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THE GEOLOGY OF EASTERN GASPE

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Geological Report 35

THE GEOLOGY
OF
EASTERN GASPÉ

BY

H. W. McGERRIGLE



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Cape Gaspé and Forillon peninsula. Gaspé bay on the left: Gulf of St. Lawrence on the right. (La Cie Aérienne Franco-Canadienne photo).

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by *H. W. McGerrigle*

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THE GEOLOGY OF EASTERN GASPÉ

by H. W. McGerrigle

INTRODUCTION

GENERAL STATEMENT

Gaspé peninsula lies in eastern Quebec between the Saint-Lawrence river on the north and Chaleur bay on the south. It faces eastward into the gulf of Saint-Lawrence.

The eastern part of the peninsula long has been known as a region of many geological problems. Chief among these are the general problems of structure and of the positions of certain of the formations, or even series, in the geological time scale. The surveys leading to the present report were made mainly with a view to determining the stratigraphy and structure of the region and the bearing of these factors on the petroleum possibilities. These surveys were carried out between 1937 and 1940, inclusive, the results obtained being outlined in preliminary reports (1) covering each season's work. The present report summarizes the information obtained by three geologists in four seasons of field work, as follows: In 1937, Jones and McGerrigle mapped Larocque and Galt townships, the major parts of Laforce and Baillargeon townships, and a small part of Baie-de-Gaspé-Sud. In 1938, R. A. Brown mapped the Devonian succession on the north side of Gaspé bay in an area included within the townships of Cap-des-Rosiers, Baie-de-Gaspé-Nord, and Sydenham. I. W. Jones, in 1938, mapped the Devonian succession west and south of Gaspé bay in the townships of Baie-de-Gaspé-Sud, York, and Douglas. H. W. McGerrigle, in 1938, 1939, and 1940, mapped the Ordovician, Silurian, and Devonian successions south of the 1937 area and of Jones' 1938 area, almost to Percé on the coast and inland for forty miles in the townships of Malbaie, Fortin, Joncas, Power, and parts of York, Baillargeon, and Laforce. The mapping of this region in eastern Gaspé added some 900 square miles to the 1,300 already mapped by Jones in north-central Gaspé between 1929 and 1936.

In addition to the above, this report reviews the geology of the bordering areas to the north and west previously reported on by Jones in Annual Reports of the Quebec Department of Mines. These include the Dartmouth River Map-Area (1934), the Upper York River Map-Area (1935), and part of the Mount Alexander Map-Area (1936). The maps which accompanied these reports have been revised in certain particulars and brought up to date in regard to roads. They are re-published here in a form somewhat

(1) a.—JONES, I. W., and MCGERRIGLE, H. W., *Geology of Parts of Eastern Gaspé*; Que. Bur. Mines, P.R. No.130, 1937.

b.—(1) JONES, I. W., *Gaspé Bay Area*; (2) MCGERRIGLE, H. W., *Joncas-Fortin Area, Gaspé County*; (3) BROWN, R. A., *North Shore of Gaspé Bay*; Que. Bur. Mines, P.R. No.125, 1938.

c.—MCGERRIGLE, H. W., *Malbaie Area, Gaspé*; Que. Bur. Mines, P.R. No.138, 1939.

d.—MCGERRIGLE, H. W., *Power-Joncas Area, Gaspé*; Que. Bur. Mines, P.R. No.153, 1940.

different from that of the original maps. An index showing when and by whom the various areas included in the present report were mapped is contained in Figure 2.

The region is underlain by Cambrian, Ordovician, Silurian, Devonian, and Carboniferous sedimentary formations. There are some volcanics of Silurian age and scattered dykes and sills of Silurian(?) to Carboniferous or younger age. These commonly are intermediate to basic in composition. The Ordovician is separated from the Silurian by an unconformity, while a disconformity is present between the Silurian and the Devonian. The Devonian is separated from the Carboniferous by a very definite angular unconformity.

The rocks of the region have been thrown into a series of folds of intermediate intensity. These are broken here and there by faults, some of which are major displacements. The fold axes in the southern part of the region trend east-west; those in the northern part have the same curving trend as the north coast of the peninsula.

The geological investigations made by the Quebec Department of Mines in recent years have shown that there are several structures in this region that are favourable to the retention of oil. The interbedding of sandstone and shale zones in the Gaspé Sandstone series is a very favourable factor in oil accumulation and retention, and some of the lower limestone horizons are known to be petroliferous to some extent. The fact that, in a part of the region, many wells have been drilled without getting commercial results is not encouraging from the point of view of the oil possibilities. However, the majority of the well sites were chosen with little apparent regard for structures. The conclusion is reached that the region still must be considered as a possible commercial oil field. Other possibilities for mineral production within the region are a few lead-zinc prospects and some occurrences of copper mineralization and, very locally, of asbestos. An important copper deposit occurs outside the region, at the head of York river, some seventy miles inland from Gaspé village. This was described in 1931 by Jones (1), and, following fairly intensive exploration by Noranda Mines, Limited, the prospect was made the subject of a special investigation and report by Osborne (2).

LOCATION AND AREA

The general extent of the region described in this report is from Capdes-Rosiers southward almost to Percé on the east coast, and inland for from forty to sixty miles. The total area is about 1,500 square miles.

In many parts of Gaspé peninsula, the artist and the photographer will find an almost endless variety of interesting subjects for his brush, pencil, and camera. Especially is this true of the eastern coast, and Percé (Plate II). Here the shades and tints and forms of Bonaventure island,

(1) JONES, I. W., *The Bonnacamp Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rep., Part C, 1931, pp.58-74.

(2) OSBORNE, F. Fitz, Unpublished report in files of the Quebec Department of Mines, 1940.

the 'Rock', the Three Sisters, and the sloping sides and tree-clad summit of mount Sainte-Anne are a constant challenge and inspiration to the artist.

Northwest of Percé, deep in Gaspé bay, the village of Gaspé lies beside its great natural, deep-water harbour (Plates IIIA and IIIB). Gaspé village, the terminus in eastern Gaspé of the Canadian National railway, is the business and shipping centre of the eastern part of the peninsula, a centre which, with better overland communications, may well, at some time in the future, become an important port.

ACCESS

Gaspé peninsula in recent years has been girdled by a highway, the Perron boulevard, or route 6, and it is now possible to reach any of the towns or settlements in the peninsula by motor road. The highway follows a coastal route and offers the traveller many a contrasting view of ocean, shoreline, and hill. The region also is served by a Canadian National Railways branch line, with terminus at Gaspé village, and connecting with the main Canadian National Montreal-Maritime, or Transcontinental, route at Matapédia. In the summer months, boats of the Clark Steamship Lines furnish passenger and freight service to Gaspé village from Montreal and Quebec by way of the Saint-Lawrence river and gulf.

Practically all parts of the coastal section of the region are readily accessible from the highway. However, lack of settlements in the inland portions means a scarcity of good roads away from the coast, and, throughout large areas, even serviceable summer trails are lacking. A good inland-running motor road follows York river to its head at the Miller copper claims (Noranda option). This road was being extended in 1947 to Lake Madeleine. Eventually it may be linked, in the central area of the Gaspé National Park, with a road leading inland from Sainte-Anne-des-Monts village on the Saint-Lawrence coast and Cascapedia village on the Chaleur coast.

Secondary motor roads built by lumber companies, and not kept in repair when the immediate need for them is gone, are a relatively new development in the peninsula. In this eastern section such roads are fairly numerous in some areas. One such road follows the north side of Dartmouth river as far as Post brook, in Sydenham township. The 'Howard Smith' road, leaving the York River road about eight miles out of Gaspé village, just west of the forest protective service gate, reaches the Galt-Larocque township line near the headwaters of the east branch of Patewegia brook. Several short roads branch off to the north of the York River road in the eastern part of Galt township. Here, also, is the road leading to Continental Petroleum No. 1 well (47, maps 662, 664). In Larocque township, to the west, the Imperial Oil road to Mississippi No. 1 well (62, map 662) branches from the York River road; it reaches to a point about one mile east of Dartmouth lake. Farther inland, in Holland and Fletcher townships, the Canadian International Paper Company recently constructed a series of long roads which connect with the main York River road. These roads were in fair condition for motor traffic in 1945. In

that year, a motor road was being completed from Sunny Bank, at the head of the Southwest arm of Gaspé bay, past Third lake to Saint-Jean (John) river, and thence up the river valley to the main forks. This road for the most part follows an old wagon road on the north side of the river to the Baillargeon-Laforce township line. At this point, the old road ends and the present motor road crosses to the south side of Saint-Jean (John) river. In 1944, a motor road was put in on the south side of Saint-Jean (John) river from the highway to Wooden Bottom brook (Big Fork), and thence southward into the southeast corner of Baillargeon township. A branch road leaving this road about a mile and a half west of the Little Fork was opened into the southern part of York township.

In addition to the above there are wagon roads and trails in various parts of the region. These are shown on the accompanying map under the same symbol as the other roads.

The region most difficult of access is that to the south of Saint-Jean (John) river, where few roads or even trails exist that go any appreciable distance. In Power, Joncas, and Fortin townships, the only trails are those cut by ourselves for temporary passage and those cut by trappers. In the eastern part of Fortin township, one wagon road is available but is now in very poor condition. The inland end of this road is at the centre-line of the township. From there it passes eastward between Malbaie river and its Big Fork to the junction of these streams, and beyond that follows Malbaie river, on its north side, to connect with a motor road at a point about six miles in from the coast. Access may be had to southern Joncas and Fortin townships by a road going north from Grande Rivière village into the bordering township of Rameau. Another motor-road leading from Chandler through Pabos township and into Pellegrin township gives approximate access to the southern part of Power township. Neither of these roads quite reaches the southern boundary of the region here described.

TOPOGRAPHY

The most striking topographic feature of the region is the broad depression of Gaspé bay. The bay narrows at its head into Dartmouth river, and apparently is the drowned continuation of that drainage line. The York and Saint-Jean (John) rivers flow into this depression and do not reach the open sea. The bay is bordered on the north by a peninsula which tapers into the five-mile-long finger of the Forillon (Plate I), ending in Cape Gaspé and Ship Head. The trend of the Forillon is controlled by the strike of the Devonian limestones — here capped by the resistant Grande Grève formation — that underlie it. This cape points seaward to the American 'banks', which begin about six miles out, and which probably mark the continuation of the Forillon rocks and structure (1)

The southern side of Gaspé bay (Plate III-C) is the mainland, reaching out in a southeasterly direction, and paralleling the Forillon, to form the broad Pointe Saint-Pierre. This latter, in turn, forms the northern border

(1) See also CLARKE, J. M., *Early Devonian History of New York and Eastern North America*; N. Y. State, Mus., Mem. 9, 1908, p. 14 and footnote.

of Malbaie bay. The point and the mainland west of it and inland to the mouth of Malbaie river are protected by the Malbaie conglomerate formation. Malbaie bay itself apparently owes its existence to the fact that it was a depression in Carboniferous times, which became partly filled with the Cannes-de-Roche sediments, and to the fact that these sediments could be removed rather readily by erosion.

The inland view (Plate IV-A) from the highway bordering Malbaie bay, or from the train as it crosses the sand-bar between Barachois and Coin-du-Banc, is one which invites questions as to the origin of some outstanding land forms. Prominent among these is a flat-topped hill with squared sides, rising just south of the Malbaie River depression and about four miles in from the coast. The hill is underlain by steeply dipping to vertical Devonian sandstones, but it is capped by, and owes its flat top to, flat-lying Cannes-de-Roche sandstones and conglomerates. Nearer the coast, and about three miles to the south, is a massive hill known locally as the Big Barn. This is just north and inland of the point where Portage river leaves the hills and enters the barachois (lagoon) flats. It serves as one of the main landmarks for fishermen entering Malbaie bay from the open sea. This hill is underlain by the resistant Lower Devonian Grande Grève limestone and is flanked on the south by the softer Mont Joli and Ordovician limestones and on the north by sandstones and shales of the Gaspé Sandstone series. To the south of this again, a little farther inland and on the south side of Portage river, is a cone-shaped hill that rises out of the Ordovician and seems to owe its shape to an accident of erosion. Large, loose blocks of vein calcite occur on its summit.

Going north from Malbaie bay along the highway, little is seen of the inland until Douglstown and the Saint-Jean (John) river valley are reached. A range of hills then shows up southward from the valley. These hills are made up of Lower Devonian limestones brought up on the axis of the Saint-Jean (John) River anticline. The wide, gently sloping valley of the lower Saint-Jean (John) river and the gentle hills and slopes north of this to the lower York River valley mark a region underlain by the Gaspé Sandstones and by a broad synclinal structure. This condition, of limestone forming ranges of higher hills (Plate V) and sandstone forming valleys, is fairly general throughout eastern Gaspé. All of the hills in the vicinity of Gaspé village are underlain by Devonian sandstones. A chain of hills running northwest-southeast, following the Northwest arm of Gaspé bay and the lower Dartmouth river on the south side, is very evident from the highway near the Dartmouth bridge or from the road on the north side of Gaspé bay (Plates IV-B, IV-C). These hills are of Grande Grève limestone, with Gaspé Sandstone covering their backs and with their fronts facing sharply, and sometimes as cliffs, to other Gaspé Sandstones on their north side. These steep fronts and local cliffs may have resulted in part from faulting and in part from sea erosion, and thus perhaps may be referred to as sea cliffs. A 600-foot apparent terrace level lies off the base of the easternmost of these steep fronts.

The chief topographic features of the area to the north of Gaspé bay are a series of sub-parallel ridges, steep-sided to the north, that traverse the country from west to east with remarkable continuity. The maximum

height reached by any of these is 1,900 feet, attained in Sydenham township east of Sydenham river, with 1,200 feet as the more normal elevation.

The topography of the inland part of the area is essentially that of a dissected plateau (Plates VI, VII). Valleys are numerous, frequently deep, and often bordered by steep sides. The valley bottoms, in their older and lower portions, commonly range from 600 feet to 1,000 feet below the bordering uplands. The uplands usually are from 1,200 feet to 2,000 feet above sea level. An area of higher land extends westward from York to Béland river, a tributary of the Madeleine. This area is underlain in large part by Grande Grève limestones with some igneous intrusions and, at the Miller claims, by limestones baked and hardened to some extent by contact metamorphic action. Many of the elevations here are between 2,900 and 3,000 feet above sea level. Needle mountain (2,985 feet), Porphyry mountain (2,865 feet), and Copper mountain (2,615 feet) are high points in the area of the Miller claims. York mountain, one mile to the west of the north end of York lake, is about 2,850 feet above sea level. In the northern part of the region, also, but well to the east of the highlands just mentioned, there are two prominent hills. These are King mountain (a little above 2,500 feet) in the northern part of Fletcher township, and Bald mountain (2,440 feet) near the northern boundary of Larocque township.

In the southern part of the region, the outstanding high points are mount Alexander (about 2,550 feet) and mount Observation (2,380 feet). These hills are high in relation to the surrounding country and may be seen from distant points. They are parts of ranges that extend westward to Little Cascapédia river and that are composed of volcanic rocks of Silurian age.

The region is drained by Dartmouth river in the north, by the York and the Saint-Jean (John) flowing west to east through the central part of the area, by Grande river in the south, and by a series of smaller streams in the east and southeast, namely, L'Anse-à-Brillant, Malbaie, Beattie, and Portage rivers. Of the last four mentioned, the Malbaie, with its branches, drains more territory than the other three together. The York and Saint-Jean (John) rivers are famed for their salmon and trout pools and several fishing clubs have been established along their waters.

The general impression gained from an examination of the inland areas is that of a region that had been reduced essentially to base-level and over which the master streams ran, roughly, in a north-south direction. Elevation of the region, with probably some tilt and perhaps some warping, caused many changes to take place in this ancestral drainage pattern. Evidences of more recent changes in drainage and of out-of-balance or out-of-scale conditions between the size of the stream and the size of the valley that it occupies are widespread over the inland areas. The description of these features, in connection with physiography, is intended at a later date.

AGRICULTURAL POSSIBILITIES

Established farming as well as recent colonization have been confined to a relatively narrow strip bordering the coast, the lower part of Dartmouth

and York rivers, and for five miles up Malbaie river. Inland from the coastal farming belt there are wide areas underlain by loamy soil that is unusually free of large fragments of rock débris. This applies particularly to ground that is underlain by rocks older than the York River sandstone-shale series, and more particularly to that underlain by Ordovician and Silurian limestone. However, while wide areas have a suitable soil cover, the land surface over much of these is so irregular that agricultural operations would be very difficult. The temperature factor must also be considered when examining areas that are favourable so far as both soil and topography are concerned. Temperature is dependent in part on elevation, and the possible farming areas that we have in mind lie for the most part between 500 feet and 1,500 feet above sea level. Favourable topographic and soil conditions are combined in the following areas:

(1) A relatively small area in the adjoining and northern parts of Joncas and Fortin townships, at 1,200-1,500 feet elevation.

(2) At intervals between Wooden Bottom brook (Big Fork) and the Little Fork of Saint-Jean (John) river, in Baillargeon and York townships, at 1,000-1,500 feet elevation.

(3) In northeastern Power township, at 1,300-1,500 feet elevation.

(4) The headwaters of Petit Pabos river across the divide with, and into, Grande River valley, all in southern Power township, at 700-1,500 feet elevation; there are settlements about six miles to the south in Pellegrin township.

TIMBER RESOURCES

The prevailing types of trees in this region are balsam fir, black spruce, white spruce, and birch. Poplar also is common locally. Stands where cedar is fairly abundant are frequent, but usually of small extent. Pine trees are rare and scattered.

Extensive long-lumber operations were carried on for many years in the Dartmouth, York, Saint-Jean (John), and Malbaie River valleys but such operations in later years have been much reduced. Stands where cuts can be obtained still remain but they are relatively unimportant. This fading of a natural resource is due only in part to the 'cut'. In part, it is due to forest fires. A wide area in western Galt and Baillargeon townships, and in southern Larocque and northern Laforce, was burned over many years ago and is now covered by young second-growth. Another area barren of suitable timber because of forest fires of some fifty years ago (and perhaps of still earlier date in the barrens of the 'Caribou ground'), includes much of Vondenvelden township. And, in 1941, a forest fire ravaged wide areas in Holland, Fletcher, and Sirois townships, and reached westward in one area as far as Bonaventure river. Extensive efforts to salvage the timber in this recently burned area are being made by the Canadian International Paper Company, operating out of the village of Gaspé.

Much damage has been caused to the forest growth by insects. The bark-beetle and saw-fly have worked havoc on the white spruce and have extensively damaged the black spruce also. Again, and in large part

attendant on the insect ravages, are the many and often large areas of woods that are blown down.

Commercial stands of timber suitable for pulpwood are common in many parts of the region. The most accessible are those in the Dartmouth and York River systems, and cuts have been made in various sections here for many years past. Others are present along the streams that drain to the Saint-Jean (John) from the south. Through Power, Joncas, and Fortin townships, the drainage area of Grande river, fine stands are plentiful. No cutting operations have been carried out in the three townships mentioned except along Malbaie river, in eastern Fortin. Pit props also could be obtained in the various pulpwood areas, and since 1939 there has been considerable production of props for export.

WATER-POWER POSSIBILITIES

Hydro-electric power may be developed in this region, but probably not on a large scale. At the rapids and falls on Dartmouth river above Lady Step brook it is estimated (1) that from 870 to 1,090 horse-power could be developed. On some of the smaller streams on the north side of Gaspé bay, where there are falls or where the valleys are gorge-like, short dams could hold up fairly large heads of water.

The section of York river beginning about half a mile below Falls brook and extending some seven and a half miles downstream is estimated (1) as being able to produce, at five different sites, 566, 255, 630, 640, and 900 horse-power. D'Argent (Silver), Galt, Patwegia, and Fourth Lake brooks have gorge-like sections where small water-power projects might be developed.

The lower part of Saint-Jean (John) river was examined by the Quebec Streams Commission (1) and it was stated that no suitable dam-site was seen. However, in that part of the river lying between the longitudes of Third lake and Peinture (Paint) lake, the narrowness of the valley and steepness of its sides, and the presence of rock ledges along the river, suggest possible sites for power development. In this part of the river, about two and a half miles in length, and with a fall of about 100 feet, the current is more rapid than in any other section between, at least, Indian Fork and the mouth. This would be about eleven miles in a straight line from Gaspé village.

None of the other rivers in the region have been investigated by the Streams Commission. On all of them, however, there are possible sites for power development, probably on a small scale in all cases.

METHOD OF WORK

Traverses for geological information were made along almost all of the stream courses and at frequent intervals in the interstream areas. These traverses usually were made by pace-and-compass method, and with the aneroid barometer; in some of them, distances were measured by chaining.

(1) Quebec Streams Commission, 12th Report, 1923.

An index map (Figure 2) shows when and by whom the various parts of the region were mapped in the present survey. For the northwestern part, mapped by Jones and McGerrigle in 1937, the Quebec Department of Mines provided a contour map on a scale of one-quarter mile to one inch and with a contour interval of 50 feet. For the southwestern part of the region, mapped by McGerrigle in 1940, a stream map at one-half mile to one inch was provided, along with the aerial photographs from which the stream map was made. The ground control for the contouring was run as the geology was being mapped, and from these data the contour map was constructed later by McGerrigle. The Department of Mines furnished topographic maps for the rest of the region. These were prepared by Canadian Airways, Limited. They were on a scale of one-half mile to one inch and had a contour interval of 100 feet. The aerial photographs from which the maps largely were compiled were extremely useful in the field work.

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We are indebted to Dr. A. E. Wilson and the late Dr. E. M. Kindle, of the Geological Survey of Canada, who determined the fossils collected in 1937 by Jones, and to Dr. M. A. Fritz, University of Toronto, who examined and reported on several lots of bryozoan fossils collected in the region. Particular acknowledgment is made to Dr. G. A. Cooper, Assistant Curator, United States National Museum, Washington, D.C., for preliminary advices on many fossils from Ordovician and Silurian formations in the Saint-Jean (John) River area. We are indebted, also, to Dr. T. H. Clark, McGill University, who was particularly helpful in the matter of identifying fossils collected in 1938 by Brown, then a graduate student at McGill University. The fossils collected by McGerrigle in 1938, 1939, and 1940, and those collected by Jones in 1938, also were determined by Dr. Clark. His conclusions as to the ages of the various formations are used freely in this report.

Special acknowledgment is made of the assistance given by Messrs. Alfred E. Miller, Wilson E. Miller, and Elvin R. Miller, all of Sunny Bank, Gaspé county, during the progress of the geological and topographical field work. Much traversing and pace-and-compass and chain-and-compass survey work was detailed to these men, and confidence in the results reported by them always was warranted.

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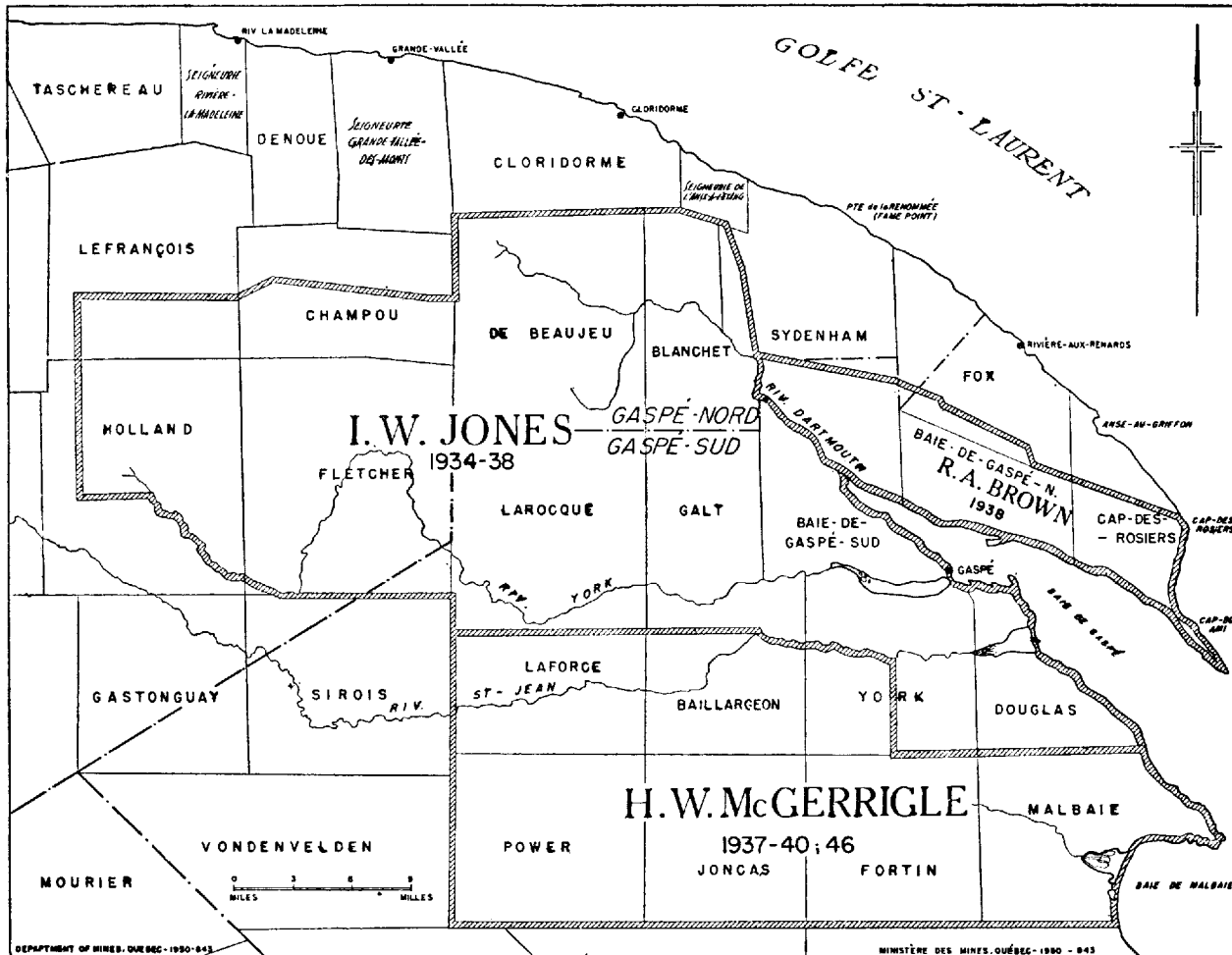


FIG. 2

Figure 2 — Index showing when and by whom the mapping of the eastern region described in this report was done.

Austen Miller, Norman Miller, Gordon Miller, all from the Gaspé district, and by G. Devlin of Quebec city, E. Beaulieu of Mont-Joli, and R. Trépanier of Grande-Rivière.

PREVIOUS WORK*

The first geologist to visit this region was W. E. Logan (1) who, in 1843, measured various sections of Gaspé Sandstones in the coastal area. This work was followed in 1844 by a survey of the Saint-Jean (John) river from its mouth to Indian Fork by Alexander Murray (2). Murray was followed in 1857 by James Richardson (3) who traversed the northwestern corner of the region during the course of much wider explorations. In 1862, Robert Bell (4) explored the Dartmouth, York, Malbaie, and Grande rivers, although his exploration on the Grande did not lead him into the present area. The results of all of these investigations are to be found in Logan's report (5) of 1863, in which they are summarized and correlated with the findings of Logan himself. In the same volume are recorded lists of fossils collected within the region by all of these geologists and mostly determined by Elkanah Billings, of the Geological Survey of Canada. Other invertebrate fossils from the region are described by Billings (6) in a later work. In Logan's report of 1863, the post-Ordovician consolidated sediments of the region were placed in two major divisions, the Gaspé Limestones and the Gaspé Sandstones. The Gaspé Limestones were referred to the 'Lower Helderberg group' and to an 'Upper Silurian' age, while the Gaspé Sandstones were referred to the Devonian, ranging from the lower to perhaps the Upper Devonian.

Between 1863 and 1888, Dawson (7) described the fossil plants of the Gaspé Sandstones. On the basis of the plants, he divided the series into three parts equivalent, respectively, to the Lower (Oriskany), Middle (Hamilton), and Upper (Chemung) Devonian.

Fairly extensive accounts of the geology of the coastal part of the region, with some generalities gleaned from an examination of certain inland areas, were given by Ells (8) in 1882 and in 1883. Again, in 1902, Ells (9) gave a summarized account of the geology of the region and also of the results obtained from the several wells that had been drilled for oil in the previous years. In this report, Ells condemned the region as a possible commercial producer of oil.

The classic account of the geology of the coastal part of the region, and particularly of the Forillon and Percé areas, is that of John M. Clarke (10), published in 1908. The Gaspé Limestones of Logan were divided by Clarke into three formations ranging from Helderberg to Oriskany in age, while the Gaspé Sandstone series was left undivided and was referred to the Middle Devonian (Hamilton). In 1913, Clarke (11) provided a summary of his 1908 work.

W. A. Parks (12), in 1929, spent about two months examining the oil possibilities of an area of some 500 square miles. In his report he reviewed the general geology of the region and presented a summary of the

* Figures in brackets refer to list of references at end of chapter.

main structural features. Parks concluded that the region had much more to commend it than was indicated by Ells so far as oil possibilities were concerned.

In 1930, the geology of the region was reviewed by Schuchert (13) in connection with his report on mountain-building times in the northern Appalachians. Schuchert and Cooper (14), also in 1930, modernized the Upper Ordovician and Lower Devonian stratigraphy and palaeontology of Percé, while Cooper and Kindle (15) and Foerste (16), in 1936, described some new Upper Ordovician fossil forms from Percé.

Between 1934 and 1936 the northern and western parts of the region were examined by Jones (17), and in 1937 Jones and McGerrigle (18) mapped and described the central part of the region.

In 1936, C. H. Kindle (19) outlined the geology of the southeastern part of the area and of the region farther south. The Upper Ordovician Pabos formation was mapped as underlying much of the area between Chaleur bay and the south lines of Fortin, Joncas, and Power townships. The distribution of the Upper Ordovician White Head formation, Devonian formations, and Carboniferous formations was shown on a second map including Malbaie, eastern Fortin, and Percé townships. In 1935, Alcock (20) incorporated in his report much of the information obtained by Kindle, and provided a general summary of the Devonian stratigraphy in eastern Gaspé. A critical study of certain of the Devonian faunas of the region was made by E. M. Kindle (21) in 1938. A detailed examination of the stratigraphy of the type section of the Gaspé Limestone series was made by L. S. Russell (22) in 1946.

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GENERAL GEOLOGY

OUTLINE OF THE GEOLOGY OF GASPÉ PENINSULA

Gaspé peninsula forms the extreme northeastern end of the Appalachian mountain system on the continental mainland. The continuation of this system to the northeast is recognized in Newfoundland, 250 miles distant across the gulf of Saint-Lawrence. To the southwest, the Appalachians extend to the State of Alabama, or for a distance of some 1,700 miles.

In Gaspé peninsula, as in the Appalachians proper of the United States, the rocks are strongly folded for the most part. The rocks involved in this folding range in age from possible Precambrian to Devonian. There were at least two major periods of folding, one at the close of Ordovician time (the Taconic), the other in the latter part of Devonian time (the Acadian). The main period of Appalachian mountain-building or folding was in Permian time, but this folding had little direct effect on Gaspé, as is shown by the flat to gentle dips of Carboniferous rocks which, in southern Gaspé, overlie the folded Devonian and older formations.

The rocks of Gaspé are arranged in four major, east-west belts — the northern, north-central, central, and southern belts — which parallel the length or axis of the peninsula.

The northern belt, ten to twenty-five miles wide, extends along the northern shore region. It is occupied for the most part by rocks of Ordovician age, with some possibly of Cambrian age — the complex forming a part of the 'Quebec group' of Logan. The rocks are chiefly slates, with some sandstones, quartzites, and more local volcanics.

The central belt, averaging forty miles wide, is the broadest of the four. It extends from the eastern end of the peninsula to its western limit at Matapédia river and for an undetermined distance farther westward. This belt is underlain mainly by Devonian rocks, but it includes also some of Silurian and Ordovician age. The eastern portion of this belt lies within the present map-region.

The north-central belt is that of the Shickshock range and lies, in part, between the northern and central belts. Unlike the other three, this belt does not extend through the length of the peninsula. It reaches for sixty miles in an east-northeast direction from Matane river to the Tabletop mountains in central Gaspé. Its average width is six miles. The belt or range parallels the Saint-Lawrence river at a distance inland of twelve to twenty-five miles, and its mass, and many of its individual summits, may be seen by voyagers on the river between the ports of Matane and Mont Louis. The range includes some of the highest peaks in eastern Canada, and topping them all is mount Jacques Cartier in the Tabletop mountains at the eastern end of the range, with an elevation of 4,160 feet above sea level. Westward from the Tabletops, several summits rise above 3,500 feet. The Tabletops, at the eastern end of the range, are held up by granite believed to have been intruded in Middle or Upper Devonian time. Five miles to the westward is the flat-topped serpentine mass of

mount Albert. Apart from these areas of granite and serpentine, and lesser areas of serpentine on the south side of the range west of mount Albert, the Shickshock belt is underlain largely by basic volcanics. These have been altered to chloritic-epidotic schists. Associated with the altered volcanics are subordinate amounts of arkose, usually schistose, and some gneissic rocks of granitic composition. The age of these rocks is in doubt; it has been variously placed as Precambrian, Cambrian, and Ordovician.

The southern belt, bordering on Chaleur bay and the gulf of Saint-Lawrence, is twenty-five to thirty miles wide. It is underlain by possible Precambrian, Cambrian, Ordovician, Silurian, and Devonian rocks, all folded to a greater or lesser degree, and by Carboniferous beds that lie with flat or gentle dips across the truncated edges of representatives of most of the older rock systems. The Carboniferous rocks lie along the southern or outer edge of this belt, and are seldom found more than a few miles inland from the coast.

OUTLINE OF THE GEOLOGY OF EASTERN GASPÉ

The stratigraphy of the eastern part of Gaspé peninsula is summarized in the *Table of Formations* given below. All systems from the Cambrian to the Carboniferous are represented. However, the section is far from complete, and at several places in the stratigraphic column there are wide time gaps.

Structurally, the region is the eastern end of a broad synclinorium extending along the axis of the peninsula, and corresponding to the central belt referred to above. In eastern Gaspé, this broad structure is characterized by two major down-folds or synclines separated by the Saint-Jean (John) River anticline. The structure to the south of the anticline is known as the Malbaie syncline. Several strong secondary folds occur in this syncline. North of the Saint-Jean (John) river anticline there is a broader and larger down-fold, also interrupted by subsidiary folds. Many of these latter are major structures which have been given individual names. They include, for example, the York River, Champou, and Northwest Arm synclines, and the Mississippi, Bald Mountain, and Haldimand anticlines. The folding in this region apparently was intermediate in intensity, the fold structures, for the most part, being fairly broad. The general plunge of the folds is to the east, but westward plunging folds occur, and in places domed structures, as for example, the Mississippi anticline, are present. The folds are products of the Acadian, or late Devonian, period of mountain-building. Some thrust faulting took place, probably at the same time as the folding. The major part of the normal faulting, however, is thought to have been later.

TABLE OF FORMATIONS

ERA	PERIOD	FORMATION	THICKNESS (Feet)	PROBABLE CORRELATION	DESCRIPTION				
CENOZOIC	Quaternary	Recent			River, lagoon, bar deposits; marine clays				
		Pleistocene			Stratified gravels; occasional ice transported debris				
?MESOZOIC ?PALÆOZOIC	? Triassic ? Pennsylvanian	Basic dykes		? Bay of Fundy and New England intrusives	Diabasic; fine to coarse in grain; often or usually amygdaloidal				
PALÆOZOIC	Carboniferous	Pennsylvanian or Mississippian	Bonaventure	800 (at Percé)		Red conglomerates, sandstones, shales; angular to rounded boulders up to 1½ ft.; occasional limestone beds			
			Cannes-de-Roche	200-250+ ?		Three members, in ascending order — red conglomerate, red and green shales and sandstones, and buff sandstones and conglomerates			
	Devonian	"Gaspé Sandstone" series	Upper or Middle	Malbaie	2,000	? Portage ? Hamilton	Conglomerates and sandstones with some shale and very occasional limestone; boulders up to 1 ft. in length, angular to rounded		
			Middle	Battery Point	5,000 - 7,000	Hamilton	Greenish-grey, coarse, feldspathic (orthoclase) sandstones and pebbly sandstones to conglomerates, some shales; red beds toward the top		
				York River	1,000 - 6,000	Hamilton	Greenish-grey, fine to coarse, feldspathic (plagioclase) sandstones, with common soft green shale		
			Middle or Lower	York Lake series	0 - 4,000	? Onondaga ? Oriskany	Greenish-grey, fine to medium, feldspathic (plagioclase) sandstones, with green shale, Grande Grève type of limestone, shaly limestone, and some conglomerate		
				Fortin series	0 - 5,000	? Onondaga ? Oriskany	Shaly slates, limestones, sandstones, and some conglomerates		
			Lower	"Gaspé Limestone" series	Grande Grève	Percé Area Murailles	2,000 - 4,500	Oriskany	Dark grey, hard, siliceous to cherty limestones and calcareous siltstones; well-bedded in 1 in. to 6 in. beds; locally of softer type and not separable from the Cape Bon Ami
					Cape Bon Ami		1,050 - 6,000	Oriskany	Dark grey, soft to hard, argillaceous to finely arenaceous limestones that often are magnesian; well-bedded in 5 in. to 2 ft. beds. Much local variation from this type description
					St-Alban	Mont-Joli	7160 - 3,000	Helderberg	Greenish-grey, soft, argillaceous limestones and finely arenaceous limestones or calcareous siltstones with occasional dark limestones and reefy limestones; some red and green shaly limestones
					Griffon Cove River Beds		200-405	Keyser or New Scotland	

TABLE OF FORMATIONS (Continued)

ERA	PERIOD	FORMATION	THICKNESS (Feet)	PROBABLE CORRELATION	DESCRIPTION	
PALEOZOIC	Silurian and Devonian	Dartmouth River series	0 - 1,000		Much the same as the St-Alban	
		Saint-Jean (John) River series	2,500 ±		Much the same as the St-Alban; characterized by a conglomerate lens up to 1,000 ft. thick	
		Grande River-Portage River series	0 - 1,000		Much the same as the St-Alban	
	Silurian	Middle	Mount Alexander series	5,000+	Chaleur series (Niagaran)	Much the same as the St-Alban; a zone of volcanics about in the middle
			?Lady Step Volcanics	1,000 ±		Highly altered, probably andesitic originally, flows and tuffs
	Ordovician	Upper	Matapedia series White Head; Pabos	1,000? - 5,000	Anticosti series	Dark grey, dove weathering, fine, smooth limestone; well-bedded. Dark grey, light grey to drab weathering, shaly limestone
		Middle	Beds at Griffon Cove to Gros Ruisseau	?	Chazy (Normanskill)	Mostly dark shales
		Lower	Cape Rosier beds	?	Beekmantown (Lévis and Matane shales)	Grey to dark grey shales and limestones, some red and green shales, some conglomerate, a little sandstone
	Cambrian	Upper	Murphy Creek	?	Marysville; Eau Claire	Thin-bedded grey limestones separated by ribboned shaly limestone
		Lower?	Corner-of-the-Beach	?		Limestones and shales

CAMBRIAN

CORNER-OF-THE-BEACH AND MURPHY CREEK FORMATIONS (1) (2) (3)

Two Cambrian formations of very brief areal extent, so far as known, have been recognized in the valley of Murphy creek. This creek enters the barachois of Malbaie bay at the extreme southeastern corner of the map-region, and the locality of the formations is shortly to the south of our map. The valley of Murphy creek is followed by the railway and by the Lemieux road, one of the three highway routes leading through the hills from Corner-of-the-Beach towards Percé. The Cambrian locality begins about one and a half miles southwest of Corner-of-the-Beach and apparently reaches about one mile upstream.

Rocks of Lower? Cambrian age were found in a railway cut at the western end of this Cambrian area, and others of Upper Cambrian age along the side of Murphy creek at the eastern end. The Cambrian formations apparently are separated along the line of Murphy creek "by a great variety of rocks . . . in isolated outcrops in the stream, oolitic limestone, shales, etc., all greatly distorted, so that their stratigraphic sequence is obscure". Apparently, also, the Cambrian is overlain by "basal, fine quartz conglomerate" of Upper Ordovician age (3, p.634).

The Lower? Cambrian rocks have been named the Corner-of-the-Beach formation and described briefly as "limestones and shales". The following fossil forms have been identified (3, pp.634-635):

<i>Acrotreta arrecta</i> Kindle	<i>Olenoides schucherti</i> Kindle
<i>Micromitra sculptilis</i> (Meek)	<i>Olenoides gaspensis</i> Kindle
<i>Obolella</i> (?) sp.	<i>Periomma claudi</i> Kindle
<i>Lingulella</i> sp.	<i>Prozacanthoides gaspensis</i> Kindle
<i>Nisusia</i> cf. <i>festinata</i> (Billings)	<i>Ptychoparella?</i> <i>gaspensis</i> Kindle
<i>Protorthis gaspensis</i> Kindle	<i>Ptychoparella?</i> <i>murphyi</i> Kindle
<i>Helcionella gaspensis</i> Kindle	<i>Solenopleurella gaspensis</i> Kindle
<i>Agnostus</i> sp.	<i>Zacanthopsis resseri</i> Kindle
<i>Chancia</i> sp.	

The specifically identified forms in this fauna are all new with the exception of two, and of these two one is provisionally determined. Correlation of the formation with other Cambrian sections is difficult, therefore. Kindle has concluded (3, p.635) that the fauna represents late Lower Cambrian or early Middle Cambrian time, and that the evidence favours slightly the Lower Cambrian.

The Upper Cambrian Murphy Creek formation "consists of hard, grey limestone in beds up to over one inch in thickness, separated by ribboned, shaly limestone. The strata dip to the south at an angle of 65 degrees and are cut by numerous calcite veins and stringers . . .

(1) ALCOCK, F. J., *Geology of Chaleur Bay Region*; Geol. Surv. Can., Mem. 183, 1935, pp.12-13.

(2) KINDLE, C. H., *A Geological Map of Southeastern Gaspé*; Eastern Geologist, Vol.1, April, 1936.

(3) KINDLE, C. H., *A Lower (?) Cambrian Fauna from Eastern Gaspé, Quebec*; Am. Journ. Sci., Vol. 240, Sept., 1942, pp.633-641.

"The Cambrian fauna includes a graptolite, a sponge, a linguloid brachiopod, and about twenty species of trilobites of which many are small forms. This fauna appears to be of about the same age as that of the Marysville limestone of the southern Appalachians and the Eau Claire sandstone of Wisconsin" (1).

(1) ALCOCK, F. J., *Op. cit.*, 1935, pp.12-13.

LOWER ORDOVICIAN

LÉVIS FORMATION

Cape Rosier Beds

Rocks of Lower Ordovician age are best exposed on the shore at cape Rosier (cap-des-Rosiers), between the cape and the base of the Devonian section two and a half miles to the south. These rocks are referred to by Kindle (1938) as the *Cape Rosier beds*. The section here is made up of dark shales, with common grey shales and grey limestones that in places are magnesian, occasional beds of conglomerate, and a zone of coloured (red, purple, olive-green) shales with interbedded grey sandstones (1).

Ells (1882, p.17) stated that from "black shales" associated with conglomerates in the "immediate vicinity" of the Cap-des-Rosiers lighthouse, "Mr. Weston obtained a variety of graptolites, among which the following characteristic Lévis species have been recognized: *Dictyonema irregulare*, *Graptolithus* (now, *Clonograptus*) *flexilis*, *Loganograptus Loganii*". Kindle (1938, p.13) gives a list of fossils collected 150 yards north of the lighthouse and determined by Dr. R. Ruedemann: *Dictyonema approximatum* Ruedemann (new), *Dictyonema pertextum* Ruedemann (new), *Licnograptus elegans* Ruedemann (genus and species new), *Dendrograptus fruticosus* Hall, *Callograptus salteri* (Hall) var. *strictus* Ruedemann (new), *Tetragraptus similis* (Hall), *Leptobolus* sp. Kindle quotes Ruedemann as stating that the fauna indicates a Deepkill or Lévis age, probably lower Lévis. Brown, in 1938, collected at this locality the graptolites *Dictyonema flabelliforme* (Eichwald), *Clonograptus flexilis* (Hall), and *Dichograptus* sp. This collection also suggests that the rocks may be correlated with the Lévis formation. This correlation is checked in a general way by Bulman (2), who correlates both the Matane shale and the beds at Cap-des-Rosiers "in whole or in part" with the Upper Tremadocian *Ceratopyge* shale of Europe. Bulman (2) lists *Anisograptus richardsoni* Bulman (new) from both the Matane shale and cape Rosier. Another lot of fossils with *Anisograptus matanensis* Ruedemann and *Acrotreta* n. sp. was collected by Jones (1934, p.18) 1,900 feet northwesterly along the shore from the cape. How far to the northwest rocks of Lévis age extend is not known, but at Griffon cove, seven and a half miles northwest of the cape, the rocks belong to a younger Ordovician horizon, the Normanskill. Fossil collections indicating Normanskill age have been made (Ells, 1882; Kindle, 1938) at Griffon cove and at intervals along the shore to Gros Ruisseau, some ten miles farther to the northwest.

Inland from the Cap-des-Rosiers shore section, the rocks bordering the Devonian and, farther inland, the Silurian, on the north have not been mapped or studied in detail except in the Dartmouth River area (Jones, 1934). Between the shore and this area, Kindle and, later, Brown examined the Ordovician here and there incidentally to their main concern, namely, the younger Palæozoics. In this intervening area, the pre-Silurian rocks have the same general character as the 'Cape Rosier beds' and perhaps

(1) See LOGAN, W. E., 1863, pp.270-271.

(2) BULMAN, O. M. B., *Some Dichograptids of the Tremadocian and Lower Ordovician*; Annals and Mag. of Nat. Hist., Ser. 11, Vol.7, 1931, pp.100-121.

can be referred to that horizon. Kindle (1938, p.18) refers the rocks under the Devonian on Griffon Cove river to the Cape Rosier beds. The Devonian-Ordovician section given by him is on the river about four and a half miles from Griffon cove, or about eight miles west of Cape-des-Rosiers. This section includes about 380 feet of 'Cape Rosier beds' made up largely of red and green shales with some dark shale, some hard grey limestone, and, at the base, a band of conglomerate 2 to 20 feet thick. Kindle (1938, p.16) also recognized 'Cape Rosier beds' in the Renard River road section, about seven miles west of Griffon Cove river. Here he mentions only the uppermost thirty feet of the Ordovician, describing this as black shale with occasional thin lenses of conglomerate.

It is of considerable interest that the Ordovician beds here, as stated by Kindle, strike nearly at right angles to the overlying Devonian, "thus indicating the great unconformity separating the Cape Rosier beds from those which follow" (p.16).

About five miles farther west, the Ordovician again is fairly well shown on Sydenham river. The beds closest to the Devonian, near the mouth of Marble brook, are limestone conglomerate, grey, dense limestone, and dark grey shale. The beds are considerably contorted locally. Still farther west, in the "Dartmouth River area" mapped by Jones in 1934, the rocks of the zone in question are well shown on several brooks that drain southward to Dartmouth river, and at many places along the river itself. Here, dark grey slates with thin beds of light grey magnesian limestone predominate, but quartzites, greenish sandstones, and limestone conglomerates are fairly common, while red and green slates are rare. At one place, just east of Béchervais brook on the slope north of Dartmouth river, there are some altered green and grey schists of volcanic origin, probably andesitic flows and tuffs originally.

Fossils were found in the pre-Silurian rocks at but one place in the Dartmouth River area, and this is the only recorded fossil locality in these rocks west of the Cap-des-Rosiers shore section. The fossils found were the trilobites *Asaphiscus* sp. and *Agnostus* sp., forms which C. H. Kindle (1) believed indicated the Upper Cambrian Murphy Creek horizon found by him near Percé.

Thus, the 'Cape Rosier beds' are almost surely Lower Ordovician — Beekmantown — in age and the probable equivalent of a part or all of the Lévis formation. But how far inland or westward from Cap-des-Rosiers the beds extend is uncertain. An Upper Cambrian horizon is suggested in the apparent continuation of the zone near Dartmouth river, and a few miles to the north or northwest from Cap-des-Rosiers, along the shore, a Middle Ordovician horizon is indicated. It is evident from the distribution of these various age horizons that the pre-Silurian rocks in the northern part of this region, and to the north and west, were strongly folded prior to Silurian time. We note again in this connection the strong angular unconformity showing in the Renard River section between the Devonian and the Ordovician. Also, it is apparent that the pre-Silurian beds in contact with the Silurian or later zones along their northern side may not everywhere represent identical horizons.

(1) Personal Communication.

UPPER ORDOVICIAN

MATAPEDIA SERIES

Pabos and White Head Formations

Two east-west belts of Upper Ordovician rocks occur in the southern half of the region. These are described separately below under the headings of 'Southern belt' and 'Northern belt'.

Southern Belt

The southern belt of Upper Ordovician rocks extends along the southern boundary of the region. The northern limit is one to three miles north of the boundary.

The rocks in this belt are of two main types. In general, the upper part of the series is a very fine-grained, dark grey, light bluish-grey weathering limestone in beds averaging two to four inches thick. Thin seams to narrow bands of grey and brownish-grey weathering shaly limestone separate the purer limestone beds. Lenses and thin beds of intraformational limestone conglomerate occur here and there. The limestone of some of the beds gives off an odour of petroleum when freshly broken. A zone about 100 feet thick of greenish shale, with interbeds of limestone up to two inches thick, occurs at the top of the series. This shale zone is lacking in some places, apparently having been removed here and there by erosion prior to the deposition of the Silurian, or cut out by faulting. A massive crinoidal limestone bed was noted at a locality on the North branch of Grande river, half a mile north of the main forks of the river. This limestone was traced westward from the west bank of the river for 800 feet. The rock is composed of crystalline fragments of crinoid stems with very occasional fragments of other fossil forms. Stratigraphically, this crinoidal limestone seems to be about 1,000 feet below the top of the Ordovician series.

The thickness of the upper part of the Ordovician sequence cannot be given closely in view of the interruptions caused by folding and faulting. However, it appears to be more than 5,000 feet. These rocks are closely similar to those of the White Head formation at the type locality. Also, to the east, they come within the area mapped by Kindle (1) as underlain by the White Head formation.

This upper part of the series shows less metamorphism than the underlying part by reason of its greater competency. Cleavage is not as pronounced nor as widely developed as in the underlying part. However, the rocks are frequently faulted, with some accompanying brecciation, and locally they are sharply drag-folded.

