Surficial geology of Saint-Joseph-de-Beauce map area, Chaudière River valley, Quebec

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Abstract

Surficial geology mapping in the Saint-Joseph-de-Beauce, Quebec area directed particular attention toward an inventory of bedrock striations and paleocurrent directions in ice-contact stratified drift. Preliminary results indicate that widespread, late glacial northward striations, observed to postdate southeastward Laurentide glacial striations in adjacent areas of Maine and Quebec, are also prominent in the highlands and interfluvies of the St-Joseph-de-Beauce region. However, in the middle and lower reaches of Chaudière and Etchemin valleys, ice contact stratified deposits have structures indicating southward paleocurrents. This suggests that northward glacial flow and melting of a remnant Appalachian ice mass was followed by limited southward expansion and readvance of Laurentide ice up major trans-Appalachian valleys, an event of regional climatic significance.

Résumé

La cartographie des formations en surface de la région de Saint-Joseph-de-Beauce au Québec, a suscité beaucoup d'intérêt pour l'établissement d'un inventaire des stries du socle et des directions des paléocourants observées dans les matériaux stratifiés de contact glaciaire. Les résultats préliminaires indiquent que des stries tardiglaciaires dirigées vers le nord et très répandues, plus récentes que des stries faites par les glaces laurentiennes et dirigées vers le sud-est dans les régions adjacentes du Maine et du Québec, sont tout aussi bien développées dans les hautes terres et les interfluvies de la région de Saint-Joseph-de-Beauce. Cependant, dans les portions moyenne et inférieure des vallées des rivières Chaudière et Etchemin, les dépôts stratifiés de contact glaciaire présentent des structures qui indiquent l'existence de paléocourants dirigés vers le sud. Ces observations semblent indiquer que l'écoulement glaciaire vers le nord et la fonte des masses glaciaires résiduelles des Appalaches ont été suivis d'une expansion limitée vers le sud et d'une nouvelle avancée des glaces laurentiennes en amont des grandes vallées trans-appalachiennes, événement qui a joué un rôle important du point de vue du climat régional.

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INTRODUCTION

Mapping of the surficial geology of the St-Joseph-de-Beauce map area (1:50 000, NTS 21 L/7) was completed in 1988. Expanding from preliminary reconnaissance mapping carried out by N.R. Gadd and Pierre LaSalle in the 1960s, this project completes mapping of the upper and central Chaudière Valley (Gadd, 1964, 1978; Shilts, 1981). The study area occupies a critical geographical spot in southeastern Quebec for both economic and academic reasons (Fig. 1). It contains areas of high gold potential in glacial and preglacial sediments and an ophiolite belt that has been explored for platinum group elements. Geochemical or overburden drilling exploration for both these commodities depends on an adequate, up-to-date interpretation and map of surficial sediments (Shilts and Smith, 1988).

Indicators of ice flow directions and paleocurrents in ice contact deposits were mapped systematically using aerial photo interpretation of the surficial geology, building on observations made by Gauthier (1975) and Lortie (1976), and investigation of several well exposed stratigraphic sections and cores from deep boreholes in and near Rivière des Plantes in the southern part of the map area (Shilts and Smith 1986a,b, 1988; Smith and Shilts 1987). The results of this research will be expanded upon in an MSc thesis to be completed by the first author.

PRELIMINARY RESULTS

Surficial deposits in the St-Joseph-de-Beauce area consist mainly of thin, stony, olive-grey, weathering tan till draped over rolling bedrock hills. In Chaudière Valley, till is thicker, but bedrock outcrops are still common. In both Chaudière and Etchemin valleys, massive deposits of ice contact sand and gravel stand as prominent hills or terraces. These deposits are thought to be subaqueous outwash facies, mainly on the strength of their occurrence well below 396 m1, which is the approximate elevation of the main outlet eastward to Saint John River valley of a series of lakes that were dammed by glaciers every time they entered the valleys of the northward flowing Chaudière and its tributaries (Shilts, 1981). In addition to the massive ice contact deposits at Vallée-Jonction (Fig. 2), there are several other geomorphically less prominent deposits of poorly sorted gravel, diamictons, and well sorted sand and gravel in bands across Chaudière Valley as far south as St-Martin (Fig. 3). In every one of these deposits in Chaudière Valley, current measurements indicate discharge southward, opposite the direction of present drainage. In the middle reaches of Etchemin Valley, current directions are similarly southward, indicating, as in Chaudière Valley, that they were deposited from an ice mass lying to and advancing from the north.

In upper Etchemin Valley and on the interfluves east and west of Chaudière Valley, ice contact deposits commonly have structures indicating northward discharge (Fig. 3).

Likewise, the abundant striae on outcrops flanking the valleys, and at some places in the valleys themselves, are oriented predominantly toward the north; in places the northward oriented striae are superimposed on southeastward oriented striae.

