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SUMMARY REPORT ON THE ST-LAWRENCE LOWLANDS SOUTH OF THE ST-LAWRENCE RIVER

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DEPARTMENT OF MINES

GEOLOGICAL SURVEYS BRANCH

SUMMARY REPORT
ON THE
ST. LAWRENCE LOWLANDS
SOUTH OF THE ST. LAWRENCE RIVER

BY

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SUMMARY REPORT

ON THE

ST. LAWRENCE LOWLANDS

SOUTH OF THE

ST. LAWRENCE RIVER

by T.H. Clark

INTRODUCTION

For several years past the Department of Mines of the Province of Quebec has been investigating the stratigraphy and structure of the St. Lawrence Lowlands. The study was undertaken because of the interest shown in this region as a possible producer of oil and gas and because of the need of an up-to-date geological map of the region. Enquiries regarding rock distribution and the existence of, or favourable indications regarding, natural resources could not be readily answered on the basis of earlier reports.

No exposure maps of this part of Quebec have ever been made, and hence all previous statements as to stratigraphy or structure were without adequate cartographical confirmation. Because of this unsatisfactory situation, a programme of exposure mapping, using as bases the topographic

maps published by the Department of National Defence, was begun. The Laval and Lachine map-areas (1) were completed first, and afterward the St.Johns and Beloeil maps (2). The present, summary report outlines the structure and stratigraphy of the remainder of the lowland region south of the St.Lawrence.

This report is a summary of the information obtained from field-work carried out during the summers of 1942 to 1946, inclusive. The area investigated, comprising about 3,000 square miles of the St. Lawrence Lowlands between longitudes 73°30' and 71°30'W., extends for 135 miles along the St.Lawrence river northeastward from opposite Montreal to approximately 10 miles up-stream from Quebec and southeastward from the river for distances ranging from 10 to 35 miles.

PHYSIOGRAPHY

"St.Lawrence Lowlands" is a physiographic term. It refers to the lowlands which are adjacent to the St.Lawrence and Ottawa rivers and bounded on the northwest by the hilly region of crystalline Precambrian rocks of the Canadian Shield and on the southeast by the prolongation into Quebec of the Appalachian mountain system extending northeastward to the extremity of Gaspé peninsula. Such boundaries cut across geological

(1) CLARK, T.H. - Preliminary Report on Montreal Area; Bur. Mines, Quebec, P.R. 158, 1941.

(2) CLARK, T.H. - Preliminary Report on the St-Jean and Beloeil Map Areas; Que. Dept. Mines, P.R. 177, 1943.

structures in several places, so that some Precambrian rocks and some mountain-built terrane of the Appalachians are to be found in the Lowlands. Save for these inconsequential exceptions, the Lowlands are underlain throughout their extent by unfolded sedimentary rocks of Cambrian, Ordovician, and Silurian ages, together with later intrusives. Thus defined, the St.Lawrence Lowlands comprise a strip of territory sixty miles wide in the vicinity of Montreal, narrowing wedge-like to a point a few score miles northeast of Quebec city. On the east the boundary, considered appropriate in the present study, is the frontal thrust or a series of thrusts of the Appalachian mountains, which, though not usually a physiographic feature in itself, does correspond roughly to the physiographic boundary between lowland and mountains. On the northwest the St.Lawrence river forms the limit of the area here considered.

Physiographically, the region is a nearly flat area which slopes down gently and gradually towards the St.Lawrence river on the northwest. Only in one or two places does it reach an elevation of 400 feet above sea-level. The St.Lawrence shore in the northeastern part of the region consists of cliffs, ranging from 50 to 100 feet in height, whereas from Gentilly southwestward the shore is flat and in many places marshy.

