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PERCÉ

A brief sketch of its geology.

BY
JOHN M. CLARKE

Advance sheets from Report of the New York State Paleontologist 1903.

ALBANY
NEW YORK STATE EDUCATION DEPARTMENT
1904

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A brief sketch of its geology

BY JOHN M. CLARKE

In seeking the solution of some problems pertaining to the distribution of the ancient faunas of New York, and the nature and extent of the old land barriers and sea channels, one follows only a blind lead if respect is had alone to such evidence as is found within our own political boundaries. In the conservation of the factors necessary to the reconstitution of these early stages in our history, nature has been kind to New York and in the quality of fulness her ancient faunas are not often excelled, but within these confines is but a part of the story; now and again a stage has been skipped here which is recorded elsewhere, or a phase is but obscurely presented in the panorama of New York events which in neighboring territories is portrayed with lucid cogency.

Much of interest lies in the time and mode of introduction into New York of the earliest faunas of the Devonian age. Here they are represented in various degrees of effectiveness and profusion, and for the most part follow with little evidence of interruption on those of the great Silurian age preceding. The pathway of movement of these faunas along the old continental border lies to the northeast and to the southwest, and the labors of our predecessors and colleagues in the latter region have thrown much light on their distribution and travels through what is now the region of the Appalachian mountains but what was then off the coast or along the water ways of the ancient continent termed *Appalachia*.

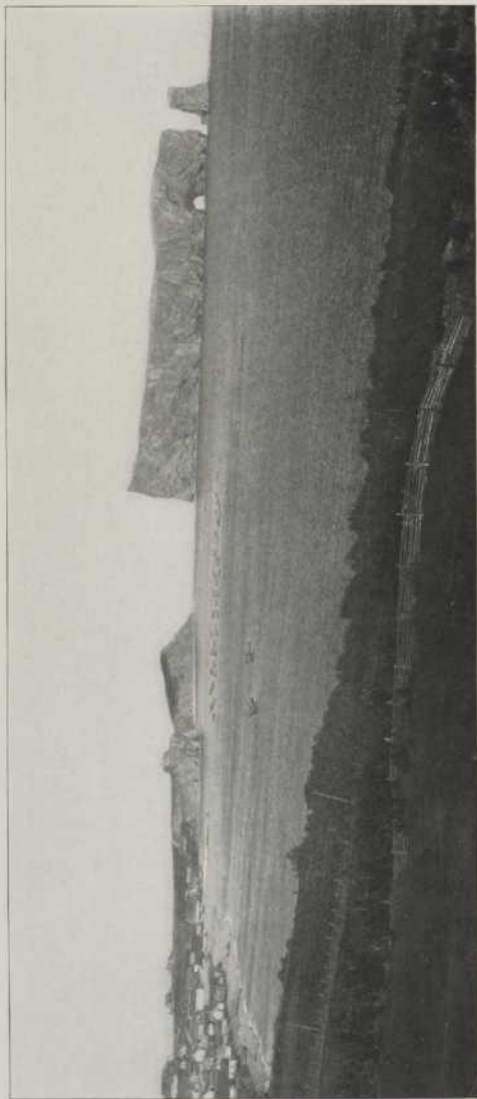
Seeking such clues to the northeast led us a few years ago into the county of Gaspé, province of Quebec, and the region just north of Gaspé bay, and likewise to the exposures about Dalhousie N. B. at the head of the Bay of Chaleurs, places where unequalled opportunity is afforded for the study of some of the New York faunas

under a new aspect and in profuse development. More recently, on a similar errand, the writer has exploited the same factors as developed about the village of Percé on the coast of Gaspé just south of Malbay and about 20 miles due south of the north shore of Gaspé bay. In due time the results of the studies thus made will be presented in some detail for the comparison of these ancient faunas with those of New York, for quite extensive collections have been brought together from all the points mentioned, and we may look for an important elucidation therefrom of some of the problems to which reference has been made.

In this paper, however, it is not so much the purpose to enter on comparisons of results and correlations of faunas as to expound with some brevity the singularly interesting geologic structure prevailing at and about Percé, as derived from observations made in the course of assembling the fossil faunas of the region.

The ancient fishing village of Percé is a spot of extraordinary beauty of situation. It lies exposed to the full force of the sea on the easternmost part of the Gaspé peninsula and no place could display with more potency the tremendous destructive power of the sea than this broken and deeply gnawed coast against which the north-east blasts have beaten ages long. It is an old settlement, one of the oldest in America. Soon after Jacques Cartier in 1535 roamed in the Bay of Chaleurs and planted a cross at Douglastown on Gaspé bay, fisherpeople from the shores of Brittany and the Channel islands settled here under the overshadowing protection of the stupendous and glorious Rocher Percé, from which the place takes name and which today draws the amazed wonder of every passing sea traveler. The narrow beach to the north of the rock and the long beach below afforded a base of operations for the fishing, and here a settlement was made long before Hendrik Hudson had wet keel in the waters of New York.

Isolated and towering stands the Percé rock at the angle between the North and South beaches, cut off from the shore by an interval of 300 feet, over which the waters roll, except at ebb tide, and beneath which lies the zone of a great displacement of the rock masses. All other presentments of the gnawing power of the ocean which the



Percé and rock from the south. At the left Mt Joli, Cap Canon and the South cove

writer has studied on American shores, in northern Scotland at Scrabster and Caithness, in Hoy and the other islands of the Orkneys, are surpassed in magnitude and effect by this leviathan rock. It lies like an immense Atlantic liner, almost at right angles to the course of the South cove, headed inward to the North cove wharf. Its limestone strata, which stand vertical, rise to a height of 290 feet at its highest landward apex, where today a weathered joint face hangs out a triangular rock mass like a pennant flying at foremast peak.

From the sharp landward bow the massive widens outward to a diameter of about 300 feet and extends in length seaward 1500 feet,

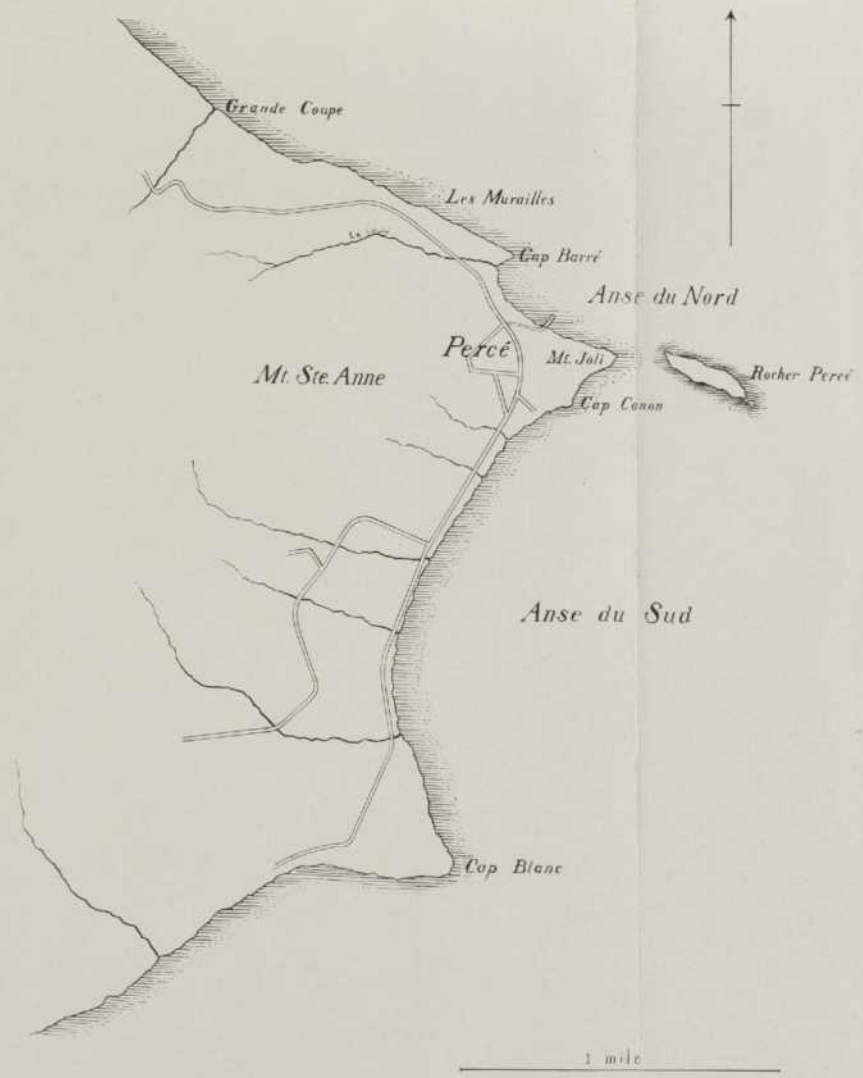


Seaward face of the pillar at outer end of Percé rock; showing the arch

its top sloping with undulating surface rapidly at first and then more gently backward. Sternward stands an isolated rock pillar, remnant of a fallen arch which the seas brought down, as my good friend Philip Le Boutillier tells me, on a rough 17th of June 1845. But the rock is still tunneled aft by a fine arch through which a boat at sail might pass were it not for the breakers. On its rearward sea face is another and smaller arch. The summit of the rock is the breeding-ground of thousands of gulls and cormorants, which make an ever moving halo of white and black about the grassy slopes and jagged asperities of the surface and whose screams and calls are as sempiternal as the breaking of the surf on the fallen rocks. The cliff is virtually inaccessible. Local traditions and Sir Gilbert Parker tell of its having been scaled, but be this as it may, the walls

are sheer and would demand surrender of the most daring. Clothed in tints of red and yellow, which are the natural shades of the rock, and veined with streaks of white, the colors of the cliffs change with every passing cloud, alive with bright purples and lustrous bronze as the sun shines full on it, in the cloud filtered light hanging like an oriental tapestry in soft madders and browns, and when the land mist hangs over it or the nor'easter is buffeting it, dark and minatory, all its soft lines lost and its asperities stiffened in resistance.

