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RICHARD - GRAVIER AREA, GASPE PENINSULA

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GEOLOGICAL SURVEYS BRANCH

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RICHARD-GRAVIER AREA

GASPÉ PENINSULA

by

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RICHARD-GRAVIER MAP-AREA

GASPÉ PENINSULA

by C. Carbonneau

INTRODUCTION

Gaspé peninsula forms a tongue of land which extends into the Gulf of St. Lawrence, in the eastern part of the Province of Quebec. The rocks exposed at the eastern end of the peninsula, in the general vicinity of the town of Gaspé, are limestones and sandstones of Devonian age which Logan (1863)* termed the Gaspé Limestones and the Gaspé Sandstones. Similar rocks underlie the Richard-Gravier map-area, and the present investigation is mainly concerned with the geology of these rocks in relation to the type section in eastern Gaspé.

The field work, performed during the summers of 1950 and 1951, was undertaken in order to study the economic possibilities of the area, and to make a general geological examination as part of the mapping programme of the Quebec Department of Mines.

Location and Area

The Richard-Gravier map-area is located approximately in the centre of Gaspé peninsula. Its southern limit is 30 miles north of Tracadigache bay, on the Bay of Chaleurs. The area is bounded by longitudes 66° and 66°30', and latitudes 48°30' and 48°45', and includes 400 square miles.

Parts of four of the five electoral districts of the peninsula are included within the boundaries of the map-area. Bonaventure electoral district (Marcil and Clapperton townships) occupies a small portion of the southeastern corner of the map-area. Shortly to the north, a strip of land ten miles wide, belonging to Matapédia electoral district (Gravier and Clarke townships), runs across the south-central part of the area. Of the remaining portion of the map-area, the northwestern part is occupied by Matane electoral district (Dunière and Richard townships), and the northeastern part by Gaspé-Nord electoral district (Baldwin and Lemieux townships).

For convenience of map publication, and in order to present a unified structural picture, parts of regions examined by other geologists (Figure 1) are included in the present map; the area west of longitude 66°15' and north of

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*Year numbers refer to the bibliography at the end of the report.

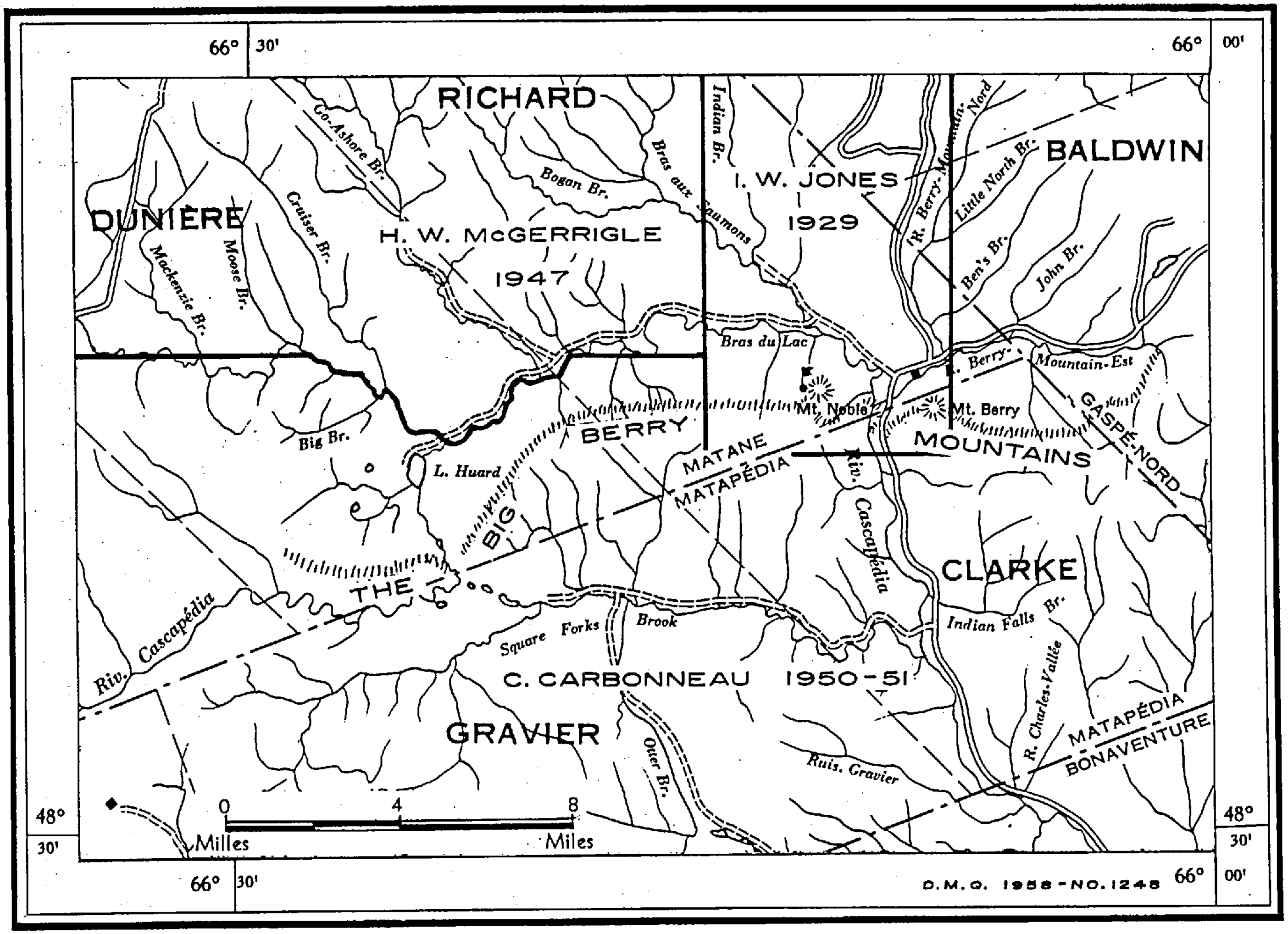

Figure 1 - Map showing the location of the Big Berry Mountains escarpment and the portion of the area mapped by each geologist.

latitude 48°40' was examined by H.W. McGerrigle in 1947, and the geology of the northern half of the present area, included between longitudes 66°07' and 66°15', was described by I.W. Jones (1930).

Local Names

A prominent escarpment runs east-west across the area, roughly parallel to, and slightly south of, latitude 48°40' (Figure 1 and Plate 1). On his trip across the peninsula in 1844, Logan climbed the escarpment in the vicinity of the Cascapédia river, but on which side of the river was not stated. He found abundant blueberries on the slope of this hill and gave it the name of Berry Mountain without specifying whether or not the name should apply to the entire escarpment or only to that particular hill.

Ells (1885, p. 9) applied the term "Big Berry Mountain" to "a range of lofty hills (which) cross the Cascapedia". He gave no explanation as to the origin of the adjective "Big". Ells used the term "Little Berry Mountains" for the tract of rugged topography "in the neighborhood of the Square Forks" where, actually, there is no particular mountain range but only a deeply dissected upland. At the present time, local people apply the term Berry Mountain (singular) to the first hill of the escarpment, east of the Cascapédia river, and the term Mount Noble to the first big hill west of the same river.

Jones (1930, p. 10) refers to the Berry Mountain range as the part of the escarpment in the general vicinity of the Cascapédia river, and shows Berry Mountain on the map accompanying his report as the first big hill to the east of the Cascapédia river. The Topographic Division of the Department of Mines and Technical Surveys, Ottawa, has retained the name "Big Berry Mountains", and apparently applies it to the entire escarpment west of the Cascapédia river. The writer is inclined to adopt this usage, but also to apply the name to the escarpment east of the Cascapédia river, inasmuch as the escarpment is essentially a continuous feature. Consequently, in this report, the term "Big Berry Mountains" (plural) applies to the whole escarpment: from Berry Mountain lake in the east, to the western boundary of the area. "Berry Mountain" (singular) will be used as Jones (1930) and local inhabitants used it. The term "Big Berry Mountains" escarpment will also often be used to avoid confusion. All the names applied to brooks, rivers and other physical features in this report are the names used locally or by governmental authorities.

Field Work

A stream and road map at the scale of half a mile to the inch, drawn largely from aerial photographs and made by the Topographic Division of the Department of Mines and Technical Surveys, Ottawa, was used as a base. To this base map, the writer added the information concerning the townships, electoral districts and surveyed lines as shown on the plans of the Quebec Department of Lands and Forests. Rechecks and corrections of the stream locations were made as the field work progressed.

Traverses were made at rather irregular intervals along brooks and across divides by the pace and compass method. A few traverses were also made along hill flanks where exposures were thought to be present. More than 90 per cent of the brooks and rivers were traversed, as well as all trails and roads.

Barometric readings, taken at various points on all traverses, were corrected by the record of a control barometer read every hour at the base camp. Elevations for base points in the area were carried from bench marks along the Cascapédia river, established in 1937 by the Quebec Streams Commission.

Previous Work

Logan (1843), as director of the Geological Survey, did his first geological work, in Canada, along the northern coast of the peninsula, investigating the possibilities for coal.

In 1844, Logan made a complete traverse across the peninsula. He ascended the Cap Chat river, went over the divide to the Bay of Chaleurs drainage basin, and reached a small tributary of Miner brook at Conical Mountain in the northwestern corner of the present area. He and his assistants then built three spruce bark canoes, and in them descended Miner brook, the Lake Branch, and the Cascapédia river to its mouth. The geological information gathered during this trip is recorded in the Reports of Progress for 1844 and 1863 of the Geological Survey of Canada.

In 1883, Ells (1885) did some reconnaissance work on the Lake and Salmon Branches of the Cascapédia river, and gave some information on the geology of the Cascapédia river in the present area. During the same year, Low (1885) ascended the Ste-Anne river to Lake Ste-Anne, portaged over to the headwaters of the West Branch of the Little Cascapédia river and descended that river to its mouth. The latter part of this traverse, from the headwaters of the Little Cascapédia river to Beaver brook, is approximately parallel to, and a short distance to the east of, the eastern boundary of the area.

In 1909, lead- and zinc-bearing veins were discovered in Lemieux township, less than four miles to the north of the present area. During the field seasons of 1917 and 1918, Mailhiot (1919) mapped a small area around the Federal Metals Corporation holdings (formerly Federal Zinc and Lead Co.). A small part of his map overlaps the present area in Lemieux township.

In 1918 and 1919, Coleman (1922) made a brief examination of the Berry Mountain area as part of his broad regional studies on the physiography and glacial geology of Gaspé peninsula.

Alcock (1922, 1926) devoted the field seasons of 1921, 1922, 1923, 1924 and 1927 to the detailed examination of the geology of the Federal area and the area to the north. His results are summarized in his memoir on the geology of Mount Albert, which occupies the region immediately to the north of the eastern half of the present area.

In 1929, Jones (1930) mapped some 50 square miles, north and west of Berry mountain (Fig. 1). The following year, he mapped the Lesseps area, northeast of the present area. From then until 1938, he worked continually eastward and northward, from the interior of the peninsula to eastern Gaspé.

During the field seasons of 1942 and 1943, P.E. Auger (1954) under the guidance of J.E. Gill (1943), made a detailed underground and surface examination of the geology of the holdings of the Federal Metals Corporation.

From 1942 to 1944, as part of a broad revision and reconnaissance mapping programme, H.W. McGerrigle (1945) travelled most of the large rivers and brooks of the interior of the peninsula, including the streams of the present area.

During the seasons of 1947, 1948 and 1949, McGerrigle (1950) mapped a belt, included between longitudes 66°15' and 66°30', from Miner brook in the present area, northerly to the north shore of the peninsula.

Acknowledgments

Fossils collected in the present area by Jones and McGerrigle were identified by the late E.M. Kindle and by T.H. Clark, respectively. All other fossils found in the Richard-Gravier area were identified by the writer. In addition, L.M. Cumming of the Geological Survey of Canada kindly checked the identification of the monograptids, and offered the photograph of the species shown in Plate IV-A.

H.W. McGerrigle visited the writer twice in the field, and at the end of the 1950 field season guided him to the type sections of the Gaspé Devonian in the "classic" area of eastern Gaspé. The writer gladly acknowledges Dr. McGerrigle's tactful and invaluable assistance.

The content of this report is part of a doctoral thesis presented at McGill University. Deep appreciation is expressed for the assistance and facilities for research provided by the Department of Geological Sciences of this institution.

During the summer of 1950, efficient assistance in geological mapping was rendered by T.J. Perry, a graduate student of the University of Toronto, and Raymond Paquet, an undergraduate student from Laval University. As general assistants, Fabien and Viateur Lapointe from St. Léon, Matapédia electoral district, Gaston and Luc Arsenault from Bonaventure, Bonaventure electoral district, performed their duties satisfactorily.

During 1951, the writer was assisted by G.V. Mueller, a graduate student of McGill University. The general assistants were C.P. Jackson of Bishop's University, Gérard Bujold of St. Jules, and Willie, Jean, Gaston and Luc Arsenault from Bonaventure, Bonaventure electoral district. All fulfilled their duties in a capable manner.

DESCRIPTION OF THE AREA

Relief

From the south, the present area appears as a highly dissected upland ending at the Big Berry Mountains escarpment. North of the escarpment lies the broad Lake Branch depression, running east-west along most of its length but roughly crescentic in shape (Pl. I, II).

At places, the upland topography is irregular; at other places, several tracts of land, at an average elevation of 2,000 feet, are almost level. The latter commonly are marshy and dotted with ponds. The Square Forks Lakes depression, located in the southwestern part of the area, departs from the general picture of a dissected upland.

From the north, the Big Berry Mountains appear as a hogback-like escarpment rising 1,000 feet and more above the bottom of the Lake Branch depression. From the east, the escarpment first appears directly south of Berry Mountain lake and about 2 miles distant. It then follows a course slightly south of west for 7 miles, is cut through by the Cascapédia river near the mouth of Berry Mountain brook, and then takes a westerly course for 10 miles to the valley of Huard (Loon) lake. It becomes progressively lower west of Mount Noble (Pl. II). West of Huard lake, it is marked by a vertical drop of less than 600 feet. It dies out near the western boundary of the area on approaching a region of higher elevation underlain by resistant Devonian volcanics. West of Huard lake, the escarpment cuts across the strike of the rock formations. The maximum elevation of the central part of the escarpment is 2,145 feet above sea-level. Mount Noble and Berry Mountain are respectively 2,125 and 1,860 feet above sea-level.

From the foot of the Big Berry Mountains escarpment, the Lake Branch depression extends toward the northern boundary of the area, with a maximum width of approximately 6 miles. It stands between 500 and 600 feet above sea-level along the Lake Branch of the Cascapédia river and the East branch of Berry Mountain brook. In the centre of the depression and nearly parallel to it, a cuesta rises to an elevation of 1,000 feet, or some 500 feet above the valley floor. From the west, this rock ridge can be first seen immediately south of Miner brook, 2 miles northwest of Huard Lake. It then follows the curving trend of the rock formations, first northeasterly, then easterly and southeasterly. It is cut through by the Salmon Branch, one mile north of The Fork (1). It dies out just east of the junction of the North and East branches of Berry Mountain brook. The total length of the ridge is approximately 17 miles.

The topographic profile of the southwestern quadrant of the area is more gentle than the profile to the east and northeast. The brooks in the upland, although still swift, are less entrenched. The centre of this quadrant is occupied by the Square Forks Lakes depression, at an average elevation of 900 feet above sea-level (Pl. III-A). This depression is 2 miles wide, and approximately 7 miles long in an east-west direction.

Resistant volcanic rocks form topographic irregularities in the high plateau region. Among the most prominent features formed by these rocks are two northeast-trending ridges, one in the northwestern and one in the southeastern corners of the map-area.

To summarize, the topography of the area has three main elements: a dissected flat upland and the Lake Branch and Square Forks Lakes depressions.

Drainage

The area is almost entirely drained by the Cascapédia river and its two main Branches: the Lake and the Salmon. A very small portion of the waters in the northeastern corner of the area flow easterly toward the West Branch Little Cascapédia river. The headwaters of the Nouvelle river lie very close to the southwestern boundary of the map-area.

In the present area, the Cascapédia river is a swift stream, powerful in freshet-time, and approximately 300 feet wide. Several of its tributaries, including its two major Branches, are relatively large streams.

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(1) The locality known as "The Fork" is the point of junction of the Lake Branch with the Salmon Branch.

