Cahiers de géographie du Québec

Notes on the Geology and Physiography of the Lake Saint-Jean Area, Québec

Peter Clibbon et Robert Bergeron

Volume 7, numéro 13, 1962

URI : https://id.erudit.org/iderudit/020420ar
DOI : https://doi.org/10.7202/020420ar

Aller au sommaire du numéro

Éditeur(s)

Département de géographie de l'Université Laval

ISSN

0007-9766 (imprimé)
1708-8968 (numérique)

Découvrir la revue

Citer cet article

Clibbon, P. & Bergeron, R. (1962). Notes on the Geology and Physiography of the Lake Saint-Jean Area, Québec. *Cahiers de géographie du Québec*, *7*(13), 81–100. https://doi.org/10.7202/020420ar

Résumé de l'article

Le lac Saint-Jean est situé à l'intérieur du Bouclier aux sources du Sague-nay. Il occupe la partie sud-est d'une dépression structurale d'environ 65 milles de long par 35 milles de large, limitée sur trois côtés par des escarpements de faille. Le sous-sol de ces basses terres est constitué de calcaires et de schistes paléozoïques recouverts d'épais dépôts d'argile et de sable. Trois séries de terrasses marines bien définies encerclent la cuvette.

Les hautes terres environnantes sont plus ou moins accidentées selon les endroits, avec une altitude relative moyenne d'environ 500 pieds. Des paragneiss, des gneiss mélangés, des anorthosites, des roches charnockitiques et des granits, tous d'âge précambrien, constituent le sous-sol de ce plateau. Les zones les plus accidentées correspondent en grande partie aux roches charnockitiques, aux granités et aux anorthosites massives, tandis que les zones gneissiques ne sont que légèrement ondulées. Des tills d'origine locale tapissent les pentes et d'épais dépôts fluvioglaciaires remplissent les vallées principales.

NOTES ON THE GEOLOGY AND PHYSIOGRAPHY OF THE LAKE SAINT-JEAN AREA, QUÉBEC

by

Peter CLIBBON

Institut de géographie, université Laval, Québec

and

Robert BERGERON *

Institut de géographie, université Laval, and ministère des Richesses naturelles de la province de Québec.

RÉSUMÉ

Le lac Saint-Jean est situé à l'intérieur du Bouclier aux sources du Saguenay. Il occupe la partie sud-est d'une dépression structurale d'environ 65 milles de long par 35 milles de large, limitée sur trois côtés par des escarpements de faille. Le sous-sol de ces basses terres est constitué de calcaires et de schistes paléozoïques recouverts d'épais dépôts d'argile et de sable. Trois séries de terrasses marines bien définies encerclent la cuvette.

Les hautes terres environnantes sont plus ou moins accidentées selon les endroits, avec une altitude relative moyenne d'environ 500 pieds. Des paragneiss, des gneiss mélangés, des anorthosites, des roches charnockitiques et des granits, tous d'âge précambrien, constituent le sous-sol de ce plateau. Les zones les plus accidentées correspondent en grande partie aux roches charnockitiques, aux granites et aux anorthosites massives, tandis que les zones gneissiques ne sont que légèrement ondulées. Des tills d'origine locale tapissent les pentes et d'épais dépôts fluvioglaciaires remplissent les vallées principales.

Lake Saint-Jean is north of the Saint Lawrence at the head of Saguenay river. It lies in the southeast part of the extensive Lake Saint-Jean lowland or basin. This lowland is approximately 65 by 35 miles, its long dimension being northwest-southeast ; its elevation above sea-level ranges between 320 and 700 feet but much of it lies between 350 and 500 feet. The surrounding Laurentian highland stands between 200 and 700 feet above the surface of the lowland.

DESCRIPTION OF THE AREA

The lowland area

Lake Saint-Jean is the dominant feature of the lowland. The lake measures approximately 29 miles by 18 miles and is subcircular in form ; it covers 375 square miles. Like the lowland its long axis is oriented northwest-southeast. Its depth does not exceed 200 feet. The lake is ringed by a series of terraces cut in marine and fluviatile sediments ; these terraces extend in low steps almost to

* Published with the permission of the Deputy-Minister, Québec Department of Natural Resources.

the margins of the lowland. The terraces are generally flat and featureless but some of those underlain by sand exhibit blowouts and dune colonies. In the vicinity of the lake the continuity of the plain is broken only by the valleys of major rivers that drain into the lake, such as the Ashuapmuchuan, the Mistassini and the Peribonca. Many of the vertical sections in the stratified sands and clays along the rivers are from 100 to 200 feet thick. The smaller water courses of the lowlands are also deeply incised.

The extensive drift cover blanketing the lowland area is here and there pierced by rounded bosses of crystalline rocks and tabular outcroppings of sedimentaries. For example, immediately to the east of the lake a series of low whalebacks of anorthosite projects through great thicknesses of clays and other unconsolidated deposits, and in the Roberval area knolls of granite rise above the covering of drift and the Paleozoic limestones of the lowland. A few eskers, kames and kettles are also scattered throughout the basin.

The Lake Saint-Jean lowland is delimited on the south, west and east by bold escarpments. A little-dissected scarp, which stands between 350 and 700 feet, defines the southern boundary of the lowland between Kenogami lake and Metabetchouan river. The scarp is oriented slightly north of west and has a rectilinear trace. West of the Metabetchouan the scarp strikes west-northwest ; here it is less bold, having an average height of only 200 to 300 feet above the lowland surface.

A well-defined, rectilinear scarp delimits the lowland on the northwest ; it strikes due north and stands 200 to 400 feet above the surface of the basin. The scarp that delimits the basin on the southeast also strikes due north ; although it stands approximately 250 feet above the lowland it has been greatly dissected along its entire length. It is breached by two major east-west trenches, the northern containing Saguenay river and the southern containing Kenogami lake.

To the north and northeast of Lake Saint-Jean the contact between highland and lowland is less clear-cut. Wide, north-striking valleys extend from the lowland deep into the Laurentian highland, which has a relatively low elevation in this area (figure 2, in pocket). The lowland and highland are thus interpenetrative and their contact is jagged and irregular. Along the entire length of the contact the highland stands more than 200 feet above the surface of the lowland. Denis (1933, p. 63) has effectively pointed out the contrast between the northern and southern boundaries of the lowland : « Were the depression once more invaded by an arm of the 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. »

The Laurentide highland

Encircling the Lake Saint-Jean lowland and separated from it by prominent escarpments is a gently rolling to rugged upland termed the Laurentian highland. The highland exhibits average local relief of approximately 500 feet

PHOTO I

(R.C.A.F. Photo A-13657-40)

The Shield-lowland contact at the western edge of the Lake Saint-Jean basin. Here the contact is rectilinear and abrupt. It is bordered on the lowland side by fluvioglacial deposits and a string of kettle-form lakes.

but in the northeast and southeast portions of the map-area relief ranges up to 2,500 feet. The area is underlain by crystalline rocks that are more or less resistant to contemporary processes of weathering and erosion, their durability being reflected in the rugged nature of the landscape. Throughout the area valleys have been deeply dissected along joints and other lines of structural weakness in the bedrock, resulting in a blocky landscape of steep slopes and cliffs. Many of these slopes are mantled with sandy till consisting of angular to subangular blocks of rock set in a matrix of coarse gravel and finely ground material. The till is locally derived and its depth over bedrock varies from a few inches to more

than 30 feet ; the deposits have considerably softened the rugged highland topography. Fluvioglacial deposits are abundant on the lower slopes of hills and in the principal valleys of the area, occurring as well-sorted outwash plains and poorly sorted kames.