It has not been the intention of the writer during the preparation of this work to give more than passing attention to the physiographic features. Nevertheless, certain generalizations are inevitable, and certain problems need to be indicated. One of the major problems concerns the basic difference between the surface expressions of the Lowlands and those of the Appalachians. Because of the more resistant rocks composing the Appa-

lachians and the partial metamorphism of these rocks during the process of mountain building, they almost everywhere stand out in relief against the less resistant Ordovician shales, etc., of the lowland. Hence the boundary between the two areas is largely the one between the plain on the northwest and the belt of low rolling hills on the southeast. However, the flat plain of the lowland is not entirely the result of the age-long erosion of rocks of comparatively low resistance. A physiographic difference between the two terranes was probably apparent in earlier geological periods during which the St.Lawrence river, or its ancestors, developed a flood plain on these softer rocks with valley walls roughly approximating the pre-Cambrian contact on the northwest and Logan's Line, or the frontal thrust, on the southeast, thus giving form for the first time to what we now call the Lowlands. Glaciation not only pared off some of the exposed rocks, but left behind a thick deposit of débris, in places 200 feet thick (including post-glacial accumulations), obscuring all but the highest points of rock. These, and such rock as has been exposed in the digging of the post-glacial river valleys, are almost our only sources of information regarding the rock floor of the lowland. Details of the historical development of the erosion surfaces in the neighbouring uplands and of the development of the St.Lawrence flood plain are subjects which have received scant attention from physiographers.

Other interesting problems worthy of study are those concerning the deposition of the thick glacial and post-glacial deposits. A wealth of information on these problems is presented to the investigator along the steep banks of the dozen rivers which have trenched the Lowlands south of the St.Lawrence.

GENERAL GEOLOGY

All the sedimentary rocks exposed in this region are of Ordovician age. Exposures of the underlying Potsdam sandstone formations, of Upper Cambrian age, are present southwest of the region. To the east, the bordering rocks of the folded Appalachians almost everywhere are part of the 'Sillery' complex, which may be Cambrian or Ordovician in age, or both. A total thickness of more than a mile of Ordovician sedimentary rocks can be seen here. Their subdivisions are described below. The so-called 'Lorraine' formation, being the thickest, occupies a large part of the area. The 'Queenston' formation, also, is widespread because of its position along the axis of a syncline.

Structurally, the beds are disposed in a canoe-shaped fold, which is here named the Chambly-Fortierville syncline, from the two localities, near its ends. The axis of the fold nearly bisects the area, and the structure dominates the lowland completely. A few subsidiary folds and wrinkles are known to complicate this otherwise simple structure. A few faults are known, or postulated, of which the St.Barnabé fault is the most important.

Because the Ordovician rocks were overridden by the Appalachian thrust-slices from the east, they were in consequence locally folded, thrusted, contorted, and in places scrambled, so that it has been thought wise to separate these distorted rocks from the others and to give them the name 'St.Germain complex'. This complex is, of course, restricted to the immediate vicinity of the Appalachian region. It is properly to be con-

sidered as a structural term, and it is not everywhere possible to tell which stratigraphic units enter into its make-up.

Igneous rocks are confined to the southwestern part and are all apparently of Monteregian affinities. Five Monteregian hills, namely: St.Bruno, St.Hilaire, Rougemont, Johnson, and Yamaska, lie within this area. Mount Yamaska probably straddles the boundary line between the Lowlands and the Appalachians.

STRATIGRAPHY

The decision to limit the area southwards at the Delson fault eliminates not only about one-fifth of the St.Johns map, but also a suite of formations south of the fault that do not occur to the north of it and that have already been described in the preliminary report on the Montreal area. Thus limited, the stratigraphic sequence of the area is as shown in the table on pages 10 and 11.

Before proceeding with the formal description of these sedimentary units, the following comments are in order:

Firstly, with the single exception of the Pierreville sandstone, every unit grades both upwards and downwards into those above and below. It appears, therefore, that there is a complete and natural sequence of beds representing Upper Ordovician time in these parts.

Secondly, the inclusion of the 'Utica group' in the Cincinnatian may be questioned by some. It is so included because of its complete conformity with and gradation into the lower Lorraine beds and also because of its sharp contact and marked lithologic break with the underlying Trenton, which, however, is not seen within the limits of this area.

Thirdly, no member-name is proposed for Foerste's Leptaena zone of the Nicolet River formation. It is very doubtful whether this unit merit separation from the Chambly member.

