

GLACIER-PLOUGHED TROUGH IN CAMBRIAN ROCKS, LOCK-
PORT ISLAND, N. S.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR.

RÉPORT
ON THE GEOLOGY
OF
SOUTH-WEST NOVA SCOTIA

EMBRACING THE COUNTIES OF QUEEN'S; SHELBURNE,
YARMOUTH, DIGBY AND PART OF
ANNAPOLIS

BY

L. W. BAILEY, Ph.D., LL.D., F.R.S.C.



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TO GEO. M. DAWSON, C.M.G., LL.D., F.R.S.,

Director Geological Survey of Canada.

SIR,—I have the honour to submit the following Report upon the geology of South-western Nova Scotia, made by myself and successive attendants at various times between the years 1891 and 1896.

In December, 1893, a report, embodying the results of explorations in the counties of Queen's and Shelburne only, and prepared in accordance with the directions of the then Director, Dr. A. R. C. Selwyn, was submitted to that gentleman for approval, and was accepted for publication, but owing to the want of funds for printing was held over to await further appropriations. In the meantime, the field-work was extended to include the counties of Yarmouth and Digby, and a second report relating thereto was also submitted. In connection, however, with the latter, several important questions having arisen requiring further investigation, and appropriation for publication being still in abeyance, it was deemed advisable to further study the points in doubt, at the same time that a preliminary report should be prepared, summarizing the more important results which had been definitely ascertained. This report, with an accompanying map, forms a portion of Volume VII. of the Annual Reports (New Series). Still further delay in publication being unavoidable, I was finally directed by yourself, early in 1896, to devote another season to the clearing up, if possible, of all doubtful points, and to prepare a report in which the substance of both the previously written reports might be condensed. In connection with this object it has been found necessary to extend the field of observation so as to include a considerable portion of Annapolis county, especially in the vicinity of Annapolis Basin. The results of the observations thus made, together with those previously attained, form the substance of the present Report.

During a portion of the season of 1890 I was assisted by Mr. J. W. Bailey, in 1891 by Mr. Lee Street, in 1892 and 1893 by Mr. W. H. Prest, and in 1896 by Mr. Roy Van Wart. While each of these gentlemen cheerfully rendered all the assistance in his power, the services of Mr. Prest were especially valuable; his previous training as a prospector, his knowledge of geology in general, and of the Cambrian system of Nova Scotia in particular, together with his skill as a draughtsman and surveyor, to say nothing of his enthusiasm and power of endurance, all combining to make his work thorough and effective.

I have the honour to be, Sir,

Your obedient servant,

L. W. BAILEY.

NOTE.—*The bearings given throughout this report are referred to the true meridian unless otherwise specially stated.*

REPORT
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GEOLOGY OF SOUTH-WEST NOVA SCOTIA

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The region to which this report relates, exclusive of Annapolis Area to be described. county, embraces 3370 square miles, being distributed as follows:— Queen's county, 1065 square miles; Shelburne, 948 square miles; Yarmouth, 736 square miles, and Digby, 1021 square miles. The portion of Annapolis considered would be about one-third of its extent, or about 327 square miles. These counties collectively constitute what are commonly known as the "Western Counties," and are so disposed as nearly to meet at a common point, whence they spread like a fan, to terminate, in every direction but one, upon the coast.

As usual in Nova Scotia, the coast-lines of the region in review are broken and indented, but, if we except St. Mary's Bay and Annapolis Basin, much more broken upon the southern than upon the northern side. As a result of the facilities thus afforded for the prosecution of maritime pursuits, the coast region is almost everywhere Distribution of settlements. thickly populated, while it also includes the city of Yarmouth, as well as the considerable towns of Liverpool, Shelburne, Lockeport, Barrington, Maitland and Weymouth, besides Digby, Bear River, Clementsport and Annapolis. Portions of the interior also, especially along the principal rivers, the Liverpool, Port Medway, Roseway, Tusket and Sissaboo, are the seats of thriving settlements; but few of these are more than ten or fifteen miles distant from the coast, while further inland are extensive tracts which are not only unsettled, but of such a character as seemingly to be unfit for settlement.

Previous
publications.

Prior to 1895, the only publications referring to this region, so far as known to the writer, were the "Acadian Geology" of Sir J. W. Dawson, in its several editions and appendices, a report of Dr. A. R. C. Selwyn upon the Gold-bearing Rocks of the Southern Coast (1871), and references by Dr. Honeyman, Prof. H. Y. Hind and others in various periodicals. The observations of these writers were, however, confined to very limited areas, with but few references to any portion of the district other than that forming the immediate seaboard. The preliminary report referred to in the letter of transmittal of the present Report, with the maps accompanying these reports, are, it is believed, the first attempt, based upon personal and systematic surveys, at the representation of the geology of the entire district. It is but right to add that even these surveys have not been as yet of an instrumental character, the great tracts occupied by unproductive rocks, such as granite, together with the rugged and unsettled character of the region, with a multitude of small lakes and streams, having been thought to involve, for their minute delineation, such an expenditure of time and money as would be unwarranted at present by any return likely to accrue therefrom.

Groups of
rocks.

Regarded geologically, the district under review embraces the following groups of rocks:—

1. Granite.
2. Quartzites and slates, resembling the quartzites and slates of Halifax and Lunenburg counties, like them auriferous, and believed to be of Cambrian age, but without ascertained fossils.
3. Micaceous, hornblendic and staurolitic strata, supposed to be the metamorphic equivalents of the Cambrian rocks.
4. Fossiliferous slates and iron ores, of Oriskany or Eo-Devonian age.
5. Red sandstones of Post—Carboniferous age—Triassic?
6. Trap (dolerite, amygdaloid, etc.), associated with No. 5.

PHYSICAL FEATURES AND SURFACE DEPOSITS.

Surface
geology.

The consideration of these different groups of rocks may be advantageously prefaced by some remarks upon the physical features and surface deposits of the region in which they occur. The study of the superficial geology of the latter not having been a primary object of exploration, no attempt has been made to present this with any

degree of fulness, or to solve the numerous and interesting problems connected therewith. As being, however, the last chapter in the geological history of the region, and intimately connected with the development of its mineral and other resources, the features of the surface well deserve some measure of attention. It is therefore proposed to notice here, though somewhat briefly, such facts relating to this subject as have incidentally been brought under observation.

For the purpose under consideration, south-western Nova Scotia Areal divisions. may be conveniently divided into the following areas, the contrasts between which will, in the sequel, be shown to be intimately connected with corresponding differences of geological age and structure:—

1. The central granite axis.
2. The southern coast.
3. The southern interior.
4. Yarmouth county.
5. The region south of St. Mary's Bay.
6. Digby Neck, with Long and Briar Islands.
7. The south side of Annapolis Basin, Digby to Middleton.
8. The Annapolis Valley.

1. *The Central Granite Axis.*—The area referred to under this designation is but a part of that great mass of granitic rock which traverses so large a portion of the peninsula of Nova Scotia, and is the most important element in its physical structure. Position of granite area. Details as to its position and limits are given in later pages of this report. Though described as central, it is only so through a part of its course, approaching in fact, in Annapolis county, the waters of Annapolis Basin, while on the other hand, in Shelburne county, it curves southward to reach the southern coast; and yet central, inasmuch as it forms the divide between the rivers which flow directly or indirectly into the Bay of Fundy, and those which drain into the Atlantic. That portion of it which occurs in Annapolis county is known as the South Mountains, while in Digby and Yarmouth counties an important diverging spur has received the appellation of the Blue Mountains.

The physiography of the above and of other smaller granitic areas Physica- features. indicated on the map, is well marked. For agricultural purposes they are well-nigh worthless, and it is interesting to notice with what suddenness and completeness settlements disappear when from any

side a close approach is made to the granite. This is at once seen to be due to two causes; the first being the thinness or complete absence of soil, often exposing broad, bare surfaces of rock, and the second, the abundance of immense boulders. Over large areas, especially over the Blue Mountains, there is little vegetation except that of low shrubs, relieved now and then by strips of wild meadow, but there can be little doubt that the whole country was once abundantly forest-clad, its depletion being the result of oft-repeated forest fires. Some portions of these forests still remain, especially in Annapolis county, about the head waters of the Sissaboo in Digby county, and at the sources of the Tusket in Yarmouth county, and these supply considerable quantities of valuable timber. Berries also are abundant and nowhere excelled for size or flavour. The general elevation of this region is about 600 feet. Over its surface are innumerable lakes, usually well stocked with fish, and the source of the numerous streams, large and small, which flow from it on every side.

Character of
coast-line.

2. *The Southern Coast.*—The first feature to attract attention in this district is the irregularity of the coast-line. Like that of the entire southern seaboard of the province, it is especially characterized by the occurrence of numerous long, narrow indentations, separating corresponding long, narrow tongues of land. Through this peculiarity the actual length of the coast-line is almost quadrupled, as compared with the shortest distance between its extreme limits. When to this is added the occurrence of numerous islands of all dimensions, the facilities offered for the residence of a maritime population and for the prosecution of its appropriate industries, fishing and ship-building, will be at once understood, and have been thoroughly utilized, the whole shore being continuously and often thickly settled, although from the paucity or sterility of the soil, few harvests are to be gathered, other than those of the sea.

Settlements.

Indentations.

The indentations referred to vary in length from two miles or less to seven miles, and in breadth from half a mile to three or four miles their sides being in most instances approximately parallel, though occasionally widening outward into bay-like forms. In the latter case they are usually divided by more or less considerable islands, into two or more main channels. A more important feature, as bearing upon their origin, is that of their close parallelism with each other and their general conformity to a north-west and south-east trend, at right angles or nearly so, to the general trend of the coast, as also to that of the peninsula as a whole, and to the strike of the rock formations which traverse it. Comparing the median lines of the principal harbours,—

those of Port Medway, Liverpool, Port Mouton, Port Jolie, Port L'Hebert, Sable River, Ragged Island, Green Harbour, Jordan Bay, Shelburne Harbour, Negro Harbour, Port Latour and Barrington, their course is found to vary from N. 45° W. in Queen's to nearly true north-and-south in Shelburne county; the minor indentations according with the prevalent trends. A like feature is also often observable in the form and grouping of the numerous islands.

The occurrence, as described, of these long and narrow inlets, can be satisfactorily explained only upon the supposition that they were formed during a period when the peninsula stood at a higher level than now. They are in fact, veritable fiords, and it is interesting to notice that one of the impressions recorded by Sir Charles Lyell at the time of his first visit to America in 1841, was that of the close resemblance borne by the similar indentations further east upon the coast, to those of the well known and typical fiords of Norway. Confirmation of this view is abundantly afforded by the associated phenomena of the coast, as it is by those of the interior, to be presently noticed.

The evidences of extensive glacial action upon the seaboard are to be found in the nature, size and arrangement of boulders, in the occurrence of both terminal and lateral moraines, of smoothed, striated or in some instances deeply ploughed surfaces, together with kames or horse-backs and irregular accumulations of till. On the other hand, the general absence of anything in the nature of raised beaches, or of clays containing marine organisms, would seem to indicate that the moulding of the surface and the distribution of its glacial deposits has been but little affected by the action either of marine currents or of floating ice. It may be added that the great extent of the dunes or sand-hills which occur at various points along the coast, and which, as in Barrington Bay, sometimes attain a height of fifty or sixty feet, give reason to believe that the coast has undergone but little change of level in recent times.

The boulders to which reference has been made vary greatly in size, but are often of large and sometimes of enormous proportions. One, near the eastern bank of the Liverpool River, seven miles from the town of Liverpool, was found by measurement to be 30 feet long, 20 feet wide and 20 feet high, while in the vicinity of Shelburne others as large or larger may be seen. For the most part these boulders are similar to the adjoining rocks, consisting largely of granite, gneiss, quartzite and mica-schist, the latter in many varieties. But while in most instances these would seem to have travelled to no great distance

from their parent beds, some, and especially those of granite, show both by their position at a distance from any known outcrops and by their well rounded forms that they have come from more remote sources. They are often piled together in great rough heaps, or are thickly distributed over limited areas, while adjacent tracts contain relatively few or none. Many of the smaller islands adjacent to the coast are nothing but irregular heaps of boulders; and even some of large size, such as Coffin's Island, off Liverpool Bay, appear to be wholly composed of drift material. That some of the accumulations are of the nature of terminal moraines, would appear probable from the circumstance that they are heaped up in lines parallel to the general coastline and transverse to that of its indentations.

Terminal moraines.

Glacial striae. Glacial striae are of common occurrence upon the coast, and are often strongly marked. From the table appended to this Report it will appear that along the coast of Queen's county their trend varies from south to south 20° east, and this is also true of much of Shelburne, but near Jordan Ferry and Negro Harbour, a deflection of 10° to the westward has also been observed. It may be noted that the average direction, about south 5° to 10° east, is also that of the principal indentations or fiords already noted, both conforming to the general slope of the country. It may be added that, in addition to ordinary striations, evidences of furrowing and ploughing are also met with, and in some instances to a depth which is very remarkable. Thus, at the extremity of the island on which Lockeport is situated, alternating beds of quartzite and slate, dipping steeply to the sea, are ploughed along their edges into canoe-like troughs, thirty or forty feet long, three or four feet wide and as many deep; while on a small island near Port La Tour, similar beds have been gouged by a like agency to a depth varying from ten to twenty feet.

Glacial troughs.

Surface features.

3. *The Southern Interior.*—In contrast with the irregularity of the southern coast, the interior region bordering upon the latter presents but few salient features. True hill ranges are entirely wanting, although the land gradually rises to where it blends with that of the granite axis, a distance which in Queen's county is from fifty to sixty miles, but is greatly reduced in that of Shelburne. Minor irregularities are, however, of frequent occurrence and are mainly attributable to two causes, the combined effect of which is clearly marked alike in the topography of the surface and in the character of its drainage.

Determining causes.

The first of these determining influences is that of the strike and varying capacity of resistance of the rock formations, and the second

the distribution of the superficial deposits. The strike being, as a rule, nearly parallel with that of the peninsula, while the groups of strata represented are of very unequal hardness, a tendency towards the development of long, but only moderately deep, north-east and south-west troughs is determined, separated by corresponding low swells. From similar differences in the ease and amount of erosion, the soils of the harder bands, which consist largely of quartzite, are comparatively meagre or wholly wanting, while those of the intermediate slate belts are usually much deeper, and the country is thus zoned with alternate bands of poor and fertile land. This arrangement is, however, markedly modified by the distribution of the surface deposits, the more prominent of which, in the form of low ridges, are generally found to be disposed in directions transverse to the alternating bands, in other words, to present northerly and southerly courses, with their steeper slopes usually to the westward. Instances, however, are not rare in which trains of boulders or other detrital matter are arranged parallel with the underlying bed-rocks, along north-east and south-west courses, and are in these cases probably frontal moraines. Under the combined influences of the two causes mentioned, much of the surface has acquired a hummocky character, low rounded hills or short ridges being separated by numerous hollows, many of which are occupied by ponds or lakes.

The above described features have a marked influence upon the drainage of the country. Of the larger rivers which traverse it, as the Port Medway, the Liverpool, the Jordan, the Roseway and the Clyde, it may first be noticed that they all conform quite nearly to northerly or north-westerly trends, and exhibit for long distances the parallelism already noticed in the case of the harbours into which they severally discharge. At the same time, in the course of their descent, they either expand at intervals into more or less considerable lakes, or are directly connected with groups of the latter occupying transverse depressions. This is well seen in the case of the Port Medway River, which rises in Annapolis county among the granite hills and expands in northern Queen's county into Ponhook Lake, parallel with which and separated only by a narrow ridge, is the still larger sheet of water known as Molega Lake. Similarly, the Liverpool River, also starting from the granite hills of the South Mountains, and at a point not far removed from Annapolis Basin, traverses the several basins of Liverpool Lake, Fairy Lake and Lake Rossignol; while the same feature, though less conspicuously, is seen both on the Jordan and Roseway rivers. On the other hand, between Lakes Rossignol and Ponhook, we have the chain of the Christopher Lakes, at least fourteen in num-

ber, marking the existence of an east and west trough, while similar depressions are indicated in the cases both of the Tobetic and the Fairy lakes. As a result of this disposition of the surface waters, easy access is given by canoe to extensive tracts, including a ready passage, with only short portages, from the Port Medway waters to those of the Liverpool River, or from the latter to those of the Jordan.

The total number of lakes included in Queen's and Shelburne counties alone is not less than one hundred, while in Annapolis, Yarmouth and Digby they are even more abundant. In the majority of instances examined, their existence and character are found to be directly connected with the distribution of the drift, and due either to the damming up of their natural outlets or to their division into more or less numerous basins. As might be expected under the circumstances, the lakes are generally quite shallow, with low and irregular shores, and their surfaces are dotted with numerous islands, the latter not infrequently consisting of mere piles of boulders. The abundance of these islands tends to introduce diversity into the aspect of the Nova Scotia lakes, but these, as seen in the counties under review, are certainly not to be compared in scenic beauty with those of the interior of New Brunswick and Quebec. At the same time, though well stocked with fish, they are only available to the angler in the spring and fall, the comparative absence of cold springs and of mountain brooks, and the consequent warmth of the water during the summer months, making fishing at that season very unsatisfactory.

Fish.

In connection with the subject of drainage, it may be worth while to note that the valleys occupied by the main streams in the section under review are, like the basins of the lakes, comparatively shallow, and but rarely exhibit distinct terraces along their banks.

Boulders.

If the superficial deposits to which reference has been made be more closely examined, they will be found, like those of the coast, to include boulders, gravel, sand and clay, variously intermixed. Boulders are especially abundant along the course of the "whin" or quartzite belts or in the vicinity of granite, and they are often so heaped together as to make travelling over the surface well-nigh impossible. The hills overlooking Tupper Lake in Queen's county, from its north-eastern side, are especially remarkable for the number and size of the granite boulders met with, as is the vicinity of Tobetic Lake, Pescawess and Kejamakuchee lakes in southern Annapolis county, or the northern edge of Lake John in Shelburne county. Bald Mountain, in the latter county, seems to be little more than a pile of huge granite

blocks, and both here and elsewhere the abundance of granite boulders make the determination of exact boundaries exceedingly difficult. On the other hand, the distribution of boulders, in the case of the whin and slate belts, is of the utmost importance to the prospector as being the only guide to the presence and position of auriferous veins. In this latter case it is evident that the boulders can have been removed to but limited distances from the parent beds, and this is probably true of most of the larger boulders, whatever their nature. On the other hand there is also abundant evidence of a wider dispersion of the drift, probably at a period somewhat earlier than that last referred to, the contained masses being such as could only be derived from a distance.* Large boulders, it may be added, are most abundant in the bottom and on the sides of valleys or depressions, while the tops of the bounding ridges are comparatively free.

Distance of travel.

Another noticeable feature of the region under discussion is that of its kames or horse-backs. These sometimes extend for miles, with more or less sinuous courses, but in many instances appear to be arranged in series of parallel and overlapping lines, the individual ridges being somewhat short and spindle-shaped. In some instances they bifurcate, and in others, as on the road from Shelburne to Lake John, east of Jordan River, they include a series of round and deep depressions or "kettles." In the case of one of the most remarkable of the ridges, which was traced by Mr. Prest from Perrot's Settlement in the southern part of Annapolis county across the Maitland River to Long Lake and Frozen Ocean, and finally into Digby county, the general course is approximately east and west; but in other instances, as at the head of the Port La Tour Peninsula, the direction is nearly a meridional one. The origin of these curious ridges, of which other instances occur in Yarmouth and Digby counties, is still disputed, but there can be but little doubt that they are in some way connected with the melting of the great ice sheet which, it is believed once enveloped all of Nova Scotia.† When exposed in road making, the interior of these kames is usually found to consist largely of fine sand, with only a small percentage of clay, in which rounded boulders of all sizes are distributed.

Kames or horse-backs.

The only other feature in connection with the superficial geology of Queen's and Shelburne counties to be noticed here, is the frequent

*In several instances boulders of the characteristic traps of the North Mountain range, skirting the Bay of Fundy, have been observed upon the shores of Queen's and Lunenburg counties.

†For further discussion of this and related topics see article by W. H. Prest in Proceedings of Nova Scotia Institute of Science, vol. IX, Part II.

Peat bogs. occurrence and large size of the peat bogs and barrens. These are most abundant near the coast, but are found in all parts of the district and are evidently the results of its imperfect drainage. In the case of true peat bogs the surface is nearly a dead level, and probably marks the site of a former lake; but many barren tracts are more or less undulating or broken, and the sterility is largely the effect of forest fires. From the two causes combined, probably two-thirds of the entire area embraced in the counties under consideration has become wholly unfit for settlement.

Growth of peat bogs. From the examination of the numerous peat bogs in the interior of Queen's county, it would seem probable that these originated in very shallow lakes, in which the first stage was mud banks and water plants, the second meadows with cranberries and moss, the third swamps with peat-moss, which increased its growth until the central part of the bog became frequently two to ten feet higher than the edges.

Pubnico Lake region. Lying between the region last described and that next to be noticed is what may be termed the *Pubnico Lake Region*. This is properly an extension of the central granite axis, which here bends southwards to the coast, but by its position becomes connected with the tracts above reviewed, and to a large extent shares their character. Lying between the Clyde and Pubnico rivers, and on either side of the line between Shelburne and Yarmouth counties, the district is everywhere extremely rough and rocky, and except for small quantities of timber and slight mineral indications, would be almost utterly valueless.

Timber. The principal timber region is near the middle of the tract, its existence being probably owing to its inaccessibility. Hemlock is the most abundant wood. Then comes spruce, with a small tract of pine between Wagner, Clearwater and Stony Creek lakes. The rest of the forest consists of scrub spruce, larch, white birch and white maple, with occasionally oak, poplar and fir. White birch, especially, is very

Water-courses abundant. Through these forests run sluggish brooks, the sources of Barren Lake Stream, Barrington River and Medoshak Brook. There are several shallow and rocky lakes, the largest of which are Pubnico (7 miles), Great Barren (4 miles), Medoshak (3 miles), and Wagner and Hepsamateejek (each $2\frac{1}{2}$ miles long). Another feature of the district is the presence of large tracts of interminable thicket, composed of interlaced alder, scrub spruce, white birch and laurel (*Kalmia*),

Shrubs. with other small bushes. This is a second growth, occupying land once covered with heavy timber, of which dead and fallen trunks are lying

in every direction, making the growing brush almost impenetrable. The agricultural capabilities demand no description, as the surface is nothing but a mass of disintegrated boulders, with here and there a peat bog or swamp.

Yarmouth County.—As in the case of Queen's and Shelburne counties, a review of the physiography of this county necessitates a separate consideration of the coast and the interior.

As regards the coast, no more remarkable illustration of the effects of glacial action in modifying ocean contours could well be found. From Pubnico to Yarmouth Harbour the shore is wonderfully broken and ragged, presenting a continuous succession of bays and inlets, off or among which the diversity is further enhanced by a multitude of islands of every size and form. These islands are rarely rocky, but usually rounded and drift-covered, their wooded surfaces, contrasted with the dark blue of the intervening sea, producing scenery which is at once varied, striking and picturesque. North of Yarmouth Harbour this irregularity becomes less marked, while the shores become at the same time much bolder, though less bold than are those of Digby county, to be noticed presently.

The interior of Yarmouth county, exclusive of the Blue Mountains and the Pubnico Lake region, both of which have been already noticed, is largely coincident with the valley of the Tusket. The length of the main Tusket, including its windings, is about 45 miles. About three miles and a half or four miles from its mouth it divides into two branches, called by the people the Carleton and Kempt rivers. The Kempt or eastern branch is slightly the longest, and obtains the credit of being the main river. There are ten or twelve tributaries from five to twenty miles long, which flow through a great number of lakes, Wallybeck Lake ($3\frac{1}{2}$ miles long) being the largest. Some of them are noted for their beauty, especially Barrio in the interior. These streams are frequently broken by picturesque falls, and supply abundant water-power for numerous saw-mills.

The surface of the tract under review is undulating in the south and west, but more level in the eastern half. The western part is deeply covered with glacial detritus, giving rise to a deep soil and a well-wooded country. In the eastern and north-eastern part the land is more barren, especially in the neighbourhood of the Blue Mountains, which here project to the south-west.

Soils. The underlying rock in this tract is mostly blue quartzite, with narrow and alternating belts of greenish slate. This has given rise in the west and south-west to partly stratified accumulations of boulder-clay and gravel beds. Those parts of the Tusket valley contain a deep soil and high rolling land, which appears to be very productive. The northern portion is bordered and underlain by granite, forming a sandy and often very strong soil. This part is still covered with timber of different kinds.

Intervales. There does not seem to be much intervale land upon the Tusket, except over its lower course from Kempt to the sea. The upper tributaries contain a large extent of uncultivated meadow land. One fine strip extends from Barrio Lake several miles up the Silver River. The meadows around Rockingham produce upwards of 200 tons of hay, which, although not equal to that cut upon the uplands, still proves a valuable addition to the winter's store. The streams running through the barren tracts are often bordered by meadows which are in pleasing contrast to the desolation around.

"Boar's Back." A large part of the northern portion of the Tusket valley, consists of slightly undulating deposits of gravel, sand and small stones. Across it stretches, in a west-south-west direction, another of the remarkable kames or horse-backs to which reference has before been made. It is known in the neighbourhood as the "Boar's Back," and, in the form of a gravelly ridge, can be traced from the Devil's Den, near the Blue Mountains, across the Tusket valley, nearly to Hectanooga station, six or eight miles from the western coast. It varies from ten to forty feet in height, and from twenty to one hundred feet in width, and runs for about twenty miles. The large desolate tract of sandy barren through which the ridge runs bears nothing except blueberries and occasional clumps of white birch, poplar and undersized spruce. It seems to have been the result of long-continued submergence beneath either marine or fluvial waters.

"The Prairie." The south-east part of the Tusket valley is mostly rocky and uneven, consisting chiefly of blueberry barrens and patches of valueless swamps and forests. The only exception to this is a small tract styled "The Prairie," near the south-east end of Wallybeck Lake, and several miles from the nearest settlement. It is composed of sandy and loamy knolls, mingled with large stretches of level marsh land, which recede and advance much like the indentations on portions of the Atlantic coast. It is destitute of trees, and its dark and mellow-looking soil seems only waiting for the plough to turn it into fields of waving

grain. This tract is several square miles in extent, and overlies a wide belt of hard blue quartzite.

This district contains considerable woods in its western and northern parts, the trees being the same species as those of the sections above mentioned. To the north-east the pine becomes a little more abundant, and to the east of Moose Lake Brook, a tributary of the Tusket, a strip of fine timber is reserved by the owners. It is apparently one of the best pieces of timber land in the province. Occasional gigantic oaks are found scattered over the barrens in the extreme north-east of the district, where young trees of the same species are rare. This leads to the belief that the large trees are the remains of a once prevailing oak forest. Two or three species of maple are seen, but neither maple, beech nor birch grows to as large a size here as in the eastern and central counties. Black ash is very large and plentiful, and it and the swamp maple are the prevailing trees on the intervale, as the birch and beech are on the uplands.

Distribution
of trees.

Parallel with the valley of the Tusket, from which it is distant about six miles, is that occupied in part by Yarmouth harbour and in part by the chain of connected lakes which discharge their superfluous waters into this harbour. In the immediate neighbourhood of this chain of waters, the protrusion of hard hornblende rocks gives to the surface a somewhat rugged character, but not sufficiently so to prevent successful farming, while the flourishing villages of Hebron and Ohio on the line of the Dominion Atlantic Railway, sufficiently attest the general capacity of the region. In addition to the Yarmouth and Hebron lakes, others farther east are Lake George, three and a half miles long, Brazil Lake and Lake Annis, all noted for their quiet beauty. Innumerable sea gulls frequent the larger of these lakes.

Yarmouth
lakes.

5. *Region south of St. Mary's Bay.*—This region embraces that portion of Digby county which lies between the southern shore of St. Mary's Bay and the granite hills of the interior, being about fifty miles in length, with a breadth of about fifteen miles at its western extremity, but narrowing eastward to about eight miles.

Area.

The coastal features of the district are, in its westerly half, from Port Maitland to Meteghan, remarkable for their boldness, the shores being almost continuously fronted by precipitous bluffs facing directly the waves of the Atlantic; but to the eastward of the last-named point, where they form the southern shore of St. Mary's Bay, these become much less prominent. On either side of the indentation of Cape Cove

Coastal
features.

Precipitous
shores.

and especially at St. Mary's light and thence nearly to Meteghan, the shore is simply a succession of precipitous bluffs, attaining in places a height of nearly 200 feet. Owing to the nature of the rock, consisting of highly inclined slates, for the most part turned edge-on to the sea, the action of the latter has been to carve them out into all sorts of irregular and sometimes fantastic forms, columns resembling chimneys and detached from the cliff, or caves hidden by the sea at high tide, being common features. At but few points is it possible to descend with safety the almost perpendicular and slippery gulches, and after the descent is made, there is always a possibility of being cut off from a return by the rapidly rising tide. In some places the cliffs overhang to such an extent that the water drops from their tops far out on the beach. Even with a boat, except in periods of unusual calm, the exploration of this coast is difficult and dangerous.

Soils.

The nature of the soil in this region depends, as usual, upon its geological structure. Where quartzites prevail, as along much of the St. Mary's Bay shore, it possesses but little depth or is very stony, and this portion has been for the most part cleared of all its valuable wood. What remains is either a second growth of fir or larch, or the scrub spruce, which usually covers wet or untillable lands. This spruce seems to be the same species as the larger variety used for lumber, but in exposed situations upon precipitous shores it becomes stunted and flat topped, with the branches turned inland. Some thickets consist of nothing but wooden pillars crowned with a dense and flat green mass of limbs and twigs, beneath which it is impossible to creep. Near the edge of the cliffs these spruces are often so stunted and compressed by the force of the gales that some of them have the appearance of low green mossy mounds. Another peculiarity of this coast is the abundance of orchids, especially over and in the vicinity of peat bogs. The most common species is the white-fringed orchis (*Habenaria blephariglotis*, Hook) but the purple-fringed orchis (*H. psycodes*, Gray) is also very common. Another plant very abundant upon the coast and found nowhere in Nova Scotia except in Yarmouth and southern Digby counties, is the skunk cabbage (*Symplocarpus fetidus*).

Stunted
spruces.

Interior.

The interior of Digby county, exclusive of the granite, is in general features similar to that of northern Yarmouth, the underlying rocks and general conditions being the same. It is drained by the Salmon River, the Meteghan and the Sissaboo or Weymouth River, as well as by the head-waters of the Tusket. Of these the Sissaboo is much the most important, the main branch with its windings being probably thirty-five miles long. In the upper part of its course it runs through

Sissaboo
valley.

a rough country, containing numerous lakes, but lower down to the south and west is a fine wooded rolling country, which has been covered with drift to a considerable depth, and which post-glacial erosion has carved into high rounded hills. The quality of the soil in this section is indicated by the well wooded condition of the country and by the rankness of the weeds and undergrowth, while wherever farms have been cleared, the strong growth of the mixed crops shows its productiveness. Fertility.

On the south side of the Sissaboo above Weymouth, is a large tract of gravelly and sandy land that seems to owe its origin to the erosion of a local outcrop of granite, or to a local deviation in the direction of glacial transportation. The nearest source of the granitic debris seen here, is about four miles and a half south-east or six miles east-north-east.

A considerable quantity of valuable timber, spruce and pine, is still held by speculators and lumbermen in the south and south-east part of the lower Sissaboo valley. A fine tract of spruce, with scattering pine, stretches from Riversdale in a southerly direction to the head-waters of the Western Tusket. Great quantities of fine hemlock are also to be found in the same region as well as along the banks of the Sissaboo, and from that south-east towards the north-eastern tributaries of the Tusket.* This is probably the best tract of timber to be found in the western part of the province. Pine is very scarce, and spruce is almost the only tree used by the lumbermen. This also is lessening at a rapid rate, and it will not be long before the now despised hemlock and fir will be the principal resource. Hemlock exceeds many times in quantity the combined spruce and pine, and in some parts of this region grows to a huge size. Timber lands.

Between the Sissaboo or Weymouth River and Annapolis Basin, about Digby, the land is as a rule more elevated than to the westward of the first named stream, and as a whole less inviting. Much of it has the character of a gently undulating elevated plateau, but near the town of Digby it becomes broken up into a number of separate hills, separated by trough-like valleys. The soil is in many places a sandy loam, in some parts fertile and especially adapted to the culture of fruit, but more commonly coarse and gravelly, while over large tracts the abundance of scattered stones, or imperfect drainage, determining swamps and ponds, render it nearly or quite unfit for cultivation. The larger Tract between Sissaboo River and Digby.

*These and the other notes given as to the nature and distribution of timber are largely based on observations of W. H. Prest.

Shore of St.
Mary's Bay.

part of the district has been deforested, but groves of spruce and birch are met with here and there, while over the more barren tracts the vegetation is mostly confined to alders and ericaceous shrubs. Along the shore of St. Mary's Bay, where the possibility of fishing partly makes up for the want of productiveness in the land, the district is somewhat thickly populated, and there are also many good farms along the slaty belt extending south-westward from Jordantown; but between these two the country, being underlain with quartzites, is for the most part uninteresting and unproductive.

Annapolis Valley.—The portion of this valley coming under review in the present connection is that which is included in Annapolis county, extending from the head of the basin of the same name to and a little beyond Middleton. Only portions of it have been subjected to critical examination, but its features would seem to be very uniform throughout.

Form of An-
napolis valley.

In a general way the sides of the valley exhibit distinct parallelism, the one constituting the North and the other the South Mountain range, but both exhibit in detail many irregularities, in the form of projecting spurs or re-entering valleys. The moment, however, that the true bottom of the main depression is reached, this is found to vary but little from horizontality and to be sharply contrasted with its bounding ridges. It is rarely the case that any rocks *in situ* are disclosed, and except near the hills there are but few boulders. The soil is often sandy, especially in the neighbourhood of Middleton, but considerable tracts are also underlaid by clay, which is largely used in the manufacture of bricks. Both kinds of soil are remarkable for their exceeding fertility, and especially for their adaptability for fruit growing, the vast orchards of apples, as well as the vigorous growth of all kinds of crops, fully justifying the appellation of the "garden of Nova Scotia" by this which and the region continuing it to the east-ward, is commonly known.

Soils.

Fertility.

Drainage.

Former sub-
mergence.

Through that portion of the valley included in this Report, and mostly near its centre, runs the Annapolis River, receiving various tributaries, such as Torbrook, the Nictau and the Laquille; while directly into Annapolis Basin flow the more considerable streams of Moose River and Bear River. From above Middleton to Lawrencetown the Annapolis River is fresh, but beyond that point is affected by the tide, and prevented from overflowing its banks by artificial dykes. It is probable that the whole region has been, in post-glacial times, an arm of the sea, as attested by the fact that the brick clays

of Middleton contain layers filled with marine shells, together with remains of star-fishes (*Ophiopholis*). Probably no portion of the bed of the valley westward of Middleton is even now more than thirty feet above tide-level.

In this connection some reference may be properly made to the isthmus separating Annapolis Basin from St. Mary's Bay, at one time no doubt its direct continuation. Uniting Digby Neck with the mainland, this isthmus has a breadth of from three to four miles, with a length, from bay to bay, of about six miles. Its elevation, on the eastern side, or near Digby, is considerably greater than that of the Annapolis valley proper, and it is also much more irregular, the general level, as on Racquet Hill, where it is crossed by the conduit pipes of the Digby water-works, being 175 feet, but to the westward the land slopes gradually away, until at the head of St. Mary's Bay it becomes continuous with extensive tidal flats. Yet here, too, an exception is found to the so-called "sea wall," six miles from the town of Digby, where the shore, for half a mile or more, presents a series of perpendicular bluffs, one hundred feet or more in height.

Isthmus
between An-
napolis Basin
and St. Mary's
Bay.

Elevation.

The soils of this isthmus are similar to those of the Annapolis valley, being usually sandy, but capable, when properly tilled, of affording an abundant harvest.

At the head of St. Mary's Bay, on the farm of Walter Nichols, is a marsh beneath which is a bed of soft black mud, five feet in thickness, and having at its base a bed of oyster shells. Beneath this again is a layer containing leaves, which are probably of birch or beech. It is now forty or fifty years since oysters have lived in St. Mary's Bay, and their occurrence here in a fossil state is one of several instances marking not only a former depression of this part of Nova Scotia, but somewhat different climatic conditions in its coast waters. The sea is again making inroads on the marsh referred to, indicating a second depression.

Evidences of
submergence.

The South Mountains.—This designation properly includes the great central granitic axis of the Nova Scotian peninsula already described, but with reference to the Annapolis valley and for the purpose of this report is restricted to the belt of high land which, as opposed to the North Mountains, overlooks the said valley from its southern side. At several points and for considerable distances, as between Clements-
port and Annapolis, and again about Round Hill, Paradise and Williamston, the granite itself borders or sends spurs into the valley;

Northern
border.

but elsewhere the hills consist to a large extent of slates and associated quartzites, determining quite a different physiography.

- Elevation. In general the rise from the valley to the hills is abrupt and not unfrequently steep, the mean elevation attained being probably between four and five hundred feet. The steepest slopes as well as the highest elevations are south of Lawrencetown, and again south of the Torbrook, where in one instance it is possible to look over the summit of the opposing North Mountains to the Bay of Fundy and the distant shores of New Brunswick. Owing to the steepness of the slope, ascent has usually to be made along the valleys of water-courses, which, as in the case of Moose River, Bear River, the Nictor, &c., have cut their way deeply into the comparatively soft slates. The tributaries of these rivers, as well as the smaller streams, often exhibit the same ravine-like character, but elsewhere the land above the summit level is comparatively flat, or with but slight undulations. Owing to the softness of the slates the soils are usually deep and good, and have been very generally utilized. But little land remains uncleared.
- Drainage.
- Soils.

The North Mountains and Digby Neck.—Though separated by the transverse gap known as Digby Gut, these two are essentially the same in their physical as they are in their geological aspects, while the same is also true of what is their obvious extension in Long and Briar islands. As a much more complete study has been made of the portion of the range westward of the Gut than that to the eastward of it, the following descriptions are for the most part confined thereto.

- Digby Neck. Digby Neck, together with the extension in the islands named, is undoubtedly the most remarkable tract in the district to which this report relates, presenting unusual features alike in its contour, its relief, its climatal conditions and its botanical characteristics.
- Form. Connected with the mainland by the narrow and relatively low isthmus, already described, at the head of St. Mary's Bay, it extends south-westerly in the form of a long, narrow but prominent ridge, separating the waters of that bay from those of the Bay of Fundy, the total length from the Gut to the Petite Passage being nearly thirty miles, to which Long and Briar islands would add about fourteen miles more. Excepting the isthmus referred to and a few minor indentations, the northern and southern shores of the entire tract are very nearly straight, and trend about north-east. They are also
- Dimensions.
- Parallelism of sides. essentially parallel, the distance separating them varying but little from two miles, though, in relation to the Neck, Long Island as a



TRAP BLUFFS. NORTH ENTRANCE OF PETITE PASSAGE, NEAR TIVERTON, N. S.

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whole stands a little farther to the north than the former, and Briar Island again a little to the north of Long Island, as though each had been pushed slightly out of place with reference to the other. The two shores are also much alike in character, being almost continuously rocky, but the south shore is in general both higher and bolder than that upon the north. Both shores again present numerous views of coastal scenery of remarkably picturesque character. This feature is familiar to travellers as seen in the high ridges overlooking Digby Gut, and is again exhibited about Gulliver's Cove, but becomes much more striking in the vicinity of the Petite Passage and along the southern sides of Long and Briar islands, where, in addition to the generally high and abrupt character of the shore, the columnar and castellated structure of the rocks and their irregular carving by the action of the sea, produce scenery which in some degree recalls that of the Giant's Causeway in Ireland. In the case of the Petite Passage, the effect is greatly heightened by the large size and grotesque aspect of the boulders perched upon the summit of the bluffs overlooking the picturesque little village of Tiverton, as well as by the aspect of the powerful tides which sweep through this passage to and fro, as through a sluice, and with such rapidity and strength as to cause, when opposed by the winds, tumultuous seas and whirlpools such as can only be safely traversed with the aid of steam.

Coastal
scenery.

Petite Passage

Tidal flow.

In the case of Digby Neck proper, a noticeable feature in its topography is the occurrence, at a number of points, of indentations breaking for short distances the continuity of the shore. The "coves" thus produced are of the highest importance to the occupants of the peninsula, as affording the only available means of ready access from the high land to the shore, as well as the only harbours of refuge from the perils of the sea. They are at once more numerous and of larger size upon the southern than upon the northern coast, the most important being Sandy Cove, Mink Cove and Little River, all of which are the seats of thriving settlements. Even when no marked break occurs in the coast-line, the contour lines of the main ridge show numerous indentations.

