Core sub-sampling, Geological Survey of Canada

Calgary, AB

SUMMARY REPORT

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INTRODUCTION

Over the Dalhousie fall reading week in November, Dr. John Gosse (supervisor) and I travelled to Calgary, AB for collaborative work with the Geological Survey of Canada (GSC). The intent of the trip was to sub-sample petroleum cores and discuss recent, current and future research in the Canadian Arctic. The GSC in Calgary houses one of the largest core holding facilities in Canada, consisting of primarily offshore cores. The GSC Calgary has primary research interests in the Canadian Arctic and Canadian Petroleum sector. Facilities like these are very few and far between, featuring many leading experts in geological research in the Canadian Arctic. The trip was a benefit to all involved, and will have a tremendous impact in future research.

TRIP DETAILS & BACKGROUND INFORMATION

Trip Details

Our journey began flying from Halifax to Calgary on November 7th, 2016. We arrived at the GSC in Calgary around 2pm, where we met Rod Smith, our host for the week. After greetings we made our way to the core warehouse to view the cores to be sampled and explore the warehouse, looking at very interesting samples from the arctic.

Tuesday the 8th, we started our sampling of the core. Sampling included two wells, with sampling target of Terrestrial Cosmogenic Nuclide (TCN) dating of the Beaufort Formation and upper Eureka Sound Group, found in the western Canadian Arctic. These are Tertiary aged units, which will be discussed further later in the background section. Samples were taken from the Sirius K-28 well from Ellef Ringnes Island and Storkerson Bay A-15 well, offshore Banks Island. Sampling continued over the next couple days, being split up by talks and discussions on arctic geology.

Sampling finished on Wednesday the 9th, after which we were shown Ion-GXT seismic data from the area, a relatively new high resolution seismic dataset for the region. Several hours were spent looking at the seismic, which proved and disproved some hypotheses and brought about new questions.

Thursday the 10th was our last day at the GSC. I presented preliminary results of my honours research. Several outstanding researchers in the area were present and gave insight into their past and current research. After finishing at the GSC, thanks to John, we attended a Gallagher Lecture at the University of Calgary given by Dr. Andrew Miall. Dr. Miall is a well-established sedimentologist at the University of Toronto. We flew back to Halifax on November 11th.

Background

The main objective of the trip was to sub-sample the cores for better age constraints on the base of the Beaufort Formation. The Beaufort Formation and the underlying Eureka Sound Group are Tertiary sediment deposits along the eastern margin of the Beaufort Sea in the western Canadian Arctic. They include clean sands and gravels (figure 2) deposited on the passive margin of the Beaufort Sea. The interest was more in the Pliocene aged Beaufort Formation as it holds many palaeoenvironmental records, such as high-arctic camel fossils. The Beaufort, like many other Pliocene formations, suggests a Pliocene warming, with global mean annual temperatures 2 ºC warmer than today. Due to atmospheric insulation towards the poles, a higher degree of warming is observed in the Arctic, with a mean annual temperature 19 ºC warmer than today. This warming caused a large sediment flux, evidenced by the Beaufort Formation and offshore equivalent Iperk Formation. The Beaufort and Iperk Formations construct a large continental terrace wedge, which in some areas is 2 km thick offshore, consisting of fluvial and marine deposits. The Beaufort Formation and underlying Eureka Sound Group are very similar, as much of the Beaufort is believed to be reworked sediment from the Eureka Sound Group.

