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NORTHWEST PART OF LAC-ST-JEAN 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

QUEBEC

PRINTED BY R. PARADIS

PRINTER TO HIS MAJESTY THE KING

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THE NORTHWEST PORTION OF THE LAC-SAINT-JEAN REGION

by Bertrand T. Denis

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THE NORTHWEST PORTION OF THE LAC-SAINT-JEAN REGION

by Bertrand T. Denis

INTRODUCTION

General Statement

Lake Saint-Jean is a nearly circular sheet of water covering some 350 square miles and is about 125 miles north of Quebec city; it lies within the area bounded by long. 71°45′ and 72°20′, lat. 48°25′ and 48°45′, and is by far the largest fresh-water lake within the settled portion of the Province of Quebec. The lake itself forms a natural reservoir into which flow the rivers and streams from a total drainage area of 30,000 square miles. The most important in-flowing rivers are the Ashuapmouchouan and the Mistassini from the west and the Péribonca from the north. From the south, smaller streams, the Belle-Rivière and the Ouiatchouan rivers, supply their quota. The outlet of the lake, which is on the east side, is the Saguenay river, the lower part of which, from Chicoutimi to Tadoussac, is renowned for its scenic beauty. The upper portion, from Ile Maligne to Chicoutimi, is also widely known from its industrial importance, being the site of a series of hydro-electric power developments which rank, both from the point of view of magnitude and the display of engineering skill, among the outstanding achievements of the century.

The lake lies in the southeast portion of a larger depression, the average elevation of which is from three hundred to five hundred feet below the elevation of the surrounding Laurentian plateau. Within the depression, a heavy mantle of drift covers the bedrock, with the exception of a few scattered outcrops along, or near, the waterways. On the edge of the plateau, outcrops are more numerous, but general information on the economic possibilities of the formations they represent has hitherto been very incomplete, outside of an area which was studied by J. A. Dresser in 1916①.

① Dresser, J. A., *Part of the District of Lake St. John, Quebec*; Geol. Surv. Can., Mem. 92, 1916.

The proximity of the great hydro-electric power developments previously referred to justifies—in fact necessitates—the study of all the natural resources of the region. The writer was therefore instructed to carry out for the Quebec Bureau of Mines an areal investigation of the geology of the edge of the depression, which, as may be seen from the accompanying map, does not follow closely the margin of the lake.

Area Covered

The area covered in this report includes the townships of Ashuapmouchouan, Demeules, Dufferin, and part of Quesnel (as well as some unsurveyed territory to the southwest of these townships); the greater part of Dumais and Girard townships and part of Beaudet; Normandin, Parent and Albanel townships, together with the greater part of Pelletier township; and Racine, Dolbeau, Proulx, Dalmas, and Milot townships. The total area is 1,222 square miles, of which, however, some 435 square miles are covered by drift and water.

Means of Access

The central portion of the area, around the northwest side of lake Saint-Jean, is well served by the Chambord-Dolbeau branch of the Quebec and Lac-Saint-Jean railway, a part of the Canadian National Railway system. Also, a very good gravelled highway, No. 15, encircles the lake, and from it are built a network of 'improved rural roads' and dirt roads quite adequate to satisfy present needs. Highway No. 15 in turn connects, either by way of Chicoutimi and Saint-Siméon, or through the Laurentide National Park, with the general highway system of the Province of Quebec. That portion of the area which, from the geological point of view, is most worthy of study, is, however, marginal to the settled central part, near, or just beyond, the limit of colonization; the transportation facilities here are naturally no more than commensurate with the development of the country. The areal map indicates the system of roads used in the opening-up of the region; beyond and around the extremities of these roads stretches an almost impenetrable wilderness of that dense vegetation which has succeeded early lumber operations and certain extensive forest fires which have swept this section of the Province.

Previous Work

The first recorded geological observations in the Lac-Saint-Jean district were made in 1828 by Major-General F. H. Baddeley, who at that time noted the presence of Palæozoic sediments in the district.

Next to carry on geological work in the district was James Richardson, of the Geological Survey of Canada, who in 1857 made an exploration from the mouth of the Saguenay to lake Mistassini, 250 miles northwest of lake Saint-Jean. The results of his examination were published in the *Report of Progress* for the year 1857.

In *Geology of Canada* (1863), references to the Lac-Saint-Jean district appear on pp. 164-5 and 923, which summarize the geological information gathered up to that time.

Richardson, in a later exploration (1870), ascended the Ashuapmouchouan river and described the geology along that stream, noting especially the granitoid gneisses and the extensive clay and sand overburden.

Mgr. J. C. K. Laflamme, Professor of Mineralogy and Geology at Laval University, Quebec, also studied the region. His observations are recorded in the *Annual Reports* of the Geological Survey of Canada for 1882, 1884, and 1892. His exploration in the district was largely directed to the Palæozoic formations, chiefly on the south side of the lake, but he also made a trip up the Ashuapmouchouan river, in 1884.

F. D. Adams, of McGill University, in the course of an extensive survey in the region under the auspices of the Geological Survey of Canada in the early 'eighties', traversed a portion of this area, including Petite Péribonca and Grande Péribonca rivers. Records of his work are to be found in *Summary Reports* of the Geological Survey for the years 1882-1885. A more comprehensive summary of his final results, which were to announce the first recognition of the Anorthosite series as a distinct terrain in Canada, was published in 1893 ①.

During the year 1890, A. P. Low ②, of the Geological Survey of Canada, conducted surveys along the Mistassini river and its tributaries, the Wassiemska (Ouiasiemska), Aux Rats, and A l'Ours.

① *Ueber das Norian oder Oberlaurentian von Canada*; Neues Jahrb. Min., Beil Bd 8, 1893, pp. 419-498. An English translation by N. J. Giroux appeared in the *Canadian Record of Science* (Montreal) in 1896.

② Geol. Surv. Can., Vol. V, Sum. Rept. 1890, pp. 50-53.

In 1900, G. A. Young, of the Geological Survey of Canada, examined the north and east portions of the Lac-Saint-Jean region, and in 1904, R. Chalmers, also of the Geological Survey, visited the area in connection with his work on the surface geology of eastern Quebec. Their observations are recorded in the *Summary Reports* of the Geological Survey for the years mentioned.

A rather more detailed study of the southern margin of the lake was made in 1913 by J. A. Dresser ①. In addition to an excellent description of the petrography and distribution of the various rock types, his report includes a discussion of the structural relations of the several formations, and attention is drawn to the extensive faulting, to which is due the preservation of the Palæozoic outlier. The general character of the district and its economic possibilities are also presented.

Professor Raoul Blanchard, of the University of Grenoble, visited the region in 1932 with the object of studying its human geography. In the account of his observations ② the topography and physical geography are described and discussed at length.

Field Work and Acknowledgments

The time spent in the field was four months, June to October, 1933. Starting from the southeast corner of the area, where it adjoins Dresser's map-sheet (G.S.C. Map No. 184A), camps were set up on the outskirts of the settled area at points so chosen that it would be possible to run pace-and-compass traverses out into the surrounding country. In this way, a roughly semi-circular strip of country, about 85 miles in length and from 6 to 15 miles in width, was examined. Detailed work over so large an area could not, of course, be done in the time available, so a compromise between a general reconnaissance and a detailed survey was undertaken. Graham S. Mackenzie, of Montreal, who had just completed post-graduate studies at the University of Toronto, acted as senior assistant and fulfilled his duties most loyally and efficiently. Jean Morency, of Montreal, graduate of l'Ecole Polytechnique, and J. René Dallaire, of Chicoutimi, a student at Queen's University, were satisfactory assistants to Mr. Mackenzie and the writer.

① *Op. cit.*

② Blanchard, Raoul, *Le Saguenay et le Lac St-Jean*; Revue de Géographie Alpine, Grenoble, Vol. XXI, 1933, fascicule I.

PHYSIOGRAPHY

The Laurentian Highland and the Lac-Saint-Jean Depression

The topography of the area included in the map-sheet comprises two distinct units and an intermediate zone separating the two. The two contrasting topographic features of the region are the Laurentian highland and the Lac-Saint-Jean depression. The Laurentian plateau, or Laurentian highland, is one of the major topographic units of North America. It is a vast area, occupying the northeast portion of the continent, and it is characterized by a rolling, uneven surface, the general elevation of which varies from 500 to 2,000 feet above sea-level. Although in detail (and this is particularly true of the margin of the plateau), the relief is quite marked, the region as a whole is distinctly a uniform plateau, to a great extent covered with the glacial débris which was left on the retreat of the Pleistocene ice-sheet. The general character of the plateau, together with the superimposed obstructions of glacial débris, have given rise to the immature drainage system, one of the outstanding features of which is the almost incredible wealth of lakes which stud its surface. Waterfalls, cascades, and rapids are numerous on the streams and rivers which form the hydrographic pattern.