"Coves."

A section or profile of almost any part of Digby Neck would show its surface to be not less peculiar than its contour. One such natural section is afforded by Digby Gut and another by Petite Passage; but the best of all is that of the similar though less deep trough at Sandy Cove. At Digby Gut the abrupt ascent of the land from the water level is well exhibited, as is also the fact that the Neck is but the westward prolongation of the ridge which, to the eastward of the Gut, constitutes

Relief.

the so-called North Mountains, extending to Blomidon and Minas Basin; but at Sandy Cove the whole structure of the peninsula is admirably revealed. As viewed to the westward from the high and precipitous bluff which overlooks the depression in question, the surface of the land, as far as the eye can reach, reveals a series of prominent ridges so arranged as to resemble in appearance successive steps, or a serrated outline, in which the successive sheets of rock slope gradually to the northward at angles of 5° or 6°, while in the opposite direction they terminate abruptly in steep hills or mural fronts. One result of this structure is the zoning of the peninsula with approximately parallel belts of prominent ridges, often bare of vegetation, separated by intervening depressions in which the soils are deeper and which are the principal seats of cultivation. Another result is seen in the direction and character of the drainage, the troughs referred to being in some instances occupied by meadows or long narrow lakes; while still another result is the rising of the land on the northern or Bay of Fundy side by a gentle slope from a comparatively low shore to the point of maximum elevation (about 250 feet), while upon the southern the ascent is much more abrupt, even the highest hills here rising directly or even perpendicularly from the sea-level.

Features of relief.

Drainage.

Contrast of slopes.

Transverse valleys.

Origin of transverse valleys.

A peculiar feature in the case of the transverse valleys to which reference has been made, is the fact that while oblique rather than rectangular in their relations to the trend of the peninsula itself, they are at the same time parallel to each other, and run in a direction about true north, which is that of the prevalent glaciation in the region. In the case of Digby Gut it was long ago suggested by Sir J. Wm. Dawson that that channel probably owed its origin to the currents of the Ice period; and though glaciers are not now usually regarded as *originating* such channels, ice of this nature probably had an important influence in modifying the features of the Gut, as it did those of the Grand and Petite Passages, and in a lesser degree, the valleys of Sandy Cove, Mink Cove and Little River. In the case of Sandy Cove the bottom of the trough is now occupied by deposits of sand, the higher beds of which are about 150 feet above high tide level; but it is not improbable that this trough, like that of Petite Passage, may have been at one time wholly occupied by water. In the case of the passage last mentioned, sand and gravel beds are also a conspicuous feature, especially upon the eastern side, where they form the high and steep hills about the ferry landing, but they are less marked on the Long Island side, while the depth of the channel is said to be about 100 feet.

Reference has already been made to the remarkable character and position of the boulders which crown the hills overlooking the Petite Passage. It is difficult to account for these peculiarities. As seen upon the summit of the bluffs above the road leading from Tiverton to the lighthouse, and as represented in the accompanying photograph they attain in many instances enormous proportions (30 to 40 feet in diameter) and are piled together in a most irregular and often fantastic way. Their general appearance and arrangement is such as would naturally be expected at the base of high and precipitous cliffs from which they had been detached by the action of frost or the undermining power of the sea; but these rest loosely upon the very top of the bluffs, and are most numerous as well as of the largest size upon the edge of the latter. They are also wholly wanting upon the eastern side of the passage. They are all composed of trap, and they resemble the beds on which they rest in the character of the veins by which they are conspicuously traversed, showing that they have not been derived from a distance; but unless it be supposed that they represent something of the nature of a lateral moraine, formed in connection with a glacier once traversing the passage, and completely filling the latter, it is not easy to account satisfactorily for the peculiar features they present.

Boulders
about Petite
Passage.

In this connection, it is interesting to notice that some very large boulders besides those of trap are to be seen in the vicinity of Tiverton, but at a much lower level than these noticed above. One of them, not far from the Tiverton post-office, and not more than thirty or forty feet above the waters of the passage, has diameters of fifteen and twenty-five feet, and is composed of a dark-gray felsite-conglomerate, closely resembling in aspect many of the rocks found in the so-called Huronian of southern New Brunswick, but which have not yet been observed in any part of south-western Nova Scotia. Granite boulders, but of moderate size, were also observed in several instances both here and on Briar Island.

Erratics.

Glacial markings are of comparatively rare occurrence upon Digby Neck. They have, however, been observed at a number of points, some of which are of special interest as bearing upon the time and circumstances of the evolution of the surface features of the region. Among these may be mentioned in particular certain striæ observed at Israel Cove near the southern part of Petite Passage. They include both ordinary striæ and broad groovings, both of which run across the tops of the denuded trap columns, which are here prominently developed, with a course S. 40° W. (mag.). They are only about ten feet above

Glaciation.

Post-glacial
deposits.

high-water mark and fully 100 feet below the level of the highest banks which border the passage on either side, and would therefore seem to indicate that whatever the origin of the passage, it has at some time been traversed and scored by glacial ice to at least one-half its present depth. The post-glacial deposits of sand and gravel which overlie them, and which thence extend down much of Long Island, are distinctly stratified, and show a succession of fairly well defined terraces, the summit of the highest one being about 150 feet above tide-level.

Supposed con-
ditions of
glaciation.

As in other parts of south-western Nova Scotia the facts connected with the glaciation of Digby Neck are, in the opinion of the writer, best explained upon the supposition of submergence beneath a continental glacier moving southward and bringing debris even from the other side of the Bay of Fundy, followed by a period of more local and restricted distribution, when the higher portions of the peninsula became themselves the centre of the movement, the latter now occurring in all directions.

Climate.

It may be supposed that in a district so peculiarly situated and possessing such a structure as that of Digby Neck, there should be corresponding peculiarities of soil and climatal conditions, and these should be reflected in the nature and distribution of vegetation. Thus, while no portion of the peninsula is distant more than a couple of miles from the sea and its climate is therefore essentially insular, being subject to frequent fogs and abundant rainfall, yet such is the difference of elevation of its lower and upper portions that the one is often enveloped in mist at the same time that the other is exposed to the full glare of the sun. Again, the fogs are more generally prevalent upon the Bay of Fundy shore than upon that fronting St. Mary's Bay, and this difference, together with that of exposure respectively to cold northerly and warmer southerly winds, determine more favourable conditions of growth upon the one side than upon the other. It is true that the north side of the peninsula is more generally covered with woods than the southern, but this is largely for the reason that there is here less inducement for their removal, the soil being of poorer quality and the conditions of existence more severe. The contrast referred to is seen in the nature of the vegetation quite as much as in its amount, the trees throughout the northern tracts being more largely evergreens than those of the central and southern belts, while in approaching the Bay of Fundy, shore the marked dwarfing of the trees, as well as the increasing abundance of low straggling or prostrate shrubs, bear abundant evidence of a struggle against unfavourable

Contrast of
northern and
southern
shore.

Contrasts in
vegetation.

GEOLOGICAL SURVEY OF CANADA.

VOL. IX., PART M, PLATE III.



TRAP BOULDERS ON BLUFFS ABOVE TIVERTON, PETITE PASSAGE, N. S.

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environment. So marked indeed are the contrasts sometimes exhibited that in the case of a valley like that of Sandy Cove, sheltered on either side by high hills, a distance of half a mile or less is, in the summer season, often quite sufficient to effect a transition from a warmth which is almost tropical to a temperature which by contrast is as decidedly frigid. In the little lake which lies at the bottom of this depression the white water-lily (*Nymphaea odorata*) may be seen in luxuriant growth, while almost in sight, at the northern end of the valley, the cliffs are clothed with saxifrage, *Sedum Rhodiola*, and other plants, of Rare plants. boreal types. It may be added that upon the warm southern sides of the trappean hill were observed, as late as the end of September, numerous blossoms of *Gerardia purpurea*, a plant rarely met elsewhere in Nova Scotia, and not known in New Brunswick.

CAMBRIAN SYSTEM.

In describing the rocks referred to this system, it is necessary to observe that they occur in widely different conditions in different parts of the area examined, and yet with so many features in common as to leave no doubt as to their essential identity. Thus over extensive areas the rocks in question exhibit evidences of profound metamorphism, while in others equally extensive they are comparatively little altered. In Queen's county the highly crystalline rocks are mostly confined to the neighbourhood of the coast, but in Shelburne county they are found in the interior as well. In Yarmouth again the rocks of this system are in general highly metamorphic, while in Digby comparatively unaltered strata prevail. Between the altered and unaltered portions of the system it is, however, impossible to draw any distinct line of demarcation. They pass into each other by insensible gradations, they exhibit a similar sequence of beds, and are equally destitute of ascertained fossils, their reference to the Cambrian system being therefore only provisional. With the more metamorphic portions areas of granite, as already noticed, are of frequent occurrence, and their condition is no doubt due mainly to the circumstances in which the latter had its origin.

From a careful study of the sequence of the supposed Cambrian strata in Queen's county, a sequence which is almost exactly paralleled in Digby, but which, owing to metamorphism, is less obviously seen in Shelburne and Yarmouth counties, their succession would appear to be as follows, in ascending order:—

*Ascending Succession of Cambrian Strata.**I. Quartzite Division.*

- (a.) Heavily bedded bluish quartzites, alternating with much thinner beds of gray argillite.
- (b.) Greenish-gray sandstones or quartzites, somewhat chloritic and less massive than in (a), and alternating with slates which are arenaceous below but become progressively more argillaceous above.

II. Banded Argillite Division.

- (a.) Greenish-gray slates, becoming bluish or light-gray, and passing upwards into—
- (b.) Purple slates, marked in the lower beds by pale, yellowish-green seams, with faint bedding lines, which are wanting in the higher beds.
- (c.) Bluish-gray and gray slates, often with cloudings of green, purple, lilac, buff or yellow, in places exhibiting a conspicuous banding or ribbanding of the beds.

III. Black Slate Division.

Black, with some blue or gray slates, often studded with cubes of pyrites, and very rusty-weathering.

The above divisions are those of a region comparatively little altered, such as the interior of Queen's county and the neighbourhood of Digby. Where the metamorphism is more extreme, as through the whole of Shelburne and much of Yarmouth, the strata present a somewhat different aspect. The two main divisions are still usually recognizable, but the minor differences disappear or show themselves only in other forms; the quartzites becoming, through an increase in the amount of mica, a sort of fine-grained gneiss, while the argillites become mica-schists, marked over large areas by the abundance of staurolite, andalusite and garnet developed in them. Finally, along certain well defined belts, as in the centre of Yarmouth county, the beds become very hornblendic as well as chloritic, assuming at the same time something of the character of conglomerates, a feature elsewhere of very rare occurrence. In most instances the degree of metamorphism is in direct relation to the occurrence of masses of intrusive granite.

Effects of
metamor-
phism.

Plications.

Throughout the district under consideration, the strata above described have been affected, in common with those of similar character

in other parts of Nova Scotia, by the great series of earth movements which from time to time have influenced the rock formations along the whole eastern coast of America. As the result of pressure, coming in all probability from the direction of the Atlantic, the strata have been thrown into a series of more or less numerous folds, the prevalent direction of which is north 45° east, or approximately parallel to that of the coast, but with evidence also of other and probably later movements whose direction has been transverse or oblique to the former. Under the combined influence of the two pressures thus exerted, the whole district occupied by the Cambrian rocks has been made to present the appearance of an extensively warped or wrinkled surface, the irregular denudation of which has left the harder rocks, chiefly those of the quartzite group, to form a series of domes or ridges, usually "Domes," anticlinal in structure, around which are enwrapped the remains of the higher and less resisting slaty beds. In general these ridges are elliptical or ovoid in outline, but some are greatly elongated, while others again are so greatly contracted as to present a form which is nearly circular. Along the axes of the folds the dips are usually high, and regular for considerable distances, but in approaching the intervening synclines the dips rapidly become less, and the strata either approach horizontality or become the subject of innumerable and complex minor flexures. Evidences of faulting are also not uncommon, though no dislocations of great magnitude have as yet been recognized. Minor flexures. Faults.

From their importance in connection with the subject of gold-mining, much time has been devoted to the working out of the position and relations of the various anticlinal folds just noticed and to their correct delineation.

As will appear by reference to the map accompanying this Report, the anticlinal domes of Queen's county tend to group themselves along three or perhaps four nearly parallel zones, in each of which "whin" Zones. or quartzite is the prevailing rock, while the intervals are in most instances strongly marked by the occurrence of the black pyritous slates of Division III. of the system. In Shelburne these upper dark and slaty beds appear to be wanting, except at a single locality near its eastern boundary, but reappear to some extent in Yarmouth, and are again conspicuous in Digby.

In the following descriptions the quartzite division is first considered, and later the slate divisions of the Cambrian system, in the four counties under review, in the order above alluded to.

I. QUEEN'S COUNTY.

DIVISION I, QUARTZITE DIVISION.

Quartzite and Green Slate Groups.

1. Central or Molega-Rossignol Belt.—This belt stretches east and west across the width of Queen's county, extending in one direction into the county of Lunenburg, and in the other into that of Shelburne. It includes the region about Molega and Ponhook lakes, as well as a portion of that bordering Lake Rossignol, while within it are also found the important mining centres of Molega, Whiteburne and Brookfield. As a belt, it is limited north and south for the greater part of its length, by the black slates of Division III. and has an average width of eight or nine miles. It is, however, broken by several subordinate flexures into a number of smaller areas of more or less elliptical outline, marked by the encircling of quartzite tracts by zones of green slates, as well as by the varying dips of both. The most important of these quartzite areas are:

- (a.) The Molega area.
- (b.) The Whiteburne area.
- (c.) The Rossignol area.
- (d.) The Brookfield area.

Molega area. The form of the Molega district (which is typical of the whole Cambrian system in this portion of Nova Scotia, and which will therefore be somewhat fully described) is that of a somewhat broad ellipse, the greater diameter being about thirteen and the lesser or transverse diameter about six miles. At its eastern extremity, in the county of Lunenburg, it is separated only by a narrow band of green slates from a nearly circular dome of quartzites occurring about the Pleasant River mines, and is similarly bordered on all its sides, though to the westward, towards Lake Rossignol, the difficulty of access and want of exposures have prevented its exact delimitation.

Quartzites of Molega mines. As seen at the Molega mines, the rock which makes up the great bulk of the deposit (Div. I a.) and which is locally known as "whin," is seen to be a massive fine-grained quartzite of nearly uniform gray colour, and occurs in beds varying from two to thirty or more feet in thickness. The quartzite is almost everywhere slightly micaceous, and crystals or nodules of pyrite, galena, and arsenopyrite are also usually present, the latter often quite abundantly. With the quartzites, how-

Minerals.

ever, slates or argillites are also found to occur, though they are relatively much thinner, usually not exceeding three or four feet, and often forming mere partings between the coarser strata. When these are present the attitude of the beds is very easily ascertained, especially if the inclination is high, but where it is at lower angles and the slaty partings are wanting, the determination of the true dip is often a matter of considerable difficulty. From observations made it seems probable that between the northern and southern limits of the belt there are several minor undulations, subordinate to a general anticlinal structure; but throughout the peninsula separating Ponhook and Molega lakes, as well as around the other shores of these lakes, and in the adjacent country east and west, little is seen but boulders with occasional ledges of massive whin or quartzite.

Interbedded
slates.

In passing in either direction from the axial line of the quartzite area above described, the rocks become less massive and include a larger proportion of slaty beds, which at the same time assume a more or less conspicuous greenish tint, due apparently to the fine dissemination of chlorite. Within the limits of the belt under review these green slates (Div. I c.) are the highest strata met with; but north and south of the main belt they are in each case followed by the coloured and black pyritous slates of Divisions II. and III.

Passage from
quartzites to
green slates.

A second area, closely resembling that of Molega, is that of Whiteburne. Its centre is about ten miles to the north-west of the centre of the first named district. It is, however, somewhat smaller than that of Molega, the longer axis, which extends from near Cameron's Lake to the head of Lake Rossignol, being a little over eight miles, while the breadth (between the Christopher Lakes on the south and Whiteburne settlement on the north) is a little more than three miles. The strata here are better exposed than about Molega, and both about the Whiteburne mines and along the road leading south from the latter to the Christopher Lakes, they are seen for a distance of nearly two miles, rising from the barrens in a series of parallel and very prominent ledges, with a nearly constant dip throughout, about N. $< 30^{\circ}$ to 40° . From the facts observed here, as well as other points, it seems probable that the thickness of this division of the Cambrian system cannot well be less than 5000 feet and may be much more.

Whiteburne
area.

Dimensions.

Thickness of
quartzites.

A third area of quartzites, with surrounding green slates, is indicated as existing to the west of Lake Rossignol, and includes a part of this large sheet of water. About one half of the area is in Queen's county (where quartzite ledges may be seen at "The Screecher" or

Lake
Rossignol.

"Thoroughfare"* between Lake Rossignol and the fourth lake, as well as at the similar "thoroughfare" at the head of the second lake) and about one half in Shelburne county. In the latter county, however, the tracing of the beds is very difficult, partly from the infrequency of exposures and partly for the reason that the rocks here assume a metamorphic character and are less readily recognizable. An exploration of the region lying between Lake Rossignol in Queen's county and Lake John in Shelburne was made by Mr. Lee Street, my assistant, in 1891, and the following summary from his notes will indicate the general nature of the country, as well as of such few exposures as were observed.

Lake John.

Starting from Lake John, an expansion of the Jordan River, a one-mile portage over low flat land, without exposures, leads to Lake Grande. From this lake to Rush Lake the distance is about one-fourth of a mile, whence to Jordan Great Lake there is about half a mile of marshy ground. From this lake there is a portage of a quarter of a mile to Silver Lake, through hemlock woods; from Silver Lake to Sixth Lake half a mile; from Sixth to Codd Lake a quarter of a mile; and thence one mile to a small brook, two miles long, leading to the Fourth Lake of Rossignol. The only exposures seen were on Jordan Great Lake; one, opposite a large island upon the eastern shore, being of slate spotted with small crystalline specks (Dip N. 5° W. < 85 and another, also on an island in the same lake, being of a gray micaceous sandstone. These evidences of metamorphism are the result of proximity to granitic masses, one of which at Lake John is clearly indicated by the enormous boulders of this rock which strew its northern shore, its southern side at the same time exhibiting ledges of gray micaceous sandstone with dull crystalline specks. The metamorphic strata of Shelburne county will be further considered later.

Jordan Creek
Lake.

Brookfield
area.

Still another area of quartzites included in the belt under consideration is that of Brookfield. It is directly north of the Molega district already described, and is separated from it by only a narrow band of green slates. As shown in the sequel it has recently acquired much importance as a gold producing centre. An admirable section of the quartzite portion of the series is made by the Port Medway River at and below South Brookfield, while to the north of this place, as well as along the road leading to North Brookfield, the overlying slates are prominently exposed. The chloritic character of the latter is especially well marked in the rocks traversed by the auriferous quartz veins of the North Brookfield mines.

*Local name for a narrow pass connecting two lakes at the same level.

2. *The Southern or Port Medway and Liverpool Belt.*—About three Southern belt.
 miles south of and parallel to the great Molega-Rossignol belt of
 quartzites and green slates, a second belt of similar rocks is again found
 to traverse the whole of Queen's county. It enters the latter from
 Lunenburg county, where it includes the gold-fields of Malipsegate Limits.
 Lake, and extends into Shelburne county until by metamorphism its
 identity is lost. On its northern side it is separated from the belt
 previously noticed by a well defined band of black pyritous slates (Divi-
 sion III.) extending from Greenfield through the northern part of
 Middlefield, to the Indian Gardens at the foot of Lake Rossignol, and
 to the south of this belt includes all the area thence to the coast. In
 this direction, however, it becomes increasingly metamorphic; and at
 various points, both in Queen's and in Shelburne counties, is invaded
 by massive granite. It has also, like the belt previously noticed, been Minor folds.
 the subject of subordinate flexures, and partly from this cause and
 partly from varying erosion, has been subdivided into a number of
 more or less separate areas in which domes or elliptical folds of
 quartzite rock, having a general anticlinal structure, are encircled and
 isolated by concentric belts of slate. Of these quartzite anticlines,
 three lie to the eastward and three to the westward of the Liverpool
 River, the latter for the most part traversing the area which marks
 their line of junction.

Of the areas to the eastward of the Liverpool River, the most north- Middlefield
 erly is that of Middlefield, and is traversed by the Port Medway area.
 River between Barry's Falls and Eight-mile Lake Brook, thence
 extending easterly into Lunenburg county and westwardly to the
 Liverpool River in the vicinity of Long Lake; the second is also
 traversed by the Port Medway for six miles north of Mill Village, and Mill Village.
 reaches the Liverpool River just south of Milton; while the third
 occupies the area south of Mill Village and about the shores of Port
 Medway Harbour. Of those west of the Liverpool River, the first lies
 between the head of Broad River and the county line of Shelburne;
 the second lies directly south of the last and embraces all the middle
 portions of Broad River; and the third, of small extent, borders the Broad River.
 granite along the north side of Port Mouton Harbour. Throughout Port Mouton.
 this belt the rocks are much more metamorphic than those of the
 middle or Molega-Rossignol belt. The quartzites are often quite
 micaceous and graduate into fine-grained gneisses, while the finer beds
 are represented by mica-slates, often conspicuously spotted by the
 development of crystalline minerals in their mass, such as mica,
 staurolite or garnet. Further facts relating to these metamorphic
 strata will be given in the sequel.

Loon Lake.

3. *Loon Lake Belt*.—A third area, in which quartzites are the prevailing rock, but of more limited extent than those already noticed, is found in the northern part of Queen's county along the course of the Liverpool River, south of Fairy Lake. It is well seen in the vicinity of Loon Lake and for a mile or two below, where its outcrop, with a northerly dip of 45°, forms Loon Lake Falls. The area is probably small; for while the width on the river is hardly two miles, being followed both north and south by bands of blue slates, it is similarly surrounded by the latter in the direction of West Caledonia; and in the opposite direction, the occurrence of granite about the Tobeatic and associated lakes would show that it is here cut off by the latter rock.

Maitland.

4. *Maitland Belt*.—Finally, a fourth band of quartzites is found to limit the entire Cambrian area upon the north, bordering the southern edge of the granites in Annapolis county. This band crosses the Liverpool and Annapolis road at the Twin Lakes, one mile and a half north of Maitland settlement, and is well exposed at the falls of the Liverpool River, whence it sweeps around through Northfield to Tupper Lake. Along the northern half of the shores of this lake, ledges of micaceous quartzite are seen, skirting a southwardly projecting granite tongue.

DIVISION II. BANDED ARGILLITE DIVISION.

Distribution.

The strata referred to this division of the Cambrian system and embracing several minor subdivisions (see p. 28 M) cover considerable areas in Queen's county. The largest is in the northern part of the county, where rocks of this character cover the greater part of the district lying between Tupper Lake upon the east and the Annapolis post-road upon the west. Thence they extend north to Fairy Lake in Annapolis county. They underlie for the most part the settlements of Rosette, Westfield, Harmony, West Caledonia, Kempt and Grafton.

Surface features.

Owing to the comparative softness of these rocks and their ready disintegration, they often produce soils of considerable fertility; but they also often present only broad bare ledges of rock, while the abundance of loose blocks of argillite or the occurrence of kames or horsebacks, determining imperfect drainage, detract materially from their capacity for successful tillage. As usual the region abounds in lakes, including Tupper Lake (in part), Minard's Lake, Eel Lake, Fairy Lake and others.

A second, but smaller area of such rocks occurs near Pleasant River, the strata being well exposed in Pleasant River village and along the several roads converging at that point. As this latter is a typical region and that in which the relations of these coloured slates to other members of the Cambrian system was first clearly made out, it will now be more particularly described.

The passage from the quartzites of Division I. to the banded slates is well seen in approaching Pleasant River from the west. In the barrens near Waterman's Brook are numerous exposures showing an always increasing amount of greenish-gray slate as we go east, while this in turn is gradually changed to purplish-gray or bluish-gray, the dip remaining the same, though the beds become subject to frequent and sudden corrugations. At the Pleasant River bridge on the New Elm road, the rocks, though the same in general character, become finely striped, and through much of the region this feature is a conspicuous one. As seen on Pleasant River above the bridge, some bands are of a purple tint with fine light-coloured pea-green seams, while others are greenish with fine light-coloured seams. Similar strata would appear to occupy all the valley of the stream above Pleasant River village, except that, about two miles below Sugar Lake, the bluish slates are first associated with and then replaced by the black slates, probably marking the centre of a syncline. Further north the succession is reversed, and bluish and gray slates are again found between the black slates and the quartzites which immediately border the granites of Annapolis county. Transitions similar to the above may also be seen in the southern part of the Pleasant River basin. Here the beds are further remarkable for their almost horizontal attitude over large areas. The transition referred to is partly one of colour and partly one of texture, the gray slates, owing to an increasing admixture of purple colouring matter, getting gradually darker until this latter tint becomes predominant, and at last exists to the exclusion of all but an occasional light, yellowish-green band; the purple slates being themselves succeeded by lighter gray bands, and finally by greenish-gray bands alternating with gray quartzite.

One particularly distinctive feature and strong point of resemblance between nearly all the rocks of the Pleasant River syncline, is the intercalation of narrow contorted bands of finely laminated material. These bands are never more than two and a half or three inches thick, and never less than three-fourths of an inch. They are separated by from one to four or five feet of fine-grained sandstone or quartzite. The colour differs somewhat in different places, but is usually lighter

than the inclosing quartzite. The general colour ranges from purple to purplish-gray, bluish-gray or slightly greenish-gray, and also light and dark-gray, but through all there can be traced the narrow, contorted and laminated bands referred to above. Another feature, quite as distinctive, is the presence at wide intervals of light, yellowish-green bands, one to two inches thick, in the purple slates. These are limited to the upper part of the said slates and are an unailing guide in their recognition.

Corrugations.

The stratigraphy of the Pleasant River district is very complicated and at first somewhat puzzling, some portions showing beds remarkable for their high dips and frequent corrugations, while in other parts the beds are nearly or quite horizontal. At some points, however, a complete gradation of dips may be seen from 40° to 0° , the beds evidently occupying the same geological horizon.

Syncline.

On tracing Pleasant River south from the Tory Bridge on the New Elm road, the greenish-gray and bluish-gray slates are seen to form a shallow basin. This coincides very fairly with the course of the river, and is the syncline dividing the Molega quartzite dome from that which occupies the Pleasant River barrens. The dip on the west of the syncline is far steeper than on the east side, where for some distance the beds are almost flat. There is, however, on the east side, at first a slight inclination to the north-west, then to west, and finally south-west (*mag.*) corresponding with the western curve of the dome which occupies the Pleasant River barrens. Going east from this intermediate syncline, the horizontal beds gradually assume an inclined position around the western end of the dome last mentioned. They are surrounded and overlain conformably, on the northern side, by the purple and blue slates. In the syncline the purple slates are not seen, as they are cut off by the elevation of the greenish-gray slates from beneath. The contortions and apparently unconformable dips of the slates are plainly owing to pressure between the two anticlines mentioned, as well as to force exerted in a direction from the North Brookfield anticline. East and west of this interruption the gray, purple and blue slates continue their usual orderly sequence.

Port Medway River.

The relations above described in the Pleasant River district, as well as the conclusions to which they lead, are repeated in the district lying to the west of Tupper Lake and north of Caledonia. This tract is traversed in a north-and-south direction by the Port Medway River, and its valley affords an admirable section of the underlying rocks. The great granite area in which this stream takes its rise, and

which, east of Tupper Lake, descends quite to the foot of that sheet of water, on the Port Medway River is wholly confined to Annapolis county, its southern border being to the north of De Long settlement, and about five or five miles and a half south-west of the Half-way house on the road to Dalhousie. The rocks which immediately border the granite at this point, like those found around the shores of Tupper Lake, are highly metamorphosed and very micaceous, but appear to have been originally greenish-gray slates with bands of quartzite. They are followed southward, in De Long settlement, by bluish-gray slates, and then by purple slates, the breadth of the former being nearly three miles. Near the granite the dips are rather high, but southward they gradually decline, the beds being spread over large areas in wave-like undulations. On the shores of Dean's Lake, an expansion of the Port Medway, are fine and continuous exposures of purple, banded slates, showing the characteristic yellowish-green bands not exceeding one and a half inch in width, already noticed upon Pleasant River, and here occupying a perfectly horizontal position. South of Dean's Lake, purple and banded slates continue to be frequently exposed as far as McGowan's Lake, on the northern border of Westfield, the dip being sometimes as much as 12° or 15° , but often wholly wanting. The ribbanding is often very conspicuous and the colours varied, including lilac-gray, bluish-gray, greenish-gray, buff, purple, light-gray and white, the proportion being in the order named. South of McGowan's Lake to the Westfield and Harmony bridge, the rocks are chiefly purple slates, often with light-green partings, and with dips which are nearly north at angles varying from 40° to 60° . South of Westfield bridge the dip gradually rises to 80° , and the blue slates hold occasional bands of light-gray with smaller seams of black slate, closely resembling those of Pleasant River. Small quartz veins are seen in the slates and are often charged with pyrites. A little above the junction of the Westfield River with the Port Medway, purple and lilac-gray slates again come in, still with a northerly dip of 75° to 80° , and are followed to the south by blue, black and occasionally light-gray bands, which are the only rocks seen as far as South Brookfield, a distance of about one mile and three-quarters. The black slates are more prominent about the mouth of Westfield River than north or south of it, and are often seamed with small veins of quartz, which, as well as the inclosing slates are pyritous. The succession corresponds on both sides of the black slates, and is similar to that of Pleasant River. Here, as before, the evidence would go to show that the blue and purple banded slates are a part of the Cambrian succession, and that they hold a position above the quartzites and below the black

Ascending
series.

slates. From observations made between Westfield and Brookfield, it would appear that a synclinal fold here intervenes, the order of succession, beginning on the south, being as follows:—

1. Quartzite—Brookfield anticline.
2. Quartzite and greenish-gray slate.
3. Greenish-gray slate.
4. Purple slate.
5. Bluish-gray and gray slate.
6. Blue and black slate, with gray seams, marking the centre of the syncline, and the highest member of the system.

The section on the opposite page, reaching from the granite to the Brookfield anticline, gives the probable arrangement of the beds, as observed by Mr. Prest:—

Westfield
River.

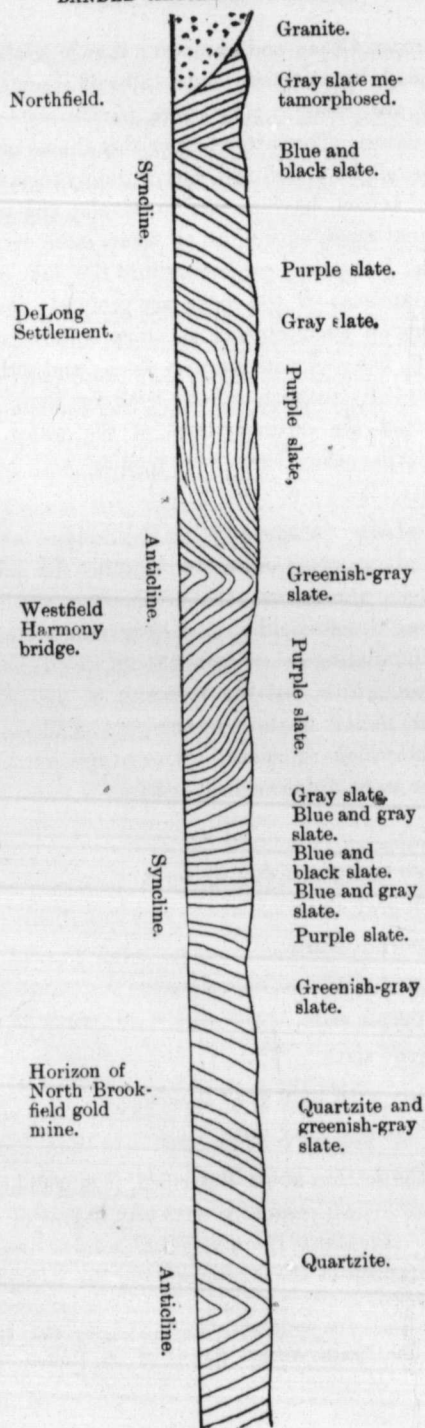
At the mouth of the Westfield River, the slates present the banded appearance already so frequently mentioned, and this feature appears with little variation to the Westfield bridge, south-east of the Westfield or so-called "Jumbo" mine. Further remarks upon the latter will be given in the sequel. Along the whole course of this river the altitude of the beds is nearly vertical. At one point, near the mouth of a brook emptying into the Westfield River, the strata include a deposit of very hard breccia or conglomerate, the cement of which is oxide of iron.

Harmony.

The features of the group of Cambrian strata above described, along the course of the Port Medway River, are repeated to the west of that river over a large part of northern Queen's county. North of the black and highly inclined slates of Caledonia corner (Division III.) the blue and banded slates spread widely in flat or gently undulating beds through the settlement of Harmony, and are well exposed at many points along the Liverpool and Annapolis post-road as far north as Maitland bridge, where the black slates again appear in force. From this point northward the distance to the southern edge of the granite is about three miles and three-quarters, the interval being chiefly occupied by whins in a highly metamorphosed condition.

Little River.

West of Maitland and the Annapolis post-road, another good line of section across the strata under discussion is that afforded by the Little River, between the sheet of water known as the Frozen Ocean in Annapolis county and Keja-ma-kuja Lake, more commonly known as Fairy Lake, on the borders of Queen's county. The tract immediately



Keja-ma-kuja
Lake.

bordering the Frozen Ocean and extending thence westerly into Digby county, is occupied by quartzite much altered; south of which, in ascending order, are greenish-gray slates, purple slates, greenish-gray slates and blue slates. The latter border the shores of Keja-ma-kuja Lake, where the slightly inclined but strongly cleaved beds, worn smooth by glacial action, have served to develop the artistic tastes of the early aboriginal races, as well as of their more recent successors. On several of the low points projecting into the lake along its southeastern side, the surfaces of the rocks are profusely covered with pictorial illustrations of such objects as ships, canoes, deer, dogs, the human hand, etc., mingled with various dates; and although many of these are undoubtedly modern, others, both by their character and their position below the ordinary level of the water, afford strong ground for believing that they are genuine and ancient Indian pictographs*.

Succession
in
Keja National Park

Keja-ma-kuja Lake (Miëmac for "next big lake") is a fine sheet of water about five miles in length. In addition to the blue slates upon its shores are others showing shades of lilac or purple, but of these there would appear to be two horizons, the lower purple slates being distinguished from the upper purple or lilac slates by their far greater width, by the presence of yellowish-green and dark green seams, similar to those of the beds at Pleasant River, and by a slightly deeper shade of colour. The entire succession as here seen would appear to be, in ascending order:—

Sequence at
Keja-ma-
kuja Lake.

1. Quartzite.
2. Quartzite and greenish-gray slate.
3. Greenish-gray slate.
4. Lower purple slates.
5. Bluish-gray slate and blue slate.
6. Upper purple slate.
7. Bluish-gray slate.
8. Blue slate, with light gray bands.
9. Black, blue and gray slate.

To the west of the section above described, it is well-nigh impossible to determine the geological structure with any degree of certainty or completeness, the increased frequency of granite bosses and the associated metamorphism of the strata making the recognition of the

*These have been made the subject of examination by Col. Garrick Mallery, and are described in the Tenth Annual Report of the United States Bureau of Ethnology.

latter difficult; while the drift covering by its abundance and coarseness not only serves largely to hide from view the underlying rocks, but makes travelling through the region extremely arduous. The following extracts from the notes of Mr. Prest will at once indicate the general geological features of the district and the obstacles encountered in its exploration:—

“The southern limit of the granite, after crossing into Digby South-eastern Digby county. county, goes about west by south, crossing the centre of Big Liberty Lake, thence on the same course past the head of the Big Meadows on the West River. The quartzite around Big Meadows shows very little metamorphism and every appearance of a farther extension into Digby county. Throughout this whole region the granite consists of black mica, quartz and felspar, the latter in large crystals. The tract shows no soil capable of cultivation, except the meadows which in places border the streams and lakes. The Thomas meadows, near Long Lake, are the largest. Heavy hardwood hills are almost absent, but the barrens are scattered over with young pines from five to fifteen inches in diameter. There seems to be no very young pine springing up, the undergrowth being principally oak. The inference is that when the present lot of pine is cut, the oak alone will form the next forest. This tract, a generation ago, is said to have formed an almost unbroken forest of pine, stretching toward Annapolis. Extensive fires, Effect of forest fires. years ago, have destroyed millions of dollars worth of timber. Thousands of acres of thickly clustered, but bare and burned, white pine stems remain to attest the destruction thus wrought. This tract lies to the north and west of the Frozen Ocean, while still further west are ridges and groves of white pine and hemlock. Hardwood is scarce and the land rough and rocky.

“Around Liberty Lake, on the line between Digby and Annapolis Liberty Lake. counties, the country is rough, rocky and full of swamps and barrens, with clumps of woods, in which moose find a home. South of this region, in the neighbourhood of West River, the land is mostly bare of forest. It contains, however, many groves of young pine, which promise to be quite valuable in a few years. There are long stretches of level barren lands of a light mellow nature and almost free from stones. Some parts of them would take the plough at once. The underlying rock is quartzite, merging into slate on the south-east. Fine meadows border the streams here, one of which on the headwaters of West River (in Digby county) yields nearly forty tons of hay. The country abounds in moose, caribou, raccoons, martens, foxes, wildcats and bears, especially the first and last. Beavers were once abundant, but trappers say that now none exist in the region—and but rarely in Nova Scotia.

Loon Lake.

"The land between West Caledonia and Keja-ma-kuja Lake has been so often burned that it is quite barren ; south of Loon Lake, however, there is a tract of timber land. The barren land reaches about one mile west of Loon Lake, after which it is wooded to the Pescawess and beyond. The land to the east and south-east of Pescawess is very level and beautifully wooded, the oaks being especially fine. Pine and hemlock are also seen, but are scattered. Birch and beech of immense size prevail in some places, but do not equal the oak in smoothness, straightness, size or healthful appearance. On the south-west of Pescawess Brook are fine forests of hemlock, which are now being made use of for lumber. On the east side of the same stream is an abundance of white pine timber, and on the west an abundance of hemlock, spruce, hardwood and white pine. The Norway pines are scarce here.

Pescawess Brook.

"At the foot of Pescawess is an exposure of greenish slate with a little quartzite. The land here, in common with that of the country around, is very rocky. Two horse-backs composed of rough glacial débris run parallel to each side of the Pescawess Brook. The granite comes in about one mile and a half north of the foot of Pescawess, and from here onward (north-west) the land is strewn with immense masses of granite, with thickets of alder, laurel, blue-berry, white birch and poplar, with occasional spruce and hackmatack. Exploration here is very difficult, the whole country north-east of the Pescawess, and thence to Keja-ma-kuja, being covered with huge granite boulders, one of the latter projects like a pyramid 35 feet from the underbrush at its base, while another, standing on the top of a high ridge, is 47 feet long, 22 feet wide, and 15 feet high, with a probable weight of 1050 tons. Progress through this boulder-strewn region, involving incessant climbing over huge blocks, separated only by moss-covered crevices serving as pitfalls, and overgrown with a jungle of alder, laurel and scrub pine, is very exhausting."

Horse Lake.

From the Pescawess Lake and the Tobeatic River, country similar to the above is found along the county line separating Shelburne and Digby counties to the lakes at the head of the Roseway River. Though equally rugged the surface here presents some unusual features. "A somewhat oval basin, some eight miles in diameter, almost bare of trees and inclosed in a rim of more elevated land, is seen just south of Horse Lake. Its floor is a wide and barren plain, slightly undulating and intermingled with meadows, laurel swamps and scattered copses of white birch and juniper ; while over this on every slope and hill, in fact in every part as far as the eye can reach, are strewed granite boulders of immense proportions. They are white and lichen-covered,

angular and often tower-like, some standing with the small end down as if a touch would upset them, some firmly rooted and others piled in great groups with bare intervals between. To the north-west are gently sloping plains, destitute of trees, but dotted here and there with boulders so large as to be quite prominent at a distance of four or five miles. It is probable that the area represents the basin of a former lake, of which the water has levelled up the spaces between the rocks, leaving similar collections of boulders on higher land untouched. To complete the desolation fires have cleared off all the trees except a few copses on swampy ground." Former lake-basin.

The chain of the Roseway Lakes has a general course which is nearly south-west, being approximately parallel to the county line between Shelburne and Digby counties, and to the chain of the Blue Mountains lying along the southern border of the latter. This chain is granite, and between the great basin described above and the Roseway Lake proper, immense ledges of this rock are exposed along the stream. "The porphyritic character, before so pronounced, now disappears and the rock becomes very fine-grained, inclosing at the same time numerous masses of metamorphosed slate. These inclosures become more frequent in going westward, and at the foot of the lake the rock shows a banded appearance, the bands being alternately granite and gneiss. Some large boulders observed here are wholly of the latter rock." Roseway Lakes.

