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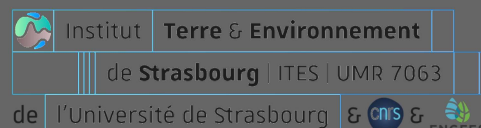
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Marine to continental transition sequence of a paleo ice-front, the case of the Pentecôte fan (Québec North Shore – Canada)

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Context

The last deglaciation sequence on the Québec North Shore (QNS) in eastern Canada has been largely documented in recent decades.

The first-order succession positions of the retreats are now well defined (fig.1), but not on a local scale.

However, there are still many uncertainties about the dynamics of the Laurentide Ice Sheet (LIS) front retreat during its marine to continental transition. This transition can lead to significant reorganisation of the ice sheet due to successive losses and recoveries of stability.

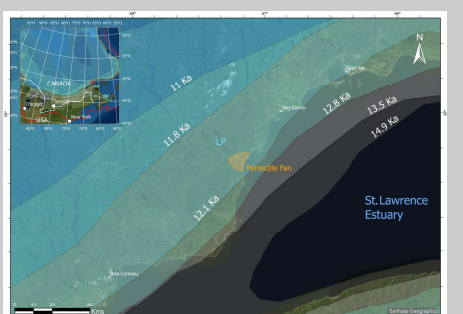


Fig.1 : Location of Pentecôte fan, between Baie-Comeau and Port-Cartier on the St. Lawrence North Shore (Québec, Canada). Insert: Reconstruction of ice-front positions from 14.9 to 11 ka cal BP (Dakton et al., 2020). LP: Lake Pentecôte.

Objectives

- Analyze the depositional ice-marginal complex of the Pentecôte fan (i.e. fig.2).
- Reconstruct the short deglaciation sequence of the ice-front retreat at the transition from sea to land.
- Identify particular events, different sedimentation rates and role of the fjord-lake Pentecôte.
- Integrate this local deglaciation sequence in the regional deglaciation context of the St. Lawrence estuary.



Fig.2 : Stratigraphic complex of Pentecôte 5 (localisation fig.4), a major sedimentary record located at the center of the fan Pentecôte composed of more than 90m of ice-marginal sediments. Person for scale (in red).

Methods

Geomorphology mapping (LiDAR)

The digital elevation model (DEM) obtained by LiDAR imagery with a resolution of 1m allows us to work on the topography near the Pentecôte fan subtracting the vegetation. This allows us to map the different landforms resulting from the last deglaciation sequence (fig.4) and in particular to see the different frontal recession moraines, the different marine limits and raised beach ridges as well as the Grounding zones wedges (GZWs).

¹⁴C datation

It is possible to find lacustrine or marine shells in this type of sedimentary complex. The ages obtained by carbon-14 dating can provide markers in the history of the sequence but can also provide us with sedimentation rates.

Stratigraphic sections

Several stratigraphic sections were made within the fan in order to reconstruct the sedimentary record, including stratigraphic units, depositional architecture and facies of the Pentecôte fan.

Photogrammetric models

The use of a DJI Mavic 2 pro drone made some outcrops accessible. The realization of photogrammetric models (i.e. fig.3) will allow us to identify depositional structures and sedimentary units. This will allow us to provide more information and therefore more robustness to our story about the deglaciation sequence. More than a dozen 3D models are planned.

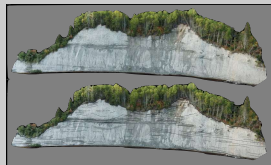


Fig.3 : 3D photogrammetric model of Pentecôte 2 with interpretation.

Preliminary results

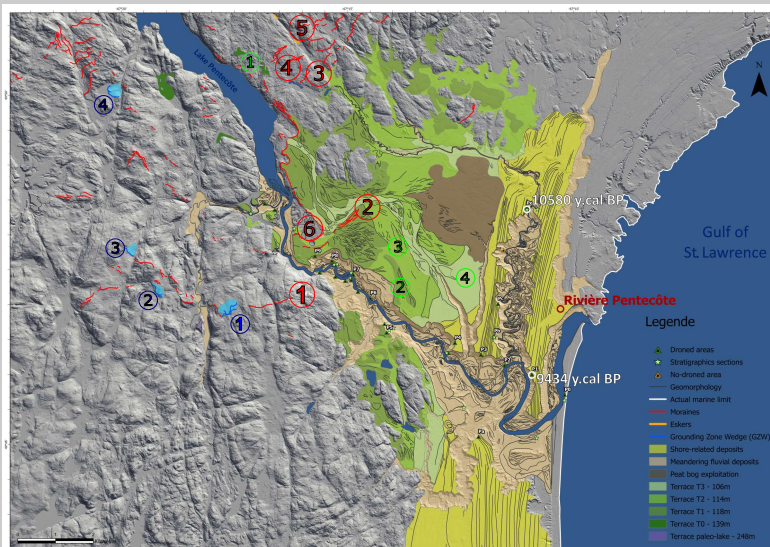


Fig.4 : Geomorphology mapping of the deglacial sequence of the fan Pentecôte.

3 ages of ¹⁴C datation

- **Maximal ages :**
Shells of *Hiattella arctica* located in Pe section, just few meters above the bedrock - alt 80m.
- 10620 years +/- 300 cal BP
- 10529 years +/- 300 cal BP
- **Minimal age :**
Shell (Dietrich et. al 2017) located in P1, at the top of the sedimentary section - alt 57m.
- 9434 years +/- 260 cal BP

Geomorphology

- 6 different important stages of stabilizations : 1 to 6 (fig.4).
- Few steps of readvance, i.e. stage 2 (fig.4).
- Formation of 2 successive (minimal) proglacial lakes crossed out by the ice front, with the presence of Grounding-zone wedges above the maximal marine limit, 1 to 4 GZWs (fig.4).
- 4 terraces at the top of the fan issues to different alignments of deposits with marine limit, 1 to 4 terraces (T0 to T3), with an altimetry of respectively 139, 118, 114 and 106m.

Discussion

The reconstruction of the deglaciation sequence obtained with the mapping of the different landforms (i.e. frontal moraines, GZWs) on the Pentecôte fan is carried out from the preserved and visible landforms. Indeed, it is highly probable that some stabilization phases, and more particularly the first ones, have been covered by the sedimentary input within the fan and thus make the reconstruction of the deglaciation history more difficult. Nevertheless, the use of photogrammetric models and stratigraphic sections will help to remove some of the doubts discovered during the geomorphological approach.

Conclusion

- The positions of the 3 ¹⁴C shell ages allow the deposition of the first and last deposits of the fan to be delineated, the deposition sequence lasting approximately 1150 +/- 300 years. The sedimentation rate is approximately +/- 100m for 1000 years (≈10cm/y). This is similar to the Portneuf deltaic complex (180 km south of Pentecôte, north coast of the St Lawrence) which took about 1000 years to build-up (Dietrich et. al. 2017).
- 6 different important stabilizations phase are observable, and some marking short re-advances events.
- The last stage of re-advancement located in the Pentecôte fjord-lake (stage 6) at the end of the deglaciation history.
- A minimum of two proglacial lakes that have been drained one or more times, to be found in the sedimentary sequence.
- 4 different levels of marine terraces on the topsets of the fan.
- The geomorphologic study coupled with ¹⁴C dating provides a preliminary scenario of the marine to continental deglaciation sequence. These initial results will have to be supplemented by sedimentological data obtained during the June and September 2021 missions in order to refine or correct the front deglacial sequence and the history of the fan.



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