

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON

EXPLORATIONS AND SURVEYS

IN PORTIONS OF

NORTHERN NEW BRUNSWICK,

AND ADJACENT AREAS IN

QUEBEC, AND IN MAINE, U.S.

BY

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Director of the Geological and Natural History Survey of Canada.

SIR,—The following report is based upon observations made by the authors, with the assistance of J. W. Bailey and W. H. T. Reed, during portions of the summers of 1886 and 1887, in Northern New Brunswick and adjacent areas of Maine and Quebec.

It also embraces a summary of the facts, ascertained from a general review of the entire Silurian system in this section of the Dominion, including its extent, its order of succession, and its relations to the formations which lie below and above it.

The map intended to accompany the present report, and representing the geology of portions of Madawaska county, New Brunswick and Temiscouata county, Quebec, is in the hands of the engraver, and will be issued when completed. It is Sheet No. 17 N.E. of the series of maps on a scale of four miles to an inch, and, as regards New Brunswick, is the last but one of the series.

A tabulated list of the fossils of the region is given in the form of an Appendix by H. M. Ami, by whom the lists of fossils in the body of the report have also been prepared.

The thanks of the authors are due to the Manager of the New Brunswick Railway for the continuation of courtesies extended since the commencement of the survey.

Respectfully yours,

L. W. BAILEY.

WM. McINNES.

FREDERICTON, N.B., February, 1889.

REPORT

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The areas to be described in the present report lie to the west and north-west of that described in last year's report, and correspond to portions of two sheets of the New Brunswick and Quebec series of geological maps. In the one of these sheets (No. 17 N.E.) the district represented is limited to that small portion of New Brunswick which is included between St. John River and the Quebec boundary, while that of the second (No. 18 S.E.) lies immediately north of and is continuous with the latter, embracing, in addition to a very small part of New Brunswick, a considerable portion of the county of Temiscouata, in the province of Quebec.

Owing, however, to the very peculiar position and relations of the geographical and political boundaries in this region, which gives to that portion of New Brunswick embraced by it, the form of a long, narrow wedge, enclosed between Quebec on the one side and the state of Maine on the other, and having for a considerable distance a width of fifteen or twenty miles, a study of the geological features has necessarily included an examination of the adjacent areas. In the case of the state of Maine, this has been found especially serviceable, as in connection with the numerous streams and lakes which, in the county of Aroostook, are tributary to the St. John, ample and unusual facilities are afforded for the study of the rock formations there met with, and which in their north-eastward extension enter and traverse New Brunswick. On the other hand, the character and relations of the Silurian rocks about the northern boundary of New Brunswick cannot well be understood apart from their representation in the adja-

Region described.

Adjacent areas in Quebec and Maine.

Comparison
with other
regions.

cent portions of Quebec, and more particularly as revealed in the sections made respectively by the Metapedia River and Lake Temiscouata, with the intervening streams. For these reasons, and with a view to bringing together, for comparison, all the available data relating to the succession and relations of the Silurian system in this section of the continent, the observations to be given have been extended considerably beyond the limits of the two map sheets to which reference has been made. For similar reasons, little account is taken in the following descriptions of either the interprovincial or international boundaries by which the region is traversed. The geology of only those portions, however, which are included within the territorial limits of Canada is represented in the accompanying maps.

Topographical
features.

The topographical features of the region under consideration are deserving of brief notice, not only as being in themselves somewhat remarkable, but also as bearing on the adaptability of the country for settlement, and as helping to elucidate its geological structure.

St. John River
and its
tributaries.

Most noticeable, probably, among these features is that connected with the position and course of the St. John River and its tributaries. In no portion of its extensive drainage area does this river receive so many and such important affluents as here. Flowing north-easterly from its source in Baker Lake, situated near the western frontier of Maine, and at a distance, measured along the stream, of 460 miles from its mouth, it first reaches New Brunswick at the mouth of the St. Francis, and thence forms the international boundary to a point a few miles above the Grand Falls. Above the St. Francis, which also forms a part of the same boundary, and is a considerable stream, draining some important lakes, the main river has already received upon its northern side the waters of the Big Black and the Little Black rivers, both sufficiently large to be navigable by canoes, while from the southern side it is similarly joined by the still more considerable stream of the Alleguash. This latter takes its rise in a very remarkable system of lakes, of which the most southerly (Lake Chamberlain) approaches so nearly the head waters of the Penobscot, and is so nearly on a level with it, that by the erection of dams, much of the water, at one time tributary to the St. John, has been diverted, for lumbering purposes, into the first-named stream. Below the mouth of the St. Francis, the principal tributaries of the St. John upon the northern side are the Madawaska and the Green River, to which may be added the Iroquois, the Quisibis, the Siegas and the Grand rivers, of less importance than the streams first named, but still large enough to be navigable by canoes. Even the Aroostook may properly be included here, for it drains the same Silurian basin, and has its origin in lakes but little removed from those in which Fish River, the Alleguash and the Penob-

St. Francis
River.

Big Black and
Little Black
Rivers.

Alleguash
River.

Tributaries
below the
St. Francis.

Aroostook
River.

seot have their origin. This close approximation of considerable Fish and game streams, flowing in diverse directions and often for great distances, is a very peculiar feature of the region, and, taken in connection with the comparatively unsettled character of the country which they drain, the beauty of the scenery, and the abundance of fish and game, has made the whole region famous among tourists and sportsmen.

The lakes of the region, already incidentally referred to, are as Lakes of the remarkable as the number and variety of its streams. In Aroostook region. county, Maine, they are exceedingly numerous, and of all shapes and sizes, but often so situated as to indicate that they are but isolated portions of what were once continuous and much more considerable basins. Of these, the most important, in relation to the present report, are those which form the sources of Fish River, and which, in the form of Fish River a chain, embracing Long Lake, Second or Mud Lake, Cross Lake, Lakes. Square or Sedgewick Lake, Eagle Lake and Nadeau or Upper Lake, occupy a trough roughly parallel with the St. John. This trough in its eastern extremity (in Long Lake) is not over seven miles distant from the St. John. In Quebec, the lakes are less numerous, but among them is Lake Temiscouata, the most considerable of all as regards both extent and depth. This remarkable and very beautiful sheet of water has a total length of twenty-four miles, Lake Temiscouata. with a breadth varying from one to two miles, its general form, as accurately surveyed by the Geological Survey, being that of the letter L, with the longer or southern arm somewhat irregularly sigmoid. This longer limb, taken as a whole, has a course almost exactly N.W. and S.E., corresponding on the one side with that of the Madawaska and a considerable portion of the St. John, while on the other, an extension of the same line will be found to coincide with that occupied, at a distance of about forty-six miles, by the deep gorge of the Saguenay. The depth of Lake Temiscouata is itself somewhat remarkable, though less so than has been sometimes represented, accurate and systematic soundings made over its different portions showing that it varies but little from 220 feet.*

As would naturally be expected, the hydrographic features of the district just described are intimately connected with, and in part Peculiar dependant upon, its orographic features. There are, however, in these features. relations, many points which are somewhat peculiar, and cannot be readily accounted for, except by reference to the former existence here of conditions and the occurrence of operations somewhat different from those which now prevail.

*In a note contributed by one of the authors to Science (Vol. VIII., No. 196) it is stated that the depth of the lake is, in some parts, over 500 feet. The statement was the result of a return submitted by a person in our employ who was engaged to make the soundings, who had already made several in our company, and in whom we had every reason to place confidence. Subsequent examinations, however, revealed, to our great surprise and disappointment, that the work thus done, if done at all, was entirely untrustworthy.

Canoe-shaped
ridges.

Green River
Mountain.

Madawaska
and St. John
valleys.

Glacial origin
of valleys.

Over the larger part of the area to which this report relates, the country is hilly, though there are few elevations of any considerable altitude. In general, the eminences are in long, canoe-shaped ridges, with easily-flowing outlines, but these are sometimes replaced by serrated crests, or, in the case of transverse river valleys, by bold escarpments. In the southern part of the tract, Green River Mountain, not far from the mouth of Green River, rises somewhat abruptly from a comparatively low country, and constitutes a very prominent object in the landscape. There are also other noticeable hills along the middle and upper courses of the same stream, but it is not until we approach Edmundston that the country begins to acquire a really rugged aspect. It is here that the St. John is joined by its main tributary, the Madawaska, and along both streams, the valleys which they occupy are bordered by a continuous succession of high rolling hills. In the case of the St. John, however, these, except within a few miles of Edmundston, run parallel to the stream, or cross it at very small angles (then usually determining the existence of rapids), while in the case of the Madawaska, its course is almost directly transverse to that of the hill ranges which border it, and which accordingly abut against it in bold and often craggy heights. Again, in the case of the St. John, the larger part of the valley is occupied by the stream itself and its immediate flood grounds, only rarely expanding to include any considerable extent of flat land; but on the Madawaska, the stream, in its present state, occupies but a very small proportion of the entire valley, being rarely more than 200 feet wide, while the valley, which is nearly everywhere flat, is seldom less than a mile in width. The great transverse trough which is thus indicated is, at its northern end, continuous with that of Lake Temiscouata, but here the whole valley is again occupied by the hills upon either side rising abruptly from the lake, as they also sink with almost equal abruptness to great depths below its surface. In the case of Mt. Wissick or the Big Mountain, nearly opposite old Fort Ingalls, they rise almost precipitously to a height of 550 feet, while at a distance of not over 100 feet from the base of the bluff, the depth of water is over 200 feet.

From the features above described, as well as from others, such as the direction of glacial striæ, and the nature of the material occupying different portions of the Temiscouata-Madawaska valley, it would seem as though the latter were a great trough of sub-ærial glacial erosion, having throughout, at one time, a depth at least equal to that of the existing lake, but which, with the retreat and melting of the ice eventually became to a large extent filled up.

The nearly uniform and flat contour of the lake bottom, its very gradual or progressive shallowing at the southern extremity, and the

extensive deposits of clay which occupy portions of the valley of the Madawaska, are all in accordance with the view here advocated. It may be added, as bearing further upon the same theory, that while Mt. Wissick, abutting, as stated, directly upon the lake, with a height of over 500 feet, is but a part of a ridge which, in an easterly direction, is traceable with equal prominence for a distance of ten miles or more, on the opposite or western side of the lake, though only a mile distant, no such corresponding ridge is to be met with, nor any trace of the rocks of the mountain, except such as form its basal beds. Finally, it may be mentioned that large boulders, filled with fossil corals similar to those of the limestones of Mt. Wissick, have been observed far down the valley of the St. John, though no beds of similar character are known to occur anywhere in the interval. Mt. Wissick.
Erratics.

The evidences of glaciation about the shores of the lake are abundant and varied, the surfaces of the slaty rocks which dip into the latter being everywhere smoothed, rounded, furrowed or striated. Some of the effects are doubtless attributable to the mere pressure of the lake ice, but others are far beyond its reach, and must have been produced by an ice-stream or glacier, filling the valley to a much greater depth, and which at the same time ploughed deeply into its bottom. To the action of such an ice-stream or glacier, the origin of the valley is largely to be ascribed. The course of the striæ above the limits of recent ice action varies from S. 45° E. to S. 60° E., the former corresponding with the axis of the lake itself, south of its principal bend. The upper part of the lake, which is very much shallower, corresponds in direction to that of the hills and rock formations which border it; but here another very peculiar feature presents itself in the fact that the movement of the ice, as indicated by the position of the travelled boulders, was to the north and north-east, rather than to the south. Thus above Mt. Wissick, which occupies the angle between the two main limbs of the lake basin, the shores of the latter are strewn with blocks of all sizes, some of them six or eight feet in diameter, which are simply detached masses from the fossiliferous rocks of the mountain, and which must have been transported several miles from their parent bed. This is in accordance with similar facts noticed by the authors on Lake Metapedia, and by Mr. R. Chalmers in other parts of the Gaspé Peninsula. Glaciation.

Of other facts connected with the Post Tertiary history of the Temiscouata region, it is worth noticing that the other lakes of the district do but repeat, though upon a somewhat smaller scale, the features of Temiscouata itself. Thus the chain of the Squatook Lakes upon one side and that of Cabano on the other, both tributary to Lake Temiscouata, and almost exactly parallel to it, like it are situated nearly at Parallelism
of lake basins.

right angles or obliquely to the rock formations and are of exceptional depth. The same north-west and south-east trends are repeated in the valley of Baker Lake and Brook, in that of the St. Francis River, including Boundary and Glazier Lakes, still further west in the course of the Big and Little Black rivers, and eastward of Temiscouata in the tributaries of the Green River and the Restigouche.

Kames.

The last feature which we shall notice in this connection is that of the occurrence of kames or horse-backs over some portions of the region. Of these, one of the most noticeable is to be seen in the vicinity of old Fort Ingalls, and for a short distance constitutes the foundation of the thoroughfare leading to the latter. It is about half a mile in length, and about thirty or forty feet in breadth at the top, having a somewhat sinuous course, but a general trend nearly S. 20° E., or the same as that of the lake on whose shore it terminates. It is composed chiefly of coarse sand and gravel, and traverses a low flat tract which, in part, at least, is occupied by beds of clay. Other kames, but of less marked character, were observed at other points, especially a few miles above the mouth of the St. Francis, on the Maine side of the St. John.

