RASM 1936-D2(A)

SAINTE-ANNE RIVER MAP-AREA, PORTNEUF COUNTY, PART D

PROVINCE OF QUEBEC, CANADA

Department of Mines and Fisheries

Honourable ONÉSIME GAGNON, *Minister* L. A. RICHARD, *Deputy-Minister*

BUREAU OF MINES

A. O. DUFRESNE, *Director*

ANNUAL REPORT

of the

QUEBEC BUREAU OF MINES

for the calendar year

1936

JOHN A. DRESSER, *Directing Geologist*

PART D

	Page
Mount Alexander Map-Area, Gaspé Peninsula, by I. W. Jones	5
Sainte-Anne River Map-Area, Portneuf County, by Abbé J. W. Laverdière	27

QUEBEC

RÉDEMPTI PARADIS

PRINTER TO HIS MAJESTY THE KING

1938

PROVINCE OF QUEBEC, CANADA

Department of Mines and Fisheries

Honourable ONÉSIME GAGNON, *Minister* L. A. RICHARD, *Deputy-Minister*

BUREAU OF MINES

A. O. DUFRESNE, *Director*

ANNUAL REPORT

of the

QUEBEC BUREAU OF MINES

for the calendar year

1936

JOHN A. DRESSER, *Directing Geologist*

PART D

PAGE

Mount Alexander Map-Area, Gaspé Peninsula, by I. W. Jones........... 5

Sainte-Anne River Map-Area, Portneuf County, by Abbé J. W. Laverdière........... 27

QUEBEC

RÉDEMPTI PARADIS

PRINTER TO HIS MAJESTY THE KING

1938

SAINTE-ANNE RIVER AREA

PORTNEUF COUNTY

by Abbé J. W. Laverdière

TABLE OF CONTENTS

	Page
INTRODUCTION	29
Location of area	29
General character of area	29
Drainage	30
Method of work	31
Previous work and bibliography	31
GENERAL GEOLOGY	32
Table of formations	33
Precambrian	33
Palæozoic	33
Trenton limestone	34
Utica shale	40
Lorraine shale	41
Formational relationship and structure	41
Quaternary and Recent	42
Glacial deposits	42
Recent alluvial deposits	45
ECONOMIC GEOLOGY	48

MAP AND ILLUSTRATIONS

Map No. 411.—Sainte-Anne River Area, Portneuf and Champlain counties.

Figure 1.—Sketch map showing the width of the Palæozoic belt, and the location of the area described	30
Figure 2.—Plan of Saint-Alban landslide	44
Figure 3.—Plan of the mouth of Sainte-Anne river before and after the Saint-Alban landslide	47

PLATES

(After page 49)

Plate I.—A. Sand overlying clay bed along the Sainte-Anne river.
B. Stratified glacial clay, Sainte-Anne river.

Plate II.—A. Limestone along Sainte-Anne river.
B. Banks of Sainte-Anne river, below Saint-Alban.

Plate III.—A. Banks of Sainte-Anne river, near Saint-Olivier bridge.
B. Thin-bedded Trenton limestone one mile below Saint-Alban.

Plate IV.—A. Ravine cut on the bank by surface waters, Sainte-Anne river.
B. Top of an anticline, two and a half miles above La Pérade.

SAINTE-ANNE RIVER AREA*

PORTNEUF COUNTY

by Abbé J. W. Laverdière

INTRODUCTION

Location of Area

In 1934, the writer mapped a section, in Portneuf county, of the belt of Palæozoic rocks which skirt the north shore of the Saint-Lawrence river between Quebec city and Montreal (1). The area studied at that time extends along the shore of the river from the vicinity of Portneuf station, on the Canadian Pacific railway, southwestward to La Chevrotière.

During 1936, this work was continued in an area immediately west of that surveyed in 1934. The present map-sheet is bounded on the north by a line which passes near the village of Saint-Alban, and from there it extends south to the Saint-Lawrence river. The east and west limits are, respectively, meridian lines 72°00′ and 72°15′. Thus outlined, it has an area of 110 square miles. With the exception of a narrow tip at the south, in Champlain county, the map-area lies within Portneuf county The main centres of population are Saint-Marc-des-Carrières, Saint-Alban, Saint-Casimir, Grondines, and Saint-Thuribe, in Portneuf county, and Sainte-Anne-de-la-Pérade, in Champlain.

The lines of both the Canadian National and Canadian Pacific railways cross the area, and the Montreal-Quebec national highway traverses it from one end to the other, following closely the shore of the river. In addition to this main highway there is a network of subsidiary roads connecting the several parishes and giving easy access to all parts of the map-area.

Saint-Marc-des-Carrières is the centre of one of the most important limestone quarrying districts in the Province. There are other minor industries, local in character, but the great majority of those living in the area are engaged in farming.

General Character of Area

The belt of Palæozoic sediments that border the north shore of the Saint-Lawrence becomes wider as it is followed from Quebec southwestward to Montreal, and in a general way the increase in width is gradual and continuous. In the vicinity of Grondines, however, there is a local abrupt widening of the belt where the sediments extend twelve miles

* Translated from the French.

(1) *The Palæozoic of the Deschambault Region, Portneuf County;* Que. Bur. Mines, Ann. Rept., Part *D*, 1934, pp. 45-62.

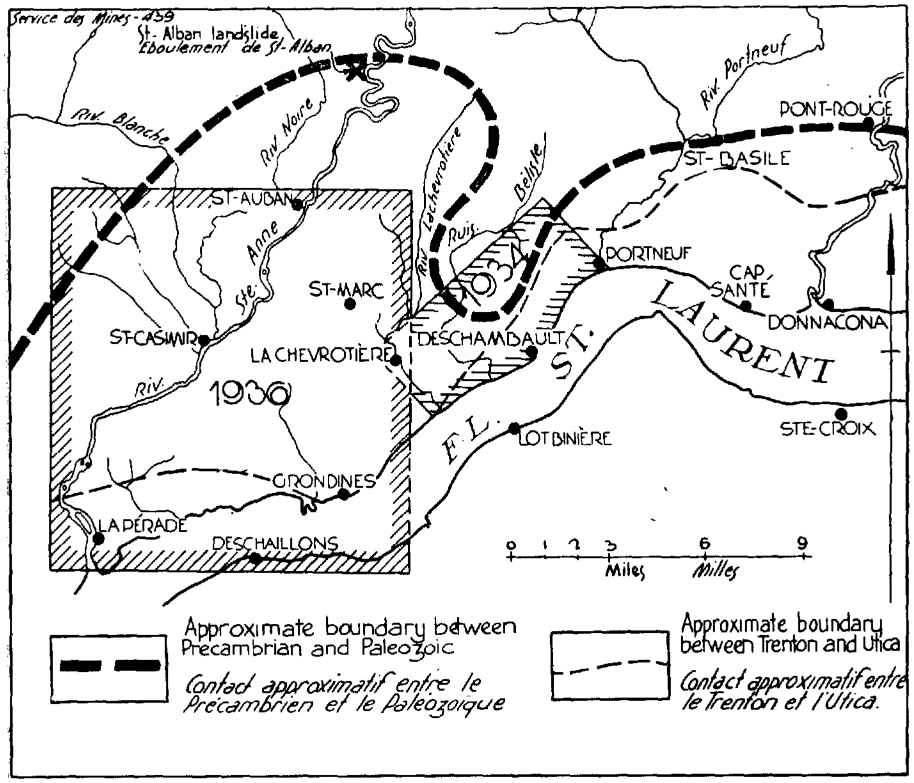


Figure 1.—Sketch map showing the width of the Palæozoic belt and the areas studied by the author in 1934 and 1936.

inland from the river, forming a large embayment in the Precambrian terrain on the west side of the Deschambault granite spur (see Figure 1). The area mapped in 1936 is in this relatively wide section of the belt. It presents an even surface, sloping gently southwestward from a maximum of 250 feet at the north to 34 feet near Sainte-Anne-de-la-Pérade. Between the latter point and the river a mile or two south of it, however, there is a rather abrupt rise to 150 feet, and this higher land extends eastward to Grondines, where it reaches the Saint-Lawrence in an escarpment 100 feet above water level.

