GASPÉ OF YESTERDAY

THE WORLD'S LEADING GEOLOGISTS
****
VISIT GASPÉ
****

Recalling the visit to Gaspesia in 1913 of the XII INTERNATIONAL GEOLOGICAL CONGRESS.

KEN ANNETT

THE XII INTERNATIONAL GEOLOGICAL CONGRESS VISITS GASPESIA.

INTRODUCTION

The XII International Geological Congress visit to Gaspesia was brought to attention by the following item published by the "TRIBUNE" of Campbellton, N.B. in its column, "SEVENTY FIVE YEARS AGO (1913)

Special Train

A special train containing the International Geological delegates passed through here Wednesday on route to Matapedia where they proceeded over the Quebec Oriental railway to Gaspe.

A subsequent issue of the "TRIBUNE" carried the following photo of this special train:

THE GASPE COAST has been attracting visitors for a very long time. This photograph shows a special train carrying a group of International geologists as it crossed the Cascapedia back in the summer of 1913. The picture was supplied by L.G. "Doc" Berthelot, a retired CNR official.

INTRODUCTION (CTD)

Intrigued by these references, GASPÉ OF YESTERDAY undertook to track down information on the XII International Congress that visited Gaspesia in 1913 . With the helpful advice of Prof. John Riva of Laval University, a record of the geological aspect of the visit was located in the library of the Ministry of Natural Resiurces of Québec. Information on the delegates was kindly supplied by Mr.Doug Tedford of the Geological Survey Library in Ottawa

GASPÉ OF YESTERDAY, in previous articles, has attempted to recall something of the story of geological work in Gaspesia. These include:

- #004 BONNYCASTLE ON GASPÉ.
- #011 SIR WILLIAM LOGAN IN GASPÉ. PARTS I AND II.
- #061 THE GOLDEN GOAL. PART II (#062) PART III (#063)
- #071 THE DOUBLETS IN GASPÉ AND THE GULF.
- #096 GRAND ÉTANG.
- #163 GEOLOGISTS REMEMBERED (H.W.McGerrigle and I.W.Jones)
- #207 THE GASPÉ FISHERY AND COAL MINING COMPANY.

These articles are now supplemented by this account of International scope. Readers will recognize in the author of the background paper on Gaspesian geology, prepared for the delegates to this XII International Congress, the Dr.John Clarke whose "HEART OF GASPE","ILE PERCÉ", and other books remain a treasury of Gaspesian lore.

MEMBERS OF THE XII INTERNATIONAL GEOLOGICAL CONGRESS THAT VISITED GASPESIA IN 1913.

****

Leader—G. A. Young.

Associate Leaders—J. M. Clarke, E. R. Faribault.

Secretary—R. Harvie.

Assistant Secretary—A. Mailhiot.

The following members have registered or will join the party en route:—

Andree, K., Dr., Privatdozent fur Geologie an der Universitat Marburg, Germany.

Arlt, Hans, Dr., Kgl. Bergassessor, Herzogparkstrasse 2, Munchen, Germany.

Bailey, L. W., Professor, University of New Brunswick, Fredericton, New Brunswick.

Bancroft, J. A., Dr., Associate Professor of Geology, McGill University, Montreal.

Barrows, W. L., M.A., 28 Brownell Avenue, Hartford, Conn., U.S.A.

Bell, W. A., St. Thomas, Ontario.

Boden, K., Dr., Privatdozent fur Geologie der Universitat, Geologisches Institut, Alte Akademie, Munchen, Germany.

Burling, L. D., Geological Survey of Canada, Ottawa.

Cadell, H. M., Grange, Linlithgow, Scotland.

Caillebotte, Jean, Paris, France.

Carruthers, R. G., H. M. Geological Survey, 33 George Square, Edinburgh, Scotland.

Clarke, John M., Dr., New York State Geological Survey, Albany, New York, U.S.A.

Cole, L. H., Department of Mines, Ottawa.

Cushing, H. P., Dr., Professor of Geology, Western University, Cleveland, Ohio, U.S.A.

Faribault, E. R., Geological Survey of Canada, Ottawa.

Gardner, S. Mc., Mining Student, Mount Vernon Colliery Co., Ltd., Glasgow, Scotland.

Goldman, M. J., Dr., Johns Hopkins University, Baltimore, U.S.A.

Gurich, Georg, Dr., Professor, Lubeckertor 22, Hamburg, Germany.

Haniel, C. A., Dr., Venusbergweg 8, Bonn a. Rh., Germany.

/ctd.

Hartnagel, Chris., Education Building (State Museum), Albany, U.S.A.

Harvie, R., Dr., Geological Survey of Canada, Ottawa.

Hayes, A. O., 112 Mercer Street, Princeton, New Jersey, U.S.A.

Haycock, E., Professor of Geology, Acadia College, Wolfville, Nova Scotia.

Hobson, B., Thornton, Hallamgate Road, Sheffield, England.

Holbrook, E. A., Prof., Nova Scotia Technical College, Department of Mining Engineering, Halifax, N.S.

Holtedahl, Olaf, Dr., Maitre des conferences, Universitetets mineralogiske Institut, Kristiania, Norway.

Hore, R. E., Canadian Mining Journal.

Howley, J. P., Director of the Geological Survey of Newfoundland, St. John, Newfoundland.

Hudson, J. G. S., Mines Branch, Department of Mines, Ottawa.

Hyde, J. E., School of Mining, Kingston, Ontario.

Jehu, J. T., Dr., The University, St. Andrews, Scotland.

Kido, Chutario, Dairen, Kantoshu, Manchuria.

Kindle, E. M., Dr., Geological Survey of Canada, Ottawa.

Lambe, Lawrence M., Geological Survey of Canada, Ottawa.

Lawson, A. C., Dr., Professor of Geology, University of California, Berkeley, California, U.S.A.

Lindeman, E., Mines Branch, Department of Mines, Ottawa.

Lory, P., 6, rue Fantin-Latour, Grenoble, France.

Mailhiot, A., Professor of Geology, Laval University, Montreal.

Martius, S. G., Dr., Assistant am mineralogish-petrographischen, Institut der Universitat Bonn, Poppelsdorfer Schloss, Bonn a. Rh., Germany.

Matthew, G. F., Dr., St. John, New Brunswick.

McIntosh, D., Professor of Geology, Dalhousie University, Halifax, Nova Scotia.

Michalon, Lucien, Ingenieur des Mines, 96 rue de l'Universite Paris, France.

Mitscherlich, H. E., Bergingenieur, Parkstrasse 9, Karlsruhe, Germany.

Part, G. M., Trinity College, Cambridge, England.

Paulcke, W., Dr., Professor der Geologie an der Grossh, Badischen Technischen Hochschule Fridericiana, Karlsruhe, Baden, Germany.

Powers, S., Technology Chambers, Boston, Mass., U.S.A.

Pruvost, P., 159 rue Brule-Maison, Lille, France.

Quensel, Percy D., Dr., Lecturer in Petrography, University of Upsala, Upsala, Sweden.

Rathgen, Miss A., Argelanderstrasse 11, Bonn a. Rhein, Germany.

Raymond, Percy, Assistant Professor of Paleontology, Harvard University, Cambridge, Mass., U.S.A.

Riedel, A. J., Gausstrasse 25, Braunschweig, Germany.

Saint-Clivier, Hubert, Paris, France.

/ctd.

Schuchert, C., Professor of Geology, Yale University, New Haven, Conn. U.S.A.

Strahan, A., Dr., 28 Jermyn Street, London, S. W., England.

Stolley, E., Dr., Professor, Technische Hochschule, Braunschweig, Germany.

Termier, Mlle M., 164 rue de Vaugirard, Paris XV., France.

Termier, P. M., Directeur du Service de la Carte Geologique de France, 164 rue de Vaugirard, Paris XV., France.

Tillman, N., Dr., Lennestrasse 19, Bonn a. Rhein, Germany.

Tolmacev, I. P., Conservateur en Chef du Museee Geologipue Pierre le Grand de l,Academie Imperiale des Sciences, St. Petersbourg, Russia.

Twenhofel, W. H., Dr., Lawrence, Kansas, U. S. A.

Ulrich, E. O., 2421 First Street, Washington, D.C., U. S. A.

von Grote, F., Dr., Martiusstrasse 1, Munchen, Bayern, Germany.

Welter, O. A., Dr., Neringstr., 4, Bonn a Rh., Germany.

Weigand, B., Dr., Professor, Schiessrain 7, Strassburg i. Elsass, Germany.

Wigglesworth, E., Geological Museum, Cambridge, Mass., U. S. A.

Williams, H. S., Dr., Professor of Geology, Ithaca, N. Y., U. S. A.

Woodworth, J. B., Professor, Harvard University, Geological Museum, Cambridge, Mass., U. S. A.

Wordie, J. M., Professor, St. John's College, Cambridge, England.

Wright, W. J., Bear River, Nova Scotia.

Young, G. A., Dr., Geological Survey of Canada, Ottawa.

Zoude, P., Ingenieur civil des Mines, 109 Boulevard de Grande-Ceinture, Bruxelles, Belgium.

Zuber, R. Professor der Geologie, Universitat, Lemberg, Austria.

A special train on the Intercolonial Railway carries the party of about 50 members. There are plenty of sleepers and two diners on the train. In the baggage cars a box is provided for each member to store specimens, etc., collected on the trip.

DALHOUSIE AND THE GASPE PENINSULA.*

(John M. Clarke.)

INTRODUCTION.

The general region dealt with in the following account embraces the head of the Bay Chaleur region and the great peninsula of Gaspe. The Bay Chaleur is an east-west arm of the Gulf of St. Lawrence, about 100 miles (160 km.) in length, and constitutes the marine boundary between the provinces of New Brunswick on the south and Quebec on the north. It was discovered and named by Jacques Cartier in 1534. The chief affluent of the bay is the Restigouche river, in its lower reaches a continuation of the boundary line between the provinces and also the site of large private salmon-fishing preserves. The mouth of the Restigouche river and the head of the bay are conventionally located at Dalhousie, N. B., on the south and Maguasha Point, P.Q., on the north, and here the width of the bay is about 3 miles (5·4 km.). Campbellton lies on the Restigouche river, 15 miles (27 km.) above Dalhousie. Here the river has narrowed to about $\frac{3}{4}$ miles (1·3 km.). Opposite Campbellton on the north (Quebec) shore is the Reservation and Mission of the Micmac Indians at Restigouche.

The Devonian beds and their volcanic intrusives about Dalhousie were early discussed by Hind, Bailey and J. W. Dawson, and the official geological maps of the region were compiled by Ells, by whom also the geological relations of these rocks were discussed at some length. The first identification of the fossils was by Billings; subsequently the fossil corals were carefully studied by Lambe and more recently the entire marine Devonian fauna and stratigraphy has been elaborated in detail by Clarke. The Devonian rocks at and near Campbellton are similarly intruded and altered by volcanics. They became of general interest through the discovery by Ells and Foord, some thirty years ago, of fish and plant remains, and it is to these fossils that geologic interest at this point has been chiefly directed.

