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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

MEMOIR 304

SILURIAN AND LOWER DEVONIAN FORMATIONS IN THE EASTERN PART OF GASPÉ PENINSULA, QUEBEC

By

L. M. Cumming

THE QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1959

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Preface

One of the first tasks undertaken by Sir William Logan on founding the Geological Survey of Canada was to study the stratigraphy of eastern Gaspé. The succession worked out by him in 1843 is still the basis on which all subsequent work rests but nonetheless with increasing information new problems have arisen.

One need that became evident was to correlate the Silurian and Devonian strata in different parts of eastern Gaspé and to determine the environment in which they were deposited. The author has completed his studies on this project and his findings are the subject of this report. They have led to a better understanding of this chapter in the geological history of eastern Gaspé Peninsula, which, in turn, aids in the search for oil and gas.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, May 7, 1958

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W. E. LOGAN						J. W. DAWSON	E. BILLINGS	R. W. ELLS	H. M. AMI; J. M. CLARKE	I. W. JONES	E. M. KINDLE	H. W. McGERRIGLE	L. S. RUSSELL		H. W. McGERRIGLE	W. A. ROLIFF
1845		1846	1863			1872	1874	1884	1900	1930-1938	1938	1946	1947		1950	1952
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		Shaly limestone associated particularly at the top, with thin beds of hard limestone		MEMBER 6			PASSAGE BEDS	SILURIAN	CAPE BON AMI FORMATION	CAPE BON AMI FORMATION		CAPE BON AMI FORMATION	CAPE BON AMI FORMATION	FORILLON MEMBER	CAPE BON AMI FORMATION	CAPE BON AMI FORMATION
	GREENISH SHALE	Dark grey, slightly greenish, calcareous shale interstratified with layers of arenaceous limestone which is occasionally sufficiently coarse grained to approach a fine conglomerate		MEMBER 5										CAPE ROAD MEMBER		
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	GREY LIMESTONE WITH FOSSILS	Grey limestone in beds 6" to 8", fossils abundant		MEMBER 1												
UNIT 1	RED, PURPLE AND BLACK SHALE. GREY LIMESTONE, CONGLOMERATE	Cap Chat to Cape Rosier, limestone conglomerate, pillar sandstone and graptolitic shales						CAMBRO-ORDOVICIAN		SILURIAN ORDOVICIAN	CAPE ROSIER SHALES (ORDOVICIAN)	WHITE HEAD FORMATION (UPPER ORDOVICIAN)	CAPE ROSIER SHALES		SILURIAN-DEVONIAN MIDDLE SILURIAN DIABASE DYKES AND SILLS VOLCANICS SEDIMENTS UPPER ORDOVICIAN	PRE-DEVONIAN

G. S. C.

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Table 1. Nomenclature of Post-Ordovician to Gaspé sandstone sedimentary rocks in the eastern part of the Central Gaspé Basin, Quebec.

SILURIAN AND LOWER DEVONIAN FORMATIONS IN THE EASTERN PART OF GASPÉ PENINSULA

INTRODUCTION

Statement of the Problem

In a report on the status of geological research in Canada, a project proposed by I. W. Jones concerning the post-Cambrian stratigraphy and palæontology of the Appalachians was stated as follows:

> Palæontological study of lithologically similar formations apparently similar in strike, mapped in some places as Middle Silurian and in others as Lower Devonian, in the Appalachian areas of eastern Canada. This would serve to establish the ages of these formations and the nature of the contact between Silurian and Devonian, and will be of direct economic value in the search for petroleum. (Hawley, 1947, p. 369)[1].

Previous Work

A brief review of the literature of the stratigraphy of eastern Gaspé is undertaken in order to provide a background for discussing the history of nomenclature, and thus clarify terminology.

A survey of the Palæozoic rocks of Gaspé Peninsula was the first regional study to be carried out by the Geological Survey of Canada. The founder of the Survey, W. E. Logan, investigated the unexplored coal possibilities of Gaspé area in 1843 and 1844. One of the rewarding experiences of the present investigation has been a rediscovery of the lasting contributions that Logan made to Gaspé geology.

Many subsequent workers have contributed to the geology of Gaspé Peninsula and summaries of previous geological investigations have been presented by Alcock (1926, pp. 7-10), Northrop (1939, pp. 2-6), and McGerrigle (1950, pp. 17-19). Relationships between Silurian and Devonian strata have, however, remained a problem. The present discussion deals briefly with previous investigations of Silurian and Devonian stratigraphy and palæontology of the Central Gaspé Basin (*see* Figure 1). These are summarized in Table I.

In 1843, Logan examined the coastal exposures of Central Gaspé Basin and classified its rocks into two major named units: the Gaspé limestones

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[1] Dates and names in parentheses are those of publications listed in the Bibliography at the end of this report.

and shales, and the Gaspé sandstones; and a third, unnamed, at the base. The results of this first survey were never published in their entirety. A preliminary notice appeared (Logan, 1845) and the results were later summarized (Logan, 1863). Logan's field notes of his 1843 survey are preserved in notebook No. 1 of the Geological Survey of Canada. It is a model of conciseness in geological note-taking, and contains accurate sketches of the coast of Gaspé, illustrations of fossils, and diagrams of various geological features.

A succession of three natural rock-units in the northeast part of Gaspé Peninsula was recognized (Logan, 1846):

1. Conglomeratic limestone, pillar sandstones, and graptolitic shales.
2. Gaspé limestones and calcareous shales.
3. Gaspé sandstone.

The youngest unit (3), the Gaspé sandstone, was divided into eight lithological members. Unit (2) was also divided into eight lithological members. Unit (1) consists of rocks that are now recognized to be Cambrian and Ordovician in age.

The results of his own and the later surveys in central Gaspé were comprehensively treated in *Geology of Canada* (Logan, 1863). There the Gaspé limestone was stated to be approximately 2,000 feet thick. Its eight members were described and their general faunal content indicated, with the statement that the fauna of the Gaspé limestone "appears to be the age of the Lower Helderberg group" (Logan, 1863, p. 391).

Logan (1863, pp. 309, 390, 413, 416) recognized Silurian limestone and sandstone in western Gaspé; these he termed the Anticosti group. Devonian limestones were known to be present farther west but nowhere did Logan observe the contact between Silurian and Devonian formations. He, therefore, concluded that the Silurian must thin out in some part of the 100-mile interval between Cape Chat and Cape Gaspé.

The difficulties in delimiting the Silurian strata of central Gaspé were well known to Logan (1863, p. 309):

> There are evidences of the existence of the Anticosti group on the south side of the Shickshock mountains, on the Chat and Matane Rivers, and, farther to the westward, on the Matapedia and Great Metis Rivers; but it has not yet been found practicable to determine its southern limit, and to separate it from the newer rocks in that direction. The corrugated condition of the rocks of the Gaspé Peninsula, and the difficulties of exploration, arising from the uninhabited state of the interior, have prevented that accumulation of facts, which is required to establish a detailed classification of its rocks.

Logan's thoughts on the Silurian-Devonian boundary were presented in an appendix to the volume *Geology of Canada* (Logan, 1863, p. 933):

> It will be seen that in Canada a portion of the Upper Silurian series has been made a separate division, under the name of Middle Silurian. The Oriskany forma-

> tion is assumed to be the base of the Devonian system, in accordance with the synchronism of De Verneuil; but the fauna of the Gaspé limestones, at present under examination, seems to indicate that it would be more proper to place that limit farther down in the series. At Cape Gaspé, the upper eight hundred feet of these limestones hold an intimate association of Lower Helderberg and Devonian species, and the *Psilophyton princeps* of the sandstones has been found in the upper part of the limestones. There is no palæontological break between these limestones, and the Oriskany sandstone which overlies them, of sufficient importance to constitute a dividing line between two great systems. At this locality the difference between the upper limestones and the Oriskany formation is not greater, so far as regards the fossils by which they are characterized, than that between the Trenton formation and Hudson River group. But if, guided by these considerations, we should place the upper limestones of Cape Gaspé in the Devonian, then the whole of the Lower Helderberg, down to the Water limestone, would follow; and the Upper Silurian would be represented, in eastern Canada, only by the series of fossiliferous rocks on the Bay of Chaleur. [This section is distinctive faunally] . . . from that of the Niagara and Guelph formations on the one hand, and from that of the Lower Helderberg on the other; while at the same time it is more closely allied to the fauna of the Ludlow group of England than any other yet discovered in the Silurian rocks of America. It seems to occupy a position between the Niagara and the Lower Helderberg, but to be more intimately connected with the former than with the latter. The Middle Silurian of Canada, as limited in the above table, appears to represent very nearly the Wenlock limestone, and the Llandovery rocks of England. In both countries this part of the series is strongly characterized by immense numbers of large *Pentameri,* with numerous corals and crinoids.

J. W. Dawson in 1872 described the primitive vascular plants from the Gaspé strata. *Psilophyton princeps* and *Prototaxites logani* he described as being the characteristic plants from the base of the Gaspé sandstone, and *Psilophyton* rhizomes, with scalariform structure preserved, were described as occurring rarely in the upper part of the underlying limestone. This limestone contains a marine fauna which E. Billings considered to be of Silurian age with an admixture of Lower Devonian in the upper part. Dawson (1872, p. 7) concluded, "the flora of the Devonian rocks (*Psilophyton,* etc., of the Gaspé sandstone) had its beginning at least in the previous geological period", and he recognized (1) the absence of Lower Devonian fossils in the upper part of Gaspé sandstone, and (2) the resemblance of the upper beds to those of the Devonian in New York. Dawson concluded that the Gaspé sandstone (by a deficiency of calcareous members seen farther west) represented the whole of the Devonian period.

Billings (1874) described some of the Gaspé invertebrate fossils. Because of faunal similarity he included Logan's members 7 and 8 (Shiphead and Indian Cove members) of the limestone with the Gaspé sandstone. The underlying members 4 to 6 (Quay Rock, Cape Road and Forillon members) he termed 'Passage Beds' of Silurian-Devonian age.

Between 1880 and 1883, R. W. Ells conducted regional surveys over Gaspé Peninsula with the objective of producing maps on a scale of 1 inch to

4 miles of the entire peninsula. In the marginal notes to Map No. 6 (1882) Ells stated:

> The Gaspé limestone series, which immediately underlies the Devonian in Eastern Gaspé, has been divided, a portion included in the 'Passage Beds' (*see* Pal. Fossils, vol. 11, p. 1) is now assigned to the Silurian, and the upper members to the Devonian.

However, Ells was not consistent in his assignment of strata to the Silurian system. In Map No. 6, members 7 and 8 of the Gaspé limestone were shown as Devonian on the Forillon Peninsula whereas the same members were shown as Silurian in the area north of Gaspé Basin.

Ami (1900) and Clarke (1900) grouped Logan's eight members of the Gaspé limestone group into three formations. In ascending order these are: St. Alban, Cape Bon Ami, and Grande Grève formations. The Cape Bon Ami and Grande Grève formations are widespread throughout Gaspé Peninsula; the St. Alban formation is restricted to the eastern part of the peninsula.

Table of Formations

Age	Group	Formation		Member
?Carboniferous		(basic dykes)		
Devonian	Gaspé sandstone	Battery Point		
Late Lower Devonian		York River		
		York Lake	Fortin	
Lower Devonian	Gaspé limestone	Grande Grève		Indian Cove
				Shiphead
		Cape Bon Ami		Forillon
				Cape Road
				Quay Rock
Silurian				Petit Portage
		St. Alban		Rosebush Cove
				Roncelles
		Griffon Cove River	Owl Capes	
		Burnt Jam Brook		
Cambro-Ordovician	Quebec	Cape Rosier		

Faunas of fifty-one species from the St. Alban formation, eight species from the Cape Bon Ami formation, and approximately 160 species from the Grande Grève formation were described by Clarke (1908). He also described a Gaspé sandstone fauna of thirty-nine species. Clarke (1908, p. 250) considered one-half of the St. Alban fauna to be typical Helderberg forms and included the St. Alban beds in the basal Devonian. The Grande Grève fossils were considered to be an Oriskany fauna and the Gaspé sandstone fauna was interpreted to be of Hamilton age.

Williams disagreed in principle with Clarke's Hamilton age assignment of the Gaspé sandstone fauna and concluded (1910, p. 691): "the dominant species of Oriskanian affinities present a much stronger testimony as to the age of the fauna than do the Hamilton species, which although greater in number (in faunal lists) are poorly represented in the fauna." Additional evidence to support Williams' conclusion has recently been advanced (Boucot and Cumming, 1953).

The second stage in the history of the geological studies of Central Gaspé Basin was initiated by the examination of a series of map-areas in central Gaspé. Alcock (1926) mapped Silurian shales and limestone, Lower Devonian shales and limestone, and Devonian sandstone in the Mount Albert map-area.

Jones (1930, 1931, 1932, 1933, 1935, 1936, 1938), in a series of areal studies in central Gaspé, mapped Silurian marine strata and Devonian marine strata, as well as the Devonian Gaspé sandstone. Furthermore, Jones (1935) mapped a belt of Silurian rocks as far east as the Dartmouth River, and defined the St. Alban-Silurian stratigraphic problem as related to this belt.