The rocks described above are underlain in Joncas and western Fortin townships by a more shaly group of limestones. These lower rocks usually are dark grey in colour, weathering to a light brownish-grey. Colour banding is frequent. Interbeds of purer, grey limestone, similar to those

(1) KINDLE, C. H., Map. in ALCOCK, F. J., *Geology of Chaleur Bay Region*; Geol. Surv. Can., Mem. 183, 1935.

typical of the upper part of the series, occur. Some of the rocks are calcareous shales rather than limestones. A strongly developed cleavage, which in general strikes east-west and dips steeply to the north, often makes it difficult to determine the structure of these rocks. In a few places, and only locally, the shales and shaly limestones have been altered to sericitic schists.

The lower rocks of the Ordovician series here extend southward beyond the limits of the area and evidently merge with what Kindle (1) has named the Pabos formation.

It is apparent from the above consideration that both the White Head and the Pabos formations are present in this area, and that the White Head overlies the Pabos. There is, however, no sharp line of division between the two formations. The White Head may be considered as an upper and more calcareous phase of the Pabos.

Fossils were found in evenly bedded limestones on Grande river in Power township, one mile west of the Power-Joncas line. Included in the collection (14-M-40) were very common crinoid stems, several small brachiopods, *Leperditia* sp. r., *Calymene* sp. r., and ?*Eophacops primaevus* (Clarke) r. Another lot (12-M-40), consisting of bryozoa, was found two miles east of the southwest corner of Joncas township and half a mile north of the Joncas-Pellegrin line. These forms were determined by Dr. M. A. Fritz as *Hallopora tolli* Bassler, a species suggesting a correlation with the Utica, and described (2) from the Baltic provinces.

A few fossils were found at each of two localities within the Upper Ordovician rocks in eastern Joncas and western Fortin townships. The forms (brachiopods) were either too small or too poorly preserved for ready identification, and they have not yet been determined.

Farther east, from the headwaters of Portage River to the mouth of Biscuit creek, fossils were found more frequently in these Upper Ordovician rocks. McGerrigle has identified the forms listed below in lots collected at the localities indicated:

Lot 18-39.—Fortin township, range IX; south headwater branch of Portage river:

Encrinurus sp.

Proetus sp.

Ostracods

Lot 28-39.—Malbaie township; one mile west of mouth of Otter brook, on Portage river

Mesograptus sp.

Lot 29-39.—Malbaie township; half a mile east of Otter brook, on Portage river:

Orthoceras gaspense Foerste

Small brachiopods, including a very small linguloid form

Lot 30-39.—Malbaie township; opposite mouth of Otter brook, on Portage river:

Mesograptus sp.

Common small pelecypods

Cheirurus sp.

Amphilichas sp.

Conularia sp.

(*Iliaenus percéensis* Cooper; loose in a gravel bar at this locality)

(1) KINDLE, C. H., *Op. cit.*, 1935.

(2) BASSLER, R. S., *The Early Paleozoic Bryozoa of the Baltic Provinces*; U.S. Nat. Mus., Bull. 77, 1911.

While the identified list of fossils from the Ordovician here is not extensive, it is sufficient to show a close relationship with the White Head at Percé.

Northern Belt

Upper Ordovician rocks are again exposed in a band up to two and a half miles in width along the Saint-Jean (John) River valley in the western part of the region. Here they are brought up on the Saint-Jean (John) River anticline, the eastward plunge of which carries them under younger rocks near the central line of Baillargeon township.

Three general types of rock which, under better conditions of exposure, probably could be established as formations, have been recognized in this band of Upper Ordovician. The best exposures of all three of these types or formations are in scattered outcrops along Saint-Jean (John) river. The oldest is most easily accessible at Little Indian pool near the point where the new motor road crosses the river, at the mouth of a small brook half a mile below the pool, and again at Peter's camp, about five miles farther down the river. For convenience, we refer to these oldest rocks as the Little Indian Pool beds. They consist predominantly of dark grey to black, argillaceous limestones which, on weathered surfaces, are dirty grey to light grey and buff. Some of the beds are several feet thick, and beds of such thickness are generally purer limestones than the average for the formation. Typically, the beds are from half an inch to three inches in thickness and are separated by seams and thin layers of dark grey calcareous shale. Occasional interbeds of grey, crystalline limestone, often magnesian, and of arenaceous limestone, occur. In many places, the crystalline limestone contains numerous fragments of fossils, particularly crinoid stems, and a few recognizable forms.

The succeeding, younger formation is dark, dense or very fine-grained limestone occurring in beds one to two inches thick. This limestone is distinguished from the underlying by its fine, smooth, and even texture, its light grey or dove colour when weathered, and its apparent greater lime content. One of the best exposures and the most accessible, is on the north bank of Saint-Jean (John) river, a few hundred feet above No. 3 camp or depot.

Probably the chief difference between these two limestone formations is the more shaly nature of the older. And, probably for this reason, the younger limestone shows the effect of metamorphism to a lesser extent than the older, Little Indian Pool, limestone. In both these respects there is a striking resemblance between the sections of the northern and southern belts of rocks referred to the Upper Ordovician. This resemblance is further emphasized by the presence of a shale formation at the top of the section in each case. In the northern belt, the shale is dark green, soft, and contains common interbeds, about one inch thick of cross-bedded arenaceous limestone and fine, calcareous sandstone. This shale is best and most conveniently seen on the road, and along the north bank of Saint-Jean (John) river, at the mouth of a small brook about one mile west of Cameron's camp.

The strata of these three formations, and particularly of the lowest, are arranged in small, complex folds subsidiary to the Saint-Jean (John) River anticline. Drag-folding on a small scale is a common feature in the two limestone formations. Cleavage is strongly developed in the lower limestone and in the shale. Its general trend is east-west and the dip is usually steep, either to the north or to the south. Fracturing and small-scale faulting are of frequent occurrence.

The complexity of structure makes it impossible to form any close estimate of the thickness of this group of formations. However, inasmuch as they are exposed over a width of a little more than a mile on the limbs of the Saint-Jean (John) River anticline, and as the dips are generally in excess of 45 degrees, although variable in direction, a thickness that is considerable, and probably in excess of 4,000 feet, is indicated. The lowest formation possibly accounts for some 3,000 feet of this total thickness, and the upper limestone for 1,000 feet. The shale formation is about 400 feet thick.

Fossils have been found only near the base of the Little Indian Pool, or lowest, of the three formations. Specimens collected from exposures on the north bank of Saint-Jean (John) river, about one mile downstream from the Laforce-Sirois boundary, were kindly given a preliminary examination by Dr. G. A. Cooper, who identified the following forms: *Bilobites* sp., *Streptis* cf. *S. monilifera altosinuata* Hortedahl, *Triplesia* sp., *Coelospira* sp., *Dayia*? sp. These fossils suggested an Upper Ordovician or Lower Silurian age for the beds, more probably the former. More definite evidence of Upper Ordovician age was yielded by a collection made (1) on Sirois brook, about two miles to the west in Sirois township, and about 4,000 feet up the brook from its junction with Saint-Jean (John) river. The following forms were determined in this collection: *Tetradella*? sp., *Pholidops* sp., *Schmidtella subrotunda* Ulrich, *Laccoprimitia* sp., *Bythocypris* sp., *Halatia healeyensis* Kay. (These fossils were determined by Drs. F. M. Swartz and M. Kay, to whom they were referred by Dr. E. M. Kindle).

The fossils so far found in the northern belt of Upper Ordovician rocks were taken from the lower part of the series, from the Little Indian Pool beds. These beds appear to correspond in rock character and in position in the section with the lower part of the series in the southern belt, the part which we have correlated with the Pabos formation. Likewise, the succeeding younger limestone in the northern section appears to correspond with the White Head of the southern belt, although the zone or formation probably is thinner here than to the south. The correspondence of sections is made more complete and convincing by the occurrence of a shale formation at the top of the series in both belts. It is concluded, therefore, that essentially the same section is exposed in each of these belts of Upper Ordovician rocks.

Both the Pabos and the White Head formations have been classed as Upper Ordovician in age, and both have been correlated with the Mata-

(1) JONES, I. W., *Mount Alexander Map-Area*; Que. Bur. Mines, Ann. Rept., Pt. D., 1936, p.12.

pédia series of the Matapédia valley (1). Discussions of the age relations of the White Head have been given by Schuchert and Cooper (2) and later by Cooper and Kindle (3). These discussions show fairly conclusively that the White Head formation is of Upper Ordovician age. Most probably it may be referred to the Anticosti series, but it cannot be correlated positively with that series in view of the rarity of identical species. Its faunal relationships are considered European rather than American.

(1) ALCOCK, F. J., *Geology of the Chaleur Bay Region*; Geol. Surv. Can., Mem. 183, 1935, pp.24-26.

(2) SCHUCHERT, Charles, and COOPER, G. A., *Upper Ordovician and Lower Devonian Stratigraphy and Paleontology of Percé, Que.*; Am. Journ. Sci. (5), Vol.20, 1930, pp. 169-170.

(3) COOPER, G. A., and KINDLE, C. H., *New Brachiopods and Trilobites from the Upper Ordovician of Percé, Quebec*; Jour. of Pal., Vol.10, No.5, 1936, p.349.



SILURIAN AND DEVONIAN

GENERAL

An excellent summary of the distribution of the Silurian in Gaspé peninsula, with sketch map and faunal lists, is given by Northrop (1). The distribution slightly modified from that given by Northrop is shown in Figure 1. Essentially, all of the Silurian in the peninsula belongs to the Middle division of the period. No Lower Silurian rocks have been recognized, and, with the possible exception of certain doubtful zones in the present (eastern) region, no Upper Silurian rocks are known in the peninsula.

Three belts of "Silurian and Devonian" rocks are shown on the maps accompanying this report. These are referred to below as the Northern or Dartmouth River belt, the Central or Saint-Jean (John) River belt, and the Southern or Mount Alexander and Grande River-Portage River belts. These belts include rocks that appear to range in age from Middle Silurian to Lower Devonian, except in the Mount Alexander belt where only Middle Silurian has been recognized. The close similarity between the rocks of Silurian and lowest Devonian age made it impossible to separate them satisfactorily. Also, the fossil evidence was scattered and often insecure, particularly in view of the similar lithology. The problem was further vexed by the correlation of certain of the fossil lots with formations in other regions — as for example the Decker Ferry and Keyser formations — which are considered by some authorities as Silurian and by others as Devonian in age. In this regard, our own view is that those rocks of eastern Gaspé which have been referred to the Upper Silurian quite probably could be shown on further study to be part of the St-Alban formation. This formation is generally conceded to be Lower Devonian — Helderberg — in age, and it marks the base of a thick Devonian series in this region.

DARTMOUTH RIVER BAND

(Silurian and Lower Devonian)

A band of Silurian to Lower Devonian rocks 700 to 1,000 feet wide extends westward from Dartmouth river, paralleling the east-west course of the river on the south side, through the townships of Blanchet and De Beaujeu. The thickness, as calculated from the dip and width of exposure, is 500 to 900 feet. The rocks are mainly greenish-grey to light green, rather soft, argillaceous and arenaceous limestones. The following list of fossils (2), kindly prepared by Dr. Alice E. Wilson of the Geological Survey of Canada, indicates that the rocks of this band are Middle to Upper Silurian in age. The lists are given in west to east order:

Lot 3.—Dartmouth river, 2½ miles above junction with Louison brook:
Leptaena rhomboidalis Wilkens

(1) NORTHROP, S. A., *Paleontology and Stratigraphy of the Silurian Rocks of the Port Daniel-Black Cape Region, Gaspé*; Geol. Soc. Am., Special Paper No. 21, 1939, pp. 89-95.

(2) JONES, I. W., *Dartmouth River Map-Area, Gaspé Peninsula*; Que. Bur. Mines Ann. Rept., Part D. 1934, pp. 21-24.

Atrypina cf. *disparalis* (Hall)
Atrypa reticularis (Linnaeus)
Proetus sp.
 Probably "latest Silurian".

Lor 4.—High bluff south of Dartmouth river, about half a mile east of Lot 3:

Crinoid discs; cystid plate
Streptelasma cf. *latusculum* Billings
Favosites sp.
 Nr. *Halysites compactus* Rominger
Cladopora sp.
Rhipidomella hybrida (Sowerby)
Delthyris elegans Muir-Wood [*Crispella elegans* (Muir-Wood)]

"The abundance of corals suggests that the rocks are of Niagaran age". The *Crispella elegans* is a form known also in the Chaleur series and in the Rochester of Maryland.

Lor 7.—In cliff half a mile south of the mouth of Logan brook:

<i>Stromatopora danielensis</i> Parks	<i>Camarotoechia</i> sp.
<i>Favosites</i> 2 sps.	<i>Nucleospira</i> ? sp.
<i>Cladopora</i> sp., crinoid discs	<i>Spirifer bicostatus</i> Hall
<i>Leptostrophia</i> sp.	<i>Delthyris</i> cf. <i>elevata</i> (Dalman)
<i>Strophonella</i> sp.	<i>Wilsonia</i> sp.
<i>Stropheodonta bipartite</i> (Hall)	<i>Proetus</i> sp.
<i>Schuchertella</i> sp.	

"The rocks are probably to be correlated with the Bouleaux-West Point succession" (Chaleur series).

Lor 16.—2½ miles south and about half a mile west of the mouth of Blanchet brook:

Favosites sp. (same as in lot 21 below)
Coelocaulus sp.
Strophostylus sp.

Lor 17.—South of Dartmouth river, 2,100 feet from a point about two miles downstream from Post brook:

Crinoid fragments
 Bryozoa (4 types)
Orthis sp.
Dalmanella cf. *elegantula* (Dalman)-Young
Rhipidomella sp.
Atrypa reticularis (Linnaeus) cf. *Pentamerus pes-ovis* Whitfield
 (short description given)
Camarotoechia sp.
Spirifer eriensis Grabau
Spirifer sp. (immature, near *S. Sulcatus submersus* Grabau); cf.
Clorinda sp.
Sieberella-like fragment; cf *Dalmanites angelini* Barrande

"This lot is high in the Silurian . . . Some of the fossils present have been cited from the Bouleaux limestone but others present suggest an even higher horizon".

Lor 21.—500 feet south of lot 17, Blanchet township:

Halysites catenulatus Linnaeus
Cladopora sp.
Favosites sp. (same as in lot 16).

"The *Favosites* present at both localities 16 and 21 is a little finer than *F. cervicornis* of the Devonian . . . The presence of the *Halysites* at locality 21 indicates that the rocks are of Silurian age, in spite of the affinities of the *Favosites*".

Lor 18.—Dartmouth river, 1½ miles above Lady Step brook:

Stropheodonta cf. *schuchertana* Clarke
Rhipidomella cf. *hybridoides* Clarke

"These Dr. Kindle classified as 'probably Lower Devonian'."

The available partial collections of fossils from this belt were submitted at a later date, along with many others from eastern Gaspé, to Dr. T. H. Clark of McGill University for examination. The forms identified by Clark are as follows:

Lot 4.—*Streptelasma* cf. *latusculum*
Favosites sp.
Dalmanites sub-carinata

Lot 7.—*Stropheodonta bipartita*
Orthotetes cf. *becraftensis*
Camarotoechia dryope
 ? *Reticularia bicostata*
 ? *R. bicostata marylandiensis*
Nucleospira sp.
Proetus sp.

Lot 21.—*Halysites catenulatus*
Favosites sp.
Cladopora sp.

The lists furnished by Dr. Wilson and the examination of the few lots submitted to Dr. Clark led the latter to conclude that this Dartmouth River belt is partly Silurian and partly Devonian. Lot 4 is believed to represent the Lower Devonian; and lot 21, Silurian or Devonian. Lot 7 suggests a transition zone, including both Silurian and Devonian forms.

Thus, both Middle Silurian and Upper Silurian to Lower Devonian horizons seem to be represented in this narrow belt. And, in the same belt, exposed where Dartmouth river, running south, cuts across it, a small fossil collection (lot 18) suggests a Lower Devonian age. Eastward from this latter locality, the apparently identical and geographically continuous band of rocks yields fossils that are almost unanimous in their indication of a Lower Devonian age, and the band is mapped as being St-Alban.

LADY STEP IGNEOUS SERIES

(Silurian ? and Devonian)

Volcanic and intrusive rocks occur in the northern part of the region in the townships of Baie-de-Gaspé-Sud, Galt, and Blanchet. These rocks are designated the Lady Step series. Included in this series are the Mount Serpentine intrusives. The intrusive rocks are younger than the associated Lower Devonian limestones. The various rock types of the series have been mapped as a unit: much more detailed work than has been done would be required to differentiate them.

The rocks of undoubted volcanic origin are of various kinds. A dark green, in places amygdaloidal, schistose, flow ? rock is overlain by tuffaceous volcanics that are mostly light green to grey in colour. The various types range from fine to coarse in texture; some are banded, and some may be classed as volcanic breccias or agglomerates, according as the enclosed fragments are angular or rounded. As the top of the series is approached, the sedimentary material tends to increase, with transition, in places, to tuffaceous sediments. These volcanic rocks are all so highly altered it is difficult to determine their original composition with certainty, but they

probably were andesitic flows in the lower part of the series and andesitic tuffs in the upper, southeastern part.

The age of this volcanic series is not definitely known. On Salmon-hole brook, the overlying rock is a conglomerate containing pebbles of quartz with some, also, of the tuff. This conglomerate grades upward in a short space to sandstone and then to limestone containing what are considered to be Upper Silurian fossils. Thus, the volcanics are not younger than Upper Silurian, and there is a possibility that they are Ordovician in age.

SALMON-HOLE BROOK BEDS

Rocks believed to be of Silurian age were found in 1934 along Salmon-hole brook, in the northeastern corner of Galt township. Here the volcanics described above are overlain by a 7-foot band of conglomerate containing pebbles of quartz, quartzite, and volcanic material. The conglomerate grades quickly to a greenish-grey sandstone, and, in a thickness of thirty feet, grades upward to calcareous sandstone, arenaceous limestone, and then massive, light grey to almost white, crystalline limestone containing abundant fossils. A short distance farther up the stream, the limestones are of the dark grey type more characteristic of the Devonian.

The fossils that have been determined (1) are as follows: fragments of bryozoa and crinoid stems, *Favosites*, sp. (resembles *F. hisingeri*), *Pholidops*, sp., *Dalmanella* cf. *elegantula* (Dalman), *Chonetes jerseyensis* Weller, *Hindella congregata* var. *pusilla* Swartz? *Rhynchospira* cf. *globosa* Hall, *Gypidula* sp., *Atrypa reticularis* Linnaeus, *Spirifer corallinensis* Grabau, *Nucleospira*? sp., *Stromatopora*? *aporita* Parks.

Drs. Kindle and Wilson placed these rocks in the late Silurian, about the level of the Cobblekill of New York and the Decker Ferry of New Jersey, on the basis of the brachiopod *Spirifer corallinensis* Grabau. At the same time, the occurrence of *Stromatopora*? *aporita* Parks was taken as an indication that the rocks carrying it were near the horizon of the Bouleaux formation of the Port Daniel-Gascons area, a horizon now definitely placed (2) as Middle Silurian, probably Lockport, in age.

SAINT-JEAN (JOHN) RIVER SILURIAN-DEVONIAN BELT

The Silurian and Devonian series of Saint-Jean (John) River valley occurs in two bands, one on the north and one on the south side of the river, on opposite limbs of a major anticlinal fold. The two bands merge at the eastern end of their exposure, as they plunge on the fold axis beneath younger rocks in the western part of York township. The northern band may be followed westward from York township to the western border of the region. The southern band is cut out by faulting near the western limit of Laforce township, and is not again exposed for about nine miles, or until within two and a half miles of the west line of Sirois township.

(1) Determined by E. M. KINDLE, and A. E. WILSON; see JONES, I. W., 1934, p.27.

(2) NORTHROP, S. A., 1939, *Op. cit.* p.102.

The thickness of the Silurian-Devonian has not been measured in detail anywhere on the Saint-Jean (John) River anticline. On the basis of dip and of width of exposure, and estimates of thickness of a generalized section, the average thickness is placed at about 2,500 feet.

The lowest formation or bed of the series is a massive limestone about 75 feet thick. This was definitely recognized only on the northern limb of the anticlinal, and it was exposed at but few places. The rock is fine-grained, grey to dark grey in colour, weathering to a light grey. It carries scattered pebbles and also lenses and patches of conglomerate. The pebbles are mainly of limestone, and from their shape and size and composition obviously were derived from well-bedded limestone similar to those of the underlying Upper Ordovician formation.

The dominating formation or member of the Silurian-Devonian here is a conglomerate lens. This is about 1,000 feet thick in its thickest part on the north side of the Saint-Jean (John) at the Owl capes and on the north side of Lazy Bogan brook. On the opposite, or south, side of the anticline, southwest of the Owl capes, between Burnt Jam and Porcupine brooks, there is a series of cliff faces exposing about 400 feet of the conglomerate zone. The formation is thinner on the south than on the north side of the anticlinal axis. It thins out to the west of the Owl capes until, about three miles from the western boundary of Laforce township, it practically disappears. Apparently it grades westward into limestone grit and into other and finer-grained limestone beds. The formation seems to thin out to the east also, but this is difficult to determine owing to the eastward plunge of the fold and the consequent progressive covering of the conglomerate layers by younger beds as the series is followed eastward.

The conglomerate is interbedded with shaly limestone, fine, finely banded, cross-bedded, arenaceous limestones or calcareous siltstones, and coarser beds of calcareous and feldspathic sandstone. The sandstone beds are composed of grains of grey feldspar, quartz, and limestone. They often show cross-bedding. The matrix of the conglomerate varies from relatively pure, fine-grained limestone to calcareous shale, calcareous siltstone, and coarse limestone grit. The pebbles in the conglomerate are chiefly limestones resembling those of the underlying Upper Ordovician formations. They are sub-angular and often lath-shaped. With them, however, are well-rounded pebbles of quartz, chert, and volcanics, and, less commonly, of jasper and of epidote-rich rock. Evidently these well-rounded pebbles were derived from a distance.

Rounded boulders of porphyritic diabase also are common here and there in the conglomerate. They are particularly abundant just to the west of the Owl capes, and again in the cliffs between Porcupine and Burnt Jam brooks. These well-rounded boulders are up to three feet in diameter, and, in view of their large size, it is probable that they are of local derivation. Lithologically, they are very similar to an intrusion of diabase between Cedar Barn and Willis brooks, and this may well have been the source of the boulders. However, this intrusion cuts rocks of the Saint-Jean (John) River Silurian-Devonian series, and a closer check on the stratigraphical succession is needed before we can definitely relate the boulders

to the intrusion. No evidence was observed, apart possibly from the boulders themselves, of the erosion interval within the series that would be required if the boulders were derived from this intrusion. Intrusions of similar diabasic rock, and related intrusions ranging from diabase to syenite in composition, occur to the south and southwest and also to the west. These are known to cut Middle Silurian sedimentaries, but they are several miles distant from the conglomerate. Intrusions of an earlier date have not been recognized in the region.

On the Wooden Bottom—Big fork of Saint-Jean (John)—brook, some 250 to 300 feet of interbedded conglomerate and shaly limestone is exposed. Here the individual conglomerate beds are up to four feet thick. The assortment of pebbles is much the same as that already given except that limestone and diabase fragments are scarce.

The conglomerate zone is overlain by several hundred feet of soft, greenish-grey, shaly limestone. Included in this upper zone is a massive 'reef' limestone varying in thickness from ten to thirty feet. The rock is light to dark grey in colour, very fine-grained in general but with common areas of fairly coarsely crystalline limestone. Such reef fossils as corals and stromatopores are frequently present and locally are abundant; they are poorly preserved for the most part. The weathered surfaces are grey in colour but are often streaked and mottled by brown and pale green stains. The type locality for this limestone is toward the head of the south branch of Ascah brook, near the eastern limit of the Silurian-Devonian exposures on the Saint-Jean (John) River anticline. So far as observed, this limestone is best exposed on the southern side of the fold axis; on the northern side it may be represented by certain 'reefy' patches or areas in the conglomerate zone. When freshly broken, this limestone almost invariably gives off an odour of petroleum.

Toward the western boundary of Sirois township, the conglomerate thins out to disappearance and its place in the section apparently is taken by a relatively thin zone of limestone grit. Associated with the basal beds in the western part are a few thin zones of red and green shale. The overlying rocks are finer-grained, shaly limestones to calcareous siltstones, of the same general type as those associated with, and overlying, the conglomerate to the east.

A few fossils were found in this Silurian-Devonian series at two localities in the western part of Sirois township. At both places they were in limestone grit. These fossils were determined by Dr. Rudolf Ruedemann as *Monograptus* cf. *regularis* Tornquist, *M.* cf. *tumescens* Wood, cf. *Grammysia* sp., and cf. *Ambonychia undata*. The graptolites, even though not specifically identified with certainty, very definitely indicate a Silurian age for the rocks, but they do not establish the division to which they belong.

Similar rocks, perhaps marking the same zone, in the western part of Laforce township, yielded *Monograptus clintonensis* (Hall) and some poorly preserved ostracods apparently of the genera *Beyrichia* and *Kloedenia*. This fauna strongly suggests the Middle Silurian. Eastward from this locality our collections give positive evidence of Silurian age within

the series at one locality only. This is on Porcupine brook, south of Saint-Jean (John) river in Baillargeon township, where *Monograptus clintonensis* again was found in massive, somewhat gritty limestones. This horizon underlies the conglomerate of the cliffs between Porcupine and Burnt Jam brooks.

The matrix of the conglomerate itself, at the cliffs just mentioned, has yielded the following forms:

<i>Stromatopora</i> sp.	<i>Gypidula</i> sp.
<i>Favosites</i> sp.	<i>Camartoechia</i> sp.
<i>Leptaena rhomboidalis</i>	<i>Wilsonia globosa</i>
<i>Plethorhyncha barrandei</i>	<i>Uncinulus</i> sp.
<i>Stropheodonia magniventer</i>	<i>Cymotrophia</i> sp.
<i>Leptostrophia irene</i>	<i>Proetus pachydermatus</i>
<i>Strophonella punctulifera</i>	<i>Dalmanites</i> sp.
<i>Atrypa reticularis</i>	

The 'reef' limestone at its type locality on Ascah brook provided the following:

<i>Heliolites</i> sp.
<i>Favosites</i> sp.
<i>Stromatopora</i> sp.

A bed tentatively correlated with the 'reef', and exposed 2,800 feet west of the mouth of McPhee brook, Baillargeon township, yielded:

<i>Stromatocerium</i> sp.
<i>Gypidula coeymanensis</i>
<i>Spirifer vanuxemi</i>

Fossils were collected at several localities in the Wooden Bottom Brook area at horizons close to the level of the 'reef', but whether above or below the 'reef' could not be determined definitely. A composite list of fossils from this general zone follows:

<i>Zaphrentis</i> sp.	<i>Wilsonia</i> sp.
<i>Favosites</i> sp.	<i>Chonostrophia</i> sp.
<i>Atrypa reticularis</i>	<i>Rhipidomella</i> sp.
<i>Leptaena rhomboidalis</i>	<i>Isorthis</i> sp.
<i>Schizophoria multistriata</i>	<i>Meristella</i> sp.
<i>Strophonella continens</i>	<i>Actinopteria</i> sp.
<i>S. cf. geniculata</i>	<i>Encrinurus ornatus?</i>
<i>Camartoechia</i> sp.	

Collections of fossils from the upper part of the series include the following:

A.—Baillargeon township, Burnt Jam brook, from outcrops beginning one and a half miles above the mouth and extending upstream for one mile; a composite list from localities 1-M-40 to 5-M-40:

<i>Zaphrentis</i> sp.	<i>Strophonella continens equiplicata</i>
<i>Atrypa reticularis</i>	<i>S. leavenworthana</i>
<i>Dalmanella subcarinata</i>	<i>Orthotetes becraftensis</i>
<i>Rhipidomella cf. lehuquetiana</i>	<i>Spirifer vanuxemi minor</i>
<i>Beachia amplexa</i>	<i>Cyrtina cf. rostrata</i>
<i>Stropheodonia pattersoni precedens</i>	<i>Pterinea</i> sp.
<i>S. schuchertana</i>	<i>Dalmanites</i> sp.

B.—Laforce township, at the forks of the West branch of Burnt Jam brook and for one-quarter mile east and west of the forks; a composite list from localities 7-M-40 to 9-M-40:

<i>Zaphrentis</i> sp.	<i>S. pattersoni precedens</i>
<i>Atrypa reticularis</i>	<i>Spirifer vanuxemi minor</i>
<i>Rhipidomella lehuquetiana</i>	<i>Camarotoechia</i> sp.
Cf. <i>Uncinulus mutabilis</i>	<i>Aviculopecten</i> sp.
<i>Stropheodonta rosieri</i>	

C.—Laforce township, Cedar Barn brook, about two and a half miles above the mouth in a small tributary stream:

<i>Dalmanella concinna</i>	<i>Brachyprion majus</i>
<i>D. cf. circularis</i>	<i>Rhipidomella</i> sp.
<i>Atrypa reticularis</i>	<i>Chonetes billingsi</i>
<i>Rhytistrophia</i> sp.	Cf. <i>Crispella elegans</i>
<i>Strophonella</i> sp.	<i>Leperditia</i> sp.

D.—Two localities, one on the centre line of Baillargeon township at 600 to 900 feet south of Mile 8 post (locality 22-M-38), the other some 6,000 feet to the east in Lazy Bogan brook (locality 21-M-38), at about the same horizon, gave the following composite collection:

Bryozoa	<i>Atrypa reticularis</i>
<i>Dalmanella</i> sp.	<i>Spirifer plicatus</i>
<i>Stropheodonta punctulifera</i>	<i>S. vanuxemi</i>
<i>S. pattersoni precedens</i>	<i>S. vanuxemi minor</i>
<i>Leptostrophia magnifica tullia</i>	<i>S. mucronatus</i>
<i>L. blainvilli</i>	<i>S. purchisoni</i>
<i>Strophonella continens</i>	<i>Leptocoelia flabellites</i>
<i>S. continens senilis</i>	<i>Cyrtina cf. chalazia</i>
<i>S. continens equiplicata</i>	<i>Aviculopecten cf. tenuilamelatus</i>
<i>Plethorhyncha</i> sp.	<i>Coelidium hebe</i>
<i>Camarotoechia alliplicata</i>	

The faunal lists given above do not afford any positive evidence of Silurian age for any of the rocks in this Silurian-Devonian belt east of Porcupine brook, in Baillargeon township. On Porcupine brook a Middle Silurian indicator, *Monograptus clintonensis*, is present in limestones underlying the conglomerate zone. The fossils identified by Clark from this latter zone indicate that the conglomerate is Lower Devonian in age. The relatively thin 'reef' limestone of the Ascah Brook section, toward the eastern end of the belt, may be Silurian. But, if Silurian, it would appear to belong to the Upper division of that period. It may be related to somewhat similar limestones in the St-Alban formation at its type section. In the composite list, given above, of fossils collected close to the level of the 'reef', the elements are chiefly Lower Devonian, but the trilobite *Encrinurus ornatus*? — if unquestioned as that species — would be indicative of the Middle Silurian. This form was collected from a horizon just below the reef.

The composite lists, A, B, C, and D, of fossils collected from the upper part of the series quite definitely suggest the Lower Devonian. They do, in fact, suggest the Grande Grève, although the general zone in which they occur occupies a stratigraphic position below the Grande Grève and, apparently, coincides with the lower part of the Cape Bon Ami formation. In view of the relative sparseness of the known Cape Bon Ami faunas

elsewhere in the region, we hesitate to place this zone in that formation until further information and evidence are obtained. Separation of this zone from the Silurian-Devonian series could have been effected in the mapping only in a somewhat arbitrary way and applied only to a part of the area concerned.

MOUNT ALEXANDER BELT

Middle Silurian rocks underlie a wide area in the southwestern part of the region, where they reach across the township of Vondenvelden and almost across the township of Power to the east. The greater part of the area underlain by these rocks was described in 1936, by Jones (1), from whose report the following description is largely summarized.

The series lies in a syncline plunging to the west. It is made up of sedimentary rocks with one thick zone of predominantly volcanic rocks. Folding within the series and the lack of good natural sections across the beds make it impossible to determine thicknesses closely. However, it is estimated that the volcanic zone is at least 3,000 feet thick. This zone occupies a stratigraphic position about in the middle of the series, and it is overlain, and, also underlain, by sedimentaries which appear, in each case, to have a thickness of 3,000 to 5,000 feet. Thus, the total thickness of the series is probably between 9,000 and 12,000 feet, an estimate comparable with the measured 13,000 feet for the Chaleur series section at Black cape.

In general terms, the sedimentary rocks of the Mount Alexander belt show little variation as between the zone above and that below the volcanics. For the most part they are grey to greenish-grey shales and thin-bedded shaly to finely sandy limestones. Interstratified with these rocks are rather rare beds and thin zones of white quartzite, white crystalline limestone, dolomitic limestone, limestone conglomerate, and red shales.

The volcanics are chiefly massive, strongly porphyritic, and locally amygdaloidal, andesites. The phenocrysts are large on the average, ranging up to half an inch in length. They are mainly of pale green labradorite set in a groundmass of similar feldspar with a minor amount of augite. Layers of agglomerate up to nearly 100 feet thick are present locally. These are made up of rounded to semi-angular masses up to one foot in diameter of the porphyritic andesite in a matrix of similar material. Sedimentary rocks are often interzoned with the flows, particularly on the south side of the synclinal axis and westward from mount Alexander on the north side.

The volcanic zone is well marked by the topography, and also by outcrops, on both sides of the synclinal axis in Vondenvelden township. However, to the eastward, in Power township, and particularly around the nose of the syncline, evidences of the presence of this zone are relatively meager. Thus, it is possible that the volcanics fade out toward the east. There is no sign that they extended to the north as far as the Saint-Jean (John) River Middle Silurian-Lower Devonian belt. They are known to continue

(1) JONES, I. W., *Mount Alexander Map-Area*; Que. Bur. Mines, Ann. Rept., 1936, Pt.D.

to the west to a position between Bonaventure and Little Cascapedia rivers, and, to the south, it is possible that they had a direct connection with the Middle Silurian volcanics of the Black Cape section.

The sedimentary rocks of all three zones in this series have yielded small collections of fossils from several localities. These have been determined by Dr. A. E. Wilson, of the Geological Survey of Canada, and reported by Jones (1936). From the zone below the volcanics, the following have been collected:

Favosites gothlandicus (Fought) var.
F. cf. hisingeri Milne-Ed. and Haine
Halysites compactus Rominger
Cf. Camarotoechia sp.
Coelospira sp.
Spirifer cf. radiatus (cf. *Eospirifer radiatus*)
Cf. Letorhynchus sp.
Encrinurus cf. ornatus

From limestones near the base of the volcanic zone and interbedded with the volcanics, the following were collected near mount Observation:

Stromatopora sp.
Cf. Diphyphyllum sp.
Favosites sp.
Heliolites interstinctus (Linnaeus)
Heliolites sp. (very fine)
Lyellia sp.
Leptaena rhomboidalis Wilckens, var.
Cf. Delthyris sp.
Cf. Parastrophia sp.
Strophonella sp.

The following were obtained from the sedimentary zone above the volcanics:

<i>Stromatopora</i> sp.	<i>Atrypa</i> sp.
<i>Aulopora</i> sp.	<i>Camarotoechia</i> sp.
<i>Cf. Cladopora</i> sp.	<i>Coelospira</i> sp.
<i>Cf. Cyathophyllum</i> sp.	<i>Cf. Delthyris</i> sp.
<i>Diphyphyllum</i> sp.	<i>Cf. Delthyris</i> sp.
<i>Favosites cf. hisingeri</i>	<i>Leptaena rhomboidalis</i> (Wilckens),
<i>Favosites</i> sp.	and var.
<i>Halysites catenularia</i> (Linnaeus)	<i>Meristina</i> sp.
<i>Halysites</i> sp.	<i>Spirifer crispus</i> Hisinger (<i>Crispella</i>
<i>Streptelasma cf. pygmaea</i> (Billings)	<i>elegans</i> Muir-Wood)
Crinoid stem sections	<i>Spirifer</i> sp.
Bryozoa	<i>Cf. Whitfieldella</i> sp.
<i>Atrypa reticularis</i> (Linnaeus)	<i>Wilsonia</i> sp.
<i>A. cf. nodostriata</i> (Hall)	<i>Leperditia</i> sp.

In 1939, Northrop (1) provided a composite list of the fossils collected by Jones from this series, with certain revisions as shown in the lists given above. Also, he included two identifications not given in Jones' lists. These show the presence of *Stromatopora cf. danielensis* and of two species of *Conchidium*.

(1) NORTHROP, S. A., *Paleontology and Stratigraphy of the Silurian Rocks of the Port Daniel-Black Cape Region, Gaspé*; Geol. Soc. Am., Sp. Paper No. 21, 1939, p. 94.

In addition to the above, a locality on the north side of the synclinal axis two miles west of the centre line of Power township, above the volcanic zone, yielded *Heliolites* sp., *Rhipidomella* sp., and *Phacops* sp.

Both Wilson and Northrop assigned this series to the Middle Silurian and compared it with the Chaleur series of Port Daniel and Black Cape. According to Northrop (1939, p.95), it "may represent practically the entire Chaleur series". Also, from considerations of stratigraphic position and fossil evidence, the Mount Alexander series may be correlated in a general way with the Middle Silurian part of the section in the Silurian-Devonian belt along Saint-Jean (John) river. This being so, it is apparent that the Silurian thins out toward the north, for the total thickness of the Silurian-Devonian section as mapped in the more northern belt is less than half the thickness of the sedimentaries in the Mount Alexander belt. And, as is pointed out below, the series either thins out very rapidly to the eastward or is cut out in that direction by faulting. It may be that both factors operated to reduce or to eliminate the Silurian to the east. However, faulting on the scale required has not been demonstrated, and we incline to the view that the series originally thinned out in the easterly direction.

GRANDE RIVER-PORTAGE RIVER BELT

A narrow band of rocks in the southern part of the region, lying between the Ordovician on the south and the undoubted Devonian on the north, is subject to some uncertainty so far as age is concerned. This band seems to stem from the Mount Alexander Silurian series just described, extending eastward from the northern edge of that series at a point about two miles east of the Power-Vondenvelden line to a position on Portage river about three miles from the coast. In its eastern part, the band lies along the northern side of Portage river and in its western part it follows along the northern side of the West branch of Grande river.

The band is offset here and there, or even cut out, by faulting. Its normal or average width, where not affected by faulting or folding, is slightly over 1,000 feet. As the beds are nearly vertical, the width is a close measure of the thickness.

In the western part, the rocks of this belt are generally similar to the sedimentaries of the Mount Alexander series. There is here, however, a massive limestone bed or lens, somewhat over 100 feet thick and exposed over a length of 3,000 feet, that seems to be unique in the region. This is found about one mile west of the centre line of Fortin township. It resembles the 'reef' limestone of the Ascah Brook area in the Saint-Jean (John) River Silurian-Devonian belt in a general way, but it lacks the fossils and the petroliferous odour of that formation.

A reefy, fossiliferous limestone with petroliferous odour does occur, and persistently, across eastern Joncas and western Fortin township. As in the Ascah Brook 'reef', it carries stromatopores and corals. It varies in thickness from about twenty-five to seventy-five feet. The beds above the reefy limestone are dark grey, firm limestones, while those below are well-bedded, grey, fine-grained, sandy limestones.

Farther to the east, or east of the centre line of Fortin township, the reefy limestone was found in place at only one locality. This was about one mile east of the line. Débris that apparently came from this limestone was noted as one large boulder on Otter brook and a few boulders on the next brook to the west of Otter brook. All other rocks of this belt seen to the east of the centre line of Fortin were well-bedded, grey, often brownish-weathering, fine-grained, arenaceous limestones.

The following fossils were found in the reefy limestone zone:

Lor 24-M-38.—Joncas township; North branch of Grande River, about 6,000 feet north from the junction with the main or West branch.

<i>Stromatopora</i> sp.	<i>Halysites catenulatus</i>
<i>Favosites</i> sp.	<i>Atrypa reticularis</i>

Lor 27-M-38.—Joncas township, in brook 1,000 feet west of the Fortin centre line; 1,500 feet south of Mile IV.

<i>Heliolites</i> sp.	<i>Cyclonema</i> sp.
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Lor 29-M-38.—Fortin township; about 4,000 feet west of the centre line, and immediately south of the range VII-VIII line. A composite list through a zone of reefy, knobby limestones interbedded with arenaceous limestones; the zone is 300-400 feet thick.

<i>Favosites</i> sp.	<i>G. cf. prognostica</i>
<i>Atrypa reticularis</i>	<i>Leptaena rhomboidalis</i>
<i>Cyphotrypa corrugata</i>	<i>Rynchotrema formosa</i>
<i>Gypidula angulata</i>	? <i>Stropheodonta pattersoni</i>

Lor 35-M-38.—Fortin township; in brook two miles west of the centre line; about in the middle of the continuation of range VII.

<i>Streptelasma</i> sp.	<i>Halysites</i> sp.
<i>Favosites</i> sp.	

Lor 15-M-39.—Fortin township; one mile east of the centre line, about on the line between ranges VII and VIII.

<i>Stromatopora</i> sp.	<i>Syringopora</i> sp.
<i>Favosites</i> sp.	<i>Lyellia</i> sp.
<i>Halysites catenulatus</i>	<i>Atrypa reticularis</i>

Fossil lots collected in arenaceous limestones, probably both above and below the reefy limestone zone, but farther east in this 'Silurian-Devonian' belt, include the following:

Lor 23-M-39.—Malbaie township, range III south; on Portage river, one-quarter mile east of the mouth of Biscuit creek.

<i>Stromatopora</i> sp.	<i>Striatopora</i> sp.
<i>Aulopora</i> sp.	<i>Favosites</i> sp.

This locality probably is the same as that of C. H. Kindle (1), who states that a "section is exposed along Portage river a half mile below Biscuit creek, where the beds contain an abundance of corals and stromatoporoids". The fossils listed by Kindle from this locality are *Stromatopora* sp., *Zaphrentis cingulosa*?, *Favosites cf. helderbergia*, and *Phacops* sp.

(1) KINDLE, C. H., in ALCOCK, F. J., *Geology of Chaleur Bay Region*; Geol. Surv. Can., Mem. 183, 1935, p.67.

Lot 32-M-39.—Malbaie township, about on the line between ranges III and IV south; half a mile north of the mouth of Biscuit creek.

<i>Orbiculoidea bella</i>	<i>Plethorhyncha barrandei</i>
<i>Meristella</i> sp.	<i>Spirifer purchisoni</i>
<i>Stropheodonta magna</i> <i>tullia</i>	

Lot 35-M-39.—Malbaie township; 800 feet east of the Fortin line, and 2,500 feet north of Portage river, in a small brook.

<i>Camarotoechia altiplicata</i>	<i>Plethorhyncha barrandei</i>
<i>Stropheodonta magna</i> <i>Orthotetes deckerensis</i>	<i>Uncinulus nucleolatus</i>
<i>O. interstriatus</i>	<i>Dalmanites</i> sp.

Lot 35A-M-39.—Same locality as lot 35-M-39 but ten feet farther north; presumably above lot 35, although the fossils of lot 35 suggest a younger age than those of lot 35A.

<i>Camarotoechia formosa</i>	<i>Spirifer purchisoni</i>
<i>Dalmanella</i> cf. <i>concinus</i>	<i>Spirifer</i> cf. <i>plicatus</i>
<i>Meristella</i> sp.	<i>S.</i> cf. <i>vanuxemi minor</i>
<i>Rhipidomella</i> cf. <i>lehuque-</i> <i>tiana</i>	<i>Trematospira multistriata</i>
<i>Stropheodonta</i> cf. <i>magna</i> <i>tullia</i>	<i>Whitfieldella</i> sp.
<i>S. varistriata</i>	<i>Dalmanites micrurus</i>
	<i>D.</i> cf. <i>cozius</i>
	<i>D.</i> cf. <i>biardi</i>

Perhaps the main points for comparison in the above lists are the fossils of lots 35-M-39 and 35A-M-39 and those collected to the westward in this belt. Lots 35 and 35A definitely indicate the Lower Devonian, and the same is true of the lots collected to the eastward. We have no hesitation, therefore, in referring this eastern part of the belt, in Malbaie township, to the Lower Devonian Mont Joli formation of the Percé area, which, in turn, may be correlated with the St-Alban or younger formations. The fossils collected to the westward, if taken by themselves, rather suggest the Silurian than the Devonian. The occurrence and association of the corals *Halysites* and *Heliolites*, in particular, would stamp the rocks as Silurian in the minds of many. Also, in lot 29-M-38 there appears to be an intermingling of Upper Silurian (Decker Ferry and Keyser) forms with others that suggest lowest Devonian (Helderberg). Thus, as in the Dartmouth River belt to the north, the possibility is suggested that the belt is made up of Silurian rocks in its western part, but of Lower Devonian rocks toward the east. This possibility gains further support from the fact that such a division would come at a gap in the continuity of the band just to the west of the Fortin-Malbaie township line. This gap is about three miles wide. It is interpreted on the accompanying map as being caused by a fault which brings the Ordovician against the Grande Grève. But it may be that the gap is due to erosion in lowest Devonian time or to non-deposition in Silurian time.

However, there is here some evidence which suggests that the 'Silurian' age of the rocks to the west of the gap is more apparent than real. Arenaceous limestones, similar to those of lots 35 and 35A in which Lower Devonian fossils occur, appear to the west beneath the purer, reefy limestones that carry the 'Silurian' corals. No distinctive fossils were found in place in these arenaceous limestones to the west, but débris from them, carrying fossils

very similar to those of lot 35A, were noted in a few brook beds. No physical evidence pointing to a reversal of the section by faulting was observed. It is suggested, therefore, that we have here, in far eastern Gaspé, much the same association of forms as found by Clark (1) in at least one district of the Eastern Townships of Quebec. In calcareous shale of the Lake Aylmer series, Clark obtained the following forms: *Zaphrentis* sp., *Amplexus* sp., *Favosites* sps., *Heliolites* sp., abundant crinoid columnals, *Strophonella geniculata* (Hall), *Strophonella punctulifera* (Conrad), *Gypidula galeata* (Dalman), *Camarotoechia litchfieldensis* (Schuchert), *Atrypa reticularis* (Linné), *Atrypina imbricata* (Hall). At another locality, but from the same series, the form "*Halysites* sp., probably *H. catenulatus* Linné" was found, associated with several other fossils. Of this form, Clark says (p.50): "The writer has collected this coral from two other localities in Quebec, where, as at this one, it is associated with Devonian fossils . . . There can be no doubt as to its extension into the Devonian in southern Quebec".

In view of the considerations given above it is concluded that the band of rocks just described is Lower Devonian in age and the equivalent of the Mont Joli, in its eastern extension at least. Silurian rocks may be present in the continuation of the band westward from the centre line of Fortin township, but there is reason for suggesting that the whole band may be Lower Devonian in age.

(1) CLARK, T. H., in COOK, H. C., *Thetford, Disraeli, and Eastern Half of Warwick Map-Areas, Quebec*; Geol. Surv. Can., Mem. 211, 1937, p.51.

DEVONIAN

GENERAL STATEMENT

Lower and Lower-to-Middle Devonian formations totalling a great thickness underlie much of the present region as well as wide areas throughout the central belt of the peninsula. Logan (1863) recognized two general divisions, a lower and an upper, which he designated the Gaspé Limestones and the Gaspé Sandstones, respectively. These general divisions are still useful for descriptive purposes, although the latter might be better described as a sandstone and shale series. Its age is placed by some as Lower Devonian and by others as Middle Devonian. The limestone, or underlying, series is unquestioned as Lower Devonian. An Upper Devonian age for certain formations in the present region has been suggested, but rocks definitely of that age are known in the peninsula only at Escuminac bay, on the north side of the inner part of Chaleur bay.

The following formations, given in descending order, comprise the Gaspé Limestone series in this region:

FORMATION	DESCRIPTION	THICKNESS		
		TYPE SECTION		INLAND AREA
		LOGAN-CLARKE	PRESENT(1)	
GRANDE GRÈVE	Dark, well-bedded, hard, siliceous to cherty limestones and calcareous siltstones. . . .	800 ft.	1,387 ft.	4,500 ft.
CAPE BON AMI	Dark, well-bedded, shaly to finely sandy, often magnesian, limestones; softer than the Grande Grève, and in generally thicker beds; some dark shales.	1,050 ft.	1,085 ft.	6,000 ft.
ST-ALBAN	Greenish-grey, soft, shaly limestones with massive, reefy limestone beds; some red and green shales to shaly limestones.	160 ft.	336 ft.	2,350+ft.
		2,010 ft.	2,808 ft.	

The striking feature of the above outline of the Gaspé Limestone series is the wide variation in the thicknesses of the formations as between the type area and inland areas. Some part of such variation may have resulted from the practice of mapping the various formations on a lithological basis. And, in the present case, the possibility that we have allowed

(1) The thicknesses given in this column are based on Russell's measurements; the present author is responsible for the redefinition of the formations. See RUSSELL, L. S., *Preliminary Report on the Stratigraphy of the Gaspé Limestone Series, Forillon Peninsula*; Que. Dept. Mines, P.R. No.195, 1946.

too great or too little a thickness for a given formation in a given part of the region is freely admitted. However, when the total thicknesses of various inland sections are compared with the total thickness of the type section, it is at once obvious that the type section is, relatively, very thin.

The series of columnar sections given in Figure 3 show wide variations of thickness along the strike within a relatively short distance. The discrepancies between the various sections may be explainable in part by lack of information. The coastal or type section has been studied and measured in detail by Logan and by Russell. The three succeeding sections to the west, however, have not been considered in such detail, and the number of exposures mapped do not indicate that similar detail is feasible. The Sydenham River and the Dartmouth River sections offer better opportunities for studying the succession, and, particularly on the Sydenham, some generalized measurements have been made. Thus, it may be that the apparently excessive thickness of the Cape Bon Ami in the Renard River section has resulted from repetition by faulting or warping. If such is not the case, then irregularities of deposition, perhaps resulting from an irregular coast-line and sea-bottom, must be called upon to explain the irregularities of thickness. In any event, it seems evident that the Gaspé Limestone series as a whole increases in thickness — more than doubles in thickness — going from east to west in a distance of some twenty-five miles. Likewise, as shown by some of the cross-sections given with the accompanying maps, the series thickens to the south in such degree that both the Grande Grève and the Cape Bon Ami are individually double or more than double the thickness of the entire series at its type locality.