Within this Laurentian plateau, at a distance of 100 miles or more from its southern limit, the Lac-Saint-Jean depression constitutes a physiographic unit whose topography contrasts sharply with that of the surrounding plateau. The importance of this depression, economically and geologically, necessitate a rather detailed description of its limits, character, and origin.

The general elevation of the Laurentian plateau, it has been mentioned, ranges from 500 to 2,000 feet above sea-level. In the vicinity of the region here dealt with, its elevation is between 800 and 1,200 feet. The elevation of lake Saint-Jean at high-water level is about 340 feet, and the terraces which surround the lake reach approximately to 500 feet. The difference in elevation between the lowland and the highland areas is therefore of the order of 500 feet, and it will be seen that, in some localities, the drop from the level of the plateau to that of the lowland is very sharp. This difference in elevation is reflected in the profiles of the inflowing streams, whose courses are in all cases

broken by falls and rapids, many of them adaptable to the installation of hydro-electric power plants, and which constitute a valuable potential natural resource of the region. The utilization of this power has been carefully studied by the Quebec Streams Commission, and the results of their surveys are published in their annual reports.

Area of the Depression

The precise limits of the lowland area are difficult to establish, for it will be seen in a subsequent paragraph that its boundaries are not uniformly sharp and definite. The depression is roughly oval in shape, measuring about 65 miles by 35 miles, with the long dimension northwest-southeast. This area of slightly more than 2,000 square miles includes the whole of Parent, Normandin, Albanel, Racine, Dalmas, Taillon, Garnier, l'Isle, and Signay townships together with parts of Mesy, Caron, Métabetchouan, Charlevoix, Pelletier, Antoine, Proulx, Dolbeau, and Milot townships.

Boundaries of the Depression and their Character

The southern boundary of the Lac-Saint-Jean lowland is marked by a sharply defined fault-scarp, which was traced over a length of 40 miles and is shown on the accompanying map. In detail, of course, the regularity of the scarp has been modified and obscured by erosion, which has more or less dissected the margin both of the high Laurentian plateau and of the terraces of unconsolidated drift which floor the lowland. From a distance, however, the difference in elevation between the two physiographic units is striking, and the chain of hills which marks the margin of the highland resembles a veritable wall about 500 feet high. This fault-scarp crosses the middle of Ashuapmouchouan township, cuts across the south corner of Demeules, and intersects the prolongation of the Demeules-Dufferin township-line at a distance of about two miles beyond the limits of the surveyed territory; it swings in again to cut across the west corner of Dufferin township and, crossing the Ashuapmouchouan river, traverses the eastern part of Dumais township and a very small section (west) of Girard. The general direction of the scarp is N.W.-S.E. On the southeast, beyond the limits of this map-sheet, it has been traced by Dresser for a further distance of about 35 miles.

In the north and west portions of the map-area, the junction between highland and lowland is less clean-cut, one reason for this being that it is much less regular, and another that the rise is more gradual. Were the depression once more invaded by an arm of sea, the southern shore would be a well-defined cliff with but few embayments, whereas to the north and northwest we should find an irregular coast with deep bays and promontories, and off-coast islands marking the site of outlying masses of rock that protrude above the level of the lowland. While it was possible to establish the southern boundary with a fair degree of accuracy, detailed topographic mapping, quite beyond the methods and means of the type of geological field-work undertaken during the past season, would be necessary in order to map the limits of the depression to the north and northwest. The establishment of this boundary is, however, a matter of great economic importance from an agricultural point of view, and it is to be hoped that a detailed study of the surface geology of the region may some day be undertaken in order to facilitate the pursuit of the best agricultural policy for the development of the region.

The north and west limit of the lowland reaches the middle of Milot and Proulx townships, swings to the north beyond the limits of the map-sheet so as to include parts of Hudon, La Trappe, and Antoine, and, crossing Beaudet and Girard townships, rejoins the Ashuapmouchouan at a point beyond the boundaries of the area examined. More extended studies would doutbless reveal the relation of the form of the lowland to the courses of the large inflowing streams, but this must be left for the future. On the north and west side, these streams are the Péribonca, Alex, Petite Péribonca, Mistassini, Aux Rats, Mistassibi, and Ouiasiemska (à Jim) rivers, and James lake.

Within the limits of the lowland area there are large outlying masses of igneous rocks, which rise above the level of the Pleistocene terraces in Milot, Dalmas, Dolbeau, Pelletier, Beaudet, and Girard townships. These will be described in the paragraphs dealing with the topography of the lowlands.

We may briefly summarize the foregoing paragraphs as follows: The map-sheet includes portions of the Lac-Saint-Jean lowlands and of the adjoining highlands, two physiographic units marked by a difference in elevation of some 500 feet. On the southern and western sides, the boundary of the depression is a well defined fault-scarp at

which the plateau rises sharply above the level of the lowlands; but on the north, the transition is more gradual, outlying masses of rock are wholly or partially surrounded by the drift which floors the lowland, and a succession of rounded hills of increasing altitude are followed, eventually becoming the typical rolling highlands at the elevation of the Laurentian plateau.

Lowland Topography

Lake Saint-Jean lies in the southeast portion of the lowland and occupies the southeast corner of the area included in the accompanying map-sheet. The lake, which is nearly circular, measures about 26 miles by 20 miles, with the longer axis N.W.-S.E., which is the direction of the major axis of the larger depression of which it fills a portion. The lake is comparatively shallow; the deepest sounding taken showed a depth of about 200 feet.

From the shores of the lake, comparatively level terraces extend to the edge of the highlands, and it is upon these that the agricultural value of the district depends. These flats, which in the extreme south of the map-area are only four miles wide, occupy more than 700 square miles on the northwest side of the lake, in the district covered by this report. Beyond the map limits, both on the north and on the southeast, the lowland covers many townships.

Near the lake, the only breaks in the continuity of the plains are afforded by the valleys of the rivers—the Ashuapmouchouan, the Mistassini, the Péribonca, and smaller tributaries and streams. Since the formation of the terraces, at the time of the retreat of the Champlain sea, these rivers and even the smaller streams have already cut deeply into the great thickness of unconsolidated sediments of which the terraces are built, and vertical sections of one hundred, and even two hundred, feet may be seen.

As might be expected, outcrops are very rare, and, as a general rule, it is only in the few places where the streams have cut their valleys to the underlying bedrock that it is possible to determine its nature. This is particularly true of the district immediately northwest of the lake. Farther to the north and west, there are outlying masses of rock, which pierce the mantle of drift. In Dalmas township, for instance, to the north and west of Saint-Augustin, there is an

area of about six square miles in which the relief is marked and rock outcrops are numerous. In the vicinity of Normandin village, low rounded outcrops of granite stand above the level of the drift, and six miles farther northwest are rugged hills which occupy a large part of Girard township. In Pelletier township, on the east side of the Aux Rats river, between Saint-Eugène and Saint-Stanislas and to northwest of them, there are large areas of visible rock.

The character and origin of the terraces which form the lowland will be discussed in the chapter on geology.

Highland Topography

The topography of the highlands, typical of the Laurentian plateau of northern Quebec, needs little description. It is a region of rounded hills, whose slopes are largely covered by moraine and vegetation, alternating with stretches of swampy muskeg. Outcrops are generally numerous on the hills, but as a rule they are not very extensive, as the mantle of drift and vegetation effectively conceals the bedrock over the greater portion of the region. Exceptionally, however, the great forest fires which have swept the district have laid bare the tops of the hills, and, where the covering soil was very thin, the vegetation has been unable to re-establish itself, with the result that what little soil there was has been washed away, leaving the rock exposed.

GENERAL GEOLOGY

Outline of Regional Geology

The district of Lac-Saint-Jean lies within the great pre-Cambrian protaxis of North America, also known as the Canadian Shield, a vast area which comprises the whole northern part of the Province, to the north of the St. Lawrence and Ottawa rivers. The Canadian Shield is made up for the most part of pre-Cambrian rocks of igneous origin, mainly granites and granitoid gneisses, which represent that long period of intense and widespread intrusive action which has been given the name of Laurentian.

Within this great development of acidic intrusive rocks there are outliers and patches of other rocks, some older and some younger than the Laurentian. Some of these represent remnants of the covering into which the batholiths were intruded—sediments, such as the

Grenville crystalline limestone, or volcanics, such as the Keewatin greenstones. Others are later rocks, intrusives such as the Algoman granites, and the Anorthosites, and sediments and volcanics such as the Temiscamian and Keweenawan. Under exceptional circumstances, outliers of much later beds, Palæozoic sedimentaries, have been preserved in certain favoured localities, as they have been in the present map-area. Finally, the whole region was subjected to heavy glaciation, which has left in its wake the accumulation of drift, boulder clay, and fluvio-glacial deposits, which form a more or less continuous mantle over northern Canada.

