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Pleistocene History and Glacio-tectonic Features in the Lack Megantic Region, Quebec

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Pleistocene History and Glacio-tectonic Features in the Lac Mégantic Region, Québec[1]

by

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The road log which follows provides detailed descriptions of field localities which define the glacial stratigraphy of the Lac-Megantic area. Evidence for three glaciations separated by two nonglacial intervals includes three stratigraphically distinct tills, lacustrine deposits related to Glacial Lake Gayhurst, a complex sequence of lake sediments and fine gravels (Massawippi Formation), late-glacial recessional moraines, and striae indicating at least two different ice-flow directions.

In addition, large-scale slump blocks involving thick sections of lacustrine sediments and till, and complex deformation structures in ice-contact sediments will be examined.

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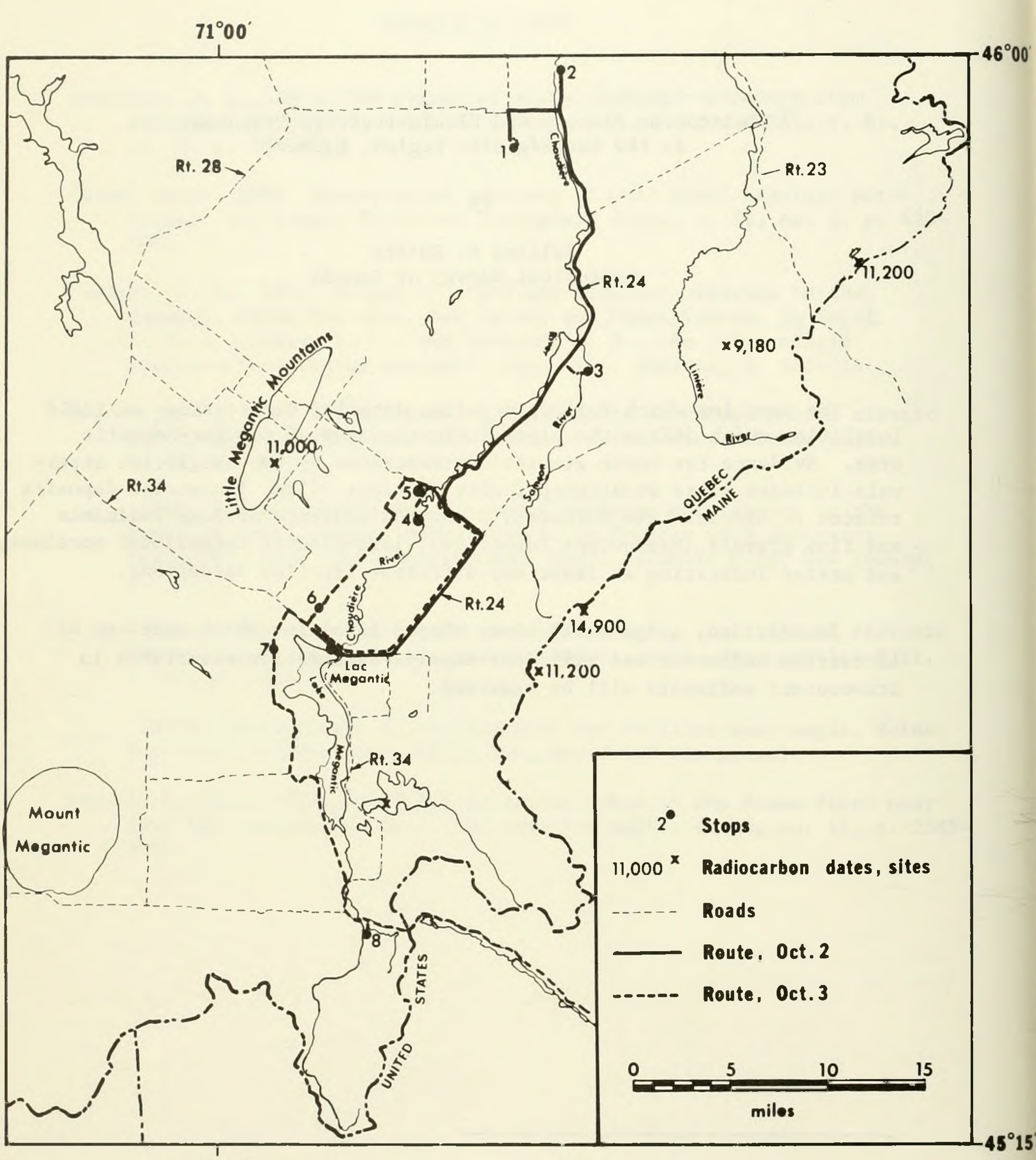