The Gaspe Peninsula, bounded on the south by the Bay Chaleur, on the north by the St. Lawrence river, and fronting east on the Gulf of St. Lawrence, covers an area of about 11,000 square miles (28,600 sq. km.). It is larger than the Kingdom of Saxony and twice the size of the State of Massachusetts. The interior of this great peninsula is a rolling, heavily timbered wilderness, only the coast region, for a maximum width of 10 miles (18 km.), having been opened to settlement. Its geological structure is best exposed in the sea sections, some of which are very striking. The peninsula constitutes the northernmost and terminal region of the Appalachian Mountain system and here the folded ridges take on their most pronounced sigmoid curvature, bending from the SW.-NE. direction which is normal to them at the south, through an arc at the north which ends at Cape Gaspe in a NW.-SE. curve. Pertaining thus to the Appalachian system, the Gaspe region is quite exclusively an area of Palæozoic rocks. The Notre Dame or Shickshock* mountains, which are the greatest elevations of the peninsula, (3,000- 4000 feet or 900-1,200 m.), lie at the north and carry areas of mica schists, jaspilites and epidotised gneiss, evidently forming a basement to the Cambrian shales, but the Pre-Cambrian age of none of these has been demonstrated. Peridotites

*See Maps—Head of Chaleur Bay, and, Eastern Part of Gaspe.

and serpentines are also of extensive occurrence in these mountains. Generally speaking, Gaspe is a region of regular appalachian folds and extensive overthrusts of the older Palæozoic strata, the extraordinary displacements in which have been largely concealed by a mantle of later (Devono-Carboniferous) nearly horizontal sandstones and conglomerates.

The geology of Gaspe was first studied by Sir William Logan in 1845. It was the first field he entered after his organization of the Geological Survey of Canada, and his reports upon the region are still fundamental. Later the region was entered by Bell, and particularly by Ells and Low, who made a resurvey of the peninsula in 1878-1882 and issued an entire series of maps of the area. Clarke has more recently studied the coastal region with special reference to the composition and correlations of its faunas and stratigraphy.

* Notre Dame is Champlain's name for these mountains; Shickshock, the Micmac Indian name.

Along the shores of the peninsula are outcrops of the Cambro-Ordovician, Silurian, Devonian and Devono-Carboniferous (Bonaventure) formations. Not all of these formations have been deposited in one basin. The evidence is very clear that the earliest endroits were the broad marine channels of an ancient St. Lawrence trough having the SW.-NE. trend of the orogenic axes of to-day, with continental land at the north (the Labrador crystalline shield) and at the south, for the most part outside the boundaries of the present land. In some degree the bays of to-day (e.g. Gaspe bay, Mal bay) running in from the coast of the Gulf lie in ancient synclines which date back to the later stages of the Devonian. Sea erosion, however, has been so efficient that the lower reaches of the St. Lawrence river which washes the north shore of the peninsula are bounded by a wave cut rock platform in places 8 miles (14·4 km.) in width, lying at a depth of not more than 300 feet (90 m.) below the present water level. Where the sigmoid curve of the Appalachian ridges is most pronounced, that is, in the little peninsula of the Forillon at the north between the St. Lawrence river and Gaspe bay, the outermost eastern tip of the Appalachian system is to be found in the fishing ground known as the "American Bank", which, submerged a few fathoms, lies 10 miles (18 km.) out to sea from the tip of Cape Gaspe, in the SE. course of the mountain folds. This fact has been determined by the dredged rocks from this bank.

The course of the St. Lawrence river is believed to be determined by a deep thrust fault of the Palæozoics to the south against the crystalline Labrador shield to the north. This probability is more forcibly pronounced in the lower part of the river bounding the Gaspe shores than it is farther inland, for in Gaspe there is no single evidence that this river traverses the crystalline shield in such direction as to leave any part of the crystallines to the south. This highly significant directive fault line was long ago located by Sir William Logan and is commonly known as "Logan's fault". Along this fault plane and against the crystalline horst behind it (north), the palæozoics have been shoved and overthrust, here as elsewhere throughout the 2,000 miles (3,600 km.) extent of the Appalachians, to the southwest, but here with the sharp crescentic curvature not elsewhere shown. The Island of Anticosti, which lies 60 miles (108 km.) east-northeast of Cape Gaspe, is an area of horizontal Silurian rocks outside the region of folding,—a *parma* lying between the horst and the Appalachian folds.

FOLDS.

From the St. Lawrence river shore southward to Percé the folds of the strata are exposed and certain fairly definite anticlinal courses across them were determined by Logan and in large measure confirmed by later observers. These are apparently five in number, beginning at the north:

1. Forillon anticline (overthrust);

2. Haldimand anticline; the axis runs through Gaspe mountain (Gaspe basin) and enters the bay at Cape Haldimand. In the trough between folds 1 and 2 lie the upper reaches of Gaspe bay and the lower course of the Dartmouth river or Nor'west arm.

3. Tar Point anticline; strikes the bay at Tar point on the south shore of Gaspe bay. Between it and fold 2 lies the barachois at Douglastown and the lower course of the St. John river which flows into it.

4. St. Peter anticline, meeting the sea at Point St. Peter.

5. Percé anticline. This is by far the steepest and most extensive of all the folds and is badly broken down at its sea end. Between it and fold 4 lies Mal Bay, its barachois and river. South of Percé the folds have been obscured by the mantle of the overlying Bonaventure formation (Devono-Carboniferous) which is feebly folded at the north end but this folding is of a much later date than the fundamental folds. This covering of red rock is spread over the south and southeastern parts of the peninsula and lies everywhere on the almost vertical edges of the great series of Ordovician-Silurian (mostly the latter) light gray and blue limestones.

ORDER OF SUCCESSION.

In proper order of succession, the earliest rocks are exposed on the St. Lawrence river shore in a narrow belt of black Cambrian or Cambro-Ordovician shale to be seen at Cap Rosiers and thence up the river (*Rosiers shale*). Following immediately south (see map for position and direction of these belts) rise the steep cliffs of Lower Devonian (*St. Alban, Bon Ami* and *Grande Grève* beds). In the ascent from the low wave cut plateau of Cap Rosiers to the heights of the Bon Ami cliffs, one traverses the thrust plane between the Rosiers shale beds and the St. Alban lime shales, along which most of the Ordovician and all the Silurian to an unknown thickness has been squeezed out.*

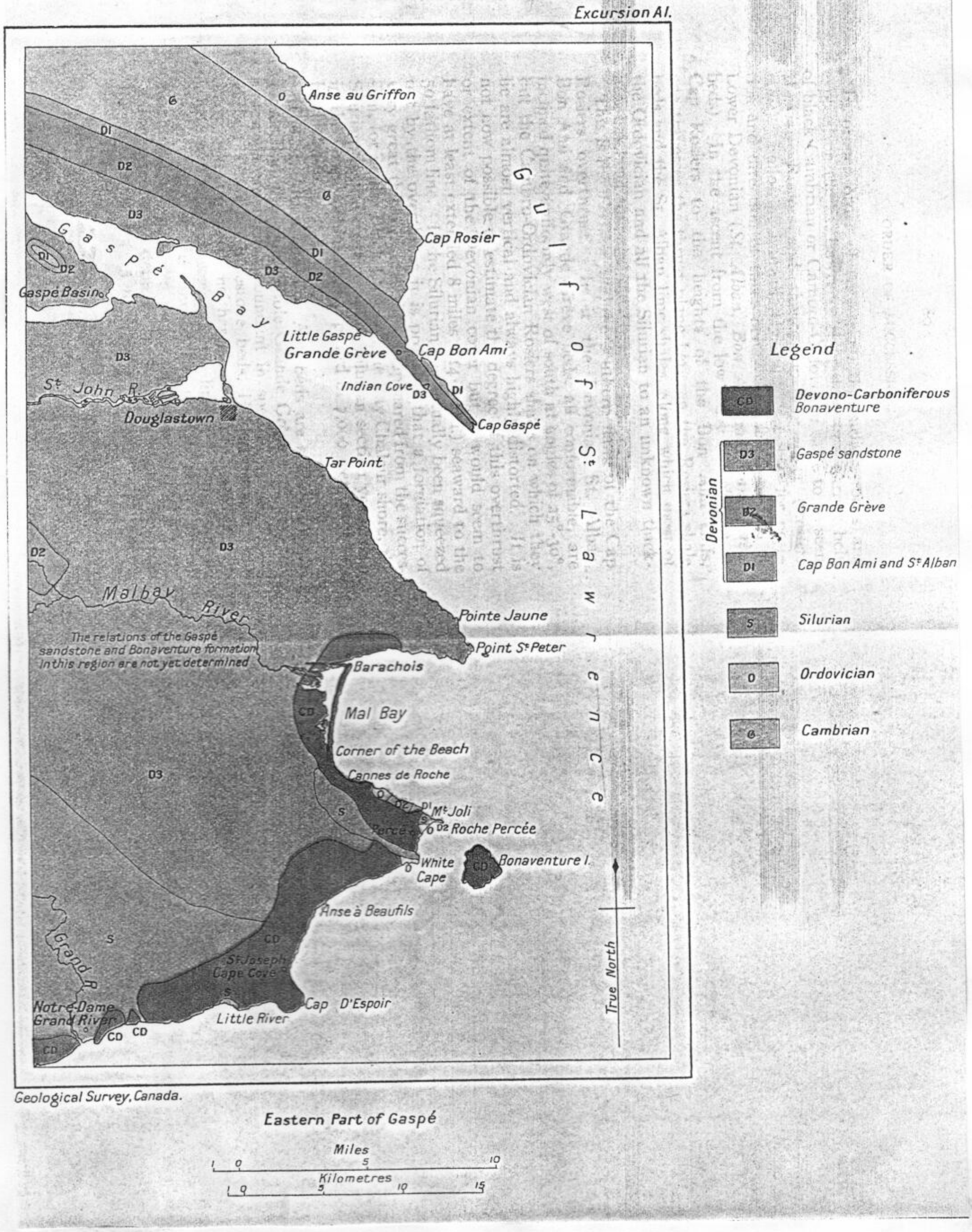
This is the *Forillon fold*, the southern flank of the Cap Rosiers overthrust. In it the Devonian St. Alban, Bon Ami and Grande Grève beds, all conformable, are inclined quite uniformly west of south at angles of 25°-30°, but the Cambro-Ordovician Rosiers shales on which they lie are almost vertical and always highly distorted. It is not now possible to estimate the degree of this overthrust or extent of the Devonian cover but it would seem to have at least extended 8 miles (14·4 km.) seaward to the 50 fathom line. If the Silurian has actually been squeezed out by the overthrust it is probable that a formation of very great thickness has thus disappeared from the succession, for at the Black Capes on the Bay Chaleur shore, the Silurian, in the most complete Silurian section yet known in the Gaspé peninsula, is upward of 7,000 feet (2198 m.) in thickness.

The St. Alban and Bon Ami beds are sparsely fossiliferous, but the conformable Grande Grève beds of purer limestone are highly abundant in species typical of the earliest Devonian limestone beds, Helderberg and Oriskany At the north neither of these formations is anywhere well exposed except on the little Forillon peninsula though both extend inward (west) into the timbered heights of the northern mountain ridges.

Two remote and detached masses of this early Devonian limestone at Percé, 15 miles (27 km.) due south from the

* There is an alternative reason to believe that the Silurian is absent at the north by extinction of the deposition, but this construction of the section would only lessen the amount and not the mode of destruction by the overthrust.

Excursion A1.



