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RECONNAISSANCE GEOLOGICAL SURVEY OF SOUTH-CENTRAL AND WESTERN GASPE PENINSULA, FINAL REPORT

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H. W. Mc Gerrigle

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RECONNAISSANCE GEOLOGICAL SURVEY

OF

SOUTH-CENTRAL AND WESTERN GASPÉ PENNINSULA, QUEBEC

BY

H. M. McGerrigle

1942, 1943 Survevs

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Reconnaissance Geological Survey, 1942, 1943,

of

South-Central and Western Gaspé Peninsula, Quebec

by

H.W. McGerrigle

CHAPTER I. INTRODUCTION

Introduction and Area

During the summer of 1942 a reconnaissance geological survey was made of an area comprising approximately 1,500 square miles in south-central Gaspé peninsula. This area included three major southward flowing rivers, the Grande Cascapédia, the Little Cascapédia, and the Bonaventure. These streams, with the two main branches of the latter two, ran almost at right angles to the structural trend of the rock formations, and thus provided a series of five natural and conveniently spaced cross-sections.

Similar reconnaissance work was carried westward from the northern part of the area explored in 1942 as far as the Matapédia river during the 1943 field season. The mid-line of the Shickshock Mountain range was the approximate northern limit of the 1943 survey, while the Lake Branch of the Grande Cascapédia river and the Causapscal river roughly formed the southern limit. The area explored was approximately 1,000 square miles, and included the upper waters of the Cap Chat river, the upper and middle waters

of the Matane with its main tributaries the Bonjour, Trout, and Tomagodi rivers, the Matapédia river from Lake Au Saumon to Causapscal, the Causapscal river, and the Miner, Go-Ashore, and Inlet tributaries of the Lake Branch of the Grande Cascapédia river.

Although of reconnaissance nature only these surveys permit the outlining of the structure and stratigraphy and the oil and other mineral possibilities of regions about which little was known previously. Sufficient information was provided to permit correlation or actual mappable connections with structures and formations observed to the east, where earlier and more detailed geological mapping was done. Parts of the areas to the east, with their mapped geology, are included in the map accompanying this report.

Means of Communication; Suggested Improvements

A motor-road maintained by the province follows the east side of the Grande Cascapédia river from the Gaspé highway inland to Berry Mountain brook, a distance of forty miles. It then follows the north branch of Berry Mountain brook to Kelly's Camp, adjacent to the Federal mine, and then in another three and a half miles crosses the divide and reaches the north end of Lake Sainte Anne. A twelve-mile foot trail along the Sainte Anne river connects this motor-road with the inland end of the motor-road from Sainte Anne des Monts, on the north coast of the peninsula.

The Bathurst Power and Paper Company, Limited, has built a motor-road eastward from the provincial road at Berry Mountain

brook to the East Branch of the Little Cascapédia river. A continuing road has been bull-dozed eastward as far as the East Branch of the Bonaventure river. This latter section has not yet been graded (February, 1944). The Bathurst company also has built a motor-road down the West Branch of the Little Cascapédia for a distance of about seven miles from its main road. The lower end of this motor-raod is about six miles from the upper end of an old wagon-road that followed the Little Cascapédia and its West Branch inland from the Coast for a distance of about thirty-seven miles. This old road is no longer serviceable in its upper twenty miles except as a foot-trail owing to local landships and to the wash-out of bridges.

Access to the forks of the Bonaventure river was had by our party in 1942 by twelve miles of motor-road between New Richmond village and the new settlement of Saint Antoine, and then by fifteen miles of wagon-road. An old wagon-road, still locally serviceable, reaches ten miles or more up the West Branch, Bonaventure, and a similar road extends about fifteen miles up the East Branch Bonaventure.

In the northeastern part of the accompanying map two sections of the York river are shown. The section farther east is paralleled on its north side by a part of the provincial motor-road leading from Gaspé village to the Miller Copper Claims at the head of York river. The other section of the river is bordered on the north side by a part of the motor-road constructed in 1941 by the International Pulp and Paper Company.

It is worth noting that only fifteen to twenty miles of construction would be necessary to link the Bathurst company and International Company roads and so provide an interior route from Gaspé to Cascapédia. This route would be about equal in mileage to that of the Gaspé highway between these two places. Such a route should be considered as an alternative to that projected, and partly laid out in 1929-1931 by the provincial government, from Lake Sainte Anne east-northeastward to the Miller Claims.

Two roads reach well into the interior in the western half of the peninsula. One of these, the "Lacroix road", leads from Causapscal northeastward to Miner brook and down that stream for several miles, or a total distance of about forty miles. This road is now (1943-44) being extended northeastward to reach Go-Ashore brook in the southern quarter of Faribault township. It is to be noted that only some twenty miles of road construction would be necessary to join the Lacroix road on Miner brook with the Grande Cascapédia River road.

The Hammermill Paper Company limits in Leclercq, Joffre, Boutet, and Dunière townships are reached by motor-road from Matane. South of the Little Matane river this road is owned and maintained by the Company. Only about six miles of road construction would be necessary to join the Hammermill and Lacroix roads. Similarly the Price Brothers Company road, leading up the Matane and Trout rivers, could be linked with either the Hammermill or Lacroix roads by a relatively few miles of road construction.

The roads referred to above were in all cases initiated by the lumber companies and their chief value at the present time is to

those companies. However, in two instances, roads extended and maintained by the provincial government provided the means or access to adequately test two important mineral deposits. The roads referred to are the Grande Cascapédia River and the York River roads, leading respectively to the Federal lead and zinc deposits and to the Miller (Noranda Option) Copper deposits. Linking of the roads that already exist, and the strategic construction of other roads, would further aid the lumber companies, would provide access to areas that merit prospecting, further develope touristic and sporting enterprises, and would open up new areas to agriculture. It should be noted that while much of Gaspé peninsula is two rugged for farming, at least in the present stage of economic development of the peninsula, there are wide inland areas that are suitable so far as topography is concerned. Much of the area bordering the Causapscal river, the upper Matane and Cap Chat drainage basins, and along Miner brook and the Lake Branch (Grande Cascapédia waters) would be topographically suitable for farming.

Method of Work

The traverses necessary to obtain the geological information on which this report is based were restricted largely to the rivers and to their main tributaries. During 1942 a Gaspé-type canoe was used to traverse the Grande Cascapédia, Little Cascapédia, and Bonaventure rivers, and also the Lake Branch of the Grande Cascapédia. On these waters the canoe is almost imperative if all the rocks exposed along their banks are to be examined. These rivers, in general, differ from those of eastern and western Gaspé in having

relatively few cross-river bars and little bordering gravel except at unusually low-water. This is particularly the case in both branches of the Bonaventure river, and in the main Bonaventure except towards its mouth. The rivers of eastern and western Gaspé may be examined on foot for the most part because of the general presence of bordering gravel and of the numerous bars that permit wading and so crossing from bank to bank or outcrop to outcrop. Nevertheless, and apart from the almost necessity in some instances, most of the Gaspé rivers may be traversed by canoe more easily than on foot provided the task of upstream poling can be avoided.

During 1943 a canoe was used only on the Causapscal river. It could have been used to advantage on the Matane river and its tributary the Trout, and on the middle portion of the Cap Chat river, the middle and lower parts of Go-Ashore, throughout the entire length of Miner except where it feathers out into the relatively short headwater brooks, and on all but the upper five miles or so of the Inlet.

Traverses were made also along brooks draining to the main rivers in certain areas where information additional to that provided on the rivers was desired. And traverses were made along most of the roads in the region. A chain and compass survey was made of the Bathurst Company road from the East Branch Bonaventure to the provincial government road at Berry Mountain brook. A pace and compass survey was made of the Hammermill road from the Cap Chat river to the lower end of the Matane lakes, and a similar survey was made of the Price Company road from its inland end on the Trout river to the John depot on the Matane river. The Lacroix road has been traversed only in part.

Topography

The greater part of the area included in the 1942 survey, that east of the Grande Cascapédia river, is an upland or plateau deeply dissected by numerous and usually steep-sided stream valleys. The plateau-like character of the inter-stream areas is interrupted by fairly prominent east-west ridges coinciding with the anticlinals that bring up the Silurian formations. In the northern part of this region, between the two branches of the Little Cascapédia river, differential erosion between Devonian igneous rocks and the associated sedimentaries has produced a very rugged land surface. This surface is traversed in part by the Bathurst company road, and it is here that the severest grades for any part of the road are found. Where the road turns east to leave the West Branch Little Cascapédia it is at an elevation of about 1,000 feet. It then climbs to about 2,150 feet in a distance of three miles to the divide between the West Branch and Lesseps brook. The highest hills in this part of the area are around 2,500 feet elevation.

The northern edge of the upland is marked in part by the Berry Mountain rage. This range is about thirty miles from Cascapédia bay. Its two named summits, Mount Berry (1,850 feet) and Mount Noble (2,125 feet), lie respectively on the west and east sides of the Grande Cascapédia river. The range slopes down steeply on the northern side, and forms the locally very abrupt southern edge of a striking east-west depression. The base of the northern slope of the range is paralleled at about a mile to the north by the west to east flowing Lake Branch of the Grande Cascapédia river. The elevation of this stream is about 500 feet where it joins the Salmon Branch, and where the Grande Cascapédia river proper begins,

and about 700 feet at Loon lake. The depression is not sharply delimited on its northern side, there being a gradual slope upward from it to the hills of the Federal mine (1800-2000 feet) and the Mount Lyall (3,000 feet) areas. The general summit level within the depression is close to the 1,000-foot contour. If this contour is taken as marking its northern edge the depression is about four miles wide. It narrows to the east of the Grande Cascapédia river, its northern border steepens, and its southern border remains fairly abrupt, until Berry Mountain lake is reached. The eastern end of the depression is marked by the lake, and its trend from the river to the lake corresponds to that of Berry Mountain brook. Towards the west the depression becomes less and less pronounced after Loon lake is passed. The distance between the two lakes is roughly eighteeen miles.

The depression just described actually merges westward with a much broader and shallower depression lying between the Chickshock range on the north and the westward continuation of the Berry Mountain range, or general upland border, on the south. Although little is known of this southern upland it probably, as previously inferred, has a general elevation of around 2,000 feet. In the depression area the interstream divides also would average about 2,000 feet, but here the slopes to the streams are much more gentle than in the upland. In fact the general depression area would be topographically suitable for farming, lacking as it does the steep slopes characteristic of the valley sides in the upland. The major streams of this depression area are the Cap Chat, the Trout tributary of the Matane, and Miner brooks heading close together and all at elevations around 1,100-1,300 feet.

In general terms, the topography in this depression is much more mature than it is in the upland area to the south. The contrast with the Shickshock range to the north is even more striking. The topographical differences between this area and the areas to the north and south probably would force any interior railway link between the Matapédia valley or Matane and Gaspé village to use this depression. Such a railway project has been toyed with from time to time and a few surveys relating to it have been made.

The Shickshock Mountain range is the most prominent topographic feature of Gaspé peninsula. The range extends sixty miles east-northeastward from the Matane river to the Tabletop mountains, with an average width of six miles. It parallels the south shore of the Saint Lawrence river at a distance inland of twelve to twenty-five miles, and its peaks may be seen by voyagers anywhere on the river between Matane and Mont Louis. The topographic high of the range and of the peninsula is Mount Jacques Cartier (4,160 feet) in the granitic Tabletop mountains at the eastern end of the range. The Tabletops include two other summits over 4,000 feet in elevation, and nineteen summits over 3,500 feet. Some five miles to the west of the Tabletops is the flat-topped and steep-sided serpentine mass of Mount Albert with its highest point at 3,775 feet elevation. About twenty miles to the west of Mount Albert the sharper summit of Mount Logan is at an elevation of about 3,760 feet, and in its vicinity several peaks rise to between 3,000 and 3,500 feet. These peaks are all within eight miles of the Cap Chat river on its eastern side, and lie in a band two miles or less in width along the northern

part of the range. This is perhaps the most rugged section of the range. In line with this band, and forming a part of the west wall of the Cap Chat river is Mount Nicolalbert at 2,800 feet elevation. This is succeeded to the west by Mount Bayfield (3,471 feet). About half-way between the Cap Chat river and the Matane lakes Mount Blanc rises to about 3,500 feet, and between these two rivers, several summits are close to 3,000 feet in elevation. Like Mount Logan and the associated peaks referred to above all the high points mentioned lie within the northern third of the range. With very minor exceptions the summit levels in the southern two-thirds are below 2,800 feet, with several between 2,700 and 2,800 feet. Thus, between the Salmon Branch of the Grande Cascapédia river and the Matane lakes, the summit levels in the northern third of the range average 400-500 feet higher than in the southern two-thirds. Here, also, the range slopes steeply, in general, to the lower bordering areas on the north and south. The northern slope is usually more abrupt than the southern.

West of the Matane lakes the general level of the range is at about 2,100 feet. The highest point is a little above 2,800 feet, and there are few summits rising to or even close to 2,500 feet. The range is not so sharply delimited on the north side as it is to the east of the lakes. On the south side, however, the edge of the Shickshocks is marked by a very steep slope averaging 1,500 feet in relief. Part of this relief is due to the Matane river which closely borders the range west of the Matane lakes and which runs at a level averaging 600 feet below the general level of the country to the south of it. Thus, if this valley were filled in to that

level the steep southern slopes of the Shickshocks would average about 900 feet in relief.

The drainage pattern within the Shickshocks generally follows north-south lines, with most of the waters draining southward from the divide in the northern third of the range. The regional drainage passing through the Schickshocks is more varied. Towards the eastern end of the range the Sainte Anne river heads in the lake of that name well to the south of the Shickshocks proper and flows northward. Ten or more miles to the west the Salmon Branch of the Grande Cascapédia river heads at the northern edge of the range and flows southward through it. Ten miles further to the west the Cap Chat river cuts through the Shickshocks (Plate .), flowing northwesterly from headwaters that are as much as six miles south of the range. The relief where the Cap Chat passes through the Shickshocks is up to 2,400 feet. Twelve miles to the west the Matane river flows southwesterly through the range to its southern border. Here, at the foot of the Matane chain of lakes, the river swings to the southwest. It then closely parallels the southern border of the Shickshocks for about ten miles before swinging to the west and then northwest to bend around them and head out to the Saint Lawrence.

The physiographic history of the area under review will prove to be of extreme interest when it is worked out. Such research however, should and must await the production of adequate topographic maps. Such information as has been gained, however, is sufficient to show that many changes have taken place in the drainage pattern of the region and particularly in the northern area dominated by

the Shickshocks mountains. Here, many drainage changes are due to glacial action, while others obviously antidate the glacial period.

Timber Resources

The major part of this region carries a forest growth having value as a source of both pulpwood and long lumber. Balsam fir, and black and white spruce are the most abundant woods while birch is common and there is some poplar, cedar, pine, maple, and Balm of Gilead. There is little economic forest growth above an elevation of 2,500 feet, while from 3,000 feet up to the highest summits there is either bare or mass covered ground or at best a stunted growth of black spruce.

Fires have destroyed most of the forest in that part of the region lying east of the East Branch Bonaventure river as far as mounts Observation and Alexander. The central and southern part of this burned area was ravaged some fifty years ago, as was also a considerable section of the area between the two branches of the Bonaventure for about twelve miles north of the forks. This old burn is now under a generally sparse second growth of poplar and birch. A fire in 1941 affected the area east of the East Branch Bonaventure from the Bonaventure County line northward to York river.

Acknowledgments

The writer gratefully acknowledges the receipt of cruiseand other maps from the Bathurst Power and Paper Company, the New Brunswick International Paper Company, the Hammermill Paper Company, and Price Brothers and Company. The many services freely extended by the first three of those companies, on whose limits much of our work was done, materially aided our survey.

Capable assistance in the actual geological exploration was given by A.E. Miller in 1942 and 1943, and also by E.R. Miller in 1942; both of Sunny Bank, Gaspé South County. Able assitance was given also by the students H.B. Lyall, Montreal, and R.G. Kekemp Quebec, in 1942, and by H. Giles, Quebec in 1943; by A. Stewart, of York Centre, Gaspé South County, Cook, 1942 and 1943; by P. Boudreau of Beauglen, Bonaventure County, 1942 and 1943; by A. Bugold, Maria, Bonaventure County, 1942; and by G. Devlin, Quebec, in 1943.

Previous Work

The first geological work in Gaspé peninsula was done in 1845, by Sir William Logan on the Cap Chat and Grande Cascapédia rivers and by Alexander Murray on the Bonaventure river. Logan, R.W. Ells, and John M. Clarke were the principal investigators between the years 1845 and 1908. In 1917 and 1918, Adhémar Mailhiot reviewed the general geology of the zinc and lead deposits of Lemieux township. Since the year 1921 much detailed work has been done in various parts of the peninsula including interior areas. A belt of almost 3,000 square miles, extending from Lemieux township in the centre of the peninsula to Gaspé bay on the east coast, has been mapped both geologically and topographically. The earliest of this more detailed work in the interior was done by F.J. Alcock of the Geological Survey of Canada, and was continued by I.W. Jones of the Quebec Bureau (now Department) of Mines. Between 1937 and 1940 the eastern end of the belt referred to above, that part which seemed most promising as an oil-field prospect, was mapped by I.W. Jones and H.W. McGerrigle. The region bordering the

Baie des Chaleurs, from Matapédia to Malbaie, was mapped under the direction of F.J. Alcock, and a comprehensive report on this region was issued in 1935. Detailed stratigraphic studies have been made of various areas along the coast, as of Percé by Charles Schuchert, G.A. Cooper, and C.H. Kindle, of the Port Daniel-Black Cape region by Charles Schuchert, D. Dart, and S.A. Northrop, of Escuminac bay and, later, of Gaspé bay sections by E.M. Kindle, and of the Matapédia valley by G.W. Crickmay.