The three formations established by Clarke for the Forillon section of the Gaspé Limestone series are re-defined to some extent by us to provide more generally recognizable bases for inland mapping. The main features of our definitions are provided in the tabulated outline given above, and are given in summary below. The St-Alban formation comprises the green and red shales and limestones, reefy limestones, and conglomeratic beds of the lower part of the series. It includes the lower three divisions (330 feet) of Logan's section and the lower two divisions (336 feet) of Russell's section. As already shown, this formation is recognized as such only from the type section westward along the strike for twenty-five miles, or to Dartmouth river. Elsewhere, it is not separated from the Silurian. The Cape Bon Ami is defined as beginning with and comprising mainly, grey and dark grey shales and limestones, the latter often magnesian. Thus, it includes Logan's divisions 4 and 5 and part or all of division 6, and it includes Russell's divisions 3 to 5 and part of division 6. Under Clarke's definition, it included Logan's divisions 3 to 6. The Grande Grève formation, as re-defined, is characterized by hard, siliceous to cherty limestones, or, as is general in the interior, by hard, sometimes cherty, calcareous siltstones. The débris from these beds is almost uniformly in small, angular fragments, weathering light grey to white.

The Gaspé Sandstone series includes the following sub-series and formations, in descending order:

- | | |
|--|------------|
| 5. MALBAIE FORMATION. — Characterized by conglomerate zones;
includes sandstones, some shales, and very occasional lime-
stones..... | 2,000 feet |
|--|------------|

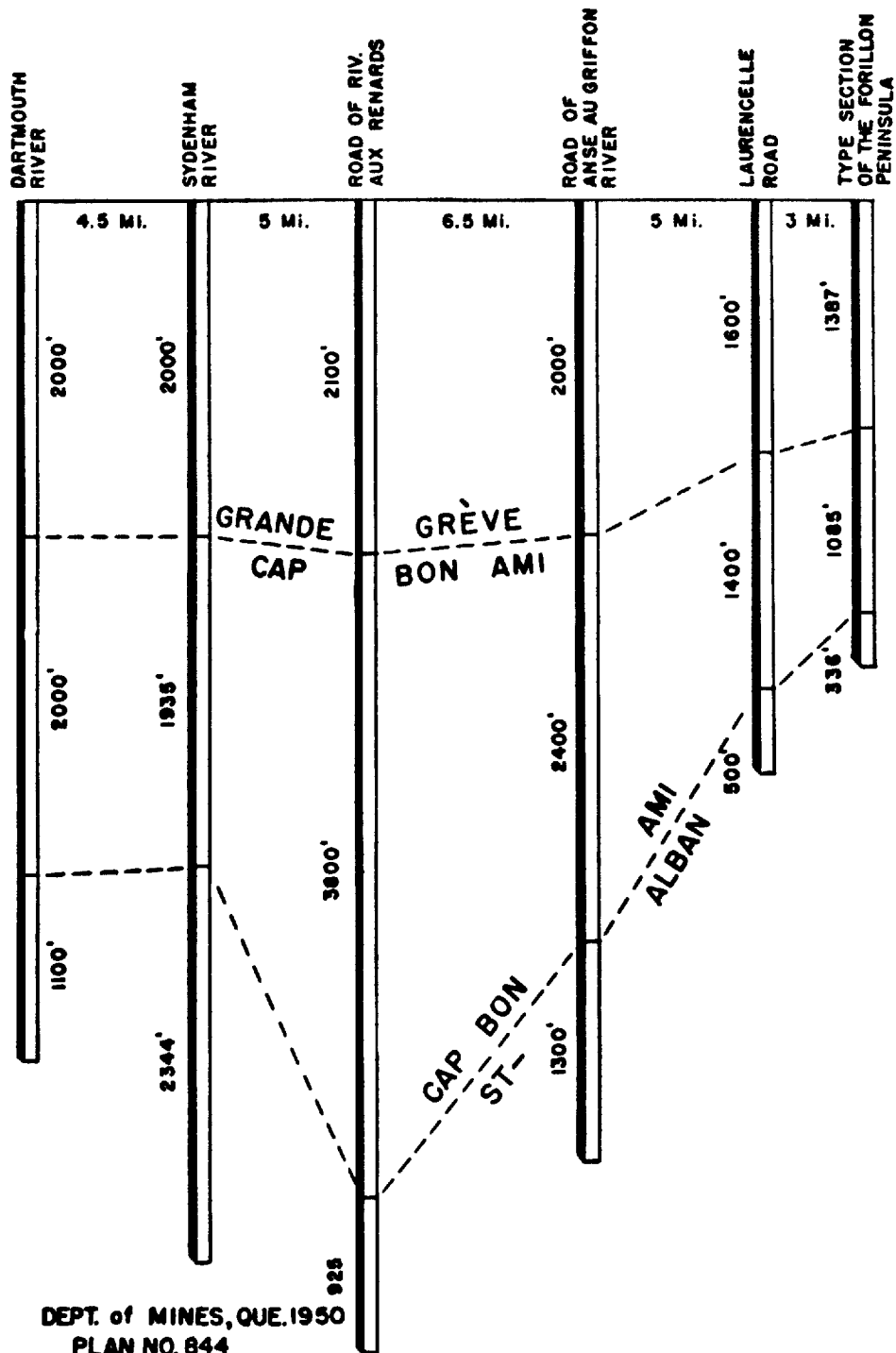


Figure 3.—Columnar sections of the Gaspé Limestone series from the Forillon westward along the strike to Dartmouth river. Top of Grande Grève used as datum plane.

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4. BATTERY POINT FORMATION. — Greenish-grey, coarse, feldspathic (red to brown feldspars), often pebbly sandstones; some conglomerates and shales; red beds toward the top. . . . 5,000-7,000 feet
 3. YORK RIVER FORMATION. — Greenish-grey, fine to coarse, feldspathic (grey feldspars) sandstones; common, soft, green shale. 1,000-6,000 feet
 2. FORTIN SERIES. — Dark shaly slates with interbeds to interzones of dark shaly limestones and of sandstones and conglomerates. This series probably is a facies referable to the general horizon of the York Lake. It is known only on the south side of the Saint-Jean (John) River anticline. 0-5,000± feet
 1. YORK LAKE SERIES. — Interbedded sandstones of York River type and limestones of Grande Grève type, with shaly limestone, conglomerate, and quartzose sandstone. This series marks a transition from the Grande Grève to the York River. It is known only on the north side of the Saint-Jean (John) River anticline, and it is not recognized everywhere in this more northern area. 0-4,000± feet

Here again, as in the limestone series, the subdivisions of the Gaspé Sandstones show much variation in thickness. The persistent horizon is that of the York River formation, and it is this formation which makes up much of the Gaspé Sandstones throughout the peninsula. Also, the York River formation has provided the great majority of the marine faunas known from the series. The Battery Point formation appears to grade in part into the York River formation both laterally and vertically. Thus to some extent, it may be considered as a phase of the York River. But, the Battery Point formation, alone, is represented in the 7,036 feet of section measured by Logan, a measurement which usually has been applied to the Gaspé Sandstone series as a whole. The Battery Point is recognized only in the eastern part of the region. It is well exposed along the south shore of Gaspé bay. The Malbaie formation is restricted to the coastal area in the southern portion of the region. The term 'Fortin series' is introduced here to cover a wide development of rocks on the south side of the Saint-Jean (John) River anticline. It is predominantly a shaly zone, with strong slaty cleavage. It overlies the Grande Grève and grades laterally (eastward), and apparently upward, into the York River formation. Thus, its stratigraphical position is roughly that of the transitional York Lake series. The Fortin series is known to extend westward to Matapedia valley, where all earlier workers have mapped it as part of the Ordovician Matapedia series (1)

As indicated above, the section of the Gaspé Sandstone series provided by Logan (1863), and since generally accepted as the type section, is essentially a section of only the Battery Point formation or phase. The base of Logan's section was at Tar point, where the rocks are bent in an anticlinal fold, and where, as a result of this fold, a thin zone of the York River type of sandstone is exposed under the Battery Point type. In 1910, Williams (2) suggested the term 'York River beds' for the basal, calcareous, and

(1) MCGERRIGLE, H. W. *A Revision of the Gaspé Devonian*; Trans. Royal Soc. Can., Sect. IV, Vol. XL, 1946, pp.41-54.

(2) WILLIAMS, H. S., *Age of the Gaspé Sandstones*; Geol. Soc. Am., Bull., Vol. 20, 1910, pp.688-698.

fossiliferous beds of the Gaspé Sandstone series. However, these beds are not included in Logan's type section, although Logan referred to them as if they were included. Something of this confusion was realized by Kindle (1) in 1938. Kindle recognized the term 'York River' and accepted Williams' general definition of it. He proposed, however, that this was a western and generally marine facies of the Gaspé Sandstones which corresponded almost exactly with, and graded eastward into, the generally non-marine 'Peninsula facies'. The rocks included in the 'Peninsula facies' by Kindle's definition are referred by us to the Battery Point formation.

LOWER DEVONIAN

St-Alban Formation

The St-Alban formation lies close to or within the debatable ground at the Silurian-Devonian boundary, but it is considered here as representing the base of the Devonian section in Gaspé peninsula. The type section of the formation is in the shore cliffs at the foot of Mount St-Alban, two and a quarter miles south of Cap-des-Rosiers village. This section was not well chosen as the type for it provides the minimum thickness (336 feet) of any part of the trace of the formation between the shore and Dartmouth river, twenty-five miles to the west. In this distance, the formation averages 1,000 feet thick. The maximum thickness was found on Sydenham river, Sydenham township, where some 2,350 feet of sediments were assigned to the formation.

The lowest part of the St-Alban formation has been designated the 'Griffon Cove River beds' by E. M. Kindle (2). In summary, Kindle recognized a thickness of 400 feet of these beds in the Griffon Cove River section, and 200 feet in the Renard River Road section to the west. He reports them also from Sydenham river, but without giving details as to section or thickness. The succession of these beds in the Griffon Cove River section is as follows, after Kindle (p.17):

Top of section 35s begins some 400 yards below waterfall over limestone at road bridge.

GRIFFON COVE RIVER BEDS

STATION		THICKNESS
35s	Drab limestones softer than <i>r</i> and argillaceous, partly covered..	225 feet
35r	Thin bedded magnesian limestone bands with black stems of plants (?) and calcareous bands with small brachiopods. Forms short gorge 20 feet wide.....	20 "
35q	Limestone shale and covered.....	40 "
35p	Hard limestone bands with bulbous fossils (<i>Scyphocrinus</i>); three on surface of slab in place 2 inches in diameter with four partitions.....	2 "
35o	Red shale with bands of grey shale (plant fragments in latter)..	60 "

(1) KINDLE, E. M., *The Correlation of Certain Devonian Faunas of Eastern and Western Gaspé*; Bull. Am. Pal., Vol. 24, No.82, 1938, pp.27-29.

(2) KINDLE, E. M., *The Correlation of Certain Devonian Faunas of Eastern and Western Gaspé*; Bull. Am. Pal., Vol. 24, No.82, Dec., 1938.

35n	Conglomerate, largely of quartz and greenstone pebbles	15 "
35m	Thin bedded calcareous sandy shale with hard limestone and conglomerate bands	2 "
35l	Coarse conglomerate SiO ₂ pebbles. Str. S.25°E.-D.28°S.W.	6 inches
35lI	Hard, thin-bedded magnesian limestone with small Spirifers	12 feet
35k	Covered	25 "
35kI	Grey shale	2 "
35kII	Conglomerate	2 "

There then follow Kindle's 'Cape Rosier beds', beginning with 125 feet of red shale with green bands. Kindle states that the boundary between the Devonian and the Ordovician is drawn here on "a provisional basis" and that "it may be somewhat lower".

In the Renard River Road section, Kindle (p.16) reports the following succession:

(Starting near top of south slope of Mountain ridge)

STATION		THICKNESS
20g	<i>Grande Grève Limestone</i> (top of section) Hard blue-grey limestones decaying to soft buff rock	50+ feet
20f	<i>Cape Bon Ami Beds</i> Shaly calcareous beds, largely covered, with numerous trilobite tails, etc.	?
20e	Blocky, green to drab, rather soft shale with some bands of reddish shale. Fossils scarce. <i>Taonurus</i> seen	600± "
20d	Hard sandy shale with calcareous lenses, small <i>Spirifer</i> abundant	250± "
20c	<i>St-Alban Beds</i> Coarse grey limestone in thin sheets interbedded below with sandy shale. Small brachiopods (<i>Spirifer</i>) and <i>Favosites</i> common	170± "
20b	<i>Griffon Cove River Beds</i> Shales with two calcareous reefs of Stromatoporoids. Large ostracodes abundant in rather dark shale below lowest reef	150 "
20a	Sandy greenish shale with interpolated bands of limestone in basal 20 feet	40 "
	Lowest limestone band with large ostracodes and corals abundant	10 "
B	<i>Cape Rosier Beds</i>	
A	Black shale with occasional thin lenses of conglomerate	30+ "

Kindle did not work out the Sydenham River section in the same detail as the two foregoing. The most interesting feature about it was the discovery of '*Scyphocrinus*?' in certain of the lower beds about a quarter of a mile south of a conglomerate on, and near the mouth of, Marble brook. This conglomerate, Kindle believed, marked the top of the Ordovician in this section.

The fossils found in these beds at their type section in Griffon Cove river, and listed by Kindle (p.20), include *Scyphocrinus* (*Camarocrinus*) sp., and 40 to 50 feet higher, the following:

- 1.—*Schuchertella becraftensis* (Clarke)
- 2.—*Camarotoechia semiplicate* (Conrad)
- 3.—*Uncinulus globulus* Schuchert

- 4.—*Stropheodonta (Leptostrophia) beckii* (Hall)
- 5.—*Spirifer vanuxemi* Hall, var.
- 6.—*Nucleospira ventricosa* Hall
- 7.—*Rhynchospira* cf. *globosa* (Hall)
- 8.—*Whitfieldella*? cf. *minuta* Maynard
- 9.—*Goniophora perangulata* Hall, var.
- 10.—*Proetus* cf. *protuberans* Hall

According to Kindle, four forms (5, 6, 7, and 8) of the above list "are characteristic forms in the Keyser fauna", and, like the crinoid genus *Scyphocrinus*, indicate a correlation with the Keyser. However, of these four forms, two are doubtfully identified, while *Nucleospira ventricosa* ranges to the Oriskany in Pennsylvania, Ontario, and perhaps Missouri and Gaspé (cf. in the Grande Grève), and the *Spirifer vanuxemi* of the present list is reported as a variety of the species. *Scyphocrinus* itself, as a genus, is not restricted to the Keyser but extends up into the New Scotland formation of the Helderberg sequence. It should be noted that although Kindle referred these beds to the Keyser, which is now generally considered to be a Silurian formation, he had no doubt that the fauna represented a low Devonian age. Actually, there is more reason for referring this fauna to the New Scotland, a formation which, up to the moment, still retains its place in the Lower Devonian Helderbergian division. Another suggested correlation made by both Kindle (1) and Cooper (2) is that the Griffon Cove River beds may be the equivalent of the Clam Bank series (3) of Newfoundland.

It is not considered necessary to separate these beds from the St-Alban formation proper, and they are considered here as the basal portion of that formation. They do not show in the type section of Clarke and of Logan in the coastal area, probably being cut out by faulting.

Overlying the Griffon Cove River zone of the St-Alban formation, and including the 336 feet assigned to the formation at the type locality, are 300 to 400 feet of interbedded limestone and calcareous shale, and then an upper zone 300 to 500 feet thick of olive-green calcareous shale with, in the upper part, common beds of red, calcareous shale. This is the general succession as far west as Sydenham river. On this river, the thickness that we assign to the St-Alban is 2,350 feet, or considerably more than in other examined sections of the formation. Here the base of the section is not exposed, and, in consequence, the estimate of thickness of the formation probably should be increased. The upper limit of the St-Alban formation on Sydenham river is placed at the line where the predominantly greenish-grey shales and limestones first give place to overlying dark grey shales and limestones. This basis of separation is not as satisfactory as it appears to be in the type — coastal — section by reason of the fact that a reddish and greenish zone (zone 11 of the following section) appears in the lower 500 feet of what we have mapped as Cape Bon Ami.

(1) KINDLE, E. M., *op. cit.*, 1938, p.19.

(2) COOPER, G. A., *Correlation of the Devonian Sedimentary Formations of North America*; Geol. Soc. Am., Bull., Vol.53, No.12, Pt.1, 1942, p.1763.

(3) See SCHUCHERT, CHAS., and DUNBAR, C. O., *Stratigraphy of Western Newfoundland*; Geol. Soc. Am., Mem. 1, 1934.

The Sydenham River section from the base of the Grande Grève to the Ordovician is as follows, the thicknesses being approximate:

GRANDE GRÈVE.....	2,000 feet
CAPE BON AMI.....	1,935 "
1. Dark grey limestones in 2- to 5-inch beds; soft at base but harder toward top.....	85 "
2. Dark grey, yellowish-grey weathering, shaly limestone to calcareous shale.....	140 "
3. Blank.....	1,035 "
4. Dark grey, pale yellowish-green weathering, shaly limestone.....	5 "
5. Blank.....	85 "
6. The same as 4.....	10 "
7. Blank.....	40 "
8. Greenish-grey, calcareous shale.....	5 "
9. Blank.....	40 "
10. Dark grey to bluish-grey shaly limestone to calcareous shale.....	260 "
11. Red and green shales interbedded.....	55 "
12. Dark grey, shaly and sandy limestone, with common small flakes of biotite.....	175 "
ST-ALBAN.....	2,344 "
13. Greenish-grey calcareous shale or shaly limestone.....	25 "
14. Blank.....	380 "
15. Greenish-grey silty limestone.....	5 "
16. Blank.....	170 "
17. Red and green shales and shaly limestones.....	25 "
18. Blank.....	75 "
19. Greenish-grey shaly limestone.....	5 "
20. Blank.....	140 "
21. Massive, red, sandy limestone.....	3 "
22. Mottled, green and red, shaly limestone.....	5 "
23. Greenish-grey, often brown to rusty weathering, thin-bedded, sandy limestones.....	25 "
24. Reddish-brown, sandy limestone to calcareous sandstone.....	6 "
25. Greenish-grey, thin-bedded, sandy limestones as in 23.....	330 "
26. Dark grey with greenish-yellowish cast, shaly to silty, cleaved limestones in 8-inch to 5-foot beds. Crinoid stem sections common, with scattered corals and brachiopods. Toward the base, <i>Strophonella punctulifera</i>	1,100 "
27. Grey and dark grey, dense limestones in 10-inch to 2-foot beds. <i>Orthotetes becraftensis</i> , <i>Meristella</i> cf. <i>laevis</i> , <i>M. lata</i> , <i>Leptostrophia</i> , sp., <i>Orthostrophia strophomenoides</i>	25 "
28. Massive, grey and dark grey, dense limestone; scattered fossils. "Reef".....	25 "
ST-ALBAN OR OLDER	
29. Blank.....	570 "
30. Massive conglomerate; pebbles of angular to sub-angular quartz, with cobbles of schist, volcanics?, schisted greenstone, and quartzite.....	15? "
31. Blank.....	210 "
ORDOVICIAN	

Many fossils have been recorded from this formation by Clarke, Ells, Billings, and Logan, in addition to those listed by Kindle (see above) from the Griffon Cove River beds. Prior to the present work, no fossils were listed from areas farther inland than Griffon Cove river, and the locality on this river and the coast section provided the fauna as previously known. The lists of fossils given by Logan and by Ells are repeated below without revision. In general, the names applied to the fossil forms in these earlier collections must now be regarded rather as suggestions than as positive identifications, and the lists could not be modernized without reference to the fossils themselves.

The two lowest divisions of Logan's section on the coast were placed by Clarke in the St-Alban formation. The lower of these carries abundant fossils. In the upper division, the only fossils noted by Logan were "flattened stems of marine plants apparently replaced by oxyd of iron" (p.391). The fossils listed from the St-Alban in the coast section are as follows:

1.—Logan, 1863, p.391. The lower 70 feet.

<i>Favosites Gothlandica</i>	* <i>Cyrtodonta orbicularis</i>
<i>F. basaltica</i>	* <i>C. lata</i>
<i>F. cervicornis</i>	* <i>C. flexuosa</i>
<i>Zaphrentis</i> sp.	* <i>Modiolopsis cultrata</i>
<i>Dictyonema</i> sp.	* <i>Avicula Bronni</i>
<i>Fenestella</i> sp.	<i>A. naviformis</i>
<i>Lucina</i> 2 sps.	* <i>Loxonema gaspensis</i>
<i>Strophomena</i> 2 sps.	* <i>L. gracilis</i>
<i>S. rhomboidalis</i>	* <i>Bellerophon Laurenticus</i>
<i>S. punctulifera</i>	<i>Platyceras</i> 2 sps.
<i>Orthis</i> 2 or 3 species	<i>Conularia</i> sp.
<i>Rhychonella acutiplicata</i>	<i>Orthoceras</i> several species
<i>Pentamerus galeatus</i>	<i>Dalmanites pleuroptyx</i>
<i>Spirifera</i> 3 sps.	<i>Phacops</i> sp.
<i>Athyris laevis</i>	* <i>Bronteus Canadensis</i>
<i>Atrypa reticularis</i>	<i>Beyrichia</i> sp.

2.—Ells, 1883, p.30E. Basal beds "at their contact" with the Ordovician.

<i>Favosites Gothlandicus</i> Goldfuss	<i>Strophomena punctulifera</i> Conrad
<i>Leptocoelia flabellites</i> Conrad	<i>Pterinea textilis</i> Hall
<i>Spirophyton Cauda-Galli</i> Vanuxem	

3.—Clarke, 1908, p.34.

Alga	<i>Rhynchospira formosa</i> Hall
<i>Spirophyton</i>	<i>R. globosa</i> Hall
<i>Favosites helderbergiae</i> Hall	<i>Nucleospira ventricosa</i> Hall
<i>F. cf. gaspensis</i> Lambe	<i>Sieberella galeata</i> (Dalman)
<i>Zaphrentis shumardi</i> E. and H.?	<i>Camarotoechia semiplicata</i> (Conrad)
<i>Dictyonema splendens</i> Billings	<i>C. cf. altiplicata</i> Hall
<i>Pholidops ovatus</i> Hall	<i>Modiomorpha varia</i> (Billings)
<i>Dalmanella subcarinata</i> Hall	<i>Goniophora mediocris</i> Billings
<i>D. cf. concinna</i> Hall	<i>Cypricardinia planulata</i> Hall
<i>Orthostrophia canadensis</i> nov.	<i>Leptodomus canadensis</i> Billings
<i>Leptaena rhomboidalis</i> (Wilekens)	<i>Mytilarca nitida</i> Billings
<i>Leptostrophia magnifica</i> Hall	<i>Palaeopinna flabellum</i> Hall
<i>Stropheodonta rosieri</i> nov.	<i>Limopteria rosieri</i> nov.
<i>S. patersoni precedens</i> nov.	<i>Pleurotomaria labrosa</i> Hall

*The names so marked appear to be without descriptions up to the present; thus, they are *nomina nuda*.

<i>Strophonella punctulifera</i> (Conrad)	<i>Probalaeum? canadense</i> nov.
<i>Orthotetes woolworthanus</i> Hall	<i>Conularia lata</i> Hall
<i>Spirifer perlamellosus</i> Hall?	<i>Cyrtocera albani</i> nov.
<i>Atrypina imbricata</i> Hall	<i>Cordania cyclurus</i> Hall and Clarke
<i>Atrypa reticularis</i> Linné	<i>Bronteus barrandii</i> Hall
<i>Meristella laevis</i> Hall	

Brown has collected the following from the coast section of the St-Alban formation:

2-B-33, just south of the Ordovician-Devonian contact.

<i>Schuchertella deckerensis</i> (Weller)	<i>Drepanellina</i> sp.
<i>Beyrichia</i> cf. <i>kirki</i>	<i>Beyrichia</i> or <i>Kloedenia</i> sp.

The second and third of this list suggest the Silurian rather than the Devonian.

From 20 feet (A) and 100 feet (B) above the base of the coast section, McGerrigle collected the following:

A.— <i>Stromatopora</i> sp.	B.— <i>Dalmanella subcarinata</i>
<i>Favosites</i> sp.	<i>Atrypa reticularis</i>
<i>Atrypa reticularis</i>	<i>Eotomaria</i> sp.
<i>Spirifer plicatus</i>	<i>Kloedenia</i> sp.
<i>Stropheodonta pattersoni</i> precedens	

Fossils collected from the Griffon Cove River section, but not necessarily from the beds discussed by Kindle (see above), are as follows:

- 1.—Logan, 1863, p.406.

<i>Favosites Gothlandicus</i>	<i>Strophomena rhomboidalis</i>
<i>Atrypa reticularis</i>	
- 2.—Ells, 1882, pp.7-8DD; 1883, p.30E.

<i>Favosites</i>	<i>Lingula Lucretia</i>
<i>Zaphrentis cingulosa</i>	<i>Rhynchonella</i> sp.
<i>Strophomena punctulifera</i>	<i>Meristella</i> sp., allied to <i>M. laevis</i>
<i>S. inequiradiata</i>	Hall
<i>S. perplana</i>	<i>Pteronitella</i> (allied to <i>P. venusta</i>)
<i>S. Blainvillei?</i> Billings	<i>Anodontopsis</i> sp.
<i>Orthis aurelia?</i>	<i>Orthoceras</i> sp.
<i>Atrypa reticularis</i> Linnaeus, abundant	<i>Illaeus</i> sp. (pygidium)
<i>Athyris (Merista) arcuata</i>	<i>Dalmanites Anchiops</i>
	<i>D. pleuropteryx?</i> Green
- 3.—Clarke, 1908, p.34.

<i>Orthostrophia canadensis</i> nov.	<i>Goniophora mediocris</i> Billings
<i>Leptaena rhomboidalis</i> (Wilckens)	<i>Leptodomus canadensis</i> Billings
<i>Leptostrophia becki</i> Hall	<i>Actinopteria textilis</i> (Conrad)
<i>Strophonella leavenworthana</i> Hall	<i>Eotomaria cartieri</i> nov.
<i>Atrypina</i> sp.	<i>Lophospira bilirata</i> (Hall)
<i>Uncinulus vellicatus</i> Hall	<i>Kionoceras</i> cf. <i>rhysum</i> nov.
<i>Camarotoechia semiplicata</i> (Conrad)	<i>Dalmanites griffoni</i> nov.
<i>C. cf. altiplicata</i> Hall	<i>Phacops logani</i> Hall
<i>Modiomorpha varia</i> (Billings)	

In addition to the above, Brown has collected the following lots from the Griffon Cove River section, given in order from youngest to oldest:

29-B-38	<i>Dalmanella perelegans</i>	<i>Dalmanites griffoni</i>
28-B-38	<i>Leptaena rhomboidalis</i>	<i>Strophonella punctulifera</i>
	<i>Atrypa reticularis</i>	<i>Stropheodonta magnifica</i>

<i>Uncinulus abruptus</i>	<i>Stropheodonta</i> sp.
? <i>Comarotoechia oriskania</i>	<i>Spirifer plicatus</i>
<i>C. litchfieldensis</i>	<i>Pteronites subplana</i>
<i>Anoplothea (Leptocoelia) flabellites</i>	<i>Actinopteria communis</i>
<i>Schuchertella</i> cf. <i>prolifera</i>	<i>Dalmanites</i> sp.
30-B-38	
<i>Strophonella punctulifera</i> ?	<i>Atrypa reticularis</i>
59-B-38	
<i>Strophonella punctulifera</i>	<i>Diaphorostoma</i> sp.
<i>Uncinulus vellicatus</i>	
59-B-38	
<i>Orthostrophia strophomenoides</i>	<i>R. semiplicata</i>
<i>Strophonella punctulifera</i>	<i>Spirifer tribuarius</i>
<i>Camarotoechia litchfieldensis</i>	<i>S. vanuxemi</i>
<i>Rhynchonella altiplicata</i>	

Between Griffon Cove river and Renard river, or about half a mile north of Renard lake, Brown noted two and possibly three reefy limestone zones close to the base of the section. At locality 48-B-38, *Stromatopora* forms were common.

The Renard River Road section gave the following lots of fossils: At 39-B-38 and 38-B-38, *Strophonella punctulifera* and *Pleurotomaria labrosa*. At 40-B-38, underlying the above, a five-foot bed of *Stromatoporas* occurred with *S. ?antiqua*. The fossils collected on Sydenham river have been listed on page 56, with the description of that section.

Jones (1), in 1934, collected the following forms from the apparent continuation of these rocks on Dartmouth river:

Lot F18— <i>Stropheodonta</i> cf. <i>schucertana</i>	<i>Rhipidomella</i> cf. <i>hybridoides</i>
Clarke	Clarke

These were classified (p.24) as "probably Lower Devonian".

According to T. H. Clark, these various lists of fossils from the St-Alban formation, exclusive of the Griffon Cove River beds of Kindle, show but three forms which have been found in undoubtedly Silurian rocks elsewhere. Of these *Spirifer vanuxemi* and *Camarotoechia litchfieldensis* are known to persist into Devonian strata. The other, *Beyrichia* cf. *kirki*, is doubtfully identified. All the other species in these lists occur in the Helderberg or in the Oriskany or in both. Hence the Devonian character of the St-Alban formation is overwhelming. This conclusion is moderated somewhat by the fact that several of the species are known in the Keyser formation of the northeastern United States, which, according to most of the modern opinion, is uppermost Silurian. Thus, in part at least, the St-Alban formation probably should be referred to the basal Helderberg.

Essentially the same conclusion as that of Clark, given above, was arrived at by Swartz. The latter (2) correlated the St-Alban fauna, as given by J. M. Clarke (1908, and repeated above), with the Helderberg

(1) JONES, I. W., *Dartmouth River Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept. Pt. D., 1934.

(2) SWARTZ, F. M., in *The Devonian of Pennsylvania*; Pa. Geol. Surv., Bull., G. 19, 1939, pp.55 and 62.

group of the Lower Devonian and stated that it probably corresponded to the Coeymans and perhaps also to the New Scotland formations of north-eastern United States.

Cape Bon Ami Formation

The original section of the Cape Bon Ami formation, like that of the St-Alban and of the Grande Grève, is in the cliffs on the north side of Forillon peninsula. The name is derived from a cape about midway of the length of the Forillon. This section barely expresses the lithology, and does not approach the thickness, of the Cape Bon Ami as recognized in the southern inland parts of the region.

Clarke (1908, pp.26-38) repeated the shore section as given by Logan (1863, pp.391-392), and assigned Logan's divisions 3 to 6 to the newly erected Cape Bon Ami formation. Logan's division 3 is here assigned to the St-Alban in view of its lithology and lack of fossils and of the absence of an observable break with the underlying beds. By the more general terms of our redefinition, the Cape Bon Ami formation includes the predominantly dark, soft limestones and shales that lie between the dark to light grey, hard, siliceous and cherty limestones and calcareous siltstones of the Grande Grève above, and the predominantly greenish, soft limestones of the St-Alban (and the Silurian-Devonian) below. The thickness of this formation at the type section is about 1,100 feet.

West of the Forillon for twenty-five miles along the strike, or as far as Dartmouth river, the formation averages about 2,000 feet thick. A section of these rocks as exposed on Sydenham river has been given with the description of the St-Alban sequence, the thickness, as approximately measured, being 1,935 feet. A much greater thickness (3,800 feet) is suggested by the width of exposure and available dips in the Renard River section, but the wide gaps between exposures here leave this estimate open to question. The formation is about 2,000 feet thick where the Dartmouth river, flowing south, cuts across the Gaspé limestones. Some sixteen miles farther west, where the Dartmouth, flowing north, again transects the series, the Cape Bon Ami is between 2,000 and 2,500 feet thick. Between the two transections by the Dartmouth, the formation appears to be quite variable in thickness, but the information at hand does not suggest whether this has been due to faulting or to factors of deposition.

To the south of the northern belt just described — which lies along the northern limit of the Devonian basin — the Cape Bon Ami formation again appears on the Bald Mountain anticline. On the eastern part of this structure, the formation appears to be 3,000 to 3,500 feet thick. To the west, the Bald Mountain anticline splits into two anticlines separated by a syncline, with the Cape Bon Ami formation showing on the two up-folds. An area covering parts of these western structures has been leased by the Peninsular Oil Corporation, which is drilling at present on the southern anticline. At the time of writing, the drill has penetrated to 1,000 feet, all within the Cape Bon Ami formation (67, map 661).

Farther to the south, on the Saint-Jean (John) River anticlinal structure, the Cape Bon Ami formation is poorly exposed except toward the

eastern end of its occurrence, where the bands on the two sides of the axis begin to unite over the nose of the fold. Here, good sections may be seen on Wooden Bottom brook — Big Fork of Saint-Jean (John) — Montgomery Lake brook, and on the Little Fork and some of its tributaries. The formation is estimated to be approximately 4,000 feet thick on the Saint-Jean (John) River fold. The lower 3,000 feet consists largely of dark brownish-grey, fine-grained, somewhat shaly and magnesian limestones that weather to dark brown and buff colours. The beds range in thickness from two or three inches to two feet. Shaly to silty laminae are common in many of the beds and often are cross-bedded on a small scale. Two inter-zones, each about twenty feet thick, of dark, hard, well-bedded, cherty limestones were seen on Montgomery Lake brook. As they were not noted elsewhere, it is possible that these cherty zones are local occurrences. One zone is 300 feet above the base and the other about the middle of the formation. Two inter-zones of soft, smooth, dark bluish-grey, dove-weathering limestone in beds from three inches to one foot thick also were noted, and, as these were seen at several localities, they may be considered as fairly persistent horizon markers. Each zone is twenty to twenty-five feet thick. One is 150 feet, and the other about 2,500 feet, above the base of the formation.

The upper 1,000 feet or so of the formation consists of limestones that are darker, softer, and more shaly than are typical of the greater part of the formation. These rocks occur in well-banded master beds up to about four feet thick (Plate VIII). The hard, siliceous to cherty limestones of the Grande Grève immediately overlie this soft shaly zone.

The maximum thickness of the Cape Bon Ami on the south limb of the Malbaie syncline appears to be about 6,000 feet, or 2,000 feet more than the thickness estimated for the formation on the Saint-Jean (John) River anticline to the north. This increase in thickness has resulted in part, and perhaps in large part, from the addition of sandstone, shale, and conglomerate inter-beds and inter-zones to the shaly limestones characteristic of the formation. These elastic beds are most common in the lower part of the formation, and a zone of them up to 800 feet thick occurs at the base. The sandstones vary from fine, calcareous, thinly bedded rocks, through shaly sandstones, to medium-grained feldspathic sandstones. The shales vary from dark greenish-grey to drab brownish in colour. They are commonly banded with thin interlayers of sandy material. The conglomerate beds vary in thickness up to eight feet. They carry the quartz-chert-jasper combination of pebbles common to both older and younger conglomerates in the general region. The matrix of the conglomerate usually is a hard, feldspathic, medium-grained sandstone.

The thickness given above for the Cape Bon Ami, 6,000 feet, is the maximum thickness and applies only to the more central occurrence of the formation on the south limb of the Malbaie syncline. Eastward from the North branch of Grande river the thickness decreases steadily to the centre line of Fortin township. On the accompanying map, the formation is shown as cut out by a fault passing shortly to the east of the centre line of Fortin. The assumption that the Cape Bon Ami actually is cut out here by a fault is somewhat arbitrary. However, eastward of the postul-

ated fault line there is nothing that is referable to the Cape Bon Ami except small outcrops of soft limestones and of sandy beds at the base of the Grande Grève type of limestones.

The thickness and characteristics of the Cape Bon Ami formation are well maintained westward from the North branch of Grande river to shortly west of the line separating Joncas and Power townships. As interpreted on the accompanying map, the Cape Bon Ami becomes progressively more and more cut out by faulting westward from this township line. And the same applies to the Grande Grève. It may be, however, that both the Cape Bon Ami and the Grande Grève grade in this direction into the Fortin series of sediments. It is worthy of note that about one-third of the Cape Bon Ami formation as mapped in Joncas township, including mainly a zone about 2,000 feet thick at the top, is lithologically indistinguishable from the typical Fortin beds of this southern part of the region.

Fossils are much less common in the Cape Bon Ami than in the underlying St-Alban and in the overlying Grande Grève. At the type or original locality, Logan (1863, pp.391-392), listed the following:

DIVISION 3.—Fucoids at the top.

DIVISION 4.—“Fucoids or compressed stems of plants”, *Chonetes* sp., “*Leptocoelia concava*, *L. flabellites*, *Spirifera crispata*”, *Conularia* sp., *Orthoceras* sp.

DIVISION 5.—“Marine plants, which are chiefly confined to long flattened serpentine stems”, “*Lucina*” 2 sps., “*Lingula*” 2 sps., “*Chonetes*” sp., “*Strophomena rhomboidalis*”, *Leptocoelia concava*, *L. flabellites*, and *Spirifera crispata*, with *Orthoceras* sp., and *Phacops* sp.

DIVISION 6.—“Obscure serpentine fucoids”, “*Lingula*, *Discina*, a *Conularia* resembling *C. Sowerby*” and *Pterygotus* sp.

Ells (1) reported the following forms from “Cape Gaspé and Bon Ami cape, which may be taken as representing the middle divisions, or, as . . . the transition beds”:

<i>Zaphrentis rugalata</i>	<i>Sanguinolites Tethys</i>
<i>Dictyonema splendens</i>	<i>Lingula Lucretia</i>
<i>Strophomena varistriata</i>	<i>L. Artemis</i>
<i>S. punctulifera</i>	<i>Pentamerus galeatus</i>
<i>Modiolopsis varia</i>	<i>Crania bella</i>
<i>Pleurotomaria princessa</i>	

Clarke (1908, p.38) listed the following from the Cape Bon Ami, largely taken from the Quay at Cap-des-Rosiers cove:

<i>Hindia fibrosa</i> (Roemer)	<i>Modiomorpha varia</i> (Billings)
<i>Duncanella</i> cf. <i>rudis</i> Girty	<i>Kionoceras</i> cf. <i>rhysum</i> nov.
<i>Lingula artemis</i> Billings	<i>Platyceras</i> cf. <i>unguiforme</i> Hall
<i>L. lucretia</i> Billings	<i>Poleumita princessa</i> (Billings)
<i>Orbiculoidea bella</i> (Billings)	<i>Cordania gasepiou</i> nov.
<i>Leptaena rhomboidalis</i> (Wilckens)	

At cape Bon Ami, the following forms were found by Brown:

Lot 102-B-38

Favosites cf. *helderbergiae* Hall

Gypidula coeymanensis Schuchert

(1) ELLS, R. W., Geol. Surv. Can., Rep. Prog., 1880-82, p.13DD.

The few forms collected on the Saint-Jean (John) River anticline were all found toward the eastern end of the exposures of the formation on the fold, and in the upper or more shaly part. Lots 44-M-38 and 45-M-38 yielded a *Crania* and an *Actinoceras* respectively. Lot 46-M-38, on Cold Spring Lake brook, includes the following:

<i>Lingula</i> sp.	<i>Orthotetes becraftensis</i>
<i>Leptocoelia flabellites</i>	

Only one fossil locality was found in the rocks assigned to the Cape Bon Ami on the southern side of the Malbaie syncline. The fossils determined include:

Lot 11-M-40.—Joncas township, half a mile west of the range V-VI post on the centre line of the township:

<i>Tentaculites leclercquia</i>	<i>Spirifer arenosus</i>
<i>Leptocoelia flabellites</i>	<i>Spirifer</i> cf. <i>cyclopterus</i>

The fossils collected from beds assigned to the Cape Bon Ami formation in the inland areas show closer relationship to the Grande Grève than to the type fauna as given by Clarke (1908). This relationship may result from the fact that the few inland fossil collections were taken from the upper part of the formation. In any event, the faunal relationship but supports our view that these two formations are gradational and part of the same time zone.

The above interpretation, strictly followed, would lift the Cape Bon Ami formation considerably above the St-Alban in time and would place it in the Oriskany division of the Lower Devonian. However, Cooper (1) has pointed out that the formation contains some Helderberg species; he retains it in the Helderberg and tentatively correlates it with the Dalhousie shale of New Brunswick, the Chapman sandstone of Maine, and the Becraft of the Appalachian region in the United States.

It should be recalled at this point that certain of the faunas (see above) from the southern part of the Saint-Jean (John) River Silurian-Devonian belt gave very strong evidence of Grande Grève relationship rather than St-Alban, although their stratigraphic position was that of the St-Alban or basal Cape Bon Ami. Thus, it may be that the St-Alban and Cape Bon Ami formations, together, comprise the whole of Helderbergian time and reach into the Oriskanian.

Grande Grève Formation

The Grande Grève formation is the uppermost of the three formations that make up the Gaspé Limestone series. The Percé Rock and Murailles limestones are considered to be phases of the Grande Grève. As defined by Clarke (1908), the formation was made up of the two youngest divisions, 7 and 8, of Logan's measured section on the Forillon. Clarke (1908, p.39), however, re-defined the lithological zones of the upper part of the section, recognizing three general divisions, as follows, in descending order:

(1) COOPER, G. A., *Correlation of the Devonian Sedimentary Formations of North America*; Geol. Soc. Am., Bull., Vol.53, No.12, Pt.1, 1942, p.1750.

3.—Pure, grey-blue limestones without chert.....	50 feet
2.—Impure, grey, cherty limestones.....	400 “
1.—Drab, hydraulic limestones, in part cherty, with pure, heavy-bedded limestone above; fossils common.....	100 “

Clarke's lowest division included the beds below the grass-green rocks marking the summit of Logan's Division 7. His upper division, No. 3, was made up of the beds exposed at Little Gaspé, just below the contact with the Gaspé Sandstone series. It will be noted that the total thickness of the section as estimated by Clarke was 550 feet, while as measured by Logan it was 800 feet. Russell (1946) retained Logan's divisions 7 and 8, but with some re-definition as to lithology and thickness, and followed Clarke in placing these divisions in the Grande Grève formation, giving that formation a thickness of 887 feet.

The lithological criteria used in separating division 6 from division 7 have not been recognized anywhere in the peninsula, except in the Forillon section itself. The same applies to the varied lithology of division 7 in general. In particular, the grass-green layer marking the summit of division 7, perhaps glauconitic and with a thickness of five feet (Russell), has been traced only a few hundred feet inland and has not been noted in any interior sections. The same is true of the several bentonitic beds discovered in division 7 by Russell. In view of such apparent failures in continuity, it was necessary to establish a more practical, and perhaps more general, basis of separating the Grande Grève from the Cape Bon Ami than was provided by the 'type' section. Consequently, the criterion of initial appearance of hard, cherty to siliceous limestones (or calcareous siltstones) was adopted as marking the base of the Grande Grève. When this standard is applied against the Forillon section, it places the Grande Grève-Cape Bon Ami contact within division 6, and removes about 500 feet of that 870-foot (Russell) division to the Grande Grève. So far as can be judged at the moment, this revision does no violence to the faunas reported from the Cape Bon Ami. The fauna reported by Clarke, for example, was derived "largely" from the Quay rocks, and these are included in division 4. As so revised, the thickness of the Grande Grève in the Forillon, or so-called 'type', section is about 1,400 feet.

Some three miles to the west of the Forillon area, in the Laurencelle road section, the Grande Grève appears to be about 1,600 feet thick. Five miles farther west, along Griffon Cove river, the thickness is estimated at 2,000 feet. From here westward along the strike to the first Dartmouth River transection, the apparent thickness remains at 2,000 feet, and farther to the west in this same northern belt the thickness is not known to exceed 2,500 feet. The median thickness of the Grande Grève in the northern belt, therefore, is about 2,000 feet.

On the Bald Mountain and the Mississippi anticlinal structures, the thickness of the Grande Grève is estimated at about 4,000 feet. These structures are roughly seven and ten miles, respectively, south of the belt just reviewed. Farther south, on the Saint-Jean (John) River anticline, the thickness of the Grande Grève generally is about 4,000 feet. One of the better sections — and one where this measure of thickness is indicated —

is along the Little Fork of Saint-Jean (John) river. On the south side of the Malbaie syncline, the formation appears to be equally as thick as to the north. For example, on the North branch of Grande river, the indicated thickness is about 4,500 feet. On the same band some ten miles to the east, or near the line between Fortin and Malbaie townships, the thickness is still about 4,000 feet, but farther east it appears to lessen — this is difficult to judge, however, due to local faulting. To the west of the North branch of Grande river, the thickness appears to become progressively less prior to complete disappearance of the formation under younger beds. Here the Grande Grève seems to decrease in thickness while the Cape Bon Ami increases up to a certain point as the formations are traced westward.

Thus, in general, the Grande Grève appears to increase rapidly in thickness from the northern edge of the Devonian basin southward within the first seven miles, and then to maintain a relatively uniform thickness throughout the basin until the southern margin is reached or approached.

A general lithological definition of the Grande Grève formation, applicable throughout the region, is that it consists of siliceous and cherty limestones to calcareous siltstones. Whatever the composition of the rocks, they are commonly well-bedded (Plates IX, X-A, X-B) in beds from one inch to one foot thick separated by thin seams to layers up to half an inch thick of shaly rock that is usually grey in colour, silty, and somewhat calcareous. The weathered débris from the Grande Grève usually is in the form of small, sharply angular fragments with a characteristic light grey colour.

The source of the silica in the Grande Grève is not definitely known. Parks (1) has suggested that it may have been leached from ash discharged from volcanoes "known to exist in Lower Devonian time to the westward" in Gaspé peninsula. If this is so, however, it is rather strange that, as the formation is traced westward, even to such places west of Bonaventure river where Lower Devonian limestones are actually interbedded with volcanic rocks, the siliceous and cherty nature of the formation progressively disappears, the rocks become arenaceous or silty, and eventually are interbedded with shales and sandstones. The suggestion that the silica may have been derived from Silurian volcanics is subject to much the same kind of objection — there is no appreciable increase in the quantity of silica in the formation as known possible sources are approached. Thin sections of Grande Grève chert specimens collected by Brown north of Gaspé bay yielded no evidence of siliceous organic remains. Likewise, Parks (1929-30, p.32) evidently found nothing of organic origin in the thin sections examined by him from the siliceous limestones of Mississippi brook. Clarke (1908, pp.220-221), however, found layers "several inches in thickness" in the "upper limestones" at both Grande Grève and Ship Head which were "matted masses of sponge spicules". He stated that these layers represented "extensive plantations of siliceous sponges"

Whatever the source of the silica, it seems evident from its occurrence and distribution in the formation, as beds of chert or of siliceous limestone

(1) PARKS, W. A., *Oil and Gas Resources of the Province of Quebec*; Que. Bur. Mines, Ann. Rept., Part B, 1929-30, p.32.

interstratified with purer limestone, and as nodules of chert, that it was deposited with the lime muds rather than introduced after deposition and solidification of the limestone. That is, it was primary rather than secondary.

On Wooden Bottom brook, a thickness of 500 feet in the upper part of the formation consists of interbedded, hard, siliceous to cherty limestones and softer shaly limestones, with occasional beds of soft, greenish to brownish shale and of sandy limestones. There then follows a zone about 75 feet thick of dark greenish, arenaceous and slightly calcareous shale with interbeds up to six inches thick of fine-grained, slightly calcareous sandstone. Immediately overlying these shaly rocks is a zone four to five feet thick of greenish-grey, medium-grained, hard, feldspathic sandstone. This in turn is overlain by rocks of the undoubted Gaspé Sandstone series. It is a question whether the contact with the Gaspé Sandstones should be at the base of the hard, feldspathic sandstone zone or at the base of the 75-foot thick shaly zone. The contact appears to be conformable in either case.

On the south side of the Malbaie syncline, the Grande Grève consists of silty, dark grey, well-bedded limestones in layers averaging six inches to one foot in thickness. Only one occurrence, apart from occasional beds, of siliceous and cherty rocks was noted. The thicker bedding here, coupled with a change in composition which produced generally softer rocks, makes separation of the Cape Bon Ami and Grande Grève formations more difficult than is usual in the region.

Eastward from about the centre line of Fortin township, limestones having various shades of brown and pink are increasingly common in association with the more typical darker limestones of the Grande Grève. These coloured limestones closely resemble the similarly tinted limestones of Percé rock, although the shades are not so bright. Coloured limestones were noted also in the Grande Grève near Wooden Bottom brook and, more particularly, on the Little Fork of the Saint-Jean (John). Here, the colours were not so striking as to the south, and were commonly limited to shades of buff and pale brown.

John M. Clarke (1) has discussed the significance of the colours in the limestones of Percé rock and the adjacent Murailles. He believed that the original colours were the dark purple-reds, and that the bands and shades of other colours have resulted from bleaching. Also, he believed that the colours indicated that the limestones were deposited in shallow waters, perhaps even in "tidal flats" in protected coves and embayments. In a later report, Clarke (2) adds the note that in certain places, as in the sea-cliff of the Pic d'Aurore at Percé, much of the colour is due to down-wash from the overlying reddish Bonaventure conglomerate. This action, in fact, may have been responsible for much of the colour in the Percé Rock limestone, which certainly once was covered by the Bonaventure conglomerate. The yellow to brown colours noted elsewhere in the Grande Grève, and also

(1) CLARKE, John M., *Early Devonian History of New York and Eastern North America*; N.Y. St. Mus., Mem. 9, Vol. 1, 1908, pp. 62-64.

(2) CLARKE, John M., *The Oriskany-Pic d'Aurore Episode of the Appalachian Devonian*; N.Y. St. Mus., Bull. 177, 1915.

very locally in the Ordovician (White Head) limestones, may also be secondary in origin, perhaps resulting from down-wash from the overlying Bonaventure conglomerate or a similar formation.

Fossils are fairly abundant in the Grande Grève formation at its original section on the Forillon peninsula, and the bulk of the fauna of the formation is known from collections made there. In the inland areas, fossils have been found at, relatively, very few places, considering the area over which the formation appears at the surface. The lists of fossils given by Logan and by Ells are reproduced below without revision.