Stream Piracy

The Square Forks lakes lie in a broad depression which is the westward continuation of the Square Forks River valley. To the west, this depression is roughly in line with the upper Lake Branch, but the latter turns sharply north at the western end of the depression. The present topography suggests that the upper Lake Branch once flowed eastward throughout its lower course and joined the present Square Forks river. Capture of the upper Lake Branch by the lower Lake Branch could have been caused by a minor tributary of the latter cutting southward into the Big Berry Mountains.

The stream pattern and some physiographic evidence suggest another case of piracy in the southern part of the map-area, in the vicinity of the Josué lakes. The four Josué lakes lie in a trough 3 miles long, trending northwest, and show little difference in elevation. The lakes drain to the south, but the waters of the northern lake are almost in equilibrium between northward and southward drainage. This fact and the arrangement of some of the tributaries of Otter brook to the north suggest that the upper part of Otter brook, now draining northward to Square Forks, once drained southeastward through the Josué Lakes depression. In fact, this is the present appearance on aerial photographs, and all maps based only on photographs show upper Otter brook actually flowing into Josué lakes.

A third case of piracy was noted near the eastern boundary of the area. The headwater tributaries of northward-flowing Petite Sud brook originally flowed southward into Jonathan brook. The divide between Jonathan brook and the present Petite Sud brook is occupied by a swampy, relatively broad valley.

A major example of piracy of a south-flowing stream by a north-flowing stream in a neighbouring area is given by the Ste-Anne and Little Cascapédia rivers in the vicinity of Lake Ste-Anne (Alcock, 1926, p. 16). Such piracies may have been accelerated by regional tilting.

Glaciation

Evidences of glaciation in the area or in its immediate vicinity include erratics, glacial cirques, disorganized and underground drainage, and hummocky topography.

Greenstones from the metamorphic series of the Shickshock mountains, 6 miles north of the northern boundary of the map-area, constitute a particularly noticeable and useful type of erratic to determine the extent and trend of the glacial movement in the area.

A few greenstone erratics are scattered unevenly in the area south of the Big Berry Mountains escarpment. One boulder of this type, eight inches in diameter, was found at an elevation of 1,900 feet at the southwestern corner of the area.

Along the tributaries flowing northward into the west branch of Square Forks river, flakes, pebbles, boulders, and slabs of greenstone up to one foot thick or three feet in diameter were found at least every hundred feet, at an elevation varying between 1,200 and 1,400 feet.

A large number of greenstone erratics were noted in the lower and middle portions of the Otter Brook valley. The abundance of such erratics in this location, and the topographic profile, suggest that glacial ice moved southeastward through the Huard Lake and the Square Forks Lakes depressions, toward Otter brook.

A particularly well-developed and, in contrast to those of Mount-Albert (Carbonneau, 1949), well-preserved glacial cirque can be seen on the south side of the valley of Square Forks river, approximately 3 miles west of Cascapédia river. Steep walls on three sides grade into an irregular valley floor. The drainage is underground through unconsolidated material; swampy areas are present.

A relatively large part of the area, compared with the rest of the interior of the Peninsula, shows topography suggestive of glacial deposition. A band approximately 2 miles wide, paralleling the Lake Branch depression from near the eastern boundary of the area to the vicinity of Huard lake, has an irregular topographic profile. Several streams flowing from the northern flank of the Big Berry Mountains disappear underground as they reach the depression. Ponds and swamps are scattered here and there, particularly west of Huard lake. It cannot be determined whether the hummocky topography is due to bedrock irregularities or to glacial deposits because the vegetative cover does not allow direct observation. Inasmuch as elsewhere in the interior of the Peninsula the profile of the underlying bedrock is fairly even, it is reasonable to assume that these irregularities are formed by glacial deposits.

Means of Access and Communications

The principal route followed into this part of the interior of the peninsula is the Cascapédia River road, also known as the Federal Mine road, constructed by the Quebec Department of Mines[x]. This motor road passes through

[x]Editor's note:-This road was replaced in 1957 by the Trans-Gaspesian highway, a connecting link between Grand-Cascapédia on the south side of the peninsula and Ste-Anne des Monts on the north side.

Grand-Cascapédia, a small village located 3 miles north of the Bay of Chaleurs. The road follows closely the east bank of the Cascapédia river for a distance of approximately 36 miles, to Berry Mountain brook. It then swings slightly north to the Federal Metals Corporation camps, situated 45 miles north of Grand Cascapédia.

At Grand-Cascapédia, the Federal Mine road connects with the Perron boulevard, or Route 6, which encircles the peninsula.

At a point 37 miles north of Grand-Cascapédia, a motor road branches from the Federal Mine road and leads westerly to a locality known as Lazy Bogan. A wagon road, in places greatly obstructed by windfalls, connects Lazy Bogan with Huard lake, in the west-central part of the area. This road follows fairly closely the north bank of the Lake Branch. Another wagon road parallels the Salmon Branch of the Cascapédia river. A trail approximately 6 miles long leads upstream along Go-Ashore brook.

The southwestern quadrant of the area can be reached by the Square Forks River trail. The Square Forks river is an east-flowing stream which enters Cascapédia river at a point approximately 30 miles north of the village of Grand-Cascapédia. The trail has a total length of 10 miles and is connected at its western end to an old "fire trail" which joins Square Forks river with the Josué lakes.

At the main fork of Berry Mountain brook, a motor road branches easterly and leads to Berry Mountain lake near the eastern edge of the area and to Lake Ste-Anne. Farther east, the same road, owned by the Cascapédia Manufacturing and Trading Co., leads across the drainage basin of the Little Cascapédia river to the Bonaventure river. This road is known locally as either the Bathurst road or the West Branch road (West Branch Little Cascapédia river). There is a relatively large number of motor roads, wagon roads and trails in the northeastern part of the area, all resulting from lumbering operations.

Nearly all township and electoral district lines shown on the map are projected, and consequently are of no help in travelling through the woods. Canoes can be used only on the major streams, and the poling of canoes up these rivers can be done only by strenuous efforts, even by expert polemen. Canoes can be poled up the Lake Branch to Huard lake, up Miner brook to the "falls" - a small rapid located at the western boundary of the area - up Go-Ashore brook for approximately 5 miles, and up the Salmon Branch for approximately 18 miles. All other rivers, except locally on their lower reaches, have their channels blocked by gravel bars, braided sections, or log jams.

Timber Resources

The area is densely covered by vegetation. The most common type of tree is the balsam fir. In the middle portion of the Square Forks river, and in the depression of the Square Forks lakes, black spruce is fairly common. Elsewhere in the area, white and black spruce, and white and yellow birch are sparsely distributed. Generally, pine and poplar are extremely rare. Balm of Gilead occurs in the Lake Branch depression in the vicinity of the Cascapédia river (Jones, 1930, p. 8). Cedar was seen at the base of the Big Berry Mountains escarpment, in the eastern part of the area. Approximately 25 per cent of the summit areas in the region is covered with a very dense, in some places almost impenetrable, growth of entangled dwarf fir and spruce.

Some 30 square miles in the southwestern part of the area were burnt some 40 years ago. At this locality, a mixture of white birch and poplar has replaced the previous cover of conifers. The vitality of the birch here contrasts strongly with the generally unhealthy condition of this type of tree elsewhere in Gaspé peninsula.

In the southwestern part of the area, there is no indication of former, large, lumber operations. No extensive operations are now taking place in the northwestern quadrant of the area, but some 30 to 40 years ago lumber was cut by the Montgomery interests along the Lake Branch as far as Huard lake, on Miner brook as far as the western edge of the area, on Go-Ashore as far up as Red Wing brook, and on the Salmon Branch nearly up to Nine-mile brook (north of the present area).

Within the last ten years the Cascapedia Manufacturing and Trading Co., a subsidiary of the Bathurst Pulp and Paper Co.,has cut a large portion of the timber in the eastern half of the Lake Branch depression. The company maintains a large depot near the junction of the North and East branches of Berry Mountain brook to control its operations north and east of the present area.

Agricultural Possibilities

The agricultural possibilities of this part of the interior of Gaspesia were considered extensively by Jones (1930, pp. 8-9) and McGerrigle (1950 MS.).

In the present area, the topography favours the development of agriculture. A large portion of the region consists of broad valleys and gently rolling interfluvial areas. Drainage conditions would have to be improved, however, in the Square Forks Lakes depression, and the middle portion of the Square Forks valley. The average elevation of this part of the area stands between 700 and 900 feet; heavy frosts come only late in September. The soil developed on fluvial, and possibly glacial-lake deposits, is of a fair quality, and could probably support good farming.

Other tracts of land could be cleared for cultivation on the southern flanks of the Big Berry Mountains, and on the interfluvial areas in the south-western portion of the map-area.

Fish and Game

In former years, the Cascapédia river was particularly well known for the size and abundance of its salmon. At the present time, and for various reasons, the number of fish here has decreased, although good "catches" can still be had. Salmon go up the Lake Branch to Huard lake and Miner brook, and up the Salmon Branch well beyond the northern limit of the area. Large trout accompany the salmon, and among the local inhabitants the upper Lake Branch is famed for the size of its trout. Trout are also plentiful in Berry Mountain lake, in the northeastern part of the area.

Game animals such as moose and deer are fairly abundant in the present area, but they are not as common as formerly. One of the reasons for this decrease in number may be the fact that the woods are now more difficult to travel through. Wherever a trail is opened, one may expect to find a greater number of these animals. This condition is particularly striking in the southwestern part of the map-area, where the forest was burnt 40 years ago; the newly grown birch and poplar form an open, park-like forest inhabited by a greater variety and number of animals than elsewhere in the area.

Beaver are common in the upper basin of the Square Forks river; elsewhere in the area, trapping appears to have hindered their development. Black bear are numerous, and cause occasional trouble to survey parties.

GENERAL GEOLOGY

General Statement

Geologically, Gaspé peninsula is divisible into three belts running east-west along its long axis: a northern belt composed of slates of predominantly Ordovician age, a central one made up of rocks of Devonian age, and a southern belt composed of rocks of predominantly Ordovician and Silurian ages, but including also some Devonian, Carboniferous, and possibly Precambrian rocks. The greenstone series (? Cambrian or older) of the Shickshock Mountains, the peridotite (Silurian) of Mount Albert, and the granite (Devonian) of the Tabletop mountains are located between the Northern and Central belts, in the western half of the peninsula.

The Richard-Gravier map-area belongs to the Central belt of the peninsula. The rocks range in age from Upper Silurian (Lower Ludlow) to possibly Middle Devonian, with a short stratigraphic gap representing a portion of Late Silurian time. The present report, however, is concerned mainly with the Devonian succession which, in this area, reaches an unusual thickness. In the following pages, the Devonian formations are correlated mainly on a lithological basis with the type-sections of eastern Gaspé.

SUMMARY OF STRUCTURAL GEOLOGY

The principal structure of the area is the Berry Mountain syncline (McGerrigle 1946, p. 50). This is a somewhat basin-like fold, subcircular in surface plan, the axis of which runs slightly south of west in the central part of the area. The fold affects the whole sequence of rocks, except in the southeastern part of the area where the Silurian beds were brought up by a series of thrust faults and a general anticlinal structure (Josué Brock anticline). The strata on the northern flank of the Berry Mountain syncline have lower dips than the strata on the southern flank, which are commonly overturned to the north near the eastern boundary of the area. The fold plunges to the west, except in the southwestern part of the area where the axis appears to be approximately horizontal.

The Berry Mountain syncline is part of the synclinorium which extends along the axis of the peninsula, and corresponds in position to the Central belt, described above. It is approximately in line with the York River syncline of eastern Gaspé.

Table of Formations

Period	Epoch	Stage	Formations	Characters and approximate thickness
			Battery Point	Greenish-grey, medium- to coarse-grained, feldspathic (pink feldspars), pebbly sandstones. Red beds toward the top. 8,000 - 10,000 feet
	Middle?	Hamilton? Onondaga?	Volcanic rocks	Fine-grained, silicified rhyolite. Porphyritic diabase. 2,000 feet
			Lake Branch	Red and brown shales and sandstones. 4,000 - 5,000 feet
		Onondaga? Oriskany?	York River	Greenish-grey, medium- to fine-grained, feldspathic (grey feldspars) sandstones. Dark green shales and siltstones. 2,000 - 10,000 feet
DEVONIAN			Volcanic rocks	Amygdaloidal diabase, andesite, olivine basalt, rhyolite
		Oriskany	York Lake	Interbedded limestones, sandstones and shales. Some basic sills or interbedded volcanics. 2,000 feet
	Early		Fortin	Calcareous slates, limestones, sandstones and conglomerates
		Oriskany	Grande Grève	Hard, well-bedded, calcareous siltstones or siliceous limestones. Basic sills or interbedded volcanics. 3,000 feet
			Cape Bon Ami	Soft, argillaceous limestones and dark shales. 500 - 1,000 feet
	Late	Cayugan	Volcanic rocks	Andesite, basalt, rhyolite, tuff, breccia. 2,000 feet
SILURIAN			Sedimentary rocks	Laminated, calcareous siltstones, limestones, sandstones and shales; Red and green shales

SILURIAN

Sedimentary Rocks

General Description

Silurian rocks are exposed in the southeastern part of the area. Folds and numerous normal and reverse faults in these rocks preclude the working out of a satisfactory stratigraphic succession, but the total thickness is probably less than 2,000 feet.

Near the axis of the general anticlinal structure (lowest beds exposed), the strata are greenish-grey, fine-grained, laminated, calcareous sandstones in beds up to one foot, but generally less than 4 inches, thick. The laminae consist of black shale and grey limestone. Fairly abundant minute grains of pyrite are disseminated throughout the fine-grained sandstone beds.

Above this sandstone zone, the predominant type of rock appears to be greenish to bluish grey, laminated siltstone carrying a fairly large number of minute pyrite grains. The laminae, generally less than 2 millimeters thick, are made up of finely-crystalline, grey, shaly limestone.

Toward the middle of the section, or approximately 1,000 feet above its base, green and red mudstones, in beds 2 inches thick, are interbedded with the siltstone (Pl. III-B). Here, also, are some light grey weathering, bluish-grey, pure limestone beds generally less than 3 inches thick.

The upper part of the section consists of dark grey calcareous shale and arenaceous limestone in beds between 2 and 4 inches thick. Yellowish-green tuff beds are found at rare intervals in the sequence.

The remarkable feature about the Silurian of the present area is the relative abundance of sandstones and siltstones in relation to limestones, as compared to the other Silurian belts of Gaspé. There are no limestone conglomerates, reefy limestones or crystalline limestones - types found fairly commonly in the Mount Alexander series (Jones,1937, p. 12), the Chaleur series (Northrop, 1939) and the Silurian belts of eastern Gaspé (McGerrigle,1950, pp. 35-49). Moreover, no fossils except graptolites were seen in these rocks. All this suggests a different environment of deposition for the present Silurian belt. On the other hand, it is possible that the more typical Silurian beds occur lower in the section, and have not been exposed by erosion.

The best and most continuous exposures of these rocks are along the West branch of Jonathan brook, but good exposures also occur on the east bank of the Cascapédia river.

Correlation

Fossils are rare in the present sedimentary belt, but the single genus found is diagnostic of the Silurian. Along the West branch of Jonathan brook, on the north limb of the Josué Brook anticline, the following fossils were found:

Monograptus tumescens Wood
M. nilssoni (Barrande) (Pl. IV-A)
M. cf. vulgaris Wood
M. cf. dubius (Suess)

On the south limb of the anticline, at the same horizon, the fossils collected were:

M. cf. colonus var. compactus Wood
M. sp. cf. roemeri Wood
M. sp.
Kinoceras? sp.

Another fossil locality on the east branch of Jonathan brook contains Monograptus cf. dubius (Suess) and another species.

There can be little doubt that this assemblage of Monograptids belongs to a Lower Ludlow horizon, that is, correlates with the lowermost Upper Silurian beds of Great Britain. The assemblage represents one of the few well-defined, post-Wenlockian age determinations from Gaspé peninsula. Its proximity to (and definite separation from) the Gaspé Limestones provides an important locality with regard to the Silurian-Devonian boundary. Monograptus tumescens Wood, M. nilssoni (Barrande) and M. colonus var. compactus Wood were reported before from Gaspé peninsula (Ruedemann, 1947).