Table of Formations

The following table lists the formations which occur in the Lac-Saint-Jean district. It may be mentioned at this point, however, that two of them, namely, the Richmond and Utica, do not outcrop in the area specifically described in this report.

Quaternary and Recent			Alluvium and swamp deposits Stratified clay and sand Boulder clay
Great unconformity			
Palæozoic	Ordovician	Richmond Utica Trenton	Limestone Shale Limestone
Unconformity			
Pre-Cambrian	Roberval formation		Granite, syenite, and gneiss
	Intrusive contact		
	Anorthosite series		Saguenay intrusives: anorthosite, gabbro, syenite, and granite
	Intrusive contact		
	Laurentian		Gneiss
	Intrusive contact		
	Grenville		Crystalline limestone, sedimentary gneiss

Geological History of Region

The oldest rocks in the region are crystalline limestones and sedimentary gneisses of Grenville age; they represent the remnants of the formations which were invaded by the great batholithic intrusions of Laurentian granite and are, as might be expected, highly metamorphosed. The limestones can be recognized with certainty, but the sedimentary gneisses are very difficult to distinguish from the later igneous gneisses, with which they form an intricate complex.

The Laurentian includes that widespread development of ancient gneissic granitoid rocks which form the greater part of the Canadian Shield, and which might, perhaps, be appropriately designated 'undifferentiated pre-Cambrian'.

The term Laurentian, thus applied, does not necessarily refer to a single uniform mass, but rather to a succession of batholithic intrusions, which have suffered much diastrophism, resulting in the formation of that complex of gneisses which constitute the body of the pre-Cambrian protaxis. These gneisses outcrop extensively in the Lac-Saint-Jean region, which lies within that protaxis.

The Lac-Saint-Jean-Saguenay region is the western limit of a very large intrusion of rocks of Anorthosite series. It is thought to be continuous eastward as far as the Natashquan river, for it has been located in ascending several of the streams, such as the Betsiamites, Manicouagan, Moisie, Saint-Jean and Romaine rivers, which flow from the north into the St. Lawrence. This great mass would thus underlie an area of 20,000 square miles or more. Although it has been mapped as anorthosite, it really includes large areas of rocks which are more properly classified as gabbro or norite, and it appears to be bordered, on the north of lake Saint-Jean at least, by a zone of acidic rocks, syenite and granite. The anorthosites are, on the whole, massive, coarsely crystalline rocks, but sudden variations in the grain size are common, and locally the rock is highly gneissoid. They are regarded as intrusive into the Laurentian and have suffered much less diastrophism than that formation.

The Laurentian gneiss in the Lac-Saint-Jean region is intruded also by a younger granite, to which the name 'Roberval' was given by Dresser. It is typically a pink, massive, unfoliated, coarse-grained rock. Associated with this granite, and representing other facies of the same intrusion, are pink to olive coloured syenites. Locally, the Roberval is distinctly gneissoid. It is believed to be intrusive into the Anorthosite series, and there is no evidence of any further igneous activity in the region since this intrusion.

The pre-Cambrian of the Lac-Saint-Jean region is therefore formed of Laurentian granitoid gneiss in which are found inclusions of the older Grenville limestones and sedimentary gneisses, and these Laurentian rocks have been invaded in turn by the Anorthosite series rocks and the Roberval granite.

At the close of the pre-Cambrian era, the region was subjected to a period of erosion, which reduced its surface to a peneplain. It is impossible to measure the duration of this period of peneplanation, but it was brought to a close by a marine transgression in Upper Trenton time ①. In this sea, limestones were deposited unconformably upon the former land surface of pre-Cambrian rocks. All the evidence points to a rapid transgression covering a rather even land surface, and the Trenton limestones are usually in direct unconformable contact with the underlying pre-Cambrian.

Following the Upper Trenton (Cobourg) limestones, Utica shales were deposited, and on these in turn the Richmond limestones ②. Neither of these formations outcrop in the present map-area, however. It is not known whether formations younger than the Richmond were ever laid down in the region. If they were, they have been completely removed by erosion.

The known thickness of the Palæozoic sediments in the district is not great. The Trenton and Utica are each about 100 feet thick.

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① McGerrigle, H. W., Que. Bur. Mines, Ann. Rept., 1932, Part D, Appendix.

② Dresser, J. A., *op. cit.*, pp. 40-43.

The thickness of the Richmond has not been estimated, but there is no evidence that it is very great.

From the Ordovician until the Quaternary, there is record of but one form of geological activity in the Lac-Saint-Jean region, but that one feature is of paramount importance. It is the faulting, to which we owe the preservation of the Palæozoic sediments, upon which, in turn, depends the present physiographic character of the region, since presumably it is due to the relative ease with which these softer sedimentary rocks are attacked by the forces of erosion that the lowland area has been hollowed out within the boundaries of the Laurentian plateau.

These faults, or rather the prominent scarps which mark their location, constitute a striking topographic feature of the region. The southern boundary of the lowlands, which coincides with one of them, can thus be traced over a distance of at least 90 miles, from Dumais township to Ha! Ha! bay on the Saguenay river. The north edge of the Saguenay trench is a more or less continuous scarp which can be followed from the St. Lawrence river to Tchitagama lake on the Péribonca river, a distance of nearly 100 miles. The general direction of the visible major faults is S.65°W., but while the northern one is on the whole rectilineal, the southern one is distinctly arcuate, with the convex side to the south. The accompanying sketch map (Figure 1), reproduced from Blanchard ①, shows clearly, in a generalized way, the position of these two faults. The vertical displacement appears to be about equal to the difference in elevation between the highlands and the lowlands, that is, approximately 500 feet.

Unfortunately, there is no direct evidence within the district which allows us to fix the age of these faults within closer limits than post-Ordovician and pre-Pleistocene. The Palæozoic sediments, and the Trenton limestone in particular, are tilted and fractured on the edge of the fault zone, and in the vicinity of Chambord Junction, Dresser② recognized a small remnant of Trenton limestone resting on the gneiss on the edge of the highlands.

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① *Op. cit.*, p. 12.
② *Op. cit.*, p. 33.

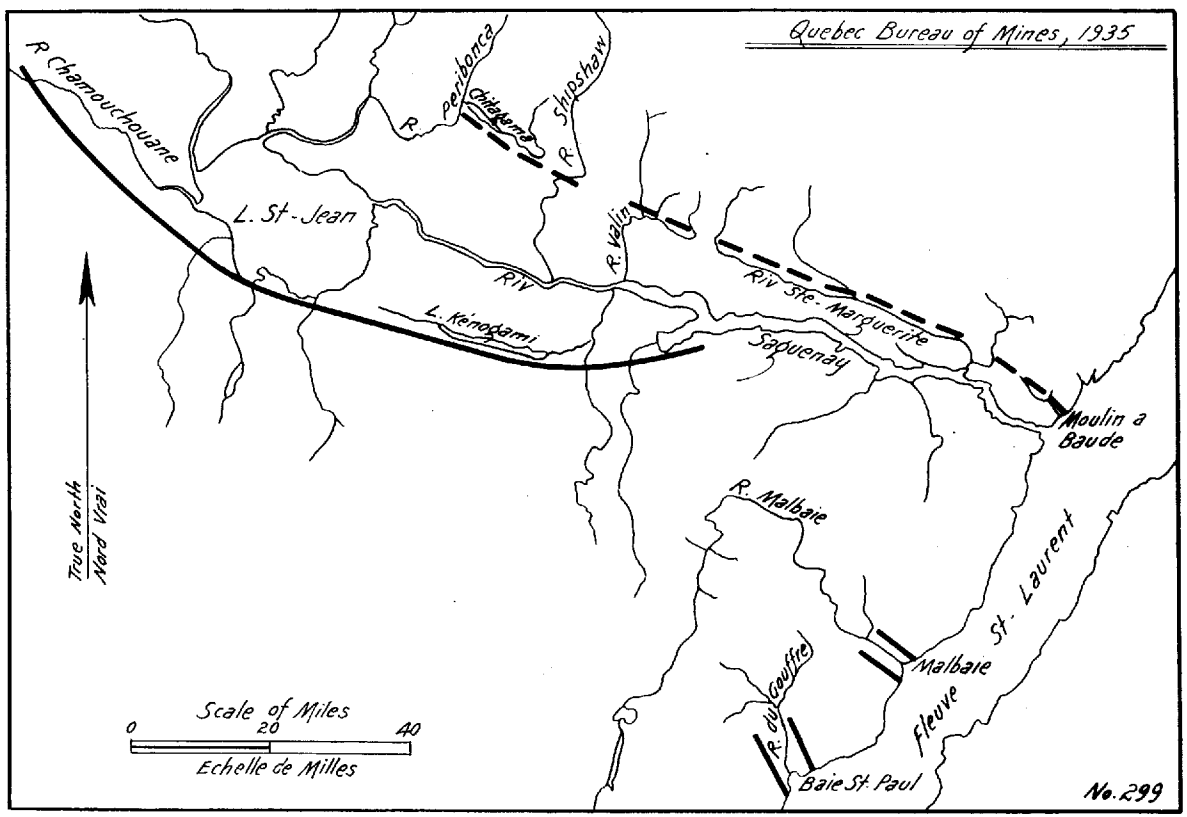

Figure 1.—Major faults of Lac-Saint-Jean region (after Prof. Blanchard)