71°00′
46°00′
45°15′
Rt. 28
Rt. 23
Rt. 24
Rt. 34
Rt.34
Chaudière
River
Samson
Linière
River
Little Megantic Mountains
Mount
Megantic
Lac
Megantic
Lake
Megantic
QUEBEC
MAINE
UNITED
STATES
11,000
11,200
9,180
14,900
11,200
1
2
3
4
5
6
7
8
2 Stops
11,000 x Radiocarbon dates, sites
Roads
Route, Oct. 2
Route, Oct. 3
0
5
10
15
miles

Figure 1

Quaternary Stratigraphic Column, Southeastern Quebec

Age		Unit	Chronologic Control
	Late Wisconsin	post-Lennoxville sediments	12,640 ± 190 (GSC-312; peat) 12,570 ± 220 (GSC-419; peat) 11,500 ± 160 (GSC-475-2; marine shells) 9,180 ± 180 (GSC-856; wood in colluvium) 12,000 ± 230 (GSC-936; marine shells) 11,200 ± 200 (GSC-1248; peat) 11,000 ± 240 (GSC-1289; peat) 11,200 ± 160 (GSC-1294; peat) 14,900 ± 220 (GSC-1339; peat)
		Lennoxville Till	
	Middle Wisconsin	Gayhurst Formation	>20,000 B.P. (GSC-1137) ca. 4000 varves
		Chaudière Till	
	Early Wisconsin	Massawippi Formation	>54,000 B.P. (Y-1683) >41,500 B.P. (GSC-507) >40,000 B.P. (GSC-1084)
		Johnville Till	
Sangamon and/or Illinoian		pre-Johnville sediments	

Stop Descriptions

Stop #1: Grande Coulée Section

Lennoxville Till; 5 m - 7 m; At east end of the section till is sandy and silty and oxidized to its base; sandy facies pinches out on the west side of the section and is represented by a compact, grey, unoxidized till facies typical of most exposures of Lennoxville Till in the region; sandy facies may represent an end moraine deposited in the proglacial lake which abutted the Lennoxville glacier during its retreat down the Chaudière valley; fabrics indicate ice flow from N to N 40°W.

Gayhurst Formation (?); 7 m thick; Interlaminated sand, silt, and clay, tentatively correlated with Gayhurst Formation sediments occurring farther south in the Chaudière valley, on the basis of stratigraphic position beneath Lennoxville Till; Chaudière Till, which underlies Gayhurst Formation sediments elsewhere, has not been identified in this section; note alternating oxidized and unoxidized beds throughout the section.

Massawippi Formation; 0.4 m thick; Fissile, structureless sand contains finely divided plant fragments dated >40,000 B.P (GSC-1084); Massawippi Formation contains pollen (predominantly Picea and Pinus) which suggest presence of a northern boreal forest at its time of deposition; i.e. a climate cooler than present; Massawippi Formation is exposed only in a lens at the west end of the section where it rests on a diamicton about 0.3 m thick. This diamicton can be traced to the east end of the section at about the same altitude and is used as a marker bed to clarify the relationships of older and younger stratigraphic units to the Massawippi Formation.

Johnville Till; 1.6 m thick; Compact, non-calcareous, grey till with strong fabric from N 40° W; only occurs in the central part of the section where it is directly overlain by the diamicton which underlies the Massawippi Formation; Johnville Till is thought to be of early Wisconsin age and correlative with the Bécancour Till of the St. Lawrence Lowlands.

Pre-Johnville Sediments;

A) Fluvial Gravel; 3 m thick; Coarse, massive gravel with strong stone imbrication indicating eastward current; gravel clasts are thickly coated with iron oxide at the west end of the section; unit can be traced from the west to east end of the section; overlain by the diamicton and Massawippi Formation at the west end of the section, directly by Johnville Till in the center, and by the diamicton and Gayhurst Formation (?) at the east.

B) Laminated silt and clay; 1.6 m thick; Possible glacial-lake sediment; non-calcareous throughout and oxidized to within 30 cm of its base; traceable with the same thickness and altitude throughout the section.

C) Fluvial Gravel; 1.3 m thick; Similar to (A) but clasts are not coated with iron oxide and are finer; rare erratics of gneiss from the Canadian Shield (70 mi to the north) found in this gravel, indicating derivation from a glaciated terrain.

D) Coarse sand grading downward into fine sand with clay partings; >4.4 m; May be a lacustrine or flood-plain sediment; unoxidized fine sand below river level contains finely-divided plant debris.