"A strip of young pine timber is seen to run for some miles along the north side of the lakes and south of the Blue Mountains. It reaches from the western part of the great basin to the north of Roseway Lake. A quantity of pine is also seen on the east side of the Roseway Lake, and the southern side of the same lake is heavily timbered with hemlock. Other trees are scarce above Roseway Lake. Below that the land is more generally wooded." Timber.

"At the eastern end of the Schoodic Lake is seen the first unmetamorphosed blue or bluish-gray slate. This is followed, going south-west along the shore, by a light greenish-gray slate, showing occasionally a little fine mica. A little farther south-west this changes to greenish-gray sandstone or quartzite."

Owing to the want of reliable maps, great difficulty was experienced in locating correctly the observations made in this complex lake-region, while the exhaustion of provisions made it impossible to spend any considerable amount of time in correcting their inaccuracies. Mr. Prest's observations, however, appear to indicate that the blue slates here lie next to the granite upon the north, they being seen on the Difficulties of exploration.

northern side of Schoodic Lake as well as on some of the lakes farther west, but chiefly in drift. Then comes the greenish slate seen on the south side of the same lake, while at the head or south end of a long cove connected with this sheet of water, is a sort of gray or greenish-gray quartzite. This latter is also seen on the barrens north-east of Whetstone Lake. The whole country is, however, covered with immense quantities of granite drift, which obscures everything except in the valleys and on some of the lake-shores. Proceeding south from Whetstone Lake, the land for two miles is covered with granite and quartzites, the latter in angular and unworn blocks, indicating a local origin. A short distance east of the river, granite, however, is again found *in situ*, forming a portion of a range of hills running south, and cutting off the sedimentary beds. At a distance of about two miles south of Whetstone Lake are seen large boulders of mica-slate, the result no doubt of the metamorphism of the green or gray slates which naturally come in next the quartzites. Half a mile south of this, at the head of Indian-field Lake, the granite approaches closer to the river than usual; in fact it seems, from the quantity of huge boulders present, to cross to the western side, with the result of cutting off and metamorphosing the schistose rocks. Thus the whole succession here seen, from north to south would appear to be:—

Indian-field
Lake.

Succession in
northern
Shelburne.

1. Granite at the Blue Mountains.
2. Gneiss at Roseway Lake.
3. Blue slate at Schoodic and Crane Lakes.
4. Gray slate at Schoodic and Whetstone Lakes.
5. Quartzite at Schoodic and Whetstone Lakes.
6. Mica-slate one mile north of Indian Fields.

A second old
lake-basin.

“ At Indian Fields is seen another of the basins such as is described above. This is a slightly undulating plain, covered with sand and gravel, but not littered as in the former case with huge boulders. The gentle swells are also less elevated, the material finer, and the lowest parts filled in with a rich black mud, forming meadows. The plain shows no gravel ridges on the edge, nor any fan-shaped glacial deposits, nor any order in the distribution of the elevations. It presents no indications of being gradually deposited by the outflow from a glacier front. On the contrary it looks as if the original hummocky deposits of glacial débris had been slowly levelled down and ground fine by the action of shallow water moved by wind, as in a lake. The large boulders, of which there are few, remain in their original positions, the sand being smoothed around them. The presence of beds of incipient bog iron

ore interstratified with the sands of Indian Fields (as in Schoodic Lake) favours the impression that this place was once covered by a body of fresh water. It is surrounded by a rim of elevated land, except at the southern edge where the river runs out. Part of the basin is yet occupied by a lake, which seems to have been lowered to its present size by the wasting away of the morainic barrier to the south. The level of Schoodic Lake has been similarly lowered four or five feet during the last twenty years.

“Nearly the whole of the country from the Upper Ohio north-east and north for thirty miles, has in a great part been wantonly burned, and millions of dollars worth of timber destroyed, in order, as explained to us, to make better walking for trappers and hunters. The largest tract of timber remaining in this neighbourhood is that on the south-east of the Roseway River, from Roseway to Crane Lake. A large fire had only recently been set in that region and had burned over many square miles of land. It has been estimated that fully nine-tenths of the original forest growth of Shelburne county has been destroyed by fire.”

Destruction of
timber.

DIVISION III. BLACK SLATE GROUP.

It has been already stated that at many different points the green slates which form the upper portion of Division II. of the Cambrian system, may be seen to pass beneath a thick series of black slates which here, as elsewhere, form the upper division of this system.

The rocks of this group form belts quite as distinctly marked as do the quartzite and green slate beds below them, and which, as indicated in the foregoing descriptions, they serve to separate. They are also more uniform in character; for while the quartzites, even when most massive, are rarely without intervening slaty beds, which in the upper portion predominate, the black slates of the present group, as far as observed, contain no arenaceous strata. They are generally earthy, and while the presence of disseminated carbonaceous or graphitic matter makes them nearly always dark and often intensely black, the abundance of pyrite in cubical crystals with which the beds are often profusely studded, by its decomposition produces a rusty aspect, which is rarely wholly wanting. Both features would seem to favour the view that the beds have been formed in somewhat deep waters, and that these were abundantly supplied with life; but owing partly if not wholly to the pressure to which they have since been subjected, and the fact that the slaty cleavage thus developed seldom coincides

Lithological
characters.

Absence of fossils.

with the dip of the folded beds, only rarely has anything resembling a fossil been found. The only specimens we have as yet been able to obtain after long and careful search, which may possibly be of this nature, are certain small circular or ovoidal pit-like depressions found in the black slate drift in the vicinity of Bridgewater, in Lunenburg county, and again upon the coast of the same county near Heckman's Island. In outline they bear some resemblance to brachiopods of the genus *Obolella* or *Linnarsonia*, but they are lacking in markings or other distinctive features by which their nature can be definitely ascertained, and for the present at least they are unavailable in evidence.*

Caledonia.

Of the several belts of black slates referred to above the most noticeable, because traversing and determining a district which is well settled, is that which underlies much of the country surrounding Caledonia Corner, extending from the Liverpool and Annapolis post-road easterly to and beyond the foot of Tupper Lake, and westwardly through West Caledonia and the northern part of Whiteburne, certainly as far as the Liverpool River, (being seen at its forks two miles and a half above Lake Rossignol) and probably to the eastern side of Tobetic Lake.

Supposed thickness.

The width of the belt of black slates, near Caledonia Corner, is about three miles, and the inclination of the beds is northward at high angles. They apparently represent an aggregate thickness of at least 3000 feet. There can be but little doubt, however, that the beds are to some extent repeated by faults, and may also include overturned folds, making any definite estimates of thickness necessarily uncertain.

Westfield.

In tracing this belt of slates to the eastward of Caledonia, it is found to be met and cut, near the foot of Tupper Lake in Westfield, by granite, near the contact with which (at the Westfield or Jumbo mine, and upon the stream which there connects the lake with the main stream of the Port Medway River), the greatly disturbed strata are considerably altered, while they at the same time contain veins or irregular masses of white quartz of remarkable size, which are to some extent at least auriferous. A little further eastward, towards Pleasant River, the black slates give place to the banded or ribbanded slates already described, and are not again seen as far as the county line, but eastward of the latter reappear, and are conspicuously seen in Hemford, in Lunenburg county, whence they may be readily followed to the Ohio River and the settlement of New Germany.

Pleasant River.

*For the occurrence of fossils in the quartzites, see remarks on the rocks of Lockeport.

It is interesting to notice in this connection that an effect which is probably due to the same granitic intrusion as that of Westfield and Tupper Lake, is to be seen far beyond the point where the granite ceases to be a surface rock, the black slates one mile and a half south of Caledonia Corner, and along a line corresponding to the strike of the Westfield rocks, showing in their hardness and semi-crystalline character, as well as in the abundance of pyrite crystals, not only a resemblance to those of the lake last named, but evidences of alteration by a similar agency. The beds are here nearly vertical. Metamorphism.

A second band of black and pyritous slates, in every way similar to the above, has already been referred to as succeeding the great whin belt of Ponhook and Molega Lakes upon its southern side. This band, as observed along the Port Medway River, between the foot of Ponhook Lake and Bang's Falls, in the settlement of Greenfield, is but little less broad than that of Caledonia, but while its northern edge has been continuously traced from the county line in Buckfield to the Indian Gardens at the foot of the First Lake connected with Lake Rossignol, its southern border has been observed at comparatively few points. Upon the Port Medway River, the black slates may be seen overlying the quartzites of the southern belt between Bear Falls and Bang's Falls, and it may be again observed in the northern part of Middlefield, but westward of the post-road which traverses this settlement, the country is uncleared and largely drift-covered, making observations difficult. It is believed, however, that the band in approaching the Liverpool River bends northward about the First Lake of Rossignol, and gradually disappears in the country eastward of Lake Rossignol proper. To the west of this point no trace of this second belt has been observed. Second belt.
Greenfield.
Port Medway River.

The third belt of black slates is only partially included in Queen's county, being found along portions of its northern border and partly in the county of Annapolis. It may readily be observed on the post-road in the settlement of Maitland, just north of the county line, and, including a part of Queen's county, is nearly five miles wide. Its southern limit passes just south of Minard's Lake and eastward through the settlements of Northfield and Hillsboro', while its northern limit is between three and four miles north of the county line, or a little over five miles from Kempt. The black slates here meet, and overlie the quartzites of the northern belt. Third belt.
Maitland.

The only other point at which rocks probably referable to this division of the Cambrian system have been observed, is upon Broad

Broad River. River, about three miles above its mouth. Being in the metamorphic portion of the district and themselves highly altered, they may be most conveniently considered a little later in connection with the other metamorphic rocks of the coast.

METAMORPHIC ROCKS OF QUEEN'S COUNTY.

Though in some degree the above title is really applicable to all the rocks of the Cambrian system, there is much difference in the amount of metamorphism exhibited, making some further reference to the more altered rocks desirable.

Degrees
metamor-
phism.

In Queen's county the more highly crystalline rocks, though not wholly absent from the interior, are most conspicuously developed near the sea-board, their occurrence here as elsewhere being evidently connected with the occurrence of masses of intrusive granite. The alteration is also, as might be expected, much more marked in the slaty than in the quartzose bands. Between the quartzites or whins of the coast and those of the interior there is but little difference; at the same time that the intervening beds, which are in the one case simple argillites, are in the other glistening mica-schists. In general, however, there is, even in the quartzites, a greater development of mica in the coastal rocks, giving them the aspect over large areas of fine-grained gneisses. The change from the unaltered to the altered rocks is progressive, and without any well-defined line of demarcation, while even among the comparatively unchanged slates of the interior one now and then meets with beds covered with little angular specks, evidence of incipient crystallization.

The following details will serve to indicate the position and extent of the areas in which metamorphism has been marked as well as some of its varying results.

Details.

It has already been stated that the rocks exposed along the lower portion of the Port Medway River consist of fine-grained quartzites alternating with mica-spotted mica-schists and fine gneisses. Similar rocks probably occupy all the area surrounding the head of Port Medway harbour, but, with the exception of a few beds exposed in East Port Medway, are concealed from view by a mantle of drift, abounding in large quartzite blocks. Near Port Medway village the quartzites are well exposed with a dip S. 30° E. < 85°. They are also well exhibited along the road to the lighthouse, skirting the shore in massive beds of which the true attitude is not easily determinable.

Port Medway.

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Their great uniformity for a distance of a mile or more, together with their broad flat or rolling surfaces broken by innumerable joint-planes, favour the idea that they are in part at least lying in low undulations, but both at Vogler Cove, on the east side of the harbour, and again at the lighthouse on the western side, the dip is comparatively high. Off the mouth of the harbour are several small islands of which one, Toby Island, shows on its east side ledges of gray sandy slate, more or less micaceous and dipping N. 10° E. $< 60^{\circ}$, while a second or outer island, known as the Frying Pan, shows massive gray quartzites which are apparently nearly flat. It is probable that the above beds are in the course of a low anticlinal which enters Queens county from Lunenburg and which is continuous eastward to and beyond Liverpool.

Toby Island.

Passing Rugged Harbour, a small but very irregular indentation in the coast line, we next meet with beds similar to the above in the fishing settlements of East and West Berlin. At the head of Blueberry Bay, just west of Berlin, the fine gneissic sandstones are very regularly bedded, with a dip S. 50° E. $< 50^{\circ}$. At Eagle Head, also, they exhibit the same regular southerly or south-easterly dip for a continuous space of a quarter of a mile; but here they include some gritty beds and are further remarkable as holding in places corrugated layers, the tortuous or serpentine twistings of which are minutely followed by small quartz veins from one to two inches in thickness. Approaching Beach Meadows the previous southerly dip becomes reversed, and from this point westward to Liverpool Bay the dip is northward. In connection with this anticline an interesting feature is the occurrence, on the shore fronting Coffins Island, of enormous veins of granite, the principal vein being for several rods conformable to the gneissic and micaceous strata, which here dip N. $< 40^{\circ}$, but at the eastern end turning almost at right angles to their course, as well as penetrating the same beds in irregular tongue-like masses. The granite is of a coarse character, with red felspar and much mica, and is in places porphyritic. The width of the main mass is from thirty to forty feet, while the smaller veins and branches vary from seven or eight feet to as many inches. In general they do not seem to have affected either the dip or strike of the beds, many of which are cut off transversely with singular abruptness. It is probable that other and more considerable masses of granite occur outside of the present coast line, Coffins Island being wholly composed of granite boulders, though no ledges could be found.

Rugged Harbour,

Berlin.

Beach Meadows.

Granite veins.

Coffins Island

At the Eastern Head of Liverpool Harbour, the fine gray micaceous or gneissic sandstones dip N. 10° W. $< 40^{\circ}$; and a similar north-

Liverpool Harbour.

ward dip, but with some variation in its amount, is maintained all along the eastern side of the harbour, through the village of Brooklyn, being well exposed at the Brooklyn breakwater. A little north of the head of the harbour and near the road to Milton, is a somewhat prominent eminence, known as Wildcat Hill, composed of gray mica slates, spotted with large crystals of black mica, and alternating with gray, micaceous quartzite. The dip is still northward (N. 10° W. < 40°). Still further north, on the Milton road, are other ledges of quartzite, followed, a quarter of a mile below the lower bridge in Milton, by gray, glossy and wrinkled talco-micaceous slates, which are nearly vertical. Similar but finer gray talcoid slates occur also at the upper bridge and near the church, in a like attitude. Half a mile north of this, in the upper end of Milton, the slates give place to a wide belt of whin, indicated however for the most part only by the number and size of the boulders with which it is thickly strewn, and which from this point northward on the Annapolis Road are the only rocks seen for a distance of seven miles. In a road-cutting on Seven-mile Hill glossy micaceous slates or mica-schists come into view; but with this exception, the strata along the Annapolis Road are wholly concealed until the band of black slates is reached, already described as crossing the same thoroughfare in the northern part of Middlefield. It is probable that the succession along the road is essentially the same as that of the parallel section on the Port Medway River, only eight miles to the eastward.

Liverpool
River.

West of the Annapolis Road another transverse section of these rocks is afforded by the Liverpool River between Milton and the foot of Lake Rossignol. As in the case of the sections previously described the larger part of the area is occupied by whins or quartzite, which are more or less micaceous; but about four miles above Milton the beds become more schistose, consisting of greenish-gray, slightly chloritic, fine-grained mica-schists, dipping N. 10° E. < 40°, with a strong and vertical cleavage.

Liverpool
Harbour,
west side.

Returning to Liverpool and continuing the examination of the coast, we find along the western side of Liverpool Harbour the evident extension of the same beds as those which skirt its eastern shore, viz., alternating beds of quartzite and mica-schists. Some of the former are hardly distinguishable from the "whins" of the interior, but others are finely micaceous, while the slates or schists are highly crystalline and present the features, elsewhere frequently observed in this region, of large black crystals of mica scattered through a much finer micaceous base which is white or silvery. These strata are continuously exposed

below the lighthouse for a distance of two miles or more, and possess throughout a northerly dip (N. 10° W. < 70° to 80°). Approaching Black Point the quartzites also become more crystalline, and graduate into an unstratified granitoid rock of dark-gray colour, containing hornblende as well as mica. Black Point.

At Moose Point the rocks again consist of gray micaceous quartzites or fine-grained gneisses, dipping N. 25° W < 60°, together with gray highly lustrous mica-schists. In places these beds contain concretionary nodules, from six inches to one foot in diameter, arranged in rows parallel with the stratification, and show concentric gneissic rings of different degrees of coarseness and colour. Veins of coarse syenitic rock also occur. The whole of the shore between Moose Point and Scotts Bay is composed of similar strata, often much crumpled; but at Strawberry Point they are again invaded by large masses of light-gray granite. The relations of the latter to the gneissic beds is quite similar to those already described on the opposite side of Liverpool Harbour, near Coffins Island; but here the contacts are further complicated by the inclosure in the granite of large detached blocks of quartzite or gneiss, which are strongly angular and vary in size from a few inches to as much as three or four feet. Both the granite and the gneiss carry small veins of white quartz. Still finer illustrations of like relations are to be seen at the government wharf, at the Western Head of Liverpool Bay. The gray micaceous quartzites here form beds varying from ten to thirty or forty feet in thickness, and alternate with beautiful silvery mica-schists, usually not exceeding two or three feet, and both very regularly bedded (N. 25° W. < 70-80°), while both along and across the stratification run large veins of granite, remarkable for the coarsely segregated character of their constituent minerals. Moose Point.
Syenite and
granite.
Western
Head.
Granite
dykes.

To the west of Western Head, the recession of the shore-line, forming the indentation of Gull Cove, exhibits only a repetition of the beds described above; but the dips are southerly, indicating that here, as on the opposite side of Liverpool Bay, the granitic extrusions are connected with and mark the crown of a lengthened anticlinal. At Whites Point the granite is represented only by small veins, the promontory being composed chiefly of gneiss and mica-schist; but at Hunts Point, forming a portion of the eastern shore of Port Mouton Harbour, granites again appear in force, as they also do in the vicinity of Somerville Centre. As before, these granites are very coarse, holding crystals of mica often as much as one inch in diameter. At the point last named the dips again become northerly, and so continue to the mouth of Broad River. The stream last mentioned affords an admir- Gull Cove.
Port Mouton.
Broad River.

Crystalline
minerals.

Black slates,
Division III.

able opportunity for the study of these crystalline rocks, besides revealing certain beds which have not been elsewhere observed within the metamorphic area of the coast. Where the post-road crosses the mouth of the stream are ledges of lustrous mica-schists, side by side with which are gray quartzites which are scarcely at all micaceous, and which differ but little, if at all, from the typical "whin" of Caledonia and Whiteburne. For a quarter of a mile above the highway bridge the rocks are chiefly sandstones or quartzites, with but few slaty beds; but in ascending the stream these become more frequent and, about a mile and a half up, are the prevailing rock. The latter are at the same time noticeable as containing not only scattered crystals of mica, (in this respect resembling the beds of the Liverpool River), but also as holding much larger, though imperfect, crystalline (andalusite) masses, varying from half an inch to an inch and a half in length, which project from the surface of the rock and give it a singularly rough aspect. Some of the beds also contain numerous but small and poor, garnets, and more rarely, crystals of staurolite and tourmaline. These rocks are frequently exposed for a distance of two and a half or three miles from the post-road, the dip being throughout to the northward, though gradually rising from 60° to 90°; but at the distance mentioned a sudden change in the nature of the beds occurs, the gray strata previously noticed being immediately followed by a broad band of very black and heavy rusty-weathering slates, holding much pyrites, as well as small veins, or beds, coincident with the bedding, of black micaceous iron-rock. These beds are also highly crystalline, being both micaceous and staurolitic. The entire breadth of the band is about 900 feet, but this may be double its actual thickness; for if, as is probable, these black and pyritous beds are the altered equivalents of the black slates of Division III, they must here be in the position of a compressed synclinal. In accordance with this supposition, they are immediately followed to the northward by light-gray silvery mica-schists in every way similar to those on their southern side. These are thence continuously exposed nearly to the forks of the stream. Above this point exposures are infrequent, but the blocks with which the bed of the river is strewed indicate that their general character remains unaltered. It is probable that the same beds, which have a very uniform and similar course both on the Liverpool River and on Broad River, occupy also the country west of the latter to the county line, but the district is so extensively covered with bogs and barrens, or strewn with boulders, that little can be seen of the underlying formations.

It has been stated that granite masses protrude, at several points, through the siliceous and micaceous strata upon the eastern side of Port Mouton, west side. The western side of the same indentation is wholly composed of the first-named rock, as are also most of the islands which dot its surface, including Mink, Spectacle, Massacre and Port Mouton Islands. The granite of these several islands is light-gray and moderately fine, but contains coarsely crystalline segregated veins. It affords many beautiful examples of rounded, grooved and striated surfaces. On the shore of the mainland, opposite the Spectacles, striking illustration of the effects of its decomposition and erosion is afforded in the occurrence of hills of blown sand which stretch along the shore for a mile or more, and in places attain a height of forty or fifty feet. The sand is so white as to appear at a distance like banks of snow; it is almost purely siliceous, and is apparently well adapted for the manufacture of glass. Similar sand-hills, though less extensive, occur on the eastern side of the harbour, as well as at points to the westward, to be hereafter noticed. Port Mouton,
west side.

Granites.

Blown sand.

As far as could be ascertained, nearly the whole of the tongue of land separating Port Mouton Harbour from that of Port Jolie is composed of granite, the only exception being that portion of the promontory separating Caddens Bay from Port Jolie Harbour, and terminating in Jolie Point. Here the rocks are in part micaceous quartzites or fine-grained gneisses, and in part coarser granitoid gneiss, both penetrated in places by granitic veins, which often carry beautiful plumose mica. Jolie Point.

The northern limit of the granite between Port Mouton and Port Jolie harbours is difficult of determination, the thick covering of drift completely concealing the underlying rocks. From the distribution of boulders, however, and other facts, it is thought to occupy a position varying from one to two miles north of and approximately parallel to the post-road which connects the heads of these two indentations. Granite ledges appear *in situ* just south of Robertson Lake and again at the mouth of Douglas Brook, where, amidst immense granitic boulders, are sometimes found the remains of ancient Indian shell heaps. The western shore of Port Jolie Harbour is mostly low and boulder-strewn, but at Sandy Cove, near the entrance to the harbour, gneisses and mica-slates, similar to those of Port Jolie Point, reappear, and are similarly penetrated by more or less considerable granitic masses, mostly very coarsely crystalline. The interior of the peninsula appears to be largely composed of granite, and is covered by extensive barrens. Granite.

Gneiss and
mica-slate

The narrow but long inlet of Port L'Hébert is, in its upper half, unbordered by roads, and its low shores show few if any exposures. Port
L'Hébert

Nearer its entrance, however, at the Lighthouse, are ledges of gneiss, dipping N. 20° W. < 40°, and directly opposite, at Taylor's, similar beds, but with dip S. 20° E. < 70°.

II. SHELBURNE COUNTY.

A large part of this county is occupied by granite. The sedimentary rocks which constitute its other portions are also all highly crystalline, making the recognition of the several members of the Cambrian system somewhat difficult.

Quartzites.

Of these members the quartzites are the most readily recognizable, there being no change other than the development of a more micaceous character, which sometimes, and especially near the granite, may become quite coarse, giving the rock all the aspect of a true gneiss, though usually lacking in felspar. At many points these quartzites, with associated mica-schists, representing the lower member of the Cambrian system, are found to graduate upwards into a series of beds which, while more slaty, have usually an aspect of much greater coarseness and roughness. This appearance is almost wholly due to the development in the beds of vast numbers of staurolite crystals,

Staurolitic beds.

associated not unfrequently with crystals of andalusite, and less commonly of garnet. The staurolite crystals are often quite perfect, and usually easily separable from the mass of the rock. The andalusites, on the other hand, are but imperfectly formed, not separable from the matrix, and, like the latter, often studded with prismatic hexagonal scales of black mica. The garnets, though well formed and clear, are generally minute. From the position of the beds observed at many points, there can be no doubt that they represent

Garnets.

group *b* of Division I., though it is probable from their thickness that they include as well some of the beds of Division II. No rocks suggesting a parallelism with the black slates of Division III. have been recognized in this county.

Parallelism of strata.

In describing the details of the metamorphic rocks of Shelburne county it will be most convenient to resume the consideration of the rocks at Port L'Hébert, this being part of the boundary between the county named and that of Queens, already described.

On entering Shelburne county, the first peninsula projection of the coast is that separating Port L'Hébert from Sable River Inlet. This area but repeats the structure of those last described, in Queens county. Along the post-road, connecting the heads of the two inden-

tations, granite boulders of large size are abundant, and at one point, three miles from Port L'Hébert, ledges of this rock appear; but at the mouth of Tom Tidney Brook, which enters the head of Sable River Inlet, and for a mile above the bridge upon the post-road, the rocks are gray quartzites and mica-slates. They dip northerly at low angles but are greatly jointed and broken. No other rocks are seen upon this stream. Farther down upon the peninsula the exposures are few until the extremity is approached; but here the gray micaceous sandstones and gneisses are frequently met with, especially about Little Port L'Hébert and Jones Harbour. They present, however, no new features of interest.

The same remark applies in the main to the area separating Sable River from that of Ragged Island, on the latter of which is situated the town of Lockeport. Along the post-road connecting Sable River with Jordan River a small patch of granite was observed nearly midway between these two places, but with this exception the rocks of this area are everywhere stratified and do not differ materially from those already described.

One mile above the mouth of Sable River proper, is a somewhat prominent ridge in which alternate beds of fine-grained gneiss and mica-slate have, by unequal weathering, produced an appearance which has caused the name of "Cart-wheel Rocks" to be locally applied to them. They dip very regularly S. 40° E. < 60°. On the other hand, along the roads leading around the shores of the peninsula, and on the more prominent headlands, such as Raspberry Head, Hemans Head, and Black Point, the rocks, like those of Jones Harbour, are fine-grained micaceous quartzites, with a dip which is usually at a high angle. Beds of a like character were also observed in Rockport, about half a mile below the head of Ragged Island Inlet, on the post-road around the head of the latter, in Allendale, on its western side, and southward to Lockeport. The dips at nearly all these points are southerly (S. 42-50° E. < 50-60°), corresponding to a north-easterly trend, which is also that of Lockeport Peninsula and of the adjacent islands. Admirable exposures of the beds may be seen at the southern end of Lockeport Island, and are made more interesting by the fact that the surface of the quartzite beds, dipping towards Cranberry Island, at an angle of about 50°, here exhibit, despite their highly metamorphic character, numerous well-marked remains of *Asteropoli-thon*, the only evidences, if such they can be considered, of organic remains yet noticed in the Cambrian rocks of south-western Nova Scotia. The evidences of intense glaciation, shown by the ploughing

Glacial
troughs.

of the adjacent beds along their strike into canoe-like troughs three or four feet deep and two or three feet wide, for distances of thirty feet or more, are other features of interest in the same vicinity.

Western
Head.

On Western Head fine opportunities are also afforded for the study of the Cambrian strata, these, though mostly similar to those of Lockeport, include some coarser beds made up of well rounded quartz pebbles of the size of bullets, and in places exhibit surfaces which are distinctly ripple-marked. They are intersected by numerous joint-planes, some of which, widened by the action of the sea, have originated remarkable "spouting horns."

Green Har-
bour.

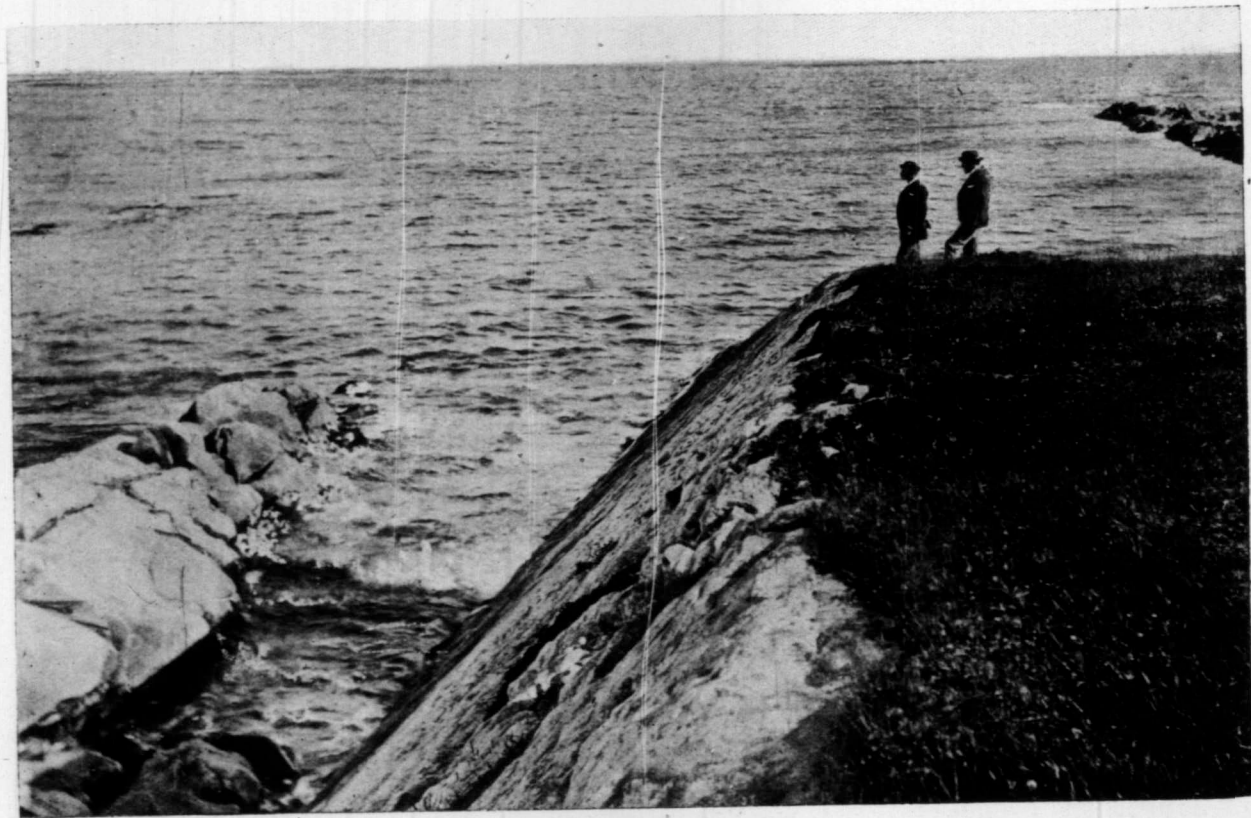
The next indentation of the coast, that of Green Harbour, presents no new features, except that some of the gneisses seen along the post-road at its head are coarser than ordinary, and contain thin layers of black mica-slate which are studded with small staurolite crystals. The general structure is anticlinal, the dip at the head of the harbour being N. W. $< 60^\circ$, while on the extremity of Patterson Point it is S. 30° E. $< 45^\circ$.

Jordan Bay.

Between Green Harbour and Jordan Bay, there are but few exposures either on the shore or in the interior, which is largely occupied by barrens; but ledges of quartzite occasionally protrude, indicating the nature of the underlying rocks. About a mile and a half below the head of Jordan Bay these quartzites become more prominent, forming a notable range of hills, the beds of which dip regularly N. 30° W. $< 60^\circ$. In addition to quartzites they include fine gneisses which are more or less studded with staurolite crystals, and the fact that these staurolite beds occupy the same position as the green sandy slates above the quartzites in the less metamorphic portions of the Cambrian system is well exhibited. Strata of similar character are still bet-

Jordan Falls.

ter shown at Jordan Falls, a locality long known for the abundance and perfection of its metamorphic rocks and minerals. In the strata here exposed the staurolites occur in both rhombic and hexagonal forms, and attain at times a length of half an inch or more. Mica crystals of black colour, distinct from and much larger than those which form the mass of the rather soft rock, give to the latter a curiously spotted aspect, while the frequent occurrence, on many of the layers, of obscurely prismatic projecting knobs, sometimes two or three inches long, that are really partially developed crystals of andalusite, still further adds to the peculiar appearance of weathered surfaces. Finally, many of the beds are studded with small red garnets.



CAMBRIAN QUARTZITE WITH ASTEROPOLITHON, LOCKPORT ISLAND, N. S.

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The development of crystalline minerals, to which reference Granite. has been made, is the evident accompaniment of a near approach to a granite mass. A small area of the latter rock has already been referred to as noticed a few miles to the eastward of Jordan River, along the post-road from Sable River; but another and much more considerable area of similar rock is met with a few miles to the westward, along the same post-road, extending to Shelburne. Between Jordan Falls and this granitic mass the staurolitic strata are exposed for a little over a mile. At the falls their dip varies from N. to N. Staurolitic strata. 25° W. < 40°, but a mile westward similar beds dip N. 20° E < 5°, to 10°, while at a less distance southward, on the road to Jordan Ferry, they graduate downward into and are replaced by quartzites. At the cove, one mile and a quarter below Jordan Ferry, the quartzites dip N. 20° E. < 40°.

A careful examination of the remainder of the peninsula separating Jordan Bay from Shelburne Harbour, shows this to be composed, as regards its southern half, almost wholly of quartzites, such as are well exposed at Jordan Ferry, along the lake road between Lake Rodney and McLean Island, about Berry Bay, and on the shore facing McNutt Island to a point nearly opposite its northern extremity. Here the quartzites may again be seen to be directly overlain by and graduate into mica-schists studded with staurolite and andalusite crystals, some of these latter being two or three inches in length. Some of the beds are also noticeable as holding layers filled with sheafs of hornblende, a feature which helps to connect them with the hornblendic rocks of Yarmouth to be presently noticed. The two sets of rocks, *i.e.* the quartzites and staurolitic slates, are strictly conformable, with a regular dip S. < 30° E 80° to 90°, and in the same relations reappear on McNutt Island; while to the northward the staurolitic and andalusitic beds are alone seen, occupying all the shore to Sand Point and thence up Shelburne Harbour nearly to the town of Shelburne. Grays Shelburne Harbour. or Pettis Island, two miles west of Cape Roseway lighthouse on McNutt Island, is said to be also composed of mica-slates. The distinction as to limits between granitic and schistose rocks is, in the vicinity of Shelburne, as indicated elsewhere in this report, a matter of much difficulty, due partly to the absence of exposures, but chiefly to the irregular way in which the one set of rocks is invaded by the other. Of this a good illustration is afforded at the Shelburne Mills on the Roseway River, near which ledges of gneiss, several hundred feet wide Roseway River. and very regularly stratified, are not only cut off abruptly by granite, across their strike, but appear to be completely surrounded by that

rock. So to the westward, while the larger part of the ridge separating Shelburne Harbour from Birchtown Bay appears to be composed of granite, small areas of quartzite also occur. In general, however, it may be said that granites prevail up the valley of the Roseway as far as the bridge in Lower Ohio, and down the westward side of Shelburne Harbour through the settlement of Churchover.

- Churchover. South of Churchover, fine-grained, gray, micaceous gneisses, marking the commencement of another area of sedimentary strata, are first met with at Green Cove, dipping regularly S. 30° E. < 60°, and are an extension of those of Sand Point, upon the opposite side of the harbour. Beyond this no exposures were seen as far as the upper part of Carleton, but the character of the boulders is such as to indicate the close proximity of staurolitic strata. These appear *in situ* on the south side of Sand Creek and form the promontory of Red Head. The staurolite crystals, imbedded in light-gray mica-schists, are here not only very abundant but exceptionally good, fine specimens, in both prismatic and rhombic forms and sometimes of large size, being readily attainable. Andalusite, in pale-pink prismatic crystals, is also found, but less abundantly and less completely differentiated. The dip of the beds is about N. 25° E. but only at an angle of 3° or 4°. The same beds run out to the extremity of East Point, and reappear, with abundant crystals of garnet, staurolite and andalusite, at the eastern end of the island of Cape Negro. They here dip N. 40° W. < 70°. The shores of North East Harbour are mostly low and bordered by cobble beaches or sand bars; but on the western side of the indentation, in the settlement of the same name, are some slaty beds which are remarkable chiefly as containing an unusual amount of chlorite. They are, however, but poorly exposed.
- Cape Negro Island. Passing round by way of Jones Point to Negro Harbour, highly micaceous strata again come into view, the slaty rocks being spotted with a black variety of this mineral in pea-like nodules, associated with which are much larger nodules, sometimes two inches in diameter, of a dark-green chloritic mineral, sometimes exhibiting a concentric structure. The dip of the beds is regular, S. 30° E. < 60°. They extend nearly to Port Saxon, beyond which, to the head of the harbour, no exposures occur.
- Negro Harbour. Between Negro Harbour and Port La Tour is the long narrow peninsula terminating in Blanche Point. The strata composing it, as seen at Purgatory Point and elsewhere, are similar in their general character to those of the opposite shore below Port Saxon. Some of the
- Blanche Point.

strata abound in small garnets, and the same peculiar chloritic blotches or nodules, referred to above, are again met with.

While the Blanche peninsula forms the eastern side of the harbour of Port La Tour, the somewhat similar peninsula of Baccaro forms its western side, separating the last-named indentation from that of Barington Bay. Port La Tour.

In the upper part of Port La Tour Harbour, on its western side, gray, micaceous quartzites are the prevailing rocks in Upper Port La Tour settlement; but a little south of the latter, about half way between this and the settlement of Baccaro, are some long, low islands and points, one of which, known as Crow Neck Point, affords the most remarkable exhibition of metamorphosed Cambrian strata, as well as of the extent to which these have been affected by glaciation, to be found in any part of Nova Scotia. The rock is massive and in its matrix rather fine-grained, but so thickly studded with staurolite crystals and semi-crystalline nodules, of andalusite (many of which are themselves studded with staurolites,) as to present, at the distance of a few yards, the appearance of a very coarse conglomerate. Crystals of black mica are also scattered profusely through the mass of the rock, while its aspect is further diversified by large dark-green blotches, of no very definite outline, but which stand strongly contrasted with the usual light-gray colour of the inclosing mass. Some portions of the rock are, however, a true conglomerate. Staurolite and andalusite rock.

The beds dip regularly in a south-westerly direction, but at an angle of only 20° , while great troughs have been cut deeply into their mass which clearly exhibit the ploughing action of ice. One gully, apparently wholly due to this agency, but now partly occupied and obscured by a large boulder, was found by measurement to be about forty feet long, from nine to fifteen feet broad at the top, with a depth gradually increasing seaward from five feet to twenty feet, its smoothed or furrowed sides being regularly curved downward to its base, like the sides of some gigantic canoe. The course of the trough is that of the glaciation on the adjacent ledges and has no relation to the dip of the beds or the occurrence of strata of unequal hardness. Still other troughs occur which are but little less remarkable. Conglomerate.

On John Island, towards the head of Port La Tour Harbour, strata similar to those of Crow Neck Point are again seen; but here the dip is south-easterly (S. 60° E. $< 40^\circ$) while the beds with dark-green nodules are seen to lie beneath staurolitic strata not containing such nodules, and are themselves underlain, on the adjacent mainland, by John Island.

Kames. massive gray quartzites, holding quartz veins. At the very head of the harbour are some further illustrations of probable ice action in the occurrence of remarkable kames, along the top of which, for a considerable distance, runs the road from Blanche and Port La Tour to Port Clyde. In Baccaro, to the south of Port La Tour, the rocks are chiefly mica-slates, filled with dark-green spots, which here approximate the form of rhombic prisms. Near the lighthouse, at the extremity of Baccaro Point, the rocks are smooth, glossy mica-slates, dipping S. 30° E. < 50°.

Barrington Bay. Between Port La Tour and Barrington Head, there are but few exposures along the post-road, the first three miles being continuous barrens; but along the east shore of Barrington Bay, both in and below Village Dale, are beds of highly crystalline coarse gneiss, filled with granitoid veins and having an attitude which is nearly vertical (S. 60° E. < 80°). Farther north, between Village Dale and "The Town," the shore is bordered by extensive tracts of blown sand, but in places these can be seen to rest upon well-stratified gneiss, which towards Barrington Head becomes more and more injected with granite, and finally, near the post-office, is completely replaced by the latter.

Barrington. From Barrington westward to the limits of Shelburne county, no other rock than granite was observed, either upon the coast or in the interior. Whether the same is true of Cape Sable Island we were unable to determine. The slight width of Barrington Passage, by which the island is separated from the mainland, together with the occurrence of large granitic boulders over various parts of it, favour the idea that it is in part at least composed of this rock, but the only exposures we could find at Baker Beach, on the south-eastern side of the island, are of gneiss.

Cape Sable Island.

GRANITES OF QUEENS AND SHELBURNE COUNTIES.