Turning landward the eye rests first on the topography of the shore line, Mt Joli, a low truncated rock cone connected at low tide with the Pierced rock by a sand bar, and about a hundred yards away, hence extending southward into another small headland, Cap Canon, sometimes Battery point, all a rock escarpment of vertical strata not more than 100 feet high at any point. To the south of this opens the broad Robin fishing beach, which reaches away to the nearly horizontal outcrops of red conglomerate at the opening of Lenfesty's brook and beyond to the headland which bounds the South cove, 2 miles away, Cap Blanc or Whitehead; another vertical mass of limestones lying between and beneath the red rocks. To the north of Mt Joli and the beach of the North cove, begin the Murailles, the high rocky sea wall which fronts the Malbay, rising with a deeply notched sky line in grassy and deeply furrowed slopes and falling off sheer to the water's edge; the tattered remains of a mountain which stretched away into Malbay but has yielded its better part to the restless tooth of the sea. The effect on the landscape of this ragged escarpment is very striking but its impressiveness is appreciated best only from the sea, from which it is alone approachable. At the north end of the North cove the escarpment rises abruptly in the calcareous and arenaceous shales of Cap Barré; thence northward framing the angular recesses beaten out by the sea, the cliff becomes even higher till the line reaches Red peak at the north and falls off abruptly into the gorge of the Grande Coupe. Except for Cap Barré these rocks are brilliantly tinted with reds and yellows and, we shall presently observe, were a part of the tinted strata comprising the Percé rock, though here the angle of their slope is greatly altered and nearly conforms to the slopes of the mountain surface.



MAP OF REGION ABOUT PERCÉ

All these bold contours are brought closely together so that in the radius of a mile from the courthouse we embrace the Murailles, cliffs of Joli, Canon, the Percé rock, the broad intervalles of the coves and the low south escarpments of the horizontal conglomerate. And behind them all, as a background to the picture, rises Mt Ste Anne, its lofty perpendicular precipices on the eastern face rising to a height of about 1400 feet. On the slopes of this easternmost member of the cluster of summits known as Percé mountain, pious ardor has cleared a broad way to the shrine at the top whence the eye travels without obstruction to Anse du Cap and Grande Rivière southward, and northward to Pointe St Peter across Malbay and to Shiphead and the shores of Grande Grève across Gaspé bay; inland over the rolling timbered wilderness toward the Shickshock mountains, and seaward beyond the Percé rock to the island of Bonaventure 3 miles away. This mountain is the summit of the great cap of red conglomerate which lies over and against the erect limestones of Percé, Cap Canon and Cap Blanc, extends downward to the sea at the Robin beach and makes the Percé reef, and doubtless continues beneath the water to Bonaventure island where only this rock is found.

From the slopes of Mt Ste Anne flow the little drainage ways of the region, the stream of Le Coulé or Barré brook to the North beach, Robin brook to the South beach and Lenfesty's brook directly through the rising escarpment of the Bonaventure rocks to the south.

This brief sketch of the topography of Percé will serve as the only necessary introduction to the sketch of its geology which, without going far afield from the confines of the settlement, follows.

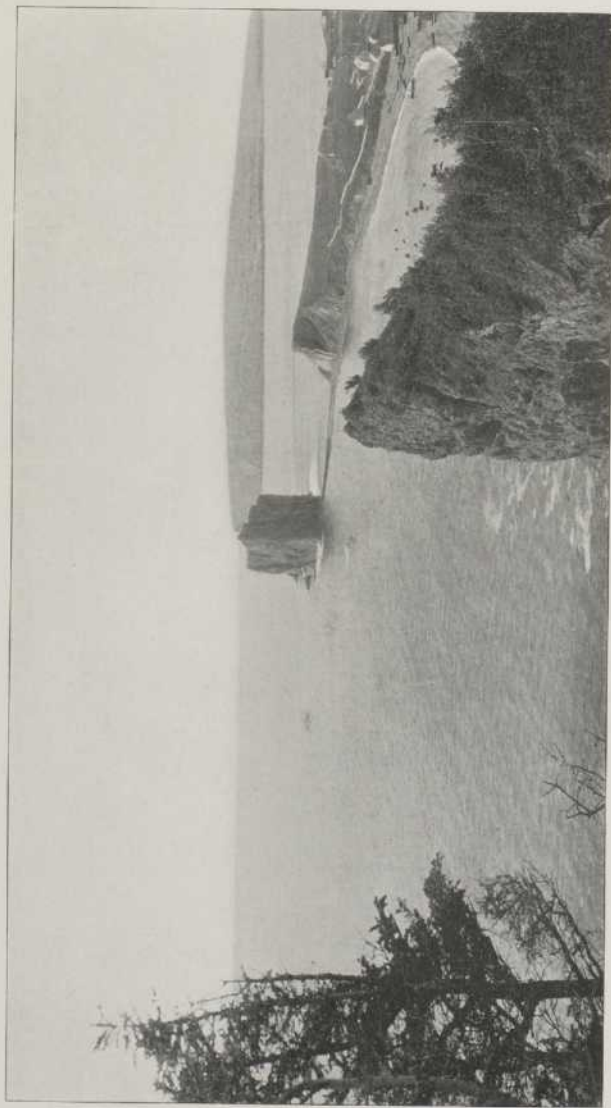
GEOLOGY

Pretty much all that has been known of the geology of this region we still owe to Sir William Logan, first director of the Geological Survey of Canada. In 1844, the second season of his field work in this capacity, Sir William made it his business to reconnoiter the rocky and wild coasts of the Gaspé country, then and in the season of 1845 making traverses from the Gulf of St Lawrence to the Bay

of Chaleurs, "living" as he has said "the life of a savage, sleeping on the beach in a blanket sack with my feet to the fire, seldom taking my clothes off, eating salt pork and ship's biscuit, occasionally tormented with mosquitos." The venerable Mr Philip Le Boutillier tells me of having piloted Sir William about the rocks of Percé and with him scaling the summit of Mt Ste Anne.

In his classical *Geology of Canada* published in 1863 Logan summarized the results of his observations here, and that part of his work in which our interest more specially lies is his detailed account of the limestones, sandstones and conglomerates of the region, enormous series of sediments which he termed the Gaspé limestones, Gaspé sandstones and Bonaventure conglomerates. Several of the Canadian geologists have added much to our knowledge of these formations; Dr Robert Bell, who early explored the region; Sir William Dawson, who studied the plant remains of the Gaspé sandstone; Elkanah Billings, who has made known almost our entire equipment of facts concerning the animal fossils of the rocks; R. W. Eells, who as late as 1882 reviewed the general geologic features of the country and added some important details, while Dr H. M. Ami has contributed a few observations on the faunas.

The Gaspé limestones were defined by Logan from their most remarkable development on the narrow tongue of land which constitutes the peninsula of Cape Gaspé eastward of Cape Rozier on the north and Little Gaspé on the south. Here the succession is apparently uninterrupted, the dip estimated at about s.w. 24° , and the series rests unconformably on the shales of Cambric age at Cape Rozier. Through this narrow neck of land not more than a mile across from the Gulf of St Lawrence to Gaspé bay at Grande Grève run two limestone escarpments, the northern terminating in Cape Gaspé, the southern in Shiphead and the two separated by an eroded, not structural, drainage way. Logan estimated the thickness of this continuous mass at about 2000 feet, and divided it into eight parts, divisions 1 to 8, between which was found no evidence of unconformity but some notable distinctions in quality, the strata becoming more highly calcareous with some intermixture of arenaceous matter toward the top. All were re-



View looking east from the Murailles. Bonaventure Island in the distance, Percé rock and Mt. Joli in middle, one of the peaks of the Murailles in the foreground

garded by him as of the age of the Lower Helderberg of New York, at a time when the Helderberg fauna was not estimated with precision. Almost all the divisions were found to be fossiliferous, but the uppermost, 7 and 8, specially so.

It became evident from the identification of the fossils of the upper beds by Billings that divisions 7 and 8 correspond more nearly in fauna to the Oriskany of New York than to the Helderberg, and these have been generally conceded to have this equivalence, but of the fauna of the lower beds, its composition and variations, we know only enough to see therein clues to the origin of the later fauna and invaluable lights on the derivation of all early Devonian faunas of the Atlantic and Mississippian provinces. Contrasted with the other beds in profusion of fossils and diversity of species, divisions 7 and 8 have been distinctively designated, Dr Ami having proposed to call these beds the Grande Grève limestones. To them Logan ascribed a thickness of about 800 feet, and in them is a fauna which differs from that of the Oriskany of eastern New York in as many respects as it agrees therewith and yet is bound to it by such striking paleontologic features as the co-existence of *Rensselaeria*, *Megalanteris*, *Hipparionyx*, *Chonostrophia*, *Spirifer murchisoni*, *S. arenosus* and many other organisms.

Over the Grande Grève limestones lie the Gaspé sandstones of Logan, shown in apparently conformable contact with the rocks below at Little Gaspé, and attaining an immense thickness. Sir William estimated them at over 7000 feet and subdivided them largely on lithologic characters, as they vary from drab ferruginous, fine grained quartz and feldspar sandstone to coarse conglomerates and red sandstones, the latter being mostly toward the top. From the lower beds Dawson described many interesting plant remains all presenting the aspect of such sedimentation as characterizes both in New York and Europe the deposits of the Devonian or Old Red lakes or lagoons. The lower beds about Gaspé basin contain a fairly rich marine fauna which has been partly described by Billings and to which we have been able to add evidences of both early and middle Devonian age.

In the region about Percé the presence of limestones corresponding to those at Gaspé "on the horizon of the Lower Helderberg and Oriskany" [*Geol. Can.* 1863, p.439] was noted by Logan in connection with his rapid but very lucid sketch of the geology of the coast section from Gaspé to the Bay of Chaleurs. Some lists of fossils were given, though these have only in part been verified by subsequent identification, Mr Billings having described a goodly number from the uppermost horizons represented in the Percé rock.



The vertical strata of Percé rock

On analyzing the relations of the various limestones and shale masses exposed about Percé, based specially on the character of the fossils, we shall find in the massives now dissevered either by topography or displacement, the key to their geologic structure not in their apparent relations, their attitude one toward another, but here again, as ever, in the nature of their fossil contents, which in themselves afford the solution to the geologic enigma of the region.

