RG 117(A)

CAUSAPCAL AREA, MATAPEDIA AND MATANE COUNTIES

QUEBEC DEPARTMENT OF NATURAL RESOURCES

RENÉ LÉVESQUE, Minister P.-E. AUGER, Deputy Minister

GEOLOGICAL EXPLORATION SERVICE

H.W. McGERRIGLE, Chief

GEOLOGICAL REPORT 117

CAUSAPSCAL AREA

MATAPÉDIA AND MATANE COUNTIES

by

C. W. STEARN

QUEBEC

1965

G.R. 117

E R R A T A

At pages 4 - 24 - 26 - 27 - 28 - 39 - 40, Jollet Brook should read "Chasseurs Brook".

P. 20, Fig. 1 (D) - Petit Ruis. et Ruis. des Quatre Milles should read: "Chasseurs brook and Jollet brook"

(C) - Petit R. des Huit Milles should read: "Petit R. La Vérendrye"

P. 24, fifth paragraph should read as follows:

"The Chasseurs Brook beds were originally named the 'Four Mile Brook beds' by Kindle (1938) from outcrops on 'Little Four Mile brook' (now Chasseurs brook) where it is crossed by the Lacroix road."...

TABLE OF CONTENTS

MAP AND ILLUSTRATIONS

Map

Figure

Plates

(Center of Volume)

CAUSAPSCAL AREA

MATAPEDIA AND MATANE COUNTIES

by

C.W. Stearn

INTRODUCTION

General Statement

The Causapscal area, mapped during the summer of 1958, lies at the base of Gaspé peninsula on the east side of Matapédia river. The sedimentary and volcanic rocks of Silurian and Devonian age that underlie the area were faulted and folded into open synclines and anticlines in the Acadian orogeny of Devonian time. The Silurian rocks are almost all siltstone but include some sandstone in their upper part. Lower Devonian rocks are argillaceous and silty limestones of the Cape Bon Ami and Grande Grève Formations, interbedded grey siltstones and sandstones of the York River Formation, and red sandstones and siltstones of the Lake Branch Formation. They are listed in ascending order and appear to be part of a conformable sequence. The Fortin slates and interbedded arkoses are in fault contact with the York River Formation, but work in other areas indicates that these rocks are a deeper water facies of some or all of the other Devonian Formations. Near their northern boundary the Fortin slates contain andesite flows several hundred feet thick and volcanic breccia.

Two asymmetrical anticlines, the Albertville and the Causapscal, trend northeast across the area. Between them is a zone of cross-folds and faults. South of the Causapscal anticline the Lake Branch Formation is preserved in a west-plunging syncline with a faulted southern limb.

Drilling in 1958 of a well (Associated Developments Causapscal No. 1) near the crest of the Albertville anticline established a thickness of at least 6,000 feet for the Silurian siltstones.

Location

The town of Causapscal, which gives its name to the map-area, is at the junction of Causapscal and Matapédia rivers. The area lies at the western edge of Gaspé peninsula on the east side of Matapédia river. It is bounded by latitudes 48°15' and 48°30' and by longitudes 67°00' and 67°15' and includes about 200 square miles. Included are large parts of Casupscull, Casault, Lepage, and La Vérendrye townships, and small parts of Blais, Assemetquagan, and Matalik townships, all in Matapédia county, and a small corner of Lagrange township in Matane county. None of the adjacent areas have been mapped on a scale of 1 mile to the inch but the Cuoq sheet to the north is being mapped in detail by N.C. Ollerenshaw* and the area to the west in reconnaissance by J. Béland (1960).

Means of Access

The Montreal to Halifax route of the Canadian National Railways and provincial Highway 6 both follow Matapédia valley in traversing the southwestern part of the area. A network of gravel roads leading from the highway serves the farming area of the west half of the area. The east half is heavily wooded but crossed by several good roads. The Kempt road runs southeast from Causapscal to the corner of the area and gives access to the valley of Creux brook. The Lacroix road leads east from Causapscal to the middle of the eastern border of the area. The northern part can be reached on three roads of the New Brunswick International Paper Co.: one along the west bank of Causapscal river, another from the mouth of Huit-Milles brook to Casault lake, and a third to Huit-Milles lake. From these main roads many lumber roads and trails branch off in all directions, a few of which are maintained in a condition that permits travel by automobile.

Both Causapscal and Matapédia rivers are navigable in a downstream direction by canoe although both watercourses are broken by rapids. The Falls of the Causapscal, about 12 miles above its mouth, interrupt canoe travel and must be avoided by portage, but the rapids of the rest of the river and of the segment of the Matapédia within the area can be passed by experienced canoemen. All the other streams are too small or shallow to be of value for travel other than on foot.

Apart from Causapscal (population in 1956 was 2,957) only two other villages, Ste-Florence and Ste-Marguerite, are included in the area of study. Around these communities the land is farmed but, away

---

*Report in preparation. Ed.

from Matapédia valley, the soil is poor and rocky and the farms are comparatively unproductive. The area east of Causapscal river is covered with bush.

Timber Resources, Fish, and Game

The chief natural resource of most of Gaspé peninsula is the forest that covers much of the uplands. In the present area most of the wood cut is for pulp. It is trucked to Causapscal for floating down the Matapédia in the spring to the mills on Chaleurs bay. Most of the wood cut is spruce and balsam fir. Many of the birch trees in the area were recently killed by disease and only within the last few years has a new crop of these trees begun to appear. The New Brunswick International Paper Co. operates a forestry experimental station on the shores of Casault lake and uses the area immediately south of the lake for experiments on forest management.

Causapscal and Matapédia rivers are both salmon streams and are under lease to the New Brunswick International Paper Co. The company also operates a private fishing lodge on the shores of Casault lake. Another private club holds reservations on fishing on Huit-Milles lake. Game is scarce in the area probably owing to the nearness of civilization. Deer, fox, and lynx were seen in small numbers.

Field Work

A contoured map on a scale of one mile to two inches supplied by the Department of Mines and Technical Surveys, Ottawa, was used as a base on which to plot the field information. A set of aerial photographs taken by the Royal Canadian Air Force and the township maps of the Quebec Department of Lands and Forests were used for locating traverses and outcrops in conjunction with the base map. In the course of the field work all the streams and rivers were traversed, for most of the outcrops lie along their banks. All roads and many of the lumber trails were also traversed by foot and automobile. Large interstream areas were crossed in search of outcrop but the bedrock is rarely exposed in such places except where the overburden has been scraped away in the course of road building.

Acknowledgments

The lists of fossils in this report were supplied by Professor A.J. Boucot of the Massachusetts Institute of Technology from collections made by the writer. The writer is glad to acknowledge the cooperation of officers of the New Brunswick International Paper Co. in providing maps of the road system south of Casault lake and for many other courtesies extended throughout the season. Thanks are also due to the Madawaska Corporation for allowing access to the Lacroix road.

N.C. Ollerenshaw of the University of Toronto acted ably as senior assistant. General assistance was given by Paul Jarry, Jules Blanchet, and Richard Hardy.

Previous Work

The results of Logan's traverses of Gaspé peninsula prior to 1863 are recorded in the volume of the Geology of Canada of that date (Logan, 1863). He recognized the presence of the Gaspé sandstones and limestones in Matapédia valley near Causapscal. Ells (1885) traversed parts of Gaspé, but his reports added little to the geology of Matapédia valley. The geology of the railway route through the valley was summarized by Young in 1913 for the International Geological Congress field trips. The geology of the valley was first studied in detail by G.W. Crickmay (1932) under the direction of F.J. Alcock. Crickmay included a small map of the region between Matapédia lake and Chaleurs bay in his account of the structure and stratigraphy of the valley. He did not differentiate the Grande Grève from the Cape Bon Ami Formations but mapped them together as the Causapscal Formation. Alcock (1935) reviewed the geology of the Causapscal area and proposed the name Heppel for the sandstones that had been mapped previously as the Gaspé Sandstone. His geological map is essentially the same as Crickmay's. Kindle (1938) discussed the correlation of the standard section of eastern Gaspé with the formations of Matapédia valley after study of the fossil collections made by Alcock in the Causapscal area. His discussion is largely limited to the Jollet (Four Mile) Brook member of the Heppel Formation (York River of this report) which he concluded was of Late Devonian age. Laverdière and Morin (1941) published a cross section of the Matapédia valley from the St. Lawrence to New Brunswick using Crickmay's and Alcock's formation names. The work of all these geologists is summarized in Dresser and Denis (1944).

Up to this time geologists had mapped the Fortin slates as part of the Matapédia Group of Ordovician age which occupies the valley farther south. The true relations of the Fortin were explained by McGerrigle (1946), who also discussed at some length the correlation of the Jollet Brook beds and threw considerable doubt on Kindle's Late Devonian age assignment. McGerrigle's map of the Gaspé peninsula (1953) includes results of his many years of reconnaissance traverses and outlines the geology of the Causapscal area accurately on a scale of four miles to the inch.

The glacial geology of Gaspé peninsula has been a subject of discussion for over 100 years. McGerrigle (1952) has recently summarized the subject. Most of the writers have been concerned with the interior highlands but Alcock (1935) and Coleman (1922) both make reference to evidence from the Causapscal area.

Topography and Drainage

On the west side of the Causapscal East area Matapédia river has cut a trench into the undulant surface of the Gaspé upland. At Causapscal the river is about 430 feet above sealevel, whereas most of the plateau surface ranges from 1,250 to 1,500 feet above the sea.

The plateau or upland surface east of the river is not flat but rises into low hills and descends generally toward the Matapédia valley (Plate I). It reaches a high point (1,870 feet) south of Casault lake. Hills in the upland surface appear to be underlain by more resistant bedrock than the depressions. The hills south of Casault lake are held up by resistant siltstones of the Grande Grève Formation where it crosses the nose of the Albertville anticline. These beds also form a prominent escarpment immediately southeast of Causapscal. The resistant volcanic rocks within the Fortin slates underlie a line of hills east and west of Ste-Marguerite.

The upland surface was the product of an erosion cycle that was interrupted when regional uplift caused the streams to incise the surface to depths of several hundred feet. The rejuvenated streams are actively downcutting and have valleys steeply V-shaped in cross profile and interrupted in long profile by many rapids and falls. Causapscal river enters the area at the northwest corner, flowing in a broad valley over weak, almost flat, sandstones and siltstones of the York River Formation. At the Falls of the Causapscal, where it cuts through the more steeply dipping Grande Grève silty limestones, the river begins to flow in a valley with steep sides 300 to 400 feet high and continues in this incised condition until it joins the Matapédia at Causapscal.

In the southwestern part of the area the streams flow directly to the Matapédia but in the southeast they flow into Assemetquagan river, a more southerly tributary of the Matapédia. The divide between the south-flowing and the north-flowing streams in the southeastern part of the area is shifting northward. The former have a steeper gradient for they flow directly to the Matapédia, whereas the latter flow against the regional slope of land, into the Causapscal and thence to the Matapédia. In the marshy areas that mark the divides, evidence of the capture of headwater tributaries of the north-flowing streams is seen in the anomalous direction of flow of the highest south-flowing tributaries.

The adjustment of the courses of the smaller streams to the underlying bedrock is fair but the relationships of the larger streams to the bedrock is not obvious. Over the York River and Lake Branch Formations the streams have a marked trellis pattern, especially in the western sector where dips are high. In the rest of the area the drainage is dendritic and only short segments of the streams follow the strike of the beds. Lack of subsequent streams following the strike is particularly noticeable over the Fortin slate. The major waterways like Causapscal river and Huit-Milles brook appear to converge into the synclinorium occupied by the Cape Bon Ami limestone in the center of the area.

Matapédia river flows in an open valley from Matapédia lake to Ste-Florence except at Causapscal where the valley narrows and the river is entrenched a few tens of feet for about a mile. South of Ste-Florence the valley sides close in and form a gorge in which the river flows to join the Restigouche near Chaleurs bay. Alcock (1928, 1935) suggested that the change in the shape of the valley and grade of the river could best be explained by the hypothesis that the upper valley was eroded by a river that flowed north to the St. Lawrence. He believed that Causapscal river was tributary to this ancient waterway and that it was captured by the headwaters of the Matapédia advancing from the south. The flow of the upper to middle part of this hypothetical northward-flowing river was then reversed by glacial damming and it became the upper segment of the Matapédia.