The pre-Johnville sediments are the oldest sediments recognized in southeastern Quebec and are tentatively assigned a pre-Wisconsin age. They may be the most complete record yet described of pre-Bécancour-Johnville deposition east of Toronto.

Stop #2: Chaudière River Section north of St. Martin-de-Beauce

Lennoxville Till; 18 m thick; Compact, grey, fissile, calcareous, pebbly, silty till; oxidized upward 5 m from base and downward 3 m from top; selenite crystals, apparently formed during breakdown of pyrite and calcite, were found near the base of the unit; fabrics indicate that the Lennoxville glacier was flowing from N 60° W - N 80° W during deposition of entire unit.

Lennoxville Till, sandy facies; 4.5 m thick; Sandy, loose, gravelly, oxidized till; similar to sandy tills of New England; texture is probably partially a result of incorporation of underlying sandy lake sediments; bottom contact irregular due to thrust faults which have carried lake sediment into the till.

Gayhurst Formation (?); 7 m thick; Interlaminated fine sand and clay; upper portion of the sediment is disturbed and sheared into overlying sandy till.

Chaudière Till; >1m thick; Grey, hard, calcareous, sparingly stony till with shear structures; fabric suggests that depositing glacier moved from about N 20° E.

Stop #3: Samson River Section

The area traversed to reach the Samson River section is on the axis of the indicator ribbon of ultrabasic rocks which extends southeast from the Thetford Mines area. This indicator train is very narrow and does not have the classic "fan" shape of indicator trains described in New England. Boulder piles on the field at the start of the traverse have 10% and 14% ultrabasic cobbles, but ultrabasic frequency drops to less than 2% 6 miles north and south of the field (the width of the source area outcrop is 14 miles).

The petrology of the upper tills at the Samson River section has been studied in detail. 155 till samples from a 10 m x 4 m vertical face have had complete textural analyses (on particles <6 mm diameter); clay-mineral analyses, calcite/dolomite (Chittick) analyses, and <2μ carbonate (X-ray) analyses. The weight percents of magnetite and total heavy minerals in the fine-sand fractions, and trace element concentrations (Ni, Cr, Zr, Ti, Cu, V) in the <63μ fraction have been calculated for most samples. The purpose of this exercise was to evaluate the vertical and lateral variations of these parameters in relation to primary (sedimentation) and secondary (weathering) processes. Preliminary results of this study will be discussed at the section.

- Stratigraphy: -

Lennoxville Till

A. Till; 1 m to 3 m thick; Sandy, compact, pebbly till, oxidized to base; includes lenses of lake sediment sheared up from beds immediately at base; fabric and high ultrabasic pebble frequencies indicate that this unit was deposited by a glacier flowing from N 50° W - N 80° W.

B. Lake Sediment; 0 m to 1. 6 m thick; Highly contorted and sheared, interlaminated fine sand and clay; oxidized where less than 0.5 m thick.

C. Till; 5 m thick; Compact, grey, pebbly, silty till with a boulder pavement at the top; fabrics and pebble lithologies indicate the unit was deposited by a glacier with flow from N 20° W - N 30° W; oxidation extends along joints almost to the base; underlying deformed, clayey lake sediments grade gradually upward into till.

Gayhurst Formation; 13 m thick; Grey, calcareous, interlaminated silt and clay; contains several 0.3 m- to 1.0 m-thick zones of massive silt-clay or stony till-like sediment; the stony bands contain convolute laminations, and thin, horizontally bedded silt and clay laminae above and below them are undisturbed; the massive zones are interpreted as "turbidity" current deposits resulting from slumping from basin sides or an ice front or subaqueous slumping of sediments already deposited on the lake floor.

Chaudière Till; 1.5 m thick; Grey, calcareous, compact, clayey till; although the fabric is similar to those in the higher Lennoxville Tills (NW) the unit contains no ultrabasic pebbles; clayey texture caused by incorporation of clayey lake sediments which crop out at the base of the section; till includes clasts of these sediments and has a maroon tinge which is typical of the lake sediments.

Pre-Chaudière Sediments

A. Fine Gravel; 3 m thick; Fine gravel with large-scale crossbedding dipping south (opposite present river flow); gravel contains 5 cm to 10 cm rounded clasts of underlying lacustrine laminated silt and clay.

B. Lake Sediment; >1 m thick; Interlaminated, calcareous, silt and clay; clay laminae are chocolate brown to maroon at this locality; this unit crops out at several places just above and below river level along the Samson River.

Approximately 0.25 miles upstream from the section a diapir of the lowest (maroon) silt and clay can be seen intruding the overlying fine gravel. The origin of this structure is not known, but it illustrates the high plasticity of clay and silt in the Lac-Mégantic area.