Percé rock massive. The tinted strata of Percé rock, standing almost erect, or according to Logan, overhanging the perpendicular



	Perce massive		Limekiln beds
	Cap Barré massive		Cap Canon massive
	Drab shale of North Beach		Devonian and Carboniferous conglomerates
	Mr Joli massive north flank		F Fault
	Mr Joli massive south flank		f Probable fault

1 mile = 8 inches

GEOLOGICAL MAP OF PERCÉ AND VICINITY

10° northwardly, are the home of a great profusion of fossils many of which are common to the upper or Grande Grève limestones of Cape Gaspé.

As to the essential concurrence of these faunas in a broad sense there can be no question but the careful comparison of them leaves room for doubt whether the actual horizon of the Percé rock is represented in the series at Grande Grève. Inasmuch as the rock succession of Cape Gaspé is constant as far as it extends there is room for the provisional suggestion that the horizon of the Percé rock with the precise expression of its fauna is there modified, but indicates an early stage of the Grande Grève limestones. Percé rock is not divisible faunally and its strata show no persistent differences. They are indifferently yellow and red according to degree of oxidation, and the process of color change, irrespective of sedimentation lines or structural features, is everywhere finely marked. They are highly veined with calcite seams, and the yellows seem, if anything, to predominate on the south, the reds on the north. Mr Ells speaks of their containing interleaved conglomerates but of such we have seen nothing. We may not at this time give a statement of exact or final determinations of its species, but the following suffices to indicate the character of the fauna. To these we shall hope to return in future with the detailed comparisons needful to ascertain the organic and time relations of this fauna to those of the New York series. Such species as are here indicated with unfamiliar names will be fully defined and illustrated hereafter.

Aulopora sp.

Lingula rectilatera Hall. As in the Helderberg of New York

L. spathata Hall. In the New York Helderberg

L. elliptica nov.

Orbiculoidea nov. cf. *grandis* Hall. New York Oriskany

Pholidops terminalis Hall. Also in New York Oriskany

Crania grandegrevensis nov.

Leptaena rhomboidalis Wilckens. New York Oriskany

Brachyprion majus Clarke. Oriskany

Stropheodonta lincklaeni Hall. Oriskany

Leptostrophia magnifica Hall. As in the Oriskany of New York

- L. irene* Billings
L. tullia Billings
Chonetes antiopia Billings
C. canadensis Billings. Profusely abundant, much more so than at Grande Grève
C. hudsonicus Clarke. New York Oriskany
Chonostrophia complanata Hall
Cyrtina affinis Billings
Spirifer murchisoni Castelnaud. This widely distributed Oriskany species is less abundant here than at Grande Grève
S. arenosus Con. As *S. superbus* Billings profusely abundant
S. dolbeli nov.
Meristella lata Hall var. *complector* nov.
Megalanteris plicata Hall
Beachia amplexa nov.
Rensselaeria ovoides Eaton var. *gaspensis* nov. cf. Oriskany
Leptocoelia flabellites Conrad. In enormous masses constituting one of the most abundant of all the fossils. World-wide at this horizon
Actinopteria cf. *communis* Hall. In the Helderberg and Oriskany of New York
Megambonia nitidula nov. A small form of the type of *M. crenistriata* (Oriskany)
Trochonema canale nov.
Diaphorostoma percense nov. of the type of *D. ventricosum* (Oriskany) and *D. affine* (Grande Grève)
Platyceras tortuosum Hall. Oriskany species in New York
P. argynus nov.
Tentaculites elongatus Hall. Also in the Oriskany
T. percensis nov.
Dalmanites (*Probolium*) *percensis* nov. This is a really remarkable species both in structure and size. Outside of the Helderberg fauna of New York, it is the only American trilobite having the long and forked cephalic snout characterizing the subgenus *Probolium* (*D. nasutus*, *D. tridens*)

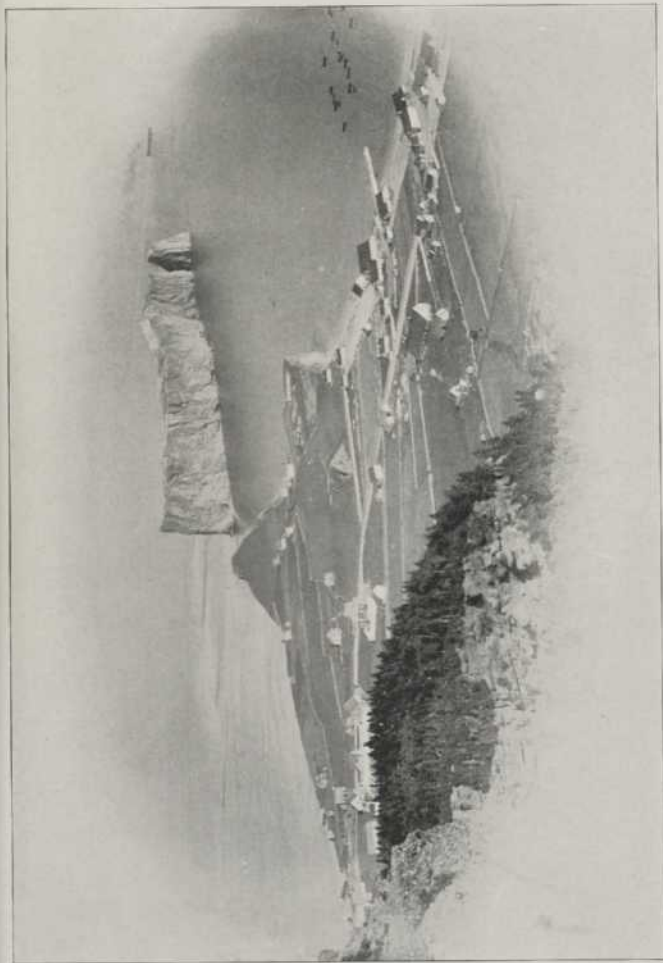


Photo by L'Esperance
Péré village and rock from the summit of Mt Ste Anne. The headlands of Mt Joli and Cap Canon in the middle distance and the Bonaventure conglomerate of Ste Anne in the foreground.

but instead of having the pygidium of those species, which is believed to be marked with a long terminal spine and irregularly pustulose surface, its caudal plate approaches more nearly that of *D. micrurus* of the same fauna. Fragments of this species are very abundant and some indicate a size greater than that attained by any known species of the genus and indeed by any known trilobite except the colossal *Uralichas ribeiroi* from the Silurian of Portugal. Restorations from these fragments show that *D. perceensis* attained a length of 25 inches. It is the only species of the genus present in the fauna.

Phacops logani Hall. A Helderberg and Oriskany species in New York

To indicate our present knowledge of the distribution of this fauna, its relation to that of the Grande Grève limestones and the composition of the latter I subjoin the following tabulation to which have also been added the species of the marine fauna of the Gaspé sandstones as developed about Gaspé Basin.

List of Gaspé Devonian fossils

	GRAND GRÈVE LIMESTONES	PERCÉ ROCK	GASPÉ SAND- STONE
	All localities on north shore of Gaspé bay from Little Gaspé (contact with Gaspé sandstone) to Shiphead		
<i>Glossina acer</i> nov.....	X	.....	.....
<i>Lingula elliptica</i> nov.....	X	X	.....
<i>L. spathata</i> Hall.....	.....	X	.....
<i>L. rectilatera</i> Hall.....	.....	X	.....
<i>Orbiculoidea cf. grandis</i> Hall.....	X	X	.....
<i>O. sp.</i>	X	.....	.....
<i>Pholidops terminalis</i> Hall.....	X	X	.....
<i>P. cf. ovata</i> Hall.....	X	.....	.....
<i>Crania pulchella</i> Hall & Clarke.....	X	.....	.....
<i>C. grandegrevensis</i> nov.....	X	X	.....
<i>Dalmanella lucia</i> Billings.....	X	.....	.....
<i>Rhipidomella lehuquetiana</i> nov.....	X	.....	.....
<i>R. logani</i> nov.....	X	.....	.....
<i>R. muscosa</i> Hall.....	X	.....	.....
<i>R. sp.</i>	X	.....	.....
<i>Schizophoria amii</i> nov.....	X	.....	.....

List of Gaspé Devonian fossils (continued)

	GRAND GREVE LIMESTONES	FRECK ROCK	GASPÉ SAND- STONE
	All localities on north shore of Gaspé bay from Little Gaspé (con- tact with Gaspé sand- stone) to Shiphead		
<i>Hipparionyx proximus Vanuxem</i>	X		
<i>Orthothetes woolworthianus Hall mut.</i> <i>gaspensis</i>	X		
<i>O. becraftensis Clarke</i>	X		
<i>Leptaena rhomboidalis Wilckens</i>	X	X	
<i>Stropheodonta parva Hall mut. avita</i> <i>nov.</i>	X		
<i>S. crebristriata Hall mut. simplex</i> <i>nov.</i>	X		
<i>S. patersoni Hall mut. praecedens</i> <i>nov.</i>	X		
<i>S. galatea Billings</i>	X		
<i>S. hunti nov.</i>	X		
<i>S. lincklaeni Hall</i>	X	X	
<i>S. magniventer Hall</i>	X		
<i>Brachyprion majus Clarke</i>	X	X	
<i>Leptostrophia magnifica Hall</i>	X	X	
<i>L. blainvillii Billings</i>			X
<i>L. irene Billings</i>	X	X	
<i>L. oriskania Clarke</i>	X		
<i>L. tullia Billings</i>		X	
<i>Strophonella continens nov.</i>	X		
<i>equiplicata nov.</i>	X		
<i>senilis nov.</i>	X		
<i>equalis nov.</i>	X		
<i>ampla Hall</i>	X		
<i>Chonetes canadensis Billings</i>	X	X	
<i>C. melonicus Billings</i>	X		
<i>C. antiopia Billings</i>	X	X	
<i>C. hudsonicus Clarke</i>	X	X	
<i>mut. gaspensis nov.</i>			X
<i>C. billingsi nov.</i>	X		X
<i>C. sp.</i>	X		
<i>Chonostrophia complanata Hall</i>	X	X	X
<i>C. dawsoni Billings</i>			X
<i>Anopia nucleata Hall</i>	X		
<i>Spirifer arenosus Conrad</i>	X	X	
<i>S. murchisoni Castelnaud</i>	X	X	
<i>S. gaspensis Billings</i>		X?	X
<i>S. dolbeli nov.</i>	X	X	
<i>S. modestus var. nitidulus nov.</i>	X		
<i>S. fimbriatus Conrad</i>	X		
<i>S. ? hera nov.</i>			X
<i>S. sp.</i>	X		
<i>Cyrtina rostrata Hall</i>	X		
<i>C. affinis Billings</i>	X	X	
<i>Meristella lata Hall var. complector</i> <i>nov.</i>	X	X	
<i>M. acerria nov.</i>	X		