Logan (1863, p.393) gives only *Fucoides cauda-galli*, common, and *Dalmanites pleuroptyx* from the lower 300 feet, or Division 7, of his section. In the upper 500 feet, however, he reports:

<i>Fucoides cauda-galli</i>	<i>Eatonia peculiaris</i>
<i>Favosites Gothlandicus</i>	<i>Rensselaeria ovooides</i>
<i>F. basaltica</i>	<i>Spirifera</i> 2 sps.
<i>F. cervicornis</i>	<i>S. arenosa</i>
<i>Zaphrentis</i> 2 sps.	<i>Atrypa reticularis</i>
<i>Fenestella</i> sp.	<i>Athyris laevis</i>
<i>Orthis oblata</i>	<i>Modiolopsis</i> 2 sps.
<i>Orthis</i> 2 or 3 sps.	<i>Avicula</i> 2 sps.
<i>Strophomena rhomboidalis</i>	<i>Murchisonia</i>
<i>S. Becki</i>	<i>Loxonema</i>
<i>S. perplana</i>	<i>Pleurotomaria</i>
<i>S.</i> 2 sps.	<i>Orthoceras</i>
<i>Chonetes</i> 3 sps.	<i>Phacops</i>
<i>Rhynchonella</i> 2 sps.	<i>Proetus</i>
<i>Leptocoelia concava</i>	<i>Dalmanites pleuroptyx</i>
<i>L. flabellites</i>	

Ells (1882, pp.13-14DD) gives the following list of fossils from the Grande Grève at "Indian Cove, Grande Grève, and Little Gaspé":

<i>Philipsastrea affinis</i>	<i>Rensselaeria ovooides</i>
<i>Polypora Psyche</i>	<i>Spirifera cycloptera</i>
<i>Zaphrentis incondita</i>	<i>S. superba</i>
<i>Strophomena magnifica</i>	<i>S. Gaspensis</i>
<i>S. rhomboidalis</i>	<i>S. raricosta</i>
<i>S. Galatea</i>	<i>Ptilodictya tarda</i>
<i>S. magniventra</i>	<i>Modiolopsis Tethys</i>
<i>S. inequiradiata</i>	<i>Goniophora mediocris</i>
<i>S. Irene</i>	<i>Mytilarca nitida</i>
<i>Chonetes melonica</i>	<i>Leptodomus Canadensis</i>
<i>C. Laticosta</i>	<i>Anodontopsis ventricosa</i>
<i>Leptocoelia flabellites</i>	<i>Cypricardinia distincta</i>
<i>Orthis Livia</i>	<i>Murchisonia Hebe</i>
<i>Orthis Aurelia</i>	<i>Platystoma affinis</i>
<i>Orthis Lucia</i>	<i>Pleurotomaria Lydia</i>
<i>Rhynchonella excellens</i>	<i>P. Voltumna</i>
<i>R. Dryope</i>	<i>P. Delia</i>
<i>R. pleopleura</i>	<i>Bellerophon plenus</i>
<i>Eatonia peculiaris</i>	<i>Proetus phocion</i>

In addition to the above, Ells (1883, p.24E) lists the following from Grande Grève itself:

<i>Zaphrentis</i> sp., allied to	<i>Spirifera arenosa</i> ? Conrad
<i>Z. prolificus</i>	<i>Athyris arcuata</i> Hall (as of Billings)
<i>Cystiphyllum</i>	<i>Pterinea textilis</i> ? Hall
<i>Strophomena punctulifera</i> ? Conrad	<i>Platystoma ventricosum</i> ? Hall

Clarke (1908, pp.43-46) gives the following table showing the fauna of the Grande Grève as found in the three divisions recognized by him:

VERTICAL DISTRIBUTION OF SPECIES

	DIVISIONS		
	1	2	3
ANNELIDS			
<i>Cornulites cingulatus Hall</i>		X	
<i>Autodetus beecheri Clarke</i>		X	
<i>Tentaculites elongatus Hall</i>		X	
<i>Spirorbis latissimus nov</i>		X	
<i>Serpulites</i>		X	
TRILOBITES			
<i>Phacops logani Hall gaspensis nov</i>	X	X	
<i>Dalmanites micurus (Green)</i>	X		
<i>D. emarginatus Hall</i>		X	
<i>D. dolbeli nov</i>		X	
<i>D. lowi nov</i>		X	
<i>D. veiti nov</i>		X	
<i>D. vatinius nov</i>		X	
<i>D. gaveyi nov</i>		X	
<i>D. phacoptyx Hall and Clarke</i>		X	
<i>Probolium esnoufi nov</i>		X	
<i>Proetus phocion Billings</i>	X	X	
<i>Cordania becraftensis Clarke</i>		X	
<i>C. gasepiou nov</i>	X		
<i>Lichas bellamicus nov</i>		X	
<i>Gaspelichas forillonina nov</i>	X	X	
<i>Ceratocephala robinia nov</i>		X	
ENTOMOSTRACA			
<i>Beyrichia kloedeni McCoy cf. acadica Jones</i>		X	
<i>Bythocypris sp. nov</i>		X	
<i>Aparchites sp.</i>		X	
CEPHALOPODS			
<i>Kionoceras rhysum nov</i>		X	
<i>K. champlaini nov</i>		X	
<i>Orthoceras</i>		X	
<i>Cyrtoceras</i>		X	
PTEROPODS			
<i>Hyalithus richardi nov</i>		X	
<i>H. oxys nov</i>		X	
<i>Conularia penoulli nov</i>		?	
<i>C. cf. desiderata Hall</i>		X	
<i>C. lata Hall mut.</i>		X	
GASTROPODS			
<i>Platyceras cf. fornicatum Hall</i>		X	
<i>P. leboutillieri nov</i>		X	
<i>P. cf. nodosum Conrad</i>		X	
<i>P. paxillifer nov</i>		X	
<i>P. tortuosum Hall</i>		X	
<i>P. lejeunii nov</i>		X	
<i>P. (Orthonychia) belli nov</i>		X	

VERTICAL DISTRIBUTION OF SPECIES (continued)

	DIVISIONS		
	1	2	3
P.....		x	
Holopea cf. antiqua (Vanuxem).....		x	
Coelidium hebe (Billings).....		x	
C. egregium (Billings).....		?	
Eotomaria voltumna (Billings).....		x	
E. lydia (Billings).....		x	
E. delia (Billings).....		x	
E. ? rotula nov.....		x	
Bellerophon plenus Billings.....		x	
B. (Plectonotus?) gaspensis nov.....		x	
Diaphorostoma affine (Billings).....		x	
D. desmatum Clarke.....	x	x	
D.....		x	
Strophostylus expansus Hall.....		x	
PELECYPODS			
Actinopteria communis (Hall).....		x	
A textilis (Hall).....		x	
Aviculopecten ? incrassatus nov.....		x	
Pterinopecten proteus Clarke mut.....		x	
Megambronina crenistriata Clarke.....		x	
Mytilarea canadensis Billings.....		x	
M. nitida Billings.....		x	
Cypricardina distincta Billings.....		x	x
Palaeopinna flabellum Hall.....		x	
Modiomorpha varia (Billings).....		x	
Leptodomus canadensis Billings.....		x	
Goniophora mediocris Billings.....		x	
G. tethys (Billings).....		x	
Conocardium cuneus (Conrad).....		x	
Schizodus ventricosus Billings.....		x	
Nuculites.....		x	
BRACHIOPODS			
Glossina acer nov.....	x		
Lingula elliptica nov.....	x		
L. rectilatera Hall.....			x
Orbiculoidea montis nov.....	x		
O.....	x		
Pholidops terminalis Hall.....		x	
P. cf. ovata Hall.....		x	
Craniella ? grandegrevensis nov.....		x	
Crania pulchella H. & C.....		x	
Chonetes canadensis Billings.....	x		
C. melonicus Billings.....			x
C. antiopa Billings.....	x		
C. billingsi nov.....	x	x	
C.....		x	
Chonostrophia complanata Hall.....	x		x
Anoplia nucleata Hall.....		x	
Dalmanella lucia (Billings).....		x	
Rhipidomella logani nov.....		x	
R. musculosa Hall.....	x		
R. lehuquetiana nov.....		x	
R.....		x	
Schizophoria ? amii nov.....		x	

VERTICAL DISTRIBUTION OF SPECIES (continued)

	DIVISIONS		
	1	2	3
<i>Hipparionyx proximus Vanuxem.</i>	x		
<i>Orthothetes woolworthanus Hall gaspensis nov.</i>	x	x	
<i>O. beeraftensis Clarke.</i>	x	x	
<i>Gaspesia aurelia (Billings).</i>		x	
<i>Stropheodonta parva Hall avita nov.</i>		x	
<i>S. crebristriata (Conrad) simplex nov.</i>		x	
<i>S. patersoni Hall precedens nov.</i>		x	x
<i>S. galatea (Billings).</i>		x	
<i>S. hunti nov.</i>		x	
<i>S. lincklaeni Hall.</i>		x	
<i>S. magniventer Hall.</i>		x	
<i>Brachyprion majus Clarke.</i>		x	
<i>Leptostrophia magnifica Hall.</i>	x		
<i>L. irene (Billings).</i>		x	
<i>L. oriskania Clarke.</i>	x	x	
<i>Strophonella continens nov.</i>		x	
<i>S. continens equiplicata nov.</i>		x	
<i>S. continens senilis nov.</i>		x	
<i>S. continens equalis nov.</i>		x	
<i>S. ampla Hall.</i>		x	
<i>Leptaena rhomboidalis (Wilckens).</i>		x	x
<i>Spirifer arenosus Conrad.</i>	x	x	
<i>S. arenosus unicus Hall.</i>		x	
<i>S. murchisoni Castelnau.</i>		x	
<i>S. cyclopterus Hall.</i>		x	
<i>S. fimbriatus (Conrad).</i>			
<i>S. plicatus (Weller).</i>		x	
<i>S. raricosta (Conrad).</i>		x	
<i>S. modestus Hall nitidulus nov.</i>		x	
<i>S. sp.</i>		x	
<i>Cyrtina rostrata Hall.</i>		x	
<i>Meristella champlani nov.</i>		x	
<i>M. lata Hall.</i>		x	
<i>Rhynchospira.</i>		x	
<i>Nucleospira cf. ventricosa Hall.</i>		x	
<i>Leptocoelia flabellites (Conrad).</i>		x	
<i>Coelospira concava Hall.</i>		x	
<i>Camarotoechia dryope (Billings).</i>		x	
<i>C. excellens (Billings).</i>		x	
<i>C. cf. ramsayi Hall.</i>		x	
<i>Plethorhyncha barrandii Hall.</i>		x	
<i>P. pliopleura (Conrad).</i>	x		
<i>Uncinulus mutabilis Hall.</i>		x	
<i>Eatonia peculiaris (Conrad).</i>		x	x
<i>Beachia amplexa nov.</i>	x	x	
<i>Megalanteris thunii nov.</i>		x	
<i>Rensselaeria ovoides (Eaton) gaspensis nov.</i>	x	x	x
<i>R. sp. ?</i>		x	
<i>Cryptonella ? elli nov.</i>		x	
<i>C. ? fausta Clarke.</i>		x	
<i>Centronella glansfagea Hall.</i>		x	
BRYOZOANS			
<i>Fenestella cf. lata Hall.</i>		x	
<i>Polypora ? psyche Billings.</i>		x	
<i>Stictopora.</i>		x	

VERTICAL DISTRIBUTION OF SPECIES (continued)

	DIVISIONS		
	1	2	3
CORALS			
<i>Zaphrentis incondita</i> Billings.....		x	
<i>Phillipsastraea verneuili</i> Billings.....		x	
<i>Favosites helderbergiae</i> Hall.....		x	
<i>F. sp.</i>		x	
<i>Pleurodictyum lenticulare</i> (Hall) laurentinum nov.....		x	
<i>Monticulipora</i>		x	
<i>Striatopora cf. issa</i> Hall.....		x	
GRAPTOLITES			
<i>Dictyonema cf. splendens</i> Billings.....		x	
<i>Chaunograptus gracilis</i> nov.....	x		
SPONGES			
<i>Hexactinellida</i>		x	
<i>Receptaculites jonesi</i> Billings.....			
TOTAL.....	154		

The collections from this formation made by Brown between Ship Head and the Renard River road include the following in addition to those listed by Clarke:

<i>Conularia gaspensis</i> Sinclair*	<i>Leptostrophia blainvilli</i>
<i>Fenestrellina multistriata</i> Fritz	<i>Spirifer tribuarius?</i>
<i>Camarotoechia lamellata</i>	<i>Dalmanites townsendae</i>
<i>Gypidula coeymanensis prognostica</i>	<i>Proetus cf. protuberans</i>

The Grande Grève formation in the York River synclinal area has yielded the following (identified by E. M. Kindle) (1):

<i>Conularia cf. desiderata tuzio</i> Clarke	<i>Leptocoelia flabellites</i> (Conrad)
Crinoid stems	<i>Schuchertella becraftensis</i> Clarke
<i>Anoplia nucleata</i> Hall	<i>Spirifer arenosus</i> (Conrad)
<i>Chonetes billingsi</i> Clarke	<i>Dalmanites phacoptyx</i> Hall and Clarke
<i>Eatonia peculiaris</i> (Conrad)	<i>Phacops logani gaspensis</i> Clarke
<i>Leptaena rhomboidalis</i> Wilckens	

The following forms have been found in the Grande Grève formation in the Saint-Jean (John) River anticlinal structure:

<i>Dictyonema</i> sp.	<i>Calymene cf. nilanderi</i>
<i>Streptelasma</i> sp.	<i>Cyphaspis</i> sp.
<i>Leptaena rhomboidalis</i>	<i>Dalmanites dolbelli?</i>
<i>Spirifer murchisoni</i>	<i>Proetus</i> sp.
<i>Spirifer modestus nitidulus</i>	<i>Zygobolba</i> sp.
<i>Eotomaria voltumna</i>	

And, in the most southern band of the Grande Grève in the region, the following have been collected:

*See Le Nat. Can., Vol. 69, 1942, pp.158-160.

(1) JONES, I. W., and MCGERRIGLE, H. W., 1939, p.21.

<i>Anastomopora</i> sp.	<i>Plethorhyncha barrandii</i>
<i>Fenestrellina fortinensis</i>	<i>P. pliopleura</i>
<i>Fistuliphragma jonesi</i>	<i>Strophonella</i> sp.
<i>Fistulipora</i> sp.	<i>Spirifer arenosus</i>
<i>Chonetes canadensis</i>	<i>S. murchisoni</i>
<i>Dalmanella penouilli</i>	<i>Actinopteria</i> sp.
Cf. <i>D. lucia</i>	<i>Diaphorostoma desmatum</i>
<i>Leptocoelia flabellites</i>	<i>D. perceence</i>
<i>Leptostrophia</i> sp.	<i>Platyceras guesnini</i>
<i>Orbiculoidea montis</i>	<i>P. nodosum</i>
<i>Orthotetes (Schuchertella) woolworth-</i>	<i>P. fornicatum</i>
<i>anus gaspensis</i>	

The first four forms (bryozoa) of the above list have been described by Dr. M. A. Fritz (1). The two definitely identified forms are known only from this southern band of Grande Grève. The specimen of *Anastomopora*, while not specifically identified, is stated to be very close to *A. quebecensis* of the overlying sandstones and of the Four Mile Brook member of the Heppel formation. The genus *Fistuliphragma* is "typically developed in the Hamilton formation of Michigan".

Earlier collections from this southern band of Grande Grève are reported by Alcock (2) from the first stream west of Otter brook and from near the Portage River falls. These include the following forms: *Fenestella*, *Leptaena rhomboidalis*, *Meristella lata*, *Naticopsis*, *Dalmanites perceensis*, *Phacops*, and ostracods. The *Naticopsis* of this list are "large gastropods" and possibly correspond to the forms in our list collected from the same locality and identified as *Diaphorostoma*.

The Grande Grève formation in this area appears to occupy essentially the same stratigraphic position as the Murailles formation in the Percé area. This latter formation includes the Cape Barre and Percé Rock units of Clarke (1908). When the Percé and Malbaie areas were mapped by C. H. Kindle (see Alcock, 1935) it was found impossible to separate the Cape Barre and Percé Rock units inland from the coast. Hence the more inclusive term of 'Murailles' was introduced. Kindle's work makes no mention of the Cape Bon Ami formation, and it is to be assumed from his map that anything referable to that formation also is included in the Murailles. The writer suggests the possibility that the eastward narrowing band referred by him to the Cape Bon Ami in the southern part of the present area may be equivalent to the Cape Barre beds. This suggestion receives some support from the discussion of the fauna by Clarke (1908, pp.66-67) and by Schuchert and Cooper (3). These authors are agreed that the Cape Barre beds are older than the Percé Rock. Clarke referred them to the Helderberg, while Schuchert placed them in the Oriskany. The Percé Rock unit also was placed in the Oriskany by both Clarke and Schuchert, but they were in some doubt as to where it belonged relative to the Grande

(1) FRITZ, M. A., *Devonian Bryozoa from Fortin and Malbay Townships, Gaspé County, Quebec*. Cont. Royal Ont. Mus. Pal., No.4, 1940.

(2) ALCOCK, F. J., *Geology of Chaleur Bay Region*; Geol. Surv. Can., Mem. 183, 1935, pp.67-68.

(3) SCHUCHERT, CHARLES and COOPER, G. A., *Upper Ordovician and Lower Devonian Stratigraphy and Paleontology of Percé, Quebec; Part 1. Stratigraphy and Faunas*, by CHARLES SCHUCHERT. Am. Journ. Sci., Vol.20, 1930, p.174.

Grève. Reviewing the case, Schuchert states that the Percé Rock fauna is, as Clarke maintained, clearly the Grande Grève fauna, "but to what part of this thick Lower and Middle Devonian series it belongs he (Clarke) can not determine; he is inclined, however, to regard the time as Oriskanian rather than Onondagan of the Middle Devonian, and with this the writer agrees" (p.174). A review of the list of fossils given above from the southern band of Grande Grève in this area shows that the fauna is that of Percé Rock rather than of the Forillon, and so subject to the same interpretation as that just quoted. The Oriskanian age of the Grande Grève is now generally accepted. But, in view of the tendency of several authors to place the overlying sandstone series also in the Oriskany, it is interesting to note the suggestion of possible Onondagan age for the Grande Grève in the quotation given above.

LOWER TO MIDDLE DEVONIAN

York Lake Series

The term *York Lake series* was introduced by Jones (1935, p.15) to designate a succession of rocks lying stratigraphically between the Gaspé Limestones and the Gaspé Sandstones. In Jones' mapping of the *Upper York River Map-Area* (1935) and the *Mount Alexander Map-Area* (1936), the York Lake series was shown as a separate map-unit. This practice is not followed in the revised maps accompanying the present report. Instead, the York Lake series is included with the York River formation. This is done by reason of the practical difficulty of mapping these divisions separately. Except for differences in detail, and the presence of some limestone beds in the York Lake series, the two divisions are very similar lithologically. Nevertheless, the term itself is not discarded for it serves as a useful label for the interbedded shale-sandstone-limestone zone which, in some areas, marks a transition between the Grande Grève and the York River formations. Furthermore, under more detailed mapping, the series yet may prove to have more significance than our present treatment assigns to it.

The disposition of this series may be seen on the maps accompanying the reports by Jones for the years 1935 and 1936. The type locality is in the general vicinity of York lake. Here the series is composed chiefly of interbedded shale, sandstone, and limestone, but limestone appears to be present in increasing abundance as the series is followed westward. Going easterly, the limestones decrease in importance until only shales and sandstones remain. The limestones of this series are of the Grande Grève type. The sandstones are variable in composition but they are generally finer in grain, more argillaceous, and buff to greenish-buff in colour, as opposed to the greenish-grey sandstones of the York River formation. Curved to hook-shaped, shale-filled worm borings or trails are found in many places in the sandstones of this series, but are rare in the York River formation.

A white to grey, quartzose, medium-grained sandstone bed averaging about thirty feet thick has been noted at several localities. Its average position is about 200 feet above the Grande Grève. In more eastern areas, where the York Lake series is not indicated, a similar sandstone was seen

in some sections at or near the top of the Grande Grève formation. On Dartmouth river, and eastward as far as Little Gaspé on Gaspé bay, there is a thin zone of interbedded hard limestone and of quartz sandstone somewhat similar to the above which may represent the same horizon. If so, this is the only suggestion of the York Lake series in the coastal part of the region.

The thickness of this series varies considerably. In the eastern part of the region, the series is not recognized in some sections and only possibly present in others. In the type region of Holland and Fletcher townships, the series as mapped by Jones in 1935 and 1936 varied from 2,000 feet to 4,000 feet thick. There is no suggestion in these areas that such thicknesses were achieved at the expense of the underlying Grande Grève formation. The Grande Grève is present in normal strength, being upwards of 3,000 feet thick on the Bald Mountain anticlinal, for example. The overlying sandstones (see Upper York River Area map, Jones, 1935), however, average only about 2,000 feet thick as compared with the minimum of 4,500 feet in the areas of more typical development to the east. Although the upper part of the York River formation is lacking here, these comparisons of thickness at least suggest that the stratigraphic position of the York Lake series is closer to the York River formation than to the Grande Grève.

The fossils that have been found in beds referred to the York Lake series are as follows (identifications by E. M. Kindle):

A.—Dartmouth River Map-Area (Jones, 1934, p.31):

Lot 14.—Eden brook, two and a half miles from the Dartmouth river, de Beaujeu township; in "light-coloured sandstones". *Stropheodonta*, *Rensselaeria*, *Spirifer*, and *Meristella cf. lata* Hall.

B.—Upper York River Map-Area (Jones, 1935, p.18):

- 1.—West of the Upper end of York lake, Holland township; in an escarpment of sandstone. *Leptaena rhomboidalis*, *Hipparionyx proximus?*, *Spirifer cf. submucronatus*.
- 2.—York river, about two and a quarter miles down from York lake, Holland township; limestones from the base of the York Lake series or the top of the Grande Grève. *Pholidops*, *Chonetes?*, *Spirifer*.
- 3.—Loose blocks in the Oat Cake Lake area, Holland and Fletcher townships:
 - (a) In sandstone: *Spirifer cf. arenosus*.
 - (b) In limestone: *Leptocoelia cf. flabellites*, *Phacops logani var. gaspensis?*

The only definitely identified form in the above lists is the long-ranging *Leptaena rhomboidalis*. The forms doubtfully identified as to species suggest the Oriskany division of the Lower Devonian, and also rather suggest the Grande Grève than the York River. However, the evidence for such correlations is weak and does not rule out the possibility of a York River age, whether this age is Lower Devonian as held by some, or Middle Devonian as held by others. In view of the indefiniteness of the fossil evidence, and the more suggestive evidence of lithological and thickness comparisons, given above, we follow the view that the York Lake series is more closely related in age to the York River formation than to the Grande Grève.

Acceptance of the above conclusion would have the effect of weakening the suggestion made as a result of earlier work that the York River and

York Lake divisions may be separated by an unconformity. Such a break was suggested because in some sections a sharp change in dip coincided closely with the boundary between these two divisions as located by lithology. However, it is now known that rapid dip changes, resulting from either faulting or flexing, are common in both the Gaspé Limestones and the Gaspé Sandstones. Thus, while the dip change in the present instance must still be considered as possibly suggesting an unconformity, it is not given as much weight as heretofore.

Fortin Series

The term Fortin series was introduced (1) to include a thick succession of sedimentary rocks occupying a stratigraphic position roughly equivalent to the York Lake series. The Fortin series underlies a belt four to six miles wide extending in an east-west direction through the northern part of the townships of Fortin, Joncas, Power, and Vondenvelden, and a narrow width at the southern edge of the townships of York, Baillargeon, Laforce, and Sirois. Thus, the series is restricted to the southern side of the Saint-Jean (John) River anticline, whereas the York Lake series is recognized only to the north of this fold. Reconnaissance work by McGerrigle has shown that this series extends at least as far west as the Matapedia valley and that it underlies a belt up to eighteen miles in width.

The rocks of the Fortin series in this region occupy a major synclinal fold, the Malbaie, and, for the most part, they are strongly drag-folded and wrinkled. Also, and particularly toward the west, they are strongly cleaved. In general terms, the series consists chiefly of dark shaly slates, with interbeds of limestones, sandstones, and conglomerates. The limestones are generally dark grey, soft, shaly, and in ribbon-banded and finely banded master beds up to four feet thick. The sandstones are greenish-grey to brownish-grey in colour, fine to medium in grain, feldspathic, and often somewhat calcareous. The conglomerates are composed of well-rounded pebbles up to two inches in diameter of quartz, black and green chert, jasper, volcanics of various types, and occasional quartzites. The matrix is sandstone similar to the beds described above.

Toward the eastern end, the series becomes more and more sandy and appears to grade into the generally overlying York River type of sediments. This gradation is not easy to prove directly owing to folding and to the fact that good sections across the measures are infrequent. However, it can be said that no sharp line of division between the Fortin series and the York River was recognizable in these eastern sections.

The basal few hundred feet of the series are generally more sandy than the overlying part of the section, and here also are found the most conspicuous of the conglomerate interzones (Plate XI). At two localities, the series was seen in contact with the Grande Grève. At both of these localities, and at others where the contact was closely approached but not

(1) MCGERRIGLE, H. W., *A Revision of the Gaspé Devonian*; Trans. Royal Soc. Can., Sect. IV, Vol. XL, 1946, pp. 47-49.

actually seen, the beds immediately above the Grande Grève limestones consisted of five to fifteen feet of conglomerates. These differ in no way from the conglomerates already described except that they carry fairly common pebbles and boulders of limestone. These fragments of limestone are tough, but rather soft, fine-grained, dark brownish-grey in colour, and brown-weathering. They are usually slab-shaped but well-rounded at the edges, and are up to eighteen inches in length by six inches thick. These fragments presumably were derived from the Grande Grève formation. This being so, they indicate that erosion intervened between Grande Grève and Fortin time. Little direct evidence of erosion, and no change in strike or dip of the beds above and below the contact, was noted at the places where the contact was seen or approached.

In the western part of the belt underlain by the Fortin series, in this region, the series rests against Silurian or Silurian-Devonian, and the Grande Grève and Cape Bon Ami formations were not recognized. Inasmuch as these latter formations are persistent in the belt to the north of the Saint-Jean (John) River anticline, and are present in the eastern part of the Malbaie synclinal structure, it is reasonable to expect them here also. This reasoning has led us to explain their absence by faulting, whereby the Fortin series was let down graben-like on both sides of the belt which it occupies. However, there is a possibility that the Fortin series in its western extension overlaps both of these formations, or that it includes both Cape Bon Ami and Grande Grève time without maintaining the characteristics of the formations. There are common beds and some zones in the Fortin series composed of limestones very similar to the Cape Bon Ami and the Grande Grève types.

The thickness of the Fortin series cannot be calculated closely in view of the sharp folding present. However, along the North branch of Grande river, the southern part of the series is not greatly disturbed, and for this part of the section a thickness of 2,500 feet has been estimated. Probably an equal thickness is present farther north and up to the main fold axis. Thus, a thickness of some 5,000 feet is assigned to the series here. Farther west, in Power township, the apparent thickness is of the order of 7,000 to 8,000 feet.

The fossils that have been found in beds referred to the Fortin series are as follows:

A.—Vondenvelden township (Jones, 1936, pp.19-20). Fossils determined by E. M. Kindle.

Lot 44.—On Indian brook, about two and three-quarter miles north of mount Alexander, in conglomeratic, calcareous sandstones; near the base of the formation as exposed here.

<i>Leptostrophia</i> cf. <i>oriskania</i>	<i>Loxonema</i> sp.
<i>Rensselaeria</i> cf. <i>mainensis</i>	<i>Tropidodiscus</i> <i>ober</i>
<i>Spirifer</i> <i>arenosus</i>	<i>Dalmanites</i> cf. <i>bairdi</i>
<i>S. cyclopterus</i>	<i>D.</i> cf. <i>micrurus</i>
<i>Plethorhyncha</i> ? sp.	<i>Homalonotus</i> cf. <i>vanuxemi</i>
<i>Sphenotomorpha</i> <i>rigidula</i>	

Examination of the available portion of this lot by T. H. Clark gave, in addition to the above,

Plethorhyncha barrandei
Cyphaspsis cf. australis

Lot 42.—Indian brook, about half a mile downstream from lot 44; in a boulder of conglomerate apparently from the same horizon as lot 44:

<i>Dalmanella cf. subcarinata</i>	<i>Rensselaeria cf. subglobosa</i>
<i>D. cf. elevata</i>	<i>Spirifer cyclopterus</i>
<i>Leptocoelia cf. flabellites</i>	<i>Tropidodiscus obez</i>

B.—Lot 10-M-40.—Power township, 3,200 feet west-southwest of mile 3 on the Power-Joncas line; 1,500-2,000 feet above the Grande Grève:

Plant fragments
Fenestrellina gaspiensis Fritz var.
Polypora orientalis Fritz

An identical fauna, minus the plant fragments, was found (Lot 17-M-40) in Laforce township, two and a quarter miles southwest of the mouth of Willis brook; near the top of a 4,000-foot zone of limestones.

C.—Fortin township:

Lot 42-M-38, range 3, just south of the range II-III line, on Malbaie river:

Conularia sp.

Lot 1-M-39.—Fortin township; range III, in the largest tributary of the Big Fork of Malbaie river, a quarter of a mile south of the range II-III line. The rock is a rust-spotted, tough, greenish-grey, quartzitic sandstone that possibly may belong to the York River formation.

Plant fragments	<i>Leptaena rhomboidalis</i>
Curved worm borings	<i>Platyceras cf. parillifer</i>

Lot 2-M-39.—Fortin township; range II, 1,000 feet north of the range II-III line, on the same brook as Lot 1-M-39. The rock is limestone closely resembling the typical Grande Grève, and the fauna is essentially that of the Grande Grève.

Plant fragments	<i>Leptaena rhomboidalis</i>
<i>Conularia</i> sp.	<i>Schuchertella becraftensis</i>
<i>Tentaculites</i> sp.	Clarke, r.
	<i>Stropheodonta galatea</i>

Lot 9-M-39.—Fortin township; range III, débris on top of the divide between Malbaie river and its Big Fork, 1,500 feet south of the range II-III line and 2,000 feet east of the centre line.

<i>Anastomopora quebecensis</i> Fritz, r.	? <i>Spirifer gaspensis</i>
<i>Fenestrellina gaspiensis</i> Fritz, r.	<i>Leptaena rhomboidalis</i>
<i>Eatonia peculiaris</i>	

The bryozoan *Anastomopora quebecensis* has already been referred to as occurring in the Four Mile Brook beds of Matapedia valley. A second bryozoan in the fauna, *Fenestrellina gaspiensis*, occurs in lots 10-M-40 and 17-M-40 in the rocks assigned to the Fortin series in this region, and also in lot 7-M-39, which will be listed below as a York River fauna, and in the Sonneau Brook beds of E. M. Kindle and which he referred to the 'Upper' Devonian. *Eatonia peculiaris* is more commonly a Grande Grève form, but it occurs in the lower part of the Gaspé Sandstones (Clarke, 1908), that is, in the York River. *Spirifer gaspensis* is more commonly a York River form, but it may occur in the Grande Grève. Thus, in the last lot of fossils given above, there is more suggestion of the York River than of the

Grande Grève. The bulk of the fossils in the other lots rather suggest the Grande Grève. The first two lots, those in Vondenvelden township, were stated by Kindle (Jones, 1936, p.20) to be Lower Devonian, probably Oriskany, with lot 42 as 'Lowest Devonian'. The reference of lot 42 to lowest Devonian is based on the insecure ground of doubtfully identified species, and can be still further discounted in view of the probability that the two lots are from the same horizon.

The Fortin and York Lake series occupy much the same general stratigraphic position, both appearing at the base of the thick section of Gaspé Sandstones. The two series are separated as to outcrop area by the Saint-Jean (John) River anticlinal structure. This fact coupled with the lithological differences, suggests that the two series were deposited in separate troughs. The barrier between these troughs would coincide with the Saint-Jean (John) River anticline and may have been a factor in determining the trend and persistence of that anticline. This barrier may have been in existence from earliest Devonian time and, if so, would help explain some of the differences as between the northern and southern representations of the Gaspé Limestones. Possibly it would explain the absence of all three of the Gaspé Limestone formations in the western part of the Fortin trough or basin.

MIDDLE DEVONIAN

York River Formation

The York River formation of this report was included only incidentally in the Gaspé Sandstones of Logan. The beds making up the formation do not occur in the 7,036 feet measured by Logan and since generally referred to as the type section of the Gaspé Sandstones. Logan did refer to them, however, as the "sandstones of York River" and the "York River beds", and he listed some fossils from them. The fossils listed by J. M. Clarke in 1908 were from this formation. In 1910, Williams (1) referred to these rocks as the "York River beds" and defined them as the basal, calcareous, marine, and fossiliferous zone of the Gaspé Sandstones. Under this definition the York River beds would be about 2,500 feet thick, although actually only a small percentage of this thickness is calcareous and fossiliferous. We have included in the York River formation all rocks in the section having the same lithology as the general series of 'York River beds'

The York River formation is well exposed in the York River syncline in the middle and lower parts of York River valley and in other adjacent subsidiary down-folds. The maximum thickness of the formation in these areas is estimated at about 5,000 feet. On L'Anse-à-Brillant river, which

(1) WILLIAMS, H. S., *Age of the Gaspé Sandstones*; Geol. Soc. Am., Bull., Vol.20, 1910, pp.688-698.

empties into Gaspé bay just below Tar point, a good section of the formation is exposed through a thickness of about 4,500 feet. The formation may be followed around the Grande Grève limestones, where they plunge to the east on the Saint-Jean (John) River anticline, and it is well developed in the next major fold to the south, the Malbaie syncline. On the south limb of the Malbaie syncline, the thickness of the formation is close to 6,000 feet. On the north limb of the syncline, or south limb of the Saint-Jean (John) River anticline, the formation is not so well or so completely exposed owing to folding and faulting. The Tar Point anticline keeps the formation up so that it actually is exposed, although thinly, at the point. These rocks on the fold axis were thought by Logan to be very close to the Grande Grève stratigraphically, and consequently he placed the base of his measured section of Gaspé Sandstones at Tar point.

On the north side of Gaspé bay, the rocks assigned to the York River formation are only up to 1,300 feet thick. They do not appear to differ from the usual York River, and, as in the Tar Point area across the bay, they include a zone of quartz-rich rock near their summit. This zone is 20 to 80 feet thick and its apparent position is about 300 feet from the top of the formation. The rock is very rich in quartz, with some grey feldspar.

The York River formation consists of greenish-grey, medium-to fine-grained, feldspathic sandstones, with common interbeds and inter-zones of greenish shale up to 100 feet thick (Plate XII-A). The shales are particularly common toward the base of the formation. Calcareous and often fossiliferous sandstone beds occur frequently in a zone 1,000 to 3,000 feet thick above the base of the formation. This zone is not easily distinguished from the York Lake formation or series, and, as suggested above, it may be that the lower part of what we have mapped as York River may be correlated with the York Lake. In general, the sandstones of the York River are coarser and less argillaceous than those of the typical York Lake. The formation is distinguished from the overlying Battery Point in many ways, although, as a result of interbedding of one type with the other, no sharp boundary can be drawn between the two formations. The York River is in general more shaly than the Battery Point, and the sandstones are finer grained, less pebbly, and not so sharply cross-bedded. The feldspar content is the chief point of difference between the two formations. In both, the sandstones are almost invariably feldspathic, and, locally, feldspar is the predominating mineral in any given bed. Grey plagioclase feldspars predominate in the York River, while in the Battery Point the chief feldspar is brownish-red to flesh-coloured orthoclase. Intraformational conglomerates, cut-and-fill structures, ripple marks, and occasional rain-prints (or bubble marks) combine with cross-bedding and rare basal-type conglomerates to show that the formation was deposited in shallow water. These structures do not necessarily imply continental conditions, as so frequently has been claimed for the Gaspé Sandstones in general. It seems more likely that the formation was deposited in shallow seas bordering the continental areas.

The fossils that have been identified from the York River formation are given below in a table which includes all the collections except those

noted by Logan and Ells. The latter are repeated here in their essential parts, without modernizing the names used.

Logan (1863, p.885) refers to plant remains as being "abundantly disseminated through the sandstones of York River", and he lists *Psilophyton princeps* as the most abundant, accompanied by (the parenthetical remarks are Logan's, quoting Dawson):

Leptophleum rhombicum (also at Perry, Maine)
Didymiphyllum reniforme (also in the Hamilton of New York)
Prototaxites (Nematoxylon) simplex
P. minus
 ? *Lycopodites* (resembling *L. milleri* of Salter).

Logan also lists (p.885) fossils from the mouth of Patewegia brook and D'Argent (Silver) brook, and (p.398) from the "north side" of Gaspé basin. These lists are not repeated here as they add nothing to Clarke's list given below, except for the names "*Avicula Woodwardi*" and "*Grammysia Verneuli*" which are credited to the last named locality.

Ells (1882, p.14DD) lists the following from "the vicinity of Gaspé and the York and Dartmouth rivers. . . from the basal beds of the Gaspé sandstone":

<i>Leptocoelia flabellites</i>	<i>Mytilarca Canadensis</i>
<i>Strophomena Blainvillei</i>	<i>Modiomorpha inornata</i>
<i>Grammysia Canadensis</i>	<i>Murchisonia egregia</i>

The last three forms in this list are not given in Clarke's list, although they may be present there under other names.

Again Ells (1883, p.24E) lists the following, collected by A. E. Barlow "from the hills in rear of Gaspé village":

<i>Psilophyton</i>	<i>Rensselaeria ovoides</i> Eaton
<i>Strophomena Blainvillei</i> Billings	<i>Spirifer Gaspensis</i> Billings
<i>Chonetes melonica</i> Billings	<i>Grammysia Canadensis</i> Billings
<i>Chonetes Canadensis</i> Billings	<i>Tentaculites</i>
<i>Leptocoelia flabellites</i> Conrad	<i>Orthoceras</i>

Ells includes this lot in the Oriskany. The two species of *Chonetes* are not present in Clarke's list of Gaspé Sandstone fossils but are present in the Grande Grève fauna of Clarke.

Clarke's collections (1908, pp.82-85) from the Gaspé sandstone were limited to the York River formation in the readily accessible areas about Gaspé basin. His principal fossil locality was just southwest of the portage road back of Gaspé village leading from Gaspé basin to L'Anse-aux-Cousins. Clarke states that here are "fossiliferous blocks all of a highly weathered

calcareous sandstone Fossils are to be found in place also in the exposures under the highway just back of the Robin-Collas fish houses and loose all along the south shore of the basin from cape Ramsay for a distance of three miles up the York river" It is to be noted that much of the material in Clarke's collections came from loose blocks which, presumably, were not far from their source. No distinction is made in his list between fossils found in place and those found in loose material. Alcock (1926, p.43) listed seventeen forms collected by him on Mississippi brook and on York river above the mouth of the brook. These fossils were determined by E. M. Kindle. Kindle (1938, pp.29-32) listed five lots of fossils from York River beds in widely separated localities in the eastern part of the region. Jones (1939, pp.23-28) listed fossils from some sixty localities in the lower to middle reaches of the valley of York river. These forms also were determined by E. M. Kindle. Fossils were collected by McGerrigle along the lower Saint-Jean (John) river, duplicating some of Kindle's localities (1938), and in Fortin township, during the years 1939-1940. These have been identified by T. H. Clark. These various collections are assembled in the following composite list.

FOSSILS OF THE YORK RIVER FORMATION

A Composite List

- A — Alcock, 1926, p.43 x — Identities
 C — Clarke, 1908
 J — Jones, 1939, pp.23-28
 K — Kindle, 1938, pp.29-32 * — Close allies or possible
 M — McGerrigle, 1938-39 identities

	Grande Grève	Oriskany	Onondaga	Hamilton
PLANTS				
<i>Psilophyton cf. princeps.</i> M				
<i>Lepidodendron</i> sp. J				
PORIFERA ?				
<i>Ischadites cf. squamifer</i> (Hall) K				
COELENTERATA				
<i>Favosites</i> sp. J				
ANNELIDA ?				
<i>Gyrichnites gaspensis</i> Whiteaves C				
<i>Tentaculites cartieri</i> Clarke ACJK				
ECHINODERMATA				
<i>Hystericrinus?</i> sp. K				
<i>Devonaster eucharis</i> (Hall) var. <i>goldringae</i> Ruedemann J, K.....				*K

FOSSILS OF THE YORK RIVER FORMATION (continued)

	Grande Grève	Oriskany	Onondaga	Hamilton
BYRZOEA				
<i>Hederella blainvilli</i> Clarke, C.....		*C		
<i>Botryllopora socialis</i> Nicholson? K.....				xK
<i>Polypora orientalis</i> Fritz K.....				*K
<i>Fenestrellina gaspensis</i> Fritz, K,M.....				
BRACHIOPODS				
<i>Athyris hera</i> Clarke C.....				*C
<i>Beachia amplexa</i> Clarke A, K?.....	xC			
<i>Brachyprion majus</i> Clarke, J.....	xC	xC		
<i>Chonetes (Eodevonaria) hudsonicus gaspensis</i> Clarke.....		*C		
<i>C. billingsi</i> Clarke, C.....	xJ			
<i>C. melonicus</i> Billings, M.....	xC			
<i>Chonostrophia complanata</i> Hall, C.....	xC	xC		
<i>C. dawsoni</i> Billings, C,M,J,K.....		*C		
<i>Coelospira concava</i> Hall, A.....	xC	xC		
<i>Cryptonella</i> sp., C.....				
<i>Cyrtina hamiltonensis</i> Hall.....				xC
<i>Dalmanella penouli</i> Clarke, C.....	xM			
<i>Eatonia peculiaris</i> (Conrad), C.....	xC	xC		
<i>Leptaena rhomboidalis</i> Wilckens, J.....	xC			
<i>Leptocoelia stabbellites</i> (Conrad), C,A,J,K,M.....	xC	xC		
<i>L. dichotoma</i> Hall, M.....				
<i>Leptostrophia blainvillii</i> (Billings), C,A,J,K,M.....	xM			*C
<i>L. tardifi</i> Clarke, M.....	xC			
<i>L. magnifica tullia</i> (Billings), M.....	xC	*C		
<i>Megalanteris</i> cf. <i>thunei</i> Clarke, K.....	xC			
<i>M. ovalis</i> Hall, M.....		xC		
<i>Meristella</i> sp., J.....				
<i>Orbiculoidea montis</i> Clarke, J.....	xC			
<i>Rensselaeria ovoides gaspensis</i> Clarke, C,A,J,K,M.....	xC	*C		
<i>Orthotetes (Schuchertella) becraftensis</i> Clarke, C,J,K,M.....	xC	xC		
<i>Orthotetes (Schuchertella) woolworthanus gaspensis</i> Clarke, J.....	xC			
<i>Spirifer arenosus</i> (Conrad), J?M.....	xC	xC		
<i>Spirifer gaspensis</i> Billings, C,A,J,K,M.....		xC		*CK
<i>Spirifer varicosus</i> Hall, var., J.....				xK
PELECYPODS				
<i>Actinopteria communis</i> (Hall), A,J?,M.....	xC	xC		
<i>A. (Pterinea) fronsacia</i> Clarke, C,K.....				*C
<i>Aviculopecten jumeaui</i> Clarke, J?,M.....	xC			
<i>A. textilis</i> (Hall), J.....				
<i>A. cf. princeps</i> (Conrad), J.....				
<i>Goniophora</i> cf. <i>hamiltonensis</i> Hall, J.....				
<i>G. tethys</i> (Billings), J.....	xC			
? <i>Gosseletia</i> sp., J.....				
<i>Grammysia canadensis</i> Billings, C,M.....				xK, *C
<i>Leda brevirostris</i> Hall, C,K.....				xC
<i>Limoptera macroptera</i> (Conrad), K.....				xK
<i>Lunulicardium convexum</i> (Clarke), C,A.....				
? <i>Liopteria</i> sp., C.....				
<i>Microdon (Cypricardella) gregarius</i> (Hall), A.....				xK

FOSSILS OF THE YORK RIVER FORMATION (continued)

	Grande Grève	Oriskany	Onondaga	Hamilton
<i>Modiella modiola</i> Clarke, C.M.				
<i>M. pygmaea</i> (Conrad), C,K				xC, K
<i>Modiomorpha</i> cf. <i>chapmani</i> Williams, J				
<i>M. inornata</i> Billings, J?, and Billings				
<i>M. cf. mytiloides</i> (Conrad), K				
<i>Mytilarca</i> cf. <i>nitida</i> Billings, J	xC			
<i>Nucula</i> cf. <i>randalli</i> Hall, J				
<i>Nuculites</i> cf. <i>oblongata</i> Conrad K,J				
<i>N. triquetrus</i> Conrad, C,A,M				xC, K
<i>Paracyclas tenuis</i> Hall, J?M				
<i>Palaeoneilo</i> cf. <i>constricta</i> (Conrad), C				xC
<i>P. maxima</i> (Conrad) var., K				xK
<i>Palaeopinna flabellum</i> Hall?, C	xC	xC		
<i>Phthonia cylindrica</i> Hall				xC, K
<i>Schizodus appressus</i> Hall, C				xC, K
<i>Sphenotus truncatus</i> (Conrad), C,J				xC,K
GASTROPODS				
<i>Bellerophon</i> cf. <i>leda</i> Hall, K, C?				
<i>Callonema</i> cf. <i>bellatulum</i> Hall, C				*C, K
<i>Coelidium egregia</i> (Billings), Billings (?)				
<i>Diaphorostoma perceense</i> Clarke, J	xC			
<i>Euphemus?</i> <i>quebecensis</i> Clarke, C				*K
<i>Holopea gaspesia</i> Clarke, C,J,K				*C
<i>H. wakehami</i> Clarke, C				*C, xK
<i>Platyceras gaspense</i> Clarke, C				*C, K
<i>Pleurotomaria sulcomarginata leclercqui</i> Clarke, C				xC, K
<i>Tropidodiscus brevilineatus</i> (Conrad), C,A,K				xC, K
<i>T. rotalineae</i> (Hall), K,M				xC, K
SCAPHOPODS				
? <i>Dentalium</i> sp., J				
PTEROPODS				
<i>Hyolithes</i> cf. <i>aclis</i> Hall, C				xC, K
CEPHALOPODS				
<i>Kionoceras rhysum</i> Clarke A,M	xC			
<i>Michelinoceras</i> sp., K				
TRILOBITES				
<i>Phacops correlator</i> Clarke, C		xC		
<i>P. cf. rana</i> Green, K				xK
ARCHAEOSTRACA				
<i>Tropidocaris belli</i> (H. Woodward) C. (genus — U. Devonian, Mississippian) — (S&S)				*C
VERTEBRATES				
<i>Machaeracanthus</i> cf. <i>sulcatus</i> Newberry, J				

NOTE: The last four fossils in Clarke's list, including *Pterygotus Cephalaspis dawsoni* Lankester, *Ctenacanthus*, *Machaeracanthus sulcatus* Newberry, probably were collected from the Battery Point formation.

No attempt is made in the report to check the names given above against the faunal lists from the Devonian formations of other areas. Rather we are restricting ourselves for the moment to a review of opinions given by previous authors as to the age of the beds, and the checking shown in the above table is part of that review. This applies to all the check marks except those in the Grande Grève column, these showing some twenty-three species common to the York River and Grande Grève formations, whereas Clarke (1908) and Kindle (1938) recognized only seven such common species. The review will be found below, following discussion of the Battery Point formation. It will be noted that some authorities favour a Lower Devonian (Oriskany) age and others a Middle Devonian (Hamilton) age for these beds and for the Gaspé Sandstone series in general.

Battery Point Formation

The term *Battery Point* has been introduced as a formational term to include the upper part of the great sandstone and shale succession in the Gaspé area. More specifically, it includes all of the 7,036 feet of shore section measured by Logan (1863) and since generally considered as representative of the entire "Gaspé Sandstone" series. The type section is at Battery point, where the Battery Park hotel stands, shortly outside of Gaspé village, and from the point westerly along the south shore of Gaspé basin for upwards of one mile.

The formation occurs along the north shore of Gaspé bay and of the Northwest arm from Little Gaspé to Dartmouth river. Its greatest development here is inland from Saint-Majorique, where, to the west and east respectively, thicknesses of 5,000 feet and almost 7,000 feet are estimated on the bases of dips and widths of exposures. The formation is again exposed in a narrower band on the south side of the Northwest arm and the Basin to, and including, the type section at Battery point. These rocks occur again on the shore of Haldimand peninsula and, farther south, from near Douglastown southerly along the shore of Gaspé bay to Tar point. Here an anticlinal fold brings up the topmost beds of the York River formation. Logan's measured section is based here at Tar point and continues southward, and stratigraphically upward, along the coast to the cove just west of Pointe Jaune (Yellow head) (Plates XII-B, XIII-A). The formation occupies most of the northern half of Malbaie township, extending westward from Long cove and cap Rouge for ten to twelve miles. It occurs on Malbaie, Beattie, and Portage rivers. On the Portage it is close to, if not against, the Grande Grève limestone, probably being brought into this position, in part at least, by faulting. The shore section, measured by Logan, is stated to be 7,036 feet thick. Some ten miles to the southwest, on the south branch of Beattie river, the estimated thickness is 5,000 feet — but this section lacks the 1,814 feet (Logan's measurement) of red beds that show in Long cove.

One of the main points of difference between this formation, or phase, and the York River is the feldspar content. The sandstones of both formations are feldspathic. The feldspar of the York River has been described above as, characteristically, light grey plagioclase. That of the Battery

Point sandstones, on the other hand, is orthoclase, ranging in colour from flesh-pink to brownish-red. Beds combining the feldspar characteristics of each formation occur quite frequently but are most common where the two formations or phases come together.

In general, the lower part of the formation consists of beds like those of the type section. Beds of this type are well exposed at Little Gaspé, Battery point, Tar point to Bois Brûlé river, on Malbaie river and its Little Fork, on both branches of Beattie river, and on many of the smaller streams in the northern part of Malbaie township. The rocks are mostly sandstone, often pebbly, with some true conglomerates and some greenish shales. The sandstones have a greenish-grey colour (a brighter green than in the York River), a 'streaky' banding that often shows cross-bedding, and in many places they carry pebbles that may be scattered or arranged in bands. The pebbles in the sandstones and in the conglomerate beds are well rounded. They are chiefly quartz, chert or flint, volcanic rock, and quartzite, with some jasper and reddish granite, and occasional grey syenite. Near the base of the Battery Point at many localities on the north side of Gaspé basin and the Northwest arm, a zone of quartz-rich sandstone occurs. This appears to be in lenses rather than in a continuous band, and is up to 100 feet thick. This sandstone contains grains of red to pink feldspar and locally carries pebbles of quartz. On weathered surfaces the rock commonly has a pinkish colour.

