The 2013 Isachsen Expedition to Axel Heiberg Island, Nunavut, Canada: A Field Report

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Carleton UNIVERSITY

POLAR CONTINENTAL SHELF PROGRAM
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OBJECTIVES

Remote Predictive Mapping

An important goal of the field campaign was to test the use of satellite images and remote predictive mapping techniques in advance of bedrock mapping (RPM; Harris, 2008). Satellite images used for the 2013 Isachsen Expedition include Landsat-7, Aster, and Spot-5 integrated with air photographs and other base maps into a Geographic Information System.

Igneous Rocks in the High Arctic Large Igneous Province (HALIP)

1. Style of eruption in the Isachsen Formation.
2. Comparison with the stratigraphy in other parts of the Sverdrup Basin.
3. Lithogeochemistry of mafic rocks.
4. U-Pb geochronology to resolve the age of intrusive rocks in the Canadian component of the HALIP.

Gossans

1. Remote Predictive Mapping (RPM) to detect gossans.
2. Measure the spectral signatures of surficial materials at key locations to improve the accuracy of RPM.
3. Map and sample surface materials of alteration zones and protoliths.
4. Determine the stratigraphy, mineralogy and geochemistry of deposits to document facies and origin.
5. Integrate the results from 1-4 with stream sediment geochemical data.

Stream Sediments

1. Detailed Study: Identify the geochemical and physico-chemical signatures of (a) gossanous zones and evaluate the downstream dispersion; (b) an evaporite dome by sampling/analyses of stream sediment and water.
2. Regional Survey: New regional stream sediment and water geochemistry coverage combined with indicator mineral samples for evaluation of the region's bedrock geology and mineral potential.

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REMOTE PREDICTIVE MAPPING

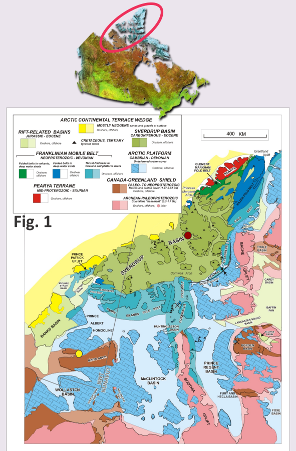

Fig. 2A

Fig. 2B

Fig. 3

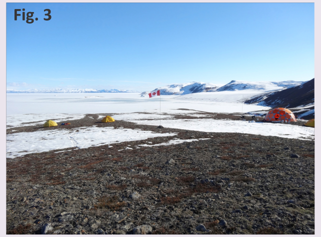

Fig. 1 Simplified geology of the Queen Elizabeth Islands (contributed by C. Harrison) showing the location of 2011 (yellow dot) and 2013 (red dot) study areas on Victoria Island, NT, and Axel Heiberg Island, NU.
Fig. 2 [A] Team logistics involved a 2-hour flight from PCSP Base Resolute to the Strand Fiord airstrip by Twin Otter aircraft. **[B]** Camp personnel, equipment, instruments and supplies were flown by helicopter from the Strand Fiord airstrip to Expedition Fiord.
Fig. 3 View of base camp on July 10, 2013.

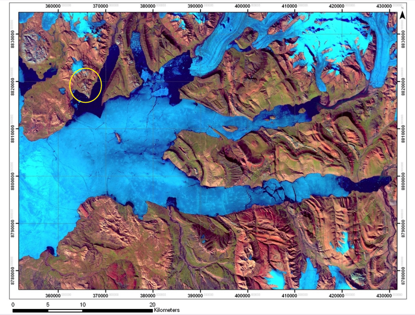

Fig. 4 Landsat-7 mosaic of the Strand Fiord-Expedition Fiord region showing the location of the study area (yellow circle; Lyon et al., 2006). Classification methods comparable to those described by Behnia et al. (2012) were applied for RPM prior to deployment.

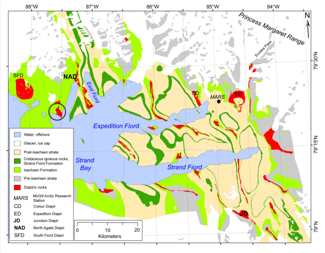

Fig. 5 Bedrock geology of the Strand Fiord-Expedition Fiord area (Harrison and Jackson, 2010). The black circle shows the location of the study area.

