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MAGMA RECHARGE AND MIXING PROCESSES IN CONTINENTAL FLOOD BASALT RESERVOIRS: EVIDENCE FROM MELT INCLUSIONS IN BASALTS FROM THE HIGH ARCTIC LARGE IGNEOUS PROVINCE, AXEL HEIBERG ISLAND, NUNAVUT

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HALIP FLOOD BASALTS

The Geo-mapping for Energy and Minerals (GEM) program is laying the foundation for sustainable economic development in the North. The GEM program provides modern public geoscience that will set the stage for long-term decision making related to investment in responsible resource development. Geoscience knowledge produced by GEM supports evidence-based exploration for new energy and mineral resources and enables northern communities to make informed decisions about their land, economy and society. The volcanic terrain of Cretaceous age exposed in the east-central Sverdrup Basin, known as the Canadian portion of the High Arctic Large Igneous Province (HALIP), has been the focus of an activity within the GEM 2 Western Arctic Region Project (2014-2017). The main objective of the activity was to evaluate the potential for Ni-Cu-PGE deposits in HALIP volcanic-intrusive complexes. This study focuses on the trace element composition of melt inclusions trapped in phenocryst-bearing lava floods of the Strand Fiord Formation.

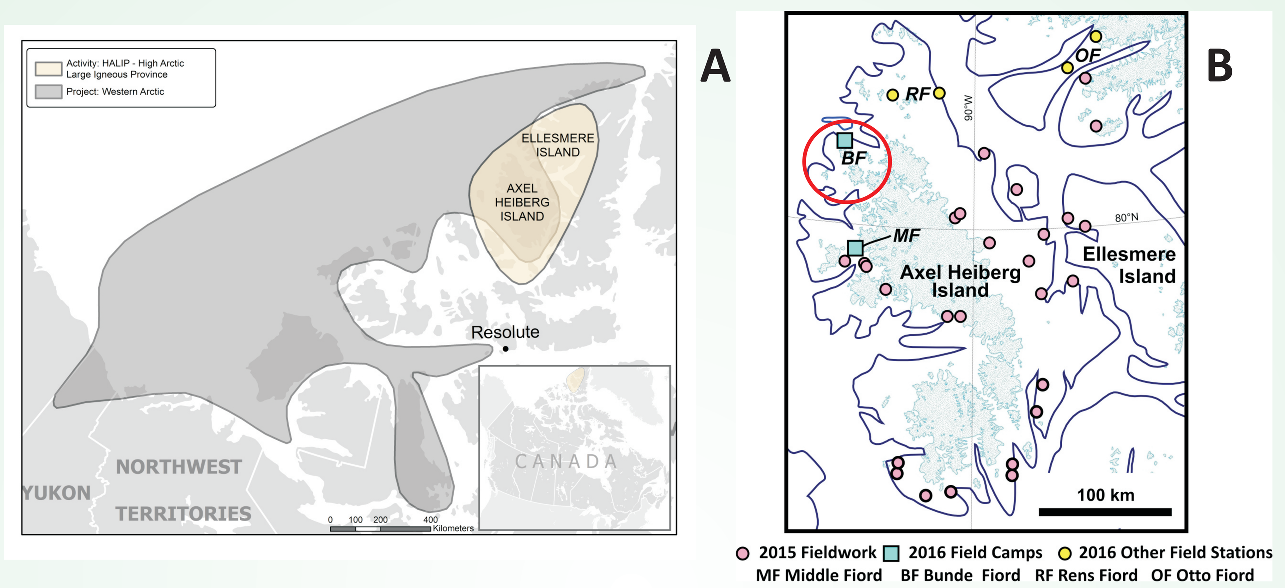


Figure 1. A. Regional map of northern Canada showing the regional coverage of the GEM 2 Western Arctic Region Project. **B.** Location of the study area at Bunde Fiord, on northern Axel Heiberg Island.

The Arthaber Creek (AC) volcanic succession is located along the south shore of Bunde Fiord (Figure 1B). The succession consists of aphyric and phenocryst-bearing lava flows of tholeiitic character (Figure 2A). The phenocrysts consist of plagioclase crystals that show disequilibrium textures and contain abundant inclusions, suggesting magma mixing and recharge prior to ascent and eruption. Figure 2B shows the variation in the An content of plagioclase in phenocrysts and groundmass plotted according to stratigraphic position; and abundance of phenocrysts in individual samples plotted against stratigraphic position. Based on these features, we selected four thin sections for LA-ICP-MS analysis of plagioclase-hosted melt inclusions.