In the foregoing descriptions numerous more or less considerable areas of granite have been incidentally alluded to, and their boundaries have been to some extent defined. It is now proposed to give a more systematic summary of these areas, with some remarks upon their character.

QUEENS COUNTY.

Coffins Island. 1. *Beach Meadows and Coffins Island area.*—The only rocks actually visible in this area are those of Beach Meadows shore, where they have already been described as penetrating the schistose strata in

large veins, in part conforming to and in part cutting across the stratification of the latter. It is uncertain to what extent similar rocks enter into the composition of Coffins Island. No outcrops could be found upon it, but from the number and size of the boulders met with it is believed that it is chiefly composed of granite.

2. *Liverpool Bay, west side.*—Veins of granite, which are sometimes hornblendic, have been described as penetrating the gneisses and mica-schists at Black Point, Moose Point, Strawberry Point and Western Head. They present for the most part features similar to those of Beach Meadows and Coffins Island, and probably mark the continuation of a line of granitic upheaval extending from Port Medway to Port Mouton, though showing at the surface only in the form of isolated patches. These granites are remarkable for the character and size of their segregated veins, which are partly of pure quartz and partly of mixed quartz, orthoclase and light-coloured mica.

Port Mouton Harbour.—The granites on the eastern side of this indentation consist of small veins at Whites Point and of larger dyke-like masses at Hunts Point and Somerville Centre. On the western side of the harbour, however, they are in much greater force, forming not only the whole of the western shore and adjacent islands (Mink, Spectacle, Massacre and Port Mouton), but thence extending westward across the upper portions of Port Jolie and Port L'Hébert to a point about half way between the last-named indentation and that of Sable River. The northern boundary, though ill-defined, is believed to extend in a nearly uniform line from the mouth of Broad River to within two miles of Tom Tidney Brook, at distances of from two to three or four miles north of the post-road. Much of the country is covered with piles of granitic boulders, many being of very large dimensions.

The rock of this area, as seen in Port Mouton Harbour, is light-gray, weathering whitish, of moderately fine grain, rarely porphyritic, but frequently traversed by large granite veins in which the constituent minerals are remarkable for their size and individuality. In places the rock exhibits a laminated structure which is hardly less perfect than the bedding of ordinary stratified rock.

Tupper Lake area.—The upper half of this sheet of water, situated in the northern corner of Queens county, is bordered on either side by gray, micaceous quartzites; but a mile or less to the eastward these are replaced by high granite bluffs, and about half way down the lake granite comes out upon the shore. Still further down, this rock appears

upon both sides of the lake as well as in the many islands which dot its surface. To the north of the lake, the granite tongue gradually widens until, along the boundary of Annapolis county, it is at least five miles wide, forming in the vicinity of Round Lake the highest land in Queens county; but to the westward it becomes rapidly narrower, and along the Rosette road is less than a mile in width, finally disappearing near the "Jumbo" mine in Westfield.

The granites of this area may be seen in the vicinity of Tupper Lake to penetrate both the quartzites of Division I. and the black pyritous slates of Division III. In the case of the former their influence is everywhere marked by increased hardness, the development of a purple or lilac colour, and the more or less perfect development of minute crystals. The granites of this area also differ in some respects from those of the coast, being usually much coarser, and often porphyritic. They are also more variable in colour, for while the prevailing tint is light gray, some portions are dark-gray and others tawny yellow.

Tobeatic
Lake.

Tobeatic Lake region.—As the north-eastern corner of Queens county is partly occupied by the granites of Tupper Lake and vicinity, so its north-western corner also includes a granitic area at and north of Tobeatic Lake, at the head of Shelburne River, which flows into Lake Rossignol. Like the Tupper Lake area, this is a portion of the main granitic axis, being another southwardly-bending spur from the granites of Annapolis county, and to the westward continuous with those of Shelburne county. Within the limits of Queens county the granites form the northern shore of Tobeatic Lake, the eminence known as Bald Mountain, the shores of Granite or Rocky Lake and the northern end of Big Pescawess Lake, whence the southern boundary of the granite, now in Annapolis county, sweeps around in a gentle curve to the Liverpool and Annapolis-road (crossing this just north of Maitland), and then south-easterly again to connect with the spur at Tupper Lake.

SHELburnE COUNTY.

Shelburne.

Shelburne Harbour.—This area is about equal in extent to that last described. On the post-road east of Shelburne, the granite is first found *in situ* about three miles east of the town, and probably extends also southward about two miles from the latter. Its northern limits are not definitely known for want of exposures, but on the Roseway River granite may not only be well seen near its mouth, but also as far up the stream as the bridge in Lower Ohio. At several points along

the Roseway it has been described as including well stratified beds of gneiss. West of Shelburne it may be seen for several miles on the road to Clyde, on the post-road to and through the settlement of Birchtown, throughout the peninsula terminating in Harts Point (where the principal granite quarries are situated), and down the western side of Birchtown Bay, through the settlement of Churchover to the point where the shore-road is joined by that from Beaver Dam. The district is mostly very rough and boulder-strewn, or occupied by extensive barrens.

Further remarks on the character of this granite will be given in connection with the economic minerals of the region.

North-east corner of Shelburne County.—A considerable area of granite has been referred to in preceding pages as occurring about the head-waters of the Jordan and Roseway rivers. On the Jordan its southern edge is indicated by the great number and the enormous size of the granite boulders which skirt the north side of Lake John. Thence it seems to occupy all the country lying to the north and west nearly or quite to the valley of the Roseway. Its western limit nearly touches John Lake, near Bower Hill, and thence it extends north-easterly almost to Schoodic and Moose lakes. In an easterly direction the belt appears to be somewhat narrowed, its northern border passing from near Schoodic Lake, by the mouth of Silver Lake, to the lower edge of Wainwright Lake, while the southern border passes by the upper end of Long Lake on the Jordan and thence to the boundary of Queens county, where it connects with the Tobeatic area already noticed.

Barrington area.—The granites of Barrington and the region northward of the latter, including a part of Yarmouth county, constitute the largest area of such rocks near the southern coast. They may indeed be considered as the continuation of the main axis, though at their northern extremity nearly if not wholly disconnected therewith.

In Barrington proper, these granites occupy the whole of the shore from Barrington Head westward to West Wood Harbour and Pubnico Beach. They probably form also the greater part of Cape Sable Island, although, as already noted, the only ledges which could be found upon the latter (on its southern side) were of gneiss. North-west of Barrington Head the granite was found to extend along the Yarmouth post-road to and beyond the county line of Yarmouth, and includes all the country bordering Barrington Lake and River, with about half of the tract

River Clyde. lying between the county line and the River Clyde. Just above the mouth of Bloody Creek, a branch of the Clyde, a spur passes off to the eastward, that may possibly connect with the granite area about Shelburne. Still farther north, the granites under notice occupy a belt from six to seven miles wide, bisected by the county line, and including numerous lake-basins, such as those of Great Pubnico, Great and Little Medoshak, Clearwater Lake, Wagner Lake and others, mostly connected with the head-waters of the Clyde. The topography of all this region, as laid down in Church's county maps, is very incorrect. The position of lakes and streams is frequently several miles out of place, while in some instances sheets of water of considerable size are wholly omitted. Even the position of the county line between Shelburne and Yarmouth is uncertain, that given in the county map of the latter being wholly and widely discordant with that of the former. In the mineral map of Nova Scotia, the large island known as McNutt Island, of which the southern extremity is Cape Roseway, crowned by one of the most important lighthouses on the coast, is wholly omitted, an omission which has been unfortunately repeated in the map accompanying the preliminary report of which this is an extension, and which, as regards its topography, was based thereon. This has made the determination of geological boundaries in the region a matter of much difficulty, a difficulty which has been further enhanced by the fact that the boundaries themselves are ill-defined, the granites some times showing actual transitions into gneiss, as this does into quartzite, while the granite sends into both irregular tongues and veins, of very variable size, often resulting in a complicated interblending of the two. A further consideration of this subject will be given in the succeeding section on the rocks of Yarmouth county.

Pubnico Lakes.

Inaccuracies of existing maps.

YARMOUTH COUNTY.

Yarmouth county. In this county, as in Queens and Shelburne counties, the rocks, exclusive of the granites, are believed to be referable to the Cambrian system only, or at least to the same horizon as those of the counties just named. It will be most convenient in the consideration of the rocks to refer first to the distribution of the granite.

GRANITES.

Granites. It has been already stated that the granitic area north of Barrington is bisected by the line separating Shelburne and Yarmouth counties, and descriptions have been given of the portion included in the

former county. It remains to notice the portion forming the southern or south-eastern part of that last-named. The following notes are based on observations made here by Mr. W. H. Prest.

Great Pubnico Lake.—This sheet of water lies about three miles and a half north of the south-eastern border of Yarmouth county, and is wholly within the limits of the latter. It is extremely irregular in outline and is diversified by numerous islands. Around the north-west end of the lake there is an abundance of gneiss and syenitic granite, while about the centre and towards the south-east end granitic drift prevails.

Great Pub-
nico Lake.

Medoshak Lakes.—These two lakes, Big and Little Medoshak, lie to the north of Great Pubnico, a little west of and parallel to the county line. The country around them is drift-covered, boulders of granite and gneiss, or of the latter banded with quartzite, being most plentiful, and sometimes of immense size.

Clearwater Lake.—This lake is also close to the county line and in the same line with the Medoshak Lakes, with which it is directly connected. On its west side there are great cliffs of gneiss, holding biotite, tourmaline, iron-pyrites and a great abundance of garnets. The latter are of a dark colour, but perfect in shape, and sometimes nearly or quite half an inch in diameter. The beds dip generally S. 42° E. < about 72°, but faults and twists are frequent, and with the stratified beds are numerous dykes or veins of granite.

Medoshak
Lakes.

English Mill Lake.—This lake, also known as Stony Creek Lake, is one mile and three-quarters north of Clearwater Lake. Its general course is N. 20° W., and it embraces two divisions, the east and west lakes, connected by narrows. It is surrounded, at least on its S.W., S.E. and E. sides, by mingled gneiss and granite, the latter occurring in veins as well as interbedded, and in both large and small masses. Garnets, some of them half an inch in diameter, are inclosed in the gneiss.

English Mill
Lake.

Wagner Lake.—The north end of this lake is about E. by N. from the S.E. end of English Mill Lake, and distant two miles and a half, or two miles and three-quarters. Wagner Lake is about two miles long and its general course is about S. 20° E. Its foot is about three miles and a quarter from McGill's farm on Hamilton Brook, or about five miles from the main road in Upper Clyde. The lake, like other parts of the district, is surrounded by granite mingled with gneiss and highly crystalline quartzite. Some of the boulders are of gigantic size, and

Wagner Lake.

would weigh 600 or 700 tons each. The usual minerals, garnet, mica (biotite and muscovite), tourmaline and sometimes olivine, are seen.

Hepsakateejik Lake.—This lake lies about five or six miles N.N.E. of Wagner Lake. Granite boulders are in great profusion, and granite is, in all probability, the underlying rock.

Blue Mountains.

Blue Mountain area.—A second and considerable area of granite in Yarmouth county is that of its eastern extremity, there forming high lands, popularly known as the Blue Mountains. The latter are in reality but a spur of the great central granitic axis extending thence through Digby and Annapolis counties to Lunenburg and Halifax counties and mark its western termination, though possibly connected by a narrow neck with the granitic region about the head-waters of the River Clyde, in Shelburne county.

The southern border of the Blue Mountain spur has been traced with considerable certainty from the county line of Shelburne, which it crosses above the head of Bloody Cr  ek, a tributary of the Clyde, a little south of Moose Lake, past the head of Wallybeck Lake, and so on nearly to the third lake on the Tusket. The tongue here terminates with a width of not more than a couple of miles; the line of its northern border thence extending north-easterly, in a nearly uniform line, and south of the settlement of Rockingham, to the head-waters of another branch of the Tusket. Here a new course is abruptly taken, the line of contact thence running north-westerly by way of Wallace Lake until it passes into Digby county. The greatest width of the Blue Mountains proper is near the middle of the spur, and would be about five miles. Their maximum elevation is about 600 feet. Their southern border is greatly obscured by drift, and it may be that a smaller spur, extending from the main ridge near the head of the Clyde, may connect with those described above as found on the lower portions of that stream about Wagner Lake; but the fact that this latter belt has here a breadth of only three miles, and narrows northward, gives probability to the view that a band of schistose rocks, extending eastward from near Wallybeck Lake, separates the two.

Tusket Wedge.

Tusket Wedge.—In addition to the granitic areas above described, another isolated but considerable area of this rock is to be found in the vicinity of what is known as Tusket Wedge, forming the promontory lying between the entrance of the Tusket River and the harbour of Little River. It is not quite certain whether it similarly constitutes the headland forming the eastern side of Green Bay, but is clearly indicated by the size, number and distribution of the boulders all

along its western side. The same rock constitutes the picturesque group of the Tusket Islands, a few miles to the south.

CAMBRIAN ROCKS OF YARMOUTH COUNTY.

With the rocks of the Cambrian system as developed in Shelburne county, and described in preceding pages, we have now to compare those which, separated from the former by the granites about the county line, are found to the north-west of the latter, in Yarmouth county.

The actual contact of the granite with the schistose strata in this direction is rarely visible, the thick accumulations of drift along their probable line of junction being such as to almost wholly conceal the underlying formations. From the character of the boulders, however, which enter so largely into the composition of these accumulations, no doubt can be entertained as to the nature of the strata. Gneiss and micaceous rocks abound, exhibiting various shades of texture and colour, while through them, in many instances, as in the case of the similar contacts in Shelburne county, run irregular veins and masses of coarse granite, sometimes shading off insensibly into the gneiss, but at other times with sharp lines of delimitation, or with the two rocks irregularly mingled. Veins of quartz are also common, and with these at times garnet, tourmaline and other minerals are well developed. The rocks are usually greatly contorted, and but little information is to be gained by the study of their ever-varying attitudes.

General features.

In advancing to the westward (the prevalent strike being here to northward), the evidences of metamorphism gradually become less marked, though the highly micaceous character of the strata and the dissemination through them of crystalline minerals still conspicuously attest the alteration they have undergone.

The first good exposures of beds of this character is to be seen along the post-road at the head of Pubnico Harbour, but they are even better exhibited at different points along the length of the peninsula bounding the latter upon the western side, and at St. Anne Point, its southern extremity.

Pubnico Harbour.

As seen along the post-road at the head of the harbour, the highly micaceous but distinctly bedded rocks are thickly studded with crystals of andalusite, varying from half an inch to three inches in length, with now and then a crystal of staurolite or garnet; but while the singularly rough and knobby appearance of the beds is largely due to the prom-

inence given to these crystals by unequal weathering, a closer examination shows that it is also in part the result of the inclosure in the beds of numerous well-defined pebbles, mostly of quartzite, the rock being in reality a conglomerate. Both features are of much importance, for on the one hand they thus show a close correspondence and probable equivalency with the similar beds already described about Port La Tour and elsewhere in Shelburne county, and on the other as nearly resemble certain beds of Yarmouth Harbour and the vicinity of the city of Yarmouth which have been thought to be of more ancient origin than the beds of the Cambrian system. If the view here taken be correct, these beds, in Yarmouth county as in Shelburne, are the representatives of Division I. c. of the Cambrian system, and in connection with facts to be presently noticed afford a key to the true interpretation of the geology of this part of Nova Scotia.

St. Anne
Point.

At St. Anne Point the width of the beds as measured across their strike is about a furlong, and the dip about E. 20° S. $< 80^{\circ}$. Both staurolite and andalusite are abundant here, but the conglomeritic character noticed at the head of the harbour is less prominent. Similar beds also form islands in the harbour.

MICACEOUS AND HORNBLENDIC ROCKS OF YARMOUTH HARBOUR, ETC.

Rocks of
Yarmouth.

We come now to consider the peculiar group of rocks found in and about Yarmouth city and harbour, to which reference has been made above as differing in important respects from the usual aspects of the Cambrian rocks, and as to the position of which much uncertainty has prevailed.

Former views.

The more prominent features of the group were first described by Sir J. Wm. Dawson in "Acadian Geology," and subsequently, in considerably greater detail, by Dr. Selwyn. Both writers remark upon the contrasts which these rocks exhibit as compared with the Cambrian rocks of the southern counties, and both suggest the probability that they are older; but no facts of a definite character were in either instance obtained from which their true position might be inferred.

Lithological
characters.

In the determination of this question it will first be necessary to consider the composition or lithological aspect of the rocks, and secondly their stratigraphical relations. As a whole, the belt, having a width of about seven and a length of about forty miles, may be described as consisting of highly metamorphosed strata in which the abundance of mica, and especially of hornblende, are the most characteristic features. Chlorite and epidote also characterize some of the

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beds, but are much less conspicuous, and in some instances the strata are either felspathic or quartzose. Good exposures of such rocks may be seen in the city of Yarmouth, and still better in the rocky peninsula, now used as a park, near the head of the harbour; again on the west side of the latter about Cape Fourchu and Yarmouth light, and finally along the eastward extension of the belt in Milton, Hebron and Ohio. The beds at Cape Fourchu are of special interest, for in them are presented features which would seem to afford an important clue to their true geological position, or at all events a means of correlation with rocks already noted elsewhere.

Cape
Fourchu.

The features referred to consist in the fact, first described by Dr. Selwyn, that the highly micaceous strata (which also contain numerous scattered sheafs of hornblende and are in part true hornblende-schists), are also to a large extent conglomerates, being filled with numerous pebbles, sometimes as much as a foot in diameter. These pebbles, in some of the beds, consist of pale-gray quartzite, and in others of a gray or purplish-gray vesicular rock, and, as remarked by Dr. Selwyn, "show a flattening and elongation in the direction of the cleavage-planes." In this conglomeritic character as well as in their general aspect, these beds closely recall those already described as occurring at the head and along the western side of Pubnico Harbour. It is true that they differ from these in the abundance of hornblende characterizing the former, and the general absence of staurolite and andalusite crystals so conspicuous at Pubnico, but the first-mentioned feature occurs to some extent in undoubted Cambrian rocks on the east side of Shelburne Harbour in connection with staurolitic strata, while in the case of the Yarmouth beds these, as will be presently noticed, exhibit in their eastward extension an abundance of both staurolite and garnet, assuming in fact aspects not distinguishable from those of many of the beds on the Shelburne county coast. The latter being clearly the metamorphosed equivalents of Division 1. *a.* of the Cambrian succession, it is reasonable to infer that such also is the position of the similar beds of Yarmouth.

Observations
of Dr. Selwyn.Conglom-
erates.Comparison
with beds of
Pubnico and
Shelburne.

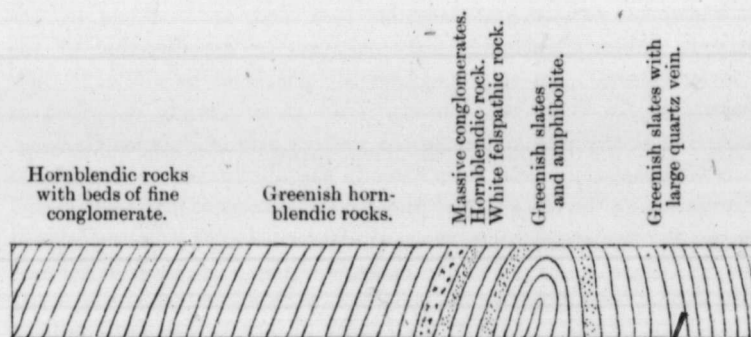
This view is entirely in accordance with the supposed stratigraphy of the region. All along the eastern side of the peninsula terminating in Point Fourchu, as well as on the opposite side of Yarmouth Harbour in the city of Yarmouth, the prevailing dips are easterly or southeasterly, usually at angles from 60° to 70°, but sometimes nearly vertical. Half a mile north of Stanwood Point on the same peninsula, the dark hornblendic schists with the same dips (about S.E. < 70°) include a considerable bed of white felspathic rock, the counterpart of

Stratigraphy.

Yarmouth.

Stanwood
Point.

one traversing the centre of Yarmouth city, but associated with massive conglomerates holding boulders of crystalline rock (resembling the Huronian of New Brunswick) imbedded in the hornblende-schists. In the succeeding quarter of a mile north of the same point, there is every indication of an anticlinal fold, the saddle inclining south-west at an angle of about 25° , while the apex shows corrugations and on the north-west side increases in dip to 86° , the hornblendic rocks being here very prominent. One hundred yards north-west of this is a belt of greenish slates apparently less metamorphosed than the surrounding beds. It is about fifty or sixty feet wide, and contains in its centre a conformable five to ten foot belt of quartz, of a grayish colour, intersected at right angles by later veins of a purer and whiter quartz, dipping N.E. This again is bounded by a belt of rocks consisting in some places of almost pure hornblende. The following section will serve to make the relations of the beds at this point clear :—



Section across Stanwood Point, Yarmouth, about two-thirds of a mile.

Chegoggin
Point.

To the north of Cape Fourchu, the shore for several miles is without exposures. At Chegoggin Point, however, the underlying rocks come into view, and are of interest as including strata which appear to be to some extent auriferous. These strata are, in their general character, similar to those of Yarmouth Harbour, consisting of hornblendic slates, some of which are an almost pure hornblende, while others are composed of an intimate mixture of hornblende and garnet. Fissures in this latter rock are sometimes covered with sheets of very lustrous and well formed, though not complete, garnet crystals, while crystals of menaccanite or titanite iron, an inch or more in breadth, also occur. One belt of this hornblende and garnet-bearing schists has a breadth of eighteen feet. At other points the softer slates appear to have their bedding planes curving around the hornblendic masses, as

though there were included boulders, one such mass being about 10 by 25 feet. The general strike of the rocks is S. 52° W. and the dip southerly at high angles. They are traversed by immense quartz veins, on one of which a mill of ten stamps has been erected, but is not now in operation.

The next principal headland north of Chegoggin Point is that of Cranberry Head, where again gold-bearing strata occur and are being worked, although quite different in character from those of the first-named promontory. In the vicinity of the mill erected here, at a point known as the "Cream Pots," the rocks are soft greenish chlorite slates and dark-gray argillites, probably corresponding to Division II. (possibly also Division III.) of the Cambrian system. The strata are much faulted, the general dip, however, being about the same as at Chegoggin.

North of Cranberry Head, similar strata, but including more or less arenaceous beds of a greenish colour are the predominant rocks, but vary every few yards in texture as they do also in altitude, while at several points they are invaded by dykes of diorite. In general the incision would appear to be a descending one, in accordance with which the greenish arenaceous beds appear to graduate into more massive sandstones, in which the colour is blue rather than green, and which in general aspect recall the quartzites of Division I. as elsewhere found in the Cambrian system. These rocks are met with as far as the outlet of Lake Allen.

Between the stream last mentioned and the promontory of High Head, the section is not a continuous one, but exposures are found at intervals, of which the greater part are greenish slates, sometimes including beds of quartzite, but with these are also parti-coloured slates, exhibiting shades of green, yellow, red, purple and light-blue, recalling the ribbanded beds of the Pleasant River district in Queens county. Approaching Maitland the prevailing rocks are again hard green slates, now dipping northerly, but exposures are few.

Section not continuous.

Attention may now be directed to some of the aspects of the group of rocks under consideration as seen in portions of Yarmouth county more remote from the coast.

From the vicinity of Yarmouth Harbour the hornblendic rocks, Hebron, Ohio, etc. there so conspicuously displayed, are readily traced to the eastward, their hardness and compactness causing them to stand out prominently wherever they occur. They can thus be seen in the settlements of Hebron, Bellfield, Wellington, Hartford and Ohio, being frequently

exposed in bare ridges along either side of the track of the Dominion Atlantic Railway, as well as about the chain of small lakes running parallel with the latter. Similar beds occur in the vicinity of Lake George as well as about Little and Great Brazil lakes and Lake Annis, but in this direction the hornblendic character becomes less marked, at the same time that the beds become much more abundantly charged with crystals of staurolite and garnet. About half a mile eastward of Brazil station are beds which are profusely studded with garnets, from the size of a pea to as much as half an inch in diameter, but coarse in texture, while on the shores of Lake Annis, with fewer garnets, staurolites are very abundant, the beds nearly resembling those of Shelburne Harbour and Jordan Bay. Crystals of menaccanite are also found here. A little farther to the north-east the belt passes into Digby county.

The total length of the belt, including the portion in Digby county, is about thirty miles, and the breadth, which is quite uniform, about seven miles. On its eastern side the hornblendic and micaceous beds may at some points be seen to be followed by black pyritous slates, the supposed equivalents of Division III. of the Cambrian system of Queens county, and thus completing the ordinary Cambrian succession; but on the western side it is probable that the belt is bordered by a line of fault, the beds, as already indicated upon the coast, exhibiting an abrupt change of character, as they likewise do wherever the western border of the belt is examined. Unfortunately, on this western side, the country is deeply drift-covered and no actual contacts of the hornblendic rocks with the succeeding beds could be found. The general character of the rocks in this direction has been indicated in the coast section from Cranberry Head to Port Maitland, but exposures are few.

DIGBY COUNTY.

The formations represented in this county, as in those already noticed, are mainly the granite and the Cambrian system, to which, however, must be added limited areas of Devonian rocks, and the red sandstones and traps of Digby Neck. These more recent sandstones can best be discussed in connection with the similar rocks of Annapolis county. It remains to notice the Cambrian rocks and the granite, and of these the latter rock may first be considered.

GRANITE OF DIGBY COUNTY.

The boundary of the central granite belt of central and western Nova Scotia, has already been given in previous pages through the

counties of Queens, Shelburne and Yarmouth to the boundary line of Digby county. This it crosses about two miles west of where the same line is crossed by the main stream of the Tusket River, and thence extends to the vicinity of Barrios Lake.* From this lake the boundary extends to the next or Carleton branch of the same river, a short distance west of Lake Doyle; but from this point turns more to the north and east until, reaching the Sissibou or Weymouth River, it crosses this a little below its forks. From this point its course is for several miles parallel to, and nearly midway between, the north branch of the Sissibou and its tributary, the Mistake River; but above the head of the latter it makes a sudden curve to the north-west, thus helping to outline a spur which occupies a considerable area south and east of North Range settlement. From North Range its course is north-easterly until it crosses the West Branch of Bear River about half-way between Bear River village and Morgantown, and not far beyond crosses the county line between Digby and Annapolis.

CAMBRIAN ROCKS OF DIGBY COUNTY.


In preceding pages the description of the Cambrian rocks as shown in the coast sections, has been given as far as Salmon River, about four miles north of the border line of Yarmouth county. To the north of this river, the first rocks met with are great angular blocks, twenty-five by thirty feet long, of greenish-gray hornblendic material, which are wholly destitute of stratification and carry small veins of asbestos. Very similar masses *in situ* are also to be seen on the post-road to Weymouth, a few miles north of Cape Cove, and both are doubtless diorite dykes. Beyond the masses referred to, on the coast, but separated by a considerable interval, is a light-gray slate holding narrow seams of quartzite and dipping northerly from 82° to 90°. These beds form a portion of a series of shore ledges which are exposed at intervals to Cape Cove, and which present upon the southern side of the latter a series of prominent cliffs, in places eighty feet high. The course of the beds often corresponds to the trend of the shore, and their character, as seen at different points, as well as their strike, indicates that they are largely if not wholly an extension of the beds already noticed about Salmon River. Among them may be especially noticed a series of argillites resembling those upon the shore north of Allen Lake in being many-coloured, though with green as a predominant tint. They are probably representatives of Division II. of the Cambrian succession, and as such are followed at Cape Cove by dark-gray and black slates, of a highly

Salmon River.

Cape Cove.

Allen Lake.

* This lake is shown on the County Map about four miles north of its true position.


 Pyritous beds.

pyritous character, that are believed to be the equivalents of Division III. So abundant are these pyrites crystals that the post-glacial beds which overlie the slates and cap the cliffs, are for a considerable distance, by the products of their decomposition, cemented into a ferruginous conglomerate, the exact counterpart of the conglomerates of similar age to be found about Bridgewater in Lunenburg county. Quartz veins are also of common occurrence, and occasionally carry small veins of copper-pyrites. The slates are often conspicuously banded with paler layers, and have a south-east dip of about 65° .

Cape Cove.

It is probable that the indentation of Cape Cove corresponds to a band of soft and easily removed strata, for no rocks are exposed at its head, and the depression which it marks extends inland for a considerable distance. Along its northern side, however, more resisting beds again come to the surface, and running out to the coast, form the conspicuous promontory upon which stands the Cape St. Mary lighthouse.

Upon both sides of this promontory the strata are well exposed, but while those on the south are easily accessible, those to the north form, for a long distance, a series of beetling cliffs, already referred to upon an earlier page, and of which the examination, either from the shore or by water, is a task of much difficulty and of no little danger. The work was, however, undertaken by Mr. Prest, and the following is a summary of his notes thereon.

Cape St. Mary.

Upon the shore south of the promontory and east of the lighthouse, the most conspicuous rocks are greenish-gray and gray arenaceous shales, containing bands of gray slaty quartzites which are more or less crystalline, as well as felsitic bands of bluish-gray, and sometimes yellowish, colours. Their dip is pretty uniformly S. 28° E. at high angles, and their exposed breadth is about thirty paces. Immediately beneath these greenish arenaceous shales, are cream-coloured and light yellowish-gray sandstones, of coarse texture, which in addition to minute garnets include numerous hard granular particles, of a dark-gray colour, imbedded in a paste which is much lighter and at the same time soft and unctuous. These beds are also noticeable as containing numerous grains of carbonate of iron and mica. In several respects they are unlike any beds seen elsewhere in the Cambrian system, and they may possibly form no portion of it. Their dip, however, which is quite uniform (S. 27° E. $< 75^{\circ}$), accords with that of the associated beds, their breadth being about fifteen paces. Immediately below the cream-coloured sandstones, an abrupt change occurs, the next succeeding beds being light and dark-gray argillites which are much contorted but which near the junction with the sandstones con-

form to the latter in dip. It is upon these argillites that the lighthouse stands.

The first beds exposed in the high bluffs to the north of the lighthouse, are light- and dark-gray argillites, similar to those last mentioned, and with a nearly similar dip. The precipices are about fifty feet high and often overhang; but further east they become still more bold and rugged, ranging from 100 to 200 feet in height and presenting a wild and desolate aspect. No other rocks than slates are visible, but these apparently form a series of folds approximately parallel to the trend of the coast, the first anticline being about one-third of a mile N. by E. of Cape St. Mary, followed, at about the same distance, by a syncline, but without repeating the green shales. The next anticline continues further and brings up lower slates, but still of the same character. Still another anticlinal fold extends parallel to the coast for three or four miles, the dip on the north side becoming N. 50° W. < 50° to 75°. A short distance south of South Metaghan, this fold seems to run out into the sea, but one mile north of Metaghan River, on the shore, are greenish-gray quartzites with numerous small seams of greenish-gray arenaceous shales, dipping S. 47° E. < 87°. Along the course of the Metaghan River also, between the village and the station, a junction of green and dark-gray or black argillites may be seen, but both the character and position of these indicate that they are the extension of strata and of folds already noticed, and the section across this part of Nova Scotia thus becomes completed.

Coast section
north of St.
Marys light-
house.

Metaghan.

The surface of the interior of Digby county is even more generally and more deeply drift-covered than that of Yarmouth. There are, however, several considerable streams traversing the district which afford good opportunities for study, and these, with such outcrops as can be found in the intervening districts, give a tolerably fair idea of the whole structure.

The first of these streams is the West Branch of the Tusket, flowing from Wentworth Lake, which is itself fed by two tributaries, the one originating in small lakes near the western border of the granite tract, the other from similar lakes in the settlements of Hillton, New Tusket and Corbrey. On the main stream, south of Wentworth Lake, the rocks are chiefly mica-schists which are more or less garnetiferous; and similar strata occupy most of the area eastward from this point to the granite, here distant about eight miles on the line of strike. To the south-west again, and southward of the road connecting Wentworth Lake with Hectanooga, are both hornblendic and staurolitic schists, an extension, no doubt, of the metamorphic belt of Brazil Lake, Lake

West branch
of the Tusket
River.

- Wentworth Lake. Annis, etc., in Yarmouth county. On the other hand, Wentworth Lake itself is bordered by quartzites, being a portion of a belt extending eastward to the granite about Barrios Lake and westward to the sources of Salmon River. Along the main line of the Tusket, this quartzite anticline has a breadth of about four miles, which becomes somewhat widened in the direction of the granite and narrowed to the westward, where it is much obscured by drift. It is here that the remarkable kame, known locally as the "Boar's Back," is to be seen, and which, between Wentworth Lake and the head of Salmon River forms the line of the road connecting these points, being just wide enough for this purpose.
- "Boar's Back." The exposures on Salmon River itself are not numerous, while the course of the stream in its upper part is nearly the same as that of the rocks. In its lower courses, however, its direction is oblique to that of the strata, and here are indications of another narrow quartzite anticline, flanked on either side by corresponding synclines of slate, all of which are traceable from the coast north-eastward to the Metaghan River.
- Salmon River. The last-named stream is somewhat larger than that of Salmon River, and the information which it affords is much more satisfactory. Its waters are derived from numerous tributaries, some of which approach quite nearly the waters of the Tusket in Hillton and New Tusket settlements, while others are not far removed from the Sissibou River.
- Metaghan River. In New Tusket and Corbrey, the rocks are light greenish-gray sandstones and greenish arenaceous slates, such as elsewhere succeed the quartzites of the Cambrian system, and here mark the north side of the Lake Wentworth anticline already described. It is not quite certain whether they connect with the similar rocks of the middle portion of Salmon River; but in the opposite direction they exhibit a well defined syncline, extending to and beyond the Sissibou River, in which direction they also include, in the form of purplish-gray slates and blue and black slates, beds occupying a higher position in the Cambrian succession than those exhibited over most portions of Digby county. These will presently be more fully noticed.
- New Tusket. The highest tributaries of the Metaghan, like those of the Tusket, drain the western end of the New Tusket synclinal. In descending the stream towards the Belliveau road, indications of an approach to a quartzite anticline are clearly indicated in the drift; and, about Metaghan or Victoria Lake, as well as about Belliveau Lake, are ledges of blue quartzite with occasional seams of bluish-gray slate. These beds
- Metaghan Lake.

dip S. 25° E. < 62°. The exact limits of this anticline are, as usual, very difficult to determine, owing to the absence of exposures, but it would seem to have, along the Belliveau road and about the middle courses of the Metaghan, a width of about eight or nine miles. Exposures of quartzite may be seen near and south of Beaver Lake, and again at a point one mile and a quarter east of Raymond's mill, or one mile and three-quarters east of the Dominion Atlantic Railway.

In the vicinity of Raymond's mill is afforded a good opportunity for Plications. the study of the numerous folds by which this part of Digby county has been affected. We have here, apparently, an anticline overturned to the east, the quartzites which mark its centre occurring about half a mile east of the mill, while on either side these are flanked by arenaceous and micaceous slates that gradually pass upward into gray slates, as these do into slates banded with lilac and purple. The dip is nearly the same upon both sides of the anticline, or about N. 50° to 60° W. < 80°, but the beds are repeated in inverse order. It is the same anticline as that already noticed upon Salmon River.

We come now to the Sissibou River, the most considerable of all Sissibou the streams traversing Digby county, as it is also that affording the River. most complete view of its geological structure.

The sources of the Sissibou are in the granite country, which occupies so large a part of the eastern portion of the county. The western limit of the granite is about half a mile below the Sissibou Forks. The rocks which adjoin the latter on the main stream, as well as about its tributary in Wagner settlement, are, as would be expected, highly metamorphic, consisting in part of quartzites showing traces of granitic dykes, hornblende slates and hornblende-rock, the latter being much shattered, though massive, while the slates are regularly stratified and continuous. Near the junction of the two streams the hornblende beds become less frequent, but the rocks are still highly altered, consisting of micaceous slates in which both staurolite and andalusite are abundantly developed. Near the same point the course of the Sissibou, previously westerly, turns abruptly to the north-east, the locality being further marked by a considerable fall. The rocks here Falls. are mainly blue slates, finely stratified, with some thin beds of light-gray slates. They are a portion of a rather broad synclinal basin, of horse-shoe form, the axis of which inclines to the eastward. Above the bend the dips are northerly, as they are at the falls, but northward of this, in descending the stream, gradually swing around through east to south-east and south. Similar southerly dips prevail all the way to the mouth of Mistake River, the slates which occupy all the interval

exhibiting slight variations in colour and texture, and in places showing a somewhat ribbanded aspect. They also show, sometimes, traces of metamorphism, and are cut by iron-bearing quartz-veins.

Mistake River.

Mistake River is the principal tributary of the Sissibou. It first takes definite form where it flows from Mistake Lake, near the settlement of North Range. The lake in question is bordered in part by granite and in part by quartzites to be presently noticed; but along the whole course of the stream, a distance of five miles, the rocks are slates similar to those of the Sissibou, of which they are the eastward extension. To the south of the stream, however, between the latter and the granite, is a belt of much more recent strata. These are also slates, but are more arenaceous than those of the Cambrian system, and show their comparatively modern origin in containing rotten ochreous layers, abounding in fossils of Lower Devonian type. They are in fact similar to the beds of this age found at Bear River farther east, and with the latter will be more fully considered in the sequel. They are here inclosed in a sort of bay formed by the granite, and probably occupy and mark the centre of the Cambrian syncline. The slates of the latter, as seen along Mistake River, abound in slickensided surfaces, an evidence of extensive movements.

Devonian rocks.

Near the junction of Mistake River with the main Sissibou the slates, some of which are greenish and more or less unctuous, others purplish or greenish with purplish bands, begin to include beds of gray and greenish-gray sandstone, and not far below the junction, at the High Falls, are fine exposures of these beds still dipping southerly. They evidently mark the transition to the quartzites of the lower division of the Cambrian system, which quartzites appear in place immediately below the falls, forming for 200 yards a series of high cliffs, the dip of the beds being S. 16° E. < 80°.

High Falls of Sissibou River.

Quartzites Div. 1 a.

About a fourth of a mile below Sissibou Falls, hard blue quartzites, with seams of greenish slaty sandstone, again form bluffs with a vertical dip (S. 19° E.), and three-fourths of a mile farther are similar beds with nearly the same dip. There are within this space some indications of an anticline, but the prominence of cleavage planes and numerous variations in the dip either side of verticality, make its determination uncertain. Beyond the quartzites last referred to, the rocks show a mixture of greenish sandstones and slates, with purplish bands, followed by purple slates, the dip being northerly and the beds evidently the same as those near the mouth of Mistake River, now repeated on the other side of an anticline. A furlong below these exposures are bluish and greenish-gray sandstones with little slate,

Purple slates.

much contorted, but with an average dip N. 6° W. < 50°, these beds being here probably brought to the surface by a fault. At a distance of another furlong, and about fifty yards from another stream entering the Sissibou from the north-east, are bluish-gray sandstones or quartzites, which also appear at intervals for a quarter of a mile, the dip throughout this distance being uniformly southerly (S. 22° E. to S. 40° E. < Fault. 60°). A fault then brings up purplish-gray slates, still with southerly dip (S. 40 to 45° E. < 70°). There is probably here a minor synclinal fold, the succeeding beds, in descending order, being greenish slates, argillaceous slates of dark-gray colour tinged with purple, bluish-gray and greenish-gray sandstones, fine dark-gray sandstones with dark argillites, and finally hard blue quartzites with greenish slaty partings. This is the regular descending Cambrian succession, the breadth of the transition beds from the fault to the quartzites being a little less than a mile, and the southerly dips averaging about 50°.

Descending
succession.

The quartzites which form the lower division of the Cambrian system are well displayed along the lower Sissibou and in the vicinity of Weymouth, as they are also at various points along the south shore of St. Mary's Bay. On the Sissibou they may be well seen about two miles and a quarter above Weymouth.

Quartzites of
Weymouth.

The Sissibou section has been referred to as typical of the structure of a large part of Digby county. This is especially true of that portion of the latter which intervenes between this stream and the shores of Annapolis Basin.

Sissibou section a typical one.

Thus the quartzites and associated beds described as occupying the lower portion of the Sissibou, below Mistake River, similarly occupy a large part of the tract eastward of the first and north of the last-named stream, on either side of the line of the Dominion Atlantic Railway. Much of the tract is indeed, as usual, covered with drift, but exposures are sufficiently numerous to afford, with assistance of the drift, clear indications of the underlying rocks. The best exposures are, as might be expected, upon the coast, and particularly in the vicinity of Gilbert Cove, of which the outer part consists of massive dark-gray sandstones or quartzites, dipping S 20° E. < 20°, while on the high road above the head of the cove are mica-schists carrying small crystals of magnetite. The quartzites are also well exposed along the road connecting the head of St. Marys Bay with the settlement of North Range, as they are between the head of the same bay and the town of Digby, where they again show evidences of considerable alteration. In North Range settlement again, where the Cambrian strata meet and have been probably in part replaced by a northward spur of intru-

Dominion
Atlantic
Railway.