In relation to the Silurian formations of North America (Swartz, et al., 1942), the present rocks correlate with the Salina group of New York State and the Great Lakes region.

Volcanic Rocks

The sedimentary rocks described above are overlain by a sequence of volcanic flows. These are best exposed in a cliff located opposite the mouth of Josué brook, about half a mile east of the Cascapédia river. Also, good exposures of these rocks may be seen along Cascapédia river. The volcanic belt forms a prominent ridge, which runs northeasterly in the southeastern corner of the area.

The rocks of this belt consist of andesite, rhyolite and basalt in approximate ratio 5:2:1, and a small proportion of tuff. No attempts were made to give a full petrographic description of these rocks, but field identifications were checked by examination under the microscope. The section exposed in the cliff east of the Cascapédia river is composed of andesitic lava flows, generally more than 20 feet thick, interbedded with thin zones of hard, acidic tuffs. The andesite is medium- to fine-grained, amygdaloidal in some places and porphyritic in others, and generally ophitic in texture. Under the microscope, the rock shows laths of plagioclase (An_{55}) set in a matrix of augite, hornblende, biotite, and volcanic glass. Chlorite is present in some thin sections, either as an alteration product of the ferromagnesians or as a thin coating around the walls of the vesicles. The material filling the vesicles is predominantly calcite, but chalcedony is also present in smaller amounts. The tuff beds are made up of very fine aggregates of quartz grains and microlites of feldspars. The remarkable feature about this exposure is the fact that individual flows up to 30 feet thick are easily detectable. Contorted flow lines and ropy structures can be observed at several places. The bottom portion of one flow shows fairly distinct pillow lavas.

The rocks exposed on the east bank of the Cascapédia river, slightly below the mouth of Charles-Vallée brook, show similar characters. Pillows are present at the north end of the exposure. At the same locality, there are blocks of limestone up to 2 feet in diameter in the andesite. Andesite breccia in a zone 30 feet thick contains blocks up to 4 feet long of highly vesicular basalt (Pl. IV-B). Baked limestone in zones up to 10 feet thick were noted in the middle of the exposure. Finally, there are also beds of dark, clastic tuffs up to one foot thick interbedded with the flows and the volcanic breccias.

Fine-grained, pale to yellowish grey rhyolite occurs in the same belt, and several sections of this type of rock may be observed along the West branch of Jonathan brook. Under the microscope, the rock shows about 80 per cent microcrystalline quartz in grains between 0.02 and 0.05 millimeters in diameter. Approximately 15 per cent of the fine aggregate consists of fresh, euhedral, feldspar crystals. At places, clusters of hematite and iron oxide were observed. Iron oxides line the walls of minute veins of clear quartz which crisscross the rock. Acidic flows appear to be predominant in the southern band of the volcanic belt near the eastern boundary of the area, either as homogeneous flows or as thick beds of volcanic breccias (Pl. V-A).

Basalt and olivine basalt are less abundant than the preceding types of rock, but they are present in fair amounts at certain localities, particularly in the lower portion of Gravier brook. They occur as black-weathering, crumbling exposures, with a surface alteration nearly 6 inches deep at places. The olivine basalts commonly contain interconnecting, minute veins of serpentine. Tongues of basaltic material were also observed in the exposures along the Cascapédia river. These tongues might represent interbedded basaltic flows or basic dykes.

Apart from the volcanic belt just described, there is an indeterminate number of igneous bodies of intermediate to basic composition in the Silurian sedimentary belt. Some of these bodies probably represent volcanic zones; others are probably sills; some are definitely dykes. The enclosing sedimentary rocks are commonly baked at the contacts. These igneous bodies do not differ essentially in composition from the ophitic andesite (or diabase) of the volcanic belt. They commonly contain amygdules of calcite, and at places contain feldspar phenocrysts up to 3 millimeters long. These igneous bodies are too poorly exposed and generally too thin to be shown on the accompanying map. Some of them represent feeders to the overlying volcanic belt.

LOWER DEVONIAN

Cape Bon Ami Formation

General Description

The Cape Bon Ami formation of the north cliffs of the Forillon peninsula and the general region of Eastern Gaspé is described by McGerrigle (1950, pp. 48 and 60) as dark, well-bedded, soft, shaly to finely sandy, magnesian limestones, and shales. This description is slightly different from the ones given by Logan (1863, p. 413), Clarke (1908, p. 36), and Russell (1946, p. 6) for the Cape Bon Ami at the Forillon peninsula. However, inasmuch as in the inland areas the succession of beds located stratigraphically between the underlying St. Alban formation and the overlying Grande Grève formation has the characteristics described by McGerrigle, this description will be adopted. In the above sense, there are some beds in the Richard-Gravier map-area that are lithologically similar to the Cape Bon Ami formation.

These rocks occupy a narrow band immediately to the north of the Silurian volcanics in the southeastern part of the area. They consist of 60 per cent dark bluish-grey, soft limestone, and 40 per cent black-weathering, calcareous, dark shale, regularly interbedded in beds generally less than one inch thick. The limestone is arenaceous in places. Toward the base of the section, several beds contain minute, carbonaceous specks and abundant flakes of muscovite on bedding planes. The calculated thickness of the formation is approximately 1,000 feet (using the width of the belt in relation to the dips).

Two igneous bodies of unknown extent were found in the Cape Bon Ami formation. One is exposed along the hillside a short distance north of the mouth of Charles-Vallée brook. The other occurs along the West branch of Jonathan brook, approximately in the middle of the formation. Both are amygdaloidal diabase, slightly porphyritic in places. The one exposed along Jonathan brook shows ball-like structures that are probably pillows.

Correlation

The Cape Bon Ami rocks of the present area are essentially unfossiliferous as the only fossils seen were comminuted plant fragments on a few bedding planes. Thus, the rocks under discussion are correlated with the Cape Bon Ami formation almost exclusively on the basis of lithology.

The Cape Bon Ami formation of eastern Gaspé is considered Oriskany in age.

Grande Grève Formation

General Description

Rocks having the same lithology as the Grande Grève formation of eastern Gaspé occupy the northwestern and northeastern corners of the area. They are the southern extensions of a belt one to two miles wide lying parallel to, and north of, the northern boundary of the map-area. The rocks are mainly dark to brownish grey, hard, brittle, calcareous siltstones to siliceous limestones in beds generally 2 to 8 inches thick, separated by thin layers of silty shale. The rock weathers characteristically light grey, and on the weathered surface is more obviously silty than on the fresh surface. There are, in places, interbeds of softer, shaly limestone, resembling the type of limestone found in the Cape Bon Ami formation.

The average thickness of the formation in the northwestern corner of the area is 3,000 feet. There is some difficulty, however, in locating the upper contact as it is transitional to the overlying York Lake formation. Some of the York Lake beds possibly should be included with the Grande Grève. The average thickness of the Grande Grève formation in the inland areas of Eastern Gaspé was estimated by McGerrigle (1950, p. 64) to be 4,000 feet, whereas in the Forillon section, the formation, as redefined, is 1,387 feet thick. Thicknesses intermediate between these two figures were also found, but 4,000 feet appears to be the most common average. In the present study, the inclusion of the basal York Lake beds with the Grande Grève formation would bring the thickness of the formation into closer agreement with its average thickness in Eastern Gaspé.

The data are not complete enough to give an estimate of the thickness of the formation north of Berry Mountain lake. In the Lesseps map-area (Jones, 1931) to the northeast, the formation was not separated as such from the Gaspé Limestones. Grande Grève beds were not seen on the south flank of the Berry Mountain syncline.

A wedge of volcanic rocks lies within the Grande Grève formation northeast of Berry Mountain lake. These rocks are almost continuously exposed in the ditch on the north side of the Bathurst road, leading from Berry Mountain lake to the West Branch Little Cascapédia river. Very good exposures can also be seen along Six-mile brook. The rocks are medium- to fine-grained, dark greenish grey, highly amygdaloidal andesite, and crumbly, fine-grained basalt and olivine basalt. At the point where the Bathurst road crosses Six-mile brook, the rock is fine- to medium-grained, amygdaloidal andesite, with fragments up to 5 inches in diameter of basalt, felsite, and limestone. The fairly abundant amygdules are composed of calcite and chlorite.

Along Six-mile brook, about $\frac{1}{2}$ mile upstream from the Bathurst road, turquoise-blue, tuffaceous and arenaceous, slightly crystalline limestones, and dark brown-weathering, soft, calcareous shales are interbedded with andesitic layers 6 inches thick.

Approximately 1,000 feet farther upstream, the andesite makes up only about 10 per cent of the rock. Approximately another 10 per cent consists of soft, bluish grey, shaly limestone resembling closely the typical Cape Bon Ami limestone. The remaining part of the exposure consists of deeply-weathered, light-green, coarse-grained to conglomeratic, highly calcareous, volcanic-fragmental sandstone. Under the microscope, this rock shows fragments of lava predominantly intermediate in composition, but also acidic and basic, cemented by about 50 per cent of calcite.

Still farther upstream, this tuffaceous sandstone is richer in amorphous silica, quartz grains, and volcanic fragments of acidic composition. Near the upper contact of the volcanic wedge, in the sandstone, abundant solitary and colonial corals occur with a few brachiopods and pelecypods. This sandstone and the soft limestones and shales are included in the volcanic wedge on the accompanying map because they are interbedded with volcanic rocks, and because they are distinctly different in lithology from the Grande Grève formation. The tuffaceous sandstones probably were deposited in a marine environment, with contemporaneous deposition of calcite. Deposition, judging from the coarseness of the volcanic fragments, must have occurred close to volcanic islands where corals and other invertebrates were striving to live in rather adverse ecological conditions.

Correlation

Three lots of fossils were collected from the Grande Grève formation on two tributaries of Miner brook near the western boundary of the map-area. The composite list of two of the lots collected near the upper limit of exposures on Moose brook includes Chonostrophia complanata Hall; Chonetes sp., and Spirifer modestus nitidulus Clarke.

The third lot, obtained from outcrops near the contact with the overlying formation, and located to the east of Moose brook, contains Leptaena rhomboidalis (Wilckens), Orthotetes woolworthanus gaspensis Clarke, Chonostropia dawsoni (Billings), Spirifer gaspensis? Billings, Spirifer cyclopterus? Hall, and Meristella champlaini Clarke. This fauna suggests a close relationship with the Grande Grève at the type locality, although some of the forms are present also in the York River formation.

The following fossils were found in a tuffaceous sandstone approximately one mile north of Berry Mountain lake, located stratigraphically near the top of the Grande Grève formation: Spirifer arenosus (Conrad), Spirifer murchisoni Castelnau, Spirifer sp. cf. modestus (Hall), Spirifer sp. cf. gaspensis Billings, Protoleptostrophia blainvillii (Billings), Leptostrophia cf. magnifica (Hall), Rhytistrophia beckii (Hall), Chonetes billingsi Clarke, Chonetes hudsonicus gaspensis? Clarke, Actinopteria sp., Dalmanites? sp., Heterophrentis prolifica (Billings), Emmonsia tuberosa (Rominger). The Spirifers and the Rhytistrophia indicate a Grande Grève age. The corals are new for the Grande Grève formation. Heterophrentis prolifica (Billings) is found in the Onondaga of Erie County, Ohio (Olentangy shale). It occurs also in the Centerfield Coral reef of the Mahantage formation (Hamilton) in Pennsylvania, and is present in Middle Devonian rocks of several other localities. Emmonsia tuberosa (Rominger) is present in the Onondaga limestone of New York and Ontario, and in the Falls of Ohio, but it is found also in the Moscow shale and the Centerfield limestone. However, it is more common in the Onondaga than in younger rocks. These species apparently have not been recorded in Oriskany rocks. Thus, the rocks correlated with the Grande Grève formation, because of their lateral gradation into typical Grande Grève beds, possibly should be considered as York Lake in age. At best, they appear to belong to the Onesquethaw stage (Onondaga), whereas the Grande Grève formation of the Forillon peninsula belongs to the Deerpark stage (Oriskany). Moreover, there is the possibility that these species developed at an earlier time in the Gaspesian basin than elsewhere.

York Lake Facies

General Description

The term York Lake series was introduced by Jones (1936) to describe a transitional sequence between the Grande Grève and the York River formations. McGerrigle (1946, p. 47) presented some comments on the usage of the term and concluded that the tendency was to include these rocks with the York River formation.

In the present area, York Lake rocks can be seen along Miner brook and Go-Ashore brook. From the distribution of the debris, it appears that a similar belt underlies Berry Mountain lake. Finally, near the eastern boundary, at the headwaters of Beaver brook, there are limestones which are correlated tentatively with the York Lake facies.

Except for the occurrence in Beaver brook, the rocks included in the facies are sandstones and shales, similar to the clastics of the York River formation, interbedded with limestones of various types. Limestone interbeds were actually observed in only a few sections. The limestone beds on Miner brook are more suggestive of the Cape Bon Ami than of the Grande Grève, whereas those in the section on Go-Ashore brook are of the Grande Grève type. The limestone near Berry Mountain lake is also of the Grande Grève type. The facies is approximately 2,000 feet thick.

Some basic lavas or sills are interlayered with the upper part of the facies. These igneous layers are of the same type as a portion of the overlying volcanics.

There is some suggestion of faulting between the York Lake and Grande Grève in the section along Miner brook, but elsewhere the two sequences appear essentially conformable.

The rocks at the headwaters of Beaver brook consist of laminated, arenaceous, light brown weathering, brownish grey limestone in layers up to 8 inches thick, interbedded with soft, argillaceous, bluish grey limestone of the Cape Bon Ami type. Some beds resemble the Grande Grève. There is no sandstone or shale but, here also, intermediate volcanics are interbedded with the limestones. This belt is faulted against a sequence of volcanic flows, so that its exact stratigraphic position is not definitely known. It is probably in the middle of the York River sequence of the present area. It is also probably stratigraphically higher than the York Lake sections of Miner brook and Berry Mountain lake.

A short distance to the east of the present area, the York River formation apparently grades laterally into the York Lake. No detailed geological mapping was done in that area, but three sections were examined across the strike at intervals of about two miles. Two are along large brooks, and the other is along the road paralleling the east bank of Little Cascapédia river. Interbedding of sandstone, shale, and limestone can be observed commonly in the exposures of the Little Cascapédia road. The limestone is mostly of the Grande

Grève type, but Cape Bon Ami type and types intermediate between these two also occur.

Along the two brooks referred to above, the distribution of the debris shows that sandstones and limestones are interbedded in some parts of the section. From the rock exposures, however, it would seem that homogeneous Grande Grève lenses, up to 500 feet thick, occur within the York River formation. In other words, Grande Grève lithology is found at a higher stratigraphic level here than at the type section in the Forillon peninsula.

In this report, the term facies, instead of series, is used for the York Lake because, at several places, it grades laterally as well as vertically into the York River. In the light of present knowledge, the boundaries of the York Lake facies appear to be too poorly defined to make it of formational rank.

Correlation

In the section along Miner Brook, the York Lake facies has yielded collections of fossils from five different horizons, mainly from sandstone beds, but in one case from a limestone bed. The composite faunal list includes: Algae?, Plant fragments, Zaphrentis sp., Favosites sp., Lingula sp., Chonetes hudsonicus gaspensis Clarke, Dalmanella lucia (Billings), Leptaena rhomboidalis (Wilckens), Leptocoelia flabellites (Conrad), Rensselaeris sp., Orthotetes woolworthanus gaspensis Clarke, Spirifer gaspensis Billings, Spirifer arenosus Conrad, Stropheodonta sp., Eotomaria cf. rotula Clarke, Strophostylus cf. expansus Hall, Platyceras tortuosum Hall, Platyceras cf. leboutillieri Clarke, Actinopteria sp., Cypricardinia sp., Grammysia sp., Pterinea sp., Dalmanites whiteavsi Clarke.

This list of fossils indicates a closer age relationship with the Grande Grève formation than with the York River, and suggests, further, that the strata belong to the Oriskany. However, the differences between the known faunas of the Grande Grève and the York River formations of the peninsula are not great, and such differences become progressively smaller as continued paleontological work is done on these formations.