The geology of the southern part of the region, as illustrated on the accompanying map, is based largely on the reports of Northrop (1939) and Alcock (1935); that of the interior is based on the writer's reconnaissance supplemented by reports of Alcock, Jones, and Gill and Auger; and that of the Matapédia valley also is based on the writer's reconnaissance supplemented mainly by the reports of Crickmay, Alcock, and Aubert de la Rue.

CHAPTER 2. DESCRIPTIVE GEOLOGY

Summary

The rocks of south-central and western Gaspé are predominantly sedimentaries of Paleozoic age. One group, the Macquereau may be Precambrian but is probably Cambrian in age. Another group, the Shickshock, was assigned to the Precambrian during the early work of the Geological Survey in Gaspé. More recently, however, it has been classed as Ordovician in age. Rocks of Ordovician, Silurian, Devonian, and Carboniferous age succeed the Macquereau and the Shickshock groups. Intrusive rocks, mainly dykes, are associated with sedimentaries of all the ages mentioned. In the northwest corner of the area there are large intrusive

bodies of granitic rocks, presumably related in origin to the large Tabletop granitic mass further north. Extrusive rocks are associated in some parts of the area with Ordovician, Silurian and Devonian sedimentaries.

The structure of the peninsula as a whole is broadly synclinal with frequent subsidiary folds often of major extent. Several of the folds recognized during the present mapping are continuations of structures to the east, revealed by earlier and more detailed mapping in eastern Gaspé. The structural trend within the region is southwest-northeast, turning to a nearly west-east trend at the eastern border of the region.

Three main periods of folding are recognized; the first in past-Macquereau-pre-Mictaw time; the second at or towards the close of Ordovician time; and the third during the middle or late stages of Devonian time.

TABLE OF FORMATIONS

Period			Formation		Character
Carboniferous (Pennsylvanian)			Bonaventure		Red conglomerates, sandstones, shales
			UNCONFORMITY		
Devonian	Middle ?	Intrusives	Rhyolite Porphyry Sills		Red, dense; phenocrysts of feldspar and quartz.
			Granite		Grey to pink, generally fine-grained, sometimes porphyritic
			Syenite		Reddish, coarse-grained
	Middle ?	?Onondaga-Hamilton?	Battery Point	Upper Member	Greenish-grey, medium to coarse, feldspathic (pink to red feldspars), pebbly sandstone.
				Middle Member	Reddish-brown, soft, shales and sandstones.
				Lower Member	Greenish-grey, medium to coarse, feldspathic (pink to red feldspars), pebbly sandstone.
			York River		Greenish-grey, medium to fine, feldspathic (grey feldspars) sandstone.
	Lower ? and Middle	Oriskany-Onondaga	York Lake		Limestones, sandstones, shales; combines the characters of the "Gaspé Limestones" and the "Gaspé Sandstones". Locally with volcanics.
	Lower	Helderberg Oriskany	Grande Grève		Hard, well-bedded, siliceous or silty limestones to fine, calcareous silstones.
			Bon Ami		Dark, soft, shaley, well-bedded limestones; some shale.
			St. Alban-Mont-Joli		Not recognized in the map-area; may be present on the Salmon Branch; may be represented by the sedimentary and volcanic series west of the Grande Cascapédia river in Maria township
Silurian (Middle)			Undifferentiated (The Silurian of the Interior)		Fine sandy limestones to calcareous sandstones, with some shales and quartzite; volcanics are present in most southern band.
			Chaleur Series (7 formations)		Basal conglomerate; limestone, shales, sandstones; volcanics at Black Cape.
Ordovician	Upper		Matapédia-Whitehead Series		Limestones, slates quartzite, conglomerates.
	Middle		Mictaw Series		Shales, sandstones, tuffaceous greywackes.
	Lower		Sillery Series		Shale, sandstone, quartzite, limestone conglomerate; some volcanics
Ordovician? Precambrian?			Shickshock Series		Basic volcanic schists; arkoses.
Cambrian? Precambrian?			Macquereau Group		Quartzites, slates, schists, with intruded granite and serpentinized peridotite.

Cambrian? Precambrian?

Macquereau Group

The Macquereau group occupies an area of about 125 square miles north and northeast of Port Daniel. The type locality is at Pointe Macquereau, where the Bonaventure - Gaspé South County line comes against the Bay of Chaleurs shore. Most of Newport township is underlain by this group and also the eastern third of Port Daniel township and small areas in Weir and Raudin townships and in the Seigneurie de Pabos.

The rocks, chiefly metamorphosed sedimentaries, are arkosic quartzites, conglomeratic quartzites, quartzose argillites, slates, micaceous and chloritic schists, and hornblende schists. In Weir township the Macquereau is intruded by serpentinized peridotite, with some amphibolite, carrying a little asbestos and some chromite. Muscovite granite is associated with the serpentine as dykes and small bosses. Hornblende schists, are developed along the contacts of the serpentine and granite with the sedimentaries.

The area of intrusive rocks is shown on the map accompanying this report. Although not shown on Alcock's map it was described in some detail by him (1). The area was examined by the writer in 1941 in the hope of finding deposits of chromite. While some occurrences were found they were later shown by private prospecting operations, including some diamond drilling, to have no indicated economic importance.

The age of the Macquereau is rendered indefinite because of the absence of fossils. Apparently, however, it is pre-Mictaw, as

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(1) Alcock, 1935, pages 10-12.

unconformable relations between it and the Mictaw are reported by Alcock. Also, the Macquereau is more metamorphosed than the Upper Cambrian Murphy Creek formation (Malbaie area, eastern Gaspé) which, in turn, is not more metamorphosed than the associated Upper Ordovician White Head formation. Thus, it is suggested that the Macquereau is older than the Murphy Creek, and, therefore, pre-Upper Cambrian.

Precambrian?-Ordovician ?

Shickshock Series

The term "Shickshock series" is here used for the first time, although the term "Shickshock formation" already is in the literature (Crickmay, 1932, p. 373). For reasons given below it is suggested that the latter term is poorly applied and that probably confusion would be avoided if it were dropped and a fresh start made with the term "Shickshock series".

The type locality of the Shickshock formation of Crickmay is along the eastern edge of Lake Matapédia. Thus, the locality is not within the Shickshock range. Actually the range begins some fourteen miles to the east of Lake Matapédia and there is no apparent structural, and certainly no topographical, connection between the two localities. Furthermore the "Shickshock formation" of Crickmay is not typical of the rocks of the range. Whereas at the lake the rock is mainly arkose with some interbedded basaltic flows, in the Shickshock range the rock is mainly chloritic to epidotic schists (altered basic volcanics) with subordinate schisted arkoses and rarely other sedimentaries. It is at least questionable that the "Shickshock formation" should be placed in our Shickshock series.

The Shickshock series is here defined as including all the rocks in the Shickshock range from the western end of that range at the Matane river eastward to the Tabletop mountains, with the granites of the Tabletop mountains and the three areas of serpentine in the eastern third of the range excepted. As thus restricted the series consists for the most part of basic volcanics altered to chloritic schists; in some places the schists are sericitic, and again epidotic, hornblendic, or quartzitic, or, as is often the case, combinations of all of these general types. This description applies particularly to the southern two-thirds of the width of the range. It seems evident from Alcock's description (1926) that the volcanics in the northern third of the range, and particularly east of the Cap Chat river, are more massive or less schistose than is generally the case. Alcock's description follows: "The most abundant volcanic type is a massive greenstone variety. In places it contains irregular masses and stringers of epidote. Locally it is sheared into chlorite schist. In thin section all the specimens, proved to be much altered. All the ferromagnesian minerals have been largely altered to chlorite, uralite, and epidote, but small amounts of augite remain. Some of the plagioclase is fairly fresh and in some sections it occurs as lath-shaped crystals that give the rock an ophitic tecture. A little quartz is present in some sections and iron oxides occur in varying amounts". Associated here and there with the evident flows are well-banded rocks suggestive of tuffs and rarely other rocks that evidently were sedimentaries. Arkoses are present in the range and series, particularly towards the west.

At the western end they occupy the whole width of the range with volcanics, or possibly intrusives, playing a very subordinate role. In the Matane lakes section, eleven miles to the east, the arkoses occupy a band under a mile in width on the northern side of the range. And, further east, arkose has been reported (Alcock, 1926, p. 130) only from the vicinity of the Cap Chat, where it is present "only in subordinate amounts. It is found on the north flank of mount Nicolalbert, and a thin bed occurs on the steep change of slope near the base of the volcanics west of mount Logan".

The age of the Shickshock series is very much in doubt and, in the absence of fossils, must be postulated on the bases of structure, degree of metamorphism, and apparent relations to its bordering formations. In regard to stratigraphic relations previous authors all are agreed that the series overlies or at least appears to overlie the sedimentaries (generally referred to as Sillery) to the north. Logan (1863, p. 265) and Alcock (1926,p. 132) stated that the succession was a natural one and that the Shickshock was younger than the Sillery and that it was Ordovician in age. These two authors differed, however, in their interpretation of the structure within the series. Logan concluded that "The whole range appears to possess a synclinal structure, with an undulation along the middle, dividing the basin into two subordinate troughs" (p. 265). Alcock, on the other hand, apparently believed that the whole series dipped more or less uniformly southward. In contrast to these views Ells (1885, p. 31E) and Low (1885, p. 16E) both place the Shickshock series in the Precambrian, and explain its apparent position on top of the Sillery as the result of overturning, and the structure of the range itself is interpreted as an overturned antidinal.

The present writer has explored several sections through the southern two-thirds of the range between its western end and the Salmon Branch. Very few readings on structure were obtained from these sections except on schistosity. Plotting of the schistosity readings revealed that in a band from one to two miles wide along the southern part of the range the schistosity dipped steeply southward, and that to the north the schistosity dipped steeply northward. This condition persisted throughout the length of the range examined and suggests that the Shickshock series is strongly folded. The fact that the series is overlain to the south by the Silurian, although the actual contact apparently is a fault, indicates that bedding dips at the southern border of the series would be southward. This, together with the schistosity, suggests that the southern two-thirds of the Shickshock range is anticlinally arranged, possibly as a single structure or, more probably, as two anticlinals separated by a synclinal. Just what bearing this may have on the structure in the northern third of the range, and on the Sillery-Shickshock contact, is not apparent except that it suggests that the general southerly dip of the Shickshock series apparently inferred by Alcock (1926) may be far from the case. Actually in the Matane lakes section, the only one pursued completely through the range by us, and one of the sections in which Alcock (1926, p. 130) states that the dips are "uniformly" to the south, we have found cleavage and rare definitely recognizable bedding to be northward in the northern part of the range and southward in the southern part of the range.

The relative degree of metamorphism of the rocks of the Shickshock series and of the rocks bordering that series may be taken as evidence of relative age. Alcock (1926, p. 132) maintained that the series was "no more highly metamorphosed that the rocks to the north, which are sheared and dragged and pass into slates". However, the greater part of the rocks in the Shickshock series, originally basic volcanics, now are altered to schists, - chloritic, sericitic, epidotic, hornblendic, and quartzitic. Basic volcanics are present at a few places in the Sillery shale-sandstone series to the north of the Shickshocks, and while these may not have had quite the same composition, they show relatively little metamorphic effect compared to the Shickshock volcanics.

The writer wishes only to make the point, in view of the above considerations, that the age of the Shickshock series still is very much in doubt, and that much more work needs to be done if its age is to be determined satisfactorily. In the meantime, it is the writer's opinion that this series is older than the shale series to the north of it and, therefore, would be Cambrian or Precambrian in age.

Lower Ordovician

Sillery Formation

Rocks of the Sillery formation were seen only in the northwestern corner of the area, west and southwest of the Matane river. This territory was included in a recent geological survey by Aubert de la Rue (1941), and a more complete résumé of the formation will be found in his report. In the present work traverses were made across Sillery rocks on the Matane river, on its

tributaries the John and the Tamagodi, and on a few of the roads near these tributaries.

The greater part of the rocks of the formation in this area are slates. Commonly the slates are grey to dark grey in clour, but red slates are frequent and there are occasional zones of green slates. Thin beds of limestone are fairly common in the slates, while beds of limestone conglomerate up to ten feet thick, and occasional beds or zones of calcareous sandstone also are present. One zone of grey quartzite a few hundred thick was noted.

The general trend of the Sillery rocks in this area is north-northeast, or more to the north than is the case for the regional structure. Near the Tamagodi river the formation overlain to the east by Silurian rocks, while further north it is succeeded to the east by the Shickshock series. After passing the western end of the Shickshock range the formation swings around to a more easterly course to parallel the range on its northern side. In detail the Sillery is sharply folded, and although the actual contact with the overlying Silurian was not seen, the fact that this this sharp folding persists up to the approximate contact position, and that some of the folds appear to strike under the uniformly dipping Silurian, suggests that the Silurian overlaps the Sillery unconformably.

Middle Ordovician

Mictaw Series

The Mictaw series has an outcrop area of about thirty-five square miles, chiefly in Port Daniel township with a small tongue extending into Weir township. Mictaw river and the North and Middle Port Daniel rivers show extensive exposures.

The series probably is several thousand feet thick. It is composed mainly of alternating black shales, greenish sandstones, arkoses, and tuffaceous greywackes. Conglomerates, carrying Macquereau boulders occur (Alcock, 1935, p. 14).

The fossils from this series consist mainly of graptolites, from which a late Middle Ordovician (late Trenton - early Eden) age was deduced, and some poorly preserved brachiopods representing several genera (Alcock, 1935, p. 14).

Upper Ordovician

Matapédia Series

A band of rocks of Upper Ordovician age extends the length of the peninsula from the southern part of the Matapédia valley to Percé. The rocks in the western half of this band, between the Matapédia valley and the Little Cascapédia river, have been referred to the Matapédia series. Those to the east as far as Percé have been referred either to the White Head or to Pabos formations. Actually there is little basis for this distinction. The Matapédia series at its type locality carries a fauna which, though meagre, shows its close age relationship to the White Head formation. And there is considerable lithological comparison as well. The "Pabos formation" has not as yet yielded a distinctive fauna. The name was proposed to include grey limestones, shaly limestones, and shales exposed in Pabos township, on the Little Pabos river, and on the lower fifteen miles or so of the Grande River. It is, in the writer's opinion, merely a more shaly, and in general somewhat older, phase of the White Head. So far as present knowledge goes these three sets of rock, the Matapédia series, and the Pabos and

White Head formations may safely be placed in one age group, the Upper Ordovician, and referred to as the Matapédia series.

The Matapédia series in the southern part of the present region consists mainly of bluish-grey to dark-grey, light bluish grey - weathering, smooth limestones in beds from one to three inches thick, separated by thin layers of shale. These "dove-weathering" limestones, as we refer to them in our field notes, are now regarded by us as typical of the Upper Ordovician of southern Gaspé. The description given above would apply to the rocks at the type section at White Head Cape. Also, rocks of this type, underlying Silurian or Devonian as the case may be, have been mapped by the writer during earlier field work from the eastern coast to the Upper waters of the Pabos river in Raudin township. They occupy that stretch of the Bonaventure river between the wide Silurian Chaleurs series band on the south and the Silurian that crosses the Bonaventure shortly above the main forks. They are seen again on the Little Cascapédia river between the New Richmond township line and the overlying Devonian to the north. And they are present on the Grande Cascapédia river from about the mouth of the Skimenac upstream for three miles, or to the point where they are overlain by the Silurian. These rocks are sharply folded and broken by numerous local faults.

South of the zone or band of "dove-weathering" limestones the rocks referred to the Ordovician are of a different character and are much less folded. On the Little Cascapédia river they are dark shales for the most part with occasional interbeds similar to the limestones to the north. These shaly beds occupy the lower ground

bordering the river for a mile or so on either side. To the east they are overlain by the Silurian Chaleur series, the contact following along the base of a westward-facing steep slope. To the west, at about a mile from the river, the shaly rocks appear to be underlain structurally by conglomerates, sandstones, and some shales.

Rocks of the latter types occupy the area between the two Cascapédia rivers and between the contact with the Bonaventure formation on the south and, roughly, the New Richmond township line on the north. The conglomerate outcrops are the most conspicuous and zones several hundred feet thick are present. The conglomerate is made up of pebbles and cobbles of common volcanics, locally common white and some rose quartz, rare flint, diabase or diorite, sandstone, quartzite, grit, serpentinized rock, and dark limestone. The matrix of the conglomerate is much the same as the sandstones, shaly, feldspathic, often gritty, and usually calcareous.

The age of these rocks is somewhat in question. Alcock (1935, pp. 23-82) placed the rocks of the northern and eastern part of the area concerned in the Ordovician, and assigned a belt in the southwestern part to the Malbaie formation. The Malbaie is the uppermost member or formation of the Gaspé Sandstone series in the type region of eastern Gaspé. The present writer mapped during two weeks in 1941, a small part of what was refered to the Malbaie and a considerable part of what was referred to the Ordovician, and did not note the evidences given by Alcock for separating the rocks into Devonian and Ordovician. It appears to this writer that they belong in the same series, both from lithological and structural evidence. However, further field work is needed in this area to show up the relations of the rocks in question to the surrounding rocks whose age is more definitely known.