By extending his observations farther afield, however, Blanchard has partially bridged the gap in the geological record between the date of the faulting and the invasion of the district by the Pleistocene ice-sheet. After outlining the peneplain forming the highlands which surround the Lac-Saint-Jean depression, he continues as follows ① :

"Thus it [the peneplain] surrounds the depression; it is therefore in this plateau at 300-500 meters elevation that the Lac-Saint-Jean basin has been hollowed and the Saguenay has cut its bed. Can this be the pre-Ordovician peneplain on which were deposited the Palæozoic sediments? Could it have persisted through the ages without suffering other damage than the mere removal of the film of Ordovician rocks? This would be quite extraordinary. But let us look further.

"As we reach these highlands, our attention is irresistably drawn to other physiographic features. At Anse Saint-Jean, about midway in the course of the Saguenay river, much greater heights are visible towards the south, rising sharply above the 450-meter plateau which dominates the fiord; they extend towards, and join, the mountains which form the imposing horizon of summits behind Murray bay. Crossing the Laurentide National Park from lake Saint-Jean to Quebec, in the midst of the labyrinth of deep valleys the relief attains and exceeds 3,000 feet. To the west of Saint-Felicien and La Doré, it is possible to distinguish, above the escarpment, which is the margin of the lower peneplain, the blue line of higher distant ridges. And finally, to the north-east of Chicoutimi, we are confronted with the striking view of the long, undulating horizon line of the Valin-Sainte-Marguerite hills, which rise to 1,000 meters. It describes an arc, closest to the Saguenay at a point opposite Ha! Ha! bay, and diverging to the east and to the west, especially towards the northwest, where it runs north-south between the Shipshaw and Péribonca rivers. In any case there is, in addition to the plateau at 300-500 meters, another topographic feature, much higher, and it can be seen both to the north and to the south of the depression.

"We are now in a position to seek analogies elsewhere, that is, to correlate these physiographic features with those previously distinguished along the St. Lawrence river between Quebec and

① *Op. cit.*, pp. 14-16. (Translated by B. T. D.).

the Saguenay①. And we find a very satisfactory similarity. The 300-500 meter plateau is the so-called intermediate plateau which was traced from the lower Montmorency as far as the Saguenay; the higher relief corresponds in elevation to the Laurentian peneplain at 900 meters, which we described behind Baie-Saint-Paul and Murray Bay. And as we had then been led to the conclusion that these plateaus on the north coast were the equivalents of the physiographic features of Gaspé and the south coast, we are more and more inclined to believe that the whole physiography of eastern French Canada may be tied-in to two erosion surfaces: one early Tertiary or Cretaceous in age, the other late Tertiary; the latter being cut out of the margin of the former. Both were uplifted before Quaternary time. It is, moreover, possible that this general pre-Pleistocene uplift was not quite even, and it may have been influenced by faults.

"If we are in truth dealing with two relatively recent peneplains, the Lac-Saint-Jean-Saguenay lowland must be still younger. It must be the result of erosion of the surface of the lower peneplain after it was uplifted, and which progressed rapidly in the less resistant Ordovician sediments; this explains why the depression is wide and deep at its head in the Chicoutimi-Lac-Saint-Jean region, whereas below, it is reduced to the channel of the Saguenay river, which traverses the peneplain like a saw-cut. The essential physiographic features of Lac-Saint-Jean would thus probably have been established at the close of the Tertiary...."

During the Quaternary, the Lac-Saint-Jean region was invaded by the great ice-sheets, which flowed in a general S.E. direction, and, on the retreat of the glaciers, the lowland region was occupied by an arm of the Champlain sea, on the floor of which inflowing streams deposited the comparatively great thickness of alluvial clays and sands which form the even flats of the lowland. On the highlands, the glaciers left the mantle of boulder clay, the morainic deposits which cover the slopes of the rounded hills of the plateau and fill the intervening hollows.

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① Blanchard, Raoul, *Le rebord Nord de l'estuaire et du golfe du St-Laurent*; Revue de Géographie Alpine, Grenoble, Vol. XX, 1932, pp. 507-509.

Since the post-Champlain uplift, the rivers and streams have already cut deeply into the unconsolidated sediments which form the lowland terraces, and, in certain areas where conditions did not favour adequate drainage facilities, extensive swamps and muskegs have been formed. These recent modifications, which are still in progress, have produced the land surface as it appears today.

DESCRIPTION OF FORMATIONS

Grenville

Distribution:

Rocks of the Grenville series occur in Pelletier township along Aux Rats river, and on the Mistassini. It is possible that they underlie a large part of that township and the northwest corner of the adjacent township of Proulx. Low ① mentions a wide band of crystalline limestone at the 6th and 7th portages on the Mistassini river, and refers also to its occurrence on Aux Rats river. Outcrops along and near this stream in Pelletier township may be seen on lot 43, range IV, where limestone is quarried; on lots 35 and 36 beside the road to Saint-Eugène; on lots 23 to 27 in the bed of the river and in the vicinity of the church of Saint-Eugène; and from lot 21 to the Chute au Marbre on lot 19; all in range IV. The total length of the zone along which the limestone outcrops discontinuously is, therefore, about 4½ miles.

In addition, however, to these outcrops of crystalline limestone, sedimentary gneisses underlie a large portion of the area to which we have just referred. It is also probable that detailed study of the areas that are indicated on the map as underlain by Laurentian would show that they include bands or zones of crystalline limestone and sedimentary gneiss. Present circumstances, however, do not in any way warrant the expense of such detailed geological mapping.

Lithology:

Crystalline Limestone.—The Grenville limestone of Pelletier township is a white, coarsely crystalline, rather impure variety. Scales of mica, grains of hornblende and of pyroxene, quartz, and feldspar, and tiny flakes of graphite, constitute the common impurities, which are

① *Loc. cit.*, p. 52.

present in varying amount. The thickness of the beds is difficult to determine as they have suffered intense diastrophism, to which they have yielded by folding, by flow, and by fracture, so that the limestone appears rather as a series of lenses than in the form of continuous beds.

Sedimentary Gneiss.—The sedimentary gneisses are on the whole light coloured, grey or pink, rocks, with a marked banded structure which is due to the alternation of zones in which predominate, respectively, the light and the dark coloured minerals. The constituent minerals are orthoclase, oligoclase, quartz, biotite, and hornblende. The orientation of the hornblende crystals frequently does not conform to the gneissoid structure of the rock, indicating that this mineral is not an original constituent of the rock. These gneisses in many places are practically indistinguishable from the pink and grey igneous Laurentian gneisses. The criteria upon which they were distinguished in the field are the association with the crystalline limestone, a tendency towards a greater continuity of narrow ferromagnesian bands, and the attitude and general appearance of the rock structure. No laboratory work which would not involve intensive and unwarranted research can afford a better basis for establishing the distinction.

AGE, AND RELATION TO OTHER FORMATIONS:

These rocks are the oldest in the district. Viewed structurally, they represent the remnants of the cover invaded by the Laurentian granitoid gneisses, and they have been subjected to every subsequent period of intrusion, of folding, and of metamorphism in the geological history of the region. They are cut by numerous dykes of pegmatite and aplite, some of which follow the convolutions of the contorted folds, while others cross the banding.

LAURENTIAN

DISTRIBUTION:

Laurentian granites and granitoid gneisses underlie the highlands to the south and west of the Lac-Saint-Jean lowland, as well as a strip, from $2\frac{1}{2}$ to 6 miles wide, of the adjacent lowland. They occupy the northwest half of Girard township, and in Beaudet township the area between the Ouiasiemska (à Jim) and Mistassini rivers. In the east corner of Girard township, in a narrow strip in the northeast of Nor-

mandin, and over the whole of Albanel township as far as the Mistassini river, the bedrock upon which the Quaternary terraces rest probably belongs to this formation. The greater portion of Pelletier township and the east corner of Proulx are indicated on the map as underlain by Laurentian, but in this portion of the area, as was explained in the discussion of the Grenville rocks, it was not possible under the circumstances to differentiate between the sedimentary Grenville gneisses and the Laurentian igneous gneisses.