Drainage

The major part of the area is drained by the Sainte-Anne river, which flows southwesterly to enter the Saint-Lawrence at Sainte-Anne-de-la-Pérade. The Noire and Niagarette rivers and Charest brook join the Sainte-Anne as tributaries from the west, but no streams enter the main river on its eastern side. This portion of the map-area drains directly into the Saint-Lawrence by La Chevrotière river, Moulin creek, and other smaller streams.

With the exception of the Sainte-Anne river, all these streams flow between banks of unconsolidated deposits, and only rarely have their channels reached bedrock.

METHOD OF WORK

As a base-map for the field work, the excellent topographical map prepared by the Department of National Defence (Grondines sheet) was used, enlarged to twice its original scale of one mile to the inch.

Traverses were made across the area at closely spaced intervals in order to locate and map all rock outcrops. In view of their economic importance, the limestones at many points were examined in detail, and a study was made of their relationship to the underlying granite and overlying shale.

The writer was ably assisted by Yves Fortier, student at L'Ecole Supérieure des Sciences, Quebec.

PREVIOUS WORK AND BIBLIOGRAPHY

The region within which the present map-area is situated has been visited by geologists on numerous occasions ever since the early days of the Geological Survey of Canada. In more recent years, attention has been directed particularly to the economic resources, which include excellent limestone for building and other purposes, clay and shale deposits, and possibilities of natural gas.

Some of the reports listed below deal with the immediate map-area. Others are more general in scope and include descriptions of the geology of the area and of its economic resources and their exploitation.

BIBLIOGRAPHY

(1) LOGAN, Sir William E.................... *Geology of Canada;* Geol. Surv. Can., 1863.

(2) LOW, A. P.. *Report on the Geology and Economic Minerals of the Southern Portion of Portneuf, Quebec, and Montmorency Counties, Province of Quebec;* Geol. Surv. Can., Ann. Rept., Vol. V, Pt. *L*, 1890-91.

(3) LAFLAMME, Mgr J. C. K.................. *L'Eboulis de St-Alban;* Roy. Soc. Can., Trans., Vol. XII, Sec. IV, 1894, pp. 63-90.

(4) LAFLAMME, Mgr J. C. K.................. *Modifications remarquables causées à l'embouchure de la Rivière Ste-Anne par l'éboulement de St-Alban;* Roy. Soc. Can., Trans., Vol. VI, Sec. IV, 1900, pp. 175-177.

(5) ELLS, R. W...................................... *Report on the Geology of the Three Rivers Map-Sheet, or Northwestern Sheet of the Eastern Townships Map;* Geol. Surv. Can., Ann. Rept., Vol. XI, Pt. *J*, 1898.

(6) PARKS, Wm. A................................ *Report on the Building and Ornamental Stones of Canada: Vol. III — Province of Quebec;* Mines Branch, Dept. of Mines, Pub. No. 279, 1914.

(7) KEELE, J. .... *Clay and Shale Deposits of the Province of Quebec;* Geol. Surv. Can., Mem. 64, 1915.

(8) GOUDGE, M. F. .... *Preliminary Report on Limestones of Quebec and Ontario;* Mines Branch, Dept. of Mines, Pub. No. 682, 1927.

(9) PARKS, Wm. A. .... *Natural Gas in the St. Lawrence Valley, Quebec;* Que. Bur. Mines, Ann. Rept., Pt. *D*, 1930.

(10) GOUDGE, M. F. .... *Canadian Limestones for Building Purposes;* Mines Branch, Dept. of Mines, Pub. No. 733, 1933.

(11) LAVERDIÈRE, Abbé J. W. .... *The Palaeozoic of the Deschambault Region, Portneuf County;* Que. Bur. Mines, Ann. Rept., Pt. *D*, 1934, pp. 45-62.

(12) GOUDGE, M. F. .... *Limestones of Canada: Part III—Quebec;* Mines Branch, Dept. of Mines, Pub. No. 758, 1935.

GENERAL GEOLOGY

Over the area as a whole, bedrock is concealed beneath a mantle of unconsolidated sand and clay deposits of Quaternary age. In places, however, and especially along and to the southeast of the Sainte-Anne river, there are outcrops of Palæozoic limestone or shale, and the same rocks are found wherever, due to relatively thin cover of drift or soil, farming operations have exposed or otherwise revealed the nature of the bedrock. From these and other considerations, it is concluded that the Palæozoic sediments underlie the whole of the map-area, with the exception of a small section in the extreme northwest. No rock outcrops were seen in this section, but as explained later, there are good reasons for believing it is underlain by Precambrian rocks.

TABLE OF FORMATIONS

QUATERNARY AND RECENT		Recent alluvial deposits Stratified sands and clays Glacial deposits, boulder clay
Long period of erosion		
PRECAMBRIAN	Lorraine	Shale
	Utica	Shale
	Trenton	Limestone, with thin beds of shale
Long period of erosion		
PALÆOZOIC		Granite, gneiss

PRECAMBRIAN

As may be seen in the accompanying sketch-map (Figure 1), the belt of Palæozoic sediments is everywhere bordered on the northwest by Precambrian rocks of the Canadian Shield. However, the actual contact between these formations is seldom exposed, and frequently they are separated by a wide stretch of drift deposits. In the region of the map-area, the writer has searched for the contact over a distance of some thirty miles along the line it presumably follows, but without finding it exposed at any point. In traverses normal to this direction, it is found that, somewhere between the last exposure of limestone and the first of granite, there is a somewhat abrupt change in the general elevation, and it is concluded that the contact follows approximately the edge of the higher land.

On the basis of this reasoning, the higher land in the extreme northwest corner of the present map-sheet is believed to be underlain by Precambrian, and it is so indicated on the accompanying map, although, actually, no exposures of Precambrian rock were found in the area.

PALÆOZOIC

As has been noted on an earlier page, the belt of Palæozoic sediments is exceptionally wide in this map-area, due to a bulge inland where the sediments extend northeasterly into a deep embayment which is bounded on the east by the Deschambault granite spur.

Over the greater part of the area, the sediments exposed are Trenton limestone. This formation extends from the northern limit of the Palæozoic belt southward to the Saint-Lawrence river, as far as a point about one mile above Grondines. Here the overlying Utica shales are exposed and occupy a strip that extends across the map-area and continues to its southern limit. In the extreme southwest, however, near the mouth of the Sainte-Anne river, the Utica is known to be succeeded by Lorraine shales, although these are now buried beneath landslide material.

Trenton Limestone

The Sainte-Anne river flows centrally through the 'embayment' already referred to and parallel to its axis, i.e., southwesterly. The limestones exposed along the river and elsewhere also dip gently in the same direction (see Plates II-A, III-A, and III-B). As a consequence, on proceeding down the river, successively younger beds are met with.

To the northwest of the Sainte-Anne river there are practically no rock outcrops, but along the river and to the southeast of it, as, for example, in the parish of Saint-Marc-des-Carrières, they are abundant. In this section of the area, the limestone is visible in the beds of even the smallest creeks, and in many places the drift is so thin that farming is difficult.