DESCRIPTION AND EROSIONAL BEHAVIOR OF THE ROCKS

Although well populated and close to the large industrialized zone of the upper Saguenay, the Lake Saint-Jean area was not well known in terms of regional geology until recent years. From 1857 to 1916 periodic investigations were carried out in the lowland area by officers of the Geological Survey of Canada, and since 1932 the general region has been under study by the Geological Surveys Branch of the Quebec government. The recent publication of a number of preliminary geological reports by Quebec has enabled the preparation of a compilation of the regional geology (figure 1, in pocket). Large gaps still exist between map-areas, and here geological contacts have been inferred from physiographic evidence and from unpublished data furnished by Quebec government geologists.

The following rock units have been identified in the Lake Saint-Jean map-area :

Paragneisses

Paragneisses represented in the Laurentian highland region of the Lake Saint-Jean map-arca include carbonate rocks and their derivatives, quartzites, amphibolites, metamorphic pyroxenites, garnetiferous gneisses, plagioclase gneisses, and hornblende and biotite gneisses. These units have in many places been injected or impregnated with granitic material. The metasedimentary series has been cut by, and is now dispersed through, the abundant intrusive rocks of the area ; it occurs as lens-shaped or irregular remnants enclosed by various plutonic rocks.

The limestone member is both friable and soluble under existing climatic conditions and consequently offers little resistance to « normal » weathering and erosional processes. For this reason the limestones of the upland generally lie in topographic depressions. Large sections of the Trenche and Mistassini valleys are underlain by crystalline limestones, and limestones are believed to underlie areas of low relief in Pelletier and Proulx townships immediately to the north of Lake Saint-Jean (Denis, 1933, p. 74).

Amphibolitic rocks underlie both hills and valleys in the Lake Saint-Jean region, and consequently their degree of resistance to weathering and erosion cannot be easily determined. The amphibolites contain a high percentage of ferromagnesian minerals, particularly of hornblende and of biotite mica. Iron-rich biotite decomposes rapidly, and by impregnating its host rock with iron rust effects its disintegration and decomposition. However, hornblende is thought to be almost entirely unalterable, and its high content in

amphibolites is believed to render these rocks resistant to most normal erosional processes.[1]

The quartzites are medium-to-coarse-grained rocks that contain up to 90 per cent of quartz. They occur in beds up to 50 feet thick with impure interbeds containing quartz, feldspar, biotite and garnet. Quartzites are virtually insoluble under cool temperate climatic conditions and their massiveness and imperviousness generally render them resistant to frost-shattering. Consequently they are ridge-formers and uphold the areas of dominant relief in zones of paragneissic rocks. However, well-jointed quartzites are very susceptible to frost action ; also, many impure quartzites display pitted weathered surfaces, the pits resulting from the weathering out of subordinate amounts of feldspar and other impurities.

Mixed gneisses

Mixed gneisses underlie much of the western part of the Lake Saint-Jean map-area. This group of rocks includes :

a. certain injected and impregnated paragneisses — particularly plagioclase, hornblende and biotite gneisses ;

b. granitic orthogneisses, which are intrusive into the paragneissic series. The injected paragneisses are generally well-layered but the orthogneisses display a discontinuous and generally vague foliation. The mixed gneisses are grey, cream or pink, and weather to dark shades. They contain variable amounts of feldspar, quartz and ferromagnesians, and compositional differences are principally marked by differences in the tenor of the ferromagnesians and in the proportions of hornblende and biotite.

The mixed gneisses generally form areas of low to moderate relief (figures 1 and 2), and are contrasted with the rugged highlands composed of massive charnockitic rocks and Roberval granites. Along the escarpment which delimits the Lake Saint-Jean lowland on the south the granites and massive anorthosites present steep cliff faces, but the part of the escarpment upheld by gneisses has been worn down and its regularity obscured by erosion.

Anorthosites and associated rocks

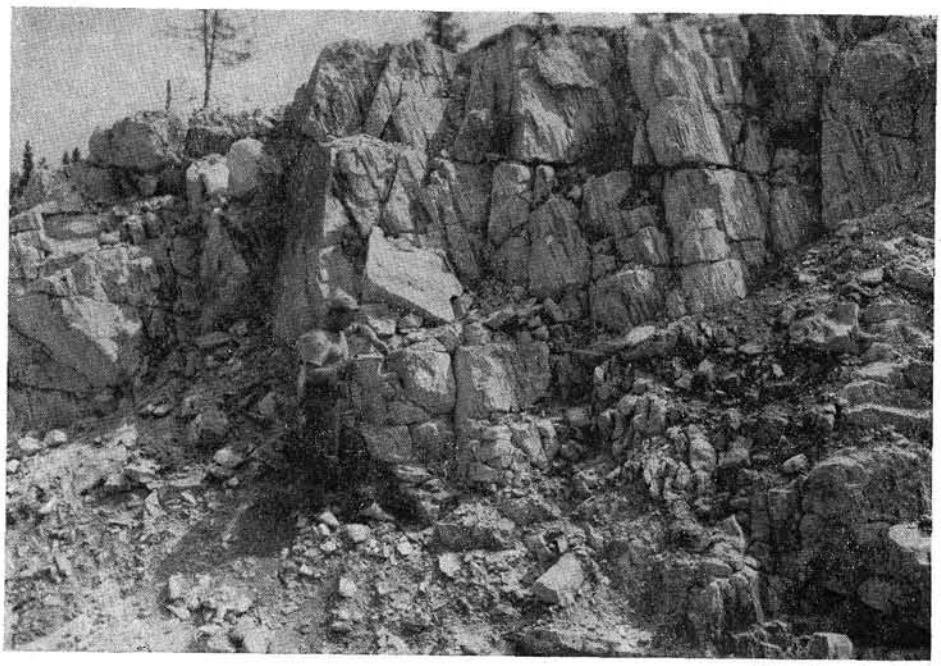
The entire northeast part of the map-area is underlain by anorthosites and associated rocks (gabbros, metagabbros, norites, troctolites, diorites, etc.). These rocks constitute the extreme southeastern part of a large anorthosite massif that has been estimated to occupy over 20,000 square miles (Dresser and Denis, 1944, p. 240). A number of scattered, roughly concordant sills and bosses of anorthositic rocks are found to the west of the massif. The anorthosites are considered to be intrusive into the paragneisses.

---

[1] DERRUAU, Max, *Les caractères différentiels des roches du socle dans l'ouest et le sud-ouest du massif central français*, in Pub. Fac. Lett. de l'Univ. de Clermont, Fascicule 6, Institut de géographie, n° 2, 1952, p. 31. « Si les biotites qui entrent dans leur composition (amphibolites) peuvent diminuer leur résistance, la difficile altération des amphiboles les rend extrêmement dures, du moins au contact de l'air sinon au contact de l'eau ».

