by the influences of the weather and the eroding action of the stream, have been excavated into a triangular gorge about 300 yards wide at the main river, with almost perpendicular sides 300 feet high, converging to a point at the fall, which has at least 130 feet of uninterrupted descent, presenting a singularly wild and picturesque scene.

The next tributary, falling in, as nearly all do, on the left bank, is Rocky Brook, nine miles from Campbell, between which and Falls Brook occur black and greenish banded or ribboned very hard slate and quartzite, dip S. E. $<60^{\circ}$; then alternating bands of hard purple quartzite and yellowish feldspathic sandstone, resembling a fine-grained imperfectly formed granite. These bands, of which there are at least two of each description of rock, are from 50 to 100 yards in width respectively, and dip to S. E. $<75^{\circ}$. The quartzite bands are much seamed with quartz veins running north and south, corresponding with the direction of the more conspicuous joints of the granite throughout; and immediately above these alternating bands appears a considerable mass of granite, extending from one-third of a mile below Rocky Brook upward for one and three-quarter miles, succeeded by a breadth of about 400 yards of banded black and green quartzite, resembling that previously noticed.

Then follows an equal amount of ordinary quartzite, still with S. E. dip, underlaid by a breadth of 100 yards of highly ferruginous decomposing quartz rock, in some places resembling an altered conglomerate, forming a very high steep crumbling bank; giving place, about eleven miles from Campbell, to true granite, extending uninterruptedly to Snake Brook, a distance of three and a-half miles, with the exception of one interposed band, not over 300 yards wide, of highly ferruginous quartzite. Between Snake Brook and Burnt Hill Brook, a distance of one and three-quarter

miles, the banks are occupied by quartzite dipping N. W. $<80^\circ$, and gradually, on approaching Burnt Hill, appearing to pass into a variety of gneiss, dip N. W. $<60^\circ$. The rocks near the mouth of Burnt Hill Brook are cut by numerous transverse veins of quartz, holding much iron pyrites and occasionally a little molybdenite. The direction of the veins, as in the case formerly cited, coincides with that of the more prominent joints of the granite, a large apparently isolated mass of which occurs about half a mile up Burnt Hill Brook. Immediately at the mouth of the brook, however, a band of very hard close-grained variegated or ribbanded silicious slate is interposed, and probably lies directly in contact with the granite, which scarcely makes its appearance on the main river, and seems to thin out to a point a little above the mouth of the brook. The aspect and attitude of the rocks here would seem to indicate that the granite lies in a synclinal, for immediately above the point last referred to, the gneiss re-appears, with S. E. dip $<60^\circ$, and sometimes enclosing in its beds masses of granite, as if detached from the main body and incorporated with the gneiss, which gives place again, in ascending, to fine-grained hard compact quartzite.

This description of rock continues, and with the same attitude, to Little Burnt Hill, one mile higher, where the dip seems again to change to N. W., and green micaceous schists, with quartz veins holding pyrites, are intercalated. The quartzite continues in bands of varying hardness and colour, and passes near the mouth of McLean Brook, sixteen miles from Campbell, into a very hard black slate rock, standing vertically, and continuing, with no perceptible change except that it becomes of a deep bluish tint, as far as Slate Island, where patches containing considerable calcareous matter, iron pyrites, and traces of copper pyrites were observed. Above Slate Island for one mile no change was noted except the absence of lime in the slate; then a band of gneiss 400 yards in width, succeeded by feldspathic slates of about an equal amount, and again, at or near the northern boundary of the New Brunswick Land Company's tract, by heavy bedded black micaceous gneiss. A very short distance above this point, near McDonald's Brook; seventeen and three-quarter miles from Campbell measured in a straight line across the strike; is the line which I have drawn on the maps, as the division between the main granitic area and the slate and quartzite band.

III. THE CENTRAL GRANITIC AREA.

The distinction noted in the close of the last section, and implied by the title given to the present, may appear to have been drawn somewhat arbitrarily; for the so-called slate and quartzite band includes, as we have

seen, three very considerable, besides some smaller, bands of granite ; although the prevailing rock of the section is undoubtedly of the nature designated by the terms used. The region beyond, and on the north-west side of the line referred to, appears to be occupied, for the most part, if not entirely, by granitic rocks.

In attempting to define or map the rocks of this region much perplexity is occasioned by the gradual manner in which many of the various feldspathic rocks seem to merge into each other. Not only does this remark apply to the granite and gneiss, which are sometimes blended in such a manner as to defy all attempts at exact definition ; but even the foliated semi-crystalline slate and quartzite frequently appear to partake of the same characteristics. In exploring the rocks of this region no evidence was met with of the injection or upheaval of the granite among the stratified rocks, or of the derivation of the latter from the former. I suspect, however, that, on the whole, the granite will be found generally to occupy a lower position stratigraphically than the other rocks.

Granites.