Veryfewfossils, and poorly preserved for the most part, have been found in the Matapédia series in this area. None were found in those parts of the Bonaventure river or the Cascapédia rivers examined by the writer. Alcock (1935, pp. 22-23), however, reports the following:-

Maria township, about two miles west of the Grande Cascapédia river:

> Streptelasma type; Calapoecia sp., Halysites sp.
> bryozoan; Orthis sp; Camarotoechia sp;
> Platystrophia (1) sp; Calymene, 2 sps; Illaenus, 2 sps;
> Proetus sp.
>
> New Richmond township, two outcrops along the road that follows the west side of the Little Cascapédia river, and at the mouth of Mill brook:-
> Atrypa-like form; Sinuites sp; Ctenodonta or Nucula sp;
> "Ceraurus cf. Trotaspis" sp;
> ? Dionide sp; Conularia sp.

Another band of Ordovician rocks, probably also referable to the Matapédia series, is exposed over a width of about two miles in the northeastern part of the area. These rocks are brought up on the Saint John River anticline, and disappear under Silurian strata in Gastonguay township as a result of the westward plunge of the fold.

Jones (1936, pp. 11-12) has described these rocks as follows: "Towards its base ... this series is composed mainly of dark grey limestone of smooth texture in uniform beds, two to six inches thick. Interbedded with these limestones is grey shale, and occasionally massive, grey, argillaceous limestone. Locally, in these lower beds,

there are lenses of dark grey, crystalline and granular limestone containing a few recognizable, and many fragmentary, fossils. Succeeding these beds, stratigraphically upward, there is a zone in which grey argillaceous limestone and shale predominate. Strong cleavage frequently masks the bedding in this zone, but the stratification is in some places indicated by fine bands of lighter colour. Above this shaly zone is another limestone phase in which the beds are usually one to three inches thick. They are of smooth texture and grey colour, weathering in places to alternate pale bluish-grey and yellow bands. There is some shale also in this zone, and the thin limestone beds are usually separated by very thin layers of brownish-grey shale. The uppermost member of the series is probably a relatively thin zone in which shales predominate. This shale zone is not well exposed. Where seen, the rock has a green to greenish-grey colour".

Fossils have been found in this belt at two localities, as follows:-

A. Sirois township, on Sirois brook, about 4,000 feet upstream from the Saint John river (Jones, 1936, p. 12)

Tetradella (?) sp.; Pholidops sp.; Schmidtella subrotunda Ulrich; Laccoprimitia sp.; Bythocypris (?) sp.; aff. Hallatia healeyensis Kay

B. Laforce township, north bank of Saint John river, about one mile east of the Sirois line (Jones and McWerrigle, 1937, p. 10).

Bilobites sp.; Strentis cf. monilifera altosinuata Holtedahl; Triplesia sp.; Coelospira sp.; Dayia ? sp.

Middle Silurian

Chaleur Series (Northrop, 1939)

The type section for the Silurian in Gaspé peninsula is in the general vicinity of Port Daniel. Here the section is divided into seven formations which, grouped together, are known as the Chaleur series. About forty miles to the west of Port Daniel the series again is well exposed along the coast for a distance of two miles westward from Black Cape. Between Port Daniel and Black Cape the series is covered in the coastal areas by the rocks of the Bonaventure formation. Inland of the Bonaventure formation, however, the Silurian underlies a belt up to eighteen miles in width. Much of the structure and stratigraphy of this belt still remains to be worked out. Detailed work has been done only about Port Daniel and Black Cape and in those parts that are readily available from the coastal villages.

A summary of the seven formations recognized in the Chaleur series is given below, in descending order of age:-

Indian Point. Muddy, fine, deep green, reddish-weathering sandstones, interbedded with lenses of yellowish limestone up to three feet thick ---------- 456'

West Point. Three thick-bedded, pink limestone members (upper = 165'; middle = 50'; lower = 200') separated by knobby, reefy limestone and shale ---------- 1714'

Bouleaux. Interbedded greenish and reddish, muddy and arenaceous shales, and thin - bedded limestones formed largely of coral reefs and breccias ---------- 888'

Gascons. Greenish-grey, reddish - to brownish weathering, shaly sandstones ---------- 1890'

La Vielle. Thin-bedded muddy limestones grading upward into thick-bedded, more or less reefy limestones ---------- 405'

Anse Gascon. Conglomerates and sandstones grading upward into the La Vielle formation ----- 332'

Clemville. This formation does not occur on the coast, but is seen inland on the Little Port Daniel river; 112 feet of basal conglomerate followed upward by greenish shales with some sandstone and rare limestone interbeds.---------- 824'

The total thickness of the Chaleur series at Port Daniel is about 6,500 feet. At Black Cape the section comprises 8,400 feet of sediments and 4,600 feet of basaltic lavas.

"In comparing the two successions which were accumulated only 40 miles apart, the Black Cape is seen to have far less limestone than the Port Daniel. Although fossils are locally common in the Black Cape formations, collecting is much better than at Port Daniel. It is curious that, whereas in the Black Cape area the Chaleur seas were overwhelmed by lava flows many thousands of feet in thickness, all evidence of such volcanism is wholly lacking at Port Daniel. Notable also is the fact that at Black Cape the first bed of volcanic ash occurs in the top of the Gascons formation, 2945 feet below the first submarine lava flow" (Northrop, 1939, p.63).

The great thickness of the Black Cape section as compared with that at Port Daniel is accounted for largely by the presence of volcanics in the former. However, the sedimentaries alone at Black

Cape are almost 2,000 feet thicker in total section than at Port Daniel, and most of this difference is owing to the augmentation of the middle portion of the series, namely, "the upper La Vielle, Gascons and Bouleaux equivalents".

The volcanics are of particular interest inasmuch as, along with fossil evidence, they serve as a basis of correlation with the Silurian belt next to the north, in the interior of the peninsula. The first, or lowest, flow comes in 226 feet above the base of the West Point formation. This flow, 80 feet thick, makes the Black Cape headland. Going up the section the succeeding flows vary from three feet to 3,630 feet in thickness. The rock is usually "dark-grey, dark-green in colour, sometimes weathering purplish, and varying from dense fine-grained types to amygdaloidal and porphyritic types. In some places the rock is basaltic and in others andesitic. In the upper few hundred feet of the flow series there are several "intercalated conglomerates, some of which are certainly water-laid".

The list of fossil species found in the Chaleur series is extensive and is not repeated here. (See Northrop, 1939, pp. 81-87). The series is referred to the Middle Silurian, Niagaran, division and is thought to include "the entire span of Middle Silurian time".

Westward from the Black Cape locality the Silurian is missing until the Grande Cascapédia river is reached. Just west of this river and about a mile and a half north of Cascapédia village, a relatively narrow band of Silurian is shown on Alcock's map (1935) as extending a few miles to the southwestward from the river. No description of these rocks is given other than that Silurian shales, limestones, and a white, locally quartzitic, sandstone are present, and that all these rocks carry fossils. (Alcock, 1935, p. 22).

Mount Alexander Belt.

The Chaleur series described above lies on the southern limb of a major anticlinal structure. The east-west axis of this fold lies within the belt of Upper Ordovician, Matapédia series, rocks already described. Silurian rocks appear again to the north of the Ordovician on the northern limb of the anticline in what may be called the Mount Alexander Belt.

The greatest development of Silurian rocks in this belt is in the southern part of Vondenvelden township and the northern part of Raudin township, where the belt is up to seven miles wide. Here the rocks are arranged in an irregularly basin-shaped synclinal, with minor fold structures on the northwest. These structures are localized in the area of greatest width, and are mainly responsible for that greater width as compared with the continuation of the belt to the southwest.

The Silurian rocks in Vondenvelden and Raudin township have been described by Jones (1936). In summary, three zones are present, as follows, in descending order:-

Zone 3. Mainly soft greenish-grey, argillaceous limestone and grey to greenish-grey shale. Grey limestones in thin and massive beds, highly fossiliferous, are present near the base and also some light grey quartzite and some dolomitic limestone. The presence of a few thin zones of red shale, and possibly some interbeds of volcanics is suggested by débris.

Zone 2. Volcanics, mostly dark greenish-grey to mauve, massive, porphyritic andesites. Phenocrysts of labrodorite up to one - half inch long are locally abundant, occuring in a matrix of labrodorite with a minor amount of augite.

Some of the coarse volcanics have scattered amygdules, up to three-eighths-inch diameter, filled with calcite and, rarely, banded silica resembling opal. Occasionally there are vugs lined with quartz crystals. Quartz and epidote are sometimes present in small patches and veinlets. Layers of agglomerate up to one hundred feet thick are present in which rounded to semi-angular masses of porphyritic andesite are included in a matrix of similar material. Volcanic breccias were observed in a few places. In the vicinity of Mount Alexander and eastward on the same band the volcanics appear to be a succession of many thick flows. The western part of this band, and the Mount Observation band, however, includes sedimentaries - dark greenish-grey limestone (sometimes fossiliferous) and shale - as well as volcanic flows.

The thickness of the predominantly volcanic zone is probably "somewhat in excess of 3,000 feet". (Jones, 1936, p. 14).

Zone 1. Limestones and shales of various types; the limestones are generally soft, light grey to dark greenish, and thin-bedded to massive; the shales vary in colour from dark green through green and grey to brownish-grey. A little limestone conglomerate is present, and the débris suggests the presence of beds of red shale, and of calcareous sandstone. Occasional layers of fine grained, pink coloured rocks may be volcanic flows interbedded with the sedimentaries.

The thickness of this series in Vondenvelden and Raudin townships can not be estimated accurately owing to scarcity of outcrops along any given section line and to the possibility of folding being concealed where outcrops are rare. Nevertheless, judging from the Mount Alexander map (Jones, 1936), a thickness of 5,000 feet is suggested for zone 1, and at least an equal and probably a greater thickness for zone 3. Jones has assigned a thickness of 3,000 feet or more to the volcanics, our zone 2. Thus, the total thickness of the series may be placed at 13,000 feet or more. This measurement appears to come fairly closely into line with that of the Black Cape Silurian section.

The lists of fossils from these rocks provided by Jones (1936, pp. 14-15) have been analysed by Northrop (1939, pp. 94-95). While Northrop could find no close comparisons with any of the individual formations of the Chaleur series he stated that "the Silurian strata of the Mount Alexander map-area may represent practically the entire Chaleur series".

The Mount Alexander belt extends twelve miles southwest from the area described to the East Branch Bonaventure river. Here, the width of the belt is about three miles, a width that apparently was maintained from near the western edge of the area mapped by Jones (1936). However, three miles further westward, on the West Branch Bonaventure the width is reduced to two miles, and some seven miles further in a westerly direction the rocks of this belt disappear.

The volcanics of the belt form a fairly conspicuous range of hills where they cross the branches of the Bonaventure. From the fire tower hill, west of the West Branch, a length-wise view of the range may be had. To the east it can be followed to mounts Alexander and

Observation. To the west, however, it can be followed for only five miles or so, where it sinks down abruptly. These topographical features, and the absence of the Silurian on the Little Cascapédia river, form the bases for the claim that the Mount Alexander belt rocks are cut out about in the position where shown on the map.

Where the belt crosses the two main branches of the Bonaventure river it may be separated into two zones. The lower zone consists mainly of sedimentaries and the upper zone mainly of volcanics. The rocks of the lower zone are very meagrely represented along the two branches and only a few scattered outcrops away from the rivers were examined. Apparently this zone is made up mainly of thinly interbedded greenish-to brownish-grey shales, and grey to dark grey, light bluish-grey weathering limestones. Diabasic sills intrude the sedimentaries in some places, and some interbedded volcanics also may be present. The volcanics of the upper zone seem to be essentially the same as those in Vondenvelden township. In some places they show a rather poorly developed banding. Here and there inclusions of sedimentary rock were noted. Occasional bands of shale, limestone, including some coral limestone, and calcareous sandstone are interbedded with the volcanics. Some agglomerate was noted towards the top of the zone, particularly, along the valley of Cotton brook.

Where the Mount Alexander belt crosses the Bonaventure rivers the rocks are not folded but seem to maintain a northerly dip averaging about 70 degrees. This dip, coupled with the width of exposure, gives a roughly estimated thickness on the East Branch Bonaventure of 3,500 feet for the lower, sedimentary zone and 9,000 feet for the upper, volcanic zone or a total thickness for the

series of 12,500 feet, more or less. Thus, while the total thickness of this section roughly approximates that in Vondenvelden township and also that at Black Cape the apparent thickness of the volcanic zone is much greater than at either of the latter localities. It is possible that this greater thickness is due to repetition of the volcanics by folding. It may be, for example, that the axis of the main syncline in Vondenvelden township (see map) should be continued westward so as to cross the Bonaventure branches. This is a question that only further field work may answer. In the meantime it can only be said that we have no direct evidence of such repetition, and that the example of contrast as between the Black Cape and Port Daniel sections, separated by forty miles, should be kept in mind.

As stated above no strata of the Mount Alexander Silurian belt were seen to outcrop on either branch of the Little Cascapédia river. That the Silurian formerly continued across the present position of these branches is suggested by fragments of Silurian-type rocks in a thin band or lense of conglomerate seen on the West Branch Little Cascapédia river at or towards the base of the Devonian series. Also, the band apparently is represented on the Grande Cascapédia river. On this latter stream greenish shales, in part well banded, are exposed for 550 feet along the river. These rocks are of Silurian aspect, and as they occupy the position of the Silurian, between Ordovician and Devonian series, they have been mapped as Silurian. Also, débris of volcanics, similar to the volcanics in the eastern part of the belt, is common in the road cuts in this locality.

Saint John River Belt.

The Saint John River belt of Silurian rocks roughly parallels the Mount Alexander belt at a distance of from six to twelve miles to the north. It is brought up on the Saint John River anticline. The westward plunge of this fold carries the Silurian rocks under the Devonian as the band approaches or crosses the West Branch Bonaventure river. In the eastern part of Gastonguay township and for a short distance into Sirois township the Silurian shows on both sides of the fold. But through most of Sirois township it shows only on the north side. Its absence on the south side has been explained (Jones, 1936, p. 24) through faulting. Eastward of the map area it shows again on both sides of the fold for about fifteen miles before again disappearing under Devonian rocks with the eastward plunge of the structure.

The Silurian rocks in Sirois township have been described by Jones (1936, pp. 16-17). "The basal beds of the series are of medium to coarse grained limestone-grit with some interbedded calcareous sandstone, shale, and crystalline limestone". This zone "is succeeded upward throughout the remainder of the series by soft, greenish-grey, argillaceous and finely arenaceous limestones with which are interbedded grey and greenish-grey shales and arenaceous shales. Occasionally, near the base of the series, above the limestone grit and possibly below it also, there are a few thin zones of red and green shale". Jones suggests the possibility that some of the upper part of the series mapped by him as Silurian may be Lower Devonian (St. Alban). The graptolie Monograptus cf. regularis Tornquist was found towards the base of the series, and near the middle M. cf. regularis, M. cf. tumescens Wood, cf. Ambonychia undata, and cf. Grammysia were collected.

About two miles west of the area mapped by Jones, on the South Fork of the Saint John and one of its small tributaries, the section is as follows, in descending order:-

6. Greenish-grey, soft, argillaceous and finely arenaceous limestones with some greenish-grey shales.
5. Limestones as above but thinly bedded.
4. Limestone grit, carrying some fossils including a Monograptus.
3. Light greenish-grey, well-banded limestones, with diabasic dykes or sills.
2. Red and green shales.
1. Base not reached.

The oldest rocks exposed on the axis of the anticline where the belt crosses the East Branch Bonaventure are grey, light bluish-grey weathering limestones in beds averaging one inch thick separated by thin shaly layers. Overlying these rocks is a rather indefinite zone of greenish-grey shale, calcareous sandstone, and limestone grit. This in turn is followed by a thick series (well exposed on a burnt-over hill on the east side of the river, about a mile north of the county line) of finely banded and cross-bedded, greenish-grey, fine calcareous sandstones or sandy limestones. Occasional non-banded beds up to a foot thick of fine to medium calcareous sandstone are present, and also a few beds of limestone grit. Well rounded grains of quartz are common in the grit. A bed or lens up to two feet thick of intraformational conglomerate was noted. Graptolites, apparently all of the genus Monograptus, were seen in profusion in three different layers. Near the anticlinal axis dykes or sills of porphyritic diabase, with phenocrysts of grey feldspar up to three-quarters inch long, intrude the sedimentaries.

On the West Branch Bonaventure a wide gap in the exposures marks the position where the Silurian should appear and no outcrops of this series were noted. Débris in the river suggests its presence, however, and the Silurian is presumed to cross this river and to plunge out under the Devonian before the East Branch Little Cascapédia is reached.

Joshua Brook Belt.

A fourth belt of Silurian rocks extends from Joshua brook on the Grande Cascapédia river to the North Branch of the Saint John river, a distance of forty miles. In this distance the belt varies from one to four miles wide. It is at its narrowest at Joshua brook and at its widest near its northeastern end, shortly before it disappears under the Devonian. How much farther the belt extends to the southwest is not known.

