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STRATIGRAPHY OF THE GASPE LIMESTONE SERIES: FORILLON PENINSULA (CANTON DE CAP-DES-ROSIERS, COMTE DE GASPE-SUD)

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GASPÉ LIMESTONE SERIES

FORILLON PENINSULA

Loris S. Russell

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Geological Exploration Service

Stratigraphy of the Gaspé Limestone Series,
Forillon Peninsula, Cap-des-Rosiers Township;
a description made in 1947.

by

Loris S. Russell

Editor's Note

This report, based on field work done in 1946, was completed by Dr. Russell in 1947. Even though never published till now, the manuscript has been made available to several workers over the years, and has been used as a basic reference to the stratigraphy of the Gaspé Limestones. In particular, the lithostratigraphic members named and defined here have been used as the framework for subsequent descriptions and revisions of much of the Devonian stratigraphy of eastern Gaspé. It is therefore felt that the report should be made public, even at this late date, as an essential reference work.

Since it would be impossible to bring the report up to date without falsifying its value as an original reference, the English text is presented as written in 1947 except for very minor language editing. No attempt has been made to bring lithologic descriptions or geologic interpretations into conformity with the results of more recent investigations, nor stratigraphic and geographic terminology into conformity with current usage. The present official versions of geographic names are given in footnotes where necessary.

W.B. Skidmore

April, 1976.

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INTRODUCTION

Purpose of the investigation. The Palaeozoic strata of the Gaspé were studied by the early workers almost exclusively in the vicinity of the coast. From these studies the systematic classification of the sediments was established. Within recent years detailed geological investigations have been extended into the interior, both by the Geological Survey of Canada, and by the Quebec Department of Mines. Attempts to apply the stratal subdivisions based upon the coastal sections to these interior areas have brought to light certain discrepancies. This situation became most notable in the case of the Lower Devonian rocks, which are commonly grouped together under Logan's designation of Gaspé limestones. Thicknesses of the various constituent formations appeared to be much greater inland than along the coast, and even the details of the succession seemed to differ considerably. Under these circumstances a re-examination of the coastal sections seemed required, so that data derived from them would be at least as detailed and as well established as those based upon the interior.

The finest exposure of the Gaspé limestone series, both for completeness and accessibility, is on the coast of the Forillon peninsula. It was here that the series was measured and recorded in 1843 by Logan. Although many geologists have examined the section since that time, none had carried the stratigraphy to greater detail than that reached by the first worker. The question therefore as to the nature of the discrepancies between Logan's Forillon

section and those more recently established in the interior, could only be settled by a new examination of the Forillon. This task was assigned to the writer for the field season of 1946. It was proposed that the entire section of the Gaspé limestone series in this area should be studied in detail, the sequence of the strata established, the natural divisions of the series delimited, and the thicknesses accurately determined. It was also hoped that additional fossil collections would be made, to permit more definitive correlation, especially of the lower and upper limits. It was further suggested that if time permitted, an examination of other sections of the Gaspé limestone series farther inland should be made. From the data so obtained it was hoped that criteria for the subdivision of the interior sections could be derived, and that the discrepancies might in part be eliminated.

As a result of the field work carried out by the writer, the detailed sequence of the Gaspé limestone series on the Forillon peninsula is now definitely established, and accurate thicknesses for the various subdivisions are available. However, the writer's results have largely tended to confirm the accuracy of Logan's observations. The various members defined by that worker are clearly recognizable, and thicknesses that he determined are in most cases good approximations. The hope that the writer's studies would eliminate most of the discrepancies between the Forillon and the inland sections has not been realized. Nevertheless, the establishment of the Forillon section on a firm basis represents a distinct step forward. Future work elsewhere in Gaspé on Lower Devonian rocks can be directed towards the recognition of criteria established on the Forillon, and, where these are not applicable, towards the interpretation of the **differences**.

Description of the area. The Forillon peninsula is one of the two most easterly extremities of the Gaspé peninsula, the other being Point St. Peter,^{*} about 8 miles to the south. The Forillon also forms the northeastern side of the entrance to Gaspé bay. Its extremity, Cape Gaspé, is taken as the official end of the St. Lawrence river. The peninsula itself is a long narrow strip of land, about 5½ miles in length, and varying in width from 1 to ½ mile. Its long axis is directed approximately northwest-southeast. As picturesquely suggested by Clarke (1908, p. 22) it resembles the index finger of a hand pointing into the Gulf of St. Lawrence. Clarke himself was responsible for reviving the name Forillon, which is an antique French designation, not used by the present inhabitants.^{**}

On the northeast or St. Lawrence side the Forillon may be considered to begin at the southern end of the settlement^{**} at Cap des Rosiers Est. At this point the low sea-cliffs and wide beach give place to cliffs 100 feet or more in height, bordered by a rather narrow beach. About 3,250 feet from the beginning of the high cliffs there is a conspicuous vertical diabase dyke, which forms a good landmark. Beyond this the beach soon gives place to shelving rock ledges, and it becomes impossible to continue on foot except during very low tide. The high cliffs terminate at a striking rocky promontory, formed of dipping limestone strata. In Logan's day the locality was known as the Petit Portage. Clarke referred to it as the Quay. In the present report it is called the Quay rock.^{***} Local inhabitants know it as Garland's Camp, after the present owner.^{**}

* Point Saint-Pierre (ed., 1975).

** The area now forms part of the Forillon National Park. There are no inhabitants. Some of the roads mentioned in the text are closed to vehicles. (ed., 1975).

*** Le Quai (ed., 1975).

Beyond the Quay rock are two more beaches, the first readily accessible, the second* reached only by clambering around a limestone promontory. From here the coast follows a sweeping curve, cutting deeper into the Forillon peninsula than at any other point. Beaches are narrow and interrupted, and the cliffs rise sheer. This portion of the shore is almost inaccessible and is best examined by means of a boat. The curve of the coast then gradually swings back towards the northeast, culminating in Cap Bon Ami, a double promontory formed by limestone masses similar to those at Quay rock. Back of the extremities of the cape, and the intervening beach, is a wooded terrace, from which the land surface sweeps upward to a steep cliff. Cap Bon Ami can be reached overland from Grande Grève, but only at the expense of a stiff climb. The best approach is by water, but care should be taken to avoid being caught along this coast by a northeast wind.

From Cap Bon Ami to the extremities of the peninsula at Cape Gaspé the appearance of the coast is most impressive. The sheer precipices (the continuation of those of Mount St. Alban** and the cove west of Cap Bon Ami) form a great wall of limestone rising to heights of over 600 feet. Although the general trend of the coast is nearly straight, the cliffs consist of a series of prominences and re-entrants. In the foreshortened view of an observer on Cap Bon Ami, they seem like the prows of great ships thrusting into the St. Lawrence. The beach is usually wide, except where buried beneath the tumbled blocks of a rock fall. Even here it is possible to continue on foot, so that for a distance of about two miles beyond Cap Bon Ami the coast is suitable for foot traverse.

* Now easily accessible at low tide (ed., 1975).

** Mount Saint-Alban (ed., 1975).

Towards the end of this portion is located the area frequented by seals (Phoca vitulina concolor). This small colony is a valuable tourist attraction, and should receive more rigid protection. Finally the beach comes to an end, and for 1.3 miles the sea cliffs fall directly into the water.

The extremity of the Forillon is truncated almost at right angles to its long axis. Cape Gaspé, therefore, is not actually a point of land, but two points, with an intervening stretch of re-entrants and promontories. The northeast corner of the cape, which can be reached only at low tide, is marked by an irregular limestone pillar known locally as La Vieille. This is not the same as the mass to which that name was formerly applied (see Logan, 1846, p. 33). From this point the cliff rim descends obliquely, following the plane of the strata, to reach a point about 25 feet above the shore, where a small stream bed terminates. This marks the end of the longitudinal valley that extends the length of the Forillon. The remainder of the cape is formed by a triangular cliff, at the apex of which the Cape Gaspé lighthouse is situated. Below is a wide beach of gravel, which can be reached by a devious path from the lighthouse, and from which the cliffs to northeast and to southwest are accessible at low tide. The section exposed here is highly variegated, displaying portions of the rock sequence not seen elsewhere on the peninsula. The name Shiphead, commonly applied to this part of the coast, is sometimes used as a synonym of Cape Gaspé, sometimes applied only to the northeast corner.

Rounding the southwest corner of Cape Gaspé, one looks along the Gaspé Bay side of the peninsula. Although formed as a succession of cliffs and coves, the nature of this coast is very different from that of the northeast side. The strata dip, not inland, but

towards the sea, and the cliffs are lower, with shelving ledges of rock. The land surface above the cliffs is gently to steeply sloping, but with a soil mantle that supports small-scale farming. This fact, together with the accessibility of the beaches, accounts for an almost continuous line of settlement* from Cape Gaspé to Little Gaspé, the focal points being the coves at Indian Cove (Anse Sauvage) and Grande Grève. Although the cliffs can be examined at many points, sometimes with the aid of the fisherman's ladder, it is not possible to traverse any considerable portion on foot. However, the road which clings to the slope above is suitable for automobile travel from Little Gaspé almost to Cape Gaspé*, although too narrow in many stretches for two vehicles to pass. Numerous small outcrops occur along this road, and it makes a convenient approach to the cliffs.

With regard to the interior of the peninsula, the presence of a continuous longitudinal valley has already been mentioned. The Forillon, in fact, consists of two almost continuous ridges, separated by this valley. Each ridge has a steep northeastern slope, truncating the strata, and a relatively gentle southwestern slope, following the bedding planes. In the case of the northeastern ridge, the sea cliffs form the steep side. The longitudinal valley is formed by the gentle slope of the northeastern ridge, and the steep slope of the southwestern. Small streams, such as Dolbel brook, break through the southwestern ridge in places, and the northeastern is partly cut away by the deep indentation of the coast immediately west of Cap Bon Ami.

Although Mount St. Alban is not strictly part of the Forillon, it lies at the base of the peninsula, and dominates the area between

* See ** p. 3.

Cap des Rosiers and Cap Bon Ami. Mount St. Alban is the continuation of the northeastern ridge of the Forillon, and similarly has an escarpment-like northeastern face, and a relatively gentle southwestern slope. However, it rises, not from the shore, but from a beach itself several hundred feet above sea level. Elevations of over 900 feet are recorded at the summit of Mount St. Alban.

Roads are few on the Forillon peninsula. The main road, from Little Gaspé to the extremity, has already been mentioned. It is well constructed and maintained, but beyond Indian Cove it is narrow. The last 200 yards, leading up to the Cape Gaspé lighthouse, is not suitable for automobile travel.* Another road crosses the base of the peninsula from near Grande Grève to Cap des Rosiers. Clarke (1908) repeatedly mentions this under the name of the King's Road. Local inhabitants say that this name properly applied to the road to Cape Gaspé. The road across the peninsula is referred to as the Cap des Rosiers road, or simply, the Cape road.** It may be used by automobile* from Grande Grève past Dolbel brook, and up the long slope of the northeastern ridge, but at the summit it descends abruptly and obliquely down the southeastern end of Mount St. Alban to the vicinity of the Quay rock. Not only the steepness, but also the narrowness of this road and the presence of loose rock on the surface, make it too dangerous to be attempted by automobile. Before the construction of the Roncelles road it was the only link between the St. Lawrence and Gaspé Bay sides east of Griffon Cove. From the summit of this road a magnificent view can be obtained of Mount St. Alban, Cap des Rosiers, and the vicinity of the Quay rock.

Previous work. The Paleozoic rocks of eastern Gaspé were among the first strata in Canada to be studied by Sir William Logan

* See ** p. 3.

** chemin du Cap (ed., 1975).

after his appointment as geologist to the Canadian government. In May, 1843, Logan landed at Halifax, after spending the winter in England. Travelling overland, he stopped to examine the already famous Joggins section, and then continued with minor pauses to the vicinity of Gaspé bay. Providing himself with the necessary assistance, he began a detailed examination of the coast, from "Cape Rosier" on the north to Paspébiac on the south, that is almost the entire east and southeast coast of the Gaspé peninsula. In his first official report (Logan, 1845), he reserves the detailed description of the formations to be incorporated with the results of his 1844 field season, but gives a summary of the general succession. This, in ascending order, is described as consisting of: (1) grey limestones, and grey and black shales, much contorted (Ordovician and Silurian formations of the modern stratigraphy), (2) grey limestones, limestone shales, and greenish shales (Gaspé limestones and calcareous shales of 1846), (3) grey, greenish or red sandstones (Gaspé sandstones of 1846), (4) conglomerates with red sandstone matrix (Bonaventure and equivalent formations).

In 1844 Logan returned to Gaspé with his assistant Alexander Murray. Starting at Cap des Rosiers, he continued his coastal survey up the St. Lawrence river to Cap Chat. Here he turned inland, ascended the Cap Chat river, and crossed the divide on foot. Building new canoes, he descended the Cascapédia river to Chaleur bay,^{*} and continued eastward along this bay to Paspébiac. Thus, in two seasons, Logan circumscribed by geological traverses the greater part of the Gaspé peninsula. The combined results of this field work appeared in his report of progress for 1844 (Logan, 1846), in which his stratigraphic observations were given under the heading

* Chaleurs Bay (ed., 1975).

of "Succession and distribution of the rocks of the district". After describing the older rocks, among which one can recognize the Ordovician Cape Rosier formation of Kindle, Logan comes to the "Gaspé limestones and calcareous shales". This section is worthy of full quotation, but space permits only a summary. The lowest subdivision is described as "gray limestones, in layers of six to eight inches, which are separated by bands of greenish calcareo-argillaceous shale, gradually increasing in amount towards the upper part; "the thickness of the whole is about seventy feet". This represents his member 1 of the 1863 report, and the Roncelles member of this report. The next subdivision consists of "an increased development of the greenish shales, which becoming interstratified with less calcareous layers of several shades of red, give altogether ninety feet". This was later termed member 2, and is here called the Rosebush Cove member. The third group of strata was described as "one hundred and seventy-five feet of olive coloured calcareo-argillaceous shales, with occasional large nodules of limestone, and a few layers of the same, some of which are rather arenaceous". This became his member 3, and is designated by the present writer as the Petit Portage member.

Next comes "a set of gray limestones in thin beds, separated by gray limestone shales, of which there are more towards the bottom than the top; and interstratified by three or four bands of the olive coloured shales". The total thickness is given as not over two hundred feet, and the presence of a zone of contorted limestone and shale is noted. This portion later became member 4, and is termed in the present report the Quay Rock member. "The next superimposed part of the formation consists of shales, in general

gray with a slight tinge of green and sometimes dark gray. Their quality is calcareous, and they are interstratified with a few bands of arenaceous limestone, which are occasionally sufficiently coarse-grained to approach a fine conglomerate." This later became member 5, and is called by the writer the Cape Road member.