Approximately one mile northwest of Berry Mountain lake, along the road leading to Taylor's lumber camp, a small collection of fossils was made from typical Grande Grève beds. This belt is shown on the accompanying map as belonging to the York Lake facies, inasmuch as very abundant sandstone debris, almost in place, was found in the road ditch. The faunal list includes: Spirifer arenosus (Conrad), Spirifer gaspensis Billings, Strophonella sp., Prionothyris sp. or Beachia sp., Etymothyris gaspensis Clarke (Rensselaeria ovoides gaspensis), Leptostrophia sp., Chonetes sp., Schuchertella woolworthana (Hall), Orbiculoidea sp., Strophonella continens Clarke, Paleoneilo sp. nov., Proetus sp., crinoid stems. The forms identified indicate affinities with the Grande Grève fauna, although they occur stratigraphically some 1,200 feet above the Onondaga corals found in the tuffaceous sandstone, one mile north of Berry Mountain lake. The internal structures of the forms identified as Prionothyris or Beachia could not be observed; the two genera range in age from the Deerpark stage (Oriskany) to the end of the Onesquethaw stage (Onondaga). The anomaly between the stratigraphic location of the present fauna and the fauna in the tuffaceous sandstone may be the result of faulting, although no other suggestions of faulting were observed.

Fortin Series

General Description

Prior to 1946, the southern half of Gaspé peninsula was shown on geological maps as being underlain by rocks of Ordovician age, except for a portion near the Bay of Chaleurs. McGerrigle (1946, p. 48) referred much of these rocks to the Devonian system under the term "Fortin series" from Fortin township in eastern Gaspé. The series forms a belt up to 15 miles wide, parallel to the length of the peninsula. The rocks show generally strong cleavage and complex structure, features which readily explain why they were considered originally as Ordovician.

In eastern Gaspé, the series occupies a stratigraphic position roughly equivalent to the York Lake facies, which may grade both laterally and vertically into the York River formation. The series is restricted to the south limb of the St. John River anticline. On the north limb, the strata are of York Lake, Grande Grève, and Cape Bon Ami age. The absence of these formations on the south limb of the anticline led McGerrigle (1950, p. 76) to suggest that the Fortin series may include also "both Cape Bon Ami and Grande Grève time without maintaining the characteristics of the formations".

Similar lithological, stratigraphical, and structural characteristics are found in the southeastern corner of the present area. Here, rocks referred to the Fortin also consist of slates interbedded with limestones, sandstones and conglomerates. Stratigraphically, they appear to correspond in age to the Cape Bon Ami, Grande Grève and York River formations. Moreover, they are on the south limb of a general anticlinal structure.

The predominant rocks are interbedded, brown-weathering, dark grey, calcareous slates, and dark-weathering, fissile siltstones. At the southern boundary of the area, a short distance east of the Cascapédia river, light grey, pure limestone beds are interbedded with thin laminae of dark grey, calcareous shale. Here, there is a widely-spaced fracture cleavage (Pl. V-B).

Toward the southern edge of the map-area, along Jonathan brook, there are beds up to 7 feet thick of sheared light grey weathering, medium-grained, greenish grey, arkosic sandstone. They contain elongated whorls and sheets of black shale, probably representing former mud fragments. At three localities, these sandstone beds are interbedded with, or grade into, conglomeratic zones up to 3 feet thick. The pebbles of the conglomerate are very well-sorted, consist mainly of milky quartz with black chert, and generally are less than $\frac{1}{8}$ inch in diameter (Pl. VI-A).

Along the East branch of Jonathan brook, approximately one mile downstream from the Silurian volcanics, shale pebble conglomerates, in zones up to 40 feet thick, are interbedded with the siltstones. The pebbles - deformed, elongated, and sheared out along cleavage planes — are set in a matrix of similar, but slightly more silty composition. These zones appear to be intraformational conglomerates.

Under the microscope, the sandstone which overlies the conglomerate shows 55 per cent quartz and chert fragments, 25 per cent potassic and plagioclase feldspars, in about equal amounts, and 10 per cent altered biotite and ferromagnesian minerals. The matrix consists of finely-shredded mica flakes, and iron oxide.

Intermediate and basic dykes, or sills, occur here and there in the series, but these are not abundant. Some are best described as lamprophyres, with biotite phenocrysts up to 3 millimeters in diameter. Others consist of 60 per cent euhedral plagioclase (An_{55}), 20 per cent epidote, 10 per cent magnetite and pyrite, and 5 per cent biotite and calcite accompanying the epidote. Some amygdaloidal diabase masses, which were found toward the top of the series, may belong to volcanic flows.

Fracture cleavage is strongly developed almost throughout the series. Within three-quarters of a mile of the Silurian volcanics, the cleavage gradually diminishes and the bedding becomes more clearly developed. The rocks of this zone are not much different from the Silurian shales and siltstones to the north, and it may be that a portion of the rocks assigned to the Fortin series perhaps should be included with the Silurian.

The Fortin series occupies too little of the present area to allow a full account of its structural features. The information at hand suggests that part of the folding developed at an incompetent stage.

Correlation

No identifiable fossils were found in the rocks assigned to the Fortin series, although comminuted plant fragments and carbonaceous markings were noted on the East branch of Jonathan brook, one-half mile south of the Silurian volcanics.

The rocks are correlated with the Fortin series of eastern Gaspé on the basis of lithology, lateral continuity, and identity of structural relationships. Here, the age of the series was established as Grande Grève or York River (McGerrigle, 1950, p. 77).

Volcanic Rocks

The zone between the Grande Grève and the York River formations is occupied almost everywhere in the area by a sequence or predominantly basic lavas. This zone corresponds in stratigraphic position mainly to the York Lake facies, but lavas interbedded with sedimentary rocks can be found from upper Grande Grève to lower York River. Those within the Grande Grève formation have already been described. The volcanics considered here form a stratigraphic unit in the northern third of the area.

These rocks strike into the area from the southwest, near Miner brook. They form a continuous, rugged ridge which extends to the northern boundary of the area following the curving trend of the adjacent rock formations. There, the belt forks or separates and continues as two bands around the Federal Mine dome. The (southern) band reappears in the area near the North Branch of Berry Mountain brook. It forms a wedge terminating southward almost at the Big Berry Mountains escarpment. Rocks tentatively correlated with the present volcanics form the core of the eastern end of the Big Berry Mountains. The latter band continues eastward for several miles outside the area (McGerrigle, MS., 1946, and Map No. 1000).

The lavas are particularly well exposed on the west flank of Conical mountain, a name given by Logan (1844) to a landmark located immediately north of Miner brook, near the western boundary of the area. At Conical mountain, a vertical section of 50 feet shows greenish, fine- to medium-grained diabase at the top, followed below by 10 to 20 feet of darker and less green diabase with scattered amygdules of calcite. This in turn is followed downward by greenish grey diabase, less amygdaloidal than that above, and containing numerous reticulating lines of calcite. In another cliff, small, angular fragments of volcanic material are enclosed in a soft, fragmental matrix, along with rounded to angular, lighter-coloured volcanics up to two feet across.

Along Miner brook, immediately upstream from the mouth of the brook west of Conical mountain, basic rocks are associated with thinly-bedded limestones. The rocks of this zone do not differ essentially from the basic volcanics described above. Diabase and olivine basalt are present. The diabase consists of augite penetrated by calcic plagioclase (An_{50}) with about 30 per cent chlorite, biotite, and magnetite. Limestones in contact with the diabase are baked, and blocks of limestone appear to be engulfed in the diabase. The olivine basalt is slightly amygdaloidal and contains rounded fragments of fine-grained, intermediate volcanic material having a large amount of feldspar and calcite. The relationships between these rocks and the limestones are not clear, but they could represent feeders to the overlying volcanic belt.

Most of the types of rocks included in the present volcanic belt were described extensively by Mailhiot (1919, p. 134), Alcock (1926, pp. 45-47), and Jones (1930, pp. 13-16), and their descriptions need not be repeated here. The rocks are predominantly amygdaloidal andesites, basalts, olivine basalts, and andesite porphyries. Individual flows are rarely detectable and pillow-lavas are scarce.

In addition to the above, acidic to basic tuffs are common toward the base of the volcanic belt north, west, and south of Berry Mountain lake. Also, volcanic breccias were seen along the road leading to Berry Mountain lake, and along Berry Mountain brook.

The belt under discussion appears remarkably homogeneous in composition and texture, which suggests the presence of some intrusive phases. In the section along Miner brook, the volcanics are approximately 2,000 feet thick. The zone either reaches a far greater thickness east of Berry Mountain brook (North branch), or else it is considerably folded, for it occupies a surface width of nearly 5 miles across the strike.

The volcanic rocks which form the core of the eastern end of the Big Berry Mountains escarpment are more acidic than the volcanics to the north. Andesite and diabase are present, but no basalt or olivine basalt was found. The predominant types of rocks are dacite and porphyritic rhyolite. The rocks are generally fine-grained to aphanitic; trachytic texture may be observed in some of the thin sections. Volcanic breccias, agglomerates, and tuffs are abundant throughout the belt, especially toward the base. Flow lines and vesicles filled with chalcedony occur at several places.

LOWER OR MIDDLE DEVONIAN

York River Formation

General Description

The first mention of the York River formation, as now defined (and the overlying Battery Point formation as well), is found in Geology of Quebec (Dresser and Denis, 1944, p. 299). Prior to Jones' and McGerrigle's work in eastern Gaspé, the rocks of this age were referred to as the Gaspé Sandstones, although Logan listed fossils from the "sandstones of the York River" and from the "York River beds". Williams (1910, pp. 688-698) defined the "York River beds" as the basal, calcareous, marine, fossiliferous beds of the Gaspé Sandstones, which includes a thickness of some 2,500 feet. McGerrigle (1950, p. 78) included in the York River formation "all rocks in the section having the same lithology as the general series of "York River beds". As now defined, the formation reaches a maximum thickness of 5,000 feet in the York River syncline of eastern Gaspé. It contains greenish-grey, medium- to fine-grained, feldspathic sandstones, with numerous interbeds and lenses of greenish-grey shale up to 100 feet thick. The sandstones of the York River formation may be distinguished from the sandstones of the overlying Battery Point formation by several lithological features, among which the feldspar content is the most diagnostic. The feldspars of the York River sandstones are grey, whereas those of the Battery Point sandstones are brown, pink, or flesh.

A considerable portion of the rocks exposed in the Richard-Gravier area shows the same lithological characteristics as the York River formation of eastern Gaspé. These rocks form two belts, one on each limb of the Berry Mountain syncline. The southern belt is very similar to the typical York River. Greenish-grey, medium- to fine-grained, feldspathic sandstones are interbedded with brownish-grey siltstones and greenish-grey shales in approximate ratio 7:2:1. All these rocks are commonly slightly calcareous. Massive beds of medium-grained sandstone, generally less than 8 inches thick, become progressively more common and thicker toward the top of the sequence, where they grade into a Battery Point-type of sandstone.

The belt of the northern limb of the Berry Mountain syncline is correlated with the York River formation largely on the basis of its stratigraphic position, inasmuch as only part of it has a York River lithology. In the section along Miner brook, the formation is approximately 2,000 feet thick and overlies a volcanic sequence. In the section along the Salmon Branch, and west of Berry Mountain lake, York River beds occur also below the volcanic sequence.

The part of the York River formation stratigraphically above the volcanics exhibits a variety of rock types. From the Salmon Branch eastward, the lower 500 feet of this section is made up of sandstones of the Battery Point type. Some beds contain scattered pebbles of brown shale and sandstone. Near the top of this zone, on the Salmon Branch 1,500 feet downstream from the mouth of Nine-mile brook, there is a bed 2 to 3 feet thick of conglomerate. The well-rounded pebbles are less than one inch in diameter and are made up of fine-grained, dark green shale, greenish grey sandstone, and dark grey, brownish-weathering, somewhat shaly to silty limestone. Small cubes of galena are scattered through the sandy matrix. The pebble conglomerate is overlain by beds of red to brown, fine- to medium-grained sandstones and grey to greenish grey sandstones. The upper 500 feet of the formation consists of grey to brown, fine-grained, commonly calcareous sandstones, with some interbeds of light grey, silty to sandy, crystalline limestone. The portion of the York River formation above the pebble conglomerate is very similar lithologically to some of the beds found along the upper Lake Branch, which will be discussed below.

Along the Salmon Branch, the part of the York River formation below the volcanics was estimated by McGerrigle (1950, MS.) to be about 1,500 feet thick. West of Berry Mountain lake, at the same stratigraphic level, the formation may reach a thickness of 2,500 feet.

On the southern limb of the Berry Mountain syncline, the formation reaches an unprecedented thickness, 10,000 feet or more, for a geological formation in Gaspé peninaula. Reconstructed cross-sections, made with careful analysis of the dips in relation to the width of the belt, indicate a thickness of 12,000 feet near the Cascapédia river. It is possible that repetition of beds by faulting partly accounts for the high value of the above estimates. However, no indication of faulting was seen west of the Cascapédia river. Moreover, strikes and dips are uniform throughout the belt. Consequently, it seems reasonable to assign a thickness of 10,000 feet to the York River formation in this southern belt.

Crossbedding on a large scale, and ripple-marks, occur sporadically in the southern belt. Graded bedding is rare. Crossbedding on a small scale and ripple-marks are common in the rocks of the northern belt, particularly in the eastern half of the area. In this same general location, plant remains and poorly preserved mollusks show, here and there, a preferred orientation. The current direction, as inferred from the orientation of fossils, crossbedding, and ripple-marks, was southwesterly.

Petrography

The York River formation, both in some parts of eastern Gaspé and in the Richard-Gravier map-area, may contain up tp 35 per cent interbedded shales and siltstones. In this study, the medium- to fine-grained sandstones were given most attention. Three thin sections of siltstone show that these rocks do not differ in composition from the sandstone. However, in the siltstone, the amount of the detrital component may be more variable than in the medium- to fine-grained sandstones. Depending upon the amount of calcite in the matrix, and the degree of alteration of the ferromagnesian minerals, the York River sandstone may vary considerably in texture and colour. Therefore, it is difficult to define a typical York River sandstone.

The percentages of the various components of the sandstones was determined in four thin sections by the Rosiwal method with an integrating stage. The results are shown in Table 1, and they are regrouped under different headings in Table 2 for comparison with Krynine's sandstone triangle in Figure 2.

Table 1.- Percentages of the Components of the York River Sandstones; Rosiwal Method

Sample	Components						
No.	Quartz	Potassic Feldspars	Plagio-clase	Chert and Acidic Volcanics	Others	Matrix	Total
8	25	26	9	9	11	20	100
9	27	15	10	7	28	13	100
10	25	22	8	17	11	17	100
11	28	21	9	6	24	12	100

Sample No. 8 - From the south bank of the St. John river, 1½ miles east of Little Fork brook (eastern Gaspé).

Sample No. 9 - From d'Argent brook, ½ mile upstream from the junction of the brook with the York river (eastern Gaspé).

Sample No. 10 - From outcrops along the Federal Mine road, 2,000 feet above the base of the formation.

Sample No. 11 - From Berry Mountain brook (East branch).

Table 2.- Percentages of the Components of the York River Sandstones; Rosiwal Method (For comparison with Figure 2)

Sample	Components			
No.	Quartz and Chert	Micas and Chlorite	Feldspar and Kaolin	Total
8	46	14	40	100
9	44	20.5	35.5	100
10	48	16	36	100
11	43	20	37	100

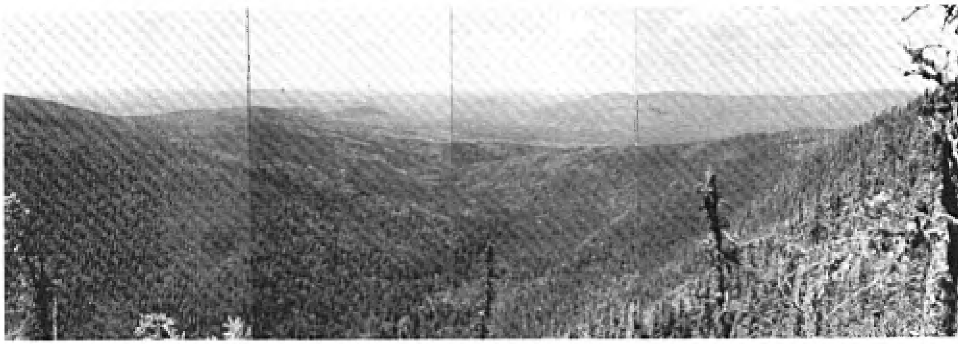
The valley of Cascapédia river where it cuts through Big Berry Mountains. Looking northwest.