The writer does not believe that such a hypothesis is necessary to explain the course of the river. The grade and bed of any river is governed by the type of load supplied to it and the degree to which it erodes its bed. Changes in the gradient and channel character are reflections of changes in the bedrock over which the stream is flowing or in the load which the stream carries. The change in the shape of the river valley at Ste-Florence is a reflection of the change in the bedrock over which it flows, from the sandstones and siltstones of the Lake Branch and York River Formations to the Fortin slates and phyllites. Alcock notes that such tributaries of the upper Matapédia as the Tobegotte, Amqui (Humqui) and Sauvage rivers are "barbed", that is, they enter the main stream in an upstream instead of the normal downstream direction. The course of the tributaries, however, is controlled by the strike of the rocks in this segment of the drainage basin. They flow along northeast-striking non-resistant beds and cannot be considered to be "barbed".

Matapédia river, like the rest of the streams in the area, is youthful. Its relatively steep gradient, scattered rapids, and lack of meanders indicate its youthful or rejuvenated position in the river erosion cycle.

Where Causapscal river enters the Matapédia, aerial photographs show what appears to be an abandoned channel of the former which enters the Matapédia about one-half mile above the present junction.

This channel is now occupied by two small streams which head 300 feet above the river. The size and shape of the channel leave little doubt that it was eroded by a greater volume of water than at present occupies the depression but whether this was supplied by the Causapscal before it became so deeply incised, or by glacial meltwater, is not apparent.

Glaciation

The controversy concerning the extent of the Laurentide ice sheet over Gaspé peninsula has been summarized by McGerrigle (1952). Even opponents of the theory that the ice sheet completely covered the peninsula (Coleman 1922) admitted that the presence of erratics from the Canadian Shield in Matapédia valley and east of Causapscal on the upland surface was evidence for the extension of a lobe of ice down the valley. As in most of Gaspé peninsula, rocks in the mantle are closely related to those in the subjacent bedrock. However, erratics transported from the Shield are common.

Glacial deposits are not widespread. Along the Matapédia valley at several places kames have been used as sources of gravel and fill. About 2 miles north of Ste-Florence a kame containing boulders of red sandstone up to 2 feet in diameter has been quarried. A large gravel pit in finer stratified drift has been dug on the west side of the Matapédia just west of the western border of the map-area. South of the Lacroix road where it joins the road to Ste-Marguerite is a gravel pit that has supplied road metal. The largest particles are cobbles of sandstone, siltstone, and vesicular andesite derived from the Ste-Marguerite volcanics that crop out about 1 1/4 miles to the south, but most of the material is sand. The beds dip gently southward. The sandy gravel beds are overlain by a layer of boulder till which locally cuts down across the bedding in the underlying sediment.

Till is not common but Alcock mentions several occurrences near Causapscal. Small islands in Casault lake are composed of till containing boulders of grey sandstone. On one small islet the till is overlain by a few feet of peat. Much of the area north of the lake is covered with till in which are set large masses of calcareous siltstone and sandstone, in some places large enough to be mistaken for outcrop. The anomalous structural attitude of these "outcrops" is the only evidence that they are blocks transported by glacial ice. These large erratics are all local and some have travelled but a few feet. Possibly the lakes in this region owe their origin to glacial damming, but this requires further investigation. The present outlet of Casault lake is through a bedrock gorge cut in York River sandstone, but the original drainage to the north may have been impounded by drift.

Some striae were recorded by Alcock from the Matapédia valley near Causapscal but such occurrences are rare in this area. The nature of the outcrops - vertical cuts in streams and roads - is not favourable for the exposure of striae.

GENERAL GEOLOGY

Table of Formations

Time			Formation (Thickness in feet)	Description
Cenozoic Pleistocene				Ice contact drift, minor till, erratics
Paleozoic	Lower Devonian	Onondagan	Lake Branch (4,000)	Red arkose, red siltstones, variegated beds
Paleozoic	Lower Devonian	Esopus	York River (11,000±)	Grey arkoses, red siltstone, grey siltstone, minor conglomerate
Paleozoic	Lower Devonian	Oriskanian	Fortin (Thickness unknown)	Slate, phyllitic slate, thin beds of arkose
Paleozoic	Lower Devonian	Oriskanian	Ste-Marguerite volcanics	Amygdaloidal and compact andesite, breccia
Paleozoic	Lower Devonian	Oriskanian	Grande Grève (3,600)	Calcareous siltstone, silty limestone
Paleozoic	Lower Devonian	Helderbergian	Cape Bon Ami (3,000±)	Argillaceous limestone, silty limestone, siltstone
Paleozoic	Upper Silurian (Ludlow)		St-Léon (6,300±)	Calcareous siltstone, minor sandstone

SILURIAN

St-Léon Siltstone

The oldest rocks exposed in the Causapscal area are greenish grey, calcareous siltstones which comprise the St-Léon Formation. The name was proposed by Crickmay for similar beds in the vicinity of Matapédia lake and along Amqui (Humqui) river north of the village of St-Léon. His map shows the extension of these rocks into the Causapscal area.

Distribution

The siltstones are brought to the surface in the crests of the Albertville and Causapscal anticlines. In the Albertville anticline the St-Léon occupies a band which is a little over 2 miles wide at Matapédia river but which narrows northeastward on the plunging anticlinal and ends a short distance west of Causapscal river. Exposures in this northern belt are small and most reveal only a few feet of beds. One of the best is a road cut in the middle of lot 17, range IISE., Lepage township (3 miles north of Causapscal).

The southern belt of outcrop is 3 miles wide on the eastern margin of the area but narrows westward with the plunge of the Causapscal anticline and ends 2 miles east of Causapscal. Where the valleys of Joliet (Quatre-Milles), La Vérendrye (Petit Huit Milles), and Petit La Vérendrye (Huit-Milles-Nord) brooks have breached this arch in the St-Léon siltstones, some of the best exposures in the area are located. The largest continuous exposure of the siltstones, approximately 1,000 feet of steeply dipping beds, is below an abandoned dam on La Vérendrye brook 4,000 feet above its junction with Petit La Vérendrye brook.

Lithology in Outcrop

Most of the formation is a calcareous siltstone of fine, even, compact texture which reacts readily to hydrochloric acid. The rock is generally greenish grey but may be bluish, or dark to medium grey. The reflection of light from small flakes of muscovite on the bedding planes is characteristic.

Under the microscope, the siltstone is composed of angular fragments of quartz up to about 1/16th mm. in diameter set in a matrix of carbonate. The carbonate content ranges from nil to 60%. A few beds are highly silty limestones. The angularity and lack of sorting of the detrital grains are reminiscent of a crushed material. The carbonate matrix has replaced the quartz particles to a minor extent but the angularity of the grains appears to be primary and not caused by replacement. Small flakes of muscovite make up about 10% of all silt fragments in the samples. Some samples contain a few grains of plagioclase.

The siltstone is massive and practically unbedded in some outcrops, yet thinly laminated in others. In some, bands of shaly siltstone alternate with less fissile siltstone in 1-inch units. In general the bedding is even and uninterrupted (Plate II A). At one locality, flow casts were observed at the base of the bedding plane; at another, fine cross-bedding; and at another, ripple mark in the coarser, sandy layers; - but these are rare exceptions to the otherwise even nature of the bedding. In outcrops where cleavage is not well developed, the St-Léon weathers to flagstones but, where cleaved, it breaks up into blade-like fragments.

Small vugs are common. They are filled or lined with iron oxide on weathered surfaces but where weathering is not far advanced they have a core of bright marcasite. The greenish grey siltstone may weather to an orange-grey surface but many outcrops weather dark grey.

Near the top of the St-Léon siltstones on La Vérendrye brook, about 1 mile above its confluence with Petit La Vérendrye brook, is an outcrop of dark reddish grey siltstone. The rock is similar to the greenish grey variety but is irregularly stained with iron oxides. The distribution of the color suggests that it is a secondary feature. This siltstone contains numerous 1/4 mm. vugs filled with calcite or quartz.

Greenish grey sandstone is a minor component of the exposed part of the St-Léon Formation. No continuous bands of sandstone were mapped owing to the scattered nature of the outcrops but the even bedded, medium- to fine-grained character of the rock suggests that bands would be persistent. Fine sandstone crops out in many places in the vicinity of the oil well in the southeast corner of Lepage township. A small escarpment of fine silty sandstones runs parallel to Highway 6 at the southwest end of lot 17, range 1, Lepage township, and the same rock crops out on Matapédia river nearby and at a small quarry in the crest of the Albertville anticline just west of the area. This medium-grained sandstone consists largely of subangular grains of quartz embayed by replacing carbonate, and smaller amounts of microcline and plagioclase feldspar.

A 2-inch bed of tuff occurs near the top of the St-Léon siltstone on Jollet brook one mile above Causapscal river. The grains are coarse (1/2 - 1 mm.) and little sorted. Most are fragments of fine-grained andesite, but twinned crystals of andesine are common. Calcite is present as discrete large crystals, as a replacement of some of the fragments, and as a matrix between others.

Subsurface Lithology

The above description applies to the St-Léon siltstones that crop out in the Causapscal area. The drilling of the Associated Developments Causapscal No. 1 well during 1958 on lot 20-A, range I, Lepage township, 2 1/2 miles northwest of Causapscal made available in core form a much better section of the formation than is exposed anywhere in Gaspé. The well reached a vertical depth of 4,695 feet (length of core = 4,715 feet) without penetrating beds other than the St-Léon, but as the lower beds in the hole dip as steeply as 85° this figure does not represent the stratigraphic thickness penetrated. The following is a summary of a log of the core paraphrased from an unpublished report by J. Béland for the Quebec Department of Mines:

Thickness	Lithology
0-80 ft.	Overburden
80-615 ft.	Sandstone, calcareous, gritty, greenish to dark grey, in graded beds 1-3 feet thick which pass upward into siltstone; interbedded with thin partings of banded, dark grey and greenish grey slate in 1- 2-inch beds. Equigranular sandstones and massive homogeneous beds of siltstone are also present. The sandstone contains abundant quartz grains, small fragments of chert, fine-grained siltstone, shreds of black phyllite, and some slate fragments. Primary slump structures and microfaulting are common in the sandstones and siltstones.
615-660 ft.	Sandstone, siltstone, and slate as above, interbedded, greenish-grey. A transition sequence to the finer-grained sequence below.
660-4,175 ft.	Calcareous, light to medium grey siltstone, in beds 1-2 feet thick for the most part but ranging up to 8 feet, some showing vague graded bedding; interbedded with argillaceous, laminated, dark grey siltstone and dark grey slate, both only slightly calcareous, in beds 3-6 inches thick in general but ranging up to 5 feet. Massive beds of silty slate are also present and, from 1,500 feet to the base, light-colored siltstones and dark slates in thin bands give a ribboned appearance to the rock. The greenish color of the upper part of the St-Léon is rare below 1,115 feet, and disappears

completely below 1,795 feet. Between 4,120 and 4,165 feet several beds of a calcarenite of broken shells and crinoid plates occur. The whole unit shows slump structures.

Breccias and shears suggest that faults of small stratigraphic displacement cut the lower part of the well. The dip of the beds is gentle (less than 18^{0}) down to a depth of 3,590 feet, where it increases abruptly to 50^{0}, presumably where the well intersects a fault. Below 3,745 feet the dip gradually flattens to 20^{0} and then steepens to 35^{0}. At 4,070 feet another abrupt change occurs to 17^{0} accompanied by brecciation. Below this, dips range from 55^{0} to 85^{0} and near the bottom of the hole contortions, phyllitization, slip cleavage, and calcite veins occur.

Thickness and Contacts

Calculation of the thickness of the St-Léon siltstone exposed in the area is difficult because outcrop is scarce and the dip changes from outcrop to outcrop. On the south limb of the Causapscal anticline about 2,000 feet of these beds are exposed. That the formation is much thicker is indicated by the Causapscal well. Béland calculates that it was started 2,190 feet below the top of the St-Léon and penetrated 4,175 feet of the formation without reaching its base. Thus, the formation is at least 6,365 feet thick.