The granite presents great varieties in colour, texture, and in the proportion of its component minerals. In general the mica is rather sparingly diffused, and sometimes altogether wanting, and the feldspar crystals frequently attain a great size, up to an inch and a-half in thickness. Occasionally irregular fragments of gneiss of all shapes and sizes are found imbedded or rather incorporated in the granite, and *vice versa* ; but no appearances of granite veins cutting the laminated rocks are noted. The direction of the granite band, whether taken as a whole or locally when seen in contact with other rocks, coincides with the general strike of the country. It is, however, extremely rare to find such junctions exposed, as the granite, probably from being more readily disintegrated, has suffered more from superficial denudation and atmospheric influences, and consequently underlies low flat land, except when flanked and protected by more resisting rocks. Within the limits assigned to the main granitic band other rocks sometimes occur, as will presently be seen.

The breadth of this band on the South-west Miramichi, in a direct line, is ten and a-half miles, extending from the point already noted to about half a mile above the forks of the north and north-west branches. Throughout the whole of this distance the country is an extensive, level, heavily wooded flat, affording no rock exposures, except occasionally at great intervals in the bed and banks of the river. Although other rocks may, and probably do, underlie this district, they are entirely concealed, and the exposures are uniformly of granite, although not always of the same character. At one place, a little below Lewey's Falls, nineteen miles from Campbell, a fine-grained yellowish feldspathic sandstone, resembling that described as occurring near Rocky Brook, is seen for a

Sandstone,

considerable breadth, succeeded by a thin band in which a multitude of angular fragments of gneiss appear to be enclosed in granite, then by gneiss, and last of all, at the falls, by true granite in massive beds, extending probably to the forks, twenty-six and a-half miles above Campbell in a direct line across the strike, through forty-six miles in following the tortuous course of the river, which, throughout the whole distance, is wide, deep and rapid, and much obstructed by huge granite boulders. The average fall I should estimate to be at least eight feet in a mile.

The region lying towards the head waters of the Nashwauk and Becaguimic has not been traversed by me, and I am indebted to Mr. Edward Jack for such facts regarding it as I have recorded on the larger map, and which I believe may be relied on as authentic.

At Hayneville and Springfield, which are included within the granitic belt, and where there are several ridges and hills composed partly of this rock, a considerable extent of country is nevertheless underlaid by very hard close-grained ferruginous feldspathic quartzite, resembling petrosilex, and sometimes traversed by great veins of quartz, holding much silvery mica. There is also found in this vicinity, and near the most northerly part of Hayneville settlement, a band of carbonaceous slate resembling that near Rocky Brook on the Nashwauk, its attitude being apparently conformable to that of the adjacent feldspathic and ferruginous rocks; but its true relations, as in the case of the Rocky Brook band, have not yet been accurately ascertained.

On the river St. John the granite band extends from the upper end of Great Bear Island, twenty-four miles above Fredericton by the river banks, to a little below Sullivan's Creek, a breadth of fifteen and a-half miles measured in a straight line across the strike. Throughout this breadth the granite is of a very varied character, as before noted with respect to that on the Miramichi. Included bands of gneiss and gneissoid quartzite are irregularly distributed, the Meductic Rapids owing their origin apparently to the varying hardness of the rocks; the carbonaceous slates appear to be nowhere represented in this section, unless it be at a point a mile and a half below the Nackawicac River, where an extremely hard jaspery rock, resembling Lydian stone, abuts upon the main river. On the right side of the river the granitic region has only been explored by me along the bank, and towards the junction of the supposed Carboniferous outlier; the limits, however, as provisionally laid down on the maps, are given on good authority.

IV. NON-CALCAREOUS SLATE BAND NORTH-WEST OF THE GRANITE.

This division comprises the rocks underlying parts of the counties of York and Carleton, extending on the St. John River from Sullivan's

Creek to a point a little above Woodstock, or a breadth of sixteen miles; and on the Miramichi seven miles, measured in a straight line across the strike; from the forks of the north and north-west branches. These rocks present few characters to distinguish them from the band already described as lying on the other side of the granitic belt, and, in the absence of evidence to the contrary, may be assigned to the same geological age. It will therefore be unnecessary, on the present occasion, to enter into any detailed description, and I shall proceed to notice a few of the most prominent points of distinction which have come under my observation.

Mica-schist.

On the St. John River, immediately above Sullivan's Creek, extending about five hundred yards upwards, and apparently in contact with or close proximity to the granite, occurs a band of highly ferruginous finely laminated mica-schist, traversed longitudinally by large quartz veins, and dipping N. W. $< 30^{\circ}$ – 50° . This is succeeded by ordinary clay slate and quartzite, which continues, with many sharp convolutions and folds, but preserving the prevailing north-westerly dip at high angles, to Patchell's Ferry, four and a-half miles from Woodstock. Here the rocks begin to assume a more crystalline aspect, and all around Woodstock afford evidences of an abnormal and disturbed condition. Bands of crystalline rocks, resembling granite, syenite, diorite, (occasionally with trappean rocks) and sometimes holding epidote, iron and copper pyrites, galena and other minerals, are intercalated in the manner of conformable or imbedded masses. Some of these I have represented upon the map, but they are too numerous and too varied in character, and have not been studied sufficiently in detail to admit of an exact description.

Crystalline
rocks.