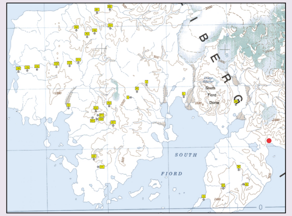

Fig. 6 Map of the study area showing the flight plan for helicopter-supported sampling of igneous rocks on the South Fiord peninsula. The map was produced on site using OziExplorer© software. The red dot shows the location of base camp.

IGNEOUS ROCKS

Fig. 7

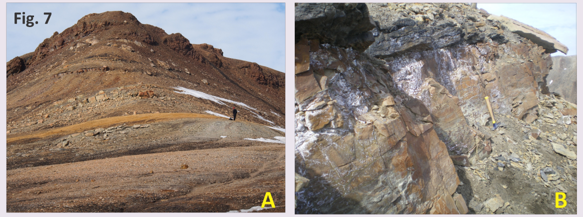

Fig. 8

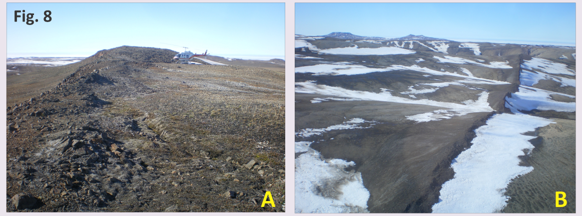

Fig. 9

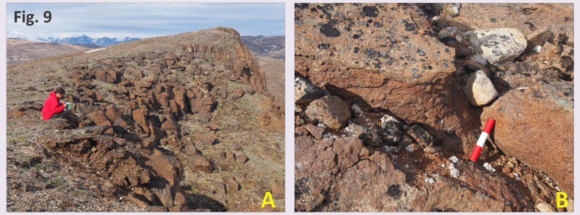

Fig. 7 [A] View of the stratigraphic succession that will form the basis of our understanding of the eruptive style in the Isachsen Formation. At this location, the section consists of alternating beds of black shale and tan-coloured sandstone. Two basaltic flows are visible in this image: (1) a ~2 m thick flow displaying crude columnar jointing crops in the centre of the succession; and (2) a ~10 m thick flow that forms a prominent cap, and extends laterally over several kilometers. Cole Kingsbury is standing at the site where gossanous soils were sampled for mineralogical and geochemical analysis (photos 10A, 10B). **[B]** Close up view of thin, glassy flow in the Isachsen Formation. Hammer is 30 cm in length.
Fig. 8 [A] Dyke sampled on South Fiord peninsula (Fig. 6) for a PhD thesis project on geochemical and geochronological studies of the Canadian HALIP (High Arctic Large Igneous Province; Kingsbury, 2013) **[B]** Aerial view of a dyke intruding the Isachsen Formation. Dykes appear to be typically thin (< 5 m) when compared to sills.
Fig. 9 Perspective showing the outcrop characteristics of a ~40 m thick coarse grained sill which may be ultramafic in composition. **[A]** Columnar jointing in the upper 2-3 m of the sill and spheroidal weathering. **[B]** Close up of the outcrop at the top of the unit showing the coarse grained character of the sill. U-Pb geochronology, whole rock, and radiogenic lithogeochemistry will be performed on samples collected from this location in order to elucidate tectonic significance, mantle source chemistry, crustal contamination processes and prospectivity of sills and dykes as host rocks for Ni-Cu-PGE mineralization.

