DEGLACIATION PATTERN OF THE WESTERN ST. LAWRENCE LOWLANDS (PETITE-NATION VALLEY, QUEBEC, CANADA) USING SURFACE AND SUBSURFACE LITHOSTRATIGRAPHY.

HURTUBISE, M.-A.[1], DAIGNEAULT, R.-A.[1] & ROY, M.[2]

UQÀM
Département de géographie
Université du Québec à Montréal

[1] Département de géographie, Université du Québec à Montréal, C.P. 8888, Succursale Centre-Ville, Montréal, Québec, H3C3P8

[2] Département des Sciences de la Terre et de l'atmosphère & GEOTOP, Université du Québec à Montréal, C.P. 8888, Succursale Centre-Ville, Montréal, Québec, H3C3P8

Introduction

The Petite-Nation River Valley (NTDB mapsheets 031G10, 031G11 and 031G14) is located in the southwestern part of Québec (Canada), in the Outaouais region, at the junction of the St-Lawrence lowlands in the south and the highlands of the Canadian Shield to the north (**fig. 1**). The sediments and geomorphology exposed in this narrow valley recorded several events during the last deglaciation, including deposits of ice retreat and glaciomarine and marine features associated with the Champlain Sea episode. The area is also characterized by the presence of the St-Narcisse Moraine (Younger Dryas) near Chénéville area. However, the understanding of the regional deglaciation remain tenuous, mainly due to the thick marine sediments layer which covers most of the deglacial landforms.

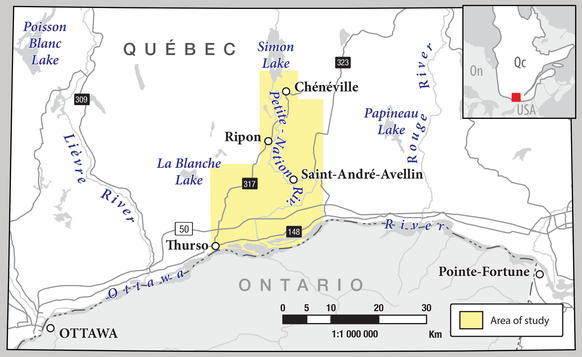

Fig. 1 Location of the studied area.

Objective

The objective of this study is to reconstruct the deglaciation pattern by combining a detailed mapping of the surficials deposits and a compilation of borehole-stratigraphic sections for the whole area.

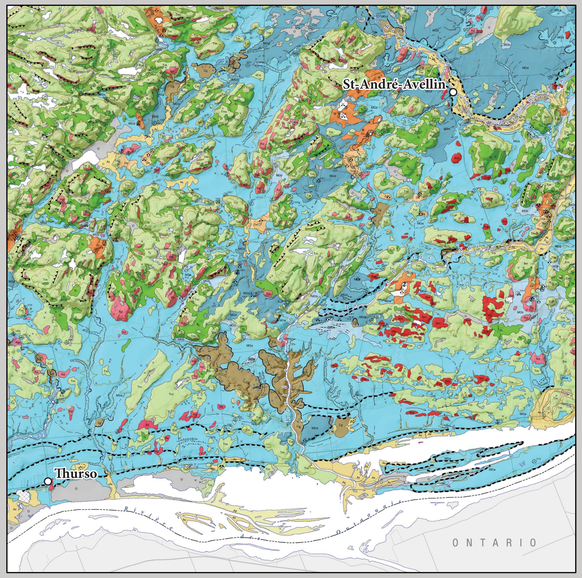

Fig. 2 Map of superficial Quaternary deposits and landforms of the Saint-André-Avellin region (031G11-E).

Références
Cummings, D.I. et Russell, H.A.J. (2007). The Vars–Winchester esker aquifer, South Nation River watershed. (Open File 5624). Ottawa : Geological Survey of Canada.
Dubois-Verret, M. (2015). Écoulements glaciaires, géomorphologie et paléogéographie de l'Outaouais (titre provisoire). (Master's thesis, in evaluation). Université du Québec à Montréal.
Hurtubise, M.-A. (2014). Paléogéographie quaternaire de la vallée de la Petite-Nation (Québec) : cartographie des formations superficielles (031G/11-EST) et modélisation de la lithostratigraphie de la sous-surface. (Master's thesis). Université du Québec à Montréal.
Ross, M. (2004). Stratigraphie et architecture des formations quaternaires au nord-ouest de Montréal - Applications en hydrogéologie régionale. (Phd Thesis). Université du Québec INRS-Eau, Terre & Environnement.

Follow this QR code to download the poster and the associated master's thesis.

