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WESTERN TEMISCOUATA REGION, PART D

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PROVINCE OF QUEBEC, CANADA

BUREAU OF MINES

Honourable J. E. PERRAULT, Minister of Mines

J. L. BOULANGER, Deputy-Minister

A. O. DUFRESNE, Director

ANNUAL REPORT
OF THE
QUEBEC BUREAU OF MINES
FOR THE CALENDAR YEAR
1933

JOHN A. DRESSER, Directing Geologist

PART D

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WESTERN TÉMISCOUATA

WITH PARTS OF KAMOURASKA AND RIVIÈRE-DU-LOUP COUNTIES

by H. W. McGerrigle

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WESTERN TÉMISCOUATA

WITH PARTS OF KAMOURASKA AND RIVIÈRE-DU-LOUP COUNTIES

by H. W. McGerrigle

INTRODUCTION

GENERAL STATEMENT

The main purpose of the present survey was to examine any rocks or minerals of commercial value within the map-area and especially near the Canadian National and the Témiscouata railways, both of which traverse the district. Slate of commercial quality was known to occur at one locality, and its existence elsewhere in the area was suspected. Limestone suitable for use in the pulp and paper industry was especially desired, both by that industry and by the railways, but there was no record of the resources of the area in respect to this material. It was also possible that rocks of the serpentine series, with which deposits of asbestos, chromite, copper ore, and talc are frequently associated, might be found. These problems were studied in the field, and a reported occurrence of gold was also examined.

Apart from the possible economic aspects, the geology of this district has long been known to be of considerable complexity, presenting many problems of peculiar interest, and it was hoped that the field work might help in the solution of some of these problems.

ACKNOWLEDGMENTS

The writer is particularly grateful to Professor P. E. Raymond, of Harvard University, and to Professor H. M. Bannerman, of Dartmouth College, for direct contributions to this report; to the former for examination of fossils, and to the latter for petrographical determinations.

Able assistance was given in the field by V. J. Okulitch, graduate student of McGill University, who, in particular, mapped the shore area between Notre-Dame-du-Portage and Cacouna; and by Georges Vaillancourt, of Jonquières, a student in engineering at Queen's University.

LOCATION AND AREA

The district described includes a large part of Témiscouata county and three neighbouring townships in the county of Kamouraska (see Map No. 279). It lies between the St. Lawrence river on the northwest and New Brunswick on the southeast. On the west it is limited by the Quebec-Maine boundary and the road leading northward from Estcourt to the St. Lawrence. The eastern boundary is the line made by the Madawaska river and the southern arm of Lake Témiscouata and thence to the St. Lawrence. The district has an area of approximately 1,000 square miles.

The Canadian National railway enters the area from the west near Saint-Éleuthère, about sixteen miles from the St. Lawrence, and thence runs southeastward to Baker lake and New Brunswick. The Témiscouata railway, from Rivière-du-Loup to Edmundston, traverses the central and eastern part of the area. In the southern half it follows the western shore of Lake Témiscouata and thence the Madawaska valley to the boundary of the Province of Quebec.

More or less parallel to the railways are two northwest-southeast highways, one from Rivière-du-Loup to Edmundston and the other from the St. Lawrence, in the vicinity of Saint-Alexandre, by a less direct route also to Edmundston. Inasmuch as these routes, highway and railway, run across the structural trend of the rock formations, they afford the best cross-sections of the area.

Range roads and others are common locally, but roads communicating between the two highways are rare, except within a few miles of the St. Lawrence. Farther south, only two roads cross the area, the more northerly being thirty-five miles from the St. Lawrence and the other seven miles farther south.

Farming and lumbering are the chief occupations. The part of the area bordering the St. Lawrence and for a few miles inland is particularly adapted to farming. This is true also of a much smaller area bordering Lake Témiscouata and in the valley of the Madawaska. Scattered throughout the district are small farming communities. But there are areas, several square miles in extent, that are not well suited to agriculture owing to rugged topography or to widely strewn, coarse glacial deposits. Such areas lie between the roads mentioned above. They are heavily forested and are being exploited by lumbering and by pulp and paper interests.

METHOD OF WORK

Although no topographic maps of this area have been made, there are several maps available that are suitable for the location and plotting of outcrops. The map used for this purpose was one published by the Department of Colonization, Game and Fisheries in 1932 and has the scale of one inch to the mile.

Most of the field work was done from roads, with short traverses therefrom. It was found by trial that, in the time available, long cross-country traverses were not economical. This was due to the heavily wooded nature of the areas back of the narrow farming strips bordering the roads and to the relative scarcity of rock exposures.

PHYSIOGRAPHY

REGIONAL

The major physiographic regions of southern Quebec and the Maritime Provinces are usually termed the Appalachian and the Acadian. As defined by Young^①, the Appalachian region includes the territory northwestward from Baie des Chaleurs and the Ristigouche river to the St. Lawrence and thus covers all of the area considered in this report. The Acadian region broadly includes New Brunswick, Nova Scotia, and Prince Edward Island. The boundary between the Appalachian and Acadian regions, however, is not a very definite one. Although, by Young's definition, it would follow the valley of the Ristigouche river, in New Brunswick, and it would seem to the writer that the territory as far northwest as Lake Témiscouata, in Quebec, might well be included in the Acadian rather than the Appalachian province.

Where the Appalachian region enters Quebec from Vermont and New Hampshire, it contains three parallel groups of ridges and isolated hills separated from one another by pronounced valleys. These ridges are the northward continuation of the Green mountains of Vermont. Of these three ridges, it is only the westernmost that continues through the present area. This is known as the Sutton range in southern Quebec and as the Notre-Dame hills farther to the northeast.

^① Young, G. A., *Geology and Economic Minerals of Canada*; Geol. Surv. Can., Econ. Geol. Series, No. 1, 1926, p. 83.

LOCAL

Dresser ① outlined and described three local physiographic divisions forming parallel northeast-southwest belts which, while not everywhere well defined, are generally apparent. These were distinguished as the St. Lawrence lowland, the middle upland, and the St. John slope.

A lowland, though not uniform in the structure of the underlying rocks, borders the St. Lawrence and extends from Lévis to the Gaspé coast. It has a general elevation of 100 to 150 feet above sea level and, in the southwestern part of the region, varies in width between four and eight miles. In the present area, however, the average width is much less. This is particularly true between Saint-Alexandre and Rivière-du-Loup, but the width increases to the northeast until, inland from Cacouna, there is a flat plain about ten miles wide with occasional low ridges and isolated hills.

Inland from the St. Lawrence, in the area described by Dresser, the lowland is separated from the middle upland by a fault escarpment. This escarpment is pronounced through a distance of 65 miles northeastward from the vicinity of the Etchemin river, but dies down in the central part of Kamouraska county, or about fifteen miles before reaching the present area. Throughout most of its length, the escarpment is 500 to 700 feet above sea level, and in Montmagny county it rises to 1,000 feet. In the present area, no such pronounced feature exists, although several relatively low northwesterly-facing scarps or slopes occur, and one or more of these may be a continuation of the fault-zone described by Dresser.

In this area, then, there is less distinction between the lowland and the middle upland. The surface rises gradually, although over rolling country, for ten to twenty miles from the St. Lawrence. Then, with the introduction of more resistant rocks, the country becomes more rugged. This more rugged belt is a continuation of that described to the southwest, and it is stated ② that the southern edge of the middle upland rises as it is followed to the northeast, into Kamouraska and Témiscouata, until hills 2,000 feet above sea level are common. These hills are part of the Notre-Dame range which, here, has a width of fifteen to twenty miles.

① Dresser, J. A., *Reconnaissance Along the National Transcontinental Railway in Southern Quebec*; Geol. Surv. Can., Mem. 35, 1912, p. 7.