LITHOLOGY:

Granitoid Gneiss.—The Laurentian rocks are rather fine-grained, pink or grey, granitoid gneisses, whose essential constituents are quartz, orthoclase, oligoclase, biotite, and hornblende. Magnetite and apatite are common accessory minerals. Wide variation in the proportion of light and dark minerals gives rise to corresponding differences in the colour of the rock. In detail, the formation is far from uniform. Streaks, patches, and bands of darker gneiss, either micaceous or amphibolitic, are common, as also are dykes and irregular patches of pegmatite and of aplite.

The gneissoid structure is highly developed in places and is made apparent by the alternation of dark and light bands. It is sometimes very fine and even, with the general strike slightly west of north and the dip steep or vertical. More commonly, however, the general structure is obscured by complicated drag-folding, by the injection, or segregation, of pegmatitic and aplitic phases, or by the irregularity of the banding. The formation is therefore rather uniform as a whole, but very complex in detail.

AGE, AND RELATION TO OTHER FORMATIONS:

The Laurentian gneisses were formed during a widespread and extended period of intrusion, and, in the Lac-Saint-Jean region, invaded the Grenville series. The Laurentian should be considered as a *period* of intrusion rather than as a single invasion of granitic magma, and this explains, in part at least, the complexity of the formation. The Anorthosite series and the Roberval granite intrude the Laurentian. A sketch-map in Dresser's report ① shows that around a small

① *Op. cit.*, p. 29.

stock of Roberval granite the banding in the Laurentian gneiss near the contact has a tendency to conform to the outline of the section of the stock. This tendency is also apparent near the margin of the large mass of Roberval granite which occupies parts of Girard, Dumais, and Normandin townships in the present area.

Anorthosite Series

Distribution:

The rocks assigned to the Anorthosite series are confined to the northeast corner of the map-area; they occupy Milot and Dalmas townships, together with the greater part of Proulx and the eastern part of Dolbeau township. They form the western extremity of the great mass of anorthosite and related rocks which extends far to the east and northeast of the present district, and has an area of more than 20,000 square miles.

Lithology:

The area underlain by the Anorthosite series may be considered in two parts. The eastern portion, which is slightly the larger, includes the principal areas of anorthosite and gabbro, while the western portion is underlain by granites and syenite.

Anorthosite, Gabbro, Norite.—The typical anorthosite is a coarse grey rock composed essentially of plagioclase feldspar, which usually has the composition of labradorite. The granulated varieties described by F. D. Adams ① are not conspicuous in the area, although they are very well developed a few miles to the east and southeast. The usual variations in grain size were, however, noted, individual feldspar crystals with characteristic striated faces often measuring several inches in diameter, though the average grain is an eighth of an inch or even less.

While the typical anorthosite is essentially a mono-mineral rock, in which plagioclase feldspar is the only constituent, large portions of the general area are underlain by rocks of the same family but in which the ferromagnesian minerals are so abundant that the rock should be termed a gabbro or norite. Hypersthene is the usual dark mineral in these rocks, but biotite and augite are also found. Olivine

① *Op. cit.*

was not observed in any of the specimens examined. The normal anorthosite occupies a distinctly smaller area than the ferromagnesian facies.

Granite, Syenite.—The syenitic and granitic phases of the Anorthosite series are particularly well-developed in Proulx township, where extensive bare outcrops of these rocks are to be found. Orthoclase, quartz, oligoclase, biotite, and hornblende are essential constituents; apatite and magnetite are usual accessory minerals. In colour, these rocks are usually pink, but occasionally they are greenish or grey. They have a well developed porphyritic structure. Though they are frequently quite massive, gneissoid varieties are common, and typical augen-gneisses have been formed where the rock has been subjected to extreme diastrophism. In thin section, it is seen that the predominating feldspar is orthoclase, crystals of which may be as much as one inch in length.

The contact between these acidic rocks and the anorthosite proper follows approximately the Petite Péribonca river. Detailed geological mapping of the northeastern part of Dalmas township and of the zone along the Petite Péribonca river, which forms the boundary between Milot and Proulx townships, would doubtless afford some desirable information concerning the mutual relations of these rocks.

An unusual facies of the syenite, found near the western margin of the mass, is composed of orthoclase and hornblende in varying proportions; biotite and ilmenite are present in smaller amount. This rock does not, apparently, underlie continuously any large area, but it was encountered at several points in the southeast corner of Milot township, near the contact between the anorthosites and the porphyritic granites and syenite. The same rock was found also on the Alex river at lot 25, range I, Milot township, at a distance of about eight miles from the above mentioned contact.

It was thought that transitional facies between the anorthosite-gabbros and the granite-syenite porphyries were recognized in places, but more detailed field work and laboratory research is necessary to establish definitely the relation between these several rock types.

In the vicinity of Saint-Augustin, in Dalmas township, and especially to the west of that village, granitic facies are found within the

gabbro-anorthosite area, and, in the northeast corner of Proulx, anorthosite is found within the more acidic rocks. On the whole, however, the contact between the two is rather sharp.

AGE, AND RELATION TO OTHER FORMATIONS:

That the anorthosite is intrusive into the Laurentian has been established by Adams, Young, and Dresser. The acidic rocks—granite and syenite porphyries—contain, near the west margin of the mass, numerous inclusions of the older gneiss. According to Dresser, the Roberval granite cuts the Anorthosite series, but within the present area the two formations were never observed either in the same outcrop or even within many miles of one another. Both the porphyries and the gabbro-anorthosites are cut by numerous pegmatite and aplite dykes, and in Proulx township, near the northeast boundary of lot 18, range IV, a dyke of fine grained, tough, dark diabase cuts the granite porphyry.

ROBERVAL FORMATION

DISTRIBUTION:

In the township of Girard, between Saint-Thomas-Didyme and Girardville, there is an area of rugged hills of granite and syenite which have been correlated with the Roberval granite described by Dresser ①. Outcrops of similar rock were noted in the vicinity of Normandin village, in the middle of the township of the same name; and also on the Ashuapmouchouan river, at the Chute à l'Ours. The southwest half of Normandin township is drift-covered and no outcrops were found.

LITHOLOGY:

Granite, Syenite.—The rocks of this mass are rather coarse, equigranular, pink or olive coloured granites and syenites. The usual essential constituents are orthoclase, more rarely microcline, quartz, oligoclase, and hornblende; common accessory minerals are biotite, apatite, magnetite, and hypersthene. The syenite, of course, contains less quartz than the granite and, as a rule, more plagioclase. Gneissoid phases are common, particularly toward the margins of the mass, but the general characteristic of the rocks is their equigranularity and the absence of evidence of diastrophism.

① *Op. cit.*, pp. 26-29.

In all the thin sections of rocks of this formation that were examined, a striking and unusual feature is the presence of a large number of very small inclusions of quartz in the orthoclase, all oriented parallel to definite crystallographic directions of the feldspar.

The rocks differ from the typical Roberval of Dresser in that here the usual potash feldspar is not microcline but orthoclase. Hypersthene was noted in sections of three specimens of the olive coloured types, one a granite and the others syenites. Riebeckite, the soda-rich amphibole, was noted in one section; it occurs in narrow veins which fill joint cracks, the veins having a width of one-tenth to one-quarter of an inch.

AGE, AND RELATION TO OTHER FORMATIONS:

The Roberval is intrusive into the Laurentian gneiss and contains, near the contact, numerous inclusions of the older formation. According to Dresser ①, it also intrudes the Anorthosite series, but the relation of these two formations is not shown in the area covered in this report. To the west of the town of Roberval, Trenton limestone rests unconformably upon Roberval granite. This is very well exposed in a cutting on the Quebec and Lac-Saint-Jean railway at the Indian Reserve, Pointe Bleue ②.

Pegmatite and aplite dykes cut the Roberval granite, but they are very much fewer in number than in the Grenville, Laurentian, and Anorthosite series.

ORDOVICIAN: TRENTON

DISTRIBUTION:

The only outcrops of Trenton limestone seen in the map-area are in Ashuapmouchouan township, at the foot of the escarpment which marks the boundary of the lowland. They are on lots 44 and 45 of range VII, and at the falls of A l'Ours river, at the power-house on lot 39, range VI.

These outcrops mark the westward extension of the formation whose limits in the area to the southeast were outlined by Dresser ③.

① *Op. cit.*, p. 28.

② Dresser, *op. cit.*, pp. 28 and 29.

③ *Op. cit.*, pp. 29-43.