The Sainte-Anne river affords exceptional opportunities for detailed study of the limestone. At several points between Saint-Alban and Sainte-Anne-de-la-Pérade, rock is exposed more or less continuously for long distances, and in places the stream has cut through the beds to considerable depths, thus permitting examination of their sequence. Logan, in *Geology of Canada*, 1863, page 152, describes the occurrence at Saint-Alban as follows:

"The most easterly exposures seen in the trough are at Three Rapids on the Sainte-Anne, where a black bituminous limestone is met with, within ten acres of the boundary between Deschambault and Portneuf, and within half a mile of the gneiss. The dip is down the river (S.86°W. < 7°); the beds visible have a transverse measure of 650 yards, giving a thickness of 250 feet. The beds are thin, and at the base much loaded with nodules of chert, and occasionally interstratified with very thin layers of the same mineral, while at the summit occasional crystals of blende occur. The most common fossils are some of those characteristic of the Trenton formation, such as *Stenepora fibrosa, S. petropolitana, Leptœna sericea, Strophomena alternata, Orthis testudinaria, O. lynx, Rhynchonella increbescens, Lingula riciniformis*, with an undetermined *Orthoceras*, some of which are replaced by chalcedony and beautifully weathered out".

The exposures referred to by Logan in the above description are now under water, a consequence of the damming of the river near the Saint-Alban (or Saint-Olivier) bridge for hydro-electric power development. This has raised the water level for several miles above the dam, so that now the most easterly exposures of the limestone are at the Saint-Alban bridge. From this point down the river to the last rapid above Sainte-Anne-de-la-Pérade, the beds are exposed almost without a break.

The thickness of limestone which has been trenched by the river is very variable from place to place. At Saint-Alban bridge, the river flows through a deep gorge between cliffs of limestone fifty feet high (measured from the stream bed), over which is some fifty feet of drift. Down stream, the depth of the gorge becomes gradually less (see Plate II-B), and at one mile below the bridge the limestone section does not exceed twenty feet. It then increases slightly in thickness until the Lefebvre bridge is reached, but below that the cliff tapers, and the limestone finally disappears in the vicinity of the Canadian National railway bridge just above Saint-Casimir village. Between this village and Sainte-Anne-de-la-Pérade, limestone is exposed intermittently along the river, but nowhere does the thickness of outcrop much exceed ten feet.

The general dip of the beds being to the southwest, those seen at Saint-Alban are stratigraphically lower than those outcropping at Sainte-Anne-de-la-Pérade.

Detailed studies of the limestones and their fossil fauna were made at a number of localities along the Sainte-Anne river and elsewhere in the area. The results of these observations are recorded below.

F1.—Saint-Alban:

As exposed in the 50-foot cliff, the limestone is rather thin-bedded, the general range being between one inch and six inches, although some beds near the bridge are as much as fifteen inches thick. Separating the individual beds are shaly partings, which are more numerous and thicker at the top than toward the base of the cliff. These layers of shale are very conspicuous on weathered surfaces, on which they stand out in relief (see Plate II-A). As many as twenty-one have been observed in a thickness of six inches. The beds have a gentle dip down stream (see Plate II-B).

The stone is grey, medium to fine in grain, and slightly crystalline. Traversing it in places are narrow veinlets of calcite. Analyses of the rock are given in the table on page 49.

The stone is fossiliferous, with an abundant fauna. In specimens collected at the point marked *F1* on the map, the following species were recognized:

CRINOIDS
Numerous stems

CORALS
Favosites sp.

BRYOZOA
Prasopora simulatrix Ulrich

BRACHIOPODS
Lingula briseis Billings
Dalmanella testudinaria (Dalman)
Dinorthis pectinella (Emmons)
Sowerbyella sericea (Sowerby)
Rafinesquina alternata (Emmons)

Rafinesquina cf. *minnesotensis* (N. H. Winchell)
Rafinesquina sp.
Parastrophia hemiplicata Hall
Rhynchotrema increbescens (Hall)
Zygospira recurvirostris (Hall)

PELECYPODS
Ctenodonta sp.

GASTROPODS
Archinacella trentonensis (Billings)

TRILOBITES
Calymene senaria Conrad
Isotelus gigas deKay
Ceraurus pleurexanthemus Green

F2.—One Mile Below Saint-Alban Bridge:

Going down-stream from Saint-Alban, the right (west) bank of the river is an almost vertical cliff, whereas the left bank has a 45-degree slope. One mile below the bridge, the river swings abruptly to the south and here, on the left side, there is an extensive exposure of the limestone having the form of a low anticlinal (see map). From the general dip, it is estimated that the beds here are 300 feet stratigraphically above those exposed at the bridge.

The rock here is similar to that at Saint-Alban. The beds, however, appear to be more uniform in thickness (see Plate III-B) and they do not exceed ten inches. Analyses of the rock are given on page 49.

Specimens collected at the locality marked *F2* on the map indicate that, while the fauna is more abundant here than at Saint-Alban, fewer species are represented. There is a striking profusion of bryozoa. At this locality, the fossils separate easily from the enclosing rock.

CRINOIDS
Stem and test

BRYOZOA
Prasopora simulatrix Ulrich (very abundant)
Pachydictya sp. (very abundant)

BRACHIOPODS
Lingula sp.
Dalmanella testudinaria (Dalman)
Sowerbyella sericea (Sowerby)
Parastrophia hemiplicata Hall
Rhynchotrema increbescens (Hall)
Triplecia extans (Emmons)

GASTROPODS
Liospira sp.

TRILOBITES
Isotelus gigas deKay

At about half a mile below locality *F2*, the limestone is cut by a northeast-southwest nearly vertical fault. This is particularly apparent in the cliff forming the northwest shore of the river; the thin-bedded limestones of the Upper Trenton are in contact with the thicker beds of Lower Trenton. Near the fault, the limestone is brecciated and numerous striæ were noted on the northwest lip of the fault.

F3.—Near Lefebvre Bridge:

From the point referred to in the foregoing paragraphs, down to the Lefebvre bridge, which is midway between Saint-Alban and Saint-Casimir, the limestone is exposed continuously along the river.

At the point marked *F3* on the map, the exposed section shows eight feet (at the top) of bituminous limestone in which are small pockets of oil and also of calcite, and, below this to water level, eight feet of grey limestone. Some of the beds in this section are eighteen inches thick. The owner of the land has done some stripping with the intention of utilizing the stone for production of lime. Following is a list of fossils collected at this point:

BRYOZOA
- *Pachydictya acuta* (Hall)
- *Chasmatopora reticulata* (Hall)
- *Prasopora simulatrix* Ulrich

BRACHIOPODS
- *Dalmanella testudinaria* (Dalman)
- *Dinorthis pectinella* (Emmons)
- *Sowerbyella sericea* (Sowerby)
- *Rafinesquina alternata* (Emmons)
- *Platystrophia lynx* (Eichwald)
- *Parastrophia hemiplicata* Hall
- *Rhynchotrema increbescens* (Hall)

PELECYPODS
- *Ambonychia amygdalina* Hall

GASTROPODS
- *Archinacella trentonensis* (Billings)
- *Conularia trentonensis* Hall
- *Bucania punctifrons* (Emmons)
- *Hormotoma gracilis* (Hall)

TRILOBITES
- *Calymene senaria* Conrad
- *Isotelus gigas* deKay
- *Ceraurus pleurexanthemus* Green

F4.—One Mile Below Saint-Casimir:

Below the Lefebvre bridge, there is a gradual decrease in the thickness of the limestone exposed along the river, and in the stretch extending from one mile below the bridge down to the village of Saint-Casimir exposures are entirely lacking. At the village, there are exposures that are completely, or almost completely, submerged at periods of high water level. This lack of exposed rock is accounted for by the dam at

Saint-Casimir, which has had the effect of raising the water level for a long distance above the village.

One mile down-stream from the dam, sections of the limestone, fifteen feet thick and drift covered, are exposed in a series of small tongues that jut out into the river. Individual beds are usually thin, one to three inches, and they are separated by shale bands. The rock disintegrates easily under the action of water, and excellent fossil specimens are to be found entirely freed from the rock that enclosed them. Brachiopods are particularly numerous. Following is a list of the fauna collected at the point marked *F4* on the map.