② Dresser, *op. cit.*, p. 8.

The St. John slope is in fairly sharp contrast with the middle upland in this part of Témiscouata county; the contrast being much more marked than in the area to the southwest. Here, the boundary between the two divisions corresponds closely with a geological boundary between the Pohenégamook and Sillery formations that is traced from near the foot of Pohenégamook lake northeastward to a position about three miles north of Lake Témiscouata.

The northernmost part of the St. John slope, in a belt about ten miles wide, is rolling country with no pronounced hills or deep valleys, and has an average elevation of around 800 feet. Beyond this belt, to the southeast, the surface is much more rugged, with steep-sided hills and more rapid streams, although the average elevation does not greatly increase.

DRAINAGE

The drainage of the area is principally in two directions, northerly to the St. Lawrence and southeasterly to the St. John. Connected with the drainage lines are numerous lakes, many of which are of considerable size and notable natural beauty. The largest is Lake Témiscouata, in the county and seigniory of that name, in the eastern part of the area. An upper, or headward, arm of the lake extends towards the northeast for about six miles. It forms almost a right angle with the lower and larger arm, which extends in a southeasterly direction for eighteen miles. The average width is upwards of a mile. Roughly paralleling the trend of the southern arm of the lake are smaller lakes, none of which, however, are less than five miles in length. Chief of these are Long lake, Meruimticook lake and Beau lake, all in the southern part of the area, and Pohenégamook lake, about midway of the western edge of the map. All of these lakes drain southwards with the exception of Long lake, which, although lying between Beau and Meruimticook lakes, drains from its northern end into Lake Témiscouata by way of the Cabano river.

The largest river of the area is the Madawaska, flowing out of Lake Témiscouata to the St. John river and crossing the Quebec-New Brunswick boundary about eleven miles from the lake. Tributary to this drainage line are the Cabano, from the southwest, and the Touladi, from the northeast, both emptying into Lake Témiscouata. The other streams of the area which flow to the St. John are the Saint-Francis

river and Baker brook. The former, rising in Saint-Francis lake, about fifteen miles from the St. Lawrence, drains first through Pohénégamook lake and then Beau lake; from the foot of Pohénégamook lake to the foot of Beau lake it forms the Quebec-Maine boundary. Baker brook crosses the Quebec-New Brunswick boundary between the Madawaska and Saint-Francis rivers and has a relatively short course in Quebec; one of its tributaries drains Meruimticook lake.

The main streams flowing to the St. Lawrence are Du Loup river and Verte river. The former takes its rise about twenty miles in a straight line from the St. Lawrence and is longer than most of the tributaries of that river in this region. In the northeastern part of the area, several small streams rise near the Rivière-du-Loup-Cabano highway. Thence they flow northeastward in roughly parallel courses along the strike of the rocks for several miles before joining the Trois-Pistoles river, which cuts across the strike on its way to the St. Lawrence.

As indicated above, some of the drainage lines are apparently controlled by the structure of the underlying rocks. This is true of certain parts of the rivers which flow to the St. Lawrence, particularly in the upper part of their courses. It is also true of the Cabano and Touladi rivers, whose courses are parallel to the major structures and in a northeast-southwest direction. The northern arm of Lake Témiscouata, also, has a northeast-southwest trend. The long southeast arm of the lake, however, and the Madawaska river trend almost directly across the main structures. These trends suggest structural control of drainage either by reason of more resistant beds or by folds and fracture lines. A study of the history of the drainage in this area would be of interest as a separate investigation.

GENERAL GEOLOGY

SUMMARY OF REGIONAL GEOLOGY

Valuable observations bearing on the general geology of the region have been presented in recent years by Schuchert ①, Alcock ②, and Parks ③. The regional geology is also shown in two recently published geological maps ④.

The southern part of the present area, as well as northern New Brunswick and adjacent parts of Maine, are underlain mainly by Silurian rocks, with occasional small areas of Devonian. The rocks are slates and sandstones, with subordinate limestones and volcanics, all of which have been more or less folded. This folding is believed to be the latest that has affected the region outlined, and is known as the Acadian folding of late Devonian time.

North and northwest of the area underlain by these youngest rocks are strata of somewhat indefinite age but probably referable to middle Ordovician. These are, in turn, underlain and succeeded to the northwest by early Ordovician formations, the Sillery and Lévis, which have played an important rôle in discussions on the 'Quebec group'. The Ordovician rocks are more folded and altered than the Silurian, having been involved in two periods of folding rather than one only. The earlier folding, known as the Taconian, marks the close of Ordovician time.

Locally, these rocks have been invaded by igneous intrusions. Some of these intrusions apparently antedate the folding of late Devonian time while others are later and have been referred to late Palæozoic. None as old as Ordovician have been identified.

① Schuchert, Charles, *Orogenic Times of the Northern Appalachians*; Geol. Soc. Am., Bull. 41, 1930, pp. 701-724.

Schuchert, Charles, and Longwell, C. R., *Palæozoic Deformations of the Hudson Valley Region, New York*; Am. Jour. Sc., Vol. 23, 1932, pp. 305-326.

② Alcock, F. J., *Relationship of the Devonian and Silurian in Gaspé Peninsula and Northern New Brunswick*; Royal Soc. Can., Trans., Sec. IV, 1931, pp. 113-117.

③ Parks, W. A., *Geology of the Gaspé Peninsula*; Geol. Soc. Am., Bull. 42, 1931, pp. 785-800.

④ *New Brunswick-Gaspé Sheet*, by F. J. Alcock; Geol. Surv. Can., 1931.

Preliminary Geologic Map of Maine, by Arthur Keith; issued by the Maine Geol. Surv., 1933.

The structure of the region in general is complicated. In north-western New Brunswick and adjacent parts of Quebec and Maine the strata appear in a succession of folds which are, however, apparently subordinate to a major syncline with its axis to the south. In the Ordovician belt northward to the St. Lawrence the strata are more confused and there is much northwestward overturning, but a general anticlinal structure is indicated. Several thrust faults of greater or lesser extent and expression have developed from these folds, with the result that the detail of the geological succession has not everywhere been determined satisfactorily. The thrusts observable along the St. Lawrence below Quebec are probably subsidiary to the main thrust (in places a normal fault), the original "Logan's Line", which remains under the St. Lawrence from Quebec to the Gaspé coast. Transverse faults also occur but are relatively local.

PREVIOUS WORK IN MAP-AREA

The district was first geologically examined by Sir William Logan ^①, prior to 1863. Logan recognized two major divisions, namely, the *Quebec group* and the *Gaspé limestones*, the line separating the two crossing the area from near the foot of Pohénégamook lake in a northeasterly direction to, and paralleling, the northern arm of Lake Témiscouata. On the north, the Quebec group extended to the St. Lawrence, and on the south the Gaspé limestones extended well into New Brunswick and Maine. The Quebec group here, as identified by Logan, was entirely Sillery. The Gaspé limestone area included within it a very thick conglomerate formation which Logan considered older than the limestones, although apparently lying above them. Later work in this area supports Logan's general conclusions, and differences that appear are only in detail.

In 1869, Richardson ^② reported on the geology of the area on the south side of the St. Lawrence from Lévis to and beyond Rivière-du-Loup. One of the main results of this work was the conclusion that certain quartzites and sandstones, apparently within the Sillery, were actually unconformably below that formation. These were referred to the Potsdam formation.

^① Logan, Sir William, *Geology of Canada*, 1863.

^② Richardson, J., *Geol. Surv. Can., Rept. of Prog.*, 1869.