Methods

Surficial geology mapping (one map; 1:50 000; see **fig. 2**) was achieved using 3D panchromatic aerial imagery computer-assisted analysis (Summit Evolution combined with ArcGIS) and validation of sediments nature and landforms through fieldwork during the summers of 2011 and 2012 (**fig. 3**). A total of 145 ice-flow indicators were also collected during the survey to document ice-flow history.

Fig. 3 20 m high subaquaous outwash mound overhanging a marine clay valley ; close-up view of the outwash showing coarse sands with stratifications facing south.

The subsurface stratigraphy was revealed through the analysis of ~2500 boreholes. After being submitted to a series of quality control tests (user validation, GIS assisted), 1645 were considered reliable for this study.

Sedimentological sequences over- laying the bedrock were then analyzed and regrouped into six category based on their origin: glacial (till), glaciofluvial sediments (ice contact), fine-grained marine sediments (deltaic and littoral), alluvial and organic.

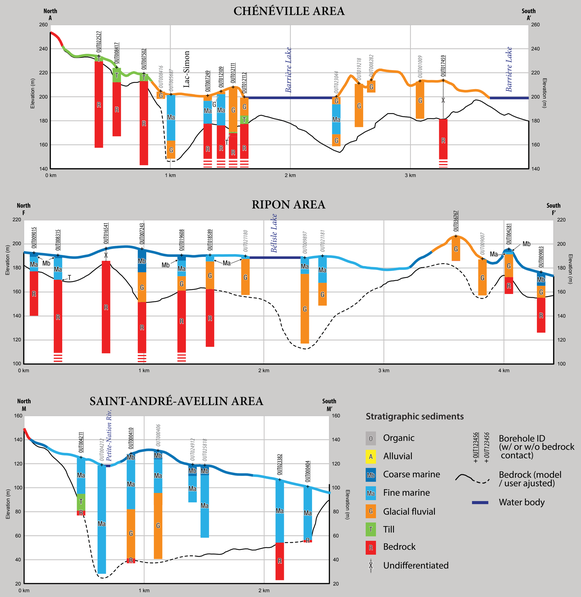

Fig. 4 Three of the 20 stratigraphic cross-sections showing the subsurface stratigraphy of the study area.

A total of 20 geological cross-sections were subsequently assembled using a GIS approach (see examples **fig. 4**). First we interpolated the total sediment thickness of the whole study area (isopach model using kriging interpolation method), then we generated several cross-sections using eXacto; an ArcGIS-based tool developed by the Illinois State Geological Survey. We subsequently exported data into Adobe Illustrator for some final adjustments. Based on the stratigraphic cross-sections and superficial deposit map, a topo-stratigraphic model representing the subsurface sediment assemblages was created (**fig. 5**).

Main results

Our results on the distribution of surficial and buried subaqueous outwash fans and ice-contacts deposits in the southern part of the study area indicate the occurrence of four pre-St-Narcisse morainic fronts (**fig. 6**). Their alignment suggests that the ice front was retreating with an ENE-WSW orientation. This is in agreement with the work made by Dubois-Verret (2015) at the larger scale for the whole Outaouais region.

Directly south of the main St-Narcisse morain ridge near Chénéville, boreholes revealed the presence of fine-grained marine sequences that are trapped between an upper and lower coarse-grained glaciofluvial deposits (**fig. 6**). The upper glaciofluvial unit is part of an outwash plain associated with the main St-Narcisse Moraine formation. Its altitude is at 220 m asl (720 ft), roughly 12 m below the maximum limit of the Champlain Sea in the area (232 m or 760 ft) (**fig. 5**). These results suggest a rather active ice retreat, which was apparently punctuated by an ice readvance during the St-Narcisse cooling episode.

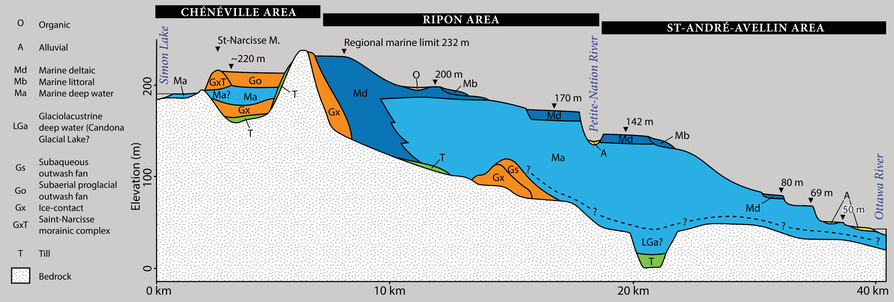

Fig. 5 Regional topostratigraphic cross-section of the study area (LGa refers to Ross's (2004) discussion about the extension of Candona Glacial Lake northwest of Montréal).