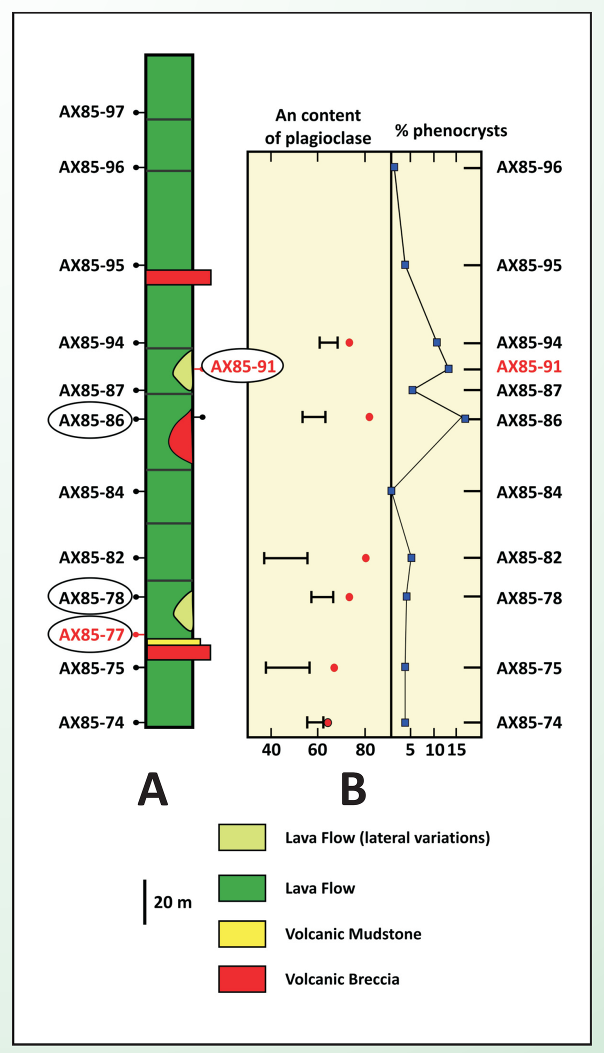
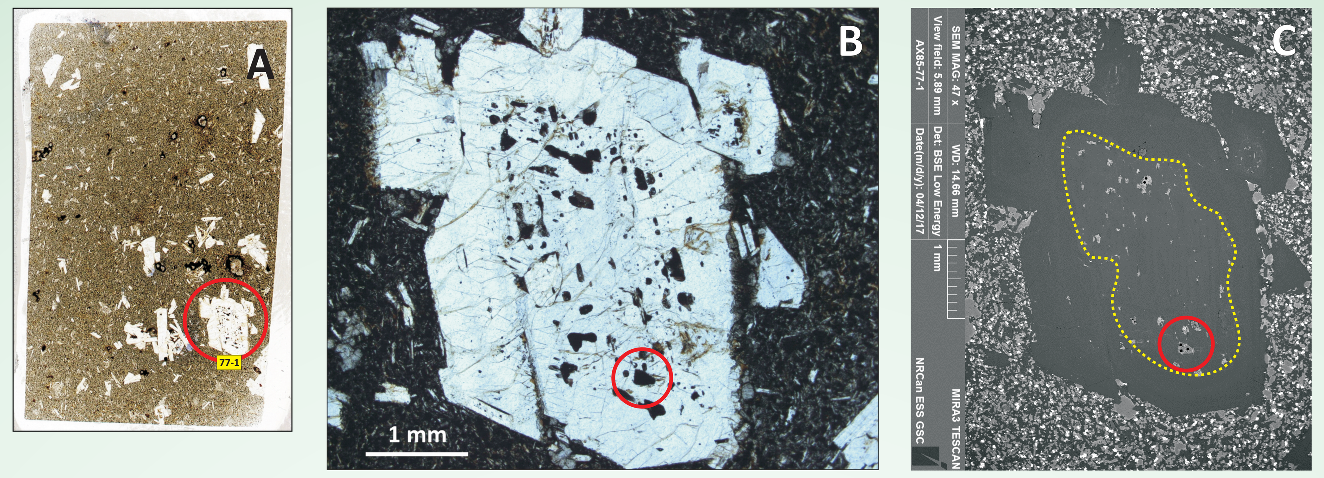


Figure 2. A. Schematic stratigraphic section of the Arthaber Creek volcanic succession. Circled sample numbers are discussed in this poster. **B.** Anorthite content in plagioclase phenocrysts and modal percent phenocrysts in AC lava flows.