Lastly, the equivalents given in the last column have been chosen, and should be accepted, very guardedly. Deposition was probably continuous in the Appalachian geosyncline - along the western marches of which our sedimentary rocks were developed - whereas farther west, in Ontario, New York, Ohio, etc., interruptions were common. There is a possibility that the Nicolet River section may become the standard for the Upper Ordovician of northeastern North America, when the faunas of the various subdivisions shall have been classified completely.

Definitions and descriptions of the sedimentary subdivisions follow.

Lotbinière shale. - The type section of this formation is along the St.Lawrence river from Pointe-Platon to Lotbinière church, where it is exposed in cliffs. The formation consists mainly of dark grey to dark brown, very thin-bedded shales. Most bedding-planes are strewn with tiny flakes of mica. The shales readily disintegrate upon exposure to the weather. Beds of fine-grained calcareous sandstone, a foot or less thick, are distributed through the formation separated by ten to twenty feet of shale. These thin sandstone beds weather a prominent buff to orange colour and, thus, are readily recognized wherever they occur. They disappear toward the south. Large elliptical concretions, calcareous and septarian, six feet across, occur plentifully at one horizon. The formation is petroliferous throughout, except where involved in the St.Germain complex.

The Lotbinière formation has a thickness of more than 300 feet. Its lower contact with the Trenton is known only on the north side of the St.Lawrence. Its upper contact with the Leclercville shale can be only approximated in this area.

Fossils are very rare in the formation, the most common being:

Dicranograptus sp.;
Leptobolus insignis;
Geisonoceras sp.;
Triarthrus eatoni.

The Lachine shale of the Montreal area, which has much similar fauna, and also similar large, calcareous septaria, is to be correlated with the Lotbinière shale.

Leclercville shale. - The type section of this formation is along Grande Rivière du Chêne from Leclercville to the first bridge up-stream. The formation is continuous southwestward through the area and is recognized at Laprairie where Dalmanella, the common fossil in the Leclercville, is exceedingly common in the shales at the brick-yard.

The formation is made up of dark-grey to light-grey sandy shale and thin-bedded sandstone. Like the Lotbinière it disintegrates readily upon exposure, but it is not petroliferous and it does not contain concretions or buff-weathering beds.

Fossils are exceedingly common on some bedding-planes, although very scarce in the formation as a whole, and include the following:

Dalmanella sp., common;
Sinuites cancellatus;
Clidophorus planulata;

Byssonychia hyacinthensis;
Cryptolithus bellulus;
Triarthrus huguesensis.

Nicolet River formation. - Lying between the soft Leclercville sandy shales and the calcareous shales of Richmond age is a great thickness of sandy shales and sandstones, with a thin limestone bed here and there. The sandstones are all lenticular bodies, and correlation even between one bank of a river and the other sometimes fails because of the discontinuous nature of the prominent lithological features. Subdivisions based upon any criterion other than the faunal content would be of no value beyond the section where such subdivision was achieved, so variable is the succession of shale and sandstone. Foerste made out four faunal zones, and for the present it seems best to follow his lead, though we shall follow present practice and bestow geographical names upon Foerste's zones, largely because of the great thicknesses concerned. The type-section for all of these subdivisions is along the northern bank of Nicolet river, about ten miles up-stream in a straight line from the town of Nicolet. The petrographic characteristics of the three under-listed members are those of the formation as a whole (a possible fourth member, as yet unnamed, is included for present purposes, partly in the Breault and partly in the Chambly). The members are listed in descending order.

St.Hilaire member (Pholadomorpha zone). Not well seen elsewhere except along Nicolet river. Fairly well exposed immediately east of St.Hilaire station.