**Character
of soils.**

The soils of the district under discussion are similar in origin, and hence similar in character, to those of the Silurian tracts further south, which have been described in earlier reports. They would seem, however, to be of less depth than the latter, as well as less calcareous, and hence less well adapted for purposes of agriculture. Along the valley of the St. John, there are many good farms, and excellent land for farming purposes is said to exist over large portions of the country drained by the tributaries of the St. John and Restigouche rivers, but to the north of Edmundston and in the county of Temiscouata, the country is so hilly as to interfere materially with tillage operations, while the shortness of the season and the constant liability to destructive frosts, are serious drawbacks to the settler. The valley of the Madawaska, it is true, is an exception to the generally hilly character of the region, but the sandy and clayey nature of the deposits with which it is filled is equally unfavorable to its productiveness, and though farms are numerous, they are in general of inferior character. The whole of the country east of Lake Temiscouata, and much of that west of it, is still in forest, and is the seat of important lumbering operations.

Formations.

The geology of the region, to which this report relates, embraces, according to our present knowledge, only strata of Silurian and Ardovician or Cambro-Silurian age. As the principal portion, however, of the area occupied by the latter, which extends to the shore of the St. Lawrence, has been only partially examined, and is still under discussion, it is not proposed to consider it here, except so far as it comes in contact with the Silurian system; the present report is therefore essentially confined to the consideration of the latter.

The first systematic description of the Silurian rocks in this portion of America is that contained in the "Geology of Canada, 1863," where an elaborate section is given of these rocks, as seen at the extremity of the Gaspé Peninsula, together with many details of their distribution in other parts of that peninsula, as well as westward in the valleys of the Metapedia, Patapedia and Metis rivers, about Lake Temiscouata and above the upper tributaries of the river St. John. The section at Gaspé, which is unequalled in its extent and clearness of exposure, was justly regarded as typical, and the name of Gaspé series was applied to that portion of the strata there exhibited, chiefly limestones, which was supposed to represent the Silurian system, as distinguished from an overlying mass of sandstones (Gaspé sandstones), which were regarded as Devonian. Subsequently, a further examination of portions of the Silurian district was made by Mr. Richardson (Report of Progress, 1869), and numerous fossils were collected by him as well as by E. Billings, T. C. Weston and others. Still later, in 1882-83 Messrs. Ells and Low, of the geological corps, made additional observations in the interior of the Gaspé peninsula, and the results are embodied in two reports, accompanied by maps showing the distribution of the formations, with large lists of fossils. In one of these reports, the fossils collected were regarded as indicating that a considerable portion of what had been considered as Silurian was in reality Devonian, but this view was subsequently abandoned. Finally, between the years 1883 and the present time, the authors of this report, while pursuing their investigations in Northern New Brunswick, have not only made numerous sections and careful surveys of the Silurian rocks included in that province, but, by extending their observations into the adjacent state of Maine, have obtained much valuable information regarding the succession of the Silurian rocks. The results of these explorations, so far as they relate to the mere details of distribution and lithological characters, have already been given in several preceding reports, with accompanying maps, but, with the exception of two communications made by one of the authors to the Royal Society of Canada, and published in its Transactions, no attempt has been made to institute comparisons or to draw any general conclusions. In the present report, it is our aim to summarize the information now available, in order to show how far it confirms or modifies the results of earlier observers, and to indicate some of its bearings upon general questions of geological history.

Former reports
Geology of
Canada, 1863.

Richardson,
1869.

Ells and Low,
1882-83.

Bailey in
Trans. R. S. C.

Gaspé Peninsula.

Gaspé section. As a basis of comparison, it will be convenient to give here a summary of the succession, as revealed in the typical section of the Silurian rocks at Cape Gaspé. This, condensed from the *Geology of Canada*, page 391, is as follows:—

1. Grey limestones, in layers from six to eight inches thick, separated by greenish calcareo-argillaceous shale; the limestones abounding in fossils, including, among others, specimens referable to the following genera; *Favosites*, *Zaphrentis*, *Dictyonema*, *Fenestella*, *Strophomena*, *Orthis*, *Rhynchonella*, *Pentamerus*, *Spirifer*, *Athyris*, *Atrypa*, *Cyrtodonta*, *Modiolopsis*, *Avicula*, *Loxonema*, *Bellerophon*, *Platyceras*, *Conularia*, *Orthoceras*, *Dalmanites*, *Phacops*, *Bronteus* and *Beyrichia*. 70 feet.
- 2-3. Calcareo-argillaceous shales of red and green colors, with nodules and layers of limestone, and remains of marine plants. 260 feet.
4. Grey limestones in thin beds, with separating layers of grey calcareous shale, and including about seven feet of limestone and limestone shale, of which the layers have been in part excessively corrugated and in part disrupted into fragments. Fossils less numerous than in 1. 200 feet.
- 5-6. Grey or greenish calcareous shales or shaly limestones, sometimes arenaceous, with thinner beds of pure limestone. Fossils—*Brachiopods* and *trilobites*. 680 feet.
7. Grey nodular shaly limestones, with some greenish calcareo-arenaceous shales. The only fossils are one resembling *Spirophyton caudagalli*, and *Dalmanites pleurotyx*.

Thickness
and age.

The lowest beds of the above section rest upon black shales, which have been supposed by Prof. Lapworth to hold a position inferior to the rocks of Point Lévis, while those of its highest member are succeeded by arenaceous beds, abounding with fossil plants and forming a portion of the Gaspé sandstone series, of Devonian age. The entire thickness of the Silurian sediments, as given above, amounts to about 2000 feet, and their age, collectively, is regarded as about that of the Lower Helderberg formation. The rocks of the inferior Niagara group, though abundantly represented on the island of Anticosti, appear to be wanting here.

Base of
Silurian in the
Shickshocks.

Of the geology of the interior of the Gaspé peninsula, we do not here propose to speak, as we have no personal knowledge of its features, and can add nothing to the information already given in the *Geology of Canada* and the later reports of Dr. R. W. Ells and his associates. It is, however, necessary to observe that at several points along the south side of the Shickshock Mountains, notably at the sources of the Chatte and Matane rivers, the base of the Silurian system is represented by massive beds, from 50 to 70 feet thick, of white, quartzose sandstone,

often vitreous in aspect and speckled with small, red, ferruginous spots. They are directly succeeded by fossiliferous limestones, holding species similar to those contained in the upper part of the Anticosti group, and the two are hence regarded as marking an horizon about that of the Niagara formation. Collections of fossils made by Dr. Ells and his associates, on the Scaumenac and Little Cascapedia rivers (Report of Progress, 1882-83-84), have also been thought to indicate a similar horizon. On the other hand, a considerable area of rocks occurring in the basin of the Casapsal River, and thence extending eastward to and beyond the Cascapedia River, and which also formed a portion of the Gaspé limestone series, as originally defined, were found, by the same author, to contain numerous fossils, indicating their probable equivalency with the Oriskany and Hamilton formations of the Devonian system.

Fossils
collected by
Dr. Ells.

Thus the boundary, as indicated between the Silurian and Devonian systems in this region, seems to have been determined upon palæontological grounds rather than upon the lithological and stratigraphical evidence, and the evidence would also seem to afford some confirmation of the view that the Oriskany is not only a transitional formation, but more nearly related to the Silurian than it is to the Devonian system.

Palæontological evidence
relied upon.

The first observations made by us bearing upon the geology of this region were made during the season of 1888, along the course of the Metapedia River, and about the lake of the same name, from which it flows.

The geology of the eastern side of Metapedia Lake, having been described in the geology of Canada, and represented in the published maps accompanying the report by Dr. Ells, need not be discussed here. Upon the western side, near the head of the lake, the lowest visible Silurian rocks are whitish sandstones, sometimes exhibiting a pinkish tinge or speckled with small red spots. As stated in "Geology of Canada, 1863," p. 414, these rocks are undoubtedly the equivalents of the similar beds on the Matane River, and, if the latter are correctly referred, would represent the upper part of the Anticosti group, or that of the Niagara formation. They may be seen at several points along the margin of the lake, and form the whole of an island near its southern extremity, but in most places they are concealed either by overlying limestones or by drift. The drift contains numerous and often large blocks of the white sandstone, from which the only fossils as yet found have been obtained. In a collection made about two miles above Cedar Hall, the following fossils have been determined by Mr. Ami.

Metapedia
Lake.

Fossils in
loose blocks.

Fossils from
Cedar Hall.

ZOOPHYTA.

Crinoidal Columns.

Zaphrentis or *Streptelasma*, sp. indt. Several casts and impressions of a *Zaphrentis*-like coral, resembling a species described by Prof. Hall in the 2nd volume of *Palæontology of New York*.

BRACHIOPODA.

Orthis (?) sp.

Pentamerus oblongus, Sowerby. Numerous large casts, which show the position of the internal plates.

GASTEROPODA.

Murchisonia, sp.

Oriostoma, sp. Several casts, which most probably belong to this genus, and resemble closely, depressed specimens of *O globosum*.

TRILOBITA.

Lichas (?) sp. A fragment resembling the tuberculated test of a trilobite allied to *Lichas*, but not large enough to warrant accurate determination.

Fossils from
six miles above
Cedar Hall.

The limestones, which may be seen to directly overlie the sandstones, and which are themselves quite hard and siliceous, are more abundantly fossiliferous, and from beds of the latter, exposed in the large quarries opened during the construction of the Intercolonial Railway, six miles above Cedar Hall station, the following were collected :—

Cyathophylloid coral.

Body-volution of a large gasteropod, perhaps of a *Pleurotomaria*.

Halysites catenulatus.

Crinoidal fragments.

Strophomena rhomboidalis, Wilckens.

Strophodonta varistriata.

Strophodonta Becki? Hall.

Meristella sp., cf. *M. didyma*.

Atrypa reticularis, L; very abundant.

Platyceras sp. indt.

Oriostoma globosum, Schlotheim.

The above-named fossils tend to confirm the idea that the beds containing them hold a position corresponding nearly, to that of the Niagara formation. It may be added that at the extreme northern end of the lake, as well as on the way to Sayabec, there are boulders, of a very

large size, of a grey conglomerate, holding limestone pebbles in a sandy matrix. These contain large corals and brachiopods of Silurian type. They repose upon rocks of the Quebec group, and can hardly have travelled to any great distance, but the source from which they were derived is not known.

Along the entire western margin of the lake, the strata present low undulations, the dip rarely rising above 8° or 10° , and no higher beds than those above noted are observed, but near the outlet and along the course of the Metapedia River are numerous sections which appear to belong chiefly to the higher members of the formation. They have not been examined in detail, but so far as seen, they appear to be quite similar to the strata described in previous reports as covering such large areas in northern New Brunswick and Maine. They consist, for the most part, of dark grey, bluish-weathering, calcareous slates, which, however, occasionally include beds of fine-grained, calcareous sandstone, or, less frequently, thin beds of limestone. The strong and highly inclined cleavage planes by which they are everywhere intersected, and the influence of the latter upon their weathering, gives rise to steep hills, narrow defiles, and, in places, to a landscape eminently bold and craggy, suggesting the idea of a highly-disturbed region. The inclination of the strata is, however, in reality, usually quite low, and the same beds are undoubtedly several times repeated through the fifty or more miles of distance which the section covers. Compared with the section at Cape Gaspé, these strata would appear to appertain chiefly to Div. 5-6, but the fact that fossils of Devonian type occur in the valley of the Casupscull, as observed by Dr. Ellis, may perhaps be regarded as indicating that the entire series is here represented. As a basis of further comparison, we add here the following list of forms collected in the vicinity of Dalhousie, N.B., and now in the cabinet of the University of New Brunswick:—

Strata on west
shore of
Metapedia
Lake.

Fossils from
Dalhousie, N.B.

Favosites basalticus.

" *Gothlandicus.*

Halysites catenulatus, L.

Syringopora.

Diphyphyllum.

Zaphrentis.

Fenestella.

Stenopora.

Orthis testudinaria, Dalman, or an allied species.

" *oblata*, Hall.

Strophomena rhomboidalis, Wilckins.

Strophodonta punctulifera, Conrad.

Strophodonta varistriata, Conrad.
Spirifera cycloptera, Hall.
Atrypa reticularis, L.
Cyrtina Dalmani, Hall.
Rhynchonella vellicata, Hall.
Athyris princeps ?
Leptocælia, allied to *L. hemispherica*.
Megambonia, allied to *M. ovoides*, Hall.
Conocardium.
Pleurotomaria, allied to *P. labrosa*, Hall.
Euomphalus sinuatus (?) Hall.
Dalmanites.

The species above named were determined by Mr. Billings, who regarded them as indicating the horizon of the Port Daniel limestones of the northern side of the Bay Chaleur, and as intermediate in age between the Niagara and Lower Helderberg groups.

Low, flat,
country.

Notre Dame
Mountains.

Metis and
Petapedia
Rivers.

In conformity with the nearly horizontal attitude exhibited by the rocks along the western shore of Lake Metapedia, the country underlain by the latter is also, for the most part, flat and relatively low. From the upper half of the lake, a similar, broad, flat and often swampy tract stretches to the westward to and beyond the Metis River. Bordering this tract upon its southern side, and stretching in a direction about west-southwest, a ridge of hills is seen to rise into considerable prominence, forming part of the range of the Notre Dame Mountains. From the abruptness with which these hills begin, and their altitude and boldness of outline, the idea is forcibly suggested that they are portions of an older series, or at least of harder or more highly disturbed strata than those which border them. Several attempts have accordingly been made to ascertain their true nature, but, even in the case of the steeper portions, these have failed so far to reveal any outcrops nor any debris other than that of the ordinary Silurian slates.