I observed isolated patches, generally of no great extent, of an altered slate conglomerate composed of rounded and angular fragments of the surrounding rocks, cemented by a feldspathic paste into a hard rock; these are probably lenticular masses occupying depressions in the older rocks. About half-way between Upper and Lower Woodstock, on the right bank of the river, an interesting exposure of green quartzose and epidotic rock, jointed so as to present some appearance of columnar structure, occurs; near the Iron Works the same kind of rock, but devoid of the peculiar structure referred to, occupies a considerable breadth; and near Lower Woodstock a narrow band of red and green fine-grained and very regularly laminated slate, not over thirty feet in thickness, was observed running conformably with the general strike, but dipping S. E. $< 40^{\circ}$. The whole district is exceedingly interesting to the geologist, and especially so in connection with the deposits of iron and copper ore in the vicinity; but would require, in order fully to elucidate its structure, a more careful and detailed examination than I had it in my power to give.

Woodstock.

In this section, a remarkable exception to the general character and

distribution of the rocks, as above described, occurs in the form of an extensive outlier of supposed Lower Carboniferous strata, occupying an area of probably not less than sixty or seventy square miles, chiefly in the parishes of Brighton and Peel, in Carleton county. This outlier has not previously, been specially described, so far as I am aware.

Carboniferous
outlier.

On the left bank of the St. John River, opposite Campbell Island, two miles below the mouth of the Beccaguimic, a band of conglomerate, 560 yards broad, abuts upon the river. It is here of the character described as belonging to the silicious conglomerate band of the main Carboniferous area ; or rather partaking of a combination of this with the underlying red calcareous conglomerate of the same series, with which, on tracing it to some distance inland, it becomes completely assimilated. The north-western outcrop of this outlier, as delineated upon the maps, has been traced by me, at intervals, for a distance of twelve miles ; and a partial traverse has been made near the centre to a distance of one and a-half mile ; where at S. B. Orser's mill, on the north branch of the Beccaguimic, coarse red sandstone and conglomerate appear to dip N. W. $< 27^{\circ}$. For the further information which has enabled me to trace approximately on the maps the boundaries of the outlier, I am indebted to Mr. Edward Jack, who, in the course of his surveys for timber locations, traversed this region in the fall of last year, and at my request, noted any remarkable geological facts which came under his observation. His remarks in reference to this outlier, which were not communicated to me until after my return to this city, are necessarily somewhat general, although sufficiently explicit to justify me in assigning to it provisionally, the limits laid down on the map ; and I consider it unnecessary to give them in detail, as you will probably deem this interesting field worthy of further special research.

On the right bank of the St. John River, a little below the band of silicious conglomerate already referred to, a somewhat similar deposit, but entirely resembling the red calcareous conglomerate and sandstone of the Carboniferous series, is displayed to the extent of 1,200 yards in breadth. Where evidence of stratification occurs in this deposit, it appears to dip to the north-west in the same direction as the metamorphic slates by which it is enclosed on both sides, although at a lower angle. The same band is traceable for seven miles on the strike, extending to the rear of the Woodstock Iron Works, where it thins out to a point, and terminates about 100 yards south of the Jacksontown Road. This is probably connected with the conglomerate and sandstone area in Brighton, as already described, but here is either brought into position by a dislocation, or occupies a narrow and shallow wedge-shaped cavity in the older rocks. The only distinction I can observe between its condition and that of the lower red calcareous conglomerate of the main Carboniferous area ; consists in the fact that here the

rock appears to be affected by numerous small faults or slips, which, in maintaining their straight course, have cut through pebbles and matrix alike.

V. CALCAREOUS CLAY SLATES IN CARLETON AND VICTORIA COUNTIES.

The narrow strip or belt of red conglomerate just described, together with the north-western boundary of the outlier in Brighton, constitute, with their continuation on the strike on either hand, the limit of the non-calcareous slates; beyond which to the north-west, without any perceptible change of attitude or general conditions, commences a set of calcareous slates and quartzites, extending on the St. John River, to and far beyond the Province line. These rocks, which present a remarkable uniformity in character for very great distances, precisely resemble those which have been described by yourself as occurring and attaining a great development on Temiscouata Lake and the river Madawaska, and for a great distance down the St. John River, and are in all probability the continuation of the same series, which you have determined to be Upper Silurian. The general description of these rocks given in the *Report of Progress* for 1849-50, page 60, is so concise and graphic, and at the same time, in its main features, so precisely applicable to those now under notice that I may be excused for quoting it here.

"The next five miles across the measures are occupied on the west side of the lake by calcareo-argillaceous slates, occasionally interstratified with non-calcareous bands, and some of the beds are more arenaceous than others. The colours are dark bluish-grey, light-grey and black; the divisions of the original bedding are obliterated, and in fresh fracture it is only by the colours, the differences of which are often very obscure, that the stratification can be made out; but the action of the weather and water on the ice-rounded or *moutonnée* forms which come upon the lake, distinctly shews the bedding by the unequal wear of the more or less calcareous layers, the one standing out in beads, and the other re-entering in grooves. The beds are almost universally thin, and the surfaces give a pictorial display of a vast variety of the most complicated contortions, sometimes in folds leaning over each other to the north-west, and sometimes in involved arrangements which it is quite impossible to disentangle or understand without a larger exposure than usually appears. Combined with the contortions there are often disruptions or dislocations which, however, shew no veins of interposed foreign material; the torn and twisted mass having been apparently compressed together and become cemented in such a way that, except for the colours or unequal wear, it would never be suspected that it had been disturbed at all. In some parts, however, these contorted rocks are cut up by a multitude of small veins of calcareous spar."