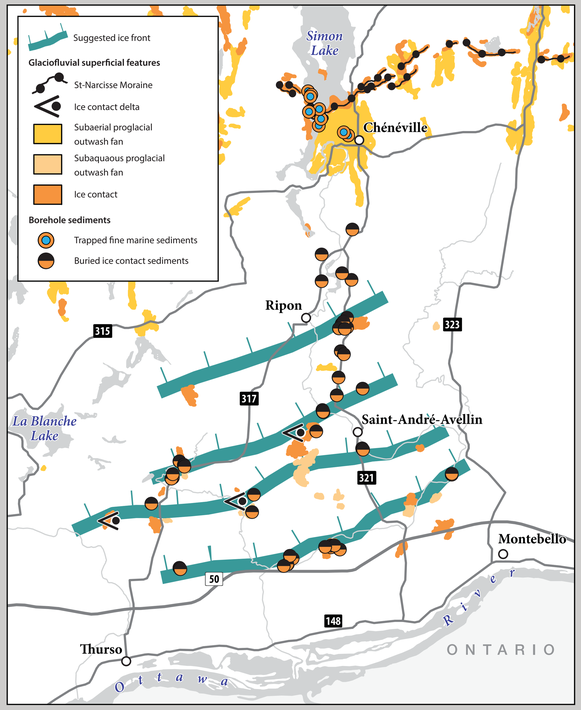

Fig. 6 Suggested ice fronts based on superficialdeposits mapping and compilation of boreholes.

Surficial mapping also suggests that deltas associated with the regressive phase of the Champlain Sea have developped at approximately 200 m (655 ft) in the Cheneville-Ripon region and at 170 m and 142 m (560 and 465 ft) in the vicinity of Saint-André-Avellin. Cross-sections indicate that those formations are usually less than 10 m thick and overlaying the marine clay. This rather small accumulation supports the idea of a fast retreating Champlain Sea from the valley.

Above the actual Ottawa River, three fluvial terraces at 80 m, 69 m and 50 m asl (260, 225 and 165 ft) carved in marine deposits have been documented. They appear to be relict features associated with a larger Ottawa River, likely formed at a time when the Champlain Sea was replaced with the fresh water of a newly formed fluvial system. As seen in the **fig. 7**, braided channels were active at a very large scale in the southwestern part of Quebec and the eastern Ontario region, with channels up to 15 km wide and a flow rate estimated at 800 000 m^3/sec, the equivalent of the Amazon River (Cummings & Russell, 2007).

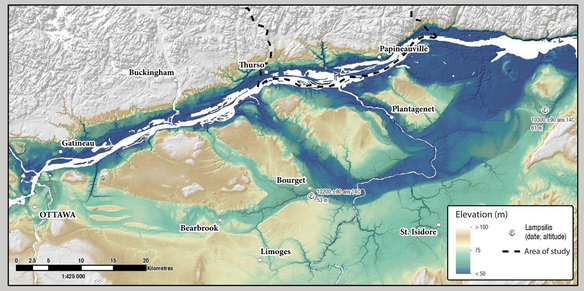

Fig. 7 Ancient braided channels carved within fine marine deposits, eastern Ontario and southwestern Quebec.

Conclusion

By mixing conventional method of superficial mapping and our method of modeling the underground stratigraphy, we think this study helped in a better understanding of the Quaternary events of the Petite-Nation Valley. Mapping and field survey gave insights about the nature and the origin of the Quaternary formations. The cross-sections revealed buried features which shed a new light on the ice margin position and fluctuations in the valley. They also provide a better knowledge of their geographical distribution, their thickness, etc. The method we suggest to modelize the cross-sections is relatively straightforward and affordable for any adept users of GIS softwares.

Acknowledgments

This study was part of the Programme acquisition de connaissances des eaux souterraines (PACES), a 2009 initiative by the Gouvernement du Québec to refine the knowledge of the aquifers. A superficial mapping survey of the administrative region of the Outaouais was initiate in 2011 in a partnership with the Université du Québec à Montréal (UQAM) and both the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP) and the Ministère des Ressources naturelles et de la Faune (MRNF). We would like to thank the Gouvernement du Québec for financing this study and their support in pushing forward Quaternary studies in the province of Québec. We also want to thank the hydrogeology team at the Université Laval for having generously shared their collection of boreholes of the Outaouais region.