The geology of the Metis and Patapedia rivers is given, in considerable detail, in the Geology of Canada, p. 416; we had hoped to have re-examined this section, and to have made more ample collections of the fossils which it yields, but were prevented from so doing from the want of sufficient water in the Metis River. We, however, ascended one of the tributaries of the Metis, the Musquegegish, a stream previously explored, to a point not more than a mile from its source in a lake of the same name. This lake itself is not far removed from the lakes at the heads of the Rimouski and Quatawamkedgwick rivers, and the information which it affords, in connection with that obtained

upon the last-named streams, to be presently described, gives the key to the character of a large tract, about which little was previously known. The rocks of the Musquegish, as might be inferred from its position, are much like those of the Metis, and are, in places, sparingly fossiliferous.

On tracing the northern border of the Silurian tract to the west-ward, the white sandstones at the base of the series, which on the Metis are represented only by loose blocks, come again somewhat prominently into view near the eastern extremity of the settlement of St. Gabriel, and about half a mile from where the Rouge stream is crossed by the Taché road. The beds here dip S. 25° W. $< 20^{\circ}$, and are, as on Lake Metapedia, directly overlaid by beds of dark blue limestone, forming together a series of low bluffs along the road leading around the eastern extremity of Mount Commis. The limestones contain fossils, but they are neither so abundant nor so well preserved as where the same beds come out a few miles to the westward, at the falls of the Big Neigette River. This fall, about 100 feet in height, and the very similar one of the Little Neigette, seventy feet, result from the singular abruptness with which the Silurian rocks terminate along their northern edge, forming an escarpment which constitutes a prominent feature in the landscape, and which is partly continuous with Mount Commis, and extends thence and to the westward for a distance of twenty miles, terminating in the ridge of the Bois Brulé, near St. Blandine. The rocks of the Neigette Falls, which are partly limestones and partly limestone-conglomerates, are chiefly remarkable for the number and the large size of the fossil corals which they contain, the chain-coral (*Halysites catenulatus*) being especially abundant. The limestones are, to some extent, burnt for lime, but are not well suited for the purpose, being quite siliceous and impure. Their dip is S. 80° W. $< 1^{\circ}$ – 20° .

On the summit and around the flanks of Bois Brulé Mountain, admirable opportunities are afforded for the study of the strata of which it is composed, and which are here of more than usual interest. On the precipitous northern face of the mountain, the rocks are chiefly hard, grey, calcareous sandstones, the continuation probably of similar beds overlying the limestones at the Neigette Falls. They dip S. 47° E. $< 40^{\circ}$, and contain a few large corals, as well as crinoid stems and ribbed shells, but these are mostly poorly preserved. Ledges of similar sandstone also form the summit of the mountain, but on the southern slope, looking towards Ste. Blandine, beds are met with in which the organic forms are both more numerous and more perfect. One bed, consisting of a buff-weathering dolomitic sand-rock, is especially remarkable as containing little besides the remains of large *Pentameri*, the species,

Fossils at Bois
Brulé Mtn.

though belonging to the section of which *P. Knighti* is the type, exhibits, nevertheless, specific differences, and is apparently new. In a collection subsequently made, however, by one of the authors, from a light grey impure limestone, several fine and very large individuals of what is undoubtedly the species last-named, were found associated with crinoidal and cystidean fragments, a *Chonetes* (or a form nearly related thereto), a *Merista* (being a young individual, either of *M. subquadrata* or *M. princeps*, Hall), and an imperfectly preserved *Euomphalus*. Mr. Ami suggests these strata may be the equivalents of the Aymestry beds of Great Britain, and perhaps of one of the zones called by the New York geologists Pentamerus limestone. A mile or so to the westward, still other fossiliferous beds appear. One of these is near the foot of the hill on the northern side, in the valley of Bois Brulé River, and is a drab-weathering, argillaceous and shaly limestone, from which the following fossils were obtained by Messrs. Ellis and Ami:—

Halysites catenulatus, L.

Strophomena rhomboidalis, Wilckens.

Orthis, cf. *O. hybrida*, Sowerby.

“ probably *O. calligramma*, Dalman.

“ “ *O. Davidsoni*, De Verneuil.

Atrypa reticularis, L.

Pentamerus, allied to or identical with *P. oblongus*, Sowerby.

Calymene Blumenbachii? Brongniart.

Coral
conglomerate
at Ste. Blandine

Another and still more prolific locality occurs directly by the roadside, about a quarter of a mile south of Ste. Blandine Church. The ledges here, which dip. S40°E < 40° 50°, may be well called a coral conglomerate, as they are higher in the series, and are literally filled with fossils. From them the following forms have been obtained:

Fossils from
Ste. Blandine.

POLYPL.

Favosites Gothlandicus, Lamarck.

Halysites catenulatus, L.

Cyathophyllum, cf. *C. Pennanti*, Billings.

Syringopora retiformis? Billings.

CRINOIDEA.

Numerous fragments of Crinoids.

BRACHIOPODA.

Strophomena rhomboidalis, Wilckens.

Orthis varica, Hall.

" sp. indt.

Rhynchonella nucleolata, Hall.

Spirifera cycloptera, Hall.

" sp., cf. *S. sulcata*, Hisinger.

Retzia or *Trematospira*, sp. indt.

Atrypa reticularis, L.

Merista arcuata, Hall.

" *princeps*, "

" *levis*, "

Pentamerus galeatus, Dalman.

" n. sp.

Tentaculites sp., indt.

GASTEROPODA.

Euomphalus carinatus? Sowerby. A large form with obscure markings. May be *E. rugælineata*, Hall (24th Reg. Rep. p. 186).

TRILOBITA.

Acidaspis sp. indt. Hypostome.

? *Lichas* " "

The above were collected by Prof. Bailey, and determined by Mr. H. M. Ami, who subsequently added the following:—

A stromatoporoid.

Favosites, sp., with small corallites.

Syringopora, resembling *S. junciformis*, Hall.

Impression or cast of a scapular plate of a cystidean allied to *Caryocrinus*.

Owing to the character of the ground, the precise relations of these several fossil-bearing beds are not easily determined. It is certain that the rocks containing the species in the list last given are above and not far removed from the beds which form the summit of Mt. Bois Brulé, while those yielding the species enumerated on p. 18 M represent still lower beds. The white sandstones are not visible here, being probably concealed by the talus on the north side of the mountain, but they are described in the Geology of Canada as seen on the Rimouski River. To the south of the coral conglomerates, the exposures are frequent, consisting chiefly of grey calcareous and buff weathering sandstones, with some limestones, which may be seen for several miles along the road leading back from Ste. Blandine to the Taché road. They dip very regularly S 40° E < 20°—40°, and occasionally hold remains of crinoids and ribbed shells.

Relation of
the beds.

Road back from
Ste. Blandine.

Quatawamkedgwick and Rimouski rivers.

Northern edge of the Silurian. From the Rimouski River at Ste. Blandine, six miles in a straight line from the shore of the St. Lawrence, the northern border of the Silurian plateau bends rapidly to the south and west, and, as described in the *Geology of Canada*, is next prominently seen on Lake Temiscouata. Between these two points, however, there is an interval of fifty miles, and with a view of obtaining more accurate knowledge of the country separating them and of the formations included in the interval, two traverses were undertaken, the one embracing the section drained by the Rimouski and Quatawamkedgwick rivers (the latter a branch of the Restigouche); and the other a similar section afforded by the branches of the Trois Pistoles and Tuladi rivers, the latter connecting with Lake Temiscouata. Mr. McInnes, by whom these traverses were made, thus describes the facts observed.

Quatawamkedgwick river. Along the lower part of the Quatawamkedgwick River, for the first few miles, the strata are a continuation of those seen along the main Restigouche River, between the Gounamitz and the mouth of the Quatawamkedgwick. They consist in the main of grey calcareous slates, with bands, half an inch to six inches in thickness, of impure limestone, and with interstratified beds of hard sandstone.

Anticlinal folds. The sandstones are seen at points three and five miles from the mouth of the river, forming the sides of an anticlinal fold, the lower exposure dipping S. 56° E. < 85°, and the upper exposure N. 46° W. < 80°. Overlying these sandstones, and exposed on the river above and below them, are grey calcareous slates, with limestone bands from half an inch to three inches in thickness; and underlying them, brought up by the fold, are grey calcareous slates again showing the limestone bands, more sparingly, however, and only in the upper beds, near the sandstones. Farther down on the river, within a quarter of a mile of the Restigouche, these sandstones, or beds of a similar character, are exposed again, apparently brought up by a fault; they are in direct contact with the banded states and cut off the beds, which are much bent and twisted at the point of contact, and have white calcite scattered through them in numerous veins and lenticular patches.

Banded slates. Grey, calcareous slates, without the conspicuous banding before noted, occur all along the river in a succession of low undulations to and beyond the main forks. The bedding of these rocks is seldom clearly seen, a strong and nearly vertical cleavage everywhere obscuring it; they are crumpled into a series of folds striking N. 50° E. to N. 70° E., but show local twisting of the most fantastic kind, and resemble quite closely the contorted slates which occur along the shore of Temiscouata Lake between Notre Dame du Lac and the foot of the lake.*

**Geology of Canada*, 1863, pages 424 and 425.

Hard, dark blue slates, with softer, fissile bands, not differing in any great degree from those seen below, extend up the river as far as the crossing of the boundary line between New Brunswick and Quebec; like the slates described above, they are cut by a nearly vertical cleavage and are folded in a like manner to them; the softer, more fissile portions of the ledges weather out readily, and leave the harder bands projecting in a succession of knife-like edges in the bed of the stream. For a distance of two miles and a quarter below the boundary line, the outcrops seen along the stream dip about N.45°E. < 30°-40°, indicating the occurrence here of a long dome in the rocks, the summit of which would lie some distance to the south-west of the stream. Above the boundary line no exposures are seen for a mile, or until the first fall is reached, where the following section is exposed, measuring at right angles across the strata which dip N.5°E. < 90°:

	FEET.
Dark blue, finely micaceous, shales.....	10
Shales, similar to above, with bands of light grey, finely micaceous sandstone, with carbonaceous markings resembling plant remains, but too fragmentary for determination.....	10
Soft, grey, calcareous shales.....	3
Soft, grey, calcareous shales, and finely micaceous, grey sandstone in thicker beds, with crinoid stems and shells.....	20
Sandstone in heavy beds, with thin bands of soft, grey shales.....	25
Sandstone in heavy beds, weathering to a rusty, buff-colored, rotten stone with thin bands of shale, very fossiliferous in certain layers, especially along the junction planes of the sandstones and shales.....	30
Soft, dark blue shales and beds of sandstone.....	50
Soft, dark blue shales and beds of sandstone with fossils in certain layers.....	250
Dark grey shales, forming falls four feet high.....	10
Same shales.....	150

A small collection of fossils from this locality, which has been examined by Mr. Ami, contains the following species:—

- Obscure *Psilophyton* or plant like remains.
- Numerous crinoidal joints.
- Orthis* sp., of the type of *Orthis rustica*, Sow.
- Strophomena* sp., with peculiar vermicular parasitic (?) organisms attached to the outer test of the individual.
- Spirifera* sp., cf. *S. Nictavensis*, Dawson, and *S. arenosa*, Conrad.
- Lichas* (?) or some closely related genus of trilobite.

The collection is scarcely sufficient or characteristic enough to state definitely whether the rocks from which it was obtained belong

to the upper portion of the Silurian system or to the base of the Devonian.

Lithological character.

These beds resemble in general lithological character the fossiliferous strata occurring near the edge of the Silurian on the Beccaguimic and elsewhere.*

Upper forks.

Beyond this fossiliferous band no exposures are seen in place for a distance of about ten miles along the stream; large angular blocks of a very hard, grit-like, grey sandstone are plentiful at a point about three miles above the boundary line, but the first exposure *in situ* occurs about a mile and a half below the lake, where ledges of finely micaceous, soft, blue slate, with layers of limestone, weathering into depressed bands and nodules, strike N.59°E. At the upper forks, half a mile below the lake, a ledge of the same character occurs, and again about half-way down the lake a similar ledge of highly calcareous, rusty blue slate, of nodular structure, weathering into irregular ridges with pitted depressions between, and with black films along the cleavage planes, forms a reef in the lake, and is exposed on the western shore on the line of strike, which is N.49°E.

Kedgwick Lake

This lake, known as Kedgwick Lake, is two miles in length and has an average width of about half a mile; it is quite shallow, and the immediate shores are flat and swampy. Low hills wooded with spruce and cedar rise about a mile back from its shores. A stream entering near the head of the lake flows from a smaller lake with the same general features. No rock occurs in place either on the stream or around the shores of the second lake; large blocks of coarse sandstone or fine conglomerate, holding small pieces of black slate, are common about the foot of the lake, and near its head, grey, fine, calcareous, arenaceous sandstone, weathering rusty, pitted in certain layers and slaty in places, similar to that described above as occurring in place on the stream, is strewn over the lake bottom in large angular blocks.

Portage to small lake on Rimouski River.

From this lake, a portage of a mile and a quarter, over a low ridge, wooded with white birch, cedar and spruce, leads to a small lake at the head of the left hand branch of Rimouski River. The only exposures seen on this lake are at the narrows, three-quarters of a mile from its head; they are soft, grey, calcareous slates with narrow black bands, which give to the ledges a ribanded appearance; the beds are considerably twisted, and are cut by a large vein of white quartz. Large angular blocks of the fine conglomerate, mentioned above, holding small pieces of soft, black slate, occur in numbers at this point.