North Range.

sive granite, the evidences of alteration may be readily seen, particularly about the eastern end of Mistake Lake, where are immense boulders of reddish slaty gneiss which are evidently local; but it is noticeable here, as in Queens and Shelburne counties, that the massive quartzites are but little changed even where the accompanying finer beds are altered into glistening mica-schists.

The section across the isthmus separating St. Marys Bay from Annapolis Basin, in the vicinity of the town of Digby, remains to be described. It is not perhaps so complete as that of the Sissibou, but it is more accessible, and, as again affording an admirable illustration of the Cambrian succession and a comparison with the rocks of that system on the Atlantic seaboard, in Queens and Lunenburg counties, well deserves a somewhat extended notice.

Brighton.

Near the south-east side of St. Marys Bay and in the eastern part of Brighton, the quartzites which form the base of the section may be seen, dipping easterly. They are greenish in tint and more or less micaceous, and are an evident continuation of those of Plymouth and the lower portion of the Sissibou River. Crossing the post-road, they probably form the basis of much, if not the whole, of the high land closely adjacent to the town of Digby, though they are completely concealed from view. Approaching Marshalltown, along the line of section, bands of green slate begin to replace the quartzites, and at last become the prevailing rock. Then, on the high land of Marshalltown, purple slates come in, resembling, even in the most minute particulars, the purple slates holding a similar position in Queens county. Here as there the lower purple slates show numerous light yellowish-green seams which are very characteristic. Wherever seen the yellowish-green seams show faint bedding lines, which here and there are discontinued or replaced by purple slate for half an inch or an inch. Occasionally a very narrow dark green seam is seen in Digby as well as in Queens county. Then come, as in the latter, bluish-gray and lilac slates, then a series of (upper) purple slates without yellowish seams, and then bluish-gray and light-gray striped slates, seen on the north-east end of Marshalltown hill. Finally, on the hills south of Jordantown and up the Lee or Bingeys Brook above the Valley Mills, is seen the transition to the black slates. A fine exposure of the latter may be seen near the railway bridge on the Grand Joggins, while they are also well exposed on the hill above Acacia cottage and along the road leading thence to North Range.

Marshalltown.

Comparison of succession in Digby and Queens.

Grand Joggins.

The above section may be continued beyond the Grand Joggins to Bear River, the eastern border of Digby county, as it is also the

natural eastward termination of the great Cambrian tract, described above.

On Hollinghead Brook the black and bluish-black slates of the Grand Joggins are again seen, exhibiting the following ascending succession on Hollinghead Brook. Succession on Hollinghead Brook.

1. Black slates, one-third of a mile. Dip N. 65° W. < 65°.
2. Gray and bluish-gray sandstones. Dip N. 60° W. < 60°.
3. Black slates. Dip N. 50° W. < 60°.
4. Belt of light-gray sandstone. Dip N. 50° W. < 60°.
5. Black slates—about 1000 ft. Dip N. 50° W. < 55°.
6. Striped slates, viz., bluish, light and dark-gray. Dip N. 50° W. < 65° to < 45°.
7. Black slates, for one-third of a mile. Dip N. 55° W. < 45° to < 30°.
8. Striped bluish-gray and light and dark gray slate.

The last-named striped slates have a prevailing south-east dip, and with some wave like undulations mark the centre of a syncline, on the other side of which the beds are reversed for about half a mile, the whole basin being at the same time inclined in the direction of Bear River. The dip on the south-east side of the syncline is in places almost perpendicular.

About a furlong south-east of the above syncline is a dyke of diorite, nearly 100 feet thick, that is probably continuous with a belt of such rock exposed on the west side of Bear River. It protrudes through the almost perpendicular slates and forms a succession of falls over fifty feet in height. South-east of the dyke the slates maintain for a time their vertical dip, then inclining northward at an angle of from 50° to 60°. Diorite dyke.

A little over a furlong south-east of the dyke is the apex of a minor fold subordinate to the main Weymouth fold. The dip is about N. 30° W. < 65°. Still farther south-east the country becomes covered with drift in which boulders of granite and diorite predominate.

On Roach Brook (or Poole Brook), which runs into Smith Cove, are still other exposures of light and dark-gray and bluish-black slates, with bands of blue sandstone. These latter are conspicuously buff-weathering, and thus become very noticeable features in the rocks of this vicinity, the bands being from three inches to one and one-half feet in thickness and standing out above the softer slates. The dip varies from N. 40° W. to N. 55° W., and the inclination from 78° to verticality. A dyke of diorite, similar to that of Hollinghead Brook and in the same range, is also seen here. Roach Brook.

Smith Cove.

About the lower part of Roach Brook, at Smith Cove, the dark slates are, as usual, in numerous short folds, dipping steeply to the eastward, the folds themselves being inclined in the same direction at angles from 70° to 80° . The slates are often stained and sometimes permeated for some distance with red, buff and green colouring matter, this being distributed usually not in lines corresponding to the bedding, but in patches. Where these colours are present the slates are softer and apparently more argillaceous than elsewhere. In these respects they resemble the soft slates described on a previous page as occurring on the coast south of Cape St. Mary.

Red slates of uncertain age.

As in the case of the beds last referred to at Cape St. Mary, it is by no means certain that the rocks of Roach Brook and the tract intervening between the latter and Bear River, are of Cambrian age. In some of their features they bear quite as close a resemblance to the rock of Eo-Devonian age, so largely developed to the eastward of this point and to be presently noticed. The apparent total absence of fossils favours the former view, but, on the other hand, beds but little removed from those in question are almost certainly to be referred to the more recent of the systems named. These occur about 100 yards north of the railway bridge at Smith Cove, and embrace a large mass of very soft unctuous and friable slates or shales, of which the prevailing colour, at least upon the surface, is a deep brownish-red, with narrow bands of light and dark bluish-gray and greenish-gray colours. Their dip is well defined N. 10° W. $< 78^{\circ}$. They will be referred to again in connection with the consideration of the Devonian system.

Shores of Annapolis Basin.

On the shores of Annapolis Basin, between Grand and Little Joggins, are still other exposures of the black and striped slates of the Cambrian system. They show a succession of small folds dipping steeply to the eastward, and at one point include a three-foot bed of sandstone. At another bend they include a band of vesicular gray sandstone, in appearance not unlike some of the light-coloured traps of the North Mountain, but considerably metamorphosed. The slates, sometimes weathering to a light buff or red, are exposed for about a furlong north-west of the railway bridge, or to within a mile and a quarter of the town of Digby, where they become drift-covered.

Bear River.

It seems altogether probable that of the beds described in the above sections, some if not all extend to and are represented in the strata of the deep valley of Bear River. It is, however, certain that a large part of the beds exposed in that estuary, and more particularly about the head of tide-water, are much more recent, being abundantly filled with recognizable Lower Devonian fossils. The line of separa-

tion between the two sets of beds is a more difficult question, and cannot well be considered until the whole character and structure of the Devonian system, as seen to the eastward, has been described.

It may be of service to close this review of the Cambrian rocks of Yarmouth and Digby counties with a brief summary of the more important conclusions which are apparently deducible therefrom. Summary of conclusions.

1. The wide distribution of the Cambrian rocks in the counties named; no other stratified rocks, except a narrow belt of Siluro-Devonian beds and the Triassic traps and sandstones of Digby Neck, being found within their limits. Their total area within the counties named would probably not fall short of 1000 square miles.

2. The almost exact parallelism in the succession of the Cambrian beds, as seen on the Sissibou and in the section from Marshalltown to the Joggins, with that seen in parts of Queens and Lunenburg counties, a parallelism which is not only a general one, but descends to the minutest details.

3. The great thickness attained by the principal members of the Cambrian system, and the consequent great thickness of the whole system as developed in this region. Mr. W. H. Prest, from a series of careful measurements on the Sissibou, has estimated the aggregate thickness as high as 28,000 feet, but in view of the many possibilities of error among rocks so highly folded and faulted, it seems to the writer that the estimate is considerably too high.

4. The absence of any distinct break between the supposed Cambrian quartzites and slates of Digby county and the associated quartzites and slates of Devonian age, the foldings and metamorphism by which both have been affected having apparently been synchronous and therefore both Devonian or later.

5. The principal anticline or dome recognized in Digby county is that of Weymouth. The quartzite which marks its course can be readily traced from the head of St. Marys Bay (Marshalltown) southwesterly through Brighton and Plympton to Weymouth; and, west of Weymouth, along the line of the Dominion Atlantic Railway, and upon the south coast of St. Marys Bay to Saulnierville. The axis of the anticline is probably in the vicinity of Weymouth Bridge.

The greenish-gray and purple slates which succeed the quartzites curve around the eastern and southern edge of the latter. From a point a little east of the head of St. Marys Bay they run south over the higher part of Marshalltown Hill and are seen in the brook beyond. They then curve gradually around to the south-west and pass through

Course of
Cambrian
folds.

Bloomfield and North Range, reaching the Sissibou a quarter to one-half a mile below the mouth of Mistake River. Thence extending to the south-west they can be traced to the head-waters of Metaghan River, but here meet and fold around another quartzite dome (that of Metaghan) which thence extends to the head-waters of Salmon River, there to unite with another belt (that of Tusket) stretching east and west either side of Wentworth Lake. A minor belt of quartzite, bordered on either side by green slates, extends from near Metaghan station to the coast at the boundary line of Yarmouth county.

The blue and black slates which form the higher member of the Cambrian succession, beginning near Digby, are first seen near Jordantown and at the Grand Joggins, and can be traced south-westerly, with many contortions, up the Lee or Bingay Brook, striking the granite a little east of North Range. South-west of the granite tongue in the latter settlement and at Mistake Lake the course of the belt is resumed and this is again seen on the Sissibou for three miles above the mouth of Mistake River. South-west of the Sissibou it has been traced to the New Tusket and Weymouth road.

Age of Yar-
mouth rocks.

6. The approximate equivalency of the micaceous and hornblendic rocks of Yarmouth Harbour and their northward extension with the micaceous and staurolitic rocks of Shelburne county, and therefore with Division I. *b*, with possibly much or the whole of Division II. of the Cambrian system.

The essential correspondence of the rocks of Point Fourchu with those of the Pubnico Peninsula, the resemblance of the latter to the rocks of Jordan Bay and Shelburne Harbour, a resemblance which is repeated in that portion of the hornblendic belt which borders lakes Annis and Brazil, the equally marked resemblance, commented on by Dr. Selwyn, between the beds of Cranberry Point and those of Chebogue Point, clearly prove these beds to be parts of a single system; while their relations to the quartzites of the Tusket on the one hand and to those of Cranberry Head and Hectanooga on the other, as well as to the black slates of Carleton and Arcadia, show as clearly their place in that system. It may be added that the abundance of hornblende which constitutes the most conspicuous feature of this belt, and which has caused it to be referred by several authors to a Pre-Cambrian horizon, is largely confined to beds which appear to be of the nature of dykes. Further, the rocks of Division I. *b*, to which these rocks have been referred, are, even in Queens and Shelburne counties markedly chloritic, and the relative abundance of one or the other of these nearly related minerals may well be only an accident of meta-

morphism. The conglomerate character of the beds of Point Fourchu and of Pubnico may be only a local feature, but even this finds its counterpart in some of the beds, otherwise strongly resembling those of Pubnico, which occur on the shore of Port La Tour, in Shelburne county.

SILURIAN, DEVONIAN AND ASSOCIATED ROCKS.

GRANITES OF ANNAPOLIS COUNTY.

In tracing the northern margin of the central granitic axis, this has been described as crossing the boundary line between Digby and Annapolis counties not far south of the forks of Bear River. On the east branch of this stream the granites are finely exposed and their contact with Devonian quartzites well exhibited, about two miles above Bear River village. From this point the course of the granitic outcrops runs just south of the settlement of Greenland, and nearly parallel to the road extending from Bear River village to Cod Lake, until, near the latter, it curves more to the northward, and reaches the settlement of Virginia just north of the forks of the Virginia road. The next point to the eastward at which granites have been observed is on the post-road connecting the towns of Annapolis and Liverpool, but here the main body of the granite, of which the exposures above noted are a part, is separated from another considerable area of similar rock, forming the hills in the rear of Annapolis, by a band, about one mile wide, of fossiliferous Devonian rocks. It is believed that these two granitic areas become confluent just east of the highway referred to, as no other rock than granite was observed on the Dalhousie road, only two miles to the eastward, thus giving to the granite hills of Annapolis the character of a spur from the main body of these rocks. On the Liverpool road as well as on the Lequille stream, whose course is here nearly parallel to the latter, the width of the granite tongue is about four miles, and west of the Lequille varies from four to five miles, its border being subject to some fluctuations and not always exposed to view. Extending in the direction of Clementsport, it includes the settlements of Birchtown and Guinea, as well as all the high land between these and Annapolis Basin, but does not quite reach Clementsport, terminating just north of Guinea in the form of two minor tongues, separated by a bay-like flexure.

Distribution
of granite
from Bear
River to Liver-
pool road.

From the vicinity of the town of Annapolis eastward, the granites, rising rather abruptly from the Annapolis Valley, constitute the range of the South Mountains, the southern border of which, in and near Queens county, has already been traced. The northern border,

South Moun-
tain.

for a distance of about twenty-five miles, lies usually a little south of the more southerly of the highways traversing the length of the valley, (though occasionally, as at Round Hill, crossing this and reaching quite to the waters of Annapolis River), but just south of Lawrencetown this uniformity of outline ceases, another bay similar to that of Clementsport and Bear River, and similarly occupied by Devonian rocks breaks its continuity, and this bay is itself further diversified by projecting dykes and outlying isolated masses of granite, making the tracing of the geological boundaries a matter of some difficulty.

Williamston. Just south and west of Williamston, the hills close to the highway, seem to be wholly composed of granite; but just where this highway is met by that leading from Williamston to Inglesville, an abrupt change of direction occurs. The border of the granite recedes to the south and west until, gradually curving around at a distance of about three miles from its former position, it again extends easterly, thus inclosing the whole of the area occupied by west, middle and east Inglesville.

Inglesville. In West Inglesville the contact of the stratified (Silurian) rocks and the granite may be seen on the old Albany road, five miles south of Lawrencetown; but at Inglesville Centre a northward spur brings the rock up quite to the corner in the middle of the settlement, whence it again recedes, barely reaching the road from East Inglesville to Alpena, and not crossing the latter until within a mile of where the Alpena road crosses that leading to New Albany. From this point the course of the granite is nearly due east, until, at a distance of about two miles and a half, it reaches, in the upper part of Cleveland,

Cleveland. the valley of the Nictaux River and the line of the Nova Scotia Central Railway. Here, however, in addition to the main body of the granite referred to above, a belt of similar rock, rather less than a mile in width and separated from the former by a band of slates of nearly similar width, is brought to view, and from the valley of the river and railway stretches for some distance, both east and west. In the latter direction, the country being thickly wooded, its limits have not been fully made out, but from the occurrence of granitic outcrops on the road from Nictaux Falls to East Inglesville, it is thought that the belt may be continuous with the latter.

Jones Brook. To the north of this latter road, and in the same general direction, a considerable mass of granite comes into view between Jones Brook and the Albany Road, (being traversed between these points, for a distance of about two miles, by the road connecting Williamston with Nictaux Falls), but this mass is certainly isolated, as between it and the granite belt described above in Cleveland, dark quartzites and diorites of the Devonian system have been found to intervene. On the other hand

the Cleveland belt, crossing the Nictaux River at and below its forks, is doubtless connected with similar rocks holding a like position and relations in the settlement of Bloomington, beyond which they have not been followed. Finally, granite veins and masses of various dimensions are found penetrating Silurian slates on the summit of the hills just west of Nictaux Falls.

In the several areas above described, including the settlements of Inglesville, Nictaux, Cleveland and Bloomington, is to be noticed the frequent occurrence in connection with the granite of masses of coarsely crystalline diorite. It is true that such masses are frequently found as dykes penetrating Devonian slates or quartzites, but they invariably increase as the granite is approached, and in many places seem to graduate into or to replace the latter. The contacts of both with the sedimentary rocks are often very intricate and present many features of interest, but these can best be noticed in connection with the Devonian rocks which the granites invade. Diorites.

Of the enormous areas of granite which occupy the larger part of the county of Annapolis, and whose borders, both on the north and south, have been described in preceding pages, but little is at present known, the work of exploration having been hitherto confined almost wholly to those borders and to the adjacent rocks of Cambrian or Devonian age. It is, however, known that at least one area of quartzites is included within the area usually assigned to the granites, and it is possible that others may exist as well. On the line of the Nova Scotia Central Railway, granite appears to be the only rock exposed between Alpena Station and Springfield; it is exposed almost continuously on the Roxbury road, south of Paradise, to and beyond Roxbury settlement; it is similarly found on the Morse or Bloody Creek Road, south of Bridgetown; and finally, on the Annapolis and Liverpool road, it is, with the exception of the small area of fossiliferous quartzites four miles south of Annapolis, the only rock seen as far as the settlement of Maitland, a few miles north of the northern boundary of Queens county. Interior of
Annapolis
county.

SILURO-DEVONIAN ROCKS OF DIGBY AND ANNAPOLIS COUNTIES.

Earlier Investigations.

The occurrence of rocks of Silurian or Devonian age, or both, at various points along the northern slopes of the central granite axis of the Nova Scotian peninsula has been long known, while these have also been made the subject of study and discussion by various writers.

Among the observations thus made those of Sir J. Wm. Dawson are not only the earliest but the most important, and some knowledge of their Early observa-
tions.

substance is a necessary prelude to the right understanding of the later work done in the region.

In a paper on the Silurian and Devonian rocks of Nova Scotia (Canadian Naturalist, April, 1860) Sir J. Wm. Dawson says:—

Beech Hill
beds.

“The oldest fossiliferous beds seen [at New Canaan] are the fine fawn coloured and gray clay slates of Beech Hill, in which Dr. Webster, many years since, found a beautiful *Dictyonema*, the only fossil they have hitherto afforded. It is a new species, closely allied to *D. retiformis* and *D. gracilis* of Hall, and will be described by that palæontologist under the name of *D. Websteri* in honour of its discoverer. In the meantime I may merely state that it is most readily characterized by the form of the cellules, which are very distinctly marked in the manner of *Graptolithus*.”

Dictyonema
slates.

“The *Dictyonema* slates of Beech Hill are of great thickness, but have in their upper part some hard and coarse beds. They are succeeded to the south by a great series of dark-coloured coarse slates, often micaceous, and in some places constituting a slate conglomerate, containing small fragments of older slates, and occasionally pebbles of a gray vesicular rock, apparently a trachyte. In some parts of this series there are bands of a coarse laminated magnesian and ferruginous limestone, containing fossils which, though much distorted, are in parts still distinguishable. They consist of joints of crinoids, casts of brachiopodous shells, trilobites and corals. Among the latter are two species of *Astrocerium*, not distinguishable from *A. pyriforme* and *venustum* of the Niagara group, and a *Heliolites* allied to *H. elegans*, if not a variety of this species. On the evidence of these fossils and the more obscure remains associated with them, Prof. Hall regards these beds as equivalents of the Niagara formation of the New York geologists, the Wenlock of Murchison. Their general strike is north-east and south-west; and to the southward, or in the probable direction of the dip, they are succeeded, about six miles from Beech Hill, by granite. They have in general a slaty structure coinciding with the strike but not with the dip of the beds, and this condition is very prevalent throughout this inland metamorphic district, where also the principal mineral veins usually run with the strike. The beds just described run with south-west strike for a considerable distance, and are succeeded in ascending order by those next to be described.” * * *

Nictaux.

“At Nictaux, twenty miles westward of New Canaan, the first old rocks that are seen to emerge from beneath the New Red Sandstones of the low country, are fine-grained slates, which I believe to be a continuation of the *Dictyonema* slates of Beech Hill. Their strike is N.

30° to 60° E., and their dip to the south-east at an angle of 72°. Interstratified with these are hard and coarse beds, some of them having a trappean aspect. In following these rocks to the south-east or in ascending order, they assume the aspect of the New Canaan beds; but I could find no fossils except in loose pieces of coarse limestone, and these have the aspect rather of the Arisaig series than of that of New Canaan. In these and in some specimens recently obtained from Mr. Hartt, I observe *Orthoceras elegantulum*, *Bucania trilobata*, *Cornulites flexuosus*, *Spirifera rugacosta?* and apparently *Chonetes Nova-Scotica*, with a large *Orthoceras*, and several other shells not as yet seen elsewhere. These fossils appear to indicate that there is in this region a continuance of some of the upper Arisaig species nearly to the base of the Devonian rocks next to be noticed.

"After a space of nearly a mile, which may represent a great thickness of unseen beds, we reach a band of highly fossiliferous peroxide of iron, with dark-coloured coarse slates, dipping S. 30° E. at a very high angle. The iron ore is from three to four and a half feet in thickness, and resembles that of the East River of Pictou, except in containing less silicious matter. The fossils of this ironstone and the accompanying beds, so far as they can be identified, are *Spirifer arenosus*,* *Strophodonta magnifica*, *Atrypa unguiformis* [now known as *Orthis hippariorynx*], *Strophomena depressa* [now known usually as *S. rhomboidalis*] and species of *Avicula*, *Bellerophon*, *Favosites*, *Zaphrentis*, &c. These Prof. Hall compares with the fauna of the Oriskany sandstone; and they seem to give indubitable testimony that the Nictaux iron ore is of Lower Devonian age.

"To the southward of the ore, the country exhibits a succession of ridges of slate holding similar fossils, and probably representing a thick series of Devonian beds, though it is quite possible that some of them may be repeated by faults or folds. Farther to the south these slates are associated with bands of crystalline greenstone and quartz rock, and are then interrupted by a great mass of white granite, which extends far into the interior and separates these beds from the similar, but non-fossiliferous rocks on the inner side of the metamorphic band of the Atlantic coast. The Devonian beds appear to dip into the granite, which is intrusive and alters the slates near the junction into gneissoid rock holding garnets. The granite sends veins into the slates, and near the junction contains numerous angular fragments of altered slate.

* Also another and smaller *Spirifer*, believed to be new and eminently characteristic of the Nictaux deposits, to which the provisional name of *S. Nictavensis* was assigned.

West Nictaux

"Westward of the Nictaux River, the granite abruptly crosses the line of strike of the slates, and extends quite to their northern border, cutting them off in the manner of a huge dyke, from their continuation about ten miles further westward. The beds of slate in running against this great dyke of granite, change in strike from south-west to west, near the junction, and become slightly contorted and altered into gneiss, and filled with granite veins; but in some places they retain traces of their fossils to within 200 yards of the granite. The intrusion of this great mass of granite without material disturbance of the strike of the slates, conveys the impression that it has melted quietly through the stratified deposits, or that these have been locally crystallized into granite *in situ*.

Moose River.

"At Moose River, the iron ore and its associated beds recur on the western side of the granite before mentioned, but in a state of greater metamorphism than at Nictaux. The iron is here in the state of magnetic ore, but still holds fossil shells of the same species with those of Nictaux.

Bear River.

"On Bear River, near the bridge by which the main road crosses it, beds equivalent to those of Nictaux occur with a profusion of fossils. The iron ore is not seen, but there are highly fossiliferous slates and coarse arenaceous limestone, and a bed of gray sandstone with numerous indistinct impressions apparently of plants. In addition to several of the fossils found at Nictaux, these beds afford *Tentaculites*, an *Atrypa*, apparently identical with an undescribed species very characteristic of the Devonian sandstones of Gaspé [this is now known as *Leptocoelia flabellites*], and a coral which Mr. Billings identifies with the *Pleurodictyum problematicum*, Goldfuss, a form which occurs in the Lower Devonian in England, and on the continent of Europe."

Fossils.

This description, than which, as regards the general features of the region, no more admirable one could be given, was subsequently represented, in nearly the same form, in the second edition of *Acadian Geology*, 1868. Eleven years later,* in reply to certain criticisms of Dr. Honeyman, Sir Wm. Dawson again states the observations above quoted, and in a summary of results states that he has recognized, on the evidence of stratigraphy and fossils, in the district extending from New Canaan to Bear River, the following groups of rocks:—

Summary by
Sir Wm. Dawson,
1879.

- I. The Niagara series, the Wenlock of English geologists, represented by the *Dictyonema* shales and coral-bearing rocks of New Canaan.

* Remarks on Recent Papers on the Geology of Nova Scotia (Nova Scotian Institute of Natural Science, February, 1879.

This group may be called either Middle or Upper Silurian, according to different classifications in use.

2. The Upper Arisaig series (of Dawson, not of Honeyman,) the equivalent of the Lower Helderberg series of America, the Ludlow of England.
3. The Oriskany series, represented by iron ores, sandstones or slates.

At the same time a list of sixteen species is given of forms found in the Moose River and Bear River beds of which the greater part were either characteristically Oriskany types or very nearly related to well-known Oriskany species.

In 1892 a collection of fossils from Nictaux, Bear River and Mistake settlement was made by the writer and Mr. W.H. Prest, and tended to confirm the conclusions of Sir Wm. Dawson, so far at least as regards the beds of Nictaux and Bear River. They were examined by Dr. H. M. Ami, who states,* as to the two former points at least, that the beds are transitional, being either at the summit of the Silurian or at the base of the Devonian epoch, the weight of evidence being perhaps in favour of the Eo-Devonian. The fossils from Mistake Settlement indicate a Silurian tract.

Collections in
1892.

The latest reference to this region are contained in the Proceedings and Transactions of the Nova Scotian Institute of Science, Vol. IX., Part I., 1896, in the form of an article by Dr. Gilpin, Inspector of Mines, on the iron ores of Nictaux, chiefly as viewed from an economic standpoint, and a brief description of the geology of the region by Dr. A. H. MacKay. The existence of Silurian as well as Devonian rocks is assumed, but apparently only on the authority of earlier writers upon the subject.

Observations
by Gilpin and
MacKay.

It now remains to see how far these views are likely to be affected by the observations of the writer.

Recent Investigations.

Nictaux-Torbrook Basin.

As the district about the Nictaux River and eastward to Torbrook has afforded the most satisfactory data, it may be first considered.

In ascending the Nictaux River the first rocks disclosed to view, near an old mill-dam a quarter of a mile below the falls, are well-stratified dark-gray sandstones or quartzites, more or less banded, and dipping S. 10° E. < 60°. Similar beds form the hills overlooking the village

Nictaux River
section.

*Dr. H. M. Ami, in Report (by L. W. Bailey) on South-western Nova Scotia, Vol. VI., Part Q, 1892-93, p. 14.

Quartzites. of Nictaux from its western side, in which direction, as will be presently more fully noticed, they have been traced to the settlement of Inglesville. They have as yet failed to yield any fossils, but as, in the hills referred to, they are penetrated by dykes of diorite, as well as by veins of granite, these are, perhaps, hardly to be expected. Their position, however, as will presently appear, is such as to indicate not only that they are the lowest beds of the series here represented, but mark the northern side of a great syncline, of which the northern side is several miles to the southward, near the granite hills.

Slates. Next above the quartzites just referred to and occupying the interval between the latter and the falls, or a space across the measures of about 700 feet, the rocks and slates are well exposed in the river and dipping as before. These slates are glossy, mostly gray in colour but sometimes with greenish shadings, and, more commonly, with reddish surface stainings of oxide of iron, a feature in which they resemble the ribboned beds of Deep Brook in the Clements Basin. Similar strata occur also at the falls, and with more conspicuous fibbonding, while, through metamorphism, they sometimes assume a gneissic aspect or are more or less chloritic. The dip remains as above.

Silicious slates. Ascending the railway track, the next beds exposed, about a quarter of a mile above the station, are very hard and silicious gray slates, with heavy dykes of diorite, closely followed by dark-gray fissile slates of which the surfaces are marked by a network of fine lines, evidences of incipient crystallization. The dip, as before, is S. 10° E. < 40°. Some gray quartzites also occur here, with diorite dykes holding much chlorite and some copper sulphide.

Diorite dykes. At a culvert a quarter of a mile above the station, the beds exposed are partly coarse-gray, light-weathering slates, with shades of red and purple, and partly black slates, the one passing into the other not only laterally but on the line of strike. The beds are evidently much affected by diorite dykes, but the general dip remains unchanged. Some of the dark slates in this part of the section show branching fucoidal (?) markings, but no recognizable fossils were obtained.

About a quarter of a mile south of the culvert are other coarse, dark gray slates, but the dip is now reversed, or N. 20° E. < 60°. This change is, however, only local, and apparently connected with the occurrence of a diorite dyke, about 100 feet broad, which is here exposed, and beyond which the southerly dip, S. 10° E. < 60°, is again resumed.

The above-described beds are not far from where the river and railway make a long and deep curve to the westward, at the inner end of which the beds are again dark-gray slates of which the surfaces are stained with red oxide of iron or marked by numerous minute black crystals. These beds are not unlike those of Nictaux Falls, and also resemble the beds of the Torbrook iron mines, a resemblance which is the more important as at this point on the Nictaux, beds of hematite are known to occur, and were formerly mined to a limited extent. They also probably mark approximately the centre of the syncline, for the dip is here again to the northward (N. 10° W. $< 60^{\circ}$) and continues to be northerly through the remainder of the section. Iron ores.

In accordance with the view last suggested, the beds which are exposed to the southward of those described above differ from the latter but little in aspect, being probably the same beds reversed. They differ, however, in one respect, *viz.*: that they are here abundantly fossiliferous, even where, as before, minute crystals on the surfaces show evidences of metamorphism. The fossils include many very large and coarse-ribbed shells, as well as some very finely ribbed, but all are difficult of removal. The width of these black fossiliferous slates is about a furlong—beyond which, after an interval of another furlong, are beds of hard, dark-gray, altered sandstone, with which are bands of black hematitic rock, resembling the beds to be presently noticed as occurring at Wheelock's iron mine, a few miles to the eastward, on the eastern side of the river. The dip at this point, which is three miles and three-quarters north of Alpena station, is N. 5° W. $< 80^{\circ}$ to 90° . Reversal of dip.
Fossils.

For nearly a quarter of a mile beyond and south of the above exposures, the railway track runs on the course of the nearly vertical beds, which, on either side, are dark, rusty and sandy slates, with white quartzose beds, holding ribbed shells and corals. The paler bandings which are very variable in length and thickness, are conspicuously contrasted with the dark lilac-coloured mass of the rock through which they are distributed, and at one point, for a distance of about 100 feet, wholly replace the darker beds, apparently along a line of fault. By similar faults these are in turn abruptly replaced by dark flinty and rubbly beds, the dip throughout being nearly vertical. The whitish beds, as well as the darker, have calcareous surfaces showing corals and shells. The cuttings showing the above features are at or near the No. 12 mile-post, or three miles from Alpena. A furlong beyond this post, the interval being without exposures, there are outcrops of granite. No. 12 mile-post.

First granites. The granitic exposures last referred to are a portion of the belt, described in previous pages, which is, on the Nictaux River as well as for several miles either side of it, separated from the main body of such rocks by an intervening belt of stratified beds. The width of the granite belt as exposed is about half a mile, when, after a furlong without exposures, is a heavy railway cutting, in black coarse-grained but compact and flinty slates, in which fossils may now and then be found. The length of cutting is over 1000 feet, but largely on the course of the beds, of which the dip varies from N. 10° E. < 90° to N. < 90°. Half a mile beyond this cutting the main body of the granite is reached.

Slates

Main granites.

Fossils.

The following fossils, determined by Dr. H. M. Ami, were obtained from the railway sections above described, mostly from the light-coloured beds about the No. 12 mile-post:—

1. *Palæophycus* (?) sp. indt. Very obscure fucoidal remains.
2. *Zaphrentis* or *Streptelasma*, sp. indt. ●
3. *Orthis* sp. Very large form, with very numerous and fine thread-like radiating costæ, recalling the species described by Hall as *O. deformis*.
- 4, 5, 6. Obscure remains of lamellibranchiate bivalve shells, probably referable to the genera *Goniophora*, *Cypricardinia* and *Modiolopsis*.

In addition to the above, the black indurated siliceous slates near the culvert, half a mile above Nictaux station, yielded a specimen of a *Bythotrephis*.

In a collection made by Dr. A. H. MacKay, and labelled "Railway near Cleveland, Nictaux, N.S., Oct. 25, 1894," were found large crushed species of *Spirifer*, too imperfect for determination, and a *Bellerophon* or *Bucania*-like gasteropod. The rocks containing these are described as being partly micaceous and arenaceous slates, and partly light yellowish-gray and greenish cherty limestones (?). They are probably the beds near the No. 12 mile-post.

Torbrook section.

About five miles east of the above section, on the Nictaux River, the valley of the Torbrook stream, in connection with one of its tributaries, affords a parallel section, which still further tends to throw light upon the structure of the whole region under review.

As in the Nictaux section, the structure appears to be synclinal, and here, as there, the lowest beds exposed are quartzites or hard sandstones. These latter are the first rocks seen to the south of the flat sandy beds of the Annapolis valley, about a mile north-east of the Torbrook mines, and in some of the beds could hardly be distinguished

from the hardest and most compact quartzites of the Cambrian system. They have, however, a pale, pinkish tint, some times becoming almost red (though weathering white), which is peculiar, and in addition contain, here and there, beds charged with fossils, which remove all uncertainty as to their true position. In collections made in these sandstones by the author of this report, Dr. Ami has identified the following species:—

1. Crinoidal fragments. Impressions of large columns. Fossils
2. Branching *Monticuliporidae*.
3. *Stropheodonta* sp. cf. *S. Beckei*, Hall.
4. *Stropheodonta*, sp. cf. *S. Blainvillei*, Billings.
5. *Orthis* sp. cf. *O. (Rhipidomella) oblata*, Hall.
6. *Orthis* sp. cf. *O. (Rhipidomella) circulus*, Hall.
7. *Trematospira (Rhynchospira) formosa*.
8. *Rhynchotreta* sp. cf. *R. cuneata*, Dalman.
9. *Rhynchonella pyramidata*, Hall.
10. *Rensselaeria (Beachia) Suessana*, Hall.
11. *Meristella arcuata*, Hall.
12. *Merista lata?* Hall.
13. *Spirifer tribulis*, Hall.
14. *Spirifer* sp. cf. *S. lamellosus*, Hall. Or *S. Nictavensis*, Dn.
15. *Amphigenia*. sp.
16. *Pterinea*, sp. indt. type of *P. macerata*.
17. *Pteronitella*, sp. indt.

Dr. Ami remarks that the above fossils appear to indicate an horizon Age. at the extreme summit of the Silurian system, or possibly at the base of the Devonian. They are for the most part preserved as casts of the interior, and present some very interesting features from a biological as well as a palæontological standpoint.

Immediately succeeding, to the south-west, the pink and red sandstones or quartzites noticed above, is a series of beds of widely different character. These consist of bright red shales or slates which, for about a furlong, form a series of bluffs on the left bank of the stream or show in ledges in its bed. These red rocks are partly coarse and sandy, partly fine and fissile, while they also contain layers which, both by their dark colour and by their weight, reveal the presence of iron or manganese, or both. A small bed of hæmatite has indeed been laid bare here, and the series as a whole is no doubt an extension, on the Red slates

line of strike, of the strata of the Torbrook mines, but while the latter, so far as known to the writer, have yielded no fossils, these abound in the former, the coarse beds showing many large *Spiriferas*, while the finer or more shaly beds abound in smaller brachiopods and crinoid stems.

Fossils.

From collections made here by the writer (1896), Dr. Ami has obtained the following forms:—

1. *Stropheodonta* sp. cf. *S. varistriata*. Conrad. Placed in the subgenus *Brachyprion* by Hall and Clarke.
2. *Stropheodonta* sp. Pedicle valve of a species showing the mode of intercalation of ~~costæ~~ along the anterior margin. There are about 40 ~~costæ~~ or striations, which are fainter along the posterior portion of the shell.
3. Obscure and imperfect impressions of what appears to be a large *Orthis*, of the type of *O. eminens* and *O. oblata*, referable to the subgenus *Rhipidomella*.
4. *Spirifer* sp., with large and rugose costæ cf. *S. rugæcostus* and *S. Nictavensis*, &c.
5. *Spirifer* sp. indt. cf. *S. arrectus*. Hall.

The dip of the beds is nearly vertical, but usually with a southward inclination (S. 10° E. < 80°.)

The section above described is included between the road running east from Meadowvale, where this is crossed by the main stream of the Torbrook, and the nearly parallel road running north-east from the corner near the Torbrook mines. Between the latter and a third parallel road south of the last, the Torbrook is joined by a tributary from the south-east, by which the same section is continued and completed.

As seen in the road and ravine between the two thoroughfares last referred to, the rocks are much like those which have been described above, consisting largely of red shales, with some red sandstones, but with these are also many black slates (the latter becoming more predominant as the stream is ascended), while the dip, though still high, is now to the northward, making probably the southern side of a synclinal fold. In connection with these slates, though not observed in the stream itself, is a bed of magnetite.

To the south of the roadway last referred to, which is intersected by the Torbrook tributary near the school-house, about a mile and

a half east of Torbrook Centre, we have not directly ascended this brook, but at about the same distance to the eastward and near the county line of Kings, a road running southward and known as the McGinty road, crosses the same tract and with numerous exposures completes the section in this direction. McGinty road.

Between the school and the corner of the McGinty road, the road running east from Torbrook crosses obliquely a series of slates and sandstones, in connection with which, but a little north and east of the junction with the McGinty road, is the Messenger mine, containing a six-foot bed of hematite, that was mined to a depth of ninety feet, the ore being similar to that of Torbrook. Other sandy beds, which are more or less hematitic, occur on the McGinty road, but as these are followed southward they become more massive and more crystalline, assuming first the aspect of quartzites and then that of coarse gneisses. This change invariably indicates an approach to granite, and accordingly this rock begins to make its appearance about a mile southward of the Torbrook road, at first in the form of small veins and later in larger masses, until eventually, at a distance of about two miles from the road last named, the only rocks seen are granites, associated with dark green crystalline hornblendic rocks, which are obscurely stratified. The attitude of the beds along the McGinty road is very variable, especially near their contacts with the granite, where in places may be seen the most complicated twists, but where most regular, the dip is northerly at an angle of about 70° . Messenger mine.
Granite.

We may now notice some of the exposures to be seen in the area intervening between the two parallel sections above described, those of Torbrook and Nictaux, and which help to connect the one with the other.

Commencing at Nictaux, the roads which, from the Falls, ascend the eastern side of the river, show little beyond beds of coarse diorite, the best exposures being upon the older and now little used of these two thoroughfares. On the summit of the hill, however, where these roads unite with those leading eastward to Torbrook, and southward to Bloomington, dark coloured slates are exposed and are to some extent fossiliferous. Southward of this point, on the Bloomington road, similar slates and dark lilac-gray sandstones are found as far as the forks of the road about a mile north-west of Armstrong's mill on the Torbrook stream, and about midway between these two points have yielded the following fossils:— East Nictaux.
Bloomington.
Fossils.

1. *Favosites*, sp.
2. *Zaphrentis*, sp., allied to *Z. rugatula*, Billings.

3. *Zaphrentis*, sp. indt.
4. *Polypora*, cf. *P. Psyche*, Billings.
5. *Leptaena rhomboidalis*, Wilckens.
6. *Orthis* (*Rhipidomella*?) *Lucia* (?), Billings.
7. *Spirifer*, cf. *S. cyclopterus*, Hall.
8. *Athyris*, or *Meristella*, sp. indt.
9. *Actinopteria*, cf. *A. textilis*, Hall.

The horizon indicated, according to Dr. Ami, is about the summit of the Silurian.

Quartzite. All of these beds are evidently the continuation of those described above on the Nova Scotia Central Railway, in the upper part of the Nictaux valley, and like them dip northerly. At Armstrong's mill are good exposures of rather fine, dark-gray quartzites, with some slate, dipping regularly N. < 70°. Just south of this point is a considerable ridge separating the two branches of the Torbrook, but here quartzites are gradually replaced by granites, the two being at first confusedly intermixed, but subsequently with granite predominant. This granite
Granite. belt is evidently an extension of the one-mile belt described on the railway section, and like the latter is followed southward by another small belt of stratified rocks, consisting first of quartzites of dark-gray colour, and then of slates, dipping S. 10° E. < 90°. The occurrence at the same point of many boulders of fine, pink, white-weathering quartzite, similar to that near the Torbrook mines, as well as to beds to be presently described at Inglesville, west of Nictaux, is very interesting, as bearing upon the general structure of the region, but the beds from which they were derived are concealed from view.

In connection with the above observations, it will be of interest to give here the results of collections of fossils made in the same vicinity by other geologists, who have courteously placed these collections at the disposal of the Survey.

Collections of
Fletcher and
MacKay 1894.