List of Gaspe' Devonian fossils (continued)

	GRAND GREVE LIMESTONES	PERCE ROCK	GASPE SAND- STONE
	All localities on north shore of Gaspe' bay from Little Gaspe' (contact with Gaspe' sandstone) to Shiphead		
Rhynchospira	x		
Coelospira concava Hall.....	x		
Nucleospira cf. ventricosa Hall.....	x		
Camarotoechia dryope Billings.....	x		
C. excellens Billings.....	x		
C. ramsayi Hall.....	x		
Plethorhyncha barrandei Hall.....	x		
P. pleiopleura Conrad.....	x		
Uncinulus mutabilis Hall.....	x		
Eatonia peculiaris Conrad.....	x		
Reachia amplexa nov.....	x	x	
Megalanteris plicata nov.....	x	x	
Rensselaeria ovoides Eaton var. gas- pensis nov.....	x	x	x
R. sp.....	x		
Cryptonella ? capsula nov.....	x		
C. ? fausta Clarke.....	x		
Leptocoelia flabellites Conrad.....	x	x	x
Centronella glansfagea Hall.....	x		
Aviculopecten perceus nov.....		x	
A. ? incrassatus nov.....	x		
Pterinopecten protenus Clarke mut.....	x		
Actinopteria communis Hall.....	x	x?	
A. textilis Hall.....	x?		
Megambonia crenistriata Clarke.....	x		
M. nitidula nov.....		x	
Palaeopinna flabellum Hall.....	x		
Modiella modiola nov.....			x
M. pygmaea Conrad.....			x
Gomophora medioeris Billings.....	x		
Leptodomus canadensis Billings.....	x		
Modiomorpha gaspesia nov.....	x		
Mytilarca nitida Billings.....	x		
M. canadensis Billings.....	x		
Cypriocardium distincta Billings.....	x		
Phthonia cylindrica Hall.....			x
Nuculites gaspensis nov.....			x
Conocardium cuneus Conrad.....	x		
Schizodus ventricosus Billings.....	x		
Bellerophon plenus Billings.....	x		
B. gaspensis nov.....	x		
Tropidodiscus wakehami nov.....			x
T. pelicea nov.....			x
Pleurotomaria delia Billings.....	x		
P. voltinna Billings.....	x		
P. lydia Billings.....	x		
P. ? rotula nov.....	x		
Trochonema canale nov.....		x	
Loxonema ? hebe Billings.....	x		

List of Gaspé Devonian fossils (concluded)

	GRAND GREVE LIMESTONES	FENCE ROCK	GASPE SAND- STONE
	All localities on north shore of Gaspé bay from Little Gaspé (contact with Gaspé sandstone) to Shiphead		
<i>Euphemus</i> ? <i>quebecensis</i> nov.	.....	.....	X
<i>Holopea gaspesia</i> nov.	.....	.....	X
<i>H. depressa</i> nov.	X	.....	.....
<i>H. cf. antiqua</i> Hall.	X	.....	.....
<i>Diaphorostoma affine</i> Billings	X	.....	.....
<i>D. desmatum</i> Clarke	X	.....	.....
<i>D. perceense</i> nov.	.....	X	.....
<i>D. sp.</i>	X	.....	.....
<i>Strophostylus expansus</i> Hall var.	X	.....	.....
<i>Platyceras gaspense</i> nov.	.....	.....	X
<i>P. argynus</i> nov.	X	X	.....
<i>P. eucerus</i> nov.	X	.....	.....
<i>P. laciniatum</i> nov.	.....	.....	X
<i>P. tortuosum</i> Hall.	X	X	.....
<i>P. conulus</i> nov.	X	.....	.....
<i>P. paxillatum</i> nov.	X	.....	.....
<i>P. cf. nodosum</i> Conrad.	X	.....	.....
<i>P. cf. fornicatum</i> Hall.	X	.....	.....
<i>P. sp.</i>	X	X	.....
<i>Hyalithus oxyx</i> nov.	X	.....	.....
<i>H. encentris</i> nov.	X	.....	.....
<i>H. cf. aclis</i> Hall.	.....	.....	X
<i>Comularia lata</i> Hall <i>mut.</i>	X	.....	.....
<i>C. desiderata</i> Hall.	X	.....	.....
<i>Orthoceras sp.</i>	X	.....	.....
<i>Cyrtoceras sp.</i>	X	.....	.....
<i>Kionoceras rhysum</i> nov.	X	.....	.....
<i>Dalmanites micrurus</i> Green	X	.....	.....
<i>D. phacoptochoides</i> nov.	X	.....	.....
<i>D. pyrene</i> nov.	X	.....	.....
<i>D. vatinius</i> nov.	X	.....	.....
<i>D. goniaca</i> nov.	X?	.....	.....
<i>D. foederatus</i> nov.	X	.....	.....
<i>D. (Proholium) perceensis</i> nov.	.....	X	.....
<i>Phacops bombifrons</i> Hall.	X	X	.....
<i>P. logani</i> Hall.	.....	X	.....
<i>P. correlator</i> Clarke	.....	.....	X
<i>Proetus phocion</i> Billings	X	.....	.....
<i>Cordania</i>	X	.....	.....
<i>Ceratocephala gaspesia</i> nov.	X	.....	.....
<i>Lichas (Terataspis) grandegrevensis</i> nov.	X	.....	.....
<i>Tentaculites elongatus</i> Hall.	X	X	.....
<i>T. cartieri</i> nov.	.....	.....	X
<i>T. perceensis</i> nov.	.....	X	.....
<i>Spirorbis latissimus</i> nov.	X	.....	.....

It will be seen from the foregoing that the Percé fauna is more sparse than that of Grande Grève and that some of the species extremely abundant there, e. g. *Eatonia peculiaris*, *Hipparionyx proximus* are absent here, while here *Chonetes canadensis*, *Leptocoelia flabellites* are profusely developed. Again striking species in each fauna are absent in the other, while there remains a number of most characteristic species common: *Rensselaeria ovoides* var., *Me-*



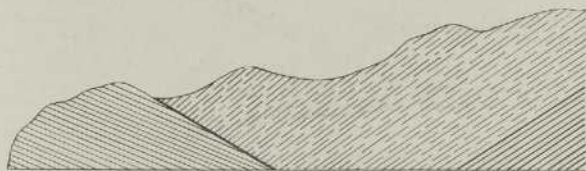
The ragged sky line of the Murailles

galanteris plicata, *Beachia*, *Spirifer arenosus*, *S. murchisoni*, etc.

There is thus a difference in the relation of the elements of the faunas to each other and also to those of New York. Hence there may be in these faunal characters a reason for regarding these limestones as the expression of a distinct substage in the deposition period of the Grande Grève beds.

On the Murailles or the high rock wall above the North cove we find Percé strata again. Rounding Cap Barré where the dip of the gray limestones and shales is to the north, beyond the first point to

the Blowhole, a sea cavern gnawed out by the waves, the tinted Percé strata again appear, but here lying at a steep angle, 20° to 40° to the southeast and abutting palpably against the thrust plane of a fault which is well marked in the face of the cliff, sloping obliquely downward and to the north. The line of displacement is well enforced by the contrast in color between the downthrown yellow and red strata and the more somber grays of the Cap Barré massive. Logan noted the fact that these downthrown strata were of equivalent age and probably a part of the Percé rock, and Ells cites the occur-



Section at Blowhole. Cap Barré beds at left, downthrown Percé beds at right

rence in the rocks at the Blowhole of the fossils *Spirifer arenosus* and *S. cyclopterus* (probably *S. murchisoni*); we have also found

<i>Dalmanites perceensis</i>	<i>Leptocoelia flabellites</i>
<i>Phacops logani</i>	<i>Leptostrophia irene</i>
<i>Acidaspis</i> sp.	<i>Chonetes hudsonicus</i>
<i>Megalanteris plicata</i>	<i>Spirifer arenosus</i>
<i>Chonetes canadensis</i>	<i>S. murchisoni</i>

and a few others, but the specimens are not very well preserved nor are they in any wise so abundant as at Percé rock.

These Percé beds about the Blowhole are probably again downthrown in themselves in their further extension along the Murailles but without essential change of dip, for this same southward dip is well expressed in the angle of the landward slope of the cliff and is apparent as far as Le Coulé on Barré brook where Percé fossils were also found. The latter seem to be the summit beds of the limestones and from them the following species were obtained.

<i>Spirifer arenosus</i>	<i>Megalanteris plicata</i>
<i>S. murchisoni</i>	<i>Leptostrophia irene</i>
<i>Chonetes canadensis</i>	<i>Coelospira</i>
<i>C. hudsonicus</i>	



On the slope of the Murailles. The Percé rock strata in the cliff

The beds are gray and nodular with redder strata. The outcrop is in the strike and the beds apparently rise uniformly into the Murailles. A displacement is evident along the bed of the brook but its amount was not estimated. Red peak, which is the highest and easternmost of the Murailles, is said by Logan to



Le Coulé. Nodular limestones and limestone conglomerate

be capped by horizontal beds of "the conglomerate" which I take to mean the conglomerate of Mt Ste Anne (Bonaventure) but I was not able to verify the observation, the beds here being apparently conformable in dip to those below. The displacement of the tinted Percé strata (the term Percé is here used as indicative of the horizon of the Percé rock) against the Cap Barré beds is evident on the south road leading up the mountain side to

the Grand Coupe, as well as in Le Coulé as just stated. In the great sea front of Red peak, the high face rising 660 feet over the water is believed to bring up the lower gray limestones in conformity and, though these beds are difficult of access and have not been properly studied, it is likely that here are the strata which fill the broken interval between the Percé beds and those beneath, the rocks of Cap Barré and perhaps also in part those of Cap Blanc.