GRAPTOLITES
Diplograptus sp.

CRINOIDS
Stems

BRYOZOA
Prasopora simulatrix (Ulrich)

BRACHIOPODS
Lingula quadrata (Hall)
Lingula sp.
Platystrophia lynx (Eichwald)
Platystrophia biforata (Schlotheim)
Dalmanella testudinaria (Dalman)
Sowerbyella sericea (Sowerby)
Rafinesquina alternata (Emmons)
Strophomena fluctuosa Billings
Strophomena trilobata (Owen)
Zygospira recurvirostris (Hall)

PELECYPODS
Vanuxemia rotundata (Hall)
Orthodesma nasutum (Conrad)

GASTROPODS
Hormotoma cf. *bellicincta* (Hall)
Hormotoma trentonensis Ulrich and Scofield
Trochonema umbilicatum (Hall)
Conularia trentonensis Hall

TRILOBITES
Isotelus gigas deKay
Ceraurus pleurexanthemus Green
Calymene senaria Conrad

F5.—Last Rapid Above Sainte-Anne-de-la-Pérade:

Three miles below the locality last described, rapids are encountered and the course of the river changes from southwest to south. At the point where it straightens to the latter course, limestone forms a cliff, sixteen feet high, along the right (west) bank. The stone is blackish in colour and bituminous, and, as elsewhere, thin layers of shale between the beds are much in evidence. Fossils collected here include the following, in addition to those listed for other localities: *Receptaculites occidentalis* Salter, and an undetermined species of *Solenopora.*

F6.—About One Mile Below Rapids:

Rather more than a mile below the rapids, the limestone is again exposed in a low anticlinal, the crest of which rises fifteen feet above the mean level of the river (see Plate IV-B). It is a bluish-grey, very fine grained stone. The beds range from two to six inches in thickness, with the usual shaly partings separating them. Fossils are abundant, and most of the species already listed for other localities were found here.

These are the highest beds of the Trenton exposed along the Sainte-Anne river. The first outcrops seen in the area south of here are of the overlying Utica shale.

F7.—Vicinity of Grondines:

The most southerly exposures seen along the Sainte-Anne river may not represent the actual top of the Trenton. The highest beds (stratigraphically) of this formation outcrop near Grondines West, along Moulin brook, between the national highway and the Saint-Lawrence river (*F7* on map). Utica shale is exposed not more than fifty yards away (*F8*). The limestone here is very dark grey (almost black), bituminous, and slightly crystalline. The fossil fauna, listed below, definitely identify these beds as belonging to the Trenton formation.

BRYOZOA
Prasopora similatrix (Ulrich)

BRACHIOPODS
Cyclospira bisulcata (Emmons)
Sowerbyella sericea (Sowerby)

CEPHALOPODS
Endoceras magniventrum Hall
Endoceras proteiforme strangulatum Hall

TRILOBITES
Calymene senaria Conrad
Isotelus gigas deKay

Along the shore of the Saint-Lawrence, from Grondines down to the mouth of La Chevrotière river, the limestone forms an escarpment whose height increases toward the northeast. At Grondines wharf, the beds are almost entirely submerged at high tide; at 2,500 feet below the wharf, the cliff is 35 feet high; and at about one mile below the wharf the escarpment reaches its maximum height of some 100 feet and maintains this level for almost two miles to near the mouth of La Chevrotière river. As is the case elsewhere in the area, the limestone beds dip very gently to the southwest, at 2 to 5 degrees.

The limestone is argillaceous and fairly friable. Twenty feet below the surface, the beds are 18 to 20 inches thick.

On the rim of the escarpment, about where it first attains its maximum height, a quarry, 175 feet by 60 feet, was formerly operated for crushed stone. The floor of the quarry is twenty feet above the level of high tide. Fossils collected here are practically the same as those seen at locality *F4* along the Sainte-Anne river, indicating that the beds in the two occurrences belong to the same stratigraphical horizon.

Utica Shale

Exposures of Utica shale were seen at several points in the southern part of the map-area: on the national highway, near the boundary between Portneuf and Champlain counties; along Moulin brook at Grondines West, as already noted (point marked *F8* on map); on a small brook which crosses the national highway about two miles east of Sainte-Anne-de-la-Pérade; and along a road which parallels the national highway where it runs north of the Canadian Pacific railway.

The contact between the Trenton limestone and Utica shale was definitely located at one point on Moulin brook, about half a mile below the national highway. A steam-shovel, in the process of deepening the brook, has excavated from the stream-bed a considerable amount of material, which has been deposited along the bank. Examination of this material shows plainly the passage from limestone to shale. Thus, although the actual contact is concealed beneath the water, its position is established within a few feet.

Another small brook, three-quarters of a mile east of Moulin brook, was being similarly deepened at the time of our visit. The material brought up by the shovel was fossiliferous bituminous shale. The underlying limestone had not yet been reached.

All the outcrops of Utica shale encountered have been plotted on the accompanying map. As may be seen, the distance between these and the nearest exposures of Trenton limestone averages less than one mile. Thus, it is safe to assume that the line of contact between the two formations, as mapped, approximates closely to its actual position. This line, as shown on our map, is in fairly close agreement with that indicated on Ell's map (1), except at its eastern end, in the vicinity of Grondines West, where, as the result of our observations, we have reduced the width of the Utica belt, as mapped by Ells, by one-half. As now determined, the shale first appears at a point one mile west of Grondines and from there extends along the Saint-Lawrence as a belt which widens toward the west.

Wherever seen, the shales have a very low dip, one to three degrees. The strike approximately parallels the Saint-Lawrence river, but, viewing the belt as a whole, it is broadly arcuate, with the convexity inland. From the width of the belt and the average dip of the beds, it is estimated that the total thickness of the Utica here is about 475 feet.

In the basal beds, immediately overlying the limestone, the rock is extremely fine grained and very dark in colour, and breaks with a conchoidal fracture into irregular blocks. When heated, it emits a pronounced bituminous odour. Beds higher in the series are light grey, not so fine grained, and not so bituminous; the rock is much more fissile and breaks readily into smooth slabs when struck with a hammer. All these shales give a slight effervescence with acid.

Fossils are fairly abundant. Numerous specimens were collected, of a varied fauna, all typical of the Utica. The following table lists, and

(1) *Eastern Townships Map: Three Rivers Sheet;* Geol. Surv. Can., Map. No. 665, 1898.

compares, the fossils collected at two localities in which the beds are, stratigraphically, as far apart as possible. The first column refers to specimens collected at about two and a half miles east from La Pérade village along a small stream crossing the national highway (point *F9* on map); the second column to material from Moulin brook at Grondines West (*F8* on map). In the table, *c* denotes *common; r, rare.*

	Upper Beds (F9)	Lower Beds (F8)
Graptolites		
Dicranograptus nicholsoni Hopkinson	c	c
Lasiograptus eucharis (Hall)	c	
Diplograptus sp.	c	
Diplograptus foliaceus (Murchison)		c
Glossograptus quadrimucronatus (Hall)	c	r
Climacograptus typicalis Hall	c	c
Climacograptus sp.	c	
Chætopods		
Serpulites angustifolius	r	r
Brachiopods		
Leptobolus insignis Hall	c	c
Lingula sp.	r	
Schizocrania filosa Hall	c	
Cephalopods		
Orthoceras sp.	r	r
Trilobites		
Triarthrus glaber Billings	r	c
Calymene senaria Conrad		r

Lorraine Shale

At the extreme southwest of the map-area, where the headland formed by the east side of the Sainte-Anne river juts out into the Saint-Lawrence, the older maps show a series of small off-shore islands, and in Ells' map (Three Rivers sheet) already referred to, these are indicated as underlain by rocks of the Lorraine formation.