"To these shales succeed another series of a harder and still more calcareous quality approaching the character of shaly limestones, which are associated, particularly at the top, with good hard but thin beds fit for burning The thickness of these shales and limestones may be about three hundred feet." This portion became member 6 in Logan's revised description (1863), and is essentially what the writer designates as the Forillon member. After explaining the relationship between these members and the topographical features of the Forillon peninsula, Logan goes on to describe the upper parts of the series. "These succeeding deposits are first a set of nodular shaly limestone beds, followed by some of a hard gray quality yielding good material for burning. These are again succeeded by nodular beds, on which rest strata of a more arenaceous quality and of a greenish colour, terminating in a thin layer, which is nearly grass green. These beds are about three hundred feet thick". This very succinctly characterizes the lithology of member 7; the present writer has excluded the lowest subdivision, and taken the rest to constitute the Shiphead member. "The remainder of the group is composed of hard gray limestones of a good quality, in beds varying from six to twelve inches, associated in some parts with chert." This constitutes member 8, in this report designated the Indian Cove member. Logan notes the difficulty in obtaining a direct measurement of this member, but considers

"that the thickness cannot be far from five hundred feet".

This rather full reference to Logan's original description is intended to bring out the fact that in his earliest detailed account he fully recognized the principle lithological subdivisions. Where he was able to measure thicknesses directly, his figures agree closely with those obtained by the writer. Only where he makes indirect estimations does he fall seriously short of the correct thickness. In the table below, Logan's subdivisions of 1846 and 1863 are compared with those established by Clarke (1900) and by the present writer.

Table of stratigraphic subdivisions of the Gaspé limestone series.			
<u>Logan, 1846</u>	<u>Logan, 1863</u>	<u>Clarke, 1900</u>	<u>This report</u>
Mostly limestone # 500 feet	member 8 500 feet	Grande Grève	Indian Cove # 600 feet
Shale and limestone; green beds 300 feet	member 7 300 feet		Shiphead 287 feet
Shaly limestone and limestone about 300 feet	member 6 300 feet	Cape Bon Ami	Forillon # 870 feet
Shale with some limestone 380 feet	member 5 380 feet		Cape Road 383 feet
Limestone and limestone-shale 200 feet or less	member 4 200 feet		Quay Rock 242 feet
Shale with lime- stone, 170 feet	member 3 170 feet	St. Alban	Petit Portage 90 feet
Greenish and red shale, 90 feet	member 2 90 feet		Rosebush Cove 191 feet
Limestone and calcareous shale 70 feet	member 1 70 feet		Roncelles # 145 feet

Logan's former assistant, James Richardson, continued the study of the Devonian limestones westward in the course of his various traverses across the Gaspé peninsula. He gave the section on Griffon Cove river*(Richardson, 1858) and noted the occurrence of the peculiar conglomerates later included by Kindle (1938) in his Griffon Cove River beds. In the same report Richardson provided a geological map of Gaspé, including the Forillon peninsula.

Logan's great compendium, usually referred to as "Geology of Canada" (Logan, 1863), contains a succinct account of the Gaspé limestones, based upon his 1843 and 1844 observations, and those of Richardson. Here he tabulated the members in ascending order, assigning numbers from 1 to 8, and giving a brief but lucid description of the lithology. He amplified his description of the contorted beds in member 4, and gave illustrations of them. An "Upper Silurian" correlation was given for the series, that is Silurian in the modern sense, but it must be remembered that it was then customary to refer the Helderberg group to that period. This was the last detailed revision of the Forillon section until the present investigation.

E. Billings, who was responsible for the fossil determinations in Logan's later works, prefaced his account of certain Palaeozoic fossils (Billings, 1847) with a summary of Logan's Gaspé limestone section. In this review Billings correlated members 7 and 8 with the Devonian, designated members 4 to 6 as "passage beds", and assigned members 1 and 2 to the Upper Silurian (i.e., Helderberg).

In the late nineteenth century the authority on Gaspé geology was R.V. Ells. In his report of 1883 Ells compared the Forillon section with that of Percé, and listed fossils from the lower part of both sections. He concluded that the rocks concerned were of Oriskany age. He also gave faunal lists for the upper part, from

* Anse au Griffon river (ed., 1975).

such localities as Cap Bon Ami, Cape Gaspé, Indian Cove, Grande Grève, and Little Gaspé. The following year (Ells, 1884) he gave lists of fossils from the lower beds at Cap des Rosiers and on Griffon Cove river. He concluded that members 1 to 6 were Upper Silurian and Lower Helderberg, and that members 7 and 8 were Lower Devonian. Ells used the fossil identifications of J.F. Whiteaves and H.M. Ami. In his 1884 report Ells included various maps, one of which (No. 6 N.M.) depicts the eastern extremity of Gaspé peninsula, including the Forillon. On this the Silurian-Devonian boundary is shown traversing the Forillon approximately along the line of Logan's boundary between members 6 and 7.

With the twentieth century a new worker appeared in Gaspé, John M. Clarke of the New York State Museum. Clarke's first account of the Gaspé limestone appeared incidentally in a report on the Oriskany (Clarke, 1900, p.p. 80-82). Here he reviewed the work of Logan, Billings, Ells, and Ami. He listed typical fossils from members 7 and 8, and determined these as mainly Oriskany, but with Helderberg elements. Following a suggestion of Ami, he designated the combined members 7 and 8 the Grand Grève limestones (sic). Noting that he was associated with Charles Schuchert in his study of the Gaspé limestone, he offers the joint proposal that members 1 and 2 be called the St. Alban limestone, and members 3 to 6 the Cape Bon Ami beds.

Clarke's full discussion of the Gaspé limestone appeared eight years later, as part of his great monograph on the Lower Devonian (Clarke, 1903). In this he quoted with comment the 1863 description of Logan, and gave more formal definitions of the three formations, St. Alban, Cape Bon Ami, and Grande Grève. To a critical review of Billings palaeontology he added the result of his own extensive

collecting. Of the St. Alban fauna he noted (Clarke, 1908, p. 36) that about half the species are present in the New York Helderberg, and one-fifth survive into the Grande Grève. The Oriskany elements were inconspicuous. The Cape Bon Ami fauna was described (p. 38) as reduced and diminutive, with resemblances to both Helderberg and Grande Grève. The Grande Grève fauna (p. 42-46) was large, and had both Helderberg and Oriskany resemblances, but the latter predominated (p. 250). A community of seaway can be postulated for the St. Alban and Helderberg, but not for the St. Alban and Dalhousie. The Oriskany fauna appears to have been developing in Gaspé while Helderberg faunas still persisted farther southwest.

A brief but useful description of the Gaspé limestones was given by Clarke (1913) in the International Geological Congress Guide Book. This included an account of the Forillon, with a geological map. Clarke's last important reference to the Lower Devonian of Gaspé (Clarke, 1915) dealt mainly with Percé but mentioned the Grande Grève fauna, which he here regarded as Oriskany in the lower part, post-Oriskany in the upper. He discussed the distribution of silica in the Grande Grève formation. Clarke's contributions to the palaeontology of Gaspé were very great, and included studies on Percé and the Bay of Chaleur area. His descriptions are picturesque, and he did much to popularize the region both to the geologist and to the tourist. Among the local residents there are still those who prize their memory of him. As a stratigrapher, however, he was usually content to accept the work of his predecessors uncritically, and his understanding of the structural relationships was not always correct.

Charles Schuchert assisted Clarke in his early work in Gaspé, but published little on the region. In the discussion of a paper by H.S. Williams (1910) he forecasted modern correlation of the Gaspé limestone by equating the lower part with the New Scotland zone, and the Grande Grève portion with the late Oriskany.

W.A. Parks made a general study of Gaspé geology with reference to petroleum resources, and published two papers (Parks, 1930, 1931) on the subject. In these he discussed the Gaspé limestone, pointing out that towards the west it becomes more siliceous, and almost unfossiliferous. The distribution of the silica was thought to favour its origin from central Gaspé volcanoes. Parks also suggested the presence of an unconformity at the top of the Gaspé limestone.

An important contribution to correlation was made by E.M. Kindle (1938). Although he did not deal directly with the Forillon area, he discussed the fault at Cap des Rosiers Est, and the upper boundary at Little Gaspé. Several sections west of the Forillon were described, including those on Griffon Cove river, Fox river*, and Sydenham (North Fork) river. The peculiar conglomerate and associated beds at the base of the Griffon Cove River section Kindle regarded as older than the type St. Alban, and to be correlated with the Keyser of the central Appalachians. A very interesting discussion on Devonian sedimentation is included in this paper.

F.J. Alcock (1935) described the geology of the Chaleur Bay region. In his account of the Devonian at Percé, he reviewed the Gaspé limestone, giving Clarke the credit for correcting Logan's "error" in assigning it to the Silurian. Actually, as pointed out above, Logan recognized the Helderberg age of the lower part, and was only following current usage in retaining it in the Silurian.

* Renard river (ed., 1975).

In 1929 I.W. Jones began geological mapping of areas in the interior of Gaspé, and in subsequent years carried the work eastward, being assisted later by H.W. McGerrigle and R.A. Brown. Their various reports on the areas adjacent to Gaspé bay have appeared only in preliminary form: Brown mapped the north side, from the Forillon to Dartmouth river, and gave a brief summary of his findings (Brown, 1939). On his unpublished map Brown gave an interpretation of the Forillon geology somewhat different from that reached by the present writer. Brown was confronted with the problem of correlating the interior sections with that of the Forillon, and endeavored to meet it by adopting somewhat different limits for the formations than those proposed by Clarke.

A recent stratigraphic review of North American Devonian (Cooper et al., 1942) discussed the formations of the Gaspé limestone series and assigned them places on the correlation chart. The Griffon Cove River beds were placed in the Silurian, following relegation of the Keyser to such a position. The St. Albans (sic) beds were shown as equivalent to the New Scotland portion of the Helderberg. The Cap Bon Ami (sic) formation was stated to contain a few Helderberg fossils and was tentatively assigned to the Becraft stage and correlated with the Dalhousie of New Brunswick. The Grande Grève was placed entirely within the Deerpark stage of the Oriskany, but the presence of beds younger than the highest Oriskany of New York was considered possible.

More recently McGerrigle (1947) issued a general review of the Gaspé Devonian. In this he compared the interpretations of various workers. Dealing with the Gaspé limestone, he noted that the thicknesses assigned to the constituent formations on the Forillon are very much less than those obtained from interior sections.

* Final report published 1950: McGerrigle, H.W., The geology of Eastern Gaspé; Quebec Dept. of Mines, geol. rep. 35 (ed., 1975).

A brief account of the writer's findings have appeared as a preliminary report (Russell, 1946). The present report may be considered as an amplification of that preliminary statement.

Present field work. Field work for this investigation was carried out during the summer of 1946. Approximately 9 weeks, from 10th June to 11th August, were spent on the Forillon peninsula and adjacent areas. After preliminary examination of the Forillon, to learn the distribution of the formations and the relative accessibility of the various parts, the detailed work was begun. This consisted of the direct stratigraphic measurement of sections and the establishment of instrumental controls. The measurements were obtained on the outcrop faces, where the nature and thicknesses of the various strata were recorded. Most thicknesses were measured directly by means of a light 5-foot rod, graduated in feet and tenths. Where the slope of the cliff was relatively gentle, this rod was used in conjunction with a hand level. On steep slopes it was sometimes found desirable to check intervals by means of a steel tape. Minor portions of the section were found to be concealed by talus and wash. In such cases trenches were dug into the concealing mantle, until the unweathered strata were revealed.

Although very considerable thicknesses of the series were measured in this direct way, it would not have been possible to compile a complete section without instrumental controls. In places there are hundreds of feet of strata without horizon markers that would serve to tie together the directly measured portions of the sections. The extreme northeasterly portion of the coast is inaccessible, and it is therefore not possible to carry a direct section around the Forillon from the northeast to the southwest side. Numerous faults also confuse the succession over any considerable distance.

To overcome these difficulties, and to provide an accurate base for the stratigraphic records, various traverses were run with alidade and plane table. One line extended from Cap des Rosiers Est along the shore past Quay rock and Cap Bon Ami to within 1.4 miles of Cape Gaspé, at which point the only remaining stratigraphic marker is faulted out of sight. Much of this traverse required the use of boat transportation. Another traverse was run from Little Gaspé along the road past Grande Grève and Indian Cove, to Cape Gaspé lighthouse and thence to the beach. A duplicate line, necessitating the use of boats, was run from Little Gaspé to well beyond Indian Cove, along the base of the sea cliffs. The two shore-line traverses were joined by a survey along the Cape road, from Grande Grève to Cap des Rosiers Est, tying in various outcrops along the route, with a side traverse to Quay rock. All of these traverses were plotted on a scale of 500 feet to the inch.

Time did not permit making extensive fossil collections, but small suites were obtained from some horizons that appear to have been overlooked by previous workers. Numerous lithological specimens were collected for laboratory study, including large samples of the several bentonite beds discovered at Cape Gaspé. Many photographs, some in black-and-white, others in natural colour, were made during the examination of the various sections.

On completion of the detailed study of the Forillon stratigraphy brief examinations were made of other sections farther west. These included the exposures along the Roncelles road, Griffon Cove river, Fox river, and Dartmouth river. On the way from the field an examination of the well known Devonian occurrence at Percé was made to permit comparison with the Gaspé limestone series of the Forillon.

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The writer is indebted to several local residents for assistance. Mr. Hormidas Riffault, Fisheries Inspector at Cap des Rosiers gave valuable advice on local conditions, and placed the writer in contact with Mr. Théophile Dunn. Mr. Dunn supplied our boat transportation to the less accessible parts of the coast, and greatly impressed us by his seamanship and his knowledge of these sometimes difficult waters. Mr. Henry Bechervaise, of Gaspé, in addition to supplying hotel accomodation, was always ready with special assistance and advice. Mr. Hilaire Cassivi, of D'Aiguillon, at whose tourist camp we established our headquarters, assisted us in numerous ways.

ST. ALBAN FORMATION

Definition. The St. Alban formation is the lowest division of the Gaspé limestone series. In the type section the formation consists of interbedded limestone and calcareous shale (Roncelles member) in the lower part, and essentially non-calcareous shale of green and red colour (Rosebush Cove member) in the upper. Faulting has concealed the base and obscured the succession, but the measured thickness is about 336 feet.

Distribution. Strata of this formation make up the northernmost part of the high cliffs south of Cap des Rosiers Est. The lowest part appears on the south side of the fault which marks the end of the settlement beach. This point is a convenient one from which to measure various distances along the base of the cliffs. For 530 feet south of the fault the calcareous beds form steep cliffs. Beyond this the lower part of the cliffs is formed from the same strata, but a seaward-dipping fault obscures the relationship. The dip, which is about 23° slightly south of west, brings the strata gradually down the cliff, and at a point 1,120 feet south of the main fault the upper member of the formation reaches almost to beach level. This shaly member forms the main part of the cliffs for some distance south, but with slight changes in strike, accompanied by faulting, the contact with the overlying Cape Bon Ami formation eventually reaches the beach at a point about 2,000 feet south of the main fault, or about 750 feet north of the diabase dyke.

Inland the basal beds of the formation outcrop along a low escarpment south of the Roncelles road (Highway 6)* and appear in the bed of a small stream that crosses the highway about 1 mile west of the road junction at Cap des Rosiers Est.

* Route 132 (ed., 1975).

Roncelles member. This name is here applied to the lower calcareous member of the St. Alban formation, approximately equivalent to Logan's member 1. The name is derived from the Roncelles road, which connects Cap des Rosiers with the Gaspé Bay area, and along which the basal beds of the member are exposed. However, the type section is to be seen along the shore, for about 1,120 feet south of the Ordovician-Devonian fault (Figure 1).