Ribanded slates

The stream draining the lake is very small, and flows through flat,

*The Silurian system of Northern Maine, New Brunswick and Quebec. L. W. Bailey. Trans. Roy. Soc. Can., 1886, Sec. IV., page 33. Annual Report, Vol. I., 1885. page G 14 et seq.

swampy land for about two miles below the lake, showing no exposures. For part of this distance, however, the stream is choked with large blocks of coarse sandstone and conglomerate, the latter holding pebbles of limestone. Descending the stream, the first exposures, which occur about a mile and a half below the lake, are rusty-weathering, soft, dark-grey slates, with satin-like surfaces and showing fine black banding; the bedding is cut obliquely by an almost vertical cleavage. These beds are followed, at a distance of two miles farther down the stream, by soft, finely micaceous, dark-grey slates; no general dip could be got on account of the violent crumpling to which the beds have been subjected.

After leaving the lake, the stream runs in a general north-westerly direction for a distance of about seven miles, it then turns with a sharp loop to the south-southwest, and preserves that direction in a general way for ten miles, to its junction with the right hand branch of the Rimouski River. On the eastern side of the bend no ledges are exposed; near its apex and for some distance to the south of that point, large blocks of hard conglomerate and sandstone are thickly scattered along the bed of the river. The section seen between the northern point of the loop and the Rimouski River supplies the place of that concealed along the upper part of the stream, the strike of the strata carrying them across both sides of the bend; the exposures consist mainly of very highly crumpled, grey, calcareous slates, with bands of limestone and occasional beds of sandstone. Taking up these beds in order towards the north, or in the reverse order to that in which they are seen in descending the stream, we have, two miles above the forks, an anticlinal fold with dark grey slate at the summit, and on either side slates, with interstratified bands of hard sandstone, ten inches in thickness. Following these are dark grey slates again, bent and contorted, dipping south; and beyond, another anticlinal fold, shewing slates with hard sandstone bands two to three inches in thickness, and hard, grey silicious sandstone, with fine, hair-like, black markings and cut by veins of mixed calcite and quartz, and by large veins of rusty-weathering, white quartz. These beds are much twisted up and altered by compression, the slates becoming quite ligniform in structure where they adjoin the beds of sandstone.

On the main Rimouski River, strata similar to those above described occur all along down to the great falls. They are mainly grey, calcareous slates, with limestone bands, and with, here and there, interstratified bands of hard sandstone.

The whole series of rocks above described has been subjected to very violent crumpling, the strata exposed along the main Rimouski River shewing its effects more particularly. The folding is often of the

Angular blocks
on stream.

General course
of the stream.

Section seen on
left hand
branch.

Rimouski
River beds.

Crumpling.

most fantastic description, shewing local dips towards every point of the compass and at every angle, but preserves a general parallelism in the trend of the folds, which run roughly north-east in broad curves. A fine and strong vertical cleavage, which cuts the slates, strikes in the same direction; this necessarily cuts the planes of bedding at various angles, and renders the finding of fossils in the strata extremely difficult.

Vertical
cleavage.

The planes of cleavage become co-incident with those of bedding only in close proximity to comparatively thick beds of sandstone, which have proved rigid enough to withstand the cleaving action of the shove, and to induce in the adjoining slates a cleavage parallel to their own bedding; a further effect of the greater resistance of these beds of sandstone is seen in the production in the slates near them of a ligniform structure. The extreme phases of crumpling have occurred near the centre of broad bands of slate, where the twisting and distortion of the beds has been very great, and where a conglomerate, similar to that seen at the mouth of the Seigas stream, on the St. John River,* has been formed.

Effects of
pressure.

Formation of
conglomerate.

This conglomerate is made up of sub-angular pieces of impure limestone, imbedded in a matrix of calcareous slate; the enclosed fragments are often very considerably rounded, and the rock might in places be readily mistaken for a conglomerate with water-worn pebbles; in other places, however, the method of its formation is clearly shown. It has evidently been formed from slates, with interstratified, harder bands of limestone, which have been subjected to great lateral pressure. The softer slates have bent and stretched under the force exerted, while the harder bands have broken up, and, after having been partially rounded by attrition, have been surrounded by the slates, which have curved around the broken pieces and filled the interstices between them, producing, on a large scale, a structure similar to that induced by flow.

The general north-east and south-west trend of the whole series of folds, and the parallelism to these of the planes of cleavage, would indicate the operation of a force acting at right angles to this direction, or from the south-east or north-west, and at right angles to the coast line to the south, and to the edge of the Laurentian Hills to the north.

Trend of folds.

The description which has been given above of the rocks exposed along the Rimouski River has been carried northward down the river only as far as the head of the Great Falls gorge; the section which the river affords, between the foot of the gorge and the St. Lawrence, has been described in the *Geology of Canada*, 1863, pages 418 and 419.

* *Geology of Canada*, 1863, p. 426.

The Silurian age of the rocks described in the above section extending from the Restigouche River westward on its tributary the Quatawamkedgwick as far as the fossiliferous strata above the provincial boundary line admits of little doubt, as, although fossils were found in them only at the one point mentioned, they are evidently, from their lithological character and stratigraphical position, the continuation eastward of the strata exposed along the St. John River. They are therefore considered to be Silurian, and probably of about the horizon of the Lower Helderberg.

There is less certainty with regard to the age of the rocks exposed along the Rimouski River and extending across the height of land to Quatawamkedgwick; no fossils have been discovered in them between the Taché Road, where the rocks are fossiliferous and of Silurian age, and the fossil-bearing ledges above referred to as occurring near the provincial boundary line. The whole extent of highly disturbed beds intervening cannot therefore, with any certainty, be assigned to a particular horizon, and the question as to whether they are of Silurian age or otherwise is left until the work of another season shall have afforded fuller evidence on the point. The parallel section further to the west, to be presently described, shows no strata further north than the Mt. Wissick ridge, which can be classed with any certainty as Silurian.

The Quatawamkedgwick River flows in a deep valley about half a mile in average width, and sweeps from side to side of this valley, leaving on either side between the bends, flat land, extending back to the hills which rise along the lower part of the river to a height of from 400 to 500 feet above its bed. The water is exceedingly clear and cold and the current very swift, with no stretches of dead water; fine deep pools, however, occur here and there along its course, which form the spawning beds of large numbers of salmon and trout. Small islands, wooded with balsam poplar, elm and ash, are plentiful along the lower stretches of the river, and the scenery all along is strikingly beautiful.

The appropriateness of the Indian name, Quatawamkedgwick (the river which runs down hill and disappears under the ground), becomes apparent at many points along this part of the river's course, where the water, always swift, seems literally to run down hill, and to disappear under the mountains, towards the base of which it again and again flows, and only turns abruptly off when to all appearance on the point of disappearing beneath them.

Higher up, the valley gradually becomes narrower, and the confining hills loftier, rising to heights of over 700 feet above the river bed. Elevations of various points along the valley and of many of the

neighbouring hills are given by Mr. Chalmers in the annual report for 1886. The general character of the valley remains the same up to within a few miles of the main forks; above this point, the hills on either side gradually disappear and the country bordering the stream becomes flat and continues so to the lakes which lie at its source.

Watershed.

These are divided from lakes draining into the Rimouski by only a low ridge, and the whole extent of country lying about the headwaters of these rivers is generally of even surface with large areas of swamp and with few elevations rising to any considerable height above the general level. Evidence that this level land which forms the central watershed was once covered by glacier ice is afforded by the deposits of boulder clay which occur at different points. A deposit of this nature, noted by Mr. Chalmers,* occurs two miles and three-quarters below McDougall's Brook, and is here overlaid by a stratified bed of sand and gravel. Boulder clay was noted at two other points further up on the stream, one of these was at a bend in the river, a quarter of a mile above the crossing of the provincial boundary line, and the other a quarter of a mile below it. At these points the river washes against, and cuts into, a bank of unstratified clay from twenty to thirty feet in height, holding pebbles and small boulders of the local rock with smoothed and flattened sides longitudinally striated; the overlying stratified sands and gravels, which occur in the exposure below, are here entirely wanting, only a thin layer of loam covering the clay. The stream at the crossing of the boundary line is probably about 150 feet higher than at the boulder clay deposit below McDougall's Brook, or, taking the heights of the latter place given by Mr. Chalmers, 570 feet above sea level.

Evidences of glaciation.

Boisbouscache and Tuladi rivers.

Trois Pistoles and Tuladi Rivers.

A second traverse was made across the watershed south of the St. Lawrence, by way of the Trois Pistoles and Tuladi rivers and their branches. The Boisbouscache or left hand branch of the former river was followed from the settlement of St. Jean de Dieu upwards for a distance of eight miles. From this point Lac des Iles at the head of the left hand branch of Tuladi River was reached by a short portage. The road which leads back from Trois Pistoles Station to the settlement of St. Jean de Dieu, a distance of twelve miles, passes over a succession of low rolling hills, rising gradually from the St. Lawrence, and crosses alternately belts of hard siliceous sandstone (so-called Sillery) forming the higher hills, and green and purple slates (so-called Lauzon) occupying the intervening valleys. These rocks

St. Jean de Dieu.

* Annual Report, 1886, page 15, M.

are all very much altered and contorted; they have been treated of at length in the Geology of Canada, 1863, and in the subsequent reports of the Survey by Dr. Selwyn and other writers; further details with regard to them are left for a later report when the structure shall have been more thoroughly worked out; all that will be attempted now will be to describe the exposures observed along the streams traversed on this route.

Ascending the stream from the settlement of St. Jean de Dieu, the first exposures seen form a low fall about 200 yards above the main road bridge; they are hard, dark grey, compact sandstones, considerably contorted, and dip S. 19° W. $<80^{\circ}$. The next exposures, which occur about half a mile beyond, are hard, grey, rusty-weathering, highly altered, nacreous slates, locally much folded, but keeping the same general dip; further on, however, the same slates dip S. 20° E. $<45^{\circ}$ – 50° . Similar sandstones and hard, grey slates continue in alternating bands beyond this point, preserving the same general strike, but shewing also local dips in various directions and at all angles from horizontal to vertical. The slates in places are banded with green, and are everywhere highly altered and contorted, and often finely cleaved with shining, satiny surfaces along the planes of cleavage. The last exposures seen on the stream occur just at the mouth of a small brook, entering on the left bank, which drains the lake through which the portage to Lac des Iles passes; they are sandstones and soft red and greenish-grey slates, with soapy feel and with limestone bands, two inches in thickness, interstratified. The same slates again appear in a low bluff on the right hand side of the portage, about three-quarters of the way across, dipping S.E. $<70^{\circ}$.

Lac des Ilets is a small, shallow lake, about two miles and a half in length, and has an average width of a quarter of a mile; the shores are quite low and show no exposures of rock *in situ*.

A number of small islands at the narrows, near the head of the lake, are formed of angular blocks of dark grey, hard, siliceous sandstone, which probably occurs in place beneath or near at hand; the nearest exposure of this sandstone seen, however, crops out on the stream (Rivière St. Jean) three-quarters of a mile below the lake, where it dips N. 38° W. $<65^{\circ}$. A mile below, hard, grey sandstone, composed largely of quartz grains, with some felspar, and with small pieces of black slate, dips N. 41° W. $<90^{\circ}$; and beds of the same character, but greenish in color and associated with hard, grey slates, crop out on the stream about a third of a mile below, and dip in the reverse direction at a very high angle. A quarter of a mile further down, the same hard sandstones and slates, with hard, very dark grey, splintery shales, dip N. 30° W. $<85^{\circ}$; these are followed

about half a mile below, by a repetition of the beds of sandstone seen above, which hold pieces of soft black slate. From this point to within two miles of Lac des Aigles no exposures are seen, then for three-quarters of a mile the stream flows over almost continuous exposures of calcareous sandstone, with white calcite along jointing planes, and calcareous slates with hard, flinty, calcareous bands, half an inch to two inches in thickness. These beds have a general dip, as nearly as could be determined, N. 50° W. < 80°; they are, however, very violently twisted and contorted, so that deviations from this general dip are very frequent. The lower quarter of a mile of this long exposure is occupied entirely by the banded slates, which terminate abruptly in a ledge which crosses the river nearly at right angles to its course and forms a fall six feet in height. No exposures appear along the stream from this fall down to the lake, a distance of one mile. A short distance above the fall, boulders of red slate, about eighteen inches in diameter, occur in the bed of the stream, together with larger, well-rounded boulders, perhaps six feet in diameter, of highly calcareous nodular sandstone, with broken bands of limestone, and containing many large corals resembling *Favosites Gothlandicus*.

Fall.

Fossiliferous blocks.

The sandstone of these blocks closely resembles that of the beds of similar character, which make up the mass of Mount Wissick on Lake Temiscouata,* and the blocks themselves are probably derived from the north-eastern end of the ridge of which Mount Wissick forms the south-western termination.

Age of the Boisbouscache River rocks.

Of the strata above described the whole series occurring along the Boisbouscache River is, with little doubt, a continuation and partly a repetition of that observed along the road leading southward from Trois Pistoles station, and the set of beds observed along the Riviere St. Jean, between Lac des Ilets and Lac des Aigles, an extension northward of those which occur along the shores of the northern arm of Lake Temiscouata, and which, as described elsewhere in the present report, underlie the fossiliferous strata of Mt. Wissick. The whole section southerly to the ridge which forms the north-easterly extention of Mt. Wissick, would thus seem to embrace only rocks of Sillery (Upper Cambrian) age.

Lac des Aigles.

The immediate shores of Lac des Aigles are quite low, and no rock in place was seen on the lake.

Rushes and water lilies grow in profusion around the lake shores, and often extend far out into its waters, which are quite shallow. The stream draining the lake also flows through flat land, and joins the Horton branch of the Tuladi River about half a mile above the junction of that branch and the Squatook branch.