Geological Survey, Canada.

Eastern Part of Gaspé

Forillon, constitute the most brilliant and striking scenic features of the Gulf coast: 1. Percé Rock (*Le rocher percé; L'isle percée*), 2. Les Murailles. These limestone masses carry a smaller fauna, in some measure distinct from that of the Grande Grève beds, but their identity of age is unquestioned. Further special reference is made in the proper place to them and to the Ordovician and Silurian cliffs of Percé.

Next south and overlapping unconformably the Devonian limestones of Grande Grève is the broad band of *Gaspe sandstone*; so named by Logan. This is a heavy mass of red, brown and grey sandstone with many coarse pebble layers. Contact of the basal beds with the limestones is to be seen on the Forillon peninsula at Little Gaspe and at several places from Grande Grève out to Cape Gaspe there are infaulted masses of the sandstone in the limestone beds, which indicate that the coating of sandstone has been stripped from the latter. Cliffs of Gaspe sandstone are exposed on all the south shore of Gaspe bay, at Chien Blanc, Point St. Peter (the south cape of the bay) and thence into the north shore of the Mal bay where their identity is gradually lost by conformity in composition to the overlying Bonaventure conglomerate. From measurements of the shore sections supplemented by traverses of the great expansion of these sandstones in the interior, Logan inferred a total thickness of more than 7,000 feet (2,198 m.). Ells has rightly believed this figure too high on account of faulting, but the amount of duplication from the displacement and the actual lines of faulting have been difficult to decipher on account of the homogeneity of the strata. The Gaspe sandstones contain an abundance of terrestrial plants which have been described by J. W. Dawson and indicate middle Devonian affinities. The marine fauna of the sandstone is profuse at certain low levels in the series and these species are characteristic survivors of the Grande Grève fauna with an addition of species of later Devonian date, identical in large part with the Hamilton (middle Devonian) species of New York.*

*Of these fossiliferous localities of the Gaspe sandstone, it may here be stated that those which have been most carefully studied lie at the rear (west) of the first hill behind Gaspe Basin at the head of Gaspe bay and thence north to L'Anse-aux-cousins and Pointe Naveau on the Dartmouth river; at Friday's bluff on the St. John river about 30 miles (50 km.) west from Douglastown and along the courses of the Mississippi and other brooks tributary to the York river, about 35 miles (63 km.) in from the coast.

The Bonaventure formation. Beginning with the south shore of Mal bay, is a great mantle of red conglomerates and sandstones which covers all the coast regions from here south over the whole Bay Chaleur region, save where it has been torn away by sea and weather and left the underlying formations exposed. The name Bonaventure was given by Logan and was taken from Bonaventure island off the coast of Percé which is entirely constituted of these conglomerates though they rise to greater heights in Mt. Ste. Anne at Percé (1,200 feet). The formation is almost horizontal throughout its extent, but the gentle undulations of its northern portion are admirably expressed in the broad rolling summit of Mt. Ste. Anne. This Bonaventure formation is in part of distinctly continental origin but its heavy conglomerates have doubtless been piled together along a rough coast not unlike that which now faces the Gulf. These conglomerates are in considerable measure composed of blocks and boulders of the fossiliferous rocks beneath, Cambrian to Devonian, and they are frequently of enormous size, having in one instance a weight of 8 tons, the angularity of this fragment indicating that it had fallen from an overhanging sea cliff. The Bonaventure formation is believed to represent the later stages of the Devonian and the early stage of Carboniferous time, indeed all of the latter that is recorded by deposits on the peninsula. It is also the youngest rock formation in Gaspe. By the early observers it was considered as altogether of Carboniferous age and was correlated with the red sandstones of Nova Scotia, Prince Edward Island and the Magdalen islands which are now known to be of Permian age. Ells was the first to recognize a distinction in the composition of the conglomerates and thereupon based a distinction in age, calling the lower or limestone conglomerates, Devonian, and the upper beds with fewer lime and more crystalline pebbles, Carboniferous, a difference not easy to recognize at many localities.

The limestone conglomerates at the base are clearly exposed at and about Percé, and the upper beds in the summits of Percé mountain. In the outcrops on the Bay Chaleur shore, this distinction is much obscured and the red sandstones and conglomerates with jasper pebbles lie everywhere on the upturned edges of the grey Silurians often producing brilliant colour contrasts. The total original thickness of these Bonaventure beds is not known. In Mt. Ste. Anne, Percé, they stand at 1,200 feet (370 m.) and in the Carleton mountains at Carleton, Bay Chaleur, at nearly the same height. They contain no contemporary animal remains so far as known, but plant remains, as yet undetermined, and even thin coal layers, have been found in the fine sandstones of Cannes-des-Roches on Mal bay.

PALEOGEOGRAPHY.

The ancient geography of this region has already been intimated. In Cambrian, Ordovician and Silurian stages the sea way or channel, bounded by the old land at the north and south, was broad and uncomplicated, forming an open passage from the north transatlantic strand into the waters of the Appalachian interior. During Silurian time especially, this passage following the Appalachian synclinal was nearly as broad as the Gaspe peninsula and we have as yet no evidence that it was greatly obstructed. So far as known its faunas, as well as those of the Ordovician bear a decided Atlantic (transatlantic) aspect. The upfolding of these strata constructed new and narrow channels at the opening of the Devonian, but these were clear and the faunal correspondence between them and contemporary deposits of the interior is very close.

Regarding these Devonian channels it may be said:—

(1) There was a definite and open passage from Gaspe into New York and the southern Appalachians during the period of the earliest Devonian (Helderbergian) when a well defined element of the Helderberg fauna flourished in the St. Alban beds.

(2) A similar open way existed at approximately or actually the same time, connecting the Dalhousie beds of northern New Brunswick with the Helderbergian of the interior.

(3) These two passages seem to have converged and united toward the west and south, for while each carries a clear predominance of Helderberg species the two have comparatively little in common.

(4) In the later stage represented by the Grande Grève limestones the northern passage became broadened while the Dalhousie channel became extinct. In addition to these open passages from the interior outward were others of Devonian date further south, and the relations of these sea ways have been discussed by Clarke (**11**, p. 153-162.).

5) The Gaspe sandstones indicate a general breaking down of the barriers of the northern channel which permitted a later (lower or middle) Devonian invasion of species from the interior, while the Grande Grève fauna still persisted. Flood and barachois conditions governed the early deposition of these sandstones but encroaching elevation eventually changed the middle and later Devonian conditions to those of a rias coast not unlike that of the present.

THE ORIGIN OF THE GULF OF ST. LAWRENCE.

The hydrographic charts of the Gulf indicate very clearly that the course of the ancient St. Lawrence river was from its present mouth southeast, far to the east of Gaspe, east of the Magdalen islands, and thence outward to the Atlantic by the passage between Cape Breton island on the west and Newfoundland on the east (Cabot strait). The St. Lawrence river is a very ancient waterway and takes its date from at least as early as the time of the marine (Lévis) channel of the early Ordovician, a passageway which led from Atlantic waters into the Appalachian gulf of the interior of the continent. Fixity was given to this waterway by the long subsequent faulting of the Palæozoic rocks against the crystalline Labrador shield at the north, and ever since this factor became efficient the passage has been now and again a salt-water channel and a fresh-water drainage way. That part of the river channel now submerged beneath the Gulf waters is not the oldest portion but a later part of the river, where the valley was cut out through marine rocks which had been deposited over the bed of the Gulf when that was open ocean.

The orogenic axes of Appalachian disturbance through the Gulf region are twofold: that at the south, passing through Nova Scotia and on into Newfoundland keeping a N.E.-S.W. trend without change of direction; that at the north, passing through Gaspe, curving at its termination in an arc, convex northward: thus:

Orogenic Appalachian axes. Gulf of St. Lawrence.

The torsion of the northern fold, ascribable to the resistance of the Labrador shield, produced a syntaxis which broke down that fold and dislocated the bottom of the Gulf area in a line continuous in direction with the course of the fold. Thus with the fracture of the pavement of the region and the consequent differential elevations and depressions, the St. Lawrence waters took somewhat the course now indicated by the hydrographic chart; probably for a part of the time or by way of a subsidiary channel taking the passage out by the Strait of Belle Isle and bending about Anticosti island to the north and east. This was thus a secondary condition of the river, dating to a time subsequent to the uplift of the folded Palæozoic rocks. Since that time, the broken down Gulf region has successively been a river way, an open marine body, an estuarine basin, and again a more or less enclosed sea.

After the recoil of the northern fold which broke down the regularity of the mountain building and left the parma of horizontal rocks at the north (Anticosti island), came a period of rough rias coast along the broken ends of the Appalachian folds with a sea which received the mantle of Bonaventure conglomerate, when the marine waters had a far wider westward extent than to-day and the river channel south of the latitude of Percé was deeply buried. This period was followed by a shallowing of the basin which brought on the estuarine conditions of the coal period, with occasional irruptions of marine conditions; then a still farther elevation of the gulf bottom, which resulted in broad coastal sand plains under comparatively arid climate, during which the red Permian sands of Nova Scotia, Prince Edward Island and the Magdalens, with their sand-etched boulders, were laid down. With the close of the Palæozoic the lower channel of the river across the Gulf region was high, the rock land on the west and east extended close to it so that the channel now buried in the Gulf was then the efficient river channel. The cutting down of the land into its present broken coast line and scattered islands and the submergence of the river channel have taken place since the opening of Mesozoic time.

GLACIAL AND POST-GLACIAL PHENOMENA.

Gaspe does not appear to have been within the reach of the great continental ice sheet. Its glacial phenomena are scattered and evince only movements of land ice downward from the mountains of its interior and deposits of this origin are everywhere complicated with sea ice transportation; thus every northern boulder is under suspicion of having been brought in by floating ice. The islands off the coast, Prince Edward Island and the Magdalens, are unglaciated.

Elevated beaches are to be found at various points on the peninsula. These are widely scattered and show evidence of Pleistocene warping as in the case of the terraces exposed at Gaspe basin.

DETAILED DESCRIPTION.

PERCÉ.*

L'Anse-au-Beaufils, the station for Percé, lies on the coast 5 miles (9 km.) to the south.

From L'Anse-au-Beaufils, Bonaventure island, from which Bonaventure formation takes its name, is seen at the east and the Percé mountains at the north. The road to Percé leads from here due north and crosses Cap Blanc or Whitehead.

View of Percé from the Summit of the Road over Cap Blanc.—The village (shire-town of Gaspe county) is on a triangular rock plateau, with Mount Joli at its apex, facing the Percé Rock; Bonaventure island 2 miles (3·6 km.) long, 3 miles (5·4 km.) out to sea; at the left Mount Ste. Anne 1,200 feet (370 m.) A. T.; on the further side of the triangle the ragged sea cliffs (Les Murailles), which front on Mal bay; the north side of Mal bay is formed by Point St. Peter with Plateau island and on the distant horizon at the right is Cape Gaspe (Shiphead). Beyond is the St. Lawrence river.

*See Maps—Percé and vicinity, and, Percé.