The stratigraphic succession of the rocks in this belt has not been determined in any detail. In general, however, three zones are recognized, not necessarily of equal thickness. The lowest zone, noted on all the river sections from the West Branch Bonaventure to the Grande Cascapédia, is made up mainly of grey, more or less argillaceous limestones and grey to greenish-grey shales in beds from one-quarter inch to several inches thick. Some of the rocks included in this zone resemble Ordovician types. This is followed upward by a zone of greenish-grey limestones and shales, red and green shales, and occasional beds of limestone grit. The upper zone consists mainly of greenish-grey, well banded, fine, calcareous sandstones to sandy limestones. Some greenish-grey shales also are included in this upper zone.

Fossils do not seem to be plentiful in the rocks of this belt. Near the eastern end of the Bathurst road a few poorly preserved corals were seen in greenish-grey, shaly limestone and shell fragments were common in a bed of limestone grit. One specimen of Monograptus was collected from this locality, and another was found on the west Branch Bonaventure one-third mile above the Bathurst road bridge.

Lake Matapédia Series

Three formations have been recognized in the Lake Matapédia Series. A summary of these formations is given below, in descending order (Crickmay, 1932, pp. 375-376; Alcock, 1935, pp. 44-50):

Saint Léon formation:	3. Grey and reddish, sandy and calcareous shales ----------	?-1,500'+
	2. Limestone conglomerate (intraformational)----------	10' +
	1. Grey, argillaceous siltstones, in places calcareous with thin limestone beds and lenses towards the base-----	1,000'+
	Total thickness -----	2,500'+
Savabec formation:	3. Unexposed ----------	205'
	2. Grey, dense, argillaceous limestone ----------	120'
	1. Sandy limestone and dolomite, often cross-bedded ---------	140'
	Total thickness -----	500'+

Val Brillant formation: Generally a white sandstone or quartzite, with some pale brown to pink; alternately thinly and thickly bedded.---------- 175'±

All of these formations carry fossils, and faunal lists are provided by Crickmay, Alcock, and Northrop. The last-mentioned (1938, pp. 92-93) has revised and analysed the various lists and suggested correlations with the Chaleur series. The total thickness of the Lake Matapédia series is somewhat in excess of 3,000 feet.

The two lowest formations of this series are exposed on the west shore of Lake Matapédia with their type localities at the respective villages from which they take their names. The uppermost formation, the Saint Léon, is also exposed west of the lake but does not appear on the lake shore. Its type locality is about six miles south of the lake, north of the village of Saint Léon in the Humqui (Amqui) river valley. Here it is brought up on an anticlinal, and, further south two other anticlinal structures bring this formation to the surface. Some two miles north of Causapscal the Albertville anticlinal carries the Saint Léon across the Matapédia river. The eastward plunge of this fold carries the Saint Léon under Lower Devonian limestones about five miles east of the Matapédia river. The formation is again exposed in the Causapscal river two to three miles eastward of Causapscal village, and it apparently continues eastward along an anticlinal fold for at least twelve miles before plunging under the Devonian.

Eastward from Lake Matapédia the base of the series passes close by Saint Tharsicius, in Blais township, between which settlement and the lake the series has not been traced. Near this settlement the Sillery-Silurian contact swings sharply to the north-northeast, and, following this course for about seven miles, it runs into the valley of the Matane river. Here the contact (now the Shickshock-Silurian) swings sharply to the east-northeast to parallel the southern base of the Shickshocks.

The succession of the Silurian series south of the Shickshocks generally is similar to that at Lake Matapédia. There are certain differences, however, as noted below. The average width of the belt underlain by the Silurian to the south of the Shickshock range is four miles. An appreciably lesser width is found only near the junction of the Trout and Matane rivers. Here faulting has narrowed the spread of the Silurian to a mile or so. The most complete section is on the Cap Chat river. Here the width of exposure and the dip of the beds suggests that the series is about 8,000 feet thick, whereas in the Lake Matapédia area the total thickness is about 3,000 feet. In this estimate of thickness, the writer has discounted the sharply folded zone of Silurian that is up to 2,000 feet wide and borders the Shickshock range. Southward from the folded zone the dips are consistently to the south and over a width of two miles they average about fifteen degrees. Continuing southward the dips steepen sharply to as much as sixty degrees and then gradually flatten to a dip of fifteen degrees where the Silurian passes under the Devonian. The sharp change in dip about the mid-width of the section warns of possible faulting and that the apparent thickness may be greater than the true thickness. The only other

reasonably complete section across these measures is on Go-Ashore brook. Here the width of exposure is three and one-half miles, and the folded zone against the Shickshocks is about a mile and a half wide. The thickness of the series to the south of the folded zone appears to be about 6,000 feet. Here again, however, there are sharp changes in dip which warn of possible repetition through faulting.

Quartzites similar to those of the Val Brillant formation were noted at several but scattered localities south of the Shickshocks as far east as Go-Ashore brook. They were not seen on the Salmon Branch, but they have been reported from points further to the east as on the Sainte Anne and Madeleine rivers. The quartzites occur towards the base of the Silurian series, but whether they actually are the basal rocks is in doubt. At some localities, particularly on the Cap Chat waters, it would seem that the quartzites are underlain by other Silurian sedimentaries. In these places a zone 1,000-2,000 feet wide of sharply folded rocks lies between the quartzites and the Shickshocks. However, it seems apparent that this folded zone resulted from the Silurian being thrust against the Shickshocks, and it is probable that the thrusting was followed by down-faulting of the Silurian. These movements have confused the succession in the lower part of the series, and it may well be that at least some of the rocks that appear to underlie the quartzites actually overlie them. In fact, it was only in this confused zone that we found any suggestion of the Sayabec formation so far as rock types were concerned. The quartzites are light grey to pink in colour, medium in grain size, and generally massive. They are

probably less than 100 feet thick. Logan (1863, p. 411) gave 50 feet as the thickness of the quartzite on the Cap Chat, but this is a minimum estimate. Logan (1863, p. 413) also referred 70 feet of quartzites at the mouth of the Tomagodi ("Tawagadie") on the Matane river to the Silurian, but these we now place in the Ordovician.

The rocks overlying the quartzites, to the top of the Silurian section, are greenish-grey, shaley to sandy limestones for the most part. Dark grey calcareous shale occurs shortly above the quartzites on the Cap Chat and greenish-grey shale zones are fairly common throughout the series. Towards the top of the section there is a zone about 1,000 feet thick of greenish-grey, well banded, fine-grained, calcareous sandstone to sandy limestone, with some interbeds of reddish to brownish shale, of greenish-grey shale and, rarely, of dark grey shaly limestone. Ripple-mark and and cross-bedding were noted here and there in the more sandy beds. This zone is well shown along the Hammermill road between Simoneau and Lubin brooks. In general, the section above the quartzites seems to correspond to the Saint Léon formation.

The graptolite Monograptus was found in some quantity in rocks of the sandy zone referred to above, on the Hammermill road about opposite the junction of the Trout brook with the Cap Chat. This fossil was found also towards the apparent base of the series on the northeast Branch Cap Chat about a mile below, and again a thousand feet above, the mouth of Wilson brook. Fossils were also found in and above the quartzites on the Cap Chat river. These have not yet been determined. It was from this locality that Logan (1863, p. 411) reported the following forms; the list given below is as edited by Northrop (1959, p. 92):

Ptilodictya sp.

Atrypa reticularis

Leptaena rhomboidalis

Orthis davidsoni (?Dolerorthis flabellites)

Orthis, n. sp.

Schuchertella pecten

Stricklandia brevis

S. lens (S. davidsoni?)

Strophomena antiquata (?S. radi reticulata)

Calymene blumenbachi

Encrinurus sp.

Eophacops orestes

"Logan correlated this fauna with the upper part of the Anticosti group. Twenhofel (1928, p. 75) suggests a correlation with some part of the Jupiter. The above list would suggest an equivalence with the La Vielle" (Northrop, 1939, p.92).

The rocks in all of these belts are referred to the Middle Silurian, no Lower or Upper Silurian having been recognized.

Devonian

Introduction

The mapping of the Devonian sedimentary rocks, and their subdivision into the various series, formations, and members shown on the accompanying map has depended of necessity on lithology, apparent continuity, and general structure as the means of correlation. While some fossils have been found these seldom have proved to be sufficiently diagnostic to serve as a basis of correlation within

the Devonian group. The relationships shown between certain formations may seem in some instances to be anomalous. Such apparent anomalies, however, are to be explained on the basis of gradation from one type of sedimentary formation to another either laterally or vertically, and sometimes within short space limits. If this explanation is not adopted the mapping must be explained in the instances concerned by complicated faulting, of which direct evidence is lacking. It should be noted that abrupt gradations, and variations in thickness, from one locality to another are not confined to the Devonian in Gaspé but appear also in the Silurian.

Lower Devonian

Conglomerate Formation at Black Cape. (Northrop, 1939, pp. 14-15)

A conglomerate formation, assumed to be Lower Devonian in age, occurs on the Chaleur coast at Black Cape. It extends eastward for a quarter of a mile from the east end of the Silurian volcanics section. Also, it is exposed for about 2,000 feet along the main highway a mile or so east of Black Cape station. The strata, in general, dip steeply to the south or southwest. They are overlain by Bonaventure beds which dip southerly at much lesser angles than the Lower Devonian.

"The pebbles and boulders of these beds consist of Silurian limestones, shales, and several types of extrusive rocks.....

"The discrepancy in attitude of the post-Silurian rocks was noted by Logan (1844; 1865, p. 447), who regarded both series as Bonaventure in age. Later, Ells (1883) assigned a Devonian age to the lower series and a Lower Carboniferous age to the upper. The writer agrees with Alcock that the lower series is probably of Lower Devonian age".

Volcanics and Sedimentaries, Maria township

The map accompanying this report follows Alcock (1935,map) in showing a band of volcanics and sedimentaries in Maria township. This was not examined by the writer, and Alcock does not describe it in any detail. In the southwestern continuation of the band, in ranges II and III of Maria township, latite "in the form of a volcanic neck and associated flows" are reported (Alcock, 1935, p. 72).

Bon Ami Formation

The Bon Ami formation has not been recognized to the east of the Grande Cascapédia river so far as the present reconnaissance is concerned. In eastern Gaspé this formation is an important part of the Devonian section and locally is up to 4,000 feet thick. It does appear, however, on the Salmon Branch of the Grande Cascapédia in a mile-wide band with a thickness of about 1,600 feet. On Go-Ashore brook, seven miles to the west, the Bon Ami band is about three miles wide. This increased width is the result of generally more gentle dips as well as of flexures or flat folds, and the thickness appears to be about the same as on the Salmon Branch. Shortly to the west of Go-Ashore the formation settles down to a fairly uniform southern dip and continues westward for about fifteen miles as a band a mile or less in width and with an apparent thickness of 1,200 feet or more. Further west the band expands rapidly with the introduction of folding and it is difficult to estimate the true thickness. In the Matapédia valley the Bon Ami (Causapscal formation of Crickmay, 1932, and Alcock, 1935) appears on the northern and southern sides of the Albertville anticlinal, and extends eastward from the valley to the Lake Branch before

disappearing under younger formations. Crickmay (1932, p. 376) and the present writer are agreed in estimating the thickness of this formation at about 3,000 feet in the Matapédia valley.

The rocks of the Bon Ami formation in this region are mainly dark grey to brownish-grey, rather soft, shaly limestones in six-inch to three-foot beds. Interbeds and interzones of dark calcareous shale are common and there are occasional interbeds of harder limestone and of dark greenish-grey, calcareous sandstone. In the Matapédia valley and Causapscal river areas the Bon Ami rocks are characterized by a strong cleavage, a feature which occurs only locally in other Bon Ami sections.

Fossils were found at two localities in the Bon Ami on the Salmon Branch, one near the base and one towards the top of the formation. In the upper horizon the forms noted were one specimen of Leptocoelia flabellites? and two specimens of Chonetes sp., In the lower horizon both of these forms were common, the former particularly so, and were associated with occasional small, straight cephalopods, small brachiopods, Dictyonema-like graptolites, tribolite fragments, Conularia sp., and a few plant fragments. Rare and scattered specimens of Chonetes were found by the writer in a few places on the Causapscal river, along with one specimen of Leptocoelia flabellites? and a small linguloid brachiopod. Three specimens of Chonetes were found near the base of the Bon Ami on the Trout river. In the Matapédia valley Crickmay (1932, p. 376) found the following forms in the "upper part" of the formation. Rodevonaria hudsonicas Clarke, Coelospira dichotoma Hall, Leptocoelia cf. L. acutiplicata (Conrad), Spirifer modestus Hall.And, in additon,

Alcock (1935, p. 69) lists the following from "Near the top of the formation, south of Causapscal":

Leptaena rhomboidalis (Wilckens), Amphistrophia continens Clarke, Rensselearia sp., Spirifer cf. S. vanuxemi Hall

On the basis of these faunas Crickmay and Alcock were inclined to correlate their "Causapscal" formation with the Grande Grève of eastern Gaspé. This inclination was made all the more natural by reason of their conclusion that the Causapscal immediately underlay the Heppel ("Gaspé sandstone") formation. It is true that south of Causapscal village the Heppel and the "Causapscal" are in contact, but this was brought about by the Heppel being down-faulted against the Causapscal to the almost, if not quite, elimination of the Grande Grève. The three formations are seen in their true succession on the Causapscal river and eastward from the river to Lake Casault. Contrary to the interpretations of Crickmay (1932, see Fig. 4, p. 378) and Alcock (1935, see Fig.9, app. p. 104) the Heppel formation does not occupy the synclinal area extending southeastward from the Causcapscal river to the Matapédia river. Rather it is found on this synclinal structure only to the east of the Causapscal river. And, actually, that part which was mapped as Heppel is Grande Grève. Even in the type areas of eastern Gaspé there are few sections which show the general succession of Bon Ami through Grande Grève to "Gaspé sandstone" better than here. Furthermore the inclusion of the rocks which we maintain are Grande Grève in the Heppel formation caused Alcock (1935, p. 84) to postulate certain rapid sedimentation changes which, under our interpretation of the succession, are not required. Also, the large fauna collected from the falls on Causapscal river (Alcock, 1935, p. 85) is stated

to be "allied to that of the Grande Grève limestone of ... eastern ... Gaspé". And, it seems apparent that the correlation of the rocks at the falls with the Gaspé sandstone is based on the presence of only two out of thirteen specifically identified forms, - two species which Alcock at that time had reason to claim were "confined to the Gaspé sandstone". These two species, Leptostrophia blainvillei and Spirifer gaspensis, are now known to be present in both the Grande Grève and the Gaspé sandstone. The rocks at the falls are included by us in the Grande Grève formation.

Thus, the stratigraphic succession, the lithology, and the continuity of the Causapscal formation show that it is to be correlated with the Bon Ami. The faunal evidence that the Causapscal is nearer Grande Grève than Bon Ami in age is not strong and should be reconsidered in the light of our interpretation of the section.

Grande Grève Formation

The Grande Grève formation occupies wide areas to the south of the belt of Bon Ami described above, and, in one belt, can be traced continuously from the Salmon Branch to the Matapédia valley. It is well exposed on the axis of the Lac au Saumon syncline where this fold crosses the Causapscal river, and also on Miner brook, some twenty to twenty-five miles to the east. In both of these sections the formation appears to be about 4,000 feet thick. On the Salmon Branch of the Grande Cascapédia the formation is estimated to be in excess of 3,000 feet thick. Good exposures and local sections of the formation may be seen in the area about the Federal mine, in Lemieux township. Gill and Auger (1943, p. 459) have referred to these rocks as the "Federal sediments". Their thickness has not been determined. East of the Grande Cascapédia river the Grande Grève

has not been mapped as a formation although rocks of Grande Grève type appear in many places and in some are in zones up to 1,000 feet thick. These occurrences will be referred to later in this report under the heading of York Lake series.

The rocks of the Grande Grève formation are mainly dark grey to brownish-grey, hard, silty limestones to calcareous siltstones. They are well-bedded throughout, the beds varying from two to eight inches thick on the average and being separated by thin layers of silty shale. Weathered débris of the hard limestones or siltstones is characteristically light grey in colour, and when weathered the silty nature of the rock often is very apparent. Occasional beds or zones of soft shaly limestone to calcareous shale, similar to some of the Bon Ami rocks, are interbedded. In the upper part of the formation fine-to medium-grained, greenish-grey sandstones are sometimes seen interbedded with the siltstones. The presence of such sandstones in the Grande Grève foreshadows the changing conditions leading to the deposition of the "Gaspé sandstones".

Fossils are not common in this formation but collections have been obtained at a few localities. Alcock (1926, pp. 40-41) reports fossils from two localities in the Federal Mine area:
1. West of the Sainte Anne trail, about half-way between the Federal mine and Lake Sainte Anne. - Atryna reticularis, Spirifer murchisoni, S. gaspensis, S. arenosus, Schuchertella becraftensis, Actinopteria sp., Tentaculites olongatus, Phacops logani.
2. In limestone interbedded with shales on the side of the hill near the mine bunkhouse.- Crinoid stems, Coelospira concava, Meristella cf. Champlaini, Leptostrophia blainvilli.

In this area also Auger (Personal communication, 1944; identifications by T.H. Clark) found following in an outcrop 1,300 feet N. 35°E from Brandy Brook tunnel entrance:

Chonetes sp. aff. C. antiopa Billings, Leptocoelia flabellites Conrad, Lingula sp. close to L. artemis Billings, Orbiculoidea sp., Proetus phocion Billings.