Fossils and Correlation

Most of the siltstones are unfossiliferous but some contain graptolites. Collections from three localities in the area were identified by L.M. Cumming of the Geological Survey of Canada as follows:

1. Small tributary north of La Vérendrye brook near west border of area.....*Monograptus ultimus* Perner
2. Loose in the headwaters of La Vérendrye brook near west border of area.....*Monograptus tumescens* Wood
3. Lot 15, range IISE., Casault township, on stream 2,950 feet southwest of the road.....*Monograptus comis* Wood

Cumming dates these three graptolite species as Lower Ludlow. This suggests that the upper part of the St-Léon, from which the collections were taken, should be considered to be early Late Silurian in age in the North American terminology.

DEVONIAN

Cape Bon Ami Formation

At the type section of the Cape Bon Ami at the east end of Gaspé, the Formation is a succession of dark, soft limestone and shale which underlies the hard, siliceous, silty limestone of the Grande Grève Formation and overlies the argillaceous and shaly limestones of the St-Albans Formation. The tracing of the Cape Bon Ami across Gaspé has been accomplished by McGerrigle. He described the formation in the central part of the peninsula as dark grey to brownish-grey, rather soft, shaly limestone in 6-inch to 3-foot beds (McGerrigle 1945, MS.). The beds designated in this report as the Cape Bon Ami limestone were included by Crickmay (1932) with the Grande Grève silty limestones in what he called the Causapscal Formation. The type section of this Formation is the road cut along Highway 6 on the southern outskirts of Causapscal. In this outcrop the lithologic characters of the Cape Bon Ami and Grande-Grève Formations are merged in such a way that there is difficulty in assigning it to one or other of the two formations. The outcrop is further discussed in the description of the Grande Grève Formation. Although the assignment of a few outcrops may be difficult, most can be definitely placed and the term "Causapscal Formation" is unnecessary.

Distribution

Cape Bon Ami limestone underlies a large part of the Causapscal area. On the north limb of the Albertville anticline it is poorly exposed but Causapscal river cuts through the Formation on the nose of this plunging fold and follows the limestone along the south limb as far as the Matapédia valley. Gently dipping Cape Bon Ami beds are exposed in cliffs high on the sides of the river valley and along the banks at rapids. Larger exposures have been cut by some of the brooks tributary to this segment of the river. The lower part of Huit-Milles brook flows in a deep valley through this Formation. About 300 feet of Cape Bon Ami limestone is exposed in a picturesque fall and cascade about 1 1/2 miles above the confluence of this stream with La Vérendrye brook (Plate III). On the south limb of the Causapscal anticline the formation crops out on Trois-Milles brook, Joilet brook, and La Vérendrye brook in steeply dipping, well cleaved beds.

Lithology

The Cape Bon Ami in the Causapscal area consists of dark grey, very finely crystalline, argillaceous, thick bedded limestones with a wide range of silt content but with generally much less silt than the

Formations above and below. Most of the Cape Bon Ami rocks react positively to the acid test for limestone even though they are very impure, but only rare rocks from the St-Léon and Grande Grève Formations will react as strongly. In general, the limestone is slightly silty and capable of scratching glass but in only a small part of the Formation does the silt content exceed 10%. As noted below, some beds of siltstone occur near the top of the unit.

Rhythmic variation in argillaceous content produces step-like outcrops in which resistant massive strata alternate with non-resistant shaly strata. Only a few beds in the whole Formation are argillaceous enough to be called shale. Changes in the proportion of argillaceous and carbonate components are reflected in the spacing of the cleavage planes. Characteristically, the limestone is cut by closely spaced, shaly or "flow" cleavage that permeates the whole rock (Plate IIB). In beds with a small argillaceous content, the planes of cleavage are more widely spaced, giving a structure commonly spoken of as "fracture" cleavage. The flow cleavage typical of Cape Bon Ami limestone in western Gaspé is absent from the type section and from most outcrops in central Gaspé.

The limestone beds are 1-2 feet thick in most outcrops but are commonly marked by a finer lamination. Large concretions were found at two localities. About 6,000 feet north of Causapscal on the Canadian National Railways line a low cut has exposed a calcareous concretion 5 feet long and 3 feet high embedded in dark grey argillaceous limestone (Plate IVA). The concretion weathers brown and yellow and stands out sharply from the drab limestone. Bedding is obscure around the football-shaped mass. On Huit-Milles brook about 3,000 feet above the entry of La Vérendrye brook, ellipsoidal concretions up to 3 feet in diameter show concentric structure on weathering. Another type of concretionary structure has been formed where the argillaceous limestones have been sheared and a segregation of the limy and shaly constituents has taken place.

In most outcrops the bedding is even and undisturbed but, on Causapscal river a few hundred feet above the entry of Trois-Milles brook, the bedding is much contorted on a small scale apparently by slumping and sliding of the rock while it was still in a plastic state. This contortion of bedding is not comparable in scale with that at The Quay near the type section of the Cape Bon Ami limestone but indicates similar conditions of deposition.

Near the top of the formation, but not immediately below the contact with the Grande Grève, dark grey, non-calcareous siltstones or mudstone is associated with pyroclastic sedimentary rocks. The best exposure of these beds is on Huit Milles brook about 2 miles above its confluence with La Vérendrye brook (SE.boundary, lot 33, range II, Casault township). Dark to bluish-grey mudstone about 15 feet thick with two prominent beds of medium grey limestone 2 feet thick is overlain by a 2-3-inch band of tuff and a band of friable, rotten material which weathers brown and may be a metabentonite. The sequence is capped by about 6 feet of feldspathic, greenish grey sandstone. Similar non-calcareous mudstone and tuff is exposed immediately east of the above locality on logging roads in the bush and on the road to Huit Milles lake at the base of the prominent hill (NW. boundary, lot 34, range II, Casault township). The tuffaceous beds crop out near the west bank of the Causapscal on lot 12, range IIIN, Casupscull township. On the south limb of the Causapscal anticline, the non-calcareous siltstone unit outcrops along the Lacroix road east of the town and on the headwaters of La Vérendrye brook. In the latter outcrops, the siltstone is accompanied by bands a few inches thick of friable, yellow-weathering, waxy clay that may be bentonitic. Typical Cape Bon Ami limestone overlies the siltstone unit in a large outcrop at the intersection of the Casault lake road with Gastonguay brook but no tuffaceous beds appear at this locality. The siltstone has been quarried for road metal. The thickness of this regionally distributed, non-calcareous unit is impossible to calculate as its top and bottom are not exposed but it probably is less than 100 feet thick. Mapping this unit as a separate formation would be feasible on a smaller scale.

In thin-section the tuffs near the top of the Cape Bon Ami limestone show a great variety of fragments. A tuff collected east of Huit-Milles brook contains about 40% pumice fragments replaced and infilled with calcite and chalcedony in a matrix of calcite. On the Huit-Milles Lake road, fragments of very finely crystalline andesite are the most prominent constituents of the tuff but crystals of quartz and andesine, and fragments of pumice are common. The tuff from Huit-Milles brook also contains andesite but is more chloritic. In the Causapscal River occurrence many of the lava fragments in the tuff have been silicified almost beyond recognition. In spite of their diversity, all these rocks can be classified as andesite tuff.

Thickness and Contacts

No more than a few hundred feet of Cape Bon Ami limestone is continuously exposed in the Causapscal area and thickness estimates must be made by calculation from width of outcrop and dip. Cross-folds and other structural complexities still further confound the calculations. McGerrigle (1945 MS.) has estimated that the Formation is about 3,000 feet thick in western Gaspé and this figure agrees with the present study.

The nature of the lower contact of the Cape Bon Ami limestone was given above in the discussion of the St-Léon siltstone. The upper contact is marked by a transition from dark grey, argillaceous, thick bedded limestone that weathers brownish grey to medium grey, finely laminated, silty limestones or limey siltstones that weather light grey. The contact is not exposed in this area but in other parts of Gaspé the two lithologies are interbedded over a small stratigraphic interval in the contact zone.

Fossils and Correlation

The Cape Bon Ami contains few fossils in the Causapscal area. The large road-cut south of Causapscal yielded a single brachiopod identified as Chonetes ? sp. Crickmay collected a richer fauna from this outcrop and lists:

Leptaena rhomboidalis (Wilckens)

Amphistrophia continens Clarke

Coelospira dichotoma Hall

Rensselearia sp.

Spirifer sp. cf. S. vanuxemi Hall

Spirifer sp.

He suggests that this fauna is similar to that of the Grande Grève of eastern Gaspé and is of Lower Devonian age.

Grande Grève Formation

The term Grande Grève is used to identify a succession of hard, silty limestone and calcareous siltstone that lies above the argillaceous limestone of the Cape Bon Ami Formation and below the interbedded limestone and sandstone that marks the base of the York River Formation. The name was originally proposed to refer to beds in Logan's section on the Forillon peninsula. However, this section proved not to be typical inland and, after a regional study, McGerrigle (1950) proposed that the base of the Formation be defined at the appearance of hard cherty to siliceous limestone (or calcareous siltstone) and the upper contact, at the appearance of sandstone of the York River Formation. The Grande Grève limestone of the Matapédia valley is dissimilar to that of the eastern Gaspé in its lack of chert, predominance of silt, its general lack of shaly interbeds, its less pronounced bedding, and stronger cleavage. In spite of these lithologic differences, the stratigraphic position and siliceous nature of the unit justify the use of the name Grande Grève.

Distribution

The Grande Grève is most extensively exposed in a Z-shaped band in the northern third of the area. The best exposures occur where the band crosses Causapscal river at and below the falls (Plate V). The Grande Grève swings around the plunging nose of the Albertville anticline south of Causapscal lake and Huit-Milles lake and is caught up in a group of cross-folds on its southern limb. The formation is poorly exposed on the south limb of the anticline.

The Formation is also exposed in a narrow band on the south limb of the Causapscal anticline. It crops out on the headwaters of La Vérendrye brook, on Jollet and Trois-Milles brooks, and south of Causapscal.

Lithology

Much of the Grande Grève can be described as medium to dark grey, finely crystalline, thinly laminated, silty limestone which weathers light brownish grey and light grey. The color of the rock is generally much lighter than that of the Cape Bon Ami and may have a bluish cast. The silt content is variable from bed to bed. It is difficult to assess by field test because weathering agents commonly penetrate the rock for distances up to an inch, leaching the carbonate and leaving an envelope of porous, brownish to light grey siltstone which does not react to acid. The degree to which the unweathered interior rock reacts to acid is only a rough indication of the silt content. In samples of this formation examined under the microscope the silt content range is 20-70%. Some of the rocks are silty limestones; others are calcareous siltstones. These two lithologies may be interbedded in units a few millimeters thick. The siltstone consists of subangular to angular grains of quartz embedded in a calcite matrix. In a specimen collected from Huit-Milles brook, outlines of many sponge spicules may be seen in the calcite matrix. Some of these are cruciform, as if broken from a hexactinellid network, but most are simple fibers (monaxons) with a central canal. Clay is rarely an important constituent of the limestone.

The bedding of the Grande Grève limestone is well defined in most outcrops by variations in silt content from lamina to lamina. The silty layers are lighter in color and commonly lenticular. Some laminae show current bedding on a small scale. In others the bedding appears to have been deformed when the sediment was unconsolidated. At one outcrop on Huit-Milles brook, the bedding has been swept up into sharp crests at intervals of a few inches in a structure commonly referred to as "antidune ripple mark". This structure is believed to be a type of load cast. None of these structures is common and the regular banding in the Grande Grève limestone is sufficiently widespread to be a valuable criterion for the identification of the formation. Thin shale interbeds, common in the type section, are not characteristic of this formation in the Causapscal area but were noted at one locality.

During the weathering of vertical faces the silt-rich layers are etched into relief on the rock surface. Where small pieces of the silty limestone have been incorporated in the soil mantle, they are leached of their carbonate content and become light grey, porous, silt fragments. The presence of such light grey fragments in the float has been used throughout Gaspé as an aid in identifying the formation. In many outcrops, the bedding is delineated by lines of small vugs on the surface. These vugs appear to be a product of weathering processes and not an indication of internal porosity.

The silty limestone beds of the Grande Grève are cut by widely spaced cleavage planes in nearly all outcrops. They are only rarely as closely cleaved as the argillaceous beds in the Cape Bon Ami limestone but show the "fracture" cleavage of the more calcareous beds of that unit. On the south limb of the Causapscal anticline the closer spacing of the cleavage planes increases the resemblance of the Grande Grève Formation to the Cape Bon Ami.