In 1888, Ells^① reported briefly on the northern part of the area, but his detailed field-work was done mainly between Lévis and L'Islet counties, which are west of the present district. One of the features of this report is the summary it contains of the evidence showing that the Sillery formation of the 'Quebec group' is actually below the Lévis, and not above as was before supposed.

In 1888 and again in 1890, Bailey and McInnes^② reported on northern New Brunswick and adjacent parts of Quebec and Maine. They separated the rocks of the area into two main divisions, the Cambrian and Silurian. These were further subdivided as summarized in the following table:

Silurian.....	{	Lower Helderberg (Mt. Wissick beds). Sandstones and lime-	{	Sandstones and lime-
		stones		Sandstone and shale
		Niagaran.....		Conglomerate
Cambrian.....		Sillery.....		Sandstone and shale

The boundary between these two main divisions is described and mapped as running from the north side of Mt. Wissick southward almost through Cabano and paralleling the course of the Cabano river for some miles before swinging northward to leave the Province about two miles south of Pohenégamook lake for points in Maine. A detailed section of the rocks of Mt. Wissick and extensive discussion of the presumed Niagaran rocks is given in the earlier report, while the later one describes in some detail the structure and lithology of a section along the road from Cabano to Rivière-du-Loup.

In 1908, a reconnaissance survey between the Maine-Quebec boundary and the St. Lawrence from the Etchemin river south of Lévis to Témiscouata county was made by Dresser^③. Four formations were recognized, namely, the Kamouraska, L'Islet, Sillery, and Pohenégamook, in order from oldest to youngest. The uppermost, Pohenégamook, formation was found to be separated from the underlying Sillery by erosional unconformity. This was shown by the

^① Ells, R. W., *Second Report on the Geology of a Portion of the Province of Quebec*; Geol. Surv. Can., Ann. Rept., Part K, 1888.

^② Bailey, L. W., and McInnes, W., Geol. Surv. Can., Ann. Rept., Part M, 1887-88; Part M, 1890.

^③ *Op. cit.*,

presence of a thick and coarse conglomerate carrying boulders of Sillery and L'Islet, and also by the fact that the Pohenegamook sometimes rests on the Sillery and again on L'Islet. The Kamouraska corresponded, in part at least, with the Potsdam of Richardson, and with the sandstones and quartzites that were stated by Logan to underlie the Sillery. The distribution of these formations, and the dips, as given on Dresser's map, showed that the structure is not simple, although in general anticlinal.

The most recent work to cover any part of the present area was that of Young ^① who, in 1913, described various localities along the south shore of the St. Lawrence and, in particular, provided a detailed description of the section at Rivière-du-Loup, where part of the Sillery is well exposed.

TABLE OF FORMATIONS

The formations represented in the present area are listed in the following table:

ERA	PERIOD	FORMATION	CHARACTER
CENOZOIC	Quaternary		Stratified sands and gravels; glacial drift
<i>Unconformity</i>			
PALÆOZOIC	Devonian (?)		Intrusives
	Devonian (?)	Mt. Wissick group	Sandstones, shales or slates, limestone
	<i>Unconformity?</i>		
	Silurian (Niagaran)	Temiscouata group	Slates with interbedded sandstone and limestone

(Continued on next page)

^① Young, G. A., Geol. Surv. Can., Guide Book No. 1, *Excursion in Eastern Quebec and the Maritime Provinces*, 1913.

TABLE OF FORMATIONS—*Continued*

PALÆOZOIC	<i>Unconformity?</i>		
	Ordovician (?)	Cabano group	Conglomerate and sandstone
	Ordovician (Middle?)	Pohénegamook	Slates, sandstones, conglomerate
	<i>Unconformity</i>		
	Ordovician (Lower)	Sillery	Slates, sandstones, quartzites
	Position indefinite	Kamouraska	Quartzite
	Ordovician (?)	L'Islet	Slates, quartzites, schists

The lithological differences between the various formations here represented are not highly pronounced. All are characterized by slates, sandstones, and quartzites, with occasional limestones. The Ordovician strata, however, have been subjected to stronger folding movements than the younger beds.

ORDOVICIAN (?)

L'ISLET

DISTRIBUTION:

The L'Islet is the least well defined formation in the present area. It occurs meagrely in very few outcrops. There is a narrow belt of these rocks to the northwest of Pohénegamook lake, where it crosses the highway between Saint-Éleuthère and Saint-Alexandre, and a small area of outcrops between Saint-Éleuthère and Estcourt is also referred to this formation. In the area to the southwest, the L'Islet occupies a belt from four to eight miles wide and over 100 miles in length.

LITHOLOGY AND STRUCTURE:

The L'Islet formation consists of black or dark grey, ferruginous, quartz-mica schists or slates, with grey quartzites or quartzitic schists occurring as lenses or broken beds. It is the relative predominance of more highly metamorphosed rocks that distinguishes the L'Islet from the Sillery and Pohenegamook. The structures within the formation are also distinctive. Intense drag-folding is common in the schists and involves also the less massive quartzite beds.

This formation, throughout its extent here and to the southwest, occurs along the axis of an anticline which apparently remains fairly level until northeastern Kamouraska county is reached. Then it pinches out, with the development of a northeast plunge. Or, it may have been caused to disappear through faulting. The actual north-eastward limit of the formation was not determined, and the boundary as drawn on the accompanying map is hypothetical. It is based, however, on the evident narrowing of the formation as it approaches and enters the present area and, also, upon the fact that no rocks along or near the projected strike of the formation and comparable to it were observed on the Rivière-du-Loup-Cabano road.

AGE AND CORRELATION:

No fossils have been reported from the L'Islet formation and the only definite clue to its age is its relation to the overlying Sillery. In the area to the southwest, Dresser ^① has found that it definitely underlies that formation and grades upward into it. "This can be well seen on the L'Islet road, near Saint-Cyrille, and also two or three miles northwest of Saint-Marcel. In these places, there is no discernible difference in the attitude of the beds, nor other evidence of a time break between them. The change from one formation to another is marked by a transition zone, consisting of a succession of alternating beds of grey L'Islet schists and red or green Sillery slates. They share in the same folding and are thought to be conformable". Thus, the L'Islet and Sillery formations are thought to belong to the same time period. The writer can add nothing definite to the discussion, for, in the present area, the contact between the two formations is not exposed. However, the field relations showing the L'Islet in a

^① *Op. cit.*, p. 21.

position between two bands of Sillery, in a part of the area where a general anticlinal structure is evident, indicates that the L'Islet is the older formation.

From the evidence given by Dresser and the general relations in the present area, it is concluded that the L'Islet and Sillery form a conformable series. The corollary of this, from the fossil evidence provided by the Sillery, is that the L'Islet formation is Beekmantown or basal Ordovician.

LOWER ORDOVICIAN

SILLERY

DISTRIBUTION:

The Sillery formation is widespread along the south shore of the St. Lawrence from Lévis into Gaspé peninsula. It occurs in a belt varying in width from four to twenty miles or more. An exceptionally large area is underlain by Sillery in Témiscouata county, where it extends inland from the St. Lawrence for 27 miles. This distance carries the formation almost to the foot of Pohénégamook lake, on the southwestern side of the area, and to a line about three miles north of Lake Témiscouata on the southeastern side. After an interval of three to four miles, occupied by the younger Pohenegamook, the formation reappears in a much narrower and less continuous belt. A part of this latter belt occurs on the northeast side of Lake Témiscouata, where it is overlain by the younger beds of the Mt. Wissiek group.

LITHOLOGY:

Lithologically, the Sillery is a series of red, green, grey, and black slates interstratified with sandstones, quartzites, and occasional beds and lenses of limestone and limestone conglomerate. In general, two great zones are recognizable in the present area. These grade one into the other, and, although their thicknesses have not been determined, it is probable that each is to be considered in terms of many thousands of feet.