A small collection of fossils was found by the writer in Grande Grève débris on the Lacroix road about a mile east of the trail leading to the Lake Branch. A few fossils were collected by us from this formation on the Causapscal river. Alcock (1935, p.85) records the following from "the falls on Causapscal river", from rocks which he considered as Heppel but which we have placed in the Grande Grève: Zaphrentis sp., Dalmanella lucia Billings, Rhypidomella logani Clarke, Stropheodonta sp., Leptostrophia blainvillei (Billings), L. cf. magnifica Hall, Schuchertella becraftensis (Clarke), Fodevonaria cf. billingsi Clarke, Chonetes cf. hemispherica Hall, Beachia cf. suessana (Hall), Rensselearia cf. ovoides (Eaton), Camarotoechia aff. oriskania Rowe, Spirifer gaspensis Billings, S. aff. plicatus (Weller) Meristella aff. lata Hall, Modiomorpha sp., Pterinia sp., Platyceras sp., Dalmanites sp.

Both the Bon Ami and the Grande Grève formations are considered to be Lower Devonian, Oriskany, in age. The relations between the two formations are conformable, and, in fact, one formation grades into the other.

York Lake Series

The York Lake series, so named in 1935 by Jones, was introduced to include a set of rocks which, in the area then being mapped, lay between the "Gaspé Limestone" series" and the "Gaspé Sandstone series". The York Lake series was not a distinctive unit but included limestones similar to the underlying Grande Grève

and sandstones and shales similar to the overlying York River as well as a few conglomerate interbeds. The base of the series was placed at the first appearance of limestone. Essentially, therefore, in the type area, the York Lake series is a gradational zone, 4,000 or more feet thick (Jones, 1935) between the Grande Grève and the York River formations.

In the present region, east of the Grande Cascapédia river, the writer assigns to the York Lake series wide areas of sedimentaries, which, in fact, comprise the bulk of the Devonian so far as areal distribution is concerned. There is little evidence of this series west of the Grande Cascapédia. Also assigned to the York Lake series is a zone of volcanics and sedimentaries which has a rather irregular distribution, due to folding, in the northwestern part of the map-area. These correlations are made in spite of the fact that, as indicated by the mapping, the stratigraphic position of the zones here does not conform strictly with that of the York Lake series in the type area. The reasons for the correlations are given below.

Sedimentaries

Devonian rocks occupy much larger areas in south-central Gaspé than was supposed prior to the present investigation. Alcock, for example, has stated (1935, p.23) that Ordovician rocks extend up the Grande Cascapédia river from near Cascapédia village to Joshua brook, "where they disappear under Devonian strata". Actually, as has been shown above, a band of Silurian rocks crosses this river about eight miles above Cascapédia village, and a second band crosses it some twelve miles further upstream at Joshua brook. The twelve-mile zone between the two belts of Silurian rocks is underlain by rocks of Devonian age. Also, wide belts on the main branches of

the Little Cascapédia and Bonaventure rivers, formerly placed by earlier geologists (Murray, Low, Ells) in the Ordovician are here referred to the Devonian.

It is not surprising that this confusion of Ordovician and Devonian rocks came about. The greater part of the rocks shown on our map as York Lake sedimentaries well might be looked upon as Ordovician if their general lithological characters and the structural confusion within their ranks, as well as prevalent strong cleavage, are used as age guides. Furthermore, fossils are rare and the gaps between known fossil localities are very wide. However, when large areas of these rocks are mapped, even in reconnaissance fashion, their general stratigraphic and structural relations become clear.

The Joshua Brook anticlinal, on which Silurian rocks are brought up, separates the Devonian sedimentaries into two areas characterized by somewhat different groups of rocks so far as types are concerned. Those to the north of the anticlinal are mainly dark limestones of the Grande Grève type with some interbeds of greenish-grey sandstone varying from fine to medium in grain and also some interbeds of greenish-grey shale. In general this corresponds to the lithology of the York Lake series. However, here the series appears to rest directly on the Silurian, although contacts between the two groups were not observed. Also, in the western part of the region, volcanics become interbedded with the upper part of the sedimentaries. And, between the West Branch Little Cascapédia and the Grande Cascapédia, the rocks referred to the York Lake apparently grade laterally into the York River formation, while on the Salmon Branch the York River appears to be absent and

the York Lake is followed directly by Battery Point types of sediments. This is the interpretation followed on the accompanying map and it appears to the writer that the only other interpretation possible would be one involving complicated faulting, of which little evidence was noted.

The rocks to the south of the Joshua Brook belt of Silurian are dark, soft, calcareous shales to shaly limestones for the most part. In some places these rocks are massive but they frequently show thin arenaceous bands as well as ribbon-banding due to colour differences. Interbeds to interzones of greenish-grey, medium-grained, feldspathic and usually calcareous sandstones are fairly common and often are accompanied by beds of dark greenish-grey shale. Here and there interbeds of dark, hard, argillaceous limestone a few inches thick were noted. Also present are a few beds up to ten feet thick of small-pebble conglomerate. In these the pebbles are well-rounded and mostly quartz, with some jasper, chert, and volcanics. Towards the base of the series in some places a zone of hard, dark, well-bedded limestones, suggestive of the Grande Grève type, was noted. Rocks of this type are brought up on the anticlinal in Mourier township, where they cause "The Narrows" on the East Branch Bonaventure.

The strata to the south of the Joshua Brook anticlinal, unlike those to the north, are strongly cleaved for the most part. The cleavage is generally of the flow type, but in the limestone at "The Narrows" a very pronounced fracture cleavage has produced layers one to two inches thick which easily may be mistaken for bedding. The rocks are strongly drag-folded almost throughout.

The banding in a shaly zone several hundred feet thick towards the middle of the series shows such intricate folding that it does not seem reasonable to attribute it all to post-consolidation movements. Rather it would seem that movement must have taken place within this zone shortly after deposition and before the muds were completely consolidated.

The above description applies to the wide belt of Devonian sedimentaries extending from the Grande Cascapédia to the eastern border of the area. It applies also to the subsidiary belt lying between the Joshua Brook and Saint John River bands of Silurian as far east as the East Branch Bonaventure. What the sedimentaries are like between the East Branch Bonaventure and the South Branch of Saint John river is not known. However, on this latter stream and for some miles to the east the rocks are referred by Jones (1936, pp.20-21) to the Bon Ami and Grande Grève formations.

The wide belt of sedimentaries extending from the Grande Cascapédia river to the eastern border of the map-area can be followed eastward from Vondenvelden township beyond the limits of the map for about thirty-five miles. It extends through Power, Joncas, and Fortin townships into Malbaie township, areas that have been mapped in some detail by the writer. Throughout the greater part of this eastward extension of the belt these sedimentaries are underlain, on both flanks of the broad syncline in which they occur, by the Lower Devonian Grande Grève formation. Locally the contact between the two is an erosional unconformity. To the east, on the axis of the syncline, this series plunges under, but also apparently is interfingered with, the York River formation. Thus, in much of the eastward extent of this series it occupies the position of the York Lake series in its type section.

As this belt is traced westward the underlying Grande Grève formation becomes reduced, and in places appears to be absent, either as a result of faulting, or erosion, or non-deposition. Also, the Bon Ami and St.Alban formations disappear. Thus in the present area the sedimentaries rest either directly on the Silurian or are separated from that older group by a narrow band of dark, hard limestones seldom more than 1,000 feet thick, - all that is representative so far as type of rock is concerned of the Gaspé Limestone series.

The normally overlying York River sandstones have not been found in contact or even in close relation with the rocks of this main belt in this map-area. The nearest approach of the two sets of rock is on the Grande Cascapédia river where York River sandstones occur to the north of the Joshua Brook anticlinal and rocks of the series in question occur to the south of that fold. As stated above, and unless faulting interveneș, the York River sandstones on the north side of the fold appear to grade into the sedimentary - volcanic series exposed in strike with them on the West Branch Little Cascapédia river.

In summary, the rocks which we have assigned to the York Lake series in this region occupy a stratigraphic position between the Silurian series and the Battery Point formation of Lower or Middle Devonian age. The series appears to correspond in part with the Bon Ami and Grande Grève formations, but also it seems to overlie or overlap those formations. Similarly it appears to underlie the York River formation in part but also to grade into that formation laterally. Such relationships could be explained on the basis of separate basins of deposition, or of more or less

separated areas in which, during the same time period, different conditions of deposition prevailed.

Volcanics and Sedimentaries

A zone of volcanics and sedimentaries, interbedded, occupies an area of irregular outline in the northwestern part of the map-area. The volcanics vary from basic to acid in composition; they are usually porphyritic, and the basic types frequently are amygdaloidal. Zones of volcanics vary from a few feet to several hundred feet in thickness. The thickest zones appear to underlie the area west and south of Lake Sainte Anne and that around the limestones in which the Federal Mine is located. In these localities sedimentaries are relatively scarce. Going away from them the sedimentaries increase and the volcanics decrease in quantity. Also, it seems to be a general rule that the volcanics become more acid towards the eastern boundary of the volcanic - sedimentary zone. The interbedded sedimentaries vary from sandstones and shales to hard, dark, well-bedded limestones that are suggestive of the Grande Grève formation.

The volcanics about Lake Sainte Anne and the Federal Mine area have been described by Alcock (1926, pp.45-46). "The rocks present considerable variations. Some are dense and black; others are distinctly porphyritic with lath-shaped feldspar crystals in a dense matrix. Some of them weather reddish brown. Amygdaloidal varieties are seen at a number of places ..... The amygdules consist for the most part of calcite, and commonly have a greenish coloured border composed of the chlorite, delessite ..... Quartz also serves as an amygdule filling, but in minor amounts". Alcock, also stated that some dense, dark acid volcanics, resembling the basic types, are present in these areas and that two localities were known where

light-coloured (light grey, light brown, and pink) acid volcanics outcropped. The light-coloured volcanics sometimes showed flow structure, and in places contained vugs lines with quartz crystals or filled with agate. Gill and Auger (1943, p.459) report that "The lower part of the series appears to be dominantly basic, the upper part dominantly acidic. The thickest section exposed is in mount Lyall, suggesting that the main source of the flows was somewhere near there".

A portion of the volcanic zone to the south of the limestone area about the Federal Mine was described by Jones (1929, pp.13-17), who confirmed much of Alcock's descriptions. Alcock and Jones each refer to one locality, apparently not the same, where volcanic breccia was noted. According to Jones, the predominantly volcanic zone overlies "Lower Devonian shales and limestones, with associated tuffs". Alcock and Jones agree that the volcanics in general underlie the "Gaspé sandstone series" but probably belong to that series, being interbedded at their base with sandstones similar to those overlying them and interbedded with them at their summit.

This zone, where it appears in Lesseps township, to the east and northeast of Lake Sainte-Anne, has been described by Jones (1930, pp.215-216). All of the volcanics noted here were of the basic type and included "andesite, olivine diabase, olivine basalt, and diabase porphyry". Some are dense, some porphyritic, and some amygdaloidal. The interbedded sedimentaries are coarse, greenish- to brownish-grey sandstones. "They appear to be more abundant in the Lesseps area than in the area to the west".

Volcanic rocks are more or less well exposed in various places along the Bathurst road from where the road crosses Berry Mountain

brook, south of Berry Mountain lake, to where it crosses the East Branch Little Cascapédia river. They are to be seen also in many stream sections adjacent to the road. Basic types appear to predominate from Berry Mountain brook to the West Branch Little Cascapédia, after which acid, generally rhyolitic types become more and more common. Several of the higher hills east of the West Branch Little Cascapédia are underlain by rhyolitic volcanics, and a prominent hill at the eastern end of the zone shows this type of rock associated with limestones.

This latter hill locality has been examined in some detail by Jones (1930, pp.216-217). Near the southwest side of the hill a steep slope 500 feet high shows, at its base, ten feet of limestone overlain by some seventy feet of rock, mostly breccia, "containing angular fragments of quartzite, slate, and limestone in a siliceous matrix ..... Near the base of this breccia zone there are interbedded grey volcanic rocks. Above the breccia the talus and escarpment are composed of grey to light green, hard, compact rocks. Some types are dense, while in others phenocrysts of feldspar .... may be seen. Wavy lines run through the rock, suggesting flow structure ..... Most of these rocks are to be classed as porphyritic rhyolite flows, with, possibly, some approaching the composition of trachyte". Some loose blocks of rhyolitic rock, similar to that described by Jones and to other types seen to the southwest, carrying some grains of chalcopyrite, were noted along the branch road leading down the East Branch Little Cascapédia from the main Bathurst road.

Throughout this area that borders the Bathurst road from Berry Mountain brook to the East Branch Little Cascapédia the volcanics

are associated with sedimentaries. In some sections the volcanics predominate while in others sedimentaries predominate. The sedimentaries vary from limestones to shales and sandstones. At one place a fine-grained breccia suggesting volcanic material, but being strongly calcareous and carrying fossils, was seen. Tuffaceous sediments were noted in a few localities. Several exposures of volcanic agglomerate or breccia were noted at one locality. These exposures are on the first brook crossing the Bathurst road west of the West Branch Little Cascapédia river and along the road itself for about 500 feet eastward from the brook. The matrix of the agglomerate or breccia is dark green to greenish grey in colour and varies from very dense or fine-grained to visibly granular. It carries sub-angular to rounded fragments of volcanics up to six inches in diameter, and also some fragments that may have been of sedimentary origin. Most of the fragments are under one-half inch diameter.

Fossils have been found in the sedimentaries interbedded with the volcanics at three localities, one in Grande Grève type of limestone a half-mile east of the Lesseps brook crossing on the Bathurst road; the second in a one-foot bed of quartz-pebble conglomerate associated with sandstone and shale about two miles west of Lesseps brook on the Bathurst road; and the third in calcareous tuffaceous grit on a small brook north of Berry Mountain lake. While the collections have not been studied in any detail as yet it can be stated that they are marine forms of the type more usually associated with the Grande Grève than with the "Gaspé sandstone". Some plant fragments were noted also in a few localities in sandstone beds.

Previous workers, as indicated above, evidently are agreed

that the "volcanic" zone lies between the Gaspé Limestone series and the Gaspé Sandstone series and that it is more closely associated with the latter, or younger, series. However, as shown above, the zone is one of interbedded volcanics and sedimentaries, and the sedimentaries include limestones as well as sandstones and shales. Thus, the period of volcanic activity apparently overlaps the Gaspé Limestone-Gaspé Sandstone contact. Furthermore, and as already pointed out in this report, the volcanic - sedimentary zone and the underlying zone in which sedimentaries only occur, on the south side of the Berry Mountain syncline, appear to grade into the York River formation of the Gaspé Sandstone series. In both of these respects the volcanic-sedimentary zone corresponds to the overlapping and interfingering York Lake series as developed in eastern Gaspé peninsula.

Middle? Devonian,

Gaspé Sandstones

The term "Gaspé Sandstones" has been in the literature since Logan's first report on the geology of the peninsula. The term was introduced to include all the sedimentaries of Devonian age which overlay the "Gaspé Limestones". In 1908 Clarke separated the Gaspé Limestones into three formations. But the Gaspé Sandstones remained unseparated for another thirty years. Alcock, in 1935, named some 3,000 feet of conglomerates at the top of the Gaspé Sandstones the "Malbaie formation". These conglomerates previously had been placed by some authors with the Gaspé Sandstones and by others with the Carboniferous Bonaventure formation. Jones (1936) proposed the term "York Lake series" for a zone or series of sedimentaries that apparently overlapped the Gaspé Limestone-Gaspé Sandstone contact. Between 1936

and 1938 Jones' work in eastern Gaspé indicated that two other mappable units were present in the Gaspé Sandstones, and these were referred to as the "York River" and "Battery Point" formations. Thus, in eastern Gaspé, the "Gaspé Sandstones" were divided into the following formations, in descending order:

Malbaie Conglomerate

Battery Point sandstones, shales, conglomerate

York River sandstones and shales

York Lake sandstones, shales, limestones

Later work by the present writer in eastern and interior Gaspé, in areas to the south of those mapped by Jones, indicated that while this was the general succession it did not always and strictly apply owing to apparent lateral as well as vertical gradations of the formations. Thus, it was found that in the Malbaie river region the York Lake series apparently interfingered with the York River sedimentaries although generally they underlay them. Similarly, and as pointed out above, these two formations or series apparently interfinger in parts of the interior area considered in this report. And, as will be shown below it seems likely that in the interior the York River and Battery Point formations or, rather, their characteristic rock types, also grade into one another. In the western part of the peninsula the Gaspé Sandstones have been designated the Heppel formation which, on evidences other than faunal, the writer tentatively correlates with the York River formation of eastern Gaspé.

York River Formation

The York River formation is presumed to be present in the extreme northeastern part of the map-area, a section that was not examined by the present writer. Jones (1956, pp.21-22) mapped these

rocks as York Lake. However he listed a few fossils from localities along the eastern boundary of Sirois township which, as he indicates, strongly suggest the York River formation. Furthermore, these rocks are the "western continuation" of the York River as recognized further to the east, and limestones are rare, if present at all (their presence is suggested by débris only) in the formation or series here.