Contacts

The contact between the northern band of Grande Grève limestone and the York River Formation can be studied only on Causapscal river. Figure IA is a graphic section of these rocks. The river descends in a distance of one mile over a series of cascades and falls. The Grande Grève is exposed on the walls of the gorge and almost continuously along the portage trail. Above the falls at Nérée-Lavoie brook, gently dipping silty limestone beds form cliffs at the riverside. Although outcrops continue upstream for several miles, few beds higher in the sequence are exposed as the river flows close to the strike of the beds. Above the upper falls the limestone is sandy and is underlain by a unit at least 100 feet thick of calcareous sandstone bearing carbonaceous material. The base of this unit is not exposed. Downstream the silty limestones continue to crop out to the Cape Bon Ami contact but between the upper and lower falls two sandstone layers, apparently no thicker than 10 feet, are intercalated in the sequence.

Ells (1885,map) placed the contact between the sandstones (which he called Devonian) and the limestones (which he called Silurian) at the falls, apparently at the base of the calcareous sandstone unit. Alcock (1935) placed the contact a mile downstream but did not explain his basis for drawing it there. Presumably he wished to include all the sandy beds in the sandstone unit. He also cites the presence of fossils at the falls as being more typical of the York River (Heppel in his terminology) even though he later states that the fauna of these beds is close to that of the Grande Grève limestone. McGerrigle (1946) points out that the fossiliferous beds at the falls are in the transition zone from the Grande Grève limestone to the Gaspé sandstones and might just as well be in one as the other. All writers are agreed that no break either structural or stratigraphic occurs in this section. The question is, "Where shall the base of the York River Formation be arbitrarily drawn?"

Geologists have advanced different interpretations of the relations between the Grande Grève and York River Formations on the south limb of the Causapscal anticline. Early workers (Ells, Crickmay, Alcock) did not recognize a fault at the boundary but regarded it as the stratigraphic contact between the Gaspé limestone and sandstone groups. McGerrigle (1953, map) mapped a fault along the contact to account for the virtual absence of Grande Grève rocks between the sandstones and the Cape Bon Ami limestone at Causapscal. Although he did not map a band of Grande Grève there, in an unpublished report he points out that a sliver of Grande Grève lithology is present locally along the contact and a fault is required to explain the thinness of the Formation. The interpretation of the contact zone that emerged from the present field work is presented in Figure 1.

The tributary to La Vérendrye brook on the eastern border of the area exposes a section without apparent structural disturbance (Figure I C). The Grande Grève limestone passes abruptly into sandstone but a single interbed of limestone occurs within the sandstone 700 feet above its base. On another tributary to La Vérendrye brook, about 2 miles west of the boundary of the area, the limestone is overlain by non-calcareous siltstone of the York River Formation without visible interbedding. On Trois-Milles brook (Figure I-B), exposures are scattered but show at least one interbed of sandstone apparently not more than a few feet thick about 700 feet stratigraphically below the highest limestones of Grande Grève aspect.

The most extensive exposures in this contact zone are on Jollet brook at its junction with La Vérendrye brook. However, parts of the section here are overturned and broken by faults. The faults appear to be of minor stratigraphic displacement and are probably adjustments largely along bedding planes. Below the brook junction the overturned Grande Grève limestone is overlain by a unit of cross-bedded sandstone about 700 feet thick. The limestone above this sandstone is apparently faulted against a block containing two interbeds of limestone in the sandstone. Farther south the beds are faulted and folded but no more limestone occurs in the sandstone-siltstone sequence.

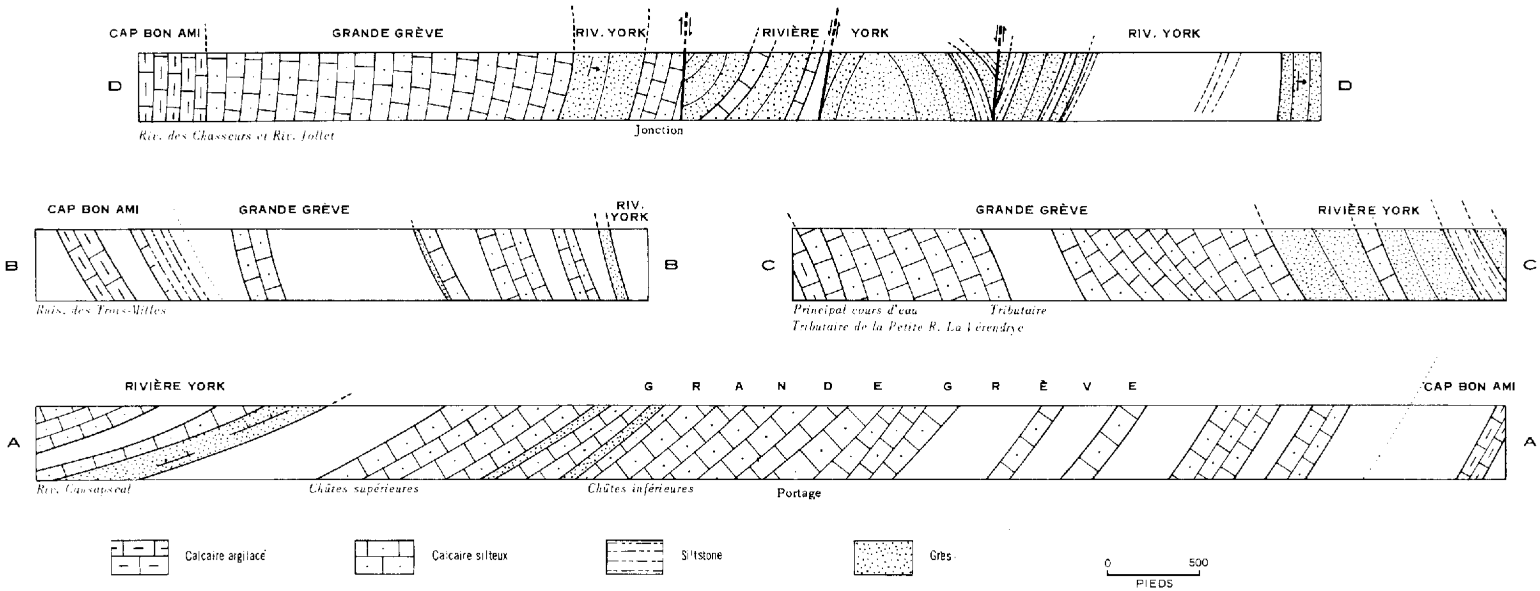
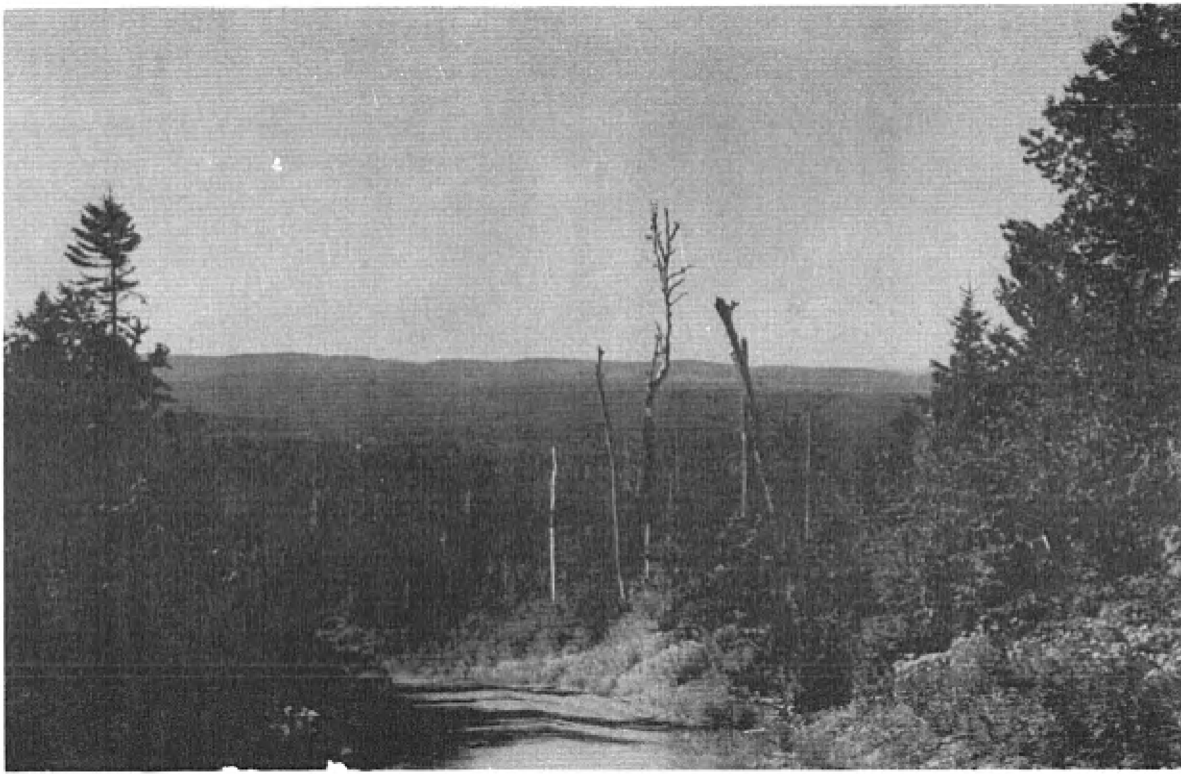


FIG. 1 COUPES DU CONTACT DE GRANDE-GRÈVE-RIVIÈRE YORK

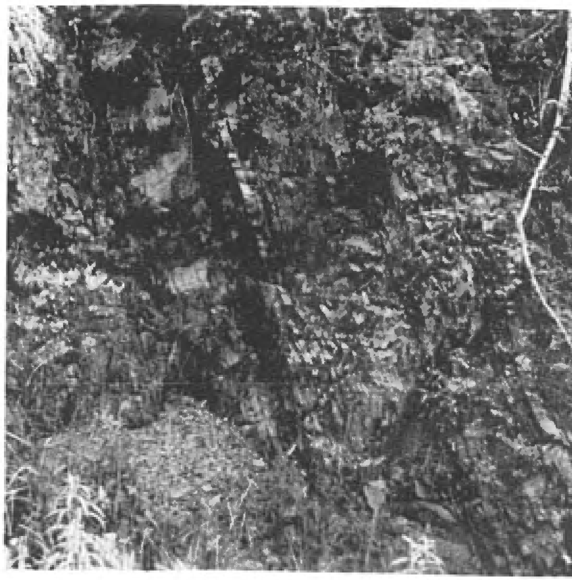
NO. B-841



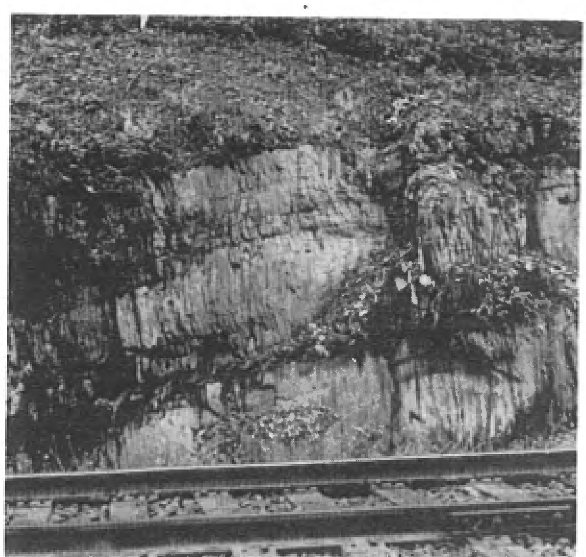
Looking south from the hill on the Huit-Milles Lake road, showing the general nature of the upland surface.

PLATE I

PLATE II



A — St-Léon siltstone. La Vérendrye brook.