Stop #4: Gayhurst Dam Borrow Pit

The section described here is a composite of the borrow pit, the deep gully on the far (east) side of the river, and a borehole drilled to bedrock just north of the gully. The stratigraphy in the borehole was determined by taking split-tube and Shelby tube samples at 1 m intervals and at changes in lithology. The three sites serve as the type section of the Gayhurst Formation.

- Stratigraphy: -

Lennoxville Till; ~10 m thick; Clay-till member of Lennoxville Till; compact, grey, calcareous clayey till with less than 10% sand and coarser fragments; note that there are no boulders in the till and that the till pebbles include no granodiorite component; the ground surface behind the section is mantled with large, predominantly granodiorite boulders - a one-boulder-thick ablation deposit; Fabric is N 20° E.

Gayhurst Formation

A. Upper Member; 6.2 m thick; Calcareous, laminated silt and clay; bottom 0.3 m is contorted with ball and pillow structures and convolute lamination suggesting subaqueous slumping; about 600 graded couplets are present in this unit.

B. Middle Member; 22 m thick; Fine sand grading upward to coarse sand and fine gravel with large-scale crossbedding; the top of this unit (altitude = 369 m a.s.l.) is thought to approximate the altitude of the water surface of the low level phase of Glacial Lake Gayhurst at this site; the upper contact can be traced at approximately 370 m several miles downstream from here.

C. Lower Member; 59 m thick; Fine-grained lacustrine sediment; contains approximatley 3400 graded, calcareous silt and clay couplets; upper 7 m and lower 10 m are very fine sand and silt; graded couplets contain sparse, finely disseminated plant fragments; several zones show evidence of subaqueous slumping.

Chaudière Till; 11.8 m thick; Two grey, compact, calcareous, silty, sandy till units separated by 2.4 m of highly deformed, brecciated silt and clay laminae; upper part of till derived from northwest; lower part derived from north or northeast.

Pre-Chaudière Sediments

A) Lake sediment; 2.4 m thick; intensely deformed laminated silt and clay.

B) Fine Gravel; 1.2 m thick; fine gravel with abundant clasts derived from sources to northwest.

C) Johnville (?) Till; 2.7 m thick; stony, compact sediment; no sample recovered.

D), Lake sediment (?); 1.8 m thick; silt and clay; no sample recovered.

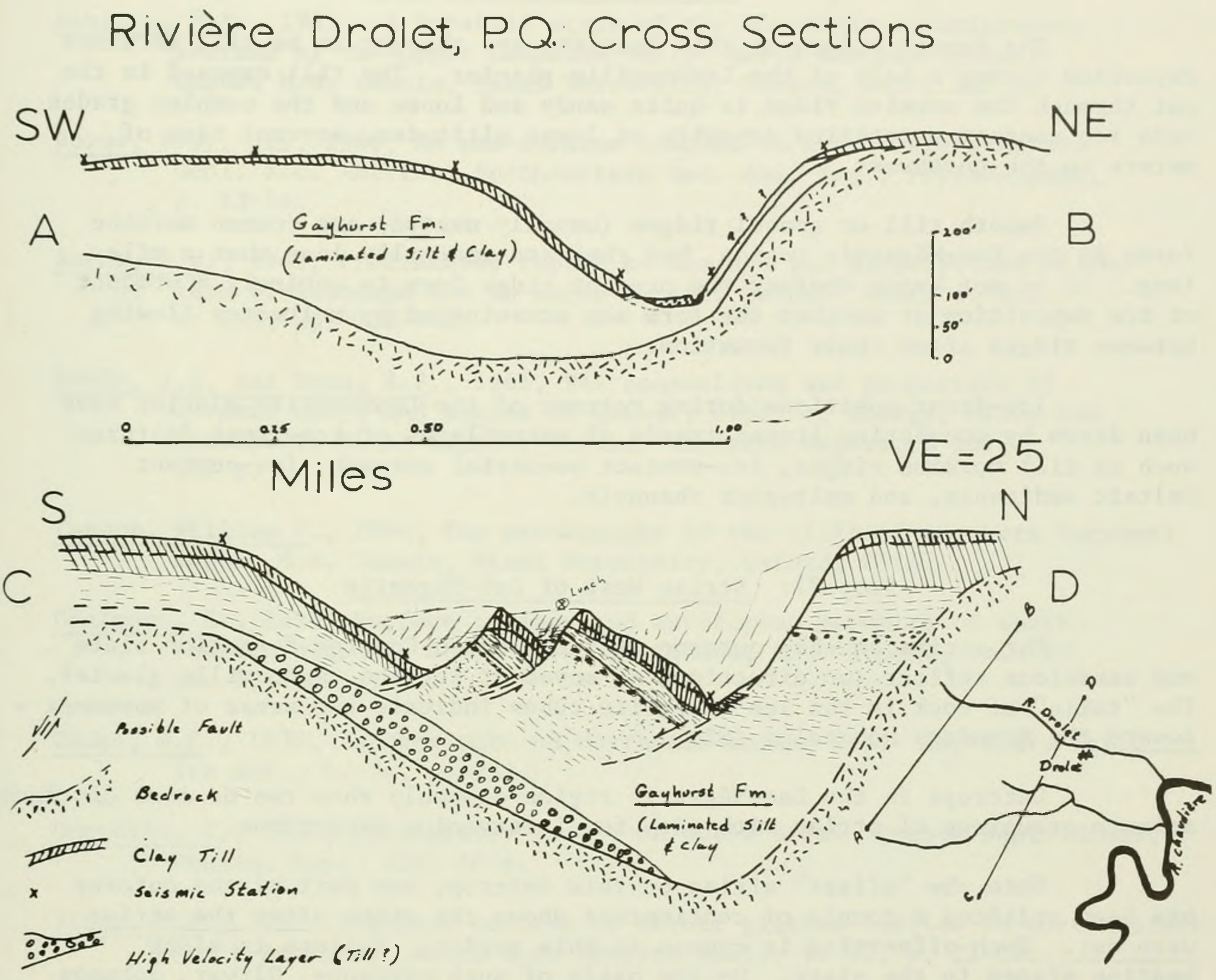
E) Weathered bedrock (?); 1.8 m thick; no sample recovered.