I have to add to the above description that the bands of non-calcareous quartzite in the region explored by me, although in general conformable, appear sometimes to cut the rocks transversely to their strike; they vary from eight to thirty feet in thickness, and are usually traversed by small strings of calspar. Where they abut upon the river banks the exposures are usually more extensive, than at other points, as if, from their superior hardness, they had more effectually resisted atmospheric influences and the erosive action of the river. There also occur in this region a few apparently isolated patches of limited extent, of more or less pure limestone, Limestones. probably lenticular in form, sometimes of a slaty structure, and sometimes massive. In two instances which came under my observation, where the rock seemed to have undergone little alteration, I discovered a few obscure fossil forms which, however, were scarcely visible except on weathered Fossils surfaces; but which have been recognized by Mr. Billings as Upper Silurian.

Intercalated with the calcareous slates of this region are some remarkable bands of highly ferruginous red and green slates, sometimes traceable for great distances on the strike. The first and most important set of these bands is that in which are situated the deposits of iron ore which Iron ores. have been mined at Jacksontown, near Woodstock; and which, in their continuation to the north-east, display at their out-crop near the Beccaguimic, twelve miles from Jacksontown, very considerable quantities of a similar ore, being an impure slaty hematite. In the Beccaguimic district there are three parallel bands of red and green slates about half a mile apart; one of these only, that nearest the river, appears to contain workable deposits of ore. Towards the south-west the Jacksontown band is traceable to the boundary line, and far into the State of Maine; where I observed it, near the boundary line, it was charged with iron pyrites. Another band of the red and green argillites is traceable from Flanigan's Hill, in Simonds, to East Glassville, a distance of nearly eight miles, and has yielded in some places good specimens of hematite and specular iron; it is five and three-quarter miles distant across the strike from the former. It would seem reasonable to expect that these bands would serve to mark the structural arrangement; but as their attitude in every instance where they were observed is vertical, and their association with other bands obscure from want of exposures, I have been unable as yet to make them available for this purpose.

A remarkable band of diorite was observed in crossing the road passing through East Glassville, about two and a-half miles south of Miller's Corners. It appears to run in conformity with the slate rocks, and is 150 yards wide where it crosses the road; in its continuation to the north-east on the strike, it appears to run into a ridge of considerable elevation

Diorite bands.

terminating at three miles distant in Garforth Mountain, which is about 800 feet high. The succession of rocks observed in the vicinity of the diorite band in traversing it from north to south is as follows: 1. Calcareous slates, being the prevailing rock of the country. 2. Black slate, a very thin band. 3. Diorite band, 150 yards wide, coarsely crystalline, of a prevailing dark-green colour, with many seams and joints filled with calcareous spar, especially towards its junction with;— 4. Slaty limestone eighteen feet thick. 5. Highly ferruginous decomposing calcareous slate. 6. Another band of diorite of a laminated or gneissoid aspect and narrower than the former. 7. Calcareous slate, as at the commencement of the section; the whole of which is comprised within a breadth not exceeding 500 yards, the attitude of all the rocks being vertical.

In the region underlaid by the calcareous slates, the soil is, as might be expected, superior for agricultural purposes, to that in which the rocks devoid of lime prevail.

VI. TOBIQUE VALLEY AND TRIBUTARIES.

In the course of my explorations of last season, I undertook an excursion up the River Tobique and one of its most important branches, the Serpentine, partly with the view of making an examination of the great Lower Carboniferous outlier there, and partly to visit certain lands which had been leased from Government on the latter stream for gold mining purposes.

Tobique River.

The Tobique is a large tributary of the St. John, falling into the main stream about fifty miles above Woodstock, from the north-east, its general course thus coinciding with the strike of the rocks of the country. It has its source in the high lands constituting the water-shed between the St. John and the Gulf of St. Lawrence; one of its main branches, called the Little Tobique, or Left-hand Branch, with a general south-easterly course, connects by a short portage with the Nepisiguit flowing, into the Bay of Chaleurs; while the other or Right-hand Branch, falling into the main river at the same point, but from the opposite direction, through a very rugged and mountainous country, is, in its turn, composed of two branches, the Campbell and Serpentine rivers. These streams form a junction at the distance of ten miles from the main forks, from which point the Tobique flows through a rich and fertile valley in a south-westerly direction to join the St. John River, a distance of sixty-two miles, following the windings of the stream. On the Serpentine, which had not previously, so far as I am aware, been visited by any one with the special view of ascertaining its geological features, the land leased for mining purposes commences about three miles from its junction with the Campbell River, and extends some twenty miles higher, the stream for the greater part of

Serpentine River.

the distance cutting across the strike of the rocks; but, owing to the extreme difficulty of exploring this region, I was compelled to content myself with penetrating about seven miles from the commencement of the leased lands, or twenty miles from the main forks of the Tobique.