Percé Rock.—This noteworthy insulated cliff, anciently the *Isle percée*, early in the history of the settlement gave its name to the mainland. L'Isle percée, le rocher percé, Pierced rock, Split rock or Percé rock, as it is variously termed, is 2,100 feet (646 m.) long from prow to the outer end of the rear obelisk, 300 feet (91. m.) wide in its greatest breadth and 288 feet (87 m.) high at its prow. The arch through it is 60 feet (20 m.) high. In plan its form is somewhat angular or zigzag and viewed from in front resembles a giant steamer coming into port.

The rear obelisk is the outer flank of a second arch which fell in 1845. Back in the early 1600's there seem to have been two other arches toward the seaward and thinner end, and the wastage of the rock has been effected within recorded time largely by the downbreaking of these arches. There is still another arch in the rock, transecting the obelisk parallel to the major axis of the mass. The wastage of Percé Rock under the impact of the waves is very slight. Freezing and thawing are more efficient agents but during the past ten years not enough has fallen from all these causes combined to alter the outline of the cliff in any perceptible degree and the line of the prow has not materially changed in 150 years. At high tide the Rock is isolated, but at low tide a batture or sandbar extends to it from the foot of Mount Joli affording ready access to the point and south side of the cliff. The north side is accessible only by boat. The sheer sides of the Rock make attempts to scale it exceedingly perilous and such attempts are now forbidden by municipal ordinance.

Fossils abound in these strata, distributed in thin layers with barren interspaces. They correspond in characters and association with the richer fauna of the Grande Grève limestones, and the Percé Rock massive is correlated with that formation (see p. 90). Forty-four species have been described, of which 31 occur in the Grande Grève beds. Characteristic species are *Dalmanites* (*Probolium*) *biardi*, *D. perceensis*, *Phacpos logani*, *Chonetes canadensis*, *Chonostrophia complanata*, *Spirifer arenosus*, *S. murchisoni*, *Leptocœlia flabellites*, *Rensselaeria ovcides*.

No other trace of the formation and fauna represented by Percé Rock is to be found in this vicinity except in the *Murailles* or sea cliffs which lie beyond the North Beach and face the Mal bay. The grey headland of Cape Barré with which the Murailles begin, is followed by a faulted and overthrust mass of highly coloured strata, dipping S.E. 20° and abutting against the Cape Barré strata, containing, sparsely, the fossils of the Percé Rock strata. These inclined strata rise to the high peaks of the Murailles but their tops are there coated unconformably by a layer of the limestone conglomerate of the Bonaventure series.

The observer will not fail to notice the colony of waterfowl nesting on the green capped top of the *Isle perce.* This settlement is composed only of the Herring gull (*Larus argentatus*) and the Cormorant (*Phalacrocorax carbo*), an association which is repeated on the cliffs of the Forillon peninsula 17 miles (30 km.) to the north (see note beyond on the bird colony of Bonaventure island).

Percé Rock is composed entirely of Lower Devonian limestones standing nearly vertical (dip 80° S.E.) and highly tinted with iron yellows, reds and purples. Its strata are seamed with calcite veins of white, red and deep brown, often with interesting crystallizations. The combination of rock colours with the green cap of verdure produces striking effects which vary with every change in atmospheric conditions and the position of the sun.*

Cape Barré.—This is the southern point of the Murailles, bounding the North Beach. Its strata are thin, sandy, blue grey shale and limestones dipping 30°-40° N.E., the red rocks of the Percé massive being faulted against them. These rocks contain only a few fossils, all of Lower Devonian type (*Spirifer* cf. *modestus*, *Leptostrophia oriskania*, *Conularia* cf. *lata*), the most significant being a species of the trilobite Dicranurus (*D. limenarcha*) of which only two other species are known, both from the Lower Devonian, one of Bohemia and the other of New York.

*For an account of the history of Percé Rock in the records of Gaspe, of its changes in form, rate of degradation, total fossil contents, etc., see Clarke [9].

These beds are not distinctly developed elsewhere in the region and they appear to represent a Devonian stage earlier than that of the Percé Rock.

The Rock Wall between the North and South Beaches.—Just at the steamboat wharf on the North Beach recent excavations, now covered, exposed a grey, steeply inclined shale carrying *Dipterus*. No other fossil has yet been determined from this shale which is regarded as belonging to a Devonian stage beneath that of the Percé massive. This shale is apparently faulted against the Silurian at the south and limited at the north by the fault lines of the beach. Following the shore southward the first outcrop is of the erect grey limestones and shales of Mount Joli. The rock exposures begin with the reefs exposed at low water to about 400 feet from the shore and the Mount Joli cliff as a whole has a sea front of about 700 feet (211 m.) and the same dip as the Percé Rock strata. This would give the formation here an approximate total of 1,100 feet (335 m.). There is little change throughout in its lithic characters, but there is clear evidence of a displacement within the mass which gives a geological meaning to the division of the massive into a *north flank* and a *south flank*. The beds of the north flank afford admirable exhibitions of jointing and ripple marks and in both flanks fossils are to be found in thin beds with barren intervals. In the north flank are the corals *Duncanella*, *Zaphrentis*, *Streptelasma* and *Pleurodictyum*, the graptolite *Monograptus* cf. *clintonensis*, the brachiopods *Dalmanella*, *Leptæna* (*rhomboidalis*), *Stropheodonta*, *Spirifer* (cf. *niagarensis*, *modestus*) and an uncertain *Phacops*: all of which indicate a Silurian stage.

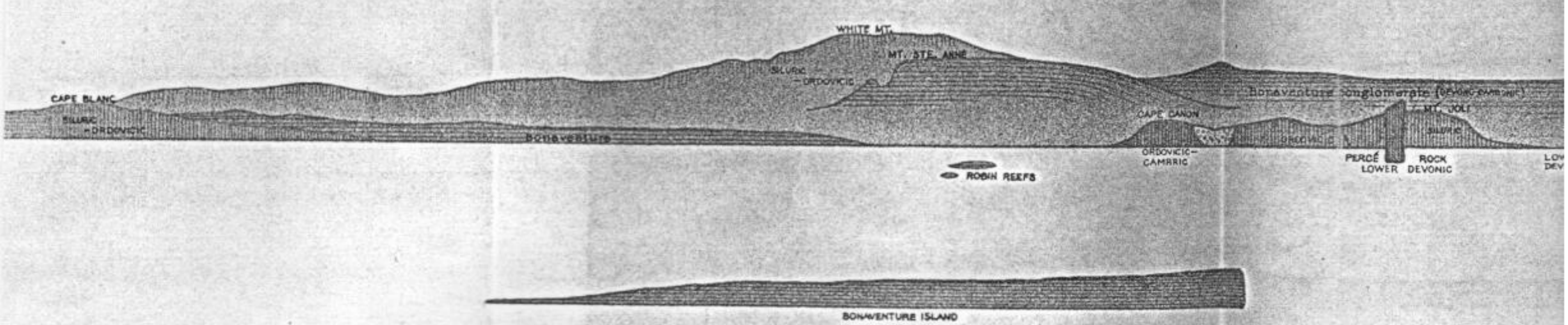
In the south flank of Mount Joli are the trilobites *Ampyx*, *Tretaspis*, *Calymmene*, *Trinucleus*, *Pterygometopus*, *Ptychopyge* and *Illænus*, the brachipods *Dalmanella*, *Rafinesquina*, *Strophomena*, *Parastrophia*, *Zygospira*, the assemblage indicating a middle or later Lower Ordovician stage. These beds seem to extend across the mountain and just touch the other shore near the wharf house.

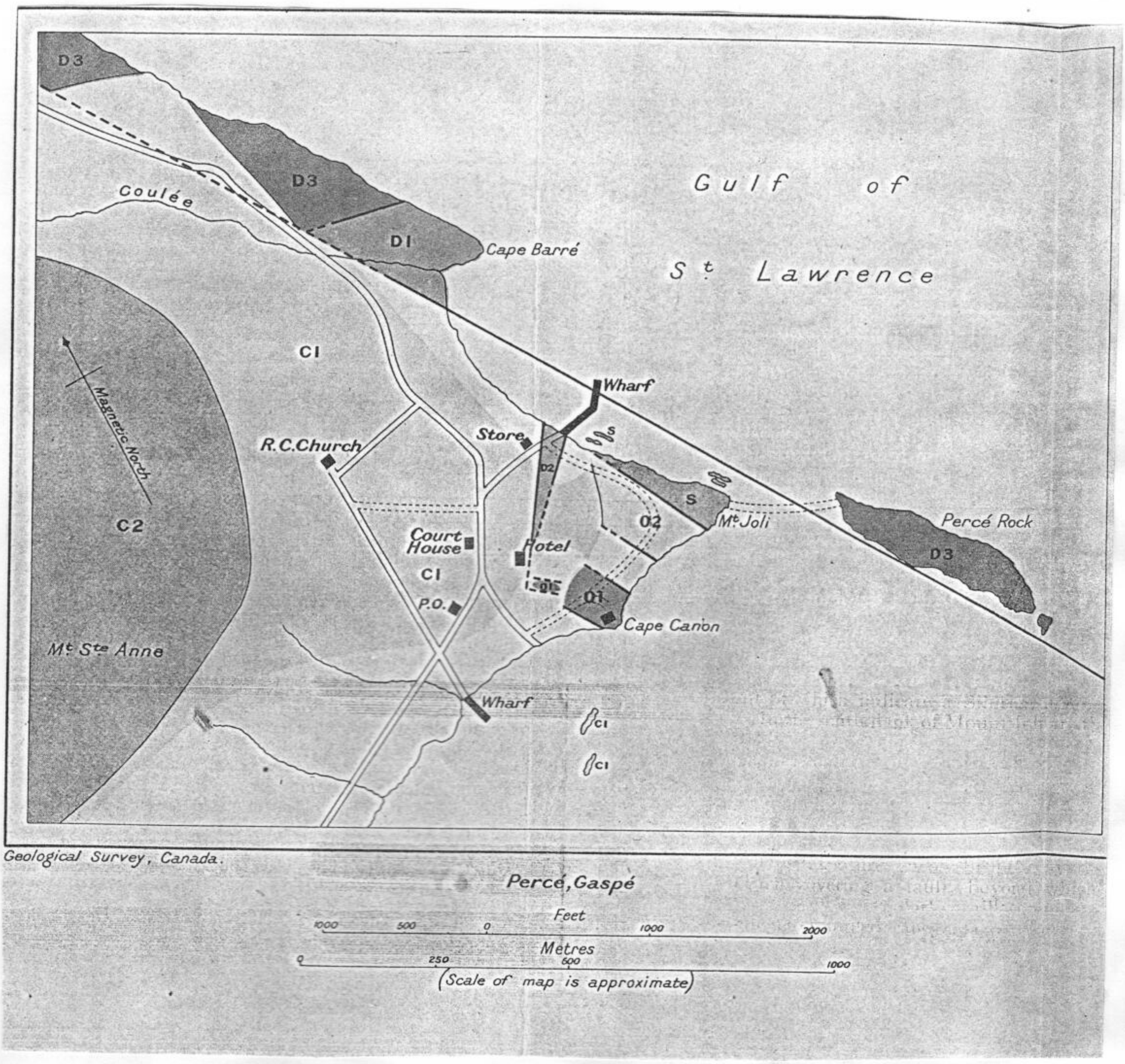
This exposure ends abruptly at the south in a short beach covering a fault, beyond which is *Cap-du-Canon*, a mass of erect, dark argillaceous and calcareous slates, much crumpled and glazed. The general inclination of the bedding is not different from that of the Mount Joli massive, but the beach interval, continued over the surface of the ground as a swampy depression, is indicative of their discontinuity.