Kindle (1938) proposed the term Griffon Cove River beds for the conglomerates containing *Scyphocrinites* (*Camarocrinus*) that underlie the St. Alban formation. These beds were correlated with the Keyser member of the Helderberg and were assigned a Lower Devonian age. Kindle recognized and discussed the facies problem within the Gaspé sandstone. He suggested that two facies (a nonmarine eastern facies and a marine western facies) were represented in eastern Gaspé. The Devonian facies problem in Gaspé has not yet been solved and Kindle's proposal appears to be an over simplification. Nonetheless, as it implies, the Central Gaspé Basin seems to have been enclosed to the east.

The concise representation of the Devonian formations in eastern Gaspé (Cooper, *et al.,* 1942) clarified certain stratigraphic relationships. The writer agrees with the placement of the Griffon Cove River beds in the Silurian but does not agree with the presence of a major non-sequence between the Cape Bon Ami and Grande Grève formations. The term Gaspé limestone group serves to emphasize the stratigraphic unity between the St. Alban, Cape Bon Ami, and Grande Grève formations.

McGerrigle (1946) reviewed the Devonian in Gaspé. The thickness of all formations in the interior was shown to be two or three times as great as that in eastern Gaspé, and four units of the Gaspé sandstone were recognized.

Russell (1946) restudied the type section at Forillon. Logan's members 1 to 8 were accurately measured by plane-table for the first time, and assigned geographic names (Russell, 1947a).

McGerrigle (1950) in a comprehensive report on eastern Gaspé showed the westward continuation of the St. Alban formation, as it appears on Brown's map, as "St. Alban-Silurian" in Dartmouth River map-area.

Roliff (1952) summarized information concerning oil occurrences in east-central Gaspé. In his Devonian stratigraphic column, McGerrigle's Fortin formation was shown as the lateral equivalent of the upper part of the Gaspé limestone group and the lower part of the Gaspé sandstone group. Furthermore, the York Lake formation was shown as grading laterally into the lower part of the York River formation.

The writer agrees with Logan's classification of the coastal sections and would use it in a modified form to conform with the tradition and usage that has grown since Logan's work. The geographic names of the eight members of the Gaspé limestone as proposed by Russell (1947a) are used. Silurian rock-units that underlie the Gaspé limestone group and that are not exposed along the coast are given formational status. These are the Burnt Jam Brook and the Griffon Cove River formations (*see* Table of Formations).

Acknowledgments

The writer wishes to thank Dr. I. W. Jones of the Quebec Bureau of Geology, whose pioneer work in Gaspé geology established a clear definition of the problems involved, for helpful suggestions during office and field work. Dr. H. W. McGerrigle of the same Bureau introduced the writer to the field stratigraphy of Gaspé and gave valued assistance in field problems. Dr. Come Carbonneau of École Polytechnique, Montreal, discussed the problems of sedimentation of the Gaspé formations with the writer. Thanks are due to Edmund Alleyn and J. John Dunn who provided efficient field assistance.

Field work was carried out during the 1950 and 1951 field seasons. The results of the investigation formed a part of a doctoral thesis presented at the University of Wisconsin. Grateful acknowledgment is made to Dr. L. M. Cline of that University who visited the writer in the field in 1951. To the many inhabitants of eastern Gaspé, particularly to Philippe Dunn of Cape Rosier, the writer is indebted for assistance.

STRATIGRAPHY

Regional Setting

The Gaspé Peninsula of Quebec lies to the north of lat. 48°00′N and east of long. 67°30′W. Geologically, Gaspé is part of the Appalachian Mountain system, which extends from Alabama to Newfoundland. The structural trends of Gaspé conform with the northeast Appalachian directions as far as long. 66°30′. Farther to the east, the structural trend gradually changes from northeast to east and then bends southeastward.

The north shore of Gaspé arcs parallel with the trace of the Logan thrust fault. South from the shore is a belt of sedimentary rocks of Cambrian and Ordovician age, which, in the western part of the peninsula, has a north-south width of 20 miles. This belt consists of easily eroded shales and limestones. At Cape Rosier (*see* Figure 1) recent marine erosion has reduced the width of exposure to 3 miles and the coast cuts sharply across the southeast trend of the strata.

Southward from this belt lies the Central Gaspé Basin (*see* Figure 1). The configuration of the basin reflects the arcuate trend of the Gaspé north shore. The basin is approximately 35 miles wide in the western part of the peninsula and narrows to 20 miles in the east. Silurian and Devonian sedimentary rocks underlie most of Central Gaspé Basin but granite intrusions and volcanic rocks occur in its north-central part.

The northern or hinged margin of the basin consists of escarpment-forming Silurian strata. Within the basin and north of St. John River is a sequence of Silurian and Devonian rocks folded into a series of open anticlines and synclines. Along the southern or overthrust margin of the basin Silurian rocks occur discontinuously along an east-west fault zone.

The Gaspé sandstone is restricted to Central Gaspé Basin but is absent in the central region of the basin, probably because of a cross flexure associated with the Tabletop intrusions and the subsequent denudation, by erosion, of the sandstone from this uplifted area.

The part of Gaspé lying south of the Central Gaspé Basin consists, for the most part, of folded sediments of Cambrian to Silurian age (Alcock, 1935; Northrop, 1939; Badgley, 1956). Smaller areas of Devonian volcanic rocks and Upper Devonian sandstones occur towards the head of Chaleur Bay. The southern belt is characterized by an overlap of flat-lying Carboniferous conglomerate, the Bonaventure formation.

For more complete information on the geology of Gaspé the reader is referred to three recent publications of the Quebec Department of Mines by H. W. McGerrigle in 1950, 1953, and 1954a.

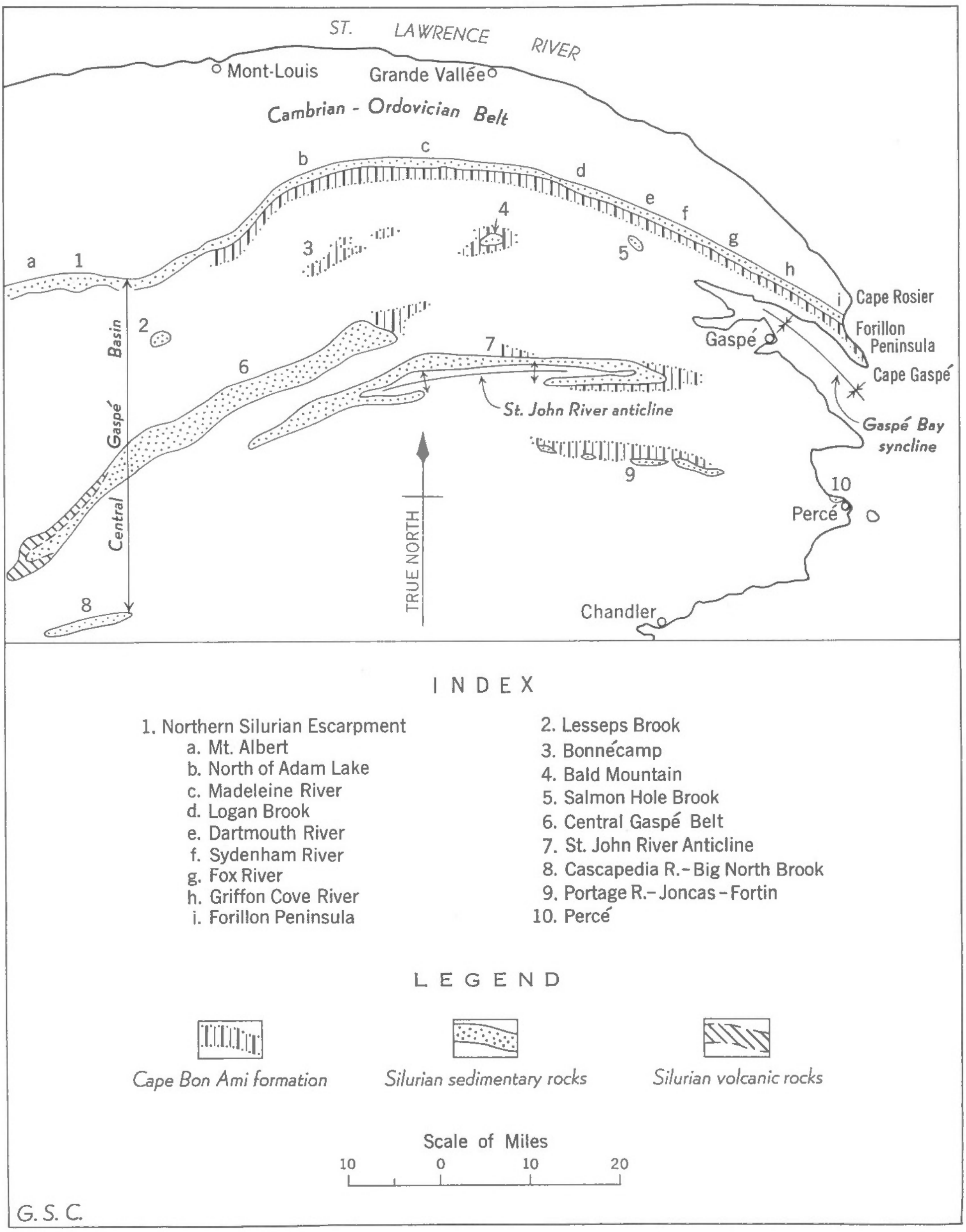

FIGURE 1. *Index map of Silurian rocks and the Cape Bon Ami formation, in the eastern part of Central Gaspé Basin, Quebec.*

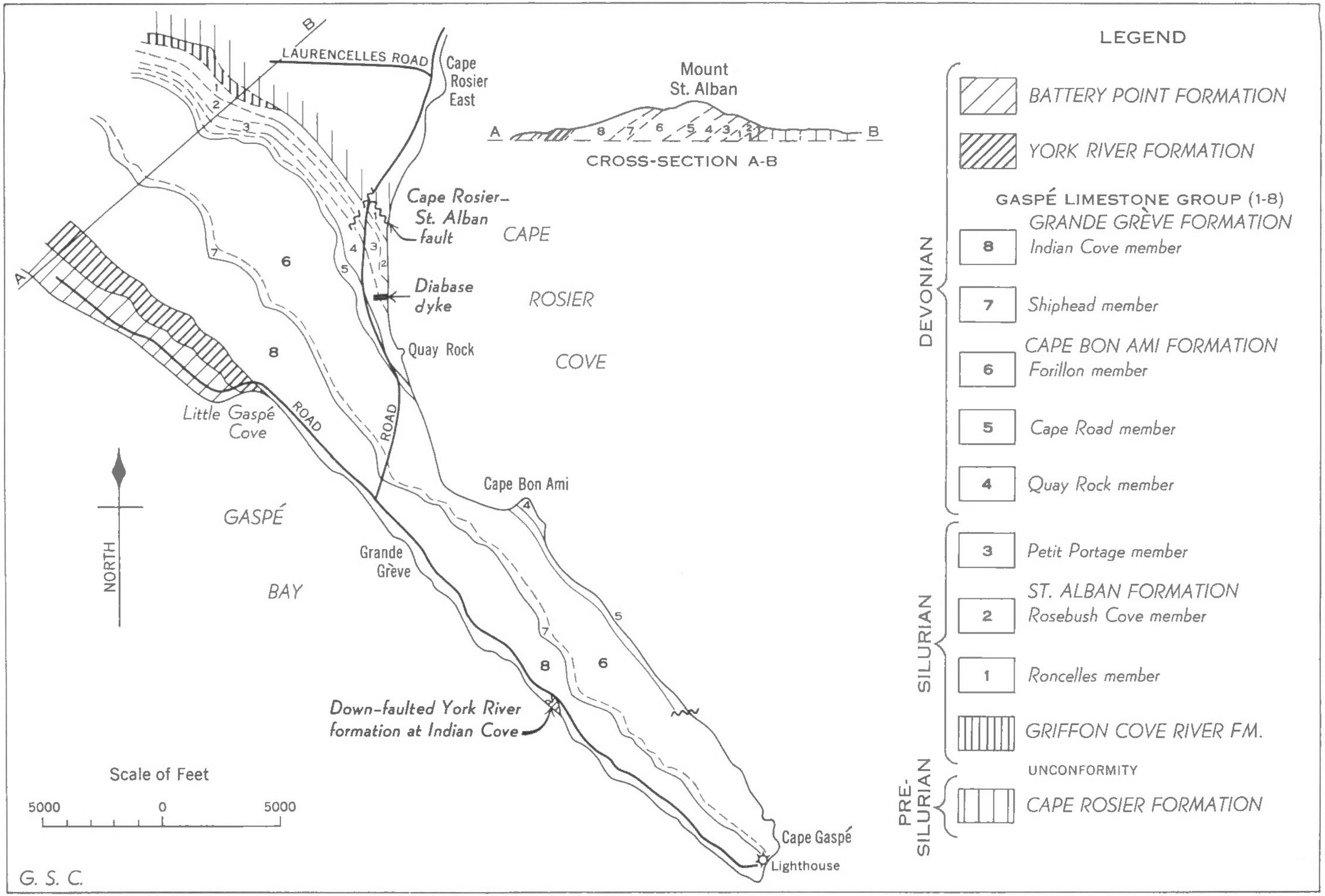

FIGURE 2. **Geological map of Forillon Peninsula, eastern Gaspé, Quebec. (Modified from L. S. Russell, 1947.)**

Figure 1 shows the distribution of Silurian rocks and of the Cape Bon Ami formation in the eastern part of Central Gaspé Basin. This figure is based on McGerrigle's 1953 map but in three places the distribution of the Silurian is modified:

1. The Silurian escarpment is shown as continuous eastward from Dartmouth River to the coast at Forillon Peninsula.
2. The axial part of the Bald Mountain dome is shown as Silurian rather than Siluro-Devonian.
3. A new Silurian exposure is shown at Lesseps Brook.

