Sediment dynamics in the western Canadian Arctic since the last millennium: a mineralogical and geochemical approach

Crystal Brochard¹, Jean-Carlos Montero-Serrano¹, Guillaume St-Onge¹

¹Institut des sciences de la mer de Rimouski (ISMER), Canada Research Chair in Marine Geology, Université du Québec à Rimouski, GEOTOP

Introduction
The Arctic Ocean currently experiences fast environmental changes due to its high response to global climate change. These changes notably include:
- reduced summer ice thickness and extent;
- reduction in multi-year ice extent;
- altered drift paths;
- major heat flow from Pacific;

The long-term natural variability is poorly constrained, leading to uncertainties in numerical climate models. In this context, sedimentary records are of great importance to decipher the processes controlling the Arctic climate and oceanographic variability for time periods prior to instrumental data.

Objectives
1. Compare the spatial distribution patterns of bulk minerals and elemental geochemistry during the Little Ice Age (LIA, between 1550 and 1850 AD), the Medieval Warm period (MWP, between 900 and 1300 AD), and the modern warming;
2. Identify different sedimentary provinces, source areas, and transport pathways of terrigenous material during these climatic periods;
3. Better document and understand the fundamental processes controlling the sediment dynamics within the western Canadian Arctic since the last millennium.

Samples
-50 box cores were sampled in the Canadian Arctic in 2016 and 2017 on board the CCGS Amundsen as part of the ArcticNet program (Figure 4).
-Sediment box cores are ~40 cm in length.

Methodology

1. ²⁰⁶Pb and ¹⁴C dating to determine recent sedimentation rates
   Sarah Lotaef, ISMER-UQAR MSc project

2. Bulk mineralogy
   H₂O, 30% 1 g sample + 0.25 g corundum
   quantitative X-ray diffraction (qXRD)
   (quartz, K-feldspar, plagioclase, dolomite, phyllosilicates)

3. Clay mineralogy
   H₂O, 30% + HCl 10%
   X-ray diffraction (XRD)
   (smectite, chlorite, illite, kaolinite)

4. Elemental geochemistry
   H₂O, 30%
   Loss on ignition (LOI): 950°C
   0.6 g sample + 6g lithium borate
   energy dispersive X-ray fluorescence (EDXRF)
   (Al, Si, K, Mg, Ca, Ti, Mn, Fe, P, Sr, V, Cr, Zn, Zr)

5. Cluster and principal component analysis (log-centered data)

6. Mineralogical and elemental geochemical maps

Preliminary results

Conclusions
- The Canadian Arctic may be separated into three sedimentological provinces:
  - The Mackenzie Trough-Canadian Beaufort Shelf, characterized by high phyllosilicate (notably, illite, chlorite, muscovite, smectite, and kaolinite) contents which are derived mainly from inputs of the Mackenzie River;
  - The Queen Maud Gulf distinguished by the association of quartz, feldspars, amphibole, and vermiculite resulting from the Ellice and Back Rivers;
  - Banks/Victoria/Prince of Wales Islands, Barrow Strait, and Lancaster Sound, characterized by high dolomite and intermediate phyllosilicate contents mainly supplied from coastal cliff erosion of Pleistocene carbonate-rich glacial tilts, as well as clastic sedimentary rocks cropping out on the islands.

- Phyllosilicates, total feldspar and detrital carbonate (dolomite) can be successfully used to track changes in terrigenous sediment inputs in the Canadian Arctic.

- This study will complement another MSc project focusing on the sedimentological, physical and magnetic properties of the sediments.

Acknowledgments
We sincerely thank the captain, crew and scientific participants of the 2016 and 2017 ArcticNet expeditions on board the CCGS Amundsen. The authors are also thankful to Marie-Pier St-Onge and Quentin Beauvais for all their help in the laboratory at ISMER. This research was funded by ArcticNet and the Natural Sciences and Engineering Research Council of Canada (NSERC) through Discovery and Ship Time grants to J.C. Montero-Serrano and G. St-Onge. We also acknowledge the financial support of the Canadian Foundation for Innovation (CFI) and Economic Development Canada for the acquisition of the PANalytical X-ray diffractometer (X'Pert Powder) and X-ray fluorescence system (Epsilon 3-XL), respectively.

References
- The Canadian Arctic may be separated into three sedimentological provinces:
  - The Mackenzie Trough-Canadian Beaufort Shelf, characterized by high phyllosilicate (notably, illite, chlorite, muscovite, smectite, and kaolinite) contents which are derived mainly from inputs of the Mackenzie River;
  - The Queen Maud Gulf distinguished by the association of quartz, feldspars, amphibole, and vermiculite resulting from the Ellice and Back Rivers;
  - Banks/Victoria/Prince of Wales Islands, Barrow Strait, and Lancaster Sound, characterized by high dolomite and intermediate phyllosilicate contents mainly supplied from coastal cliff erosion of Pleistocene carbonate-rich glacial tilts, as well as clastic sedimentary rocks cropping out on the islands.

- Phyllosilicates, total feldspar and detrital carbonate (dolomite) can be successfully used to track changes in terrigenous sediment inputs in the Canadian Arctic.

- This study will complement another MSc project focusing on the sedimentological, physical and magnetic properties of the sediments.