Since the Saint-Alban landslide in 1894, however, the immense amount of alluvial material carried by the river has silted-up the channels between the islands, which now appear as an extension of the mainland.

All the former rock outcrops are now concealed beneath these alluvial deposits. In our map, however, we have followed Ells and show this extension of the mainland as underlain by Lorraine rocks.

Formational Relationship and Structure

Although no contacts between the Palæozoic and Precambrian formations are exposed in the area, the evidence at hand indicates that the Trenton limestone is lying diectly upon the Precambrian, with no intervening beds of lower Ordovician or other formations such as are found in certain other places in the Saint-Lawrence valley. This would mean that the sea which submerged these shores advanced in Trenton time.

No actual contacts between the Trenton and Utica were seen, although at one point, near Grondines West, outcrops of the two are not more than fifty yards apart. Here and elsewhere, however, dip measurements show conclusively that the two formations are conformable, the Trenton beds dipping beneath the Utica. Apparently, there was no break in the continuity of deposition from one formation to the other.

A study of the observed dips brings out the fact that the strata present low undulations, and on the map we have indicated the axes of the three main folds. In a number of places, also, local flexures were noted.

It is difficult to fix the age of the folding, since there are no rocks in the area younger than Ordovician. The Champlain fault is known to be pre-Devonian, and there is no indication that the later Hercynian folding extended to the region west of that fault. We therefore incline to the belief that the gentle folds observed in the map-area must be related to the Taconic folding at the close of the Ordovician period. They would represent effects of the initial thrusts, preceding the formation of the Champlain fault, against which subsequent movements from the east spent themselves.

Quaternary and Recent

Glacial Deposits

Apart from those restricted patches where the Palæozoic rocks are exposed, the entire surface of the map-area is covered by glacial drift and recent alluvial deposits.

The nature and the manner of accumulation of the glacial deposits has been well summarized by Keele (1), as follows:

"When the ice melted, the débris accumulated by them [the ice sheets] remained behind in irregular patches and heaps. Much of this drift material has since been worked over by stream action and assorted into deposits of coarse gravel, sand, or clay, which were deposited at various localities, depending on conditions of grade and outfall of drainage.

"Each period of glaciation, and the marine submergence, contributed drift materials, such as sands, gravels, boulder clays, and stratified clays, which have been more a less disturbed, confused, or modified by each succeeding event. It is rarely, then, that an orderly record of the materials contributed by all of these events is found in any one locality.

"The series of surface deposits that occurs most commonly consists of boulder clay, stratified clay, and sand (arranged in that order from bottom to top)".

---

(1) Keele, J., *Preliminary Report on the Clay and Shale Deposits of the Province of Quebec;* Geol. Surv. Can., Mem. 64, 1915, p. 42.

From the standpoint of their nature, and also of their thickness, the glacial deposits of the present area may be described briefly as follows :

A.—Southeast Section of Area. — In the section of the map-area extending from the Deschambault granite spur southward to the Saint-Lawrence, and within which are situated the villages of Saint-Marc-des-Carrières, La Chevrotière, Hamelin, and Grondines, the cover of glacial drift is very thin. The Trenton limestone is exposed in many places, and over wide stretches farming presents difficulties owing to the nearness of the rock to the surface. The soil is a mixture of sand and clay, and it holds great numbers of boulders of all sizes.

B.—Sainte-Anne-de-la-Pérade to Saint-Casimir. — The country in the vicinity of Sainte-Anne-de-la-Pérade, and stretching east and west of the Sainte-Anne river, is a clay plain, well suited for agriculture. Proceeding northward from here, sand gradually makes its appearance, overlying the clay.

C.—Saint-Casimir Northward. — From about two miles above Saint-Casimir northward to the limit of the map-area, the Trenton bed-rock is overlain by a thick bed of clay, above which are sand deposits which increase in thickness as they are followed to the north.

At the Saint-Alban (or Saint-Olivier) bridge, where the Sainte-Anne river flows through a deep gorge, the Trenton limestone is overlain by a thickness of some fifty feet of drift, and Laflamme has estimated that in places in this vicinity the sand beds attain a thickness of 200 feet (see Plates I-A and IV-A).

One mile above the bridge there is a clay bluff about forty feet high, in the upper part of which the clay is stratified in very thin beds — we counted as many as 150 beds (see Plate I-B). It is probable that each narrow bed, or band, represents the material deposited in one year. The beds are slightly curved or folded, the result, perhaps, of the piling-up of material in the centre of the basin of deposition, or, it may be, of thrusts produced by floating ice or by the tongue of a land glacier.

It is to be noted that the thickness of the glacial deposits increases as one proceeds from south to north up the Sainte-Anne river. As mentioned on a previous page, the river flows axially through a deep embayment in the Precambrian on the west side of the Deschambault granite spur, this embayment being a flat plain underlain by Palæozoic sediments. The greater thickness of the glacial deposits in the north than in the south can be explained on the reasonable assumption that the inland part of the 'bay' must have been protected from the action of the strong currents which doubtless swept the Saint-Lawrence plain at the time the glacial deposits were being laid down.

The line of demarcation between sand and clay in these deposits is often marked by a rusty staining, due to deposition of iron oxide or hydroxide by waters from springs, which ooze out along the contact between the two.

These springs, as well as meteoric waters, wear away the face of cliffs and bluffs of the unconsolidated material, and streams carry away the resulting débris. As a consequence, the face does not easily attain a