The present report brings together the results of stratigraphic studies in three localities: Forillon Peninsula, St. John River anticline, and the northern Silurian escarpment. These are shown on Figure 1.

Succession at Forillon Peninsula

The Forillon Peninsula forms the northeast side of Gaspé Bay, and Cape Gaspé, its termination, is the eastern end of the St. Lawrence River.

The Forillon Peninsula has a unique physiographic expression. It is a narrow spine of land 5½ miles long and a half to a mile wide. The peninsula represents the exposure along strike of a group of Silurian and Devonian strata of the Gaspé limestone group that are more resistant than either the underlying pre-Silurian shales or the overlying Devonian sandstones and shales. The Gaspé limestone group consists of limestones and shales that dip at 24°SW and represent the north limb of the Gaspé Bay syncline. Mount St. Alban, at the western extremity of Forillon Peninsula, has an elevation of over 1,000 feet. The sea-cliffs on the northeast side of the peninsula are carved from limestone and shale, which dip inland and form precipitous slopes. By contrast, the coast on the southwest is formed of cherty limestone dipping seaward allowing the development of small coves protected by low cliffs.

Several geological maps of Forillon Peninsula have been published; these are: Ells (1884) 1 inch=1.75 miles; Clarke (1908, p. 22) 1 inch=93 chains; Clarke (1913, p. 104) 1 inch=1.75 miles; McGerrigle (1950, No. 663) 1 inch=1 mile, and Russell (1947a) 1 inch=500 feet. Figure 2 is a geological sketch map of Forillon Peninsula, and Figure 3 illustrates the stratigraphic succession of the rocks that form the peninsula.

The oldest rock-unit shown on Figure 2 consists of pre-Silurian sedimentary rocks. These underlie the area to the north of the limestone escarpment and are mainly red and green shales with some dark shale and limestone-conglomerate. They are isoclinally folded and are the Cape Rosier beds of Kindle (1938).

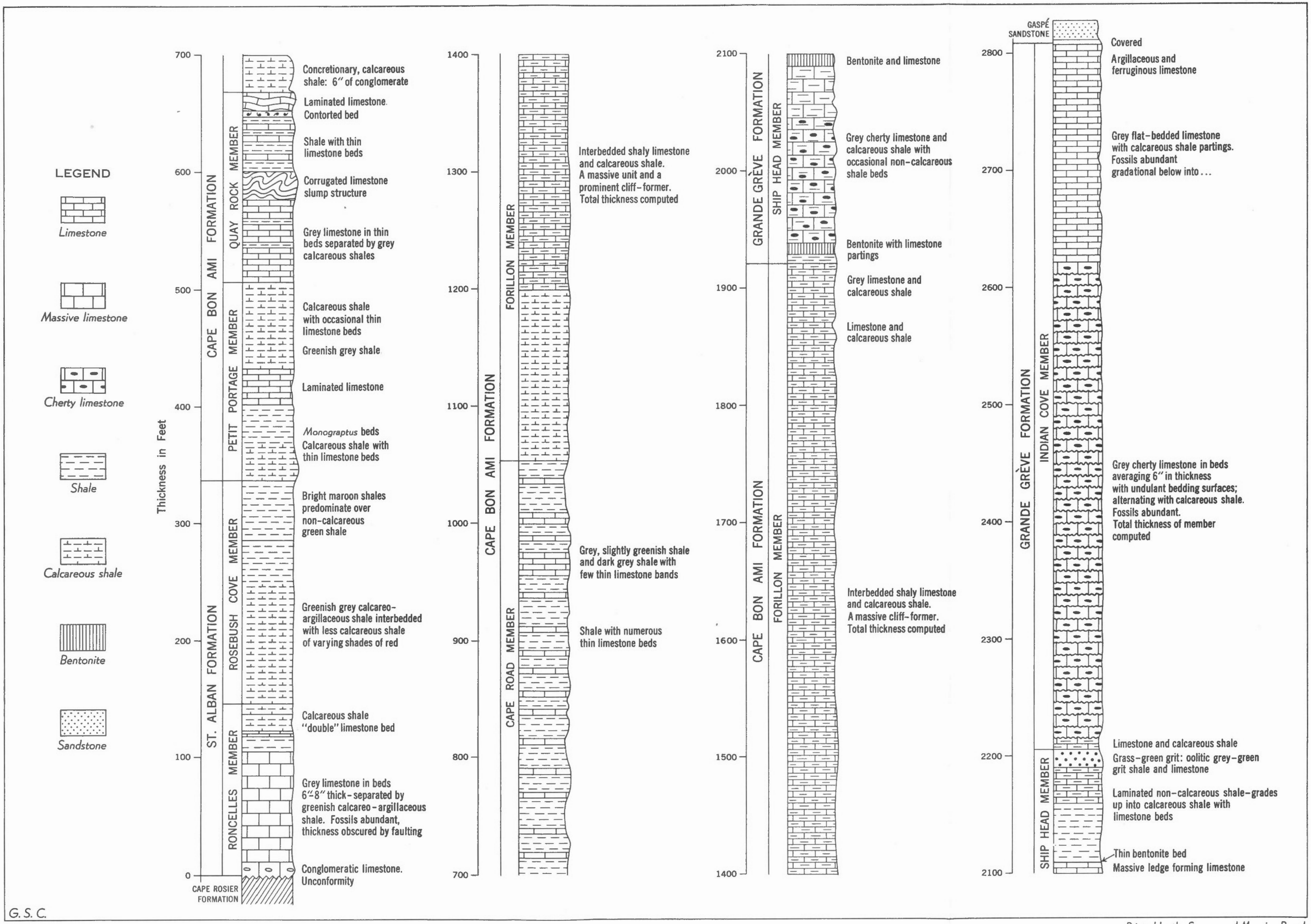

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Figure 3. Stratigraphic succession, Gaspé limestone group, Forillon Peninsula, Cap-des-Rosiers township, Gaspé, Quebec
(After L. S. Russell, 1947)

Overlying the Cape Rosier beds unconformably are coarse conglomerates (Griffon Cove River formation) which wedge out approximately 1.5 miles from Cape Rosier East. Overlying this in turn, or the Cape Rosier beds directly where the Griffon Cove River formation is absent, is the Gaspé limestone group which is divided into three formations and eight members.

The Roncelles and Rosebush Cove members together make up the St. Alban formation and form the first prominent topographic step in the escarpment. They are truncated by the coast at Cape Rosier Cove and are well exposed to the south of the Cape Rosier-St. Alban fault (*see* Figure 2). The Petit Portage member of the Cape Bon Ami formation is a soft calcareous shale which is best exposed along the Cape Rosier Cove shore, north of the diabase dyke. The massive and resistant limestones of the overlying Quay Rock member form Quay Rock as well as the tip of Cape Bon Ami. The Cape Road member (unit 5) is a relatively soft shale sequence that forms the wooded slopes above the tip of Cape Bon Ami. This member forms the base of the cliffs along the northern part of Forillon Peninsula, up to a point 6,700 feet from Cape Gaspé where it is faulted below sea-level.

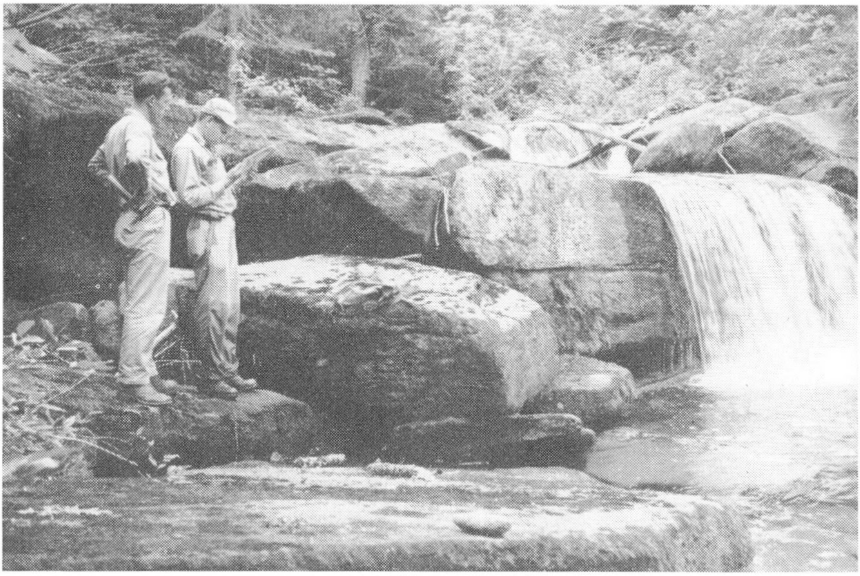
The Forillon member is a massive cliff-forming unit of alternating calcareous shale and limestone that makes up the high north-facing ridge that extends to the northeast tip of Cape Gaspé. The Shiphead member of the Grande Grève formation consists of limestones and calcareous shales, non-calcareous shales, fine-grained sandstones, and bentonites. This member is relatively soft and forms a valley between adjacent members. Most of the south coast of Forillon Peninsula is formed by the massive cherty limestones of the Indian Cove member, which forms the second and more southerly ridge of the peninsula (*see* Figure 2, structure-section).

At Little Gaspé, there is a covered interval of only 2 feet between the grey limestone of the Indian Cove member (Grande Grève formation) of the Gaspé limestone group and the coarse buff-coloured feldspathic sandstone (York River formation) of the Gaspé sandstone group.

The only intrusive rock on Forillon Peninsula is a vertical diabase dyke that cuts the Petit Portage member at Cape Rosier Cove. This dyke is presumed to be of Carboniferous age.

Forillon Peninsula is the type section for the Gaspé limestone group. Coastal erosion has produced nearly complete exposures of these limestones and shales, whose total thickness is approximately 2,800 feet (Russell, 1946) although sea-cliffs, some with a vertical height of 700 feet, make most of the middle part of the group inaccessible.

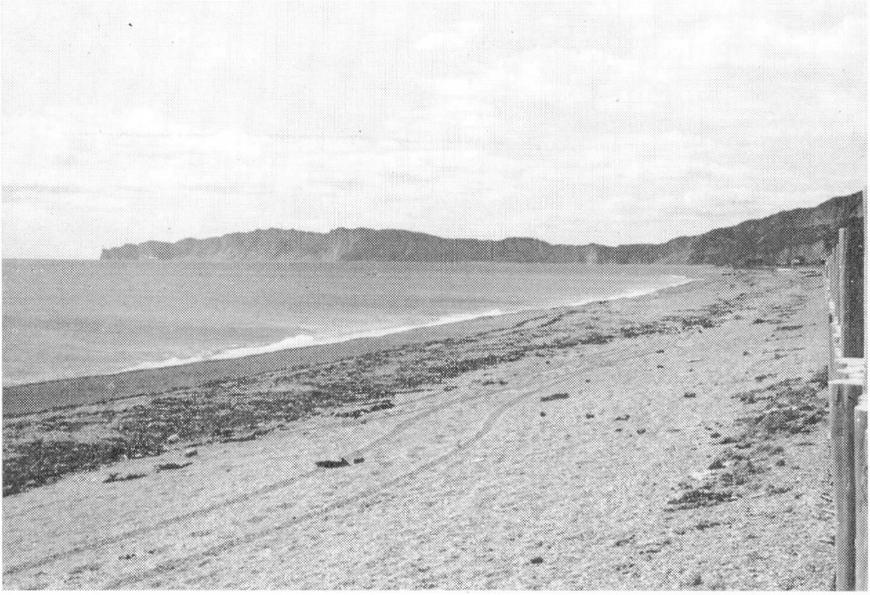
In the following pages each rock-unit, in ascending order, is described in tabular form. The lithology is based on the examination of surface exposures only.



Cumming, 4-3-1957

PLATE I. *Conglomerate immediately above the Camarocrinus beds, Griffon Cove River formation, Griffon Cove River. The base of the formation is approximately 325 feet downstream from the waterfall.*

NAME	***Griffon Cove River Formation*** (Kindle, 1938)
Type Locality	Griffon Cove River
Lithology	Shale, limestone, and conglomerate
Distribution	Extends 6 miles eastward from type section as a thin belt and pinches out 1.5 miles from the coast. Extends westward from type section and is exposed on the Fox and Sydenham Rivers.
Thickness	Kindle (1938) assigned 400 feet to the unit. Minimum thickness, 1.5 miles from the coast, is 40 feet and the rock there consists of edgewise conglomerate.
Boundaries	Lower boundary, an unconformable contact with the underlying Cape Rosier formation; upper boundary conformable transitional into St. Alban formation.
Facies	A shallow-water marine deposit; may be a facies equivalent of the Owl Capes formation.
Age	Formerly interpreted as Devonian basal beds, regarded by the writer as of Silurian age. Kindle's evidence for correlation with the Keyser member of the Helderberg formation (lowermost Devonian) of West Virginia rested mainly on the occurrence of *Camarocrinus* (ibid., p. 53). This genus is now known to range from Middle Silurian to Helderbergian (Springer, 1917).
Remarks	Section I (*see* Appendix) shows the stratigraphic position of the crinoidal beds at the type section (*see also* Plate I).