Much of the massif is composed of massive, dark grey, coarse-grained anorthosite containing an average of 95 per cent of plagioclase feldspar. However, around the margins of the massif the rocks exhibit wide lithologic variation, containing between 10 and 40 per cent of dark minerals, principally hypersthene and hornblende. This aureole has been termed the marginal dioritic facies of the anorthosite massif (Berrangé, 1960, p. 2), and its rocks generally exhibit a gneissic texture. Throughout the massif the anorthosites are locally strongly granulated (Photo 2), which results in a general weakening of the rock and a

PHOTO II



(*Photo Jehan Rondot*)

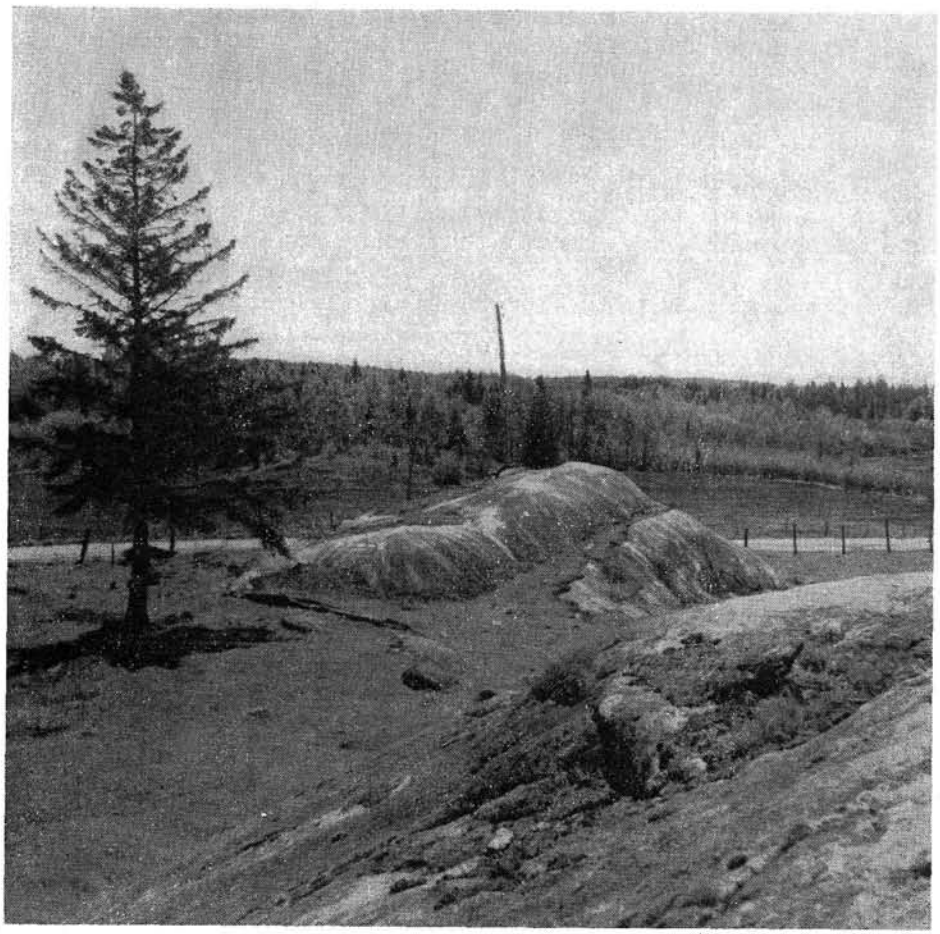
Very strongly granulated anorthosite with pronounced streaks of ferromagnesian minerals. On La Tuque – Lac-Saint-Jean road.

lowering of its resistance to weathering and erosional processes, particularly to frost-riving.

Although the anorthosites and associated rocks of the map-area find typical expression in rugged terrain they also underlie large portions of the Lake Saint-Jean lowland and certain low areas on the Laurentian highland. It is proposed that, in general, massive anorthosite is typically expressed by rugged topography. Anorthosite areas of low relief are, for the most part, underlain by strongly granulated, or gneissic, ferromagnesian-rich anorthosites.

Anorthositic rocks underlie a flat to gently undulating lowland east of Lake Saint Jean. This lowland exhibits less than 200 feet of local relief and

PHOTO III



(Photo by Auguste Mailloux)

Low anorthosite whalebacks piercing a thin cover of unconsolidated deposits – Saint-Henri-de-Taillon, northeast shore of Lake Saint-Jean.

is characterized by bosses and whalebacks of anorthosite projecting through the thick drift cover. The anorthosites are spotted with small clots of soluble ferromagnesian minerals, chiefly hypersthene and iron ores (Osborne, 1933). The weathered surfaces are pitted with small depressions and the rock exposures disintegrate by spalling. They crumble « into a greyish powdery material, and the rocky hills consequently assume a smoky hue which causes a singular contrast with the non-decomposed portions » (Laflamme, 1885*a*, p. 7D). The anorthosites « must have been decomposed to a greater depth than the granitic rocks at the time when ice invaded the country. Whence it follows that these rocks would have been more deeply eroded during the glacial epoch, and this would perhaps explain the fact that the labradorite [anorthosite] hills

are, as a general rule, lower than the granitic hills or those of gneiss or syenite.[2] At first sight it seems as if the surface of the country occupied by the labradorite had undergone a kind of depression, whilst in reality this appearance may more likely be solely due to greater erosion » (Laflamme, 1885*a*, pp. 7D-8D).

Charnockitic rocks

Charnockitic rocks are widely distributed throughout the Lake Saint-Jean region but are particularly extensive in the area to the west of the lake. They are characterized by their green colour and by the presence of hypersthene. They formed in the aureole zone of the anorthosite massif and are intrusive into the paragneisses and anorthosites. They probably are genetically related to the latter. Numerous injections, sills and dykes of charnockitic rock cut or impregnate the surrounding rocks and form extensive migmatitic or transition zones around the margins of charnockitic bodies.

Fresh charnockitic rock is dark green to olive green but weathered surfaces are typically yellow ochre. Weathering is deep, as much as ten feet in places. In general, charnockitic rocks are medium to coarse grained (rarely fine), and the texture is xenomorphic granular. They are generally quartz-poor, and compositions grade from that of a diorite to that of a syenite. Also, they are generally massive, but in transitional zones gneissic relics give the rock a foliated appearance.

Massive charnockitic rocks are among the most resistant rock types of the map-area ; most exposures form comparatively rugged highlands and domes exhibiting little drift cover. Rugged charnockitic terrane is particularly well displayed in the Laurentides Park and in the Trenche and Croche river areas to the southeast. However, several large charnockitic exposures northwest of Lake Saint-Jean have almost negligible topographic expression. These exposures are well foliated, have a high content of dark minerals, and include extensive zones of pinkish granitic material (Benoît, 1961, p. 7).

