GLACIAL GEOLOGY, DRIFT AND BEDROCK PROSPECTING, AND RELATED REMOTE SENSING APPLICATIONS ON NORTHERN BAFFIN ISLAND, NUNAVUT

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Introduction

In 2003 the Canada–Nunavut Geoscience Office, in collaboration with the Geological Survey of Canada and the Polar Continental Shelf Project, initiated a multi-disciplinary geoscience project to evaluate the economic potential of northern Baffin Island, with the overall intent of reducing exploration risk in this remote region of Nunavut. The 2003 field season focused on the NTS 37G map area (Fig. 1).

During the 2003 field season, 155 till samples and 76 bedrock assay samples were collected. These data will be released soon; some results are presented on this poster. In tackling the third objective, the 2003 field season identified four regional ice-movement events. The glacial history of this region is known to be complicated by overprinting of both warm- and cold-based basal thermal regimes at various stages of deglaciation. Thus, collaborations with academicians have been established to elucidate the glacial history and chronology, and hence improve understanding of glacial transport for examining drift survey results.

In 2005, the project will conduct surficial geology and drift prospecting within NTS 37E, covering a region that lies along the northwestern margin of the Barnes Ice Cap. Specific objectives include the production of eight 1:100 000 scale surficial geology maps; completion of reconnaissance-scale till and bedrock sampling programs; and evaluation of ice-movement chronology and glacial history of this region. In advance of helicopter-supported surficial mapping, a preliminary surficial geology map will be constructed using Remote Predictive Mapping techniques (Landsat and RADARSAT I). These maps will also be used during the planning stages of the till geochemistry surveys in order to maximize the efficiency of the field program.