Zone 1.—The lower of the two zones is exposed along either side of the anticlinal axis which is generally occupied by the L'Islet formation. It is a series of sandstones and quartzites interbedded with

slates and occasional slaty schists. The slaty beds are more important than the sandstones quantitatively, although the latter are more prominently exposed. Red and green slates occur in this zone, but the most typical slates are dark grey and black in colour. They are hard, brittle, thin-cleaving, with the cleavage and joint faces often stained with iron oxide. Many of the outcrops show regular interbedding of dark slate with quartzite layers up to two inches in thickness. In such outcrops, it is usually apparent that the slaty formations, at least, of this lower zone have been highly contorted.

The sandstones and quartzites are quite variable in composition, colour, grain size, and thickness of beds. The most common type is a greenish-grey sandstone or quartzitic sandstone, weathering grey, often highly feldspathic, and usually sheared. Under the microscope, a typical specimen of this sandstone shows the following: quartz, about 60%, in sub-angular grains varying in size from 0.5 mm. to 2.0 mm.; feldspar, about 10%, with orthoclase and oligoclase the common types, and the latter more abundant; blotches of kaolin, and occasional minute grains of zircon and rutile. The matrix is mainly secondary silica and chloritic material, with some iron oxide; inter-fingering of the secondary silica with the chlorite has produced radial structures around many of the quartz grains. In some of the slides, shearing is shown by the elongation of chloritic wisps and occasionally by orientation of the quartz grains. Strain shadows in the quartz are common.

There are also quartzites with the percentage of quartz running much higher than 60 per cent. The colour of these varies from grey to dark grey, and on the weathered surface they are light grey to whitish. These quartzites are in places associated with the greenish-grey, feldspathic type, but usually they are found with considerable thicknesses of black slate above and below. The best and most easily accessible exposures occur in a band which strikes through the village of Saint-Louis-de-Ha! Ha!. In thin section, quartz is seen in rounded grains, up to 2 mm. in diameter, fairly evenly distributed throughout the slide. The grains are surrounded by secondary quartz, sometimes optically oriented with them. A few small grains of oligoclase, rutile, zircon, and pyrite are present. The oligoclase is in fresh, well-formed crystals and is perhaps secondary. The pyrite is replaced in part by iron oxide. The interstitial material, apart from secondary quartz,

consists of chlorite in wisps around some of the quartz grains, specks of biotite, and long, lath-like muscovite flakes. Structurally, the rock shows little sign of foliation.

In addition to the rocks already described there are occasional beds of pebble conglomerate, varying in thickness from a few inches to 25 or 30 feet; and also beds, with about the same thickness, of arkosic sandstone. The conglomerate beds are composed mainly of sub-angular quartz pebbles ranging up to one inch diameter. Subsidiary to the quartz are smaller and more angular feldspar pebbles, and lath-shaped pebbles of black slate up to four inches in length.

Zone 2.—The higher of the two zones here recognized in the Sillery extends from the St. Lawrence shore southeast for 16 to 20 miles. This zone may be distinguished from the lower zone of the Sillery and from other formations in the area by the red and green slates and drab-green sandstones which it contains. Dark grey and black slates also occur, and other types presently to be described.

Dark grey quartzites occur throughout the slates as interbeds usually less than one foot thick, although beds up to four feet are not uncommon. Similarly distributed are beds, one foot or less in thickness, of dense, grey limestones, and small lenses of conglomerate in which the pebbles are mostly limestone.

Apart from the slates and their interbeds (Plate I-A) there are occasional occurrences of coarse sandstones in beds usually less than three feet thick and separated by thin, muddy partings; the whole making a succession of sandstones upwards of 150 feet thick in some places. Where these sandstones outcrop in the flats bordering the St. Lawrence, they stand up as prominent hills and are clearly exposed. No evidence of overturning was found in these sandstones, though close folding and northwest overturning is evident in the slates and their interbeds.

Drab-green sandstones of a type sometimes described as typical Sillery sandstone occur as beds or lenses, mainly the latter, in the slates. Several square miles in the northwestern part of the area are underlain by sandstones of this type. Judging from Logan's map ① and from the evidence in the present area as given by distribution and structure,

① Atlas accompanying *Geology of Canada*, 1863.

this sandstone area represents a huge lens in the Sillery slates. Disconnected exposures of the sandstone occur on the Saint-Alexandre-Estcourt road from Saint-Alexandre southward for about twelve miles. No other type of rock was observed throughout this distance. The width here displayed is apparently maintained for nine or ten miles to the northeast, beyond which the formation appears as two unequal tongues separated by Sillery slates and quartzites.

In hand specimen, these green sandstones are medium to coarse in grain and show quartz, feldspar, and mica; they contain occasional pebbles of black slates or shale, whose flattened, rounded shape gives the impression that they were incorporated in the sandstone as soft mud pellets. Quartz grains make up 40 to 50 per cent of the rock, and feldspars are present in sufficient quantity in some places to warrant the term 'arkosic'. As seen in thin section, the quartz grains are angular to rounded in outline and range in size up to 3 mm.; crushing is evident in some of the grains. Orthoclase is present in clouded or decomposed grains up to 2 mm. size. The oligoclase, on the other hand, is fresh, and much of it is interstitial and probably secondary, although some rounded, detrital grains occur; a few of the crystals are bent. Scattered through the slides are minute grains of muscovite, biotite, magnetite, zircon, rutile, epidote, and graphite. In the matrix, chloritic and sericitic material is most abundant and occurs in wisps around the quartz and feldspar grains; secondary silica, serpentine, and limonite also are present. In general, the structure is massive, with little sign of foliation.

The characteristics of the red and green and other slates of the Sillery and their associated beds have been described many times, and it is not thought necessary to review them here. One observation, although relating to detail, deserves mention, however. In two small lenses of limestone conglomerate near Rivière-du-Loup, 'pellets' of what, in hand specimen, appear to be rounded bits of dark mud, although harder, are scattered through the rock. On the surface of an area six inches square, 25 to 30 of these 'pellets' may be seen, ranging in size up to 5 mm. Similar occurrences were described by Logan^① from the vicinity of Rivière-Ouelle as phosphatic nodules. Chemical analyses of our 'pellets' confirm the phosphatic composition.

^① *Geology of Canada*, 1863, p. 462.

STRUCTURE:

The structure and succession of beds in the Sillery can be given only in a very general way, except in certain restricted areas. The most continuous cross-section is to be seen at Rivière-du-Loup, where the river of that name has cut a winding gorge (Plate I-B) which, in straight line, exposes a section about a mile long. It has been described in detail by Young^①. Going downstream from the southern edge of the town to the bridge on the shore highway, we found the following succession, in descending order (the thicknesses given are approximate):

	<i>Feet</i>
1. Red, green, and dark slates, with occasional beds of limestone and lenses of limestone conglomerate.....	2,000
2. Black and dark grey slates, with interbeds of quartzite.....	350
3. Black slate, in part highly contorted (Plate II-A) and in part less disturbed.....	400
4. Light grey quartzites, in massive beds.....	450
5. Gap in section: amount missing is about.....	800
6. Black slate and shale, with thin, quartzitic interbeds; sharply folded.....	300
7. Interbedded greenish-grey slates and thin, grey, feldspathic sandstones; slates predominating.....	800+
8. Massive greenish-grey quartzites and pebble conglomerate beds..	100
9. Massive quartz-pebble conglomerate beds.....	50
10. Dark, thinly-bedded slates and quartzites, with occasional beds of grey limestone; slate pebbles (few) scattered in a sandy matrix...	75
11. Massive, bluish-grey quartzite; a few beds of quartz-pebble conglomerate and arkosic sandstone.....	50+
12. Green slates, interbedded with heavy quartzite beds; much drag-folding in the slates.....	100
13. Massive, greenish-grey, grey- and red-weathering sandstones.....	45

Zone No. 13 occurs near the bridge on the shore highway (Quebec-Gaspé route). There is then a gap in the section, and the nearest beds that can be assigned to it are about 2,000 feet distant, and these are projected from their outcrop about a mile northeastward of the section line, where they rise in a prominent hill through the St. Lawrence flat. These beds are about 300 feet in total thickness and consist of greenish-grey sandstones and quartz-pebble conglomerates. Pebbles of dense, grey limestone and of black slate occur, but perhaps

^① Guide Book No. 1, *loc. cit.*, p. 55-66, and map opposite p. 58.