* Geology of Canada, 1863, p. 421.

The Tuladi is a remarkably smooth-flowing river without falls or rapids, with the exception of one small fall just below the first lake and a short rapid above its mouth.

Fine flats occur at many points along its course, indeed the whole tract of land along the river seems to be of excellent quality. Good land.

The traverse which has been described follows an old Indian route, which once formed one of the main highways of communication between the St. John River and the St. Lawrence. Two of the old camping places on the route, which are now over grown with quite large trees were visited; one of these is situated on a point on the south shore of Lac des Aigles, opposite the mouth of the inlet from Lac des Ilets, and the other is on the left bank of the river at the foot of First Tuladi Lake. The latter place has evidently been a favourite one for the manufacture of flint implements, as the surface over a considerable area is dotted with little piles of flint chips. Old Indian route.
Flint chips. The material used must have been derived from the drift, as no suitable rock occurs in place in the vicinity.

The exposures occurring on the lake and at the rapids in the lower part of the river are described in another part of this report.

Lake Temiscouata.

The rocks of Lake Temiscouata have been described in considerable detail, and are given with sections illustrating the relations and probable thickness of the principal beds in the *Geology of Canada*, 1863, pages 419-425. It is with pleasure that we bear testimony to the general accuracy of these descriptions, which, so far as the lithology of the rocks is concerned, leave little to be desired. A careful review, however, of the admirable but complex section here revealed has enabled us to add very considerably to the lists of organic remains in the beds already known to be fossiliferous, as well as to record their presence in certain portions of the series in which they had not previously been observed; while the exploration of the surrounding country and the comparison of this with districts studied elsewhere, have served to throw new light on points hitherto obscure. The following section is a condensation of that in the *Geology of Canada*, with such additional information as has been recently obtained. The section begins on the north side of Mount Wissick or Mount Lennox, where the rocks of the Silurian system may be seen to rest unconformably upon those of the "Quebec group":—

Greenish grey and black slates, alternating in thin bands, two to three inches wide, with grey or buff weathering dolomitic limestones. These beds occur on the north-east side of a small cove above Mt.

Lake
Temiscouata.

Accuracy of
section in
*Geology of
Canada*, 1863.

Condensed
section of Mt.
Wissick beds.

Condensed
section of Mt.
Wissick beds.

Wissick, and are a part of a similar series of rocks, supposed to be of the same age as those of Point Levis which occupy all the upper part of the lake. They have been subjected to much crumpling, and exhibit considerable irregularity of inclination, their dip, where nearest to the Silurian, being $N.40^{\circ}W. < 70^{\circ}-80^{\circ}$. They have as yet yielded no fossils, and their thickness is unknown.

Measures concealed for about half a mile.

Grey quartzose sandstone, containing white quartz pebbles, mingled with fragments of limestone in a greenish sandy matrix. These grits or conglomerates apparently occupy a space across the measures of about 1,000 feet, and with a dip of $S.65^{\circ}E. < 40^{\circ}$ would give a thickness of.....642 feet.

White sandstone or quartzite in massive beds. These rocks are grey within, but weather almost snow white, with vitreous surfaces, often drusy with small quartz crystals. Some portions are pinkish or reddish, and others spotted with small red dots. Their thickness, as given in the Geology of Canada, is only 40 feet, but they were found to have a surface breadth of 250 paces, which, with an average dip of 50° , would give a thickness of.....420 feet.

Coarse, shaly and rubbly conglomerate, holding limestone pebbles (with some quartz). They dip $S.60^{\circ}E. < 70^{\circ}$, and have a breadth of 60 paces, corresponding to a thickness of.....114 feet.

Dark grey sandstones. Dip $S.70^{\circ}E. < 20^{\circ}$. Thickness about....10 feet.

Grey calcareous shales, filled with bands, nodules and lenticular masses of limestone, abounding in fossils. Among these are the following:—*Favosites Gothlandicus*, Lamarck; *Chaetetes* sp. or *Dendropora*; *Zaphrentis* sp.; Crinoidal fragments; *Chonetes*; *Strophodonta varistriata*, Conrad; *Rhynchonella nucleolata*, Hall, R. sp. indt.; *Atrypa reticularis*, L.; *Meristella* or *Merista*, very abundant, and including three species, *M. bella*, Hall, *M. laevis*, Vanuxem, *M. didyma*, Dalman; *Megambonia* sp.; *Grammysia* sp. resembling *G. Acadica*, Billings; *Orthonota*, sp.; *Cucullella* sp.; *Orthoceras*, with large siphuncle on one side, ten septa in the space of seven centimetres, and seven septa to its own diameter; *Cornulites flexuosus*, Hall; *Calymene Blumenbachii*, Brongniart; *Beyrichia tuberculata*, Kløden, typical examples, and in great abundance; *Froetus*? sp. indt.

These beds are regarded by Mr. Ami, by whom the fossils have been examined and in part collected, as corresponding to the Chat River limestones, equivalent to the upper part of the Chaleur group, and about equivalent to the lower part of the Lower Helderberg formation. Dip $S.65^{\circ}E. < 60^{\circ}$. Thickness about....10 feet.

Red and green shale, in alternating bands, with green argillaceous sandstones. The dip of these beds where they overlie those last mentioned is $S.65^{\circ}E. < 15^{\circ}$, their strong slaty cleavage having an underlay of $N.65^{\circ}W. < 80^{\circ}$, but in following them along the precipitous face of the mountain, they are found to fold over and exhibit a dip $N.40^{\circ}W. < 40^{\circ}$. They are also broken by a fault. Their estimated thickness is.....125 feet.

Condensed
section of Mt
Wissick beds

Grey nodular limestones, conspicuously divided by vertical joints, which often present curved surfaces and produce an appearance resembling that of fluted columns. These beds rest directly upon the red and green shales, and are probably arched with them, but towards the southern end of the bluff resume their normal dip S.65° E. at an angle of 50°. The columnar limestones, which contain but few fossils, have a thickness of about 10 feet, and are followed by about the same thickness of finely banded massive limestones, having at the top a zone, from one foot to 18 inches thick, filled with branching corals, chiefly *Pavosites*—it also holds shells of *Atrypa reticularis* and *Pentamerus*. This is capped by more columnar limestone, the whole having an aggregate thickness of about..... 50 feet.

Grey hard sandstone, with beds of impure limestone, the sandstone containing remains of *Meristellae*,.....30 feet.

Grey nodular limestone, without observed fossils,.....30 feet.

Grey banded limestone, filled with corals and other fossils, including *Pavosites Gothlandicus*, Lamarck; *Strophodonta varistriata*, Conrad, in great abundance and forming the typical representative of the zone; *Grammysia*, sp., resembling *G. Canadensis*, Billings; ? *Megambonia mytiloidea*; *Euomphalus*, resembling a species obtained by Dr. Ellis from the forks of the Scaumenac river; *Leperditia*, a narrow reniform species, having a length two and a half times its breadth; *Alveolites* (?) sp. indt.; *Zaphrentis*, sp. indt.; *Orthis* sp.; *Rhynchonella formosa*, Hall; *R. Wilsoni*, Sowerby; *R. nucleolata* ? Hall or a very closely allied species; *Merista* sp. ? *Pterinea* sp.; *Anodontopsis* sp.; *Megambonia* sp.; *Orthonota* sp.; *Leperditia*, sp.; *Beyrichia Kloedeni*, Sowerby or a variety of that species; *Beyrichia* sp. allied to *B. equilatera*, Hall; *Beyrichia*, a third species, elevated and globose, not recognized as a described form; *Calymene*, like *C. Blumenbachii*, Brongniart.

[Mr. Ami considers these fossils also to indicate the horizon of the lower portion of the Lower Helderberg series. The authors were assisted in the collection of the fossils by Mr. Ami and Mr. W. T. H. Reed.] Thickness about.....30 feet.

Grey arenaceous limestones and sandstones forming the upper portion of Mt. Wissick, but sloping to the level of the lake, with a dip S.70° E. <18°. These higher beds contain comparatively few fossils, among which are the following: A stromatoporoid form; crinoidal fragments, in abundance; *Chonetes*, sp., a rather arcuate form, smaller than *C. Nova-Scotica*, Hall, and larger than *C. tenuistriata*, Hall, resembling somewhat *C. Melonica*, Billings; *Meristella*, sp. Their supposed thickness is about.....500 feet.

The beds may, therefore, be correlated with the Lower Helderberg or with the Ludlow formation of Britain.

The eminence of Mt. Wissick, including the above section, is situated Mt. Wissick. on the eastern side of Lake Temiscouata, near the angle between the lower and upper portions. On the western side of the lake and opposite the mountain, the only trace of this great series of beds is to be

White sand-
stone at Cabano found in a few outcrops of fossiliferous shale, occurring on and near the Portage road, about a mile northward of the village of Cabano. There is in this village also a considerable mass of white sandstone or quartzite, bearing much resemblance to that at the base of the mountain, but it equally resembles other great masses of rock a few miles to the north, which have been supposed to represent the Silly formation of the Quebec group. These have a much higher dip than any of the beds of the mountain, and are probably correctly referred to the older series.

Black and
Burnt Point
conglomerates. Between the highest beds of Mt. Wissick and those of Black Point, the first exposure to the south, there is a sufficient interval for 1276 feet of strata with the dip above given (Geology of Canada, page 421).

Thickness.

Upthrow fault.

Fossils in shales

Pointe-aux-
Trembles
fossils;

In the rocks of this point, however, and its counterpart, Burnt Point, on the opposite shore of the lake, not only does the character of the beds become greatly altered, but their inclination is greatly increased, the coarse conglomerates of which they are composed now dipping S. 50° E. < 50°. Notwithstanding the enormous thickness of these conglomerates, by estimate nearly 1,000 feet, they would appear to be quite local, stretching eastward from the lake for a few miles only, and for a still less distance upon its western side, while there is but little to represent them over other portions of the Silurian area. This fact, in connection with others to be presently noticed, favors the idea that these conglomerates with some of the succeeding beds are older than those of Mt. Wissick and that the interval above alluded to marks the course of an upthrow fault. So far as the conglomerates are concerned, we have failed, after repeated search, to find in them any remains by which their age can be determined*. In the soft, grey, slaty and sandy beds which succeed them, we have, however been more fortunate, and have obtained a considerable number of fossils, which appear to indicate that the beds belong to a lower horizon than those of Mt. Wissick. These fossils were collected (by Messrs. Reed and Ami, with the authors) upon the western shore of the lake just above Pointe aux Trembles, and partly from the hard sandstones of the point itself. From the shales were obtained crinoidal columns with shells of *Leptaena transversalis*, Dalman, a *Rhynchonella*, sp. indt. and also an *Orthoceras* of small size.

In the sandstones were found the following species:—

POLYPI.

Streptelasma, sp. indt. A rather large or straight form, showing some resemblance to *Petraia rustica* of Billings.

* Fossils are said to have been obtained from the limestone pebbles of these conglomerates many years ago by Mr. Billings, but so far we have failed to find any.

BRACHIOPODA.

Lingula, sp. indt.*Orthis*, sp. indt., apparently allied to *O. hybrida*, Sowerby, or *O. elegantula*, Dalman.*Platystrophia biforata*, Schlotheim, var. *lynx*, Eich.*Strophomena*, sp., of the type of *S. alternata*, Conrad.*Rhynchonella*, sp.*Triplisia* ? sp.

GASTEROPODA.

Pleurotomaria or *Platystoma*.*Murchisonia* sp., an apparently young shell, with comparatively large body-chamber, and small acute spire.

PTEROPODA.

Hyalithes (*Theca*) *Forbesi*, Sharpe. A specimen which resembles the species found in the Silurian of Arisaig, N.S., and here identified with *H. Forbesi*.

CEPHALOPODA.

Orthoceras, sp. indt.

These fossils suggest the idea that the rocks from which they were obtained are about the age of the Niagara Limestone.

It is important to notice in connection with the Pointe aux Trembles sandstones the evidence which they appear to afford of contemporaneous volcanic activity. This is, perhaps, partly indicated by the colour of the rock, which varies from green to red and purple, but is more clearly seen in the abundance of epidote with which the rock is charged and, in places, its somewhat amygdaloidal aspect. Much of it is a conglomerate rather than a sandstone, the pebbles and paste being much alike in character, and both somewhat porphyritic. The presence of bands of purplish black jasper is also a noticeable feature.

The rocks above described, in addition to their somewhat conspicuous display on the shore of the lake at Pointe aux Trembles, are also well seen along the course of the Tuladi River, the first mile of this stream being over the green and reddish sandstones, here dipping S.50°E. <75°-80°, while at the Tuladi Falls and in the rapids above, the rocks are the grey, sandy shales and sandstones, with coarse grey grits, holding fragments of black slates and yellowish weathering dolomite, having a pretty uniform dip of S.65°E. <70°. In black splintery shales near the falls graptolitic fragments were found by Mr. Reed, apparently of the genus *Diplograptus*.

Fossils from
First Tuladi
Lake.

Following the course of the beds the same strata come out upon the shores of the First Tuladi Lake, where they again contain numerous fossils, indicative of their age. The following were obtained from soft, grey shales, forming low ledges along the western shore of the lake, about half a mile above the outlet, and in a position corresponding to that of the fossiliferous beds of Pointe aux Trembles :—

BRACHIOPODA.

Orthis hybrida, Sowerby.

Orthis flabellulum ? var. ?

Spirifera or *Platystrophia*, possibly *P. bifurcata*, var. *lynx*, Eich.