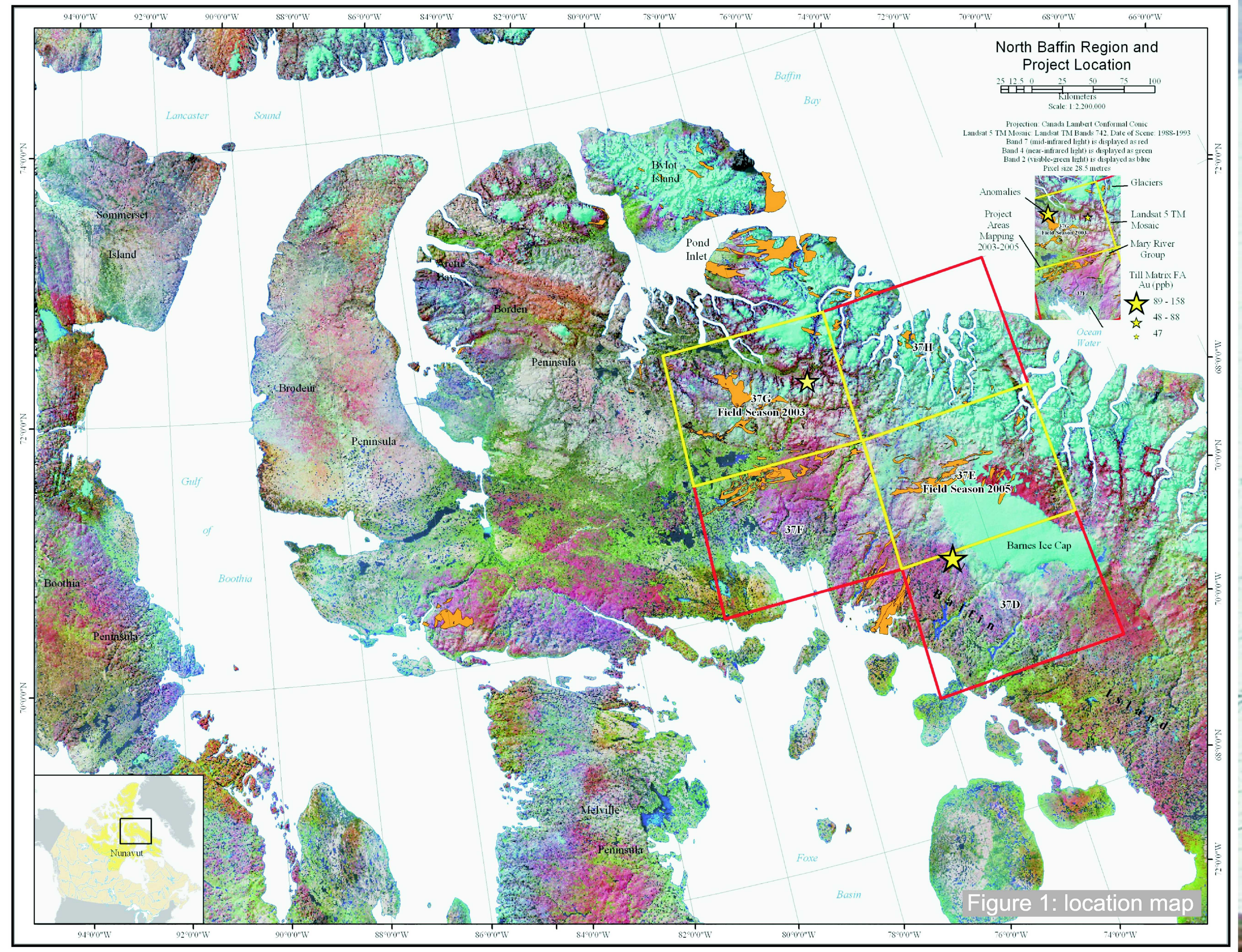


Figure 1: location map

Study Area

The study areas for 2003 and 2005 field seasons are located on northern Baffin Island and occur in NTS map areas 37G and 37E, respectively (Fig. 1). The area encompass six main physiographic regions: Baffin Uplands, Davis Highlands, Arctic Lowlands, Lancaster Plateau, Foxe Plain and Coastal Foreland (Bostock 1970). On figure 1 the known extent of metamorphosed Neoarchean supracrustal rocks of the Mary River group are shown in orange (de Kemp and Scott 1998). There is a potential for iron-formation-hosted gold and Ni-Cu-PGE magmatic sulphide occurrences in the area. The map above also highlights recent mapping by the GSC (NTS 37F, Dyke 2004), and the C–NGO and GSC (Central Baffin Project, NTS 37D, Dredge 2003).

Glacial Geology

Evolving ideas of ice dynamics in the North American ice sheets have important implications for the interpretation of till geochemistry as a prospecting tool. Historical paradigm shifts include a range of views from: a multi-domed ice sheet; to a monolithic ice sheet centred in Hudson Bay; and returning to an ice sheet with several independent, confluent areas of outflow. Current advances in the understanding of ice sheet dynamics include (1) the identification and realization of the presence of many transient ice streams, (2) the hypothesis that there existed dramatic differences in flow regimes (e.g. uplands vs. fiords), and (3) the view that the Laurentide Ice Sheet (LIS) was polythermal, both temporally and spatially.