The upper part of the formation consists, in general, of variously shaded red and brown sandstones, shales, and conglomerates. Some of the beds are mottled to streaked red-brown and green. Many of these higher beds are strongly calcareous. Ripple-marks, mud-cracks, and cross-bedding are common features, and rain prints were occasionally observed. Except for the colour and the more pronounced evidences of shallow-water deposition there is little difference between these beds and those more characteristic of the lower part of the formation. The coloured beds are well exposed along the shore from Pointe Jaune, where the Malbaie formation overlies them, northward to Bois Brûlé river. They form a band about two miles wide bordering the shore. The band swings to the west from Pointe Jaune to follow under the Malbaie formation almost to the Little Fork of Malbaie river. This swing is caused by the gentle bending of the beds over the axis of the Pointe Saint-Pierre anticline. Farther inland, the red beds are practically absent, appearing to give place to the greenish-grey rocks already described. This change may be due in part to faulting, but it seems more likely that it is due to other factors. It is significant that on the West branch of Beattie river, and between the two branches, the Malbaie conglomerate overlies greenish-grey Battery Point beds with which reddish beds are only occasionally associated. Thus, it appears that the red beds which, on the coast, form the upper part of the formation, are here replaced by greenish-grey beds at the same horizon. This change might well be due to initial conditions, those of deposition, with the red beds representing a shore or sub-continental part of the formation, as opposed to the shallow-water but off-shore greenish-grey beds.

Red beds of the upper part of the formation may be seen also at the north end of the bridge over the Northwest arm and at intervals along the

shore and in brooks eastward to Peninsula. These beds constitute the type section of the "Peninsula facies" of E. M. Kindle (1938), which we have included, without specific differentiation, in our Battery Point formation.

Fossils have been found in Battery Point beds, but not in sufficient quality to date the formation definitely. Fragmentary remains of plants are widespread and occasionally determinable plant fragments are found, but these determinable forms are by no means of such common occurrence as is assumed by many authors. The same is true of the remains of fossil fish. In the present work, very little plant or vertebrate material was found. Dawson's collections of plants, listed below, are assumed to have been taken from the Battery Point formation, but they may have been taken from the York River. Neither Dawson's descriptions nor the labels on his collections are definite as to location.

Logan (1863, p.394) lists as occurring in his division No.1 — the basal 528 feet of his section and of our Battery Point formation — the following forms:

<i>Prototaxites Logani</i>	<i>P. robustius</i>
<i>Lepidodendron Gaspianum</i>	<i>Selaginites formosus</i>
<i>Psilophyton princeps</i>	<i>Cordailes angustifolia</i>

Also, *Psilophyton* is stated to occur at least as high as 1,500 feet above the base. *Calamites?* sp. is listed by Logan (p.396) from the rocks at Little Gaspé.

Ells, (1882, pp.6-7DD), Alcock (1935, p.78) and White (1) repeat the plant determinations of Dawson (1871 and 1882) more or less completely. The complete list of fossil plants as given by Dawson is as follows:

<i>Prototaxites logani</i>	<i>Lepidophloeos antiquus</i>
<i>P. (Nematozylon) crassum</i>	<i>Psilophyton princeps</i>
<i>P. (N) tenue</i>	<i>P. robustius</i>
<i>Stigmara areolata</i>	<i>P. elegans</i>
<i>S. minutissima</i> (?rhizomes of	<i>P. glabrum</i>
<i>Psilophyton</i> : White)	<i>Arthrostigma gracile</i>
<i>Didymophyllum reniforme</i>	<i>Cyclostigma densifolium</i>
<i>Calamites inornatus</i>	<i>Cordailes angustifolius</i> ;
<i>Annularia laxa</i>	<i>Parka</i> related to, though smaller
<i>Lepidodendron gaspianum</i>	than, <i>P. decipiens</i> of Scotland
<i>Leptophleum rhombicum</i>	

White said of these plants that they represent the "*Psilophyton-Arthrostigma flora*" which occurs in the Middle Devonian but "seems hardly to have survived the Hamilton group", and occurs as low as the Chapman sandstone of Maine. By this interpretation, the range of this flora is not sufficiently restricted to date either the Battery Point or the York River any closer than as Lower or Middle Devonian. Recently, however, Dorf and Cooper (2) pointed out that the *Arthrostigma gracile* of Dawson's collection is synonymous with *Drepanophycus spinaeformis*

(1) WHITE, David, pp.108-109 of *Dalhousie and the Gaspé Peninsula*, by J. M. CLARKE; Geol. Surv. Can., Guide Book No.1, Part I, 1913.

(2) DORF, E., and COOPER, J. R., *Early Devonian Plants from Newfoundland*; Journ. of Pal., Vol.17, No.3, 1943, pp.264-270.

Göppert, which is "represented at widely scattered localities in Europe and Asia" where it is "unequivocally regarded as confined to the Lower Devonian". In North America, this form is known in Lower Devonian beds at Campbellton, N.B., in the Hudson Bay region from the Sextant formation which underlies the Onondaga, and from Newfoundland and Gaspé. Therefore, this form is considered by Dorf and Cooper as "indicative" of the Lower Devonian.

On the north side of Gaspé bay, the only invertebrate fossils known from the Battery Point formation are mentioned by Kindle (1938, pp.27-28) as being collected by J. W. Dawson from the "east side of Gaspé bay at D'Aiguillon wharf". "This fauna includes two or more species of *Lingula* and a few species of small pelecypods. None of the species in it are known in the region west of Gaspé Bay".

On the south side of the bay in all of the Battery Point beds between Gaspé basin and Beattie river, only two fossil lots have been reported. Logan (1863, p.399) states that at one place between Tar point and Douglas-town, a few shells of *Rensselaeria*, "probably *R. ovoides*", were found. This would be at least 1,100 feet above the base of the section. Apart from this there is the following collection:

Lot 40-M-39, Malbaie township, range IV North. On the Little Fork of Malbaie river, about three miles north of the mouth of the brook:

<i>Spirifer gaspensis</i> Billing's	<i>Modiella modiola</i> Clarke
<i>Actinopteria</i> cf. <i>communis</i> (Hall)	<i>Nuculites triquetrus</i> Conrad
(Grande Grève)	? <i>Sphenotus truncatus</i>
<i>Grammysia canadensis</i> Billings	(Conrad)
<i>Leda</i> sp.	<i>Coelidium egregia</i> (Billings)
<i>Megambonia crenistriata</i> Clarke	
(Grande Grève)	

Spirifer gaspensis occurs in great abundance in this lot and is the only brachiopod represented with the exception of two unidentified specimens of *Spirifer*. The fauna is notable for the abundance and variety of pelecypod forms. T. H. Clark, who studied the collection, provides the following analysis: One of the definitely identified species, *Megambonia crenistriata*, is not known elsewhere above the Grande Grève-Oriskany level. Four are Hamilton species, and none is characteristic of a horizon higher than the Hamilton. There is nothing in the collection that suggests a palaeontological level higher than the York River. Thus, the following review of opinions as to the age of the Gaspé Sandstones apparently applies as much to the Battery Point as to the York River formation.

Gaspé Sandstones (York River and Battery Point Formations) *Recapitulation and Correlation*

The Gaspé Sandstones were so named by Logan and were stated by him to be about 7,000 feet thick. Logan recognized the possibility that the series might represent a considerable length of time, and, while he referred the "lower part" to the Lower Devonian (Oriskany), he considered it possible that the upper part might be as young as Upper Devonian. Dawson ranged the age of the series from Lower to Upper Devonian, as follows:

CORRELATION OF GASPÉ SANDSTONES
(After Dawson)

SUBDIVISION	NEW YORK AND WESTERN CANADA	GASPÉ	SOUTHERN N.B.	COAST OF MAINE
UPPER DEVONIAN	Chemung	Upper sandstones Long Cove, etc.	Mispec Group	Perry sandstones
MIDDLE DEVONIAN	Hamilton	Middle sandstones Bois Brûlé (= ? Cap Brûlé) Cape Oiseau (= Cap-Aux-Os)	Little River Group	
LOWER DEVONIAN	Corniferous (Onondagan) and Oriskany	Lower sandstones Gaspé Basin Little Gaspé, etc.	Lower conglomerates, etc.	

Ells (1882) divided the Devonian of eastern Gaspé into three groups, namely, from oldest to youngest, the Gaspé Limestone series, the Gaspé Sandstone series, and an upper conglomerate series (the Malbaie formation, which Logan had correlated with the Carboniferous Bonaventure formation). In 1883, Ells placed the "upper portion of the limestone series and a portion of the sandstone series" in the Oriskany, the "middle and upper portions" of the Gaspé Sandstones in the Hamilton ("probably"), and the upper conglomerates (the Malbaie formation) in the Portage and Chemung.

Clarke placed the Gaspé Sandstone series in the Middle Devonian (Hamilton) and the upper conglomerate (Malbaie formation) in the Carboniferous as part of the Bonaventure formation. In 1910, H. S. Williams (1) divided the series into two parts, naming the basal part the "York River beds" and correlating it with the Oriskany. Clarke (1), however, still maintained that these beds were Hamilton, while Schuchert (1) took a middle course and placed the York River beds in the Onondagan (lower Middle Devonian). The Malbaie conglomerate formation was not mentioned or considered in this discussion (1).

W. A. Parks, in 1929, apparently included the upper (Malbaie) conglomerate in the 7,000 feet of Gaspé Sandstones, contrary to Logan's definition. Parks did not aid in settling the question of age relationships, and the geological section of his report dealt mainly with structure.

In Alcock's report on the Chaleur Bay region, published in 1935, the Gaspé Sandstone series in the area between Beattie and Portage rivers was

(1) WILLIAMS, H. S., *Age of the Gaspé Sandstones* (with discussion by John M. CLARKE and Charles SCHUCHERT); Geol. Soc. Am., Bull., Vol. 20, 1910, pp. 688-698.

estimated to be 8,500 feet thick. The Malbaie formation was not included in this thickness, and it was, in fact, distinguished for the first time as a separate formation. This conglomerate formation was recognized as the upper part of the Devonian succession, following conformably upon the Gaspé Sandstones, but with a sufficiently distinct lithology and sufficient thickness to be established as a separate formation. The York River beds were included with the Gaspé Sandstones by Alcock, and apparently he believed the series, as a whole, to be Middle Devonian. C. H. Kindle (1), in 1936, divided the Gaspé Sandstone series into two "members", the lower being the "York River" sandstone (7,000 feet) and the upper, the Malbaie conglomerate (3,000 feet). This division was not in accordance with either Logan's definition of the Gaspé Sandstone series or Williams' definition of the "York River beds", but it served to emphasize the importance of the Malbaie formation and the fact that it is Devonian in age and not a part of the Carboniferous conglomerates. The Gaspé Sandstone series was believed by Kindle to be Middle Devonian.

E. M. Kindle (1938) recognized the fossiliferous York River beds as a marine facies of the Gaspé Sandstone series, and he correlated them with his Peninsula facies. He stated that the latter facies so far had yielded "non-marine vertebrates and plant fossils" mainly, but that it included at least one interbed or interzone of marine rocks. The Peninsula, or eastern, facies was defined as including all of the Gaspé Sandstones northeast of Gaspé bay and a narrow strip on the southwestern side. "Bordering this eastern facies with only local evidence of a distinctly marine fauna and interfingering with it is the York River or western facies representing a deeper and more seaward area which was characterized by greater salinity. The York River facies is characterized by a marine fauna which embraces some survivors of the Grande Grève fauna and several representatives of the Hamilton fauna together with some species peculiar to the Gaspé Sandstone" (1938, p.29). Kindle seems to show rather conclusively that the Gaspé Sandstones, by which he meant, however, only the York River formation or facies, is Middle Devonian (Hamilton) in age. At an unstated level higher in the Gaspé Sandstone series, Kindle determined a fauna as Upper Devonian (Ithaca) in age. The beds enclosing this fauna he called the Sonneau Brook member of the Gaspé Sandstones. He correlated this member with his Four Mile Brook shale formation of the Matapédia valley — this formation was included in the Gaspé Sandstones of Crickmay or the Heppel formation of Alcock. There seems to be little basis for referring the Sonneau Brook beds to the Upper Devonian because, stratigraphically, they belong well down in the York River formation. Kindle's conception of an eastern and a western facies may be correct in a general way, but in at least one section we have found 4,000 to 5,000 feet of "western" facies (York River) underlying 7,000 feet of "eastern" facies (Battery Point; "Peninsula" was the term used by Kindle).

In 1939, A. B. Cleaves (2), in discussing the correlation of the Ridgely and Shriver members of Pennsylvania stated that they "are both definitely

(1) KINDLE, C. H., *A Geological Map of Southeastern Gaspé*; Eastern Geologist. No.1, 1936.

(2) CLEAVES, A. B., in *The Devonian of Pennsylvania*; Pa. Geol. Surv., Bull., G. 19, 1939.

Oriskanian and may be correlated with the *gaspensis* fauna". The type formation for this fauna was the Moose River sandstone of Maine. Cleaves quotes Allan (1) as placing in the *gaspensis* fauna the following: the Moose River sandstone of Maine, the Gaspé Sandstones and the Grande Grève limestone of Quebec, the Oriskany sandstone of New York, and the Ridgely and Shriver of Maryland. Cleaves adds to this list, among others, the Littleton formation of New Hampshire. Allan suggests that the sandstones of the Moose River, Gaspé, and the Oriskany of New York, may be correlated with the Lower Emsian (Cobblentzian) of Europe.

In 1942, Cooper (2) pointed out that correlation of the Gaspé Sandstones with the Hamilton was based very largely on comparisons between pelecypods. Such comparisons he believed to have doubtful value because the mollusks of the Gaspé Sandstones are poorly preserved and thus difficult to identify. Therefore, Cooper questioned "many of the specific determinations recorded". He also pointed out, and quite correctly, that the so-called 'relict' forms of Clarke's list (1908) and of Kindle's list (1938), those that continue into the Gaspé Sandstones from the Grande Grève, "are numerically the most abundant in individuals". And, on these bases, with other arguments of lesser weight, Cooper concluded that the Gaspé Sandstone series is of Schoharie (Camden Chert) age, and thus equivalent to a part of the Onondaga.

Following on from Cooper's reasoning, it may be said that, if we are to question the recorded identifications of the pelecypods, there is no use arguing the case. However, these identifications were made by three different professional palaeontologists on at least three different groups of collections, and their results check rather closely. Furthermore, some of the brachiopods and some of the species from other groups also suggest a Hamilton rather than an older age. Thus, in the absence of any valid reason as so far presented for not accepting the recorded identifications, we must refer the York River and the Battery Point formations to the stratigraphic level of the Middle Devonian Hamilton formation. This is in accordance with the standing rule for correlation by means of fossils, that the value of a number of introduced or new elements in any fauna is much higher than the value of a number of persisting types. Hence, the age of the formations in question, or of the 'Gaspé Sandstones', is the age of its mollusks and particularly of its pelecypods, and not of its persistent brachiopods.

Malbaie Formation

The Malbaie formation extends from Pointe Jaune on the south side of Gaspé bay, around point St-Pierre, and along the north side of Malbaie bay to the northwest bank of Beattie river. It is conformable with the Battery Point sandstones and forms the upper part of the continuous succession of Devonian deposits in this region. These beds were placed by Logan (1863) in the Bonaventure formation, by Ells (1882 and 1883) in

(1) ALLAN, R. S., *The Fauna of the Reefton Beds, New Zealand*; New Zealand Geol. Surv., Pal. Bul. 14, 1935.

(2) COOPER, G. A., *et al.*, *Correlation of the Devonian Sedimentary Formations of North America*; Geol. Soc. Am., Bull., Vol.53, 1942, pp.1760-61.

the Gaspé Sandstone series, by J. M. Clark in the Bonaventure, and later by Alcock (1935) and by C. H. Kindle (1936) in the Devonian.

“The base of the formation is arbitrarily placed below the lowest of the thick limestone pebble conglomerates which outcrop along the south shore of Gaspé bay westward from point St-Pierre. Below the lowest of these conglomerates, in the cove immediately west of point Jaune, there is a fault mentioned by Logan as marking the top of his Gaspé sandstone. Six thick beds of limestone pebble conglomerate, separated by sandstone (and shale) strata and dipping 15 degrees east, make five points of land and an island on this part of the coast . . . The thickness of the formation along this part of the shore is 3,000 feet” (1). This estimate of thickness originated with Logan, was repeated by Ells, and was accepted by Alcock and Kindle. The thickness is closer to 2,000 feet according to our estimates.

About two miles inland from the mouth of Malbaie river, the conglomeratic beds of this formation are interbedded at their base with Battery Point types of rock and probably interfinger with the same along their strike. Malbaie conglomerate beds are also exposed three-quarters to one mile up the north branch of Beattie river, “tightly folded in the axis of a syncline of Devonian rocks” (Alcock, 1935, p.83), that is, in the axis of the Malbaie syncline. The conglomerate continues westward on the axis of the syncline between the two branches of Beattie river for about one mile, where it is cut off by a fault. On the west side of this fault, the conglomerate again appears on a high hill, offset about 3,500 feet to the north. The dragging on either side of this fault, which trends north-northwest, can be seen plainly on the aerial photographs and shows that some part of the movement was, relatively, northward on the west side of the fault.

The formation is made up largely of interbedded conglomerates and sandstones (Plate XIII B), with subordinate interbeds of shale. Individual conglomerate beds and lenses are seldom more than two feet thick, but zones up to 75 feet thick, composed largely of conglomerate separated by thin sandstone layers and lenses, occur. Interzones of sandstone and some shale up to 175 feet thick were noted, and thicker zones of this type probably occur in some of the larger coves, where the rocks are concealed. Along the inner part of the north shore of Malbaie bay, a bed of knobby limestone two to three feet thick was noted. The texture of the limestone varies from finely crystalline to smooth; the rock is soft, reddish in colour, and breaks into roughly rounded chunks. In some places, the limestone was overlain by conglomerate, in others by red shale, and in still others by a four-inch-thick zone of banded white and reddish limestone, resembling calcareous tufa, with interbedded cherty layers. Along this shore, also, a few local developments of a siliceous deposit with onyx-like banding were noted. These were one to two inches thick. They occurred on the surfaces of conglomerate beds.

The phenoclasts of the Malbaie conglomerate usually are of pebble size and are well-rounded (Plate XIVA). At a few places, however, notably above Beaton's salmon pool on Malbaie river and about two miles east of

(1) ALCOCK, F. J., *Geology of Chaleur Bay Region*; Geol. Surv. Can., Mem. 183, 1935, p.83.

Barachois on the shore, boulder beds occur. At the latter locality, the boulders range in size up to one foot long and eight inches thick. They are rounded at the corners, but they are squarish to slabby in large part. The predominate boulders here are of Ordovician (White Head) limestone, but there are many of sandstone — some gritty and some pebbly to conglomeratic — as well as of other types. At the locality on Malbaie river, the boulder beds contain slabs of White Head and of Grande Grève limestones up to one and a half feet by one foot by four inches in size. The corners and edges of these slabs are rounded. With these are pebbles of quartz, chert, jasper, and volcanics, all well-rounded.

In nearly all occurrences of the Malbaie conglomerate, the most abundant pebbles and boulders are Ordovician (White Head) limestone, but in some places, as noted above, pebbles and boulders of Grande Grève limestone are equally, or even more, numerous. Others, of Mont Joli limestone, are frequently present. Sandstone pebbles and boulders are common everywhere in the conglomerate and many of these evidently were derived from the Battery Point formation. Whether or not York River sandstones are represented was not determined.

It is evident from the above that much of the material making up the Malbaie formation was derived locally from formations that are known. But pebbles of other rocks are represented in the conglomerates and the sources of these are not definitely known. These include very common quartz, common chert or flint, some jasper and volcanics, and rare red granite, hornblende syenite, and hornblende syenite gneiss. The quartz pebbles often show the effects of strain, or even are shattered, and frequently they are discoloured.

The matrix of the conglomerate is a grey to reddish-brown, feldspathic, medium- to coarse-grained, calcareous sandstone. Many of the sandstone interbeds are of similar character and composition. The shales are soft, often calcareous, sometimes green and sometimes reddish in colour.

The age of the Malbaie formation can be approximated from structural and stratigraphic evidence. The fact that it was involved in folding, as may be seen in exposures along Beattie river, whereas the Cannes-de-Roche and Bonaventure formations were not, shows that the Malbaie antedates the close of the Acadian period of folding and that it cannot, therefore, be younger than Upper Devonian. Its position at the top of the Gaspé Sandstone series shows that it is no older than Middle Devonian. The formation was placed in the Middle Devonian by Alcock (1) on the basis that, between pointe Jaune and Whale head, "plant fragments similar in appearance to those in the Gaspé sandstone below" were found. The presence of boulders of the Battery Point types of sandstones in the conglomerate suggests erosion of the former while the Malbaie was being deposited. Thus, the further possibility is suggested that the formation may be Upper rather than Middle Devonian in age.

(1) ALCOCK, F. J., *Geology of Chaleur Bay Region*, Geol. Surv. Can., Mem.183, 1935, p.83.

CARBONIFEROUS

The term 'Carboniferous' has been used as a period name. However, the present tendency is to subdivide this division into two periods of approximately equal rank, namely, the Mississippian and the Pennsylvanian. The latter is the younger. In the present case, dealing with the Cannes-de-Roche formation, and incidentally with the Bonaventure, the term Carboniferous is retained inasmuch as it is uncertain whether the formations are Mississippian or Pennsylvanian. They are "more probably" the latter.

CANNES-DE-ROCHE FORMATION

The type locality of the Cannes-de-Roche formation is along the Malbaie Bay shore northwest of Percé, just beyond the southeast corner of the present area. In the area it is well exposed at intervals between Malbaie and Portage rivers.

C. H. Kindle (1) recognized three members in the Cannes-de-Roche formation at the type locality, namely, a lower red conglomerate (Plate XIV-B) 40 feet thick, a middle division of red and green shales and shaly sandstones about 80 feet thick (Plate XV-A), and an upper division of sandstone and conglomerate at least 80 feet thick.

Good exposures of this formation occur on Beattie River, and here the three members mentioned by Kindle were recognized. The order of age is from oldest to the west, or inland, and youngest to the east. At the forks of Beattie river, the oldest member, the basal conglomerate, is exposed. This member also occurs farther west almost to the Malbaie line between the two branches of the river, and again between the North branch and Malbaie river. At the latter locality it caps a flat-topped hill that may be seen plainly from the highway along the Malbaie Bay shore. The thickness of the basal conglomerate member is greater here — locally at least — than at Cannes-de-Roche. At one place, half a mile above the forks on the South branch of Beattie river, a small brook cuts steeply through a thickness of 85 feet of conglomerate. The minimum thickness of the formation as a whole appears to be slightly more than 200 feet.

The sandstones and shales of this formation are not essentially different from those of the Malbaie formation. Nor is there much difference in the conglomerates. In general, however, the beds are more persistently reddish in colour, and the pebbles in the conglomerates are less well-rounded, than in the Malbaie. Also, limestone pebbles of Ordovician (White Head) age seem to be even more common in this formation than in the Malbaie. So far as the rocks themselves were concerned, we noted nothing that could be used to distinguish definitely the two formations. Small wonder, therefore, that the Malbaie and Cannes-de-Roche were assigned by most earlier workers, prior to C. H. Kindle, to one and the same formation.

Kindle noted that the Malbaie formation was involved in the same folding as the Gaspé Sandstone series, and that the Cannes-de-Roche was

(1) See ALCOCK, F. J., *Geology of Chaleur Bay Region*; Geol. Surv. Can., Mem. 183, 1935, p.93.

not involved. The evidence for this is found on the North branch of Beattie river, where the Malbaie is bent down in the axis of a syncline. Shortly to the east of the branch, in line with the trend of the synclinal axis, flat to gently dipping Cannes-de-Roche beds occur. Furthermore, wherever these beds outcrop in the area they have a flat or nearly flat attitude. The Cannes-de-Roche was not seen in contact with the Malbaie. However, its unconformable relations with the Battery Point may be seen on Beattie river in the first half-mile east of the forks, and on Portage river about three-quarters of a mile below the falls (Plate XV-B). At both these places, the Battery Point beds stand almost vertically and the Cannes-de-Roche beds overlie them almost horizontally.

No new palaeontological evidence that would help to establish the age of this formation has been found by us. The evidence, and opinions of age, advanced by Alcock (1935, p.94) are summarized below. Pith casts of *Calamites* and a small fragment of a species of *Adiantites* were recognized by W. A. Bell in the material collected by C. H. Kindle from the type section, on Murphy creek, and from outcrops on Beattie and Portage rivers. "Bell concluded that a late Mississippian or a Pennsylvanian age is indicated more probably Pennsylvanian" (1935, p.94).

"It is probable that the Cannes-de-Roche formation is of the same age as the Bonaventure. It has the same general type of lithology and the same relation to the older formations. It was, moreover, nowhere found either above or below the Bonaventure. The most probable explanation is that it was formed in a separate basin" (Alcock, 1935, p.94). If this explanation is valid there existed here, in the Percé-Malbaie region, a condition very similar to those that obtained in the Maritime Provinces during the Carboniferous. Here, according to Bell (1), sedimentation, mainly fresh water, took place "in subsiding linear basins of deposition that were partially or, more rarely, wholly separated by linear rising areas of erosion". The separating area of erosion in the present case probably would be the area underlain by the band of Grande Grève which, in the extreme southeastern part of the region, has been caused to disappear by faulting.

(1) BELL, W. A., *Outline of Carboniferous Stratigraphy and Geologic History of the Maritime Provinces of Canada*; Roy. Soc. Can., Trans., Vol. XXI, Sec. IV, 1927, pp. 75-108.

STRATIGRAPHIC RELATIONS

ORDOVICIAN-DEVONIAN AND ORDOVICIAN-SILURIAN

Much has been written *pro* and *con* the fact of the 'Taconic revolution'. The stock feature used in supporting evidence of this revolution, throughout the region said to have been affected by Taconic movements, is that the Ordovician rocks are more folded and crumpled, more metamorphosed in general, than the rocks of younger periods. This is not a very convincing argument, for such differences depend on the relative competency of the rocks concerned as well as on their experiences. Clark (1), in 1921, showed that, in the areas or localities cited up to that time as providing evidence of Taconic folding, only those of eastern and southeastern New York furnished evidence that was at all definite, and he justifiably concluded that only these New York regions were affected by this folding.

Clark's conclusions led investigators to view this problem more critically, and, in 1932, Crickmay (2) re-examined the evidence for Taconic mountain-building in Matapédia valley. He concluded that the Ordovician and the Silurian here actually had been separated by a period of folding, which he dated as post-Richmond? and pre-Clinton. The post-Richmond? date was based on the fact that the Matapédia series was involved in the folding, and this series Crickmay correlated with the White Head formation of eastern Gaspé. It is unfortunate that at no place in Matapédia valley have Ordovician and Silurian beds been found in contact. Consequently, the evidence for Taconic folding (or even for the existence of an unconformity between the Ordovician and Silurian) remains circumstantial. This evidence, however, is reasonably convincing. Similar circumstantial evidence is outlined by Northrop (3) in the Port Daniel area at L'Anse-à-la-Vieille.

In eastern Gaspé, the evidence for Taconic folding is also indirect. The Lower to Middle Ordovician rocks of the Quebec group on the northern side of the Gaspé synclinorium are everywhere sharply folded and strongly cleaved, and locally they are severely crumpled. The Silurian and Devonian rocks to the south of the Ordovician, on the other hand, are gently folded and cleavage is but weakly developed. The Lower Devonian St-Alban formation and the Silurian formations would seem to be little or no more competent on the whole than the Ordovician. It is important to note in this connection that the Silurian and Devonian here appear to overlap various horizons of the Ordovician, for there is little correspondence in detail between the various known sections of Ordovician at or close to the contact. If no folding or erosion had taken place between Ordovician and Silurian time, the post-Ordovician rocks should succeed and rest on the youngest Ordovician of the north shore belt. Actually, however, the youngest Ordovician rocks are some miles to the north of the contact.

(1) CLARK, T. H., *A Review of the Evidence for the Taconic Revolution*; Boston Soc. Nat. Hist., Proc. Vol.36, No.3, 1921, pp.135-163.

(2) CRICKMAY, G. W., *Evidence of Taconic Orogeny in the Matapedia Valley*; Am. Journ., Sci., Vol.24, 1932, pp.368-386.

(3) NORTHROP, S. A., *Paleontology and Stratigraphy of the Silurian Rocks of the Port Daniel-Black Cape Region, Gaspé*; Geol. Soc. Am., Sp. Paper No.21, 1939, pp.11-12.

Stated in another way, a considerable thickness of rocks of Normanskill age is missing at the contact of Ordovician with younger rocks. Further-more, in the Renard River Road section, as noted by E. M. Kindle (1938), the strike of the Ordovician is nearly at right angles to the strike of the overlying Devonian. There is little, if any, reason to suppose that the Ordovician and younger rocks are separated by a fault anywhere along their contact in this northern area except at the coast (Cap-des-Rosiers) and for a mile or two inland.

Farther south, on the Saint-Jean (John) River anticline, Middle Silurian rocks rest on the Upper Ordovician White Head formation. So far as general trend is concerned, the relations between the two would seem to be conformable. However, here again, the Ordovician is more disturbed than the overlying beds. Some ten miles across the strike to the south, the Mount Alexander Middle Silurian series rests on the White Head, and the trend of the two seems generally conformable. No details of the nature of the contact are known here, however. Still farther south, conglomerates up to 112 feet thick occur at the base of the Clemville formation of the Chaleur series on Little Port Daniel river, where they overlie the Middle Ordovician Mictaw series (1).

In summary, while nowhere in Gaspé peninsula have Silurian or Devonian rocks been found actually in contact with the Ordovician in such a way as to prove without peradventure that the Ordovician was folded independently of later rocks, the circumstantial evidence is sufficient to convince most open-minded investigators that such was the case. The sharper and more complex folding, and the greater metamorphism, of the Ordovician rocks as compared with later rocks point to Taconic orogeny. The Silurian conglomerates mentioned above show that locally, at least, erosion was active between Ordovician and Silurian time.

SILURIAN-DEVONIAN

The Silurian-Devonian stratigraphic relations in this region are somewhat difficult to discuss in view of the fact that we are not yet sure of the age of certain members of the rock section that are close to the Silurian-Devonian boundary. For example, the St-Alban formation may be correlated with the Coeymans of New York and Pennsylvania, and this, according to some, is the absolute base of the Devonian system. But at the base of the St-Alban there are the "Griffon Cove River beds" (Kindle, 1938) which may be correlatable with the Keyser of New York and Pennsylvania. And the Keyser is placed at the bottom of the Devonian by some and at the top of the Silurian by others. The latter is the latest pronouncement (2) known to us. If the "Griffon Cove River beds" are the equivalent of the Keyser we would be strongly inclined to place the Keyser in the Devonian. This would be on the grounds that, if Gaspé had been

(1) NORTHROP, S. A., *Op. cit.*, 1939, p.26.

(2) SWARTZ, F. M., in *The Devonian of Pennsylvania*; Pa. Geol. Surv., Bull. G 19, 1939, pp.47-50.

COOPER, G. A., *Correlation of the Devonian Sedimentary Formations of North America*; Geol. Soc. Am., Bull., Vol.53, No.12, 1942.

regarded as the type region for the Lower Devonian of eastern North America, these beds undoubtedly would have been looked upon as the base of a very thick Devonian succession. This being so, there is no Silurian-Devonian problem to discuss so far as the belt between Cap-des-Rosiers and Dartmouth river is concerned.

Westward of the Dartmouth, in this northern belt of Silurian-Devonian sedimentaries, no separation could be made in the mapping between 'Silurian' and 'St-Alban', if, in fact, both are present.

The Saint-Jean (John) River Silurian rocks appear to be generally conformable with the Devonian, but the relations in detail have never been clearly shown. The thick conglomerate member or lens toward the base of the Devonian in the eastern part of this belt carries Ordovician boulders and thus provides evidence of erosion between Ordovician and Devonian time. This conglomerate also carries boulders of a diabase similar to an adjacent intrusive mass which possibly is Silurian in age. Thus, there is some possible indirect evidence here of erosion between Lower Devonian and some stage of Silurian time.

The Mount Alexander Silurian rocks are separated from the Devonian in surface exposure by a fault. The narrow band that parallels the Grande River and Portage River depressions is Lower Devonian in age toward the east and may be Lower Devonian throughout its length, though, toward the west, it suggests the Silurian. In any event, while it was nowhere seen in contact with the undoubted Devonian, it is strictly conformable structurally to the overlying rocks.

Unconformable relations between the Silurian and the Devonian, such as are indicated by the Saint-Jean (John) River conglomerate lens, are not unique in Gaspé. At a locality on Escuminac river, according to Alcock (1), "good outcrops of this (Lower Devonian) basal conglomerate are exposed on both sides of the Escuminac river along the highways which ascend either side of the valley and on a number of tributary streams which join the Escuminac. The conglomerate has a thickness up to at least 300 feet. It rests on fossiliferous Silurian limestone and is overlain by shales and volcanics of the Helderberg. The boulders consist largely of limestone of the Matapédia series . . .

"On the opposite side of the syncline in northern New Brunswick a similar conglomerate is exposed on the south side of the Campbellton-St. Leonard highway near Glenlivit church . . . The boulders . . . consist largely of Ordovician limestone of the Matapédia series, but Silurian limestone and sandstone pebbles containing corals, brachiopods, and crinoid stems are also present . . .". Thus, locally at least, there was uplift and erosion between the Silurian and Devonian in the Gaspé region.

(1) ALCOCK, F. J., *Relationship of the Devonian and Silurian in Gaspé Peninsula and Northern New Brunswick*; Roy. Soc. Can., Trans., Vol. XXV, Sec. IV, 1931, pp. 113-117.

ST-ALBAN—CAPE BON AMI—GRANDE GRÈVE

These three formations seem to form an unbroken succession through the Lower Devonian. The St-Alban corresponds to the Helderberg and the Cape Bon Ami and Grande Grève to the Oriskany. No unconformable contacts, represented by changes in dips or by erosion surfaces, were noted. In many sections it is difficult to impossible in a practical sense to separate succeeding formations. In some sections, the lowest formation, the St-Alban, seems to be missing.

GRANDE GRÈVE—"GASPÉ SANDSTONES"

Many of those who have discussed the geology of eastern Gaspé have understood or assumed that the change from Grande Grève limestone to the overlying sandstones and shales represents a time break of some importance. This thesis was based on the apparently sudden change in lithology and on the belief that the Grande Grève was Oriskany and the Gaspé Sandstones Hamilton in age.

The correspondence in fauna between the Grande Grève and the Gaspé Sandstones has grown increasingly close with every collection (Alcock; Kindle; Jones; McGerrigle) made since Clarke's work of 1908. And, although the Hamilton age of the Gaspé Sandstones is subscribed to in this report, its fauna, as given by Clarke, has been thought to be Hamilton by some authorities, Onondaga by others, and Oriskany by many. These faunal interpretations suggest that the Grande Grève may not be separated from the Gaspé Sandstones by a time break of any importance. The evidences of erosion that have been noted at a few localities would not refute this conclusion. They would indicate, however, a shallowing of the sea, and even local emergence, between Grande Grève and later time — just such conditions as probably recurred again and again during the deposition of the Gaspé Sandstones. Furthermore, as pointing to complete gradation between the Grande Grève and the Gaspé Sandstones, the York Lake series, in its type area, apparently grades downward into the Grande Grève and upward into the Gaspé Sandstones proper.

YORK RIVER-BATTERY POINT

The relations within this series are believed to be essentially conformable. Local exceptions pointing to emergence and submergence and represented by cut-and-fill, cross-bedding, and other structures, are common, but the time represented by such structures individually is of slight importance.

BATTERY POINT-MALBAIE

The stratigraphic relations between the Battery Point sandstones and the Malbaie conglomerates are apparently variable. Wherever they are seen in contact, the two formations are strictly conformable, and, in fact, they grade one into the other. However, boulders of Battery Point type of sandstone occur in the conglomerate and suggest that some part of the Battery Point was being eroded while the Malbaie was being deposited.

Other boulders show that formations as low as the Ordovician had been raised above sea level and were being eroded in Malbaie time.

MALBAIE—CANNES-DE-ROCHE

The Cannes-de-Roche formation has not been seen in actual contact with the Malbaie. However, in the Beattie River area, the two formations may be seen close together — the Malbaie folded in the axis of the Malbaie syncline and the Cannes-de-Roche apparently quite unaffected by the folding which disturbed the Malbaie and Battery Point formations. Also, the Cannes-de-Roche has been seen in contact with the Battery Point on Portage river (Plate XV-B), and there the relations are distinctly unconformable. The flat-lying Cannes-de-Roche beds rest horizontally upon the upturned edges of almost vertical Battery Point beds. Thus, it is evident that folding took place in this area prior to Cannes-de-Roche time and after Malbaie time. This folding was related to the Acadian mountain-building interlude, which had its climax in late Devonian time.

CANNES-DE-ROCHE—BONAVENTURE

The relations of the Cannes-de-Roche to the Bonaventure formation are not definitely known. It is believed that both were deposited at the same time, although possibly in separate basins.

IGNEOUS GEOLOGY

The volcanic rocks of the region already have been described along with the sedimentaries with which they are associated. They include the andesitic flows and tuffs of Middle Silurian? age in the northeast corner of Galt township, and the mainly andesitic flows of Middle Silurian age in the Mount Alexander area. Intrusive rocks in the area are limited mainly to dykes, with some sills. These are difficult to date exactly and the ages given below are in most cases suggestions only.

SILURIAN INTRUSIVES

The oldest(?) of the intrusives is a group of five dykes cutting the Upper Ordovician limestones in the southern part of the region. Four of these are on Grande river within about half a mile of the centre line of Joncas township. The fifth is on Petit Pabos river, in Power township, a thousand feet north of the Pellegrin line. All of these dykes are light grey, pinkish to rusty-brown weathering, very fine-grained rhyolites. They carry small and scattered crystals, and occasional stringers of pyrite. The dykes vary in width from eight to thirty feet. Locally, the intruded limestones are slightly altered against the dykes and are discoloured for three feet or so away from the contacts. No evidence of economic mineralization was noted in their vicinity. Inasmuch as these dykes cut Upper Ordovician rocks but have not been seen cutting younger sedimentaries, their age is assumed to be Lower Silurian.

Dykes, with possibly some sills, are common in the south-western part of the region, where they are associated with the Middle Silurian sedimentaries. Most of them are diabase, but some have the composition of diorite or syenite. They are from fine to coarse in grain and frequently are porphyritic. A few occurrences of more acid igneous rock, somewhat resembling the rhyolites described above, were noted. Coarse diabase porphyries, in thick sills, intrude the Silurian south of Observation mountain. In these, the feldspar phenocrysts are highly altered. A somewhat similar type of porphyry crosses the South branch of Saint-Jean (John) river near the Ordovician-Silurian contact. This diabase contains abundant, weathered, labradorite? phenocrysts, commonly half an inch and sometimes two inches long. The coarse groundmass contains labradorite? and secondary albite with varying amounts of augite, chlorite, biotite, and ilmenite. Similar porphyritic diabase follows the general structural trend between Cedar Barn and Willis brook, south of Saint-Jean (John) river in Laforce township. Diabases of fine to medium grain and dark grey colour intrude the Ordovician sedimentaries along Saint-Jean (John) river in Sirois township. None of the dykes and sills referred to are known to intrude rocks definitely assigned to the Devonian. Hence, they are assumed to be of Silurian age. The fact that, in the Mount Alexander Silurian belt, the intrusives seem to be confined to the zone below the volcanics suggests that some of them may have been the feeders for the volcanics, and thus would be Middle Silurian in age.

LOWER? DEVONIAN PORPHYRY SILL

A porphyry sill twenty feet thick intrudes sandstones of the York Lake series in the escarpment west of the upper part of York lake (1). The rock is pale bluish-grey, with yellowish weathering. The texture is coarsely porphyritic, with phenocrysts of feldspar and quartz in a ground-mass of the same material. Accessory minerals are calcite, hornblende, and apatite. This intrusion probably is related to similar quartz-feldspar porphyries at the Miller copper claims three miles to the west.

DEVONIAN OR CARBONIFEROUS DYKES

Basic dykes of Devonian or later age are known at several localities in the region. These dykes are generally diabasic in composition, fine to medium in grain, dark grey, and amygdaloidal. Commonly they show both horizontal and vertical jointing. Shearing and slickensiding are frequent, and some of the dykes are offset by faults. Thus, some movement was taking place in the region after the dykes were intruded. Carboniferous rocks to the south are intruded by dykes not radically different from those here considered, and some of these intrusives also have been faulted. Hence it is likely that the later basic dykes of the present region are at least as young as the Carboniferous.

Perhaps the best known of these intrusives is the Tar Point dyke. This is a dark grey, fairly coarse-grained diabase, in which the druses, amygdules, and joints generally are lined with chalcedony and often filled with liquid petroleum or with pitch. The dyke is about thirty feet wide. Another dyke crosses the Little Fork of Saint-Jean (John) river about one mile upstream from its junction with the river. It is intrusive into the York River formation not far stratigraphically above the Grande Grève limestones. At Anse-aux-Cousens, a dyke about fifteen feet wide cuts sandstones of the Battery Point formation.

Five dykes have been mapped in the area north of Gaspé bay. One is on the northeast side of Forillon peninsula, about 1,000 feet north of the quay, where it cuts the Cape Bon Ami. Three of the others are on the shore of Gaspé bay, one about 3,700 feet east of the point where the Laurencelle road leaves the bay, another at Cap-aux-Os, and the third at cap Brûlé. The remaining known dyke is on Annett's run, about 800 feet from a bend in the highway. All five of these dykes cut the Battery Point sandstones.

The examination of samples derived from well-drilling operations has shown the presence of igneous rocks which have not been noted in surface exposures. Cuttings from narrow intrusions of dyke or sill type were noted in samples from several of the early wells drilled in the southwestern part of Baie-de-Gaspé-Sud township and the adjacent part of Galt township. Generally, the cuttings represented rocks medium to coarse in grain and syenitic in composition. They were found in the following wells: Petrol-

(1) See, for details, JONES, I. W., *Upper York River Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1935, Pt. D, pp. 20-21.

eum Oil Trust No. 11 at 1,450 feet, No. 15 at 950 feet, (15 and 19, maps 662, 663, 664, 665), No. 22 at 2,450 to 2,500 feet, No. 37 at 2,350 feet, and No. 38 at 1,950 feet, (26, 41 and 42, map 662). In every case, the host rock was the York River formation.

Cuttings of igneous rock were found also in samples from Venture No. 1 well (68, map 662) at 1,230-50 feet, at 1,282-84 feet, and at 1,300-10 feet. At 1,230-40 feet the associated rock was shale while at 1,240-50 feet and below, the associated rock was limestone. The contact between the Grande Grève and York River formations in this well is at 1,240 feet. The igneous rocks here are grey to dark brownish-grey in colour. They carry phenocrysts of biotite up to one-tenth of an inch in diameter in a dense groundmass containing up to 80 per cent carbonate.

LADY STEP IGNEOUS SERIES, MOUNT SERPENTINE AREA

Besides the volcanics referred to in earlier pages, the Lady Step igneous series includes intrusive rocks. These are chiefly highly altered types represented by serpentine and amphibolite, and diorite(1).

The serpentine is best exposed on the northwest slope of mount Serpentine and on both sides of Johnson brook. The rock is massive, generally dark green to almost black in colour, but in places olive-green. Tongues of the serpentine have been seen cutting Lower Devonian limestones, and hence the intrusive must be Lower Devonian or later in age. The serpentine masses are usually at or near the trace of a thrust fault that crosses this part of the region, and it may be that the magma entered along this fault.

(1) For a more detailed discussion, see JONES, I. W., *Dartmouth River Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1934, Part D, pp.33-35.

STRUCTURAL GEOLOGY

The structural features of the present region are indicated on the accompanying maps and cross-sections and need be reviewed here only in a general way. The region includes the eastern end, as exposed, of a broad structural trough, or synclinorium, which extends through the east-west central belt of the peninsula to Matapédia valley and for an unknown distance still farther west. In eastern Gaspé, the synclinorium is bounded on the north and south by rocks mainly of Ordovician age, these also forming the 'basement' of the Silurian-Devonian succession which fills the trough. Historically, the region has experienced two periods of major folding, one at the close of Ordovician time and affecting, therefore, only the basement or Ordovician and older rocks of the sequence, and one in late Devonian time. The main structural trends of the peninsula as a whole probably were established by the former, or Taconic, disturbance, if not by a still earlier one, while the structures shown by the present mapping were the result mainly of the latter, or Acadian, disturbance.

Few structures of sufficient continuity to be shown on the accompanying maps have been recognized in the belts of Ordovician rocks bordering the synclinorium. Both on the north and on the south these rocks were strongly folded and a pronounced and generally nearly vertical cleavage was developed. In the southern belt of Ordovician, drag-folding on a varying scale is a common feature, and in a few places, but very locally, the rocks are altered to sericitic schists. The structure of the Ordovician limestones and shales brought up on the Saint-Jean (John) River anticline may be described similarly, and although this anticline is a major fold it is not easily distinguished in the dips of the Ordovician rocks alone.

The Saint-Jean (John) River anticline is one of the dominant folds of the region, and it practically divides the synclinorium into two major downfolds or synclines. The trend of the anticline is east-southeast in its western part, then turning more to the southeast. It is well marked throughout its length from the western border of the region until shortly after entering Malbaie township, at a point a few miles inland from the shore. Here the structure becomes vague through an area where the dips are generally monoclinial, but probably it can be correlated with the open Pointe Saint-Pierre anticline. The eastward plunge of the eastern half, more or less, of the Saint-Jean (John) River anticline reveals, in gradual progression, successively older rocks westward along the fold axis until about the western border of Baillargeon township. Westward from here for a few miles the plunge appears to be essentially flat. Then a westward plunge develops and is maintained to the western border of the region and beyond to at least the West branch of Bonaventure river. The angle of plunge is gentle, averaging five to ten degrees. The average slope of each flank of the fold is about forty degrees, but irregularities, resulting mainly from faulting, are common.

A thrust fault is assumed as roughly paralleling the Saint-Jean (John) River fold axis on its northern side from Wooden Bottom brook to within a few miles of the western border of the region. Such a fault appears necessary to explain the apparent elimination of the Grande Grève formation

to the west and the reduction of the Cape Bon Ami formation to the east along the northern side of the fold. A series of faults of the normal type have been mapped on the southern side of the anticlinal axis, and again roughly parallel to it. Chief among these is the fault traversing Vondenvelden township along the valley of Saint-Jean (John) river. This is interpreted as having dropped on the south side, producing a displacement of some thousands of feet whereby the Fortin series was let down against the Ordovician core of the anticline. Reflections of this fault continue to the east, but with generally decreasing displacement, to the headwaters of the Little Fork of the Saint-Jean (John). In the area of the Little Fork, a welter of faults of relatively small displacement has been introduced to explain the distribution of formations along and to the south of the anticlinal axis.

The Saint-Jean (John) River anticlinal is succeeded to the south by the broad, compound Malbaie syncline. Several strong secondary folds are present within this structure. The dip of the southern limb of the syncline as a whole is steeper than the northern limb, and in some sections the dips on the southern limb are steeply reversed. Thus, the fold is not only asymmetrical in general but in some sections it is overturned to the north. Some thrusting appears to be associated with the overturning.

In the western part of the main synclinal, through Vondenvelden and Power townships, drag folding on a varying scale is common and the main fold axis can be located only in general terms. Farther east, in western Joncas township, some of the secondary folds referred to above are apparent. Here the Grande Grève limestones are brought to the surface from beneath the Fortin series on the Joncas dome. This structure, a double anticline or a double and elongated dome, is elongated along east-west lines and plunges to the east and to the west. Both to the north and to the south of the domed area there are definite synclinal structures. These secondary folds can be traced for five to seven miles, giving place to the east to an area where the structure is again masked by much drag folding. Farther to the east, in Fortin township, the drag-folding is less apparent and, in the main, transfers to four relatively strong folds, two anticlines and two synclines, all to the north of the main synclinal axis. Still farther east, in Malbaie township, the sharp folding of the interior gives place to gentle structures which prevail to the shore.

The Malbaie syncline is succeeded to the south, in the southwestern part of the area, by the Mount Alexander syncline. The anticline which should intervene between these two down-folds is cut out almost completely by faulting, though there are some indications of it in the southwestern part of Power township. The fault separating the synclines appears on the surface along the eastward-flowing part of Indian brook and, farther east, in the valley of the East branch of Grande river. This fault may be normal, downthrown on the north side, or it may be a thrust with older rocks thrust from the south over younger rocks to the north.

The Saint-Jean (John) River anticline is followed to the north by an equally persistent fold, namely, the York River syncline. This is a broad structure with a flat or gently rolling bottom. These characteristics,

along with cross-bedding, make it difficult in some places to localize the axis of the fold. The axial trace is lost due to faulting in the section between the north-south centre-line of Baillargeon township and the east boundary of Galt township. Eastward from this faulted zone to the coast, the plunge of the syncline is to the east, but westward of the faulted zone as far as Narrows brook the plunge is to the west. Westward of this longitude, the plunge is again to the east.

The faulted zone referred to above, which locally obscures the position of the York River synclinal axis, is part of a major dislocation named the Third Lake fault. This fault, or fault zone, extends southeasterly from the northern part of Larocque township across York river, Third lake, and Saint-Jean (John) river to extend almost through the township of York. The downthrown side is on the northeast. The amount of displacement evidently is variable and probably is at its greatest where the fault crosses York river. Here it is estimated (1) to be 3,000 feet.

The York River syncline is succeeded to the north by the Mississippi anticline. In Larocque township, this anticline is accompanied by faults branching from the Third Lake fault, and the position of the fold axis locally is obscured by such faulting. To the east, however, in Galt and Baie-de-Gaspé-Sud townships, the fold structure appears to be uniform. A locally domed structure appears on the axis of this fold where it crosses Galt brook. Off to the west, in Holland township, the Mississippi anticline appears to fade into, or to be cut out by, a thrust fault.

Farther north again, a major syncline succeeds the Mississippi anticline and is followed in turn by the Bald Mountain anticline. Bald mountain itself is near the eastern end of the anticline. It may be that the fold is re-expressed farther to the east in the Galt Brook anticline or dome. To the westward of Bald mountain through Fletcher township, the Bald Mountain anticline is a uniform structure although apparently domed where it crosses Patch brook. In the eastern part of Holland township a secondary anticline (Holland anticline) branches away from the main fold, and from here to the western margin of the region the two anticlines, with the intervening syncline, are present.

The synclinal structure following to the north of the Bald Mountain anticline is the most northern fold for most of the region. This, the Champou syncline, extends in a west-east direction across the southern parts of Lefrançois and Champou townships into De Beaujeu township. Near the line between Champou and De Beaujeu townships, the synclinal axis, in conformity with the regional trend (see below), swings to the southeast and maintains that direction until the fold dies out on approaching the Northwest Arm thrust fault.