It is reasonable to suppose that the Trenton underlies a considerable portion of the area in Ashuapmouchouan township between the highlands and lake Saint-Jean. There are, however, no outcrops in this flat, drift-covered section.

Boulders of Trenton limestone are numerous in the glacial débris on the highlands immediately to the southwest of the Lac-Saint-Jean lowland. It is of particular interest to note that three large boulders of this limestone were seen on the Mistassibi river, lot 30, Mistassibi range, Pelletier township, at a distance of about 15 miles to the north of lake Saint-Jean. In the vicinity of lot 25, near the southwest end of range VI, Pelletier township, there are numerous slabs of Utica shale and a few fragments of Trenton limestone scattered through the glacial drift. There are, however, no known outcrops of these Palæozoic sedimentary rocks in the region immediately to the north of lake Saint-Jean.

LITHOLOGY:

The Trenton is a grey, rather compact limestone, highly fossiliferous in places. The few outcrops noted were on the edge of the escarpment, where the beds are broken and tilted in the vicinity of the fault.

AGE, AND RELATION TO OTHER FORMATIONS:

Strictly speaking, the age of this limestone within the area has not been determined, but on lithological grounds, as well as by reason of its geological and geographical position, its correlation with the Trenton of the adjoining map-sheet (G.S.C. Map No. 184A) is so obvious that palæontological confirmation is unnecessary. The limestone rests unconformably upon the underlying pre-Cambrian crystalline rocks, and it has been pointed out that, in the zone where the outcrops were found, the beds have been broken and disturbed by regional faulting.

QUATERNARY

DISTRIBUTION:

Unconsolidated drift, either of glacial origin or consisting of material deposited on the floor of the Champlain sea after the retreat of the glaciers, forms a discontinuous mantle over the area. In certain sections, the Champlain sediments extend continuously over many square miles.

Southwest of the Ashuapmouchouan river and as far as the margin of the highlands, the mantle of drift is almost uninterrupted in Ashuapmouchouan, Demeules, and Dufferin townships. The west corner of Dumais township and the whole of Normandin, with the exception of a narrow zone running southward from the northwest corner of the township, are completely drift covered. So also are Parent, Albanel, and Racine townships, apart from one outcrop, in the east corner of Albanel. In the east corner of Girard township, there are no outcrops of bedrock, and in Pelletier there is a strip of land from two to six miles wide east of the Mistassini river in which there are no outcrops. The southwest half of Dolbeau township is completely mantled by drift, and in Dalmas the outcrops of bedrock are nearly all located within the northwest quarter of the township. The central-southern portion of Milot township is completely drift covered. In the section of this report dealing with physiography, attention has been drawn to the irregularity of the northern and northwestern boundary of the lowland, where Champlain sediments penetrate the embayments and depressions on the edge of the highlands.

CHARACTER OF THE FORMATIONS:

Boulder Clay.—The lowest member of this system is boulder clay. It occupies the higher areas and forms the discontinuous mantle of drift which covers the bedrock of the Laurentian plateau.

The boulder clay consists essentially of boulders of various sizes buried in unassorted clay. The boulders are rounded or sub-angular, and often represent rock types which are quite foreign to the immediate vicinity in which they are found. On the other hand, the presence of numerous boulders of one and the same type generally implies that bedrock of that type is nearby. Associated with the boulder clay there are, locally, fluvio-glacial deposits—clays, sands, and gravels which are generally stratified.

Stratified Clays and Sands.—The stratified clays and sands of the Champlain period overlie the unsorted or roughly sorted glacial débris and form the extensive flat terraces of the Lac-Saint-Jean lowland.

According to A. E. Barlow ①, these terraces, above Pemonka rapid on the Ashuapmouchouan river, reach an elevation of nearly 650 feet. The material is well stratified and consists of clay overlain by sand. The clay forms the rich, boulder-free, fertile soil of the district, and is extensively developed in the south and east portion of the basin. In the north and west, the clay is only exposed in the deeper valleys and upon it rests a great thickness of less fertile sandy-soil which, in the uncultivated state, supports a growth of jack pine. In the townships of Ashuapmouchouan and Demeules, the sand is confined to a narrow zone at the foot of the highlands. In range VII of Ashuapmouchouan township, in the valley of l'Ours river, a short distance above the power-house, there is an excellent exposure of the contact between boulder clay and the overlying stratified sediments (Plate I-B)

Fossils are not common in this formation, but several specimens of *Portlandia arctica* (Gray) ② were found on lot 12, range I, Pelletier township, on the banks of the Mistassini river, at a point where the well stratified clays enclose numerous concretions.

Glaciation

The average direction of advance of the ice, as determined by the strike of glacial striæ at twelve points (indicated on the accompanying map) in the northern half of the area, was S.11°E., and on the whole the readings were very concordant; the three observations which deviated most from the average were S.22°E., S.5°E., and S.5°E. In view of the fact that observations were taken at every favourable opportunity and that all are recorded, the concordance of the results is quite remarkable.

In the southern portion of the area, no observations were made. Those recorded by Dresser ③ within the adjoining area to the southeast, together with those given by Chalmers ④ for points farther east, indicate great differences in the direction of flow of the ice-sheet.

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① *Geology and Mineral Resources of the Chibougamau Region, Quebec;* Mines Branch, Department of Colonization, Mines and Fisheries, Quebec, 1911, p. 76.

② Identified by Geological Survey of Canada.

③ *Op. cit.*, p. 44.

④ Geol. Surv. Can., Summ. Rept., 1904, p. 256A.

ECONOMIC GEOLOGY

Grenville Formation

Limestone:

The coarse grain of the crystalline limestone, together with the fact that it contains inclusions of various minerals, does not permit its utilization for building or ornamental purposes. The rock is, however, quarried on lot 43 of range IV, Pelletier township, to furnish lime to the Lake St. John Pulp and Paper Company at Dolbeau; the quarry is about six miles from Dolbeau and the output is transported by truck. The limestone at this point is reported to be very pure, and free from graphite flakes, which would constitute a very deleterious impurity. In the quarry, the limestone is cut by pegmatite dykes, in which sphene (titanite) is a common accessory mineral. The pegmatite is easily sorted out by hand. This quarry is operated by the Trappist Fathers of Mistassini, and in 1933 the production was 4,000 tons.

M. F. Goudge of the Mines Branch, Ottawa, has kindly furnished the following results of the analysis of a composite sample of several pieces of limestone received by him from various individuals of Dolbeau. The analysis was carried out in the laboratories of the Division of Chemistry of the Mines Branch.

Analysis of Limestone Sample ①

$CaCO_3$	94.07	(equivalent to 52.69 per cent CaO)
$MgCO_3$	2.07	(" " 2.07 " MgO)
Al_2O_3	0.26	
Fe_2O_3	0.30	
$Ca_3(PO_4)_2$	0.02	(equivalent to 0.01 per cent P_2O_5)
SO_3	0.12	
Insoluble	3.00	
Total	99.84	

Analysis of Insoluble

SiO_2	1.16
Fe_2O_3 and Al_2O_3	0.56
CaO	0.46
MgO	0.82
Total	3.00

① Analyst: Chas. Brian, Ottawa.

Crystalline limestone from the Trappist Fathers' quarry was analysed in the laboratory of the Technical Department of Price Brothers & Co. Ltd., who have kindly furnished the following figures:

ANALYSES OF CRYSTALLINE LIMESTONE ①

$CaCO_3$	97.93	96.93	95.50	97.20	95.12
$MgCO_3$	1.08	0.83	1.00	1.14	2.68
SiO_2 and Insol	1.03	2.29	3.24	1.59	1.94
Al_2O_3 and Fe_2O_3	0.06	0.13	0.40	0.15	0.38
Total	100.10	100.18	100.14	100.08	100.12

OTHER POSSIBILITIES:

On lot 36 of range IV, Pelletier township, the limestone is abundantly stained with malachite in the vicinity of a narrow seam or crack, but there is no evidence of the existence of a body of copper ore.

It is reported that lead and zinc sulphides have been found in the Grenville limestone in this region, but we were not able to trace the source of this rumour. The possibility is, however, very real, and prospectors should always be keenly alert when they are within areas of Grenville limestone, since, in other districts and under essentially similar conditions, this rock has acted as host-rock to important ore-bodies of economic minerals such as galena, sphalerite, graphite, etc.

None of the areas of sedimentary gneiss seem to have any economic interest, but the possibility of sillimanite or garnet deposits should not be overlooked.