Not far landward of this cliff is an isolated boss of limestone conglomerate which is apparently a part of the same mass, though its much more massive calcareous character indicates a part not there represented and possibly cut off from that by a displacement. No fossils have been with certainty derived from these rocks,* but their age is probably Ordovician or Ordovician-Cambrian.

The Cap-au-Canon can be passed only at a low stage of the tide, and with it the rock section ends at the South Beach.

PANORAMA SKETCH OF THE SEA FRONT AT PERCÉ




D3
D3
D1
Coulée
Cape Barré
Gulf of
St Lawrence
C1
Magnetic North
Wharf
Store
S
R.C.Church
O2
S
C2
O2
Mt Joli
Percé Rock
Court House
Hotel
D3
C1
O1
P.O.
Cape Canon
Mt Ste Anne
Wharf
C1
C1
Geological Survey, Canada.
Percé, Gaspé
Feet
1000 500 0 1000 2000
Mètres
0 250 500 1000
(Scale of map is approximate)

Mount Ste. Anne.—This mountain (1,200 feet, 370 m.) rises just behind the village, exposing toward the sea its upper precipitous face of red conglomerates. A grassy road leads up to the mountain on the north side, but on nearly all other sides the mountain faces are vertical fault walls. The view from the summit is fine with clear weather, affording a panorama of the coast, its capes and islands, from the St. Lawrence river at the north to the Bay Chaleur at the south, and of the rolling wilderness of the hinterland. Ste. Anne is the foremost of a mountain cluster known as the Percé mountains and is the only member of it that is composed of the *Bonaventure conglomerate.* The ascent of the mountain shows limestone conglomerates in the lower part and jasper conglomerates above. The attitude of these beds approaches the horizontal at the south, but is undulating and dips gently down toward the north. The mass everywhere sheets the upturned broken and eroded edges of the vertical Ordovician-Lower Devonian cliffs, and it here reaches its northernmost limit in recognizable expression. At more northern points a distinction between these conglomerates and the Gaspe sandstones is obscure but there are reasons to believe that the upper sands and conglomerates on the south shore of Gaspe bay, which have been included in the Gaspe sandstones, pass without much change of attitude into the Bonaventure formation.

* The limestone boss was formerly a place for lime burning, but the limestone for this purpose was brought from Cap Blanc and the Ordovician fossils that have been referred to this outcrop may have come from the more distant locality.

The mass of Mount Ste. Anne is peculiarly isolated by a series of fault scarps one of which fronts the sea at the east; a second, the Grand Coupe, faces the north; and a third, the Amphitheatre, lies behind the mountain facing the southwest and separates the mountain mass from the zone of Silurian limestones which almost encircles it.

The throw of these faults is indicated by the fact that the exposed beds of conglomerate seen in the coast ledges south of the South Beach and thence on southward to Cap Blanc are mostly of the middle and upper beds carrying jasper pebbles with a few fossil-bearing limestone and slate pebbles. These intimate a displacement of approximately 1,000 feet (300 m.). (See under Cap Blanc).

Cap Blanc or Whitehead is the sea-end of the southern rock ridge bounding the Percé triangle. It is a mass of light grey Ordovician limestones, having the steep dip (80° SE.) of all Palæozoic strata here lying beneath the Bonaventure formation. In approaching the cape from the north these limestones are seen to rise gradually from the sea, and are overlain by the slightly inclined basal beds of the Bonaventure conglomerate. The entire series of the lower beds is overturned, the Ordovician lying above the Silurian. The first or northernmost of these are latest in age and they alone in the series are tinted red and greenish, but soon pass into grey. Probably some part of the red stain in these beds has been derived from the red Bonaventure over them. The overlapping beds soon disappear leaving the erect strata standing alone and giving name to Cap Blanc which is conspicuously white by contrast to the red rocks about it. Just beyond the point of the cape these grey limestones are cut off and terminated by a sharp fault against the Bonaventure beds, the former having moved down, as shown by the down-dragged edges of the Bonaventure. Access to the cliff for purposes of examining the rocks is difficult except at low tide in a gentle sea.

The lower and later red-greenish beds contain some fossils in abundance: *Favosites* (cf. *hisingeri*), *Halysites catenularius typicus*, *Lyellia*, *Callopora*, *Cladopora*, *Lichas*, *Chonetes* (type of *novascotica*), *Catazyga* or *Zygospira*: enough to indicate a Silurian age, though most of the species have not been determined. The grey beds farther south are sparsely fossiliferous but carry an Ordovician fauna as early as the Trenton and comparable to that of

Mount Joli-south flank:—*Phacops primævus, Calymmene senaria, Ceraurus pleurexanthemas, Camarospira bisulcata, Zygospira recurvirostra, Bolboporites*, etc.

The total thickness of these limestones approximates 1,000 feet (300 m.) and there is no evident displacement within the mass. Their relations otherwise conform closely to the beds of like age in the Mount Joli section, though there is no noticeable degree of identity in the species of fossils which occur in the two sections.

Bonaventure Island—This island, 2 miles (3·6 km.) long, 1½ miles (2·7 km.) wide and 3 miles (5·4 km.) out to sea, is separated from the mainland by a channel in which the tidal currents run heavy. The island is an ancient fishing site dating back to the days of the 16th and early 17th centuries when Basques, Bretons and the men of La Manche came out every year for the fishing, returning to France in time for the lenten market. The rocks of the island are entirely of the Bonaventure conglomerate and represent the upper beds, the basal limestone conglomerate not being present. It is thus, in the present interpretation of the formation, a mass of Carboniferous rocks. The island presents a low face on the channel side but the cliffs on the east rise to 400 feet (120 m.) making a noteworthy fault face. These cliffs have an added interest because of the large colony of water birds which nest here. The assemblage is not surpassed in size anywhere in the Gulf except on the celebrated Bird Rocks of the Magdalen islands which politically belong to Gaspe but lie 160 miles (288 km.) out to sea. The species nesting here are the gannet (*Sula bassana*), Kittiwake (*Rissa tridactyla tridactyla*), Brünnich Murre (*Uria lomvia lomvia*), Puffin (*Fratercula artica artica*), Razor-billed Auk (*Alca torda*) and perhaps one or two more—an association entirely like that on the Bird Rocks. In these Gaspe waters there are two bird assemblages of this kind and two other associations which consist only of the Herring Gull and the Cormorant. It is a curious coincidence that the former and larger assemblages, alike in kind, nest only on the horizontal ledges of Carboniferous sandstones while the lesser combination breeds only on the inclined strata of the Lower Devonian limestones.

The Girdle of Ordovician-Silurian from Cap Blanc (south) to Corner-of-the-Beach (north).—From Cap Blanc this heavy mass of overtipped limestones passes inland, bounding the south flank of Mt. Ste. Anne, then passing behind that mountain, rising to greater heights and forming the broken range known as White mountain, which almost encircles and isolates Mt. Ste. Anne, approaching sea level at Corner-of-the-Beach on Mal bay. A fault-bounded outlier of this rock may be seen in a white cliff on the sea front beyond the Murailles, where it lies at an angle against the Bonaventure beds beyond. Much remains to be learned of the fauna of this extensive belt of limestones.

GEOLOGICAL RELATIONS.

The foregoing account of the leading topographical and geological features has intimated the geological history of Percé. The steeply tilted older strata present the seaward end of an Appalachian fold of great magnitude, which has been variously broken down. The uniformity of the inclination in the steep fold is expressed by the coincident dip of all the older beds, 80°-85°SE., and this fold, steeply inclined to the north, involves beds from (Cambrian) Lower Ordovician into upper Lower Devonian.

The construction of the tectonic changes here is complicated, perhaps not altogether clear, but the secondary movements expressed by dislocations of the strata are of two orders in time. Of the older faultings there are unlike orders in magnitude. The great Percé fold, exposed only at its sea edge, may be construed as typically Appalachian in its thrust northward. It was an earlier fold than those to the north of it, and was not thrust against a horst of crystallines. The over-tipped Silurian and Ordovician strata present in the Mount Joli section and repeated 2 miles south at Cap Blanc, indicate a profound displacement along the thrust plane after folding which carried southward the inverted succession of the strata; a displacement which would involve the conception of gravitational movement backward (south) along the plane of thrust; a conception apparently reasonable, and squaring with carefully repeated tests. The lesser displacements involved in the down-breaking of the Percé fold are indicated on the accompanying map in which those of earlier age are marked by single lines, and those visibly affecting the Bonaventure formation only, by double lines, in both instances dotted where the break is uncertain. Percé Rock is evidently bounded on its long sides by faults which have isolated it wholly and cut out from beneath it the earlier Devonian stage represented by the rocks of Cape Barré and the wharf-foot. This cut-off mass of Devonian extending along the face of the Murailles has itself been faulted across, as indicated.

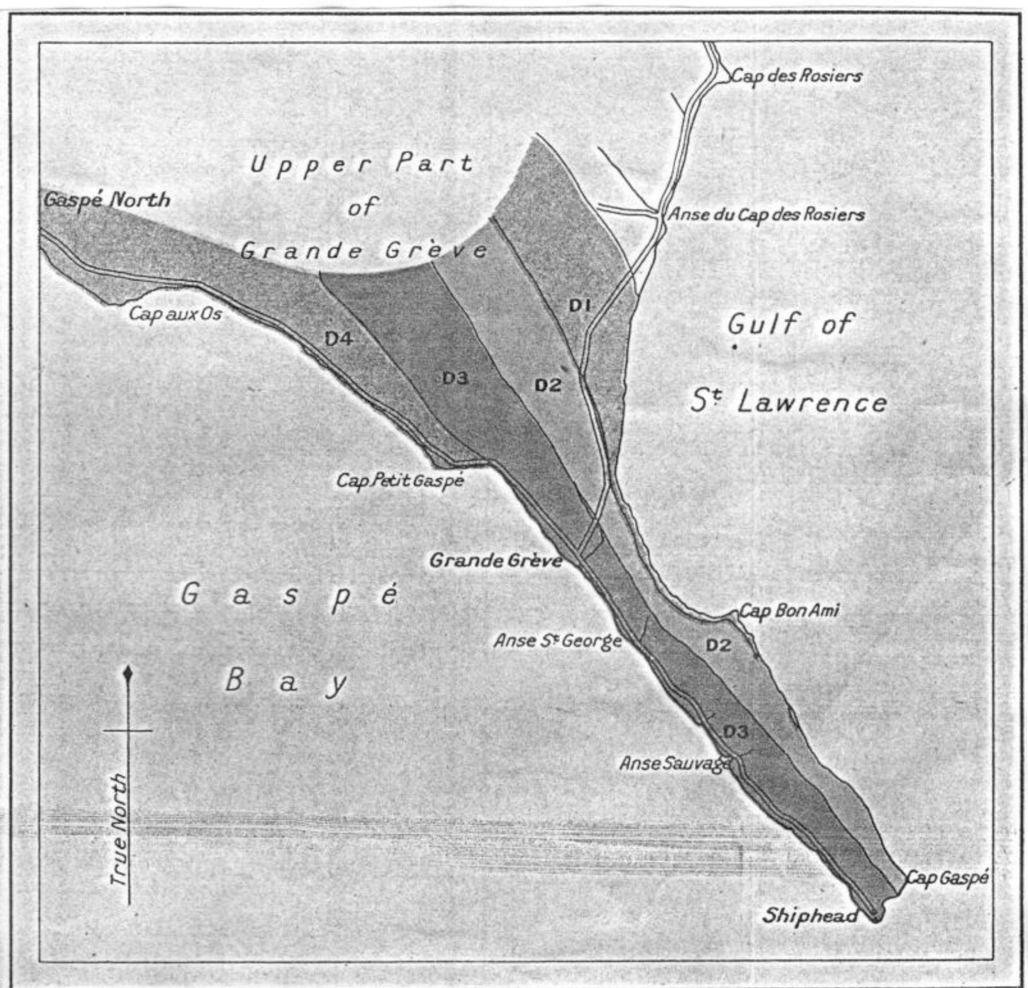
The beach depressions both north and south are undoubted displacement areas, the first being the interval between the Devonian of the Murailles and the Silurian of Mt. Joli (North Beach); the second or broad South Beach being the area of general breaking down of the great arch.