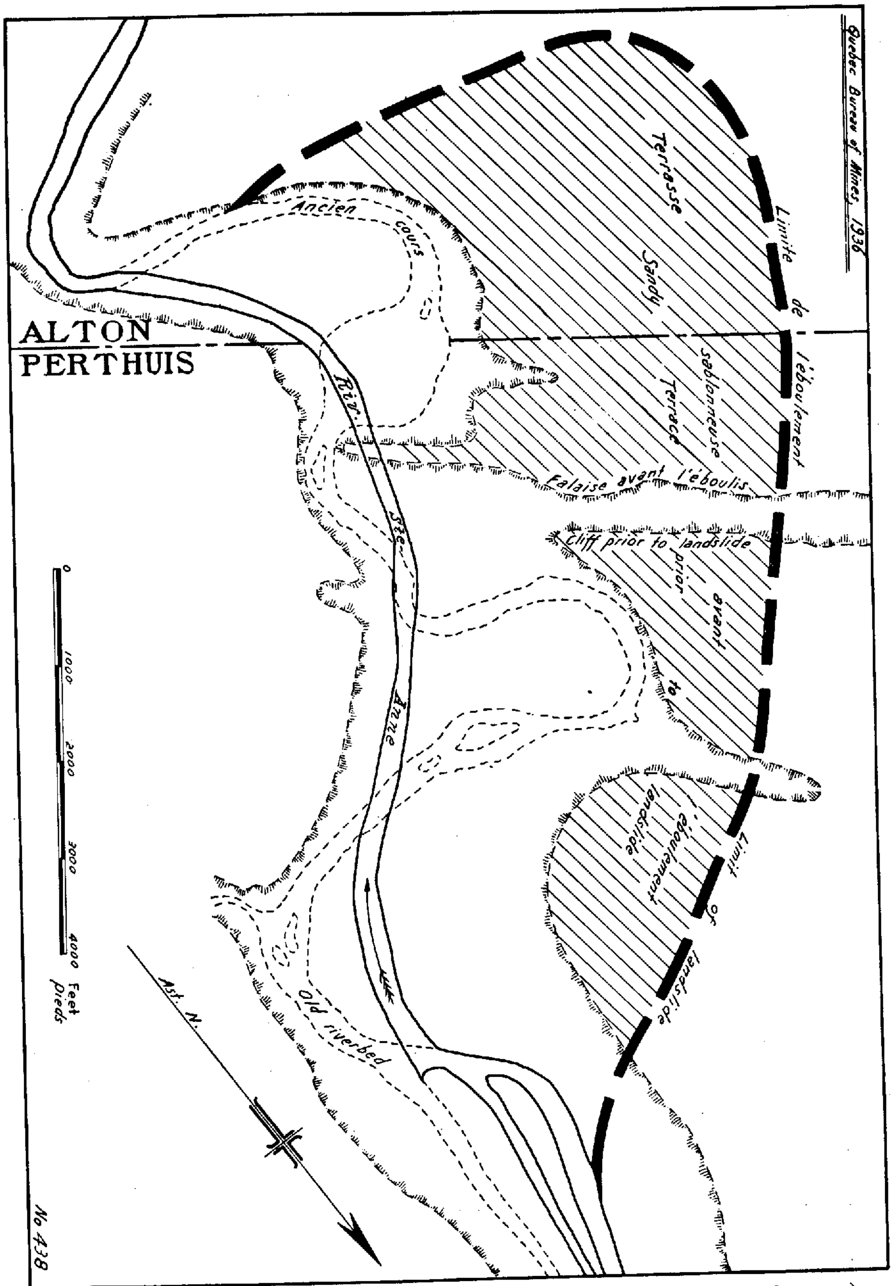


Figure 2.—Plan of Saint-Alban landslide. (After sketch by Mgr Laflamme).

stable or permanent angle of slope. Conditions are thus favourable to landslides. In many places along the river, masses of earth are to be seen which have quite recently slid down the steep banks, carrying with them trees and bushes, which tumble into the river.

The most notable landslide in this area in recent years was that which occurred five miles northeast of Saint-Alban in 1894. Material from an area 3 miles long by 1½ miles wide, and having a volume estimated at between six and seven million cubic feet, slid from a height of 120 feet into the valley of the Sainte-Anne river below. Prior to that time, the river here passed over two or three falls separated by long meanders. It has now cut a new channel through the slide material and flows in a straight course through a continuous series of rapids, between banks of sand and clay.

Figure 2, reproduced from the detailed description of the occurrence by Mgr. J. C. K. Laflamme (1), illustrates clearly the extent of the slide and the topographic and other changes it wrought in the area affected.

Recent Alluvial Deposits

From what has been said above, it will be evident that, in this area, alluvial deposits of recent origin may assume considerable importance. Processes of erosion and transportation, with later re-deposition, of material are everywhere at work unceasingly, modifying the land surface, but as a rule they proceed so slowly that the changes they effect are scarcely, if at all, apparent to the casual observer. In the case of the Saint-Alban landslide, however, an enormous volume of material was suddenly submitted to the action of a river of fairly steep grade — averaging eighteen feet to the mile — and the results of the transportation and redistribution of this material were on such a scale that they became evident almost at once.

The river carved a new channel through the obstruction that blocked its path, carrying along, in suspension and otherwise, the material it had gouged out. In the vicinity of Saint-Alban, deposition of this material was not possible, as here the Sainte-Anne flows rapidly through a limestone gorge. But in the relatively slack water below the last rapid, two and a half miles above Sainte-Anne-de-la-Pérade, the river began to drop its load of sediment and, in an indentation of the bank, a series of islets gradually formed. They are still markedly unstable in outline.

Another striking effect of the landslide is seen a little farther down stream. Charest brook, which is to the west of the Sainte-Anne, formerly emptied directly into the latter, joining it at right angles. The slide material having blocked its junction with the Sainte-Anne, it cut a new channel parallel to the river for one-third of a mile to join Gendron brook, and its waters now reach the Sainte-Anne by way of that brook.

(1) *L'Eboulis de Saint-Alban;* Roy. Soc. Can., Trans., Vol. XII, Sec. IV, 1894, pp. 63-70.

It is, however, at the mouth of the Sainte-Anne, where that river enters the Saint-Lawrence, that the effects of the landslide are most marked. There have been important modifications here in and adjacent to the shore line as well as in the river channel. The following graphic description is reproduced (translated from the French) from a paper by Mgr. J. C. K. Laflamme (1):

"In the part of its course which is nearest the Saint-Lawrence, the bed (of the Sainte-Anne river), before the landslide, was deep and the current quite slow. At the time of the Saint-Alban slide, the solid material, violently hurled from the upper reaches of the river, blocked this deep estuary and was carried away to the Saint-Lawrence with great force. The greater proportion was deposited in the Saint-Lawrence itself, forming new islands, or joining to the mainland islets which were formerly surrounded by water. The current was so strong, the moving mass so huge, that the wooden bridge at the village was carried away as if it were of straw.

"Nevertheless, a substantial part of this material did not reach the Saint-Lawrence, but was deposited, even at that time, in the deep part of the Sainte-Anne river, near its mouth, and it then began to line and raise the bed of the stream in a remarkable manner.

"Gradually, the channel became more and more shallow, and the rapidity of the flow increased day by day, although remaining slower than the current in the upper parts, where deposition was practically impossible. During many months, the channel, which previously was so safe and so well marked, became uncertain and changing. Water was digging up material on one side and depositing it on the other. In the space of twenty-four hours, we observed the digging out of a channel nearly ten feet deep, through what was, on the evening before, a sand-bank emerging from the level of the water.

"The violence of the current was so great that we saw large blocks of earth, of such volume that they constituted islands, crumble and disappear in less than two hours, carried away by the current, despite the depth of the water".

---

(1) *Modifications remarquables causées à l'embouchure de la rivière Sainte Anne par l'éboulement de Saint-Alban;* Roy. Soc. Can., Trans., Vol. VI, Sec. IV, 1900. pp. 175-177.