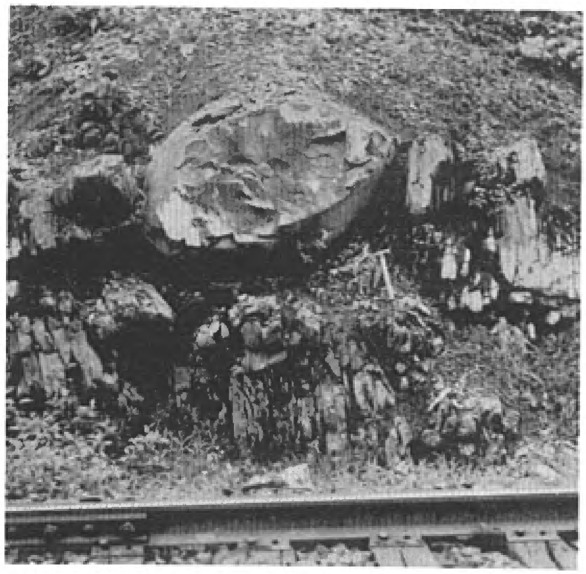


B — Cape Bon Ami limestone, showing thick bedding cut by closely spaced cleavage. C.N.R. track, Causapscal.

PLATE III

Cascade over Cape Bon Ami limestone about 4 miles below Huit-Milles lake on Huit-Milles brook.

PLATE IV



A — Large concretion in Cape Bon Ami limestone. C.N.R. tracks, about 1½ miles north of Causapscal.

B — Thick-bedded, red, Lake Branch sandstone. Quarry, Lajoie (Carrière Rouge) brook.

PLATE V

Silty Grande Grève limestone at the upper falls of Causapscal river.

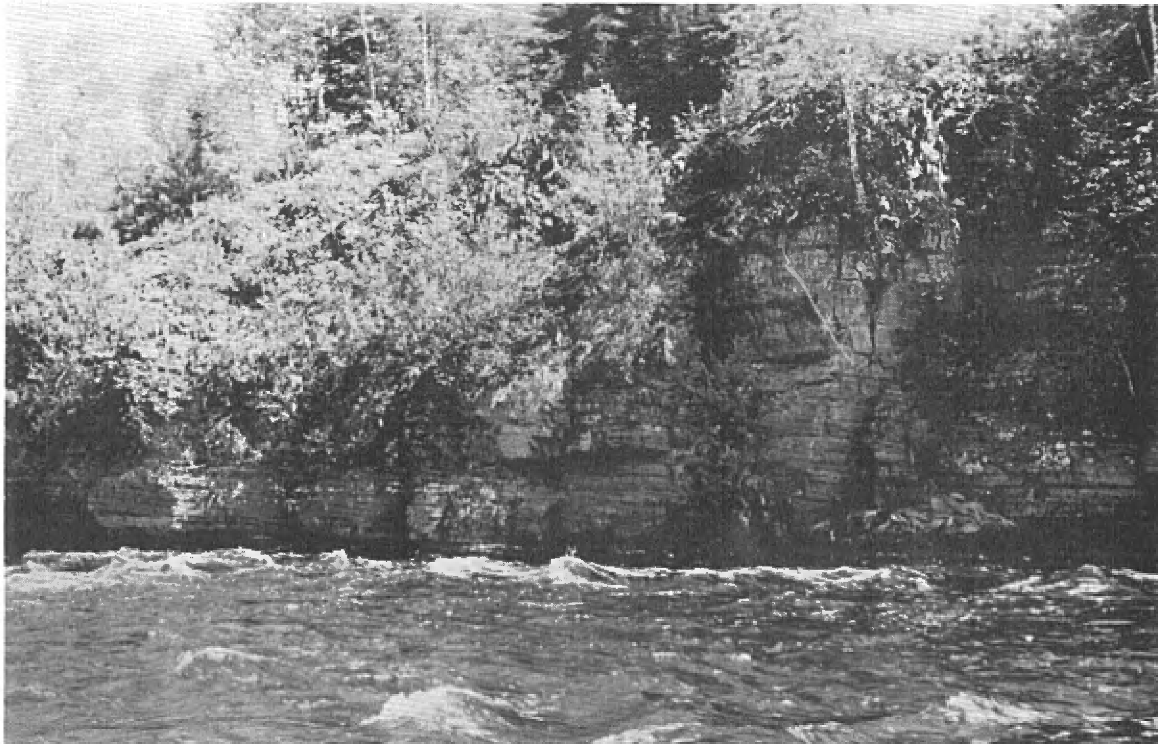
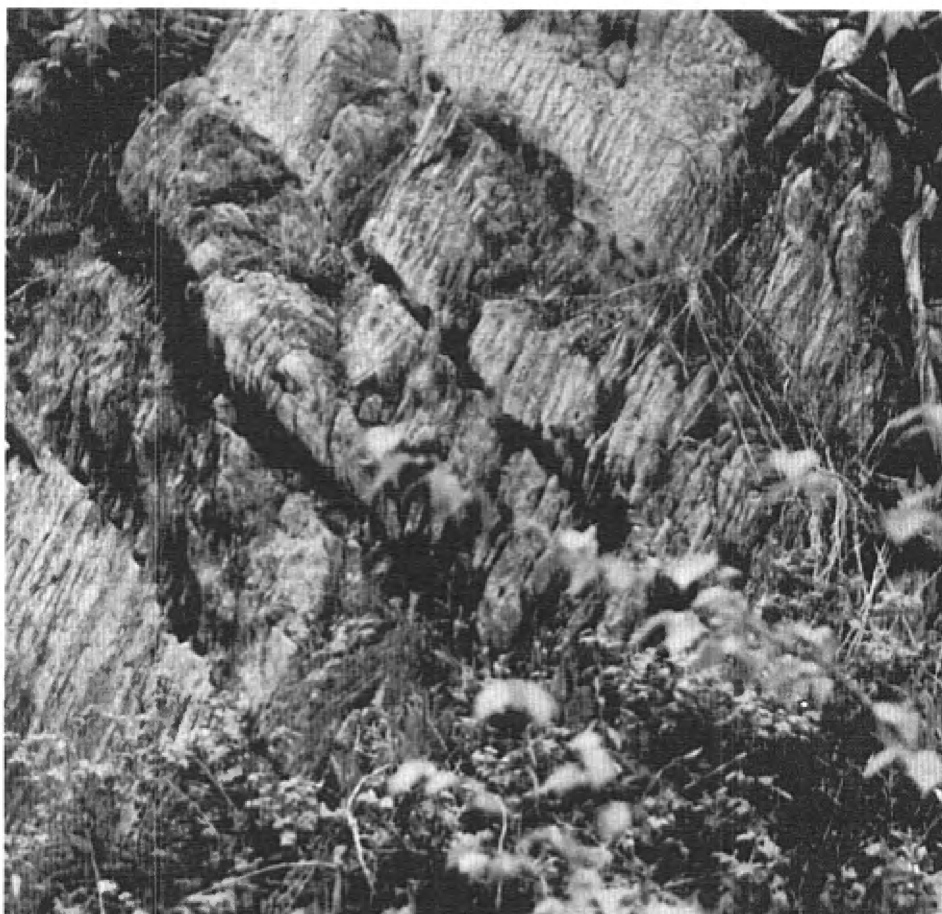


PLATE VI

Calcareous siltstone of the basal part of the York River Formation on Causapscal river (lot 3, range I, Blais township).

PLATE VII



Fortin slate showing the intersection of cleavage and bedding, 1 mile S. of Ste-Florence.

These sections indicate that the Grande Grève and York River lithologies are interbedded along both the southern and northern outcrop bands, and that little evidence of regional faulting along the southern contact exists. Jones (1936) has suggested that such transitional successions be separated as the "York Lake formation" but McGerrigle (1946, 1950, 1953) has given reasons why the unit is not a useful one except in restricted areas. The only logical place to draw the boundary between the York River and Grande Grève Formations is at the base of the first sandstone bed of regional distribution. This has been the horizon used by other geologists in Gaspé. Thin beds of sandstone, such as those at Causapscal falls and on Trois-Milles brook below the first large sandstone unit, are included in the Grande Grève, and much silty limestone above this sandstone unit is included in the York River.

South of Causapscal the contact between the Grande Grève and Cape Bon Ami Formations is faulted. The Cape Bon Ami is bent into an asymmetrical anticline on its southern border and apparently thrust southward against the Grande Grève. The fault thins the Grande Grève Formation greatly and, westward, may cut it out completely. Eastward, the fault apparently loses displacement and dies out in the Cape Bon Ami Formation. The relationship of these formations can be seen along the road leading up the escarpment southeast of Causapscal. At the base of the hill argillaceous Cape Bon Ami limestone is exposed. About half way up the hill Grande Grève limestone crops out and can be followed southward in scattered exposures to the contact with the York River sandstone.

The large roadside outcrop on the southern outskirts of Causapscal on Highway 6 is composed of strikingly banded limestone which forms the type section of Crickmay's "Causapscal formation" (now abandoned). Alcock (1935) states in error that the type section is below the falls on Causapscal river. These beds bear some of the features of the Cape Bon Ami and some of the Grande Grève Formation. The consensus of opinion of geologists familiar with these Formations is that the outcrop should be assigned to the Cape Bon Ami and this view is accepted in this report. However, the inclusion of these beds in the Grande Grève is supported by some evidence and would require only a slight change in structural interpretation. Probably the characters of the two formations converge westward by facies change and difficulty in distinguishing one from another may be anticipated.

Thickness

On Causapscal river the beds assigned to the Grande Grève are 3,600 feet thick. On the two sections near the headwaters of La Vérendrye brook, they are 2,250 feet and 1,750 feet thick, and on Trois-Milles and Jollet brooks they are 2,000 feet thick. Several explanations for the relative thinness of the Formation in the southern outcrop band are possible:

1. Faults such as the one mapped south of Causapscal may eliminate part of the Formation, but no evidence of such faults was seen in the other sections.

2. The thinning may be caused by attenuation of the south limb of the anticline through shearing. In a shear fold all the Formations are thinned on the limbs and maintain their true thickness only on the crest. The intensity of the cleavage in this belt suggests that this process may be important.

3. The thinning may be due to a facies change between the northern and southern belts of outcrop. The deposition of the York River sandstones probably started earlier in the south nearer the recently uplifted highlands in the center of the Appalachian geosyncline and spread northward. The base of a deltaic sandstone formation which can be shown to interfinger with the underlying marine beds is unlikely to be parallel in time. However, the transgressive nature of this stratigraphic boundary is difficult to prove in the absence of abundant fossils. The upper part of the Grande Grève on Causapscal river was probably laid down at the same time as the basal beds of the York River Formation south of Causapscal. The Grande Grève may also thin by passage southward into the top of the Cape Bon Ami, but this formation is also thin on the south limb of the anticline.

Fossils and Correlation

The Grande Grève Formation in the Causapscal area is unfossiliferous and no fossils were collected that would indicate the age of the beds. In this lack of evidence the beds are considered to be equivalent to the formation in eastern Gaspé and to be of Oriskanian (Lower Devonian) age.

Gaspé Sandstone Group

The Cape Bon Ami and Grande Grève Formations are part of the Gaspé Limestone group of Logan. They are overlain, conformably in most places, by the Gaspé Sandstone group throughout the length of the peninsula. In the type area the group has been divided, in ascending order, into the York River, Battery Point, and Malbaie Formations largely on the basis of the color of the strata themselves or the color of the feldspars in the sandstones. In the central part of the peninsula a sequence of red sandstones and shales intervenes between the two lower Formations. This stratigraphic unit was first described by Jones (1930) as the middle member of the York River Formation but later was removed by McGerrigle (1950-B) as a separate formation called the Lake Branch. Carbonneau (1959) has described this formation in its type area.

In the Matapédia valley, Alcock (1935) referred the beds mapped as the Gaspé Sandstone by Ells and Crickmay to the Heppel Formation and designated the fields around Heppel station south of Causapscal as its type section. He also mapped a band of the same formation extending from above the falls of Causapscal river southwestward to Matapédia river in the vicinity of Saumon lake. McGerrigle (1946) has discussed the problems of the correlation of the Heppel with the Gaspé Sandstone Group of the eastern end of the peninsula and this subject is further discussed below.

The present work in the Causapscal area has indicated that the Heppel sandstone can be divided into two stratigraphic units, the lower of which is lithologically similar to the York River Formation and the upper, to the Lake Branch Formation. The Battery Point Formation does not appear to be represented in this area because no sandstones with conspicuously pink feldspars occur.

York River Formation

The name York River Formation is used in the Causapscal area to refer to the greenish grey to dark grey, medium-grained sandstones and siltstones that overlie the Grande Grève Formation and underlie the red sedimentary rocks of the Lake Branch Formation. The name was originally proposed by Williams (1910) for the lower division of the Gaspé Sandstones and later defined by McGerrigle (1950-A).