Cumming, 2-5-1950

PLATE II A. *View towards north shore of Forillon Peninsula. Lower slopes of Mount St. Alban on right. Maximum height of sea-cliffs, 700 feet.*

PLATE II B. *Unconformity between the Cape Rosier formation and the St. Alban formation. Low tide, 145 feet south of the Cape Rosier-St. Alban fault at Cape Rosier Cove.*

Cumming, 1-7-1950

Silurian and Lower Devonian Formations in Eastern Gaspé

NAME	***St. Alban Formation*** (Ami, 1900; Clarke, 1900)
Type Locality	Cape Rosier Cove
Lithology	Argillaceous limestone and calcareous shale
Distribution	Forillon Peninsula to Dartmouth River
Thickness	Average, 345 feet
Boundaries	Lower contact, at Cape Rosier Cove, a marked unconformity, underlying beds Cape Rosier formation (*see* Plate IIB); farther west lower contact conformity, underlying beds Griffon Cove River formation. Upper contact conformity, overlying beds Cape Bon Ami formation.
Facies	A shallow-water marine deposit composed of two distinct members; a lower limestone member (Roncelles) and an upper red shale member (Rosebush Cove).
Age	Silurian
Remarks	The St. Alban formation comprises only members 1 and 2 of the Gaspé limestone series of Logan (1863). The term as used by Brown (1939b) and McGerrigle (1950) was expanded to include the Griffon Cove River beds of Kindle.

NAME	*Roncelles member* (Russell, 1947a)
Type Locality	Cape Rosier Cove
Lithology	Grey limestone and calcareous shale. Logan (1863, p. 391) described the member as: "Grey limestones in layers of from six to eight inches thick, which are separated by bands of greenish calcareo-argillaceous shale, gradually increasing in amount towards the upper part." The basal few feet of the member, as exposed on the Forillon coast, consist of massive limestone and intercalated limy shales (*see* Section II, Appendix). The limestone is arkosic and contains quartz sand grains.
Distribution	Forillon Peninsula to Dartmouth River
Thickness	Maximum 154 feet. Seaward-dipping normal faults make it difficult to obtain a composite section (Logan, 1846; and Russell, 1946).
Boundaries	Lower boundary same as for St. Alban formation; upper boundary conformity, overlying beds Rosebush Cove member.
Facies	A shallow-water marine deposit; contains reworked corals in basal beds.
Age	Silurian
Remarks	Species of *Favosites* make up the dominant colonial corals of the Roncelles member. Species of this genera were referred to *Favosites helderbergiae* Hall and *Favosites* sp. cf. *F. gaspensis* Lambe by Clarke (1908, p. 33). A restudy of this material shows that the species determined as *F. helderbergiae* is more properly to be referred to *Favosites niagarensis* Hall, and, in addition, that *Favosites aspera* d'Orbigny is also present.

Zaphrentis is the dominant tetracoral genus of the member. Clarke (1908) referred all specimens to *Z. rugulata* Billings. A re-examination of these forms shows that the species determined as *Z. rugulata* is more correctly termed *Z. shumardi* Edwards and Haime (Lambe, 1901, p. 121). In addition, *Z. stokesi* (Edwards and Haime) is present.

The above five species of corals are indicative of a Silurian age. A Silurian-Devonian ostracod genus *Drepanellina* is also present in the Roncelles member. One-fifth of the fauna of this member is known only from eastern Gaspé and thus their stratigraphic range in the New York and European sections has not been established.

Clarke (1908, p. 33) revised Logan's faunal list and described approximately 50 species from this member. He correlated the St. Alban formation with the Lower Devonian.

NAME	*Rosebush Cove member* (Russell, 1947a)
Type Locality	Cape Rosier Cove
Lithology	Shale, red and greenish grey
Distribution	Forillon to Dartmouth River. May occur 40 miles west of the type locality at Patch Brook.
Thickness	191 feet (Russell, 1947a, p. 11)
Facies	A shallow-water marine deposit
Age	The unit contains no diagnostic fossils
Remarks	Logan (1863, p. 391) described the unit as, "Greenish calcareo-argillaceous shales, which are interstratified with less calcareous layers, of various shades of red. The only fossils observed occur about the middle of the deposit, and consist of flattened stems of marine plants, apparently replaced by oxyd of iron."

Unconformity Below the St. Alban Formation

The unconformable contact between the St. Alban formation and older rocks is exposed at the base of the sea-cliffs, 145 feet south of the vertical Ordovician-St. Alban fault at Cape Rosier Cove (*see* Plate IIB). There the rocks of the Cape Rosier formation form a sequence of grey-green and maroon-grey, thinly bedded shales. A rhythmic banding of green and maroon shales occurs approximately every inch within the strata and the bands are themselves made up of $\frac{1}{16}$-inch colour bands of grey and maroon shales. At 8-to-12-inch intervals within this sequence are bands and lenses 1 inch to 4 inches thick of limestone breccia. The general strike of the strata is N80°W and the dip 60°S; the sequence at this point has been overturned and drag-folded. Calcite veins cut the older rocks but do not continue into the overlying beds.

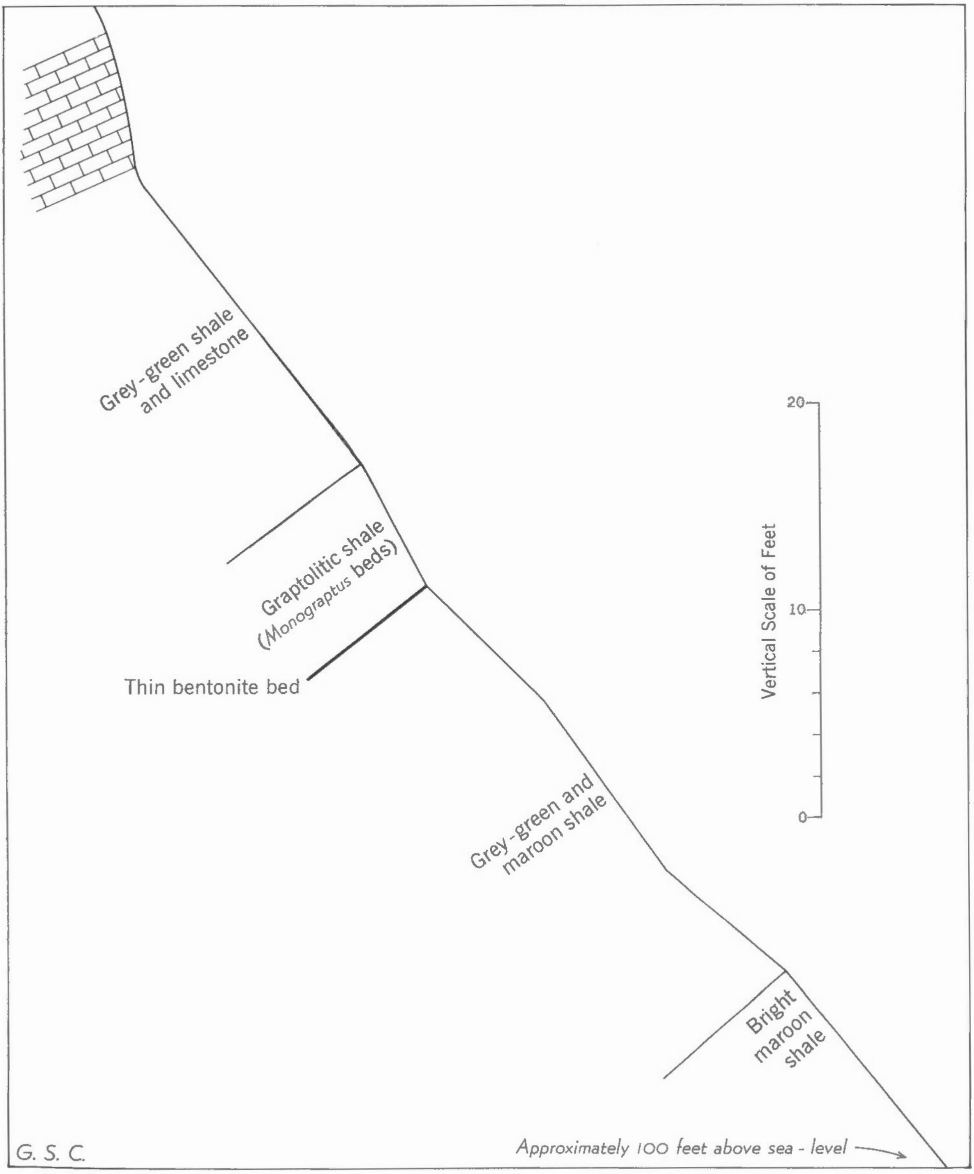


FIGURE 4. *Cliff profile of the upper beds of the St. Alban formation and the lower beds of the Cape Bon Ami formation, Cape Rosier Cove, Forillon Peninsula, showing the position of the Monograptus beds.*

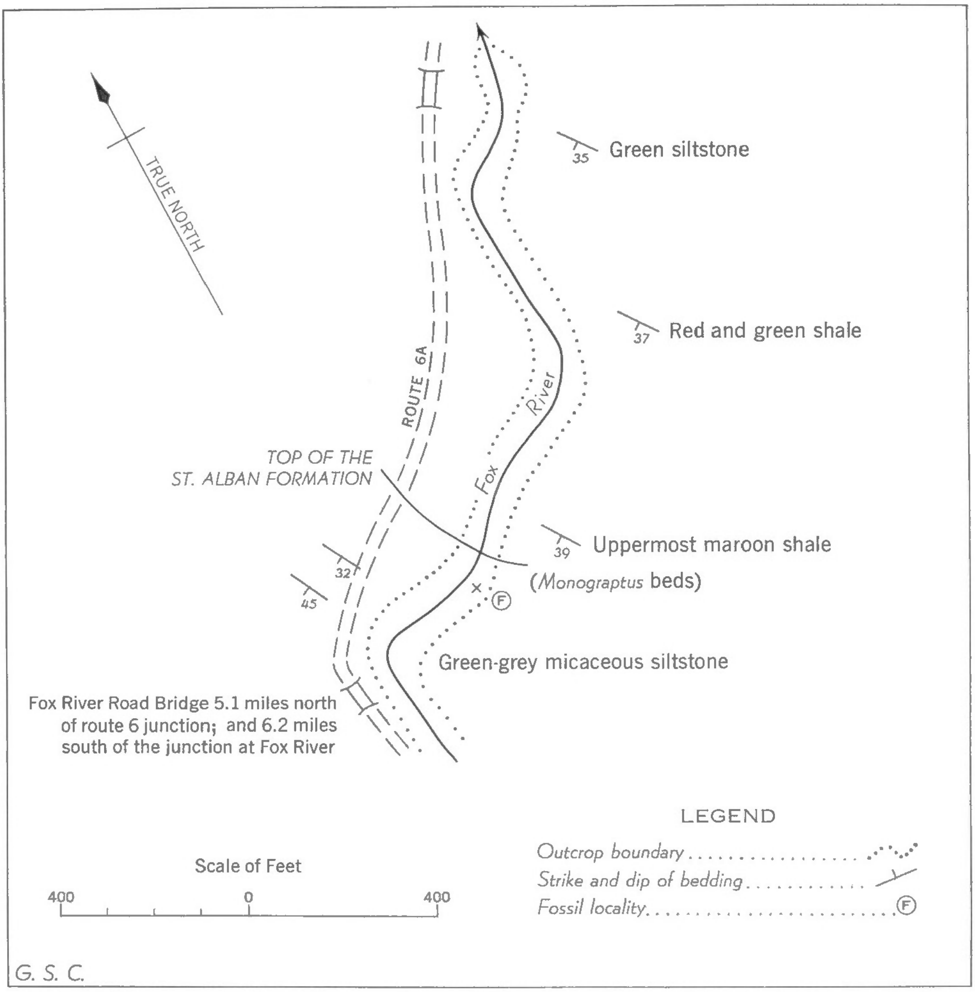


FIGURE 5. *Sketch map showing location of Monograptus beds on Fox River.*

The basal beds of member 1 of the St. Alban formation rest with sedimentary contact and angular unconformity upon the Cape Rosier beds. Massive limestone beds approximately 8 inches thick with interbedded arenaceous limy shales lie at the base. The bedding planes are undulating and strike in the southeast direction of the elongation of Forillon Peninsula, (i.e., at a 40° angle to the strike of the Cape Rosier beds). The dip is 24°SW. A thin detrital layer of arenaceous limestone has been deposited on the ragged surface of the upturned Cape Rosier beds. This arenaceous limestone has been deposited in the cracks between the upturned bedding planes of the older shales.

The contact between the Roncelles member of the Gaspé limestone group and the older beds has been variously interpreted in the past (*see* Logan, 1845, p. 31, and 1863, p. 391; Clarke, 1913, pp. 84 and 89; Johnson, 1925, p. 207; Jones, 1932, p. 19; Kindle, 1938, p. 11; McGerrigle, 1950, p. 96).