Strophomena, sp.

Leptaena transversalis, Dalman.

Rhynchonella, sp.

Pentamerus ? sp.

Leptocælia, sp.

LAMELLIBRANCHIATA.

Modiolopsis orthonota ? Conrad.

Modiolopsis, sp. indt.

Orthonota solenoides ?

Pterinea, sp. indt., showing coarse reticulate surface markings.

GASTEROPODA.

Bucania stigmosa, Hall. Two typical examples.

Murchisonia Conradi, Hall, or a closely allied species.

Murchisonia, sp., like *M. subulata*, Conrad.

Loxonema, sp.

Pleurotomaria cf. *P. Axion*, Hall, with fine cancellated markings on the shells, which are well preserved.

Holopea, type of *H. Harmonia*, Billings, but much smaller.

? *Turbo Octavius*, d'Orbigny, or *T. carinatus*.

TRILOBITA.

Portion of the pleuron of a trilobite.

These fossils probably indicate as low a horizon in the Silurian system as the lower part of the Niagara formation, or perhaps the Clinton.

Annelid trails.

These shales are followed here, as elsewhere, by sandstones corresponding to those at Pointe aux Trembles. They re-appear also on the south-eastern side of the lake, and are here remarkable as containing numerous tracks or trails of some marine animal, probably of an annelid. These tracks resemble those known from the Silurian rocks of Western

Ontario, as *Harlania* or *Arthropycus*; also, and in a marked degree, those described by Mr. Whiteaves from Gaspé, under the name *Gyrichnites*. As the Lake Tuladi specimens most probably belong to the genus last named, the name of *G. minor* is here suggested for them by Mr. Whiteaves.

Still further east the same sandstones, with the same stratigraphical relations, and the same semi-volcanic aspect, come out upon and cross the main Squatook Lake, forming in addition to an island in the latter the remarkable hay-stack like mountain, known as the Sugar Loaf or Squatook Peak. No fossils were found in the sandstones of the mountain, but at its base, in a position corresponding to that of the shales described on Tuladi Lake, are numerous loose fragments of shale and sandstone, in which fossils are numerous. They are not well preserved, but among them the following have been recognised:—

Squatook Lake fossils.

Crinoidal fragments.

Zaphrentis, sp. indt.

Favosites.

Halysites catenulatus, L.

Orthis, sp., of the type of *O. hybrida*, Sowerby.

Strophomena, sp.

Leptaena transversalis, Dalman.

Spirifera plicatella, var. *radiata*, Sowerby.

Goniophora, sp.

Straparollus, sp.

? *Holopea*, sp.

These fossils are of about Niagara or Wenlock age.

The series of rocks above described, extending from Pointe aux Trembles up the Tuladi River to Squatook Mountain, though stratigraphically occupying a position which would seem to make them newer than the rocks of Mount Wissick, are thus throughout characterized by a fauna indicative of a lower horizon. We hence regard the Mt. Wissick beds as having been brought to the surface by a fault running just north of and parallel to the conglomerates of Black and Burnt points, which would thus become the true base of the Silurian system. The further fact that the strata of Mount Wissick rest directly upon rocks of the Quebec group, and have a comparatively low inclination, would indicate that this break occurred prior to the deposition of the Mount Wissick beds, and hence that the lower and upper portions of the Silurian system are here unconformable. Compared with the rocks of the Gaspé peninsula, those of Mount Wissick are evidently the representatives of those on the south side of the Shickshock Mountains, on

Stratigraphical position.

Fault and unconformity.

the Chatte and Matanne rivers, as also of those on Lake Metapedia, the Metis and Rimouski rivers. In this peninsula, as in Mount Wissick, the lower division of the system appears to be wanting.

Probable age
of the slates.

The rocks which immediately succeed the Pointe aux Trembles, Tuladi and Squatook sandstones, referred to the Niagara formation, are the dark grey bluish-weathering and more or less calcareous slates which occupy the whole of the southern part of Lake Temiscouata, as well as the Madawaska River and a large section of the St. John, thence extending east and west over a large portion of northern New Brunswick and Aroostook county, Maine. The position of these slates in the Silurian system has not been certainly determined. At no point has their actual contact with the Pointe aux Trembles sandstones been observed, and though appearing to dip off from these, and conformably so ($S.65^{\circ}E. < 70^{\circ}$), they are everywhere so extensively crumpled that but little reliance can be placed upon their attitude. Over the greater part of the area covered by them, they seem to be mostly destitute of fossils, and when these do occur, they are usually too few or too poorly preserved to indicate with certainty the exact horizon of the beds which contain them. The general aspect of these fossils, however, as indicated in earlier reports, is that of the Lower Helderberg group, and this and other facts render it probable that they represent the upper and more shaly portion of the Gaspé limestone series, being possibly the deep-water representatives of the latter. The only points where a lower horizon would appear to be indicated are the vicinity of the Siegas (or Shiguash) River, in Victoria county, N.B., and part of the valley of the Aroostook River, in northern Maine. As each of these localities has afforded us some information not obtained by previous authors, and as they have important bearings upon the geology of the whole region in which they occur, we now propose to give some of the results of their recent exploration.

Section in vicinity of Siegas River, Victoria Co., N.B.

Siegas River
conglomerate.

In "Geology of Canada, 1863," p. 426, a section in the vicinity of the Siegas River is given, of which the most remarkable feature is the occurrence of a coarse conglomerate, said to bear much resemblance to that of Black Point on Lake Temiscouata. It is, however, very much thinner than the latter, the conglomerate proper not exceeding fifty feet, and is further characterized, in addition to pebbles of limestone, serpentine and jasper, which are in various positions, by what appear to be disjointed portions of limestone layers from half an inch to four inches in thickness and sometimes four feet long, which lie parallel to the stratification and occasionally curve with it. In following the beds

upon their strike these limestone bands or layers increase in number, and, with only thin, shaly partings, finally coalesce, or nearly so, into a bed, about forty feet thick, of tolerably pure limestone, used for burning; in which, however, each layer is still divided by numerous transverse breaks, into separate blocks. In the features thus described they appear to nearly resemble a portion of the Gaspé section, as described and figured on page 392 of the "Geology of Canada." We have been unable to find any fossils in these conglomerates, though they are stated in the work last referred to to contain them. In the examination, however, of the sandstone beds which are associated with and succeed the conglomerates on the south, we have found a fossil resembling the *Zaphrentis* from Squatook Mountain, together with the remains of an *Orthis* and a *Strophomena*, apparently *S. rhomboidalis*, Wilckens. These fossils, together with the character of the sandstones, which are often coarse and more or less vesicular, and nearly resemble those of Pointe-aux-Trembles, render it very probable that they are the equivalents of the latter, and belong to the lower or Niagara portion of the Silurian system. Their dip, like that of the conglomerates, is vertical (S. 40° – 45° E. $< 90^{\circ}$), and their breadth about a furlong. Beyond these are exposures of blue slates, which, at about the same distance, are succeeded by a second set of limestone beds, much like the first but purer, and which are also in a vertical position, with an exposed breadth of 150 feet. To these limestones succeeds the valley of the Siegas, beyond which there are no exposures as far as Grand River. South of Grand River the rocks are again slaty, grey, green and red argillites, with thin hematitic bands; their dip being N. 40° W. $< 80^{\circ}$.

Fossils from
Siegas River.

Upper St. John and Aroostook Section.

With the several sections of the Silurian basin which have now been given, and which lie wholly within the territorial limits of Canada, we may finally compare still another. This section is parallel to but westward of that last described. It crosses parts of Quebec and New Brunswick, and also a considerable portion of northern Maine. Its comparison with those already given is desirable, not only from the peculiar geographical position of a portion of New Brunswick, which is, as it were, dovetailed between Quebec and Maine, but from the further fact that in the county of Aroostook, in Maine, the facilities for the study of the Silurian system are exceptionally good and help to throw much light upon the same system as developed in adjacent parts of Canada.

Upper St. John
and Aroostook
section.

In passing to the westward from Lake Temiscouata, much difficulty is experienced from the comparatively level character of the country, and the want of exposures, in determining the character of the underlying rocks, or fixing their proper boundaries. It is, however, quite certain that the northern limit of the Silurian system, as given by Mr. Richardson (Report of Progress 1866-69, page 139) is, both on the Temiscouata Road and again on the St. Francis, somewhat out of place. As regards the first named road, the contact line with the Quebec group is both described and mapped as corresponding nearly to the position of the thirty-fourth mile-post in the settlement of St. Louis de Ha! Ha! Not only, however, are the slates at this point Cambro-Silurian rather than Silurian, but for three miles south-eastward of it great reefs of white sandstone and red slates are exposed to view which are unquestionably a part of the former system; the true line of contact is probably not more than a mile northward of the village of Cabano. So on the St. Francis, the limiting line between these two systems is placed at the head of Pohenegamook or Boundary Lake, whereas its true position, as correctly represented in the Geology of Canada (p. 426), is somewhere near and probably below the foot of the lake. The rocks which border Pohenegamook Lake, even to its southern extremity, are certainly those of the Quebec group, so called; but in exploring the adjacent country, the only beds by which the beginning of the Silurian could be determined were certain whitish-weathering sandstones which outcrop on a small brook in the vicinity of Cabano Portage. These appear to be lying at a very low angle and may possibly represent the white sandstones at the base of Mount Wissick, but no trace of any associated limestones or of any fossiliferous strata could be found, and beyond the fact of their being Silurian, little can be said as to their relations. Still further west similar difficulties were met with upon the Big Black and Little Black rivers, except that upon the latter, which is for the most part very tortuous and bordered by low swampy land, what would appear to mark the northern boundary of the Silurian occurs at its junction with its main or north-east branch about fifteen miles from the St. John River. The rocks at this point consist of dark purplish grey to black and somewhat graphitic slates, associated with beds of hard grey grit or sandstone which are in part conglomerates, and hold numerous fragments of black slate. Their dip is S. 60° E. < 60°. These are supposed to be of Silurian age, but differ in important respects from any portion of this system elsewhere seen. We were unable to penetrate above this point upon the Little Black for want of water.

Northern limit
of the Silurian.

St. Louis de
Ha! Ha!

Pohenegamook
Lake.

Cabano Portage

Big Black and
Little Black
River.

To the south of the line above described, the whole country between the lower half of Temiscouata Lake and the Madawaska River upon the

one side, and the valley of the upper St. John on the other, appears to be entirely occupied by slaty strata. The conglomerates of Black Point and the sandstones of Pointe aux Trembles can be traced, for a short distance only, to the westward of the lake, and unless the former be represented by the beds referred to above on the Little Black are wholly wanting to the westward, as are also the limestones of Mount Wissick. The exposures of the slates on the other hand are numerous, especially along the valley of the St. John where they were frequently observed as high as the Seven Islands, eighty-five miles above Edmundston. They present in this distance but very little variation, except that they occasionally include beds of sandstone and have a nearly uniform bluish-black or dark-grey colour, which, by weathering, becomes greenish, or by action of water somewhat reddish in aspect. They are only slightly calcareous but are not unfrequently micaceous, their dark-green colour being apparently the result of finely disseminated chlorite. Owing to their strong slaty cleavage the true dip is not always easily made out, but when this is distinctly discernable it is usually at pretty high angles and sometimes nearly vertical, or with abrupt and intricate plications. Their western limit was not reached on the main St. John, but from such information as we have been able to obtain we think it probable that this limit is not far from, and has the general course of, the International Boundary, crossing the sources of the Big Black River and the north-west branch of the St. John a few miles west of Seven Islands.

Extension
westward of
Temiscouata
rocks.

Seven Islands.

Limit of
Silurian on
upper St. John.

Aroostook County, Maine.

The area lying to the southward and westward of the St. John River comprising the county of Aroostook, Maine, is, like the adjacent parts of New Brunswick, largely occupied by slates. They cover the whole of the northern part of that county as seen on Fish River to Eagle Lake, and on the Alaguash for fifteen or twenty miles from its mouth and, with the possible exception of Mars Hill, are the only rocks seen along the International boundary as far south as Houlton; but a few miles to the westward these slates are interrupted by several bands which are quite different in character if not in age, and which are of much interest in their bearing upon the geology of New Brunswick and Quebec.

Aroostook
section.

The first of these areas is a trough, or series of troughs, having a generally north-east direction and a length of about thirty miles, extending from Long Lake at the extremity of the eastern branch of Fish River, through Second or Mud, Cross, Square or Sedgewick and Eagle Lakes to Nadeau or Upper Lake on the main or south-western branch of the same

Fish River
Lakes.

Square Lake
limestone.

Paper by
E. Billings.

stream. At various points along the shores of these lakes the rocks are dark grey, bluish-weathering slates, not differing from those which elsewhere characterize the Silurian system, but with these occurs also a tolerably well-defined belt, consisting in part of reddish and chocolate brown shales and in part of grey grits and conglomerates, which are more or less fossiliferous and have associated with them beds of impure limestone, some of which abound in organic remains. The best exposures of these limestones are on Square or Sedgewick Lake (near the middle of its western side) where their existence and fossiliferous character was first made known by the officers of the Maine State Survey in 1862. In the following year a valuable paper descriptive of the organic remains found in this locality, was published by Mr. E. Billings, in the Journal of the Portland Society of Natural History. In addition to critical remarks upon Silurian and Devonian fossils from various parts of Maine, this paper contains figures and identifications of twenty-eight species, fifteen of which were therein described for the first time. As this work was therefore essentially Canadian, and as the only more recent explorations of the locality have been those of the Canadian survey, and as we have been able in our collections not only to recognize all the forms described by Mr. Billings but to add several additional species, including at least two more forms which are new, we think it but right that the complete list of these interesting and often typical remains should be given here.