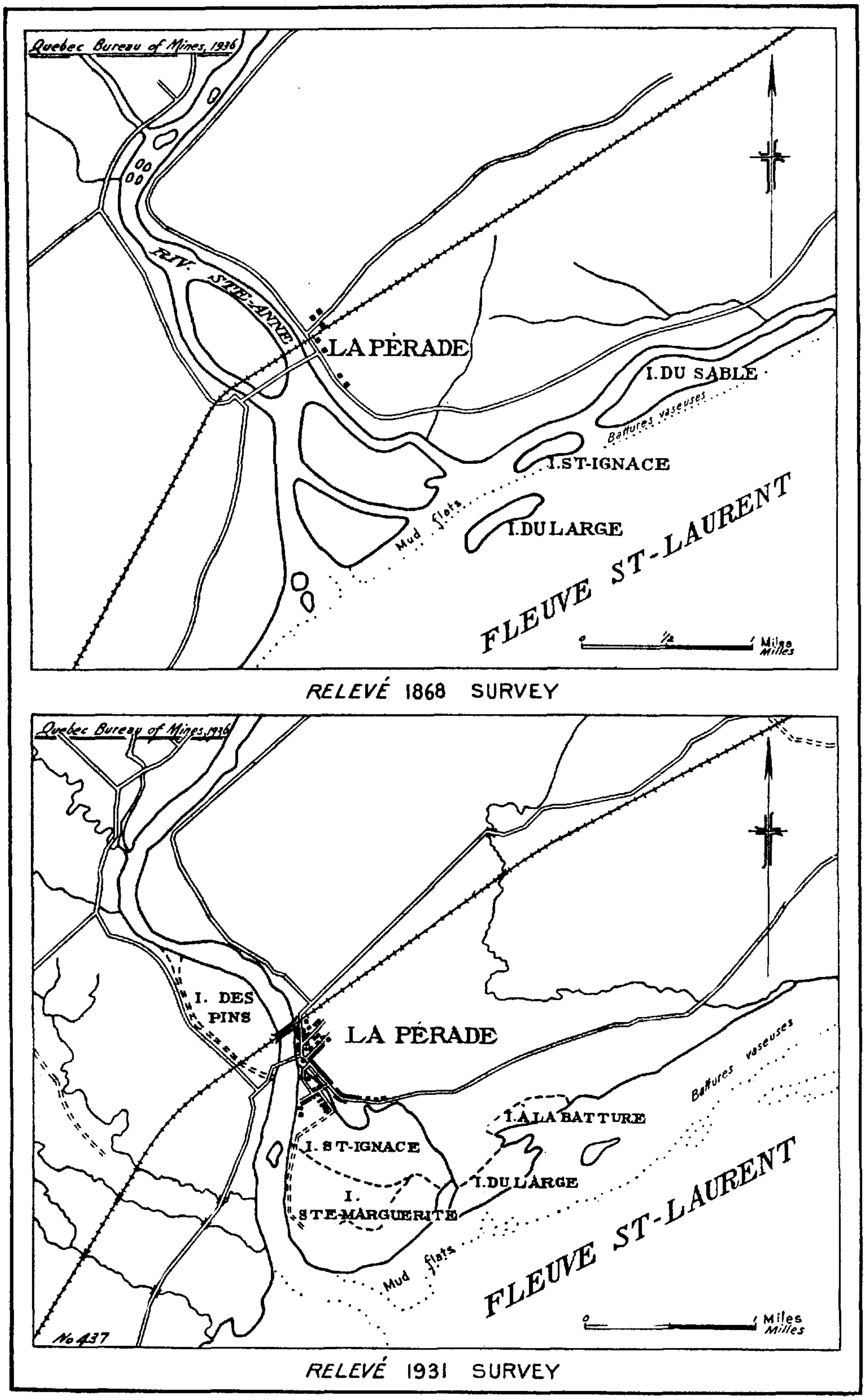


Figure 3.—Plan of the mouth of Sainte-Anne river before and after the Saint-Alban landslide.

The two comparative sketches (Figure 3), reproduced from Laflamme's article, show the scale of the changes affecting the topography in the vicinity of Sainte-Anne-de-la-Pérade, near the mouth of the Sainte-Anne river.

According to the Three Rivers map-sheet, published by the Geological Survey in 1898, there were at that time eight quite distinct islands close to the shore of the Saint-Lawrence at the mouth of the Sainte-Anne river. Today, as shown by the Grondines sheet issued by the Department of National Defence in 1931, these former islands are a part of the mainland, and the channels between them are completely filled in or are represented by slight depressions which carry water only in time of flood. Minor changes in this new land surface continue to the present day.

ECONOMIC GEOLOGY

Trenton Limestone

Nearly the whole of the map-area is underlain by Trenton limestone, which is well exposed at numerous points along the lower reaches of the Sainte-Anne river, between Saint-Alban and Sainte-Anne-de-la-Pérade, and also in the parish of Saint-Marc-des-Carrières, east of the river.

Quarrying operations have been carried on in Saint-Marc-des-Carrières and vicinity for more than one hundred years, and this remains one of the most important centres in the Province for the production of limestone. The quarries yield excellent building stone, and much of the output is used also for making lime, as crushed stone, and for soil amendment. Numerous reports dealing with the occurrence, and the physical and chemical properties, of the stone, and describing the quarrying operations, have been published by the Federal Department of Mines, and reference to the more important of these appears in the *Bibliography* on page 31. It is therefore not necessary to discuss them further here.

The limestone exposed in the 50-foot cliffs between which the Sainte-Anne river flows at Saint-Alban is pale grey in colour, hard, and medium to fine grained. The upper beds in the section are thin, but some of the lower beds are as much as fifteen inches thick. In the table below, analyses are given of three samples taken from beds ten feet apart.

Analyses were made also of samples from the exposures along the Sainte-Anne river one mile below Saint-Alban bridge, and from those about 700 feet below the Lefebvre bridge. As was noted in the description of the latter occurrence, some of the beds in the lower half of the section exposed are eighteen inches thick. In the upper half, however, for a thickness of eight feet, the stone is bituminous and of inferior quality. The cost of opening and operating a quarry here for extraction of the better quality stone would doubtless be prohibitive.

The analyses in the accompanying table were made in the Quebec laboratory of the Bureau of Mines.

ANALYSES OF LIMESTONES, SAINTE-ANNE RIVER AREA

Sample	SiO_2 %	Fe_2O_3 %	Al_2O_3 %	CaO %	MgO %	P_2O_5 %	CO_2 (*) %	$Ca_3(PO_4)_2$ %	$CaCO_3$ %	$MgCO_3$ %
No. 1	1.04	trace	3.67	53.13	0.05	0.20	41.56	0.44	94.39	0.11
No. 2	1.56	trace	1.53	54.10	0.06	0.27	42.28	0.59	95.99	0.13
No. 3	0.82	trace	0.45	55.01	0.21	0.38	43.03	0.83	97.36	0.44
No. 4	2.44	trace	2.05	52.92	0.48	0.09	41.95	0.20	94.24	1.00
No. 5	2.54	trace	1.01	53.80	0.10	0.05	42.27	0.11	95.90	0.21
No. 6	1.01	trace	1.22	54.71	0.05	0.04	42.95	0.09	97.55	0.11
No. 7	0.50	trace	0.78	54.98	0.20	0.07	43.32	0.15	98.01	0.41
No. 8	8.85	0.16	2.17	48.53	1.06	0.08	39.16	0.17	86.45	2.21
No. 9	6.51	trace	0.58	50.87	0.90	0.09	40.81	0.19	90.60	1.88
No. 10	8.90	0.06	2.89	49.10	0.29	0.14	38.70	0.31	87.32	0.60

(*) Carbon dioxide not determined, but obtained from chemical formula.

No. 1.—Saint-Alban bridge, upper beds.

No. 2.—Saint-Alban bridge, taken 8 feet below the surface.

No. 3.—Saint-Alban bridge, 16 feet below the surface.

No. 4.—Surface sample taken at point F2, one mile below Saint-Alban bridge.

No. 5.—Same locality, 10 feet below No. 4.

No. 6.—Same locality, 20 feet below No. 4.

No. 7.—Sample taken along Sainte-Anne river, 700 feet below Lefebvre bridge.

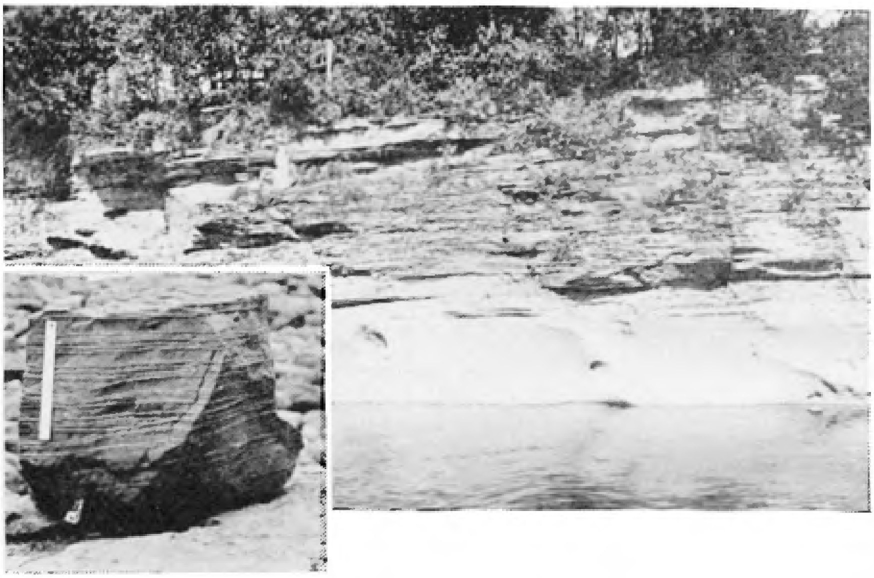
No. 8.—Sample taken on the shore of Saint-Lawrence river, 5,000 feet east of the old wharf of Grondines, five feet below the surface.