99 per cent of the pebbles are quartz up to two inches in size. The dip of the formation is 40° southeast and the beds do not appear to be overturned.

After another gap of about 2,000 feet, outcrops again appear. These are on Rivière-du-Loup point, and the section exposed is as follows, in descending order:

	<i>Feet</i>
1. Greenish-grey slates.....	200
2. Red and green slates, interbedded; mainly red; dip variable.....	800
3. Interbedded dark slates and quartzites.....	50
4. Dark grey to black slates; extend out under the river.....	100+

A succession similar to the above, but with massive sandstone and quartzite beds, occurs in a ridge bordering the shore to Cacouna. Beyond Cacouna, a strong ridge of sandstone appears to the northwest and is separated from the vari-coloured slates above described by a flat, half a mile wide. This ridge is composed of beds similar to those occurring between zone 13 of the Rivière-du-Loup section and zone 1 of the Rivière-du-Loup Point section, namely, sandstones and quartz-pebble conglomerates.

Sharp folding with the development of faults is common along the shore between Rivière-du-Loup point and Cacouna. These features are illustrated in Plates II-B and III-A.

The conclusion is, then, that either there is a more or less continuous succession of Sillery slates and sandstones, with many original repetitions of similar beds, or that repetition has been caused by normal faulting or perhaps by slicing.

AGE AND CORRELATION:

Nothing new may be added to previous determinations of the age of the Sillery here exposed. In the brief time that it was possible to devote to the search for fossils, only unintelligible fragments were found, and those but rarely. Work done in this area by officers of the Geological Survey of Canada^① has shown that the rocks here referred to the Sillery are Lower Ordovician or Beekmantown in age.

^① Eils, *op. cit.*, p. 68.

Bailey and McInnes, *op. cit.*, 1890, p. 15.

Raymond, P. E., quoted by Young, *op. cit.*, pp. 61-62.

KAMOURASKA

Associated with *Zone 1* of the Sillery, described above, are a few occurrences of quartzite which are similar to, and perhaps identical with, a type which Dresser^① named the Kamouraska. From various structural evidences, Dresser concluded that the Kamouraska underlies the Sillery and is perhaps in unconformable contact with it.

The best showing of the quartzites is at the extreme northwestern corner of the map-area, on the shore of the St. Lawrence. Quartzites of the Kamouraska type also occur in a series of disconnected outcrops with a total length of six miles crossing the Rivière-du-Loup-Cabano highway about four and a half miles south of the former town. These exposures have the general strike of the nearest Sillery strata and are again dipping to the southeast, although at a higher angle than those on the St. Lawrence shore.

In hand specimen, these quartzites are fine to medium-grained and show very little but quartz. The colour is grey with a bluish cast on fresh surfaces and weathers to a light grey. In thin section under the microscope, it is seen that primary and secondary quartz make up more than 95 per cent of the rock; some rounded and sub-angular grains remain, but most have had silica added. Around some of the grains a suture growth of quartz and carbonate has developed. Scattered grains of pyrite occur between or interstitial to the quartz.

Analyses of specimens of the quartzite from the longest island of "Les Pélérins", Kamouraska county, appear on page 126.

MIDDLE (?) ORDOVICIAN
POHENEGAMOOK

DISTRIBUTION:

The main occurrence of Pohenegamook in the area is in a belt about three miles wide extending northeasterly from the vicinity of the foot of Pohénégamook lake to the northern arm of Lake Témiscouata. A broad band also occurs to the west of Pohénégamook lake. This is the continuation of the belt which, as described by Dresser^②, is seven or eight miles wide in the Province of Quebec and extends across the International boundary into the State of Maine.

^① *Op. cit.*, pp. 14-20.

^② *Op. cit.*, p. 25.

LITHOLOGY:

The Pohenegamook consists of slates with numerous interbeds of sandstone and quartzite and more occasional beds of limestone. A conglomerate occurs at the base of the formation in the area to the southwest, but has not been noted in the present area.

The slates are dark grey to black, usually softer than those associated with the formations above and below, and sometimes graphitic. They cleave into very thin plates whose surfaces are often stained with iron oxide; this staining often occurring also on joint planes. Grey slates, with a greenish tinge, are occasionally interstratified with the darker varieties. In thin section, the dark slates show a few minute grains of angular quartz and plagioclase in a matrix that is not readily determinable but is mainly chloritic-sericitic.

The sandstones and quartzites are variable in colour but commonly dark grey. For the most part they are in beds up to three feet thick interstratified with the slates. More massive beds occur, and locally a succession of sandy beds up to 50 feet thick. In places, small-pebble conglomerate beds are associated with the sandstones. The pebbles are mainly quartz, sub-angular in outline, and ranging in size up to half an inch. Subsidiary to the quartz are smaller and more angular pebbles or granules of feldspar, and angular, elongated pebbles of black slate up to four inches in length.

The sandstones are variable in composition. Generally feldspathic, they occasionally grade to arkoses; on the other hand, some beds contain above 95 per cent quartz. In thin section, the common, feldspathic types show the following: Quartz, making up about 65 per cent of the slide, in rounded grains up to 2 mm. and in small angular grains; some of the grains carry inclusions of tourmaline, which also occurs as minute grains scattered through the slide. Feldspars, about 10 per cent, as decomposed, angular grains of orthoclase and oligoclase, and fresh grains (probably secondary) of oligoclase. Zircon and muscovite occur in small, scattered grains. In the matrix, chlorite and sericite are most abundant; secondary silica, and minute, primary, rounded grains of quartz are common.

STRUCTURAL RELATIONS:

Although local folding and fracturing are pronounced, the formation has a general anticlinal structure. This structure apparently has been cut by a transverse fault that follows the valley occupied by Pohé-

négamook lake. This fault, along with the strike-fault that separates the band of Sillery on the east of Pohénégamook lake from the Pohe-negamook band to the south, has caused an offsetting of the latter formation. Or, as an alternative suggestion, the Pohenegamook has been narrowed, without offsetting, to less than half the width that it occupies in the area to the west.

AGE AND CORRELATION:

Inasmuch as no fossils have yet been found in the unquestioned Pohenegamook, its age cannot be definitely stated. The several possibilities are reviewed by Dresser ①. These suggestions are that it may be equivalent to (1) the Lévis, (2) the Farnham and Memphremagog slates of Middle Ordovician (Trenton) age, (3) the Silurian (Niagaran) series known to occur about Lake Témiscouata and in northern and northwestern Maine. The preponderance of the evidence at hand favours the second suggestion, that is, that the Pohenegamook is Middle Ordovician in age. A summary of the evidence follows:

(1) The Pohenegamook has been traced "almost continuously" southwestward to localities where Middle Ordovician fossils have been found.

(2) The Pohenegamook conglomerate beds are so similar to the Cabano conglomerate as to suggest that the two are correlatives. Fossils found in beds which, structurally at least, are above the Cabano conglomerate, indicate a Middle Ordovician age for that formation.