Plate 1

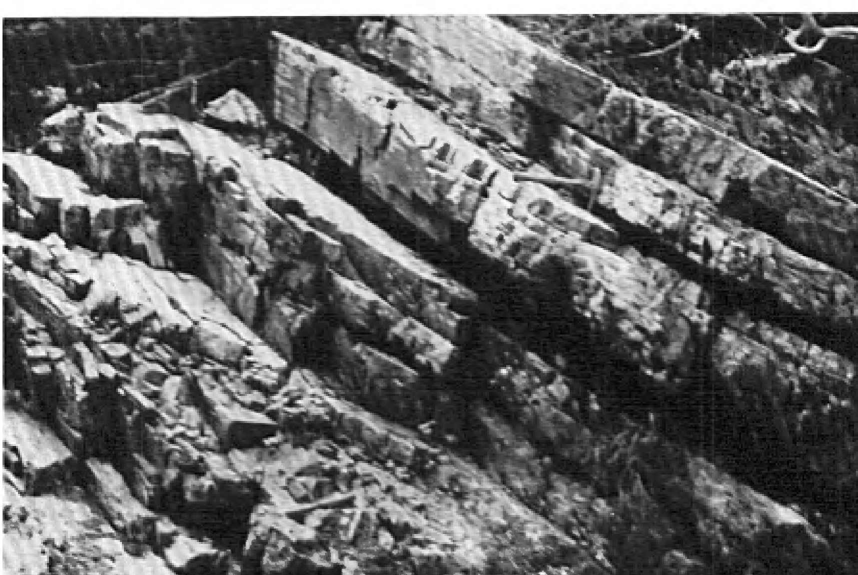
The western portion of the Big Berry Mountains escarpment. Looking west from Mount Noble.

Plate 11

Plate III



A - The Square Forks Lake depression. Looking northwest down the valley of Otter brook.



B - Green Silurian shales, dipping southward, West Branch of Jonathan brook, one mile upstream from the Bonaventure-Matapédia county line.

Plate IV

A – Monograptus nilssoni (Barrande) X2.5. The hooked theca is apparently due to preservation. (Photograph courtesy of L.M. Cumming, Geological Survey of Canada).

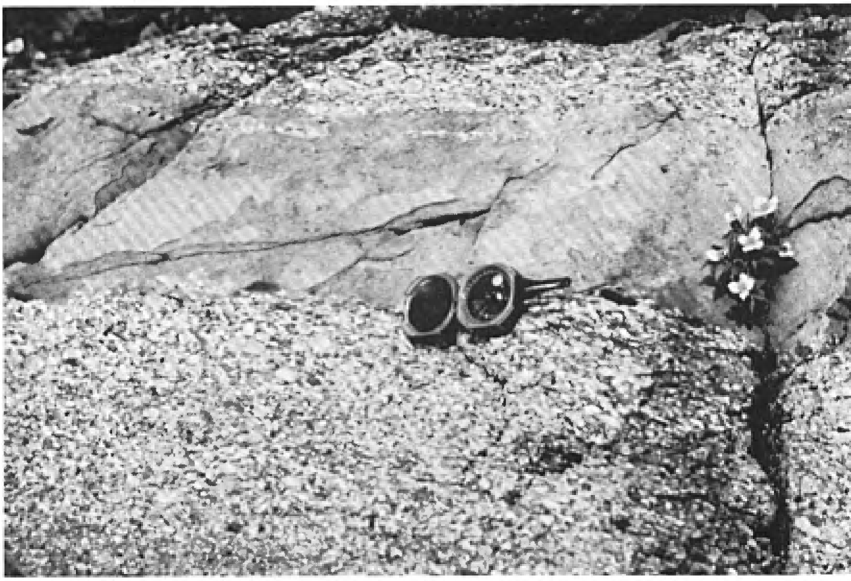
B – Basaltic blocks in Silurian fragmental volcanics. East bank of Cascapédia river, near mouth of Charles Vallée brook.

Plate V

A - Boulder of volcanic breccia. East branch of Jonathan brook.

B - Limestone beds of the Fortin series with widely spaced fracture cleavage, leading to solution channels.

Plate VI



A - Interbedded sandstone and fine-pebble conglomerate in the Fortin series. Jonathan brook, at the southern edge of the area.

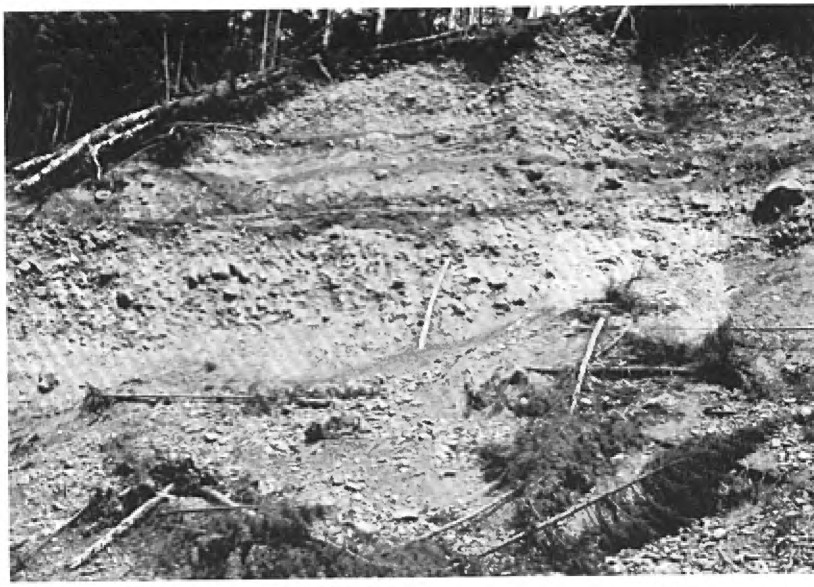
B - Thick, green beds in the Lake Branch formation. Lake Branch, two miles east of western edge of area.

Plate VII

A – Green sandstones interbedded with red sandstones (top and bottom). Lake Branch formation. Berry Mountain brook, East branch.

B – Cut-and-fill structure in Battery Point sandstone. Indian Falls brook, two miles above mouth.

Plate VIII



A - Typical unconsolidated material in the lower parts of the Cascapedia and Lake Branch. Indian Falls brook.

B - Drag fold in Silurian beds near a volcanic zone. West Branch of Jonathan brook.

In some thin sections, fresh or altered biotite may compose up to 20 per cent of the rock. Generally, the York River appears richer in biotite and decomposed ferromagnesian minerals than does the Battery Point. Six thin sections each contain up to 10 per cent fresh and altered volcanic fragments.

Calcite is present in the matrix of nearly one-half of the samples. It commonly replaces the feldspars and, in some cases, forms up to 20 per cent of the total composition. Secondary quartz is a common cementing material.

As shown in Figure 2, the York River sandstones fall near the boundary between arkoses and greywackes. However, owing to the presence of chlorite and micas in the matrix of most of the specimens, these sandstones would be more correctly considered as greywackes.

The lithological characteristics of the York River sandstones are very similar to those of the Battery Point, which will be described more fully below.

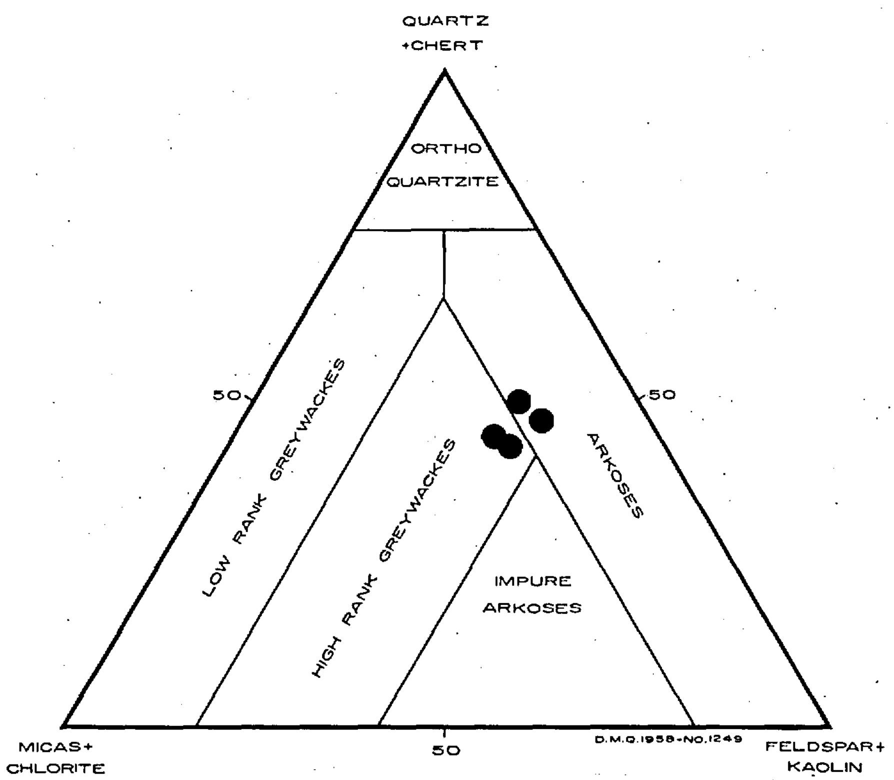


Figure 2 - Location of York River sandstones in the sandstone triangle of Krynine (1948, p. 137).

Correlation

In the portion of the area mapped by McGerrigle (Fig. 1), fossils were found in beds at four localities assigned to the York River formation. Two of the exposures are along Indian brook, one near the top of the formation and the other about 1,000 feet below the top. The former includes some poorly preserved corals: Favosites? sp., Cystiphyllum sp., Zaphrentis sp., as well as Leptocoelia flabellites (Conrad); the latter contains a poorly preserved Rensselaeria sp. Along Go-Ashore brook, a horizon near the middle of the formation yielded Rensselaeria atlantica Clarke, Leptodomus cf. communis Clarke, Paleoneilo sp., and some unidentifiable pelecypods representative of two or three species. This horizon is notable for the number of pelecypods present. A fourth collection, also from a horizon near the middle of the formation, along Miner brook, includes Coelidium sp., Kionoceras rhysum Clarke, and Cypricardinia distincta Billings. Judging from these fossils alone, without knowledge of their stratigraphic position, the formation could be correlated as well with the Grande Grève as with the York River; the fossils suggest a Lower Devonian (Oriskany) age.

Jones (1930, p. 19) collected the following fossils from the "finer-phase of the lower division", i.e. the York River formation, in the Berry Mountain map-area: Edmondia?, Edmondia sp., Goniophora tethys? Billings, Modiomorpha sp., Lingula rectilatera Hall, Stropheodonta cf. schuchertana Clarke, Spirifer gaspensis Billings, Aviculopecten? sp., Favosites heldergergiae Hall, Cyrtina sp., Rensselaeria cf., atlantica Clarke, Spirifer cf. concinnus Hall, Spirifer sp.

E.M. Kindle, who identified the fossils for Jones, concluded that the fauna belonged to a period of transition between the Lower and Middle Devonian.

In the same area, where the road to Brandy brook turns sharply northeast to follow the east bank of the brook, the writer found a few forms not previously mentioned. The fossils occur in a coarsely crystalline, light grey, arenaceous limestone. Fossils are found also in the overlying calcareous, green, fine-grained sandstones. The collection includes Spirifer arenosus (Conrad), Spirifer murchisoni Castelnau, Schuchertella sp., Heliophyllum halli (Edwards and Haime), Syringopora sp., Trachytoechus moniliformis Fritz, and Cladopora sp.

The spirifers of the present collection are found also in the Grande Grève formation of eastern Gaspé and in the Oriskany of New York, Maryland, and New Jersey. Heliophyllum halli (E. and H.) occurs in very abundant varieties in the Onondaga of Ontario, Ohio, Michigan, and Kentucky. It is also of widespread occurrence in Middle Devonian rocks of these and other localities.

Trachytoechus moniliformis Fritz is a species peculiar to this area

(Fritz, 1944, pp. 35-37). It is even possible that the holotype comes from the present locality. When Trachytoechus moniliformis was described, the genus had not been reported from rocks other than Middle Devonian, and this was taken as indicating a Middle Devonian (Onondaga-Traverse) age, for the formation. However, later Fritz (1951, p. 27) described the same genus from the Helderberg formation of New York. In summary, then, the spirifers of the present locality indicate an Oriskany age, Heliophyllum halli (E. and H.) indicates an Onondaga-Traverse age, and the few other forms are less diagnostic.

Three other lots of fossils were collected from beds assigned to the York River formation, in the section along Berry Mountain brook (East branch) and along one tributary to Berry Mountain brook. The first lot, near the top of the formation, yielded Leptodomus communis Clarke, Paleoneilo sp. cf. marylandica Prosser, Panenka sp. nov., Lingula sp., Orbiculoidea sp. nov.?, Orthonota sp., Kionoceras? sp. The collection from a tributary to Berry Mountain brook contains Globithyris callida (Clarke), several unidentifiable pelecypods and gastropods, Psylophyton princeps Dawson, and other poorly preserved plant fragments.

The York River formation on the south limb of the Berry Mountain syncline has yielded only one fossil locality, although fossiliferous debris is common. This locality is toward the middle of the formation, at the head of Charles Vallée brook, and yielded Spirifer gaspensis Billings, Mendathyris mainensis (Williams) (Rensselaeria atlantica), Sphenotus? truncatus (Conrad), Goniophora sp., Actinopteria communis (Hall), Paleoneilo maxima (Conrad), Paleoneilo sp., Pterinea edmundi Clarke, Leptodomus communis Clarke, "Cyrtoceras" sp.

Actinopteria communis (Hall) indicates a Lower Devonian age, whereas Paleoneilo maxima (Conrad) occurs in the Hamilton formation of New York and Maryland. The other forms are not diagnostic.

Lake Branch Formation

General Description

The term "Lake Branch formation" was introduced by McGerrigle (1950,MS.) to apply to an extensive lens of red sandstones and shales located in the northern third of the area. The formation derives its name from the Lake Branch of the Cascapédia river. There is no type section for the formation, as the continuity of exposures is limited. Scattered exposures of the formation can be seen along the Lake Branch, the Salmon Branch, Miner brook, Go-Ashore brook, Brandy brook and Berry Mountain brook.

The predominant colour of the rocks is brown to dull and bright red.

Green streaks and spots are common in some exposures. The formation is well bedded; but so poorly consolidated that it crumbles very easily under the effects of weathering. Along the Salmon Branch, shales are interbedded with fine-grained, argillaceous sandstones and siltstones. On Go-Ashore brook, the rocks are medium- to fine-grained sandstones. Along Brandy brook, there are shales, mudstones, and argillaceous, laminated siltstones. These three sections are near the bottom of the formation.

Toward the top of the formation, along the Lake Branch, shales and fine-grained sandstones are interbedded in about equal amounts. Here and there, beds of medium-grained sandstones are present.

Throughout the formation, the beds rarely exceed two feet in thickness. In some exposures, fine- to medium-grained sandstones occur in layers one inch thick, separated by thinner layers of red shale. Crossbedding in the sandstone and siltstone, and mud-cracks in the shale, are common features, as are ripple-marks of both current and wave types. Plant fragments, and features suggestive of rain imprints and rill marks, as well as worm borings, occur here and there on some of the bedding planes.

The formation, at places, grades into the underlying York River formation through a transition zone of nearly 400 feet. Here, the red beds are interbedded with light green beds of about the same composition and texture.

Consideration of lithology only would lead one to consider the section along the upper Lake Branch as part of a formation distinct from the Lake Branch formation. However, this section, 3,000 feet thick, is at the same horizon as the Lake Branch formation. The rocks are green, medium-grained, hard, calcareous sandstones (Pl. VI-B) in beds up to 2 feet thick, interbedded with laminated, dark grey siltstones and shales, and with red sandstones and shales of Lake Branch type. The red beds constitute less than 30 per cent of the section. Toward the base of the section, there are some beds of medium-grained, greenish grey to dark green sandstone containing abundant pink feldspars, and, therefore, very similar to the Battery Point sandstones. Marine or brackish water invertebrates were found at several localities in this section, suggesting that these rocks belong to a near-shore facies where marine and fresh water conditions alternately occurred.

The part of the York River formation which crosses Berry Mountain brook (East branch) is made up of a succession of beds very similar to those described above. Interbedded green and red sandstones also occur. The red sandstones are generally more argillaceous, and crumble more readily than the green, slightly calcareous sandstones (Pl. VII-A).