No. 9.—Same locality, 30 feet below the surface.

No. 10.—Same locality, 65 feet below the surface.

A.—Sand overlying clay bed along the Sainte-Anne river. The contact is well marked by a line of springs which leave iron stained deposits.

B.—Startified glacial clay, Sainte-Anne river.



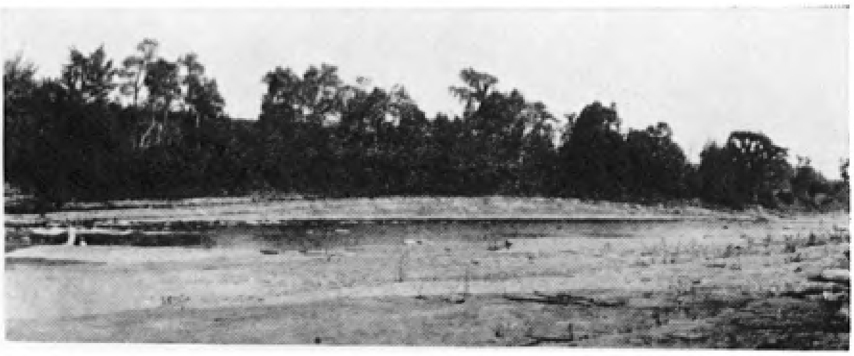
**A.—Limestone, in apparently compact beds, along Sainte-Anne river.
Insert: — Thin beds of shale showing in relief by weathering.**

**B.—Step banks of Sainte-Anne river, below Saint-Alban.
The limestone beds dip down stream.**

A.—Banks of Sainte-Anne river, below Saint-Olivier bridge.

B.—Thin bedded Trenton limestone, one mile below Saint-Alban.

A.—Ravine cut on the Bank by surface waters.
Sainte-Anne river.



B.—Top of an anticline, on left bank of Sainte-Anne river, two an a half miles above LaPérade.

ALPHABETICAL INDEX

PAGE

Adams, C. 10
Agglomerate, Mt. Alexander area .. 13
Albert brook, Mt. Alexander area —
  Fossils collected at 15
Alexander, Mt., map-area —
  See Mount Alexander map-area.
Alluvial deposits —
  Ste-Anne River area 45
Analyses, Trenton limestone —
  Ste-Anne River area 49
Andesite, Silurian —
  Mt. Alexander area 13

Black Cape, Gaspé —
  Native copper at 6, 26
Blue brook —
  Fossils collected at 15
  Native copper in float 25
Bon Ami formation —
  Mt. Alexander area 20
Buteau, Lucien 10

Cariboo grounds, Gaspé 8
Chalcocite —
  Mt. Alexander area 25
Clay deposits —
  Ste-Anne River area 42
Conglomerate, L. Dev. (?) —
  Mt. Alexander area 19
Copper, native —
  Mt. Alexander area 6, 25

Devlin, G. 10
Devonian, Mt. Alexander area —
  Lower 20
  Lower (?) 19
  Lower or Middle 21
  Middle (?) 22
  (or Silurian) 17
Diabase, Mt. Alexander area 17

Fletcher tp., Gaspé 6
Fortier, Yves 31
Fossils, Mt. Alexander area —
  L. Devonian (?) 19
  L. or M. Devonian 21
  Ordovician 12
  Silurian 14, 16
Fossils, Ste-Anne R. area —
  In Trenton limestone 35, 39
  In Utica shale 41

Gaspé limestone series —
  Mt. Alexander area 20
Gaspé sandstone series —
  Mt. Alexander area 22
Glacial deposits —
  Ste-Anne River area 42

PAGE

Grande Grève formation —
  Mt. Alexander area 20, 21
Grondines —
  Fossils in limestone n'r 39

Indian brook —
  L. Dev. (?) conglom. along 19
  N. copper in float along 25

Jones, I. W. —
  Rep't, Mt. Alexander area 3, 26

Kay, Marshall —
  Fossils determined by 10, 12
Kindle, E. M. —
  Fossils determined by 10, 19

Laflamme, Mgr. J. C. K. —
  Quoted, St-Alban slide 46, 48
Landslide, St-Alban 45, 48
Laverdière, abbé J. W. —
  Rep't, Ste-Anne R. area 27, 49
Limestone, Mt. Alexander area —
  Lower Devonian 20
  Lower Devonian (?) 19
  L. or M. Devonian 21
  Ordovician 11
  Silurian 12, 16
Limestone, Trenton, Ste-Anne —
  River area 34, 39
  Analyses 49
  Fossils in 34, 35, 39
Lorraine shale —
  Ste-Anne River area 41

Miller, Alfred E. 10, 25
Miller, Elvin 10
Miller, Wilson E. 10
Miller, Wilton 10
Mississippi anticline —
  Mt. Alexander area 23, 26
Mount Alexander —
  Diabase dykes on 18
  Height above sea-level 7
  Native copper on 6, 25
  Silurian volcanics on 13
Mount Alexander map-area —
  Rep't, I. W. Jones 3, 26
  Agricultural possibilities 8
  Drainage 8
  Geology, descriptive 10
  Geology, economic 25
  Glaciation 25
  Routes to 6
  Structure 22
  Timber resources 9
  Topography 7
Northrop, S. A. —
  Fossils determined by 10

PAGE

Observation mountain —
Diabase dykes south of 18
Height above sea-level 7
Silurian volcanics on 13
Oil possibilities, Mt. Alexander area 26
Ordovician rocks —
Mt. Alexander area 11
Ste-Anne River area 34

Patterson, D. 10
Petroleum possibilities —
Mt. Alexander area 26
Precambrian rocks —
Ste-Anne River area 33

Quaternary & Recent deposits —
Ste-Anne River area 42

Raudin tp., Gaspé 6
Ruedeman, R. —
Fossils determined by 10, 17

St-Alban —
Analyses of ls. at and n'r 49
Fossils collected and n'r 35
Landslide near 45, 48
St-Casimir —
Fossils collected near 37
St-Marc-des-Carrières —
Trenton limestone at 34, 48
St-John river 8
Conglomerate along 19
Diabase along 17
Fossils collected along 16
Ordovician rocks along 11
Sandstone (L. Dev.) along 21
Ste-Anne River area —
Rep't, abbé J. W. Laverdière 27, 49
Ste-Anne-de-la-Pérade —
Fossils collected near 38

PAGE

Sandstone, Mt. Alexander area —
Lower Devonian 21
Lower Devonian (?) 19
L. or M. Devonian 21
Middle (?) Devonian 22
Silurian 16
Shale, Mt. Alexander area —
Lower Devonian 20
Lower Devonian (?) 19
L. or M. Devonian 21
Ordovician 11
Silurian 12, 16
Shale, Ste-Anne R. area —
Lorraine 41
Utica 40
Silurian, Mt. Alexander area 12
Correlation of 15, 17
Fossils in 14, 16
Silurian or Devonian —
Mt. Alexander area 17
Sirois tp., Gaspé 6
Swartz, F. M. —
Fossils determined by 10, 12

Trenton limestone —
Ste-Anne River area 34, 39
Analyses 49
Fossils in 34, 35, 39
Utica shale —
Ste-Anne River area 40
Fossils in 41

Vondenvelden tp., Gaspé 6

Wilson, Alice E. —
Fossils determined by 10, 15
York Lake series —
Mt. Alexander area 21
York River syncline —
Mt. Alexander area 23