SAMPLE AX-85-77



Sample AX85-77 was collected at the base of the AC volcanic succession (Figure 2). The morphology and texture of the plagioclase phenocryst are illustrated in Figures 3A and 3B. A backscattered electron (BSE) image of the zoned crystal (Figure 3C) shows an inclusion-rich core (yellow dashed contour) and the selected inclusion (red circle). A glass bubble with a poorly-preserved, altered rim (Figure 3D; labeled as [A] on Figure 3E) is trapped within the melt inclusion.

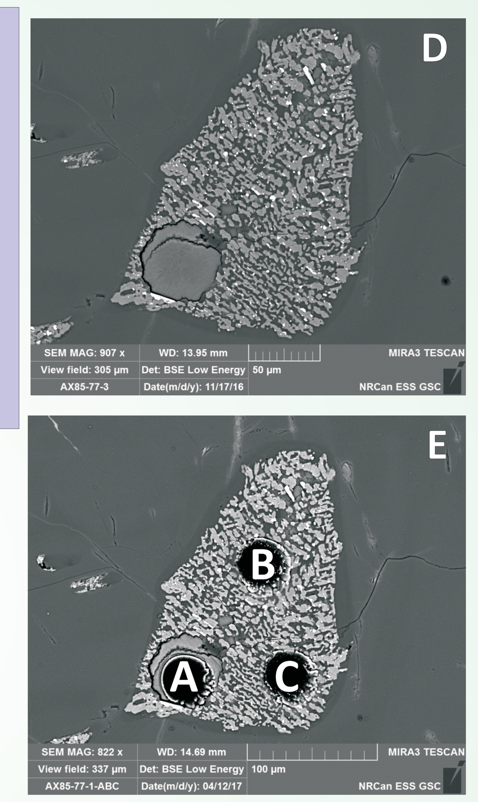
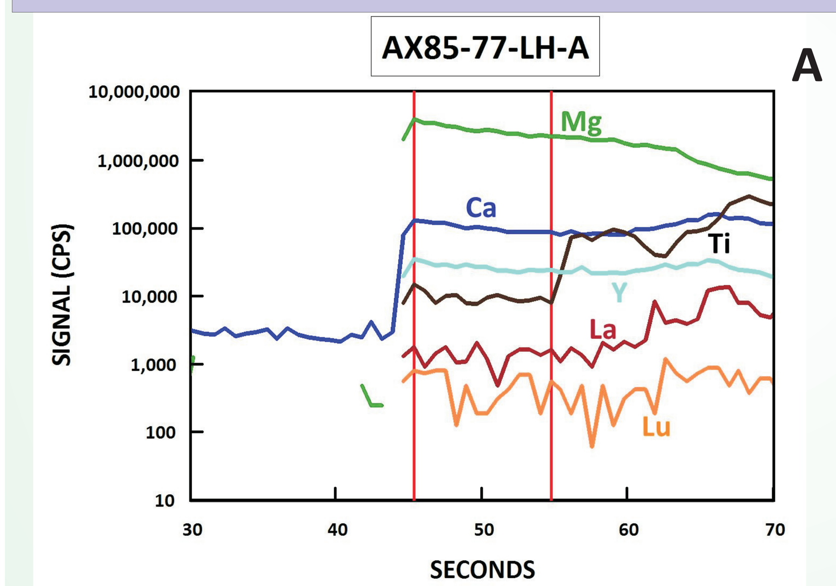


Figure 3

- **A.** Thin section scan
- **B.** Plagioclase phenocryst (ppl)
- **C.** BSE image of phenocryst
- **D.** BSE image of melt inclusion
- **E.** BSE image of melt inclusion showing laser spots