Pink granites

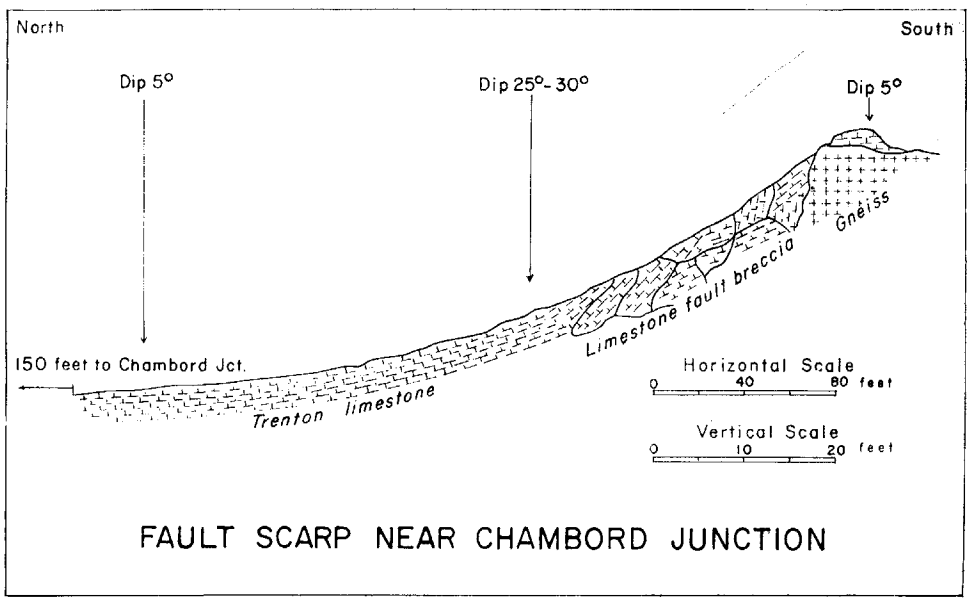
Three large exposures of pink, coarse-grained inequigranular granite occur in the map-area. The rock consists principally of potash feldspar with lesser amounts of plagioclase feldspar, quartz and dark minerals. Because of the limited number of exposures in the area it is difficult to determine whether the rock has a distinctive topographic expression.

Roberval granite

A large massif of Roberval granite underlies much of the Laurentides Park in the southeastern part of the map-area. The formation is also conspicuously developed on the southwest shore of Lake Saint-Jean in the townships of Roberval and Ouiatchouan. These granites are intrusive into all the rock formations described above and are the youngest rocks of Precambrian age in the map-area.

[2] The writer is referring to the area along the east shore of Lake Saint-Jean.

FIGURE III



FAULT SCARP NEAR CHAMBORD JUNCTION

J. A. DRESSER, *Part of the District of Lake St. John, Québec.* Memoir 92, Geological Survey, Department of Mines, Ottawa, p. 33.

Roberval granites are pinkish or flesh-coloured, coarse grained and slightly porphyritic. They consist chiefly of pink microcline feldspar but contain subordinate amounts of plagioclase feldspar, quartz, hornblende and biotite. The granites generally are slightly gneissic to massive.[3] However, around the margins of granite bodies foliation is well-marked.

The large exposures of Roberval granite underlying the Laurentides Park are expressed by rugged, blocky terrain exhibiting great local relief. The pronounced topographic expression probably reflects : *a*) the massiveness of the granite in large exposures ; and, *b*) the resistance of microcline feldspar,[4] of which the granite is principally composed.

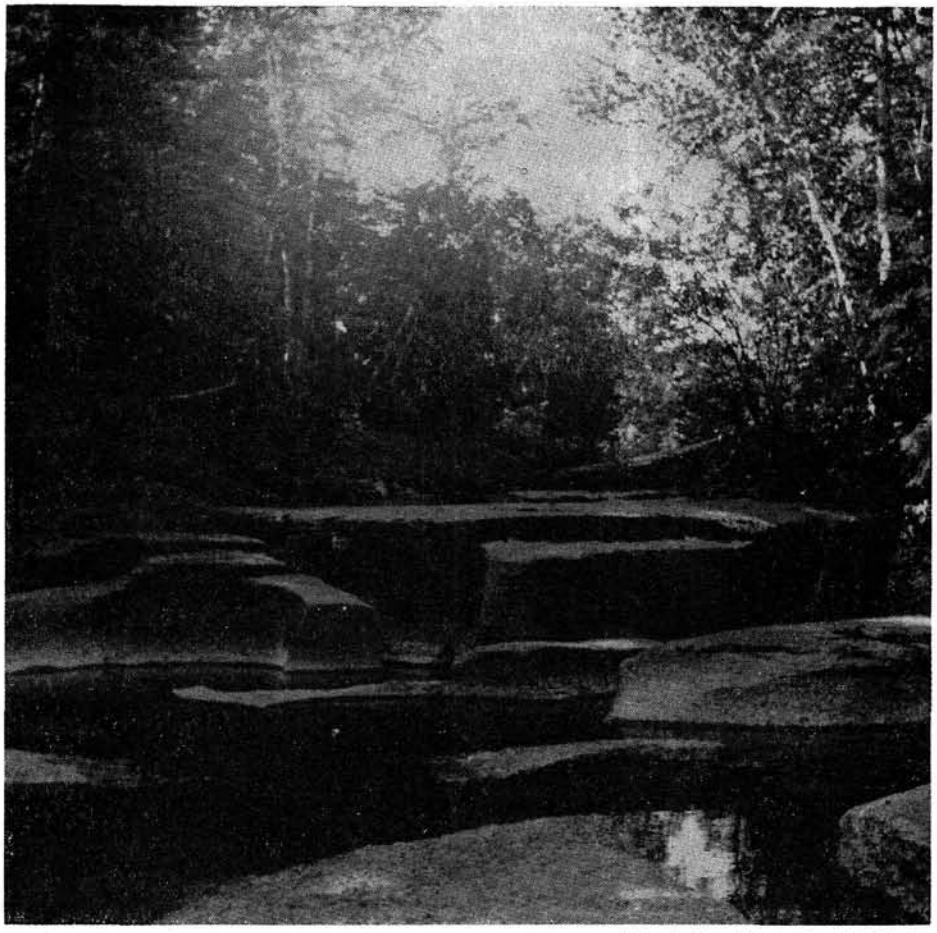
Paleozoic rocks

Much of the lowland area of the Lake Saint-Jean – upper Saguenay region is underlain by flat-lying Paleozoic (Ordovician) sedimentary rocks that rest

[3] DRESSER (1911, p. 27) refers to large bosses of granite in the Roberval area which are massive in their central portions but which display pronounced gneissic structure around their margins.

[4] DERRUAU, referring to the work of the French pedologist D. Collier (COLLIER, *Contribution à l'étude de l'altération des granites et de l'évolution des sols sur les plateaux granitiques de l'Auvergne,* in Bull. Ass. fr. pour l'étude du sol, July 1951, pp. 1-12), reports : « Dans le sol le microcline est inaltéré, et sa potasse est aussi stable que la silice qui constitue le quartz. En revanche les plagioclases sont pulvérisés, probablement par hydratation, après quoi commence l'altération argileuse. Les plagioclases du granite paraissent donc s'altérer tandis que les feldspaths alcalins restent intacts. » (DERRUAU, 1952, p. 18.)

PHOTO IV



(Office du film de la province de Québec)

Trenton limestones exhibiting potholes and solution phenomena – Ouellet river, south shore of Lake Saint-Jean.

uncomformably upon the Precambrian basement complex. The map-area contains two principal zones of Paleozoic sediments : one lies along the south and southeast shores of Lake Saint-Jean and the second is east of the lake and north of Saguenay river (figure 1). Trenton limestones are the most widely exposed rocks of both areas but the Utica and Richmond formations are also represented.