Structurally, the Lake Branch formation dips gently southward on the north limb of the Berry Mountain syncline. Minor faulting and drag folding occur in the section along Miner brook, but such features are rare. In the Berry Mountain map-area, Jones (1930, p. 23) assigned a thickness of 4,000 feet to the formation. McGerrigle (1950,MS.) estimated the thickness to be about 5,000 feet, but admitted to uncertainty as to the location of the upper contact.

Correlation

Plant fragments are the only fossils in the Lake Branch formation, and these are generally much comminuted. Along the upper Lake Branch river, the green calcareous sandstones, interbedded with the typical Lake Branch red beds, have yielded Globithyris callida (Clarke), Sphenotus truncatus (Conrad), and several other poorly preserved pelecypods. Globithyris callida (Clarke) is very abundant in some beds, and is persistently smaller than typical specimens of this species (20 mm. long, 17 mm. wide). In some beds, all the pelecypods are half the size of the typical species. Thus, these beds seem to contain a dwarf fauna. Globithyris callida (Clarke) is a Lower Devonian species, whereas Sphenotus truncatus (Conrad) is found in the Hamilton of New York, and in the York River formation of eastern Gaspé.

Petrography

The rocks of the Lake Branch formation show only minor differences with the Gaspé Sandstones. Lithologically and stratigraphically, the formation may be considered a red facies of the York River formation. Only two thin sections of typical Lake Branch rocks were examined and they show the same minerals as thin sections from the York River formation, with a slightly larger percentage of limonite. The iron-rich minerals in the Lake Branch formation are more extensively decomposed than those of the Gaspé Sandstones, and these could have made an important contribution of limonite.

The greenish grey sandstone along the upper part of the Lake Branch, and mapped with the Lake Branch formation in view of their stratigraphic position, contain a higher percentage (20 per cent) of calcite than average Gaspé Sandstones. One Rosiwal analysis of a typical bed showed 34 per cent quartz, 15 per cent potassic feldspars, 15 per cent plagioclase, 3 per cent chert or acid volcanics, 24 per cent matrix, and 9 per cent biotite, muscovite, lava fragments, and decomposed ferromagnesian minerals. The matrix is made up of detrital quartz, altered feldspars, chloritic clayey "paste", and calcite.

Volcanic Rocks

A small lens of acidic and basic lavas forms part of the Big Berry Mountains escarpment in the western half of the area. The lens is 5 miles long, about 2,000 feet thick, and located along the contact between the Lake Branch and Battery Point formations. The rocks in the eastern part of the lens are predominantly acidic; in the western part, they are basic. Individual flows could not be distinguished.

The acidic rocks are hard, very fine-grained, porphyritic rhyolite. They vary in colour from light green to grey, pink or red, owing to the orthoclase phenocrysts. At places, there are amygdules containing quartz and chalcedony, vesicles, small lumps and stringers of quartz, and rare, very finely textured flow lines. Thinly bedded, acidic tuffs and volcanic breccias were found in the central portion of the lens.

The acidic rocks of the present belt were given a closer study than the other igneous rocks in the area as disseminated, sub-microscopic flakes and grains of chalcopyrite were found in one of the outcrops. The main rock type is essentially a feldspar porphyry. The groundmass appears as an aggregate of cryptocrystalline quartz and microlites of feldspars. Two thin sections show rosettes of chalcedony. The phenocrysts consist mainly of albite, with potassic feldspars in lesser amount and some quartz. The feldspar phenocrysts are fractured and crushed; some have been extensively altered to sericite.

The quartz "phenocrysts" are apparently largely the result of recrystallization of the groundmass, or were produced through the introduction of later silica. This is indicated by secondary growth rings, and connection of the "phenocrysts" with openings filled with quartz showing comb structure.

In the six thin sections studied, approximately 20 per cent of the quartz appears to be secondary. This quartz is clear, well crystallized, and can be identified easily, whereas that of the matrix is poorly visible. Fractures in the matrix and the feldspar phenocrysts are filled with secondary quartz. Here and there, thin bands of muscovite and semi-opaque minerals line the walls of fractures, and these, along with quartz veinlets, form microscopic banding. Pseudomorphs of quartz after feldspar commonly contain "booklets" of sericite. Some microscopic, rounded cavities contain radiating crystals of quartz.

In addition to the phenocrysts of quartz and feldspar, small crystals of apatite and zircon are scattered sparingly throughout the groundmass. The semi-opaque minerals and stains, which possibly contain chalcopyrite, constitute a very small portion of the total groundmass. They appear to be related genetically to the secondary quartz, for they commonly accompany druses, vesicles filled with clear quartz, and quartz-filled channels leading to aggregates of clear quartz crystals. They bear the same relationships to the muscovite. These semi-opaque minerals occur in slightly larger amounts in specimens from the eastern portion of the igneous mass.

The basic part of the volcanic lens corresponds to a diabase in composition and texture. The rocks are fine-grained, commonly amygdaloidal and, in places, porphyritic. A porphyritic phase contains phenocrysts of plagioclase (An_{40}) up to a quarter of an inch long.

Calcareous tuffs and shales, in beds 8 inches thick, were noted near the acidic portion of the lens. At another locality, fine-grained, clastic tuffs, in layers 2 inches thick, are interbedded with a sedimentary breccia in beds up to 8 inches thick. The sedimentary breccia is made up of 60 per cent diabase fragments, basaltic glass, and basaltic tuff, set in a matrix of quartz (20 per cent), feldspar (10 per cent), and finely comminuted and decomposed igneous material. The granules of volcanic material are up to one centimeter, but generally less than 3 millimeters, in diameter.

Battery Point Formation

General Description

The section of Tar Point, in eastern Gaspé, measured by Logan (1863, p. 416) and named by him the Gaspé Sandstones, is made up almost entirely of the Battery Point formation. Only the uppermost beds of the York River formation appear on the nose of the Tar Point anticline, and the rest of the section (7,036 feet) southward is made up of Battery Point beds. The type section is at Battery Point "where Battery Park hotel stands, shortly outside of Gaspé village, and from the point westerly along the south shore of Gaspé basin for upwards of one mile" (McGerrigle, 1950, p. 84).

In eastern Gaspé, the formation consists of medium to light greenish-grey sandstones varying in grain size from fine to very coarse. Some beds are pebble conglomerates. The pebbles, generally well-rounded and less than one-half of an inch in diameter, are composed of quartz, jasper, chert, quartzite, volcanic material and, here and there, reddish granite and syenite. Individual beds may be up to 15 feet thick. Crossbedding is a common feature. Red sandstones, shales and conglomerates occur toward the top of the Battery Point formation at Pointe St. Pierre. Ripple-marks, mud-cracks, crossbedding, and rare rain imprints were observed in these red beds (McGerrigle,1950, p. 85).

The Battery Point formation differs from the York River formation in its generally coarser and more angular grains, in its pink rather than grey feldspars, in being less shaly, more pebbly, and more sharply crossbedded.

The description of the Battery Point formation given above applies to 80 per cent of the rock shown as Battery Point in the Richard-Gravier map-area.

Major crossbedding is common, and cut-and-fill structures were observed at two localities (Pl. VII-B). The sandstones appear homogeneous throughout, and bedding is difficult to discern. Jones (1930, p. 22) noted the presence of fine-grained, brown sandstones and chocolate-brown shales in the formation at a few places.

Along the west bank of Cascapédia river, approximately 2,000 feet downstream from the mouth of Square Forks river, green and brown shales, in layers 8 inches thick, are interbedded with medium-grained, green sandstone in beds 8 feet thick. Although none of these beds contain pink feldspars, they are included in the Battery Point formation inasmuch as definite Battery Point beds occur stratigraphically lower along nearby brooks. No other brown or red beds were seen in the area at this general stratigraphic level. However, south and east of the mouth of Otter brook, the distribution of abundant debris suggests that here, also, red beds are interbedded with the green sandstones.

In the southwest corner of the area, the distribution of the debris, along with a few scattered exposures, indicate that the underlying bedrock is composed mainly of red sandstones, siltstones, conglomerates, and shales, in order of decreasing abundance. These red beds occur at the top of the Battery Point sequence, a position identical to that of the red beds of the Battery Point formation in eastern Gaspé.

Along the upper Lake Branch, the stratigraphic interval corresponding to that of the Battery Point formation is occupied by medium- to fine-grained, light greenish grey, calcareous sandstones interbedded with dark green, well-bedded sandstones and siltstones. Some beds of argillaceous limestone are also present. Upstream, and near the base of the section, several beds of red, purple, and green sandstones and shales occur with the dark green sandstones. Some poorly preserved corals were found in the calcareous sandstones at the point where the upper Lake Branch turns sharply north toward Huard lake (McGerrigle's collection).

In the eastern half of the area, where faulting apparently has not greatly disturbed the sequence of beds, the formation reaches an apparent thickness of 10,000 feet. This figure, added to the 10,000 feet of York River beds, represents a considerable thickness for a single series of rocks in a restricted region. In the western half of the area, the Battery Point formation is too poorly exposed to allow an estimate of its thickness.

Petrography

The Battery Point formation consists of about 80 per cent sandstones of various grain sizes and 20 per cent interbedded shales. The sandstones are made up of "igneous quartz", vein quartz, quartzite, siltstone, mica schists, acidic and basic volcanics, chert, potassic feldspars, perthite, plagioclase, micas, and iron oxides.

Calcite, in one occurrence, makes up to 20 per cent of the cementing material, but generally calcite is found only in traces, and several thin sections do not contain any. Commonly, quartz crystals are "welded" together with apparently no addition of binding material. Secondary quartz generally contributes up to 30 per cent of the matrix. This "secondary" quartz might have been deposited contemporaneously with the other components, or it might have been derived from quartz detritals. There is no evidence that silica was introduced later.

The remaining portion of the matrix is made up of a mixture of chlorite, biotite, muscovite, quartz, comminuted minerals (clay), and iron oxides. In several thin sections, chlorite appears to be the only binding material; some of it is ingrown with secondary quartz. Opal is very rare.

The above description applies to all the thin sections studied. Only the relative proportions of the individual components vary from one section to another. Specimens from the red beds of the Battery Point formation show the same characteristics. Limonite or the iron oxides were not found to be more abundant than in the typical sandstones.

The relative proportions of the various components of the sandstones were computed in four samples by the Delesse method, and in two others by the Rosiwal method. In order to compare the results with published diagrams, the computations were reworked along different lines. Quartz and chert, micas and chlorite, and feldspars and kaolin were grouped together, as shown in Table 3.

The results grouped according to the end-members concept were incorporated into the sandstone triangle of Krynine (1948, p. 137), (Fig. 3). Pettijohn (1949, p. 227) applies the term "greywacke" to Krynine's high rank greywacke, and "subgreywacke" to the low rank greywacke. In Figure 3, the six analyses of the Battery Point sandstones fall at or near the boundary between arkoses and high-rank greywackes. The estimated percentages of the components of several other specimens show also that their composition falls close to the same boundary, but generally on the greywacke side. The micas and chlorite never exceed 30 per cent of the total, whereas the feldspars generally show a tendency to increase at the expense of quartz and chert.

Table 3.- Percentages of the Components of Battery Point Sandstones (Delesse and Rosiwal methods combined)

Samples	Components			
No.	Quartz and Chert	Micas and Chlorite	Feldspar and Kaolin	Total
1	46.5	24.3	29.2	100
2	62.3	15.8	21.9	100
3	48.0	26.0	26.0	100
4	55.2	19.0	25.8	100
5	48.0	19.3	32.7	100
6	49.0	19.0	32.0	100
Total	309.0	123.4	167.6	600
Average	51.5	20.6	27.9	100
Average greywacke	0 to 75	20 to 80	20 to 42	
Average subgrey-wacke	0 to 80	20 to 100	0 to 20	
Average arkose	0 to 80	0 to 20	20 to 100	

Sample No. 1 - From type-section in eastern Gaspé, below Battery Park hotel.

Sample No. 2 - From present area, at headwaters of Indian Falls brook.

Sample No. 3 - From a point one mile southeast of Mount Noble.

Sample No. 4 - From Battery Point exposures along Otter brook.

Sample No. 5 - From Logan's type-section at L'Anse-à-Brillant.
Sample No. 6 - At Clarke-Gravier township line, near Square Forks river.

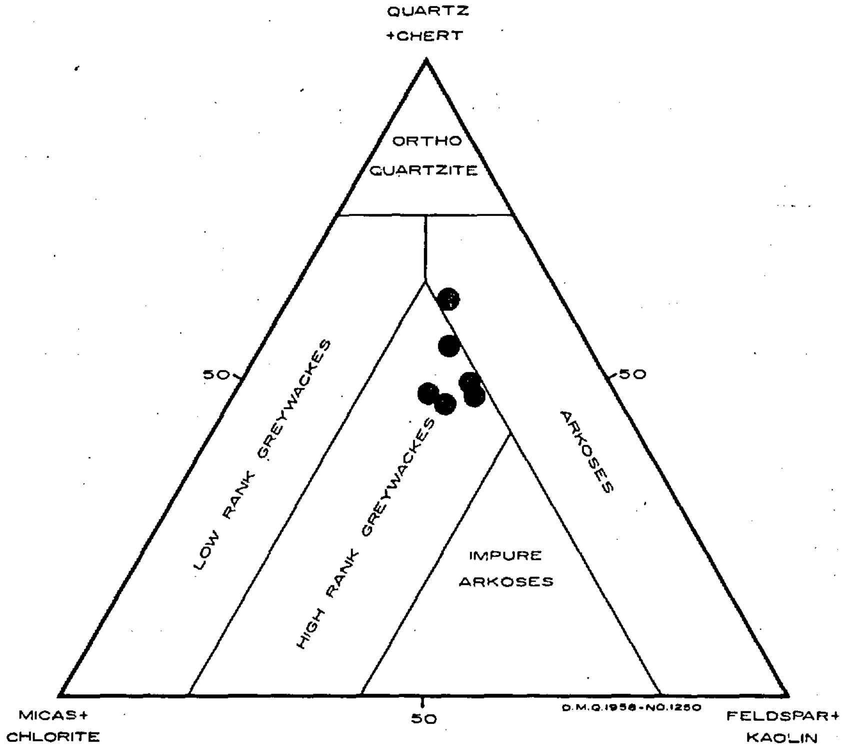


Figure 3 - Location of some Battery Point sandstones in the sandstone triangle of Krynine (1948, p. 137).

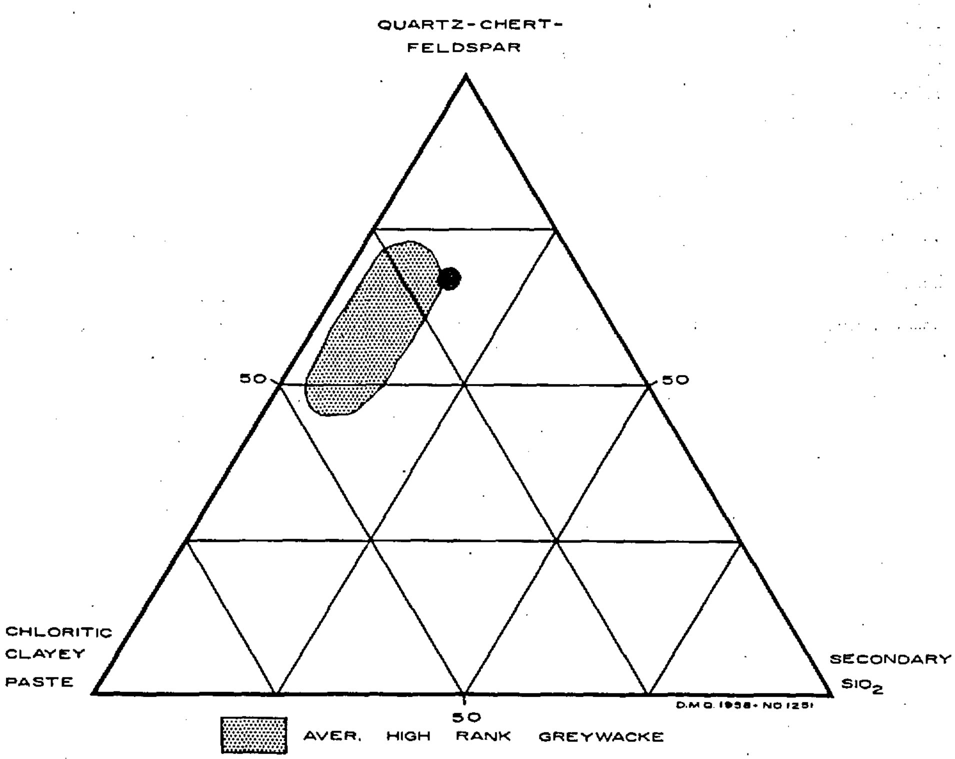


Figure 4 - Comparison of the average composition of some Battery Point sandstones with the composition of the average high rank greywacke (data from Krynine 1948, p. 150).