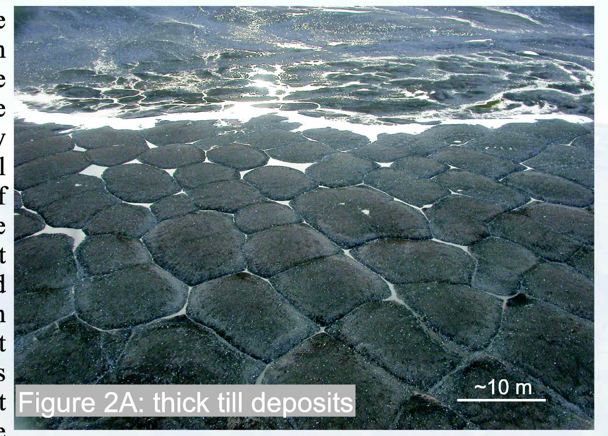


Figure 2A: thick till deposits

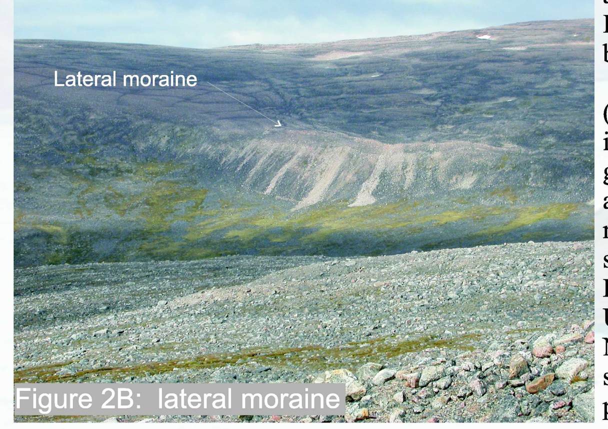


Figure 2B: lateral moraine

The North Baffin Project (NBP) will be using Aster satellite imagery, in conjunction with till geochemistry sampling, to identify areas of carbonate material that may indicate the presence of an ice stream originating from the Foxe Basin. In collaboration with the University of Alberta's NSERC Northern Chair, the NBP will also study isostatic rebound based on palaeo-sea level data, and thus make inferences on the structure of the ice sheet. Through scientific collaboration with Dalhousie University, concentrations of terrestrial cosmogenic nuclides will be examined in various materials to elucidate areas of differing basal thermal conditions. Based on 2003 field evidence, Little et al. (2004) identified evidence for warm-based conditions such as: abundant thick till deposits (Fig. 2A); well developed lateral moraine (Fig. 2B); and roches moutonnées suggesting sculpting of the substrate (Fig. 2C). Descending lateral meltwater channels (Fig. 2D), have been ascribed to cold-based conditions (Dyke, 1993).

Figure 2C: roches moutonnées

In the 2003 field season, four ice movement events were identified (Fig. 3). The earliest, event 1, was towards the north. This event is tentatively associated with mid- to early-deglaciation of the region because it is consistent with flow from the Foxe Dome (ca. 10.2 ka). This event is followed by flow towards the northeast, attributed to changes in ice dynamics resulting from early collapse of the Foxe Dome flow allowing the development of the Baffin Ice Cap (ca. 9 ka). Subsequent flows (events 3 and 4) are related to the eastward migration of the centre of outflow of the Barnes Ice Cap.

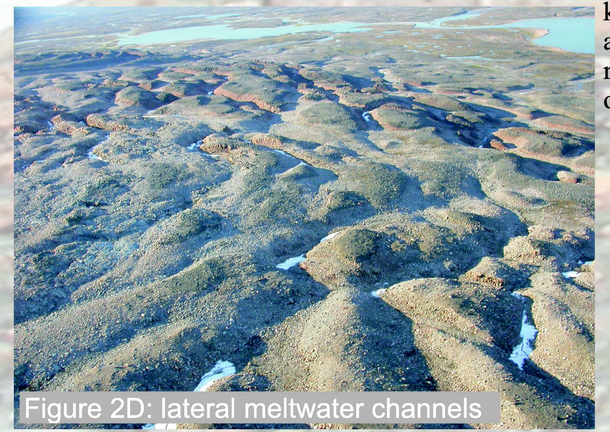
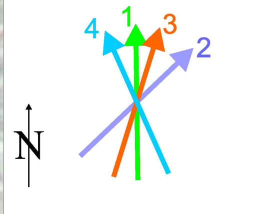