LAURENTIAN FORMATION

MOLYBDENITE:

The Laurentian gneisses are not regarded favourably as prospecting ground, and nothing to contravert this view was found in the map-area. The numerous dykes and patches of pegmatite are of more interest. The occurrence of molybdenite in these dykes is widespread, and excellent specimens of this mineral have been obtained at various places, notably on lot 43 or 44, range VI, Dufferin township. The dykes are usually comparatively narrow, and the molybdenite is present in such small, irregular pockets that occurrences yet found are

① Analyst: A. G. Muirhead, Kénogami.

not of economic value. On the other hand, large dykes, richer in molybdenite or other economic minerals, may exist, and should be sought.

In Pelletier township, on lot 41, range VI, and on lot 37, Mistassini range, molybdenite prospects have received some attention. The country rock is dark, massive, crystalline, and rather fine grained and is composed essentially of quartz, hornblende, and biotite; its relation to the normal granitoid gneiss is not shown in the outcrops. The molybdenite occurs in quartz veinlets and lenses. No molybdenite was seen in place on lot 37. On lot 41, a pit 10 to 12 feet square, now partly filled with water but about 10 feet deep to water level, has been excavated. Molybdenite is rather abundant on the dump and on the walls of the pit. It is obviously associated with the quartz veinlets, but, owing to the inaccessibility of the pit walls and to the fact that the dump has without a doubt been rather thoroughly picked over, it is very difficult to estimate the tenor of the ore. It is claimed that an appreciable amount of molybdenite was taken out, but no records of shipment are available.

MAGNETITE:

On lot 43, range IX, Ashuapmouchouan township, to the south of A l'Ours river, on the hills within about 200 yards of the river, there are numerous nests and streaks of magnetite scattered through pegmatitic patches in granite. These segregations are small and of no economic value, so far as at present known.

QUARTZ:

A large mass of white vein quartz outcrops on the boundary line between lots 2 and 3, range III, Dequen township. The locality is near Lac-Bouchette and south of the area particularly dealt with in the present report, but on account of the obvious abundance of the material and the accessibility of the occurrence, the writer was instructed to examine and sample the deposit.

Lac-Bouchette is on the Quebec and Lac-Saint-Jean branch of the Canadian National railway, 240 miles from Montreal. The quartz deposit is about 1,700 feet southeast of the boundary-post between the parishes of Lac-Bouchette and Saint-François-de-Sales, on the road which links the two villages, and is distant about three miles from the church in each.

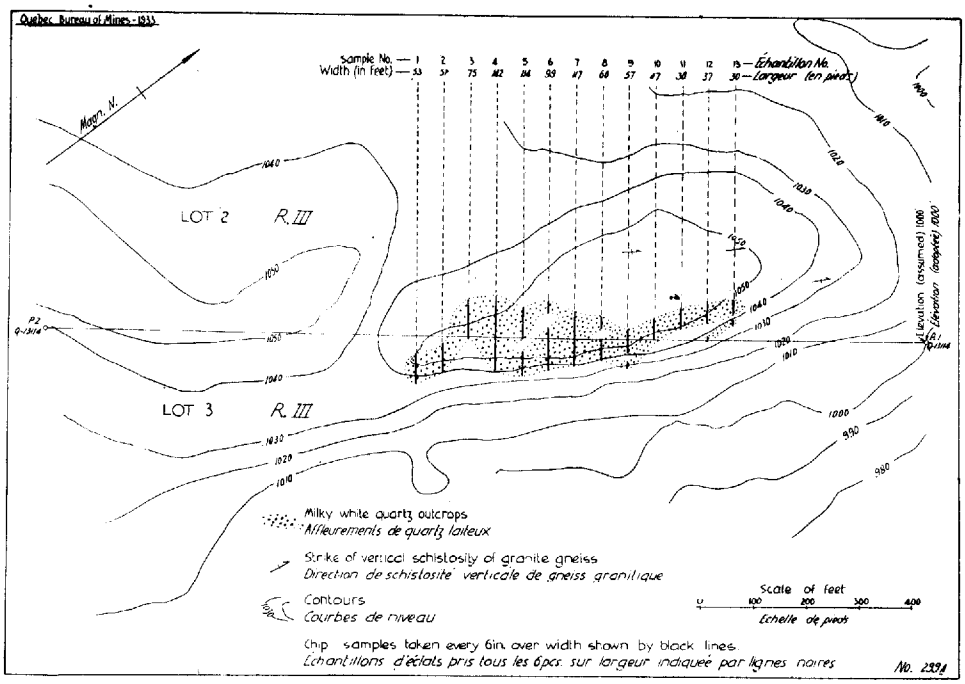


Figure 2.—Plan of silica deposit at Lac-Bouchette, lots 2 and 3, range III, Dequen township.

NOTE:—Analyses of samples are given on page 87. The datum point for the contours is Post No 1 of claim Q 13114, on line between lots 2 and 3, at an assumed elevation of 1,000 feet.

The sketch-map (Figure 2) shows the outcrop of the deposit and the topography of the country in the immediate vicinity. The quartz outcrop forms the top and the steep east flank of a small hill. The exposure is about 650 feet in length with a maximum width of 142 feet, and the direction of the longer dimension, N.30°E. (mag.), conforms to the strike of the schistosity of the enclosing Laurentian granite gneiss. The dip of the quartz body is not apparent, but it is probably like that of the gneiss, vertical or very steep to the west.

Some of the quartz is pure milk-white and massive, with occasional small vugs filled with colourless quartz crystals, but much of it has a faint pink colour. Rusty stains were not noted, and, within the limits outlined in the sketch-map, the material contains no visible impurities. To the west, and at the northeast end, of the deposit, the quartz grades

into granite gneiss through a zone of impure quartz and quartz-injected gneiss. The impure material was not sampled, as it was clear that, by judicious exploitation of the deposit, it would be easy to avoid contamination of the product by the impure quartz.

Thirteen samples were taken across the width of the deposit at fifty-foot intervals, as indicated on the sketch-map. On account of the width of the outcrop, chip samples were taken rather than the more accurate channel samples. Chips taken at every six inches over such a great width should give sufficiently representative samples of the deposit as a whole. These samples were submitted to Maurice Archambault, of the Laboratory of the Quebec Bureau of Mines, for determination of silica. The results of his analyses are as follows:

ANALYSES OF LAC-BOUCHETTE QUARTZ

Sample No.*	Width (feet)	Silica (SiO_2)	Impurities, by difference, chiefly Fe_2O_3
1	53	99.89	0.11
2	51	99.82	0.18
3	75	99.91	0.09
4	142	99.71	0.29
5	114	99.95	0.05
6	99	99.84	0.16
7	117	99.96	0.04
8	60	99.89	0.11
9	57	99.71	0.29
10	47	99.94	0.06
11	38	99.65	0.35
12	39	99.91	0.09
13	30	99.86	0.14

(*) For location of samples see Figure 2, page 86.

The preparation of the samples for these analyses involved preliminary crushing in a laboratory jaw crusher, followed by quartering. The sample, reduced to between 40 and 50 grams, was pulverized in an agate mortar, and any metallic iron which might have been introduced during the preliminary crushing was removed by electro-magnet. This operation would, of course, also remove any admixed magnetite, but none was observed in the samples or in the deposit as a whole. In any case, the method adopted in the preparation of the samples conforms closely in principle to the flow-sheet of the mill.

The owners of the property are the Silica Products of Canada, Limited, of which Jos. Gauthier, of Chicoutimi, is president. This Company has erected a mill on a siding on the Quebec and Lac-Saint-Jean railway at a point about one mile distant from the deposit. Dry crushing and pulverization are adopted, with the following flow-sheet: Gyratory crusher—bucket elevator—secondary crushers (rolls) —magnetic pulley—screens—Hardinge pebble-mill (flint lined)—Gayco air separator.

Power is obtained from two Junkers Diesel engines of 50 h.p. each, but it is expected that the capacity of the installation will be increased. This mill should be able to produce from 6,000 to 9,000 tons of finely pulverized quartz per year.

"① Canadian production of quartz in 1933, including crushed quartzite and silica in other forms, totalled 185,807 tons valued at $298,497 as compared with 189,132 tons valued at $276,147 in 1932. The records indicate that it was used for the fluxing of metalliferous ores, manufacture of scouring compounds, electrochemical and electrometallurgical processes, glass manufacturing, moulding, brickmaking and artificial abrasive manufacture. Several modern plants are now in operation in Eastern Canada for the production of ground and crushed silica products.

"Production in Canada and Imports of Quartz, 1932 and 1933

	1932		1933	
	Tons	Value	Tons	Value
Production:—				
Nova Scotia	—	—	1,017	1,447
Quebec	20,123	71,645	28,443	110,395
Ontario	66,135	93,574	66,472	86,020
Manitoba	87,253	102,493	67,207	82,954
British Columbia	15,621	8,435	22,668	17,681
Total	189,132	276,147	185,807	298,497
Imports:—				
Silex or crystallized quartz, ground or unground	6,186	167,997	4,370	82,823
Flint and ground flint stones	1,926	16,075	2,277	26,615
Total	8,112	184,072	6,647	109,438

① Extract from "Mineral Prod. of Can., 1933" (prelim. rep.), Dominion Bureau of Statistics, Ottawa.