Fossils from
Square Lake.

CATALOGUE OF FOSSILS FROM SQUARE LAKE (LAKE SEDGEWICK) AROOSTOOK COUNTY, MAINE.

ZOOPHYTA.

Zaphrentis, sp. indt.

Favosites Gothlandicus, Lamarek.

POLYZOA.

Fenestella, sp.

BRACHIOPODA.

Pholidops ovata? Hall.

Orthis discus, Hall.

" *eminens*? Hall.

" *strophomenoides*, Hall.

Streptorhynchus perplanum? Conrad.

- Strophodonta punctulifera*, Conrad.
Strophomena rhomboidalis, Wilckens.
 " *indentata*, Conrad.
Spirifera macropleura, Conrad.
 " *perlamellosa*, Hall.
 " *modesta*? Hall.
 " *sp. indt.*
Athyris Harpalyce, Billings.
 " *Blancha*, Billings.
Meristella laevis, Vanuxem.
Retzia dubia, Billings.
 " *Electra*, Billings.
 " *formosa*, Hall. (sp.)
 " *Hippolyte*, Billings.
Atrypa reticularis, L.
Rhynchonella Mainensis, Billings.
 " *bialveata*, Hall.
 " allied to *R. Aspasia*, B., and *R. altiplicata*, Hall.
 ? *Rensselaeria Portlandica*, Billings.

Fossils from
Square Lake.

LAMELLIBRANCHIATA.

Pterinea, sp.

GASTEROPODA.

- Platyceras ventricosum*, Conrad.
 " *tenuiliratum*, Hall.
 " *dilatatum*, Hall.
 " *retrorsum*, Hall.
 " *curvirostrum*, Hall.

CEPHALOPODA.

- Orthoceras rigidum*? Hall.
Oncoceras, sp. indt.

TRILOBITA.

- Proetus Junius*, Billings.
 " *Macrobius*? Billings.
 " n. sp.
Bronteus Pompilius, Billings.
Phacops Trajanus, Billings.
Lichas Billingsi, N. sp.
Leperditia, sp.

No other rocks are seen in immediate connection with these limestones on Sedgewick Lake, but on several of the associated lakes and on the intervening "thoroughfares" are beds which cannot be very far removed from them in age. On Long Lake, the most easterly of this chain of depressions, and which is not more than seven miles from the St. John River, the rocks are chiefly slaty, and much the same in character as on the latter stream, but on a small island near its head include also ledges of soft and rubbly dark grey sandstone, from which was obtained the pygidium of a trilobite. These sandstones are believed to mark the eastern extremity of a belt of rocks which extends all the way from Long Lake to Eagle Lake, but which is best seen upon the latter. The exposures at Eagle Lake are in a series of bluffs which form its eastern shore about a mile below the entrance of the "thoroughfare" from Square Lake, and present the following apparently ascending section:—

Brownish red shales and conglomerates. The latter are produced by the enclosure in the shales of numerous small rounded pebbles and one very large irregular mass, 10 feet by 4 feet (possibly a lenticular bed), which are themselves conglomerates or coarse grits, containing numerous particles of green, red and black jasper, as well as serpentine, mingled with the remains of shells, corals and crinoids.

Brownish-red conglomerates, similar to the above, but containing less shale, the pebbles mostly small, and with few fossils.

Hard and fine grey buff-weathering sandstone and grits, showing casts of crinoids on weathered surfaces.

Dark-grey sandstones and shales, much contorted and filled with seams of spar, the joint surfaces often somewhat plumbaginous.

Dark-grey slates, holding obscure remains of plants.

Bright red slates and dark rubbly slates.

Dark-grey, bluish-weathering slates, of the ordinary Silurian type.

All of the above beds have a north-westerly dip, and though not forming an absolutely continuous section, appear to be all members of one group. Similar beds are seen at intervals also along the Square Lake thoroughfare and again on that by which Fish River flows from Nadeau Lake near the road to Fort Kent. They are a part of the series which in the Maine reports is described and mapped as Devonian, and the occurrence in the shales of gritty pebbles containing Silurian fossils (*Favosites*, *Alveolites*, *Nematopora*, *Chetetes* and crinoidal stems), would seem to give some support to this conclusion, but as similar grits are interstratified with the shales and also contain similar fossils, it is quite as probable that all are contemporaneous and all Silurian. It may be added that the whole series bears a most marked resemblance to the beds of the Beccaguimic river, in Carleton county, New Brunswick, (described in Report of 1882-84) and which are undoubtedly Silurian.

About twenty miles to the south of the depression or series of de-
 pressions above described, and drained by the east branch of Fish River, is the approximately parallel east and west depression occupied by the Aroostook. The intervening tract is occupied by comparatively high and broken land which, however, is almost completely intersected by the south-westerly or main branch of Fish River, and which thus serves to reveal to some extent the general character of the rocks composing it. These, as seen at different points on the shores of Nadeau Lake, are somewhat various, some consisting of coarse, reddish-grey conglomerates, holding pebbles of grey and red felsite and red jasper, and having a moderately low dip (N. $< 30^\circ$) while others are hard grey felsitic and dioritic rocks associated with hard greenish-grey and reddish or purplish jaspery slates with a dip N. $< 80^\circ$.

It is altogether probable that the former are of the same age as the conglomerates of Long and Eagle Lakes, and like the latter presumably Silurian, but their relations to the crystalline and silicious rocks on which they rest and from which their material has evidently been derived, would seem to indicate that we have here another older and unconformable formation. From somewhat similar facts observed elsewhere, as for instance on the river Alleguash at Churchill Lake, we are disposed to regard these latter as either Cambro-Silurian or possibly even Cambrian. It may, however, eventually turn out that they represent the very lowest portion of the Silurian system, which in southern New Brunswick presents the same silicious and volcanic character, but which has not been elsewhere observed in the more northerly portions of that province. The reference of the conglomerates to the Silurian receives some confirmation from the fact that midway between Nadeau and Portage Lake coarse-grey, gritty limestones, similar to those of Sedgewick Lake, are again met with and like them contain remains of corals, shells and crinoids. Their dip here is S. 50° E. $< 60^\circ$. Following them, as the stream is ascended, are slaty rocks which are rubby and filled with concretionary layers, recalling the beds seen at the eastern extremity of Long Lake. No other exposures are seen on this stream as far as Portage Lake.

Between the head of Portage Lake and the Aroostook River the distance is ten miles. Neither on the lake nor along this portage have we had any opportunity of making extended examinations. It would appear, however, that about the former the rocks are chiefly trappean, forming a portion of an extensive belt of such rocks which is very conspicuous about the upper Alleguash lakes (Churchill and Spider lakes) and about the head-waters of the Aroostook. It includes the somewhat prominent chain of the Aroostook mountains and thence extends eastwardly to and beyond Portage Lake on Fish River. Between

this lake and the Aroostook at Ashland, the rocks are partly slates and partly conglomerates which are better seen in the valley of the first named stream between Ashland and Presquile.

The strata to be first noticed occur in the village of Ashland. Just opposite the hotel, in this village, is a low ridge of limestone, which was at one time quarried for burning, but is now mostly concealed by soil. These beds were described to us as being abundantly fossiliferous and there is little doubt that, like the Square Lake rocks and like other beds to be presently noticed, they are of Lower Helderberg age. Just south of and beneath them, on the road to Masardis, are other ledges of grey buff-weathering sandstone alternating with grey rubbly shales and holding soft crumbling ochreous bands which are filled with crinoid stems and other organic remains. Among the latter, but poorly preserved, are the following:—? *Atrypa reticularis*, L.; *Orthis*; a lamellibranchiate shell, most probably a *Cypricardina*; *Eatonia*, sp., and *Spirifera*, sp.

Fossils on
Masardis road.

The course of these beds is a little south of west, and in this direction they run towards the Aroostook River, not far from which, and at a distance of three-quarters of a mile from Ashland, the limestones again crop out on the farm of Mrs. Adams. From these beds the following fossils, of Lower Helderberg age, were collected:—

Fossils from
Mrs. Adam's
farm.

Stromatopora.
Favosites Gothlandicus, Lamarck.
Polypora Psyche? Billings.
Strophodonta punctulifera, Conrad.
Strophomena rhomboidalis, Wilckens.
Merista arcuata, Hall, (fine specimens.)
Murchisonia, sp.
Loxonema Fitchi, Hall.
Platyceras, sp.

Aroostook
River.

Plant remains.

These limestones are not exposed in the channel of the Aroostook, but not far from where they should appear, the right bank of the river, three-quarters of a mile above Ashland bridge, shows ledges of grey and flaggy calcareous sandstones, filled with what appear to be carbonized remains of plants. Their dip is W.<80°. The next rocks seen in descending the stream occur about a mile below the bridge and are a continuation of similar beds, better exposed at the Mill on the Big Machias. They are grey slaty sandstones, so calcareous as almost to deserve the name of limestones; associated with them are bedded grey and buff-weathering arenaceous slates, dipping N.80°W.<70°.

About one mile and a half further down, the shore shows ledges of red, green and grey slates, forming a low arch, with a dip N.30°W., sinking from 45° to 30°. Similar rocks including there beds of grey, calcareous conglomerate cross the Ashland road not far from the village. To these, at a distance of a quarter of a mile, succeed hard grey sandstones, dipping E.<60°, which, with bluish weathering slates, continue to occur at intervals, as far as a point about three miles above Beaver Brook. The only fossils observed in them were crinoids, contained in soft rusty and gritty beds, much like those in Ashland. Half a mile below the last exposure of these sandstones the next rocks are found to be quite different in character, being very coarse conglomerates, filled with large and well-rounded pebbles of metamorphic rocks, including red syenite, grey quartzite, porphyry and amygdaloid, as well as green and black silicious slates and jasper. The beds are massive, and as indicated by finer layers, dip quite regularly S.80°E.<50°. These conglomerates constitute a very striking feature in the geology of northern Maine, being exposed at various points both north-west and south-east of the Aroostook River, while large boulders derived therefrom are thickly strewn over the adjacent country. On the road from Ashland to Castle Hill, and four miles from the former, where they form somewhat prominent ridges, they may be seen to be overlaid by the grey sandstones and grits, now dipping N.<20°, and forming a portion of a low fold.

On the Aroostook also, the next succeeding beds, about half a mile below the last exposures of the conglomerates, are sandstones, but here their dip is at a still lower angle, being only 5° or 10° in a S.S.E. direction. In the Maine geological reports both the conglomerates and sandstones are represented as being portions of long belts of such rocks crossing the state, and regarded as of Oriskany or Devonian age. Both the character of the rocks, however, and their organic remains would seem to indicate that their true position is very much lower, and that they are the probable equivalents of the Pointe aux Trembles and Tuladi rocks of the Temiscouata section, or of those of the Seigas River, described above. The sandstones possess the same vesicular or amygdaloidal aspect, are similarly marked by the occurrence of numerous small fragments of black slate, with others of serpentine, and contain, in addition to carbonized vegetable remains, shells which appear to indicate a horizon about that of the Niagara formation. Among these are the following :—

Impression of a coral, resembling *Favosites*.
 Impression of a Bryozoon, probably *Callopora*.
Orthis, sp.

Fossils from
 Aroostook
 River.

Red and green
 slates.

Coarse
 conglomerates.

Strata
 described in
 Maine reports
 as Devonian.
 probably
 Silurian.

Streptorhynchus subplanm.? Conrad.

Strophomena rhomboidalis, Wilckens.

Spirifera, sp., like *S. radiata*, Sowerby.

Atrypa reticularis, L.

Rhynchonella, sp.

Cornulites, like *C. Clintoni*, Hall.

Beaver Brook
to Salmon
Brook.

Limestones of
peculiar
structure.

Slaty hematite.

Intrusive
syenite.

Volcanic rocks.

On the great bend of the Aroostook below Beaver Brook, both the conglomerates and sandstones reappear at intervals for a mile or two, their low inclination (from 16° to 30°) and varying direction of dip indicating a succession of low folds. These are still more conspicuously seen in the slaty rocks which then succeed and border the river for the greater part of the distance to Salmon Brook in Washburne. These slates are mostly dark bluish grey, but often have a pale greenish cast, which is heightened by weathering. They include thin layers of grey sandstone, and in places also thin layers of dark-blue compact limestone. These are especially noticeable as presenting precisely the same peculiarity as that already noted in the case of the limestones on the Siegas in New Brunswick, viz., that of their being transversely broken into distinct and separate blocks, as if by a series of vibrations, and leave little doubt that they are a continuation of the same beds. The green and red slates are similarly an extension of those noted on the south side of Grand River, N.B. For much of the distance the folds are so broad and low as to be almost flat, but at times there is an abrupt transition from these to plications of a much steeper and more complicated character. Near the Salmon Brook the slates contain, as first noticed by Dr. Chas. T. Jackson, beds of slaty hematite, another feature in which they resemble those of Grand River, as well as those of Jacksontown, near Woodstock. It is highly probable that, with the latter, they are the representatives of the Clinton group of the New York system.