Trenton limestones

The Trenton formation consists of flat-lying, grey, fossiliferous limestones up to 100 feet thick. The limestone strata north of the Saguenay are almost

horizontal, but the beds along the south shore of Lake Saint-Jean dip approximately 5 degrees toward the north. Along the scarp at the edge of the lowlands the strata dip between 24 and 35 degrees north (figure 3) and « are irregularly warped and in places broken into a confused mass nearer the actual contact » (Dresser, 1916, p. 31). Solution along fault and joint planes in the Trenton formation has opened fissures 12 inches wide and up to 12 feet deep in the Simard area (Denis, 1932, p. 74), and has developed incipient caverns and sinkholes south of the lake.

PHOTO V

(Photo by C. Laverdière)

Precambrian erratics resting on flat-lying Utica shales, île de la Traverse.

That the Trenton formation persists beneath at least part of Lake Saint-Jean is evidenced by the small Pierre à Chaux island at the head of the Petite-Décharge. It is probable that the Lake Saint-Jean and upper Saguenay limestone outliers formed part of a continuous sedimentary cover in Ordovician times.

Utica shales

Utica shales are exposed along the south shore of Lake Saint-Jean between Saint-Louis-de-Chambord and Ouiatchouan falls, and on Traverse island to the north. A few exposures have been reported in Simard township north of Saguenay river. Utica shales overlie and are conformable with the Trenton

limestones. Their maximum thickness has been estimated as 100 feet.[5] They are dark grey or black but weather to a light or rusty brown. The shales are predominantly argillaceous in composition and are highly fossiliferous. They are very regularly jointed in two directions. Because of their composition and structure the shales yield readily to wave erosion around the lake shore. « The rock debris thus formed accumulates in places to many feet in thickness. The rock particles being flat are commonly arranged in rude parallelism and rest either horizontally or inclined at a common angle. Through the percolation of calcareous waters from the shores, this « shingle » becomes consolidated in places and forms a recent conglomerate » (Dresser, 1916, p. 37).

Richmond limestones

Richmond limestones crop out at Platte point south of the town of Roberval and on Couleuvres island in Lake Saint-Jean. The limestones are grey and their composition grades from argillaceous to cherty. The strata are flat-lying and have been deposited in regular sequence upon the Utica shales.

Unconsolidated deposits

Great thicknesses of stratified clays, sands and silts blanket the lowlands. Most such deposits are of marine origin and they form extensive level areas dissected by post-Pleistocene valleys. Boulder clay and sandy moraine are exposed in places. The highland area exhibits a thin, patchy cover of unstratified sandy and bouldery till and moraine. The valleys of the area contain extensive deposits of fluvioglacial sands and gravels.

STRUCTURE

The Lake Saint-Jean-Saguenay region is cut by two major northwest-trending faults [6] (figure 1). The southern fault extends from Ha ! Ha ! Bay on the upper Saguenay west-northwest to Lake Saint-Jean and then curves northwest toward Ashuapmuchuan river. Its vertical displacement is approximately 500 feet and the resulting scarp marks the southern edge of the Lake Saint-Jean lowland. The northern fault extends from the Saint Lawrence at Moulin-à-Baude to Peribonca river northeast of Lake Saint-Jean. Only a small portion of this fault lies within the map-area. The fault zone is marked by a narrow longitudinal trench occupied by rectilinear stream courses and

[5] By Sir William Logan, as reported by Dresser, 1916, p. 36. However Dresser states that « no evidence has been found that its thickness is as great as this ».

[6] A possible third fault lies along the axis of the Saguenay trench to the east of the map-area. The origin of the trench is generally ascribed to erosive action by a local glacier during the Pleistocene epoch. However, it has been postulated that the valley is preglacial in origin and was cut out along the axis of a longitudinal fault striking east-northeast and extending roughly parallel to the two faults described above. (R. BLANCHARD, *L'Est du Canada français*, vol. 11, p. 45, and other authors.) However, mapping by Miller (1952) has shown no evidence of a major fault along the lower part of the Saguenay river. The valley was widened and its form modified during the Pleistocene period.

elongate lakes. A series of aligned river and lake channels extending northwest of Peribonca river suggests the continuance of the fault in this direction.

The Lake Saint-Jean area is cut by a series of transverse faults striking north and north-northeast. The largest of these is found in the Commissaires lake area of the Laurentian highland, but the fault has little topographic expression. Faulting has also occurred west of the Pointe Bleue Indian reserve along the northwest foot of Saint Prime hill. Here the Trenton limestones have been brought into abrupt contact with Roberval granites, and the fault is expressed in relief by a scarp which stands from 80 to 100 feet above the lowlands. The Paleozoic formations of the Lake Saint-Jean – upper Saguenay lowland also exhibit numerous local faults of small displacement that were probably synchronous with the larger faults of the region. In Metabetchouan township, some of these find expression in « series of small step-faults which appear to extend only a short distance into the foot of the escarpment » (Dresser, 1916, p. 37). They cause a succession of sharp rises and flat intervals along the road between Metabetchouan river and Chambord. A north-trending, arcuate fault 4,000 feet long and marked by minor vertical displacements transects the Utica formation south of Roberval. Faults have been observed in the Richmond formation, and it has been postulated that the Couleuvres island limestone outlier may have been faulted into its present position.

The two prominent rectilinear scarps that define the Lake Saint-Jean lowland on the east and the west (described above under the heading *The lowland area*) strike roughly parallel to the transverse faults of the map-area. They may possibly represent faults along which vertical displacement of the order of 200 to 300 feet has occurred. The Lake Saint-Jean lowland would therefore have resulted from the relative down-faulting of a number of large blocks in post-Ordovician times. The numerous outliers of Ordovician age that are confined to the basin would have been preserved as a consequence of being less liable to erosion than rocks at greater altitudes.