The displacements which took place at a later date than those mentioned have visibly affected only the Bonaventure conglomerate. These may be thus enumerated: (1) The seaward scarp of Mt. Ste. Anne. Bonaventure island seems to be the downthrown mass from this displacement, the "Robin reefs" lying off the South Beach remnants of the same mass; (2) The strata of Bonaventure island dip slightly to the S.W. and the sheer cliffs of the northeast front are a fault face. At the foot of these cliffs the bottom drops immediately to 30 fathoms; (3) The Grand Coupe at the north; (4) The Amphitheatre at the back of Mt. Ste. Anne.

Relative Thickness of the Older Palæozoics at Percé.

Devonian	Percé beds in Percé Rock 250–300 feet but probably rising in Les Murailles to	500 ft. (153 m.)
	Cape Barré Beds	100 ft. (33 m.)
Siluro-Ordovician	Mt. Joli massive	1,100 ft. (339 m.)
	Cap-au-Canon massive	600 ft. (200 m.)
		2,300 ft. (725 m.)

The thickness of the strata at Cap Blanc which are doubtless a repetition of part of the foregoing beds, is 800–1000 feet (303 m.). The estimated thickness then of the pre-Bonaventure beds at Percé [Lower Devonian-Ordovician (Cambrian?)] is about 2,000 feet (606 m.), without making allowance for loss by faulting.

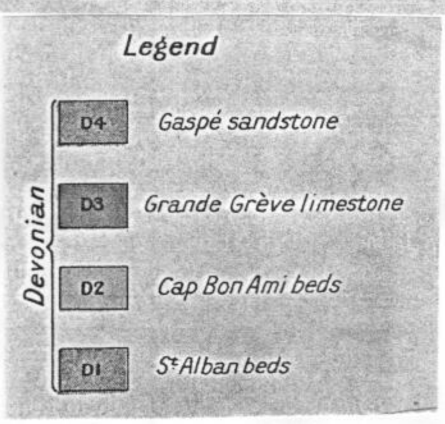


Geological Survey, Canada.

The Forillon, Gaspé

Miles 1 0 1 2 3

Kilometres 1 0 2 4 6



The terminus of the railway is at York on the south side of Gaspe Basin, passing an instructive cut through the Gaspe sandstones (Middle Devonian). These are however not the lower beds with marine fossils, but the plant-bearing strata which at this point probably lie above the marine beds. Crossing by ferry to the Gaspe side, the Gaspe sandstones may be seen near the landing dipping at a steep angle to the north. Gaspe bay lies in a synclinal of the sandstones, that is, in an ancient Appalachian trough the other arm of which constitutes the hill slopes on the north side of the bay where the dip is to the south. The marine fossils occur for the most part in strata behind the Gaspe mountain and up the Dartmouth river (at the north), distances of 3 to 4 miles from Gaspe Basin. The fossils are Middle Devonian species of the interior or New York sea commingled with more or less local Lower Devonian types which have survived from the period of the Grand Greve fauna.

GRAND GRÈVE AND THE FORILLON.*

Grande Grève, 14 miles (22·5 km.) distant by water from Gaspe, is a little fishing settlement on the peninsula of the Forillon. This Forillon peninsula bounds the north side of Gaspe bay and lies between that bay and the St. Lawrence river. At its upper end and near the head of the bay it has a width of 20 (32 km.) or more miles, but at Grande Greve and thence to the Cape, a distance of 4 miles (6·4 km.), its width does not exceed ½ mile (0·8 km.). As elsewhere observed, this part of the Forillon is a single Appalachian ridge sliced vertically in half along its axis, its end at Cape Gaspe making the easternmost seaward face of the Appalachian system. From Grande Grève westward the ridges are multiplied in number by the accession of the slate cliffs at the north, but from Grande Grève east the half ridge alone remains, though furrowed on its surface by a coulée which gives the cape a double head; the northern, Cape Gaspe; the southern, Shiphead.

Only the south flank of this ridge remains and the dip of the strata—almost coincident with that of the hills—is toward the south, while their cut-off edges form the high cliffs which face the St. Lawrence river.

*See Map.—The Forillon, Gaspe.

We have here to deal with a heavy series of early Devonian limestones and lime shales unconformable to and overthrust upon the Cambro-Ordovician slates exposed at the north. The upper limestones, facing the south, are exceedingly rich in fossils, but the exposures are for the most part to be found on the little crescentic fishing beaches where the sea has cut out joint blocks of the strata. The thrust plane or base of the Devonian series has not yet been observed though further exploration may reveal it at the north base of the sea cliffs.

Starting from Grande Grève beach the section of the rocks is approached in reversed order, from top to bottom. Here and along all the neighboring beaches the upper strata of fossil-bearing Grande Grève limestones are exposed and actual unconformable contact of the uppermost beds with the red plant-bearing Gaspe sandstone is to be seen at Little Gaspe 1½ miles (2·4 km.) westward on the shore. The division of the total limestone series (St. Alban, Bon Ami and Grande Grève) is as yet a broad one based upon lithologic and faunal rather than diastrophic characters. The upper member of this series or Grande Grève limestone is also divisible on the basis of its fuana, into distinctive early and late elements, but taken as a whole the species of the Grande Grève member are eminently characteristic of the Helderberg-Oriskany with a considerable representation suggestive of incipient stages of the later Onondaga fauna of the New York standard. A total fauna of 155 species has been described from the Grande Grève limestone and a visitor may expect to find in the upper beds characteristic species of the trilobites *Phacops* (*logani, gaspensis*), *Dalmanites* (*phacoptyx, dolbeli, emarginatus*, etc.), *Probolium, Cordania, Lichas* and *Gaspelichas*; the cephalopods, *Kionoceras* and *Orthoceras*; the pteropods *Hyolithus* and *Conularia*; abundant gastropods of the genera *Platyceras, Eotomaria* and *Diaphorostoma*; the pelecypods *Pterinea, Megambonia, Palaeopinna*, etc.; a large array of brachiopods, *Spirifer arenosus, murchisoni* and many more, *Rhipidomella logani, Stropheodontas* and *Leptostrophias, Leptocoelia flabellites, Nucleospira, Rensselæria ovoides gaspensis, Megalanteris*, etc., etc. A very notable percentage of these species have a wide geographical rang and the affiliation of the fauna is distinctly American.

The lower beds of the Grande Grève division are exposed on the Kings road and carry an association of species which is most distinctively indicative of the Oriskany horizon; such as *Hipparionyx proximus, Rensselaeria ovoides gaspensis, Spirifer arenosus, Chonostrophia complanata, Rhipidomella musculosa*, etc. The limestones carry much nodular chert and in some places masses of silicious sponge spicules constitute the basis of the rock.*

Beneath the Grande Grève limestone lies a series of less purely calcareous, more magnesian beds, with but few fossils and these mostly diminutive forms,—a deposit formed under impeded marine conditions in which life was unable to flourish. These are the *Bon Ami beds*, and they form a large portion of the cliff face of the river escarpment. They can be examined on the face of Mt. St. Alban at the summit of the Kings road and at Cape Bon Ami, where a ladder down the face of the cliff at the end of the Portage road makes them accessible and they constitute the greater part of the bold front of Mt. St. Alban. Such fossils as they contain are quite distinctively of Helderberg age.

Beneath and conformable to the Bon Ami beds are the *St. Alban beds* with a fauna quite exclusively identical with the Helderberg (lowest Devonian) fauna of New York. These calcareous compact shales are to be seen in exposures along the shores of Cape-des-Rosiers cove at the foot of Mt. St. Alban. About 50 species have been identified from these rocks of which more than one half are found in the lower divisions of the Helderberg series in New York, while hardly more than one-fifth occur in the Grande Grève limestones. Access to these exposures requires the descent of the Kings road down the slope of Mt. St. Alban and thence across the fields to the shore of the St. Lawrence river.

Sir William Logan estimated the thickness of these limestones at 2,000 feet (610 m.) and of this the Grande Grève beds include approximately 600 feet (180 m.). The boundary, however, between the sub-divisions is not a sharp one, but in all, the beds afford a total not paralleled in the Devonian section at Percé. In fact the entire series is wanting elsewhere and in all the other Gaspe folds, so far as known, except so far as represented by the Percé Rock limestone which conforms faunally with the Grande Grève beds. The absence at Percé of the major part of the Devonian limestone series serves to indicate how extensively the formation has been lost by faulting out rather than by lack of continuity.

*The fauna of all these Devonian beds has been described in detail by Clarke.

Unconformity between the Devonian limestones and the Cape-des-Rosiers slates.—Similarly the entire representation of the Silurian and Ordovician, as indicated in the Percé section (a minimum of 1,000 feet and probably much more), has been lost in the Forillon section, by the overthrust which has carried these Devonian limestones over the erect and distorted Rosiers slates of Cambrian (Cambro-Ordovician?) age. So far as we have any evidence, the vast overthrust of this Forillon fold is due to the resistance imposed by the crystalline horst lying at the north of the St. Lawrence river (Canadian shield) and the degree of the reaction is expressed both in the fold itself and in the great fault ('Logan's fault') which outlines the course of the river.

Relation af the limestones to Gaspe sandstone.—As observed, an actual unconformable contact of the limestones with the overlying sandstones is seen at Little Gaspe 1 ½ miles (2·4 km.) west of Grande Grève where the first ridge of sandstone mountains comes to the coast. Infaulted masses of these red sandstones in the limestones are also to be seen eastward of Grande Grève indicating the removal of an entire mantle of the Gaspe sandstone from above the limestones.

The Flora of the Gaspe Sandstone, by David White.—Gaspe is the most interesting locality for Devonian plants yet known in Canada. The Gaspe sandstones are remarkable for the abundant plant fragments, mainly representative of Psilophyton which occur in great numbers at some horizons, and which interestingly enough appear, at several levels, to be rooted in old soils. Fragments, frequently but slightly compressed, from this district are present in many of the museums of Europe, as well as in most of those in America. Gaspe was twice visited by Sir William Dawson, who described all the species reported from this region. The Psilophyton-bearing beds occur at many horizons in the section, one of the most interesting being near Watering brook on the north side of the bay. Several plant-bearing layers were described by Dawson as old soils. Associated with other plant remains are numerous petrified trunks of the giant alga (*Prototaxites*) (*Nematophyton*). One trunk, partially exposed, was described as exceeding 3 feet (0·9 m.) in diameter.