This fault presents some interesting features, and will be described before dealing with the stratigraphy of the Roncelles member. The fault plane finds expression as a small steep cliff of limestone projecting across the beach at a sharp angle. Strike of the fault plane is 322° and the dip is 75° to the southwest. Considered alone, this fault plane would suggest a normal, high-angle fault. However, immediately to the north, where a small creek comes down to the beach, there are blocks of limestone resting on the Cape Rosier shale, with a contorted and slickensided contact. Either these blocks represent wedges sheared off the Roncelles beds during fault movement, or the whole complex of limestone blocks and Cape Rosier shale represents a slump which took place at a time when the creek channel was deeper than at present. No evidence was observed to indicate thrust faulting, although such an interpretation has been advocated by Clarke (1913, p. 89).

Returning to consideration of the main fault plane, it is possible to recognize three sets of shallow, broad striae cutting the surface of the limestone. Kindle (1938, p. 45) noted only low angle striae here. The oldest set observed by the writer consists of two grooves directed approximately 63° to the southeast. These are cut by the striae of Kindle's description, which are numerous, both broad and narrow, and have an inclination of about 9° to the

southeast. These in turn are cut by a few grooves, 1 inch or more in width, dipping 26° to the northwest. From these striae it is clear that the fault movement was of a multiple nature. Distances involved in any of the individual movements cannot be determined accurately, but they were obviously in the order of several feet.

Immediately south of the fault a section of over 80 feet of Roncelles beds can be measured. The following is the writer's compilation.

Section in descending order, of lower Roncelles beds immediately south of the Ordovician-Devonian fault (Figures 2 and 3).

10. Alternating limestone and shale: the limestone hard, grey, fossiliferous, in beds averaging 0.3 foot in thickness, the bedding planes irregular, the fossils including corals, stromatoporoids, and brachiopods; the shale grey, rather calcareous, friable rather than fissile, in beds from 0.2 to 5 feet in thickness; also irregular hard beds with fossils 28 feet
9. Limestone, grey, very hard, ledge-forming, not very fossiliferous 0.9 "
8. Shale, gray, as above with numerous hard, irregular limestone bands; fossiliferous 5.5 "
7. Alternating limestone and shale, as above 1.9 "
6. Limestone, hard, ledge-forming, with shale parting near top . 0.8 "
5. Alternating limestone and shale, with preponderance of shale. 7.7 "
4. Alternating limestone and shale, limestone beds predominating but very irregular in places; limestone fossiliferous. 2.9 "
3. Limestone, conglomeratic; matrix both calcareous and shaly, pebbles of limestone and chert, up to 6 inches in diameter but mostly small, many of them flat; also numerous corals

- with other fossils, many of them water-worn; some beds appear arkosic 2 "
 - 2. Alternating limestone and shale, as above 2.1 "
 - 1. Limestone, gritty or arkosic, irregularly bedded, with shale partings; fossils mostly broken 4 "
- Faulted and concealed.

The conglomeratic beds at the base of the above section, Nos. 1 and 3 of the compilation, are of special interest. Apparently they are concealed at times, for they were not mentioned by Kindle. As noted above, they also outcrop along the Roncelles road. Similar coarse calcareous beds occur at the base of the St. Alban formation on Fox river, associated with stromatoporoid beds. However, this type of rock is almost completely absent from the section on Griffon Cove river, where its place is taken by the peculiar quartzite conglomerates described by Kindle (1938, p. 51). The widespread occurrence of coarse clastic material at the base of the St. Alban formation strongly suggests that the sea came in over an erosion surface. These basal beds also have a practical importance, because of their relatively high porosity. They constitute the only zone in the lower part of the Gaspé limestone series that might be expected to serve as a gas or petroleum reservoir.

Returning to the sea cliffs south of Cap des Rosiers, it should be noted that the above described section is terminated above by a low angle fault, which cuts across the Roncelles beds. As exposed high on the cliff this fault appears to follow the bedding planes below. However, as it approaches beach level, it descends more abruptly, apparently because of change in orientation of the cliff face. The following observations were made on this where it reaches the beach, 530 feet southeast of the main fault.

Strike of fault	214°
Dip of fault	19° SE.
Strike of foot-wall beds	354°
Dip of foot-wall beds	24° W.
Strike of hanging-wall beds	354°
Dip of hanging-wall beds	36° W.

No satisfactory means of determining the displacement along this fault could be observed, but it is not thought to be great because of the similarity of the rocks on either side. The presence of the fault, however, makes the writer's determination of the thicknesses of the Roncelles member and the St. Alban formation approximations rather than exact measurements.

South of this fault the section of the Roncelles beds can be continued to the top, which, in the writer's interpretation, comes to beach level about 1,200 feet south of the main or Ordovician-Devonian fault.

Section of upper Roncelles beds between 530 and 1,400 feet south of main fault, in descending order:

- 10. Shale, grey, friable to somewhat fissile, calcareous, with numerous thin, irregular calcareous beds; fossiliferous. 8 feet
- 9. Limestone, hard, grey with minute fragments of shelly material 0.2 "
- 8. Shale, greenish grey, fissile 0.15 "
- 7. Limestone, as above 0.5 "
- 6. Shale, calcareous, greenish gray, with numerous limestone beds; thickness obscured by small-scale faulting and slumping, but probably about 14 "
- 5. Limestone, hard, ledge-forming 1 "

- 4. Shale, calcareous 0.6 feet
- 3. Limestone, hard, ledge-forming 1 "
- 2. Shale, greenish grey, calcareous, friable, but breaking off in vertical faces; numerous hard calcareous beds not persistent, but reaching thicknesses of 1 foot, grey, rusty weathering; irregular calcareous nodules with fossils; stromatoporoid masses; general assemblage different from well-banded Roncelles beds below † 25 "
- 1. Alternating limestone and shale, the limestone hard, nodular, fossiliferous, irregularly bedded, grey in colour; the shale grey, friable, not very hard; similar to beds in section immediately south of main fault (page 22) 12 "

Concealed by above described fault.

In the above section, No. 2 forms a conspicuous portion, appearing as an overhanging cliff, with nearly vertical jointing. A persistent horizon is provided by the two limestone beds with the shale parting (Nos. 7, 8 and 9), which can be followed for some distance along the beach, and which serve to reveal the displacement of some small faults. The top of the member is taken somewhat arbitrarily at a horizon 8 feet above this double limestone bed, at what appears to be the top of the obviously calcareous shale. This is somewhat higher than the top selected by Logan for his member 1, which apparently included only part of the calcareous shale. However, the description given by Logan for member 1 is essentially a definition of the Roncelles member.

Rosebush Cove member. This is the approximate equivalent of Logan's member 2. The name is a free translation of L'Anse de Cap des Rosiers, which is not available in the original. The beds appear first in the higher part of the cliffs near the north end, and being relatively soft, form a conspicuous slope between the cliff-forming rocks of the Roncelles member and the lower part of the Cape Bon Ami formation. The top of the Rosebush Cove beds reaches beach level at a point about 2,000 feet south of the main fault, or about 750 feet north of the diabase dyke.

This member is predominantly shale, with a relatively low calcareous content. The colour is mainly a greenish grey, but in the upper part this is interbedded with thin and thick beds of maroon shale, which appear very conspicuous in bright sunlight. Individual maroon beds come and go, and small-scale faulting obscures the succession in places, so that sections taken at different points along the cliff do not agree in all details. The following compilation may be taken as typical of the Rosebush Cove member here (Figures 4 and 5).

Section of Rosebush Cove member between 1,150 and 2,400 feet south of main fault, in descending order:

- Shale, calcareous, with limestone beds (base of Cape Bon Ami)
4. Shale, friable, essentially non-calcareous, greenish grey in colour, with maroon beds in lower part; thin limestone beds, rusty in colour, in upper part 18 feet
 3. Shale, maroon, friable with grey-green beds in upper and lower part 33 "
 2. Shale, greenish grey, weathering rusty, friable to irregularly fissile, breaking off in places as a sheer face; thin reddish streaks in upper part; becoming somewhat calcareous below; moderately fossiliferous 138 "

1. Shale, grey, friable to somewhat fissile, moderately calcareous 1.6 feet

The above section is continuous with the top of the Roncelles section given on page 24. It will be seen that the Rosebush Cove member has a measured thickness of 191 feet. An accurate determination of thickness for No. 2 of the above section is difficult to obtain. The figure obtained by detailed measurement was checked by measuring the total thickness with a steel tape. Near the point where the maroon shale descends to each level there is a 2-foot maroon bed 19 feet below the top of the thick greenish grey shale (No.2). This conspicuous bed disappears to the northward.

Palaeontology and correlation. No attempt was made by the writer to obtain a fossil collection from the St. Alban beds. Some observations, however, were made on the distribution of fossils within the member. The richest occurrence is in the gritty zone at the base of the Roncelles member. Corals are the commonest fossils here, but many of the specimens are water-worn or broken. In the calcareous zone above, the limestone beds carry corals or stromatoporoids at intervals. The thick calcareous shale that forms the upper part of the Roncelles yields excellent pelecypods, in addition to the corals. Fossils are not abundant in the Rosebush Cove member, and appear to be absent from the maroon shale zone.

The most recent discussion of the St. Alban fauna is that given by Clarke (1908, pp. 39-46), who made a critical study of Billings's determinations as given by Logan, and incorporated the list based upon his own collections.

CAPE BON AMI FORMATION

Definition. This formation constitutes the middle and by far the thickest part of the Gaspé limestone series. It was established by Clarke (1900, p. 81) to include Logan's members 3 to 6 inclusive. This procedure is followed by the writer, substituting geographic names for Logan's numbers. As so recognized, the Cape Bon Ami formation consists of a basal member of non-calcareous shale with limestone beds (Petit Portage), a banded limestone and calcareous shale member (Quay Rock), a thicker non-calcareous shale member (Cape Road), and a very thick limestone and calcareous shale member (Forillon). Only the first three can be measured directly, and the thickness of the Forillon member, and of the entire formation, has been determined by structural compilation. The thickness so estimated for the Cape Bon Ami formation is 1,585 feet.

Distribution. The lowest member of the Cape Bon Ami appears at the summit of the cliff south of Cap des Rosiers beach, and continues for some distance south as a sheer face above the slope of the Rosebush Cove beds. South of a faulted zone it descends towards the beach more abruptly, and, as noted above, the contact (Figure 6) with the underlying St. Alban may be observed at a point 750 feet north of the diabase dyke. From here to Cape Gaspé the entire coast of the Forillon peninsula is formed by Cape Bon Ami beds. Many conspicuous landmarks occur in them. The diabase dyke, so useful as a reference point, cuts vertically through beds of the Quay Rock member. This portion forms the cliffs north of Quay rock (Garland's Camp), as well as that extraordinary promontory itself. The same member reappears in the two extremities of Cap Bon Ami. Southeast of Quay rock the shales of the Cape Road member come down to the beach, and are also well

exposed on either side of Cape Bon Ami. The main cliffs of Mount St. Alban, above the Cape road, are formed by the Forillon member, which descends to sea level in the southernmost part of Cap des Rosiers cove, forms the cliffs above Cap Bon Ami, and continues as the main or exclusive part of the great precipices from here to Cape Gaspé. Isolated outcrops of uppermost Forillon beds occur in Dolbel brook, north of Grande Grève settlement.

Petit Portage member. The lowest division of the Cape Bon Ami formation is named from Logan's designation (1846, p. 32) for the vicinity of Quay rock. It is accessible from the beach immediately to the north of the diabase dyke, and is seen to rise diagonally up the cliff to the northward. The following section, measured in this vicinity, is continuous above with Quay Rock beds, and below with the shales of the Rosebush Cove member.

Section of Petit Portage member on beach immediately north of dyke, in descending order:

Limestone, hard, ledge-forming (base of Quay Rock member).	0.6 foot
10. Shale, grey-green, rusty weathering, friable, not conspicuously calcareous	8.3 feet
9. Limestone, hard, ledge-forming, with wavy partings	0.5 "
8. Shale, grey-green, friable, not very calcareous, with thin rusty limestone beds in upper part	15.0 "
7. Limestone, grey massive, ledge-forming, made up of several bands, rusty weathering, about 0.2 foot thick, between which is a softer limestone, showing peculiar wavy stratification, forming beds up to 1 foot thick; limestones appear somewhat argillaceous. (Figure 8 & 9)	6.4 "

6. Shale, greenish grey, rusty weathering, friable, probably not very calcareous, with numerous rounded rusty concretions in irregular layers (hard limestone ledge appears in this portion farther northwest along cliff) 15.5 feet
5. Shale, grey, friable, weathering maroon 1.5 "
4. Shale, friable, greenish grey, rusty weathering, with a few thin, rusty limestone beds 10.0 "
3. Shale, calcareous, grey, rusty streaked, with 0,3 foot of ironstone at top 1.0 "
2. Shale, friable, greenish grey, rusty-weathering, with thin rusty streaks. 5.0 "
1. Shale, probably calcareous, rather fissile, grey in colour, with numerous thin limestone beds, not usually more than 0.2 foot thick, some of them rather irregular in distribution, fossiliferous in places; this rock tends to form sheer faces, and looks like limestone from a distance (Figure 7). 25.5 "

Shale, friable, grey-green (top of Rosebush Cove member)

Total thickness of the Petit Portage member in the above section is 89 feet. Logan gives 170 feet as the thickness of his member 3. The discrepancy is probably due to Logan's inclusion of beds placed by the writer in the overlying Quay Rock member.

Quay Rock member. This subdivision consists almost exclusively of interbedded limestone and calcareous shale, presenting a regular banded appearance. It forms sheer cliffs (Figure 10) between the diabase dyke and Quay rock, with several re-entrants caused by high-angle faults.

Quay rock is formed by strata of this member, as are the low cliffs along the beach immediately to the southeast. The top of the member may be seen on the next promontory southeast of Quay rock. The following section is based on detailed observations in the upper and lower parts, but the middle portion, being less accessible, is described in generalized form, with thickness determined by survey methods.