Figure 4 shows the comparison of the Battery Point sandstones with the average high rank greywacke. It can be seen that the Battery Point sandstones are not typical greywackes, but greywacke is the closest rock type to which they come.

The pink particles of the Battery Point sandstones are potassic feldspars and grains of jasper. The potassic feldspars of the York River sandstones, nearly twice as abundant as in the Battery Point, are grey. The plagioclase feldspars (An_5 to An_{30}) in both formations are grey, except for some rare albite fragments.

Heavy Mineral Analysis

A representative sampling of the heavy mineral content of the Gaspé Sandstones would require a very large number of analyses, in view of the thickness and the large areal distribution of the sandstones. Since there were no correlation problems involved, only a small number of samples were selected. The analyses were made to obtain a general knowledge of the characteristics of the source-area. Altogether, twenty heavy mineral residues were studied: ten for the Battery Point and ten for the York River.

Two Battery Point samples come from the type-section in eastern Gaspé, near the Battery Park hotel. One sample was collected from Logan's type section, one mile south of L'Anse-à-Brillant. The seven other samples come from the Richard-Gravier map-area.

The heavy mineral residues of the Battery Point sandstones contain 17 mineral species and 5 varieties. In order of abundance, these are garnet (2 varieties), magnetite, muscovite, biotite, chlorite, pyrite, ilmenite, zircon, tourmaline (3 varieties), rutile, sillimanite, titanite, kyanite, leucoxene, diopside, monazite, and fluorite.

Garnet (grossularite) is the most abundant and the most widespread heavy mineral of the Battery Point formation. It is largely a first-cycle mineral, as the edges of the crystals are worn very little. Some 5 per cent of the garnet found in the residues is very well-rounded and was probably derived from a sedimentary terrane.

Magnetite follows garnet in abundance. The other minerals combined make up less than 35 per cent of the residues.

The York River formation contains more garnet than the Battery Point. Magnetite, however, is predominant in a sample from D'Argent brook in eastern Gaspé. Colourless zircon of two or more depositional cycles appears more abundant in the York River formation than in the Battery Point. Two varieties of tourmaline were found: one, a dark yellow-brown one in sub-rounded prisms, like that in the Battery Point; the other, a nearly colourless (slight smoky tint) variety occurring in prisms and rounded grains. The colourless tourmaline seen in 6 samples appears to be confined to the York River formation. Apatite was found in two separations. Leucoxene, titanite, kyanite, monazite, and fluorite were not found. All other minerals or rock fragments found in the Battery Point are represented in the York River and in approximately the same amount. A sample from the quartz-rich beds of the north shore of Gaspé bay has a smaller amount of magnetite.

Environment of Deposition

The Battery Point formation is believed to be a piedmont deposit built at sea-level where littoral currents spread the sediments. The York River formation is assigned to an epineritic environment, that is, to that part of the neritic environment where the waters are agitated by normal waves and littoral currents. The Lake Branch formation is considered a deltaic deposit.

The source-area is believed to have been the Canadian Shield, particularly in view of the general composition and abundance of feldspars in the sandstones, and also inasmuch as the Lake Branch formation thins toward the south, as suggested in Fig. 5. In addition, the shale-limestone Fortin series, located farther south, appears to be an off-shore facies of the Gaspé Sandstones.

Correlation

The typical Battery Point beds are generally nearly unfossiliferous. Poorly preserved plant fragments and coal laminae occur here and there. The coal laminae, however, are much less abundant than in eastern Gaspé. A fish spine was found in the debris near the eastern boundary of the area, 2 miles south of Berry Mountain lake.

Along the upper Lake Branch, *Globithyris callida* (Clarke), *Leptodomus communis* (Clarke), *Sphenotus truncatus* (Conrad), and *Platyceras* sp. were collected from greenish grey, calcareous sandstones, in strike with typical Battery Point beds. This faunule is very similar to the one found in the Lake Branch formation, along the upper Lake Branch, and it has the same unsatisfactory correlation value.

General Correlation

A complete, composite list, including Jones', McGerrigle's, and the writer's collections, of Devonian fossils known in the Richard-Gravier map-area is presented in Table 4. The table shows that the Grande Grève formation of the present area contains 11 species reported from the Grande Grève formation of east-

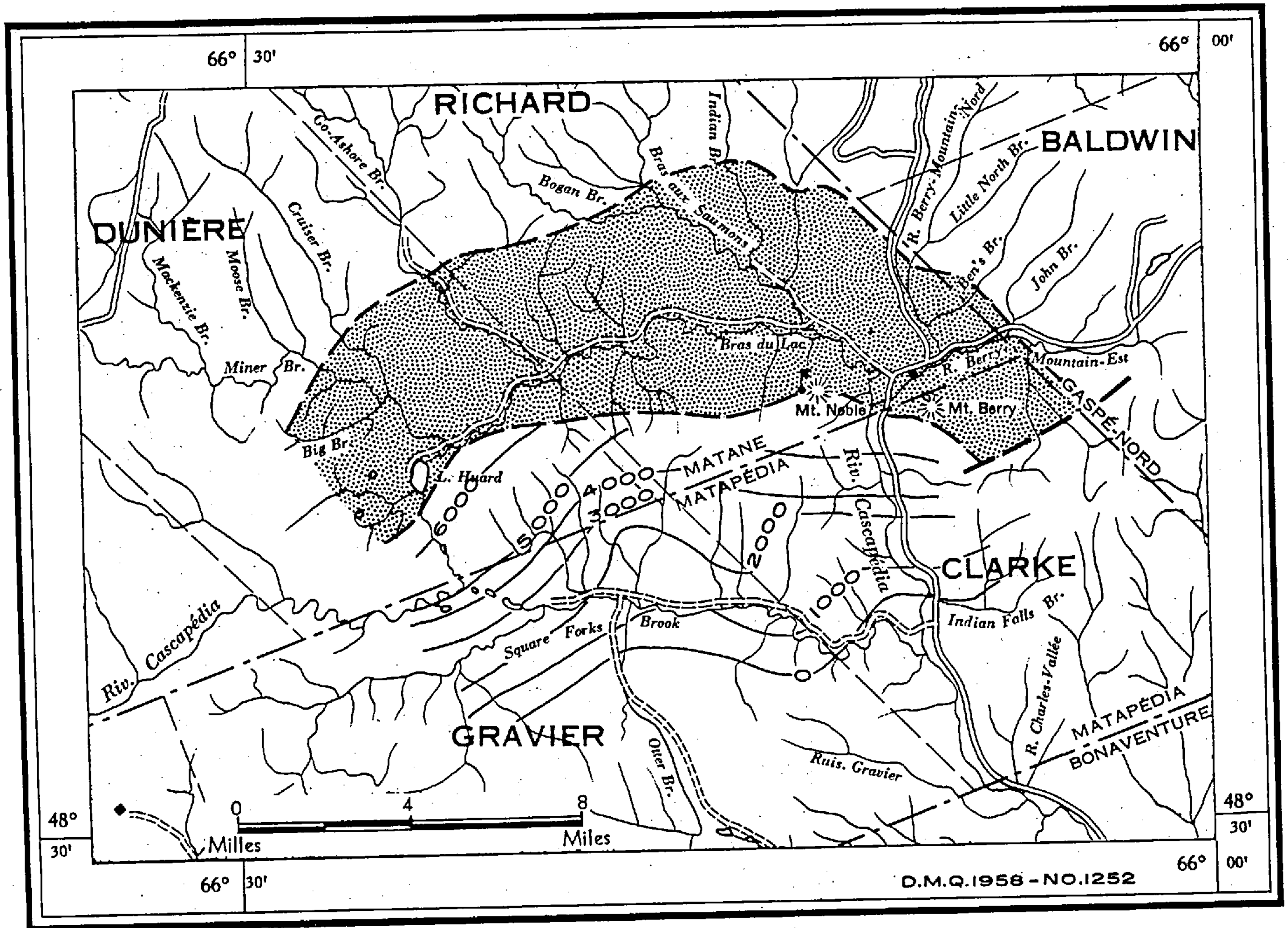


Figure 5 - Isopach map of a portion of the Lake Branch formation, assuming no faulting at the Big Berry Mountains escarpment.
Contour interval=1,000 feet. Shaded: area of exposure of the formation.

ern Gaspé or from the Oriskany of other regions. Two fairly well preserved species are Onondaga or Hamilton in age. However, the relative stratigraphic position of these two species is too uncertain to invalidate the evidence provided by the other 11 species. It appears, therefore, that the lithologically defined Grande Grève formation of the present area is correctly correlated with the Grande Grève formation of eastern Gaspé, and is Oriskany in age.

Table 4.- Composite List of Devonian Fossils
Collected in the Richard-Gravier Map-area
(Fossils assigned to the formations in which they were found)

X = identities
\- = affinities
J = Jones
M = McGerrigle
C = Carbonneau

		Grande Grève	Oriskany	Onondaga	Hamilton
GRANDE GREVE FORMATION:					
Emmonsia tuberosa				X C	X C
Heterophrentis prolifica Billings				X C	X C
Chonetes billingsi Clarke		X C			
C. hudsonicus gaspensis ? Clarke	C				
C. sp. nov.	M				
Chonostrophia complanata Hall		X M	X M		
C. dawsoni Billings			X M		
Leptaena rhomboidalis (Wilckens)		X M			
Meristella champlaini Clarke		X M			
Leptostrophia cf. magnifica (Hall)	C				
Orthotetes woolworthanus gaspensis Clarke		X M			
Protoleptostrophia blainvillii (Billings)		X C			
Spirifer arenosus (Conrad)		X C	X		
S. cyclopterus ? Hall	M				
S. gaspensis Billings			X M C		-M C
S. modestus nitidulus Clarke		X M			
S. murchisoni Castelnau		X C	X C		
Rhytistrophia beckii (Hall)		X C	X C		
Actinopteria sp.	C				
Dalmanites ? sp.	C				

(Continued)

		Grande Grève	Oris-kany	Onon-daga	Hamil-ton
YORK LAKE FORMATION:					
Algae ?	M				
Plant fragments	M				
Favosites sp.	M				
Zaphrentis sp.	M				
Chonetes hudsonicus gaspensis Clarke			X M		
Chonetes sp.	C				
Dalmanella lucia (Billings)		X M			
Eotomaria cf. *rotula* Clarke	M				
Etymothyris gaspensis (Clarke)		X C	- C		
(*Rensselaeria ovoides gaspensis*)					
Leptaena rhomboidalis (Wilckens)		X M			
Leptocoelia flabellites (Conrad)		X M	X M		
Leptostrophia sp.	C				
Orthotetes woolworthanus gaspensis Clarke		X M			
Prionorthis sp. or *Beachia* sp.			X C	X C	
Rensselaeria sp.	M				
Schuchertella woolworthana (Hall)	C				
Schuchertella sp.	C				
Spirifer arenosus Conrad		X M C	X M C		
S. gaspensis Billings			X M C		
Stropheodonta sp.	M				
Strophonella continens Clarke		X C			
Strophonella sp.	C				
Strophostylus cf. *expansus* Hall	M				
Lingula sp.	M				
Orbiculoidea sp.	C				
Platyceras tortuosum Hall		X M	X M		
P. cf. *leboutillieri* Clarke		X M			
Actinopteria sp.	M				
Cypricardinia sp.	M				
Grammysia sp.	M				
Paleoneilo sp. nov.	C				
Pterinea sp.	M				
Dalmanites whiteavsi Clarke	M				

(Continued)

		Grande Grève	Oris-kany	Onon-daga	Hamil-ton
Proetus sp.	C				
Crinoid stems	C				
YORK RIVER FORMATION:					
Heliophyllum halli (Edwards and Haime)				X C	X C
Cystiphyllum sp.	M				
Favosites helderbergiae Hall		X J	X J		
Favosites sp.	M				
Syringopora sp.	C				
Zaphrentis sp.	M				
Trachytoechus moniliformis Fritz				- C	- C
Cladopora sp.	C				
Cyrtina sp.	J				
Globithyris callida (Clarke)			X C		
Etymothyris gaspensis (Clarke)		X C	- C		
(*Rensselaeria ovoides gaspensis*)					
Edmondia ?	J				
Edmondia sp.	J				
Leptocoelia flabellites (Conrad)		X M	X M		
Mendathyris mainensis (Williams)			X J C		
(*Rensselaeria atlantica* Clarke)					
Prionorthis sp. or *Beachia* sp.			X C	X C	
Rensselaeria sp.	M				
Rhynchosphira formosa ? Hall		X C			
Schuchertella sp.	C				
Spirifer arenosus (Conrad)		X C	X C		
S. cf. *concinnus* Hall	J				
S. gaspensis Billings			X J C		
S. murchisoni Castelnau		X C	X C		
Stropheodonta cf. *schuchertana* Clarke	J				
Lingula rectilatera Hall		X J			
Lingula sp.	C				
Orbiculoidea sp.	C				
Orbiculoidea sp. nov.	C				
Actinopteria communis (Hall)			X C		

(Continued)

		Grande Grève	Oris- kany	Onon- daga	Hamil- ton
Anodontopsis sp.	C				
Aviculopecten sp.	J C				
Cypricardinia distincta Billings		X M			
Goniophora tethys ? Billings		X J C			
Leptodomus communis Clarke			X M C		
Macrodus sp.	C				
Modiomorpha sp.	J				
Mytilarca sp.	C				
Orthonota sp.	C				
Panenka sp. nov.	C				
Paleoneilo maxima (Conrad)					X C
P. cf. marylandica Prosser	C				
P. sp.	M				
Pterinea edmundi Clarke			X C		
Sphenotus truncatus (Conrad)					X C
Coelidium sp.	M				
"Cyrtoceras" sp.	C				
Kionoceras rhysum Clarke		X M			
Kionoceras ? sp.	C				
Annelid trails	J				
Coprolites	C				
LAKE BRANCH FORMATION:					
Globithyris callida (Clarke)			X C		
Sphenotus truncatus (Conrad)					X C
Plant fragments	C				
BATTERY POINT FORMATION:					
Globithyris callida (Clarke)			X C		
Leptodomus communis Clarke			X C		
Sphenotus truncatus (Conrad)					X C
Platyceras sp.	C				
Corals	M				
Plant fragments	C				
Fish spine	C				

The York Lake formation of the present area has yielded 10 species reported from the Grande Grève formation of eastern Gaspé and/or the Oriskany of other regions, and one genus common to the Oriskany and Onondaga of other regions. Therefore, the formation appears to be Oriskany in age. In the type area near York Lake, only the long-ranging species Leptaena rhomboidalis (Wilckens) was identified specifically (Jones, 1936, p. 18).

The York River formation of the present area contains 14 species of Grande Grève or Oriskany age, one genus common to the Oriskany and Onondaga, one species of coral common to the Onondaga and Hamilton, and two species of pelecypods of Hamilton age. Eight brachiopods, 4 pelecypods, 1 cephalopod, and 1 coral make up the 14 Grande Grève or Oriskany species. In eastern Gaspé, the brachiopods of the York River formation indicate an early Devonian age (Oriskany), whereas the mollusks are of Hamilton age. To reconcile the intermingling of these fossils, it has been suggested by various writers (1) that the brachiopods are part of a relict fauna inherited from Oriskany time; the pelecypods would thus have greater importance in assigning an age to the rocks. On this basis, the York River formation would be Hamilton in age.

In the present area, four pelecypods are Oriskany and two are Hamilton species. One coral is Oriskany and another Onondaga or Hamilton in age. The brachiopods are all Oriskany in age.