(3) On the basis of structure and degree of deformation, the Pohenegamook would be classed as older than the Temiscouata group, which is of Silurian age. The Pohenegamook has been exposed to two periods of folding, the Temiscouata to one only.

ORDOVICIAN (?)

CABANO CONGLOMERATE

The Cabano conglomerate formation is one of geological rather than economic importance, and hence is not dealt with in detail here. It has been described by Logan ② and by Bailey and McInnes ③.

① *Op. cit.*, pp. 27-28.

② *Op. cit.*, p. 421.

③ *Op. cit.*, 1887-88, p. 32.

The conglomerate is best exposed at Burnt point and Black point, on the western and eastern sides, respectively, of Lake Témiscouata. On the western side, it extends in discontinuous exposures for about four miles away from the lake. It does not outcrop again until near the head of Long lake, on the highway through Rivière-Bleue, in the western part of the area.

The formation consists of interbedded sandstones and boulder and pebble beds (Plates III-B and IV-A and-B). The thickness, estimated from the width of exposures and from the dip, is in excess of 1,500 feet, locally at least. The boulders are mainly sandstone and quartzite of types indistinguishable from those in the older formations of the district.

Although the conglomerate is probably a record of shallow-water deposition along a bold coast, its origin has not definitely been determined. It is a subject which would well deserve detailed investigation.

Fossils found in pebble beds about a mile southward of the main exposures indicate^① that the age may be Middle Ordovician, and suggest a link with the Pohenegamook formation. But, inasmuch as the fossils were not specifically identified, the age is not yet precisely defined.

SILURIAN (NIAGARAN)

TEMISCOUATA

I.—CABANO RIVER LIMESTONE

DISTRIBUTION AND THICKNESS:

Two outcrops of limestone appear in the northward-facing escarpment of the Cabano River valley, each about half a mile south of the actual stream. As this is the only occurrence of this much desired rock in the area, it was given especial attention. One of these outcrops is about four miles from the head of the Cabano river, where it emerges from Long lake. The other is almost an equal distance farther downstream.

^① Raymond, P. E., personal communication, April 27th, 1934.

In each outcrop, the limestone is exposed for 1,000 feet or more along the strike. The width of exposure is 200 feet, which approximates the true thickness, as the dip is vertical or very steep to the southeast. The actual thickness may be greater than 200 feet, for the exposures of limestone are separated by a drift-covered interval of a few hundred feet wide from the nearest outcrops of slate, which belong to the main Témiscouata group.

LITHOLOGY:

The limestone is a massive, sheared, dense rock, bluish-grey on fresh surfaces but weathering to a light grey. It breaks along the shearing or cleavage planes in large, flat-sided blocks that have formed a prominent talus at the foot of a vertical cliff which, in some places, is as much as 75 feet high. The shearing planes are stained light brown by iron oxide. Numerous calcite veins cut through the limestone in various directions.

In thin section, the rock seems to be at least 95 per cent calcite, with spotty recrystallization in a dense groundmass; calcite crystals up to 1.5 mm. have formed. Small bits of angular quartz, minute lines of carbonaceous matter, and specks of iron oxide are present.

A chemical analysis of this rock is given in the section on *Economic Geology* (page 125).

STRATIGRAPHICAL RELATIONS:

This formation is not seen in contact with any other, and its vertical dip gives no clue to its relations. However, it lies south of the line of strike connecting the exposures of conglomerate near Long lake with those near Lake Témiscouata, and thus may reasonably be expected to overlie the conglomerate formation. It underlies the banded slates of the Témiscouata series proper and is separated from them, in the outcrop, by only a few hundred feet. It is, therefore, between the conglomerates and the slates.

II.—SLATES AND SANDSTONES; AGGLOMERATE

DISTRIBUTION:

The northern limit of the Témiscouata group runs roughly parallel to, and near, the Cabano river throughout its length from Lake Témiscouata to Long lake. From this line it extends southward to the New Brunswick boundary.

LITHOLOGY:

Apart from the limestone member already described, the Temiscouata is an interbedded series of black clay slates, dark grey and grey arenaceous or sandy slates, and grey and dark grey quartzitic sandstones. At one locality volcanic agglomerate occurs.

The slates are characterized by thin sandy layers, usually of light brown colour, and less than 3 mm. thick. These bands are regular and continuous but are not evenly spaced; in places, an average of one band to an inch may be seen, and again the bands are several feet apart. The most important of the slates, from an economic point of view, is the black variety which is apparently of local distribution. At one locality, between Glendyne and Les Étroits, this was quarried as roofing slate for a few years, and for this purpose it seems to be well suited ①. The sandy slates do not split so regularly or into as large plates as the black variety.

The sandstones are usually dark grey in colour, medium-grained, and, in hand specimen, show little but quartz. Successions of quartzitic sandstones in massive beds also occur, the thickest noted being about 100 feet.

In thin section, a dark slate intermediate between those described as 'arenaceous' and those described as 'clay slates' shows the following: Very fine-grained, colloidal-appearing quartz; small, irregular crystals of carbonate; and oriented wisps of chlorite and sericite, mainly the latter; all in a muddy matrix, undetermined, and making up 60 to 70 per cent of the slide. A dozen extremely thin laminations could be counted in five-eighths of an inch, the width of the slide.

The quartzitic sandstones, in thin section, show a high percentage of quartz in angular to sub-angular grains up to 2 mm. diameter, and varying quantities of secondary silica around the grains. Minute, fresh plagioclase occurs in the interstitial material, along with a few grains of zircon, shreds of chloritic material, and stringers of iron oxide and graphite.

① See section on *Economic Geology*.

Volcanic Agglomerate.—On an inconspicuous point about midway between Cabano and Notre-Dame-du-Lac, on the western shore of Lake Témiscouata, volcanic agglomerate appears. This agglomerate has been described by Logan ① and by Bailey and McInnes ②, and in detail by Gregory ③.

The following quotations give Gregory's general description; for further detail the reader is referred to the original report: "At Point aux Trembles, the rocks, both along the railroad and on the lake-shore, appear at first sight to be greenish sandstones and coarse brown conglomerates. They are interstratified with the other beds of the region, and have practically the same dip and strike. . . . The finer, more sandy, beds contain quantities of volcanic ash, and the coarser ones are conglomerates of typical andesitic fragments, with scarcely any foreign material. Parts of the rock contain very prominent rounded fragments of amygdaloidal andesite. As with the volcanics of northern Maine, so here the gradation from the sandstones of the region to pure volcanic material can be traced, and like the Maine breccias and tuffs, these rocks show more or less rounding of their pebbles and sorting by water. It is believed that the volcanic vents were near some body of water, and that the material fell in or near the water and received a limited amount of wearing before final consolidation. . . . The volcanic conglomerate consists of subangular pebbles of andesite and amygdaloidal andesitic bombs, embedded in a finer matrix of red and green grains of the same material. The pebbles range in size from $\frac{1}{2}$ inch to 6 inches in diameter. The embedded bombs form a conspicuous feature of the rock. They are quite spherical and are distinctly different in appearance from the matrix".

Although rocks of the character above described are confined within narrow limits on the western shore of the lake, they extend for several miles northeastward from the lake and in general follow the course of the Touladi river ④.

STRUCTURE AND AGE:

The structure of the Témiscouata group, when considered broadly, is apparently a monoclinial succession of beds dipping to the southeast at angles greater than 45 degrees. In detail, the group is much folded.

① *Geology of Canada*, 1863, p. 423.

② *Geol. Surv. Can., Ann. Rept.*, Vol. 3, Part 2, Section M, 1888, p. 33.

③ Gregory, H. E., *Volcanic Rocks from Témiscouata Lake, Quebec*; *Am. Journ. Sci.*, (4), Vol. 10, 1900, pp. 14-18.