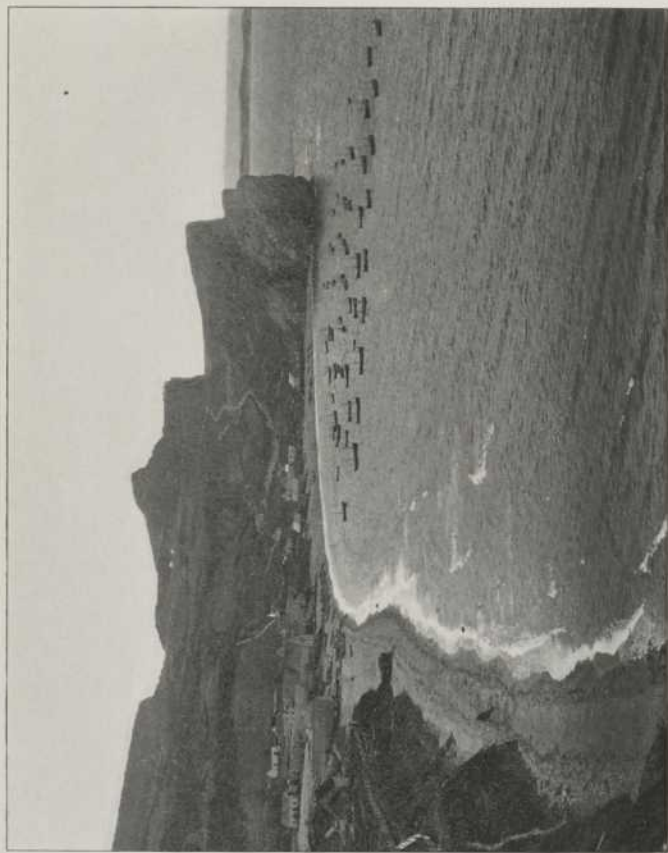
As a whole, we may say of the Percé beds that though they are now but remnants left by recent rapid and profound changes in topography, due to the tremendous destructive energy of the sea, and their surfaces, both on the Percé rock and in the Murailles, are the slopes of lost mountains, yet they have been subjected to disturbances in themselves much greater and much more ancient, witnessed by their difference in inclination and their tremendous displacements. These displacements we shall endeavor to portray more particularly in summing up the evidence relating to the geologic structure of the region.

There is little evidence yet on which to base any kind of subdivision of the Percé rock mass, either from its fossils or its rocks. The yellow beds seem to bear in greater abundance the prolific species *Chonetes canadensis*, *Leptostrophia irene*, *Chonostrophia* etc., and the red layers the trilobite remains, *Spirifer arenosus*, *S. purchisoni*, etc., but this occurrence is open to constant exception.¹

Cap Barré beds. In first considering the limestones of Percé rock we have started with the latest of the limestone deposits. In close if not immediate succession beneath them seem to follow the gray schists exposed only at Cap Barré, the southernmost and lowest point of the Murailles.

These beds consist of thin, sandy, blue gray limestones with intercalated shale, the rock becoming reddish at the top beneath the soil cap. They dip northeast 30° to 40°, which is an angle not repro-

¹Most of the fossils from the Percé rock described by Billings were evidently picked up loose at the foot of Mt Joli whither they are washed in great quantity from the rock itself. Hence Billings, not personally acquainted with the situation, frequently cites Mt Joli as a locality of these fossils which is misleading for the Joli mass is of very different age.



The Murailles and North cove, looking toward Malbay

duced in any of the strata elsewhere exposed, and their attitude toward the Percé strata farther north has just been expounded, from which we may infer that these rocks are normally subjacent to the latter and have been separated therefrom by the downthrow of the superjacent mass. These Cap Barré beds, so far as exposed, may attain a thickness of 75 to 100 feet. Their relations with the strata at Mt Joli are determinable from no structural relation exhibited, for they are separated from the latter by the long interval of the

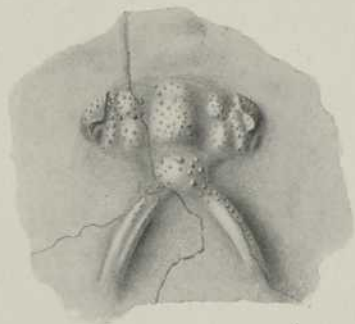


Cap Barré from North cove.

North cove. These beds contain fossils, but very sparsely. I have found a few *Lingulas* and an *Ambocoelia*-like brachiopod probably allied to *Spirifer modestus* Hall, which is a Helderberg species, also a small corrugated *Leptostrophia* like *L. oriskania* Clarke, but the age and position of the strata are decisively indicated by the presence of a species of the trilobite *Dicranurus*.

This fossil is of more than ordinary interest. The genus *Dicranurus* has been described heretofore only from two geologic formations, the Helderberg (New Scotland beds and Coeymans

limestone) of eastern New York (*D. hamatus* Conrad) and from the equivalent horizon Etage G, of Bohemia (*D. monstruosus* Barrande sp.). The species from Cap Barré (*D. limenarcha*) is represented only by an incomplete cephalon but it is rarely that any other part of the genus has been observed in any of its occurrences. It was a species larger than the New York form and perhaps even larger than the Bohemian. Its elongate, subconate middle lobe is well delimited by a deep nuchal furrow, the lateral lobes are separated by a shallow transverse or oblique groove, while the axial diameter of the occipital ring from the base of the



Dicranurus limenarcha

central lobe to the fork of the spine is relatively less than in *D. hamatus*. The free cheeks were attached to this specimen, but they have not been preserved except along the sutures. The great neck spines are highly divergent and very heavy. Barrande gave the angle of divergence in *D. monstruosus* as 60° , in *D. hamatus* it is 45° , in *D. limenarcha* it is 80° , measured from the central occipital tubercle as apex, axially for one third of the length of the spines. These spines are curved outward, downward and back, and probably made a deep recurvature as in the other species, though they are not preserved at the tips. On their proximal extent is a low median depression. The surface of the head is covered with acute pustules scattered sparsely with very much finer

ones between. On the occipital ring the central pustule, which is more conspicuous than the rest as in other species, is punctuated at the top by a circle of depressions. The head had an original length to the point of recurvature of the neck spines of about 40mm, the greatest divergence of the spines is 29mm, the axial length to the angle of the spines, 23mm, of which 9mm belong to the occipital ring; width between the eyes, 25mm.

From no other evidence have we so satisfactory a basis for the conclusion that the Cap Barré beds follow close below the beds of Percé rock and above those of Mt Joli. We may therefore conclude that either these strata lie buried in the tide-swept interval between the Percé rock and the outermost vertical strata belonging to the Mt Joli massive, or that, originally in place here, they have been pinched out by faulting.

The space between these two massives not in the line of the connecting sand spit but rather in the line of vertical thickness of the strata, at right angles to their present position, is barely enough to admit the beds of Cap Barré. Doubtless they have been largely squeezed out in faulting and pitched over on their side where they now lie, though some part of them may remain in the interval, to be exposed by some favoring neap tide to the eye of the trained observer.

Shales of the North beach. Faintly exposed at spots in the bank along the North beach, in the dugway road to the wharf and at points from there toward Mt Joli are beds of soft shale usually gray, sometimes black, blue black and green black, lying under the reddish soil cap. These are slightly inclined away from the vertical and it is not in my present judgment at all certain that they are continuous with the Joli escarpment which we are about to consider. They have furnished no fossils and outside of them, beneath the water not far from the wharf, is a vertical reef in which cyathophylloid and favosite corals occur and these are doubtless the latest and uppermost beds of the Joli series. Soft drab shales similar to those on the North beach appear also in the roadway between the Cap Canon cliff and the escarpment at Lamb's limekiln, and I have inferred therefrom the presence of an infaulting through which this mass of shales has been displaced from its proper position.

Mt Joli massive. The erect strata of gray thin limestones and calcareous shales which constitute the low headland at Mt Joli begin not at the scarp itself, but at low water may be seen extending well out from the shore. Along the North beach these outlying strata form little reefs, but the intervals between them and the wall of the promontory is concealed by the beach. Taking the Mt Joli massive



East face of Mt Joli

as a whole, it has an approximate length along the sea front of 700 feet, the highest point being at the north, the upper slope declining southerly, ending rather abruptly, and the rock mass being separated from that of Cap Canon, by an unexposed and probably entirely interrupted area of about 350 feet. There is little change in the lithologic composition of the strata composing Mt Joli, but there is definite evidence of displacement in the mass itself. For the greater

part of the length of the sea wall the strata are essentially vertical with slight undulations; but at a distance of about 250 feet from the south end of the cliff the strata become much more irregular, maintaining their essentially vertical attitude but are folded and slightly displaced among themselves and faulted against the more erect strata of the main part of the mountain. The southern part of the mass is composed of strata similar to those of the northern but increasingly slaty in composition. In both parts of this Mt Joli massive fossils were found, but they are by no means of common occurrence; moreover they are wedged in the vertical strata so that their extraction is not easily accomplished. From their calcareous layers, which with the eroded interleaved shales form the outermost northern reach of the strata and are exposed only at low tide as reefs, were obtained a few fossils: *Platyceras*, large species of Helderberg type; *Zaphrentis corticata* Billings; *Z. cingulosa* Billings.