The fold structures outlined above have a general east-west trend. In the eastern part of the area, however, in De Beaujeu, Blanchet, and Baie-de-Gaspé-Sud townships, both the fold and the major fault structures trend southeast-northwest. This change of direction is in conformity with

(1) JONES, I. W., and MCGERRIGLE, H. W., *Report of Geology of Parts of Eastern Gaspé*; Que. Dept. Mines, P.R. No.130, 1937, p.30.

the regional control expressed by the northeastern outline of the peninsula itself. The Northwest arm of Gaspé bay and the bay itself (apart from being the drowned continuation of Dartmouth River valley) is a southeast-northwest trending, depressed, structural trough or syncline. The axis of this syncline and of the York River syncline probably converge beneath the waters of Gaspé bay. Where the trough line of the Northwest Arm syncline should appear on the land, to the northwest, it has been destroyed, so far as surface expression is concerned, by thrusting from the south along the Northwest Arm thrust fault.

The Northwest Arm thrust extends from a point shortly to the south of Gaspé village northwest into the northern jut of Baie-de-Gaspé-Sud township, swinging thence more to the west to reach into De Beaujeu township. In the southern part of its trace, movement along this fault from the southwest has thrust Grande Grève and York River formations against and over the Battery Point formation. Evidence of such movement is found in the geology and the topographic expression of a chain of hills reaching northwest from a point about three miles from Gaspé village. In the two most southern hills, taken together, the Grande Grève is arranged in a broken dome, elongated, parallel to the fault. The dips are fairly regular on the southwest side, where the Grande Grève passes under the York River, but on the northeast the dips are irregular and locally the limestones are sharply folded. A narrow strip of the sandstones on the northeast side may belong to the York River formation, but farther to the northeast the sandstones are of the Battery Point type. In this area and farther to the northwest, the sandstones on the northeast side of the fault are overturned, dipping (steeply) to the southwest rather than to the northeast, as would be normal in relation to the axis of the Northwest Arm syncline. Still farther to the northwest, in the Mount Serpentine area of southern Blanchet township, Silurian(?) volcanics and sedimentaries and Lower Devonian limestones apparently have been thrust from the south over the Battery Point and York River formations.

The domed structure showing in the hills north of Gaspé village, and referred to above, is considered here to be the probable continuation of the Haldimand anticline. However, this dome is considered by some to be a separate structure and is designated in some private reports as the Hay Creek anticline. The type locality of the Haldimand anticline is southeast of Gaspé village, in Haldimand township, in an area where several other, but lesser, folds are developed.

Those who are familiar with the literature on the geology of eastern Gaspé peninsula will note that the present interpretation of the structure of that region is at variance in many respects with previously published interpretations. This, of course, is to be expected, particularly as previous interpretations were based for the most part on broad reconnaissance mapping. While no claim of absolute exactness in detail is made for the structures as here mapped, it is believed that most of the structural features, and particularly the fold structures, are portrayed with reasonable accuracy. The work done by Parks (1929) cleared up some of the misconceptions that resulted from the habit of earlier workers of joining observed coastal

and interior structures without tracing them through, but other misconceptions remained or were developed. The Tar Point anticline was projected inland by Logan (1863, p.882) so as to connect with an anticline crossing D'Argent (Silver) brook "about two miles" above its junction with York river and to continue to the westward. It is now known that these two folds are widely separate, that the one crossing D'Argent (Silver) brook at about the location given by Logan is the Mississippi anticline, and that the Tar Point anticline is, relatively, a very local fold. All of these distinctions were deduced by Parks (1929), and we differ from Parks only as to detail of location of the axes of the Mississippi and Tar Point folds. Likewise, the Pointe Saint-Pierre anticline was projected inland by Logan in such a way as to have it correspond very closely with the trace, to the south of York river, of the Third Lake fault. The error here was detected also by Parks, who states (1929, p.46): "I am unable to find any support for the assumption that the Point Saint-Pierre anticline passes near the Mississippi group of wells, although it was on this assumption that hundreds of thousands of dollars were expended."

The "Point Saint-Pierre" anticline of Parks is essentially synonymous with the Saint-Jean (John) River anticline of this report. The latter term is adopted here for the reasons that, while there is an anticline at point Saint-Pierre, its development is very feeble as compared with the Saint-Jean (John) River structure and, actually, there is some doubt that the two structures are continuous. Thus, under our usage, the term Pointe Saint-Pierre anticline applies only to the low fold in the coastal area which, possibly, is a continuation of the Saint-Jean (John) River anticline. Prior to the work of Parks (1929), the term "Malbaie anticline" was applied to the present Saint-Jean (John) River fold under the belief that the Saint-Jean (John) structure bent sharply southeastward to join what we now recognize as merely a secondary fold within the compound Malbaie syncline.

The Haldimand anticline is interpreted in essentially the same terms by Logan and by Parks. However, Parks was able to show that this structure, in its extension northwest of Gaspé village, is broken along the Northwest Arm thrust (Haldimand fault in Parks' terminology), and he indicated the probable overturning of the sandstone beds on the east side of the fault between Gaspé village and Watering brook. Parks believed that both the Haldimand anticlinal and fault were offset by a transverse fault traversing the outer part of the Southwest arm. Also, he believed that the Northwest Arm (Haldimand) fault probably extended to the southeast to cross Saint-Jean (John) river and come to the shore of Gaspé bay at the mouth of Seal Cove brook. Under our interpretation, the transverse fault is denied, the Haldimand anticline crosses the Southwest arm without offset, and the Northwest Arm fault, passing to the east of Gaspé village instead of to the west, dies out beneath the waters of Gaspé basin. The steep dips along the south shore of Gaspé basin may indicate that the fault does extend farther to the southeast, but there is no other evidence of the break in this direction and the general evidence indicates that the displacement decreases as the fault is traced from the northeast toward Gaspé basin. In view of the considerable differences of interpretation as to loca-

tion and effects, the term "Northwest Arm fault" is introduced here, replacing the term "Haldimand fault".

The York River syncline was conceived by Parks, as it is by ourselves, to be the major down-fold of the region to the north of the Saint-Jean (John) anticline. Parks (1929, p.45) considered that this down-fold was "interrupted" by the Mississippi anticline "which divides it into two". That is, the axis of the major syncline extended from the barachois of Saint-Jean (John) northwestward in a sweeping curve to the mouth of York river, whence one axis branched west to follow the York and one branched northwest to traverse Baie-de-Gaspé-Sud and Galt townships. Reference to our maps will show that no individual fold axis traverses Baie-de-Gaspé-Sud township in a manner approaching that indicated by Parks. Several minor folds, some of them cross folds, are present in this area. Farther to the northwest, the axis of Parks' northern syncline corresponds in position to the axis of our Champou syncline, which actually enters Baie-de-Gaspé-Sud township to the north of the Galt Brook anticlinal.

ECONOMIC GEOLOGY

INTRODUCTION

Most of the known mineral occurrences of this region have been reviewed in one or another publication of the Quebec Department of Mines since the year 1932. Consequently, they will be reviewed only briefly here, reference being given to the original account, when such is available for further information.

LEAD AND ZINC (1)

A few small deposits of galena and sphalerite along the north shore of Gaspé bay have been explored periodically since the year 1665, but with unsuccessful results. The date mentioned marks one of the earliest mining ventures in Canada. The known deposits are at five localities extending in line from near the Laurencelle road on the northwest to Indian cove on Forillon peninsula to the southeast, a distance of about six miles. All the deposits are near, or at the top of, the Grande Grève limestone formation. The lead and zinc sulphides occur in limestone breccia zones, which have a calcite matrix, or in calcite veins. These fracture fillings have steep dips and they usually trend about at right angles to the strike of the bedding.

Very similar deposits (2) are present in an area about one mile square toward the headwaters of Gravelly brook in range V of York township, three-quarters of a mile to one and three-quarter miles west of the York-Douglas township line. This area, constituting the Cuning-Gault claims, has been prospected intermittently since 1929. Zones of brecciated limestone and narrow veins of calcite carry sporadic galena, sphalerite, and some pyrite mineralization. One brecciated limestone zone can be followed for 600 feet along the bed of a small stream tributary to Gravelly brook from the south, and what probably is the same zone has been observed here and there approximately along the strike for another 1,200 feet to the north. The zone strikes a little east of north and dips 80° west. It is three to eight feet wide. Galena has been found in this zone over a length of fifty feet in small veins and lenses.

A brecciated limestone zone similar to that mentioned above occurs farther west in York township, in lots 45 and 46 of range III. This zone has been traced southward along Wooden Bottom brook—Big Fork of Saint-Jean (John) river—from the falls and then across Briand's Lake brook for a total distance of over 1,000 feet. Its general trend is north-south, with a dip of 75° to the west. The zone averages about three feet in width. "In parts of the breccia zone, which is composed mostly of fragments of limestone in a limestone matrix, there are a few small pockets and spots of galena and sphalerite accompanied by a little calcite Chalcopyrite was also observed, but in very small amount" (3).

(1) JONES, I. W., *Lead and Zinc Deposits near Gaspé Bay and on Marsoui River*; Que. Bur. Mines, Ann. Rept., Pt.D., 1932, pp.35-43.

(2) JONES, I. W., *op. cit.*, pp.36-38.

(3) JONES, I. W., *op. cit.*, 1932, p.39.

Small quantities of galena and sphalerite have been found at various places in the Patewegia Brook area. One such locality (1) is on Lizard Lake brook, in the northern part of block 41, Galt township, about 1,600 feet downstream from the point where the north boundary of the block crosses the brook. Some prospecting was done here in 1938. The mineralized zone of brecciated limestone trends northerly, and some veins were followed about 150 feet to the north from the brook. At places, the veins follow for short distances the strike of the steeply southward-dipping limestones. Two main veins are exposed here fifteen to thirty feet apart, with a few narrow veinlets between them. The dip generally is to the east. They consist of calcite and brecciated limestone with rusty cavities from which, apparently, zinc-bearing minerals have been leached away. Galena is scattered in the veins and in some places forms narrow seams. Grains of sphalerite are distributed through the vein material, locally forming small clusters. The veins are said to vary in width from a few inches to several feet.

Another (2) fractured limestone zone that in places carries galena and sphalerite is exposed along a brook flowing from the west to Patewegia brook and crossing the Larocque-Galt township line midway between mile-posts VI and VII. About half a mile west of the township line, a breccia zone about eight feet wide trends in a general east-west direction. Mineralization here appears to be confined to a calcite vein, one to three inches wide and with an observed length of eighteen feet, carrying sphalerite lenses and scattered sphalerite crystals and grains. At the intersection of the brook and the township line there is a fractured limestone zone about twenty inches wide with an east-west trend. Here galena is scattered through narrow, irregular veins of calcite and in the bordering limestone. A few specks of sphalerite also were noted in calcite.

A third deposit in the Patewegia Brook area was referred to briefly in 1932 (3) and 1939 (4) and described in some detail in 1934 (5). This deposit is near the northwest corner of Larocque township in block 33, 125 feet west of Patewegia brook on a tributary stream. Two zones of brecciated limestone, two feet wide and twenty feet apart, carry irregular streaks and lenses of galena and sphalerite. Sphalerite is the more abundant. The breccia zones appear to parallel the bedding planes, which trend east-west and dip 70° north.

Slightly fractured limestones at the southern edge of the Grande Grève formation on Galt brook carry a few specks of sphalerite. On Logan and Eden brooks, tributary to Dartmouth river, in De Beaujeu

(1) (a) JONES, I. W., *op. cit.*, 1932, p.39.

(b) JONES, I. W., and MCGERRIGLE, H. W., *Report on Geology of Parts of Eastern Gaspé*; Que. Bur. Mines, P.R. 130, 1939, p.32.

(2) *Op. cit.*, 1939, p.32.

(3) *Op. cit.*, 1932, p.40. Here the location of the showing was erroneously stated to be in block 28.

(4) *Op. cit.*, 1939, pp.31-32.

(5) JONES, I. W., *Dartmouth River Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1934, Pt. D, pp.41-42.

township, limestone breccia occurs near the contact with the overlying Gaspé Sandstone series but there is very little mineralization.

Some mineralization has been noted (1) at two adjacent localities in Holland township. About a quarter of a mile west of York lake, along the forestry survey line, there is a zone more than 100 feet wide composed of brecciated limestone with veinlets of ankerite and calcite. All this rock is highly decomposed and contains a large percentage of rusted material. This zone is about on strike with similar material three miles to the west-southwest on the west side of York river (2). The second locality is west of the upper part of York lake, where a minor amount of galena is present in sandstones adjacent to a quartz-feldspar-porphyry sill.

In the southern part of the region, about half a mile west of the centre line of Fortin township, on Malbaie river, a little galena and sphalerite were noted in calcite veins cutting limestones of the Fortin or Grande Grève formations.

Some generalizations follow from the above account. Lead and zinc minerals are scattered over a wide region. Most of the occurrences are in the Grande Grève limestone formation near its contact with the overlying Gaspé Sandstone series. Slight mineralization has been reported at a few places in the Gaspé Sandstone series, either near its contact with the Grande Grève or near the sites of presumed faults. Most of the deposits are in zones of limestone breccia which, for the most part, are transverse to the bedding. Some are in calcite-filled joint planes.

The origin of the limestone breccia zones is not clear. They may have resulted from movement along joint or other planes of weakness; or they may have been caused by slumping of the limestones above cavities produced by underground solutions. The former origin seems the more likely. However, this conclusion is largely negative, resulting as it does from the fact that more lines of evidence can be found against the latter manner of origin than the former.

Whatever the origin of the breccia zones they and their associated fractures, represented by calcite veins, became channels along which solutions carrying lead and zinc minerals travelled. The facts that the deposits are so widespread and so rarely associated with any apparent igneous intrusion suggest that they did not have an igneous source. However, certain deposits in other regions of the continent, where igneous sources likewise are not apparent, are considered by many authorities to have had such sources.

The known occurrences of lead and zinc in this region are small and non-commercial. However, they indicate that further search might reveal larger bodies, and that the most likely areas would be those underlain by the Grande Grève formation.

(1) JONES, I. W., *Upper York River Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1935, Pt.D, pp.26-27.

(2) JONES, I. W., *The Bonnacamp Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1931, Pt.C, pp.74-75.

COPPER

A large body of low-grade copper ore is present in the Grande Grève formation in western Holland township just beyond the limits of the region here considered. The geology of this area, and the nature of the copper deposits as exposed, were described in 1931 (1). In 1938, the Miller claims, or the principal group in the area, were taken under option by Noranda Mines, Limited, which, during the years 1938-40 carried out a progressive programme of diamond drilling and surface exploration. This work was discontinued with the outbreak of war, but not before proving the existence of a large body, or bodies, of low-grade ore. However, neither the vertical nor the lateral limits of the deposits were determined. According to Osborne (2), the closest parallel to these deposits are the disseminated or 'porphyry coppers' of the southwestern United States.

Débris of altered sedimentary rock, similar to the rocks at the Miller claims and containing chalcopyrite and malachite, is abundant at the outlet of York lake and in some places shortly to the east and to the southwest — of the lake (3). It is possible that this débris is from rocks in place in the vicinity of the lake. If such be the case, the area surrounding the southern part of the lake would well merit prospecting, preferably by geophysical methods in view of the overburden. However, it seems more likely that the débris was transported from the Miller claims' area.

Native copper and chalcocite are present in the basic volcanic rocks of Silurian age in the range marked by mounts Observation and Alexander in Vondenvelden township (4). While the known occurrences of copper here are not of commercial interest they point to the possibility of finding more important deposits in this range, which is known to extend westward to a point between the two branches of Bonaventure river.

Chalcopyrite with associated malachite was seen at two places on Wooden Bottom brook. One locality is shortly upstream from the main falls, in the limestone breccia zone already referred to in the discussion of lead and zinc occurrences. The other locality is about 2,000 feet downstream from the falls, in sandstones of the York River formation.

The possibility of finding copper deposits in the rocks of the Lady Step igneous series is suggested by the presence of a six-inch boulder, much decomposed but apparently volcanic, carrying a high percentage of copper mainly as malachite and chalcocite, in the gravels of Lady Step brook (5).

(1) JONES, I. W., *The Bonnecamp Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1931, Pt.C.

(2) OSBORNE, F. Fitz, manuscript in files of Que. Dept. Mines.

(3) JONES, I. W., *Upper York River Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1935, Pt.D, p.26.

(4) JONES, I. W., *Mount Alexander Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1936, Pt.D, pp.25-26.

(5) JONES, I. W., *Dartmouth River Map-Area, Gaspé Peninsula*; Que. Bur. Mines, Ann. Rept., 1934, Pt.D, p.43.

ASBESTOS AND CHROMITE (1)

The serpentine rock of the Mount Serpentine area in the southern part of Blanchet township locally contains narrow veins of asbestos. Veins from one-sixteenth to one-eighth of an inch wide have been observed, and it is reported that at one point, where several narrow veins united, a lens three-quarters of an inch wide was seen. A little prospecting has been done in this area, particularly on the western side of Mount Serpentine and along Johnson brook.

Chromite occurs sparsely as grains visible to the naked eye in some parts of the serpentine mass, and the mineral may be seen in most thin sections of the rock.

IRON

Lumps of limonite frequently are ploughed out of the soil in the fields near Peninsula on the north shore of Gaspé bay, lots 28 to 33 of range I, Baie-de-Gaspé-Nord township. While these do not appear, in themselves, to be of economic importance, they are of considerable interest locally. The lumps range in size up to ten inches in diameter. According to R. A. Brown, who mapped this part of the region for the Quebec Department of Mines in 1938, the limonite appears to be of local rather than of transported origin, for the reasons given below. The lumps show little evidence of wear by any transporting agent, and a few of them retain smooth and practically unmarked mammillary surfaces. One specimen in the possession of the late Mr. F. J. Richmond, of Gaspé, had sandstone, similar to Battery Point types, attached to it. Occurrences of the limonite appear to be restricted to a zone one-quarter to one-half mile wide extending from the base of Peninsula point to about one-quarter mile west of Ascah brook, or a distance of about a mile and a half in east-west direction. Finally, some of the beds in the Battery Point formation as exposed in this locality have an unusually high iron content. On the shore just east of the base of Peninsula point, the strata include beds of very bright red shale giving an orange-brown streak. Here, also, is a bed one foot thick of medium-grained sandstone which contains many nodules, about an inch and a half in diameter, of sand grains firmly cemented by hematite. Examination of several cellar excavations, made possible through the courtesy of residents of the locality, showed that the beds in question were continuous along the strike from the shore to where the limonite lumps are found most abundantly. Also, about 400 feet upstream from the dyke outcrop on Ascah brook there is a bed of dark brown shale sufficiently rich in hematite to give the red-brown hematite streak. This bed is in strike with the iron-rich beds just described. Thus, it is suggested that the limonite lumps are derived from the Battery Point formation. Furthermore, it is possible that the dyke on Ascah brook may have intersected the zone of iron-rich beds and caused local concentrations of the iron.

Abundant limonite is present in the matrix of a sandstone bed two feet thick exposed in the banks of a brook about one mile east of the Griffon

(1) JONES, I. W., *op. cit.*, 1934, pp.42-43.

Cove road and about 2,500 feet upstream from the mouth. Also present are a few finely banded, nodular aggregates of very finely crystalline gōthite.

So-called ochres in deposits of small size, and resulting from the weathering of beds of red shale, are present near Peninsula and near the south end of the Renard River road. The red shale source-rocks have been used locally as a pigment, with some degree of success.

BENTONITE

Bentonitic beds of possible economic importance are present in the cliffs directly below the lighthouse on the northeastern edge of cape Gaspé or Ship Head, Cap-des-Rosiers township. These were discovered and reported on by Russell (1) in 1946. As the stratigraphy of the section is interpreted by Russell, the bentonitic beds are present in the basal zone of Division 7, or in the basal 187 feet of the Grande Grève formation. According to the interpretation followed in the present report, the stratigraphic position of the zone in question would be about 500 feet above the base of the Grande Grève. "At least twelve separate bentonitic beds occur in this zone, but nearly all are concealed by talus and wash. Not more than four of these beds reach a thickness of more than 1 foot. The lowest and thickest occurs 8 feet stratigraphically above the base of the member and is 4.4 feet thick. However, it is somewhat contaminated with calcareous material near the top. The next bentonite of importance occurs 56 feet above the base of the member and has a thickness of 1.4 feet. Above this is a thick series of calcareous beds, with occasional, thin bentonitic partings, but at 157 feet above the base of the member another 1.4-foot bentonite bed occurs. This bed appears to be the most uniform of any examined. The highest important bentonite occurs 162 feet above the member base and is 1.8 feet thick" (1). The bentonite beds in the outcrop are described by Russell as greenish or yellowish in colour, with a waxy appearance.

Samples from three of the thickest bentonitic beds were submitted to the Industrial Minerals Section of the Department of Mines and Resources, Ottawa, for examination. Laboratory tests on these samples gave the following results:

SAMPLE No.	THICKNESS OF BED	SAND FRACTION	CLAY FRACTION
1.....	1.8 feet	57.9 per cent	42.1 per cent
2.....	1.4 "	59.1 "	40.9 "
3.....	4.4 "	64.6 "	35.4 "
	(Only the lower 2.9 feet sampled)		

(1) RUSSELL, L. S., *Prelim. Rept. on the Stratigraphy of the Gaspé Limestone Series, Forillon Peninsula*; Que. Dept. Mines, P.R. No.195, 1946, pp.11-12.

It will be noted that the grit or sand fraction in these samples is high, averaging 60.5 per cent. Thus, the bentonites must be classed as very impure. To quote from the report by H. S. Spence on the samples tested: "While no precise specifications on the grit tolerance in commercial bentonite are in general use, a grit content of not over 5 per cent of the dry weight is usually considered the maximum allowable". Thus, it is doubtful that these bentonites would have much commercial value. However, the fact that they absorb water and swell makes them of potential value as a thickener in diamond-drilling and well-drilling operations, and also as a seal against the infiltration of water.

No attempt has been made to trace these beds inland from their outcrop in the cliffs at cape Gaspé, and they have not been recognized in any of the inland sections. Inasmuch as the bentonitic part of the beds is of volcanic origin, resulting from falls of volcanic ash in water, it should be widespread. Bentonite beds, in general, are good horizon markers, and in some regions have been traced for many miles. In the present case, the beds easily may have been overlooked. The dip of the bentonitic and associated beds in the cliff at cape Gaspé is about 20° to the south. Although the beds are difficult of access in the cliff, a small amount of prospecting should reveal them on the side of a small valley just to the north of the lighthouse. The overburden here probably is thin.

CLAY

Clays of Pleistocene to Recent age were noted along the north shore of Gaspé bay from Peninsula westward for about three miles and at Saint-Majorique. The presence of the pelecypod *Mya arenaria*, identified by R. A. Brown, in the clays near Peninsula suggests that some of them, at least, are to be correlated with the marine Champlain clay of the Saint-Lawrence Lowland region. The clays in the Peninsula area extend at least 800 feet back from the shore in irregular deposits filling pockets and depressions in the underlying sands and gravels. Verbal information regarding wells drilled for water indicates that the clays are twenty feet thick in places. They are stratified in alternating layers of light and dark grey colour, one to two inches thick. A few pebbles, mostly limestone, are present. The clays generally are calcareous.

It is reported by a former resident now engaged in the ceramics industry that, mixed with water, the clay can be worked or moulded easily, and that it fires to a material resembling terra cotta.

Somewhat similar clays underlie the blunt point of land in Douglas township between Sandy Beach point and Gaspé station on the south side of the Basin. A naval base was established here during the second world war. These clays were used in making brick during the years 1924-26 and in 1928 by E. P. Suddard, Gaspé village. The brick produced apparently was of good quality but the demand was not sufficient to warrant continuing the operations. The total production amounted to approximately 500,000 brick, with a total value of about \$7,000.

Blue clays occur in fairly wide expanse along the north shore of the Southwest arm, and particularly toward the mouth of Hay creek.

SAND AND GRAVEL

The most obvious deposits of sand and gravel in the present region are those of the more or less localized beaches, the spits of Sandy Beach and Peninsula, and the bars across the mouths of Saint-Jean (John) and Malbaie rivers. The last mentioned occurrence has been made part of the title and subject of a paper by J. M. Clarke (1). Older beach deposits, at elevations up to 154 feet, have been reported (2) on the south side of the Northwest arm of Gaspé bay.

Terraces cut in sand and gravel deposits usually are present in the lower reaches of the main river valleys. Glacial deposits of the kame or esker type, excellent sources of gravel and sand in many areas elsewhere, are scarce in this region. Two small hummocks projecting from the York River flat at Sunny Bank possibly are kames. Also, the topography on the south side of York river near the road bridge shortly above Pine Hill brook, Fletcher township, suggests an area of low kames. In general, sand and gravel deposits are scarce in the inland parts of the present region, except along the river courses.

Practically the sole use for the sand and gravel deposits in this region has been for surfacing roads. The material forming the beach near Cap-des-Rosiers consists of smooth, well-rounded pebbles about an inch and a half in diameter. It makes a durable road, but one that is very dusty when the surface is old, and very slippery when first laid down, due to the smooth and rounded form of the pebbles. The gravels from Cap-aux-Os and from Sydenham river require considerable sorting before being used. A deposit on the property of Mr. H. Mullen, York Centre, on the south side of the Southwest arm, has provided road material for many years. The deposit may be classified as a bank gravel, containing cobbles of various types of rock and many small blocks of friable sandstone. The material requires sorting or crushing before being laid down. Two deposits on the north side of the Northwest arm were examined and reported on by Picher (3). In one of these, six and a half miles west of Gaspé village, on the farm of Mr. R. Patterson, the material is a "coarse and fairly well graded gravel". The deposit is thought to include, in rough estimate, about 11,000 cubic yards. The maximum depth of the gravel is given as nine feet. The deposit consists of 64 per cent pebbles and 36 per cent sand. The pebbles, some angular and others well rounded, are chiefly sandstone (50 per cent) and limestone (35 per cent). This gravel makes a smooth, firm, durable road. The other deposit is a mile and a quarter west of Gaspé village, on the property of Mr. W. Kenny. Here the material is 88 per cent pebbles and 12 per cent sand, and all the pebbles are sandstone. This deposit is reported by the owner to underlie eight acres, with the gravel up to sixteen

(1) CLARKE, J. M., *Barachois, Bar and Tickle*; N.Y. State Educ. Dept., Bull. 412, 1907.

(2) LOGAN, Sir William, *Geology of Canada*; Geol. Surv. Can., Rept. of Prog. to 1863, p. 922.

(3) PICHER, R. H., *Road Gravels in Quebec*, Mines Branch, Dept. Mines, Ottawa, No. 751, 1935, pp. 169, 193, 194, 199, 209.

feet thick and overlain in places by silt. The gravel resembles "partly sorted glacial drift". It makes a smooth road but not a durable one.

The bar across the mouth of Malbaie river also was examined by Picher (1). This bar extends from Coin-du-Banc almost to Barachois, a distance of about three and a half miles. "The coarseness of the gravel varies in a gradual way from place to place across and along the bar, so that material of any coarseness desired can be obtained right at the surface. The quantity of gravel in the whole bar amounts to millions of yards. The gravel has been used in surfacing long stretches on several roads. It has poor binding quality but, after being mixed with binding material, . . . makes a firm and durable road".

MARL

Several small deposits of marl are present in ponds and swamps in the Forillon area, on the north side of Gaspé bay. The largest of these is about one acre in area, covering the bottom of a pond at the north end of the road leading north from Cap-aux-Os. The deposit is at least three feet thick. It has been exploited to some extent for use on the farm lands in the vicinity. Other and smaller deposits occur well up toward the summit of the southern ridge on the Forillon, and one was noted between the forks at the head of Little Gaspé brook. These marls are white to pale grey in colour. Shells of minute mollusks and rootlets of plants are common in them.

The marls of the Forillon appear to be much the same as that flooring Peinture (Paint) lake, Baillargeon township, the only other deposit known in the region. A composite sample of the Peinture (Paint) Lake marl contained 52.14 per cent lime and 1.02 per cent insolubles, the balance being mainly carbon dioxide. No organic forms were observed in the sample under the microscope.

PETROLEUM

Introduction

Interest in the economic mineral prospects of this region has centred to a very large extent on the possibilities of obtaining petroleum in commercial quantities. Oil seepages in Gaspé were recorded as early as 1836, and in 1860 the first wells were drilled to test the sandstones near two of these showings. Between 1890 and 1903 considerable interest was shown in the region and some fifty wells were drilled. Then, until recent years, interest lagged and no prospecting was done except for the drilling of one well in 1913.

The earlier drilling was not directed by much knowledge of the geology of the region, although some of the wells were 'on structure'. Consequently, it was recommended by the Quebec provincial geologists that the geology of eastern Gaspé should be studied more carefully with a view to determining whether further attempts to find oil here in commercial quantity

(1) *Op. cit.*, 1935, p.142;209.

would be warranted. As a direct result of this work, the Imperial Oil Company drilled two wells, one in 1939-40 and the other in 1941-42. Neither of these exploratory wells meeting with success, the leases of this Company in Gaspé were allowed to lapse. Later, several companies were formed, three of which are engaged in drilling operations at the present time.

The fact that recently completed wells have not encountered oil in commercial quantity is disappointing. However, the region is extensive, and most of the individual structures on which drilling has been done are too large to be considered as tested adequately by the few holes drilled on them. Thus, the belief remains that the region warrants continued attention and that exploration and drilling should be continued to test its oil possibilities. It should be borne in mind that, in some areas elsewhere, great expenditures of time and money have been made before even an oil show was discovered by the drill and before the areas concerned were developed eventually into paying fields.

Existence of Petroleum

Seepages of petroleum are known at many localities in the east-central part of the region. The area in which they are known may be described, broadly, as a triangle, the three points of which would be Dartmouth lake, the junction of Lady Step brook with Dartmouth river, and Tar point. The locations of the more important known seepages are indicated on the accompanying maps.

There are at least three 'compound' seepages of petroleum in block 41, Galt township, bordering a brook tributary to Galt brook. Groups of three or four of them occur close together in the vicinity of the *I.O.C.* (4, maps 662-664) well and of *P.O.T. 41* and *P.O.T. 42* wells (45 and 46, maps 662-664). The oil is dark and thick, probably because the lighter constituents evaporated during exposure. Undoubtedly this oil is escaping along the major faults, or along fractures related to them, that pass by these localities. The most westerly of these three groups of seepages has its source in the fault-contact between the Grande Grève and York River formations. At the other localities, the underlying rock is York River formation, but the zones of major faulting are not far distant. An interesting feature of this seepage area is that smears of the oil may be seen on nearby trees against which bears, probably using the oil as an insecticide, have rubbed themselves after rolling in the oil-pools. Such bear-markings aided in locating some of these seepages where brushy undergrowth more or less concealed them.

Some seepages, with freely flowing, amber-green oil, were observed at localities northwest of those just mentioned. One of these is on Sonneau brook about a quarter of a mile from its mouth, in the southwestern part of block 32, Galt township. The oil flows out of gravels at the edge of the brook but undoubtedly comes from Grande Grève limestones, outcrops of which are nearby. The locality is on the crest of a sharp anticline. A seepage of similar type comes from outcrops of limestone that show on the crest of the same anticline where it crosses Patwegia brook in block 33, Larocque township, about half a mile upstream from the crossing of

the Galt-Larocque township line. There is a third seepage of greenish oil about 4,500 feet farther up Patewegia brook. This comes from much contorted limestone that is believed to be near the major fault-zone already mentioned. Two adjacent seepages of freely-flowing, amber-green oil were seen on a tributary to Patewegia brook in the northwest corner of block 33, Larocque township. These shows are in gravels but probably have their source in an underlying anticlinal zone in the Grande Grève limestones.

Oil seeps have been reported by residents of the region to be present on the upper waters of Mississippi brook to the west of Patewegia brook, and on Galt and D'Argent (Silver) brooks to the east. Those assigned to Galt brook probably are the ones described above and located on a Galt Brook tributary. No seepages were observed on Mississippi brook during the present investigation, nor on D'Argent (Silver) brook. In regard to the latter stream, Parks (1) refers, without description, to a seep near the Campbell well (2, maps 662-664). Evidently this is the seep described by Logan (2), as follows: "The petroleum oozes from a mass of sandstone and arenaceous shale . . . The oil, which here collects in pools along the brook, has a greenish colour . . . From a boring which has been sunk in the sandstone to a depth of about 200 feet, there is an abundant flow of water, accompanied with a little gas, and very small quantities of oil". The seep referred to on another page (p.403) of Logan's report may be the same as that near the Campbell well. However, it is said to have been observed "about 200 yards up a small branch of D'Argent (Silver) brook", where, although "the orifice of the spring was not seen . . . the oil . . . collects on the surface of quiet pools, as a thick film".

Two oil seeps are known in Baie-de-Gaspé-Sud township. One of these is on the property of Mr. N. Boyle, on the southwestern edge of Hay creek, about a mile and three-quarters above its mouth. Here, on lot 20A, range I, patches of light grade, green oil may be seen forming on a small pool of water, but there is no accumulation of the oil as there is at some of the seeps described above. The underlying rocks are the sandstones and shales of the York River formation. The other seep is on the northwest side of Roaring Bull brook, about 1,000 feet upstream from the crossing of the range Dartmouth line. The location is near the contact between the Grande Grève and York River formations.

Several small petroleum seepages have been reported (2) in the coastal area between Gaspé village and Tar point. While none of these seeps were seen during the present investigation, their reported locations indicate that most, if not all, of them would have their sources in the Battery Point formation.

Some seepages of petroleum are known outside of the roughly triangular area outlined above, in which the great majority occur. On Eden brook (3), seepages show at three adjacent localities near the borders of

(1) PARKS, W. A., *op. cit.* 1929, p.7.

(2) LOGAN, Sir William, *op. cit.* 1863, p.789.

(3) JONES, I. W., *op. cit.*, 1934, p.38.

blocks 16 and 21, De Beaujeu township, or about three and a half miles up the brook from Dartmouth river. The rocks here are Grande Grève limestones, at the crest of a general anticlinal structure which is strongly fractured. Salt springs, also, are present here.

Occasionally, vugs and thin seams or fractures in the Grande Grève limestones have been found to be oil-filled. This was noted particularly in the upper part of the formation, along the Saint-Jean (John) River valley between the Owl capes and Third lake. One locality easy of access where such features may be seen is south and southeast of Peinture (Paint) lake along the new road leading up Saint-Jean (John) river. The oil is dark brown and fairly viscous. A little oil was observed in the narrow exposure of limestone along the fault-zone near York river, at the north-south centre-line of Baillargeon township. Such occurrences have been noted elsewhere in the Grande Grève but they are not so common as has been indicated by some earlier investigators.

The presence of petroleum in the dyke at Tar point has attracted attention from an early date. The dyke is a medium- to coarse-grained diabase. Many of the druse and amygdule cavities in the dyke are filled with petroleum which generally is viscous and in some cases is hardened to pitch. Similar petroleum substances are present, and perhaps in relatively greater quantity, in calcite veins bordering the dyke. According to Parks (1), viscous petroleum occurs in a layer of limestone that crops out on both limbs of the anticline at Tar point. "Far more bitumen" he says, "was found in the limestone than in the dyke as described by Logan".

The existence of petroleum in the Gaspé region was well established by the presence of seepages before any drilling was attempted. The many wells drilled, while still not proving the presence of petroleum in commercial quantities, proved its existence at depth at several localities. Petroleum still flows slowly from a few of the old wells or stands in some of the well-casings (Plate XVII), and some of the wells of recent date have encountered shows of oil and gas. A well which has maintained its show of petroleum for some fifty years, and one of the most easily accessible of the old wells, is *P.O.T. 20* (24, maps 662-664). This well is in Larocque township, shortly to the north of York River road and about twenty-two miles from Gaspé village. Clear, light, amber oil in small quantity flows fairly constantly from the standpipe. This oil is reported to have been used upon occasion in the gasoline tanks of automobiles, with results not immediately deleterious to the functioning of the engines. Another well easy of access and from which oil may be bailed is the Conant well, in range I Sandy Beach, Douglas township, about one mile south of the government wharf.

Oil shales and highly bituminous sandstone layers, and even rare seams of coal, are present in the Gaspé Sandstone series. The source of the bituminous material in such deposits probably was the plant life of Gaspé Sandstone time. The deposits have been described by Parks (2), who quotes

(1) PARKS, W. A., 1929, p.60.

(2) PARKS, W. A., *op. cit.*, 1929, pp.62-67.

extensively from Logan (1) and from Ells (2), and the following is essentially a summary of Parks' account.

Oil shales are reported to be fairly common in the region, but few occurrences have come to official attention and several deposits that have been described as 'oil-shales' actually are bituminous sandstones. In the oil-shales noted by Parks, "the more volatile constituents have escaped, leaving a black, shiny, soft carbonaceous residue distributed throughout the shale or aggregated in irregular bands in it". One deposit observed by Parks was on Saint-Jean (John) river, to the east of *P.O.T.* 26 well (30, maps 663-665), on lot 49 or 50 of range II, York township. The late Mr. F. J. Richmond, of Gaspé, provided Parks with samples of bituminous shale probably obtained from Seal Cove river. Also, Mr. Richmond provided information on a band of oil shale struck in a water-well in the rear of Gaspé village. "At an elevation of 450 feet, a well of 100 feet in depth struck a show of oil at 33 feet. About 500 feet east of this point, another well passed through 16 feet of oil-shale at a depth of 70 feet". The dips of the beds being steep here, the actual thickness of the deposit would be considerably less than 16 feet. The best samples of this material were analysed through the kindness of Dr. J. M. Clarke, Albany, New York, with the following results, by dry distillation:

Oil.....	42.2 gal. per ton
Sp. gr. of oil.....	0.955
Ammonium sulphate.....	7.4 lb. per ton

A detailed description of the bituminous seams in the Gaspé Sandstones is given by Logan. In brief, the material has a reddish-brown colour, vitreous lustre, and conchoidal fracture, and it is resinous and soft. It is scarcely fusible, but at high temperatures it gives off abundant inflammable vapour. It burns readily on being kindled.

According to Ells, some twenty-three seams in all, from one to five inches thick, were searched out by him in the lower parts of Dartmouth, York, and Saint-Jean (John) rivers, and on Seal Cove brook. "These thin beds sometimes unite to form zones. Thus, on the Saint-Jean (John) river near Flat Rock, zones of 5 to 8 feet carry numerous thin bands of the resin-bearing shale separated by sandy partings".

Parks reported that zones of bituminous sands were to be found "practically everywhere that the interbanded grey shales and sandstones occur". He states that "the total amount of bituminous matter contained in these sands is enormous and one cannot but feel that sites may yet be found where the layers are sufficiently rich and continuous to permit profitable extraction".

Such bituminous sands are less ubiquitous than implied by Parks. They were noted particularly in the lower half of the York River formation, especially along Saint-Jean (John) and York rivers, where, often, they are associated closely with beds rich in invertebrate fossils. They are less

(1) LOGAN, Sir William, *op. cit.*, 1863, pp.791-792.

(2) ELLS, R. W., *Oil-shales of Gaspé, Que.*; Geol. Surv. Can., Sum. Rept., 1909, pp.212-216.

conspicuous and more scattered in the upper part of the York River formation and in the Battery Point formation

Following are some analyses of bituminous sandstones from eastern Gaspé:

A.—Four samples from a bed 14 to 15 inches thick found near the site of Shaw's mill (now demolished) on the north side of Gaspé basin (Logan, 1863, p.791):

	I	II	III	IV
Volatile matters.....	32.4	22.8	42.8	30.4
Carbon.....	8.9	8.1	7.4	8.9
Residue.....	58.7	69.1	49.8	60.7

B.—Three analyses reported by R. W. Ells (1909, p.213):

LOCALITY	CRUDE OIL	SP.GR. OF OIL	AM. SULPHATE
St-Jean (John) river, on Law brook: No. 1 from band 14 inches wide....	30.0 Imp. g./t.	0.962	42.20 lb./ton
No. 2 from band 5 inches wide. Oil tarry. (Probably from along the York river).....	31.5 "	0.977	40.00 "
No. 3 from loose piece on York river, pieces large and numerous.....	36.00 "	0.953	59.50 "

C.—Three analyses reported by Parks (1929, p.66):

LOCALITY	YORK RIVER, below falls, near Narrows brook	TWIN LAKE BROOK, York river	LITTLE FORK, St-Jean (John) river
Weight of sample.....	75.0 grams	45.0 grams	45.0 grams
Distillation up to 360°C, crude, oil, gal. per ton.....	15 g./t.	11 g./t.	14 g./t.
Specific gravity of crude oil.....	0.9183	0.9493	0.9525
Ash.....	76.10%	86.21%	86.20%
Volatile matter.....	17.08%	11.93%	11.52%
Fixed carbon.....	6.82%	1.86%	2.28%
Ammonium sulphate, lb.....	38 lb.	30 lb.	35 lb.

D.—Four analyses reported by S. C. Ells (1):

LOCALITY	CRUDE OIL	CRUDE OIL	AMMONIUM SULPHATE
31. St. Jean (John) river.....	30 Imp. g./t.	36.0 U.S. g./t.	40 lb./ton
32. ".....	31.5 "	37.8 "	42.2 "
33. York river.....	20 "	24.0 "	22 "
34. ".....	36 "	43.2 "	59.5 "

(1) ELLS, S. C., *Oil Shales of Canada*; Mines Branch, Dept. of Mines, Can., Sum. Rept., 1921, Pub. No.586, 1923, p.51.

These analyses show that the bituminous sandstones in the Gaspé region are sufficiently rich in oil to be of commercial value provided they had sufficient extent and thickness. However, these bituminous zones are neither thick nor extensive. Essentially, so far as known, they are lenses up to a foot and half thick at the most and traceable for only a few hundred feet. There is no indication that any one zone or any concentration of zones exists which would be of commercial value.

Source of the Petroleum

The immediate source of the oil in the seepages described above is in the Gaspé Sandstones or in the upper part of the Grande Grève limestone formation. The same may be said of the oil obtained to date as a result of drilling operations. In the drilling, however, the best results were obtained, in general, at the contact of the Grande Grève with the overlying Sandstone series or from within the upper few hundred feet of the Grande Grève formation. Nevertheless it seems probable that most of the oil was formed at lower stratigraphic horizons and, following its habit, migrated upward. Possible source-rocks are the reefy or often highly fossiliferous limestones occupying stratigraphic levels toward the base of the Devonian sequence and which seem to be Silurian in age in some sections and certainly Devonian in age in others. Such reefy limestones are widespread in the peninsula as a whole, and, in many localities, the rock exudes a petroliferous odour when freshly broken. The Upper Orovician limestones exposed on the Saint-Jean (John) River anticlinal have a bituminous odour, and freshly broken pieces of these rocks often yield a faint oil film when placed in water. Rocks of this same age and general type underlie wide areas throughout the southern half of the peninsula. Also, oil-bearing shales of Ordovician age are known southwest of the present region, in the Port Daniel River area (1). The best yield from samples of these shales was less than one gallon per ton.

Quality of Petroleum

The petroleum obtained to date in the wells of eastern Gaspé may be grouped in two general types, one with a paraffin base and the other with an intermediate base. The paraffin types are relatively light in colour and in weight. Generally, the colour is amber although in some instances it is light red or claret red. The intermediate, or heavier, oils generally are dark green or brownish-black in colour. The general characteristics of various samples of petroleum from eastern Gaspé are given in Table 1.

(1) SWINNERTON, A. A., *Report on Oil Shales from New Glasgow Area, Pictou County, Nova Scotia, and from Port Daniel, Bonaventure County, Quebec*; Mines Branch, Dept. of Mines, Ottawa, *Investigation of Fuels and Fuel Testing for 1930 and 1931*; 1933, pp.136-148.

TABLE 1.—ANALYSES OF GASPE OILS (1)

Sample (4)	Colour	GRAVITY		SULPHUR % by wt.	VISCOSITY Saybolt U. 100° F.	POUR POINT °F.	B.T.U. Per lb.	RESIDUUM % by wt.	PETRO- LEUM BASE	REMARKS
		Sp. Gr.	*A.P.I.							
P.O.T. 7	Br.-black	0.853	34.3	0.07	47 sec.	15	19,588	20.78	Intermediate	
P.O.T. 11	Br.-black	0.863	32.5	0.08	32 sec.		19,490			Quantity of sample insuffi- cient for other determina- tions
P.O.T. 16	Br.-black	0.840	36.9	0.09	40 sec.	below 25	19,625	17.37	Intermediate	
P.O.T. 20	Amber 4 Union Col.	0.800	45.5	0.06	36 sec.	30	19,852	12.04	Paraffin	
P.O.T. 31	Amber 4½ Union Col.	0.803	45.9	0.05	36 sec.	35	19,879	13.06	Paraffin	
P.O.T. 32	Light red 5½ Union Col.	0.798	45.9	0.05	35 sec.	25	19,863	12.02	Paraffin	
P.O.T. 42	Br.-black	0.890	27.4	0.22	119 sec.	below 25	19,363	33.28	Intermediate	
C.P.C. 3	Br.-black	0.863	32.4	0.09	55 sec.	below 25	19,570	24.31	Intermediate	
Conant	Br.-black	0.843	36.4	0.09	52 sec.	below 25		26.9		
C.P.L. 2 1,925 ft.	Amber 4½ Union Col.	0.796	46.3	0.04	35 sec.	30		11.3		
C.P.L. 2 2,046 ft.	Amber 4½ Union Col.	0.816	41.9	0.05	39 sec.	45		14.9		
C.P.L. 2 2,338 ft.	Amber 4½ Union Col.	0.791	47.4	0.05	34 sec.	10		9.4		
C.P.L. 2 1st after acid	Amber 4½ Union Col.	0.803	44.8	0.05	36 sec.	20		26.9		
P.O.T. 5(2)	Dark 8 Union Col.	0.855		0.22	53 sec.		18,700			Water = 20%. The analysis given by Parks is repeat- ed here only in part

TABLE 1.—ANALYSES OF GASPÉ OILS (1) — *Continued*

Sample (4)	Colour	GRAVITY		SULPHUR % by wt.	VISCOSITY Saybolt U. 100° F.	POUR POINT °F.	B.T.U. Per lb.	RESIDUUM % by wt.	PETRO- LEUM BASE	REMARKS
		Sp. Gr.	°A.P.I.							
I.O.C. seep	Br.-black	0.937	19.6	0.29	1,705 sec.	0	19,094	56.62	Intermediate	Water = 16.08%. The seep is about 1,000 feet south of P.O.T. 42.
Conant (3)	Br.-green	0.875	30.2	0.15	145	below 0	19,720	39.0	Intermediate	
P.O.T. 9(3)	Grn.-black	0.861	32.8	0.11	53	below 0	19,620	22.8	Intermediate	
P.O.T.20(3)	Light red	0.800	45.4	0.07	35	30	19,550	12.0	Paraffin	
P.O.T.20(3)	Claret-red	0.811	43.0	0.13	38	45	19,500	14.0	Paraffin	
P.O.T.34(3)	Claret-red	0.793	46.9	0.09	35	30		12.4	Paraffin	

(1) (a) Only the general characteristics are reported here; distillation results are on file with the Quebec Department of Mines.

(b) Generalised analyses of light green oil from district No. 27 and of amber oil from district No. 5 are given by J. OBALAKI, Dept. of Colon. and Mines, Quebec, 1899, pp.40-41. These are repeated by Parks (see below).

(2) PARKS, W. A., Que. Bur. Mines, Ann. Rept. for 1929, Pt.B., pp.28-29. Parks gives analyses for the I.O.C. seep or spring, for P.O.T.5, 15, 20, 31; and for the Conant well. Only P.O.T.5 is repeated here.

(3) ROSEWARNE, P. V., CHANTLEE, H. McD., and SWINNERTON, A. A., *Analyses of Canadian Crude Oils, Naphthas, Shale Oil, and Bitumen*; Mines Branch, Dept. of Mines, Ottawa, Pub. No.765, 1936. Chart in pocket.

(4) P.O.T. = Petroleum Oil Trust; C.P.C. = Canada Petroleum Co.; Conant = Gaspé Oil Co.; C.P.L. = Continental Petroleums, Ltd.; I.O.C. = International Oil Co.

Ells' (1) opinion, and apparently that of Parks (2) also, that the oils of lighter colour and grade are characteristic of the Gaspé Sandstones while the darker, heavier oils are characteristic of the Grande Grève limestones is not well substantiated by the available evidence. It is true that most of the oil obtained by drilling in the limestones was of dark green or brownish colour, but that similarly obtained in the Gaspé Sandstones was dark green or brownish at least as often as it was light-coloured. Furthermore, reference to the review of the oil seeps, given above, shows that a particular type of oil is not restricted to a particular formation — two seeps flowing amber oil issue from the Grande Grève limestones, and two of the three seeps flowing dark oil issue from the Gaspé Sandstones (York River formation).

Drilling Operations

The following account summarizes the history of the drilling operations in eastern Gaspé. It is supplemented by Table 2, which provides an outline of the wells drilled to date and the results obtained.

The first drilling done in Gaspé was by the Gaspé Mining Company which, in 1860, put down two shallow holes adjacent to oil seepages. Likewise, in 1865-66, the Gaspé Oil Company drilled the shallow Conant well in or near a seepage that was well known locally at that date. The first two wells yielded nothing better than traces of oil. The Conant well (3, maps 663, 665) produced some oil by pumping — in one nine-hour test giving 25 to 30 barrels. The well was reported to have been abandoned owing to loss of the tools at 684 feet depth. However, when it was reopened in 1944 by Mr. W. R. McMaster, no tools were encountered. According to Mr. McMaster, the hole as cleared by him was at least 767 feet deep and possibly 821 feet or more. Thus, it is possible that the Conant was deepened at some time after the original drilling date.

No further drilling was attempted in the region until 1889. About that year, the International Oil Company, of St. Paul, Minnesota, did some exploratory work and road-building prior to sinking one well (1891) (4 maps 662, 664) adjacent to oil seeps on a branch of Galt brook, Galt township. Correspondence in the Quebec Department of Mines files indicates that this well was drilled beyond a depth of 2,200 feet. There is also correspondence referring to a well in block 33 which, however, has not been identified; it may be a location only.

The Petroleum Oil Trust, with headquarters in London, England, began extensive operations in 1889. Subsidiaries of this Company were the Canada Petroleum Company, Belgium Oil Company (La Société Belge des Pétroles du Canada), and Oil Fields of Gaspé, Limited. The Petroleum Oil Trust drilled forty-one wells under its own designation and twelve under the name of the Canada Petroleum Company. These fifty-

(1) ELLS, R. W., *The Oil Fields of Gaspé*; Geol. Surv. Can., Ann. Rept., 1902-03, Vol. XV, p. 345A.