Section of the Quay Rock member between the vicinity of Quay rock and the diabase dyke, in descending order:

Shale, calcareous, with numerous rounded nodules (base of Cape Road member)	16 feet
37. Limestone, hard, impure, with thin partings of calcareous shale; colour light grey	16 feet
36. Limestone, platy, with shale partings in places; colour grey	1-1.5 "
35. Shale, non-calcareous, soft, friable, greenish grey	1.2-2.5 "
34. Limestone, hard, grey, with irregular bedding and many wavy shale partings	3.5 "
33. Shale, calcareous, hard, with numerous thin limestone beds	18.7 "
32. Shale, moderately hard, friable, grey-green in colour, with a few thin, flat, limestone beds	10.0 "
31. Limestone and calcareous shale, hard, ledge-forming	0.7 "
30. Shale, friable, grey-green, as above	2.5 "
29. Limestone, flat, ledge-forming, grey	0.4 "
28. Shale, friable, grey-green, as above, with thin, irregular limestone beds	9.5 "
27. Limestone, nodular, irregularly bedded, with calcareous shale, grey in colour; this is the contorted bed	

	described by Logan (1863, p. 391) at the "Petit Portage" (Figure 11).	24 feet
26.	Alternating calcareous shale and limestone; upper part consisting of limestone beds up to 0.3 foot, separated by shale beds up to 0.2 foot, the limestone somewhat nodular and with sinuous fucoid markings on the surface; this portion forms Quay rock; limestone becomes progressively less conspicuous downwards, and in lower part the rock is an almost homogeneous calcareous shale, with occasional limestone partings; thickness not measurable directly, but computed from instrumental data as about (Figure 11 & 12)	.104 "
25.	Limestone, hard grey, rusty weathering	0.15 "
24.	Shale, calcareous, light greenish grey, friable . . .	0.7 "
23.	Limestone, hard, grey	0.05 "
22.	Shale, calcareous, as above	7.0 "
21.	Limestone, hard, grey, rusty and buff weathering, with wavy partings; thickness variable, about	0.6 "
20.	Shale, as above.	3.0 "
19.	Limestone, hard	0.05 "
18.	Shale, as above	0.6 "
17.	Limestone, hard, wavy partings	0.1 "
16.	Shale, as above	2.2 "
15.	Limestone, hard	0.05 "
14.	Shale, as above	5.7 "
13.	Limestone, hard	0.05 "
12.	Shale, as above	0.05 "
11.	Limestone, hard	0.1 "
10.	Shale, as above	4.0 "

9. Limestone, hard, grey, with fine wavy banding	0.2-0.4 "
8. Shale, as above	4.0 "
7. Limestone, hard, grey, with wavy banding.	0.3 "
6. Shale, as above	1.2 "
5. Limestone, hard, ledge-forming, grey, with fine wavy partings; ripple marks on some planes	1.3 "
4. Shale, calcareous, grey, friable, rather hard	10.0 "
3. Limestone, hard, ledge-forming, as above.	0.6 "
2. Shale, calcareous, greenish and purplish grey, friable, with several thin limestone beds	5.0 "
1. Limestone, hard, ledge-forming; partings few	0.6 "
Shale, grey-green, rusty weathering (top of Petit Portage member)	8.3 "
Total thickness of Quay Rock member, approximately . . .	242 "

Several portions of the above section are worthy of special comment. The 10-foot bed of calcareous shale (No. 4) near the base is cut by the diabase dyke at beach level. On the north side of the dyke the uppermost 2 feet of this bed show a peculiar aggregation of rounded, pebble-like masses, which give the appearance of a conglomerate. However, the masses are pyritic and nodular, and some contain the coralla of Favosites. These nodules persist in the shale for a distance of 30 feet north of the dyke, at which point they become confined to the top of the bed, and shortly beyond they disappear. The detailed sequence of calcareous shale and fine limestone beds shown by Nos. 10 to 25 is also characteristic of the lower part of No. 26, but details of this last could not be measured directly. The thickness of No. 26 was determined by taking angle readings, from a known distance, on the base of the friable grey-green shale (No. 25)

and on the top of the wavy-bedded limestone in the Petit Portage member (No. 7 of the section on page 29) which outcrops directly from the computed vertical interval, corrected for the dip of the strata, the directly measured portions of the section were deducted.

The upper portion of No. 26 can be examined in detail on Quay rock, where it may be seen that the limestone beds stand out more conspicuously from the shale than in the lower part. Here may be seen in abundance the peculiar sinuous markings that have been compared with Spirophyton cauda-galli and are supposed to be remains of sea-weeds. The next group of beds in ascending order (No. 27) can be inspected on the south side of Quay rock, and can be seen from a distance on the face of the cliffs about 500 feet to the northwest. This is one of the two occurrences of contorted beds mentioned by Logan. This one, in the vicinity of Quay rock, is characterized by moderate contortion, lack of common orientation of the folds, and an abundance of nodular masses. These features, in the writer's opinion, do not support the view that the contortion is of diastrophic origin, but rather suggest that it has resulted from unequal settling shortly after deposition. As will appear below, the contorted beds on Cap Bon Ami do offer evidence of deformation.

The shaly zone (Nos. 28 to 32) above the contorted beds forms a conspicuous marker, which can be seen to continue along the cliffs north of Quay rock. The thin shale bed (No. 35) near the top of the member also is a useful marker bed locally.

The upper part of the Quay Rock member forms the two projecting points of Cap Bon Ami. Here the section is somewhat different from that in the vicinity of Quay rock.

Section of Quay Rock beds on southeast side of Cape Bon Ami, in descending order:

Concealed interval to lowest exposed beds of Cape Road member, equivalent to a vertical interval of	118	fee
14. Limestone, and calcareous shale, alternating, in beds averaging 0.3 foot; the limestone beds are nodular, hard, cliff-forming, light grey in colour, weathering almost white; highest exposed bed of Quay Rock member.	37	"
13. Limestone and calcareous shale, alternating; bedding highly contorted in folds, the strike of which agrees with that of the undistorted strata (Figure 13)	5.5	"
12. Limestone, and calcareous shale, undistorted, as above. .	16	"
11. Shale, not conspicuously calcareous, light greenish grey, with some thin limestone beds.	13	"
10. Limestone, hard, light grey, regularly bedded, with thin banding in upper part.	2.5	"
9. Shale, friable, not obviously calcareous, grey in colour.	7	"
8. Shale, hard, with limestone beds; grey in colour.	4.8	"
7. Limestone, and calcareous shale, alternating, similar to alternating beds above	11.5	"
6. Shale, friable, apparently not calcareous	9	"
5. Shale, rather calcareous, with thin limestone beds.	7	"
4. Shale, friable, grey.	2.3	"
3. Shale, hard, grey, rusty weathering, with irregular lime- stone beds	2	"
2. Shale, friable, grey.	4	"
1. Limestone and calcareous shale, similar to alternating beds above; limestone very nodular, with lumpy bedding planes; this forms the points of Cap Bon Ami and the base is not exposed	?	"

The contorted beds of the above section (No. 13) are those figured by Logan (1863, p. 392), who evidently regarded them as the same as those occurring at Quay rock. However, it appears that the occurrence at Cape Bon Ami is considerably higher in the member. Other differences are the greater degree of contortion, the orientation of the folds with the general strike of the strata, and the presence of brecciation in places, seen on Cape Bon Ami. From these features it is deduced that the latter occurrence is the result of differential movement associated with the regional deformation. However, the localization of this movement may have resulted from the presence in these beds of previously existing contortion of similar origin to that postulated for the occurrence at Quay rock.

Cape Road member. This is a conspicuous shale member, with limestone ledges, similar in general lithology to the Petit Portage beds, but considerably thicker. It is the exact equivalent of Logan's division 5. The name is derived from the Cape road (erroneously called the King's road by Clarke, 1908, p. 23), which connects Grande Grève with Cap des Rosiers, and which, for much of its course below Mount St. Alban, follows the bench formed by these relatively soft beds. A complete section of the member is exposed in the lower part of the cliff that rises above the second beach southeast of Quay rock. This is the cliff (Figure 14) that lies below the summit of the Cape road, and which is referred to so picturesquely by Clarke (1908, p. 23). A number of faults cut this outcrop, but due to the abundance of conspicuous marker beds, the displacement in the Cape Road member can be readily determined.

Section of Cape Road member on cliff below summit of Cape road
in descending order:

Limestone and calcareous shale, cliff-forming; Forillon member; more than	200	feet
53. Shale, hard, friable, not very calcareous, grey in colour, weathering rusty brown	9	"
52. Limestone, hard, ledge-forming, light grey, weathering rusty grey, merging into shale below, but approximately	0.8	"
51. Shale, friable, as above, but irregular, harder, more calcareous beds in places; colour ranges from light grey to light greenish grey	35	"
50. Shale, hard, apparently calcareous, friable, light grey-brown in colour, forming an irregular ledge .	4	"
49. Shale, friable, less calcareous, with irregular harder beds, grey to light grey-green in colour .	12	"
48. Shale, friable, hard, ledge-forming.	8	"
47. Shale, friable, not very calcareous, mostly light grey-green in colour	6	"
46. Shale, harder, ledge-forming, brownish grey, weathering rusty	0.7	"
45. Shale, not very calcareous, rather fissile, grey in colour	2.5	"
44. Shale, hard, apparently calcareous, bedding irregular, forming a conspicuous hard zone; colour light grey-brown, weathering grey and rusty . . .	22	"
43. Shale, very friable, with some thin hard beds, grey to grey-brown in colour	5	"
42. Limestone, hard, grey in colour, with irregular surfaces	0.05	"

41. Shale, friable, light grey, rusty-weathering below. . .	2.7 "
40. Shale, as above, with ironstone concretions.	1 "
39. Shale, friable, light grey and greenish grey.	1.8 "
38. Shale, harder, rusty-weathering, with ironstone concretions	1.4 "
37. Shale, friable, grey. ,	2.8 "
36. Limestone, hard, grey	0.7 "
35. Shale, friable, grey.	3 "
34. Shale, harder, rusty-weathering	1 "
33. Shale, friable, grey.	5 "
32. Limestone, impure, hard, friable, grey in colour, rusty-weathering, ledge-forming.	4.5 "
31. Shale, very friable, with occasional harder beds, grey to greenish grey in colour, weathering dark grey or rusty.	16 "
30. Shale, friable, with numerous thin, hard, calcareous beds, grey in colour, weathering rusty.	6 "
29. Shale, friable, grey, no hard beds.	6 "
28. Shale, harder, friable, with many thin, hard, rusty-weathering limestone beds; forms conspicuous ledge.	7.5 "
27. Shale, very friable, grey, with thin limestone bed in upper part.	7 "
26. Shale, harder, with rusty-weathering concretionary masses	2.7 "
25. Shale, very friable, grey	7 "
24. Shale, harder, friable, light grey, with rusty-weathering, hard, calcareous beds	25 "
23. Shale, friable, light grey, with occasional hard beds .	2.6 "
22. Shale, friable, light grey, with many thin hard rusty-	

weathering beds	7.1 "
21. Shale, friable, grey.	2 "
20. Shale, harder, friable, with many hard rusty weathering calcareous beds.	15 "
19. Shale, very friable, not calcareous, with some thin, rusty weathering limestone beds	24 "
18. Shale, harder, friable, grey-green, with rusty stains; numerous thin, hard, rusty weathering calcareous beds.	29 "
17. Shale, harder, light greenish grey, with rusty stains; irregular concretions	27 "
16. Shale, friable, light greenish, with some thin hard rusty bands	5.7 "
15. Shale, as above, with thick, rusty weathering concretions	2.0 "
14. Shale, friable, light greenish grey	1.1 "
13. Limestone, regular bed, hard, light grey, rusty weathering; lower surface with ridges and prominences.	0.1 "
12. Shale, very friable, light greenish grey, with rusty stains.	15.5 "
11. Limestone, hard, light grey, with fine colour bands; upper surface irregular, lower surface with ridges and small rounded prominences	0.2 "
10. Shale, very friable, light greenish grey, with rusty stains.	11.5 "
9. Shale, with numerous hard reddish concretions	0.8 "
8. Shale, harder, light grey, with numerous hard, rusty stained limestone beds	10.5 "

7. Shale, very friable, light greenish grey, with thin hard beds near top	5 feet
6. Limestone, hard, regular, with ridges and prominences on lower surface	0.3 "
5. Shale, very friable, light greenish grey, with four thin limestone beds.	10.5 "
4. Limestone, hard, finely banded, grey, with rusty stains; irregular top; lower surface shows many irregular prominences.	1.5 "
3. Shale, very friable, light greenish grey, with a few thin hard beds	13 "
2. Shale, hard, calcareous, with wavy bands; concre- tions and nodules; light grey, rusty weathering.	1.3 "
1. Shale, calcareous, friable; grey with rusty stains; numerous rounded nodules	16 "
Limestone, hard, impure; top of Quay Rock member.	16 "

Total thickness of the Cape Road member in the above section is 381 feet. Logan (1863, p. 392) gives 380 feet for his division 5. This close agreement may be in part coincidental, but it strongly suggests that division 5 is the exact equivalent of the Cape Road member as here defined, and that the type locality is the same for both.

The Cape Road shales are downfaulted from view at the southeast end of the cliff, 2,600 feet from Quay rock. The shore line beyond here is bordered by cliffs composed entirely of the Forillon member. However, as the cliffs swing around to the northeast towards Cap Bon Ami they cut back across the strike of the contact, bringing the Cape Road shales to the surface, at a point 1,150 feet by the shore from Cap Bon Ami. A large portion of the member is exposed here,

but several faults of undetermined displacement make compilation of a useful section impracticable. On the southeast side of Cap Bon Ami, at the beginning of the great sea cliffs that extend uninterrupted to Cape Gaspé, an almost complete section of the Cape Road member is exposed. The sequence here is the same as that near Quay rock in general characters, but differs almost completely in detail. It is evident that the individual shale and limestone beds of the member are very discontinuous laterally, and do not serve as useful horizons. Only the top of the member can be shown by direct observation to have marked lateral persistence.

Section of Cape Road beds on the southeast side of Cap Bon Ami, in descending order:

Limestone and calcareous shale, massive, hard, cliff-forming;

Forillon member; more than	300 feet
50. Shale, friable, somewhat calcareous, thin limestone beds	9 "
49. Limestone, hard, impure, rusty-weathering, ledge-forming	1 "
48. Shale, friable, rather hard, grey, grey-brown, and grey-green, with thin limestone beds.	15 "
47. Shale, calcareous, ledge-forming, rusty-weathering, approximately	1 "
46. Shale, friable, as above	21.5
45. Shale, calcareous, and limestone, partly friable, rusty-weathering, ledge-forming.	17 "
44. Shale, friable, grey and greenish grey	3.5
43. Shale, friable, hard, ledge-forming, with thin limestone bed at top; rusty-weathering	2.3
42. Shale, friable, grey and greenish grey, with thin irregular limestone beds	6.5

41. Shale, friable, hard, light grey in colour, rusty-weathering.	2.2 feet
40. Shale, friable, grey.	3.5 "
39. Shale, calcareous, hard, partly friable, with numerous thin limestone beds; rusty-weathering.	27.5 "
38. Shale, friable, grey and greenish grey, with thin limestone beds	8.5 "
37. Shale, friable, as above, but with calcareous and limestone beds; rusty-weathering	5 "
36. Shale, friable, grey and greenish grey.	12.5 "
35. Shale, hard, rusty-weathering, ledge-forming.	0.8 "
34. Shale, friable, grey.	4 "
33. Shale, hard, rusty-weathering	0.7 "
32. Shale, friable, grey.	4 "
31. Shale, hard, calcareous, with limestone beds; rusty-weathering	13.5 "
30. Shale, friable, grey.	7.5 "
29. Shale, hard, rusty-weathering, with softer beds	5 "
28. Shale, friable, grey.	2.5 "
27. Shale, friable, light brownish grey, rusty-weathering, with many very thin limestone beds	4 "
26. Shale, calcareous, and limestone, hard, rusty-weathering, ledge-forming.	6 "
25. Shale, friable, grey and greenish grey.	5.5 "
24. Shale, calcareous, and limestone, interbedded, hard, ledge-forming, grey in colour, rusty-weathering.	9.5 "
23. Shale, friable, grey.	0.6 "
22. Limestone, hard	0.1 "
21. Shale, friable, grey.	12 "

20. Shale, hard, with numerous limestone beds; ledge-forming; rusty-weathering	18 feet
19. Shale, friable, grey.	2.8 "
18. Shale, hard, with numerous thin limestone beds; ledge- forming; rusty-weathering.	13 "
17. Shale, friable, grey and greenish grey, with some thin limestone beds	13.5 "
16. Limestone, hard, rusty-weathering	0.2 "
15. Shale, friable, greenish grey	4.6 "
14. Limestone, hard, finely banded, rusty-weathering, ridges and prominences on lower surface	0.4 "
13. Shale, friable, grey and greenish grey, with thin lime- stone beds	14 "
12. Limestone, hard, finely banded, rusty-weathering, ridges and prominences on lower surface	0.4 "
11. Shale, friable, grey and greenish grey.	3.3 "
10. Limestone, hard, rusty-weathering, ridges and prominences on lower surface	0.2 "
9. Shale, friable, grey and greenish grey, with thin lime- stone beds	5 "
8. Limestone, hard, rusty-weathering, ridges and prominences on lower surface	0.3 "
7. Shale, friable, greenish grey	6 "
6. Limestone, hard, rusty-weathering, finely banded, ridges and prominences on lower surface	0.2 "
5. Shale, friable, greenish grey	11.2 "
4. Limestone, hard, rusty-weathering, ridges and prominences on lower surface	1.5 "
3. Shale, friable, grey, with irregular rusty-weathering hard masses.	7.5 "

2. Shale, hard, light grey-green, rusty weathering, ledge-		
forming, irregularly bedded	2.4	"
1. Shale, friable, greenish grey, more than	1.5	"
Concealed interval to highest exposed beds of Quay Rock member,		
equivalent to a vertical interval of.	118	"

It is probable that the concealed interval at the base of the above section is part of the Cape Road member, as the much harder rocks of the Quay Rock member would be likely to outcrop. If so, the total thickness of the Cape Road member here would be 436 feet, or 55 feet thicker than in the vicinity of Quay rock less than 2 miles to the northwest. From Cap Bon Ami the upper beds of the Cape Road are exposed almost continuously for a distance of 1.7 miles, and the contact with the Forillon member, being usually accessible, makes an excellent horizon for structural determinations. The Cape Road shales terminate against a high angle fault, which intersects the cliff about 1.4 miles from Cape Gaspé. The remainder of this shore is formed exclusively by cliffs of the Forillon member.