Pholidops subtruncata
Rafinesquina mucronata
Strophomena planumbona

Table of Stratigraphic Sequence

System	Series	Group	Formations, Members, Zones	Thickness (feet)	Equivalents
Ordovician	Cincinnatian	Richmond	Bécancour River - red sandstone and shale. Pierreville grey sandstone member (115 feet) at or near top Carmel River grey shale member (170 feet) at base.	1500 +	Queenston
			Pontgravé River - calcareous shale	156	Waynesville
		Lorraine	Nicolet River - shale and sandstone St.Hilaire member (539 feet) (Pholadomorpha zone) Chambly member (Proetus zone, 287 feet) (Leptaena zone, 569 feet) Breault member (Cryptolithus zone, 962 feet)	2357	Pulaski
			Leclercville shale	1000 +	Frankfort
		Utica	Lotbinière shale (base not exposed)	300 +	Utica
	Mohawkian	Trenton	'Trenton limestones'		
Total thickness of exposed formations above Trenton				5313	

S. hecuba
Zygospira modesta
Catazyga headi
Pholadomorpha pholadiformis
Ctenodonta lorrainensis
Cornulites flexuosus

Chambly member (Proetus zone and part of Foerste's Leptaena zone). Well exposed along both banks of the Richelieu river at Chambly.

Pholidops subtruncata
Leptaena moniquensis
Rafinesquina alternata
Sowerbyella sericea
Catazyga headi
Modiolopsis anodontoides
Orthodesma pulaskiensis
Cymatonota recta
Pterotheca pentagona
Proetus chambliensis

Breault member (Cryptolithus zone, and part of Foerste's Leptaena zone). Well exposed along both banks of the Bécancour river at Breault.

Orthograptus quadrimucronatus
Coeloclema commune
Dalmanella sp.
Leptaena moniquensis
Catazyga cf. erratica
Cymatonota pholadis
Cryptolithus bellulus
Triarthrus huguesensis

Pontgravé River formation. - Calcareous shales, with common thin beds of limestone, make up the bulk of this formation. Sandstone occurs as in the Nicolet River formation, but is nowhere a dominant feature. The tendency to disintegrate upon exposure is most marked. Because of this, fossils are easily collected, though they, too, sometimes break. The high calcareous content of the Pontgravé River formation allows it to be distinguished easily from the lower beds. It grades insensibly into the overlying Carmel River member of the Bécancour River formation. The type section is on the north bank of Pontgravé river, immediately above the mouth of Carmel River. It is also well exposed on both banks of Nicolet river.

The more common fossils in this formation are as follows:

Streptelasma rusticum;
Platystrophia clarksvillensis;
Strophomena sulcata;
S. hecuba;
Hebertella occidentalis;
Zygospira kentuckiensis;
Pterinea demissa;
Byssonychia radiata;
Pholadomorpha pholadiformis;
Whitella sp.;
Cyrtolites ornatus;
Lophospira bowdeni.

Bécancour River formation. - The highest formation exposed here has its type locality on Bécancour river, between Bécancour and a point about eight miles up-stream from there. It is composed largely of red shales and sandstones. The shale disintegrates easily, and the sandstone is rarely well cemented. The sandstone ranges in

grain upwards to a fine conglomerate, with pebbles attaining a diameter of half an inch, though such coarseness is rare and confined to thin beds. Pale greenish-grey beds of both shale and sandstone occur throughout. It seems likely that the sandstone is concentrated towards the top of the formation. Good sections can be seen along the banks of St.Francis, Nicolet, Pontgravé, Bécancour, and Gentilly rivers, and also Petite Rivière du Chêne. No fossils have been found anywhere in this formation, though at one place on Bécancour river some obscure trail-like markings occur.

Carmel River member. - The lower 170 feet or so of the Bécancour River formation has been designated the Carmel River member. It is typically exposed at the confluence of Carmel and Pontgravé rivers. This member comprises a uniform, greenish-grey, non-calcareous shale, devoid alike of bedding and fossils. The lower contact of the member is gradational, but the separation usually is achieved at the highest fossiliferous layer of the underlying Pontgravé River formation; absence of bedding seems to be an equally useful criterion for separating the two zones.

The greenish-grey shale of the Carmel River member grades upwards into well-bedded alternations of greenish-grey and red shales and sandstones of the Bécancour River formation proper.

Pierreville member. - A sandstone zone, 115 feet thick, at or near the top of the Bécancour River formation, has been named the Pierreville member. It consists of light grey, medium- to fine-grained sandstones. The sandstones are strongly cemented and well jointed and can be used as building stones. At the type locality,

about five miles above Pierreville along St. Francis river, this is the highest exposed zone, but, according to some of the well logs, the grey sandstone is covered by more red shale and sandstone.