④ Bailey and McInnes, *Op. cit.*, pp. 33-34.

Vertical dips and dips steep to the southeast and northwest are common. Details of the structure are well exposed in sections along the Canadian National railway in the eastern part of the area. In many places it is seen that the slates are thrown into narrow, but shallow and open, folds, with axes, as a rule, plunging to the northeast. No evidence of overturning was found anywhere in the group.

The bedding and the cleavage agree closely in strike, following a northeast-southwest direction. The dip of the cleavage planes is uniformly to the southeast at very high angles. Veins and stringers of quartz, and occasionally of calcite, cut the strata at various angles, but are generally either parallel to the axes of folding or at right angles to them; thus corresponding with the directions of major jointing.

The Temiscouata group is definitely younger than the Sillery, this being shown by fossil evidence as well as by structural differences. It is believed to be younger than the Pohenegamook. In the present area, it rests on the Cabano and is probably separated from it by unconformity.

The fossil evidence provided by earlier published work indicates that the Temiscouata group is Middle Silurian (Niagaran) in age and that it is older than the Mt. Wissick group. Structurally, however, the latter appears to underlie the Temiscouata group and the Cabano also. The apparent contradiction seems to demand a thrust or a fault along a line between the Mt. Wissick exposures to the north and the Cabano with following Temiscouata to the south.

DEVONIAN (?)

I.—MT. WISSICK GROUP

The Mt. Wissick group is apparently confined to the eastern side of Lake Témiscouata, at Mt. Wissick and its extension to the northeast. No beds of this group were found in the area of the present report. They are considered here only for purposes of comparison.

A summarized description of the group is given by Logan ①, and a more detailed one by Bailey and McInnes ②, with faunal lists. Summarizing the latter description, the Mt. Wissick series consists of

① *Op. cit.*, 1863, pp. 420-421.

② *Op. cit.*, 1888, pp. 29-31.

sandstones and arenaceous limestones in which fossils are rare, and which occupy the upper 500 feet of the section; below these are about 275 feet of sandstones, limestones, and shales in alternating beds, with fossils occurring in relative abundance in certain of the beds; below these, and occupying the lower 1,200 feet of the section, are massive beds of quartzitic sandstones and pebble conglomerates, with no fossils reported. The total thickness is about 2,000 feet.

The faunal lists provided by Bailey and McInnes are not of high value at this date; nevertheless, they indicate that the Mt. Wissick group is of high Silurian or low Devonian age. The correlation made by the earlier workers was with the Helderbergian, now classed as of Lower Devonian time. The Mt. Wissick group was referred to by Kindle ^① as 'Silurian'.

II.—INTRUSIVE ROCKS

TRACHYTE:

Apart from one small dyke, only one occurrence of intrusive rock was noted in the area. This is in Estcourt township, on the line between lots 34 and 35, range VII, or about five miles east-northeast of Sully.

The igneous mass is elliptical in outcrop, measuring 1,000 feet by 600 feet, with the longer axis parallel to the general strike of the rocks, at N.40°E. It forms a conspicuous knob rising about 350 feet above the valley of Bleue river (Plate V-A and V-B).

Actual contacts with the country rocks were not observed, but along the southern side of the mass angular inclusions of the country rock form local breccias. Some of the fragments are cherty and others are remnants of thin quartzitic beds. In such brecciated rock, blebs and stringers of epidote occur. This mineral is common also along fracture planes and around ellipsoidal or pillow-shaped structures that are probably due to flowage. Only a few of these ellipsoidal structures were observed and all towards the margin of the mass. The rock is aphanitic to porphyritic, and nowhere does it show much variation in the grain of the groundmass.

In hand specimen, the rock is brownish- to greenish-grey, with no minerals determinable to the unaided eye except feldspar pheno-

^① Kindle, E. M., *Columnar Structure in Limestone*; Geol. Surv. Can., Mus. Bull. 2, 1914, pp. 35-39.

crysts, where these are present. In thin section, also, the aphanitic phase shows little that can be identified, but in the somewhat coarser rock the groundmass is seen to be a fine-grained intergrowth of feldspar and pale, unidentified material, most of which is probably chlorite. Distributed through this are phenocrysts of feldspar up to 2.5 mm. in diameter, smaller phenocrysts of pyroxene, and minute crystals of topaz, zircon, epidote, and tourmaline. Epidote occurs also replacing the feldspar and pyroxene and as filling of rounded, amygdule-like cavities. Apatite is present as small crystals enclosed in the pyroxene; carbonate as an alteration product, in small amount; and specks of hematite and magnetite are scattered throughout. The pyroxene is a pale, bluish-green variety.

The feldspar phenocrysts include both orthoclase and plagioclase. Orthoclase and microperthite are abundant in well-formed crystals somewhat altered to pale chlorite and epidote. The plagioclase phenocrysts also have fairly sharp outline and are almost as plentiful, but they are altered to such a degree that definite determination of their composition is not possible. The general optical characters, as seen in thin section, indicate a sodic variety of oligoclase, and this receives support in the fact that determinations of the refractive index by the powder oil-immersion method in no case gave a value higher than 1.544. It would seem, therefore, that the rock is a soda-rich feldspar porphyry, and so to be classed as a soda-trachyte or keratophyre. However, final classification is impossible without the aid of a chemical analysis.

Although this igneous mass is not found in contact with any sedimentary formation, there are included in it fragments of thin, quartzitic bands of a type most commonly associated with the Sillery and Pohenegamook formations. Also, it occupies a position within the limits of a band of Sillery. There is nothing to indicate extrusive conditions, unless it be the rare, ellipsoidal, pillow-like structures noted above. These, however, do not have the glassy border characteristic of 'pillows', and may better be explained as flow structures that formed in an upwelling, viscous magma. Thus, it may be concluded that the rock is intrusive and that it cuts the Sillery.

The fact that the rock shows no evidence of crushing or shearing, either in the field or under the microscope, indicates that it was not involved in any intense folding movements. Thus, it was probably intruded in late- or post-Devonian time.

In a general way, this conclusion agrees with the determination made by Dresser of the age of the 'Talon' basic intrusives some fifty miles to the southwest, in the counties of L'Islet and Montmagny.

BASIC DYKE:

The dyke referred to at the beginning of this section is exposed in a ditch along the road running between lots 171 and 172 of Sainte-Rose-du-Dégelé parish, or about two miles south-southwest of the town of that name. It is about twenty miles east of the trachytic mass described above.

The dyke is about two inches wide and has an exposed length of three feet. It has a strike of N.30°W., and dips to the northeast at 60°.

Examined in thin section, the rock is seen to be entirely recrystallized. The alteration products indicate, however, that it was originally a basic type, perhaps peridotite. No evidence of foliation was seen, and this, coupled with the fact that it cuts part, at least, of the Témiscouata series (Silurian), points to its probable relation in time with the trachytic rock already described.

ECONOMIC GEOLOGY

Gold has been reported on a property a mile and a half southwest of Notre-Dame-du-Lac, but apart from this no occurrences of metallic minerals that might prove of economic value are known in the map-area. Some of the slates, limestones, and sandstones, however, offer possibilities for profitable exploitation.

SLATE

Slate of the Témiscouata formation has been quarried at one locality in the area. The slates in which the quarries have been opened are on the west side of Long lake (see Plate VI-A) and are traversed by the line of the Canadian National railway. The outcrop begins about 1,100 feet to the north of the point where the highway and railway intersect at Les Étroits. The total width of the exposure, measured across the strike, is 950 feet, but not all of this width is slate of good quality. The quarries, of which there are two, are located 250 feet from the northern end of the outcrop, one on either

side of the railway and both immediately adjacent to it. The western quarry (Plate VII-A) is the larger, with length of 80 feet and width of 55 feet, and a depth varying from 15 to 40 feet. The eastern quarry is 75 feet long, 25 feet wide, and 20 feet at maximum depth.