NAME	***Cape Bon Ami Formation*** (Ami, 1900; Clarke, 1900)
Type Locality	Forillon Peninsula
Lithology	Limestone and shale
Distribution	Eastern part of Central Gaspé Basin
Thickness	Approximately 1,585 feet at type locality. The average thickness to the west is 2 to 3 times greater than that at the type section.
Facies	A shallow-water marine deposit. It is composed of four members, in ascending order: the Petit Portage, Quay Rock, Cape Road, and Forillon.
Age	Silurian and Devonian
Remarks	The Cape Bon Ami formation had previously been regarded as a rock-unit that contained no important fossils by which to date the strata. The presence of graptolites in the shales of its lowermost member provides new evidence for the Silurian age of the lower part of the formation. The scarcity of fossils in the Cape Bon Ami formation was noted by Logan (1846, p. 32; 1863, p. 392). A short faunal list, based on Billings' determination was given by Ells (1883, p. 13). Clarke (1908, pp. 37, 38) noted the small size of the fossils and the few species represented, and he gave a faunal list based on his collection from member 4 of Logan. M. A. Fritz (*in* Russell, 1947a, p. 52) identified the following brachiopods: *Orbiculoidea bella* Billings, *Pholidops, Chonetes, Meristella laevis* Vanuxem from the Cape Bon Ami formation and stated that *Platyceras* and ostracods were present.

NAME	*Petit Portage member* (Russell, 1947a)
Type Locality	Cape Rosier Cove
Lithology	Green and maroon shales

PLATE III. *Monograptus* *locality at base of the Petit Portage member, Forillon Peninsula. Cape Rosier East in the background.*

Cumming, 2-6-1950

Distribution	Cape Rosier Cove to Fox River
Thickness	Type section is approximately 170 feet thick
Boundaries	The base of the member grades into the red shales of the underlying St. Alban formation. The upper limit of the member is arbitrarily drawn where limestone dominates over shale, the rocks then being assigned to the Quay Rock member.
Facies	A shallow-water marine deposit
Age	Silurian. *Monograptus uncinatus* var. *micropoma* Jaekel is preserved as compressed films.
Remarks	A section of the Petit Portage member is given in the Appendix, Section III and a more detailed section of the lower beds in Section IV. Figure 4 illustrates a cliff-profile of these beds at a point 2,250 feet south of the Cape Rosier-St. Alban fault. Plate III is a view of the graptolite locality. The same graptolite beds occur at the same stratigraphic level at Fox River, 15 miles to the west (*see* Figure 5). Logan (1863, p. 391) concisely described the member at the type locality as: "Olive-green calcareo-argillaceous shales, with occasional nodules and layers of compact limestone; the former from an inch to a foot in diameter and the latter six inches to two feet thick. Some of the layers are rather arenaceous; remains of fucoids occur at the top."

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PLATE IV. *Cape Rosier Cove, looking southeast along the northern shore of Forillon Peninsula. To show the submarine gravity slump structure of the Quay Rock member (foreground). Cape Bon Ami with the shales of the Cape Road member forms the seaward-facing wooded-slope in the middle distance. In the far distance are the vertical cliffs of the Forillon member.*

NAME	*Quay Rock member* (Russell, 1947a)
Type Locality	Cape Rosier Cove
Lithology	Grey limestone and shale
Distribution	Not delimited beyond Forillon Peninsula
Thickness	At type section, 161 feet
Boundaries	The lower part of the member is transitional with the shale of the underlying Petit Portage member. The upper part of the member grades into the shales of the overlying Cape Road member.
Facies	A shallow-water marine deposit characterized by gravity slump structures.
Age	Silurian or Lower Devonian. Has not yielded diagnostic fossils.
Remarks	The lithology of this member was described by Logan (1863, p. 391) as: "Grey limestones in thin beds, separated by grey calcareous shales, of which there are more towards the bottom than the top. The whole mass is interstratified with three or four bands of olive-green calcareo-argillaceous shale." It contains "corrugated beds" described by Logan as . . . "a bed of seven feet, made up of several thin layers of limestone and limestone shale, and presenting a singularly wrinkled structure, from which the beds

above and below are free. It would appear as if the layers, after their deposition, had been contorted by lateral pressure, the underlying stratum remaining undisturbed; and had then been worn smooth, before the deposition of the next bed. Where the inverted arches of the flexures occur, some of the lower layers are occasionally wanting; as if the corrugated bed had been worn on the under as well as the upper side."

These "corrugated beds" are one of the most striking minor structures of Gaspé limestone sedimentation. They have been figured in only two publications. In Logan (1863, p. 392) the upper right wood cut of figure 425 was printed upside down; in Harrington (1883, p. 220) the upper of 2 wood cuts was printed upside down.

In present-day terminology these "corrugated beds" may be termed gravity slump structures. The best exposure of the Quay Rock member gravity slump structure is in the sea-cliff immediately north of Quay Rock (*see* Plates IV and V). The limestone bands of the slump structure folds become brecciated at the up-dip end of the exposure.

Pressures on these limestone bands farther down dip did not exceed the limit of plastic deformation and individual bands can be traced through a number of folds. A primary gravity slumping of calcareous muds, under optimum conditions of diagenesis, at the margin of the Central Gaspé Basin, is the suggested interpretation of the origin of these "corrugated beds".

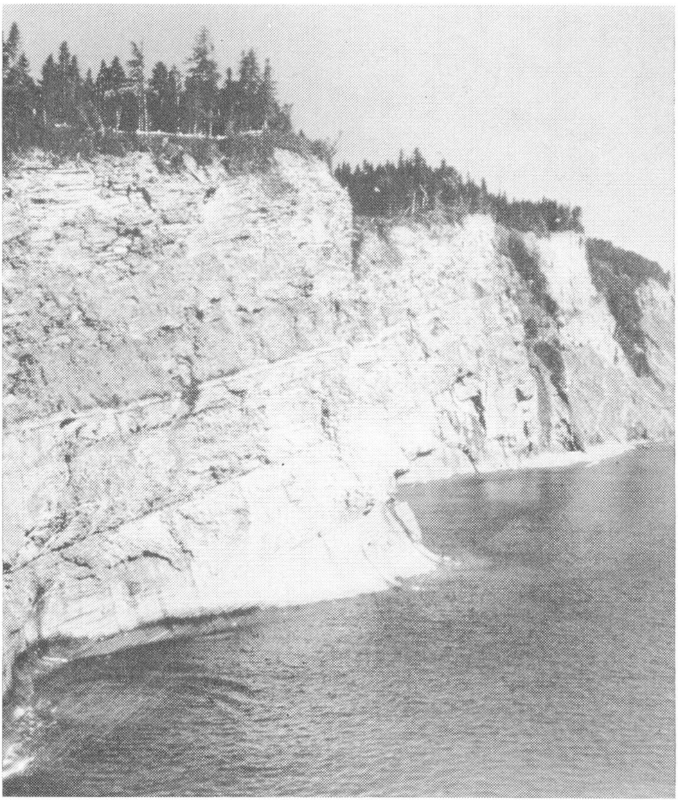

PLATE V. *Cape Rosier Cove, looking northwest from Quay Rock. The submarine gravity slump structures of the Quay Rock member are in the overhanging cliff in the foreground. Dark shales of the Petit Portage member, cut by a vertical diabase dyke, are on the extreme right.*

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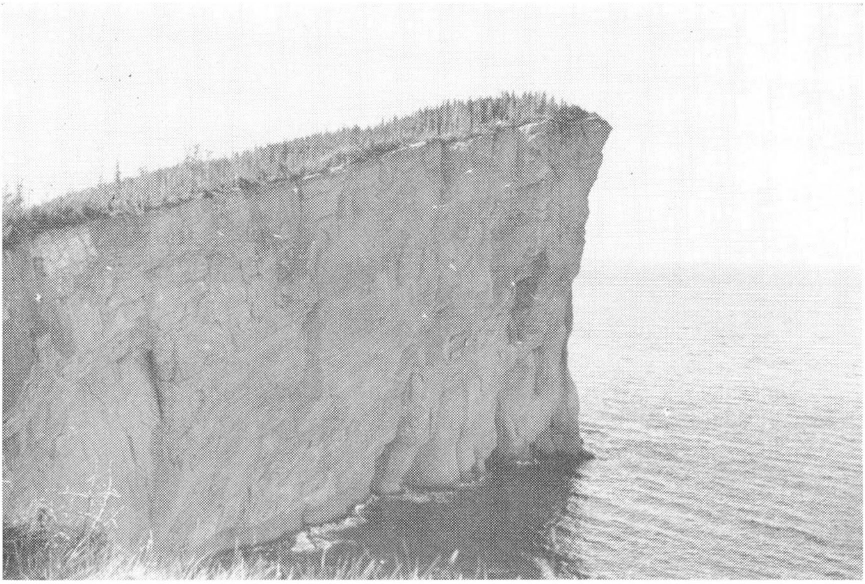
Slump structures occur at more than one horizon in the member. A zone of primary slumping, 5.5 feet thick, in alternating beds of limestones and shale occurs on the south east side of Cape Bon Ami. Slump structures are also exposed along Laurencelles road.

NAME	*Cape Road member* (Russell, 1947a)
Type Locality	Forillon Peninsula
Lithology	Described by Logan (1863, p. 392) as: "Grey or slightly greenish calcareous shales, associated with bands of dark grey. Both are interstratified with layers of arenaceous limestone, which are occasionally sufficiently coarse grained to approach the character of a fine conglomerate."
Distribution	Not delimited beyond Forillon Peninsula
Thickness	380 feet
Boundaries	The member is conformable with the underlying Quay Rock member, and with the overlying Forillon member.
Facies	A shallow-water marine deposit
Age	Lower Devonian
Remarks	Concerning fossils, Logan (1863, p. 392) wrote: "...in addition to marine plants which are chiefly confined to long flattened serpentining stems, the species which prevail are two undetermined species of *Lucina,* and two of *Lingula, Strophomena rhomboidalis,* an undetermined *Chonetes, Leptocoelia concava, L. flabellites,* and *Spirifer crispata,* with two undetermined species of *Orthoceras* and one of *Phacops.*" In addition to the marine plants mentioned above there is evidence of another flora, in the form of fragments of carbonized stem-like axes of terrestrial plants. The main occurrence is in the middle of member, where resinous spore cases are associated with the carbonized plants. Some of these microfossils have been described by Radforth and McGregor (1954).

NAME	*Forillon member* (Russell, 1947a)
Type Locality	Forillon Peninsula
Lithology	Grey limestone and shale, bentonite, and sandstone; upper part of member shown in Plate VI.
Distribution	Not delimited beyond Forillon Peninsula
Thickness	870 feet (Russell, 1947a, p. 50)
Facies	A shallow-water marine deposit
Age	Lower Devonian
Remarks	The member corresponds to Logan's member 6 plus an additional 128 feet at the top of the section.



Cumming, 2-3-1950

PLATE VI. *View from the northeast extremity of Forillon Peninsula at Cape Gaspé. To show the upper part of the massive upper member of the Cape Bon Ami formation.*

NAME	***Grande Grève Formation*** (Ami, 1900; Clarke, 1900)
Type Locality	Forillon Peninsula
Lithology	Dense siliceous limestone, shale, bentonite, and sandstone
Distribution	Eastern part of the Central Gaspé Basin
Thickness	Approximately 885 feet at type section; may be from 3,000 to 4,000 feet thick in the interior of Gaspé Peninsula (McGerrigle, 1946).
Facies	A shallow-water marine deposit; composed of two members: Shiphead member, with thin bentonite beds, overlain by Indian Cove member, characterized by siliceous limestone.
Age	Lower Devonian. The formation has a rich and well-preserved fauna which has been divided into three faunal zones by Clarke (1908).

NAME	*Shiphead member* (Russell, 1947a)
Type Locality	Cape Gaspé
Lithology	Shale, calcareous shale and limestone; minor amounts of bentonite and sandstone.
Distribution	Not delimited beyond Forillon Peninsula

Thickness	287 feet
Boundaries	The lower beds are conformable with the underlying Forillon member. The top of the member is a grass-green sandstone or grit bed.
Facies	A shallow-water marine deposit. The grass-green sandstone contains fragments of brachiopods and an underlying bed is composed of angular quartz and feldspar grains, calcareous fragments, and comminuted plant remains.
Age	Lower Devonian
Remarks	The Shiphead member corresponds to Logan's member 7. About a dozen bentonitic shale beds occur, mostly thin and averaging 6 inches thick. Two beds are about 1.5 feet thick and a single impure bentonitic shale is about 4 feet thick.

NAME	*Indian Cove member* (Russell, 1947a)
Type Locality	Southern part of Forillon Peninsula
Lithology	Siliceous limestone and shale; chert nodules common in the limestone. Bedding planes between alternating limestone and shale beds are characteristically undulatory.
Distribution	Eastern part of Central Gaspé Basin
Thickness	Approximately 600 feet at the type section, increases in thickness westward.
Boundaries	Lower beds are in conformable contact with the grass-green sandstone of the underlying Shiphead member; uppermost beds are conformable with the sandstones of the overlying York River formation.
Facies	Shallow-water marine deposit.
Age	Lower Devonian (*see* Clarke, 1908)

Succession at St. John River Anticline

The St. John River anticline occupies a medial position along Central Gaspé Basin (*see* Figure 1). It is the only fold in the basin that exposes Ordovician shale and limestone.

The course of the St. John River in Gaspé has been controlled by the structure of Silurian and Devonian strata. The upper reaches of the river follow the axis of the anticline and cut a steep-sided valley (*see* Plate VII). Some 12 miles from its mouth the river cuts through the north flank of the anticline and continues seaward in a broad valley along a syncline in Gaspé sandstone.