STRUCTURE

The dominant feature of the structure of this area is the Chambly-Fortierville syncline. This is in fact an elongated basin, for its southwestern end at Chambly plunges to the northeast and its northeastern end near Fortierville plunges to the southwest. The position of the axis can be traced fairly accurately. The earlier maps, following Ells, showed only isolated patches of Queenstone red beds, but they were made from incomplete data, as the Bécancour River (Queenston) red beds occupy the centre of the fold continuously from end to end. The northwestern limb is everywhere less steep than the southeastern limb. In fact, the latter has in places been so affected by the overriding Appalachian thrust-slices that its rocks have been distorted almost out of recognition. Hence it has seemed advisable to group these contorted and slightly metamorphosed rocks into what is here called the St.Germain complex. This includes, as observed, the Lotbinière and Leclercville formations, and without doubt parts of the Nicolet River formation. There is also reason to suppose that some of the underlying Trenton may be involved in this structural hodgepodge. This complex is well exposed along the larger rivers, particularly along the St.Francis in the vicinity of St.Joachim. The type section is along St.Germain river at St.Germain, where recent excavations deepening the river have exposed splendid sections of fresh rock. The rocks of the St.Germain complex are everywhere highly

inclined, being nearly vertical in places, and have been subjected repeatedly to drag folding and faulting. Their complicated structure grades gradually into the less disturbed eastern limb of the main syncline.

In the main syncline the dips are rarely as high as 10 degrees on the southeastern limb and 5 degrees on the northwestern limb. Secondary crumpling can be recognized in a few places. One of these can be seen very well along Yamaska river, five miles below St.Hyacinthe, where alternations of shallow anticlines and a syncline with dips up to 15 degrees can be followed on both sides of the river. Farther down Yamaska river, near St.Hugues, similar undulations occur. In both these cases the rocks involved are the beds of the Breault member. Other complications can be seen along Bécancour river, and can be deduced from exposures along the St.Francis river. Geophysical surveys have indicated other irregularities. In the Lotbinière region folding of the soft, incapable Lotbinière and Leclercville shales is the rule.

Faulting is a common feature in the rocks of the St.Germain complex. Elsewhere, though it has doubtless affected the territory, little evidence can be seen. The St.Barnabé fault, with a downthrow at St.Barnabé of at least 1,100 feet, is the most important. Another which has resulted in the juxtaposition of the Pontgravé River beds and the Leclercville shales in the vicinity of Ste.Angèle is not known with sufficient definiteness to be mapped at present. The Delson fault, with a downthrow to the north of several hundred feet, bounds the area on the south. The Bas-de-Ste.Rose fault is not recognized in this area, but is projected from the Laval map-area (Que. Dept. Mines, P.R. No. 158).

To the east the frontal thrust of the Appalachians is the boundary of the area mapped, but there is one complication in that concept. A mass of foreland rocks, consisting of Chazy, Black River, Trenton, and probably Utica and Lorraine, has been cut away from the main mass of the foreland terrane and shoved over the relatively stable foreland in the vicinity of St.Dominique, so as to appear like a slice from afar. It is a slice, but it has not been shoved more than a mile or two, and is not comparable to the slice containing Sillery beds in the Appalachian belt that may have come from several score of miles. Because of the nature of the complications inherent in this St.Dominique slice, it seems best not to describe the component beds in detail here.

Oil and Gas. - Nowhere in this area have seeps or other direct evidences of oil been found. Natural gas, however, is of fairly common occurrence. Not only are there dozens of records of gas being found in wells dug for water, but the Lotbinière shales (and, north of the St.Lawrence river, the Trenton limestone) are strongly petroliferous. In isolated spots some of the higher beds are also petroliferous. The source rock is there, and signs of gas are abundant. It remains to be seen whether a reservoir rock and an appropriate geological structure can be found. Most of the sandstones of the Nicolet River formation are sufficiently porous to allow gas to percolate into and through them, though perhaps not sufficiently so for the passage of petroleum. Moreover, these sandstone beds are markedly lenticular, (probably none is more than a mile across in any direction) and they would therefore provide admirable stratigraphic traps for the retention of natural gas. In a general way, the synclinal nature of the lowland is adverse to the

retention of gas, but as indicated above, under 'Structure', several known undulations, and probably many more unsuspected ones, could easily provide the necessary closures for the holding of sufficient amounts of gas to justify exploration. Little gas has been encountered on the eastern limb of the fold, and none in the rocks of the St.Germain complex, as one would expect, for wherever the Lotbinière shales can be identified in that complex they have lost their petroliferous character.