The main Tobique, for about two miles from its junction with the St. John, flows with great rapidity through a deep, rocky gorge, its course nearly coinciding with that of the slates, which dip N. 70° W. $<60^{\circ}$; they are here highly calcareous, and enclose many seams and bunches of pure calc-spar. Half a mile higher a narrow band of red and green slate occurs, associated with a tolerably pure compact or massive limestone, containing fossils, apparently in considerable profusion, although only visible on weathered surfaces. Among them, according to Mr. Billings, are *Favosites Gothlandica*, *Atrypa reticularis*, and *Strophomena perplana*, belonging to the Upper Silurian series. Above this the river assumes a course nearly at right angles to the strike, cutting sparingly calcareous but highly ferruginous and contorted brown-weathering slate and quartzite, which must underlie those formerly referred to as prevailing at the mouth of the river. Small straggling strings of galena were observed at one place filling cracks in the rock, but are of no economic importance, except as indicating the metalliferous character of these rocks. At three and a-half miles from the mouth, measured in a straight line on the strike, the soil assumes a red tint from the proximity of the red conglomerate of the outlier; a small patch of which is visible in the bank here, but is again succeeded by the older rocks, till reaching Red Rapids, four and a-half miles up, where this formation; apparently identical in character with that mentioned in other parts of this report as the lowest rock in the Carboniferous series; appears in force in the bed and banks of the river, dipping due E. $<4^{\circ}$, extending over half a mile further up stream, and forming a steep, rocky channel.

Above this point the rock exposures are few, and for a distance of nine and a-half miles indicate no change, except in the prevalence of finer red calcareo-arenaceous sediments in ascending. Then, about half a mile below the Wapskehegan, appear red, grey, and green marls, interstratified with blue limestone, all in thin alternating bands, still dipping slightly S. E., and extending to the mouth of that tributary; a little above which the limestone re-appears in more massive beds, some being thirty inches thick, interstratified, as before, with red shales or marls, also of greater volume. This is a distance, in a straight line, of fourteen and a-half miles from the mouth of the river, and here the outlier attains its greatest breadth, of about nine miles, of which by far the greatest proportion lies on the south-east side of the river. The general character of the limestone of the Tobique outlier is fine-grained, with conchoidal fracture, mottled red

Silurian fossils.

Carboniferous series.

Marls and limestone.

or pink and green, but sometimes bluish-grey; frequently seamed with calcareous spar, and containing, according to Professor Hind's analysis, 82.6 per cent. of carbonate of lime.

Gypsum.

Superimposed upon the limestone and marl beds here, are heavy beds of gypsum, which first appear at the mouth of the Wapskehegan, but in much greater development at Plaster Cliff, a mile and a-quarter higher; where, for a distance of 80 or 100 yards, they rise perpendicularly from the left bank to a height of 120 feet. The great body of the rock is an impure, massive but earthy and exfoliating red and greenish gypsum, containing a varying proportion of carbonate of lime and silicious matter; but it is seamed with layers of pure white gypsum and of fibrous selenite, containing, according to the analysis of the late Dr. Robb, 77.7 per cent. of sulphate, and 3.0 per cent. of carbonate of lime. Nodules of nearly pure carbonate of lime are occasionally met with, imbedded in the red gypsum. The whole appears to dip S. E. at a very low angle, and to be of limited extent, where it abuts upon the river; but I am informed, on competent authority, that the plaster beds are traceable at least four miles up the Wapskehegan, alternating with the other rocks of the series. Two small brooks were observed flowing into the river near the junction of the gypsum and marl beds, the waters of which were decidedly saline and brackish; this character being, doubtless, derived from salt springs, which however, were not met with.

Amygdaloids.

Above Plaster Cliff, for a distance of eight miles, the strata, which are now horizontal, consist, as before, of grey and red sandstone and conglomerate, blue, red and green limestone, and marl; thereafter, at the point indicated, near Phillips's Brook, promontories and low knobs of dark brown amygdaloidal trap appear at intervals among the red rocks on the left bank, becoming more numerous and extensive in ascending the river. The red rocks, however, continue to occupy exclusively the bed and right bank of the river, and occasionally also appear on the left bank, but now with westerly dip, until a point thirty-one and a-half miles from the mouth is reached, where the outlier may be said to terminate; although for the last three miles of this distance, or from Blue Mountain upwards, only slight traces of its existence can be detected in the red colour of the rocks in the bed of the river, where they are at rare intervals seen in place. Thus the total length of the outlier, measured in a straight line, may be stated at twenty-seven miles; it is of a rudely elliptical form, and its total area is not less than 190 square miles. It is bounded on all sides by ferruginous and generally non-calcareous contorted slates and quartzite, its outlines forming a very marked topographical feature, being defined in every direction by lofty ridges of the older rocks. A comparison of the rocks of the outlier, both in respect to their mineral character and apparent

order of sequence, leaves little room to doubt that they belong to the same series which I have described as lying at the base of the main Carboniferous area of the Province.