Cumming, 4-1, 2,-1957

PLATE VII. *View looking south across St. John River, towards Porcupine and Burnt Jam Brooks (see Figure 6).*

Figure 6 is a geological sketch map showing the distribution of formations in the eastern part of the St. John River anticline. The arrangement of formations across the nose of the anticline demonstrates the moderate eastward plunge of the structure.

The regular and symmetrical arrangement of formations around the St. John River anticline has been disrupted by faults. Along the southwest corner of the area shown, a high-angled reverse fault progressively cuts out the succession between the Fortin formation and the Ordovician. Another fault along the northern flank of the anticline brings the Grande Grève formation in contact with Silurian rocks and cuts out the Cape Bon Ami formation along a 6-mile stretch to the north of Cameron's Camps. Small-scale, northeast-trending normal faults occur in the Ascah Lake region at the nose of the anticline.

Sedimentary rocks exposed in the axial region of the St. John River anticline are dark and light grey limestones and dark green shales. These are of Upper Ordovician age (McGerrigle, 1950). Their contact with the overlying Silurian strata was not observed.

Burnt Jam Brook Formation

The oldest Silurian strata in the St. John River anticline area are dark and pale, green and grey shales exposed on Burnt Jam Brook. These beds are known only from a limited area on the eastern part of the south limb of the St. John River anticline. *Monograptus clintonensis* (Hall) was reported from the formation on Porcupine Brook by Clark (1943).

Outcrops are lacking in the lower 5,000 feet of Burnt Jam Brook, where the brook cuts into the alluvium of the valley floor of St. John River. In its higher reaches, the brook cuts a gorge through soft shales that are

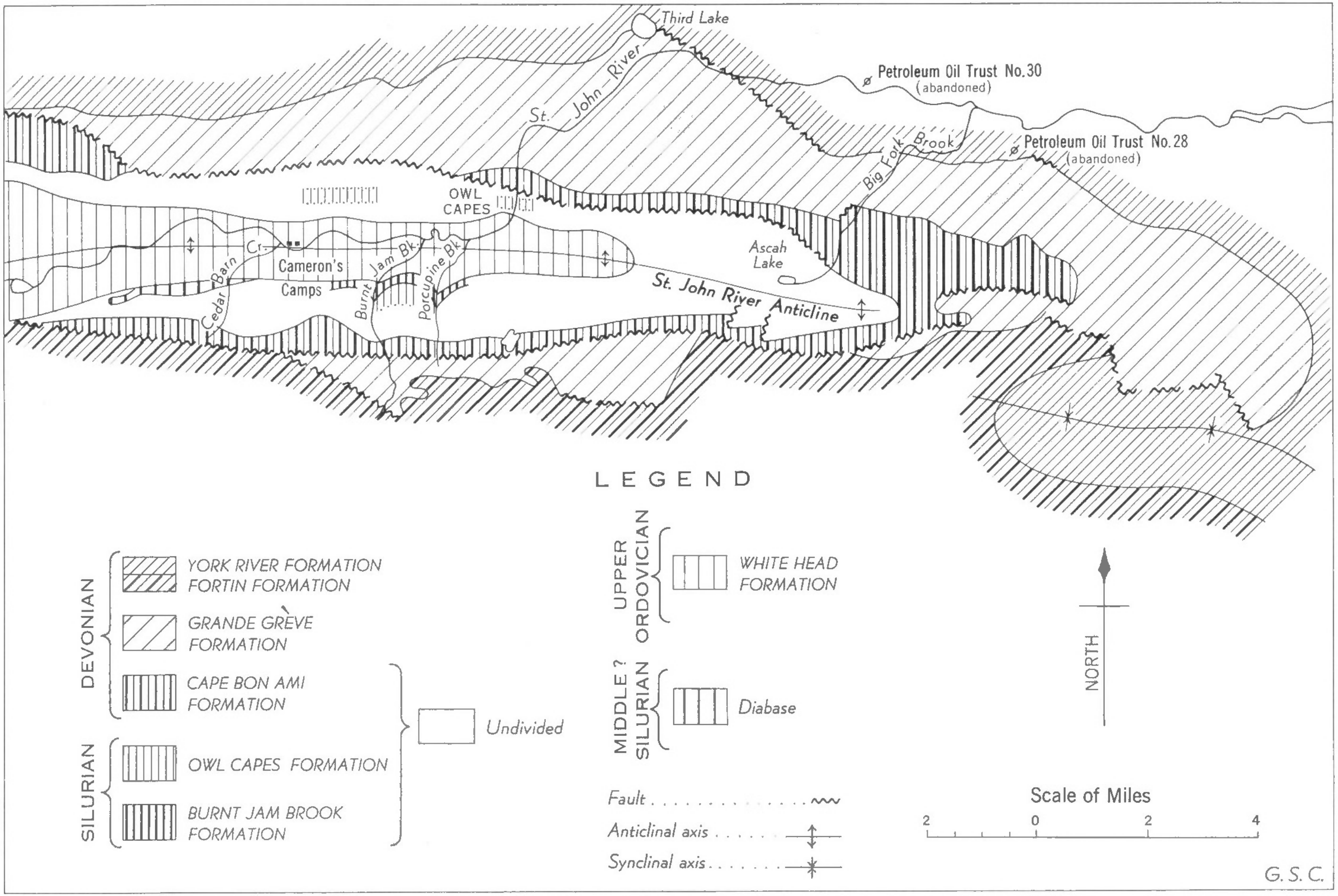


FIGURE 6. *Geology of the eastern part of the St. John River anticline, Gaspé, Quebec. (Generalized from Quebec Dept. Mines maps 664 and 665 by H. W. McGerrigle, 1950.)*

thinly laminated, light green and dark grey, and that outcrop for a distance of 4,000 feet across strike. They are overlain by grey, arenaceous, crinoidal limestone and coarse conglomerate. The beds are closely folded and it was, therefore, not possible to compute the composite thickness. It is, however, estimated to be of the order of 400 to 500 feet.

Dips vary from horizontal to vertical; locally, beds are overturned. In several sections along Burnt Jam Brook competent limestones occur and the associated interbedded shales have developed flow cleavage. Many small faults occur.

Despite its deformation the Burnt Jam Brook formation has yielded an assemblage of Upper Llandovery (Clinton) graptolites. These graptolites occur at several localities across the 4,000-foot exposure of folded strata. In individual outcrops the graptolites are restricted to particular beds, generally less than a foot thick, composed of dark grey shales or paper-thin alternations of buff and dark grey shale. Fossiliferous localities in the shales on Burnt Jam Brook are shown in Figure 7.

The following graptolite species have been identified from the Burnt Jam Brook formation on the south side of the St. John River anticline, and their zonal distribution in Britain (Elles and Wood, 1918) is given below.

British Species in Gaspé	***Zonal Range of British Species***							
	Zone	19	20	21	22	23	24	25
Monograptus decipiens Tornquist		x^{r}	x	x				
Monograptus urcoelus Richter			x					
Monograptus halli (Barrande)				x^{r}	x			
Monograptus turriculatus (Barrande)					x^{c}	x		
Monograptus exiguus (Nicholson)					x	x^{c}		
Monograptus nodifer Tornquist					x	x		
Monograptus pandus (Lapworth)					x	x		
Monograptus marri Perner					x	x	x	x^{r}
Rastrites maximus (Carruthers)						x		
Retiolites sp. cf. *R. obesus* (Lapworth)						x		

r=rarely collected
c=commonly collected

It is concluded that the shales exposed on Burnt Jam Brook represent zones 22 and 23 of the British graptolite succession and thus an Upper Llandovery (Middle Silurian) age.

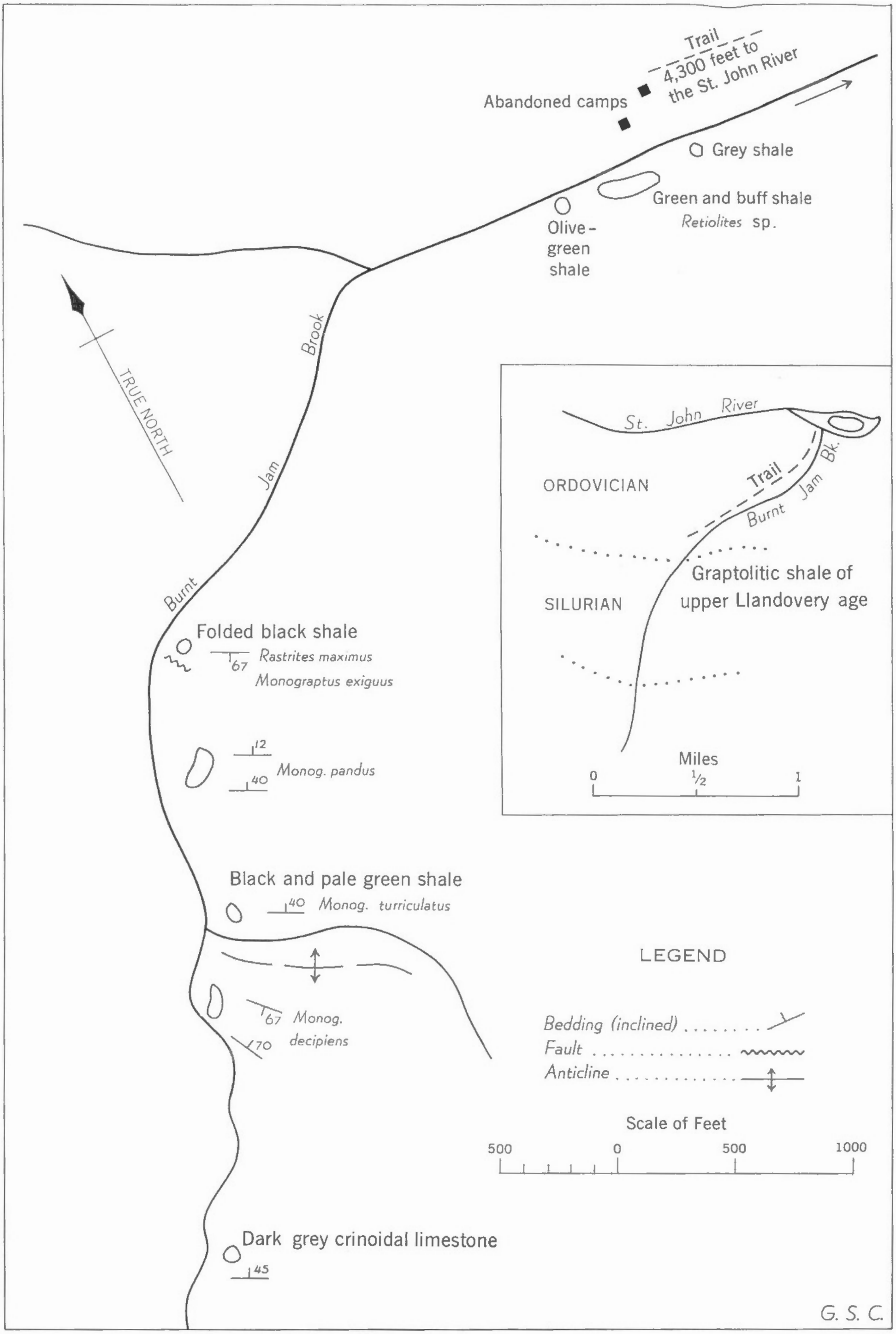


FIGURE 7. *Sketch map showing upper Llandovery (Middle Silurian-Clinton) graptolite localities, Burnt Jam Brook, LaForce township, Gaspé, Quebec.*

Owl Capes Formation

A section of Silurian conglomerate with maximum thickness of 1,000 feet overlies the Burnt Jam Brook shales. These conglomerates have been described by McGerrigle (1950, pp. 39, 40). The formation is best exposed at Owl Capes, between Porcupine and Burnt Jam Brooks, and in the ridge north of Cameron's Camps. Lithologically the beds are limestone-conglomerates but may contain large amounts of volcanic detritus (*see* Appendix, Section VI).

A boulder count of the conglomerate beds of Section VI showed that fragments of coralline limestone make up about one-half of the volume of the rock and were the most abundant rock type. Light grey detrital limestone make up approximately a quarter of the rock debris. The remaining fourth consists of about equal numbers of pebbles of light green felsites and milky quartz. Large pentameroid brachiopods occur commonly in the rock debris. The coralline fauna is restricted to *Favosites* sp. and *Streptelasma* sp. Stromatoporoids and trilobite fragments also occur. Purplish red, and dark green, fine-grained felsites are the most common type of volcanic pebble but multicoloured volcanic breccias are also common.

The conglomerates on both the north and south flanks of the anticline contain well-defined Silurian faunas. Graptolites have so far been found in the northern part only, in siltstone (Section V, unit 16) at the base of a cliff-forming coarse limestone-conglomerate. They are preserved in relief because the thecal interiors of the colonies became wadded with silt particles before lithification of the sediments. These graptolites belong to the single species of *Monograptus vomerinus* (Nicholson) of Middle Silurian age. The conglomerate is overlain by a reddish grey shale containing *Monograptus* sp. indet.

Passage Beds and Devonian Formations

To the south of the Owl Capes conglomerate, on the south flank of the St. John River anticline, is a belt of poorly exposed light grey limestones. Contacts with the underlying Owl Capes formation and the overlying Cape Bon Ami formation were nowhere observed. These grey limestones are highly fractured, and the fractures are filled with white calcite. Fossils are poorly preserved and do not provide evidence for the age of these beds, which were termed "passage beds" by McGerrigle (1950). They have been shown as part of an undivided Silurian and Devonian unit in Figure 6.