F) Pyritiferous black slate (Compton Fm., Devonian (?); 2.8 m of core recovered.

Stop #5: Drolet Slump Blocks

The asymmetric ridges on which we will eat lunch are thought to be large, coherent slump blocks composed of Gayhurst Formation sediments capped by the clayey lentil of Lennoxville Till. The blocks have dropped as much as 50 m vertically along normal fault planes, appparently in response to erosion by the Chaudière River. Although rotational slumping is quite common everywhere in the Lac-Mégantic region, these blocks are unusual for their size (more than 1 mile long) and location more than two miles from the site of river erosion.

The Drolet River occupies a broad, deep bedrock depression (see accompanying figures).



Diagrammatic Cross Section
of Rotational Slump:
Rivière Chaudière, P.Q.

Figure 2

Stop #6: Mégantic Moraine Complex

The smooth ridges at this locality are thought to be till moraines deposited during a halt of the Lennoxville glacier. The till exposed in the cut through the moraine ridge is quite sandy and loose and the complex grades into ice contact stratified deposits at lower altitudes, several tens of meters to the northwest.

Smooth till or gravel ridges (usually nested) are common moraine forms in the Lac-Mégantic region, but they are generally less than a mile long. It is not known whether the present ridge form is entirely a product of ice deposition or whether the form was accentuated by meltwater flowing between ridges after their formation.

Ice-front positions during retreat of the Lennoxville glacier have been drawn by connecting linear trends of assemblages of ice-front features such as till moraine ridges, ice-contact subaerial outwash, ice-contact deltaic sediments, and meltwater channels.

Stop #7: Striae West of Lac-Mégantic

The striae on this outcrop of interbedded Compton Formation slate and sandstone reflect two directions of movement for the Lennoxville glacier. The "tails" of rock in the lee of pyrite cubes indicate the sense of movement - toward the Boundary Mountains (SE).

Outcrops in the Lac-Mégantic region commonly show two or more distinct azimuth groupings of striae with very few intervening directions.

Note the "offset" striae on this outcrop; one part of the outcrop has been uplifted a couple of centimeters above the other after the striae were cut. Such offsetting is common in this region. Failure is along bedding planes in the slate. On the basis of such evidence, Oliver, Johnson and Dorman (1970) have suggested that the cumulative postglacial displacement along such faults may have been "substantial".

Stop #8: Woburn Esker Gravel Pit

This pit has exposed in the past an excellent assemblage of structural features resulting from melting of buried ice. The pit face exposes two main areas of slumping over melting ice. Note that the faults formed in response to subsidence are high-angle reverse faults with small compensating normal faults. The significance of this observation will be discussed briefly.

This stop is about $1\frac{1}{2}$ to 2 miles from the Coburn Gore customs houses. The field trip ends here and those travelling to Rangely-Stratton need only follow route 34 east to the border where it joins the Arnold Trail (rte. 27) which passes through Rangely and Stratton. Drive very carefully as this road is tortuous, narrow, and heavily travelled by logging trucks.

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