The writer is inclined to rely more on thickness comparisons and stratigraphic position than on conflicting paleontological data. The Grande Grève and York Lake formations seem definitely Oriskany in age. The York River formation partly grades laterally into and overlies the York Lake formation. Since there is no evidence of a hiatus above the York Lake, it is reasonable to assume that the lower part, at least, of the York River formation is either Oriskany or Onondaga in age, but not Hamilton. On the south limb of the Berry Mountain syncline, it is possible that York River beds take the place of the Grande Grève formation immediately above the Cape Bon Ami. A Hamilton age for the base of the York River, in the present area, would imply a considerable change in the conditions of sedimentation. If such a change or slackening took place, it failed to impress the rocks and to affect the shape of the stratigraphic units. Therefore, it appears that the stratigraphic relationships should have more importance than the incomplete and conflicting paleontological evidence in deciding the age of the York River formation. This being so, an Oriskany or Onondaga age for the lower part of the York River formation in this area is more acceptable than a Hamilton age.

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(1) McGerrigle (1950, pp. 87-91) gives a complete historical treatment and a review of the various opinions on the subject.

In view of their fossil contents, the Lake Branch and Battery Point formations could have been included in the above discussion and could be considered Oriskany or Onondaga in age. On the other hand, thickness comparisons would suggest that the Battery Point, and possibly the Lake Branch and the uppermost beds of the York River are Hamilton in age. The great thicknesses involved point toward this conclusion.

As a final conclusion and summary, it may be added that, in relation to the standard section of North America (Cooper,1942), the Devonian formations of the present area range in age apparently from middle Lower Devonian to lower Middle Devonian. The Grande Grève and York Lake formations belong to the Deerpark stage (Oriskany), the York River partly to the Deerpark and partly to the Onesquethaw (Onondaga), and the Lake Branch and Battery Point formations possibly to the Cazenovia stage (Hamilton). This correlation is based on fossil evidence for the Grande Grève and York Lake formations, on fossil evidence and on stratigraphic relationships for the York River, and on comparison of thicknesses for the Lake Branch and Battery Point formations.

PLEISTOCENE AND RECENT

The regolith, as a whole, is comparatively thick over most of the area, particularly on the upland. Debris which can be found near the roots of overturned trees is usually representative of the underlying bedrock. There are no indications of residual soil, but the vegetation is thick enough to prevent an examination of the soil at most places. Residual soil occurs in the Federal Mine area to the north (Gill, J.E., personal communication).

In the Lake Branch and the Square Forks Lakes depressions, and along the lower reaches of the tributaries to the Cascapédia river, the streams commonly cut through unconsolidated material. Along the upper Lake Branch and the Square Forks river, the deposits, generally less than 30 feet thick, are made up of stratified, in places imbricated, generally well sorted gravels interbedded with lenses of medium-grained sand and pebbly sand. Red silt and fine-grained sand are found at places toward the base of the sections. These are river deposits belonging to the former floodplains of the upper Lake Branch and the Square Forks river. Till was not observed here.

In the Lake Branch depression, and along the tributaries to the Cascapédia river, the section generally consist of three zones totalling up to 60 feet in thickness. An upper zone is made up of interbedded, roughly to well stratified gravels and medium- to fine-grained sands in beds up to 2 feet thick (Pl. VIII-A). The gravels are composed of generally well-rounded pebbles to cobbles. Below this upper zone is a layer of till up to 10 feet thick of highly unsorted material, with angular to rounded fragments ranging in size from 2 inches to 3 feet across. Striated boulders and abraded pebbles are found here and there in this layer. The zone below the till is generally hidden by slumping from above. Where it could be observed, it consists of well-sorted and stratified gravels interbedded with fine-grained sand and silt. At several places along Berry Mointain brook (East branch), reddish brown clay, in beds up to 3 feet thick, is found at this level. This clay and the fine-grained sediments contain rare pebbles and cobbles, the latter probably having been ice-rafted.

Not all sections show the distribution given above. At places, stratified gravels do not occur above the till layer, or only the stratified gravels show in sections less than 10 feet thick. Varved clay was not observed. The reddish brown clay and the silt beds were probably deposited in a relatively calm body of water, possibly a pro-glacial lake.

Well-stratified gravel deposits are common along the banks of the Cascapédia river. They evidently belong to the floodplain of the river and are of a recent age.

STRUCTURAL GEOLOGY AND STRATIGRAPHIC RELATIONS

Silurian

The Silurian rocks of the present area are moderately folded. Dips over 50° are uncommon and the beds generally are not severely fractured. No persistent overturning of the beds was observed. Near the volcanic bands, however, there is some local cleavage and drag folding (Pl. VIII-B). Cleavage is also developed near fault zones, which are fairly abundant in the sedimentary belt. Most of these zones show definite horizontal movement. Several of the fault planes are vertical. Low-angle thrust faults were observed along Beaver brook, just outside the eastern boundary of the area. The fault planes dip 20° to the south and strike eastward. The magnitude of the movement along these zones could not be determined, but, from the nature of the rocks on both sides of the faults, it does not appear to be large. In the volcanic belt, flow lines are commonly contorted, and joints and fractures occur throughout.

The Silurian beds are exposed on a major anticline trending northeast. Although only a short portion of this structure is exposed in the present area, it appears to be very irregular in detail and to plunge alternately northeast and southwest.

Devonian

Cape Bon Ami - Silurian Rocks

Rocks of the Cape Bon Ami formation are severely fractured and cleaved along visible contacts with the Silurian volcanics. South of the Silurian volcanics, the beds are fractured and haphazardly jointed almost everywhere. Dips are fairly steep, and, east of Jonathan brook (West branch), the beds are overturned. No internal textures suggesting overturning were observed in the formation, but a few such textures are present in the overlying York River beds to the north. Moreover, the apparent position of the Cape Bon Ami above the York River indicates overturning, if not faulting.

Cape Bon Ami - York River Formations

The Cape Bon Ami formation appears essentially conformable with the overlying York River formation. A transition zone between the two formations was seen at three localities in the area. On the ridge between the Cascapédia river and Charles-Vallée brook, typical Cape Bon Ami beds are oriented vertically within 280 feet stratigraphically of similarly oriented, typical York River beds. The lower 10 feet of the transition zone between the two formations are made up of arenaceous, medium grey limestones with shaly partings, interbedded, at the upper end of the exposure, with rusty brown weathering, medium-grained, calcareous sandstones in beds 2 inches thick. The upper 270 feet of the zone is occupied by large blocks of similar calcareous sandstones, almost in place. There is no evidence of faulting.

The same structural relations were observed near the crest of the sharp ridge rising between Gravier brook and the Cascapédia river. At this locality, calcareous siltstones and sandstones, some 500 feet thick, immediately overlie the Cape Bon Ami beds.

Calcareous shales, siltstones and sandstones, at the same stratigraphic level, were observed also on a brook tributary to the west branch of Jonathan brook and which flows along the contact between the two formations. The sequence of beds at this locality is interrupted by a diabase sill, or flow, which causes some change in the attitude of the adjacent formations. However, variations in attitude within the York River beds along this brook are more common than between the Cape Bon Ami formation and the York River formation. In the present report, the calcareous siltstones and sandstones are included in the York River formation, since several zones of similar beds are known higher in the York River sequence.

Grande Grève Formation

The Grande Grève formation dips gently toward the axis of the Berry Mountain syncline, southeasterly in the section in the northwestern corner of the area, and westerly in the section north of Berry Mountain lake. Immediately west of Conical Mountain, at the western boundary of the area, the formation is folded into an open anticline with a north-south trend.

Minor folding is suggested in the band north of Berry Mountain lake. Immediately east of the eastern boundary of the area, the exposures along the road leading to Lake Ste-Anne reveal a gentle anticline trending northeasterly. The curving trend of the contacts shown on the present map is a reflection of this fold.

Fortin Series - Silurian Volcanics

The structural complexity near the contact between the Fortin series and the Silurian volcanics suggests faulting. In addition, the Cape Bon Ami beds are missing on the south limb of the Josué Brook anticline. The uncertainty of the age of the Fortin series prevents determination of the characteristics of the assumed fault. The Fortin series may be an off-shore facies of the York River formation; in such a case, the structural complexity of the Fortin series here could be the result of minor adjustments of an incompetent series to orogenic forces.

Lower Devonian Volcanics

On the accompanying geological map, a northeasterly-trending thrust fault is shown at the base of the volcanic belt immediately south and southwest of Berry Mountain lake. This is evidenced by: 1) a contorted zone running parallel to it, south of Berry Mountain lake, 2) a distinct discontinuity of structure in the same general vicinity, and, 3) the sedimentary formations strike into the volcanic belt. A second fault, trending north, is postulated to account for a displacement of the axis of the Berry Mountain syncline. Assuming that the volcanic belts on each side of the north-trending fault are of the same age, one is forced to accept overthrusting to the northwest for the west block and overthrusting to the southeast (or underthrusting to the northwest) for the east block.

In the adjacent area to the east, the volcanics are possibly York Lake in age, that is, they occur between the York River and Grande Grève sequences. On the west side of the north-trending fault, their stratigraphic position is uncertain; there are no Grande Grève beds underneath, and according to the present interpretation, their lower contacts are faults. However, the volcanics of both sides consist of the same types of rocks in about the same proportion. In the area adjacent to the east (McGerrigle's and the writer's mapping), acidic volcanic rocks become progressively more and more abundant along the belt.

If no faulting is assumed, the volcanics of the western side on the north limb of the Berry Mountain syncline are very late York River, and middle York River on the south limb. Moreover, with such an assumption there would be an angular unconformity of a large order (nearly 90°) between the York River formation and the volcanics on the north limb of the syncline in a group of rocks which, elsewhere in the area, appears essentially conformable. Faulting, therefore, appears the most plausible explanation for the present distribution and orientation of the rock units.

Granting the existence of the faults, there is still the possibility that the volcanics of the western side may be slightly younger than the volcanics near the northern and northwestern boundaries of the area.

York River Formation

A fault cutting the York River formation at the headwaters of Beaver brook, near the eastern boundary of the area, appears to be of the normal type. It dips steeply south, and the displacement increases eastward. As a result of this fault, the York River belt appears to be exposed over a greater width than would be expected in that part of the area. On the accompanying map, south of the fault under discussion, several beds are shown overturned to the north. Overturning was inferred mainly from the stratigraphic succession (see Cape Bon Ami formation), in one case, and graded bedding in another.

Lake Branch - Battery Point Formations

The contact between the Lake Branch formation and the overlying Battery Point formation was not seen in the area. In the western half of the area, the zone between the two formations is occupied locally by volcanic rocks. Along the upper Lake Branch, a difference of 20° seems to exist between the regional trends of the two formations. In the general vicinity of the Cascapédia river, there is also a persistent difference of approximately 20° between the dips of the two formations. This divergence in attitude may be attributed to faulting, to the character of the folding, or to the shape of the basin of deposition.

The idea of a fault along the north front of the Big Berry Mountains is appealing in view of the escarpment marking this front. Irregularities in the strike and dip of the Battery Point beds in the vicinity of Mount Noble also suggest faulting. However, there are no faults in the upper Lake Branch section, and the escarpment does not follow the trend of the rock formations west of Huard lake. The escarpment seems to be the result, primarily, of the relative resistance of the Battery Point sandstones. West of Huard lake, the escarpment owes its existence apparently to the interfingering of firm, calcareous, green sandstones in typical Lake Branch beds. Consequently, although faulting may account for the differences in dips near the Cascapédia river, it cannot explain the differences in trend of the two formations along the upper Lake Branch.

For identical reasons, folding alone cannot account for the divergence in trend of the two formations along the upper Lake Branch. As for the difference in dip, it appears to be too consistent to be accounted for folding alone.

The steepening of dips, and change in attitude, may be partly explained by the shape of the basin of sedimentation, that is, by thinning of the Lake Branch formation southward and westward. This suggestion fits well with the composition, colour, and the textural and structural features of the Lake Branch formation, which seems to be a deltaic deposit.

However, the proposal of a deltaic foreset slope, alone, seems inadequate to explain a difference in dip of 20°. The writer favours the additional concept of a steepening of slope in the basin of deposition; that is, steep initial dips in the Battery Point formation, with contemporaneous deformation and thinning of the Lake Branch southward. Subsequent faulting at the Big Berry Mountains escarpment would accentuate the original divergence in attitude. The fact that the Lake Branch formation does not appear on the south limb of the Berry Mountain syncline supports such an explanation. At the contact, the beds of the two formations would be conformable. Only observations some distance from the contact (laterally or vertically) would reveal a change in attitude.

The Battery Point formation is located structurally in the centre of the Berry Mountain syncline. Minor folding and, possibly, faulting occur near the axis of the syncline in the eastern half of the area. A nearly east-west set of vertical joints is developed in the formation, at the headwaters of the Square Forks river. Such joints give way to a narrow shear zone in the southwestern corner of the area. How much movement took place along the shear zone cannot be determined, but according to the succession of beds on the two sides of the zone the movement was slight.

Two parallel faults are shown in the same general location on the accompanying map. The tracing of these faults is based on very little information, and the irregularities in the direction of dips could be explained as well by folding.

ECONOMIC GEOLOGY

Base Metals

The present area is located a short distance to the south of the long-known base metal deposits of Lemieux township. These deposits, mainly on the property of the Federal Zinc and Lead Company, were being explored in 1951-54 jointly by East Sullivan Mines Limited and Sullivan Consolidated Mines Limited, with some 7,000 acres of mining claims under option. In 1952, Federal Metals Corporation was formed by the same interests to acquire the property of the Federal Zinc and Lead Company. Thus, the present area is part of a territory which could hold promise of economic mineral occurrences.

A favourable site for prospecting appears to be the escarpment of the Big Berry Mountains. Very small amounts of submicroscopic grains and flakes of chalcopyrite were noted in an exposure located toward the eastern end of the mass of porphyritic rhyolite, 2 miles west of Mount Noble. Under the microscope, the chalcopyrite appears to be related to secondary quartz filling minute fractures in the rock.

Pyrrhotite and a little chalcopyrite were noted also in a boulder along the front of the Big Berry Mountains, approximately 2 miles east of Cascapédia river. A similar occurrence was observed in a pebble in Berry Mountain brook, approximately one mile upstream from the mouth of the brook. The enclosing rock in both cases is a green tuff similar to some found in the mass of porphyritic rhyolite.

Thin smears of malachite occur on the joint planes of the Battery Point sandstones in an exposure located along the Square Forks river, approximately 5 miles upstream from its mouth. This exposure is on the left bank of the river, at water level, approximately where the projected Clarke-Gravier township line crosses the river.

Gravel Deposits

Gravel deposits are fairly common in the lower part of the main tributaries to Cascapédia river, and in the floodplain of the river. A major portion of the Lake Branch depression is covered by a blanket of fluvio-glacial gravel. The type of gravel obtainable from these different localities is fair for road building purposes. However, locally, it contains a high percentage of clay and is poorly sorted.

Building Stone

Although none of the formations of the present area constitute ideal building stone, some Battery Point and York River sandstones could be used for construction purposes. The church of St. Jules de Cascapédia is faced with slabs of these sandstones taken from talus slopes along the Cascapédia river.

Petroleum

Oil seepages or other indications of petroleum have not been found in the rocks of the present area. The general region, however, is not devoid of possibilities. Alcock (1945, pp. 13-15) has reported the occurrence of "oil residuals" in some Lower Devonian volcanics, a short distance to the north of the present area.

Several zones in the Middle Silurian of Gaspé peninsula may be considered as favourable source-beds for petroleum, particularly the coral-rich beds. Such biostromal beds were not found in the Silurian of the present area, which is dated as lowermost Upper Silurian, but they may occur lower in the section on the Josué Brook anticline.

The rocks of the present Silurian belt are faulted and fractured, but not severely; at places they are intruded by diabase dykes. Petroleum may be sealed or trapped against such dykes or against fault planes. Cross-folds or reversal of plunge could provide enough closure at certain places alonq the Josué Brook anticline. Also, there are several shaly zones and diabase sills or flows that could serve as cap-rocks.

The prospects of structural traps appear to be largely lacking in the Devonian rocks of the present area, although they might be expected in the Gaspé Sandstones, in which abrupt facies changes are common. It is unlikely that there are good source-beds in the Lake Branch and Battery Point formations. However, petroleum could have migrated from lower stratigraphic levels and accumulated in stratigraphic traps. The York River formation in the present area seems to lack both structural and stratigraphic traps, although the interbedding of shales and sandstones in the formation offers some promise.

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