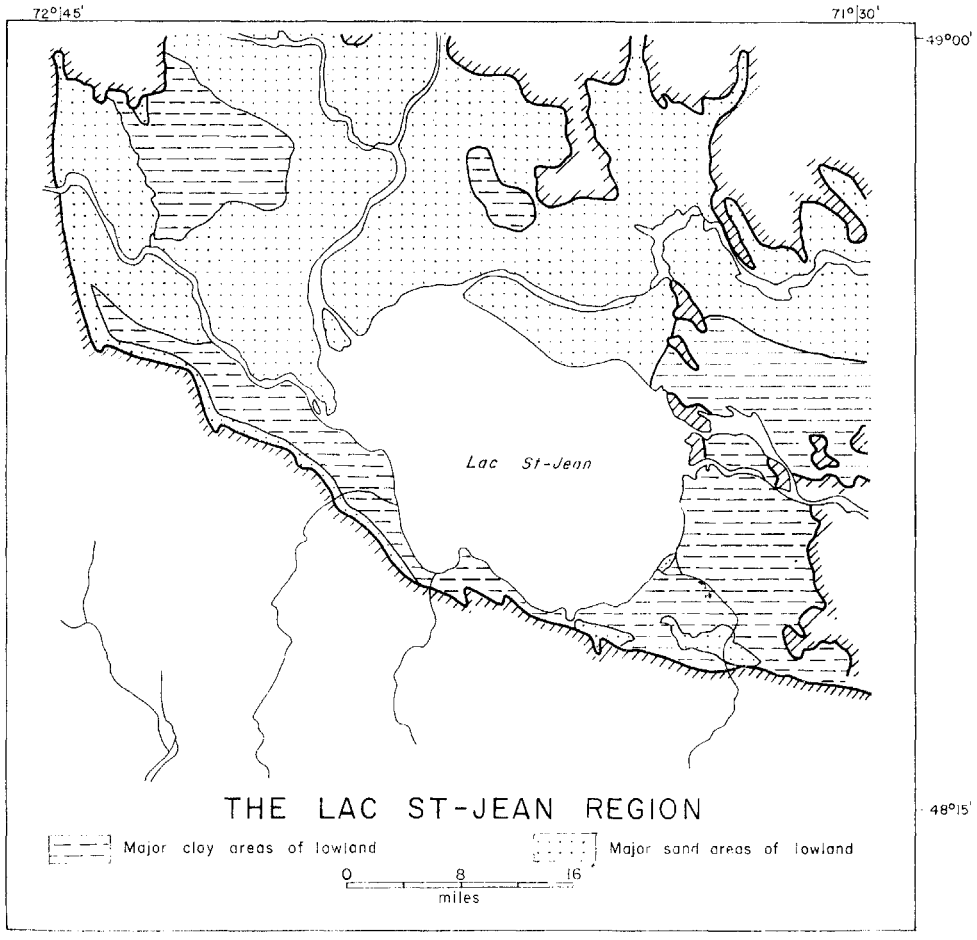
Kenogami upland

The Kenogami upland stands 250 to 300 feet above the surface of the Lake Saint-Jean lowland. This upland and the lowland area immediately west of it are underlain by massive anorthosites. The upland is believed to represent a horst-type fault block upraised along two sets of faults intersecting at right angles. Only faulting adequately explains the abrupt topographic break in the lithologically homogeneous rocks of this area.

Joints

The crystalline rocks of the Laurentian highland, particularly the anorthosites and mixed gneisses, exhibit well-developed joint systems. The joints generally have vertical dips and strike north, northeast and northwest. Throughout the map-area drainage patterns reflect prominent joint directions,

FIGURE IV



Land divisions of the Lac Saint-Jean lowland. Modified after R. M. Glendinning, *The Lake Saint-Jean Lowland, Province of Québec*, in *Papers of the Michigan Academy of Science, Arts and Letters*, Vol. XX, 1934, p. 315.

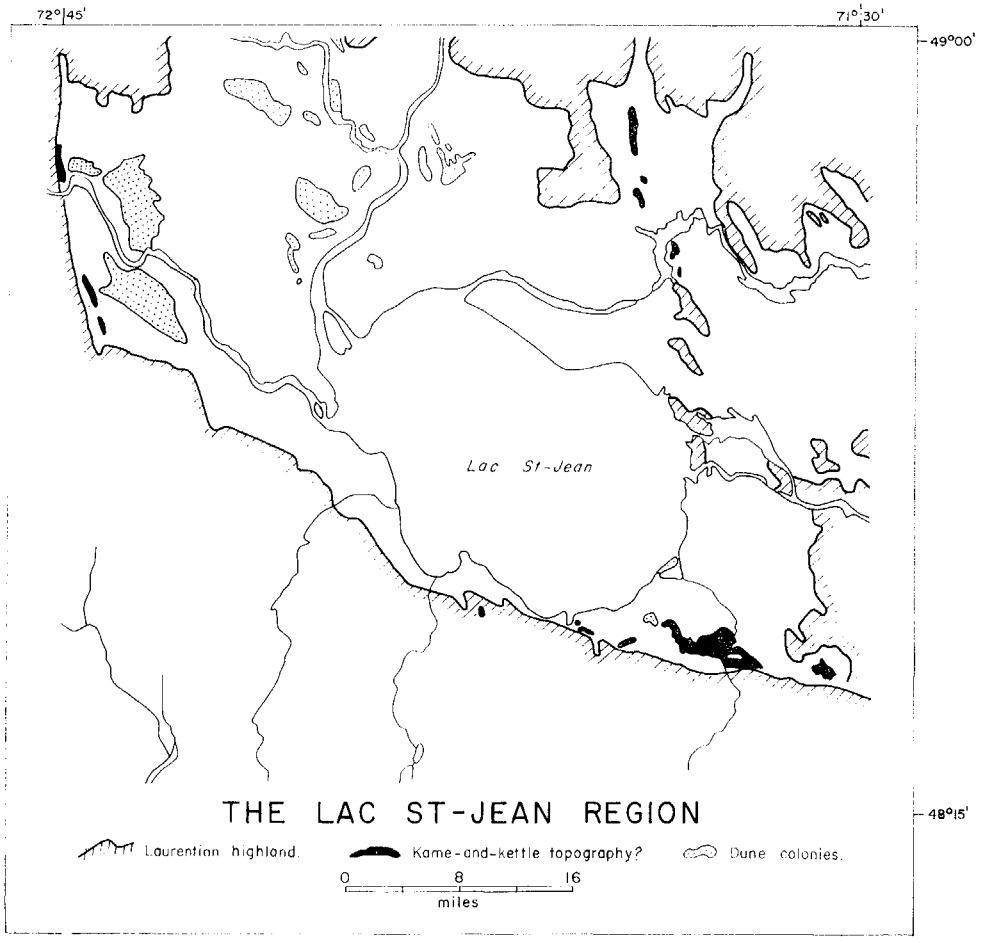
and it is believed that joint systems controlled much of the preglacial drainage of the area (Bray, 1959, p. 21).

GLACIAL AND POST-GLACIAL HISTORY

Blanchard (1935, pp. 1-60) has provided the only comprehensive study of the glacial and postglacial history of the Lake Saint-Jean – Saguenay region and consequently a summary of his thesis is set forth in the following paragraph.