Rocks characteristic of the York River formation were seen on the Grande Cascapédia river on the south flank of the Berry Mountain synclinal. Here the rocks are sandstones with interbeds of soft, dark green and grey shale. The sandstones generally are well-bedded, greenish-grey, and fine to medium in grain. Occasional beds of medium to coarse sandstone are present. The sandstones are composed largely of quartz and grey feldspars. Some of the beds carry flattened pebbles of shale similar to the interbedded shale layers. Thin seams of carbonaceous matter were noted in a few places. The formation shows here only on the south flank of the Berry Mountain synclinal. The corresponding position on the north flank of the fold is occupied by an entirely different set of rocks which we refer to the Battery Point formation. Along the strike to the eastward the York River types of rocks appear to grade into the York Lake sedimentary-volcanic series. Also, the position of these rocks on the south flank of the Joshua Brook anticlinal appears to be taken by York Lake sedimentaries.

Northward of the Berry mountains the structure succeeding the synclinal is the Federal dome. This dome brings the Grande Grève limestones to the surface. On the southern side of the dome the Grande Grève is overlain by Battery Point types of sedimentaries and associated volcanics. On the northwestern side, along the line of

Brandy brook, the Grande Grève is overlain by York York River types of sedimentaries and associated volcanics. This difference in the rock type overlying the Grande Grève is one of the evidences which suggests a local structural break between the Grande Grève and the Gaspé Sandstones in the Federal mine area.

Rocks of the York River type occur on the Salmon Branch above the Grande Grève and below Battery Point types. They are not well exposed here, however, and most of the exposures in the width assigned to the York River are volcanics. The situation is similar on Go-Ashore brook. On the lower part of Miner brook rocks of York River type are much restricted compared to the Go-Ashore and Salmon Branch sections and, in fact, the only exposures definitely considered to be of this type immediately overlie, or are interbedded with, the Grande Grève limestones. Very typical York River sandstones and some shales lie in a synclinal further up Miner brook, and are there exposed for about ten miles along the brook. West of the point where the Lacroix road comes down to Miner brook this synclinal band widens considerably. It extends westward to within the big loop of the Causapscal river and is well exposed on the middle reaches of that river.

Battery Point Formation

The rocks here assigned to the Battery Point formation are found on the Grande Cascapédia river and on many of its headwater tributaries including the Salmon and Lake branches. These rocks, as also those here assigned to the York River formation, were included previously in the Gaspé Sandstone series undivided.

The three members of the formation shown on the accompanying map were described and mapped by Jones (1929). The present mapping gives all three members further extent.

The lowest member of the formation may be divided into two zones. The lower zone consists of greenish-grey and brownish-grey sandstones of medium and coarse grain, with some beds carrying small pebbles of quartz and of volcanics. The sandstones are mainly of quartz and pink to brown feldspars. Cross-bedding is well shown in some beds. Plant fragments were noted at a few places. This zone is overlain by thinner-bedded and fine-grained grey to brown argillaceous sandstones, with which are interbedded some brown and light green shales as well as rare beds of limestone and of coarser grained sandstones. Some of the beds show ripple mark and cross-bedding. The two zones of this member are about 1,000 feet and 1,300 feet thick respectively, giving a total thickness for the member of around 2,300 feet. Included in this thickness are several bands of volcanics of undetermined thickness which occur mainly in the lower zone.

A conglomerate outcrop near the contact of this member with the Grande Grève deserves special mention. Going down the government road from the Federal mine we noted Grande Grève outcrops, or débris almost in place, to a point 100 feet north of mile post 48.

Volcanics show at mile 48 and southward along the road for 500 feet when they are overlain by a 20-foot zone of conglomerate which in turn is overlain by volcanics. The conglomerate is rather roughly bedded in bands up to a foot thick separated by layers an inch or less thick of greenish-grey, pink-feldspared (Battery Point-type) sandstones and occasionally of reddish-brown sandy shale. The matrix is like the separating bands, generally the sandstone but sometimes the shale. The pebbles predominantly are grey, dense, banded or massive, hard, silicious rock very similar to certain silicified layers noted in the upper part of the Grande Grève near the Federal mine. The pebbles vary in shape from well-rounded to sub-angular and are up to one and one-half inches in diameter; some are as much as three inches long by one inch thick. Small fragments of dark grey Grande Grève-type of limestone also occur, as well as common flattish pebbles of green shale.

The inference to be drawn from this conglomerate is that the volcanic-sandstone series overlies the Grande Grève unconformably. Gill and Auger (1943, pp.470-471) have already made this suggestion. This is a subject that will be considered in more detail later in this report.

The following fossils have been reported from the lowest Battery Point member by Jones (1929, pp.19-20); this is a composit list of seven localities:

Annelid trails, Favosites helderbergiae Hall, Lingula rectilatera Hall, Stropheodonta cf. schuchertana Clarke, Cyrtina sp., Spirifer gaspensis Billings, S. cf. concinnus Hall, Rensselaeria

cf. atlantica Clarke, Edmondia sp., Modiomorpha sp., Aviculopecten? sp., Goniophora tethys Billings?

The middle member of the formation consists of brownish to reddish-brown and red, fine, argillaceous sandstones and arenaceous shales. Occasional thin beds of green shale were noted. Many of the sandstones show green spots that usually are circular in outline, probably resulting from the reduction of the iron-colouring material through the action of organic matter. Jones has remarked that the rocks become redder as the top of the member is approached, taking on a deep brick-red colour. "Prominent features associated with the red sediments are cross-bedding, lenticular structures, ripple-marks of fine and coarse types, mud-cracks, worm-borings, and occasional rain-prints. Thin green lenses and spots, and green coatings on bedding planes, are common" (Jones, 1929, p.21).

This member is readily recognized not only on Brandy and Berry Mountain brooks, where it was examined by Jones, but also to the west on the Salmon Branch, the lower parts of Co-Ashore and of Miner brooks, on the Lake Branch and on Inlet brook. On the Inlet greenish-grey sandstones, often calcareous, occur fairly commonly as interbeds in the reddish sandstones and shales and suggest that the red beds may be grading out to the west and being replaced by the more typical Battery Point sandstones. Exploration to the south of the Inlet will provide information bearing on this suggestion as well as on the question of the westward continuation of the Berry Mountain synclinal. Small collections of marine fossils were had from three horizons in this member on the Inlet, thus disturbing the previously promoted

theory that the red member was deposited under continental conditions.

The thickness of this member, estimated on the bases of dips and width of exposure, is about 4,500 feet on the north limb of the Berry Mountain syncline. Yet on the south limb of the fold it is absent, or at best is represented by a zone only a few feet thick. Either this member is cut out by a fault on the south side of the syncline, and there is little evidence of such a break, or the member thins rapidly as it passes southward under the syncline. The latter interpretation is followed here.

The upper member of the formation is made up predominantly of greenish-grey, coarse-grained, feldspathic sandstones. Many of the sandstones are pebbly to conglomeratic, with well rounded pebbles of quartz, chert, jasper, and volcanics one inch or less in diameter. The feldspars, which along with quartz make up the major part of the rock, are commonly pink to red in colour, in contrast to the common grey feldspars of the York River formation. The beds are more massive than those in the underlying members and often show cross-bedding.

Jones (1929, p.22) notes the presence of a few interbeds of "fine-grained, brown sandstones and chocolate-brown shales". Some poorly preserved plant remains were the only fossils found.

The thickness of this member is estimated to be about 10,000 feet, which, with the two underlying members, would give a total thickness of about 18,000 feet to the Battery Point formation in this region. This is about three times the average thickness estimated for the Battery Point at the eastern end of the peninsula, the only other region where it has been recognized.

The unsymmetrical arrangement of the members of this

formation on the Berry Mountain synclinal is explained on the principle that formations and members are lenses. In the present case the middle member of the formation is interpolated between the upper and lower members on the north flank of the synclinal and perhaps along its axis. Going southward, however, the middle member fades out and the upper and lower members come into contact. The lowest member may or may not lense out southward. Probably it does, if we judge on the basis of thickness on either side of the fold. However, the top and bottom members are very similar lithologically, and if the distinctive middle member did not intervene between them on the north flank of the Berry Mountain synclinal they probably would not have been mapped as separate units. Thus, on the southern flank of the synclinal, the lowest member actually may grade into the upper member laterally as well as vertically.

There is also the question of whether or not the lowest member may be the equivalent of the York River in stratigraphic position. As has been pointed out above, this member, with associated volcanics, directly overlies the Grande Grève along the southern side of the Federal dome. On the northern and northwestern side of the dome, however, the Grande Grève is overlain by typical York River sediments with associated volcanics. It is evident that further and detailed work is needed in the Federal area to straighten out such stratigraphic problems.

Heppel Formation.

The Heppel formation lies isolated in the western part of the peninsula so far as geological exploration is concerned. The

type locality is near Heppel station in the Matapédia valley. The formation has been traced eastward as far as Four-Mile brook, a tributary of the Causapscal river, or only eight miles eastward of Heppel station.

The presence of Gaspé Sandstones in the Matapédia valley was first announced by Logan (1863, p.415) who described the succession briefly and assigned a width of six miles to the sandstones. Actually the width in the valley is closer to three miles, the formation extending from about a mile south of Causapscal to about a mile north of Sainte Florence. Crickmay (1932, p.377) briefly refers to these sandstones. Alcock (1935, pp.83-85) named the sandstones the Heppel formation. Much of Alcock's description, apart from the type locality, unfortunately applies to the Grande Grève formation, the upper part of which on the Causapscal river Alcock placed in the Heppel and from which the long list of fossils (p.85) was derived. It should be noted here, also, that the more northern of the two belts of Heppel sandstone shown on Alcock's map (1935, Fig.9, opp. p.104) is Grande Grève and that only the more southern belt is true Heppel.

The Heppel formation at the type area opposite Heppel station consists predominantly of greenish-grey, medium- to fine-grained sandstones with abundant quartz and common grey feldspars. There are some interbeds of quite quartzose sandstone, and a few interbeds of calcareous sandstone showing crinoid stem sections. The beds here dip 75 degrees to the south, and a thickness of about 1,000 feet is exposed. These rocks suggest the York River type of sandstone more than any other phase of the Gaspé sandstone but they are not typical York River. About one-half mile south of Heppel

station an outcrop 500 feet east of the highway shows greenish-grey sandstones, some brownish-grey sandstones, and some of the brighter greenish-grey variety with faint pinkish feldspars, - in all a toss-up between the York River and Battery Point types. Another 3,000 feet further south is a small outcrop of greenish-grey, fine- to medium-grained sandstones. And, still further south, at a distance of about 1,600 feet, an outcrop 60 feet wide showed reddish-brown, medium- to fine-grained sandstones with grey feldspars common. Cross-bedding was conspicuous in this last outcrop, the tops being towards the south. The master beds were one foot to five feet thick, with cross-beds at one-half to two inch intervals. This was the most southerly exposure of sandstone noted by the writer on the highway, the only section in the valley examined by him. The Ordovician series outcrops one mile to the south of this sandstone exposure.

North of the Heppel station exposures the next outcrop along the highway consists of grey, rusted, fine- to medium-grained sandstone in one-half to two inch beds. And another 400 feet farther north a small outcrop on the south side of the highway showed greenish-grey, medium-grained, somewhat calcareous, faintly banded sandstone.

In all of these exposures the dip is either vertical or steeply to the south. Therefore, unless reversals are present, the thickness of the formation in the Matapédia valley should be roughly equivalent to its surface width, and this is estimated at about three miles. The lower half of the formation here compares lithologically with the York River while the upper half rather

suggests the Battery Point in rock . . Admittedly these are rough comparisons, and, according to the fossil evidence provided by Kindle (1938), and of which more will be said later, it is possible that we are dealing here with Upper Devonian rocks.

At the south edge of Causapscal village two roads run east from the highway, branching from it 50 feet apart. The more southerly of these crosses the northern contact of the Heppel at a distance of about 3,000 feet from the highway. Ascending this road the first outcrops seen are the soft, argillaceous limestones of the Bon Ami (Causapscal) formation. After a short interval these are followed by harder, arenaceous limestones or calcareous siltstones in one-inch to eight-inch master beds with which some soft limestones are interbedded. These latter beds suggest the Grande Grève and, as there is room for a few hundred feet only of them before the sandstone is reached, it is further suggested that a fault intervenes between the Grande Grève type of rock and the Bon Ami type. The Grande Grève type of rocks become more sandy towards their exposed summit. After an interval of fifty feet these rocks are succeeded by sandstones. The sandstones are greenish-grey, medium-grained, and in beds up to one foot thick. Some of the sandstones are calcareous. Rare and thin interbeds of reddish-brown sandstone are present. This zone is less than 100 feet thick. It is succeeded by about ten feet of greenish, banded, soft shale which in turn is overlain by fifty feet or less of greenish-grey sandstones. In general this sandstone succession suggests the York River type of sedimentaries.

The only other section of Heppel rocks examined by the writer includes that previously examined by Kindle (1938, pp.39-43), and from which Kindle established his "Four Mile Brook member of

the Heppel sandstone". The brook in question is the South Branch of Four Mile brook, or, as it is sometimes called, Little Four Mile brook. The extensive fauna reported by Kindle from this member was taken from abundantly fossiliferous roadside outcrops where the Lacroix road comes down from the west into the valley of the brook. This is the type and only known locality of the Four Mile brook member. The rocks are greenish-grey shales with frequent arenaceous bands varying from thin layers up to one inch thick and with some calcareous sandstone beds up to one foot thick. Kindle gives the thickness of this member as 600 feet more or less; this would appear to be a maximum estimate.

The Four Mile Brook beds are succeeded southward for a distance of at least one half mile across the strike by vertical to steep south-dipping sandstones. These are in beds up to three feet thick and are greenish-grey, medium-grained, and quartzose-feldspathic. Green and reddish-brown shale interbeds were noted about 1,500 feet south of the Four Mile Brook member and again about 1,000 feet still further south. This is apparently the zone of Heppel sandstone that Kindle mentioned (p.39) as underlying the Four Mile Brook member, and the thickness of which he gave as 1,500 feet more or less. Actually this zone appears rather to overlie the Four Mile Brook member so far as dips, admittedly steep, are concerned. The primary structures noted in the sandstones, ripple-mark, cross-bedding, and rare rain drop impressions also suggest that the tops are to the south. In any event, southward of the Four Mile Brook member there would seem to be at least 2,500 feet of sandstones, and how far the section extends in that direction and how many more feet should be added to the section is not known.

A sandstone succession very similar to that just described extends northward from the Four Mile Brook member for a distance of about 7,000 feet across the strike. This succession is fairly well exposed along Little Four Mile brook and down from the mouth of that brook for 1,000 feet or more along Four Mile brook. The sandstones here are in beds varying from two inches to ten feet thick. Cross-bedding and ripple mark show here and there. Quartz is the most common mineral in the sandstones, with grey feldspars abundant, both generally fine to medium in grain size. Interbeds of greenish, finely sandy shale are fairly common, and there are some interbeds of reddish-brown shale and of calcareous sandstone. About 700 feet above the junction with Four Mile brook a small outcrop of calcareous siltstone or silty limestone was noted which resembled the Grande Grève although it did not show the characteristic bedding. Typical Grande Grève limestones are interbedded with the sandstones from the junction of the brooks downstream for 1,000 feet. Downstream for another 1,000 feet the rocks are mainly Grande Grève type limestones with here and there a sandstone interbed or interzone. And further downstream the rocks are more the Bon Ami type than the Grande Grève.

The above succession suggests that the sandstones and the Grande Grève limestones grade into one another, and that the major part of the Grande Grève has been cut out by faulting so that the Bon Ami is brought against the lower part of the Grande Grève-sandstone contact zone. Other sections in this area must be examined, however, before definite conclusions can be drawn.

Throughout this section north of the Four Mile Brook member the dips are vertical or steep to the south except close to the contact with the Bon Ami, where the dips are 65 degrees or more to

the north. Thus, if there are no reversals, the thickness of the known section north and south of, and including, the Four Mile Brook member is roughly 10,000 feet.

Kindle (1938, pp.40-41) provided an extensive list of fossils from the Four Mile Brook member of the Heppel, as follows:

Heliophyllum? sp., Crinoid stems, Botryllopora socialis Nicholson, Anastomopora quebecensis Fritz, Cf. Coscinium striatum H. and S., Fenestrellina occidentalis Fritz, F. gaspensis Fritz, Polypora orientalis Fritz, Sulcoretopora cf. incisurata (Hall), Toeniopora penniformis Nicholson, T. exigua Nicholson, Pholidops sp., Strophalosia truncata (Hall) var., Productella sp., Stropheodonta cf. demissa (Conrad), Dalmanella sp., Rhipidomella vanuxemi Hall var., Camarotoechia sp., Rodevonaria hudsonicus gaspensis Clarke, Chonetes sp., Cyrtina cf. hamiltonensis Hall, Spirifer audaculus (Conrad) var., Leptodesma cf. rogersi Hall, Modiomorpha cf. sublata Conrad, Nucula sp., Cypricardinia cf. indenta (Conrad), Goniophora cf. carinata Conrad, G. cf. rugosa (Conrad), Palaeoneilo cf. muta Hall, Phacops cf. rana Green, Proetus sp., Tentaculites cf. bellulus Hall; ---- Spirifer pennatus posterus Hall and Clarke, Actinopteria boydi Conrad, Nucula corbuliformis Hall, Paracyclas lirata Conrad, Palaeoneilo plana Hall, Bellerophon cf. leda Hall.