Forillon member. This is essentially member 6 of Logan's description, although the writer has extended the upper limit somewhat. It constitutes the thickest and most conspicuous portion of the Cape Bon Ami formation, and is, in fact, the thickest subdivision in the entire Gaspé limestone series. The characteristic lithology is an alternation of thin limestone and calcareous shale beds, the whole being homogeneous enough to form high cliffs. In general the lower part resembles the Quay Rock member, in that the limestone beds are not cherty, have flat bedding planes, and do not weather out distinct from the shale. The upper part, in contrast, suggests the upper

member of the Grande Grève formation (Indian Cove member of this report) in having some chert in the limestone beds, which have very undulate top and bottom surfaces, and which weather out to form ledges separated by shale beds. However, it is not possible to determine an exact horizon at which this change takes place, and the two types of lithology can be seen to fluctuate up and down the section, and even to alternate in places.

The Forillon member forms the more northerly of the two long ridges which constitute the axes of the Forillon peninsula (figs. 15, 16). The ridge in question has a precipitous northern face, where the member is abundantly exposed in sea cliffs, and a gentle, timbered southern slope, approximately conforming to the top of the member. Within the area of this report the westernmost outcrops form the vertical precipices of the southeast part of Mount St. Alban, and can be examined at close range on the upper part of the Cape road. Due to the direction of the coast line, which cuts more deeply into the peninsula here than farther east, the limestone cliffs descend, and the base of the member disappears beneath sea level. It emerges once more before Cape Bon Ami is reached, but, as noted above, the Cape Road shales are confined to the lower part of the cliffs, so that the upper and main part of the cliffs consists of Forillon beds. It is here that the irregular transition between the two types of lithology can be observed from a distance, and samples of each examined in the great slump blocks. At a point 1.4 miles from Cape Gaspé the cliff is faulted, and the base of the Forillon member finally disappears beneath the sea. Near Cape Gaspé the cliffs fall sheer into the water and cannot be negotiated on foot. The northeast corner of Cape Gaspé is marked by the curious monolith called La Vieille (the old woman); a similar column for-

merly stood a few hundred yards to the west, and was called Le Vieux but it has since collapsed*. The extremity of Cape Gaspé is a

*These designations are as given to the writer by inhabitants of Cap des Rosiers. They do not agree with the account of the guide books.

truncated point, and displays in miniature a cross section of the peninsula (fig. 15), consisting of two parallel ridges, with steep northern and gentle southern slopes. The upper beds of the Forillon member form the northern ridge, and underlie the intervening valley. The contact with the lower member of the Grande Grève formation occurs at the base of the southerly ridge.

Owing to the relative inaccessibility of most outcrops, and the scarcity of persistent horizons, it was not considered practicable to compile a stratigraphical section of this member. As typical of the lower part, a small section may be quoted, representing the basal beds at the point where the member first comes to beach level southeast of Quay rock.

Representative section of basal Forillon beds 2,600 feet southeast of Quay rock, in descending order:

Limestone, grey, banded, interbedded with calcareous shale; not measured.	
Shale, very calcareous, hard, breaking into angular fragments; grey in colour	10 feet
Limestone, hard, ledge-forming, with bedding 0.1 to 0.2 foot thick.	2.5 "
Shale, as above	3.5 "
Limestone, shaly, prominent, about.	1.1 "
Shale, as above	6.3 "

Limestone, hard, ledge-forming, with thin shale partings 1.5 "
Concealed.

Similar lithological types can be examined along the upper part of the Cape road. Probably this phase does not exclusively make up more than the lower 200 feet of the member, as the irregularly bedded, ledge-forming limestones become conspicuous in the cliffs between here and Cap Bon Ami. Here also may be seen a feature common in Forillon beds, a locally persistent horizon formed by the weathering away of a particular thin bed. These bedding-plane crevices are useful for short-distance tracing of the dip.

A continuous section of Forillon beds was measured across the face of Cape Gaspé, from the northeast corner to the upper contact. This was done to establish the exact position of Logan's contact between his members 6 and 7, and to determine whether or not this was the best position at which to place the Cape Bon Ami-Grande Grève contact. As a result, it was concluded that Logan's boundary, based on a topographic feature did not coincide with any important lithological break. A more suitable horizon was found to occur 128 feet higher in the section, and the writer has included the beds below in his Forillon member, thus making it somewhat more inclusive than Logan's member 6.

Section of upper Forillon beds at Cape Gaspé, in descending order:

- Limestone and calcareous shale; base of Grande Grève formation. 1.3 feet
- Missing, represented by deep bedding-plane crevice; probably
bentonitic clay 0.7 "
- 9. Limestone, hard, ledge-forming, with thin shale partings;
thickness variable, but approximately 1.2 "
- 8. Limestone and calcareous shale; the limestone with lumpy
surfaces, in beds up to 1 foot thick; the shale irre-

- gularly laminated, in beds up to 0.5 feet thick;
 moderately cherty 46 "
 - 7. Limestone and calcareous shale; limestone beds flatter
 but irregular; the shale softer and less calcareous;
 in beds up to 1.5 feet thick; grey with rusty stains;
 eroded to form a sea gallery, the beds above forming
 the roof. 4.3 "
 - 6. Limestone and shale, the limestone flat-bedded and per-
 sistent, up to 1 foot thick, the shale relatively
 soft but more calcareous than that immediately above,
 colour grey, with whitish mottling, as if limestone
 were gritty 4.2 "
 - 5. Limestone and shale, much as above, but the limestone
 more irregular, up to 1 foot thick; the shale a little
 more calcareous and harder, irregularly fissile, up
 to 1 foot; grey to greenish grey in colour. 6.5 "
 - 4. Limestone, with very lumpy bedding; thin shale partings;
 very fossiliferous. 3.0 "
 - 3. Limestone and calcareous shale; the limestone beds thin,
 with very lumpy bedding, moderately cherty; shale
 very irregularly laminated; individual beds usually
 less than 0.5 feet thick, but the strata form sheer
 cliffs in places. 63 "
- Conspicuous bedding-plane crevice; this is approximately the
 horizon of the dry bed of brook coming down ravine,
 and is therefore the top of member 6 as defined by
 Logan; however, there is no fundamental change in
 lithology from above to below.

2. Limestone and calcareous shale, as above.	86.5	"
Conspicuous bedding-plane crevice.		
1. Limestone and calcareous shale, as above.	95	"
Total thickness of Forillon beds exposed	310	"

The above section terminates at the base of La Vieille, which may be reached at low tide. The beds below are locally concealed or inaccessible. It should be emphasized that from the lowest part of this section to the top of No. 8 there is no marked change in lithology, except for the somewhat softer nature of No. 7, as indicated by its tendency to erode. For this reason the writer has rejected the horizon chosen by Logan as the top of his member 6, that is, the beds at the base of the ravine. The horizon selected instead, No. 9 of the above section, as the top of the Forillon member, is conspicuous, and marks the beginning of the alternation of limestones and non-calcareous shales and clays that characterize the Shiphead member of the Grande Grève formation. Topographically this boundary lies at the base of the steep or northern side of the southerly ridge. It can be located on the basis of land form with reasonable accuracy. The stratigraphical interval involved is 128 feet; that is to say, the writer's Forillon member includes 128 feet more of beds at the top than does Logan's member 6. The structural and topographical relationships are illustrated in figure 15, which is a section across Cape Gaspé through the site of the lighthouse, and at right angles to the strike of the strata. This should be compared with Clarke's section for the same locality (1908, p. 41). Not only is Clarke inaccurate as to topographic profile, but he represents the sea level far below its actual position, so that most of the Cape Bon Ami formation appears to outcrop. As noted above, only 310 feet of the uppermost

Cape Bon Ami (Forillon member) are above the sea at Cape Gaspé, even according to the writer's more generous interpretation. Clarke's section must be condemned as very misleading. Returning to the writer's section in figure 15, it may be noted that the topographical profile is taken from the latest topographical maps, and the position of the contacts derived from plane-table and alidade surveys. The two longitudinal ridges of the Forillon peninsula are clearly indicated, as well as the valley between. The ravine that forms the lowest part of this valley at Cape Gaspé, and almost reaches sea level, was taken by Logan as the topographical marker for the top of his member 6. Clarke (1908, p. 37) in defining his Cape Bon Ami-Grande Grève contact, accepted this position without serious question. Stratigraphical reasons for placing the formational boundary 123 feet higher have been given above. The ravine is an incidental feature; the topographical interpretation followed here is that the Forillon member forms the face and slope of the northerly ridge, whereas the Grande Grève formation forms the southerly ridge. Essentially the same condition prevails for the entire length of the peninsula.

As it was not found possible to compile by direct measurement a complete section of the Forillon member, it became necessary to obtain an estimate of thickness (and thereby the thickness of the Cape Bon Ami formation) from a structure compilation along a line where both bottom and top of the member are accessible. Such a compilation appears in figure 16, which is a section across the base of the peninsula just west of Grande Grève. At the north end the line of section intersects the Cape road at its highest point. The direction is again at right angles to the regional strike.

The base of the Forillon member was not surveyed exactly at this line of section, but horizons at a known interval below were surveyed on the beach. From this the basal boundary may be plotted, as shown. The approximate top may be located in the bed of Dolbel brook, adjacent to the Cape road. Here limestones and calcareous shales are exposed, which the writer assigns on lithological and topographical grounds to the summit of the Forillon member. The highest exposure here, instrumentally located, is taken to mark the vicinity of the Cape Bon Ami-Grande Grève contact. Projecting the dip readings taken at various points along the line of section, the interpretation of figure 16 results. From this it may be determined graphically or by trigonometry that the thickness of the Forillon member is not less than 870 feet. This is in marked contrast to Logan's estimate of 300 feet for his member 6, even allowing for the extra 128 feet that the writer has added. This error, the only serious one in all of Logan's estimates of thickness, apparently was due to the fact that Logan, like the writer, could not find a locality where a direct measurement could be made. He therefore made certain structural assumptions, i.e., that the cliffs of the north shore approximately followed the strike, and obtained his figure for thickness by adding to the nearly 200 feet that he could measure at Cape Gaspé another 100 feet for concealed strata. Actually the north shore near Cape Gaspé cuts obliquely across the strike. Furthermore, faulting at a point 1.4 miles from Cape Gaspé, and probably elsewhere, has carried the base of the member much lower than suspected by Logan. In view of the fact that he had no topographical map, and lacked the opportunity to make an instrumental survey, Logan's inadequate estimate does not detract from the high quality of his work on the Gaspé limestone series.

Palaeontology and correlation. The relative paucity of fossils in the members of the Cape Bon Ami formation was noted by Logan (1846, p. 32, 1863, p. 392). A short list of fossils "from Cape Gaspé and Bon Ami Cape" was given by Ellis (1883, p. 13), based on Billings's determinations. Clarke (1908, pp. 37,38), after referring to the lists of Logan and Billings, gave a faunal list for the Cape Bon Ami formation based upon his own collection from Quay rock. He too noted the small size of the fossils, and the comparatively few species represented. These diminutive fossils in the upper part of the Quay Rock member were observed by the writer, but no specimens were collected. A similar assemblage, however, found in the basal beds of the Petit Portage member (No. 1 of the section on page 30) just north of the diabase dyke, was given some attention. The resultant small collection was referred to Dr. Madeleine A. Fritz, of the Royal Ontario Museum of Palaeontology, who kindly undertook a study of the material, and furnished the following preliminary report.

"In the first place the macrofossils are rare and, for the most part, small. They seem to represent what one might call a 'depauperate fauna'. In view of these circumstances, their specific identification is attended with considerable difficulty. Brachiopods predominate and include:

Orbiculoidea bella Billings

Pholidops (Cranlops) sp.

Leptaena sp. - very small

Chonetes sp. - very small and mucronate

Meristella laevis (Vanuxem)

Among the gastropods a small example of Platyceras is represented by two specimens. Aside from this macrofauna, a microfauna consisting of

ostracodes is present, though it has not been as yet investigated. More comparative material would be necessary in order to study adequately the fauna.

The inadequately known fauna of the Cape Bon Ami formation does not permit a detailed correlation at present. Because of the intermediate position of the formation between the St. Alban and the Grande Grève, the Cape Bon Ami fossils will probably always present a confusing mixture of Helderberg and Oriskany resemblances. As presently known, the Helderberg elements seem to predominate, and such a correlation is given in the most recent revision of the North American Devonian (Cooper et al., 1942, p. 1750).

GRANDE GRÈVE FORMATION

Definition. The uppermost formation of the Gaspé limestone series was designated by Clarke (1900, p. 81) the Grande Grève formation, from the fishing village of that name on the south side of the Forillon peninsula. Original suggestion of the name was ascribed to Ami. Clarke defined the formation as consisting of Logan's members 7 and 8. The present writer has followed Clarke in this respect, but has placed the basal contact about 128 feet higher in the section. According to the interpretation here offered, the Grande Grève formation consists of a lower member (Shiphead) of non-calcareous shales and clays, with limestones, and an upper member (Indian Cove) of interbedded cherty limestone and calcareous shale. The lower member can be measured directly but the thickness of the upper has to be computed. The total thickness of the formation is approximately 887 feet.