The market price of the 'sand and quartz' in 1932 ranged from $1.50 to $4.00 per ton, and of the 'pulverized silica' from $10.00 to $30.00 per ton. Of the total consumption, 25 per cent of the former, and 80 per cent of the latter, were imported.

General information on the uses of silica may be found on pages 17 to 34 of Mines Branch Report No. 555, *Silica in Canada*, by L. Heber Cole. This report may be obtained through the Director, Mines Branch, Department of Mines, Ottawa.

Anorthosite Series

Anorthosite is chiefly noted, in other districts, as the host-rock of ilmenite or titaniferous magnetite. These deposits are usually irregular masses and some of them are very large. Their utilization is a problem yet to be solved. No large bodies of these minerals were seen in the rock of that formation which outcrops in the present area.

Black Granite:

The anorthosite is quarried in the vicinity of Saint-Gédéon, on the southeast side of lake Saint-Jean, and marketed under the name of 'black granite'. It is prized as a monument stone. The porphyries of Proulx and Dolbeau townships are generally too coarse grained, and frequently also too foliated, for use as building or ornamental stone.

Feldspar:

Pegmatite dykes cut the Anorthosite series at various places. On the south side of the road west of Saint-Augustin, on lot 28, range V, Dalmas township, is an outcrop of pegmatite in which there is a lens of large orthoclase crystals. While this body is not of economic dimensions, it indicates the possibility that elsewhere in these pegmatites large masses of feldspar may be found. In Proulx township, on the extension of the range-line between ranges VI and VII, and about half a mile west of Proulx lake, a few crystals of a green variety of feldspar, amazonite, were noted in a pegmatite dyke.

Gold:

On lot 20, range VII, of Dalmas township, some work has been done on a gold prospect. Two pits have been sunk, the larger of

which is 6 ft. by 6 ft. by 9 ft. deep. The other is about 4 ft. by 4 ft. by 3 ft., and is 250 feet to the northeast (N.65°E. mag.) of the first.

The prospect is located at the contact of granitic augen-gneiss and anorthosite. The direction of schistosity of the gneiss varies from N.20°-80°E. and the dip is steep to the southeast. Small stringers and lenses of quartz, which has a greenish tinge, traverse the rock, their direction tending to parallel the schistosity.

The bodies of quartz are discontinuous and, from present indications, they appear to be distinctly of insufficient size to be of economic interest. In the larger pit, a width of four feet is exposed, and at this point the quartz is slightly mineralized with light-coloured pyrite and traces of chalcopyrite, galena, and sphalerite(?). In the smaller pit no mineralization was noted. Encouraging assays for gold were reported from the larger pit, but two samples taken from the dump by the writer gave only $0.35 and $0.29 per ton, respectively.

Roberval Formation

Granite:

Roberval granite, taken from a nearby quarry, was used in the construction of the church at Normandin. In the vicinity of Roberval itself, southeast of the present area, the granite has been quarried extensively for many years, for use both as building stone and for ornamental purposes.

Tin:

On the boundary between lots 17 and 18, range VI, of Normandin township, a shaft has been sunk to a depth of some 30 feet on a pegmatite dyke, which cuts syenite, the country rock here. The dyke is from 5 to 8 feet in width and is exposed over a length of about 30 feet. Tin is reported to be present, but no tin-bearing minerals, or any others of economic value, were noted at the workings or in the vicinity.

Trenton Formation

Trenton limestone has been quarried in the region to the southeast, for use in the pulp and paper industry, but utilization of the limestone of this formation that occurs in the present map-area is a most remote possibility.

Quaternary Formations

Apart from the question of the utilization of the clay deposits in the ceramic industry, and the location of gravel pits to supply material for road construction, the economic aspect of the Quaternary unconsolidated sediments of the area is agricultural rather than related to the mineral industry.

Clay:

A description of some of the clays of Chicoutimi county, together with the results of tests looking to their possible uses, is contained in the report by J. Keele on the clay and shale deposits of the Province of Quebec, published by the Geological Survey in 1915. A report by Keele on a sample of clay from the east bank of the Saguenay river, at the mouth of Vases river, is quoted by Dresser① and was reproduced in Part D of the Annual Report of the Bureau of Mines for 1932. The tests on this sample of clay showed that "its use, as far as the manufacture of burned clay products is concerned, is confined to making common brick by the soft-mud process". The report added that it might be used for making the smaller sizes of field drain tile, but was not suitable for the manufacture of vitrified ware.

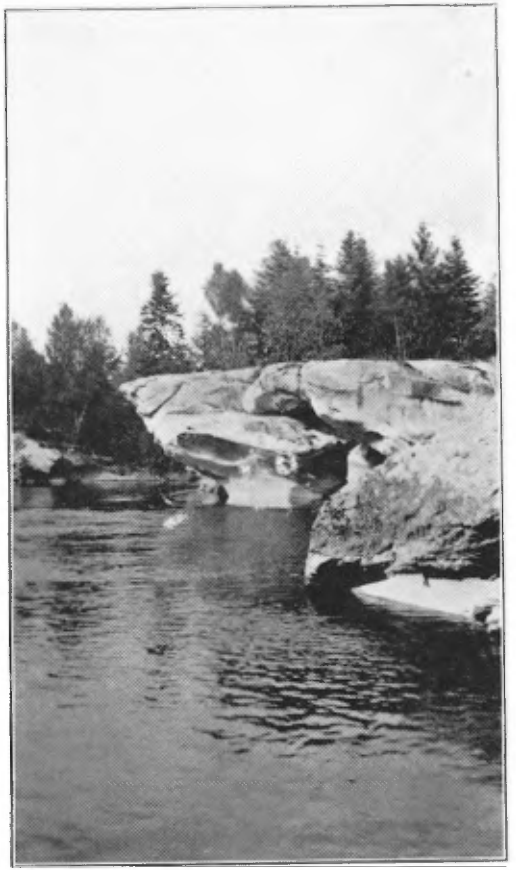
Gravel:

In this region, it is difficult to obtain gravel suitable for road construction. The extensive Champlain terraces of the lowland are free from boulders and gravel. North and west of the lake, however, toward the limit of the lowland, roughly sorted gravel occurs at a number of places in the immediate vicinity of outcrops of bedrock.

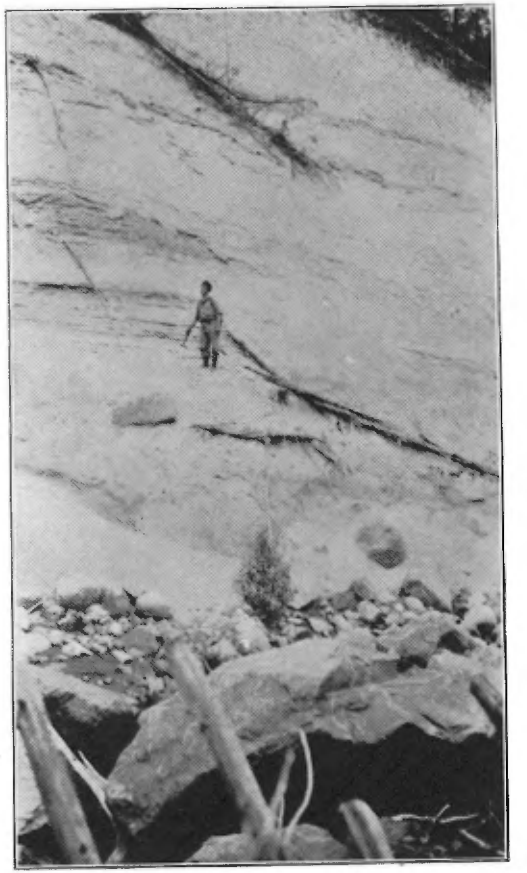
Soil:

The terraces of stratified Champlain clay form the best soil. The boulder clay of the highlands is apparently also quite fertile, but the great accumulations of piled stones in each field bear witness to the effort and patience demanded of the farmer in cultivating such land, and protruding outcrops, steep slopes, and the shallowness of the soil add greatly to his difficulties. The extensive sand plains, locally termed 'Africa', which occupy large areas to the north of the lake, and near the larger inflowing streams, are also being opened up by settlers.

① *Op. cit.*, pp. 49-50.



A.—Grenville crystalline limestone on Aux Rats river, above Saint-Eugène village, Pelletier township.



B.—Contact of boulder clay and stratified sand, range VII, Ashuapmouchouan township.