The *Cape Bon Ami formation* is poorly exposed on the St. John River anticline. As shown in Figure 6, it lies continuously along the flanks of the anticline, except where it is faulted out of the succession north of Cameron's Camps.

The *Grande Grève formation* in the St. John River anticline region is typically a cliff-forming, cherty, grey limestone with undulating bedding surfaces similar to the lower part of the Indian Cove member at Forillon. Its thickness has been estimated to be several times greater than that in the Forillon section (Roliff, 1952, p. 60).

Succession at Northern Silurian Escarpment

The northern Silurian escarpment is a geographic feature that extends along the northern margin of Central Gaspé Basin (*see* Figure 1).

The occurrence of strata of Silurian age in the western part of the northern Silurian escarpment was shown on the first regional map of Canadian geology, constructed in 1862. The recognition of strata of this age eastward from Dartmouth River was delayed, because in that region the Silurian beds form only the lower part of the escarpment. Faunal lists from collections from the Dartmouth River area have been given by McGerrigle (1950, pp. 35-37).

At Tabletop Mountain, the approximate mid-position in the northern margin of the basin, the escarpment-forming rocks outcrop over a relatively uniform width of a third of a mile. They extend eastward along the south side of parts of the Madeleine and Dartmouth Rivers to Cape Rosier Cove.

Stratigraphic Succession

Description of the stratigraphic succession at two localities will serve to give the general stratigraphy of the entire northern escarpment. At a point northwest of Adam Lake (*see* Figure 1) the escarpment rises abruptly above the Ordovician strata to the north (*see* Appendix, Section VII, for detailed section).

The abundant occurrence of *Conchidium knighti* in unit 12 of this section is evidence of the Silurian age of these strata. The beds are dominantly alternating limestone and shales, but 1½ miles southwest along the escarpment three types of lithology give place one to another along strike over a distance of half a mile: biohermal limestone, graptolitic shales, and quartzite.

The limestone is a massive white unit that forms a projecting bare ridge. This limestone is composed of fossil debris, algal material, stromatoporoids, and bryozoa, and contains *Halysites* sp. and *Favosites* sp. It is approximately 60 feet thick.

Eastward along the escarpment for 0.3 mile, well-bedded, slabby, light green and dark grey micaceous shales are exposed. These shales show primary gravity slump structures, 1 inch to 2 inches thick, and contain poorly preserved *Monograptus* specimens. To the east of them is a massive pink quartzite, whose contact with graptolitic shales has not been observed.

The probable succession in this part of the northern Silurian escarpment is as follows:

3. Uppermost beds: grey and green shales with *Monograptus*
2. Light grey limestones with *Conchidium knighti* and local biohermal developments
1. Quartzite.

A series of five low topographic ridges occurs southward from the escarpment and south of Beland River. Each is composed of a relatively hard band of light grey to buff silty shale and limestone. These rocks contain fucoid markings and worm-like patterns on their bedding surfaces. The strata composing these five ridges are lithologically similar to the Forillon member of the Cape Bon Ami formation, and are therefore assigned to the Devonian system.

The Silurian-Devonian boundary is concealed by the intervening low land occupied by Beland River. The structure of this region is not known and the position of the Silurian-Devonian boundary beyond this point is in doubt. However, Silurian strata are exposed to the southwest along Lesseps Brook (*see* Figure 1) in an area formerly mapped as Lower Devonian limestone.

Lesseps Brook Silurian Locality

The Lesseps Brook locality (*see* Figure 8) is in Gaspé county, approximately 6.5 miles southwest of the south end of Lake Madeleine and 6 miles south of the northern Silurian escarpment. A graptolite assemblage in the thin-bedded siltstones and dolomitic limestones of the Lesseps Brook region is evidence of the Silurian age of these sediments. The graptolite-bearing strata are exposed for a minimum distance of 3,200 feet across strike. Assuming the average dip to be 12°S, not less than 600 feet of strata are present.

The strata are cut by vertical diabase dykes that trend northeast. These dykes are up to 30 feet wide and alter the enclosing strata for a distance of 2 feet from their contact.

Associated with the graptolites is a crinoid fauna that is preserved as casts in the dolomitic limestone. Some of the crinoid material is interpreted as parts of a bulbous root, similar to *Camarocrinus* of the Griffon Cove River formation. Eurypterid fragments also occur with the graptolite and crinoid material in the Lesseps Brook region.

The following six species of *Monograptus,* identified from the Lesseps Brook locality, provide a basis for correlation with the British Silurian succession.

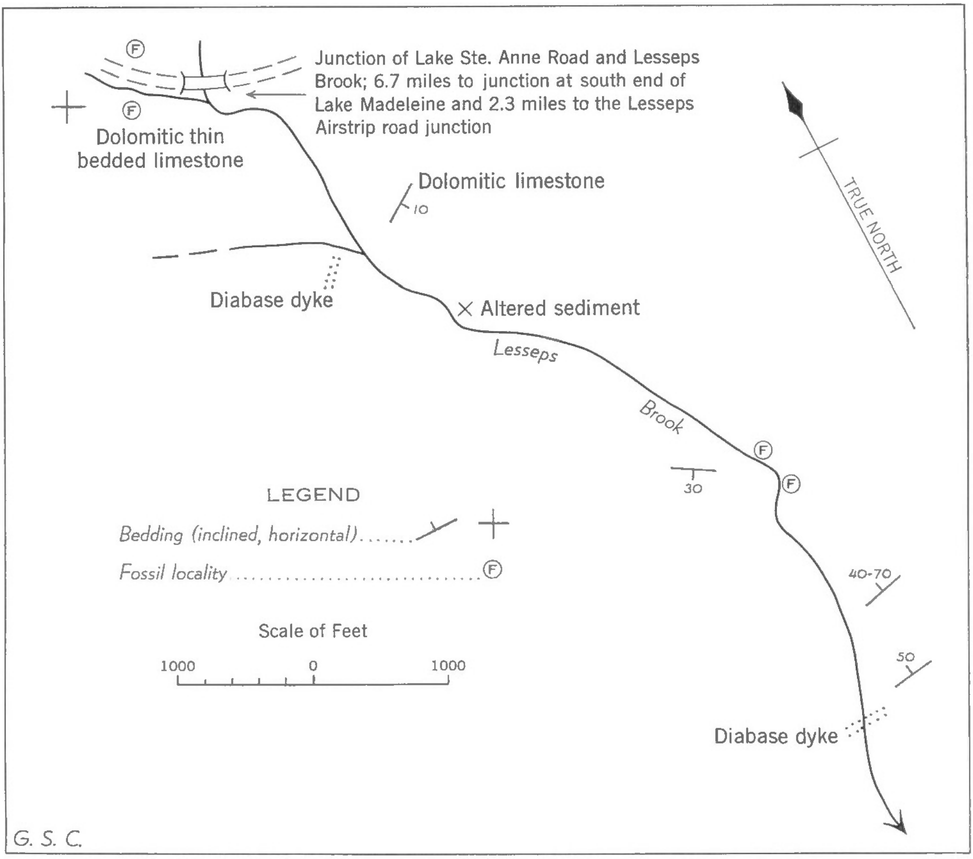


FIGURE 8. *Sketch showing Monograptus localities, Lesseps Brook, Lesseps and Deville townships, Gaspé, Quebec.*

British Species at Lesseps Brook	***Range of these species in terms of the British Graptolite succession (Elles and Wood, 1918)***											
	Zone	26	27	28	29	30	31	32	33	34	35	36
Monograptus nilssoni (Barrande)									x			
Monograptus uncinatus var. *micropoma* Jaekel									x	x		
Monograptus ultimus Perner												x
Monograptus sp. cf. *M. flemingii* (Salter)							x	x				
Monograptus sp. cf. *M. dubius* (Suess)		x	x	x	x	x	x	x	x			
Monograptus sp. cf. *M. retroflexus* Tullberg						x		x				
		Wenlock				Lower Ludlow						

It is concluded that a Lower Ludlow horizon is represented on Lesseps Brook, although the upper part of the Wenlock may also be present.

Silurian and Devonian Sedimentation in Gaspé

Subsidence during the Silurian period was moderate only along the northern margin of Central Gaspé Basin. While calcareous sediments were accumulating in the area that is now the northern Silurian escarpment, thick deposits of conglomerate, shale, and volcanic rocks were forming to the south. This more rapid subsidence in the central region of Gaspé Peninsula in Silurian time formed the pattern for sedimentation in Devonian time. The position of the hinge-line remained unchanged and a stratigraphic break between Silurian and Devonian strata has not been observed.

A reconstruction of the Silurian and Devonian sedimentation in eastern Gaspé is shown in Figure 9. This diagram is an interpretation of the stratigraphic sequence as known in the area north of Gaspé Bay and in the region of the St. John River anticline. The line of section is approximately at right angles to the margin of the Central Gaspé Basin.

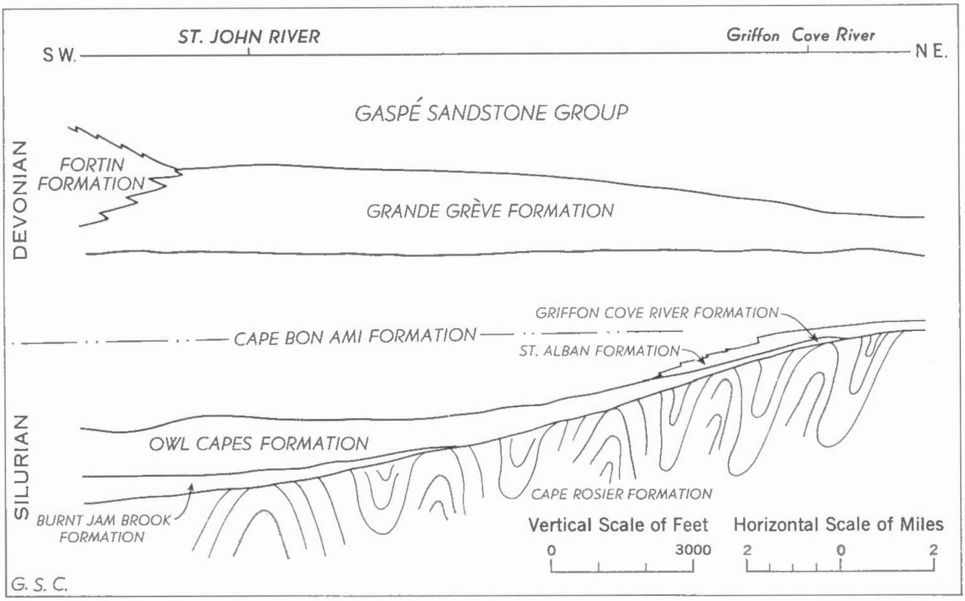


FIGURE 9. *Cross-section showing reconstruction of Silurian and Devonian sedimentation in eastern Gaspé, Quebec.*

This reconstruction is based upon the following lines of evidence:

1. Observed isoclinal folding and high dips in the Cape Rosier formation.
2. Regional evidence of late Taconic folding before the deposition of Silurian sediments.

3. An anticlinal structure beneath St. John River.
4. Upper Llandovery (Middle Silurian-Clinton) age of the Burnt Jam Brook formation representing the oldest known Silurian sedimentary rocks in the region of the St. John River anticline.
5. The limited distribution of the Burnt Jam Brook formation along the St. John River anticline and its absence north of the anticline.
6. Unconformable relationships between the St. Alban formation and the Cape Rosier formation at Forillon, and conformable contact between the Griffon Cove River formation and St. Alban formation at Griffon Cove River.
7. Non-recognition of St. Alban fauna or lithology in the St. John River anticline region.
8. Thickness of the Owl Capes formation, estimated as 1,000 feet (McGerrigle, 1950), its Middle Silurian age based on graptolite occurrences, and its limited distribution in the St. John River anticline region.
9. A lithological correlation between the Owl Capes and Griffon Cove River formations.
10. A revised thickness (1,585 feet) for the Cape Bon Ami formation (Russell, 1946) and the southward thickening of this formation (McGerrigle, 1950; Roliff, 1952).
11. The uniform development of the Grande Grève formation throughout the area and the faunal similarity of the Grande Grève with that of the basal Gaspé sandstone.
12. A thick blanket of sandstones overlying the marine Silurian and Devonian sediments. Only the lower part of these Devonian sandstones is shown on the diagram and their total thickness may be greater than 10,000 feet.

Gaspé Petroleum Possibilities

Logan (1845) recorded the presence of petroleum springs and seepages in eastern Gaspé. The structure of Palæozoic folds related to these seepages led T. Sterry Hunt (1865) of the Geological Survey of Canada, to postulate the now famous anticlinal theory of oil accumulation. Early interest in Gaspé petroleum was initiated by the Drake discovery in Pennsylvania in 1859 and the first drilling for oil in Gaspé was done in 1860. Since then, approximately 75 holes have been drilled. The Gaspé Peninsula has, however, not produced commercial quantities of oil or gas, bearing out Ells' (1902) opinion that the possibilities in the area were remote. Parks (1929), however, concluded that the failure of many test holes was due to the unfavourable location of drilling sites. He stated that the region was widely petroliferous and that the entire area should not be condemned. Hume (1941) also considered Gaspé to be a prospective oil area. Bates and Copeland (1946) discussed the general petroleum possibilities in Gaspé and presented a structure contour map of the Grande Grève-Cap Bon Ami contact in Holland township. Gray and Roliff (1949) summarized recent operations in Gaspé and Jones (1951) indicated the reef development in the Silurian marine limestones to be an unexplored factor in Gaspé oil prospecting. Report No. 35 of the Quebec Department of Mines (McGerrigle, 1950) comprehensively described five map-areas in eastern Gaspé. This report contained detailed geological maps, structure-sections, a summary of drilling operations and analyses of Gaspé oils.