Distribution. The Grande Grève formation forms the southerly range of hills throughout the Forillon peninsula, extending from Shiphead to Little Gaspé and beyond. The steep north slope of these

hills is underlain by the lower member, but outcrops are almost completely absent except at Shiphead, where the member is entirely exposed. The south slope of the hill is underlain by the upper member, the surface of the land closely following the dip of the bedding planes. The exposure of the beds is almost continuous from Shiphead to Little Gaspé along the shore, with subsidiary outcrops along the road. As the coast line follows, in general, the strike of the strata, no extensive section can be seen at one place, except at Shiphead. The top of the formation outcrops in the cove at Little Gaspé. At Indian Cove (Anse Sauvage) there is a downfaulted block of Gaspé sandstone, which appears to include also the uppermost beds of the Grande Grève formation.

Shiphead member. This is essentially Logan's member 7. As noted above, the writer assigns 128 feet of calcareous beds, the lower part of member 7, to the Forillon member (member 6), but the upper boundary of Logan's member 7 and the writer's Shiphead member are identical. Variety is the only general lithological character of this member. Limestones, shales, and sandstones of various kinds are interbedded. The limestones vary from the thin-bedded, cherty type, with calcareous shale partings ("Grande Grève limestone") to massive, rather pure beds, with partings thin or absent. Among the argillaceous types are calcareous shales, either as partings between limestone or as thick beds. Again, the shale may be non-calcareous and fissile. Or it may contain arkosic or chloritic sand. The extreme is reached in the unconsolidated bentonitic clays, which occur at several horizons. Sandstone is almost exclusively confined to the top of the member, where it appears as calcareous or arkosic grits, very similar to some of the sandstones of the Middle Devonian Battery Point formation. Within the green zone at the top of the member the

most conspicuous bed consists of calcareous grit, with abundant grains of chlorite. Fossils abound in both limestone and shale, mostly well preserved, but in some cases highly comminuted. Further details of the lithology, together with the sequential relationships and the thicknesses, appear in the following complete section of the member.

Complete section of Shiphead member in cliff below lighthouse at Cape Gaspé (Shiphead), in descending order: (Figure 17)

Limestone, hard, grey, weathering light grey and buff, in beds up to 1 foot, separated by thin, irregular beds of calcareous shale (base of Indian Cove member)	2.7	feet
86. Shale, calcareous in places, in part finely fissile or friable, greenish grey in colour	0.9	"
85. Shale, arenaceous, finely friable or fissile, light green in colour	0.5	"
84. Grit, hard, calcareous, fine-grained above, coarser below, deep green in colour, banded	0.35	"
83. Grit, argillaceous, rather soft to rather hard, finely friable, light green	0.65	"
82. Limestone, hard, grey	0.1	"
81. Grit, argillaceous, finely friable, light grey-brown	0.3	"
80. Limestone, hard, grey, with rusty yellow stains	0.9	"
79. Grit, very argillaceous, finely friable and fissile, soft, light grey-green	0.6	"
78. Limestone, hard, grey, with rusty yellow streaks.	0.4	"
77. Grit, calcareous, moderately hard, grey in colour, with darker streaks; rusty yellow stain	0.2	"
76. Shale, very arenaceous, earthy, light grey-green.	0.1	"

75. Limestone, impure, hard, greenish grey, weathering greenish and rusty yellow; massive in upper part but with cleavage planes below; a conspicuous flat bed 1.3 feet
74. Shale, calcareous, fissile, light greenish grey. 0.1 "
73. Limestone, argillaceous, almost a shale at top, but merging into hard, massive rock below; greenish grey, weathering greenish, with rusty stains. 1.4 "
72. Shale, finely gritty above, becoming less arenaceous below; fissile above, platy below, colour greenish grey above to grey below 1 "
71. Limestone, impure, hard, splitting into irregular plates top surface flat, but numerous irregular nodular masses within bed; colour grey with suggestion of green 0.6 "
70. Shale, calcareous, and finely gritty with irregular platy cleavage, greenish grey 1.1 "
69. Limestone, hard, grey, weathering greenish or rusty yellow; upper surface crinkly 0.5 "
68. Shale, calcareous and finely gritty; irregular platy cleavage; colour variegated grey, greenish grey, and bluish grey, with rusty yellow stains; lowest 0.6 feet is more finely laminated, with a $\frac{1}{8}$ -inch bed of greenish grey calcareous grit, below which is another 1 inch of greenish grey shale 3 "
67. Grit, calcareous, hard, with distinct grains, consisting of grey, greenish, white, and pink particles, and fragments of fossil shells; general colour light grey, bedding planes bear many rusty brown markings, some showing branching, and a vague structure; some irregularity of lower surface but thickness about 0.5 "

66. Grit, calcareous, but more shale-like than above; grains larger, the pink ones being very common; general colour greenish grey; some small green fragments 0.3 feet
65. Grit, calcareous, hard, with fine banding; grains similar to those of bed above, but rock more calcareous; colour less greenish than that of bed above. 0.5 "
64. Grit, moderately calcareous, not hard, breaking readily into fine irregular slivers; grains similar to those above but rock softer; colour dark greenish grey, speckled with pink 0.2 "
63. Shale, calcareous, finely arenaceous, cleaving into small, irregular plates, light greenish grey 4.2 "
62. Limestone and calcareous shale, alternating; the limestone hard, not noticeably cherty, rather regularly bedded, in beds up to 0.3 feet, but many much thinner, some calcareous nodules; the shale hard, with wavy bedding, in thicknesses up to 0.7 feet; large amount of fossil shell, much of it fragmentary; colour grey, weathering light grey and yellowish. 15.5 "
61. Shale, soft, bentonitic, weathering readily, with formation of a conspicuous bedding-plane fissure; light greenish grey 0.15 "
60. Shale, calcareous, well laminated, with some thin limestone beds: very large amount of fossil material, much of it badly broken 6.4 "
59. Shale, calcareous, hard, becoming less calcareous and more friable in lower part; no true limestone beds, but upper part shows some calcareous banding; no conspicuous marker beds; colour light grey, becoming darker,

	almost bluish, below; rusty yellow stains; well preserved fossils in upper part of the darker, less calcareous phase	51 feet
58.	Shale, as above, but harder and more calcareous	3 "
57.	Clay, bentonitic, plastic, soft, light grey and yellowish; numerous limestone concretions	0.3 "
56.	Clay, bentonitic, plastic, light buff in colour, grey, rusty, or brown in places	0.2 "
55.	Limestone, hard, in beds of about 0.5 feet above, becoming more massive below; thin, irregular shale partings; colour light grey or bluish grey, weathering rusty yellow; abundant fossils	10.5 "
54.	Bentonite, soft, friable, with soapy feel, pale greenish grey or buff in colour, with rusty stains in cracks . . .	1.8 "
53.	Limestone, hard, nodular, dark grey in colour, with brown stains	0.2 "
52.	Clay, earthy, brown in colour	0.1 "
51.	Clay, somewhat arenaceous, moderately hard, dark bluish grey in colour, with rusty stains, ferruginous at base; imperfect fossil gastropods	0.3 "
50.	Limestone, hard, massive, dark grey, rusty weathering . .	1.2 "
49.	Clay, moderately hard to earthy or slightly plastic; light brown to brownish grey.	0.4 "
48.	Limestone, hard, massive, dark grey-brown, with rusty stains	0.8 "
47.	Bentonite, harder and less friable than bed number 54, soapy feel, pale greenish or yellowish grey	1.4 "
46.	Limestone, dark grey, with rusty stains	1.5 "
45.	Bentonite, soft, moderately plastic, light greenish grey	

	in colour, rusty brown on top	0.5 feet
44.	Shale, moderately hard, coarsely friable, concretionary in places, dark greenish grey, with brown stains. . . .	1.5 "
43.	Shale, bentonitic, soft, rather plastic, pale greenish grey, with rusty streak at base	0.5 "
42.	Limestone, massive, ledge-forming, with thin calcareous shale partings; scattered spheroidal calcareous nodules; colour grey, weathering light grey and rusty yellow . .	4.3 "
41.	Limestone, similar to above, including nodules, but with numerous shale partings of about 0.1 feet thickness; grey-brown in colour.	3.3 "
40.	Shale, moderately hard, rather fissile, grey-brown . . .	1.5 "
39.	Shale, bentonitic, soft, crumbly, pale yellowish grey. .	0.6 "
38.	Limestone, hard, massive, ledge-forming, purplish grey in colour, with fine beds of dark grey; yellow and rusty stains	1.1 "
37.	Shale, moderately hard, rather fissile, grey-brown; some- what softer, and slightly bentonitic in lower 0.2 feet.	0.9 "
36.	Limestone, hard, massive, ledge-forming, purplish grey, not banded, weathering light grey and yellowish	1.4 "
35.	Shale, moderately hard, rather fissile, slightly bento- nitic, grey-brown in colour	1.1 "
34.	Shale, harder, yellowish brown, with dark brown streaks and purplish stains	0.4 "
33.	Shale, moderately hard, as in No.35.	2.6 "
32.	Shale, bentonitic, soft, plastic, yellowish grey to yellow	0.3 "
31.	Limestone, hard, massive, ledge-forming, with numerous thin partings of fissile shale; colour grey to grey-brown with some banding; weathers yellowish and purplish . .	6.0 "

30. Shale, moderately hard, fissile to very fissile; grey to grey-brown, with numerous fine convoluted dark markings on the bedding planes; spheroidal calcareous nodules . . 1.6 "
29. Shale, rather soft, friable but crumbly, slightly bentonitic; greenish grey, with rusty streaks 1.0 "
28. Limestone, cherty, hard, massive, ledge-forming, very flat on top, irregular below; colour grey, weathering light grey, with yellow stains 1.3 "
27. Limestone, and calcareous shale, thinly and irregularly interbedded, slightly cherty; individual beds not over 0.3 feet thick: forms small cliff but weathers into irregular fragments; some spheroidal calcareous nodules colour grey, weathering light grey and yellowish; beds more massive near base 2.4 "
26. Clay, bentonitic, soft, crumbly, light grey and rusty yellow. 0.2 "
25. Limestone, hard, massive, with thin shale parting 0.4 feet from top; grey, weathering brown, light grey, and yellowish. 2.2 "
24. Limestone, concretionary, and soft, crumbly clay, irregularly mixed; light grey-brown 0.7 "
23. Limestone, hard, massive, with one or two thin shale partings; grey in colour, weathering brown, light grey, or yellowish; fossiliferous 4.5 "
22. Shale, soft, finely flaky above, becoming plastic and bentonitic below; brownish grey, light grey at base . . 0.9 "
21. Limestone, hard, cliff-forming uppermost 1.5 feet massive, but remainder with numerous thin calcareous shale partings; colour grey, weathering pale grey, pale

- yellow, and rusty 15.5 "
20. Shale, rather hard, friable, becoming softer and somewhat bentonitic towards base; colour steel grey, with rusty brown streaks 4.2 "
19. Limestone, hard, cliff-forming, with numerous beds of calcareous shale except in upper 4 feet and lower 1.5 feet, which are massive with a few thin partings; colour grey to grey-brown, weathering light grey, yellowish, and rusty. 16.5 "
18. Shale, soft, bentonitic, crumbly, semi-plastic, colour light grey-brown, yellowish and rusty at base 1.4 "
17. Limestone, hard, massive cliff-forming, with some calcareous shale; top bedding plane very flat; colour grey, weathering brown, light grey, and light buff; conspicuously fossiliferous 5.4 "
16. Shale, finely fissile, moderately hard, grey-brown in colour; merging below into calcareous shale 0.9 "
15. Limestone, and shale, cliff-forming, irregularly interbedded: the limestone hard, nodular, in beds up to 1.5 feet thick; the shale fissile, partly calcareous; colour grey and grey-brown, weathering pale buff and rusty 5.7 "
14. Shale, rather soft, fissile but crumbly, becoming somewhat bentonitic at base; flat nodules at top; colour grey, slightly greenish, weathering pale grey and rusty. 1.5 "
13. Limestone, hard, massive, ledge-forming, with a few thin shale partings, and streaks of calcareous grit in places; colour grey, weathering light grey and buff. . 1.5 "
12. Shale, mostly soft, fissile at top, remainder crumbly

- with calcareous streaks, distinctly bentonitic in lower 0.1-0.2 feet; colour grey, greenish grey, and pale yellow 0.5 "
11. Limestone and calcareous shale, cliff-forming; the limestone hard, massive, in moderately regular beds, up to 1.5 feet thick, with furoid markings: the shale irregularly laminated, hard, with calcareous nodules in beds up to 1.5 feet thick but usually less; colour grey, weathering light grey and buff 13.3 "
10. Shale, moderately hard, finely friable, grey in colour, weathering light grey 1.4 "
9. Limestone and calcareous shale, cliff-forming, similar to No. 11 above. 8.4 "
8. Shale, rather hard, top non-bentonitic, but progressively more bentonitic toward base; colour grey at top, shading to bright grey-green at base; large spheroidal concretionary masses, presumably calcareous 1.6 "
7. Limestone, hard, ledge-forming, massive, with thin shale partings in lower part; colour brownish grey, weathering light brown and rusty yellow 3.0 "
6. Shale, rather soft, coarsely friable, but weathering flaky, distinctly bentonitic; colour greenish grey with rusty stains; calcareous bed about 0.4 feet thick occurs at 1.1 feet from top 4.4 "
5. Limestone, hard, massive, ledge-forming, flat on top; furoid markings; colour grey, weathering buff and brown. 1.8 "
4. Limestone and calcareous shale, hard; the limestone with lumpy bedding; the shale irregularly laminated; grey

in colour weathering buff; fucoïd markings	3.7 feet
3. Missing, represented by deep bedding-plane crevice, probably bentonitic clay.	0.8 "
2. Limestone and calcareous shale, as in No. 4 above, but more massive in places; fucoïd markings and some brachiopods	1.3 "
1. Missing, represented by deep bedding-plane crevice; probably bentonitic clay.	0.7 "
Limestone, hard, ledge-forming, with thin shale partings; top of Forillon member; thickness varies, but about. . . .	1.2 "

The base of the above section, and the contact with the underlying Forillon member, appears on the northeast side of the small point down which one climbs to reach the shore at Shiphead. It is at this horizon that the relatively uniform limestone and calcareous shale gives way to the highly varied sequence of the Shiphead member. Conspicuous are the very flat-bedded limestones, usually fossiliferous, the grit beds near the top, and the green zone at the summit. Many of the softer beds including the bentonites, are normally concealed by slumped material and have to be exposed by digging. Of the numbered components of the section, the following were made accessible in this way: Nos. 6, 29, 30, 32, 35, 37, 39, 40, 43, 54, 56, and 58. Some of the bentonitic beds, such as Nos. 6, 47, and 54, are thick enough to have commercial possibilities. Of these, No. 47 appears to be the most uniform in composition. These bentonites are very similar to those occurring in the Upper Cretaceous of southern Manitoba, and are no more consolidated. The waxy appearance, the soapy feel, the conchoidal fracture, and the light green or yellow colour, are characteristic features in field recognition. If fragments of the material are thoroughly dried, and then placed in water,

they swell up and flocculate in a manner similar to that of the Cretaceous bentonites, and do not crumble, as do the meta-bentonites of the Ordovician. It is now generally held that bentonite is an alteration product of volcanic dust. In marine deposits, where the "ash" fall may be expected to have settled as a uniform layer over a wide area of sea bottom, bentonite beds have great lateral persistence, and make excellent stratigraphic horizons. However, being soft, they appear only in the freshest of outcrops, and being flocculent, they are often lost from well records. A special effort should be made to locate these beds in sections of the Grande Grève formation farther west, as they offer the best hope of direct correlation with the Forillon section. Speculation as to the origin of the volcanic material is probably of little value, but if it were derived from the Lower Devonian volcanoes of the Restigouche area, the deposits might be expected to thicken, rather than to disappear, west of the Forillon.