(2) PARKS, W. A., *Report on the Oil and Gas Resources of the Province of Quebec*; Que. Bur. Mines, Ann. Rept., 1929, Pt. B, pp. 27-28.

three wells were drilled between the years 1889 and 1901. One other drilling project, *P.O.T. 39* (43, not mapped), was located but not drilled. Most of these wells gave meagre shows of oil and gas, although a few were entirely negative. In the latter part of the drilling campaign, some wells were more encouraging — so much so that the Canada Petroleum Company erected a pumping station and a refinery. The pumping station and central collecting tank for wells in the Mississippi Brook area were erected at the site of *P.O.T. 29* well (33, maps 662, 664) and the refinery on the north side of York river, about 1,000 feet east of *P.O.T. 12* well (16, maps, 662, 663, 664, 665). A two-inch pipe-line, eleven miles in length, connected the refinery and the pumping station. These structures were built in 1900-01. The failure of any of the wells to produce oil in commercial quantity led to complete abandonment of the region by the Petroleum Oil Trust and its subsidiaries in 1904.

The production record of the Petroleum Oil Trust and Canada Petroleum Company wells is summarized below, from the accounts given by Ells (1902-03) and by Parks (1929) and from old records. Most of the wells were shot with nitroglycerine before being tested, and some were so treated at various times and depths.

PRODUCTION RECORD, PETROLEUM OIL TRUST AND
CANADA PETROLEUM COMPANY WELLS

(Production recorded as gallons unless otherwise stated)

- (5)**P.O.T. 1*.— Pumped; no oil. (Maps Nos. 663, 665).
 (9) *P.O.T. 5*.— Bailed 4 barrels, January, 1892. Pumped 2 barrels, November 9, 1892; and at rate of 2 quarts per day December 23, 1893, and January 5-6, 1894. (Maps Nos. 662, 663, 664, 665.)
 (11) *P.O.T. 7*.— Pumped water only, December 15, 1893; 20 barrels, December 16; 3 barrels, December 19; ½ barrel per day, December 23, 1893, and January 5-6, 1894. 200 barrels lost by breaking of storage tank, February 14, 1894. (Maps Nos. 662, 663, 664, 665.)
 (14) *P.O.T. 10*.— 1901: Pumped 125, June 5; 8, June 24; 1, June 27. 1903: Pumped 93, July 17; 5, July 21. (Maps Nos. 663, 665.)
 (15) *P.O.T. 11*.— 1901: Pumped 1 or 4, May 25; 50, June 4; 17, June 28; 4 July 6. Estimate of "some hundreds of barrels" reported lost during night of May 2, 1894, after explosion and fire destroyed rig (oil and gas struck at 2,200 feet on that date). (Maps Nos. 662, 663, 664, 665.)
 (16) *P.O.T. 12*.— 1901: Pumped 30, June 26; 1, July 3; 55, July 26. (Maps Nos. 662, 663, 664, 665.)
 (17) *P.O.T. 13*.— 1901: Pumped 40, June 12; ½, July 6. (Maps Nos. 662, 663, 664, 665.)
 (18) *P.O.T. 14*.— 1901: Pumped 16, June 25; 1, June 26; 1, July 6. (Maps Nos. 662, 663, 664, 665.)
 (19) *P.O.T. 15*.— Bailed 50 barrels from show at Grande Grève-York River contact. "Yielded continuously about 7 to 8 gallons oil for several months". 1901: Pumped 10, May 25; 80, May 27; ; 22, May 29; 35, June 4; 30, June 12; 6, June 18, June 22; 4 ½, June 24; 2 ½, June 25; 2, June 27; 2 ½ June 29; 4, July 6; 2 ½, July 8; 7, July 11; 2, July 16, July 24; 10, August 5. (Maps Nos. 662, 663, 664, 665.)
 (20) *P.O.T. 16*.— 1901: Pumped or bailed 150, June 10. (Maps Nos. 662, 664.)
 (21) *P.O.T. 17*.— 1896: 10 barrels bailed at depth of 2,348 feet. 1901: Pumped 30, April 24; 230, April 25; 4, June 5; 20, June 19; 5, June 21, June 25; 10, June 26; 1, July 3; ½, July 6; 2, July 8,

(Continued on page 144.)

* Figures in parentheses refer to numbers at left of Table 2.

TABLE 2.—SUMMARY OF
(For explanatory notes,

WELL (1) Name and Date	LOCATION	PRESENT CONDITION	ELEVATION Feet
G.B.M. 1860 (1)	Douglas tp., R.I, lot 17; 170 ft. E. of W. line of lot S. shore St-Jean (John) R. barachois	Hole covered with rocks No sign oil or gas Oil seeps reported nearby	15
G.B.M. Campbell 1860 (2)	Baie-de-Gaspé-Sud tp., R. II, lot 16 W. side D'Argent (Silver) brook, 4,700 ft. E. of W. line of tp.	Not seen Negative (Parks, 1929) Water, a little gas and oil (Logan, 1863)	230-300
G.O.C. Conant 1865 or 1866 Reopened 1944 W.R.M. (3)	Douglas tp., R.I, Sandy Beach, lot A6, 1 mile S. of Gov't. wharf, E. side Gaspé basin	Stand-pipe. Flow salt water and little black oil (1929). Water static; 1 ft. dark greenish-brown oil; hole blocked at 8 ft. (1938). Hole cleared to 767 ft., and deepened to 821 ft. (or cleared to 821 ft.) in 1944; plugged at 300-270 ft. (1945)	335
I.O.C. 1891 (4)	Galt tp., block 41. About 2 miles up main west branch of Galt brook	Wooden conductor. Dry. Oil seeps adjacent	345
P.O.T.1 1889-91 (5)	Douglas tp., R.I, Sandy Beach, lot A6. About 100 ft., N. of Conant	Wooden conductor. Fresh water and mud to 8 ft.; a little gas and brownish oil	345
P.O.T.2 1890 (6)	Douglas tp., R.I, Sandy Beach, lot B1. Midway between Gov't. wharf and P.O.T.1	Square wooden conductor; casing. Fresh water from around casing. Green oil to 4 ft. where hole blocked. Bubbles of gas	200
P.O.T.3 1890-91 (7)	Douglas tp., R. Haldimand, lot 1. N. shore St-Jean (John), R. barachois, 1,500 ft. W. of r'ly. and 300 ft. S. of highway	Not seen Negative (Parks, 1929)	20
P.O.T.4 1890-91 (8)	Douglas tp., R.I, Bois Brulé, lot 1. ½ mile S.S.W. of mouth Seal Cove brook; 60 ft. N. of r'ly.	Wooden conductor. Casing; plugged. 3 in. water with dark scum of oil	160
P.O.T.5 1891-92 (9)	Baie-de-Gaspé-Sud tp., R.I, lot 32; 3,500 ft. W. on York River road from gate; 40 feet S. of road	Square wooden conductor. Mud 3 ft. from surface, 1 ft. water with thin film oil; a few gas bubbles. Ground dry around hole. Water pipe 4 ft. from well	100
P.O.T.6 1892 (10)	Galt tp., block 42. Valley of Galt brook, about 1,500 ft. above York River road	Not seen. Perhaps covered by brook gravels Negative (Parks, 1929)	About 135
P.O.T.7 1892-93 (11)	Baie-de-Gaspé-Sud tp., R.I, lot 34. 2,000 ft. W. of P.O.T.5; 700 ft. S. of York River road	Stand-pipe, perforated wooden plug. Salt water, gas bubbles, a little oil	70
P.O.T.8 1892-93 (12)	Douglas tp., R. Sandy Beach, lot B1. About midway between P.O.T.2 and P.O.T.1	Stand-pipe. Hole clear to depth of at least 20 ft. Dry	275

WELLS IN EASTERN GASPÉ

(see end of Table)

GEOLOGY	WATER	OIL SHOWS:(2) FORMATION, DEPTH (feet)				TOTAL DEPTH Feet
		G.G.	G.G.-Y.R. CONTACT	Y.R.	B.P.	
3,000 ft. S. of York River syncline; gentle dips. Log not seen; Battery Point						7600
3,700 ft. S. of Mississippi anticline; dips 10°-15°S. York River	Abundant flow in 1862 (Logan)			A little gas, oil		7600- Perhaps 200 (1883, p. 789)
600 ft. S. of Haldimand anticline. 25 ft. drift. Log of adjacent C2 well (1945) gives: 0-600 ft. (about) = Battery Pt. 600 (about)-805 ft. = York River	238 Very salt			Oil and gas 600 Oil and cons. gas 648	Gas and oil 83 Show of thin light oil and black gas 425, 430 Good show 444	(old log) 684 (1944) 767 or 821
Faulted area. Log not seen; York River formation; may have reached Grande Grève. "Sandstone to 1,700 ft. No oil" (Parks, 1929)						2,200+ (3)
500 ft. S. of Haldimand anticline Dips about 15° S. Log not seen.—Estimate: 0-600 ft. (about) = Battery Point 600-2,430 ft. = York River	Salt: 1,325 1,700			2,048 2,400		2,430
2,000 ft. N. of Haldimand anticline. Dips about 25°N. Log not seen. Estimate: 0-1,700 ft. = Battery Point 1,700-2,582 ft. = York River	- 235 235 450 500			2,582	500 965	2,582
2,000 ft. S. of Haldimand anticline. Dips about 7°S. Log not seen. Estimate: all Battery Point	Salt: 1,304					2,225
About 2,000 ft. N. of Tar Point anticline. Dips 30°-60°N. Log not seen. Estimate: 0-1,000 ft. = Battery Point 1,000-2,970 ft. = York River				2,215		2,970
2,500 ft. N. of York River syncline. Dips probably low S. 28 ft. drift. 0-2,361 ft. (perhaps) 2,458 ft. = York River (2,361?) 2,458-2,640 ft. = Grande Grève	Salt: 1,600	Small 1,950	?	Good 2,360 (green?)		2,640
Faulted area. About in line with York River syncline. Dips low west — York River	Salt: 395, 440 A little: 590; 690			Small 2,950		3,640
About 1,700 ft. N. of York River syncline. Dips probably low S. 28 ft. drift. 0-2,385 ft. = York River 2,385-2,867 ft. = Grande Grève	Salt 2,385	Oil, gas 2,589 oil 2,650	2,385	gas 910		2,867
About 1,000 ft. N. of Haldimand anticline. Dips 10°-20°N. 0-1,000 ft. = Battery Point 1,000-2,650 ft. = York River	745 936 Salt: 1,175 1,400					2,650+

TABLE 2. — SUMMARY OF WELLS

WELL (1) Name and Date	LOCATION	PRESENT CONDITION	ELEVA- TION Feet
P.O.T.9 1894 (13)	Baie-de-Gaspé-Sud tp., R. Dartmouth (I.N.), lot 14. About $\frac{1}{2}$ mile up Stanley brook from road; 400 ft. E.	Hole blocked 5 ft. from surface. Dry	245
P.O.T.10 1895 (14)	Baie-de-Gaspé-Sud tp., R.I, lot 30. 1,400 ft. W.N.W. of junction of York River and Howard Smith roads	Wooden conductor. Flow slightly salt water with little oil and few bubbles of gas. A little yellow scum	80
P.O.T.11 1893-95 (15)	Baie-de-Gaspé-Sud tp., R.I, lot 35, N.W. corner. 6,500 ft. W. on York River road from gate; 750 ft. N. of road	Wooden conductor; full of water, oil film. Some oily muck around well. No gas	About 125
P.O.T.12 1894 (16)	Baie-de-Gaspé-Sud tp., R.I, lot 33. About 3,300 ft. E. of York-Baillargeon line, N. of York river	Stand-pipe. Water and some green oil 10 ft. below surface. Gas bubbles	30
P.O.T.13 1894 (17)	Baie-de-Gaspé-Sud tp., R.I, lot 32. 3,300 ft. W. on York River road from gate and 1,700 ft. N. of road	Wooden conductor. Hole blocked 7 ft. from surface. Flow sulphur water; common bubbles gas and oil. Some yellow scum. Ground oil-soaked	About 150
P.O.T.14 1895-97 (18)	Baie-de-Gaspé-Sud tp., R.I, lot 36. 6,800 ft. W. on York River road from gate; 700 ft. N. of road	Wooden conductor. Hole blocked 20 ft. from surface. Dry. Iron water-pipe $2\frac{1}{2}$ ft. distant	About 100
P.O.T.15 1895 (19)	Baie-de-Gaspé-Sud tp., R.II, lot 6. $\frac{1}{2}$ mile N.W. of P.O.T.13	Square wooden conductor, plugged 12 ft. from surface. Water to 4 ft. from surface; thin layer oil; gas bubbles. Stand-pipe $2\frac{1}{2}$ ft. distant; blocked 4 ft. from surface; 4 in. oil	About 250
P.O.T.16 1894? 1895 (20)	Galt tp., block 42, Bean brook, S. side, about 7,000 ft. above York River road	Wooden conductor. Water with bubbles, gas and light bluish oil. Yellow scum around well	450
P.O.T.17 1895-97 (21)	Larocque tp., block 40. 4,300 ft. W. on York River road from Larocque-Galt line; 165 ft. S. of road; W. side No. 17 brook	Stand-pipe blocked $2\frac{1}{2}$ ft. from surface. Water to 8 in. from top of pipe; a little oil	435
P.O.T.18 (22)	Larocque tp., block 40. 2,700 ft. W. on York River road from Larocque-Galt line; 700 ft. N. of road	Wooden conductor. Water to 1 ft. from surface, with 1 in. brownish amber oil	475
P.O.T.19 1895-96 (23)	Larocque tp., block 40. 1,200 ft. S.W. of P.O.T.17	Wooden conductor. Hole filled in. No sign oil, gas	415

IN EASTERN GASPE — Continued

GEOLOGY	WATER	OIL SHOWS:(2) FORMATION, DEPTH (feet)				TOTAL DEPTH Feet
		G.G.	G.G.-Y.R. CONTACT	Y.R.	B.P.	
About 1,200 ft. from thrust fault in vertical to overturned beds. 15 ft. drift. Battery Point	495, 560 Fresh: 500					2,719
Between York River syncline and eastern end of Mississippi anticline. Dips 20° or less S. 28 ft. drift. York River	700 775			Gas: 775 +800 Oil and gas 1,108 Oil: 1,140 1,190 1,265		1,400
About 3,200 ft. N. of York River syncline. Dips probably low S. 40 ft. drift 0-2,200 ft. = York River 2,200-2,957 ft. = Grande Grève	Salt: 806	2,220 2,485		Oil and gas 2,185 or 2,085		2,957
About on the York River synclinal axis. Dips very low. 105 ft. drift 0-2,700 ft. = York River 2,700-3,002 ft. = Grande Grève	Salt: 816	Small gas and oil 2,837		Small 2,075 Gas pockets 850 1,240		3,002
Between York River syncline and eastern end Mississippi anticline. Dips 20° or less S. 12 ft. drift 0-2,000 ft. = York River 2,000-2,160 ft. = Grande Grève	Salt and mineral, overflows hole 2,050	Gas 2,160	Oil and gas 2,000	Gas 790 1,040 Gas and oil 1,500 1,935		2,160
About 3,300 ft. N. of York River syncline. Dips probably low S. 39 ft. drift 0-2,250 ± ft. = York River ±2,250-2,775 ft. = Grande Grève Suspect crevice at about 2,775 ft., lost some casing				Oil or oil shale 1,835 Gas 2,160		2,775
2,000 ft. S. of Mississippi anticline. Dips probably low S. 0-1,880 ft. = York River 1,880-2,012 ft. = Grande Grève		"Oil sand" 1,966, 72,012	1,880			2,012
About midway between York River syncline and Mississippi anticline; 2,000 ft. N. of fault. Dips 5°-10° S. 0-2,840 ft. = York River 2,840-2,925 ft. = Grande Grève	Salt? 7ft.		2,840	2,664		2,925
About 3,500 ft. N. of York River syncline. Dips 25° or less S. to S. W. 13 ft. drift 0-2,000 ft. = York River 2,000-2,550 ft. = Grande Grève		2,348?		1,013 1,045 1,200 (dark) 1,286 (straw)		2,550
About 4,500 ft. N. of York River syncline. Dips about 25° S.S. W. 14 ft. drift 0-1,865 ft. = York River 1,865-1,960 ft. = Grande Grève	300 738 Salt: 1,950		Oil, gas 1,860	738 990 1,095 (amber) gas 1,556		1,960
About 2,800 ft. N. of York River syncline. Dips about 15° S.W. 14 ft. drift 0-2,200 ft. = York River 2,200-2,250 ft. = Grande Grève	480 Salt: 719 1,464			1,185 1,792 (amber) 2,040		2,250

TABLE 2. — SUMMARY OF WELLS

WELL (1) Name and Date	LOCATION	PRESENT CONDITION	ELEVA- TION Feet
P.O.T.20 1896 (24)	Larocque tp., block 40. About 200 ft. E. of No. 21 brook; 800 ft. N. of York River road	Stand-pipe 2 ft. above ground; blocked 10 ft. from top. Occasional overflow oil; ground soaked	535
P.O.T.21 1896-97 (25)	Larocque tp., block 40. W. side No.21 brook, about 3,300 ft. above P.O.T. 20	Stand-pipe 2½ ft. above ground. Flow of sulphurous but palatable water (medicinal?)	860
P.O.T.22 1896-97 (26)	Bale-de-Gaspé-Sud, R.III, lot 22, 120 ft. N. and 30 ft. E. of intersection Howard Smith road and W. line of tp.	Wooden conductor filled with débris to 8 ft. from surface. Dry	1,095
P.O.T.23 1896-97 (27)	York tp., R.III, lot 25 (24?), 4,000 ft. S. of St-Jean (John) R.; N. side road, 3½ miles from highway	Two stand-pipes a few feet apart. One filled 6 ft. from top with débris; one filled to top with decayed wood. Dry	143
P.O.T.24 1896 (28)	York tp., R.III, lot 31 (32?). 7,000 ft. west of P.O.T.23; 900 ft. N. of road; S. of St-Jean (John) R.	Stand-pipe blocked with débris 4 ft. from top. Dry	About 350
P.O.T.25 1895-97 (29)	Beilargeon tp., block 44. At extreme N. edge Fourth lake near canoe shed	6-in. casing inside 8-in. drive pipe, filled with salty but palatable water; oil film, some gas bubbles	670
P.O.T.26 1896 (30)	York tp., R.II, lot 50. 30 ft. from N. bank St-Jean (John) R.; 5 ft. above river. 6,200 ft. E. of west line of York	Stand-pipe blocked with débris near top; standing, slightly salt water	165
P.O.T.27 1897 (31)	Larocque tp., block 40. 3,000 ft. W. of E. line of tp., 1,700 ft. S. of York River road	Part of derrick standing in 1937. Hole caved in; no sign of stand-pipe or conductor. Dry	315
P.O.T.28 1897-98 (32)	Larocque tp., block 38. W. side Narrows brook, about 6,000 ft. above York River road	Wooden conductor. Strong flow clear, slightly salt water	1,010
P.O.T.29 1897-98 (33)	Larocque tp., block 40. 1,500 ft. S. of P.O.T.27, N. side of York river	Drive pipe, in wooden conductor, full of salty but palatable water; thin film oil; occasional gas bubbles	230
P.O.T.30 1898-99 (34)	Larocque tp., block 40. Mississippi brook, 400 ft. below mouth of No. 21 brook. 1,000 ft. N. of York River	Wooden conductor; water 4 ft. from surface	325
P.O.T.31 1898-99 (35)	Larocque tp., block 40. W. of mouth of Mississippi brook; N. side York river	Stand-pipe; oil 2 ft. from top of pipe; and apparently to depth of 31+; yellowish-amber colour	270

IN EASTERN GASPÉ — Continued

GEOLOGY	WATER	OIL SHOWS:(2) FORMATION, DEPTH (feet)				TOTAL DEPTH Feet
		G.G.	G.G.-Y.R. CONTACT	Y.R.	B.P.	
About 3,800 ft. N. of York River syncline. Dips about 35°S. 21 ft. drift 0-2,150 ft. = York River (samples) 2,150-2,173 ft. = ?; no mention of limestone in old log	Salt: 550			2,058		2,173
About 6,000 ft. N. of York River syncline; 4,500 ft. S. of York River-Grande Grève contact. Dips about 25°S. 80 ft. drift. 0-1,520 ft. = York River 1,520-1,887 ft. = Grande Grève			Trace: 1,520			1,887
2,000 ft. N. of Mississippi anticline; 4,000 ft. S. of syncline. Dips flat to 22°N. 11½ ft. drift. 0-2,750 ft. = York River 2,750-3,107 ft. = Grande Grève	Salt: 2,352 3,105	Gas and oil: 2,945 3,105 (amber)		Gas and oil: 2,342 (dk. blue)		3,107
2,800 ft. N. of Grande Grève-York River contact. Dips about 15°N. 40 ft. drift 0-1,350 ft. = York River (2 "limestone" zones) 1,350-1,795 ft. = Grande Grève	Salt: 1,678 (much)			1,100 very faint		1,795
200± N. of Grande Grève-York River contact Dips 25°-30°N. 16 ft. drift 0-100 ft. = No record 100-1,230 ft. = Grande Grève						1,230
1¼ miles S. of York River syncline. Dips 10°-35° N.W. 60-70 ft. drift 0-720-750 ft. = York River 750-1,160 ft. = Grande Grève						1,160 or 1,160+ (1,230 ?)
About 5,500 N. of Grande Grève-York River contact. Dips 10°-23° N. 30 ft. (?) drift 0-2,750 ft. = York River (Interbedded limestone and sandstone = 2,500-2,750 ft.) 2,750-2,975 ft. = Grande Grève			2,650	1,700 2,650		2,975
1,800 ft. N. of York River syncline. Dips 5°-15°S.W. 0-2,100 ft. = York River 2,100-2,160, (2,200 ?) ft. = Grande Grève (Old log reports conglomerates, but none show in samples)	Salt: 790			Oil and gas 1,467 gushed 2 days at intervals		2,160 (2,200 ?)
1,000 ft. N. of York River syncline. Dips 5°S. 0-3,500 ft. = York River	Salt: 71,100					3,500 3,525 ?
400 ft. N. of York River syncline. Dips very low to W. 81 ft. drift 0-2,100 ft. = York River 2,100-2,183 ft. = Grande Grève (Old log gives figures to 2,600 ft., but no comment)	Salt: 840 1,209 1,300 1,450	Oil and gas 2,183		2,000		2,183
600 ft. N. of York River syncline. Dips 7°-10°W.S.W. 10 ft. drift. York River	Salt: 860, 930, 1,022, 1,075, 1,150, 1,210, 1,450, 1,480			Gas 550 1,030		1,580
1,000 ft. S. of York River syncline. Dips 10°W.N.W. 145 ft. drift. 0-2,450 ft. = York River 2,450-2,815 ft. = Grande Grève	1,890 (little)			1,700		2,815

TABLE 2. — SUMMARY OF WELLS

WELL (1) Name and Date	LOCATION	PRESENT CONDITION	ELEVATION Feet
P.O.T.32 1899 (36)	Larocque tp., block 40. 1,000 ft. W. of E. line of tp.; 600 ft. N. of York river	Rotted wooden conductor 13 ft. below surface. Hole blocked with mud; 2 ft. greenish-amber oil	305
P.O.T.33 1899-01 (37)	Larocque tp., block 40. N. side York river, 1½ miles above P.O.T.31. On lawn at E. end Stillpool camps	Wooden conductor; salt water 3 ft. from surface. Gas bubbles	300
P.O.T.34 1900 (38)	Larocque tp., block 40. W. side No. 17 brook; 1,300 ft. S. of P.O.T.17	Burnt remains of derrick mark location; hole not visible	380
P.O.T.35 1901 (39)	Larocque tp., block 40. E. side No. 35 brook, 1,800 ft. N. along old road from York River road	Rotted wooden conductor. Fresh water to 5 ft. from surface	About 500
P.O.T.36 1901 (40)	Baie-de-Gaspé-Sud tp., R. II, lot 7. 4,000 ft. N.N.W. of P.O.T.15; 1,200 ft. S. of Howard Smith road	No conductor or stand-pipe. Hole probably blocked about 15 ft. below surface. Dry	About 850
P.O.T.37 1901 (41)	Galt tp., block 31. 3,500 ft. S.W. of intersection E. line of tp. and Howard Smith road; on branch of D'Argent (Silver) brook	Wooden conductor; fresh water 5½ ft. below surface	About 900
P.O.T.38 1901-02 (42)	Galt tp., block 42. 3,800 ft. S. of intersection E. line of tp. and Howard Smith road	Wooden conductor; filled to about 20 ft. from surface. Dry	875
P.O.T.39 (43)	Baie-de-Gaspé-Sud tp., R. II, lot 5	Located, but not drilled	
P.O.T.40 1901 or 1902 (44)	Larocque tp., block 38; Falls brook, E. branch, 2,800 ft. N. of York River road	Stand-pipe plugged. Small flow fresh water. No oil	About 825
P.O.T.41 1902-03 (4) (45)	Galt tp., block 41. S. side old road of I.O.C., about 3,600 ft. N.W. of I.O.C. well	2 ft. by 3 ft. depression walled with wood. No oil	475
P.O.T.42 (46)	Galt tp., block 41. 1,000 ft. E.N.E. of P.O.T.41, 500 ft. W. of main W. branch of Galt brook	Stand-pipe 2 ft. above surface. Thick green oil 8-10 ft. from surface on water	455
C.P.C.1 1899 (47)	Larocque tp., block 40. 3,500 ft. W. on York River road from E. line of tp., 1,400 ft. S. of road; 700 ft. E. No. 17 brook; E. side old road	Wooden casing. Some water about 7 ft. below surface	350
C.P.C.2 1899 (48)	Larocque tp., block 40. 500 ft. S.S.W. of C.P.C.1; E. side old road; 300 ft. W. of No. 17 brook	Hole filled in. No pipes visible	320
C.P.C.3 1899 (49)	Baie-de-Gaspé-Sud tp., R.I., lot 34. 5,700 ft. W. on York River road from gate, 1,200 ft. N. of road; 700 ft. N.E. of P.O.T.11	Wooden conductor. Some flow water with little gas and green oil	150

IN EASTERN GASPÉ — Continued

GEOLOGY	WATER	OIL SHOWS:(2) FORMATION, DEPTH (feet)				TOTAL DEPTH Feet
		G.G.	G.G.-Y.R. CONTACT	Y.R.	B.P.	
2,500 ft. N. of York River syncline. Dips 15°W.S.W. 0-1,825 ft. = York River 1,825-1,925 ft. = Grande Grève	Salt: 1,008 (little)		1,825	860		1,925
3,100 ft. S. of York River syncline. Dips 10°N.W. 12 ft. drift. York River	Several points, some salt			Gas at several points		2,607
2,300 ft. N. of York River syncline. Dips 12°W.S.W. 25 ft. drift. York River	1,075 Salt: 1,600			Gas 545 Oil 1,600		1,677
3,000 ft. N. of York River syncline. Dips 30°-35° S. 14 ft. drift 0-1,800 ft. = York River ?1,800-1,810 ft. = Grande Grève?	Small: 690 820					1,810
1,600 ft. N. of Mississippi anticline. Dips 13°-22°N. 0-1,780 ft. = York River 1,780-1,955 ft. = probably York River (Samples at 1,845, 1,950 and 1,955 ft. are sandstone)	1,110 Salt: 1,065 1,225					1,955
3,300 ft. N. of Mississippi anticline. Dips 7°N.N.W. 73 ft. drift. York River (Samples do not confirm the logged alternation of sandstone and limestone between 455 and 645 ft.)	Salt: 927 1,875			Gas: 1,925 Gas, oil: 2,193 Oil: 2,218 (green)		2,600
1,000 ft. N. of Mississippi anticline. Dips ?°N. 18 ft. drift. York River	Salt: 955 2,089			2,080		2,089
						0
5,000 ft. N. of York River syncline. Dips about 25°S. York River						2,305
(3) About 1 mile S. of Mississippi anticline in faulted area. 20½ ft. drift 0-70 ft. = York River 70-460 ft. = Grande Grève		(3) 258 (slight)				(3) 460
(3) 4,500 ft. S. of Mississippi anticline in faulted area. 16 ft. drift. March 7th, in York River at 1,000 ft. May 2nd, in Grande Grève at about 2,000 ft.						(3) 2,000±
2,100 ft. N. of York River syncline. Dips 5°-12°W.S.W. 0-1,582 ft. = York River	Salt water flow in 1902			1,141 Oil and gas 1,550		1,582
1,600 ft. N. of York River syncline. Dips 5°-12° W.S.W. 0-1,591 ft. = York River	Salt: 848			Oil and gas 1,550 flowed one night		1,591
3,500 ft. N. of York River syncline; 4,000 ft. S. of Mississippi anticline. Dips probably low S. 0-2,125 ft. (about) = York River 2,125-2,438 ft. = Grande Grève		2,325				

TABLE 2. — SUMMARY OF WELLS

WELL (1) Name and Date	LOCATION	PRESENT CONDITION	ELEVATION Feet
C.P.C.4 1899-01 (50)	Larocque tp., block 40. 600 ft. E. of C.P.C.1	Hole plugged by tree trunk; no pipes visible. Dry	360
C.P.C.5 1900 (about) (51)	Larocque tp., block 40. 1,000 ft. S. of C.P.C.4	Rotted wooden conductor. Hole clear to depth of at least 32 ft. Dry	285
C.P.C.6 1900 (about) (52)	Larocque tp., block 40. W. side No. 17 brook, 700 ft. W.S.W. of C.P.C.2	Rotted wooden conductor. Hole blocked at 14 ft. below surface. Dry	345
C.P.C.7 1900 (about) (53)	Baie-de-Gaspé-Sud tp., R.I, lot 29. 1,400 ft. N. on Howard Smith road from gate; 350 ft. W. of road	Wooden casing and plug. Water, gas bubbles, and oil foam comes up around plug. Some yellow scum	About 100
C.P.C.8 1900 (about) (54)	Larocque tp., block 40. 1,400 ft. S.W. of C.P.C.6; E. side Mississippi brook	No conductor or pipes. Hole clear to depth of at least 25 ft. Seepage of amber oil, possibly from the well, comes out E. edge of Mississippi brook	300
C.P.C.9 1900 (about) (55)	Baie-de-Gaspé-Sud tp., R.I, lot 32. 1,500 ft. S.W. of C.P.C.7; 800 ft. S.W. of P.O.T.10	Rotted wooden conductor. Hole clear to at least 13 ft. from surface. Some flow water; gas bubbles. Some yellow scum	About 100
C.P.C.10 1901 (56)	Baie-de-Gaspé-Sud tp., R.I, lot 33. 4,500 ft. W. along York R. road from gate; 400 ft. S. of road	Wooden conductor; no stand-pipe. Conductor full of water with 3 in. yellow scum on top; gas bubbles.	About 100
C.P.C.11 1901 (57)	Larocque tp., block 40. 15 ft. W. of E. line of tp.; 140 ft. N. of York river	Wooden conductor. Dry	240
C.P.C.12 1901 (58)	Larocque tp., block 39. N. bank York river, 500 ft. below mouth Narrows brook	Rotted wooden conductor. Water 6 ft. below surface	380
Unidentified (59)	Baie-de-Gaspé-Sud tp., R.I, lot 32 or 33. 600 ft. E. of C.P.C.10. In a spring	Stand-pipe. Some flow slightly saline and sulphurous water; gas bubbles.	100
E.C.C. 1913 (60)	Malbaie tp., R. Malbaie N., lot 17. About 7 miles up Malbaie River road and trail from highway; 70 ft. N. of road	Stand-pipe full of fresh water	275
M.P.G. 1937-38 (61)	Baie-de-Gaspé-Sud tp., R.I, lot 51. About ½ mile N. along Renard River road and ½ mile E. of road	Water about 15 ft. below surface in 1938	About 160
MISSISSIPPI No. 1 IMP. O. Co. 1939-40 (62)	Larocque tp., block 35. 3,500 ft. E.N.E. of S. end of Dartmouth lake 5 1/3 miles by road N. of York R. road	16-in. casing 0-22 ft. 10 ¼-in. casing 298-1,865 ft. Hole bridged at 1,750 ft.	1,500

IN EASTERN GASPÉ — Continued

GEOLOGY	WATER	OIL SHOWS:(2) FORMATION, DEPTH (feet)				TOTAL DEPTH Feet
		G.G.	G.G.-Y.R. CONTACT	Y.R.	B.P.	
2,200 ft. N. of York River syncline. Dips 5°-15° W.S.W. 0-2,100 ft. = York River (?Grande Grève at 2,200? ft.)	Salt: 816					2,100 2,200?
1,300 ft. N. of York River syncline. Dips low to W.S.W. 0-2,100-2,150 ft. = York Riv. 2,150-2,200 ft. = Grande Grève			2,140	1,349 2,140		2,200
1,300 ft. N. of York River syncline. Dips 5°-12° W.S.W. 0-2,300 ft. = York River Grande Grève contact at 2,360? ft.; some limestone shows in sample from 2,300 ft.			2,340	2,340		2,360
2,000 ft. S. of E. end of Mississippi anticline. Dips 20° or less to S. 0-2,046 ft. = York River 2,046-2,065 ft. = Grande Grève				1,945		2,065
600 ft. N. of York River syncline. Dips 9° S.W. Log samples not seen. 0-2,340? ft. = York River 72,340-2,394 ft. = Grande Grève	Salt: "upper part"		2,340			2,394
About midway between York River syncline and E. end of Mississippi anticline. Dips 20° or less S. 0-2,215 ft. = York River 2,215-2,226 ft. = Grande Grève	1,132 (much)					2,226
2,000 ft. N. of York River syncline. Dips probably low S. 0-2,355 ft. = York River 2,355-2,383 ft. = Grande Grève				3 bbls. ?depth		2,383
2,100 ft. N. of York River syncline. Dips 8° W.S.W. 0-1,900 ft. = York River 1,900-1,924 ft. = Grande Grève	Salt: 1,490			1,490		1,924
About 2 miles S. of York River syncline 0-1,500 ft. = York River						1,500
Log, samples not seen						
Steeply folded area on N. side of Malbaie syncline. Dips 80° N.E. Battery Point. (Log and samples not seen)						2,950
About 9,500 ft. S. of York River-Battery Point contact and 6,000 ft. N. of Northwest Arm syncline. Dips about 30° S. 0-842 ft. = Battery Point	15					842
About 8,000 ft. S. of Mississippi anticline. Dips 20°-25° S. 0-1,240 ft. = Grande Grève 1,240-2,610 ft. = Cape Bon Ami (normal) 2,610-3,410 ft. = Cape Bon Ami? St-Alban? 3,410-4,980 ft. = Cape Bon Ami (normal) 4,980-5,995 ft. = St-Alban-Silurian	Fresh: 50-52 (strong flow); 890 (15 gal. per min. water rose to 15 ft.)					5,995

TABLE 2. — SUMMARY OF WELLS

WELL (1) Name and Date	LOCATION	PRESENT CONDITION	ELEVATION Feet
HALDIMAND No. 1, IMP.O.Co. 1941-42 (63)	Douglas tp., R.II. North, lot 2. About 2 miles S. of Gov't. wharf, Gaspé Basin; 8,200 ft. by road S. of highway	20-in. casing 0-9 ft. 8 $\frac{1}{4}$ -in. casing 1,652-2,012 ft. Hole bridged at 2,050, 1,650, 1,100 and 700 ft. 20-in. casing projects 3 ft. above ground; soldered cap	About 415
C.P.L.1 1943 May-Dec. 0-2,137 ft. 1946-47-48 2,137 to 2,751 ft. (64)	Galt tp., block 42. W. side Galt brook about 2 miles N.W. of mouth. 2 1/3 miles by road N.W. from York River road	10 $\frac{1}{2}$ -in. and 13 $\frac{1}{4}$ -in. casing pulled. Hole plugged at 500 ft. and from 75 ft. to surface. Capped by 3 ft. of cement	600
C.P.L.2 1944-45 (65)	Larocque tp., block 40. 113 ft. E. of P.O.T.20	Bailing and pumping after acidizing gave production of 2-5 gals. oil per day. Standing, all machinery re- moved (December, 1948).	545
C2 W.R.M. 1945 (66)	Douglas tp., R.I, Sandy Beach, lot A. 350 ft. S. of Conant well	Casing pulled Hole plugged at 245, 260, 150, 125, and 78 ft.	340
P.O.C.1 1945 (67)	Holland tp., 1 $\frac{1}{2}$ miles W. of centre line, 2,000 ft. S. of York River road	Drilling (December, 1948)	About 1,650
VENTURE 1 G.O.V. 1946-47 (68)	Galt tp., block 31. 400 ft. N. and 4,800 ft. W. of mile V on E. line of tp.; E. side Silver brook	Drilling suspended, all machinery re- moved	About 1,575
VENTURE 2 G.O.V. 1947-48 (69)	About $\frac{1}{2}$ mile S. of Venture 1. Galt tp.; 3,000 ft. N. of east-west centre line and 4,120 ft. W. of east line of tp.	Wood plugs set at 1,870 ft., 1,715 ft., and 615 ft. with 12 ft. cement on top in each case. Hole filled to top of ce- ment with earth	About 1,475
VENTURE 3 G.O.V. 1948- (70)	50 ft. S.40°E. of Venture 2	Standing (December, 1948)	About 1,475

IN EASTERN GASPE — Continued

GEOLOGY	WATER	OIL SHOWS: (2) FORMATION, DEPTH (feet)				TOTAL DEPTH Feet
		G.G.	G.G.-Y.R. CONTACT	Y.R.	B.P.	
About 4,000 ft. S.W. of the Haldimand anticline, possibly on or near a subsidiary fold. Dips very low. 3 ft. drift. 0-1,370? ft. = Battery Point 1,370-4,779 ft. = York River	Fresh: 130-150 (2 bbl. per hour); 365 (3 bbl. per hr.) 390-395 (large) Salt: 1,066 (strong) 1,200				Gas: 780 1,060 to 1,066	4,779
Near top of dome on Mississippi anticline. Well started in Grande Grève about 400 ft. below top of formation. 8 ft. drift. 0-2,751 = Grande Grève	Fresh: 65 (5 gal. per hour); 147 (slow); 245 (7 gal. per min.) Brackish: 945 (96 gal. per hour)	Gas: 833-846 2,100? Oil: 847				2,757
About 3,600 ft. N. of York River syncline. Dips about 35° S. 0-2,363 ft. = York River 2,362-2,932 ft. = Grande Grève	Fresh: 75 (2 bbl. per hour); 245, 680 Salt: 1,350 (4-5 gal. per hour)			1,350 1,925 2,036 2,086 2,200 2,338		2,932
1,000 ft. S. of Haldimand anticline 0-800 ft. (about) = Battery Pt. 800 (about)-805 ft. = York Riv.	Fresh: 78 Salt: 141 600?			600 (2 to 5 gal. per day)	Gas: 90, 105, 240, 494 Oil: 141, 210, 278, 465, 494, 600	803
400+ ft. S. of anticline. Dips to S. 0-1,460 ft. = Cape Bon Ami 1,460-3,115 ft. = Cape Bon Ami or, Silurian-Devonian	Heavy flow at 36 ft. 56 Salt: 700; 1,883 2,230 (about)	Cape Bon Ami or older; Gas shows: 700, 1,883 2,230 (about)				3,115 (December, 1948)
300± ft. S. of Galt anticline. Dips 5° or less to S. 15 ft. drift. 0-1,240 ft. = York River 1,240-2,424 ft. = Grande Grève	Fresh: 63 (20 gal. per hr.); 360-368 (10 gal. pr hr.); 966 (10 gal. per hr.) 1,041-60 (45, then 10, gal.hr.) Salt: 1,282-84 (140, then 40, gal.hr.) 1,784 (20, then 13, gal. hr.) 2,074 (100 gal. hr.)	Gas: 1,027 1,282 1,466 1,992 Oil: 1,027 (trace) 1,460 (trace) 1,581 (4 gal. in 36 hr.)		1,027 (trace)		2,424
3,000± ft. S. of Galt anticline. Dips 15° S.E. 10 ft. drift. 0-1,940 ft. = York River 1,940-2,005 ft. = Igneous (sill?) 2,005-2,132 ft. = Grande Grève	Fresh: 140 (100 gals. pr. hr.) 160 (250 " 677 (50 " 830 (25 " 973 (5 " Salt: 1,933 (some) 1,965 (some) 2,036 (100 gals per hr.)	Gas: 2,036 (failed after 2 days)		1,765 (trace) 1865-75 (trace oil and gas)		2,132
3,000± ft. S. of Galt anticline. Dips 15° S.E. 10 ft. drift. 0-1,945 ft. = York River 1,945-2,000 ft. = Igneous (sill?) 2,000-2,390 ft. = Grande Grève	Fresh: 115-30 gals. per hr.) Salt: 1,973 (120 gals. per hr., then down to 15 gals)	Gas and Oil: 2,297½ (show)	Gas: 1,973 (in sill?) (a little)			2,390 + 4 (December, 1948)

TABLE 2. — SUMMARY OF WELLS

WELL (1) Name and Date	LOCATION	PRESENT CONDITION	ELEVATION Feet
IMPERIAL GASPÉ 1 C.P.L. 1947- (71)	Fletcher tp., east side Patch brook, approx. 5,000 ft. from the junction of Patch brook and York river	Standing (December, 1948)	About 900
CONTINENTAL GASPÉ 1 C.P.L. 1948- (72)	Galt tp., Block 42 W. side Galt brook 647 ft. N.17°E. of C.P.L.1	Drilling (December, 1948)	615

NOTES:

- (1) C.P.C. = Canada Petroleum Co.
 C.P.L. = Continental Petroleums
 E.C.C. = Eastern Canada Co.
 G.B.M. = Gaspé Bay Mining Co.
 G.O.C. = Gaspé Oil Co
 G.O.V. = Gaspé Oil Ventures
 I.O.C. = International Oil Co.
 M.P.G. = Minéraux et Pétroles de Gaspé (Cie)
 P.O.C. = Peninsular Oil Corp.
 P.O.T. = Petroleum Oil Trust
 W.R.M. = W. R. McMaster, drilling contractor

IN EASTERN GASPÉ — Continued

GEOLOGY	WATER	OIL SHOWS:(2) FORMATION, DEPTH (feet)				TOTAL DEPTH Feet
		G.G.	G.G.-Y.R. CONTACT	Y.R.	B.P.	
Near crest of dome on axis of Bald Mt. anticline. 15 ft. drift. Dips variable. Possibly Silurian from surface to present bottom	Fresh: 50 (20 gals. per hr.) 430 (180 gals. hr.) Salt: 703 (15-25 gals. per hr.) 1,000 (50 gals. per hr.) 1,210 - 17 (Strong flow)	(Silurian?) Gas: 4,711 (show)				6,360 (December, 1948)
Near top of dome on Mississippi anticline. 5 ft. drift. Well started near top of Grande Grève formation						311 (December, 1948)

Notes:

- (2) G.G. = Grande Grève formation
Y.R. = York River formation
B.P. = Battery Point formation
- (3) Letter, Secretary of I.O.C. to Commissioner of Crown Lands, Quebec
- (4) Diary of the late B. P. Patterson, Gaspé, driller

- July 15, July 17; 1, July 19; 2, July 23, August 3, August 7, August 21. (Maps Nos. 662, 664.)
- (23) P.O.T. 19.—1896: Bailed? 10 barrels amber oil, August 1, and, after being shot and cleaned, bailed $\frac{1}{2}$ barrel a day "for a time". Pumped for a few days after August 25 with yield $\frac{1}{2}$ barrel per day. (Maps Nos. 662, 664.)
1901: Pumped 18, May 22; May 28 to August 24, successive days except for holidays, as follows: 25, 250, 75, 25, 22, 40, 11, 5, 5, 5, 4, 2, 5, 3, 2, $\frac{1}{4}$, 2, 2, 6, 3, 2, 3, 2, 2, 0, 8, 3, 3, 3, $\frac{1}{4}$, 3, 3, 3, 3, $2\frac{1}{2}$, $2\frac{1}{2}$, $2\frac{1}{2}$, $2\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, 2, 2, 2, 3, 2, 3, 2 gallons a day for 17 days, 3, 2, 2, 2, 2, 2, 3, 2, 2, 0, 2; 4, August 28; 9, September 2, September 17; 5, September 21.
1902: Pumped $\frac{1}{2}$ to 1 gallon per day through September. (Maps Nos. 662, 664.)
- (24) P.O.T. 20.—1896: Bailed $\frac{1}{2}$ barrel in 24 hours after well was shot at 2,059 feet.
1901: Pumped almost daily from March 28 to August 24 with total yield of 1,001 gallons or daily average of 6.67 gallons; the first day's pumping yielded 40, the second 115, and the third 117; after an interval of three days the yield was 90, and the drop in yield was marked from that time on. No tests August 25-29; 10, August 30; 10, September 5; 10, September 21.
1902: Pumped April 2 to August 9 with total yield of 708; daily average generally 2 to 3; 2, April 21; 280, April 22; 7, April 28. Pumped September 1 to 13, averaging about 2 per day, with total yield of 29. Pumped September 22 to 27, averaging about 2 per day, with total yield of 13.
1903: Pumped 10, July 17; 247, July 18; 64, July 20; 65, July 21; 3, July 22.
1904: Pumped 2, May 30; 250, June 2; 60, June 4; 175, June 7; 40, June 8; 5, June 16; 10, June 18; 7, June 20; 10, June 21; 6, June 23; 10, June 24; 6, June 25. (Maps Nos. 662, 664.)
- (26) P.O.T. 22.—1897: Pumped "good show" April 5; $\frac{1}{2}$ barrel, April 22; 4 barrels, April 23; 1 barrel April 24, and well began to flow, so shut down; 1 barrel pumped and 3 barrels flowed then water pumped, April 26; 2 barrels, April 28; 3 barrels, April 29; 2 barrels, April 30; 1 barrel, May 3; $\frac{1}{2}$ barrel May 4; $1\frac{1}{2}$ barrels, May 8; 1 barrel, May 28; $2\frac{1}{2}$ barrels, May 29; 2 barrels, June 5; $1\frac{1}{2}$ barrels, June 12. Gaps in production caused by pumping difficulties due to depth and to wear by 'sand'.
1901: Pumped 600 gallons, June 1; 200, June 3. (Map No. 662.)
- (31) P.O.T. 27.—1897: Flowed three times (estimated total of 400 barrels) before being plugged; oil lost.
1898: Estimated 1,000 barrels, stored in tanks, destroyed by fire (P.O.T. 27 may not have been the source of all this oil).
1901: Pumped almost daily from April 5 to June 24, with total yield of $302\frac{1}{2}$ gallons, or daily average of about 5 gallons (mean, about 3 gallons); 9, June 28; 9, July 6; 8, July 12; 9, August 15.
1902: Pumped 192, June 18 - August 9; 29, September 1-13; $9\frac{1}{2}$, September 22-27.
1903: Pumped 5, July 21; 365, July 22; 75, July 23; 65, July 25.
1904: Pumped 6, May 27; 280; May 28; 90, May 31; 431, June 4-30; 85, July 7. (Maps Nos. 662, 664.)
- (35) P.O.T. 31.—1901: The pumping log gives the figure " $6\frac{1}{2}$ " for March 9 and March 15, and "2" for March 22. It is a question whether these figures refer to barrels (as interpreted by Eills) or to gallons. Pumped 258 gallons, March 27 - April 12; $37\frac{1}{2}$, April 19; 87, May 6; 20, May 7 - May 11; 13, May 15; $8\frac{1}{2}$, May 16 - May 17; 9, May 23; 16, June 25; 1, June 26; 1, July 6; 2, July 11. (Maps Nos. 662, 664.)
- (36) P.O.T. 32.—1899: 10 gallons per day "for a time".
1901: Pumped 10, March 22 and 26; 15, April 6; 10, April 13; 783, April 27 - August 23, or, about $6\frac{1}{2}$ gallons per day on the average; 20, August 30; 40; September 4; 30, September 12; 45,

- September 19; 20 September 21.
 1902: 54, September 1-13; 31, September 22-27.
 1903: 4, September 24.
 1904: 144, June 17-25 (15 the first day, 102, the second day, and 1, the last day). (Maps Nos. 662, 664.)
- (38) P.O.T. 34.— 1901: Pumped 10, March 16; 24, April 13; 38, April 20; 928, April 22 - August 22, or about 7½ gallons per day on the average; 12, August 27; 20 August 31; 40, September 3; 65, September 11; 50, September 18; 40, September 21.
 1902: 34, September 1-13; 26, September 22-27.
 1903: 2, July 22; 120, July 24. (Maps Nos. 662, 664.)
- (41) P.O.T. 37.— 1901: Bailed two barrels. (Maps No. 662.)
- (47) C.P.C. 1.— 1901: Pumped 320, June 25; 20, 15, 15, on June 26, 27, 28; 60, July 5; 45, July 8; 35, July 11; 10½, July 12; 10, July 13; 40, July 22; 220, July 26 - August 23; 20, August 29; 60, Sept. 5; 25, Sept. 13; 36, Sept. 20; 7, Sept. 21.
 1902: 75, May 22 - July 24; 10½, September 1-13; 2½, September 22-27. (Maps Nos. 662-664.)
- (48) C.P.C. 2.— 1901: 2½, June 25. (Maps Nos. 662, 664.)
- (49) C.P.C. 3.— 1899: 43, June 24; 1, June 26, 29, and July 6. (Maps Nos. 662, 664.)
- (51) C.P.C. 5.— 1900-01: Bailed ? about 3 barrels. (Maps Nos. 662, 664.)
- (53) C.P.C. 7.— 1900-01: Bailed ? 2 to 3 barrels. (Maps Nos. 663, 665.)
- (56) C.P.C. 10.— 1901: 20, July 6; 135, July 8. (Maps Nos. 662, 663, 664, 665.)

Some ten years elapsed after the Petroleum Oil Trust withdrew from eastern Gaspé before another drilling venture was undertaken in the region. Then, in 1913, the Eastern Canada Company drilled one well near Malbaie river, in Malbaie township. This is the most southerly by several miles of any well in the region, and it is the only one to the south of the Saint-Jean (John) River anticline. The results were entirely negative, and no further drilling was done until 1937.

In 1937-38, a well (61, map 662) was drilled on the north flank of the Northwest Arm syncline by the Minéraux et Pétroles de Gaspé company. The hole was carried to 342 feet depth in November and December, 1937, by churn drill, and was deepened to 842 feet by diamond drill in October, 1938. This well, and also that of the Eastern Canada Company, in Malbaie (61, map 665), were put down in the Battery Point formation. Neither well was favourably located with regard to structure.

The Imperial Oil Company has drilled two wells in this region. The first, or *Mississippi No. 1* well (62, map 662) (Plate XVI-A), drilled in 1939-40, was put down to the east of Dartmouth lake, in Larocque township. It was designed to test the lower part of the Gaspé limestone series on the Mississippi anticline. The second, or *Haldimand No. 1* (63, maps 663, 665) well, located in Douglas township and drilled in 1941-42, was designed to test the Gaspé Sandstone series on the Haldimand anticline. Both of these wells were located well down on the south flank of the fold structure being drilled. Neither gave encouraging results.