Roliff (1952) summed up the petroleum possibilities of eastern Gaspé as follows:

> The nature, character, and depositional environment of the Devonian rocks in eastern Gaspé, and the numerous seepages, indicate that the Gaspé basin was a favourable one for the origin and possible accumulation of oil and gas in the Devonian rocks. In considering the nature of the types of oil occurrences now in evidence, however, it is difficult to escape the conclusion that, at least in the extreme eastern portion of the basin, much of the Devonian oil which may have been pooled has been dissipated.

However, Roliff also pointed out that only one of the wells drilled could be considered to provide a test for the Cape Bon Ami formation; that the St. Alban formation had not been tested by the drill; and that too little was known about the pre-St. Alban strata to make a worth-while appraisal of oil indications in these rocks.

An important factor in the search for petroleum in Gaspé is the dense and highly indurated character of the upper part of the Gaspé limestone group. However, beds deeper in the section do show appreciable porosity and permeability, e.g., unit 11, Section V (*in* Appendix). Surface weathering of the highly fossiliferous parts of the Gaspé limestone group and the Silurian formations show good porosity.

On the basis of the reconstruction shown in Figure 9 it is suggested that a zone of increased porosity and permeability occurs along the major unconformity, but there is insufficient evidence to show if the known reef structures are a marginal feature or if they are part of a blanket deposit that extends towards the centre of the basin.

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Appendix

Stratigraphic Sections

Section I

Lower part of the type section of the Griffon Cove River formation, to show position of *Camarocrinus* beds.

Top of section		Thickness (feet)
11.	Conglomerate, bright red, coarse-grained near top with well-rounded white quartz pebbles of 1½-inch average diameter in red shaly matrix. Forms lip of small waterfall	5
10.	Shale, light green with red bands, soft and mealy; well bedded	3
9.	Conglomerate, dark green, massive with milky quartz pebbles up to an inch in diameter (*see* Plate I)	4
8.	Shale, green and red, mealy	1
7.	Limestone, bright red with red and green mottled zones, shale parting; crinoidal with numerous ossicles and numerous well-preserved specimens of the bulbous root *Camarocrinus* of the crinoid *Scyphocrinites*	0.6
6.	Shale, red, mealy	0.3
5.	Limestone, mottled red and green; crinoidal	0.5
4.	Shale, red, mealy	0.7
3.	Shale, dark grey	0.5
	Covered (probably shale)	10
2.	Shale, green-grey, mealy	7
	Covered	55
1.	Conglomerate, dark red, with milky quartz pebbles in a non-calcareous shale matrix	2
	Base of section	
		89.6

Section II

Lower part of the St. Alban formation, Cape Rosier Cove.

Top of section		Thickness (feet)
6.	Limestone, hard, grey, fossiliferous; in beds averaging 4 inches in thickness alternating with calcareous grey shale in beds from 2 to 6 inches thick; a stromatoporoid, brachiopod, and coral fauna occurs in the limestone	30.0
5.	Shale, grey, calcareous; numerous limestone bands	5.5
4.	Limestone and shale interbedded; stromatoporoids, gastropods, favositid corals, and atrypid brachiopods are dominant forms in this highly fossiliferous horizon. The favositid corals are twisted cylindrical colonies that indicate intermittent disruption of colony growth during the deposition of these sediments	38.0

Section II—Conc.

Top of section	Thickness (feet)
3. Limestone, conglomeratic and arkosic, pebbles of limestone, and chert up to 4 inches in diameter; corals and shell debris water worn	2.0
2. Limestone and shale interbedded	2.0
1. Limestone, grey, sandy and arkosic; massive; grey shale parting; fossil debris water worn	9.0
	86.5
Unconformity Cape Rosier formation	

Section III

Lower part of the Cape Bon Ami formation, Cape Rosier Cove (*modified after* L. S. Russell, 1947a).

Top of section	Thickness (feet)
20. Limestones and intercalated shales (base of Quay Rock member)	
19. Shale, calcareous, occasional thin limestone beds and limestone partings, sinuous fucoid markings in the limestone	40.0
18. Shale, calcareous, light greenish grey, friable	7.0
17. Shale, calcareous, light greenish grey, massive, in beds up to 5.5 feet thick; 5% of the thickness intercalated thin limestone bed an inch or less thick	16.6
16. Limestone, grey, fine-grained with fine wavy banding	0.5
15. Shale, calcareous, light greenish grey, friable	1.2
14. Limestone, ledge-forming, grey, ripple-marked	1.3
13. Shale, calcareous, grey, friable	10.0
12. Limestone, ledge-forming, grey, ripple-marked	0.6
11. Shale, calcareous, greenish and purplish grey, friable; several thin limestone beds	5.0
10. Limestone, hard, ledge-forming; partings few	0.6
9. Shale, grey-green, rusty weathering, friable; not conspicuously calcareous	8.3
8. Limestone, hard, ledge-forming, with wavy partings; and shale, grey-green, friable, slightly calcareous, with thin rusty limestone beds in upper part	15.5
7. Limestone, grey, massive, ledge-forming; made up of several rusty weathering bands about 0.2 foot thick between which is a softer, somewhat argillaceous limestone showing wavy stratification, forming beds up to a foot thick	6.4
6. Shale, greenish grey, rusty weathering, friable with numerous rounded rusty concretions in irregular layers	15.5
5. Shale, grey, friable; weathering maroon	1.5
4. Shale, friable, greenish grey, rusty weathering, with a few rusty limestone beds	10.0
3. Shale, calcareous, grey, rusty weathering	1.0
2. Shale, friable, greenish grey, rusty weathering, with thin rusty streaks	5.0
1. Shale, slightly calcareous, rather fissile, reddish grey with numerous thin limestone beds rarely more than 0.2 foot thick, some rather irregularly distributed; fossiliferous in places. This unit tends to form sheer faces	25.5
	171.5
Shale, friable, grey-green and maroon (top of St. Alban formation)	

Section IV

Monograptus beds of the Cape Bon Ami formation, Cape Rosier Cove.

Top of section		Thickness (feet)
15.	Shale, maroon-grey, friable and slightly calcareous	0.25
14.	Limestone, grey, hard, ledge-forming; rusty weathered surface	0.58
13.	Shale, maroon, grey-green, best preserved graptolites	0.17
12.	Shale, dark maroon, in beds ¼ inch thick separated by paper-thin shale partings; graptolites abundant throughout	0.75
11.	Limestone, grey	0.25
10.	Shale, dark maroon-grey, non-friable; flattened elongated concretions 3 inches in length	0.67
9.	Shale, maroon-grey, massive	1.33
8.	Limestone, grey, fine-grained	0.25
7.	Shale, maroon-grey, massive with graptolites, scaphopods, and neotremous brachiopods throughout	4.0
6.	Limestone, grey, massive, fine-grained	0.33
5.	Shale, dark maroon, non-friable, graptolitic, with scaphopods and neotremous brachiopods, conularids, and sponge spicules	1.75
4.	Shale, grey-maroon, massive, mealy, graptolitic	7.0
3.	Shale, dark grey-green, friable	0.17
2.	Clay, creamy white, unindurated	0.04
1.	Shale, grey-green and maroon, chunky weathering, mealy textured; upper 10 feet more massive and more resistant to weathering	25.5
		43.04

Section V

Part of Owl Capes formation, St. John River anticline north of Cameron's Camps.

Top of section		Thickness (feet)
21.	Shale, arenaceous, reddish grey, interbedded with thin bands (0.2 foot) of argillaceous beds that weather pale green; contains poorly preserved *Monograptus* sp. indet.	14.0
	Covered	50.0
20.	Limestone, arenaceous, light grey, massive, cliff-forming	14.0
	Covered	3.0
19.	Limestone-conglomerate with pebbles averaging ½ inch in diameter, massive, interbedded with 1-foot bands of arenaceous light grey limestone	23.0
18.	Limestone, arenaceous, light grey, crossbedded	5.0
17.	Limestone, light grey; buff coloured shale and siltstone partings averaging an inch in thickness	0.6
16.	Siltstone, mealy, pale buff-green, with *Monograptus*	1.0
	Covered (probably shale)	5.0
15.	Limestone-conglomerate, massive with pebbles of coralline limestone; interbedded with 1-inch bands of reddish grey arenaceous limestone	3.0
14.	Limestone, arenaceous, reddish brown, interbedded with reddish brown calcareous shale	8.0
13.	Shale, mealy, pale grey-green, grading up into a pebble conglomerate with light grey limestone pebbles averaging ¼ inch in diameter	1.0
	Covered	4.0

Section V—Conc.

Top of section	Thickness (feet)
12. Conglomerate, coarse, made up of limestone slabs; reddish brown and light grey, 7 inches long by 2 inches thick; matrix is an arenaceous limestone showing crossbedding. The sand fraction of the matrix is approximately 55% by volume	3.0
Covered	10.0
11. Limestone-conglomerate, massive, with limestone cobbles of light grey limestone averaging 4 inches in diameter. Sand fraction in matrix approximately 20% and consists of well-rounded, transparent quartz grains	40.0
Covered	80.0
10. Limestone, arenaceous, and limestone-conglomerate. Three units of graded bedding are represented; in each the limestone-conglomerate bed is 4 inches thick and grades upward into arenaceous limestone	8.0
9. Limestone, arenaceous and limestone-conglomerate with graded bedding	9.0
Covered	2.0
8. Limestone-conglomerate, massive, grey-buff and black limestone fragments up to 10 inches in length but averaging ½ inch in cross-section	2.0
7. Limestone, arenaceous, light grey. One graded bedding unit seems to be represented. The basal 8 inches is a limestone-conglomerate	8.0
6. Limestone-conglomerate, massive pebbles of light grey limestone averaging ¼ inch in diameter, pebbles of reddish brown shale and black limestone occur. Current markings with a 5-inch frequency and a 1-inch amplitude occur in the upper more arenaceous beds	16.0
5. Limestone, arenaceous, light grey	1.0
Covered	4.0
4. Limestone, fine-grained, light grey	1.0
Covered	5.5
3. Limestone, arenaceous, light grey, massive	6.0
Covered	2.0
2. Limestone, arenaceous, fine-grained, light grey, with coralline limestone pebbles	5.5
1. Limestone, massive, light grey with lenses of limestone-conglomerate, limestone pebbles averaging ¼ inch in diameter; well-bedded, favositid, crinoid, and brachiopod fragments common. The arenaceous fraction is about 20%	8.0
	342.6

Section VI

Owl Capes formation, east side of the St. John River opposite Owl Capes.

Top of section	Thickness (feet)
4. Boulder conglomerate with grey limestone boulders up to 3 feet in length; cobbles are composed of coralline limestone, milky quartz, light green volcanic tuffs, and light grey detrital limestone; matrix is fragmental volcanic material, predominantly light green	60
3. Conglomerate, coarse, as above with lenses of light green calcareous sandstone	25.0
2. Volcanic breccia, multicoloured, interbedded with light grey limestone; the breccia consists of angular felsite fragments and well-rounded milky quartz pebbles	15.0

Section VI—Conc.

Top of section		Thickness (feet)
1.	Volcanic breccia, multicoloured with fragments of light and dark green chloritized felsite sand, milky quartz and pink feldspar up to ½ inch in length	10.0
	Base of exposure, 35 feet above the level of St. John River	
		110.0

Section VII

Part of an unnamed Middle Silurian formation, northern Silurian escarpment, northwest of Adam Lake.

Top of section		Thickness (feet)
13.	Limestone, light grey weathering, soft, nearly a coquina of diminutive brachiopods	5.0
	Covered	2.0
12.	Silty limestone, dark grey; contains a fauna of *Conchidium knighti, Palaeofavosites,* and trilobite fragments	20.0
11.	Nodular limestone, massive, shaly stringers between nodules; at its base is a sandy limestone a foot thick with well-rounded and sorted quartz sand grains	6.0
10.	Calcareous siltstone or silty limestone, reddish to buff weathering, thin-bedded	10.0
9.	Shale, light grey, more calcareous towards the base	5.0
8.	Limestone, light grey, massive; the lower part contains thin, wavy bedded shale interbeds	5.0
7.	Shale, light grey, white, grey weathering	5.0
6.	Limestone, light grey with limy nodules which average ¾ of an inch in diameter, buff coloured; shale partings associated with the nodules; wavy bedding at base due to build-ups of algae material	10.0
5.	Silty limestone, white-grey, massive	10.0
4.	Limestone, massive; forms third prominent cliff from base of escarpment	60.0
3.	Limestone, massive, harder than that above; forms second prominent cliff from base of escarpment	40.0
2.	Coquina of giant pentamerid brachiopods mostly of the species *Conchidium knighti;* matrix of light grey limestone; massive resistant unit	5.0
1.	Limestone, massive, light grey; forms nearly vertical cliff at base of escarpment	100.0
	Talus, heavy blocks of the above limestone	
	Contact with the underlying rocks not exposed	
		283.0

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