GOSSANS

Fig. 10

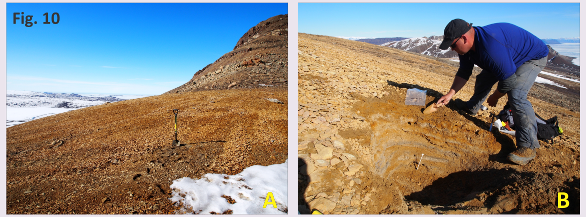

Fig. 11

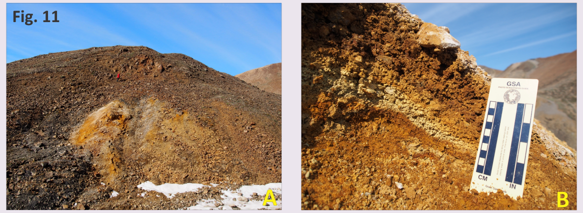

Fig. 12

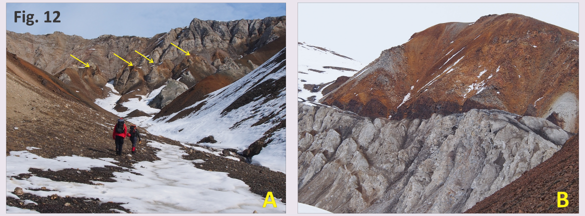

Fig. 10 [A] Gossan associated with the basal portion of the volcanic and sedimentary succession illustrated in Fig. 6 A. The gossan appears homogeneous at the surface but trenching reveals a complex stratigraphy and acidic soils. **[B]** Cross section of the gossan from the surface layer to permafrost showing the cyclic nature of the stratigraphy. Each layer is exquisitely preserved. Careful sampling and analysis of individual layers will clarify the processes that led to the formation of this unique occurrence.
Fig. 11 [A] Gossan developed at the base of a mafic sill (Cole Kingsbury for scale). Black shales are associated with the sill and gossan but the contact relationship is unclear. This type of gossan was also found in the Minto Inlier of central Victoria Island in 2011 (Williamson et al., 2014). **[B]** A cross section of the gossan revealed poorly-developed stratified layers and acidic soils.
Fig. 12 [A] A third type of gossan occurs in close association with evaporite domes. The photograph shows the conical features that were investigated during field work (yellow arrows). **[B]** These features could represent mafic sills that are deformed, segmented, and altered by fluids circulating in and around the evaporite dome as it rises over time.

Recommended Citation
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STREAM SEDIMENTS

Fig. 13

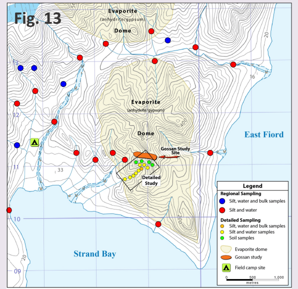

Fig. 14

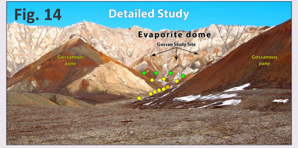

Fig. 19

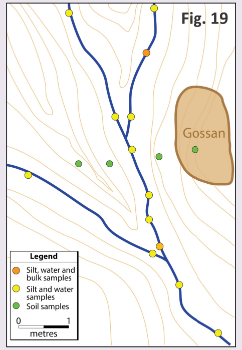

Fig. 20

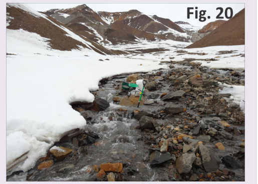

Fig. 15

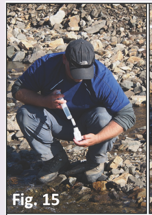

Fig. 16

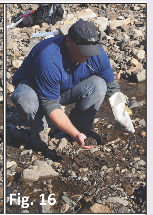

Fig. 17

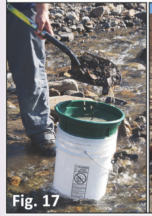

Fig. 18

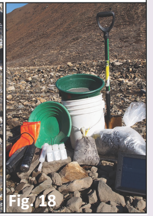

Fig. 13 Location map showing regional stream sample sites and sample locations in the study area.
Fig. 14 Detailed stream study sites within the evaporite dome and associated gossanous zones. These evaporite domes form topographic highs and represent drainage divides between catchment basins.

Fig. 15 Filtering water sample with 0.45um filter into 60ml HDPE bottle.
Fig. 16 Approximately 2 kg of silt and clay were collected from the lower energy part of streams into a cloth bag.
Fig. 17 ~ 12 kg of bulk sediment for heavy minerals were collected by wet-sieving with a 12-mesh sieve in higher energy part of streams into large plastic bags.
Fig. 18 Field equipment used and samples collected at a typical stream site.
Fig. 19 Schematic diagram illustrating an idealized sampling plan of a detailed drainage study to: (1) identify the areal extent of the geochemical and mineralogical signatures and (2) the dispersion down drainage of a known gossan. The resulting dataset will be an important tool in interpreting the regional datasets and identifying unknown gossanous areas.
Fig. 20 Typical moderately flowing immature stream intermixed with boulders, cobbles, gravel and fines. The shovel shows the location of bulk sample collection.

Canada