Blue Mountain, rising with a steep slope immediately from the bank of the Tobique, fifty-one miles from its mouth, as measured along the windings of the river, attains a height of 1,641 feet above the sea, and displays the red rocks towards its base. It was not ascended by me, but from its contour and surrounding conditions, seems to be composed mainly of eruptive rocks, of which a great variety, probably detached from its sides, are strewn in boulders and pebbles in the bed of the brook which bears its name. The same description of rocks, offering many varieties of colour and texture, occupy the left bank of the Tobique for over three miles above the last mentioned brook, and have apparently altered the red sandstone and conglomerate of the outlier into a hard jaspery rock. At Riley Brook, thirty-four and a-half miles in a straight line from the St. John, light green very soft non-calcareous clay slates are displayed, but only to a limited extent, succeeded by the same hard highly feldspathic brown-weathering contorted slate and quartzite already so frequently referred to, extending to, and for an unknown distance beyond, the main forks of the Tobique, and within three miles of those of the Campbell and Serpentine rivers. This character, in fact, seems to be generally prevalent here over a very large tract of country, and does not appear to differ in any important particular from that which I have described in reference to Sections II and IV, into which I have divided the region explored by me.

Some of the highest mountains in the Province are situated in the remote region and among the rocks now under review. I ascended one of these, called Bald Mountain, which I found to be 2,060 feet above the sea, or 1,535 feet above the Tobique at its nearest point. It stands alone, in the midst of a comparatively level country, the distance being five miles from the Tobique and about the same from the Right-hand Branch. The mountain, from base to summit, is nearly conical, its sides sloping at an angle of 35° to the horizon. The rock, wherever exposed, consists of a very hard ferruginous feldspathic quartzite in massive beds, weathering to a brownish-white or cream colour, dipping N. W. $<65^{\circ}$; no change either in the nature or attitude of the rocks was observed from base to summit.

Soft ferruginous slate and quartzite, some of the bands of which are highly calcareous and contain impressions resembling fucoids, are seen a little above the main forks of the Tobique, with north-westerly dip $<60^{\circ}$; above which, in ascending the Right-hand Branch, and for a distance of four and a-half miles, measured in a straight line across the strike, heavy-bedded greenish yellowish-white and brown-weathering quartzites, sometimes very slightly calcareous and pyritiferous, occupy both banks of the

river, rising in abrupt cliffs to a uniform height of 600 or 700 feet, resembling an artificial embankment. About five miles from the main forks of the Tobique, and the same distance from those of the Campbell and Serpentine rivers, the lamination, and probably also the dip of the rocks changes to S. E. ; and a band of excessively hard and tough silicious rock, resembling petrosilex, and exhibiting a tendency to columnar structure, crosses the river, forming a fall of moderate height. This is precisely on the line of strike from Bald Mountain, about five miles to the south-west.

About three miles higher up the branch a high ridge, running also in the direction of the strike, abuts against the river, with apparently a similar nucleus of hard rock, which, however, in this case, resembles some of the red trappean rocks described as occurring near Bald Mountain in York County, at the base of the Carboniferous series. This ridge deflects the course of the river sharply to the north-east, about the forks of the Campbell and Serpentine. At a point called Salmon Hole, where the red trappean rock first makes its appearance on the bank of the river, a narrow band of soft green argillaceous slates, with glossy surfaces, occurs, seamed with numerous small lenticular veins of quartz, carrying iron pyrites and a little galena, and said also to yield some silver. The breadth of the hard red rock, which, however, seems to include some narrow bands of slate, does not exceed half a mile ; it is followed, at the forks of the Serpentine and Campbell, by light green quartzite devoid of metalliferous indications, dipping N. W. This continues, with interruptions from two narrow belts of the red and dark green glossy rock, for three miles up the Serpentine, where the mining leases commence, at a point where traces of copper pyrites are said to have been seen in dark grey contorted slates seamed with quartz veins, and resembling those on the St. John River, a little below Woodstock. Two miles higher a band of yellowish-red trap, or other hard rock, again deflects the course of the river sharply to the north-east ; and a mile beyond this point, or six miles from the forks, a band of highly pyritous slate appears, followed by light grey micaceous schist, with much interlaminated quartz, or rather a mixture of quartz and slate, in which gold was said to have been found. The breadth of this band is uncertain, though probably not great ; it is succeeded by a compact quartzose and feldspathic rock resembling petrosilex, showing no traces of metallic minerals, but sometimes of a feebly laminated structure, resembling gneiss ; and which gives place, at a distance of eight and a-half miles from the forks, to a band of granite not exceeding 600 yards in width, over which considerable fall in the river occurs ; and above this the same alternations of gneiss and quartzite which were observed below the granite band, but without the talcoid and pyritiferous slates. This was the limit of my observations in this region.

Metalliferous
veins.

ECONOMIC MINERALS.

To this branch of the subject I have alluded incidentally in describing the rocks at the various localities where minerals capable of such applications exist, or are supposed to exist. From a very early period in the history of this Province, much has been said and written regarding its mineral wealth, both in coal and the metals; and capital has been to some extent employed in the development of its mineral resources, although it is to be regretted that hitherto the success which has attended such ventures has not been very marked. My own observations have not been made with any very special reference to this subject, but, in so far as they have been directed to it, I confess that I have been somewhat disappointed, both as regards the probabilities and actual results. Mere indications of valuable ores or minerals are insufficient to constitute a mining region; and the failure of operations undertaken on inadequate grounds acts as a check upon others which may have a legitimate basis, and tends to retard rather than promote the mining interests of the Province.