The shaly layers on the high vertical north face of the scarp have afforded species provisionally identified as follows:

- | | |
|---|--|
| 1 <i>Hindia</i> sp. | 8 <i>Stropheodonta</i> cf. <i>varistriata</i> Conrad |
| 2 <i>Monograptus</i> cf. <i>clintonensis</i> Hall | |
| 3 <i>Duncanella</i> cf. <i>borealis</i> Nich. | 9 <i>Spirifer</i> cf. <i>niagarensis</i> Conrad |
| 4 <i>Streptelasma</i> cf. <i>calculus</i> Hall | 10 <i>Spirifer</i> <i>modestus</i> Hall? |
| 5 <i>Michelinia</i> cf. <i>lenticularis</i> Hall | 11 <i>Cypricardina</i> aff. <i>sublamellosa</i> Hall |
| 6 <i>Dalmanella</i> cf. <i>perelegans</i> Hall | |
| 7 <i>Leptaena</i> <i>rhomboidalis</i> Wilkens | 12 <i>Phacops</i> sp. |

Giving special attention to the trilobite in which lies the clearest indication of geologic age, we find it to be a fully developed *Phacops* such as nowhere occurs in the typical Siluric deposits of the Mississippian sea or Appalachian gulf. Its glabella is large, rotund and coarsely pustulose, the glabellar furrows obsolete, eyes large and the genal angles have minute spinules. The pygidium is broad, the axis having six to eight well defined rings, the first bearing a prominent tubercle, the pleurae having five to six ribs all grooved and separated by deep furrows. These structural points indicate an early period in the history of the genus, hence if Siluric, a final stage. The species is equivalent to *Phacops logani* of the Helderberg and Oriskany of New York, of the Percé rock and the Grande Grève limestones.

The construction of this assemblage as a whole as indicative of a very late upper Siluric marine fauna is justified and we would therefore put together the entire mass of the strata 550 to 600 feet thick, as appertaining to this horizon, that is the series of limestones and shales extending from the reefs bordering the north flank of Mt Joli, southward almost to the first palpable shear zone.

In the layers of the south flank of the mountain which strike n. 30° w., are essentially vertical but with many undulations and irregular inclinations toward the north, and are thin, fairly pure limestone strata from 2 to 5 inches in thickness separated by sandy shale masses, fossils have been found:

Hindia (apparently identical with foregoing)	Ortonia <i>sp.</i>
Subretrepora	Ampyx <i>bastatus</i> Ruedemann
Dalmanella testudinaria Dalman	Tretaspis <i>reticulatus</i> Ruedemann (very common)
Rafinesquina <i>sp.</i>	Calymmene <i>callicephala</i> Green
Strophomena <i>sp.</i> strongly geniculate form (very common)	Pterygometopus <i>cf. intermedius</i> Walcott
Parastrophia <i>hemiplicata</i> Hall small form	Ptychopyge <i>ulrichi</i> Clarke (common)
Zygospira <i>cf. uphami</i> Winchell & Schuchert	Iliaenus <i>americanus</i> Billings

This very striking though small array of species is emphatically indicative of early Siluric age, we might say in a general sense equivalent to the Trenton, but can not escape the inference that it is early Trenton with suggestions of Pretrenton age. The trilobites are specially noteworthy, for *Ampyx hastatus* and *Tretaspis reticulatus* have been found before only in the lower Trenton conglomerate of Rysedorph hill near Albany and definitely indicate not the Trenton fauna normal to the Mississippian province of that time, but the invading fauna from the Atlantic province whose closer affiliations are with European species.

Two spots in the sea wall have afforded these fossils, one not far from the south end of the cliff where were taken

Calymmene <i>callicephala</i>	Parastrophia <i>hemiplicata</i>
Dalmanella <i>testudinaria</i>	Zygospira
Rafinesquina	

These were from calcareous nodules embedded in the shales.

The other locality lies just north of the most apparent line of displacement where the strata have lost their contortions. Here were obtained

Tretaspis reticulatus
Ampyx hastatus
Ptychopyge ulrichi

Illaenus americanus
Pterygomctopus cf. intermedius

It is not safe to infer great difference in age of these associations.



Vertical strata on north face of Mt Joli. The Murailles in the distance

Mt Joli then with its 700 feet of calcareous strata represents a long stretch of Siluric time, and it would appear that the apparent line of main faulting of the southern or lower against the northern or upper mass, marks the disappearance of some interval in the lower elements of the series as indicated. Such departure as there has been from the vertical position of the strata is in the direction of overthrow so that the lower lean up against the higher strata.

We shall presently note the paleontologic evidence indicating displacement in the vertical mass itself.

Cap Canon massive. Directly south or below the abrupt termination of Mt Joli is a beach interval where no rock exposure is seen for a length of 345 feet. The grass grown bank shows a red soil cap and in it here and there are blocks of red conglomerate, as though (and to such evidence we may return) deposition of the red conglomerates was over a rough bottom wherein this clay-banked beach was a deeply gullied line of disturbance. The rocks of Cap Canon are calcareous shales and black argillaceous slates, greatly



The Limekiln massive

disturbed internally by folds and undulations, thrusts of slight measure which have produced glistening shear faces, veined in all directions, richly jointed and cleaved, but in spite of these internal displacements the vertical attitude of the mass is still apparent with a slight general inclination toward the north.

This mass, irrespective of its undulations has a sea front 630 feet long and this is approximately a measure of its actual thickness. In lithologic character there is a marked difference between it and that of Joli, chiefly expressed in its slatiness. It has, after repeated search, revealed no fossils.

On the summit of Cap Canon is the summer home of Mr Frederick James. From this spot the well grassed rock surface slopes deeply landward, then abruptly rises at a distance of about 400 feet from the edge of the cliff and the strata stand upright again in a bare dome of rock at which is a now abandoned limekiln. The rock here was burned by Mr Philip Le Boutillier and from him I learn that the burning has been only partly successful but at times a purer limestone has been brought to the kiln from the outcrops at Cap Blanc, 2 miles south.

Limekiln massive. The rocks at the Limekiln are as a whole notably distinct in character from those constituting Cap Canon though they stand vertical and hold the attitude characterizing the rest of the strata.

These beds are limestones much seamed with calcite veinules and heavy bedded, largely a limestone conglomerate but with no jasper pebbles as in the limestone conglomerate of Mt Ste Anne to which reference will be made. They have a thickness of 200 feet. A single bed of a similar conglomerate was observed infolded in the schists of Cap Canon.

Just beneath these on the south slope are even bedded impure gray limestones and from these latter only have fossils been obtained. There is to my mind a reasonable security in regarding these fossil-bearing rocks here in place, though blocks have been found only in displaced condition. Concerning this point, however, I would not venture to be unqualified in my statement. These fossils are:

Plectambonites scriceus <i>Sow.</i> (very common)	<i>Protozyga exigua</i> <i>Hall</i>
	<i>Ambonychia</i> <i>sp.</i>
<i>Rafinesquina</i> , a geniculated species	<i>Ceraurus pleurexanthemus</i> <i>Green</i>
<i>Leptaena rhomboidalis</i> <i>Wilckens</i>	

Though few in number, the species abound in individuals and the assemblage clearly indicates a later stage of Lower Siluric than the fauna in the south flank of Mt Joli, somewhere equivalent to middle or upper Trenton age. The road in front of Mr James's house, as it rises from the depression between the escarpment and Cap Canon, shows trace of an unfaulted mass of soft, brown shale elsewhere referred to as occurring on the North beach near the wharf. If we

have construed the fauna correctly, the place of the Limekiln rocks is between the south and north flanks of Joli or is a corresponding portion in the series. We may find no clear evidence of the necessary fault plane in that escarpment, but this cliff at the Limekiln is evidently cut off by faults both therefrom and from the Cap Canon mass.

Cap Blanc massive. From Cap Canon southward for a distance of 2 miles sweeps, first, the broad Robin fishing beach or South cove buttressed at the south by horizontal or slightly dipping beds of red sandstone and conglomerates rising into a constantly more elevated sea wall till Cap Blanc is reached. Here as one turns the point of the headland and rounds the light, vertical limestone strata are once more exposed and their contrast in color to the horizontal or slightly northeast dipping red strata which overlie them and abut against their slopes, gives name to the place. The sea wall is sheer and the foot of the cliff accessible with risk, even by water.

The vertical thickness of these rocks measuring from the point of the cape southward is estimated at 700 to 1000 feet. They are light gray in general effect and the succession of the strata is obscurely presented in the highway and field outcrops. With the slight inclination of the strata away from the vertical toward the north as seen in the Mt Joli massive, we first find in the highway cut ascending the cliff from the north a red limestone, suggesting in tint the Percé rock and carrying

<i>Halysites catenulatus</i> <i>Linne</i>	Bellerophon
Heliolites or <i>Lyellia</i>	Lichas (fragment)
<i>Ortonia</i>	Trematopora (very slender branches)
<i>Anodontopsis</i>	Callopora
<i>Trochonema</i>	Small Whitfieldella-like brachiopods

but principally and oftenest a large and heavy shelled pelecypod having a broad cardinal plate extending inward from the hinge line, not attached to the bottom of the valves nor thickened at its junction therewith. This rock is of such character that it breaks in almost any direction except along the surface of these fossils but one example of this species has the valves together and this, sectioned vertically shows these projecting plates not in apposition as though

*Dissected limestone
of the
Limekiln*

*Cap Canon
620'*
*Caliche greatly
disturbed but is
generally vertical which*

Net exposed 285'
Red soil cap with occasional conglomerate blocks

*Mt Joli
700'*

*Percé Rock
250-300'*

SECTION ALONG THE COAST FROM ROBIN BEACH TO PERCÉ ROCK

connected with the articulation of the valves, but standing apart with a well defined space between, indicating that they are a broad chondrophore. Further material will be necessary to elucidate the nature of this shell.

It is clear however, from the list given, even though generic determinations only seem safe at present, that this congeries represents a stage of late Siluric, clearly older than the fauna of the Percé rock, probably older than the beds of Cap Barré, but not necessarily older than the north flank of the Mt Joli massive. These beds, the highest in the series, lie lowest as the entire mass is slightly overturned. Working southward over the remaining exposures in exceedingly rainy and cheerless weather, it is probable that we have overlooked much that will throw light on the relations of the series.