At one place, near the middle of the section, a coal bed one inch to three inches in thickness, associated with highly bituminous shales abounding in remains of plants, and containing fragments of crustaceans and fishes, is said to occur in the midst of grey sandstones and dark shale which resemble ordinary coal measures. The coal, which is shining and laminated, has no underclay, and appears to consist of what was once a peaty mass of rhizomes of Psilophyton, which now lies between layers of laminated bituminous shale. This thin coal occurs near Tar point on the south side of Gaspe bay, a place named for the occurrence of a thick dyke of trap holding petroleum in its cavities. The coal is supposed to be of considerable horizontal extent, the Tar Point outcrop being provisionally correlated with a similar bed about 4 miles (6·4 km.) distant on Douglas river.

The plants described by Dawson from Gaspe include *Prototaxites logani*, *Prototaxites* (*Nematoxylon*) *crassum*, *P. tenue*, *Stigmaria areolata*, S. *minutissima* (the latter species being perhaps based on the rhizones of Psilophyton) *Didymophyllum reniforme*, *Calamites inornatus*, *Annularia laxa*, *Lepidodendron gaspianum*, *Leptophleum rhombicum*, *Lepidophloios antiquus*, *Psilophyton princeps*, *Psilophyton robustius*, *P. elegans*, *Arthrostigma gracile*, *Cyclostigma*, *Cordaites angustifolius* and *Parka* related to, though smaller than, the Scotch *P. decipiens*.

The plants in the Gaspe section represent the Psilophyton-Arthrostigma flora, which preceded the Archæopteris flora The genus Archæopteris is present practically everywhere in the floras of the Upper Devonian in Europe and America, whereas the typical *Psilophyton princeps*, including the spinous forms, together with *Psilophyton robustius*, *Psilophyton grandis* and *Arthrostigma*, are characteristic of a lower zone in both Canada and the eastern United States. This older flora which is found in the Chapman sandstone in Maine, seems hardly to have survived the Hamilton group, above which (especially above the Portage) the Archæopteris flora reigns to the close of Devonian time.

Extension westward of the Devonian limestone series.— In the direction of the mountain trend the limestones have been traced well inland along the course of the Dartmouth river and southward, but are here mostly exposed in the ridge summits by erosion of the sandstone mantle Their relation there to the rest of the Palæozoic series is not yet fully understood.

BIBLIOGRAPHY.

1. Logan, W. E.......Geology of Canada, 1863.
2. Billings, E........Descriptions of Fossils in (1).
3. Ells, R. W........Report on the Geology of the Gaspe Peninsula: Rep't. Geol. Surv. Canada, 1880-82.
4. Ells, R. W... ....Report on Surveys made in 1883 in Gaspe: Rep't. Geol. Surv. Canada, 1882-84. Pt. E.
5. Low, A. P..... ...Report Geological Survey Canada, 1882-84.
6. Dawson, J. W.....Fossil Plants of the Devonian and Upper Silurian of Canada, 1871 and 1882; also Quarterly Journal Geological Society of London, v. 15, 1859 and v. 19, 1863 (Plants of the Gaspe sandstone).
7. Billings, E.. ....Palæozoic Fossils, v. 2, 1874.
8. Lambe, L. M.... ..Contributions to Canadian Palæontology, v. 4, pt. 2. 1901.
9. Clarke, John M....Early Devonic of New York and Eastern North America, v. 1, 1908. N. Y. State Mus. Mem. IX.
10. Clarke, John M...Sketches of Gaspe, 1908.
11. Clarke, John M...Relations of the Palæozoic Terranes in the vicinity of Percé, N.Y. State Mus. Rep't. Director, 1911.

BLACK CAPE SILURIAN SECTION.

Black cape on the north shore of the Bay Chaleur, is immediately east of the Little Cascapedia river and 70 miles (112 km.) from Matapedia. The rock section here is of special interest for its extraordinary development of the Silurian, the shore section from the mouth of the river named to Black cape itself displaying an unduplicated thickness of fully 7,000 feet, (2,130 m.) of strata.

In this Silurian section the strata are nearly all calcareous with intercalations of red shale near the top. They stand at high angles to the horizon, usually dipping 60-80° S.E., but these dips vary somewhat though without uncomformities. The eroded edges of the strata are overlain elsewhere in the region by the red sands and conglomerates of the Bonaventure formation, and there are several considerable fissures in the Silurian limestones of this section which are filled in with red sand derived from the overlying beds. All these occurrences indicate land exposure of the Silurians during all the early and middle Devonian time.

The base of the section at the west begins with greenish, highly nodular lime shales, very compact and heavy bedded, weathering out into irregular and gnarled shapes. These alternate with more highly calcareous shales and compact limestones of red and ochreous tints. These compact limestones contain Stricklandinias of great size (*S. gaspensis*, Billings) and in great number and with these are Spirifers of the *S. radiatus-niagarensis* type and occasional Whitfieldellas. Throughout the lower beds the rest of the fauna is largely of Stromatoporoids and corals which occur in enormous quantity and great diversity. There are Halysites of several species, having horizontal values, Favosites and Alveolites of great size, Heliolites, Syringopora, Eridophyllum in extensive colonies, Zaphrentis and other cyathophylloids in considerable variety. Additional species in these lower beds are Calymmene, Chonetes, *Atrypa reticularis* (Silurian type), Tentaculites, cyclostomatous gastropods, etc.

At an elevation in the series of about 1,500 feet (450 m.), where the scraggy limestones continue, there is some indication of change in the fauna by the addition of brachiopods of the genus Camarotoechia, Rafinesquina, the cephalopods Orthoceras, Trochoceras, etc. From Howatson's (elevation in section 1500 feet) eastward, the scraggy limestones continue as far as the breakwater. Then follows (at 6,500 feet or 1,980 m.) a heavy mass of sandy shale. This sedimentation continues sandy to near the end of the section which terminates at the volcanic mass forming Black cape, but toward the top the sands become interlaminated with thin beds of volcanic ash, with red and purplish shale and eventually calcareous and variegated beds succeed to these, becoming in places compact limebanks entirely constituted of the debris of fossils.

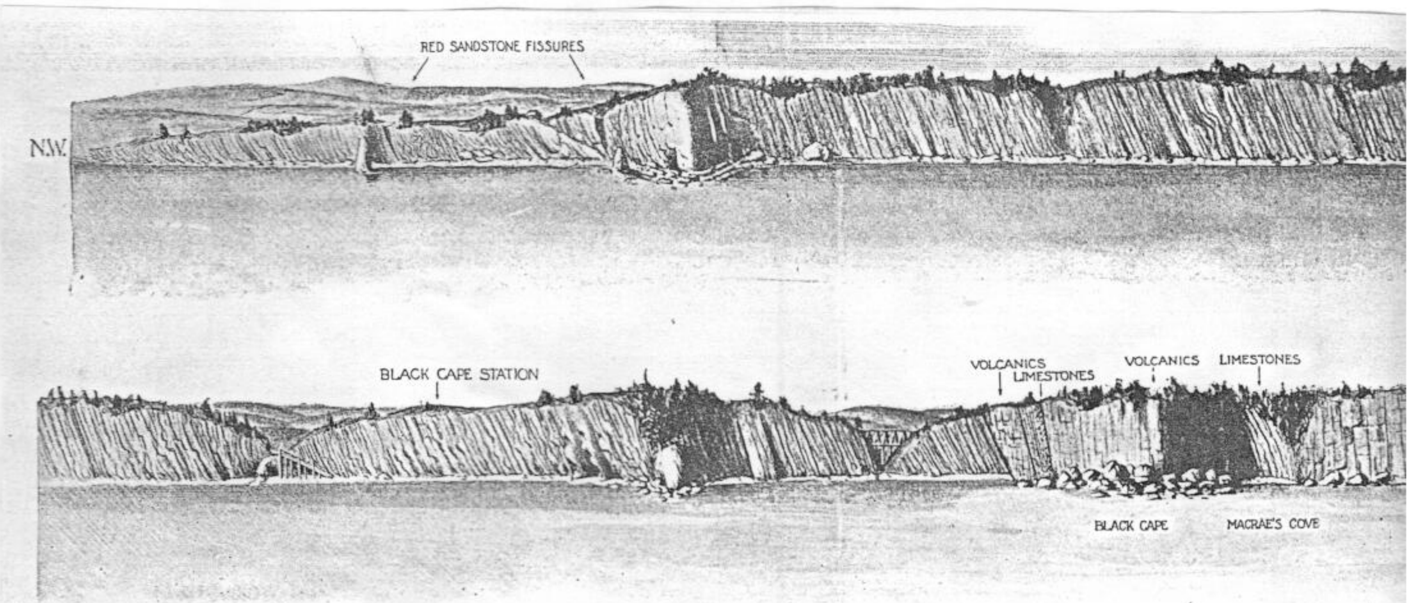
These upper sandstones and sandy shales are remarkably profuse in corals, some of the species being palpably unlike those of the lower beds. The volcanic mass which forms Black cape itself and against which these upper strata abut presents a total sea face of 4,600 feet (1,400 m.) and within it are two notable inclusions or separate masses of Silurian strata. The first of these is in Macrae's cove, 600 feet (180 m.) from the beginning or base of the intrusive and the second at Lazy cove, $\frac{1}{3}$ mile (0·5 km.) further east. The intrusives are interbedded but the necessary study of the fossils is yet wanting to determine whether these fossiliferous masses are or are not additional parts of the section. At Macrae's cove the thickness of the sediments is 150 feet (45 m.) and in the narrower Lazy cove they are 75 feet (23 m.). These coves may be reached on foot along the beach by favouring tide. The volcanic cliff ends ½ mile beyond Lazy cove and at its termination the red conglomerates of the Bonaventure formation lie against it at an angle of 30 degrees.

So far as at present indicated by the fossils, this section from base to top is of the age of the Niagara (exclusive of Clinton) or Rochester shale of the interior Silurian, though the assemblage will doubtless show a preponderance of Atlantic or European types which will bring it into more proper comparison with the Gulf sections at Arisaig and on Anticosti island. Its thickness is very great and in this respect the section overpasses any Silurian section known in America.

BIBLIOGRAPHY.