The following forms were obtained by Mr. Hugh Fletcher and Dr. A. H. MacKay from the Bloomington road (not far north of the school-house) 25th October, 1894 :—

1. *Streptelasma* or *Zaphrentis*, sp.
2. *Monticuliporida*, sp.
3. *Orthis* (*Rhipidomella*) sp., cf. *O. oblata*, Hall.
4. *Orthis*, cf. *O. (Dalmanella) perelegans*, or a closely related species.
5. *Orthis* (??) sp.
6. *Spirifer*, sp., cf. *S. Nictavensis*, Dawson.

7. *Spirifer*, cf. *S. macropleura*, Hall.
8. *Pterinea*, sp.
9. " sp., cf. *P. textilis*. Hall.
10. Eye of *Dalmanites* or other genus of trilobite.
11. *Orthis multistriata*, or an allied species.

The collection is regarded by Dr. Ami as probably near the summit of the Silurian, but contains no typical species.

Through the kindness of Sir J. Wm. Dawson, the interesting collections made by him in the Nictaux district, and now in the Peter Redpath Museum, Montreal, have been re-examined by Dr. Ami, and are referred in part to the Silurian and in part to the Lower Devonian.

Collections of
Sir J. Wm.
Dawson.

I.—The following are classified as Devonian :—

1. Crinoidal fragments.
2. *Favosites*, sp. [1926]* Devonian.
3. *Zaphrentis*, sp.
4. *Pleurodictyum problematicum*. [1925]
5. *Stenopora*, sp.
6. *Leptostrophia magnifica*, Hall. [1912]
7. *Leptaena rhomboidalis*, Wilckens.
8. *Orthis Hipparionyx* (= *H. proximus*, Vanuxem. [1906])
9. *Spirifer arenosus*. Conrad. [1910, 1916, 1917]
10. " *Nictavensis*. [1922]
11. " *arrectus*.
12. " cf. *S. perlamellosus*.
13. " indt.
14. *Rensselaeria ovoides*. [1911]
15. *Leptocalia flabellites*. [1913]
16. *Actinopteria*, cf. *A. textilis*. [1901]
17. *Megambonia* (?) *lamellosa*. [1893]
18. *Tentaculites arenosus*. [1900]
19. *Bellerophon*, sp. [1902]
20. *Bucania*, sp. [1905]
21. *Orthoceras*, sp. indt.
22. *Homalonotus*, sp. [1899]

The horizon indicated is probably equivalent to the Lower Oriskany, or base of the Devonian system, the Eo-Devonian of the classification of Prof. H. S. Williams.

* The numbers inclosed in brackets correspond to the numbers on the specimens in the Peter Redpath Museum.

Silurian.

II.—The following are referred to the Silurian, and are described as “fossils from the Nictaux” limestones” :—

1. Crinoidal fragments.
2. *Stenopora*. A very small fragment of what appears to have been a branching or ramose bryozoary.
3. *Chonetes* (?) sp. A small *Chonetes*-like brachiopod, which, however, does not show all the characters of *Chonetes*.
4. The above form (*Chonetes*) is associated with an obscure *Rhynchonella*.
5. *Bellerophon*, sp., allied to *B. plenus*, but not determinable.
6. *Pleurotomaria Arisaigensis*. This is a low-spined gasteropod, preserved as the cast of the shell. No band nor impression of the band is visible. Volutions four. Possibly a *Pleurotomaria*, but resembles some of the Guelph Cyclonemas.
7. *Murchisonia*, sp., very nearly related to *M. Arisaigensis*, Hall.
8. *Murchisonia aciculata*, Hall. Five volutions preserved, a very small form.
9. *Megambonia*, sp. very obscure.
10. *Goniophora*, sp. indt.
11. *Orthoceras*, sp. Two specimens, one preserved as a cast, the other as a mould. Both are clearly allied to *Orthoceras rigidum* Hall. One specimen—the larger, and about five inches and a half in length—shows some fifteen septa in the space of five inches.

The precise localities within the somewhat extensive area known as “Nictaux” from which the above fossils, both those referred to the base of the Devonian and those regarded as Silurian, have been obtained, are not known to the writer of the present report. The only beds exposed in the railway section on the Nictaux River which at all approach the character of limestones are the light-coloured beds near the 12th mile-post, and these, though calcareous, are very impure and cherty. Between this section and Inglesville, however, to the west of the Nictaux River, somewhat more distinct limestones do occur, which will be presently noticed.

Geological
Survey collec-
tions.

In the Geological Survey collections, and not included in those already noticed, is the following small group, labelled “Nictaux, Nova Scotia” but the precise locality and collector are not known.

1. *Eatonia*, sp.
2. *Spirifer arenosus*, Conrad.

3. *Spirifer*, sp., cf. *S. arrecta*, Hall.
4. *Megambonia*, sp.
5. *Tentaculites*, sp., cf. *T. arenosus*, Hall. This is probably only a variety of *Tentaculites elongatus*, Hall.

Horizon, probably Lower Oriskany or Eo-Devonian.

The following collection (marked No. 12, between Bloomington School and Nictaux River, Annapolis Co. was made by Dr. A. H. MacKAY, 25th October, 1894. Collection of
Dr. MacKAY,
1894.

1. Coral, too imperfect for identification.
2. *Monticuliporidae*, sp.
3. *Orthis (Rhipidomella)* cf. *R. oblata*.
4. *Spirifer*, sp. A large coarsely ribbed variety, crushed and twisted by pressure.
5. *Spirifer*, sp. Too imperfect for determination.
6. *Stropheodonta* (?) sp.
7. (?) *Pentamerus (Anastrophia) Verneuilli*, Hall.
8. *Renssellaeria* (?) sp. Very imperfectly preserved.
9. *Tentaculites* (?) sp. Too imperfect for identification. Horizon, probably summit of Silurian system.

Returning to the forks of the Bloomington road with that leading east to Torbrook, we come, at a distance of three-fourths of a mile from the corner, to what is probably the most interesting locality in the whole region, the Wheelock mine. This interest arises partly from the nature of the ore here found, and partly from the number and preservation of the organic remains of which it is the repository. The ore-bed, Fletcher Wheelock's, is about five feet in thickness, and has been trenched on its course for a distance of 200 yards or more, the material removed being partly hæmatite and partly magnetite, but mostly the latter. It is locally known as "shell ore," a name suggested by the great number of fossil shells found on the bedding planes, and which, by the retention of much of the lime of which they were originally constituted, are still nearly white, and thus in contrast with the black rock in which they are imbedded. From collections made here by the author of this report, Dr. Ami has noted the following species:— Wheelock
mine.
Collections of
L. W. Bailey,
1897.

1. Branching *Monticuliporoid*. Gen. and sp. indt.
2. *Fenestella*, sp.
3. *Stropheodonta*, sp., cf. *S. varistriata*. Conrad.
4. " , sp. indt., possibly an *Orthothetes*.
- 4a. " , sp., cf. *S. perplana*, H.

5. *Orthis (Rhipidomella) oblata*, Hall.
6. " " sp. indt. Large crushed and distorted species.
7. *Rhynchotrema (?)* sp.
8. *Leptocælia*, sp. Crushed individual.
9. *Spirifer concinnus*, Hall.
10. " *arenosus*, Conrad.
11. " sp. cf. *S. arrectus*, Hall.
12. " sp. cf. *S. cyclopterus*, Hall.
13. *Pentamerus*, sp. Dorsal valve of an imperfect individual.
14. *Sieberella galeata*, Dalman. (= *Pentamerus galeatus*, Dalman.)
15. *Amphigenia (?)* or *Newberria*, sp., too imperfect for determination.
16. *Tentaculites elongatus*, Hall.
17. *Bucania*, sp., allied to *B. profunda*, Conrad.
18. *Megambonia*, sp. nov.
19. " sp., cf. *M. aviculoidea*.
20. *Cypricardinia* sp., large species.
21. Trilobite remains, too imperfect for identification.
22. Fish spine allied to *Macheracanthus*, sp.

This collection appears to be somewhat transitional in facies.

Age.

From the same vicinity the following were obtained (October, 1894) by Mr. Fletcher and Dr. MacKay.

Collections of
Fletcher and
MacKay, 1894.

1. *Monticuliporida*, Undeterminable.
2. *Spirifer* sp., too imperfect for identification.
3. " sp., resembling *S. Niagarensis*, Hall.
4. *Bellerophon* (or *Bucania*) sp., not unlike the species found in the red shales of Sunny Brae, East River, Pictou Co., N.S.
5. *Platyceras*, sp., cf. *P. sinuatum*, H.
6. *Murchisonia*, sp. A short-spined species with concave portion on upper part of volutions.

Collections of
T. C. Weston,
1879.

To the above lists may be added species obtained by Mr. T. C. Weston in 1879. These include the following, contained in two slabs of rock, one of which consists of a brownish-weathering light-coloured sand-rock, with fossils preserved as casts of the interior; the other a low-grade iron ore or hæmatitic sand-rock with casts of the exterior of *Spirifera*, etc. These slabs are numbered (a) and (b) respectively, and present the following assemblage of Eo-Devonian forms:—

- (a.) 1. *Stropheodonta*, cf. *S. Blainvillei*, Billings.
2. *Leptostrophia magnifica*, Hall.

3. *Schizophoria*, sp., cf. *S. multistriata*, Hall.
4. *Hipparionyx proximus*. Vanuxem.
5. *Rhynchotrema* sp. indt., cf. *R. formosa*, Hall.
6. *Leptocelia* (?) sp.
7. *Renssellaeria*, sp.
8. *Cyrtina* ? sp. indt.
9. *Spirifer*, cf. *S. duodenarius*, Hall.
10. " cf. *S. arrecta*, Hall.
11. " sp.

(b.) 1. *Spirifer Nictavensis*, Dawson.

The course of the beds at the Wheelock mine is about N. 65° E., the dip being nearly vertical, and this course, if continued, would, in a westerly direction, connect them with the similar ore-beds of Cleveland, as to the eastward it would make them continuous with the hæmatites of the Torbrook mines. On this supposition, if confirmed, the ore-beds of the Wheelock mine would, like those of Torbrook, occupy a low position in the series of rocks here represented, while the section on the Nictaux would mostly represent a syncline to the westward or north-westward of that of Torbrook. Neither the red slates nor the pale quartzites of the latter have, however, been observed here, and it is probable that careful instrumental surveys of the whole region will be required before correlation of its beds can be fully made out.

It only remains to notice here the rocks of the Torbrook mines and of the tract lying south-east of the latter. The ore-bed at the mines is at the surface about six feet wide, increasing, however, below to a width of eleven feet, and is wholly hæmatite, of deep red colour, soiling the fingers, and with a tendency to break into rhomboidal blocks. There is no magnetite. There are also no fossils, although at a point only sixty feet removed from beds that continue those of the mines, are beds of "shell ore" abounding in fossils. The dip of the beds is southerly, but, while nearly vertical at the surface, is found, at a depth of 280 feet, to have so far declined as to allow of walking on the foot-wall. The bed is then cut off by a fault. Further facts as to the nature of the ore and the operations here carried on will be found in the sequel. The rocks bordering the hæmatites on either side are gray and red shales, similar to those exposed in the bluffs on the Torbrook stream a mile or so to the northward, and which, between the two are also exposed on the road from Torbrook to Meadowvale. In this vicinity Mr. T. C. Weston, in 1879, collected the following fossils,

Torbrook
mines.

contained in two slabs of iron ore ; one (a) a bright red hæmatite rock, the other (b) a dark bluish-gray impure ore.

Collections of
T. J. C. Weston

(a.) 1. *Orthis* sp., cf. *O. hipparionyx* (= *Hipparionyx proximus*), Vanuxem.

2. *Spirifer*, cf. *S. Nictavensis*, Dawson ; very closely related to *S. concinnus*.

3. *Actinopteria*, sp. A very obscure form probably referable to this genus.

(b.) 1. *Orthis* (?) sp.

2. *Rhynchonella* sp. indt.

3. *Spirifer arenosus*, Conrad.

4. ?? *Megambonia* or *Mytilarca*. Too obscure for identification.

Both (a) and (b) are regarded as probably referable to the Lower Oriskany or Eo-Devonian.

Collections of
J. E. Leckie,
1894.

Another collection made in this vicinity, east of J. E. Leckie's (collector J. E. Leckie, 1894) contains the following forms :—

1. *Orthis* (*Rhipidomella*) cf. *O. oblata*, Hall. Very large specimens, very much flattened, but fine.

2. *Rhynchonella* ? sp. indt. Resembling somewhat *R. plicatella* L.

3. *Stropheodonta* sp. S, Becke.

4. *Leptocalia* ? sp. indt.

5. *Spirifer*, cf. *S. perlamellosus*, Hall ; or new species, very large.

6. *Megambonia* or *Pterinea* sp.

Horizon, about the summit of the Silurian.

Magnetite.

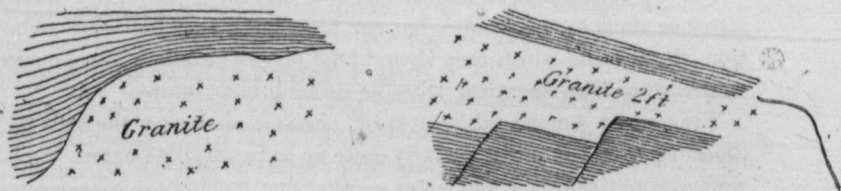
From the centre of Torbrook village, a road leads to the southward ascending the high ridge which, with an elevation of fully 600 feet here overlooks the Annapolis Valley. Near the top of this eminence, on its northern side, a bed of black granular magnetite has recently been opened and several hundred tons removed, the inclosing beds being dark and slaty, with much iron, and with obscure remains of shells. The dip of the beds is S. 25° E. < 80° to 90°, and their course therefore such as to indicate continuity with similar beds on the tributary of the Torbrook described on a previous page. A little south of these iron ores, are ledges of quartzite and diorite, dipping northerly (N. 10° W. < 70°), and below these, beds of slate. Still farther south, and in a valley beyond the ridge above noticed, are still other slates, but of a more siliceous character and darker colour, as well as somewhat micaceous, resembling in these respects the beds of Cleveland as they also do some of those in the lower portion of the Nictaux Valley. The dip of these slates is like the last northward (N. 10° W. < 60°).

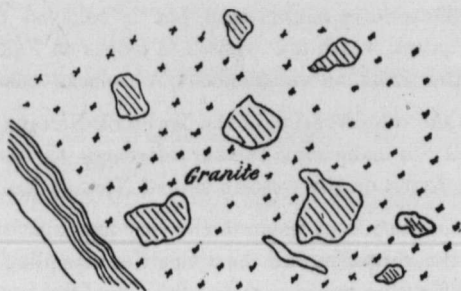
Beyond them the country is uncleared, but is believed to be mainly occupied by granites, which are exposed in ledges on Fales Brook, two Granite miles below Allen Lake, as well as about Wheelocks meadow.

To complete the consideration of the Torbrook-Nictaux basin, it will now be necessary to make some further references to that portion of the basin to be found on the western side of Nictaux Valley.

Allusion has already been made to the very irregular distribution of the granite in this direction and the difficulties attending its delimitation. These difficulties apply equally to the stratified rocks, with the additional one that, through the invasion of the granite, these have been so far altered that fossils are wanting and means of identification also for the most part lost. Fortunately, however, the course of the beds and the stratigraphy in general has been but little affected by these intrusions, and, with the assistance of some easily recognizable beds, the general structure can be made out.

The first road traversing the region westward of the Cleveland road (which latter by its proximity to the railway presents no new features), is about a mile and a half westward of Nictaux and half or three-quarters of a mile eastward of Jones Brook. The rocks which cross this road are gray sandy slates and sandstones, sometimes becoming quartzites with pink and lilac tints, and associated with dykes of diorite, the dip of the beds being very regular S. 20° E. < 70°. They thus show, both by their character and trend, that they are the same with the beds forming the hills near and north-west of Nictaux station. With the same course they extend to Jones Brook, and beyond to Inglesville, thus separating the granite dome which skirts the lower part of Jones Brook (and which extends thence to Williamston), from the similar rocks in East Inglesville. Similar beds, with similar dip, are exposed all the way to the cross-road on the summit of the hill leading thence to Nictaux Falls, as well as on this latter road; but here the beds are more highly altered, evidently through the invasion of granitic as well as dioritic veins. Some of the exposures seen on this road and illustrating such invasion are very remarkable, and are represented in the accompanying figures.





Granitic intrusions similar to the above are again seen to the southward of the latter on the road connecting Nictaux Falls and East Inglesville, and may be connected eastwardly with the one-mile belt of such rocks seen in the upper part of Cleveland, though this has not been ascertained. However this may be, it is certain that a considerable area of stratified rocks, belonging to the system under review, occurs to the south and west of this belt, occupying a tract which in all previous geological maps and descriptions of the region has been represented as granitic. This tract includes the whole of the settlements of East, Centre and West Inglesville, as well as a considerable area along (but mostly eastward of) the road connecting the first-named settlement with Alpena. One exposure upon this latter road is most important, as probably representing the beds from which came the blocks of fossiliferous limestone referred to in the description of Sir J. Wm. Dawson. It is on the farm of Henry Whitman, and just west of where the road crosses a considerable brook, probably Jones Brook. The rocks here seen are mostly dark-gray, fine-grained and somewhat micaceous sandstones, similar to many of the beds in the upper as well as the lower part of the railway section, but include also beds of coarse and impure crystalline limestone, some of which contain ribbed shells and other organic remains. The fossils are few, poorly preserved and difficult to remove, but among them have been recognized a *Spirifer*, sp. indt., an *Orthis*-like shell, too imperfect for specific determination, and what is probably a *Stropheodonta*, but also too imperfect for identification.

Inglesville.

Limestones.

Fossils.

The dip of the beds at this locality is S. 20° E. < 60°. They occupy a bay or sinus in the granite, but can have but a very limited distribution, the position which they should hold on the parallel road one mile westward of that described, showing nothing but granite.

The granite tongue which cuts off, across their strike, the beds last described, extends north-westerly quite up to Inglesville Centre. To the west and south-west of the latter another and much more considerable

sinus in the granite includes the settlement of West Inglesville, and reveals some beds of interest. Through most of the settlement the rocks are quartzites and diorites, the former of the usual dark-gray colour and micaceous aspect, a continuation evidently of the beds on Jones Brook, and of the hills overlooking Nictaux Falls; but about half or three-quarters of a mile south or south-east of the road traversing the settlement, is a rather conspicuous ridge, also composed of quartzites, but in which these are of quite a different character. Perhaps their most noticeable feature is the absence of colour, for while usually exhibiting in the interior a pale pinkish tint, sometimes tending towards red, this is apt to be wanting on weathered surfaces, leaving the latter nearly white. Another striking feature is their hardness and purely siliceous character, well brought out by glacial action in the wonderful polishing of exposed surfaces; a polishing so complete as to readily reflect light, and to cause their surfaces, especially when wet, to be slippery to the foot. Finally these same surfaces are in places covered with jet-black coatings of oxide of iron.

The whole aspect of the above quartzites is suggestive of very ancient rocks, yet their characters are so peculiar and so readily recognizable that no doubt can exist as to their identity with the loose blocks referred to on a previous page as found, with similar associations, north of Alpena on the railway section, and yet again below the red slate bluffs on the Torbrook stream. Were it not for the fossil layers found in the latter case, but which were not discovered in Inglesville, both might, on lithological grounds, be well referred to the Cambrian system. It will presently appear that precisely similar beds, which again contain fossils, occur in the Clementsport and Bear River basin. The dip of the above-described quartzites is southerly, in which direction, at a distance of a little over a mile from the main road, they give place to granite. A similar southerly dip prevails throughout West Inglesville and along the roads leading thence to the Annapolis Valley.

On the old Albany road, as well as that to the westward of it, the stratified rocks are soon cut off, across their strike, by the granites south of Lawrencetown; but between the latter and the Jones Brook granites, the first-named rocks come quite down to the valley south of Williamston. As exposed on the highway in this settlement, half a mile eastward of the road from Lawrencetown to Albany, they are purplish-gray imperfect gneisses, dipping S. 10° E. $< 60^{\circ}$. The course of the beds both here and in Inglesville is more nearly east-and-west than in Nictaux. In but few cases does the granite appear to have any influence on the trends, though profoundly altering the nature, of the strata it invades.

We may conclude this review of the east Nictaux district by reference to some further collections made by other observers. The rocks containing these fossils are much altered and most of the specimens are consequently obscure.

Fossils collected by Dr. MacKay, 1894.

Locality No. 1. Gates limestone quarry, Inglesville, at Lawrence-town and Alpena roads, Annapolis county. October, 1894. Dr. A. H. MacKay.

1. Large Bryozoary, obscurely preserved and crushed, too imperfect for identification.
2. *Monticuliporidae*.
3. Crushed *Fenestella*-like frond, too imperfect for identification.
4. *Stropheodonta*-like sp. very imperfectly preserved.
5. " cf. *S. Beckei*.
6. *Spirifer*, sp., cf. *S. macropleurus*.
7. *Orthis* or *Rhynchonella*, sp.
8. Obscure coral-like remains.

Locality No. 2. At and near ridge or Boars-back, north of Jones Brook, East of Inglesville. October, 1894. H. Fletcher, A. H. MacKay.

1. *Pleurodictyum problematicum*, Goldf; showing the *Serpula*-like stage very well. Referable to the genus *Michelinia*.
2. Coral-like fragment too imperfect for determination.
3. *Streptelasma*, sp., with fifty larger and fifty smaller or intermediate septæ or radiating lamellæ.
4. *Crinoidea*, fragments of columns.
5. *Monticuliporidae* sp. Branching species.
6. Crushed fragments of Brachiopoda, too imperfect for identification.
7. *Orthis*, cf. *O. (Rhipidomella) hybrida*, Sby.
8. " sp. too imperfect for identification.
9. *Strophomena* (?) sp.
10. *Meristella* (?) sp. indt.
11. *Spirifer perlamellosus* or *S. macropleurus*, or closely related species.
12. *Spirifer* or *Rhynchonella*—crushed and twisted beyond recognition.
13. *Renssellæria* (?) sp.
14. *Leptocælia* sp.
15. *Anastrophia*, cf. *A. Verneuilli*, Hall; imperfectly preserved.
16. *Atrypa*, cf. *A. reticularis*, L.

The horizon indicated, appears again to be a transitional one. The locality has not been visited by the author of this report.

Another small collection is marked as from north of Jones Brook, on a meadow-road east of G. W. Gates, on Lawrencetown road. October, 1894.

1. *Monticuliporidae*.
2. *Orthis*, sp., cf. *O. (Rhipidomella) hybrida*, Sowerby.
3. *Stropheodonta*, sp.
4. *Atrypa*, cf. *A. reticularis*, Linné.
5. *Spirifer*, sp. indt. Doubtful.
6. *Leptocælia*, sp. indt. Doubtful.

The horizon is referred to the Silurian system.

These fossils might be referred to the Silurian.

From a review of the facts which have been presented in the Tor- Conclusions.
brook-Nictaux section, some conclusions of more general application may
be drawn.

I. The succession of Strata.—This, in ascending order, is believed Succession
to be as follows:— of strata.

a. Dark-gray, dark-weathering quartzites, associated with numerous dykes of diorite and veins of granite, becoming, when metamorphosed, more or less micaceous or hornblendic, with shades of lilac and purple. Thin bands of fossiliferous limestone.

Loc. West Nictaux and Inglesville, Jones Brook, Bloomington, McGinty road, etc.

b. Pale gray to pink, sometimes reddish, white-weathering quartzites, in places highly fossiliferous.

Loc. Inglesville Centre, Cleveland (in boulders only), Torbrook stream.

c. Dark-gray, green and reddish argillites, with beds of iron ore, and highly fossiliferous.

Loc. Torbrook stream, Torbrook mines, Nictaux Valley below the falls.

d. Dark-gray argillites, often silicious, with bands of quartzite and beds of hæmatite or magnetite. Fossils abundant.

Loc. Railway section in Nictaux Valley, Wheelock mine, Cleveland.

e. Dark-gray argillites, banded with paler layers, and holding beds of buff-weathering sandstone. Fossils abundant.

Loc. Railway section in Nictaux Valley, etc.

Note.—This scheme is only tentative and may require modification as the result of further study.

II. Structural Relations.—The nature and disposition of the beds as seen on the lower Torbrook stream, its tributary, and the McGinty road, near the Kings county border, leave little doubt that the general structure here is synclinal, the axis of the syncline being about midway between Torbrook Centre and the county line last-mentioned, and its course about north-east. On either side of the line the beds are probably repeated in inverse order, but through metamorphism the hæmatites of the one are represented by the magnetites in the other. The fossils of the more northerly beds are rare or wanting nearer the granite, and colours due to contained iron change from red to black.

Torbrook.

The structure on the Nictaux and along the line of the Nova Scotia Central Railway is also apparently synclinal, but that of a syncline which as a whole is more northerly than that of Torbrook. On this supposition, (which, however, is not fully established) the ore-beds of Wheelock's farm, the direct continuation of those of Torbrook mine, mark at once the northern side of one syncline and the southern side of the other. This is not clearly seen in the railway section, but to the westward, in Cleveland, are quartzites which probably represent the base of the system, while still farther west, but on the same general line, are the black and pink quartzites of Inglesville.

Nictaux River

The Torbrook syncline, in its western extension, would thus seem to be cut off by the Cleveland and Alpena granites (though reappearing to a limited extent to the south of the first or one-mile granite belt), while the Nictaux syncline is similarly cut off, across the strike, by the granites south of Lawrencetown.

Relations to granite.

The uniformity in the strike and general relations of the different groups of rocks described, in spite of their numerous and extensive granitic invasions, is most remarkable, especially when taken in connection with the position and relations of the similar beds in the Clementsport,—Bear River basin, and that of Mistake settlement in Digby county yet to be described.

III. Age.—The collections of fossils referred to here are about twenty in number, some seventeen being from the Nictaux-Torbrook basin, and the remainder mostly from that of Clementsport and Bear River. It will be convenient to consider those of both basins together. Of these collections, six are regarded by Dr. Ami as being of Lower Oriskany or Eo-Devonian age, and among these are the large collections made by the writer from the Wheelock mine at Nictaux, and by Dr. MacKay from Inglesville, the former including twenty-two and the

Age.

latter sixteen species, mostly well-preserved. Several collections, including one by the writer from Bear River, with twenty-one species, and that of Mr. Weston, from Wheelock's farm, with eleven species, are described as being either at the summit of the Silurian or base of the Devonian, with, in some instances, a marked transitional character. Five collections are referred to the summit of the Silurian, but one of these is from beds at and near Wheelock's, which other and better collections show to contain Devonian forms; while another from Bloomington is evidently a continuation of the same beds as the last, though containing no typical species. It would seem, therefore, to be tolerably certain that a large part of the deposits in the two basins under review occupies a geological horizon at or near that of the line of demarcation between the Silurian and Devonian systems.

In the five collections which have been definitely assigned to the Silurian, some indicate a horizon near the very summit of the system, while others present forms somewhat older or lower down in the Silurian.

One part of the Redpath Museum collection of Sir J. Wm. Dawson, has been classified as Devonian, including twenty-two species, and another portion including eleven species, has been referred to the Silurian, the latter most probably equivalent to Division D of the Arisaig series of Nova Scotia (=Lower Helderberg=Ludlow). The writer, as already stated, is not aware of the exact locality from which this collection was made, or whether, indeed, the specimens were all from the same locality. In view, however, of the fact that several collections are at or near the boundary line between the Silurian and Devonian, great probability is given to the view that the collection is, in part at least, of a decided transitional character, with perhaps a little stronger development of Silurian aspects than usual.

The conclusion arrived at from the fossils at hand from the Nictaux-Torbrook and Clementsport and Bear River basins, that the beds hold forms referable, some to the Silurian, some to a transitional series, and others to a horizon at the base of the Devonian (Eo-Devonian), is in accordance with the stratigraphy of the district, which indicates a perfectly continuous and conformable series of beds. Conclusion.

It only remains to add that no *Dictyonema* or graptolitic forms have been found in either of the basins, and therefore no definite proofs exist of the equivalency of any of the beds of the latter with those of New Canaan.

The fossils from Mistake settlement are too few and too imperfectly preserved to fix with certainty the horizon of the beds containing them, but little doubt can be entertained that this is near the summit of the Silurian.

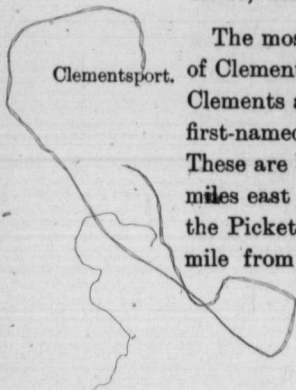
CLEMENTSPORT AND BEAR RIVER BASIN.

The granites which abruptly cut off, on their western side, the Eo-Devonian rocks of the Nictaux basin have in earlier pages been described as occupying all the area thence to Annapolis. On the Basin front they extend, indeed, beyond Annapolis and almost to Clementsport, but this is only a tongue, to the south of which, separating this from the main body of the granite, stratified rocks again appear, marking the beginning of an area which, rapidly widening, extends thence to Bear River, and beyond the latter into the county of Digby.

The most easterly exposures of the rocks in question are to be seen on the post-road connecting Annapolis and Liverpool, five miles south of the fort in the first-named town. They here form a belt about a mile in width, but probably do not extend much farther to the eastward, no sign of their presence being seen on the Dalhousie road, only one mile distant. On the Liverpool road the belt is represented chiefly by loose blocks, but partly by outcrops, of dark-gray, sometimes purplish or lilac sandstones, with some more slaty beds, both resembling closely the rocks in the upper part of the railway section at Nictaux, or those of Wheelock's mine, and like the latter carrying fossils. These are mostly found in ochreous crumbling layers and are but poorly preserved, but shells of brachiopods (*Spirifer*, etc.) and stems of crinoids are readily recognizable.

To the westward of the Liverpool road, the area occupied by the group of rocks under review rapidly widens, but for a considerable distance exposures are few. Thus, on the road from Annapolis to Virginia, four miles distant from the Liverpool road the only ledges seen are where the first named road passes the outlet of Bela Lake, and consist of dark-gray quartzite evidently greatly altered by the granite near by. Along the course of the east branch of Moose River exposures are more frequent, and on this stream, as well as by the main stream of Moose River and by Bear River, admirable sections of the whole area are shown.

The most northerly beds exposed on Moose River proper, are those of Clementsport, but between the latter and the granite spur in Upper Clements are rocks which are geologically beneath those of the village first-named and form the real base of the system in this direction. These are best seen in the vicinity of Balcoms Corner, about three miles east of the bridge in Clementsport and along what is known as the Pickett road, extending a mile or so further east. A quarter of a mile from the corner, on this latter road, are ledges of dark-gray to



lilac hard sandstones or quartzites, which are identical with those of the Annapolis and Liverpool road, and like the latter have something of a gneissic aspect. No fossils were, however, detected here, a circumstance readily understood from the fact that the beds are not more than 100 yards removed from the granite, a mass of which runs directly across their strike. The dip at this point is northward at a high angle, but a little farther to the east and south, where a bay or sinus occurs in the granite spur, similar rocks present great diversity of attitude, some dipping S. 40° W. < 40°, others N. 20° E. < 80° and still others S. < 90°. The quartzites are coarsely laminated and contain numerous white quartz veins, some of which, it is asserted, have yielded gold.

Other quartzites of like character may be seen on the Guinea road where this descends to the village of Clementsport, but in proceeding in this direction the beds become more slaty and less micaceous. They still show, however, evidences of alteration in the occurrence of numerous minute crystalline prisms on their cleavage-planes. These slates are admirably exposed on a small brook crossing the Frazertown road half a mile south of the Guinea road, forming here a picturesque fall, probably a hundred feet in height, though of no great volume. Along both branches of Moose River they are similarly exposed, and, with the exception of some beds of diorite, are the only rocks seen between the mouth of the river and Clementsvale. In the more northerly part of the section, as at Clementsport and near the Guinea road, the prevailing dips are southerly, but of very variable amount, from verticality to 30° or less, indicative of many subordinate flexures. On the other hand, towards the southern side of the basin, as in Frazertown and south of the Hessian line road, the dips are northward, the border of the syncline being further indicated by a change from slates to quartzites. These latter rocks are well exposed on either of the roads leading south from the Hessian line to Round Lake mill, and are of special interest in that some of the beds exactly resemble the pink white-weathering quartzites of Inglesville, while, like the similar beds of the lower Torbrook, they are fossiliferous. In collections made on the Potter road, the most easterly of the two roads referred to, Dr. Potter road. Ami has found the following species:—

1. Crinoidal fragments.
2. *Orthis (Rhipidomella)* sp. crushed and distorted.
3. *Stropheodonta* sp.
4. " " cf. *S. varistriata*, Conrad.
5. " " " *S. Blainvillei*, Billings.

6. *Camarotoechia*, sp. indt.
7. *Spirifer* sp. with from 6 to 8 costæ on each side of mesial fold.
8. *Spirifer* sp. of the type of *S. cycloptera*.

These are probably referable to the Lower Devonian.

The beds at this point are about half way between the Hessian line road and the granite hills.

Iron ores of
Clementsvale.

Another feature of special interest in the Moose River section, is the occurrence of iron ores similar to those of the Nictaux basin. The most important of these are found in Clementsvale, a mile or so west of the main stream of Moose River, and a little north of the Hessian line road. This is the locality from which the ores formerly worked at Clementsport were obtained, and the long and deep trenches there, testify to the amount of material removed. The rocks inclosing the ore are slates which are dark and more or less chloritic, and in a nearly vertical attitude, while the ore is a dark granular magnetite. Like the beds at the Wheelock mine in Nictaux, they are fossiliferous, and while quarrying operations were in progress many fine specimens of broad-winged spirifers and other forms were obtained here, but these are not now accessible, while the fossils which are found in the associated slates are few and not well preserved.

Fossils.

Among them is a *Tentaculites* like *T. arenosus*, Hall, which is closely related to *Tentaculites elongatus* of the same author.

It is interesting, in this connection, to note that towards the northern side of the Moose River basin, indications of ore-beds have been recently observed which may be the equivalents of the Clementsvale beds on the other side of the syncline. These indications occur near the top of the hill south of Clementsport, where the east-and-west Waldeck road meets the road leading south to Clementsvale, and in the form of blocks of magnetite derived from bluish argillite ledges near by. The beds, however, are not well exposed.

Bear River
section.

We have now to consider the section, parallel to that of Moose River, furnished by Bear River and its tributaries.

The occurrence of fossiliferous strata in and about Bear River village has long been known. It could not indeed well be otherwise, for there is hardly a slab of slate in the thickly scattered drift or in the stone walls constructed of the latter which does not teem with organic remains. Of the rocks *in situ*, the most prolific are a series of gray and dark-gray slates, which form low bluffs about the head of tide-water, and about the mill-pond on the east branch just above.

From a collection made by the author of this report in 1892, twenty-
 one species were obtained by Dr. Ami, which, as identified by him,
 are given below :—

Fossils from
 Bear River.

1. *Psilophyton* (fragments). Crinoidal fragments.
2. *Pleurodictyum problematicum*, Goldfuss.
3. *Polypora* or *Fenestella* sp.
4. *Dicranopora*? Sp.
5. *Bryozoa*. Sp. indt.
6. *Calamopora* or *Favosites* sp.
7. *Strombodes* or *Pleurodictyum*.
8. *Favosites* allied to *F. Gothlandicus*. Lam.
9. *Orthis*, cf. *O. Davidsoni*, de Verneuil.
10. " " *O. oblata*. Hall.
11. " allied to *O. hybrida*, Sowerby.
12. " *elongatula*, Dalman.
13. *Stropheodonta* sp.
14. *Leptocoelia flabellites*, Conrad.
14. *Spirifer rugicostus*, Hall.
15. " cf. *S. arenosus*, Conrad.
16. " *cyclopterus*, Hall.
17. " *Nictavensis* (?) Dawson.
18. *Pterinea textilis* var.
19. *Cypricardinia sublamellosa*, Hall.
20. *Tentaculites* sp. cf. *T. elongatus*, Hall.

It is noticeable that the fossils are mostly brachiopods and include no trilobites, though corals and crinoid stems are not uncommon.

The horizon indicated by the above fauna is that of a transition series. Some of the species have a decided Lower Devonian or Oriskany aspect, whilst others appear to belong to a somewhat lower horizon. The presence of such forms as *Leptocoelia flabellites*, *Spirifera arenosa*, *S. Nictavensis*, *Stropheodonta*, etc., point to the Lower Devonian age of the fauna, whilst upon the whole, the bulk of the collection has considerable affinity to rocks of Silurian age.

Geological
 horizon.

In ascending the main stream of Bear River from the Forks, at the head of tide, the rocks are fairly exposed in the bed of the stream and in the adjacent hills for about two miles, and for a little more than half this distance they are fossiliferous. The fossils, however, gradu-

ally become less abundant at the same time that the beds become more arenaceous, the approach to the granite being at the same time indicated by the development of a gneissic aspect in the coarser beds, and the spotting of the finer ones with incipient crystals. The last fossils seen were at a distance of 1450 paces south of the uppermost bridge, at the mills. Finally, at the head of the section, are finely laminated gneissoid sandstones which directly abut against the granite, just below a series of falls. These quartzites are remarkable for the extremely fine layers of which they are composed, and not so less for the wonderfully complicated contortions into which they have been thrown, but neither, in these respects nor in others do they bear any resemblance to the massive quartzites of the Cambrian system, and they doubtless represent the base of the Devonian. In this connection, it may be added that reefs of quartzite are exposed to view about two miles north-eastward of those last noticed, *viz.*: on the Jefferson road connecting the Hessian line with the Negro line road, and a little south of the Middlesex road. These, however, are probably a little higher in the series, being evidently the westward extension of those already described on the Potter road, exhibiting, like the latter, the peculiar pale-pink tint and brightly polished glaciated surfaces so conspicuous in Inglesville, or, indeed, wherever this particular set of beds is exposed to view. This comparison is also confirmed by their fossiliferous character, layers in the otherwise massive rock containing shells in considerable numbers. The fossils found here are similar to those of the Potter road.

Jefferson road

Fossils.

In this connection the following list of species, as determined by Dr. Ami, etc., obtained from the drift along the Middlesex road, is not without interest.

1. *Pleurodictyum problematicum*, Goldfuss.
2. *Favosites* sp. Small branching species allied to *F. polymorpha*.
3. *Fenestella* sp. Showing both the celluliferous and poriferous sides, but preserved as impressions of both.
4. *Stropheodonta* sp.
5. *Leptæna rhomboidalis*, (Wilckens.)
6. *Orthis*, of the type of *O. Livia*, Billings, evidently a *Rhipidomella* and allied forms.
7. *Renssellæria* sp., cf. *R. ovulum* or *R. Cayuga*, probably a new species.
8. *Atrypa* (?) sp., cf. *A. hystrix*. Too imperfect for determination.
9. *Spirifer* sp. several species with smooth fold and sinus, with rugose costæ, regularly and evenly disposed.

10. *Pterinea* sp., cf. *P. textilis*.

11. Crinoidal columns and rings, apparently belonging to two distinct genera and species.

The horizon indicated is Lower Devonian.

It has already been stated, in the sections of this report relating to the Cambrian rocks of Digby county, that the line of separation between the latter and Eo-Devonian strata has not been definitely made out. The uncertainty as to identity of the two groups begins to be felt in the lower part of the Bear River section.

Separation of
Cambrian and
Devonian.

In descending the estuary from the head of tide, the rocks continue to be mostly slates, not obviously different from those of the village, but in which fossils become gradually less abundant, until, at a distance of three-fourths of a mile from the upper bridge, they fail altogether. At about this point also the strata change their character, the slates being replaced by heavy beds of quartzite, while both have a southerly dip—(S. 20° E. < 80°). They therefore probably represent the northern side of a syncline of which the southern side is represented on the east branch and on the Negro line road, while the axis of the syncline would be not far south of the forks of Bear River. The quartzites here exposed have, it is true, no great thickness, but this may be the result of faulting, the beds which occupy the remainder of the distance to the railway bridge affording abundant evidence of the dislocations to which they have been subjected. Alternations of slates and quartzites occupy the whole interval of nearly a mile, but these are in places so abruptly folded as to look like the teeth of a gigantic saw. The slates are dark-gray to black in colour, sometimes showing a banded or ribboned aspect, while the sandstone or quartzites are laminated, in some beds acquiring by the action of the water a reddish-brown tint, and in others becoming ochreous and buff-coloured. The last beds seen above the railway bridge are quartzites.

Bear River
syncline.

To the north of the bridge, in the railway cutting between the latter and the station, on the west side of the river, the influence of intrusive diorites is well exhibited. These latter, which chiefly occupy the eastern end of the cutting, are slightly amygdaloidal, but shade into light-gray sandstones which are associated with black iron-stained slates. Not less than fourteen small folds may be counted upon one side of the cutting, the prevailing dip, however, being south-easterly. No fossils have been seen, though the beds bear much resemblance to those which, near Bear River village, are so highly charged with organic remains.