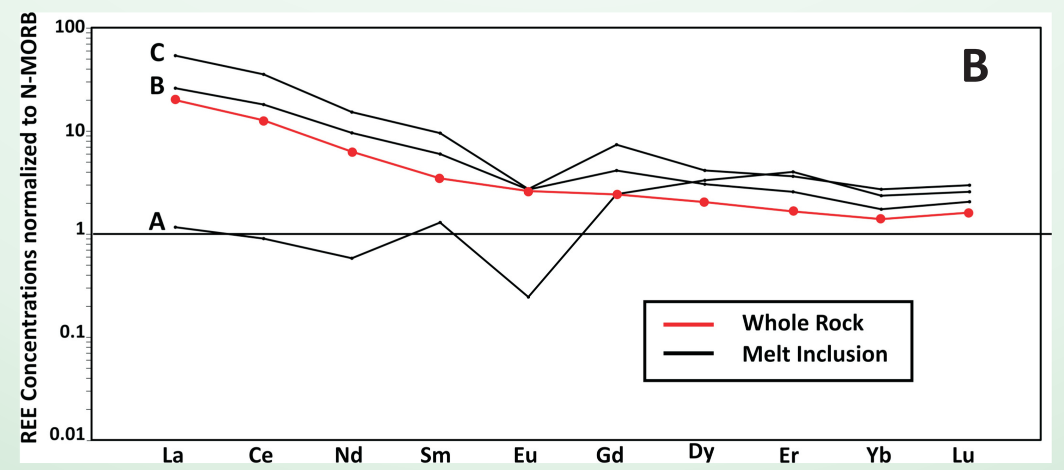
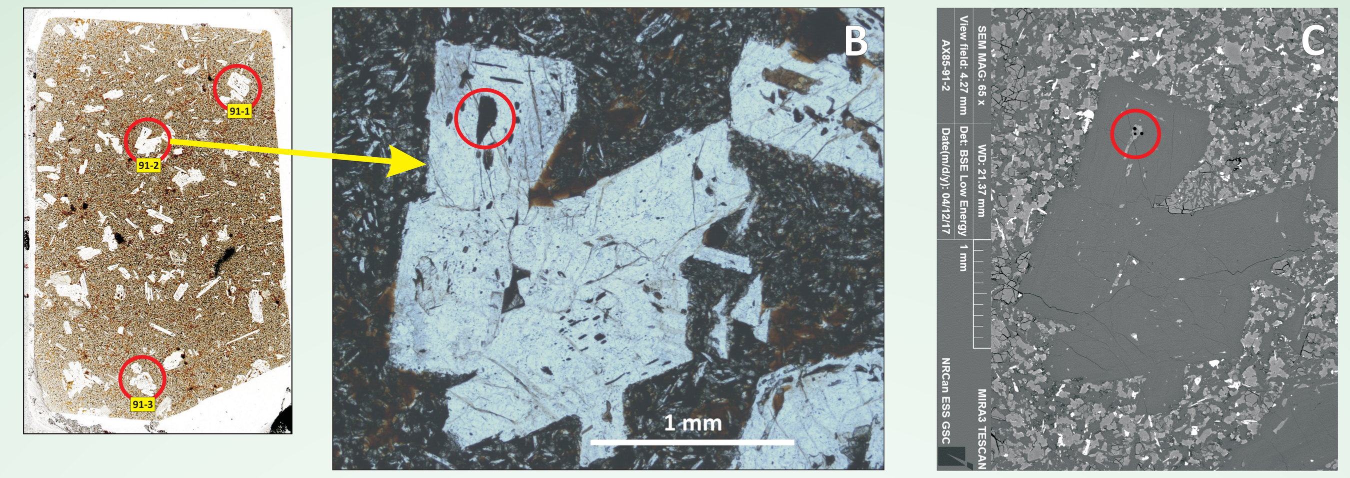


Figure 4. A. Plot of Signal (Counts per Second) vs. Time showing the spectra obtained for selected major, minor and trace elements. The red lines show which area of the spectra was used to calculate element concentrations. **B.** Rare Earth Concentrations of melt inclusions and host lava normalized to N-MORB.

SAMPLE AX-85-91



Sample AX85-91 was collected from the central part of the AC volcanic succession (Figure 2). The morphology and texture of the plagioclase phenocryst selected for study are illustrated in Figures 5A and 5B. A backscattered electron (BSE) image of the crystal (Figure 5C) shows the selected inclusion (red circle). A well-preserved glass bubble with an altered rim (Figure 5D; labeled [A] on Figure 5E) is trapped at the centre of a texturally distinct, homogeneous melt inclusion.