Distribution

The York River Formation crops out in three bands. Only a few hundred feet of the formation are exposed in the Lake Saumon syncline on the north boundary of the area for the dip of the beds is very gentle in this structure. Except along Causapscal river and east of Huit-Milles lake, the sandstones and siltstones of this belt are poorly exposed.

The best exposures of the Formation occur in the middle band, which crosses the area about a mile south of Causapscal. Chasseurs (Petit Quatre-Milles) brook cuts an almost continuous section through the middle part of the Formation. Jollet brook also cuts a good section through these beds and particularly through the upper part of the Formation. One of the poorer exposure areas is that designated as the Heppel type section.

The southern band of the Formation is in fault contact on one side with the Lake Branch Formation and on the other with the Fortin. Only scattered outcrops represent this belt in the western part of the area, but on the southern tributary of Lajoie brook (Carrière Rouge) outcrops are adequate to define the structure and lithology of the Formation.

Lithology

In the present area, the York River can be divided into three informally defined members for purposes of description: the basal beds, the Jollet Brook beds, and the upper beds.

On Causapscal river above the falls, the basal beds of the York River Formation resemble the Grande Grève in being silty and calcareous (Plate VI). Much of this unit consists of dark grey, very fine-grained sandstone to coarse siltstone but some coarser sandstone occurs; nearly all are calcareous. At Huit-Milles lake the calcareous siltstones are succeeded by grey sandstones that form ledges on the hillside east of the lake.

The unit is at least 3,000 feet thick on Chasseurs (Petit Quatre-Milles) brook below the Lacroix road and may be thicker for the basal part is cut by faults and folds. Here, it consists of interbedded dark greenish grey siltstones and sandstones. Crossbedding in some of the sandstone units indicates that the steeply north dipping beds are overturned. Just above the confluence with Jollet brook the beds are structurally disturbed but the intercalation of calcareous sandstone beds toward the Grande Grève contact can be observed. Some of the basal beds bear fossils but they are not as fossiliferous as the overlying Jollet Brook member.

The Jollet Brook beds were named by Kindle (1938) from outcrops on Chasseurs brook where it is crossed by the Lacroix road. Kindle has recorded the vertically dipping section upside down for all of the beds face south. At the type locality (see Appendix), the member consists of 900 feet of interbedded, fossiliferous, dark brownish grey siltstone, shale and sandstone. The siltstone and shale contain plant remains as well as invertebrate fossils preserved as casts and moulds.

The Jollet Brook member is persistent across the area but is nowhere as well exposed as at the type locality. The stream that joins the Matapédia at Heppel station flows on this member and has cut into the fossiliferous siltstones and shale at several places, notably in the middle of lot 36, range 4, Casupscull township. The member is also crossed by Jollet brook and can be identified on the eastern margin of the map-area on a detour of the Lacroix road.

The upper member of the York River Formation is about 3,500 feet thick. It consists of greenish grey, fine- to medium-grained, thick-bedded sandstone that weathers reddish, brownish, and dark grey. Some thin beds of siltstone are present but they do not generally crop out. The sandstone forms steep, canyon-like walls where the outcrop band is crossed by Chasseurs and Jollet brooks. A section through the lower part of this member that was measured on the first of these streams is recorded in the Appendix.

York River sandstones are all feldspathic and many are arkoses. In a typical grey arkose from Huit-Milles lake decomposed potassium feldspar and microperthite account for about 30% of the detrital grains. In most of these sedimentary rocks a few grains of fresh oligoclase or andesine stand out in marked contrast to the weathered, cloudy, potassium feldspars. Fresh grains of muscovite are common in some arkose but rarely make up more than 5% of the rock. Lithic grains are not common, but in some of the rock fine sandstone and trachyte fragments occur. Only the sandstones and siltstones near the base are calcareous and these are generally not feldspathic. In the sandstone and arkose the sorting and rounding of the grains are poor, and most grains can be classed as subangular. Muscovite and biotite constitute less than 10% of the sandstones but are more abundant in the siltstones. In general the grain boundaries in the sandstone are well defined and recrystallization has occurred only locally. Replacement of quartz grains by carbonate and chloride has embayed the original outlines of the grains in some of the specimens examined in thin-section, but most of the grains seem to have been but little rounded when they were deposited.

A more complete account of the petrology of the York River sandstones is given by Carbonneau (1959).

Contacts and Thickness

The contact of the York River Formation with the Grande Grève has been discussed above.

The upper contact of the York River is not exposed in this area. The best section across the contact is on Jollet brook, one mile below the Lacroix road. The red siltstones and sandstones of the Lake Branch Formation crop out 500 feet upstream from the highest York River sandstones. The contact has been mapped on the basis of the color change, but it is also marked by an increase in the amount of silt and a decrease in the resistance to weathering of the sedimentary rocks as a whole.

The thickness of the York River Formation in the Jollet Brook section, where the beds are close to vertical, is about 8,000 feet.

However, in the Matapédia valley, where the dip of the beds is slightly lower, the width of outcrop indicates a thickness of nearly 11,000 feet.

Fossils and Correlation

The York River Formation is the most fossiliferous of all the formations that crop out in the Causapscal area. Virtually all the fossils collected come from the Basal and the Jollet Brook units. The preliminary identification of these fossils by Dr. A.J. Boucot (personal communication) is summarized in the accompanying table. Although a greater variety of species are found in the Basal beds, the Jollet Brook beds bear a greater number of individuals and more corals and trilobites. Boucot states that the Basal beds are equivalent to the Lower part of the Esopus Formation of the New York succession and belong in the zone of *Etymothyris*. The Jollet Brook beds he believes are of upper Esopus to lower Onondaga age and are in the zone of *Amphigenia*. He suggests that these beds may be equivalent to the Battery Point sandstones of eastern Gaspé and that considerable facies changes may be detected along strike when the paleontology of the Gaspé sandstones is worked out on a regional scale.

Fauna of the York River Formation

	Basal Beds	Jollet Br. Member
Etymothyris gaspensis	9	
Etymothyris sp.	1,2,8	
Amphigenia cf. parvula		12
Rensellaeroid	11	
Atrypa reticularis	11	
Eodevonaria cf. arcuata	6	
Eodevonaria sp. (flat)	1,8	
Eodevonaria sp.	2	
Leptostrophia sp.	2	
Megastrophia sp.	8,6	
Protoleptostrophia sp.	6,8	
Brachyspirifer? sp.	2,8	
Costispirifer sp.	4	
Mucrospirifer? sp.		5,7
Acrospirifer sp.	6	
Fimbrispirifer cf. divaricus		7
Cyrtina? sp.	8	
Pryonothyris sp.	2	
Schuchertella sp.	3,6,8,11	
Chonetes sp.	8	
Pliochonetes sp.	6,8	13
Brachyprion sp.	3,10	
Stropheodonta aff. demissa		5,7,12,13
Rhipidomelloides cf. muscularis solaris	8	12
Rhipidomelloides sp.	6	
Meganterella finksi	8	
Leptocoelia flabellites	3,10	
Productid		5
Conocardium sp.	6	
Tentaculites sp.		13

Cypricardinia sp.		5
Dalmanites sp.	3,4	
Trilobites		12
Tetracorals	11	5,12
Fenestellids	8	5,7,12

Localities

1. Nérée-Lavoie brook, about 300 feet above Causapscal river.
2. 1/2 mile northwest of Ste-Florence on road between lots 40-39, range I, Matalik township.
3. 1/4 mile south of discharge of Huit-Milles lake.
4. West side confluence of Jollet and Chasseurs brooks.
5. Type section of Jollet Brook beds, intersection of Chasseurs brook and Lacroix road.
6. 500 feet above Chasseurs brook on small east flowing tributary 1/2 mile above confluence with Jollet brook.
7. By-pass road from Lacroix road 1 mile west of border of area.
8. Discharge of Casault lake, about 1 mile north of the map-area.
9. Jollet brook, 3,000 feet above confluence with Chasseurs brook.
10. Middle of lot 6, range II, Casault township.
11. 2 miles north of International Paper Co. camp at east end of Casault lake.
12. Jollet Brook beds type locality 360-365 feet of measured section (see Appendix).
13. 292 feet of same section as 12.

Kindle (1938) has also published a list of fossils from the type locality of the Jollet Brook beds including 9 species of bryozoa identified by M.A. Fritz (1938):

Heliophyllum? sp.
Crinoid stems
Botryllopora socialis Nicholson
Anastomopora quebecensis Fritz
cf. Coscinium striatum H. and S.
Fenestrellina occidentalis Fritz
Polypora orientalis Fritz
Fenestrellina gaspensis Fritz
Sulcoretepora cf. incisurata (Hall)
Taeniopora penniformis Nicholson
Taeniopora exigua Nicholson
Pholidops sp.
Strophalosia truncata Hall var.
Productella sp.
Stropheodonta cf. demissa (Conrad)
Dalmanella sp.
Rhipidomella vanuxemi Hall var.
Camarotoechia sp.
Eodevonaria hudsonicus var. gaspensis Clark
Chonetes sp.
Cyrtina cf. hamiltonensis Hall
Spirifer pennatus posturus Hall and Clarke
Spirifer audaculus Conrad var.

Leptodesma cf. rogersi Hall
Actinopteria boydi Conrad
Modiomorpha cf. sublata Conrad
Nucula corbuliformis Hall
Nucula sp.
Cypricardinia cf. indenta (Conrad)
Paracyclas lirata Conrad
Goniophora cf. carinata Conrad
Goniophora cf. rugosa (Conrad)
Palaeoneilo plana Hall
Palaeoneilo cf. muta Hall
Phacops cf. rana Green
Proetus sp.
Tentaculites cf. bellulus Hall
Bellerophon cf. leda Hall

Kindle believed that this fauna could be correlated with the Ithaca beds of New York of early Late Devonian age. Cooper (1942), however, analysed the fauna and concluded that some specimens were probably misidentified and that the assemblage is probably of Onondagan age. As stated above, Boucot's interpretation is that the Jollet Brook beds are of Esopus to lower Onondagan age.

Lake Branch Formation

The name Lake Branch is applied to a sequence of red sandstones, siltstones, and variegated beds that are the youngest sedimentary rocks in the Causapscal area.

Distribution

The Lake Branch beds occupy a syncline whose southern limb has been largely eliminated by faulting. Lake Branch rocks have been preserved in two basinal structures, or doubly plunging synclines, within the York River zone. The rocks of the type area occur in such a structure in the Big Berry mountains, and the present basin begins on the east side of the Causapscal area. Reconnaissance work by J. Béland (1960), indicates that the western limit of this belt of Lake Branch beds is about 10 miles west of Matapédia river.

Within the Causapscal area the Lake Branch is exposed in three regions: the valley of Lajoie (Carrière Rouge) brook, and the headwaters of Chasseurs and Joliet brooks. The best exposures are on Joliet brook where it cuts the axis of the west-plunging syncline.

Lithology

In most outcrops the sandstone of this formation is conspicuous but on Jollet brook much red siltstone is intercalated between the more resistant sandstone beds. The sandstones are commonly dark to dusky red although some are brownish grey and some are vivid green. The bedding planes are generally widely spaced, well defined, and may be ripple marked. In many of the sandstone beds thin layers of shale pebbles indicate that a layer of mud has been broken up and redeposited. The pebbles are generally equidimensional, not tabular like those that form edgewise conglomerate. The bedding planes are locally covered with a mat of comminuted fossil plants, and most of the sandstones are, in some degree, carbonaceous. The best exposure of these sandstones is a quarry about 1,000 feet from Highway 6 on Lajoie brook (Plate IV-B).

Thin-sections show that these rocks are arkoses and highly feldspathic sandstones. They contain 20-30% feldspar, most of which is decomposed potash feldspar. A few fresher grains of microperthite and plagioclase are present in nearly all samples. The grains are generally poorly sorted and angular to subangular in shape. Evidently the sand was deposited rapidly in a deltaic environment and not significantly reworked by waves. The quartz grains are thinly coated with a layer of red iron oxide.

The siltstones are red and green but more commonly red. In some places, alternations of the two colors in layers less than 0.5 mm. thick produce a strikingly banded rock. Some of the siltstones also contain layers of pebbles.