Bear River
station.

Section near
Bear River
station.

The subjoined section of the railway cutting has been made by Mr. Prest:—

3 3 3 3 3 3



1 2 2 2 / 4 4 1 4 1 1 1
 1. Diorite. 3. Faults.
 2. Black slate with 12 or 13 folds. 4. Gray arenaceous slate.

Diorites.

The diorite of the above section is apparently an arm, nearly 1000 feet wide, of a more considerable mass of such rock forming the core of the high hills on the west side of Bear River, whence it has been traced westward, through the hills south of the Grand Joggins,* to Lee or Bingay Brook, two miles south-west of the railway bridge. It here becomes slightly vesicular and more nearly resembles the trap of North Mountain, than a true diorite. On Lee Brook it is cut by a large quartz veins.

Before passing to the further description of the west side of the river, it is necessary here to make brief reference to the sections afforded by some of the smaller streams which, between Moose and Bear rivers flow northerly to the Annapolis Basin. Of these Deep Creek, nearly midway between the two rivers last-named, is the most important.

Deep Creek.

Just below the crossing of this brook by the highway connecting the towns of Digby and Annapolis is a series of bed, quite unlike anything ordinarily found elsewhere in the Bear River basin, but which forcibly recalls some of the rocks seen in the northern portion of the Nictaux section, and especially on Torbrook River. They consist of bright red slates, which are rather soft and somewhat ribboned, dipping regularly N. 10° W. < 80°. At two points only have strata resembling these been seen in the area under review, viz.: at the mouth of Moose River, north of the railway bridge, and at the mouth of Smith Cove, in a similar relation to the railway. At the first-named locality, however, the red beds alternate with green and black slates exhibiting great irregularity of dip, while at Smiths Cove the deep brown-red colour seems to be largely a surface one, and alternates with narrow bands of light and dark bluish-gray and greenish-gray colours, the dip

Red slates.

*The localities known as the Grand and Little Joggins, referred to in this report, are indentations of the coast-line on the south side of Annapolis Basin, and should not be confounded with the better known Joggins at the head of the Bay of Fundy.

here being northward at an angle of 75° . It will be noticed that the three localities are on the same general line, and the beds referred to doubtless occupy about the same horizon, which, if they are the equivalents of the Torbrook beds, would be near the base of the Eo-Devonian. If this latter comparison is correct, it would also go far to establish a similar age for all the rocks of Bear River and those of a somewhat extensive tract to the westward as well as to the eastward of the latter. At none of the points referred to, however, though the beds are but little metamorphosed, have we been able, after prolonged search, to find any fossils.

To the south of the post-road, at Deep Creek, there are no exposures for a quarter of a mile, but beyond this distance they are of frequent occurrence for a further distance of three-quarters of a mile, or to where the creek is crossed by the Waldeck road. The first rocks met with in ascending the brook are rather dark-coloured slates, exhibiting a succession of low folds, but farther up these become conspicuously marked by narrow alternate bands of lighter and darker colour, the former being also of coarser texture and from one-quarter to one-half an inch in thickness. Thin beds of quartzite also occur, the dip throughout being northerly, usually at high angles, but sometimes as low as 20° . The last beds seen at the crossing of the Waldeck road, were black slates. At several points the rocks are intersected by and more or less altered by diorite dykes.

A quarter of a mile east of Deep Creek station, another small brook, known as Purdy Brook, shows another section parallel to the above and with essentially similar features, the rocks being slates with included beds of sandstone. The slates are mostly gray, but often surface-stained with red, or sometimes red throughout, giving them a conspicuously banded or ribboned appearance, and in this, as in other respects, bearing much resemblance to the beds seen in the lower part of the Nictaux Valley, below the falls. The sandstones, on the other hand, are hard and massive, of a bluish colour within, but weathering deeply with an ochreous-brown surface. The dip of the beds, as on Deep Creek, is northward ($N. 10^{\circ} W. < 70^{\circ}$). In the lower part of the stream the slates include many purplish beds, not unlike those of the Cambrian system, but these become less frequent as the stream is ascended.

Still another section, parallel to the above but on the other side of Deep Creek, is afforded by Ditman Brook, but the only noticeable feature is the occurrence of diorite dykes, carrying veins of asbestos.

We have now to consider the area lying to the westward of Bear River, in the county of Digby.

In tracing the fossiliferous belt from Bear River village westward, exposures resembling those already noted at the head of tide on Bear River inlet, are seen on several of the streams which are tributary to the latter. Thus, on the west branch, above Bear River forks, and about a quarter of a mile west of the fossiliferous beds on the East Branch, is a dark seamy and crumbling fossiliferous rock, well stratified, with slaty and arenaceous layers, and dipping N. 70° W. < 85°. Two hundred yards farther up the same stream, are grayish-blue slaty rocks, with similar brown, crumbling, fossiliferous layers, and with the same dip. Also, on another brook, half a mile or more north-west of the last (a brook which empties into the main river half a mile above the centre of the village), similar beds again occur, and, besides brachiopods, contain corals and crinoids, the latter sometimes three-fourths of an inch in diameter. Farther up, on this brook, the dark slates and friable brown sandstones gradually change to finely laminated, wavy, light-gray and bluish-gray sandstones and arenaceous slates. These beds, except in being less contorted, resemble those in the upper part of the West Branch, while, unlike the latter, but like those of the Jefferson road, they are abundantly fossiliferous. On the same brook, one-eighth of a mile below the road from Morgantown to the Weymouth road, and about one mile and three-quarters from Bear River village, are light-blue slates with thin seams of gray sandstone, the former being to the latter in the proportion of six or seven to one. A few rusty-brown seams contain fossils. These rocks exactly resemble those of the upper part of the West Branch, and, as upon the latter, begin to show metamorphism as the granite is approached. Fossils are sometimes found in the most crystalline parts of the sandstone or quartzite. The fossiliferous beds are finally cut off by the granite about a mile west of the road mentioned above, or three miles and a quarter from Bear River village. Near the granite the blue slates which underlie the fossil beds seem to have been converted into finely stratified gneiss. Boulders of similar gneissoid material, finely laminated, large and angular, are profusely scattered over the country to the south of the Morgantown and Weymouth roads for several miles, and no rocks not metamorphosed are seen in this direction. Where seen *in situ* the dip is southerly (S. 5° E. < 85°).

While the undoubted Siluro-Devonian rocks are thus clearly traceable westerly from their exposures at and above Bear River village until cut off on their strike by the granites in the vicinity of the Weymouth

Uncertainty
as to age.

West Branch
of Bear River.

Fossils.

Granite.

road, the same uncertainty as to the age of the rocks in the tract intervening between this road and the foot of Annapolis Basin exists, as in the corresponding tract east of Bear River. This much, however, appears to be certain, that whatever the age of the beds described above as occurring above the lower part of Bear River, on Deep Creek and Purdys Brook, the same age must be assigned to the tract intervening between the same part of Bear River and the inlet of the Grand Joggins, south of the town of Digby; for among the beds disclosed upon the various streams which flow northward from this elevated tract into Smith Cove and the Grand Joggins respectively, are some as to the identity of which with those of the streams first enumerated there cannot be any doubt.

On Roach Brook (or Poole Brook) which runs into Smith Cove, Roach Brook the rocks exposed are light- and dark-gray and bluish-black slates, with bands of blue sandstone. These latter are conspicuously buff-weathering, the bands being from three inches to a foot and a half in thickness and standing out above the softer slates. They thus become a very noticeable feature in the rocks of this vicinity, at the same time that they recall the similar beds observed on Deep Creek and elsewhere east of Bear River. Their dip varies from N. 40° W. to N. 55° W. and the inclination from 78° to vertical. The upper part of this brook is crossed by a dyke of diorite which appears to be an extension of a large mass of such rock forming the core of the hills overlooking Bear River Inlet, and has been traced in a westerly direction as far as Hollinghead Brook, to be presently noticed. About the lower part of Roach Brook the dark slates are, as usual, in numerous short folds, dipping steeply to the eastward, the folds themselves being inclined in the same direction at an angle of from 70° to 80°. The slates are often stained and sometimes permeated for some distance with red, buff and green colouring matter, this not being distributed usually in lines corresponding to the bedding, but in patches. Where these colours are present the slates are softer and apparently more argillaceous than elsewhere. In these respects they recall the green and red slates noticed above as found on the shore of the basin at the mouth of Bear River, but perhaps bear equal resemblance to certain soft, coloured slates, described in connection with the Cambrian system as occurring on the coast south of Cape St. Mary.

The soft red shales found to the north of the railway bridge at Smith Cove have already been referred to.

About a mile and a half west of Smith Cove, as measured along the highway, is the mouth of the Grand Joggins, the western side of which inlet has been described on an earlier page of this report as consisting of a series of black pyritous slates, supposed to be the upper member of the Cambrian system. On the southern side of the same indentation, not far from its mouth, it receives the waters of Hollinghead Brook, on which may be seen the following succession of beds, in ascending order:—

Succession on
Hollinghead
Brook.

1. Black slates, one and one-third mile. Dip N. 55° W. $< 65^{\circ}$.
2. Gray and bluish-gray sandstones. Dip N. 40° W. $< 60^{\circ}$.
3. Black slates, 500 feet. Dip N. 30° W. $< 60^{\circ}$.
4. Bed of light-gray sandstones. Dip N. 30° W. $< 60^{\circ}$.
5. Black slates, about 1000 feet. Dip N. 30° W. $< 60^{\circ}$.
6. Striped slates, bluish, light- and dark-gray. Dip N. 30° W. $< 65^{\circ}, 45^{\circ}$.
7. Black slates, one and one-third mile. Dip N. 35° W. $< 45^{\circ}, 30^{\circ}$.
8. Striped bluish-gray and light- and dark-gray slates.

The last-named striped slates have a prevailing south-east dip, and with some wave-like undulations mark the centre of a syncline, on the other side of which the beds are reversed for about half a mile, the whole basin being at the same time inclined in the direction of Bear River. The dip on the south-east side of the syncline is in places almost perpendicular.

Striped slates.

About a furlong south-east of the above syncline, is a dyke of diorite nearly 100 feet wide, being the westward extension of that already noticed on Roach Brook. It protrudes through the almost perpendicular slates, and forms a succession of falls over fifty feet in height. South-east of the dyke the slates maintain for a time their vertical dip, then inclining northward at an angle of from 50° to 70° . A little over a furlong south-east of the dyke is the apex of a minor fold, the dip being N. 30° W. $< 65^{\circ}$. Still further south-east the country becomes covered with drift in which boulders of granite and diorite predominate.

Diorites.

Difficulties of
separation.

From the above observations it will appear that the line of separation between the Siluro-Devonian and supposed Cambrian rocks has not yet been definitely ascertained. On the one hand there would seem to be little doubt that to the latter system must be assigned all the rocks to the south and south-west of Digby town as far as the Grand Joggins and the head of Bingay Brook; this belief being based on the similarity of the succession no less than on the minute details of these beds as compared with the supposed Cam-

brian rocks of Queens and Lunenburg counties; while on the other hand, where the beds are fossiliferous, definite proof as to the occurrence of more recent rocks is at hand. Between these two, however, is a considerable area in which, along with an entire absence, so far as known, of any fossils, the rocks, consisting chiefly of slates, with some sandstone beds, are of such a character as might allow of their being referred to either of these systems. When, further, metamorphism comes in to obscure any distinctive differences which otherwise exist, the task of separation becomes a most difficult if not a hopeless one. For the present, as a provisional arrangement, the line of the Grand Joggins and Bingay Brook may be accepted as best according with the observed facts; but should it hereafter turn out that the beds in the hills south of the latter are to be assigned to the Cambrian system, a like conclusion must follow as regards a large section lying on the south side of the Annapolis Basin, and either side of the estuary of Bear River. Provisional boundary.

Mistake Settlement.—It remains to notice one other locality or basin of fossiliferous rocks, of presumably Silurian age, viz., that of Mistake settlement, this being about nine miles west of the Bear River basin, from which it is separated by a northward spur of granite in the settlement of North Range. Mistake Settlement.

A good locality for the study of these rocks is the farm of Benj. Sabeau, one mile and a quarter south of South Range. They consist of a mixture of slate and sandstone, and are similar in every way to those previously described as occurring on the West Branch of Bear River, and like them hold crumbling seams carrying numerous but poorly preserved fossils. Among these *Orthis oblata* may be mentioned as especially common, but with this are *Spiriferi*, strophomenoid shells, crinoidal joints and corals resembling *Favosites*. Fossils.

It is remarkable that these beds should be almost exactly upon the line of strike of those of Bear River, notwithstanding the intervening tongue of granite, and that their attitude as well as their characters should be so nearly identical. It would seem as though the granite had simply melted its way across the course of the Devonian beds, in the manner referred to in the description of the Nictaux-Clementsport basin by Sir J. Wm. Dawson, or that these had themselves been in part converted into granite. It would also appear further, as long since maintained by the author last-named, that the granites are of intrusive or aqueo-igneous origin, and that the period of their intrusion was during the latter portion or at the close of the Devonian age. Relations to granite.

Limits.

In attempting to fix the limits of the Mistake settlement basin, the same difficulty is met with as in that of Bear River. Exposures are few and of those which do occur it cannot always be said that they are not Cambrian rather than Devonian. From what has already been said, however, regarding the Cambrian rocks in the Sissiboo section and on the Mistake River, as well as from the comparatively small area over which fossiliferous boulders are found, it is probable that the belt is of no great extent.

TRIASSIC (?) ROCKS OF DIGBY AND ANNAPOLIS COUNTIES.

In the earlier portion of this report, as well as in other publications referring to the same region, reference has been frequently made to the rocks which respectively underlie the Annapolis valley, with its natural extension in St. Marys Bay, and the long but interrupted ridge forming the North Mountain of Annapolis county, Digby Neck, Long and Briar islands. It has been usual, also, to regard the rocks of the valley, consisting mostly of coarse sediments of a red colour, as being of Triassic age, while those of the mountainous ridge separating the latter from the Bay of Fundy have been regarded as of more recent origin, though still referable to the same division of the geological scale. I have now to show that, while these references may in part be true, there are also, among the red sediments of the valley, deposits of wide distribution, which if not positively more recent than the traps of the North Mountain can at least not antedate them, though possibly of contemporaneous origin.

It will be convenient to consider the sedimentary formations first.

FRAGMENTAL ROCKS.

Sea Wall
St. Marys
Bay.

Red Sandstones of St. Marys Bay.—By far the best exposures of the red sandstones heretofore regarded as of Triassic age to be found within the area under review, occur not far from the head of St. Marys Bay, and about six miles distant from the town of Digby. They are in the form of a series of bluffs which, beginning a few rods south of the post-road at the so-called "Sea Wall" with a height of only a few feet, rapidly rise into such prominence as to make them, both by their height and bright red colour, a conspicuous feature in the landscape. The plane of the section is nearly in the line of the dip of the beds, which is to the north or north-north-east at an angle of from 5° to 8°, and its total length about half a mile, the precipitous bluffs for much of this distance attaining a height of nearly 100 feet and exhibiting many curious illustrations of marine sculpture. Though the prevailing

colour is, as stated, a brick-red, it includes both light and dark shades, while at intervals are interstratified bands, from half an inch to five or six inches in thickness, in which the red is replaced by light-green and gray tints. These green and gray beds are mostly beneath the reddish ones, and from this position form the larger part of the ledges which, at low water, are seen extending out into St. Marys Bay for a hundred yards or more. The layers thus exposing their nearly flat surfaces, afford some very fine illustrations of fossil ripple marks, as they do also of dendritic crystallizations, but the only organic remains found were a few branching fucoïdal stems and what appeared to be the cast of a tree-trunk several feet in length, but without definite markings. The lower beds are distinctly more arenaceous than the upper, and are made up largely of small quartz pebbles and coarse sand, while on the neighbouring beach are large boulders of red conglomerate unlike anything in the cliffs, but of which the origin is unknown. The dip of the beds referred to above, would gradually carry the gray and green bands out of sight, were it not that they are repeatedly brought to the surface by faults, the latter having an upthrow on the north side of from one to ten feet. Some of the red layers are very micaceous, and through others run veins of calcite, in the forms both of Iceland and of dog-tooth spar.

To the west of the bluffs at the Sea Wall described above, similar red sandstone beds occur at intervals along the north side of St. Marys Bay as far as the vicinity of Johnston's mine in Waterford. Along this part of the shore they are in much nearer proximity to the trappean rocks, forming in fact a narrow fringe at the base of the trappean ridge, and dipping towards the traps, but nowhere showing any instance of the superposition of the latter, or of any alteration therefrom.

Compared with the rocks of Blomidon and Minas Basin, the red sandstones of St. Marys Bay differ chiefly in the absence of the gypseous layers so conspicuous in the latter. In their texture and consistency, however, as well as in their colour, these do not differ markedly from the Blomidon beds, and no facts are known which would tend to show that they are not the equivalents of the latter. They differ at the same time in all these respects from some of the beds to be presently noticed.

Red Sandstones of Annapolis Basin.—The extent to which the red sandstones, etc., occupy the isthmus separating St. Marys Bay from Annapolis Basin is not easily determined, the exposures being few and the soil indications obscured by the abundant drift from the neighbouring trap ranges. They may, however, be seen at several

Elevations.

points, as where the post-road crosses a small brook flowing into St. Marys Bay, about three miles from Digby, and again on the slopes of the trap range where this is ascended by the road leading from Digby to Broad Cove. Their elevation at this point is about the same as that of the higher bluffs near the Sea Wall, and the inference is therefore justified that all portions of the isthmus not exceeding 100 feet, were covered by the waters in which these sandstones were deposited. As, however, the "Racquette Hill," which lies between this point and the town of Digby, has an elevation of 175 feet, and the hill in the rear of Digby 225 feet, there being in neither case any indication of derivation from red sediments, it is altogether probable that this high land is underlain by Cambrian strata, and that any direct connection between St. Marys Bay and Annapolis Basin in Triassic times, if existing at all, was narrow and shallow.

Digby.

The first exposures of rocks more recent than those of Palæozoic age found on the shores of Annapolis Basin are those revealed along the shore in the town of Digby. In the more northerly portion of the town these may be well seen on the bottom and sides of the bay commonly known as "the Racquette." They present here considerable diversity both of attitude and character, for while most of the beds consisting of reddish-gray sandstones, are not less firm than those of St. Marys Bay, others are quite soft and incoherent. The dip at the same time varies within a few rods from N. 20° E. < 30° to N. < 10°, with some appearances of unconformity. Other and still more interesting beds occur just below the railway in the more southerly part of the town, the most noticeable feature being the inclosure between the compact reddish-gray sandstone beds, of irregular layers of pebbles, among which, in addition to a few of granite and quartzite, are many *which cannot possibly be distinguished from the trap of the North Mountain*. One of these coarser beds is nearly five feet in thickness, the trappean blocks imbedded in it being from a few inches to a foot or more in length, but is continuous for a few yards only, gradually passing into the sandstones, which at the same time exhibit much false bedding. It seems hardly possible to avoid the inference that these strata are more recent than the traps which form so large a proportion of their inclosed pebbles.

Trap conglomerates.

Granville.

Facts very similar to the above may again be seen on the opposite or northern shore of Annapolis Basin in lower Granville. In passing along this shore in the direction of Digby Gut, the first rocks met with, forming a series of low bluffs, are bright red sandstones, with which in places are associated very soft red shales. Similar beds are exposed for

about half a mile, or to within a short distance of the base of the high trappean hill, which, denuded by a landslide, marks the southern entrance of Digby Gut. About here the beds become more pebbly, and while as a whole nearly horizontal, show an abundance of false bedding. Still farther north, but at a distance of only a few yards, the beds become very coarse, of a chocolate-brown colour mottled with light-gray, and at the same time soft and clayey, while imbedded in them are numerous blocks and some large fragmentary columns of the readily recognized North Mountain trap. One such columnar block has indeed been left by erosion projecting fully two feet from the face of the bluff of which it forms a part. These coarse beds are exposed for a short distance only, but beyond them the finer beds extend for some little distance, becoming at the same time harder, of a purplish colour and somewhat vesicular. Finally, these terminate abruptly along what appears to be a vertical line of fault, beyond which a small interval, occupied by loose blocks of trap, separates them from the main body of this rock. Trap conglom-
glomerates.

It is of course barely possible that these trap-conglomerates, which form the uppermost beds of the section here exhibited, may be of Pleistocene origin; but apart from the fact that between them and the regularly bedded sandstones below, which can hardly be Pleistocene, there is no clear line of separation, their similarity to the conglomerates above described upon the Digby shore point strongly to the view that, while newer than the traps, they long antedate the last-named epoch. Other facts pointing in the same direction remain to be noticed. Age.

The next beds to be referred to in this connection are found on the southern side of Annapolis Basin, near the foot of one or more of the streams emptying into the latter. One of these is Deep Creek, midway between Moose and Bear rivers, wherein, near the mouth, or just below the high-road, is exposed a series of bright red slates, dipping at a high angle and supposed to be of Devonian age. Directly overlying the latter, however, is another series of reddish beds, evidently of much later origin. Of these the most noticeable feature is their soft and unctuous character, they seeming to consist indeed of a paste which is hardly firmer than a bed of ordinary clay, but which, by its irregularly mottled colour, its sandy texture, and the inclined position of its beds, differs wholly from any of the ordinary Pleistocene beds of the region. Like the red slates on which they rest, these beds dip northerly, but while the inclination of the older set is 80°, these have a dip of only 20°. Beyond the facts stated no direct clue to their age is afforded. Deep Creek.

Red sandstones of Annapolis Valley.—Of the sediments underlying the Annapolis Valley, as distinct from Annapolis Basin, we are in position to say but little, it being for the most part outside the limits of the region to which this report relates. A few observations, however, made incidentally, are of interest as related to those already noticed.

Bridgetown. The first locality requiring mention is that locally known as "Hell's Kitchen," a gulch on the south side of the North Mountain, not far from Bridgetown. Here are red and gray sandstones exposed on the mountain side at least 350 feet, probably 400 feet, above the river level. The upper beds, as described by Mr. Prest, are greenish-gray, and these overlie red beds. Here again the very fine-grained, almost soapy, character of the beds seen on Deep Creek reappears, the red rocks being so soft as to be readily cut with a knife, while interstratified with them are bluish-green layers, from a quarter of an inch to one inch in thickness, which are similarly unctuous. Compared with the beds of Rossway, at the head of St. Marys Bay, they differ in having the greenish beds above instead of below the red beds, as well as in being of much finer texture; but the upper greenish-gray beds correspond fairly well with the lower greenish-gray beds at Rossway. The beds at this point are perfectly horizontal, and in this position form a junction with the trap, veins of iron ore being seen, near the latter, to penetrate the slightly altered soft red sandstone.

Lawrencetown. A second locality is Lawrencetown. Here, at the eastern end of the village, a cutting for the passage of the railway shows a series of horizontal sandstones, which, both in their colour, (red mottled with paler blotches,) and in their soft and unctuous character, nearly resemble the beds already noticed.

Kentville. Finally, in Kentville, just below the mill on Black River, the gray and red slates which there represent the Devonian system, are, like the similar red slates at Deep Creek, unconformably overlain by a second set of beds, strongly contrasted with the latter. These newer beds are mostly of a bright red colour, but alternate with layers which are pale-gray or white, both being so soft as to crumble between the fingers. They almost exactly resemble the beds of Lawrencetown and Deep Creek, while they lack the firmness of the beds both of Minas Basin and St. Marys Bay. Their attitude is nearly horizontal and their exposed thickness about thirty or forty feet.

Scott Bay. It only remains to notice the observation of Dr. Ellis as to the occurrence at Scott Bay, near Blomidon, of green sandy shales and sand-

stone, with limestone, resting upon the traps, and therefore of more recent origin.*

Reviewing all the facts above set forth, it is reasonable to believe that a large part of the reddish sediments underlying the Annapolis Valley, and which it has been customary to regard as older than the traps of the North Mountain, are newer than the latter, though no data are at present available whereby their exact age can be determined. The supposition that the beds at Digby containing blocks of trap are of the nature of agglomerates and contemporaneous with the traps, is opposed by the fact that with the trappean fragments are others of granite and quartzite which are well rounded.

TRAPS AND ASSOCIATED ROCKS.

The general features of the trappean rocks which intervene between the Annapolis Valley and the Bay of Fundy, with their extension westward in Digby Neck, Long and Brier islands, have been the subject of frequent description by earlier writers, among whom in particular may be mentioned Dr. A. Gesner (1836) and Sir J. Wm. Dawson (1868 and 1878). It is only recently, however, that the rocks have been subjected to close petrographical examination.

Regarded macroscopically, the most abundant and characteristic rock of the range is a compact crystalline admixture of augite and felspar, of a dark greenish-gray tint and a granular texture, but very hard, without stratification and with a tendency, which is sometimes very marked, to exhibit a jointed or columnar structure. On flat or slightly inclined surfaces, the divisional planes which produce this structure often give to these surfaces the aspect of a tessellated pavement; while in vertical bluffs or when exposed to the wearing action of the sea, they determine scenic effects resembling, though on a much smaller scale, those of the Palisades of the Hudson or of the Giants Causeway. The same joint-planes are also frequently marked by the presence of minute quartzose veins, while across the whole mass run much more considerable veins of a like nature, but more variable in coloration, producing agates and jaspers often beautifully clouded and banded. With these, at a number of points, are veins wholly or in part composed of magnetite or of octahedral hæmatite (martite) probably a pseudomorph of magnetite.

Macroscopic
character.

*Notes on Recent Sedimentary Formations on the Bay of Fundy Coast. Trans. Nova Scotia Institute of Science. Ser. 2, vol. I., p. 416.

Minerals.

While massive and more or less columnar beds predominate, they are frequently associated with less compact beds which are ashy, scoriaceous or amygdaloidal. These latter, especially when viewed from a distance, show a much more distinctly bedded arrangement, and are disposed in parallel sheets which are sometimes horizontal, but more commonly dip seaward at a moderate angle. These latter beds also vary much in colour, exhibiting various shades of gray, green, red and purple, the amygdules being commonly white and consisting of zeolites, often with thin incrustations of green chloritic matter. Instead of quartzose veins, these beds usually contain veins of a zeolitic nature, thompsonite being one of the most common minerals, but associated sometimes with stilbite or analcite. The occurrence of soft and easily decomposable substances like these, helps greatly in the disintegration of the rocks containing them, which are rarely found exhibiting the prominence that marks their harder and more massive associates.

In both the hard and the soft rocks, indications of copper, in the form of green stainings, are not uncommon, while in places minute grains or in some instances strings of native copper are met with.

The petrographical description of these rocks to which reference has been made, is contained in a paper by Mr. F. V. Marsters.* His remarks refer particularly to those found to the eastward of Digby Gut, but doubtless apply equally to those occurring to the west of this channel, and are as follows:—

Microscopic character.

“Under the microscope the rock proves to be composed chiefly of plagioclase, with generally irregular and scattered masses of augite, magnetite, sometimes showing perfect octahedral forms, but in the main massive, and a brownish mineral probably resulting from the decomposition of the augite. The plagioclase, which presents little evidence of decomposition, consists of lath-shaped crystals exhibiting very good crystallographic terminations. They are almost universally twinned, but seldom exhibit marked zonal structure. These sections approaching the zone of the axis of symmetry show a decided fracturing as if subjected to great pressure or some mechanical disturbance subsequent to the completion of their crystalline form. It makes up the most prominent component of the rock. Augite exhibits irregular small masses, with brightly polarizing centres and muddy dark brown peripheries. The brownish product, which is of secondary origin, extends along the cracks so universally present in augite, presenting a

* Triassic Traps of Nova Scotia, *American Geologist*, March, 1890.

net-like appearance. Whenever a crystal occurred sufficiently fresh and regular in form for orientation, it proved to be twinned on the orthopinacoid. Magnetite occurs for the greater part in irregular aggregates which may be of secondary origin, but not presenting a titaniferous aspect. The perfect octahedra are undoubtedly primary and were probably the first to form during the cooling of the fused mass. Compared with sections of Triassic traps from New Jersey, I find a marked resemblance both as regards the optical characteristics of the individual minerals and the relative quantities of each component."

The specific gravity of the more compact columnar trap is given as 2.93.

Among the localities in which the peculiar features of this group of rocks may be most conveniently studied, may be enumerated the shores of Digby Gut, Broad Cove, Sandy Cove and the Petite Passage.

The eastern side of Digby Gut, about the entrance, shows well both the more solid and columnar traps and the softer bedded amygdaloids. The cliffs are from 60 to 100 feet high, and show from five to seven layers or beds, the lower mostly gray or purple and vesicular, while the upper are dark-gray, compact and ashy. In places the beds are nearly horizontal, but in general they have a distinct northward or seaward dip of 5° to 10°. The amygdaloids have numerous veins of thompsonite, or show surfaces over which incrustations of this mineral are spread in circular radiating sheafs. Analcite and native copper have also been obtained here.

On the western side of the passage the exposures are similar, except that the columnar crystalline trap is more augitic than usual, and that this type of rock is here found above as well as below the amygdaloids, forming the promontory of Cape Prim. Surfaces a yard in diameter are here covered with white sheafs of thompsonite crystals, a mineral which is also very abundant at Broad Cove.

At Sandy Cove, the most interesting feature is the occurrence of precipitous bluffs, nearly midway between the two bays, and the information these give in regard to the structure of that portion of the Neck which lies to the westward of this point. As seen from the more prominent of these eminences the fact that the whole peninsula is composed of successive sheets or lava-flows is very clearly seen in the curiously serrated outline thereby caused. Each great bed has its highest portion to the southward and slopes thence at a gentle angle northward until it reaches and is abruptly covered by the next succeeding flow, which but repeats these features.

Petite
Passage.

Finally, in and about the Petite Passage, are afforded the most remarkable illustrations of columnar structure. This is quite conspicuous about the wharfs in the little fishing village of Tiverton, but much more striking at Israel Cove, a little below the village, and on the south shore of Long Island. Here the cliffs are not only very bold and high, but so perfectly jointed and upon so large a scale, as to present an extremely rugged front, the columns or groups of columns, isolated by the action of the sea, being left standing in prismatic or needle-like projections, often ten or fifteen feet in height.

While the bedded arrangement referred to above appears to be the result of several successive outpourings or overflows of igneous rock, it is possible that a part of the peculiar topography indicated may be due to repeated down-throws by faulting. No indications of any special line of extrusion have been observed, and it is altogether probable that the main lines of fracture giving vent to the igneous outflows or fissure-eruptions, lay beyond the present line of coast, and nearer the centre or axis of the great trough by the sinking of which the fractures may have been produced.

Further remarks upon the iron ores of Digby Neck and their associated minerals will be found in the sequel.

ECONOMIC MINERALS.

In the course of the preceding pages, references have from time to time been incidentally made to the occurrence of minerals of economic value in the several regions described. These may now be made the subject of more particular consideration.

List of
minerals.

The minerals and rocks to be thus noticed include gold and copper, in the native state; oxides of iron, such as magnetite, hæmatite, martite, ilmenite and limonite; metallic sulphides, such as pyrite, arsenopyrite and molybdenite; tungstate of lime or scheelite; ornamental stones, as quartz, amethyst, jasper, garnet, tourmaline, *etc.*; building stones, including granite and slate; brick- and fire-clays; rocks suitable for road construction; sand, and infusorial earth.

Gold.

Gold.—This is, of course, by far the most valuable mineral met with in the area under consideration, and the one around the existence of which cluster the most important interests. It is therefore desirable that the fullest possible information should be had regarding both the extent and the circumstances of its occurrence.

The fact of the existence of gold in connection with the so-called Cambrian coast-belt of Nova Scotia, was made known in Lunenburg

and Halifax counties some years prior to its discovery in the south-western counties ; and, though numerous reports and papers relating to the above-mentioned counties have appeared, the only one based upon observations in the south-western counties known to the writer, is that by his assistant, Mr. W. H. Prest.* The general conditions are, however, very much the same in all these districts, and hence it will be unnecessary here to do more than describe the particular localities in which mining operations have been entered upon, and to state such facts and conclusions as they may suggest. The following particulars are based partly upon the writer's own observations, partly upon information courteously afforded by the managers of different properties, and partly upon facts contributed by Mr. Prest, whose intimate and extended practical knowledge of gold mining in Nova Scotia has been of the greatest service.

The following are localities, within the limits of this report, in which the gold found has been thought sufficient to justify the commencement of mining operations and the erection of stamp mills :—

List of
gold districts.

Queens County.

- (1.) Malaga gold district.
- (2.) Whiteburn gold district.
- (3.) North Brookfield gold district.
- (4.) Westfield gold district.

Yarmouth County.

- (1.) Kempt gold district.
- (2.) Carleton gold district.
- (3.) Chegoggin gold district.

In addition to these, gold has been reported at Fifteen-mile Creek, north of Middlefield ; near Mill Village, on the Port Medway ; on Broad River, and near Grafton Lake ; all of these being in Queens county. Reports have also been made of discoveries in Shelburne, Digby and Annapolis counties, but most of these have not as yet been fully verified.

Malaga gold district.—Until recently, this has been the most important of the Queens county gold districts, there being here not less than five mining properties, on each of which large expenditures have been made. These are :—

Malaga
gold district.

1. The Parker-Douglas mine, with mill of twenty stamps.
2. The Caledonia mine, ten stamps.

*Proc. and Transactions, Nova Scotia, Inst. of Sc. Vol. I. Series 2. 1890-94.

3. The Minneapolis mine.
4. The McGinn mine, twenty stamps.
5. The Ballou mine.

History and
development.

The first discoveries in this district were made in 1886, one year after similar discoveries in Whiteburne, and were of such a promising character that, within a very brief period, what had been a wilderness of forest and huge boulders, became the seat of a busy and thriving mining community, with a population of over 600 souls. Besides residences for the managers, comfortable houses were erected for the workmen and their families, a commodious school was provided, stores and hotels were opened, and, together with the smoke of chimneys, the moving of cars on the tramways, and the hum of machinery, everything betokened a prosperous future. Such was the condition of affairs at the time of our first visit in 1891. Two years afterwards, on the occasion of a second visit, a great change had taken place. The largest of the mills previously at work, and the most thoroughly equipped, that of the Parker-Douglas Company, had ceased work. But little was being done at the other mines, though the Ballou Company was obtaining some very encouraging returns. The hotel and boarding-house had been burned, and a large part of the population had removed elsewhere. What causes were chiefly instrumental in contributing to this result, the writer is unprepared to say, but the fact that, more recently, work has been resumed at several of the mines previously abandoned, including that of the Parker-Douglas Company, together with facts to be presently noticed in regard to the Brookfield mines, would seem to indicate that other circumstances besides the quantity of gold present might have something to do with the result.

The leads at Malaga are all in quartzite with interbedded slates, representative of Division I. of the Cambrian system, and forming part of an anticlinal dome lying between Malaga and Ponhook lakes. There are but few exposures at the surface, and underground plans, if made, have not been open to our inspection.

Whiteburne.

Whiteburne.—This district is situated about twelve miles to the westward of Malaga, but geologically at about the same horizon in the Cambrian system, *i.e.*, in the quartzite division, not far below where the rocks of the latter graduate into greenish arenaceous slates. The beds are much better exposed than at Malaga, and over the greater part of the district dip northerly (N. 10° W. < 40°) with great regularity. The leads vary from five inches to ten inches in width, and are said to yield, upon an average, about \$20 to the ton in gold.

The first discoveries made here were in 1885, it is said by an Indian, on the property of the Whiteburne Mining Co., when work was begun in the following year, with the erection of a five-stamp mill. This mill was subsequently doubled in capacity and a force of from 50 to 100 men was employed, a shaft being sunk to a depth of 100 feet. At the same time several other companies commenced operations close by, one of these being the Queens County Mining Company, with a plant of ten stamps, air compressors, *etc.*; another, the Rossignol Mining Company, working the so-called Cushing vein, with a mill of ten stamps; and finally the Gammon mine, at one time owned by the Parker-Douglas Co., and on which Gammon and others proposed to erect a Wiswell mill, with revolving rollers instead of stamps.

History and development.

North Brookfield Gold District.—The vicissitudes of gold mining, remarked upon in the case of the Malaga district, find an equally striking illustration here, but fortunately in the reverse direction, of greater returns and an enlarging prospect.

North Brookfield.

Our first visit to this neighbourhood was made in the year 1890. Two mines had then been opened, both a little to the south of the main road through the settlement, and distant about half a mile from each other. Of these the first or Maguire mine was idle, work having been stopped from a failure to obtain remunerative returns, while the second, known as the Philadelphia mine, was giving employment to about forty men and a mill of ten stamps, with, as represented, a good output of gold. On the occasion of a second visit, made in the summer of (1896), this condition was found to be almost reversed. Work was indeed still in progress at the Philadelphia mine, but only in a small way, while the previously idle site of the Maguire mine had now become a scene of bustling activity. Not only had the old mill been again brought into action, and the homes of the workmen been re-occupied, but a far larger mill, to include not only a battery of fifty stamps but the necessary plant for a combined amalgamation and chlorination process, was in course of rapid erection. About fifty men were found to be employed as miners and as many more in various occupations connected with the mines.

History and development.

The explanation of this gratifying change, so far as the Maguire mine is concerned, is of course to be sought in the record of its more recent workings, which, as given in the returns of the Mines Office, is as follows :—

Returns of yield.

	Rock crushed. Tons.	Yield of Gold. Ounces.
1894.		
December.....	150	127
1895.		
January.....	375	144
February.....	380	128
March.....	390	151
April.....	300	140
May.....	318	205
June.....	268	231
July.....	272	211
August.....	202	183
September.....	364	303
October.....	450	321
November.....	458	394
December.....	465	561
1896.		
January.....	390	350
February.....	427	424
March.....	425	330
April.....	445	352
May.....	476	565
June.....	452	385
July.....	470	396
August.....	431	376

Auriferous
tailings.

An interesting circumstance in connection with the development of these works, is that of the yield afforded by the re-working of the tailings of former operations. I am informed that a ton and a half of the latter, sent to North Carolina for treatment, yielded \$75; and it has been in part with a view to subjecting the whole mass of these tailings to a similar process that the new works are erected.

The company working this property is known as the North Brookfield Mining Company, its managers being Messrs. Libby and Maguire.

The main lead at this mine is a fissure lead, from four inches to four feet in width, with a dip about N. 45° E. < 70° to 80°, while the rock is partly quartzite and partly a highly chloritic slate, which is easily crushed. The main lead is intersected by several "angulars," and it is at the junction of these with it that the greatest quantity

of gold is found. The gold is mostly carried in the sulphides with which the rock is highly charged, the free gold not being more than fifty per cent of the whole, if as much.

Nature of
leads.

The following additional particulars of this mine, based on observations by Mr. Prest, are reproduced here from the authors preliminary report, published in 1895. (Annual Report, Geol. Surv. Canada. Vol. VI.)

Prest

"In the case of the Brookfield leads, it has been further noticed (1) that only those bedded leads which dip towards or intersect the cross or fissure leads contain gold; (2) that those bedded leads which dip away from or do not intersect the said cross leads do not yield gold; (3) that those bedded leads which do carry gold become more and more barren as we recede from the neighbourhood of their junction with the cross leads; (4) that those bedded leads which are found in the western part of the district, although in the same geological horizon as those intersecting the cross leads, have thus far proved barren, and (5) that those bedded leads which intersect the cross leads contain the same metal. From these several facts the conclusion is suggested that, in the case of the Brookfield area at least, the bedded leads have been mineralized from the great fissure or cross leads upon which nearly all the work in this vicinity has been done.

Productive-
ness of leads.

"It may be added that while the bedded leads all dip away from the apex of the anticline, the cross leads dip towards it. Thus the bedded leads often intersect the cross leads. The former curve with the quartzite and slate belts of the dome, but dip away from it at an angle of from twelve to thirty degrees, according to their position around the anticline.

"The general course of the anticline at Brookfield is S. 60° W., and it seems to be subsidiary to the great Malaga dome or fold.

The Philadelphia Company's mine is situated on the south-easterly extension of the Maguire vein, and has a dip about N. 40° E. < 80°. Its width varies from a few inches to four feet. The gold is reported to be irregularly distributed by those having no interest in it; but it is certain that rich as well as poor spots occur, and as in the case of the Maguire mine it is probable that much gold may yet be recovered from the tailings. The workings have reached a depth of over 200 feet.

Philadelphia
Company's
property.