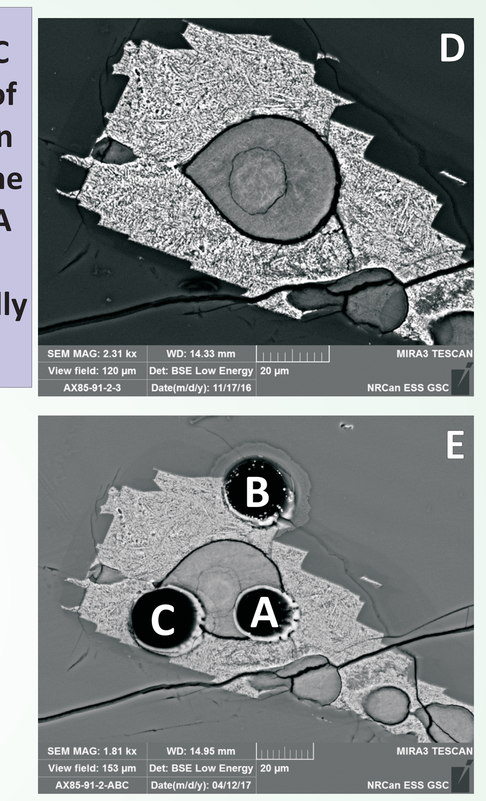
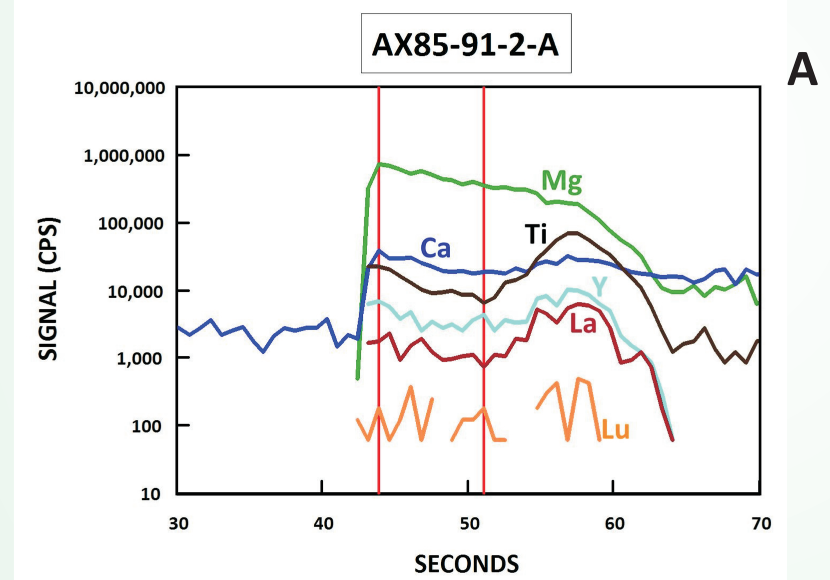


Figure 5

- **A.** Thin section scan
- **B.** Plagioclase phenocryst (ppl)
- **C.** BSE image of phenocryst
- **D.** BSE image of melt inclusion
- **E.** BSE image of melt inclusion showing laser spots



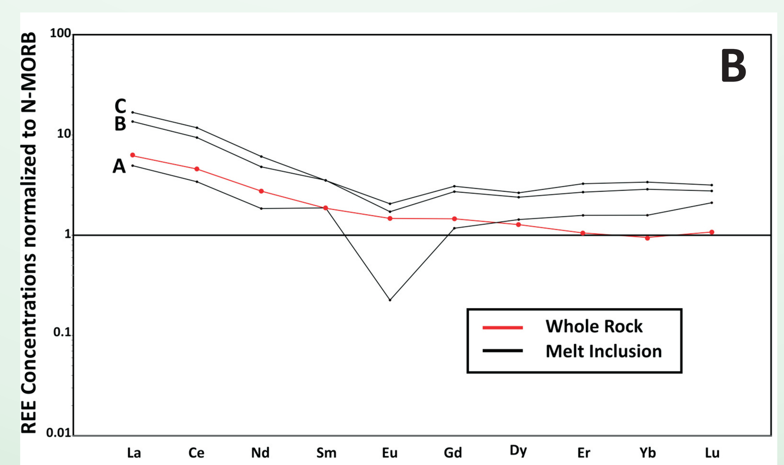


Figure 6. A. Plot of Signal (Counts per Second) vs. Time showing the spectra obtained for selected major, minor and trace elements. The red lines show which area of the spectra was used to calculate element concentrations. **B.** Rare Earth Concentrations of melt inclusions and host lava normalized to N-MORB.