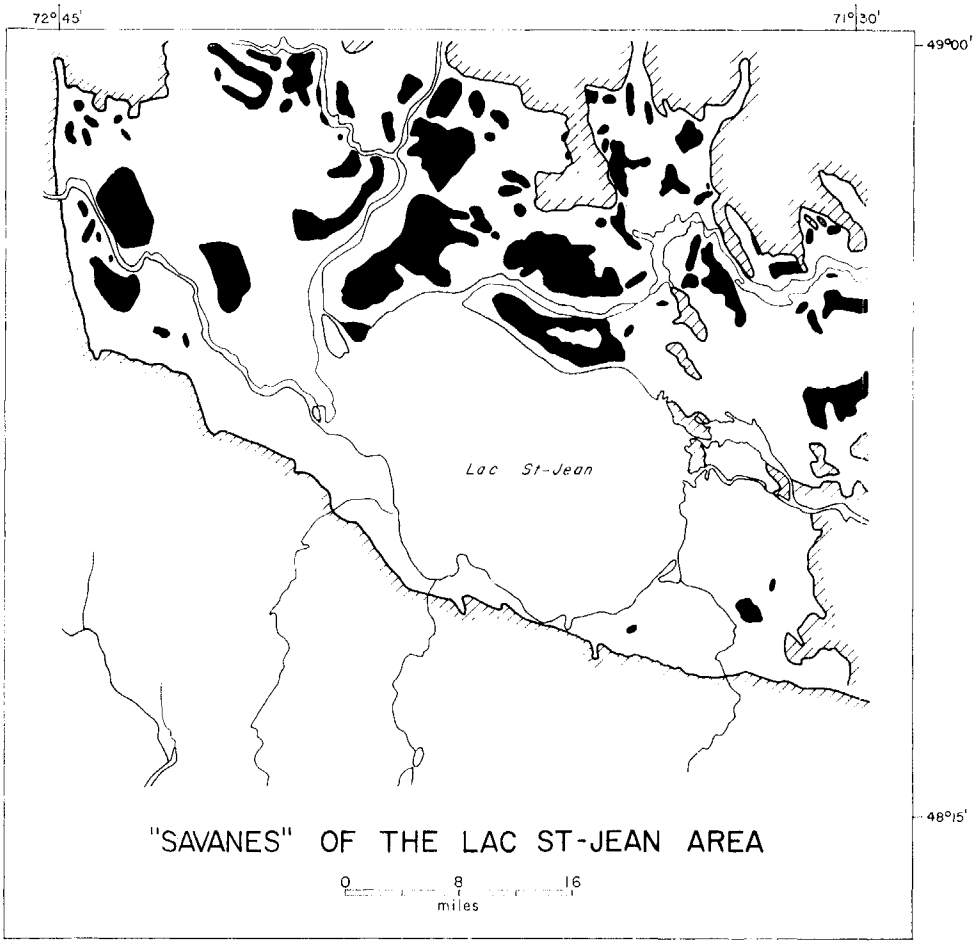
Blanchard postulates that the Lake Saint-Jean lowland is a glacier-eroded basin which was contained on the east by the resistant Kenogami upland, lying transverse to the local direction of ice flow. The upper Saguenay valley

FIGURE V



and the Kenogami lake – Ha ! Ha ! Bay trench are trough valleys of glacial origin cut out along the axes of parallel fault zones. The northern valley was more deeply excavated than the southern. After the disappearance of the glacier the Lake Saint-Jean lowland was occupied to a height of 700 feet above present sea-level by an arm of the Champlain sea. As the sea receded the northern valley soon captured most of the drainage of the lake basin. The wide, shallow portions of the southern channel silted up, particularly to the east of Kenogami lake. The drainage of Kenogami lake was then diverted toward the Lake Saint-Jean basin, as evidenced by a deep drainage channel cut in Champlain sea sediments along a line marked by Kenogami lake, Aulnets river and La Belle river. Further recession of the Champlain sea resulted in the capture by Saguenay river of the Kenogami lake drainage system. The lake now drains north into the Saguenay by the valleys of Sables and Chicoutimi rivers.

FIGURE VI



Deposits of the Sainte-Croix area

The Sainte-Croix – Hébertville area of the Lake Saint-Jean lowland exhibits a complex of steep-sided sand and gravel hills and round, water-filled depressions. Local relief is approximately 100 feet. The origin of these features is problematical for it is not known if marine sediments underlie the sand and gravel deposits. If the deposits are underlain by Champlain sea clays they could represent ice-contact features resulting from the readvance of a local glacier during or after Champlain times. The rugged Laurentides Park massif to the south of the lake basin has been proposed as the node of such a readvance (Osborne, 1951). This ice mass would probably have blocked the southern drainage channel of Lake Saint-Jean and could have been sufficiently extensive to exclude high-level marine water from the basin until late Pleistocene times.

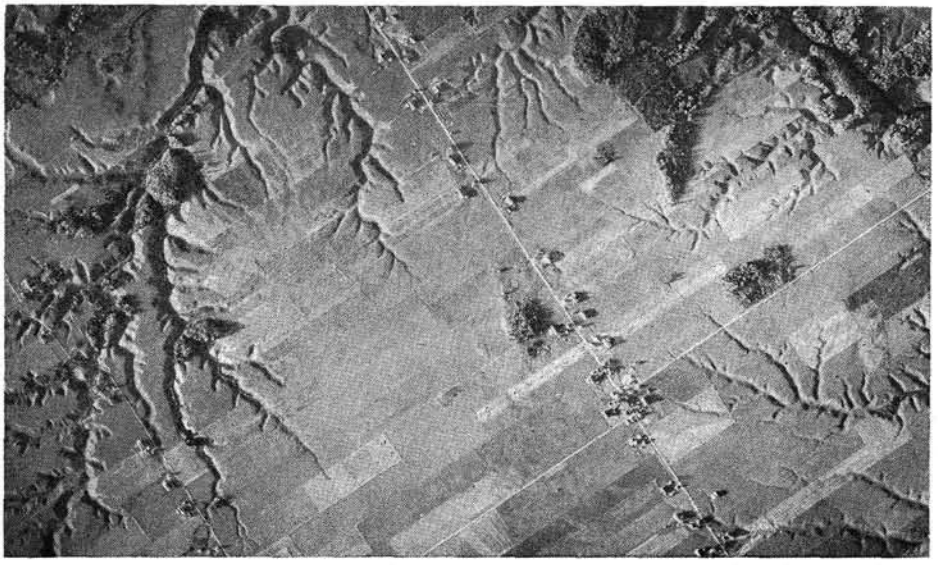
It is also conceivable that the sands and gravels were deposited by ice masses floating in the Lake Saint-Jean basin (Derruau, 1959).

If the sands and gravels are not underlain by marine clays they are possibly fluvioglacial deposits associated with a pre-Champlain ice mass which melted *in situ* in the lowland.

Marine terraces

The Lake Saint-Jean basin is ringed by several series of well-defined marine terraces.[7] To the east, south and southeast of the lake the terraces are underlain by flat-lying marine clays and to the north and northwest by

PHOTO VI



(R.C.A.F. Photo A-10827-94)

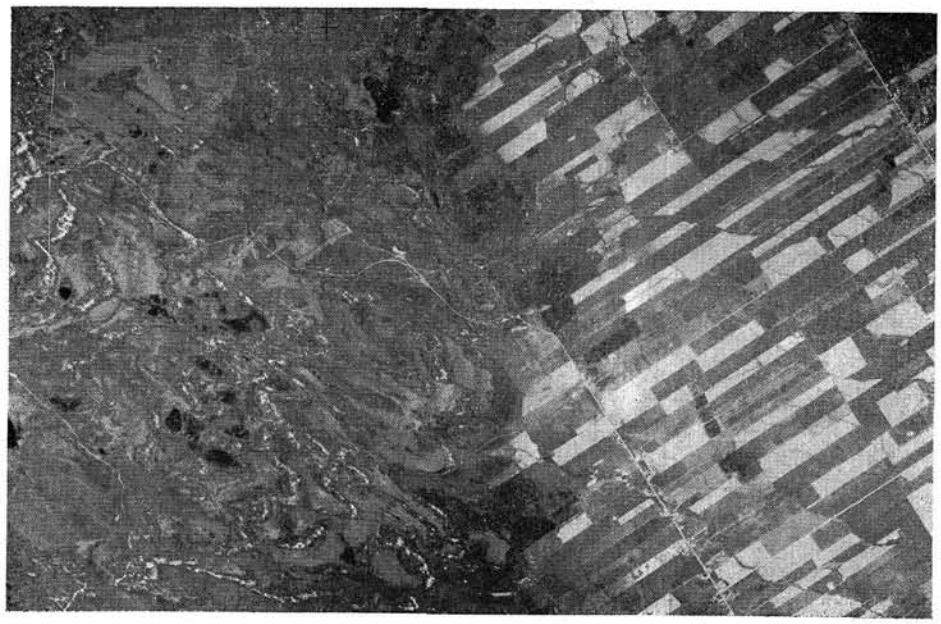
Severely dissected clay plain – Normandin area, northwest of Lake Saint-Jean.