On Bécancour and St.Francis rivers, as shown by the accompanying map, there are anticlinal structures that merit experimental and intelligent drilling. Those on Bécancour river are indicated by the outcrops of the Bécancour formation, whereas the structure on St.Francis river has been determined by geophysical methods. The undulations near St.Hugues seem to lie along a line connecting several actual gas occurrences, and would be well worth a geophysical survey. The lower part of the Nicolet river formation, the Leclercville, and the Lotbinière beds along the St.Lawrence shore from Sorel southwestward show an abundance of gas, and a hidden terrace structure there might be uncovered by relatively inexpensive geophysical prospecting.

It should be emphasized that, with hardly an exception, no deep well drilled expressly for natural gas has been located with regard to a favorable structure. Hence the record of discouraging negative results obtained in the deep drilling is not to be wondered at and should by no means be taken as an indication of the ultimate possibilities of this region.

73°00' 72°30' 72°00'

46°30'

46°00'

45°30'

- Gas well - Producing
  Puits de gaz - Productif
- Gas well - Formerly producing
  Puits de gaz - Autrefois productif
- × Deep well - 1000 feet + (Dry)
  Puits profond - 1000 pieds + (Stérile)
- Anticlinal axis
  Axe anticlinal
- Synclinal axis
  Axe Synclinal
- Fault
  Faille
- ■ Localities
  Localités

ST LAURENT

TROIS-RIVIÈRES

NICOLET

SOREL

BAS-DE-STE-ROSE

ST-HYACINTHE

DRUMMONDVILLE

MT. ST-BRUNO

MT. ST-HILAIRE

MT. ROUGEMONT

MT. YAMASKA

FLEUVE

Riv. Richelieu

Riv. Yamaska

Riv. St-François

Riv. Nicolet

Riv. du Chêne

Petite Rivière du Chêne

Gde Riv. du Chêne

Gentilly

Bécancourt

Pontgravé

L

N

L-N

DELSON FAULT

0 8 16 24
Miles Milles

MONTEREGIAN - Igneous rocks
Roches ignées MONTÉRÉGIENNES
} DEVONIAN or YOUNGER

BÉCANCOUR RIVER - (QUEENSTON) Sandstone, Shale
RIVIÈRE BÉCANCOUR (QUEENSTON) Grès, argile schisteuse

PONTGRAVE RIVER, Shale
RIVIÈRE PONTGRAVÉ - Argile schisteuse
} RICHMOND

L LECLERCVILLE - Shale
LECLERCVILLE - Argile schisteuse

N NICOLET RIVER - Shale Sandstone
RIVIÈRE NICOLET - Argile schisteuse, grès

LOTBINIERE - Shale
LOTBINIÈRE - Argile schisteuse
} LORRAINE

} UTICA

ST-GERMAIN COMPLEX, Utica, Lorraine, etc.
COMPLEX DE ST-GERMAIN - Utica, Lorraine etc.

ST-DOMINIQUE THRUST SHEET - Chazy River, Trenton, etc.
LAMBEAU DE CHARRIAGE DE ST-DOMINIQUE - Chazy, BLACK RIVER, TRENTON etc.,

ORDOVICIAN

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ST-LAWRENCE LOWLANDS

SOUTH OF ST-LAWRENCE RIVER

To accompany
summary report by T.H.CLARK

No. 642

TERRES BASSES DU ST-LAURENT

RIVE SUD DU FLEUVE ST LAURENT

Pour accompagner
le rapport sommaire de T.H.CLARK