DISCUSSION

This juxtaposition of striae in the Estrie-Beauce region has long been known (Lamarche, 1971; Gadd et al. 1972; Lortie and Martineau, 1987). It is attributed to the formation of a late glacial ice divide in the Appalachians east of Rivière Saint-François. The ice divide developed as the result of the creation of a saddle in the ice sheet over St. Lawrence Valley in response to drawdown of ice into marine water encroaching up the lower St. Lawrence estuary (Gadd et al., 1972; Thomas, 1977). This saddle cut off the southward to southeastward flow of Laurentide ice across the St. Lawrence and Appalachians. Till deposited by this southeastward flow contains Precambrian and unmetamorphosed fossiliferous Paleozoic erratics derived from within and north of the St. Lawrence Lowlands. Development of the saddle caused ice flow to reverse toward the St. Lawrence, thus accounting for northward trending striae being superimposed on southeastward trending striae.

Notwithstanding this erosional evidence on outcrops that flank it, the southward current directions of ice-contact sediments in Chaudière Valley and the elevations of the lowest cols in the Chaudière drainage basin suggest that the last glacial event was an ice lobe that advanced up the valley in a deep lake. The lobe would represent a readvance from a body of Laurentide ice that lay in the St. Lawrence Lowlands. Similar lobes may have projected up other major trans-Appalachian valleys, such as the Saint-François and Etchemin. However, the fact that northward paleocurrent directions are present in the ice contact deposits of upper Etchemin Valley suggests that once that part of the valley was deglaciated by southward retreat of northward-flowing ice, it was not reoccupied by glaciers.

The results of this and previous studies indicate that the paradox of stratified sediments deposited by southward flowing glaciers lying in major valleys surrounded by evidence of late glacial northward flow is explained best by the readvance theory. At several places in Chaudière and tributary valleys, deposits of clayey till lying on intensely deformed lacustrine sediments were observed to rest directly on typical Lennoxville Till as defined by McDonald and Shilts (1971). Taken together these sites may provide depositional evidence for a readvance.

CONCLUSION

In the St-Joseph-de-Beauce map area the understanding of a complex history of ice movements has been augmented by elucidation of the details of Lennoxville glaciation, based largely on bedrock striations and paleocurrent data from ice contact stratified deposits. Recent work by Shilts and Smith (1986a,b, 1988) has confirmed the pre-Lennoxville Appalachian stratigraphy first discussed by McDonald and Shilts (1971). From the present and earlier studies, a picture of at least three glaciations has emerged. Deposits of each

1 A lower col at 305 m could carry water westward to the Saint-François drainage system thence by a complicated route through Lake Champlain to Hudson River. This col is still considerably higher than the surface of the ice-contact deposits in Chaudière Valley (213 m at Vallée-Jonction).
Figure 1. Location map of Saint-Joseph-de-Beauce map area.
glaciation with accompanying interstadial or interglacial beds are well represented in the Rivière des Plantes sections at the south border of the Saint-Joseph-de-Beauce map area (Shilts and Smith, 1987; Poliquin, 1987; Paul, 1987). From oldest to youngest, they are:

1) Johnville glaciation: Glaciers crossed the study area southeastward from a Laurentide source.

2) Chaudière glaciation: Glaciers crossed the study area first west-southwestward from an Appalachian ice cap to the east, shifting to flow southeastward from a Laurentide ice cap.

3) Lennoxville glaciations: Glaciers crossed the study area first southeastward from a Laurentide ice cap, flowing across the Appalachians to the New England coast (Shilts, 1976, 1981). During the general deglaciation of New England and eastern Quebec, ice south of St. Lawrence River flowed northward to northeastward from a local ice divide developed in response to drawdown along the axis of St. Lawrence Valley into a marine calving bay that formed in the lower St. Lawrence estuary. After retreat of this northward flowing ice to an ice divide located near St-Georges, about 40 km south of the map area, Laurentide ice again flowed up Chaudière and Etchemin valleys in the form of tongues of thin ice advancing into deep lakes. The southward flowing lobes of ice apparently covered only the middle Chaudière and Etchemin river valleys and the lower Appalachian foothills flanking these rivers to the northwest and northeast, respectively. It is probable that other major Appalachian valleys, such as the Saint-François, were similarly affected, because the youngest ice contact deposits also show southward current directions (Banerjee and McDonald, 1975). It is not possible to say whether the readvance started from the Appalachian front south of St. Lawrence River or whether ice advanced across St. Lawrence Valley through proglacial lakes or the Champlain Sea. Because the readvance appears to postdate melting of the remnant northward flowing Appalachian ice, it probably represents at least a regional paleoclimatic event—a deterioration of climate causing expansion of the eastern Laurentide Ice Sheet.

Figure 2. Ice-contact stratified drift at Vallée-Jonction, Quebec. Esker complex fed subaqueous outwash fan. Paleocurrents measured from ripple cross-laminae in medium to fine sand.
Figure 3. Selected striations and mean directions of paleocurrents in ice contact stratified drift in Saint-Joseph-de-Beauce and adjacent map areas. On many outcrops, northward striae clearly cut earlier regional southeastward striae, but no unequivocal evidence of later southeastward striations, formed during the readvance, has been found.
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Cover description

Lower Silurian Goldson Conglomerate with large unsorted clasts of bedded shale and siltstone, New Bay, northeast Newfoundland. Photo by H. Williams
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