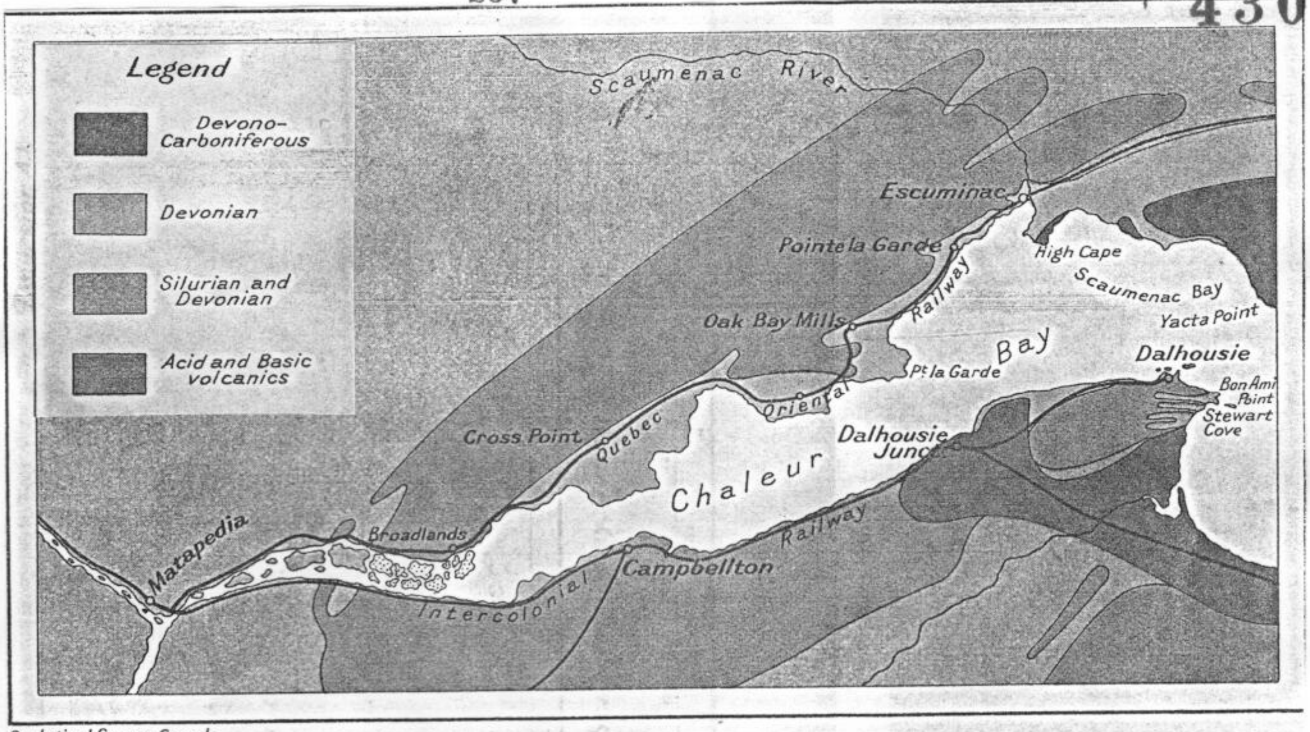
[Note.—The Black Cape section has only recently come under close observation. It has now been studied in some detail and the fauna assembled, but identifications and classifications have yet to be made.]

1. Logan, W. E. Geology of Canada, p. 447, 1863.
2. Ells, R. W. Geological Survey of Canada, Rept. for 1883, E. p. 27, 1884.
3. Clarke, John M. A Remarkable Siluric Section on the Bay of Chaleur. N.Y. State Mus. Rept. Director for 1911. p. 120-126. 1912.



The Silurian section at Black Cape, Cl
(The lower part is continuous with that

35063—p. 111.

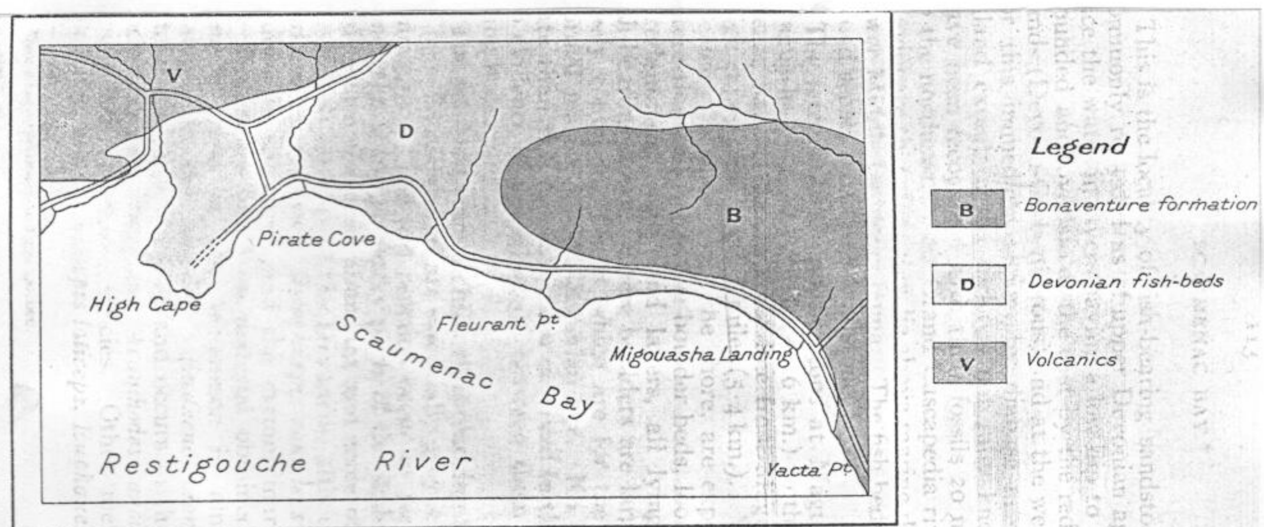


Geological Survey, Canada.

Head of **Chaleur Bay**

Miles: 5 4 3 2 1 0 — 5 — 10

Kilometres: 5 4 3 2 1 0 — 5 — 10 — 15



Geological Survey, Canada.

Scaumenac Bay, Quebec

Miles: 1 0 1 2 3

Kilometres: 1 0 1 2 3 4 5

SCAUMENAC BAY.*

This is the locality of fish-bearing sandstones which are commonly regarded as of upper Devonian age. The beds face the water in layers having a low dip to the east, are bounded and overlain at the east by the red Bonaventure sands (Devono-Carboniferous) and at the west are limited, for this immediate region, by diabase intrusions. The inland extent of the rocks is not fully known but they have been recognized with their fossils 20 miles (36 km.) to the northeast on the Grand Cascapedia river, and there is evidence that there they lie above marine deposits with a lower Middle Devonian fauna. The fish beds are thus, in a broad sense, "Old Red-sandstone."

The ferry from Dalhousie stops at Maguasha Landing. Maguasha point lies 2 miles (3·6 km.) to the east. Scaumenac bay covers the coast line from Maguasha point to High cape at the west—3 miles (5·4 km.). Westward from the ferry landing along the shore, are exposures of very interesting and suggestive boulder beds, loosely cemented, interlaminated with sand layers, all lying beneath the fish-bearing strata. These boulders are largely limestone, freely containing fossils which are for the most part of normal marine Lower Devonian age. No fossils of later date than this age have been observed in them. There is no evidence of unconformity between them and the overlying beds.

The fish beds stand in high cliffs reaching 100 feet (30m.) or more in places and are essentially grey sand-shales and sandstones. The fish remains occur in the nodules and concretions, and in blocky parts of the shale beds. These beds afford the most abundant and some of the best preserved fish remains of the Devonian, although the genera and species are few. *Bothriolepis canadensis* is the most profuse in specimens and the extraordinary restorations by Patten are based on material obtained here. *Scaumenacia curta* is not uncommon in almost complete examples in the nodules. *Eusthenopteron foordi* often attains a size of 2-3 feet, and occurs in the shale layers. *Coccosteus canadensis* and *Acanthodes concinnus* are also among the commoner species. Other members of this fish fauna are *Cephalaspis laticeps*, *Euphanerops longaevus*, *Diplacanthus striatus*, *D. horridus*, *Holoptychius quebecensis* and *Cheirolepis canadensis*.

*See Map.—Scaumenac Bay, Quebec.

Intermingled with the fish remains are excellent examples of Devonian ferns which have been described by Sir Wm. Dawson.

BIBLIOGRAPHY.

Stratigraphy—

1. Ells, R. W.......... Report Geological Survey of Canada. 1880–82.
2. Clarke, John M...... N.Y. State Museum, Rep't Director 1911.

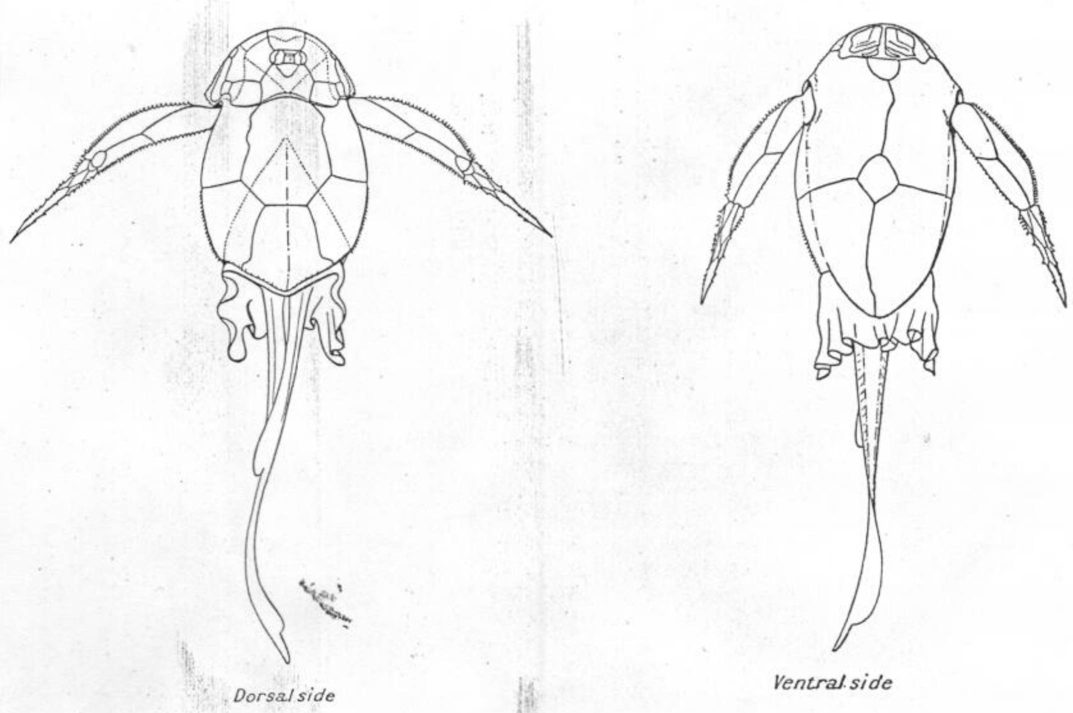
Fossils—

3. Whiteaves, J. F...... American Journal of Science 1880, v. 30.
4. Whiteaves, J. F...... Canadian Naturalist, 1881, v. 10.
5. Whiteaves, J. F...... Royal Society of Canada. Trans. v. 4, s. 4, 1887.
6. Whiteaves, J. F...... Royal Society of Canada. Trans. v. 6. s. 4, 1889.
7. Woodward, A. Smith. Geological Magazine. 1892.
8. Woodward, A. Smith. Outlines of Vertebrate Paleontology.
9. Traquair, R. H...... Fishes of the Old Red Sandstone: Monogr. Palaeontogr. Society, 1904.

10. Eastman, Charles R. Devonic Fishes of the New York Formations. N.Y. State Museum Mem. 10, 1907.

11. Patten, William.... The Evolution of the Vertebrates and their Kin. 1912, p. 368.

12. Hussakof, L........ Notes on Devonic Fishes from Scaumenac Bay: N.Y. State Mus. Rep't. Director 1912.



Patten's restorations of *Bothriolepis canadensis* Whiteaves, from Scaumenac bay.