Beyond the light, seaward of the road, on the edges of the escarpment in the field whence the purer layers of limestone have been removed for burning, and which appertain to the lower and southernmost part of the series here represented, after careful search fossils were found, not in the blue and more abundant limestone, but in thin clinking limestone plates.

The mode of preservation here is singularly favorable were the material sufficiently abundant, the fossils being weathered out on the surfaces of the plates and doubtless the fauna will prove an interesting and instructive one under more favorable opportunities for exploration. These slabs have afforded:

Spicules of hexactinellid sponges	<i>Whitfieldella cf. bisulcata</i>
<i>Platyostoma</i>	<i>Orthothetes</i> (small)
Many crinoid stems and an occasional crushed head with ornamented plates resembling <i>Glyptocrinus</i> .	
<i>Calymmene</i> (small species)	Phacops of <i>P. logani</i> type
<i>Bumastus</i> (small species)	<i>Phacops sp.</i>

Taking up for more minute consideration the trilobites, the time values of whose structure is best understood, we may note

1 The common species of *Phacops* is fully developed, with glabellar lobes fused by almost entire disappearance of the furrows, eyes rather small, cheeks rounded with the faintest trace, if any, of the genal spinules indicating early age, and the doublure of the cephalon

crenulated to a degree shown only in pronounced development in this genus.

The pygidium is short and stout with a short blunt axis bearing four defined rings but eight axial sulci can be counted. Of the pleural ribs but two can be counted and these are flat and sulcate.

This completely developed *Phacops* is in itself indication of either Devonian age or a very late stage of Silurian. In the Mississippian Silurian no such form presenting fully matured cephalic features is known. The species, however, shows in the sulcate pygidial ribs index of early phylogenetic stage. It can not be identified with the Helderbergian and Oriskany *P. logani* which is found in the Percé rock and at Joli, but approaches thereto.

2 The second species of *Phacops* is known only from its cephalon which is of a singular and unusual type. In this the first furrows of the glabella are faint without entering the dorsal furrows and are like a pair of eyebrows, defining obscure round lobes, behind which the second lobes are also round and better defined, while the third lobes are obscure. The eyes are small and with few lenses, the cheeks broad, flat and dalmanitiform, running out into short flat spines at the angles.

The aspect of the species is that of immaturity with reference to the development of the genus *Phacops* and presents the combination with features pertaining to *Dalmanites* which is indicial of the passage forms from the latter to the former. The aspect of this cranidium is shown in some early Devonian forms such as *P. (D.) tumilobus* Clarke from the Amazonas but without association with checks of notable *Dalmanites* type.

One of these forms of *Phacops* indicating late age is counterbalanced by the somewhat earlier expression of the other and this combination is verified by the presence of *Bumastus* and *Calymene*.

We must call the horizon late Silurian but are disposed to make it so late as to be an almost final stage in the passage from the lower limestones into those of the Percé massive or lowest lower Devonian.

The Cap Blanc limestones appear then from the evidence before us to be a downthrown mass representing a part of the series shown more continuously in the sea wall at Percé, and indeed such part as

is either not there clearly presented or is presented here with some change of faunal association. It is not, in our view, a section of the series there lost by faulting out, but the expression of the later Siluric beds there, with a variant geographic association of species.

Relations of limestone masses about Percé. We have estimated roughly the thickness of the masses here discussed as follows:

Percé beds, 250 feet at Percé rock but probably rising in red peak to.....	400 feet
Lost interval between Percé rock and Mt Joli (Cap Barré beds).....	100-200 feet
Mt Joli massive.....	700 feet
Cap Canon massive.....	630 feet
Limekiln massive.....	200 feet
	2030-2130 feet

Thus there is a development of approximately 2000 feet of limestones representing the geologic series from early Siluric (Black River-Trenton) to well into the early Devonian or Oriskany. The Cap Blanc massive with a thickness of 700 to 1000 feet is not in our judgment an addition to, but a repetition of a part of the series. The rocks on the Murailles are likewise regarded as not adding to, but repeating the series in part, with the exception of the Cap Barré beds which are partially provided for in the rock interval between Mt Joli and the Percé rock. In order of succession from the top downward, we should, from present evidence arrange the masses thus:

Percé beds	(?) Limekiln beds
Cap Barré beds	Mt Joli (south flank)
Mt Joli (north flank)	Cap Canon

Some doubt will attach to the proper position of the strata of the Limekiln for the reasons already stated.

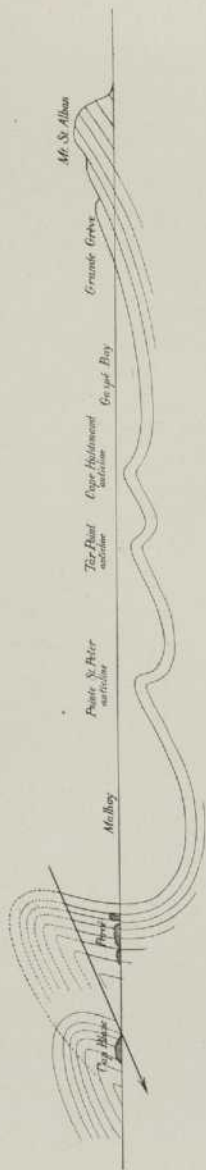
With the foregoing succession we deduce a profound displacement between the Percé rock and the north face of Mt Joli by which the beds of Cap Barré for a thickness of 100 or more feet were squeezed out, and their remnant overturned to their present place and attitude, a quarter mile away, and their dip reversed.

On the face of Mt Joli among the vertical strata we believe it probable that a displacement has taken place by a downthrow which has squeezed out the rocks represented by the fauna found in the beds at the Limekiln. This is inferred wholly from the nature of the fossils of the latter. Their place is here in the succession of the faunas, but should subsequent developments tend to show that the fossils there found were derived from another source, either from the rocks of Cap Blanc or the limestones northward toward the Barachois, we need not open the cliff to admit this mass. On the other hand, were such the evidence, it would seem to be the remnant unfaulked by a displacement whose zone rests where now is the short beach between Joli and Cap Canon.

The displacement we have already noted in the south flank of Mt Joli and shown in the rock wall is within the succession of lower Siluric faunas, these fossils occurring on both sides, and we hence infer it not to have been of great depth.

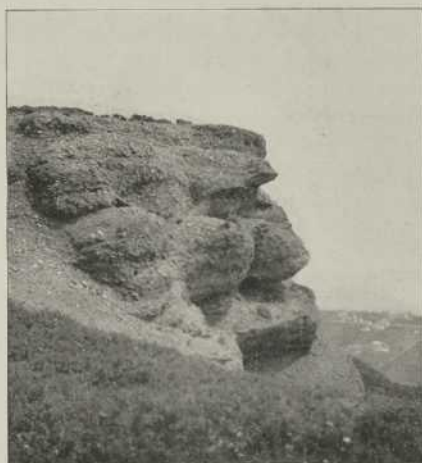
On the Murailles we find the clearly defined line of displacement along which the Percé beds have slipped down over the Barré beds inverting their dip, and this entire mass of Barré and Percé beds was evidently cut off by the longer line of faulting from the Percé rock. These lines of probable displacement of the limestone masses we have expressed on the map adjoining.

Surface conditions preceding deposition of red sandstone and conglomerates. Strip off the mantle of red, almost horizontal conglomerate through which the limestone cliffs project their heads and the country would present an irregular series of jagged limestone bluffs, the remnants of broken and eroded folds, which the tooth of sub-aerial weathering, of stream erosion and the endless gnawing of the ocean, left standing. The vertical position of most of those once horizontal rocks is in itself an indication of the immense proportions attained by the primary folding of the strata. The presence of an anticline at Percé was recognized by Logan, and without venturing to go so far afield as to connect the structures here with those beyond the scope of this sketch, it may be said that the simplest explanation of the relation of the Percé limestones with the series as exhibited from Little Gaspé to Shiphead is a great syncline beneath the sea, of



Restoration of the syncline in Devonian and Silurian limestones along coast line from Percé at the south to Grande Grève at the north and showing the downthrow at Cap Blanc; also the anticlines riding on this depression and more clearly expressed farther inland

which the Grande Grève limestones lie on the northern more gradually sloping arm and the Percé rock on the southern erect arm. With this reconstruction, the massive of Cap Blanc represents the faulted downthrown crest of the Percé fold, while lesser anticlines indicated by the government geologists as those of Pointe St Peter, Tar point, Cape Haldimand, developed further back from the coast, ride on the surface of this synclorium.

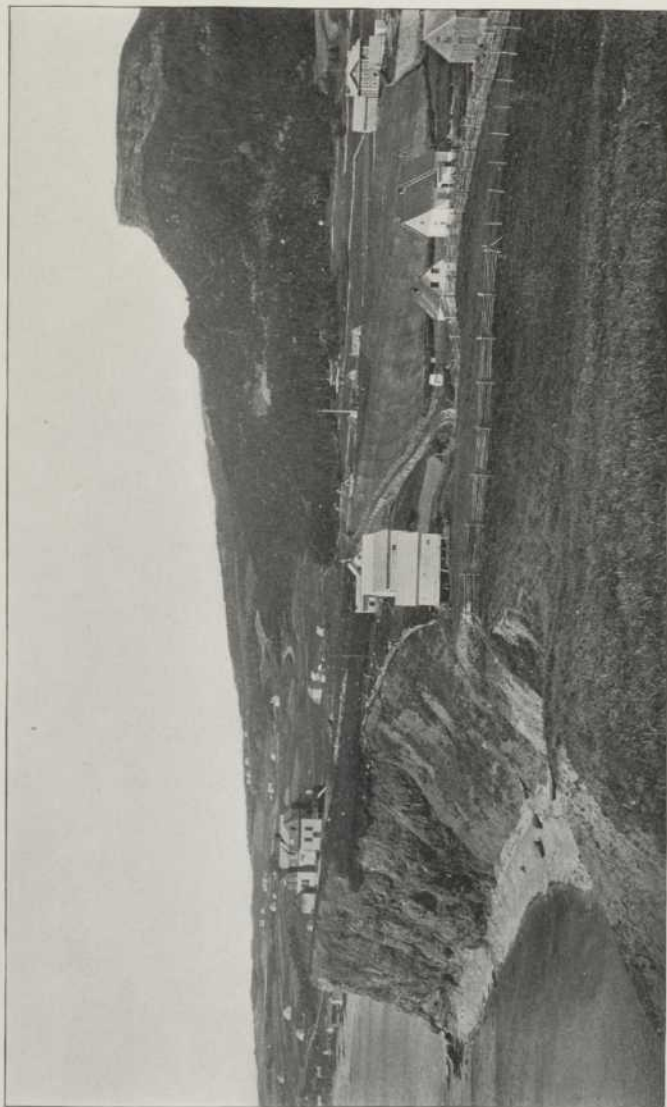


Bonaventure conglomerate at summit of Mt Ste Anne

Immense time was necessary for the destruction of these old folds before the ragged country was carried down beneath the water level for the deposition of the red conglomerates and sandstones.