Thickness and Correlation

The width of the Lake Branch band coupled with its dip at Lajoie (Carrière Rouge) brook indicates that the formation is about 4,000 feet thick. This is not the total thickness of the formation for the southern boundary is a fault. On the east side of the area the synclinal form of the beds precludes any estimate of their thickness. At the type section in the Berry mountains area, thicknesses of 4,000 to 5,000 feet have been suggested (Carbonneau, 1959).

No identifiable fossils were found in these beds in the Causapscal area, only comminuted plant remains.

Fortin Formation

The term Fortin was applied by McGerrigle (1946) to a sequence of dark shaly limestones and slates that underlies the northwest corner of Fortin township in eastern Gaspé. In his reconnaissance mapping he extended this belt of rocks the length of the peninsula to the Matapédia valley (1953). The term is used in this report to refer to the calcareous slate, phyllite, and sandstone which occupy the southern part of the area.

Distribution

The Fortin is bounded on the north against the York River sandstone by a fault of unknown, but probably small, displacement. Its southern boundary against the Ordovician Matapédia group is 12 miles south of the map-area. In this Formation, streams cut deep, steep-sided valleys along which outcrop is abundant. In the main streams and major tributaries of Fraser and Creux brooks, slates are well exposed. The largest outcrop of the Formation is a road-cut on Highway 6 east of Ste-Florence.

Lithology

The Fortin Formation consists of medium grey slate and phyllite and intercalated sandstone units. These rocks apparently are slightly more metamorphosed than those of the type section. Flow cleavage is well developed and the rocks split readily along closely spaced planes. The cleavage in the dark slates is crossed by lighter-colored bands about 1 inch thick which define the bedding (Plate VII). These bands are more silty or sandy than the adjacent slate and cleavage is refracted sharply as it crosses them. The banding is not ubiquitous in the Formation but most outcrops show it to some degree. Where deformation was intense, the lighter bands are drag folded and may show boudinage.

The carbonate content of the slate and phyllite may be large or small. Most samples react slightly to acid, but many show no reaction and presumably have little or no carbonate, and a few react to acid as if they were limestone. Some of the slate contains small pyrite cubes and some has small limonite spots where the sulphide has weathered out.

The slate and phyllite are composed of fine-grained muscovite flakes, uniformly elongated in the direction of cleavage, with some biotite, quartz and chlorite. The coarser silty and sandy layers are sharply set off from the finer bands and are composed of detrital grains of quartz and feldspar. The schistosity of these bands is defined by muscovite and chlorite shreds in the matrix. Some of the sandy bands contain enough feldspar to qualify as fine-grained arkose.

Sandstone beds are prominent in the Fortin because they are more resistant than the argillaceous phases of the Formation. The sandstone units are medium to dark grey and several tens of feet thick. Attempts to use the sandstone units as horizon markers for the delineation of structure failed probably owing to their lenticular nature. Hand specimens of the sandstones are not conspicuously cleaved but in thin-section planar structures are evident. At one outcrop on Fraser brook, a sandstone bed is intricately folded and yet in contact with uncontorted slate along an even bedding plane. This is good evidence that the sandstones were emplaced by slump and turbidity flow into a deep water environment. McGerrigle (1945 MS.) noted in the Fortin slates farther east that the intensity of folding of some of the beds could only be explained by deformation soon after deposition while the sediment was still soft.

The sandstone units are feldspathic, and most are arkose. In a typical arkose from near Ste-Florence the grains are as large as 1 mm. in diameter and are subrounded. About 50% of the rock is quartz, about 30% is considerably altered potassium feldspar, and about 5% is relatively fresh plagioclase feldspar. The rest is a matrix of muscovite, chlorite, and carbonate. The arkose is similar in composition to that of the York River Formation but has a slightly more schistose matrix.

Large pods and veins of white quartz are common, and in the soil overlying the Formation masses of quartz are conspicuous.

Before deformation the Fortin must have consisted of a sequence of calcareous siltstones and shales with interbeds of medium- to coarse-grained arkose, similar to the lower member of the York River Formation.

Thickness and Contacts

Folds, faults, and the absence of exposed upper and lower contacts make it impossible to estimate the thickness of the Formation in this area. In the type area, McGerrigle (1946) estimates that it is 5,000 feet thick.

Fossils and Correlation

Fossils were collected from the Fortin Formation at a single locality, 1/2 mile south of Ste-Florence, west of Matapédia river, in a sheared greywacke, as follows: Leptocoelia cf, L. flabellites; Rensselaeria? sp.; spiriferid. This is an Oriskany assemblage according to Boucot.

The stratigraphic relations in the Causapscal area add nothing to the problem of the correlation and conditions of deposition of the Fortin. McGerrigle has pointed out that it occupies the stratigraphic position of the lower part of the York River Formation in central Gaspé and that both the Cape Bon Ami and Grande Grève limestones may pass laterally into it. The single fossil collection from the present area would indicate the equivalence of the Fortin slates to the Gaspé Limestones rather than to the York River.

Ste-Marguerite Volcanic Rocks

Volcanic rocks crop out in a belt near the northern boundary of the Fortin Formation. They are well exposed on a knoll about 1/4 mile south of the village of Ste-Marguerite. The band of volcanic rocks enters the area from the east near the headwaters of Creux brook, and forms cliffs along both sides of this stream. It may be traced westward to the Ste-Marguerite exposure by fragments in the float. Similarly, float indicates that volcanic rock underlies the hill southwest of the village along the line between range VII and range Kempt W., Casupscull township. The lavas are exposed on the headwaters of Fraser brook, on two of its tributaries, and on the hill to the west of the main stream. West of this hill no lava occurs either in float or in outcrop. The band apparently has been cut off abruptly by faulting.

The volcanic rock is dark greenish to bluish grey, dark grey weathering andesite. Some of the andesite is compact but much is vesicular and amygdaloidal. The vesicles are empty or filled with quartz, and in places quartz fills veins in the igneous rock. The flow of the lava has elongated the vesicles in many places and produced layered and contorted structures in others. On Fraser and Creux brooks, interbeds of chloritic phyllite occur in the volcanic sequence and may represent contemporaneous sediments.

The andesite is composed largely of plagioclase feldspar of trachytic texture associated with much chlorite and a minor amount of augite. The feldspar is mostly andesine but some is oligoclase. Some phases are porphyritic and contain crystals of feldspar visible to the naked eye. The andesite contains 5-10% of opaque iron oxides and a little carbonate. Chlorite occurs in large grains that may be replacements of augite, but such grains do not contain augite remnants and the rocks in which they occur contain fresh, unreplaced augite.

The position of these volcanic rocks in the Fortin is a problem, partly because dips in the sedimentary rocks change rapidly and partly because the lavas show little bedding. At the headwaters of Fraser brook, the trace of vesicular zones seems to indicate that the lavas dip north at about 70°. A short distance downstream from the south margin of the belt of outcrop of the volcanic rocks Fortin slate dips south at 30°. However, the dip of bedding is so variable in the Fortin that these determinations do not necessarily mean that the igneous rocks are discordant with the bedding. That the andesite is within the Fortin and not associated with the York River along the boundary fault is shown by three areas in which Fortin slates crop out between the lavas and the York River sandstone. Unfortunately at none of these outcrops was a determination of bedding attitude possible. Although the contact between the volcanic rocks and the Fortin was not seen, on the headwaters of Creux brook outcrops of Fortin slate and of andesite are separated by only a few tens of feet of soil.

About 1/2 mile northeast of Ste-Florence on the edge of Matapédia valley, breccia forms a large outcrop about 30 feet wide and 1/2 mile long. The rock consists of pebble-sized fragments of light-colored very fine-grained lava in a schistose matrix of finer material. Some of the fragments seem to be rounded. The microscope shows the fragments of the breccia to be fine-grained andesite and large crystals of andesine feldspar. A mosaic of cryptocrystalline quartz has replaced the matrix, which was probably volcanic ash, and many of the lava fragments. Fine veins of quartz cut the rock throughout. At the north end of the Ste-Florence road cut on Route 6 a similar, but apparently more sheared, breccia has been exposed. Thin lenses of breccia that occur in Fortin slate for a short distance to the south consist largely of chlorite and carbonate in which are embedded large crystals of plagioclase and fragments of andesite. They appear to be tuffs deposited in the waning phases of the volcanic episode. The breccia occupies a stratigraphic position similar to that of the Ste-Marguerite volcanics and most probably is genetically related to them.

Intrusive Igneous Rocks

Intrusive rocks were found in the Causapscal area only on La Vérendrye brook about 1 1/2 miles above its confluence with Petit La Vérendrye brook. Here an andesite dike intrudes the Cape Bon Ami Formation apparently along the north-dipping cleavage but across the bedding which dips steeply south. The southern contact is exposed just below an abandoned lumber camp and is marked by a thin envelope of non-calcareous hornfels. The north contact is exposed 1,000 feet downstream. Although both contacts cannot be seen in the same outcrop, the dike appears to be about 8 feet wide. Vesicles in the dike are up to 1 cm. in diameter, the larger being filled with a bituminous substance and the smaller with chlorite and calcite.

The rock is composed of a fine mass of andesine laths in which are set slightly larger phenocrysts of the same composition.

No ferromagnesian minerals occur, but chlorite, which has probably replaced them, is abundant in large and small grains. The bitumen has apparently been mobilized from hydrocarbon-rich sedimentary rocks and incorporated in the intrusion. The presence of hydrocarbons in igneous intrusions is fairly common in Gaspé peninsula.

STRUCTURAL GEOLOGY

The Devonian and Silurian rocks of the Causapscal area were deformed during the Devonian period in the Acadian orogeny. Many of the structures produced were folds and thrust faults.

The Fortin rocks are folded into open anticlines and synclines whose limbs have dips up to 50^{0}. In most places where the axes of folds are exposed the axial planes are vertical. On Highway 6 at the south border of the area two faulted anticlines with steeper northern limbs are exposed in a road cut. In the absence of key beds, folds are difficult to follow from one stream valley to another and the role of faulting in the deformation is difficult to assess. The Fortin band is bordered on the north by a fault of unknown attitude and displacement. It is shown as a south-dipping reverse fault in the cross-section because such a structure is in keeping with the pattern of deformation in the rest of the area. In the Causapscal area the fault brings together the Fortin and York River Formations, which appear to be of similar age. Thus, it would have little stratigraphic throw, but brings up rocks of similar age from a deeper zone of deformation. The degree of deformation of the Fortin is slightly higher than that of the York River as is shown by arkose beds which are lithologically almost identical but which are much more schistose in the Fortin.

The Fortin boundary fault is not exposed anywhere in the area but the north end of the long road cut 1/2 mile northeast of Ste-Florence is within a few tens of feet of it. At the north end of the cut, cleavage in the Fortin is better developed than at the south end, and micaceous minerals are so conspicuous along the cleavage planes that the rock can be referred to as schist or phyllite. Contortion of the cleavage, dislocation and boudinage of sandstone beds, quartz veins, and drag folds in the slate are common. The drag-folds have almost vertical axes, which suggests that movements on the fault were largely along its strike. The attitude of the York River beds on the north side of the fault has also been affected by the movement for anomalous dips and strikes characterize this belt.

The Lake Branch Formation is preserved in a syncline whose south limb has been eliminated by faulting and erosion except in the eastern part of the area. The axis of the syncline plunges about 30^0 to the west where it crosses the headwaters of Jollet brook. The east margin of the Lake Branch basin and the fault that bounds it on the south are lost in the large drift-covered area northeast of Ste-Marguerite. The presence of the fault that cuts out the south limb of the syncline is indicated by an abrupt change in dip and the repetition of the lower beds of the York River Formation.

The Lake Branch Formation and the middle band of the York River Formation are on the south limb of the westward plunging, asymmetrical Causapscal anticline. The fold dies out on the eastern border of the town of Causapscal. It has a steep southern limb, overturned as much as 15^0 on Chasseurs brook, and a gentle northern limb which is faulted and involved in minor cross-folding. The southern limb is also cut by faults of small displacement and minor folds (Figure I-D). The overturning on the south limb of this anticline and the north-dipping reverse fault just south of Causapscal along strike are indicative of southward compression in this belt or of underthrusting. The St-Léon siltstone is exposed in the crest of the anticline in the eastern half of the map-area but is carried under the Cape Bon Ami limestone by the westward plunge where the axis of the fold is cut by Causapscal river. The anticline can be traced along the river to the eastern outskirts of Causapscal where it apparently dies out on the flanks of the Albertville anticline.