West Caledonia Gold District.—The structure here seems to be that

of an oblong fold which flattens out towards the east, and turns into a series of undulations south of DeLong settlement. The beds to the north and south succeed each other regularly, the gray or greenish-gray slate, however, occupying on the north more than the usual amount of space. The purple slates are seen about two miles and a quarter south of the anticline. The latter slates seem to continue east to McGowan Lake on the Port Medway River, while the greenish-gray slates circle around the eastern end of the quartzites in Kempt and meet the northern gray slates.

West
Caledonia.

The gold occupies a higher horizon than that of Malaga, but lower than that of North Brookfield. Its distribution is extremely irregular, and success in prospecting, which is all that has been yet attempted, is a matter of much uncertainty. Some money has been spent here but without success.

Westfield.

The Westfield Gold District.—This district is situated about three miles north-west from North Brookfield, and not far from the southern extremity of Tupper Lake. It includes, as far as known, but a single property, locally called the "Jumbò mine," and known rather for the unusual size of the quartz reefs there exposed, and the magnitude of the expectations based thereon, than for its actual gold contents.

The rocks of this vicinity are somewhat higher in the Cambrian system than those of the districts previously noticed, consisting chiefly of the black slates of Division III., together with some coarser and more sandy beds. Through these, and coincident with the bedding, run reefs of white quartz from twenty to thirty feet in thickness, much of the mass being white and vitreous, while other portions are gray or stained with oxide of iron. The rock contains both iron and mispickel, the latter abundantly, and from these sulphides it is stated that gold has been obtained to the extent of two pennyweights to the ton, with sixteen of silver. For its removal a mill of twenty stamps was erected and fully equipped, but to be almost immediately abandoned, with the removal of the machinery elsewhere. It is said that not less than \$30,000 was expended upon the property, while its subsequent sale realized only \$1,500. It is, however, the opinion of many that this mine, like that of Brookfield, has a future before it.

The Kempt Gold District.—(Yarmouth county.) It is an interesting confirmation of the reference of the Yarmouth county rocks to the Cambrian system that, like those of the latter age in Halifax, Lunenburg and Queens counties, these should also be auriferous.

The horizon of the beds in which the Kempt mine has been opened is the same as that of the mines at Brookfield, *i. e.* in greenish arenaceous slates overlying the quartzites of Division I. As at Brookfield, the veins are chiefly fissure veins, crossing the bedding-planes at various angles. As far as known, however, they are much less productive. We were informed by the manager that about \$25,000 worth of gold had been obtained here, but at a cost considerably greater. At the time of our visit, (1896) no work was being done, but it was thought that it would be at once resumed. Kempt.

The ledges holding the leads were not exposed at the surface, and, as far as we could judge, the work of excavation had been largely haphazard. The property includes a good 50 horse-power engine and a battery of ten stamps.

Half a mile south-west from the Kempt mine is the Cowan mine, opened in rocks similar to those of the former, and with similar results.

Carleton Gold District.—The work carried on here is only exploratory, and little or no return has yet been realized. A mill of eight stamps, worked by a branch of the Tusket River, has been erected at Carleton, the rock, which is similar to that of the Cowan and Kempt mines, being obtained from beds but little removed. Some good "finds" are said to have occurred in the vicinity, but the outlook at present can hardly be regarded as encouraging. Carleton.

It is noticeable that the beds carrying the auriferous leads at the several localities above referred to, all occur on the northern side of a single anticline traversing a considerable portion of Yarmouth county in a south-westerly direction.

Cheggogin District.—In the description of the coast section north of Yarmouth Harbour given in preceding chapters, reference had been made to two localities as having been the site of gold mining operations.

Of these the first is Cheggogin Point, where, in the year 1890, a mill of ten stamps was erected for the purpose of crushing quartz from a series of large reefs of this rock exposed upon and near the shore-cliffs. The rocks composing the latter are partly coarse sandstones approaching quartzite in character, and partly gray slates, both of which exhibit short and sharp corrugations, though with a general south-easterly dip of 45°. With the above dip, but apparently in inferior position, are micaceous, staurolitic and hornblende rocks, and Cheggogin.

all are probably the altered equivalents of the green chloritic sandstones and slates of Division 1 *b*, the same in which occur the auriferous veins of Brookfield and Kempt.

One of the masses of quartz exposed at this locality is not less than twenty-six paces across, and others occur of scarcely smaller dimensions. A considerable quantity of this quartz has been removed and crushed, but no reliable data as to its yield could be obtained. At the time of our visit in 1892, all work had been abandoned, without prospect, so far as we could learn, of its renewal.

Cranberry
Head.

The second locality on this coast is that of the Cream Pots at Cranberry Head, about five miles north of Chegoggin Point. Here the rocks exposed on the shore in high bluffs, are more slaty than at the headland last named, but the near association with them of quartzites, micacious and hornblendic schists, would seem to indicate that their geological position is not greatly different. In this case again the original find of gold seems to have been sufficient to justify considerable expenditure in the erection and furnishing of a mill, but with the same result as at Chegoggin Point, that of its speedy abandonment. The works have been recently reopened (1897) and operations renewed, but we have no information as to the results.

Copper of
Digby Gut.

Copper.—In the traps of the North Mountain, and of Digby Neck, it is not an unusual thing to find the rock more or less stained by small quantities of the carbonate of copper. These stainings are, no doubt, due to secondary products derived from native copper, of which small grains and irregularly branching strings also occur. The latter were observed in some of the amygdaloids which form the bluffs just east of the entrance of Digby Gut, and it is said that deposits of considerable size have been found in this neighbourhood. On Brier Island, also, native copper was observed in isolated grains in amygdaloid. But in no case have any real veins of this metal, or anything which would seem to justify expenditure in the search for it, come to our notice.

Iron ores.

Iron.—The oxides of this metal found within the region under review and constituting ores, are referable to two widely separated systems of rocks, and are as strongly contrasted in their nature, mode of occurrence and conditions of origin.

a. Iron ores of the Nictaux-Torbrook and Clementsport Basins.—In connection with the discussion of the geological structure of these

basins, in earlier pages of this report, frequent reference has been made to the occurrence therein of extensive deposits of hæmatite and magnetite, and the view has been expressed, from the nature of the fossils with which at many points they are filled, that they belong to the lowest portion of the Devonian system.

The fact of the occurrence of such ores has been known for many years, and more or less detailed accounts of their nature, composition and extent, as well as of the attempts made to work them (the earliest, at Clementsport, being in 1831) have been given by various authors.* Clementsport. Accordingly, only such facts will be referred to here as seem to throw additional light upon their possible future development. It should be added that as the study of the Nictaux-Torbrook basin was undertaken chiefly with a view to ascertain what light it might afford in the investigation of doubtful points in the geology of Digby county, and as that study was neither exhaustive nor accompanied by instrumental measurements, the observations which follow must be accepted as only partial and tentative.

In the discussion of the structural relations of the different parts of the Nictaux-Torbrook basin, an attempt has been made to show that this structure is that of a broad syncline, or more correctly of two synclines, which are parallel and overlap. In this view the principal ore-belts are repetitions, more or less complete, of the same sets of beds, successively brought to the surface by folding. It is certain that these ore-belts stand in such relations to the associated strata that one familiar with the character and succession of the latter may predict, with considerable confidence, where these ores are to be found, and that with few exceptions their occurrence is strictly in accordance with this view. It is also certain that ore-beds of essentially the same character and thickness persist upon the strike for long distances, though from causes which are not always obvious, what is a "shell ore" at one point, abounding in organic remains, may be nearly or quite destitute of fossils at another; while an ore which is ordinary hæmatite at one point may at another be more or less magnetic. Such variations do indeed occur within a distance of a few yards in what are evidently

Relations of
ore-belts.

* Haliburton—History of Nova Scotia, 1829.
Genser—Remarks on the Geology and Mineralogy of Nova Scotia, 1836.
Dawson—Acadian Geology, 1868.
Harrington—Notes on the Iron ores of Canada, Report of Progress, Geol. Surv. Can., 1873-74.
Gilpin—Mines of Nova Scotia, 1880.
Gilpin—Proc. and Transactions, Nova Scotia Institute of Science, vol. IX., part 1., 1896.

continuous ore-beds—a fact which must be constantly borne in mind in any attempt to trace out these beds across the country. In illustration of the wide distribution of these ores, the following list of lots upon which they have, according to reliable authority, been found, is given :—

LIST of Farms in the Nictaux-Torbrook Basin, containing deposits of iron ore.

List of
ore-deposits.

1. Mrs. Jeannette Banks.....	Meadowvale.....	Hæmatite.
2. David Banks.....	".....	"
3. Eaton.....	Torbrook Road.....	"
4. Nealy.....	".....	"
5. Ezekiel Barteau.....	Torbrook Centre.....	"
6. R. J. Lecky.....	".....	"
7. Saml. Barteau.....	Torbrook Mines.....	"
8. Capt. Burns and J. H. Banks	".....	"
9. Banks.....	Torbrook.....	"
10. Wm. Nealy.....	".....	"
11. Parker.....	".....	"
12. Stanley Brown.....	".....	"
13. Holland.....	".....	"
14. Banks.....	Canaan Mountain.....	"
15. Stearns.....	(Ore first found here)	"
16. Benj. Wheelock.....	Canaan.....	"Shell ore" magnetite.
17. Foster.....	".....	"
18. Fletcher Wheelock.....	".....	Magnetite and hæmatite.
19. Banks.....	".....	Shell ore.
20. Hanley Wheelock.....	".....	"
21. Edward Martin.....	".....	"
22. James Allen.....	".....	"
23. Mrs. John Ward.....	Nictaux River.....	"
24. Danl. Armstrong.....	Bloomington.....	"
25. Page & Stearns.....	Cleveland.....	Magnetite.
26. John Heately.....	".....	"
27. S. B. Willet.....	".....	"
28. Abner Saunders.....	".....	"
29. Whitnan Wheelock.....	Canaan Mountain.....	"
30. Benj. Wheelock.....	".....	"
31. Banks.....	".....	"
32. Foster.....	".....	"
33. Foster.....	".....	"
34. Messenger.....	".....	Hæmatite

Torbrook ores. The ore worked at the Torbrook mine is a bed of red hæmatite, from five to seven feet thick, massive and fine-grained, with a tendency to break in rhomboidal blocks, and in parts containing considerable pyrites, from which, however, the greater part is free. This bed has been traced in an easterly direction for about two miles, to the county line, and has been supposed to connect in a westerly direction with beds of similar character near Nictaux Falls. A reference, however, to the strike of the rocks, in connection with the general structure of the basin, renders it probable that, while occupying geologically the same horizon, as indicated by their similar associations, the Nictaux beds mark a line forming the rim of a more northerly basin, there cut off

from view by the sandstones of the Annapolis Valley, while the real extension of the Torbrook beds is to be found along a line, which is their line of strike, connecting Torbrook with Wheelock's farm, and the latter with the ore-beds of the upper part of the Nictaux valley and of Cleveland. Similarly, the beds which are exposed at the Messenger mine, on the McGinty road, and on the hills south of Torbrook Centre, and in Bloomington, may be regarded as representing another repetition of the same strata, brought to the surface and more or less metamorphosed in connection with the extrusion of the adjacent granite. Until, however, careful instrumental surveys shall have fixed the position of all available outcrops, and possible errors due to folding and faulting have been duly considered, these conclusions can hardly be looked upon as final.

It is interesting in this connection to notice that the ores of Clementsvale occupy, both geographically and geologically, a position similar to that of the principal ore-belt at Nictaux. As, moreover, the structure of the region south of Kentville, although not yet fully worked out, seems to be but a repetition of the Nictaux and Clementsport basin, it is reasonable to expect that iron ores similar to those of the latter locality will be found to have a wide distribution in the intervening district.

b. Iron ores of the North Mountain and of Digby Neck. While, as stated above, iron ores have a wide distribution along the southern side of the Annapolis Valley, the hills which overlook the same valley from the north and their extension westward beyond Digby Gut are also at many points the repositories of ores of the same metal.* But while the former are always of the nature of *beds*, running with and conformable to the course of the strata which inclose them, and often characterized by accumulations of fossil shells, the latter are in the form of veins, intersecting trappean rocks, and with courses usually transverse to such bedding as these rocks exhibit. They are of course without fossils, being instead usually highly crystalline, and having associated with them a variety of other crystalline minerals, such as quartz and zeolites.

Digby
iron ores.

The only locality of such ores known to us, to the east of Digby Gut, is one referred to by Dr. Harrington in his report on the Iron ores of Canada, as found two miles north of Middleton, in An-

*The existence of iron ores in Digby Neck was first discovered by Sieur de Monts, Lieutenant-General of Nova Scotia under Henry IV. of France, in the year 1604.—Pioneers of France in the New World. Parkman.

napolis county, and said to be from six to nine inches thick. To the west of Digby Gut their occurrence is more frequent.

A pit or trench from which a considerable quantity of ore was at one time taken is to be seen about three miles north of the town of Digby, near the road to Broad Cove. Fragments of the ore piled by the roadside consist partly of red and brown hæmatite and partly of magnetite.

The thickness of some of the blocks is as much as a foot, indicating veins of somewhat greater thickness than those to be next noticed, though apparently of inferior quality. Barytes was present in the vein, though not in large quantity. At present the trenches are filled with water and rubbish and no very definite information is available.

The next locality to the westward is that of "Nicholl's mine" in Rossway. The veins here, as elsewhere in this range, consist mainly of magnetite, or of hæmatite having the crystalline form of magnetite (martite). The ore is mostly in lenticular masses, but occurs also in irregular pockets or in veins dipping in various directions. The widest parts of the veins usually form geodes, which are often lined with amethysts, and very beautiful specimens of this mineral, either alone or associated with calcites and zeolites, have been obtained here. Other cavities are filled with crystals of pure limpid quartz, sometimes showing double terminations; while still others contain a very soft unctuous or clayey material, which both in colour and consistency may be compared to brown soap. The latter substance is also found filling every seam and crack in the rock, as well as lying beneath the surface next the solid trap.

Nicholl's
mine,
Rossway.

We have been unable to obtain particulars as to the amount of ore taken from this locality, its percentage composition or the cost of its removal. Only a small trench was opened on the vein, and this is now largely filled with rubbish.

About four miles westward of "Nicholl's mine" is "Johnson's mine," in Waterford. This is a much broken deposit of magnetic iron, partly massive or micaceous and partly in the form of isolated octahedral crystals, of which fine specimens, either alone or in association with quartz and zeolites, may be obtained. A considerable amount of rock and ore had been removed, but evidently at too great a cost to justify a continuance of the work. Nothing has now been done for several years.

Johnson's
mine,
Waterford.

Of other points at which ores similar to the above occur, may be mentioned the "Moorehouse vein,"¹ about one mile east of Sandy Cove

on the shore of St. Marys Bay, where fine octahedral and dodecahedral crystals abound; the same shore, just below Mink Cove, the veins here being more compact and from three to four inches in width; and the hills overlooking the Lobster Ponds at Long Beach. Mink Cove.

It should be added that loose blocks of magnetic iron ore, sometimes a foot or more in diameter, are met with at other points in the same range, as between Rossway and Digby Gut, and seem to indicate the presence of veins as large as or larger than any heretofore opened; but notwithstanding the comparative purity and richness of the ores, they being in these respects much superior to the deposits of Clements-port, Nictaux and Torbrook, it is doubtful whether, they can ever be profitably worked, in view of the large amount of very hard rock requiring to be removed at the same time.

We have been informed of the occurrence of spathic iron in the cliffs on the coast south of Metaghan, in a vein said to be six feet wide, and have seen a specimen of excellent ore of this character, stated to have been derived therefrom, but no such ore was observed by us in our examination of this well-nigh inaccessible shore, and we can say nothing regarding it from personal knowledge. Spathic iron.

Titanic Iron.—It has been stated in the description of the rocks about Yarmouth Harbour and the extension of the same belt north-eastward to Digby county, that the hornblende which is so conspicuous a feature of this belt is sometimes accompanied by crystals of ilmenite or menaccanite. This has especially been observed to be the case at Chegoggin Point and the vicinity of Brazil station, on the Dominion Atlantic Railway, but is probably true to a greater or less extent of the rocks lying between these two somewhat distant points. At the former locality, a dyke or vein of mixed hornblende, mica and garnet, showed black and lustrous tabular scales of ilmenite an inch or more in diameter, and others as large or larger were observed just east of Brazil. Titanic iron.

Metallic Sulphides.

Pyrite or sulphide of iron is a mineral so abundant in the upper or black slate division of the Cambrian system, as properly to be regarded as one of its distinctive features. At many points these black slates are literally studded with cubic crystals of this mineral, while its presence is no less strikingly shown by the result of its decomposition, in the excessively rusty weathering of many of these rocks, a feature indeed of almost universal occurrence; also by the not unfrequent consolidation of beds of drift, derived from such pyritous slates, into Pyrite.

hard ferruginous conglomerates. Striking instances of this latter effect may be seen in the town of Bridgewater, and others, scarcely less remarkable, in the beds, already noticed, which cap the slate bluffs on the southern side of Cape Cove in Yarmouth county.

It would seem not improbable that some of the more highly pyritous of the slates in question, might be profitably used as the basis of sulphuric acid and alum manufacture.

Arsenopyrite. *Arsenopyrite* or *Mispickel* is a not uncommon mineral in connection with the quartzites of the Cambrian system, but apart from the fact of its frequent association with gold, and being to some degree a favourable indication of the presence of the latter, has little economic value.

Molybdenite. *Molybdenite* or *Sulphide of Molybdenum*.—A small vein of this mineral was observed in a brook, tributary to Jordan River, about six miles above Jordan Falls, in Shelburne county, and it has been reported at other localities.

Ornamental Stones, Etc.—The following substances, valued chiefly for their beauty or as mineralogical specimens, occur within the region discussed in this report.

Quartz. *Quartz* or *Rock Crystal*.—This mineral is of common occurrence in connection with the veins traversing the traps of the North Mountain and Digby Neck, but especially so in connection with the magnetite veins in Rossway and Waterford, Digby county. Both isolated crystals, sometimes doubly terminated, and groups of crystals occur here, exhibiting many interesting modifications. In the same vicinity, large veins and loose boulders often yield very curious examples of mammillary, saccharoidal, drusy and stalactitic quartz, sometimes clear, sometimes opaque, but pure white; in other cases pale pink or amethystine in various degrees.

Specimens of similar variety and beauty were observed among the loose blocks strewing the shores of the Petite Passage near Tiverton.

Amethysts of great beauty were formerly obtained from the iron mines of Digby Neck (especially the Nicholl's mine in Rossway) while this was worked, but similar specimens can now only be secured at these points by blasting. The beauty of these specimens was often much enhanced by their form, and by the association of various minerals together, nodules or cavities of amethyst being bordered by parallel or concentric layers of agate, jasper of red and yellow tints, yellowish calcite, stilbite and black iron crystals. Veins of amethystine

quartz, unaccompanied by iron, also occur, but rarely, and good specimens are difficult to obtain.

Agates, Chalcedony and Jaspers.—The trappean rocks of the North Mountain and of Digby Neck, abound in these, as in other varieties of quartz, and specimens may be readily had in great variety and beauty. As with the minerals above noticed, the finest specimens have been found in the vicinity of the iron veins. Thus, on the hillsides near the Johnson mine in Waterford, Digby county, are found large numbers of loose blocks, consisting wholly or chiefly of these minerals, and sometimes exhibiting cloudings and bandings of great beauty. The cliffs overlooking the northern entrance of Petite Passage, between Digby Neck and Long Island, are also remarkable for the number and variety of the agate veins which traverse them. At Gulliver Cove, on Digby Neck, interesting specimens may be had in the coastal cliffs, as well as in the blocks with which the shore is strewn.

Zeolites.—The species of this group of minerals observed by us in the trappean range of Annapolis and Digby counties, are the same as those so long known as occurring in the more easterly parts of the same range, and particularly about Blomidon, but are rarely found in specimens comparable with the latter in size or beauty. *Zeolites.* Stilbite, of unusual forms and colours was noticed and collected at Johnson's mine in Waterford, but the species is not of common occurrence. Thompsonite is much more abundant, especially about the entrance to Digby Gut and at Broad Cove. On the east side of the latter, a vein attaining a thickness of five or six inches and composed of what had once been very beautiful sheafs of very large crystals, was observed, but from long exposure to the air and sea these had lost both lustre and firmness, crumbling at the touch. At Digby Gut the thompsonite was in some instances found to be accompanied by cubical crystals of analcime, and still more rarely, of natrolite. Heulandite crystals of small size, associated with stilbite, were observed at the Waterford iron mine. A considerable cavity in the face of the amygdaloidal bluff, half a mile east of Margaretville, in Annapolis county, was found to be lined with clusters of laumontite crystals, of great beauty when removed, but which rapidly crumbled, upon drying, to an amorphous powder. Fine natrolite has been found in the same vicinity.

Garnet, Staurolite, Andalusite and Tourmaline.—These minerals, excepting the last, are all of very frequent occurrence in the more metamorphosed portions of the Cambrian system, but especially of those of Division I. *b.* Thus they abound in the mica-schists of Shelburne county, more especially on either side of Shelburne Harbour and

Garnets, etc. about Jordan Bay and River; as they do again in Yarmouth county, about Pubnico Harbour, at Chegoggin Point and in the belt of metamorphic strata extending thence to and beyond Brazil. As seen along the coast of Shelburne county, the garnets, though clear, are small, rarely attaining the size of a pin's head, and often requiring a glass for their detection. In the interior, near the granite, they are larger, sometimes with a diameter of half an inch or more, but these are usually coarse and opaque. In Yarmouth county, some of the strata exposed in the fields near Brazil station are thickly studded with large garnet crystals, but without lustre or transparency. Perhaps the most interesting specimens seen by us were on the Atlantic shore near the gold mine at Chegoggin Point. Here are veins or dykes of mixed mica, hornblende and garnet, so largely charged with the latter mineral that some of the rock has been removed for abrasive purposes; and in this, along surfaces of fracture or jointing, layers of pure garnets are sometimes found, which, though opaque, are sharply defined and brilliantly lustrous, making, as illustrated in the Survey museum, very handsome specimens.

Staurolite. The best localities for the collection of staurolite are Jordan Falls, the shores of Shelburne Harbour (on the eastern side, opposite McNutt Island, and on the western, in Carleton settlement), at St. Anne Point in Pubnico, and above Lake Annis, in Yarmouth county. They vary in colour from gray to dark brown or black, and in shape from right rhombic prisms to various secondary forms, the prisms being sometimes half an inch in diameter. Crossed crystals occur, but are not common, while all the specimens seen were opaque.

Andalusite. Andalusite occurs in the same rocks as the staurolite, and is, indeed, in some instances very curiously blended with the latter. While less common than the staurolite it is often more conspicuous from the larger size of the crystals, which are as much as six inches long and an inch in width. The crystals are, however, usually very imperfectly formed, the prismatic shape being only roughly outlined, and the surface usually obscured by small mica and staurolite crystals, similar to those of the surrounding matrix, from which they are not easily removed. Occasionally bright cleavage surfaces of a pale-pink or rose colour are met with, but no distinct macles were observed. Port La Tour is a good locality in which to collect specimens, especially on Goose-neck Point.

Tourmaline is of much less common occurrence than the minerals previously mentioned. It is, however, sometimes met with as a con

tact mineral along the lines of junction of the granite and gneiss or mica-schist. It was thus observed by Mr. Prest in the region above the head-waters of Bloody Creek, a branch of the Clyde, in Shelburne county, and by the writer near Pubnico Lake, in Yarmouth county. It has also been observed in Broad River, in Queens county. Finally it has been long known as occurring near the town of Paradise in Annapolis county, where quartz veins penetrating granite are, in some instances, filled with black lustrous prisms of this mineral.

Building Stones.

Granite.—The distribution of this rock in south-western Nova Scotia has been fully described in earlier pages of this report, as well as represented in geological maps, and no further details as to such distribution are needed here.

The granitic rocks present much variety of texture, but less of colour, being of light-gray to pinkish tints, rarely dark, and, so far as known to the writer, never very red. Their use for purposes of construction would seem to have been determined as much by their facilities for removal as by any distinctive features possessed by them. The largest quarries which have been yet opened are those of Shelburne Harbour, where, at the time of our visit in 1891, about fifty men found employment. The rock here is a light-gray granite, and is obtained partly from ledges and partly from huge boulders. Portions of the bed-rock show a strongly laminated appearance, and to this structure in part is no doubt due the ease with which it is removed, as well as its adaptation to special uses. Among the latter may be mentioned the manufacture of cubical blocks for paving, of which 1500 were made in a day, and of which two or three ship-loads were, at the date referred to, being sent off every week. There are, however, constant fluctuations in the demand for this as for other purposes. The quarries are admirably situated and any possible demand for that particular type of rock could be easily met.

Another locality at which quarries have been opened in granite is that of West Nictaux. These were first opened to obtain stone for the culverts of the Nova Scotia Central Railway, about six or seven years ago. Subsequently the material, like that of Shelburne, was used for the making of paving blocks, and three or four car-loads were removed. Two car-loads of large blocks were also sent to St. George, N.B. The rock is very fine, and easily split, though hard. The work, under the direction of John Kline, is carried on with the aid of steam drills.

Still other quarries of less importance occur along the line of the Central Railway, near Springfield, Annapolis county.

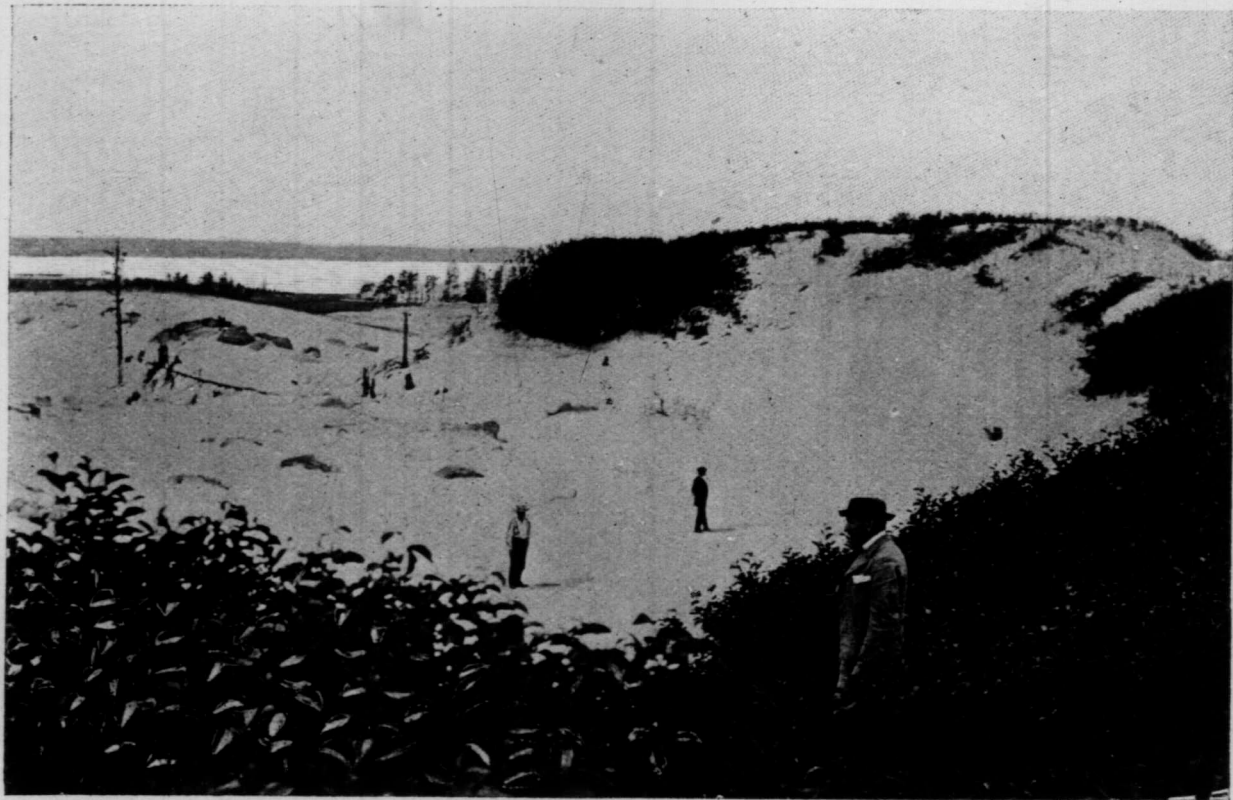
Slates.

Slates.—In a country in which argillites are of such common occurrence as in south-western Nova Scotia, it may reasonably be supposed that some of these would be suitable for roofing or writing purposes. No attempt has, however, as yet been made to discover any such beds, still less to open up any quarries therein. In the case of the black slates of Division IV. of the Cambrian system, the amount of pyrites with which these are charged would seriously interfere with their value, but the underlying blue and ribboned slates are free from this disadvantage, while their low inclination in many instances, together with their highly pronounced cleavage, would seem to recommend their use. Rocks of this character occur in the northern part of Queens county, about Fairy Lake in Annapolis county, as well as in different parts of Digby county. Slates of more recent age also occur in the Bear River and Nictaux-Torbrook basins, in Annapolis county.

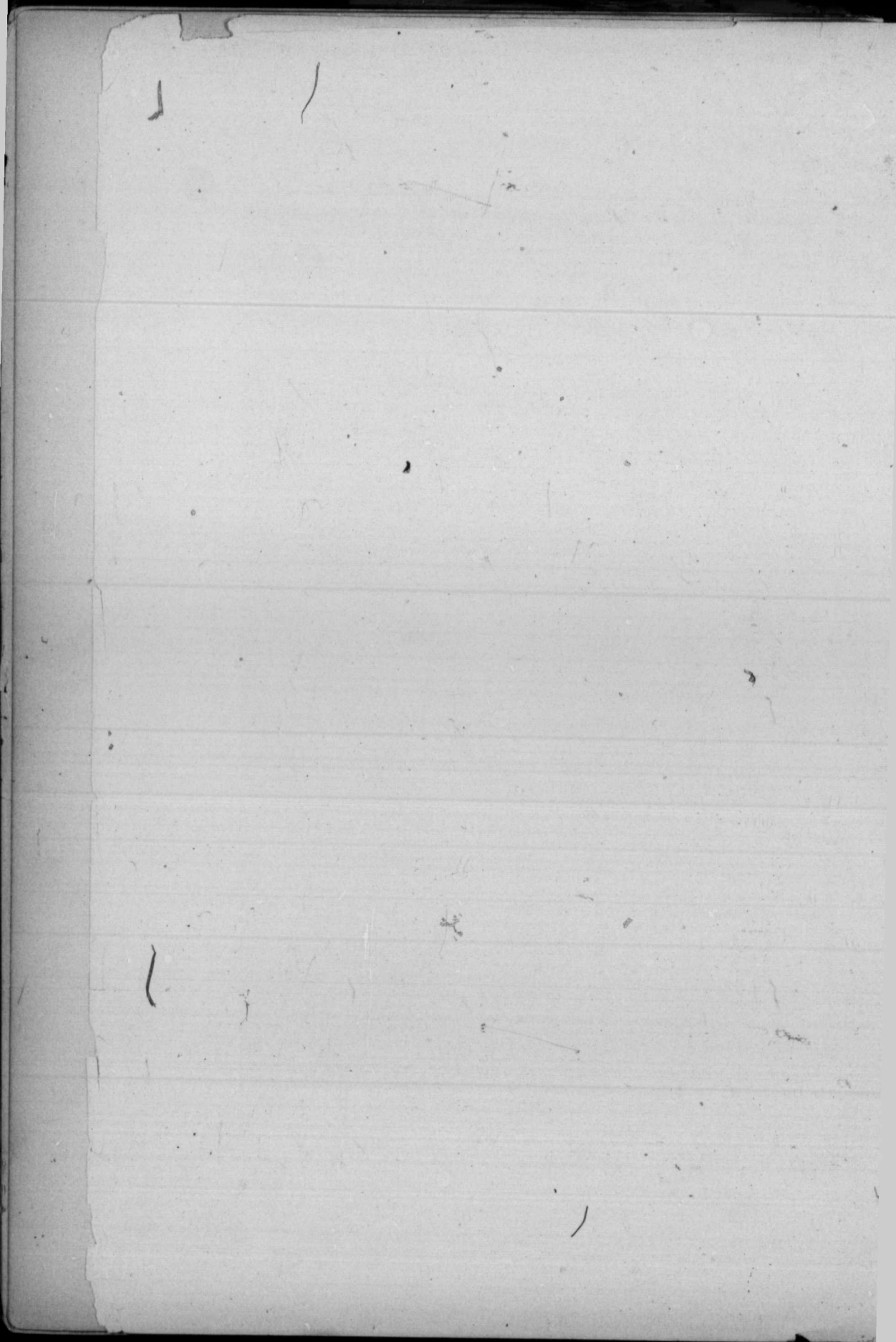
Clays.

Clays.—Materials suitable for the manufacture of bricks and tiles have probably a somewhat wide distribution in south-western Nova Scotia, but have only been utilized in a few instances. We are without definite information as to their occurrence in Queens, Shelburne or Yarmouth counties, though we believe that in the first-named county bricks have been manufactured to a limited extent in the vicinity of Liverpool. In Digby county a deposit apparently suited for the making of fire-brick has recently been found about one mile south-east of the church in Marshalltown. Some 500 acres of land have here been leased by Mr. J. Lonergan, over which a white clay occurs with a depth of three to twelve inches, with clays of other kinds beneath. A specimen of the white clay sent to the Survey office was found to be fusible with difficulty.

Clays of marine origin, probably underlie a considerable part of the Annapolis Valley. They are well exposed three miles west of Middleton station, where operations for the manufacture of bricks have for some years been in progress. The clays used here are very pure and tough, but, as indicated by their brick-red colour even before burning, contain much iron, and are therefore unsuitable for fire-bricks. As they hold shells of mollusca, as well as fossil starfishes, the lime derived from these would further unfit them for such use. The clays are covered with beds of sand, but neither the extent nor depth of the clays is known. Wells sunk to a depth of 65 feet at Kingston failed to reach solid rock.



HILL OF BLOWN SAND, EAST SIDE OF BARRINGTON BAY, N. S.



Sands.—In addition to the red sands referred to above in the Annapolis Valley, there are with these, at various points, beds of very white sand, which might be suitable for glass-making or other purposes. Far more extensive as well as purer deposits of such material have, at different points upon the Atlantic coast, been piled up by the action of the winds. Of these deposits of drift sand the most remarkable are those on the west side of Port Mouton Harbour and the east side of Barrington Bay. In each case they cover considerable tracts along the shore, and are annually marching inland. In places they attain a depth of fifty or sixty feet, and are so situated as to be capable of easy removal. They are almost snow-white in colour, and purely silicious. Sands.

Rocks suitable for Road Construction.—In view of the increased attention now being given to the construction of highways, and the need felt in some portions of south-west Nova Scotia, especially in the Annapolis Valley, for the use of some road-making material having greater binding power than the sands there so widely distributed, it may not be out of place to refer here to the inexhaustible supplies of the very best material for such purposes afforded by the trappean rocks of the North Mountain and Digby Neck. So admirably indeed are these adapted for such use and so favourable is their situation for removal, that they have already attracted the attention of strangers and have been referred to in recent reports of the United States Geological Survey, as a possible future source of supply in connection with the macadamizing of the roads of New England. Tests carried out by officers of that survey in connection with the Highway Commission of Massachusetts, have fully shown the high relative value of diabase rock for road purposes, and there is no reason to suppose that the qualities of such rock, as found abundantly in the ridges which skirt the south shore of the Bay of Fundy, will be less valuable than those of similar rock found elsewhere. Road-metal.

APPENDIX A.

LIST OF GLACIAL STRIÆ IN SOUTH-WESTERN NOVA SCOTIA.

1.—QUEENS COUNTY.

1. Moose Point. Coastal. On gneiss. S. 20° E.
2. Somerville Centre. Coastal. On granite. S. 18° E.
3. Mink Island. Port Mouton. Coastal. On granite. S. 5° E.
4. Massacre Island. Port Mouton. Coastal. On granite. S. 5° E.
5. Port Jolie Harbour, east side. Coastal. On gneiss. S.
6. Cadden Bay. Coastal. On granite. S.
7. Port Jolie Head. Coastal. On gneiss. S. 5° E.
8. Port L'Hebert. Coastal. On gneiss. S.
9. Shore opposite Coffin Island. Coastal. On mica-slates. S. 20° E.
10. Eagle Head Breakwater. Coastal. On gneiss. S. 10° E., S. 15° E.
11. Port Medway Harbour, west side. Coastal. On gneiss. S. 10° E., S. 15° E.
12. Buckfield. Interior. S. S. 20° W.
13. Pleasant River road. Interior. On quartzite. S. 35° E., S. 60° E.
14. Hills near Round Lake, on summit. Interior. S. 20° E.
15. South Brookfield. On quartzite. S. 10° E.
16. North Brookfield. On quartzite. S. 20° E.
17. Rosette. On slates. S. 40° E.
18. Port Medway River at crossing of Kempt Road. On slates. S. 20° E., S. 30° W.
19. Kempt, near Annapolis post-road. On slates. S. 10° E.
20. Westfield. On slates. S. 10° E.
21. Pleasant River settlement, at crossing of New Elm road. On slates. S. 34° E.
22. Dean Lake. Port Medway River. On flat slates. S.
23. North Brookfield. On slates. Exposures north. S. 7° E.
24. Port Medway River below Dean Lake. On flat slates. S. 15° E.
25. " " " " " " Further south. Two sets of striæ (1) on surface sloping to lake. S. 10° W. (2) on level surfaces only. S. 18° E.
26. Port Medway River, south of McGowan Lake, in Westfield, same as course of river. S. 3° W.
27. Horse Lake, one mile east of Port Medway River and one mile and a half south of Westfield River. S. 2° W., S. 4° W.
28. Rosette road. S. 22° E., S. 2° W.

2.—SHELBURNE COUNTY.

1. Near Jones Harbour. Coastal. On gneiss. S. 5° E.
2. Lockeport. Coastal. On quartzite. S. 10° E.
3. Jordan Ferry, half a mile below. S. 10° W.
4. Shelburne, on road to Ohio. Interior. On quartzite. S. 10° W.
5. Between Ohio and Clyde. Interior. On quartzite. S. 70° W.
6. Negro Harbour, east side. Coastal. " S. 10° W.
7. Purgatory Point. Coastal. On mica-slate. S.
8. Port La Tour, opposite Jones Island. Coastal. S. and S.E.
9. " " " on road to Baccaro. Coastal. On quartzite. S. 10° E., S. 15° W.
10. Baccaro Point. Coastal. On mica-slates. S.
11. Shag Harbour, at church. Coastal. S. 20° E.
12. Shelburne Harbour, above Sand Point. Coastal. On mica-slate. S. 30° W.

13. Villagedale. Barrington Bay. On gneiss. S. 15° W.
14. Upper Port La Tour, opposite John Island. On quartzite. S. 20° W
15. Cape Negro Island, eastern end. On mica-schist. S. 25° W.

3.—YARMOUTH COUNTY.

1. Wellington. On gray mica-schist. S. 50° W.
2. Yarmouth city. " " S. 35° W.
3. Pubnico Harbour, at head. On gray mica-schist. S. 40° W.

4.—DIGBY COUNTY.

1. Digby Neck, on road to Broad Cove. South side of trap range. S. 5° E.
2. Petite Passage. On side of bluff looking east. S. 50° W.
3. " " at Israel Cove, crossing top of trap columns ten feet above high-water. S. 60° W.

5—ANNAPOLIS COUNTY.

1. Fairy Lake, at the Pictured Rocks. S. 2° W., S. 10° W. (The first record is in small lines, the second in furrows.)
2. Fairy Lake, at Mill Cove. On slates. S. 10° W.
3. Fairy Lake. On shore. S. 6° W. (General course of lake.)
4. West Nictaux. On slates. Exposures north. S. 10° E.
5. Roxbury. (South of Lawrencetown.) On summit of South Mountain. Rock granite. S. 20° W.
6. Virginia settlement. On Silurian slates. N. 4° W.



Legend

- Tr Red sandstone Triassic
- E&F Quartzites, sandstones, slaty and shaly argillites, grey blackish, green and pink, with iron ores Devonian and Silurian
- C1b Ribbon slate and black slate Cambrian
- C1b Green slates and their metamorphic equivalents, mica-schists, staurolite schists, etc. Cambrian
- C1b Quartzite Cambrian

- C1b equivalents, mica-schists, staurolite schists, etc. Cambrian
- C1b Quartzite Cambrian
- Tr Trap (Triassic)
- Gr granite

J. White, Chief Draughtsman, L.N. Richard, Draughtsman. Geographical outlines from Church's Map of Nova Scotia, 1888.

Accompanying Part M, Vol. IX, 1895. Geologically surveyed by L.W. Bailey, L.L.D.

MAP OF THE WESTERN PORTION OF NOVA SCOTIA

Scale 8 Miles to 1 Inch

Natural Scale 1:63,360