The last six species in this list are stated by Kindle (p.42) to occur in the Ithaca fauna of the Cayuga Lake section, and on this evidence he correlates the Four Mile Brook member with the Ithaca stage of the New York Upper Devonian. Except for these six species the fauna is stated to be that of the Middle Devonian Hamilton formation. Kindle's list of fossils has been analyzed by

Cooper (1942, p.1759) who throws doubt on Kindle's determinations without, however, as he admits, having examined the specimens. He concludes, rather weakly unless Kindle's determinations are incorrect, that the Four Mile Brook "shale fauna is probably actually an Onondaga fauna".

The present writer has no paleontological contribution to make to this question of age. Some fossils were collected from the Four Mile Brook member but these have not yet been studied. It is hoped that a good collection soon will be secured. Also much work in the field is required to demonstrate whether or not the Heppel belt is folded within itself. The investigations so far conducted suggest that it is not folded and that it dips more or less uniformly southward at a very steep angle. If this is the case the formation must be at least 10,000 feet thick. Also, the Four Mile Brook member would be at least 2,000 feet below the top of the formation, rather than at its top as inferred by Kindle.

Carboniferous

Bonaventure Formation (See Alcock, 1935, pp.89-93)

The youngest consolidated sedimentaries in Gaspé peninsula are believed to be of Carboniferous, and probably Pennsylvanian, age. The rocks of this age in this area are referred to the Bonaventure formation. They appear along the Bay of Chaleur coast and up to seven miles inland.

The Bonaventure consists of red conglomerates, sandstones, and shales and occasional limestones. In general, the beds lie with flat or gentle dips across the eroded edges of the older strata. Such angular unconformity shows that all the older beds, including those of Devonian age, were folded prior to the deposition of the Bonaventure. The Bonaventure itself generally was not disturbed by the late Paleozoic Appalachian folding movements. Locally, however, it has steep dips, caused by faulting in many cases but by folding in some.

Intrusive Rocks

Cambrian ?

The oldest intrusive rocks exposed in the region are those which cut the altered sedimentaries of the Macquereau group in Weir township. Here an area up to one and a half miles long in northeast-southwest direction and 1,500 feet wide of serpentinized peridotite lies within the altered, generally quartzose, sedimentaries of the Macquereau. The serpentinized rock has a border of amphibolite in some places. Here and there towards the border, and occasionally within the serpentine area, are bodies of hornblende schist. All of these rocks are cut by dykes and small pipes of fine- to coarse-grained muscovite granite. The general trend of the granite

intrusions is parallel to the serpentinized area and judging from Alcock's report (1935, pp.1012) they are restricted to that area. Thus, it may be that the granite was responsible for the serpentinization.

The age of the intrusion is placed by Alcock as post-Macquereau and pre-Mictaw. The basis for this assignment is the presence on North Port Daniel river of a conglomerate carrying boulders of granite similar to that cutting the serpentine. This conglomerate lies between the Macquereau group and the Silurian to the north, and was believed by Alcock to be of Mictaw age.

Silurian ?

Two dykes have been reported by Alcock (1935, pp.14-15) as cutting the Mictaw series on the North Port Daniel river, just east of the present map-area. One of these is described as a highly altered, dark green to black, fine-grained intrusive, and the other as a somewhat similar rock fresh enough to be determined as an augite diorite. Alcock (1935, p.23) also has referred to "dark, basic dykes, reddish porphyry dykes, and .... a syenitic granite" cutting the Matapédia series at Duthie pool on the Grande Cascapédia river.

Diabasic dykes and sills intrude the Matapédia series near its contact with the Silurian on the Grande Cascapédia. On the West Branch Little Cascapédia river, just south of the Devonian-Ordovician contact, the Matapédia apparently is intruded by fine- to coarse-grained syenite and a rhyolitic type of rock. A similar rhyolitic dyke cuts the Ordovician about in line of strike on the East Branch Little Cascapédia river, and a few hundred feet

to the south the Ordovician is intruded by a basic sill. Diabasic dykes and sills up to twenty-five feet thick intrude the Ordovician in several places on the Bonaventure river. They show frequently, probably because the meandering of the stream exposes the same intrusives at various places, on the West Branch Bonaventure for a mile or so above the main forks. A few rhyolitic dykes also cut the Ordovician on the Bonaventure.

The diabasic rocks mentioned above are dark greenish-grey in colour and fine to medium in grain. Occasionally they are porphyritic, showing small phenocrysts of feldspar. The rhyolitic dyke rocks are light grey, with greenish to pinkish cast, and very fine-grained.

Rocks apparently similar to the above have been noted by Jones (1936, pp.17-18) cutting Ordovician and Silurian rocks in the Mount Alexander area. In that area, also, and in the various Silurian belts described above, porphyritic diabase dykes and sills show in many places. In these, phenocrysts of grey feldspar up to one-half inch long are common and some up to two inches long have been noted in the largest mass known in the region. This mass crosses the South Branch of the Saint John river near the western limit of Sirois township. The groundmass is described as coarse-grained and containing considerable feldspar "and varying amounts of augite, chlorite, biotite, and ilmenite". Similar diabases but more uniformly coarse or medium in grain are also widespread in the Silurian belts.

In general, the diabases are associated with the Ordovician and Silurian sedimentaries, and in the Mount Alexander area none

are shown as cutting the Silurian volcanics or the sedimentary zone that immediately overlies the volcanics. Similar rocks, however, were noted by the writer associated with the volcanics where this zone crosses the Bonaventure rivers.

A few intrusions of this general type are associated with Devonian rocks in the northern part of the region, but it is a notable fact that the porphyritic and medium- to coarse-grained diabases are almost entirely restricted to the areas underlain by Silurian or older sedimentaries. This is particularly the case in Vondenvelden and Sirois townships. This suggests that most of the intrusions just described are pre-Devonian, and probably either Upper or Middle Silurian, in age. This suggestion finds further support from the presence of boulders of porphyritic diabase in conglomerate outcrops ten to fifteen miles east of the present map-area, on the flanks of the Saint John River anticlinal. There is some question as to the age of this formation, but it is known to be either at the top of the Silurian or the base of the Devonian section in the area where it occurs.

Devonian

Intrusionsof various types cut Devonian rocks in the northern part of the map-area. Some of these undoubtedly are related to the Tabletop granitic mass a few miles to the north. Most of the intrusives have been described by Alcock (1926, pp.45-49) and Jones (1930, pp.215-223; 1932, pp.23-27).

Granite

The granite mass shown to the north of Lake Sainte Anne is a part of the Mount Sterling intrusive. This is separated on the surface from the Tabletop mass to the north by a belt of Devonian and Silurian sedimentaries about three miles wide. The granite of the region varies from red to grey in colour and from fine to coarse in grain. Some of the finer varieties are porphyritic. Contact phases are frequently dense, sometimes porphyritic, and vary from grey to chalk white in colour. Devonian limestones near the contact are baked and altered to lime silicate rocks.

Red Rhyolite Porphyry.

Extending eastward from the southeast corner of the Mount Sterling granite mass is a relatively narrow dyke or sill which Jones has described as a rhyolite porphyry. "It is brownish-red in colour, dense and fine-grained, with scattered phenocrysts of red orthoclase up to one-quarter of an inch in length. There are also occasional small phenocrysts of quartz".

The summit of Mount Lyall shows a "rhyolite-porphyry consisting of a dense red groundmass in which small phenocrysts of feldspar and quartz" are visible to the naked eye. A hill one and a half miles north of the Federal mine also is made up of these rocks, and many smaller intrusions occur in the Federal Mine area (Auger, P.E., Pers. Comm.).

Syenite and Diorite

A number of intrusions are shown on Alcock's map in the vicinity of the Federal mine. These are said to be mainly syenite, reddish on the weathered surface, granitic in texture, and fairly coarse-grained. According to Gill and Auger (1943, p.460), however,

many of the rocks mapped as syenite are more properly to be classed as diorites, while one mass as "a typical diabase".

The possible presence of syenite, underlying an area of six to eight square miles southeast of Lake Sainte Anne, was suggested by Jones (1930, pp.221-222) from the presence of syenite débris. The area corresponds roughly to a ridge the southern end of which reaches to the Bathurst road a short distance to the east of the West Branch Little Cascapédia crossing. At this place syenitic rock is exposed on and just to the north of the road over a width of about 500 feet. The rock is much weathered, varying in colour from dark greenish-grey to pink and brown, and varying from medium to fine in grain. Weathered feldspars of pink to brown colour are abundant in the rock.

Diabase Dykes

The several dykes shown on Lesseps brook, in the north central part of the map-area, are included by Jones (1930, pp.219-220) among those described by him as diabases. They are dark green, "sometimes with spots of light coloured feldspar. In thin section they exhibit the typical structure of diabase".

Somewhat similar dyke rocks are associated with the volcanics in the areas along the Bathurst road and on the Salmon Branch of the Grande Cascapédia river. Also, on the Salmon Branch, the Bon Ami formation is cut by dark, fine- to medium-grained dyke rocks of this general type. These dykes are generally narrow. One, however, appears to be about 1,000 feet wide, and is fairly continuously exposed along the strike for about 4,000 feet upstream from Sixteen-mile (Salmon) falls. The rock is massive, dark grey, and medium- to fine-

grained. One light-coloured, fine-grained dyke was observed cutting the Bon Ami just above the mouth of Fourteen-Mile brook.

Diabase dykes are common on the upper part of Go-Ashore brook where they cut Bon Ami and Silurian limestones. Some three miles below these occurrences, a zone of diabasic intrusions up to two miles wide is suggested by infrequent exposures along the brook and by the cliffs and general character of the country to the westward. Here the diabases intrude sandstones of the York River type. Four to five miles up Miner brook diabase dykes, with locally brecciated contact phases, cut the Grande Grève limestones. And, on the upper part of the Inlet, diabase masses are associated with the Bon Ami for a distance of about two miles along the stream. When all these occurrences are mapped it is at once suggested that a zone from one to two miles wide of diabasic intrusives extends northeast from the Inlet to the Salmon Branch, or a total distance of roughly 25 miles. While the zone itself may trend southwest-northeast the individual dykes trend generally southeast-northwest. Thus, roughly, the trend of the dykes is at right angles to the trend of the zone. This apparent zone of fracture and diabasic intrusion is closely related to an anticlinal fold axis on the Inlet and on Miner brook, but no such structure is apparent where the zone crosses Go-Ashore or the Salmon Branch.

The lower limit of age of all of these intrusives is Lower Devonian. The upper limit, however, is not known definitely. Alcock (1926, pp.53-54) has assumed that the granitic intrusions accompanied the Acadian, or Middle Devonian, folding movements. And Jones (1930, pp.217-223) suggests that the age of both the granitic and diabasic types is probably early Middle Devonian.

The strong point in favour of such age assignments used by these writers was that the Gaspé sandstones proper in this region are not seen to be cut by any intrusives. According to the present mapping this is generally the case, but, as pointed out above, York River sandstones are cut by diabasic intrusives on Go-Ashore brook. Also, the tendency has been to affirm unconformable relations between the Gaspé Limestones and the Gaspé Sandstones, and to associate the intrusives with the time period during which such unconformity was produced. No good evidence of physical unconformity has been provided, however, except in the Federal Mine area, and the fossil evidence as interpreted to date is not decisive. Furthermore, if the major period of igneous intrusion is to be correlated with the Acadian period of folding it should be kept in mind that the Gaspé Sandstone series was involved in that folding, and apparently to the same degree as the Gaspé Limestone series. In view of these considerations it is suggested that the major period of intrusion may have been late rather than early Middle Devonian, or even Upper Devonian. However, the information at hand is far short of what is desired to provide an adequate conclusion to this problem.

CHAPTER 3

SUMMARY OF STRATIGRAPHIC RELATIONS

The Macquereau is believed to be the oldest formation or series in Gaspé peninsula.

The Shickshock series may be of the same age, but this would be difficult to prove. The two series are on opposite sides of the peninsula, separated across the strike by an interval of about 50 miles, and with the Macquereau exposed some 40 miles further east than the Shickshock. The Macquereau is overlain by the Middle Ordovician Mictaw formation. Its base is not known. The Shickshock series appears to be overlain by Middle Silurian rocks and it appears to overlie the Lower Ordovician Sillery formation. The possibility has been suggested earlier in this report, however, that these apparent relations may not be the true relations and that the Shickshock series actually may underlie the Sillery. It is evident, therefore, that we cannot use the order of succession as a means of correlating these two series. Nor can we use any other methods of correlation except in a very general and inconclusive fashion.

The Macquereau series suffered considerably more metamorphism than the overlying Mictaw formation. The latter is dated as Middle Ordovician from its fossil content. Boulders of Macquereau-type rocks and of intrusive rock suggestive of some of those cutting the Macquereau sedimentaries have been found in the basal Mictaw conglomerate. These boulders indicate an erosional unconformity between the Macquereau and the Mictaw, and, along with the structural differences, suggest that the time interval separating the two units is of major or period importance.

The Mictaw formation is overlain by the Upper Ordovician Matapédia series. The relations between these two groups is not known. The Matapédia series, as here understood, includes the original Matapédia series as well as the White Head and Pabos formations. Rocks of Middle Ordovician age, as the Mictaw, may be included in this series in the present mapping as well as in that of Alcock (1935).

The Matapédia series, in the southern part of the peninsula, and the Sillery-Shickshock group, in the northern part of the peninsula, are succeeded by rocks of Middle Silurian age. In the southern sections the Middle Silurian generally rests on the Matapédia series but in some places it rests on the Mictaw and in others on the Macquereau. In the northern sections, between Lake Matapédia and the Shickshock range, the Middle Silurian rests on the Sillery. To the east the Middle Silurian follows along the southern base of the Shickshock range and its contact with the Shickshock series appears in many places to be a fault. No actual contacts between the Silurian and older rocks have been observed anywhere in the peninsula. But the greater, and general, deformation of the older rocks points to folding movements in pre-Middle Silurian times. The latest of these movements has been referred to as the Taconic period of folding, which, in Gaspé, took place between very late Upper Ordovician and Middle Silurian (Clinton) time.

The Middle Silurian is overlain by strata of Devonian age. Nowhere in the peninsula have rocks of Upper Silurian age been recognized definitely, although such an age has been suggested for parts of the northernmost Silurian belt. This belt extends

from Lake Matapédia to the Salmon Branch in the present map-area, and continues to the east as far as the Dartmouth river. It is only in this eastward continuation of the belt that any Upper Silurian elements are considered as possibly present in the faunas. Lack of Upper Silurian rocks would imply unconformable relations between the Middle Silurian and the Devonian. Such relations need not be apparent in either structure or lithology, and, in fact, in some parts of Gaspé it has not been possible to separate the Silurian from the Saint-Alban, or lowest Devonian formation, when fossil evidence was lacking. This was the writer's experience in areas to the east of the present, and there is some question of the section on the Salmon Branch. It was Jones' experience also in Sirois township and in areas to the north of the present map. Throughout most of the present region, however, the Saint-Alban formation appears to be lacking and the Middle Silurian is overlain either by the Bon Ami or by the York Lake series. Between the Salmon Branch and the Matapédia valley the rocks overlying the Middle Silurian have been identified as the Bon Ami formation. In the southern part of the map-area, however, in the region east of the Grande Cascapédia river, the rocks overlying the Middle Silurian have been classed as the York Lake series. Some redefinition of the York Lake series was necessary in order to accommodate the rocks concerned. The evidence for this assignment and reasons for redefinition are reviewed below:-

All available structural and stratigraphic evidence, including the scattered fossil evidence, points to the Devonian age of these rocks. They rest on the Silurian without the intervention of the

Saint-Alban or Bon Ami formations or the usual thickness of the Grande Grève formation. This might suggest that these formations were eroded prior to the deposition of our York Lake series. If so, this would support the arguments of some previous authors who have postulated an unconformity between the Gaspé Limestones and the Gaspé Sandstones. However, in many places, a zone about 1,000 feet thick of Grande Grève type of rock intervenes between this series and the Silurian. Obviously, if erosion took place it would have removed the Grande Grève first, not last. And so we have adopted the theory that the Lower Devonian limestone formations were not deposited here as such. Perhaps the type of sedimentation during the time of their deposition was different here than to the east and north, or perhaps the seas had not reached some of the areas concerned.

In any event, and whatever the actual time position of these rocks which are here assigned to the York Lake, the transition from Silurian to Devonian type generally is sharp. And in some places actual erosion of the Silurian took place prior to the deposition of the Devonian. A thin zone of conglomerate, caught in a synclinal drag-fold, occurs near the contact of the Devonian-Ordovician groups on the West Branch Little Cascapédia river. This conglomerate carries Silurian-type pebbles. It is to be noted that here the Devonian rests on the Ordovician, and the same is true on the East Branch Little Cascapédia river. Yet Silurian rocks occur both to the west and east between the Ordovician and the Devonian. Also, there is a notable difference in thickness of the Silurian sections on the East and West branches of the Bonaventure. The loss, or thinning, seems to have been effected at the top of the Silurian. Thus, it is suggested that Upper Silurian, or possibly early Lower Devonian, time, or both, was a time of uplift and erosion in this area.

It is possible that the conglomerate immediately to the east of the volcanics at Black Cape, which is assumed to be of Devonian age and which carries Silurian boulders, may have some relation to this gap in the Mount Alexander Silurian belt.