OBSERVATIONS

REE highlighted in this poster
Other element determined by LA-ICP-MS

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	*Ln*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn

Lanthanides	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Actinides	Ac	Th	Pa	U											

Figure 7. Periodic table of the elements highlighting the elements discussed in this poster.

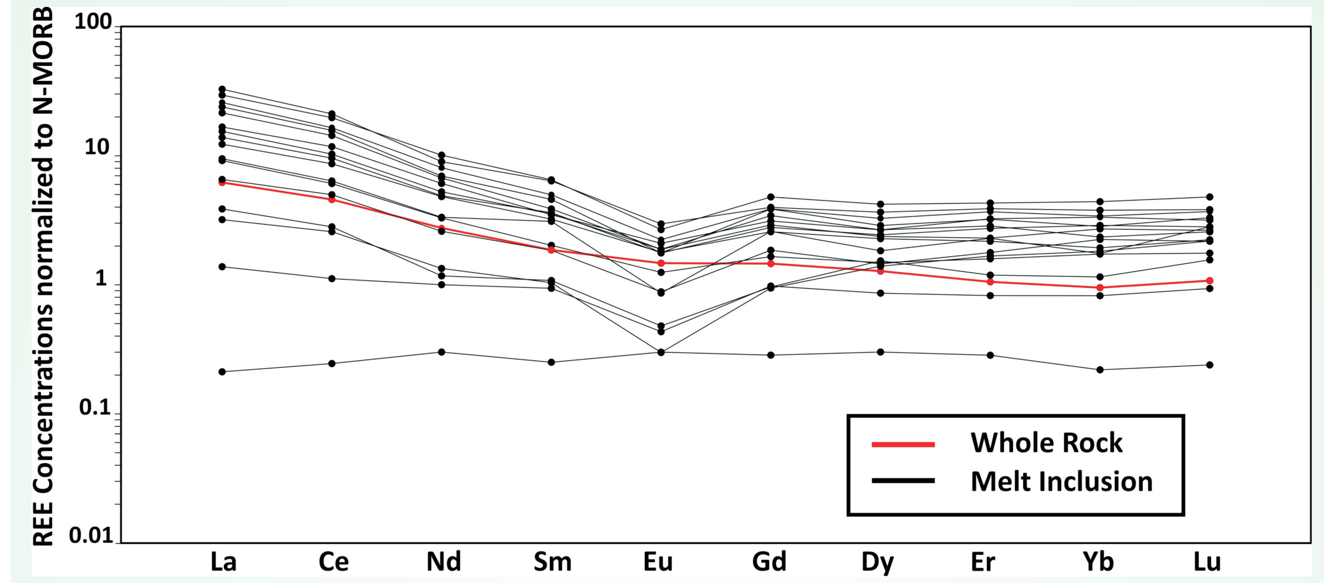


Figure 8. Rare Earth element (REE) concentrations normalized to N-MORB for all the melt inclusions analysed in 3 plagioclase phenocrysts, sample AX85-91 (see Figures 2 and 3A). The REE concentrations for the whole rock are shown for comparison.

Samples of basaltic lava from the Strand Fiord Formation at Bunde Fiord, Axel Heiberg Island, Nunavut, show petrographic, mineralogical and compositional evidence of magma mixing and recharge. Four phenocryst-bearing samples from the Arthaber Creek (AC) volcanic succession were selected for trace element analysis of melt inclusions by LA-ICP-MS. The objective of the study is to determine if the melt inclusions that were trapped during crystal growth represent more primitive melts than the host rock. In this poster, we present the results of the laser ablation experiment for rare earth elements only.

Our preliminary results demonstrate that:

1. Melt inclusions show a wide range of sizes and textures in zoned plagioclase phenocrysts. Homogeneous melt bubbles are present.

2. Targeting micron-scale melt inclusions for laser ablation is challenging but achievable. Detailed textural studies using the Scanning Electron Microscope constitute an essential first step in this type of investigation.

3. Careful selection of time-integrated windows is required.

4. Rare earth elements show coherent patterns indicating that they are reliable indicators of petrogenetic processes for melt inclusions and the host rock.

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