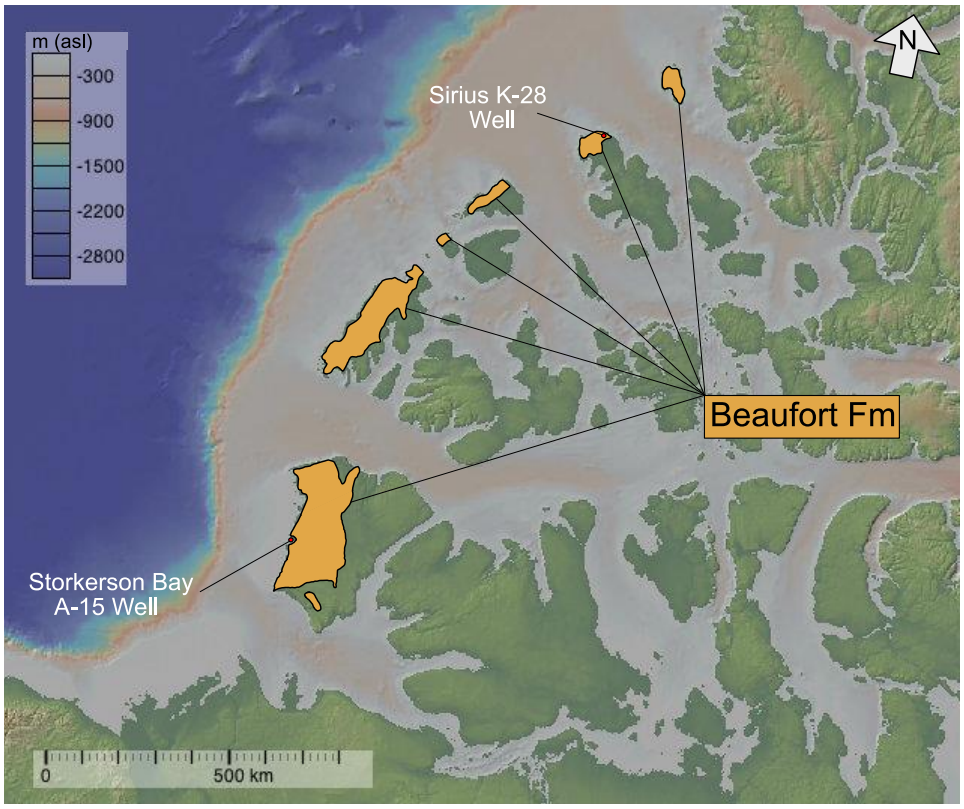

Figure 1: Map of the Canadian Arctic Archipelago with ribbon-like distribution of Beaufort Formation outcrops along the western Arctic coast. Location of Storkerson Bay A-15 (Banks Island) and Sirius K-28 (Ellef Ringnes Island) wells are outlined with red dots. Map from http://www.geomapapp.org/ and outcrop pattern from John Fyles (1990).

The Beaufort Formation is seen on several islands in the western Arctic, distributed in a ribbon-like pattern along the continental margin (figure 1). It is postulated that the Beaufort Formation was deposited

along a contiguous coastal plain, stretching from Alaska to Ellesmere Island, allowing camels to walk from modern day USA to Ellesmere Island. This suggests the Northwest Passages were not present or at least filled during the Pliocene. My research is to look at flexure and dynamic topography on the islands in the western Canadian Arctic. Specifically, to see what is the response from incising the large channels and what does the response appear to be from sediment loading offshore. Dating the core will help control timing and rates of uplift modeled from the loading offshore and unloading onshore.

TCN dating is a method of dating exposure and burial ages of material. This is done by measuring cosmogenic radioisotopes in the material. As cosmic rays bombard the earth's surface they create cosmogenic radionuclides from interaction with certain elements. These cosmogenic radionuclides decay after exposure is withdrawn. In this study, focus is to measure Al^{26} and Be^{10} isotope concentrations to date the exposure age of the sediments found in the Beaufort Formation. The easiest material to measure these isotopes in is quartz. Luckily, the cores were quite quartz rich, making significantly easier. By taking samples from targeted depths with quartz rich sediment, we can get multiple ages for the Beaufort Formation, and constrain the lower age limit of the formation.

Figure 2: Sand comprising the Beaufort formation from the Sirius K-28 well. Mature quartz arenite sand with lithic clasts scattered throughout and woody detritus (fibrous, white). This is the type of sample taken for TCN dating. Image courtesy of Rod Smith, GSC Calgary.

BENEFITS OF TRAVEL

This trip brought about a multitude of benefits, which will not fit into this report. The biggest benefit is the collaboration and discussions with members at the GSC who have spent decades researching in this area. Many interesting ideas and topics were touched on throughout the week, that will strengthen my thesis and hopefully future work in the region. Positive discussions following presentations answered some

questions and sparked interest in researching new ideas.

Better constraints on deposition of the Beaufort will potentially support or possibly refute many of our hypotheses. From this I learned much about the TCN dating method, mainly the advantages, disadvantages and limitations. In addition, our afternoon spent looking at the seismic data gave a superb visual and understanding of the geology in the region, which benefited everyone involved. The newly acquired data may shed a new light on solving the problem of dynamic topography in the Arctic.

OUTCOMES OF TRAVEL

Several outcomes will come to light from this trip. The most important outcome will be the results of TCN dating of the sediment. The samples will take several months to prep and several weeks to analyze, probably finishing analysis in March. Unfortunately, these dates will not be ready for my thesis deadline. Another magnificent outcome is the potential evidence from seismic imaging the GSC will send to us once the interpretation is finished. This tremendously helped visualization of regional geology through cross sections. Lastly, the most beneficial aspect of this trip was the professional relationships started by working with the folks at the GSC. Future collaboration is inevitable from the ideas and discussions that were shared during our visit.

SIGNIFICANCE TO NOVA SCOTIA

The significance of this travel can directly apply to offshore study in Nova Scotia. As the Geologic Setting is very similar, many correlations can be made from offshore in the western Canadian Arctic Islands and offshore Nova Scotia. Understanding of Pliocene climates in the arctic can give insight into the Pliocene records in Nova Scotia. Correlation can be made in both the Pliocene records and the flexural modelling. Nova Scotia has some of the most well understood flexural models regarding glacial isostasy and sediment loading. A possible application erosional isostasy can be applied to large rivers in Nova Scotia and development of the Fundy basin. Pliocene records can be correlated to those in the Arctic and may provide future research to the understanding of Pliocene offshore of Nova Scotia.

ACKNOWLEDGEMENTS

I would like to thank OERA for funding the travel to Calgary, it was an amazing learning experience and will strengthen the extent of my research and future research to follow. Without funding this trip would not have possible.

The folks at the GSC in Calgary who were nothing but outstanding hosts and their insights gave me new angles to look at the problem I am trying to solve. Specific thanks to Rod Smith for bringing us to Calgary, helping with sampling and sharing what he has learned over the years. As well as the seismic division at the GSC for their insights into the region and future collaboration based on newly acquired data.

Lastly, I would like to thank Dr. John Gosse (Dalhousie University) for bringing me on this trip. His endless advice and insights will never be forgotten, and hopefully put to good use.