Red sandstones, conglomerates and limestones

The country is so completely sheeted with these horizontal deposits that they may be studied at numerous places away from the limestone cliffs, but nowhere in their continuity so well as along the slopes of Mt Ste Anne. Let us however, first take note of the opinions which have been expressed by Logan and Ells concerning these



Looking south from Mt. Joli, Cap Canon in left foreground, Mt. Ste. Anne at the right

deposits. We have remarked that while almost horizontal, there is a definite dip in the strata to the northeast which is conspicuously displayed in the precipitous eastern face of Mt Ste Anne, and in the western wall of the distant Bonaventure island, 3 miles out to sea. From Bonaventure island, which is wholly composed of these strata, Logan derived the term Bonaventure which he originally applied to the entire series of these rocks, chiefly conglomerates, and these he regarded as of Carbonic age. Ells, approaching the region from a study of the conglomerates of the Bay of Chaleurs interstratified in which have been found Devonian fossils (chiefly fishes of Old Red sandstone type) recognizes differences in the conglomerate mass and assigns to the Bonaventure the upper beds of Mt Ste Anne and all those covering Bonaventure island with which they were continuous, believes an unconformity to exist between the upper and lower conglomerates of Mt Ste Anne and assigns the latter including the sandstones and interbedded limestones, to the Upper Devonian age. Of such interruptions of deposition in the conglomerates we could find no evidence in the Percé region but if we interpret these interesting sediments aright, it is quite in accordance with the judgment we have been able to form, that they do actually represent a period of time partly Devonian but transcending that era into the next succeeding. We may note the character of these strata in some detail, beginning at the lowest accessible exposures.

Shore between Robin beach and Cap Blanc. Near the mouth of Lenfesty's brook we find in the shore wall an exposure about 25 feet in height, at the base of which are red shales overlain by red and white sandstones and conglomerates, then red shales followed by conglomerates and above these are gray hydraulic limestones. The conglomerates are variable in lateral extent, passing into sandstones but reappearing in great force to the south, the limestones disappearing. The pebbles of the conglomerate are at this horizon, largely of jasper and with a very small percentage of limestone of the character of the higher beds. On Bonaventure island the conglomerates also contain much jasper but the limestone pebbles predominate.

Mt Ste Anne. The sandstones and limestones of the lower beds are also seen in climbing Mt Ste Anne and in the vicinity of Irish-

town. All the higher beds of Mt Ste Anne are composed of limestone conglomerates with very little jasper and as the cement is calcareous it falls away freely. It was noted by Ells that these pebbles and boulders of the conglomerate contain Siluric fossils. We have found in them *Chonetes canadensis*, *Spirifer purchisoni*, *Megalanteris plicata*, *Meristella arcuata* and *Dalmanites perceensis*, all fossils of the



Limestone conglomerate, Mt Ste Anne

Percé rock; also *Halysites catenularia*, *Heliolites*, and in some sandstone pebbles a small *Spirifer* like *S. vanuxemi*. These fossil-bearing pebbles were found to the summit of the mountain even in the platform on which rests the shrine of Ste Anne. As this point is nearly 1400 feet above tide, the thickness of these red beds can not be less than 1200 feet and down along the shore land it seems to fill or to have stained all the depressions between the scarps of vertical limestone so that even on the shore when the soil is opened, blocks of the conglomerate are set free.

General remarks on the conglomerates

One is struck with the absence in the Percé region of the great thickness of the rusty brown Gaspé sandstones which at Little Gaspé rest conformably on the limestones and at Gaspé Basin carry marine fossils. Doubtless we are to find the contemporary of these deposits in the red and white sandstones of Percé, but they are only feebly developed and to them as an equivalent of the work elsewhere done, we must add some part of the conglomerate series. We follow ideas before expressed in regard to the tremendous deposits of the Gaspé sandstone, as sediments laid down first along an embayed coast and eventually in a deep coastal estuary which received heavy drainage from an elevated and rapidly decaying land surface. That estuary may have extended far to the southeast and at times it appears to have been shut off from the ocean entirely by the upbuilding of bars across its mouth but it was virtually and for long periods a coastal lagoon subject to inroads from without in times of stress.

Then was the period of Old Red lakes in New York, in Scotland, Orkney and Russia. They did not all begin at the same period of time nor continue their existence for equal times; some began in the late Siluric, others in middle Devonian, several are known to have continued their existence beyond the Devonian and into the Carbonic. So here, we are disposed to believe, this peculiar mode of sedimentation has transcended the limits of Devonian time and entered the Carbonic, though we have no traces of marine life of either period after the deposition was once established. The conglomerates of eastern Gaspé are contrasted with the sandstones of the more westerly parts of the county, and we may interpret them as the deposits of the seaward ends of the long estuary where for countless time the waters of the sea beat, as today, on the upturned edges of the ancient limestone cliffs and rolled their fragments up along the margin of an ever sinking continent.

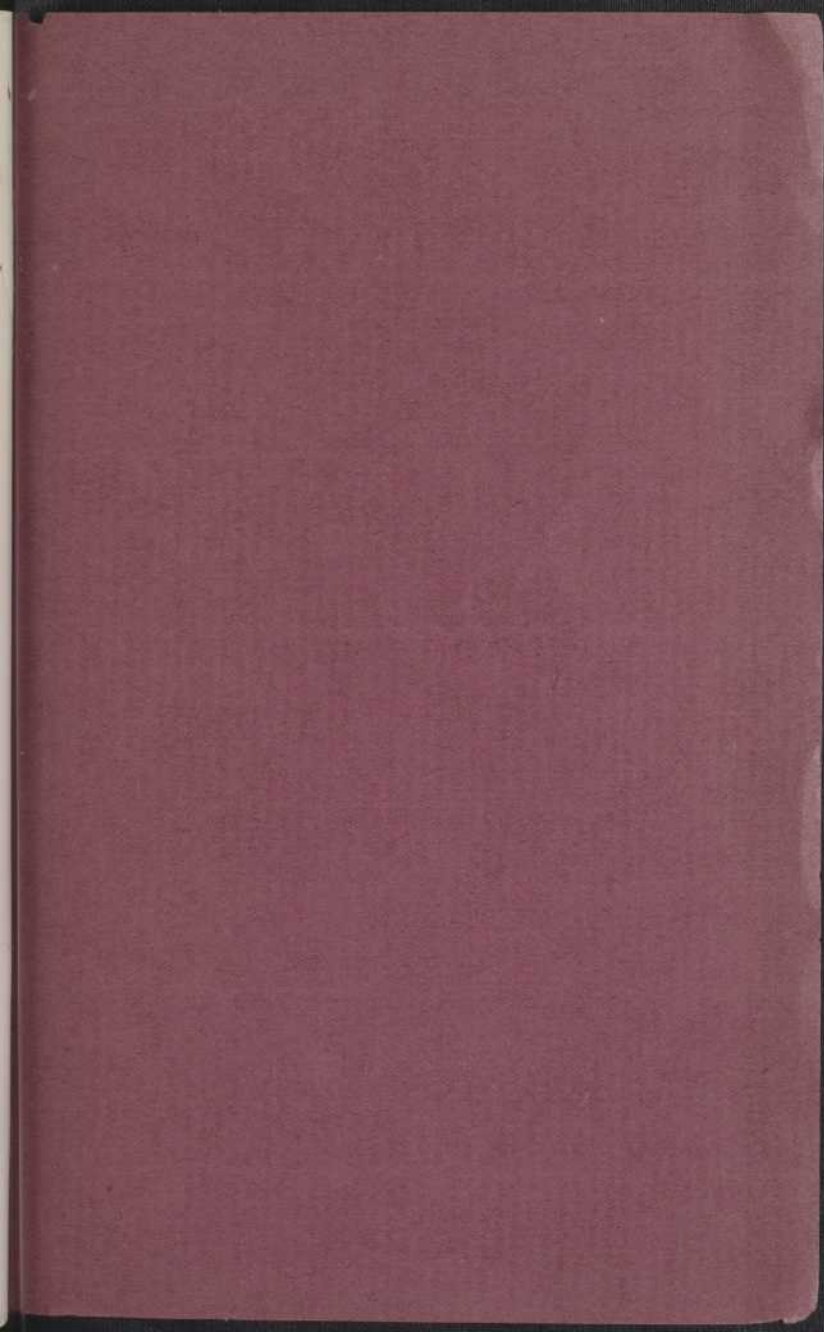
Conclusion

From the future detailed study of the faunas preserved in this series of Siluric and Devonian limestones, we may expect a flood of light on the significance of contemporaneous faunas in the north-

Appalachian basin. In the Percé rock and its more northerly development in the limestones of Grande Grève, we confidently look for a solution of the questions of origin and derivation of the faunas which represent the earliest Devonian life of the Appalachian basin, and their path of migration once determined, evidence to infer the outline of the continental borders and the definition of the waterways.

In this brief sketch we have omitted from consideration through lack of personal acquaintance, reference to the Silurian limestones which occur in detached masses along the Malbay to the north, and at spots remote from Percé, along the southern coast. When these have been studied in detail, the entire series will be found to present an important supplement to our present knowledge of the factors of that ancient time.





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