With reference to the small portion of the Carboniferous area examined by me; I have already given my views as to the futility of any expectation of the occurrence of workable coal seams in these rocks, which are altogether below the productive coal measures. The sandstones are in general too coarse-grained and too ferruginous to make a good building material, although some of the beds of purple sandstone appear well adapted for such purposes. In some places I found them tolerably well suited for grindstones, flags and tiles. The red marls towards the base of the series may be available as a pigment, where free from silicious matter; and excellent brick clays, some of which seem also to possess the qualities of fuller's earth, abound.

In the metamorphic rocks of this region the first mineral of economic importance which claims attention, is antimony. The antimony mines of Prince William have been worked at intervals and to a small extent for six or seven years at three adjoining locations situated twenty-four miles from Fredericton and three miles from the Woodstock road. The rock of the country is talcoid slate and quartzite, coinciding in strike and dip with that generally prevalent throughout the section. The mines are in the immediate vicinity of the supposed Carboniferous outlier of Prince William, and within two miles east of the junction of the slate and granite. The veins, which have been partially developed by mining, have the character of true or fissure veins cutting the rocks, and thus may be expected to prove persistent in depth. Two of them have a course nearly parallel, and at the distance of about one hundred feet apart, underlying due N. $< 45^{\circ}$ — 52° ; while the third has a bearing exactly at right angles to these,

and underlies to the E. $< 43^\circ$. In the former cases the matrix is slate and quartz, without any admixture of calcareous spar, while in the latter a considerable amount of this mineral is found in the vein. The ore is stibnite or sulphuret of antimony, occurring both in pure solid masses, and more or less mixed with the gangue. The thickness of the veins, which is nearly the same at the different locations, varies in the same shaft from four to twenty inches. In so far as hitherto developed, the best ore and the thickest part of the veins have occurred within fifty feet of the surface. On the vein first worked the shaft has been sunk ninety feet, and ten tons of ore sent to market. At the second the shaft is two hundred feet deep, and drifts have been carried to the aggregate length of four hundred feet; ore to the amount of one hundred tons was obtained, of which thirty tons have been sold. At the third, which was in operation at the time of my visit, the shaft is sunk two hundred and eight feet, and seventy or eighty tons of ore had been obtained, some of which was said to contain a considerable proportion of silver. I must add that two specimens taken by me, for assay by Dr. Hunt, have shewn no traces of silver, although this may be no conclusive proof that it does not exist in some part of the vein.

Molybdenum.

In the account which I have given of the section of rocks exposed on the South-west Miramichi, I have mentioned the occurrence, near the mouth of Burnt Hill Brook, of sulphuret of molybdenum in thin quartz veins in gneiss. Some of the veins at the surface are charged with the mineral in thin foliated hexagonal plates. This mineral has found some important applications in the arts, chiefly for the production of a dyeing material and as a re-agent in the laboratory. It is somewhat rare, and the price was quoted in the Paris Industrial Exhibition of 1855 at \$3.45 per lb., (see *Geology of Canada*, p. 755). It is doubtful, however, if any of the veins visible at the surface at the locality named, which is remote and not easily accessible, will yield a sufficient quantity of the mineral to repay the cost of mining and sending to market.

Copper.

About three miles below the town of Woodstock, on the right bank of the St. John, veins of yellow sulphuret of copper, associated sometimes with much iron pyrites, occur at several points in the vicinity of an apparently stratified mass of rock resembling diorite, but holding a small proportion of quartz. These veins have attracted attention from a very early date in the history of the Province, and have formed the object of mining enterprise on a considerable scale, but were abandoned several years ago as unprofitable. The veins opened, though tolerably promising at and near the surface, were not found to maintain that character in sinking. In the rock cutting on the railway, about a mile below Woodstock, is a bed of light green or grey highly altered epidotic slate, con-

formable with the stratification, and resembling that near the Iron Works, in contact with which is a band of chloritic slate charged with iron pyrites and galena, and near to this a conglomerate similar to those formerly described as seen at the mouth of the Meduxnakeag. I found among the shingle on the bank of the river St. John, seven miles below Woodstock, a large boulder of rich copper pyrites in a matrix of slate conglomerate. Although, so far as yet known, the copper ore in the vicinity of Woodstock does not occur in true veins, masses of the character described, when of sufficient magnitude and richness, have been profitably worked in other parts of the world, and such may yet be brought to light here.