The grit zone, Nos. 64 to 70, is of some theoretical interest. The abundance of angular quartz grains, and fragments of calcite* and pink feldspar, strongly suggest certain rocks of the Gaspé sandstone series. This is further emphasized by the abundance of carbonaceous fragments, and even recognizable plant structures, in certain beds. It is suggested that this grit zone indicates a brief approach to near-shore or even non-marine conditions before the re-establishment of stable marine conditions, represented by the Indian Cove member.

The green zone at the top of the Shiphead member is a very unusual and conspicuous set of beds. Logan (1863, p. 393), who designated these as the top of his member 7, referred to them as calcareo-arenaceous shales, nearly grass green. The writer's observations show that while many of the beds are distinctly argillaceous, the abundance of angular grains of quartz and calcite suggests the term

*Calcite fragments are not characteristic of the Gaspé sandstones (ed., 1975).

grit as a more suitable designation. The most conspicuous bed, No. 84, is very low in argillaceous matter, and is properly called a calcareous grit. The unusual colour of the beds, especially bright in the case of No. 84, is not strictly a grass green, but has a faint bluish tinge which suggests the colour of Paris green. It is difficult at present to reach the green zone, as it is almost completely concealed by fallen material where it comes down to beach level. At other points it occurs immediately above a sheer cliff, making its examination risky. The writer reached it by climbing the talus slopes immediately below the fog signal-house, a somewhat arduous but not particularly difficult approach. This limited accessibility may account for the fact that no effort appears to have been made in the past to learn the composition of the green beds and the nature of the colouring matter. The writer's samples from beds No. 83 and No. 84, together with thin sections of the latter, were submitted to Dr. W.W. Moorehouse, of the Department of Geological Sciences, University of Toronto. Dr. Moorehouse reports as follows.

"The rock is a bright green sandstone, containing recognizable calcareous fossils and a variable amount of carbonate. In thin sections the rock is found to consist of fragments of quartz, feldspar (alkali plagioclase and orthoclase), altered acid and basic volcanics (?), and carbonate (including fossil remains). For the most part these grains are quite angular in form. In addition to this clastic material, there are oolitic grains and shreds of green chloritic material of which the majority has a clear blue-green colour, and appears to be chiefly in the form of microcrystalline aggregates. Some is much paler in colour and typically shreddy in habit. Leucoxene granules are abundantly associated with both types. In addition there are a few oolites of greenish brown colour, some of which

are enclosed within fossil remains. A little sericite is present.

"Due to the extremely fine grain of most of the material, and the presence of more than one type of material, it has been practically impossible to obtain accurate data on the optics of these chlorites. Two unusually clear grains gave biaxial negative figures with a $2V$ probably about 10° and strong dispersion ($2V$ for red light greater than $2V$ for blue light). This material however seems to have higher indices than the typical microcrystalline chlorite. The index of refraction seems to lie in most cases between 1.59 and 1.60, probably nearer 1.592. The birefringence appears to be about .008. The above minerals are imbedded in a matrix of carbonate.

"The rock is obviously a combination of chemical and clastic deposits. The clastic material appears to have resulted from predominantly mechanical breakdown of granites and volcanics. The shreddy chloritic material appears to have been formed by the alteration of some ferromagnesium mineral such as biotite. The microcrystalline aggregates (oolites) may have a similar origin but I think it more likely that they represent colloidal addition compounds formed on the sea floor, at moderate to shallow depths."

Indian Cove member. This, the uppermost subdivision of the Grande Grève formation and Gaspé limestone series, is that portion designated by Logan (1863, p. 393) as member 8. A characteristic and uniform lithology marks this member, except for a few feet at bottom and top. This lithology is of the type commonly associated with the name Grande Grève. It consists of an almost regular alternation of limestone and calcareous shale. The limestone, hard, and more or less cherty, occurs in beds about 0.5 feet in thickness, or occasionally much thicker. The surfaces of these beds, especially the upper surfaces, are characteristically of an undulatory form, as if the original sediment has settled very unevenly. Seen on the outcrop face, the bed thus presents an appearance of repeated thickening and thinning. It is assumed that the presence of chert has some relationship to this character of the bedding, but the thicker portions of the beds show little trace of concretionary structure. Fossils are usually abundant in the limestone beds, but are difficult to extract. The calcareous shale beds have an average thickness of about 0.3 feet. They consist of numerous plates or laminations. The greater resistance to erosion of the limestone as compared with the shale causes the former to project along the face of the outcrop, producing a characteristic ribbed appearance.

As noted above, the rocks of this member form the southerly slope of the southern ridge on the Forillon peninsula. Outcrops, however, are almost entirely confined to the coast, where they are nearly continuous from Shiphead to Little Gaspé (Figure 18). As this shore closely approximates in direction the general strike of strata, and as there is an absence of persistent horizons, no complete section of the member could be compiled. The lower portion was measured at Shiphead, where the outcrop is transverse to the strike, and small sections were compiled for the vicinity of the upper boundary. Total thickness was computed indirectly, as explained below.

Section of lower part of Indian Cove member at Shiphead, in descending order:

Limestone and calcareous shale, alternating; typical "Grande Grève" lithology, as described above	+85	feet
Grit, calcareous, hard, grey in colour, with fine shaly partings in places but with little tendency to split; top and bottom irregular, but conspicuous flat bedding plane near middle	1.3	"
Limestone and calcareous shale, as above, but with thin beds of earthy shale, having a fine, wavy bedding.	10	"
Shale, non-calcareous, moderately hard, with fine, rather regular bedding; grey in colour, weathering light grey.	0.2	"
Limestone, hard, grey, weathering light grey and buff, in beds up to 1 foot in thickness, separated by thin, irregular beds of calcareous shale	2.7	"
Shale, arenaceous, pale green, crumbly (top of Shiphead member)	0.5	"

From the above section it will be seen that the passage from Shiphead to Indian Cove beds is abrupt, although a few thin beds of non-calcareous or gritty rock do occur above. The possibility of this boundary being a minor unconformity must be taken into consideration; such a view is supported not only by the abruptness of the change, but by the apparently non-marine nature of some of the beds below.

The top of the Indian Cove member is exposed at Little Gaspé, in the angle of the cove, close to the old galena prospects. Here the following section was measured.

Section at Indian cove - York River contact, in vicinity of Little Gaspé

Sandstone, medium-grained, somewhat calcareous, with fine carbonaceous fragments: light grey in colour, weathering light brown; well bedded but not noticeably cross-bedded average layer about 3 inches in thickness, forming flagstones readily; top concealed, but thickness at least . . .	12 feet
Sandstone, somewhat calcareous, thinly and irregularly bedded (base of York River formation)	0.4 "
Limestone, impure, ferruginous, bluish grey in colour, weathering rusty grey; upper surface very irregular, suggesting concretionary structure (top of Indian Cove member) . . .	0.4 "
Limestone, impure, rather thinly bedded, splitting readily; colour light bluish grey; apparently very argillaceous .	3 "
Limestone, massive, relatively pure: bedding planes flat; colour light bluish grey; numerous fossils, especially corals and brachiopods, and also abundant fucoid markings: thickness not measured	

The occurrence of this contact at Little Gaspé was noted by Logan (1846, pp. 33, 34). Others who have commented on this contact are Ellis (1883, p. 9) and Kindle (1938 p. 65). The massive, flat-bedded limestone begins to merge into the cherty, undulating limestone of Grande Grève type within about 20 feet of the contact. The uppermost bed of the Indian Cove member in the above section is of peculiar lithology, and has the appearance of having been subjected to subaerial oxidation. This, together with the very abrupt change in lithology, suggests the possibility of an unconformity at this horizon.

A second exposure of the Indian Cove-York River contact occurs at Indian cove (Anse Sauvage). At the east end of the beach here, where a small brook comes down, there is a steep wall of typical Indian Cove limestones and shales, with strike 354° , and dip 41° to the west. It is thought that the brook follows the line of a fault here. Immediately to the west the beds, still of Indian Cove type, have a strike of 328° and a dip of 31° to the southwest. About 170 feet northwest of the brook a well-defined fault appears in the low cliff. The plane of this fault has a strike of about 10° , and dips about 80° to the west. West of this fault the beds are still of Indian Cove type, but are highly disturbed, with a dip and strike almost coinciding with those of the fault plane, and some suggestion of drag folding. About 80 feet northwest of the fault the limestones become massive and flat-bedded, although shale partings persist. Here the strike is 357° , and the dip 53° to the west. Above the highest massive limestone are about 5 feet of thin-bedded limestone, with much calcareous shale, grey in colour, weathering rusty yellow. This is taken to be the top of the Indian Cove member.

The strata above consist of about 15 feet of argillaceous sandstone, massive to thin-bedded, with some cross bedding. Next come 50 feet or more of thin-bedded sandstones and impure shales, the colour varying from grey to grey-brown, greenish grey, and buff. Plant remains and scraps of fishbone occur in these beds. Towards the west end of the outcrop, massive beds of light brown sandstone appear, with thin-bedded sandstone above. There is a concealed interval of about 100 feet horizontally, and then comes a wall of Indian Cove limestone and shale, forming the western boundary of the cove. This wall apparently follows a fault plane, which would have a strike of about 33° and an almost vertical dip*. The strata to the west have a strike of 328° ., and a dip of 17° to the southwest. From

*This fault is the site of a former galena prospect, mentioned by Logan (1846, p. 35).

this it will be seen that the change from Indian Cove to York River beds, although differing in details from the sequence at Little Gaspé, is similarly abrupt.

Although the various outcrops of Indian Cove beds between Shiphead and Little Gaspé were carefully examined, both in the sea cliffs and along the road, it was found impracticable to attempt direct compilation of a columnar section. The line of outcrops closely parallels the strike, there is a complete absence of useful horizon markers, and there are numerous small-scale faults. An approximate estimation of the thickness can be obtained from the structure section across the Forillon in the vicinity of Grande Grève (fig. 16). From the uppermost Forillon beds in Dolbel brook to the shore near Grande Grève, there is a stratigraphic thickness of about 870 feet.

Subtracting 287 feet for the Shiphead member, about 583 feet may be assigned to the Indian Cove division. However, the uppermost boundary outcrops 3,900 feet to the northwest of this line of section, and is somewhat higher stratigraphically. It may be estimated, therefore, that the Indian Cove member has a thickness of at least 600 feet.

Palaeontology and correlation. The rich invertebrate fauna of the Grande Grève formation has been the subject of study and comment by many previous workers in this field. Logan's faunal list (Logan, 1863, p. 393) was a preliminary one, and referred mainly to genera. Later, Billings (1874) described the Gaspé Limestone fossils, most of which were from Logan's member 8. Ells (1883, p. 13) gave a list of species, obviously derived from member 8, and based mainly on the determinations of Billings. A second list was subsequently given by Ells (1884, p. 24), based on new material from the vicinity of Grande Grève, and determined by Ami. Clarke apparently devoted more time to collecting in the Grande Grève beds than in any other part of the series, and his list (Clarke 1908, pp. 43-46), incorporating the revision of Logan's collection, is a lengthy one. He distinguished three subdivisions of the formation, the first corresponding to Logan's member 7 (or approximately the Shiphead member of this report), the second to the main part of member 8 (Indian Cove member), and the third to the relatively pure limestone at the top of the Indian Cove member. The overwhelming majority of species are recorded by Clarke as from his subdivision 2. It should be noted that the fossils from Dolbel brook, included by Clarke in subdivision 1 of his Grande Grève, would be placed by the writer in the upper part of the Forillon member of the Cape Bon Ami formation.

The writer made no attempt to collect the abundant but firmly

inbedded fossils of the Indian Cove member, in view of the extensive series accumulated by his predecessors. However, some attention was given to the fossil content of the Shiphead member at Cape Gaspé. Here, too, the hard limestone beds contain abundant specimens, well preserved but difficult to extract. Fortunately, however, fossils also occur in the softer, non-calcareous shales, and excellent material may be obtained from the upper part of No. 59 of the section on page 57. From this zone the writer made a representative collection. Subsequently Mr. G.E. Lindblad obtained additional material here for the Royal Ontario Museum of Palaeontology. As this occurrence has not been recorded previously, and as the fossils of the Shiphead member are not well known, the writer requested Dr. Madeleine A. Fritz to examine the combined collections. Dr. Fritz offers the following identifications and comments.

List of fossils from Shiphead Member, Cape Gaspé

Brachiopoda

Chonetes billingsi Clarke

Chonetes canadensis Billings

Leptocoelia flabellites (Conrad)

Leptostrophia sp.

Pelecypoda

Nuculites cf. nyassa Hall (possibly new species)

Nuculites sp. (a long variety)

Nuculites triquetra Conrad

All these Nuculites suggest a later fauna.

Gastropoda

Coelocampus hebe (Billings)

Eotomaria delia (Billings)

Incertae Sedis

Hyolithus oxys Clarke

Hyolithus richardi Clarke

Conularia penoulli Clarke

Conularia sp. (coarse form with strong nodes)

Cephalopoda

Orthoceras sp.

Kionoceras champlaini Clarke

Ostracoda

Aechmina sp. (possibly new)

Kloedina sp. (possibly new)

Trilobita

Odontocheile cf. micrurus (Green)

Phacops logani cf. gaspensis Clarke

Plantae

Undetermined fragments of stout stems.

Students of the Grande Grève fauna have been almost unanimous in correlating it with that of the Oriskany of New York. Logan (1863, p. 391) originally referred the entire Gaspé limestone series to the "Lower Helderberg", and hence, by the then current usage, to the Silurian. Later Billings (1874, p. 2), recognized the Oriskany aspect of the upper faunas, and assigned members 7 and 8 to that equivalence. Ellis (1884, p. 25), after listing fossils from Grande Grève and from the Gaspé sandstone, says, "all of the above belong to the Oriskany".

In Clarke's first reference to the Gaspé Limestone faunas (Clarke, 1900, pp. 80-81), he spoke of the fauna of members 7 and 8 as having strong Oriskany traits, with a notable constituent of Helderberg origin. This opinion he amplified later (Clarke, 1908, pp. 250, 251), after revising the Grande Grève fauna, and his state-

ment is worthy of full quotation. "The more profuse fauna of the Grande Grève limestones, rising to about 150 recorded species, has a less proportion of community with the Helderbergian but still a substantial number of species (21 identities and 14 close affines). With the Oriskany there is a larger community of species (39 identities and 13 affines) and so commanding is this percentage and the composition of the congeries itself, consisting as it does of the most typical species of the Oriskany, that it compels this inference: The development of this Oriskany fauna was synchronous with the prevalence of the Helderbergian fauna in this region and the differentiation of the two faunal elements which we commonly recognize in the Appalachian regions as Helderberg and Oriskany, was subsequent in date to the development of the combined faunas together in Gaspé. Thus again we have evidence that the Gaspé basin was a center of dispersion of these two faunas and that the direction of this dispersion so far as the facts now indicate was still toward the southwest".