In the quarries, the cleavage of the slate is vertical or very steep to the southeast, and the bedding dips to the northeast at 32 degrees. The bedding is shown by thin arenaceous bands and by broader colour bands. This relationship of bedding and cleavage prevails through a distance of 250 feet, or from the quarries to the northern limit of the section exposed. Immediately south of the quarries there is a concealed interval of 140 feet, beyond which the slate again appears; but here it is not suited for roofing purposes, owing to its sandy or arenaceous composition and also to sharp folding and crumpling, with occasional faults. Thus, it is indicated that the good quality slate here has a width of 250 feet across the strike of the beds. Along the strike, the slate is well exposed for about 300 feet westward from the edge of the lake, beyond which, for another 800 feet, there are weathered exposures, which give little clue to the true quality.

The slate seen in the quarries appears to meet all the requirements of a first-class roofing slate. It splits to give a smooth, even surface (Plates VI-B and VII-B), and slabs measuring three feet by four feet are obtainable. The closeness of splitting is variable. Five slabs to an inch is common, but some of the material does not split readily to less than three-quarters of an inch thickness. The larger slabs are readily trimmed to smaller sizes with even-edged outlines. The 'ring' of the slate indicates good quality, as does the fact that it 'punches' readily. When newly exposed or split, the slate has a black or very dark grey colour. On weathering, it becomes uniformly greyish, without spotting or staining.

That this slate makes good roofing material is proved by its ready marketability for that purpose at the time the quarry was in operation. Also, the slate roof on a shed on the quarry property is in excellent condition. Quarrying operations ceased in 1915 due to the economic stresses of the time, and they have not been resumed for similar reasons. The quarry is excellently located for transportation facilities, both by railway and highway.

It is only in railway cuts or in natural sections exposed along streams that it is possible to evaluate the quality of the slate. Elsewhere, it is exposed as weathered surfaces of slight relief above the drift, and these give little clue to the potential value of the slate. To determine definitely the quantity of commercial slate available in the area would require test quarrying on a wide scale.

Red, green, and black slates are abundant in the Sillery formation. In general, these slates are too highly folded to permit of structural use, and probably they would find their greatest value when employed for ornamental purposes, either as small slabs or as pulverized products. The supply is plentiful along the shore of the St. Lawrence and inland for several miles.

LIMESTONE

The only limestones previously reported in the area were impure beds of the Mt. Wissick group, and thin beds interstratified with slates and sandstones of the other formations. The present field-work has revealed the presence of a band, or lenses, of limestone along the southern side of the Cabano River valley. There are two exposures of this limestone, each about 1,000 feet long and with a width and thickness of at least 200 feet. Both are half a mile south of the Cabano river. One is located about three miles west of Saint-Eusèbe, in lots 19 and 20, range XI, of Cabano township, and the other about two and a half miles north of the village, in lots 50 and 51, range X. They may be reached either from the road running northeast-southwest through Saint-Eusèbe or from the road immediately north of, and paralleling, the Cabano river.

The limestone is grey on fresh surfaces, with dove-grey weathering, and is very fine grained, with spotty recrystallization. It is strongly sheared and much cut by calcite veins. On the shearing planes, light stains of iron oxide are seen. Analysis of a sample gave the following result:

SiO ₂	1.52
CaO.....	53.80
MgO.....	0.68
Fe ₂ O ₃	0.52
Al ₂ O ₃	0.79
CO ₂	41.89
	<hr/>
	99.20

The analysis indicates that the rock is a fairly pure limestone, containing above 95 per cent CaCO_3 . It is sufficiently high in calcium carbonate to warrant further examination of the occurrence by those interested in the use of limestone.

SANDSTONE AND QUARTZITE

The area abounds in sandstone and quartzite beds which may be used as building stone whenever needed. Of these rocks there is, in particular, the Kamouraska quartzite. This formation is but slightly represented in the present area compared with its development to the southwest. In the general region there is a practically unlimited supply for whatever purpose used.

Following are the results of chemical analyses of quartzite from the longest island of "Les Pélerins", Kamouraska county, made by the Mines Branch, Ottawa ①:

SiO_2	98.24	97.77
Fe_2O_3	0.24	0.19
Al_2O_3	1.52	1.27
CaO	0.10	0.10
MgO	0.16	0.17
Loss on ign.....	0.29	0.29
	<u>100.55</u>	<u>99.79</u>

Fifty tons of this rock from near Saint-André were shipped during the past summer to the Mining Engineering Department of McGill University for use in research work on the fine grinding of ores. For this purpose it is particularly suited owing to its "uniform composition and great toughness" ②.

GOLD

One property on which gold had been reported was examined. It is situated a mile and a half south-southwest of Notre-Dame-du-Lac, and half a mile west of the 'old Témiscouata road'. The workings consist of a pit 55 feet long by 30 feet wide, and 30 feet deep in its deepest part.

① Quoted by L. Heber Cole in Report on *Silica in Canada*, 1923, p. 98.

② Professor W. G. McBride, Department of Mining Engineering, McGill University; personal communication, April 11th, 1934.

The country rock is dark grey slate, with bedding rather obscure, but showing that the rock is closely folded. The cleavage strikes N.60°E. and has a vertical dip. Quartz and calcite veinlets cut the rock in various directions. Two quartz veinlets were seen cutting the slate in the pit, each less than a quarter of an inch in width and with an observed length of ten to fifteen feet. One is parallel to the cleavage and has a vertical dip, the other cuts the cleavage and dips to the northwest at an angle of 45 degrees. It is said that, where such veinlets intersect, large blebs of quartz are formed. Although this was not seen because of water in the pit, the statement is borne out by the presence on the dump of chunks of quartz, about six inches across.

Besides veinlets, there are a number of very thin and discontinuous stringers of quartz and calcite which are usually parallel to the slaty cleavage; also, small lenses of quartz, up to three inches in length, and with width and thickness, respectively, about half an inch and a quarter of an inch.

The observable mineralization consists of pyrite, in cubes and small granular blebs, which, with a little epidote, is scattered through the quartz. An assay of the quartz, made in 1930 for the owners of the property, is reported to have yielded \$5.00 in gold and \$0.23 in silver to the ton. Two of three samples forwarded by the writer to the Bureau of Mines for assay showed traces of silver; but none showed any gold.

Should it be decided to continue with the development of the property, it would be highly advisable to determine the lateral extent of the veins before continuing the sinking of the pit.





A.—Interbedded slate, sandstone, and limestone, in the Sillery near Notre-Dame-du-Portage.



B.—Falls and part of the gorge at Rivière-du-Loup.



A.—East face of gorge at Rivière-du-Loup, showing wrinkling in Sillery slates.



B.—Folding in Sillery slates along shore near Cacouna.



A.—Folding in Silly slates along shore near Cacouna.



B.—Cabano conglomerate near the head of Long lake.



A.—Boulder bed in Cabano formation.
Near Lake Témiscouata.



B.—Interbedded sandstones and conglomerate;
Cabano formation. Near Lake Témiscouata.



A.—Trachyte knob. Viewed from the west across Bleue River valley.



B.—Close up of Trachyte knob. Viewed from the south.



A.—Section through slate. Near Les Étroits.



B.—Quarry near Les Étroits. Eastern side of railway, showing cleavage and bedding.



A.—Quarry near Les Étroits. Western side of railway, showing vertical cleavage.



B.—Slate, near Les Étroits, showing even cleavage and thickness of plates.