The contact between Cape Bon Ami and St-Léon on the north limb of the Causapscal anticline is characterized by a change in regional structure, drag-folds, minor faults, breccia, and veins in the rocks on either side of the contact. These phenomena indicate that a fault follows the contact, but little stratigraphic displacement appears to have taken place along it.

Between the Causapscal anticline and the Albertville anticline is a wide synclinorium occupied by the Cape Bon Ami limestone and crossed by a series of shallow, minor folds. In this area most of the dips are less than 20^0 and strikes do not follow the regional northeast trend. The small cross-folds die out both southwestward and northeastward. This anomalous structure, which forms a node in the center of the area, may be a reflection during deformation of an irregularity of the basement surface.

The Albertville anticline brings Silurian rocks to the surface in the western part of the area. These are carried beneath Cape Bon Ami beds just west of Causapscal river by the northward plunge of the structure. The axis of the anticline is exposed in a small quarry on the west bank of Matapédia river just west of the map-area. The northern limb of this fold dips steeply (up to 65^0 on Causapscal river), but the southern limb is caught up in the gentle cross-folding described above.

The northwestern corner of the Causapscal area is occupied by the northeast plunging Saumon Lake synclinorium. The limbs of this shallow fold dip less than 10°. The major structure contains several minor anticlines and synclines whose axes are difficult to define owing to lack of outcrop. Only along Causapscal river can the gentle reversals of dip and changes of strike be determined.

Nearly all the rocks in the Causapscal area are cut by a prominent cleavage. In the more argillaceous rocks, such as the Cape Bon Ami and Fortin Formations, this structure is a closely spaced flow cleavage. In other rocks, the planes are more widely spaced and the structure can be characterized as fracture cleavage. The strike of the cleavage is consistently about 60° and the dip is generally within a few degrees of vertical.

ECONOMIC GEOLOGY

Interest in the petroleum resources of western Gaspé was stimulated by the drilling of Associated Developments Causapscal No. 1 well on lot 20-A, range I, Lepage township, about 2 1/2 miles northwest of the town. The well is just west of the western border of the map-area on the east bank of Matapédia river. It was started in the St-Léon siltstone with the object of locating reef reservoirs in the Sayabec limestone at the base of this unit. Because a much thicker section of St-Léon was present than had been anticipated, the objective, if present, was not reached and the well was bottomed 4,695 feet below the surface (length of core = 4,715 feet). No shows of gas or oil, and no porous beds other than those fractured, were encountered.

The Sayabec limestone, which crops out north of the Causapscal area at Matapédia lake, is the most likely reservoir for oil and gas in the region. It is highly organic in nature and in places reefy. Some samples give off a tarry odour when broken. The Sayabec has been correlated by most paleontologists with similar limestones of the La Vieille Formation on Chaleurs bay. The reefy limestone unit may well extend continuously from Matapédia lake to the south side of Gaspé peninsula and so underlie the Causapscal area although its presence is impossible to prove in the absence of deeper drill holes. Structural traps along the Albertville and Causapscal anticlines caused by variations in the plunge of the folds would be likely places to test this potential reservoir.

In eastern Gaspé, oil has been produced in small quantities from the base of the York River and top of the Grande Grève Formations. In the Causapscal area no closed structures that could contain oil at this stratigraphic interval are known to exist but stratigraphic traps may be present. A thin, porous sandstone bed in the York River Formation on Chasseurs brook contains much bituminous material that appears to be a petroleum residue. Bitumen was also found in vugs in the dike on La Vérendrye brook. These occurrences indicate that hydrocarbons have been present in the rocks.

No mineral occurrences of economic importance were found.

The sedimentary rocks of the area are generally unsuitable for construction materials. Some foundation stone has been taken from a small quarry 1 1/2 miles north of Causapscal. Sandstone in the St-Léon Formation has been quarried in a small way on the west bank of the Matapédia at the crest of the Albertville anticline. A small quarry was also opened in the red sandstones of the Lake Branch Formation a short distance from the intersection of Lajoie brook and Highway 6. All these operations have been abandoned.

Crumbly siltstones in the Cape Bon Ami and York River Formations have been used locally for road metal in the construction of the Lacroix, Casault Lake, and Huit-Milles Lake roads.

REFERENCES

ALCOCK, F.J. (1935) Geology of Chaleur Bay Region: Geol. Survey Canada, Mem. 183.

ALCOCK, F.J. (1928) Rivers of Gaspé: Bull. Geol. Soc. Amer., vol. 39, No. 2, pp. 403-20.

BÉLAND, J. (1960) Rimouski-Matapedia Area, Electoral Districts of Rimouski, Matapedia, Bonaventure and Matane: Que. Dept. Mines, P.R. No. 430.

CARBONNEAU, C. (1959) Richard-Gravier Area, Gaspé Peninsula: Que. Dept. Mines, Geol. Rep. 90.

COLEMAN, A.P. (1922) Physiography and Glacial Geology of Gaspé Peninsula: Geol. Survey Canada, Geol. Series No. 41, Bull. 34.

COOPER, G.A., et al., (1942) Correlation of the Devonian Sedimentary Formations of North America: Bull. Geol. Soc. Amer., vol. 53, Pt. 1, pp. 1729-1794.

CRICKMAY, G.W. (1932) Evidence of Taconic Orogeny in Matapedia Valley, Quebec: Amer. Jour. Sci., vol. 24, pp. 368-386.

DRESSER, J.A. and DENIS, T.C. (1944) Geology of Quebec, Vol. II, Quebec Dept. of Mines, Geol. Rept. 20, pp. 336-364.

ELLS, R.W. (1885) Report on Explorations and Surveys in the Interior of Gaspé Peninsula, 1883, Geol. Survey Canada, Rept. Progress 1882-4, pt. E.

FRITZ, M.A. (1938) Devonian Bryozoa of Gaspé: Bull. Amer. Paleontology, App. 82A, pp. 1-14.

JONES, I.W. (1930) The Berry Mountain Map-area, Gaspé: Que. Bureau of Mines Ann. Rept. 1929-30, pt. D, pp. 1-40.

JONES, I.W. (1936) Upper York River Map-area, Gaspé Peninsula, Que. Bureau of Mines Ann. Rept. 1935, pt. D, pp. 1-28.

KINDLE, E.M. (1938) The Correlation of certain Devonian Faunas of Eastern and Western Gaspé: Bull. Amer. Paleontology, vol. 24, No. 82.

LAVERDIÈRE, J.W. and MORIN, L.-G. (1941) Géologie des Appalaches Canadiennes entre Rivière-du-Loup et Matane: Natur. Canadien, vol. 68, pp. 216-60.

LOGAN, W.E. (1863) Geology of Canada, p. 415.

McGERRIGLE, H.W. (1945) Reconnaissance Geological Survey of South-Central and Western Gaspé Peninsula, Quebec: Que. Dept. Mines, Unpublished Manuscript.

McGERRIGLE, H.W. (1946) A Revision of the Gaspé Devonian: Trans. Roy. Soc. Canada, vol. 40, Sect. IV, pp. 41-54.

McGERRIGLE, H.W. (1950-A) The Geology of Eastern Gaspé, Que. Dept. Mines, Geol. Rept. 35.

McGERRIGLE, H.W. (1950-B) The Tourelle-Lake Cascapedia Map Area, Gaspé Peninsula: Unpublished Manuscript, Que. Dept. Mines.

McGERRIGLE, H.W. (1952) Pleistocene Glaciation of Gaspé Peninsula: Trans. Roy. Soc. Canada, vol. 46, Sect. IV, pp. 37-51.

McGERRIGLE, H.W. (1953) Geological Map of Gaspé Peninsula: Que. Dept. Mines, Map 1000.

STEARN, C.W. (1959) Preliminary Report on Causapscal Area (East Half), Matapédia Electoral District. Que. Dept. Mines, P.R. No. 382.

WILLIAMS, H.S. (1910) Age of the Gaspé Sandstone: Geol. Soc. Amer. Bull., vol. 24, pp. 688-698.

YOUNG, G.A. (1913) Annotated Guide, Bic to Matapédia Junction: 12th. Int. Geol. Congress Guide Book No. 1, pt. 1, pp. 79-84.

APPENDIX

Section through part of the York River Formation at the intersection of the Lacroix road with Chasseurs (Petit Quatre-Milles) brook. From the base upward (north to south).

Basal Beds

0-7	Sandstone, fine grained, dark greenish grey, weathering light grey, in 2-inch beds; plant remains in the upper foot.
7-175	Drift.
175-198	Sandstone, very fine grained, dark greenish grey, weathering dark grey, in 1-foot to 3-inch beds with irregular bedding planes; pyrobitumen and plant fragments common.
198-216	Drift.
216-226	Sandstone, very fine grained, dark grey to black, in 1-inch beds; carbonaceous.
226-233	Sandstone, medium to fine grained, dark brownish grey, in 6-inch to 1-inch beds; locally porous and bitumen-stained.
233-254	Drift.
254-269	Sandstone, fine to medium grained, dark greenish grey to brownish grey, in 6-inch to 1-inch regular beds; some beds show good intergranular porosity.

Jollet Brook Beds

269-279	Siltstone, grading to very fine sandstone, carbonaceous, in thick irregular beds, scattered plant remains and crinoid? columnals.

279- 311	Siltstone and shale interbedded: siltstone, dark grey as above; shale, dark grey, poorly fissile, slightly nodular, non-calcareous, in 2-foot units: fossiliferous, a coquinoid in parts.
311- 329	Sandstone, silty, very fine grained, dark grey, carbonaceous, in 2-inch regular beds.
329- 347	Sandstone, fine grained, medium grey, weathers light grey in regular 3-foot resistant beds; some intergranular porosity.
347- 350	Siltstone, argillaceous, dark brownish grey, in irregular, crumbly beds, porous, with many leached and partly leached fossils.
350- 360	Sandstone, dark brownish grey, medium grained, porous, as above.
360- 365	Siltstone, dark brownish grey, highly fossiliferous, mostly coralline, porous with the molds of fossils.
365- 380	Siltstone, as above but compact, unfossiliferous.
380- 385	Sandstone, medium grained, dark greenish grey, weathering light grey in irregular 1-foot beds; scattered plant remains.
385- 395	Drift.
395- 411	Sandstone, as above.
411- 686	Drift.
686- 734	Shale or mudstone, slightly silty, poorly fissile, non-calcareous.
734- 919	Drift. (Road)
919-1111	Mudstone or shale, dark grey both fresh and weathered, poorly fissile, breaking into fragments on weathering about 1-inch square; highly fossiliferous.
1111-1171	Shale, silty, slightly calcareous, fossiliferous, in 1-inch beds, dark grey; contains masses of Disphyllum-like coral which builds small reefoid humps a few feet across.

Total thickness of Jollet Brook Beds - 902 feet.

Upper Member

1171-1204	Sandstone, very fine grained, becoming medium grained upward, greenish grey, weathering medium grey or reddish brown, in 3- to 12-inch resistant beds.
1204-1220	Drift.
1220-1225	Sandstone, dark greenish grey, weathering brownish grey, in 12-inch beds.

1225-1331	Drift.
1331-1490	Sandstone, very fine grained, some siltstone, dark grey to greenish grey and brown; locally conglomeratic.
1490-1550	Drift.
1550-1594	Sandstone, fine grained to very fine grained, light greenish grey, weathering dark grey, in thick resistant beds, poorly preserved fossils and ripple mark.
1594-1618	Drift.
1618-1715	Sandstone, medium to fine grained, dark brownish grey, weathering reddish grey, in 12-inch beds; some silty argillaceous beds in upper part; limonite in small vugs.
1715-1770	Drift.
1770-1855	Sandstone, fine grained, greenish grey as above.
1855-2010	Drift.
2010-2118	Sandstone, fine grained, dark to medium grey, weathering brownish grey, in beds 1-2 feet thick.
2118-2135	Drift.
2135-2230	Sandstone, as above, thin layer of fossil debris and plant fragments at 2160.
2230-2270	Drift.
2270-2560	Sandstone as above; covered between 2316-2335 and 2400-2415.
2560-2580	Drift.
2580-2720	Sandstone, dark greenish grey, as above, some fossil fragments in limonite-coated vugs.

Thickness of Upper Beds exposed for 1,559 feet.

ALPHABETICAL INDEX