In 1943, Continental Petroleum, Limited, drilled their *C.P.L. No. 1* well (64, maps 662, 664) (Plate XVI-B) to a depth of 2,137 feet. The well was then plugged and left standing until 1946. In the latter half of 1946 and early 1947, efforts made to clear the hole and effect a water shut-off were attended by many difficulties. In particular, much trouble

was experienced when the first attempt was made to drill out the plugs and cuttings at about 2,100 feet. Shortly after this drilling commenced, gas pressure forced the tools upward and jammed them in the casing at 2,060 feet. The hole was at a depth of 2,728 feet on June 24, 1947. Operations were suspended on that date but were again renewed May 21, 1948, with intentions of going to greater depth. Much of the time between this latter date and August 18 was spent in an effort to improve the condition of the hole. These efforts were unsuccessful and on August 18 the hole was abandoned. The total depth is 2,751 feet, all within the Grande Grève formation. This well is located in Block 42, on the west side of Galt brook in the central part of the township of Galt.

On abandonment of *C.P.L. No. 1* (64, maps 662, 664) a new location was made 647 feet N.17°E., also on the west side of Galt brook. Drilling commenced at this location, *Continental Gaspé No. 1* (72, maps 662, 663) well, October 8, 1948. Operations were halted at a depth of 311 feet December 18, and resumed January 10, 1949. Like the adjacent *C.P.L. No. 1* this hole was being put down in the Grande Grève limestone on a domed structure on or near the axis of the Mississippi anticline.

In 1944-45, *C.P.L. No. 2* (65, maps 662, 664) was drilled at a point 113 feet east of the old *P.O.T. 20* (24, maps 662, 664). These wells are located on the east side of No. 21 brook shortly to the north of the York River road, in the eastern part of Larocque township. *C.P.L. No. 2*, penetrated 2,362 feet of York River strata, and 570 feet of Grande Grève, in its total depth of 2,932 feet. Oil shows were met with at several horizons in the York River formation and, for the first time in Gaspé, acidizing was resorted to in an attempt to increase the flow. On November 1st, 1944, the well had reached a depth of 2,556 feet, and on the 4th of that month it was acidized between 2,556 feet and 2,295 feet. Then the hole was bridged at 2,410 feet and, on November 7th, was acidized between 2,410 feet and 2,275 feet. On November 6th, eight gallons of oil were recovered, and subsequently, by bailing once a day between November 8th and December 6th, recoveries of from half a gallon to five and a half gallons were obtained. The daily average was two and a quarter gallons. A second acidizing test was made between December 11th, 1944, and January 12th, 1945, with the hole bridged at 2,398 feet. On January 13th, 70 gallons of oil were recovered; January 14th, a show of oil; January 15th, 50 gallons; January 16th to 19th, show of oil, some gas; January 20th, 3 gallons; January 25th, 5 gallons. From January 26th to February 5th, the best daily recovery was 8 gallons and the average was 3 gallons. Mechanical difficulties and corrosion of the tubing impaired the value of this acidizing test. The hole was cleared to 2,556 feet, drilling was resumed, and after many delays the hole was bottomed at 2,932 feet on June 23rd. Bailing tests made almost daily between February 14th and July 25th, gave a total production of 280 gallons, or about $1\frac{3}{4}$ gallons per day. The well was closed in August and September. It was acidized a third time in early October, and a fourth time in November. Production after the third acidizing from October 18th to November 5th averaged 3 gallons per day with a high of 5 gallons. After the fourth acidizing, production for the period December 4th to 19th averaged 2 gallons per day with a high of 4

gallons. On January 7th, after an interval of eighteen days, 49 gallons were bailed, and during the final testing period of January 1st to 16th, 1946, the daily average had dropped to about $1\frac{1}{2}$ gallons.

Imperial Gaspé No. 1 (71, map 661) (originally *Bald Mountain No. 1*), the third well of Continental Petroleum, Limited, is located on the east side of Patch brook approximately one mile north of York river, in the eastern part of Fletcher township. This well is near the crest of a domed structure on the axis of the Bald Mountain anticline. It was spudded August 6, 1947, and had reached a depth of 6,360 feet on October 27, 1948, when operations were suspended. Neither oil nor gas (except a slight show at 4,711 feet) was encountered in this drilling. The hole remained free from water after casing was set at 1,998 feet. The log of this well has not permitted definite correlations and although most of the section suggests the Silurian some younger rocks may be included as a result of faulting.

During 1944 and 1945, Mr. W. R. McMaster, drilling contractor of Caledonia, Ontario, held claims for oil and gas over an area including the *Conant* well (3, maps 663, 665) in Douglas township. In 1944, at intervals between May 19th and December 5th, he cleaned out the *Conant* well in the hope that, with modern methods, it might be made to produce commercially. As already pointed out, Mr. McMaster found that this well was at least 767 feet deep, and possibly 821 feet, rather than the 684 feet given in the old records. Wooden rods were found extending from the surface to about 270 feet, where there was a wooden plug. Other plugs were found at 440 and 636 feet. All three of the plugs were packed with sand and beans. Sand and beans were found also at 709 feet and, from 800 feet to 821 feet, considerable flax seed was present with the rock débris. From 711 feet to 821 feet, iron, probably from various fittings, was found in the hole. When the plug at 636 feet was removed, gas flowed at the rate of 20,000 cubic feet per day for about twenty minutes. Most of the oil in the hole comes from between 268 and 721 feet and it probably enters with a heavy flow of salt water. It was not possible to lower this water below 23 feet from the surface by bailing. On abandoning the hole it was sealed at 300 feet with a wooden plug, on top of which was poured 30 feet of mud and cement.

W. R. McMaster's *C2* well (66, maps 663, 665), 350 feet south of the *Conant*, was drilled in July-October, 1945, to a total depth of 805 feet. Shows of oil or gas, or of both, were encountered at several depths. The best was at 600 feet, with a production capacity of two to five gallons a day. On October 18th, after the well had been standing for twenty-one days, 45 gallons of oil were bailed. Four gallons were bailed on October 25th. On abandonment, plugs were set in this well at 245 to 260 feet and at 150, 125, and 78 feet.

The most westerly well of the region was spudded early in December, 1945, at a location in Holland township about 2,000 feet south of York River road and 9,000 feet west of the bridge over York river. This well, *P.O.C. No. 1* (67, map 661), is being drilled by the Peninsular Oil Corporation, with head office in Montreal. In June, 1946, it was at 465 feet. Due to mechanical difficulties and crooked hole, deepening was not resumed

until November 13th, from which time to the year end it was carried to a depth of 720 feet. At the end of 1947 the hole was at 2,257 feet. The rig was damaged by fire January 14, 1948, and no drilling was done that year until June 11. At the end of 1948 the hole had been deepened to 3,115 feet, with drilling continuing. Considerable interest is attached to this well in view of its westerly location and the low stratigraphic position of its surface location. The well was started in the upper part of the Cape Bon Ami formation, on or near the axis of an anticlinal fold. The rock penetrated was dark grey, shaly limestone to shale suggestive of the Cape Bon Ami formation except for a zone from 1,460 feet to 1,860 feet of greenish-grey and brown shales to siltstones.

A third company, Gaspé Oil Ventures, Limited, with head office in Montreal, has put down two wells and is drilling a third. *Venture No. 1* (68, map 662), is located on the east side of a headwater branch of D'Argent (Silver) brook in the eastern part of Galt township. Its structural location is on the crest of the Galt anticline. Drilling began here on May 8th, 1946, and was suspended May 28th, 1947, at a depth of 2,424 feet. The well passed through sandstone and shale beds of the York River formation from the surface to 1,240 feet, and from this depth to the bottom, or for 1,184 feet, limestone beds of the Grande Grève formation were penetrated. A little gas was met with at 1,027 feet, 1,282 feet, 1,466 feet, and 1,992 feet. Films of oil were noted at 1,027 feet and 1,466 feet. One other, and the best, oil show was at 1,581 feet, or approximately 350 feet below the top of the Grande Grève formation. In the only test of its volume this show gave 4 gallons of oil in 36 hours.

Venture No. 2 well (69, map 662) is located approximately one-half mile south of *Venture No. 1* (68, map 662), on the east side of the same headwater branch of D'Argent (Silver) brook. It was spudded October 1, 1947, and had reached a depth of 2,090 feet on December 13, 1947, when drilling was suspended. Operations were resumed January 19, 1948. Bad caving conditions coupled with non-recovery of tools lost in the hole led to abandonment in April, 1948, the depth being increased only to 2,132 feet. The geological log of this well essentially parallels that of *Venture No. 3* (70, map 662), outlined below.

When *Venture No. 2* well was abandoned the drilling rig was moved 50 feet S.40°E. and a new well *Venture No. 3* was started. Drilling commenced May 5, 1948, and was suspended December 17 of the same year at a depth of 2,399 feet. Geologically, this well is located on the south flank of the Galt anticline. Sandstone and shale beds of the York River formation were penetrated from the surface to 1,945 feet. From 1,945 to 2,000 feet the drill cut syenitic igneous rock, evidently a sill. The Grande Grève formation followed from 2,000 feet to 2,399 feet. Slight shows of gas were encountered at 1,970-77 feet, and a show of oil and gas with a slight flow of water at 2,297½ feet.

Sixty-five wells have been drilled in eastern Gaspé, fifty-eight prior to the year 1903. At two other wells, *C.P.L. No. 1* (64, maps 662, 664) and *Venture No. 1* (68, map 662), although all machinery has been removed, the respective companies report that operations have been suspended

only. Another two wells, *Imperial Gaspé No. 1* (71, map 661) and *Venture No. 3*, are standing, with drilling rigs on the sites. Two others, *P.O.C. No. 1* (67, maps 661) and *Continental Gaspé No. 1* (72, maps 662, 664), are actively being drilled at the present time (December, 1948).

Some thirty of the older wells reached the Grande Grève limestone, and of this number only thirteen penetrated 200 feet or more of that formation. *P.O.T. 24* (28, maps 663, 665), starting essentially at the York River-Grande Grève contact, went to a depth of 1,230 feet in the Grande Grève formation. This well was located well down the flank of the Saint-Jean (John) River anticline and the beds penetrated are open shortly to the south, or toward the crest of the structure. Thus, its location, for the depth penetrated, cannot be considered as favourable. Apart from this well, the greatest penetration of the Grande Grève, 757 feet, was achieved by *P.O.T. 11* (15, maps 662, 663, 664, 665). It is evident, therefore, that none of the older drilling can be considered to have tested the Grande Grève formation on a favourable structure or to a satisfactory depth. Of the more recent wells, *Mississippi No. 1* (62, map 662) penetrated the lower 1,200 feet or so of the Grande Grève before entering the Cape Bon Ami formation. However, the Grande Grève beds cut here probably are open within 3,000 feet to the north. Thus, the only wells that can be considered as providing tests of the Grande Grève are *Venture No. 1* (68, map 662) and *C.P.L. No. 1* (64, maps 662, 664), neither of which as yet has progressed through the upper half of the formation.

The Cape Bon Ami formation has been tested at one locality only, namely, by the *Mississippi No. 1* well (62, map 662), and is being tested at the present time by *P.O.C. No. 1* (67, map 661). No well as yet has penetrated to the reefy and generally petroliferous limestone zone or zones present in the Silurian-Devonian strata underlying the Cape Bon Ami formation. This was one of the objectives of *Imperial Gaspé No. 1* well (71, map 661), and although such a zone was expected above the present bottom of 6,355 feet it has not been recognized in the cuttings from this well.

The main objective of the older drilling in Gaspé, whether by design or by reason of mechanical limitations, was to test the Gaspé Sandstone series. This objective was realized adequately in certain sections, notably in the Mississippi Brook and D'Argent (Silver) Brook areas. In the former area, some twenty wells were concentrated in the southern half of block 40, Larocque township. In the latter area, eighteen wells were drilled. All of the twenty wells in the Mississippi Brook area and eight of the eighteen in the D'Argent (Silver) Brook area were located close to the York River synclinal axis. In addition, four wells drilled between these two areas, and four others drilled to the west and south of the Mississippi Brook area, were located within the area of influence of the York River syncline. Thus, thirty-six of the fifty-eight wells drilled prior to 1903, and comprising the great majority of the wells in the two main areas of drilling, were located in the York River synclinal structure. Such location, according to the anticlinal theory, is quite unfavourable to the chances of obtaining production. The fact that some oil was found in several of these wells may be considered an encouraging sign. Some half-dozen of

the wells in the D'Argent (Silver) Brook area were quite favourably located with relation to the Mississippi anticline. However, the beds tested, whether of the York River or the Grande Grève formation were open to the west along the axis of the fold, thus providing opportunity for any petroleum that may have been present to escape.

The wells *P.O.T. 23, 24, and 26*, (27, 28 and 30, maps 663, 665), located roughly midway between the York River syncline and Saint-Jean (John) River anticline, tested York River and Grande Grève beds which, however, were open to the south within short distances.

Eight of the fifty-eight wells drilled prior to 1903 were located in the coastal region. While the locations of six of these, and also of the more recent *C2* (W. R. McMaster) (66, maps 663, 665) and *Haldimand No. 1* (63, maps 663, 665) (Imperial Oil), were favourable in terms of the anti-clinal theory, it is doubtful if any of them, except possibly *Haldimand No. 1*, were drilled to sufficient depth, to penetrate closed horizons.

CONCLUSIONS

It is known from the 'shows' of oil in seepages and in wells that there is petroleum of good quality in this region. It has not yet been established that commercial deposits are present. The fact that sixty-five wells have been drilled without finding such deposits is not proof of their absence, because the wells cannot be considered as having tested all the possibilities. Few of the wells fulfilled the requirements of being favourably located in relation to anticlines and at the same time of having sufficient depth to test closed horizons. Judged on the basis of such requirements, the Battery Point formation has not been tested; the York River formation has been tested doubtfully or inconclusively on part of the Haldimand structure only; the Grande Grève formation is receiving its first tests by the current drilling; the Cape Bon Ami formation has been tested at only one locality (Mississippi No. 1) (62, map 662) and is being tested at another locality (P.O.C. No. 1) (67, map 661) at the present time; and the basal Devonian and the Silurian rocks have not been tested, and, in fact, have never been penetrated by the drill except in the *Imperial Gaspé No. 1* well (64, maps 662, 664).

The fact that the wells completed in recent years were failures, although located, in the main, with careful regard to the geology, is disappointing. However, the individual structures on which drilling was done are too large to be condemned by one failure or even by several failures, in view of experiences in other and eventually productive fields. The drilling results to date have shown that commercial deposits of petroleum are not present generally at shallow depths in this region. The fact that several of the wells did produce some oil in spite of unfavourable location, and the further fact that this production has come from any of three formations (Battery Point, York River, Grande Grève), may be considered encouraging.

From such general considerations as the ages and nature of the rocks of the region, and the nature of the folding, it must be concluded that in several localities, conditions are quite favourable to the accumulation and

retention of oil in commercial quantities, provided the initial source material was present. However, for reasons given below, it seems apparent that better chances for production rest in the Gaspé Limestone series than in the Gaspé Sandstone series.

RECOMMENDATIONS

The accompanying maps and cross-sections will serve to direct particular attention to localities that seem worthy of consideration by well-financed organizations experienced in exploration drilling. The following remarks are supplementary to the maps and sections.

The Battery Point and York River formations are particularly attractive from the viewpoint of petroleum production by reason of the alternating zones of shales and sandstones present in each. Pebble zones also are present in both formations, and small-pebble conglomerates are common in the Battery Point. However, it is difficult to point to locations in this region where these formations, and particularly the Battery Point, could be tested under conditions of outstandingly favourable structure and closure.

The Battery Point formation is restricted essentially to the coastal sections of the region, extending appreciable distances inland only in the Malbaie area. There is no apparent reason for testing this formation anywhere north of the Haldimand anticline, although this was done by *P.O.T. 9* (13, map 663) in the vertical to very steep beds in the valley of Stanley brook and to a shallow depth by the *Minéraux et Pétroles de Gaspé* well northeast of St-Majorique. It seems apparent that no closure of Battery Point horizons is effected on the Haldimand fold. However, this structure, which is complex and generally steep to the west of a line joining the *P.O.T. 1(5)*, *2(6)*, *3(12)*, the *Conant(3)*, and the *Haldimand No. 1(63)* wells, is reduced to a single fold about on that line and becomes a low, gentle fold to the east of it. It is reasonable to expect, therefore, that better chances of self-sealing or self-closure would prevail to the east, or towards Haldimand point, than along the line of wells mentioned above. The Tar Point anticline does not appear to offer opportunity for favourably testing the Battery Point formation. However, while this fold is pronounced in the shore cliffs, little is known of its projection inland, due to scarcity of outcrops. No strikingly favourable anticlinal structures are recognized in the wide expanse of this formation in Malbaie township. The possibility of favourable terrace structures is suggested by abrupt changes of strike and dip in several places between the Saint-Jean (John) and Malbaie rivers. This is particularly apparent on what could well be a major scale between the coast and the first major tributary of Malbaie river, in the northeastern part of Malbaie township. In the southeastern part of the township, steeply-dipping Battery Point beds are overlain by low-dipping Cannes-de-Roche beds, producing a pronounced angular unconformity. The Cannes-de-Roche formation occurs in four isolated patches, the largest of which has an area of seven to eight square miles. Inasmuch as this formation probably is little more than 300 feet thick, the possibility of oil being trapped at the unconformity at its base could be tested by shallow wells.

The York River formation is widely distributed in the region, but, for the most part, it occurs in synclinal structures. Opportunities for favourable well locations on known anticlines are relatively few. The Galt anticline, or elongated dome, offers opportunity for testing the lower part of the formation through horizons which, for 1,200 to 1,500 feet, appear to be closed. This zone already has been tested without success by *Venture No. 1(68)* well. Other tests on this structure probably are warranted. The remarks in regard to the Battery Point formation on the Haldimand anticline apply also to the York River formation. The succession of folds between the Haldimand anticline and the York River syncline, in north-eastern York township, offers possibilities of closure for roughly the lower half of the York River formation. A westward plunge for some of these structures is suggested, while, toward the east, an eastward plunge is virtually certain. The Tar Point anticline is clearly marked only on the shore. There is some suggestion in the shore section that the fold is plunging to the east, and eventually such a direction of plunge probably would show on this fold if it could be traced eastward. Also, a westward or inland plunge is suggested because the York River type of rocks appear to pass beneath Battery Point types in that direction. Thus, there is at least a good possibility that the Tar Point structure is a dome. In such case it offers an opportunity for testing perhaps most of the York River formation, with the probabilities favouring penetration of the Grande Grève at about 4,000 feet.

The upper Malbaie River area may offer structures favourable to the testing of the York River formation as well as a part of the Fortin series. In this area, the Fortin consists of alternating sandstones and limestones, with some shales. The folds here generally are sharper than is usual in eastern Gaspé and, normally, closure does not appear to be present. However, closure may have been effected by some of the numerous faults. This is an area in which more and detailed work is required to check the interpretations presented by the accompanying maps.

Apart from the possibilities in the region of the upper Malbaie river, the Fortin series does not display recognizable structures on which drilling opportunities could be classed as favourable. The larger structures have been masked by a prevailing strong cleavage and by general and sharp drag-folding. Nevertheless, the belt underlain by this series should not be discounted completely. The Fortin series is known to overlie the Grande Grève unconformably in some localities. In many places, and perhaps generally, the basal member of the series is a conglomerate up to fifteen feet thick. Coincidence of the unconformity and the basal Fortin conglomerate with sufficient cover and with anticlinals could produce situations eminently favourable to the accumulation of petroleum. The Joncas dome, prior to erosion of the Fortin series cover, would be a case in point. Recognition of this dome might not have been possible without the factor of formation distribution, that is, without the presence and exposure of the Grande Grève formation on the crest. Similar structures may be present elsewhere in the belt underlain by the Fortin series.

The Joncas dome appears to offer opportunities for testing the Grande Grève and older formations under conditions as favourable as any in eastern

Gaspé. The structure actually is double, consisting of two elongated domes separated by a narrow syncline. The southern dome is the major of the two up-folds. Closure in the southern dome would be effected at about 1,000 feet below the top of the Grande Grève, and in the northern dome at about 500 feet. The thicknesses of the Grande Grève and older formations under the Joncas dome must be inferred from sections on the flanks of the major syncline in which the dome occurs. Thus, to the south, the Grande Grève is about 2,500 feet thick and to the north about 3,000 feet. Under the dome, therefore, the thickness probably would be close to the average of these figures, or 2,700 to 2,800 feet. The thickness and even the nature of the Cape Bon Ami formation on this structure is more difficult to predict. To the south, the Cape Bon Ami is estimated to be 6,000 feet thick on the bases of dips and width of exposure, or 2,000 feet thicker than to the north of the dome. The increase of thickness in the southern section has resulted from the introduction of sandstones, shales, and conglomerates to the shaly and magnesian limestones which generally comprise the bulk of the formation. If these clastic beds extend under the Joncas structure, the number of potential reservoir rocks would be increased. The possible general section under the Joncas dome would include 2,000 feet of Grande Grève underlain by 5,000 feet of Cape Bon Ami. This structure is worthy of a programme embracing the drilling of several wells, all of which would test the Grande Grève and Cape Bon Ami. In addition, at least one well should be planned to test the possibilities of the Silurian-Devonian section underlying the Cape Bon Ami formation and in which other clastics, including conglomerates, possibly occur.

As already pointed out, the Tar Point anticline offers possibility of penetration of the Grande Grève formation at about 4,000 feet from the surface. Similarly, the Grande Grève could be tested on possibly domed structures under a cover of York River strata in the succession of folds southwest of the main Haldimand anticlinal fold in the northeastern corner of York township. This and the Tar Point areas would seem to lend themselves to geophysical exploration in view of the sharp change in lithology at the Grande Grève-York River contact.

The Grande Grève and probably the Cape Bon Ami formations could be tested on the extension of the Haldimand anticline shortly to the northwest of Gaspé village. Here, in a relatively high ridge, the Grande Grève comes to the surface on a section of the fold that is obviously an elongated dome (sometimes referred to as the 'Hay Creek' structure). This dome has been broken on its northeastern flank by the Northwest Arm fault. The fault is interpreted here as a steep-angle thrust, but possibly it is a normal fault with downthrow on the northeast side. In either event, it is not likely that the break would interfere with tests of the Grande Grève and Cape Bon Ami formations if locations were made near the crest of the dome but on its southwest flank. It is probable that some 3,000 feet of Grande Grève overlies the Cape Bon Ami under the crest of the dome.

The Galt anticline, another elongated dome, offers possibilities for testing the pre-York River formations under a minimum cover of 1,200 feet of York River sandstones and shales. *Venture No. 1* well (68), with loca-

tion apparently close to the high point of the dome, suspended operations after penetrating the upper half, or less, of the formation. No direct measurement of the thickness of the Grande Grève or Cape Bon Ami formations has been possible on this structure. However, it is probable that each is about 3,000 feet thick. This estimate is based on an assumed regular rate of thickness increase from north to south between the northern edge of the Gaspé synclinerium to the north and the Mississippi anticline to the south. If such estimates are correct, the minimum drilling required to reach the Silurian-Devonian zone underlying the Cape Bon Ami formation on the Galt dome would be about 7,500 feet.

On the Mississippi anticline, opportunities for testing the Grande Grève formation under closure appear to be most favourable where this structure crosses Galt brook. Here a dome is developed and closure is effective to within a few hundred feet of the top of the formation. *C.P.L. No. 1* well (64) and *Continental Gaspé No. 1* are located on this dome. The former penetrated 2,751 feet of the Grande Grève formation before being abandoned. It is assumed that the drill here would penetrate the Cape Bon Ami at about 4,000 feet. An additional minimum of 3,000 feet would be required to penetrate the Silurian-Devonian zone underlying the Cape Bon Ami. Westward from Mississippi brook for several miles, the anticlinal offers some possibilities of a flat plunge, if not of local doming, and may offer favourable locations for wells designed to test the lower 2,000 feet of the Grande Grève, the Cape Bon Ami formation, and, at depths probably in excess of 6,000 feet, the Silurian-Devonian horizons.

The Cape Bon Ami formation comes to the surface in such fashion as to outline an elongated dome on the south flank of the Mississippi anticline and crossing Mississippi brook in the central part of Larocque township. Thrust faults are mapped as paralleling the dome axis shortly to the north of that structure, and these may mar its possibilities. However, if these thrusts are no more prominent than interpreted on the accompanying cross-sections, this dome offers good opportunities for testing most of the Cape Bon Ami formation. Also, it is probable that the underlying Silurian-Devonian zone would be reached by the drill at about 4,000 feet.

The Bald Mountain anticline is worthy of consideration, particularly with a view to testing the Cape Bon Ami and underlying formations. Domed structures have developed on this anticlinal where it crosses Patch brook in the eastern part of Fletcher township, and on Holland brook and to the south of York Lake in Holland township. While the strata are poorly exposed on the crest of the Patch Brook dome, it is evident that they cannot be referred to a stratigraphic horizon above the lower half of the Cape Bon Ami formation, and it seems more likely that they belong to the Silurian-Devonian sequence underlying the Cape Bon Ami. As pointed out above, *Imperial Gaspé No. 1* well has tested this structure to a depth of 6,360 feet without encouraging results.

Farther to the west, the Holland Brook dome begins and is traceable westward from the Holland-Fletcher line for a distance of eight miles. Only the uppermost few hundred feet of the Cape Bon Ami formation are exposed on the crest of this structure, except where erosion has failed to

remove thin coverings of Grande Grève. In other words, most of the Cape Bon Ami formation can be tested on this structure, under closure, without drilling through any of the Grande Grève formation. A second elongated dome, also traceable for about eight miles, branches from the eastern part of the Holland Brook structure and then continues south of and sub-parallel to that structure as far as the western border of Holland township. This dome also favours testing of the Cape Bon Ami and older formations. *P.O.C. No. 1* well, (47, maps 662, 664), located shortly to the south of the axis of this structure, started near the top of the Cape Bon Ami formation. The thickness of the Cape Bon Ami under these structures is estimated to be about 3,000 feet.

The structures referred to above are those that appear to be most favourable to the accumulation of oil according to the anticlinal theory. In addition, favourable locations for testing certain of the formations can be visualized along several of the faults as mapped in this region. For example, the suggested conditions on the north side of the overthrust fault on the north flank of the Saint-Jean (John) River anticline appear to place closed Cape Bon Ami and underlying Silurian-Devonian formations within reasonable reach of the drill. While faults are breaks or fractures and may provide means of escape of petroleum, they may become sealed before such escape is complete. Also, the shift of formations along fault planes actually may provide a seal or closure for a petroliferous horizon which was lacking prior to faulting.

Again, petroleum deposits may be trapped in lenses within formations under such conditions that there is no structural clue to their presence. This probably is the explanation of the petroleum occurrences in such an unlikely structural locality as the Mississippi Brook area of the older drilling in Gaspé. It is possible, too, that some of the occurrences of petroleum noted in wells in generally unfavourable synclinal basins may have come from terrace structures. Such structures may be more frequent than supposed in view of the wide areas in this region where exposures are few. Finally, petroleum may be sealed or trapped in certain horizons against such dykes as that of Tar point.

Most of the areas or structures which have been recommended above would involve drilling to depths generally greater than any yet attempted in Gaspé. The deepest wells drilled to date, on which costs have been reported, are the Mississippi No. 1 (62) (5,995 feet) and Haldimand No. 1, (63) (4,779 feet). The former, drilled in the Gaspé Limestones, cost approximately \$65,000 for actual drilling operations, while the latter, drilled in the Gaspé Sandstones, cost about \$55,000. Costs have increased since these wells were drilled. It is obvious, therefore that drilling programmes designed to test this region adequately could be undertaken only by organizations prepared and able to spend and to risk large sums of money with no guarantee of return. Expenditures of the order of, and in some instances considerably greater than, those envisaged as possibly necessary to prove this region one way or another have been incurred in other regions before they were developed as producing fields, or, in many instances, before they were abandoned as barren.



Percé: Percé Rock, The Three Sisters, The Peak of Dawn. Looking southeast. (La Cie Aérienne Franco-Canadienne photo).

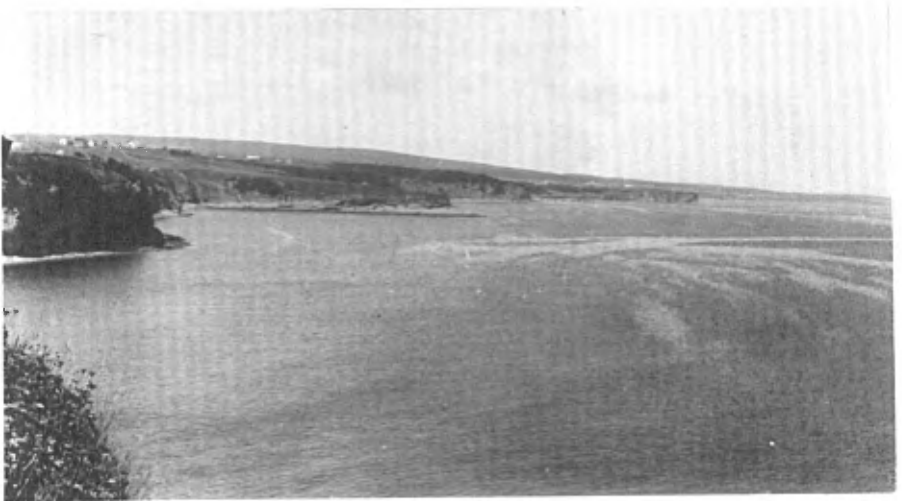
Plate III



A.—Looking east from Gaspé village over Gaspé bay.
Hills in background underlain by Grande Grève limestone.



B.—Gaspé bay, a natural harbour for ocean-going ships. Looking northeast.



C.—Southern side of Gaspé bay, looking northwest from Whale Head.

Plate IV



A.—Northwesterly view across Malbaie barachois from near Corner-of-the-Beach. Portage River valley at extreme left; Malbaie River valley at extreme right.



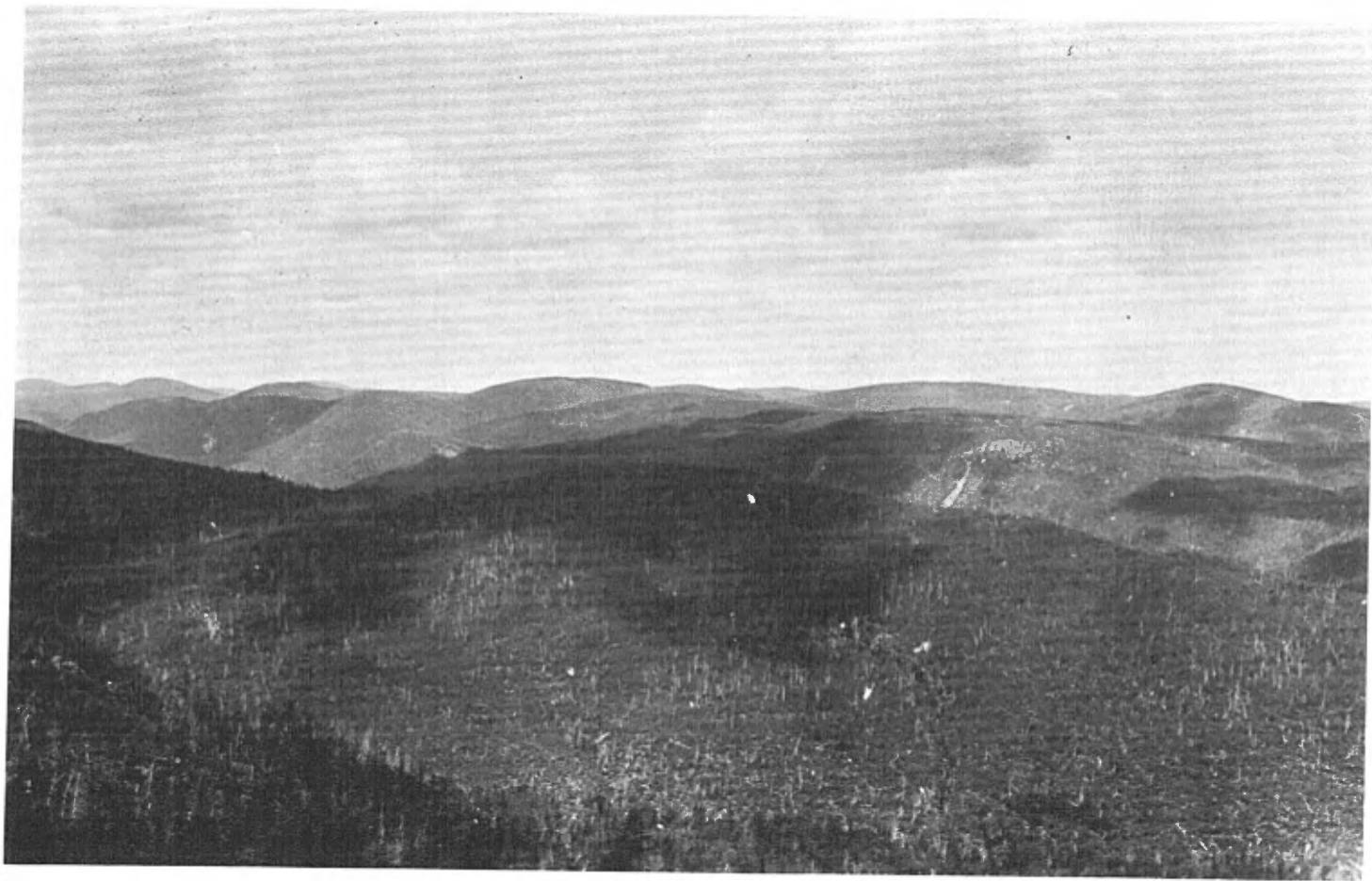
B.—Grande Grève limestone hills northwest of Gaspé village. Looking northwest along the front of the hills.



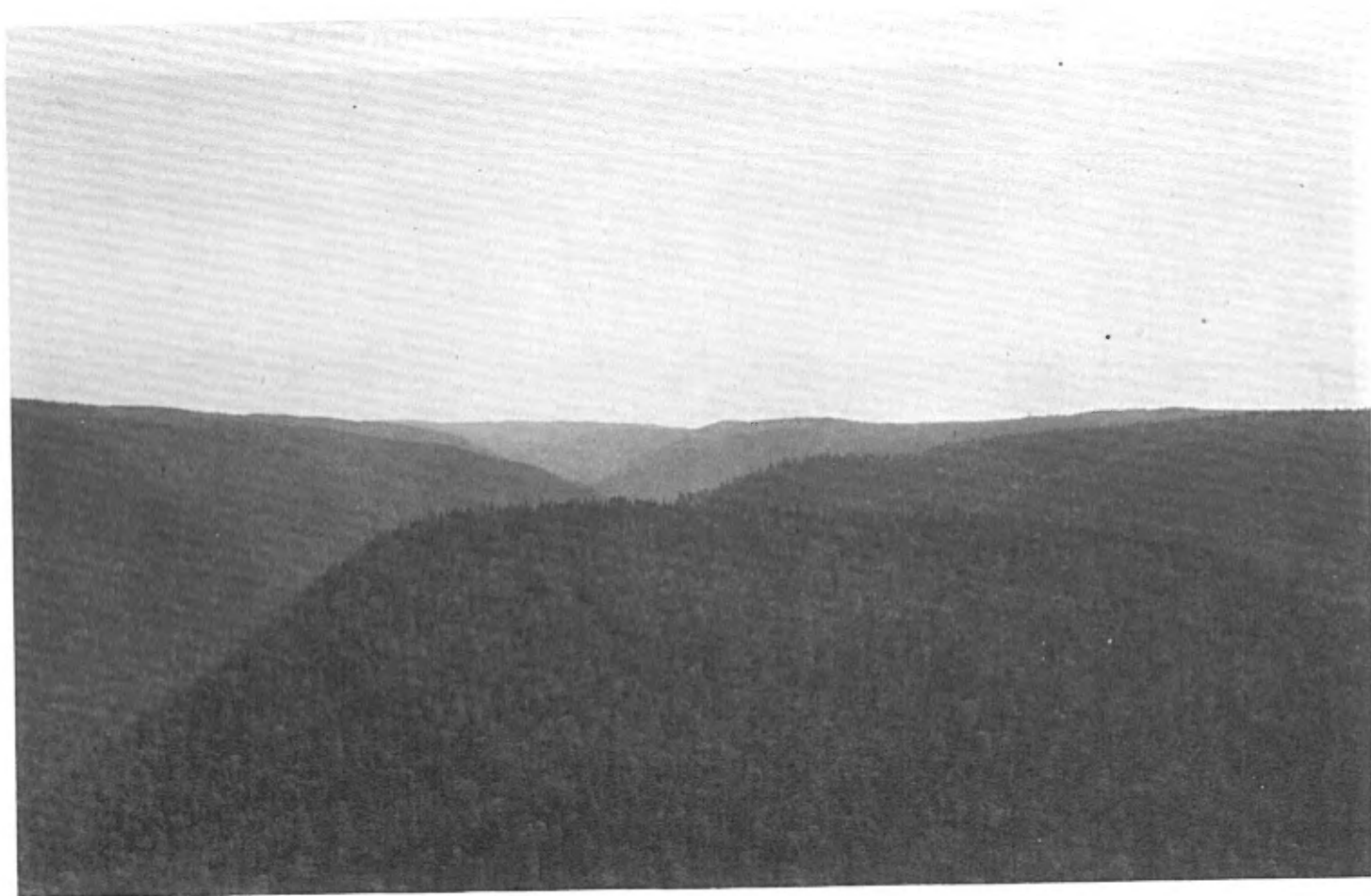
C.—Idem, looking southwest across the Northwest arm (Dartmouth river) to the front of the hills.



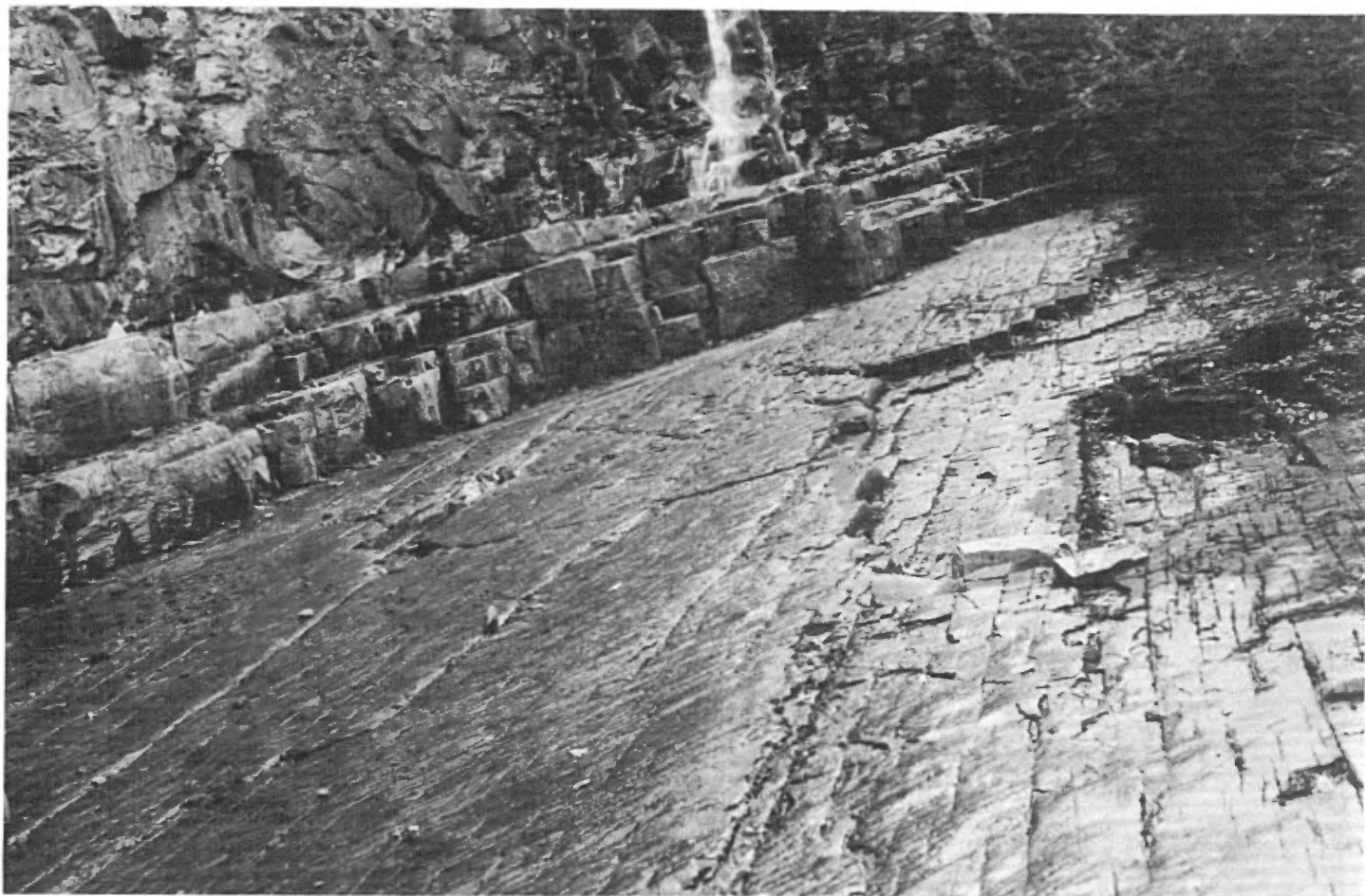
Southerly view from north bank of Saint-Jean (John) river; Grande Grève limestone ridges cut through by Wooden Bottom brook — Big Fork of Saint-Jean (John).



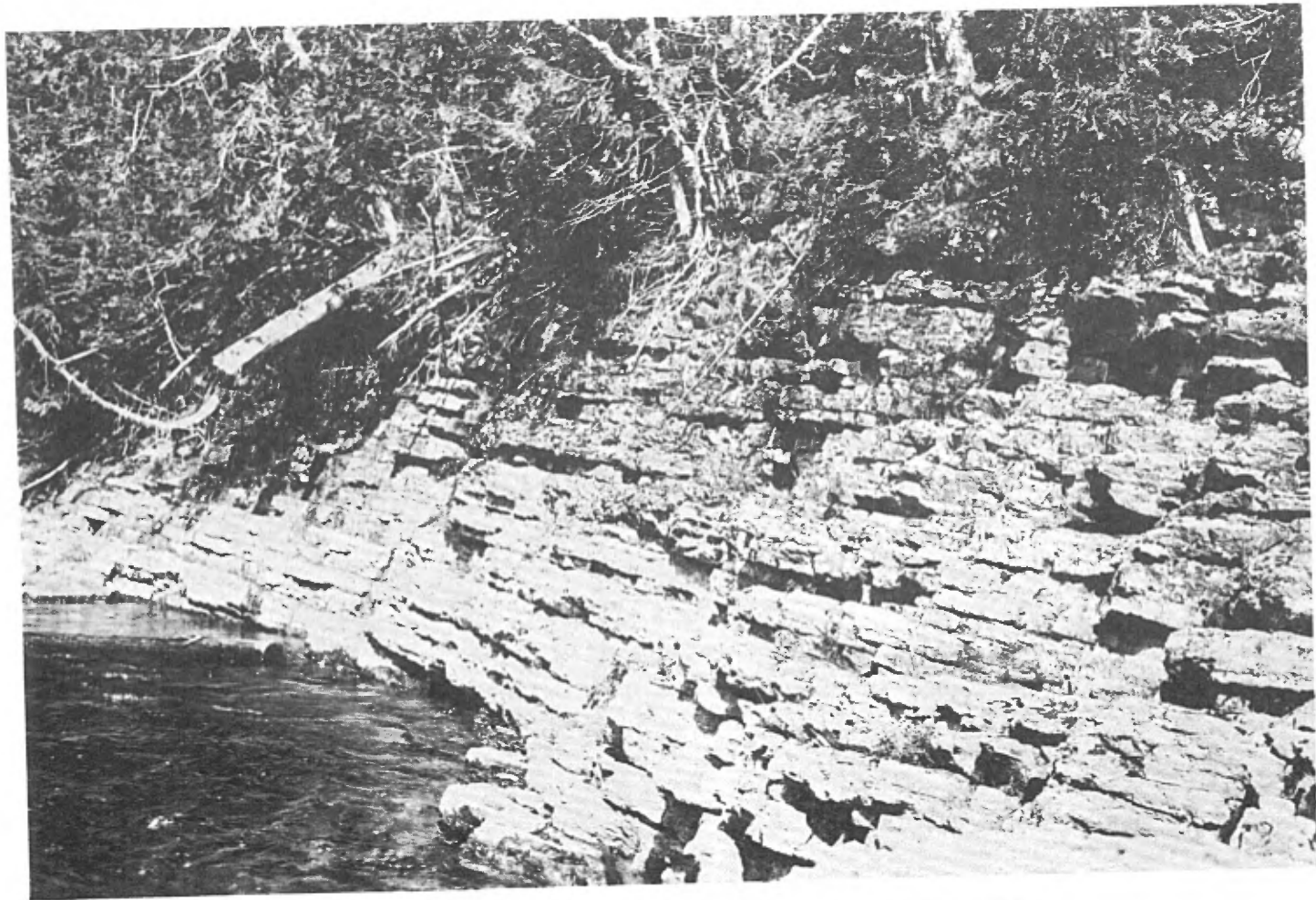
A portion of the Gaspé upland. Northwesterly view from top of cliffs between Burnt Jam and Porcupine brooks, Baillargeon township. Saint-Jean (John) river lies behind the rounded hills in the foreground.



Valley of the West branch of Grande river, sunk into the Gaspé upland. Looking west.

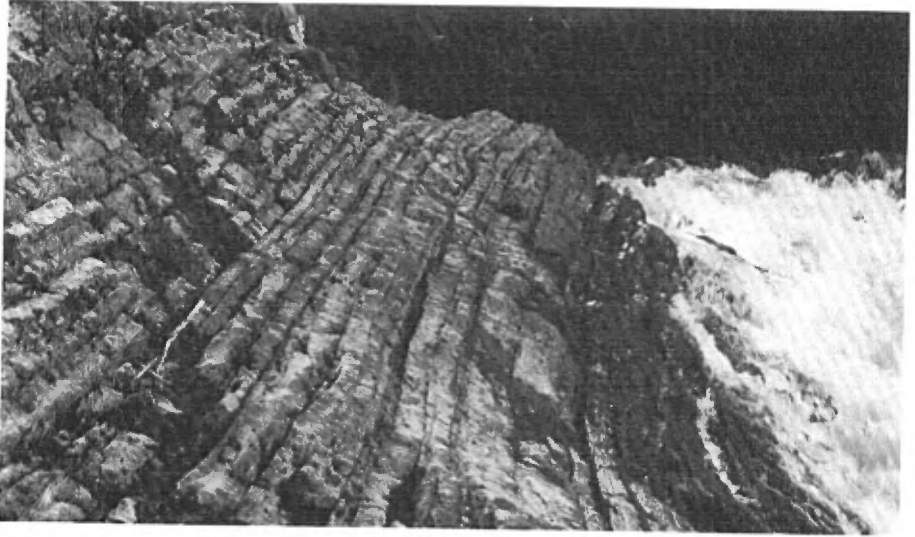


Cape Bon Ami limestone. Brook flowing west to Little Fork of Saint-Jean (John) river, York township.



Grande Grève limestones at Maitland's pool, Saint-Jean (John) river, Baillargeon township.

Plate X



A.—Grande Grève limestone near mouth of brook flowing west into North branch of Grande river; Joncas township, just south of median line.



B.—Grande Grève limestone on Mississippi brook near Villeneuve brook, Larocque township.

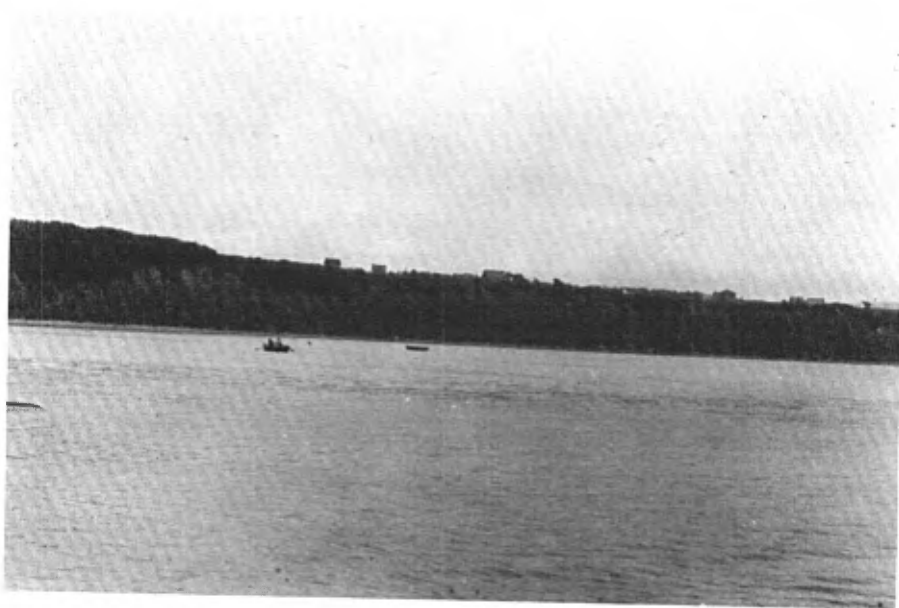


Basal conglomerate, Fortin series. Baillargeon township, about one mile north of the Joncas line, on Wooden Bottom brook.

Plate XII



A.—York River sandstones and shales on Wooden Bottom brook; near base of formation.



B.—Battery Point beds on Gaspé bay shore just north of cape Rouge.

Plate XIII



A.—Fault cutting Battery Point beds near top of formation at point St-Georges (cape Jaune).



B.—Malbaie beds in front of Barachois village.

Plate XIV



A.—Conglomerate bed in Malbaie formation. Near Beaton's salmon pool on Malbaie river.



B.—Cannes-de-Roche conglomerate at type locality of the formation.



A.—Cannes-de-Roche beds, part of the middle member of the formation at the type locality. The steep dip results from faulting.



B.—Unconformity between the Cannes-de-Roche and Battery Point formations; about three-quarters of a mile below the falls on Portage river.

Plate XVI.—Oil-well drilling operations:



A.—Mississippi No. 1 well.



B.—C.P.L. No. 1 well; southerly view down the valley of Galt brook.

Plate XVII.—Old wells from which oil can be bailed:



A.—P.O.T. 20.



B.—P.O.T. 31.



C.—P.O.T. 42.

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