Evidence of erosion between the Silurian and the Devonian was noted by the writer at localities to the east of the present area on the Saint-John River belt.

Evidences of pre-Devonian erosion of Silurian strata in the area towards the head of Chaleurs bay have been presented by Alcock (1931, pp.113-117). In this area the erosion has been dated as pre-Helderberg, or, "late Silurian".

The great thickness of Devonian sedimentaries was divided as early as Logan's time into the Gaspé Limestone and Gaspé Sandstone series. These broad divisions still have a general usefulness in describing the Devonian section, although both have been subdivided into formations.

The Gaspé Limestone series long has been conceded to be Lower Devonian in age. The Gaspé Sandstone series has been considered by some as Middle Devonian in age, and by others as Lower Devonian. The bulk of its fauna suggests Lower Devonian and many of its species are the same as in the Grande Grève. In fact, as work progresses, the number of species common to the Grande Grève and the Sandstones increases in known quantity. Nevertheless, and relying mainly on the evidence of some pelecypod elements in the fauna, the Middle Devonian (Hamilton) age of the Sandstones is subscribed to here. Thus, speaking in general terms, we regard the Gaspé Limestones as Helderberg-Oriskany in age and the sandstones

as Hamilton. Apparently, then, the Onondaga formation is missing.

Only one area in Gaspé has provided good evidence of unconformity between the Limestone and the Sandstone series. This is the Federal Mine area in the central part of the peninsula. Gill and Auger (1943, pp.470-471) report on the relations here as follows:- The contact between the lava-sandstone series and the Grande Grève sediments is not exposed but the former series dips at lower angles southward than do the Grande Grève beds near the contact. "This difference is 5° to 20°. It could be accounted for by an increase in the thickness of the lavas southward, rapid flattening of a conformable series, or partial erosion of the Federal (Grande Grève) sediments prior to the extrusion of the lavas". A study of the intrusive bodies provides "some indirect evidence that considerable erosion of the Federal sediments occurred in this area before the extrusion of the lavas ..... The intrusive diorite bodies are numerous in the Federal sediments .... but no diorite has been found intruding the volcanics or the sandstones. In the Block 6 area, it can be seen that coarse-grained diorite occurs very close to the contact of the Federal sediments with the volcanics. One outcrop at this place is particularly significant. In it, a fine-grained amygdaloidal dyke, with about the composition of diorite, cuts through a coarse grained diorite sill. If, as is strongly indicated, this dyke is genetically related to the lavas, the coarse-grained diorites must have been emplaced before the volcanism was complete. The coarse grain of the sill implies a cover of considerable thickness at the time of its intrusion. The

fine grain and amygdaloidal character of the dyke cutting the sill indicate that the cover was relatively thin at the time of this intrusion. These relations, therefore, suggest that considerable erosion occurred between the intrusion of the diorite masses and the pouring out of the lavas. Doming as an accompaniment of the intrusion of the diorite seems probable".

The line of evidence followed by Gill and Auger is suggestive but not convincing; cover is not the only factor determining the grain size of an igneous body. Of more significance is the conglomerate exposure described above, which lies between volcanic flows and which shows fragments of silicified rock, similar to some within the Grande Grève, in a sandy-shaly matrix. If these fragments actually are from Grande Grève strata, they imply erosion of that formation prior to or during the outpourings of the volcanics. The variation in the sandstones overlying the Grande Grève in the Federal dome structure may have some significance also, - York River types of sandstone in the northern and northwestern segments of the dome and Battery Point sandstones in the southern segment of the dome. Alcock (1926, p.44) pointed to the presence of pebbles of shale (like the shale in the underlying limestone-shale series) in beds of sandstone towards the base of the Gaspé Sandstone series in the Federal area, as evidence of unconformity between the limestone and the sandstone series. The writer has not seen the exposures referred to by Alcock, but many beds in the Gaspé Sandstone series carry shale pebbles resulting from contemporaneous or intraformational rather than interformational action.

Thus, there is some fairly direct evidence and some rather

indirect evidence suggesting unconformity between the Grande Grève and the younger rocks in the Federal area. Elsewhere in Gaspé there is no good evidence of unconformity at this level. At best there is only the abrupt change from limestone to sandstone, and, in interior Gaspé, a zone of alternating limestone and sandstone beds between the two series suggests that they grade one into the other.

The Devonian rocks of the peninsula are succeeded upwards by the Carboniferous Bonaventure formation. In the present map-region the relations of this formation to the Devonian are not directly shown. To the east, however, flat-lying Bonaventure rocks have been seen in contact with underlying, and folded, Devonian strata. The Devonian beds evidently were involved only in the folding accompanying the disturbances of Middle to Upper Devonian time; neither these beds nor the Bonaventure were affected to any notable degree by the folding movements of Permian time.

CHAPTER 4

SUMMARY OF STRUCTURE

The peninsula of Gaspé long has been recognized as a structural arc convex northward. The area of greatest northward convexity is included in the present mapping. The strike of the structures is southwest-northeast throughout the map-region except near the eastern border, where it changes to west-east. In general, the structures strike slightly south of east for several miles eastward of the map-region, and then turn to the southeast as the eastern coastal region is approached.

The pre-Carboniferous rocks of the region have been thrown into a series of more or less parallel folds with trends as

outlined above. Most of the major folds are shown on the map and they are not reviewed exhaustively here. It should be noted that towards the northern border of the map-area the folding is less prominent. In southern Lesseps and northern Deville townships, for example, and for a few miles further north in the Lesseps (Jones, 1930) and Bonnecamp (Jones, 1931) areas, the folds are of much lesser magnitude than they are to the south. Roughly in latitude with these areas, however, are the folds in the region about Lake Sainte Anne, where the dome structure closely including the Federal mine is worthy of special note. Westward along the same general latitudes the folds apparently fall away, for along the whole length of the Salmon Branch and Go-Ashore brook as far up as the Shickshock mountains the rocks dip consistently southward. Further west the southward dips are first reversed in an open synclinal, the axis of which is from six to nine miles south of the Shickshock range. This fold plunges to the west at its eastern end and plunges to the east where it crosses the Matapédia valley at Lac au Saumon. This synclinal is followed to the south by a series of fairly sharp folds in the Matapédia valley. Further east one fold structure, an anticlinal, succeeds the synclinal. This fold plunges to the east, and apparently fades out in that direction, for while it has been recognized on the Inlet and on Miner brook it does not extend to Go-Ashore brook.

One of the strongest if not the strongest fold in the region is the Berry Mountain syncline, a westward-plunging structure. Probably this fold may be joined with the York River syncline, the eastward-plunging structure in the extreme northeastern corner

of the map-area. The succeeding structure to the south, the Joshua Brook anticline, plunges to the east in its eastern part and disappears as a fold structure in this direction. The Saint John River anticline plunges westward in this area, but a few miles to the east the plunge is reversed. In the eastern part of the Mount Alexander belt a series of at least two folds is present; the major fold being a syncline which plunges from the east and from the west to form a basin-shaped structure.

The wide belt of Ordovician rocks in the southern part of the region is brought up on a major anticlinal the axis of which we have not been able to place definitely owing to the rapid changes of strikes and dips within the Ordovician series. The Silurian Chaleur series to the south lies on the southern limb of this anticlinal and is folded to some degree; this folding has bot been mapped except very locally.

Faulting does not seem to have played a very important role taking the region as a whole. Some faults of both normal and thrust types are postulated, however, and shown on the accompanying map, and many small, local faults have been noted. Further work may show that some of the apparently eccentric distributions of formations which are displayed on the map are due to faulting rather than to the lensing and interfingering interpretations followed here.

CHAPTER 5

ECONOMIC GEOLOGY

Lead, Zinc, Copper

New interest in the lead, zinc, and associated copper deposits in Lemieux township has been created by the demand for

these metals in war industries. Detailed examination of the deposits is being carried out by P.E. Auger for the Quebec Department of Mines. This examination was begun in 1942 and is continuing in 1944. An interim report already has been provided by Auger (1943) supplying information on the potentials of the Federal Mine prospect.

The main deposits are located in the limestones and shales of the Gaspé Limestone series, or, according to our mapping, in the Grande Grève formation. Some sulphides are also reported (Alcock, 1926) from the generally overlying volcanics. The youngest rocks in the region in which any of these minerals are known to be present is the lowest member of the Battery Point formation. Several cubes of galena were noted in a conglomeratic bed in this member, located on the Salmon Branch 300 feet below the mouth of Nine-Mile Brook. This occurrence may have some bearing on the age of the deposits as a whole, suggesting a younger age than that previously assigned to them.

Apart from the deposits referred to above very few and scattered indications of metallic minerals have been noted in the region. Chalcopyrite in small grains was noted in rhyolitic volcanic débris along the branch road leading down to the East Branch Little Cascapédia river from the main Bathurst Company road. And copper minerals were seen here and there in basic igneous rock about two miles eastward from the John depot of the Price Brothers Company on the Matane River road. These rocks are found near and for one-half mile or more north of the road. Some stripping and shallow trenching was done here. A little chalcopyrite and malachite was noted in the exposures near the road, along with some jaspery hematite. And to the north a little cuprite, malachite, and specular

hematite was seen in arkose at and near the contact with the igneous rock. In some places banding and calcite-filled amygdules suggest a volcanic origin for these rocks. And again the contact phases with the arkose on the northwest side suggest that some, at least, of the rocks are intrusive. In either event they do not resemble the volcanics of the Shickshock series, being fresher and not schisted, although they form the western end of the Shickshock range.

Grains of pyrite were locally common in the breccia and other contact phases of the diabases and associated sediments on Miner brook.

Gold, Antimony

Claims are presently held in Marcil township to cover some showings of quartz veins carrying traces to low values of gold and silver. The claims are about a mile to the west of the West Branch Little Cascapédia river, and close to the mid-line of the township. The few quartz veins seen cut sandstones and shales of the York Lake series. In no case have they been exposed for more than a few feet along their strike, and they vary from thin veinlets to lenses or knots one and a half feet thick. The best assay reported by the owners was 58¢ in silver and 28¢ in gold to the ton. Occasional grains of pyrite and chalcopyrite, and rare grains of bornite and galena were noted in the quartz veins. Our examination of these showings did not lead us to suppose that they were of economic merit.

An antimony-gold prospect, ... reported by Alcock (1935, pp.130-131) and examined by the writer in 1941 ..., is located in the

northern half of lot 9, range VI, New Richmond township. The prospect lies within an area of sedimentary rocks thought to be Ordovician in age. It occurs as a quartz vein and silicified zone striking N.20°W. and dipping vertically or nearly so. The quartz vein is one to four feet wide. Immediately east of the vein is a silicified conglomerate zone up to eight feet wide. It was in this silicified zone that most of the stibnite showings were noted, and from which most of the gold values were obtained. Veinlets of quartz cut this zone here and there. The silicified zone grades eastward into pebble-cobble conglomerate carrying lenses of shale. The rock on the west side of the vein is shale, badly weathered and crumpled as exposed.

Some good assay values in gold have been obtained from this prospect. Usually, however, these have been had in association with stibnite, and the general indication from the assays is that gold in paying quantities is not present in the quartz vein or in the silicified conglomerate outside of the stibnite lenses. And the stibnite itself, which originally was present in quantities sufficient to indicate a fair antimony prospect, apparently showed less and less as development work carried the surface down. At thirty-three feet below the original rock surface, the greatest depth to which prospecting was carried, the stibnite was reduced to rare and very small lenses or pockets. Thus, as it stands at present the prospect is not an encouraging one. Nevertheless, diamond drilling might show values again at lower depths.

Gold-bearing quartz veins have been reported from a locality overlapping the Weir-Honorat township line, and five to six miles south of the north line of these townships.

Asbestos, Talc, Chromite

Chromite, asbestos, and talc have been found in the serpentine area within the Macquereau formation in Weir township. This area is included largely within the surveyed portion of range II, and extends across the two arms of the North Branch Port Daniel river just above their junction. The area was examined by Harvie (1920, p.84) and Alcock (1935, pp.10-12) for the Geological Survey of Canada and by the present writer for the Quebec Department of Mines.

The investigations and sampling of asbestos-bearing rocks done by the MacLaurin brothers led to a mining patent being issued to them in 1906. This patent, still retained, covers a part of the northern halves of lots 32 and 35 of range II. In the following years some prospecting work was done, consisting of a few shallow pits and one pit about twelve feet across and apparently about thirty feet deep.

Most of the workings were located between the two branches of the Port Daniel river. Apparently the best asbestos showings were at the main pit or shaft location. This is now filled with water but quite a quantity of serpentine pieces showing asbestos are scattered around the edge of the pit. The asbestos was of good quality but in short lengths, the longest noted being about one-sixth inch. Some pieces were seen in which asbestos made up about ten per cent of the rock, but the average would be very much less. Elsewhere in the serpentine asbestos was rarely noted. Harvie, Alcock, and the present writer all agree that it does not seem likely that an economic deposit of this mineral is present in this serpentine area.

A showing of talc also was prospected by the MacLaurin interests. This was found about 1,300 feet east of the North Branch Port Daniel river in lot 37 of range II, Weir township, or towards the eastern end of the serpentine exposures. A pit 40 by 40 feet was put down to a maximum depth of 15 feet. Some talc occurs here, but the quantity does not seem important nor the quality particularly good.

Prior to the writer's brief examination of this area in 1941 no chromite had been reported. At that time chromite grains were noted throughout the serpentine and a concentration of the mineral was found at one locality. This discovery led to intensive prospecting of the area by private interests and some other concentrations were found. Trenching and some diamond drilling showed that the chromite occurred in scattered and short lenses and that there was not a sufficient quantity of the mineral to make it exploitable.

Two masses of serpentine occur on the southern border of the Shickshock range west of Mount Albert and roughly in line with the southern part of the Mount Albert serpentine body. Examination of these bodies in 1942 and 1943 by ourselves and by a prospecting party operating for a private company failed to reveal any chromite and only traces of asbestos. One of the masses, South mountain, extends eastward from the Salmon Branch for two and a half miles. It is one-quarter to one half miles wide. Its eastern end is about five miles from Mount Albert. The other mass, a new discovery, begins one mile and a half west of the Salmon Branch and has about the same dimensions as South mountain. It is slightly north of the general line of strike of South Mountain. Both masses

are succeeded to the north by the schists of the Shickshock series and appear to be succeeded to the south by the sedimentaries of the Middle Silurian.

Petroleum

The Gaspé Sandstones and the Gaspé Limestones have been shown to contain "free" oil in the eastern part of the peninsula. Both of these series are present over wide areas in western Gaspé, particularly between the Salmon Branch of the Grande Cascapédia river and the Matapédia valley. Therefore, if structural conditions are favourable, western Gaspé should be as attractive to the petroleum prospector as is eastern Gaspé. The only apparently favourable structure crossing the Matapédia valley itself is the Albertville anticline. This, however, has been worn down so that Middle Silurian shows on its crest, with the Bon Ami formation on the flanks. Farther east the plunge of this fold carries the Middle Silurian under the Bon Ami and Grande Grève formations. So far as is known there is no effective "closure" for any of these formations on this structure. South of the Albertville anticlinal the succession apparently is interrupted by a fault which appears to have cut out all or most of the Grande Grève and to have brought the Heppel sandstone formation against the Bon Ami. The dips of the Heppel beds in the valley and for at least six miles eastward are so uniformly steep as to preclude the possibility of any commercial quantity of oil remaining in them. Eastward of Matapédia valley it would appear that the only favourable structure is the anticlinal which crosses the Inlet and trends northeast across Miner brook, fading out before it reaches Go-Ashore brook. It is not

known how far this fold extends to the southwest beyond the Inlet. The Grande Grève is exposed on the northern flank of this fold, between the Inlet and the upper reaches of Miner brook, and here the dips are very gentle, perhaps offering an opportunity for testing the limestones. North of this anticlinal the next fold is a relatively shallow synclinal which we believe to be continuous with the Lac au Saumon synclinal in the Matapédia valley. And beyond this as far as the Shickshock range the dips are consistently southward.

In all the region east of the Grande Cascapédia river and south of the Berry Mountain synclinal neither the Gaspé Limestones nor the Gaspé Sandstones are typically developed. Here, also, the structures are generally too sharp to be looked upon as favourable from a petroleum viewpoint. Consequently it would seem that the conditions are less favourable for oil production here than they are to the northeast, where no commercial production yet has been made. It would seem reasonable to await such production before entering this region with a drilling programme.

An opportunity for testing Silurian and older rocks may be waiting the driller in the wide area underlain by the Silurian Chaleur series. The structure of this series has not been worked out in any detail except along the coastal border.

Some of the rocks in this region give off an odour of petroleum when freshly broken. Such were noted among the limestones of the York Lake series between Cotton brook and the third East branch on the Bonaventure, in limestone conglomerate towards the base of the Devonian-Silurian section on the Salmon Branch of the

Grande Cascapédia, and in various Devonian and Silurian limestones between the Salmon Branch and the Matapédia valley.

An examination of oil shales of the Mictaw series on the Port Daniel river, its North Branch, and the Mictaw river all within seven miles of Port Daniel village, was made by Swinnerton (1933, pp.145-148) who concluded as follows:- "The results of the analyses and distillation of samples from seven beds" show that "there is little or no possibility for the economic extraction of oil from the Port Daniel shales ---- the best yields being less than one gallon per ton".