Another statement by Clarke on the Grande Grève fauna appears in the International Geological Congress Guide Book, (Clarke, 1913, p. 106), and is as follows: "Taken as a whole the species of the Grande Grève member are eminently characteristic of the Helderberg - Oriskany with a considerable representation suggestive of incipient stages of the later Onondaga fauna of the New York standard". One of the last words on the subject by this author appeared in his "Pic d'Aurore" paper (Clarke, 1915, p. 148), where he said of the Grande Grève formation that "its upper beds carry clear indications of a later than Oriskany fauna, while its lower beds express the Oriskany element".

In the controversy over the age of the Gaspé sandstones (Williams, 1910), the age of the Grande Grève beds was discussed. Schuchert (op. cit., p. 695) mentioned the occurrence of typical late Oriskanian fossils at the base of, or below, the Grande Grève (presumably from

the outcrops on Dolbel brook). He also noted occurrence of Onondaga-like elements among the predominantly Oriskanian fauna of the typical Grande Grève. Similar views were expressed by Clarke on the same occasion.

The latest correlation of the Grande Grève is that given by Cooper (Cooper et al., 1942, pp. 1762, 1763), who referred the entire formation to the Deerpark stage of the Oriskany, stating that although the top of the sequence may be higher than any New York Oriskany, no unequivocal Onondaga forms have yet been taken from it.

OTHER SECTIONS OF THE GASPE LIMESTONE SERIES

Roncelles Road. This name is applied locally to Highway 6* between Cap des Rosiers Est and the junction with the shore road near D'Aiguillon. Calcareous grits of the lower Roncelles member are seen on the north side, about 1 mile west of the road junction at Cap des Rosiers Est. The first distinct rise in the road, travelling from Cap des Rosiers towards Gaspé, is formed by the limestones of the Roncelles member. An interval marked by a broad valley crossing the road evidently represents the position of the shales of the Rosebush Cove and Petit Portage members. This is followed by a steep hill, on both sides of which are exposures of alternating limestones and calcareous shale. The presence of contorted beds identifies these as part of the Quay Rock member. In the interval of comparatively level road south of here the shales of the Cape Road member might be expected to occur, but the intermittent exposures reveal only calcareous beds. Neither is the position of this member discernible on the mountain face immediately to the west. Examination of aerial photographs shows that the escarpments extending west from the sea cliffs, and marking the respective positions of the Quay Rock and Forillon members, appear to come together in the vicinity of the

* Route 132 (ed., 1975).

Roncelles road. From these observations it appears likely that the Cape Road member loses its identity in this locality, and that the Quay Rock and Forillon members form a continuous series of calcareous beds. The next important group of outcrops occur on the north side of the last big hill, where the road crosses the southerly range. This range is the continuation of the southerly ridge on the Forillon, and has a well defined valley marking its north side. By analogy, the Shiphead member would be expected to form the north face, and the Indian Cove member the crest and southern slope. Unfortunately the exposures are intermittent, and somewhat weathered. Soft, non-calcareous shale occurs at several points on the north slope, but the bentonites or the green zone were not observed. Towards the summit of the hill the calcareous shales and limestones of the Indian Cove member come in, and appear in several outcrops on the top and part way down the southern side. The contact with the Gaspé sandstone series is believed to cross the road about half way down the slope. The bed of Little Gaspé brook, which parallels the southern side of the range, is certainly located on lower Gaspé sandstone.

Headwaters of Little Gaspé brook. Followed westward from the Roncelles road, the course of this stream continues parallel to the trend of the range to the north. North of D'Aiguillon, however, there is an abrupt change in direction where the main branch descends directly down the south slope of the mountain. Climbing the stream bed, one encounters outcrops of Gaspé sandstone not far above the bend. These appear to be typical York River beds. Eventually the characteristic limestones of the Indian Cove member are met. The actual contact is concealed, but the obscured interval is small, and the change must be abrupt.

Griffon Cove river. Basal beds of the Gaspé limestone series are well exposed in this stream about 3 miles north of Gaspé bay. The contact with the dark Ordovician shale appears to be faulted. The Devonian beds consist of reddish limestone conglomerate and arenaceous shales, overlain by a massive dark conglomerate with white quartzite pebbles. These beds were designated by Kindle (1938, p. 51) as the Griffon Cove River beds, and considered to be older than the lowest St. Alban exposed on the coast. Farther upstream the rocks are calcareous shales and limestones, with only a trace of the calcareous grits seen at the base of the coastal section. Other outcrops farther upstream are too isolated to be assigned to any particular member, although the characteristic topography of the two ranges, with intervening valley, persists.

Fox river. Good exposures of lower members of the Gaspé limestone series occur on Fox river and the adjacent Highway 6A* about 5 miles north of Gaspé bay. Here the contact with the Ordovician appears conformable. The basal Devonian beds are varied, including grey, greenish, and red shales, laminated limestones, calcareous grits, and beds of stromatoporoids. The peculiar quartzite conglomerate of Griffon Cove river was not seen here. Above this varied zone the rocks are mainly calcareous shales, as in the Roncelles member. These pass into greenish and reddish shales, similar to those of the Rosebush Cove member. The Petit Portage and Quay Rock members appear to be represented by shales and limestones in the vicinity of the three bridges, $4\frac{1}{2}$ miles north of Gaspé bay.

* Route 197 (ed., 1975).

Dartmouth river. The Ordovician-Devonian contact appears to cross this stream just downstream from the site of the fish hatchery, $1\frac{1}{2}$ miles above the mouth of Ladystep brook*. Here dark sandstones and shales, with calcite veins, are overlain by conglomerates containing quartzite, chert, and volcanics, very suggestive of the Griffon Cove River conglomerate. From here to a point about $3/4$ mile downstream, exposures are few, but from there on the strata appear almost continuously in the bed and along the banks. The first group of limestones and shales encountered probably represents the upper part of the Forillon member. Eventually the stream makes a sharp bend to the east, and just above this point there are softer shales present, suggesting the occurrence of the Shiphead member. From here to Ladder pool the rocks appear to belong to the Indian Cove member, and have the typical "Grande Grève" lithology of hard, ledge-forming limestones, partly cherty, with undulatory bedding planes, separated by platy calcareous shale. At Ladder pool the transition to the Gaspé sandstones (York Lake beds) is exposed. These are mainly thin-bedded limestone and calcareous grits, with comminuted fossils. Above these again are typical Gaspé sandstones with plant remains.

* Pas de Dame brook (ed., 1975).

Percé. The Devonian section at Percé, as currently interpreted (Alcock, 1935, pp. 66-68), consists of two formations, the Mont Joli, outcropping along the south and east faces of Mt. Joli, and the Murailles, which forms Cap Barré, the Murailles, and Percé rock (Figures 19 to 22). The following comparisons are intended to be merely suggestive and not to imply definite correlations. The Mont Joli beds are very similar to the lower part of the Cape Road member near Quay rock. In the Percé development the limestones are thicker and more numerous, and the shale occurs in thinner beds. On the south face of Cap Barré there is a transition from calcareous shale and limestone to beds predominantly limestone. The massive, vertically dipping limestone of Percé rock shows in places the banding with calcareous shale that is so characteristic of the Quay Rock member and the lower part of the Forillon member. No cherty undulating

limestones of Grande Grève type were observed. The reddish colours of Percé rock are probably the result of seepage from the Bonaventure beds which once overlay all of the Devonian here. Lithological evidence favours a close comparison of the Percé Devonian with the Cape Bon Ami formation of the Forillon. Palaeontologically the closest resemblances are said to be with the Grande Grève (Clarke, 1913, p. 96).

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Figure 1 - St.Alban (Roncelles) limestone in fault contact with Cap des Rosiers shale to right. Shore south of Cap des Rosiers Est (p.21).

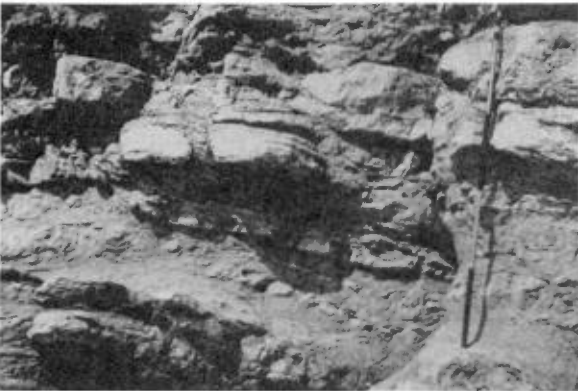


Figure 2 - Gritty and conglomeratic beds near base of Roncelles section. Shore south of Cap des Rosiers Est (p.22).



Figure 3 - Roncelles limestone and shale. Shore south of Cap des Rosiers Est (p.22).



Figure 4 - Greenish shale, Rosebush Cove member. Shore south of Cap des Rosiers Est (p.26).



Figure 5 - Maroon shale zone in Rosebush Cove member. Shore south of Cap des Rosiers Est (p.26).



Figure 6 - Contact of St.Alban (Rosebush Cove member) with overlying Cape Bon Ami (Petit Portage member). Shore south of Cap des Rosiers Est (p.28).



Figure 7 - Calcareous shale with fossiliferous limestone beds in lower Petit Portage member (No. 1, p.30). Shore south of Cap des Rosiers Est.



Figure 8 - Limestone ledge (No. 7, p.29) in Petit Portage member. Shore south of Cap des Rosiers Est.

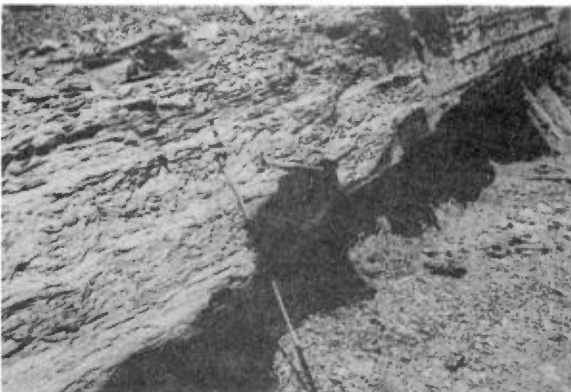


Figure 9 - Detail of fig. 8, showing crenulated bands.

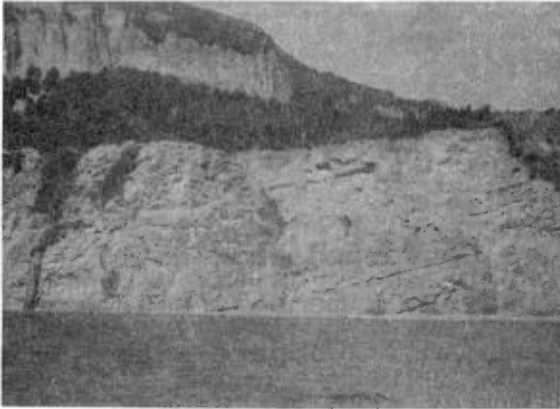


Figure 10 - Cliffs south of Cap des Rosiers Est. Petit Portage member overlain by Quay Rock member in sea cliff. Diabase dike on left. Forillon member in cliffs of Mt. St. Alban above. Intervening belt of trees underlain by Cape Road member (p.30).

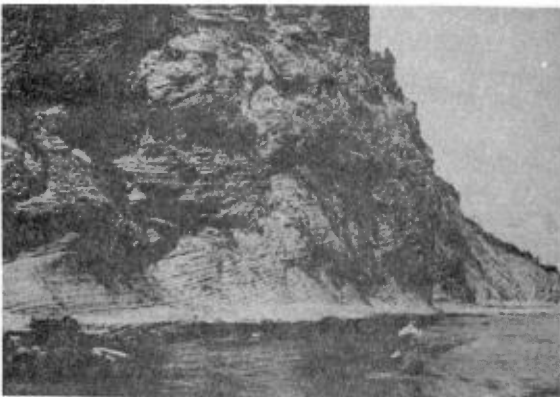


Figure 11 - Looking northwest from off-shore rocks about 600 feet southeast of diabase dike. Quay Rock member. Contorted beds (No.27, p.31) overlying calcareous shale and limestone (No.26, p.32).



Figure 12 - Northeast face of Quay Rock. Quay Rock member. (No.26, p.32).



Figure 13 - Contorted bed (No.13, p.35) in Quay Rock member, southeast side Cap Bon Ami. Compare with Logan's figures (1863). Hammer to left of centre gives scale.



Figure 14 - Cliffs below summit of Cape road. Cape Road member below; Forillon member above (p.36).

Figure 15 & 16 - See fold-out

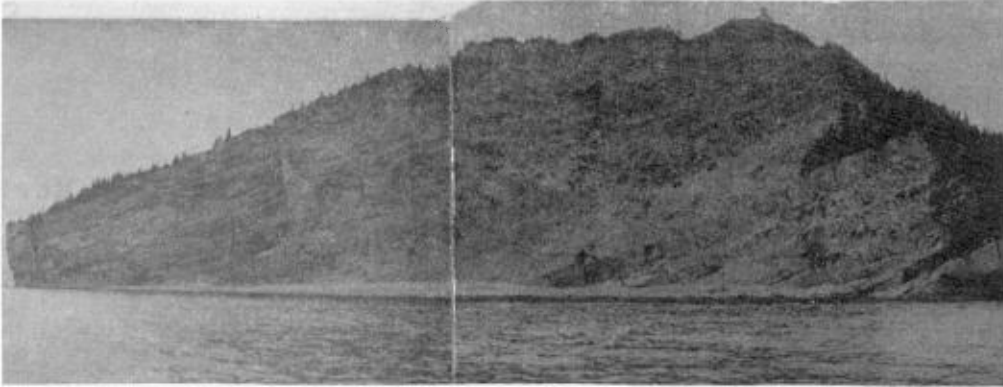


Figure 17 - Cliff at Cape Gaspé. Top of Forillon member (lower right) entire Shiphead member, and lower part of Indian Cove member. Green zone (Nos. 83-86, p. 55) at base of sheer cliff.



Figure 18 - Looking southeast along coast from Little Gaspé towards Grande Grève, showing seaward-dipping Indian Cove beds (p.67).



Figure 19 - Mt. Joli, Percé, from bar leading to Percé rock (p.79).

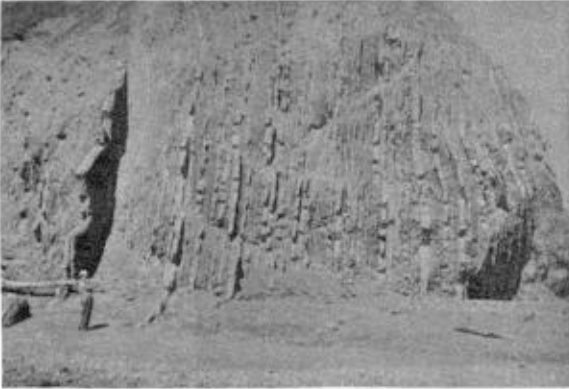


Figure 20 - South face of Mt. Joli, showing Mont Joli beds.



Figure 21 - Biard's beach, Percé, looking northwest. Vertical Mont Joli shale and limestone in foreground. Cap Barré, (Murailles formation) right background.



Figure 22 - Percé rock (Murailles formation) from base of Mt. Joli.



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