Between the mouth of Salmon Brook in Washburne and the town of Presquile, the banks of the Aroostook, which here flows south-easterly, are mostly occupied by intervalles, the only exposure seen being of syenitic rock, undoubtedly intrusive. Between Presquile and the confluence of the Aroostook with the St. John, in which distance the stream does little more than double back upon itself, the exposures are also very few, except in the last four or five miles, where, as fully described in former reports, they consist of highly disturbed calcareous slates, intersected by numerous dykes of trap. On the south of Presquile, however, along the Houlton and other roads leading in that direction, beds are soon met with, which indicate that the silicious and volcanic rocks, already described, to the northward of the Aroostook

Valley, here come again to the surface, and again break the continuity of the Silurian tract. They are best seen along the road leading through Mapleton, where, after passing a belt of bright red sandstones and conglomerates, which are believed to be of Lower Carboniferous age, and which rest unconformably upon the Silurian slates, we find these latter succeeded, four miles from Presquile, first by a series of grey sandstones, which are more or less vesicular (and which are better seen in the village of Spragueville), and then by grey ochreous rocks, which are both porphyritic and amygdaloidal. The most striking exhibition, however, of these last-named rocks is that to be seen, twelve miles from Presquile, in and around what is known as the Haystack Mountain. This singular eminence, rising abruptly, and on one side almost precipitously, from a comparatively flat country, and constituting a very conspicuous landmark, is itself essentially composed of a pale liver-grey, white-weathering felsite, which is more or less porphyritic; but around its base are heavy beds in which these felsites alternate with coarse amygdaloidal and ash-like rocks, in places carrying considerable quantities of chlorite and jasper. Not far from the mountain there are also exposures of very black and fine-grained flinty slates, but we have had no opportunity of ascertaining their relations or of further investigating this interesting country.

Comparison of the Silurian System of Southern with that of Northern New Brunswick and Quebec.

In the several Reports of Progress for the years 1870-76 inclusive, details of the distribution and distinctive features of the Silurian system, as developed in the southern counties of New Brunswick, have been given by one of the present authors, in connection with Messrs. Ells and Matthew. As these features present many interesting points, both of resemblance and of contrast, with those of the region described in the earlier pages of the present report, it has been thought that a brief comparison of the two and a statement of some of the conclusions thereby suggested would not be devoid of value. It may be added that a further interest has been given to the subject by the observations of Prof. N. S. Shaler, made in 1884, on behalf of the United States Geological Survey, in and about Passamaquoddy and Cobscook Bays, and published in the form of a preliminary notice, in the American Journal of Science, July, 1886. In the following remarks we shall have occasion to refer to some of the conclusions therein arrived at.

Among the several localities in Southern New Brunswick characterized by the occurrence of Silurian rocks, there are two in which, from the completeness of the exposures, they may be most advantageously

Typical
localities.

studied, and which may hence be regarded as typical. These are the shore of Mascareen peninsula, forming a portion of the eastern side of Passamaquoddy Bay, in Charlotte county, and the southern part of Queen's county. The sequence of strata in each of these, and their parallelism, as explained in the reports referred to above, is given in the following comparative table:—

Sequence of Silurian Strata in Southern New Brunswick.

Comparative table of Silurian strata.	I.—MASCAREEN PENINSULA.		II.—SOUTHERN QUEEN'S COUNTY.	
	Div.	Ft.	Div.	Ft.
	I. Grey felspathic slates, about.	400	I. Grey and dark grey slates...	400
	II. Grey and black banded silicious slates, with nodular layers	620	II. Dark grey and black silicious clay slates, distinctly banded	600
	III. Grey flaggy sandstones, with some conglomerate. Shells of <i>Lingula</i> , <i>Modiolopsis</i> and <i>Loxonema</i> ? with comminuted vegetable matter	350	III. Dark grey and greenish grey (sometimes purplish) sandstones, becoming slaty above	600
	IV. Red and green slates and sandstones, with diorites and felsites	300	IV. Ash grey and greenish grey schistose beds, dioritic and amygdaloidal	300
	V. Dark grey and reddish porphyritic felsites	300?	V. Grey and dark grey, sometimes reddish, porphyritic felsites, with chlorite schist and breccia conglomerate. Thickness 800 feet or more.	

Since the publication of the reports upon which these tables are based, much more numerous collections of fossils from certain of the strata have been made, both in New Brunswick and Maine. As a list of those found in New Brunswick has not yet appeared in the reports of the survey it may appropriately be given here. For the Maine lists reference must be made to the preliminary Report of Prof. Shaler, cited above.

The following fossils have been obtained from Back Bay, in Charlotte county, in beds supposed to be those of Division I. The list is based upon collections made partly by Mr. T. C. Weston in 1869, and partly upon others made subsequently (1884) by L. W. and J. W. Bailey, G. F. Matthew and others.

Back Bay
fossils.

List of Fossils from Back Bay, Charlotte County, N.B.

Heliolites, sp. indt.
Obolus Davidsoni? Salter.
Orthis hybrida, Sowerby.
Orthis uberis, Billings.

Orthis, sp. indt.
Streptorhynchus subplanum, Conrad.
Strophodonta indentata ? Conrad.
Strophodonta punctulifera, Conrad.
Strophomena rhomboidalis, Wilckens.
Leptaena transversalis, Dalman.
Spirifera crispa, Hisinger.
Spirifera radiata, Sowerby.
Atrypa reticularis, L.
Rhynchonella, allied to *R. cuneata*, Dalman.
Pterinea, sp. indt.
Euomphalus ? with *opercula* associated.
Proetus, sp. indt.
Encrinurus punctatus, Wahlenberg.
Dalmanites limulurus, Green.

In Pal. Fossils, Vol. III., Part 1 (1884), Mr. Whiteaves expresses the opinion that the Back Bay rocks are possibly of about the same age as the Guelph limestones of Ontario.

Age of Back Bay rocks.

The fossils collected by Prof. Shaler are chiefly from Shackford's Head and other points about Cobscook Bay, some of which, with their fossiliferous character, were described in the New Brunswick report for 1871*. From the lists given, which, however, are stated to be incomplete, the horizons represented would appear to include the Lower Helderberg group, as well as the Niagara and Clinton, while in southern New Brunswick the former would seem to be nearly, if not wholly absent. Another recent discovery of much interest in connection with the Silurian system of southern New Brunswick is the finding, by Mr. G. F. Matthew, of the remains of pteraspidian fishes, in banded shales, referred to Div. II. of the Mascareen section, near the Nerepis Hills in King's County. (Can. Rec. Science, Vol. II., No. 4, Oct. 1886., and American Journ. Science.) The fish-bearing beds are regarded by Mr. Matthew as being at least as old as the Lower Ludlow, and probably of about the same age as those holding the *Palaeaspis* of Prof. Claypole.

Shackford's Head fossils.

Discovery of pteraspidian fishes in King's county.

If now we compare these rocks of southern New Brunswick with those described in the northern part of the same province, and in Quebec and Maine, it will appear that neither in the Gaspé peninsula nor along the south shore of the St. Lawrence have we anything which, either in lithological features or in its contained fossils will correspond to Divisions I. and II. of the first named district, although such equivalency is perhaps to be found in Divisions II. and III. of the

Equivalency of rocks in Northern and Southern N.B.

*Geol. Survey of Canada, Report of Progress, 1870-71.

Anticosti group. If, however, the structure which we have described on Lake Temiscouata be the true one, the counterpart of these beds is perhaps to be found in the conglomerates and succeeding slates, more or less silicious, which occur between Black Point and Pointe aux Trembles, and of which the fossils indicate a low zone in the Silurian system. In northern Maine silicious and felspathic slates have also been described as rising from beneath the Silurian rocks on the Alleguash and Fish rivers, as well as south of Presquile, but these are much finer-grained and more nearly resemble some of the beds which, upon the Beccaguimic River in Carleton county, N.B., have been found to contain a Cambro-Silurian fauna. It is interesting also to notice that in northern Maine, as in southern New Brunswick, there are, in association with undoubted Silurian rocks, extensive beds which may be a portion of the same system, altered by contact metamorphism. The most noticeable of these are fine-grained micaceous and gneissic sandstones, with some interbedded slates, which are found on the shores of Umsaskis Lake of the Alleguash River, and which, alike in their texture, in their peculiar purplish or lilac colour, and in the abundance of what are probably imperfectly formed crystals of staurolite, bear the closest possible resemblance to strata found in various parts of New Brunswick, as on the St. Croix River in Charlotte county and in portions of York county. (See Geol. Survey Reports, 1871, 1882-4.)

Contact
metamorphism.

Intrusive
quartz-
porphyry.

In these latter instances the alteration is evidently connected with the proximity of great masses of intrusive granite; and so, in northern Maine, not far from the micaceous and gneissic strata are found extensive tracts of what is also evidently intrusive rock, here consisting, however, chiefly of a rather fine white-weathering quartz-porphyry, which in some places becomes granitoid, and in others epidotic and amygdaloidal. Too little, however, is known of the relations of these beds to enable us at present to speak with any confidence as to their true position.

Age of
Division III.

Division III. of southern New Brunswick, as indicated by its organic remains, may be regarded as the equivalent of the Niagara formation, and consists chiefly of sandstones of grey, greenish and purplish colours. Their equivalents in the north would evidently seem to be found in the rocks of Pointe aux Trembles and the Tuladi River on Lake Temiscouata, the very similar beds of the Siegas River, New Brunswick, and those of the Aroostook Valley, in Maine, the similarity being marked both in their lithological characters and in their contained fossils. In accordance with this view, the underlying conglomerates of Burnt and Black Points, together with the shales which immediately succeed them, may not improbably be regarded as representing the Oneida, Medina and Clinton groups.

Age of Black
and Burnt
Point rocks.

The remaining groups of the Silurian system in southern New Brunswick are remarkable for the abundance and variety of volcanic or semi-volcanic material which they contain, such material being quite noticeable in Division IV., but reaching its maximum in Division V. A further peculiarity characterizing these higher beds is that of their low inclination as compared with the groups below them, and which appear to indicate extensive physical movements as accompanying, and perhaps determining, the igneous outflows which there originated. This latter feature is also paralleled at the north, where, if the views advanced as to the structure on Lake Temiscouata are correct, a similar want of conformity and difference of attitude exists in the two divisions of the Silurian system as there represented. But while in southern New Brunswick these movements would seem to have left the areas affected for the most part above the sea level, the higher members of the system being but slightly represented, if at all; in northern New Brunswick and in Quebec they were followed by a subsidence which, over very extensive areas, led to the origination of marine sediments, including thick beds of coral-bearing limestones,—the lower or calcareous portion of the Gaspé series—and which continued to or beyond the close of the Silurian era. It may be added, that in the red and green shales which underlie the limestones at the base of Mount Wissick, in the somewhat similar beds found about the Fish River lakes, and on the Aroostook River, in Maine, and again near the Grand River and the Beccaguimic River, in New Brunswick, we have what are probably the equivalents of Division IV. of the Mascarene and Nerepis sections; while in such rocks as the felsites and dolomites of the Haystack Mountain, in Maine, that of Moose Mountain, in Carleton county, N.B., or, still better, in the similar rocks so conspicuously developed about the Bay Chaleur, we may likewise have the equivalents of Division V.

The following table, by comparison with those given on page 48 M will serve to make the above relationships more intelligible:—

*Supposed Sequence of Silurian Strata in Northern New Brunswick,
Quebec and Maine.*

Divs. I. and II.—Grey argillaceous and silicious slates, including (locally) heavy beds of conglomerate. Fossils somewhat numerous in upper part, including shells and graptolites, indicating a low Silurian horizon.

Sequence of
Silurian strata.

Conglomerates and succeeding slates of Black and Burnt Points, on Lake Temiscouata; felspathic and silicious slates of Fish River and Alleguash River, Aroostook county, Me.? Conglomerates and graptolitic slates of Beccaguimic River, Carleton

Sequence of
Silurian strata.

county, N.B. Supposed to be equivalent to the Medina and Clinton groups of New York, Divs. 2 and 3 of Anticosti group, or groups B and B' of Arisaig.

Division III, A.—Grey flaggy and massive sandstones, with some conglomerate, becoming frequently greenish or purplish, and more or less amygdaloidal. Fossils rather numerous, including corals and shells, as well as worm-tracks and comminuted remains of plants.

Sandstones and conglomerates of Pointe aux Trembles, Tuladi and Squatook Rivers, Quebec; similar beds of Siegas River, New Brunswick; sandstones and conglomerates of Aroostook county, Me.; similar beds of Beccaguimic River and other parts of Carleton county, N.B.

Niagara formation, or Wenlock group.

B.—Lower sandstones, shales and limestones of the Gaspé peninsula. Similar sandstones and limestones of the head waters of the Chatte and Matane rivers, Metapedia Lake, Metis and Rimouski rivers, and lower part of Mount Wissick. Fossils numerous, marine.

Supposed to be equivalent to the Guelph formation of Ontario. Divs. IV. and V.—Red and green shales of Cape Gaspé; red and green slates and sandstones of Mount Wissick; similar slates on Fish River (Eagle Lake) and Aroostook River, Maine; red and green slates of Grand River and Carleton county, N.B.; often including argillaceous iron ores. ? Felsites and associated trappean rocks of Campbellton and Bay Chaleur, Moose Mountain, New Brunswick, Haystack and Spider Lake, Maine.

Division VI.—Grey, often nodular or columnar limestones, abounding in fossils.

Upper limestones of Cape Gaspé; middle and upper rocks of Mount Wissick, regarded as equivalents of the lower portion of the Lower Helderberg.

Fossiliferous limestones of Square Lake and Ashland, Me.; Lower Helderberg.

Fossiliferous limestones of Carleton county, N.B.

Fossiliferous slates and sandstones of Metapedia River, Restigouche, Victoria, Madawaska and Carleton counties, N.B. Similar slates, etc., of Aroostook county, Me. Lower Helderberg?