stratified sands and silts. Laflamme (1885*a*, p. 17D) noted that the lower terraces are « much more elevated on the southeastern shore of the lake than in any other place. At Hébertville . . ., as a central point, their level lowers usually almost imperceptibly as far as Saint-Prime on one side and Grammont on the other ».

The lowest terrace stands about 30 feet above the present level of Lake Saint-Jean (present lake-level is 321′ above sea-level). The terrace is particularly well developed to the north and northwest of the lake. A second major

[7] Marine fossil occurrences in the lowland area have been catalogued by C. Laverdière and A. Mailloux, *État de nos connaissances d'une transgression marine post-glaciaire dans les régions du haut Saguenay et du lac Saint-Jean*, in *Rev. can. de géog.*, vol. 10, n° 4, 1956, pp. 201-220.

PHOTO VII



(R.C.A.F. Photo A-13664-25)

Stabilized dune colony (left) west of the Normandin clay plain of the Lake Saint-Jean lowland.

PHOTO VIII

(Photo by C. Laverdière)

Small dune colony near the village of Saint-Gédéon, Lac-Saint-Jean. The dunes have been partially stabilized by vegetation.

terrace occurs at approximately 195 feet above lake-level ; it is best developed in the Sainte-Croix – Hébertville area where it is flat and featureless. Raised beaches at Ouiatchouan falls and terrace remnants in the Saint-Jérôme area point to the existence of a third major terrace in the lowland at 245 feet above lake-level. Finally, in the southeastern portion of the basin a narrow terrace at 380 feet above present lake-level marks what is believed to be the upper marine limit in this area. Remnants of this terrace are found in the valleys of creeks draining the Kenogami upland and in the foothills zone behind Roberval.

Savanes

Much of the northern part of the Lake Saint-Jean lowland is occupied by extensive swamps and marshes (figure 6). Theses *savanes* are underlain principally by sands, with clays in many places presenting an impermeable substratum three or four feet below the surface. A few *savanes* have been drained and cleared for agriculture.

Dune colonies

Large dune colonies occupy much of the northwest portion of the lowland (figure 5). Most of these colonies have been stabilized by vegetation but those located immediately to the west of Mistassini river exhibit large areas of bare sand. The inhabitants of the area refer to the dune fields as « l'Afrique ».

Bibliography

Benoît, F. (1961), *Condé Area, Roberval County*, P. R. No. 463, Geological Surveys Branch, Québec Department of Natural Resources.

Berrangé, J.-P. (1959), *La Trappe – Hudon Area, Roberval Electoral District*, P. R. No. 404, Geological Surveys Branch, Québec Department of Mines.

Berrangé, J.-P. (1960), *Antoine Area, Electoral District of Roberval*, P. R. No. 429, Geological Surveys Branch, Québec Department of Mines.

Berrangé, J.-P. (1962), *The Plutonic Geology of the Grenville Province North of Lake St. John, Québec*, Ph. D. thesis, University of London, 1962.

Blanchard, R. (1935), *L'Est du Canada français, province de Québec*, t. II, Beauchemin, Montréal.

Bray, J. G. (1959), *Lyonne Area, Roberval Electoral District*, P. R. No. 387, Geological Surveys Branch, Québec Department of Mines.

Bray, J. G. (1960), *Raimbault River Area, Roberval Electoral District*, P. R. No. 421, Geological Surveys Branch, Québec Department of Mines.

Chalmers, R. (1906), *Surface Geology of Eastern Québec*, in *Geol. Surv. Can., Ann. Rep. No. 16*, 1904, Part A.

Denis, B. T. (1933), *Région de la carte de Simard, comté de Chicoutimi*, in *Rapp. ann. Serv. des des Mines Québec, 1932*, Partie D, pp. 59-90.

Denis, B. T. (1934), *The Northwest Portion of the Lac Saint-John Region*, in *Québec Bur. Mines Ann. Rep., 1933, Québec*, pp. 55-92.

Derruau, Max. (1952), *Les caractères différentiels des roches du socle dans l'ouest et le sud-ouest du massif central français*, in *Pub. Fac. Lett. Univ. de Clermont*, fascicule 6, Institut de géographie, 11, 1952.

Derruau, Max. (1959), *Un problème morphologique de la région du Lac Saint-Jean*, in *Cahiers de géographie de Québec*, n° 6, pp. 149-152.

DRESSER, J. A. (1916), *Part of the District of Lake St. John, Québec*, in *Memoir 92, Geol. Surv. Can.*

DRESSER, J. A., and DENIS, T. C. (1944), *Geology of Quebec, Vol. 2, Descriptive Geology*, Québec Department of Mines.

JOOSTE, R. F. (1958), *Bourget Area, Chicoutimi and Jonquière-Kénogami Electoral Districts*, G. R. 78, Geological Surveys Branch, Québec Department of Mines.

LAFLAMME, J.-C.-K. (1885*a*), *Report on Geological Observations in the Saguenay Region*, in *Rep. of Progress, (1882-83-84)*, Geol. Surv. Can., Part D, pp. 1-18.

LAFLAMME, J.-C.-K. (1885*b*), *Le Saguenay, essai de géographie physique*, in *Bull. de la Société de géographie de Québec*, 1, pp. 54-60.

LAVERDIÈRE, C., and MAILLOUX, A. (1956), *État de nos connaissances d'une transgression marine post-glaciaire dans les régions du haut Saguenay et du lac Saint-Jean*, in *Rev. can. géogr.*, vol. X, n° 4, pp. 201-220.

LEGGET, R. F. (1945), *Pleistocene Deposits of the Shipshaw Area, Quebec*, in *Proc. Trans. Roy. Soc. Can.*, Sect. IV, Ser. III, vol. XXXIX, pp. 27-39.

MAILLOUX, A., and DUBÉ, A. (1958), *Érosion et conservation des sols dans la région du lac Saint-Jean-Saguenay*, in *Cahiers Géogr. Qué.*, n° 5, pp. 77-84.

MILLER, M. L. (1952), *Tadoussac Area*, P. R. No. 266, Québec Department of Mines.

OSBORNE, F. F. (1933), *Commercial Granites of Québec*, in *Québec Bur. Mines Ann. Rep.*, 1933, Part E.

OSBORNE, F. F. (1951), *Parc des Laurentides Ice Cap and the Québec Sea*, in *Nat. can.*, vol. LXXVIII, nos 7-8, pp. 222-251.