The iron ore of Jacksontown, three and a-half miles north-west from Iron ore. Woodstock, has attracted much attention from an early period, having been first noticed by Dr. Jackson in his Report on the Geology of Maine, 1837, and has been treated at various times in the smelting furnaces at Upper Woodstock, about the same distance from the mines. The ore is an impure slaty hematite, containing on an average 46 per cent. of the peroxide of iron, equivalent to 32 per cent. of metallic iron; it also contains a variable proportion of oxide of manganese, to which the iron probably owes some of its peculiar qualities. It occurs irregularly imbedded in red and green clay slates, and it is thus impossible to assign any specific or definite thickness or length to the deposits; enough, however, is known to justify the assertion that the ore may be found in very great abundance. That hitherto obtained, which has been extracted altogether by the method of open cuttings, and smelted at the Woodstock Iron Works, amounts to about 40,000 tons; many of the bunches of ore have been worked out at a depth of from twelve to twenty feet from the surface; some, however, seem to be connected with beds or courses, probably of greater regularity and continuity and of richer quality. In one of these (Carnie's mine), where much quartz was associated with the bed, and some of the ore was of the specular variety, I found small portions of purple copper ore.

The pig-iron produced from the Jacksontown ore is remarkable for its great hardness and strength, and when mixed in certain proportions with other kinds, has been found very advantageous for railway car-wheels. When converted into wrought iron, it is said, on the authority of Mr. Fairbairn of Manchester, to be specially suited for the plating of iron-clad war vessels and similar purposes, where a combination of great hardness and tenacity are requisite; it is also said to be admirably adapted for the manufacture of steel. The fuel used for smelting the ore at the furnaces, which were not, however, in operation at the time of my visit, is wood charcoal; of which 126 bushels, together with about $3\frac{1}{4}$ tons of ore, were consumed to make one ton of pig iron. The cost of the fuel and the somewhat low produce of the ore have hitherto retarded the vigorous prosecution of an undertaking which otherwise seems to possess the elements of success.

Woodstock
furnaces.

Similar ores occur, apparently in the same band of rocks, and in great abundance, near the River Beccaguimic, and also, although probably not so abundantly, in a parallel band running from Flanigan's Hill on the St. John, toward East Glassville settlement. If found economically available in other respects at either of these places, they will possess an advantage in the proximity of forests, from which a supply of fuel could be derived.

Gypsum and
limestone.

The deposits of limestone and gypsum on the Tobique, already described, are practically inexhaustible and easily accessible; and although their colour, and the admixture of foreign constituents might render them unsuitable for building and decorative purposes, they are well adapted for use in agriculture. These deposits are in the supposed Lower Carboniferous rocks. At several points also in the calcareous slate band between Woodstock and the Tobique, as at Pole Hill, Windsor and Glassville settlements, the bank of the St. John River in Peel parish, and two and a-half miles up the Tobique, bands or more or less extensive lenticular masses of limestone, sometimes fossiliferous, occur, which may advantageously be burnt in kilns, and employed for general purposes. As a flux for the smelting of iron ore, that from Pole Hill has been quarried and conveyed to the Woodstock furnaces; but I understand that the deposit on the St. John River in Peel, about four miles above the Beccaguimic, which has latterly been employed, is preferred, as it is said to contain less magnesia than the former.

The geological conditions in the north-western part of New Brunswick, being by many supposed to be analogous to those of auriferous countries generally, and more particularly of Eastern Canada and Nova Scotia, it is not surprising to find that, from an early period, hopes and expectations should have been entertained that it might prove a gold-bearing region, and these have been from time to time confirmed by reported actual discoveries of the precious metal.

Within the past two years, and since the Canadian and Nova Scotian gold mines have begun to attract increased attention, attempts have been made on a small scale, both by alluvial washings and by explorations in the supposed gold-bearing rocks, to realize these hopes. The results in both cases, so far as I have had the means of judging, are moderately encouraging; but it would require the expenditure of a larger amount of capital than has hitherto been applied in order to establish the *profitably auriferous* character of the region. In the few places where sluicing has been tried, and that only on a rude and tentative scale, the conditions appear to have been unfavourable, owing either to the absence of the older drift clays, which are supposed to be more especially gold-bearing, or to their being too far below the drainage level to be accessible without special and expensive appliances for pumping, etc.

With regard to gold in the rocks, although rumours are current on

respectable authority to the effect that pebbles and boulders enclosing a little of the metal have been picked up in various localities, I am not aware of any well authenticated instance of gold being found in a vein. On the Serpentine and Campbell rivers, and on the Wapskehegan, tributaries of the Toibque, where the rocks are supposed to be more especially favourable to the existence of gold, and where chiefly the auriferous pebbles are reported to have been found, mining leases have been taken up, but very little work done. I made a cursory examination of part of the lands leased for gold mining on the Serpentine; and although the rocks, as I have described them in another place, seemed to be of a favourable nature and condition, specimens of quartz which I took from what were considered the best spots here, as well as from several other places which I deemed worthy of trial, have yielded to careful assays by Dr. T. Sterry Hunt, neither gold nor silver.

The conditions both of the rocks and veins here appear to me to resemble those in the Chaudière district in Quebec, where the quartz veins are lenticular, interrupted, and only in exceptional cases yield gold; rather than those in the gold districts of Nova Scotia, where they are more regular and persistent, and very generally auriferous to a greater or less extent. The fact that no gold has been found in the specimens taken by me, by no means militates against the possibility of its being found in other specimens and at other localities in the region.

I have the honour to be,

Sir,

Your most obedient servant,

CHARLES ROBB.