Figure 2D: lateral meltwater channels

Figure 3: Generalized ice-movement sequence for map area NTS 37G



Drift and Bedrock Prospecting

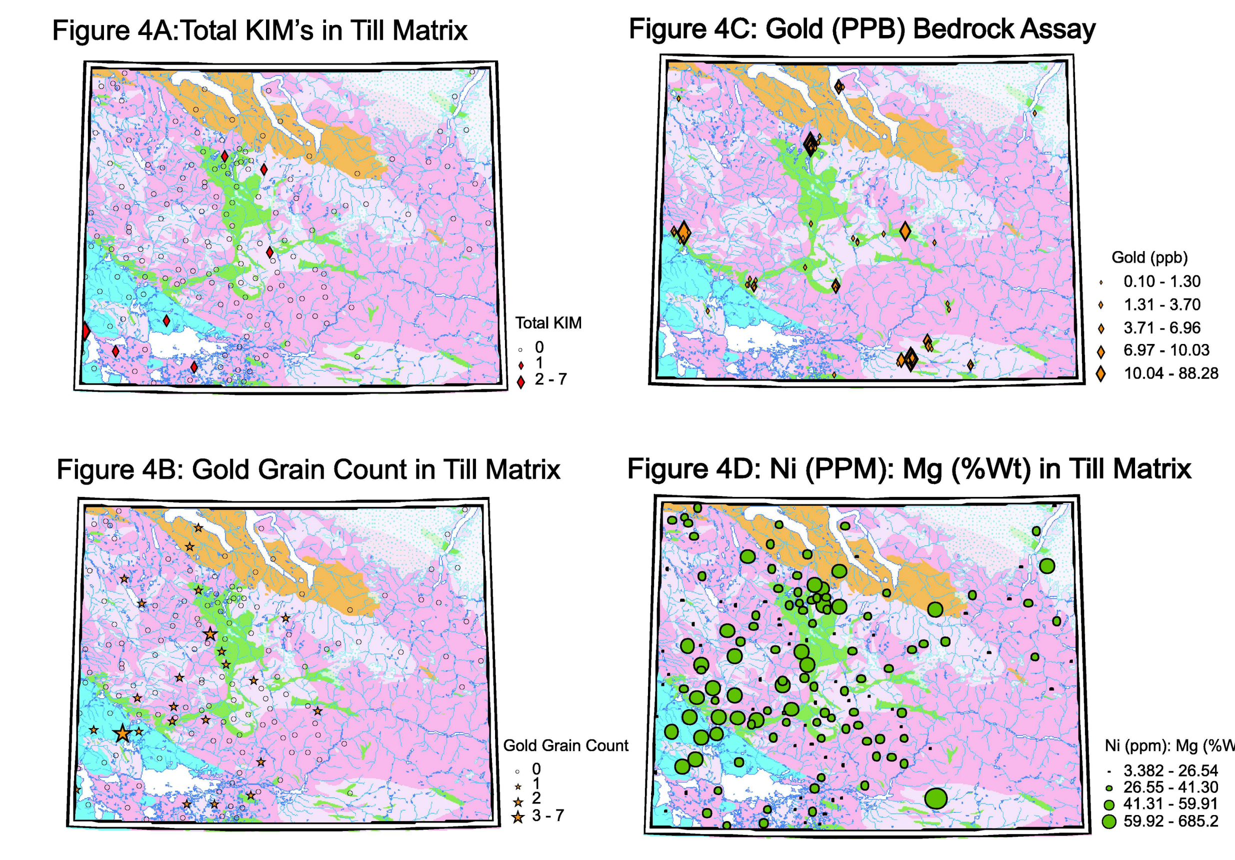


Figure 4A: Total KIM's in Till Matrix

Figure 4C: Gold (PPB) Bedrock Assay

Figure 4B: Gold Grain Count in Till Matrix

Figure 4D: Ni (PPM): Mg (%Wt) in Till Matrix

Till sample site

Simplified Bedrock Legend for Figure 4

- Cambrian to Silurian Sediments
- Mesoproterozoic Sediments
- Paleoproterozoic Granitoids
- Archean Greenstone
- Archean Granitoids

During the 2003 field season, 155 till samples were collected for trace element analysis on the silt–clay and clay fractions using ICP-AES following aqua regia digestion. Pebble lithology counts were performed on the 48 mm fraction. Gold and Pt values were determined in the silt–clay fractions using fire assay. To complement this till study, 76 bedrock assay samples were also collected. On four maps (Fig. 4A, B, C and D) a selection of results from till matrix analyses for 37G (GGC, KIM's, and Ni:Mg), as well as bedrock geochemistry samples (Au) are shown. A gold anomaly from till matrix analysis (fire assay) discovered by the C-NGO and GSC's Central Baffin Project (ca. 2001–2003) is also presented on the regional map (Fig. 1) from Dredge (2004). The highest values of kimberlite indicator minerals occur in the southwest corner of 37G, with other anomalies around the "long lake" area in the north central portion of the map area. The greatest number of gold grains are found near the Archean greenstone belts, as well as in the southwest of 37G. Gold assay values from bedrock grab samples are generally low (<10 ppb), but two main areas appear to be most prospective. In the southeast, 2–4 m thick iron formation is locally gossanous, especially when in contact with ultramafic sills. In the north, 3–5 m thick gossanous iron formation can be traced for approximately 800 m of strike length.

Box and whisker plots A and B (Fig. 5) explore some partitioning of elements in different grain sizes, anomalies of which may indicate different mineral sources. Some anomalies are evident in the Ba (<0.002 mm) to Ba (<0.063 mm) ratios and in the Pb (<0.002 mm) to Pb (<0.063 mm) ratios. This may be related to weathering differences, areas preserved under cold-based ice conditions, or may indicate differences in the source material. The plot of the trace metal Cr (Fig. 5C), shows that there is a strong bedrock control on the mineralogical composition of till. As expected, the highest values of Cr are from the samples taken from till overlying ultramafic bedrock. One sample (21853) has an anomalously high value of Ni when compare to Mg (wt %) in <0.063 mm fraction (Fig. 5D), indicating possible sulphide mineralization. Sample 21853 also has the anomalous Cr value, and was taken from till overlying ultramafic rock.

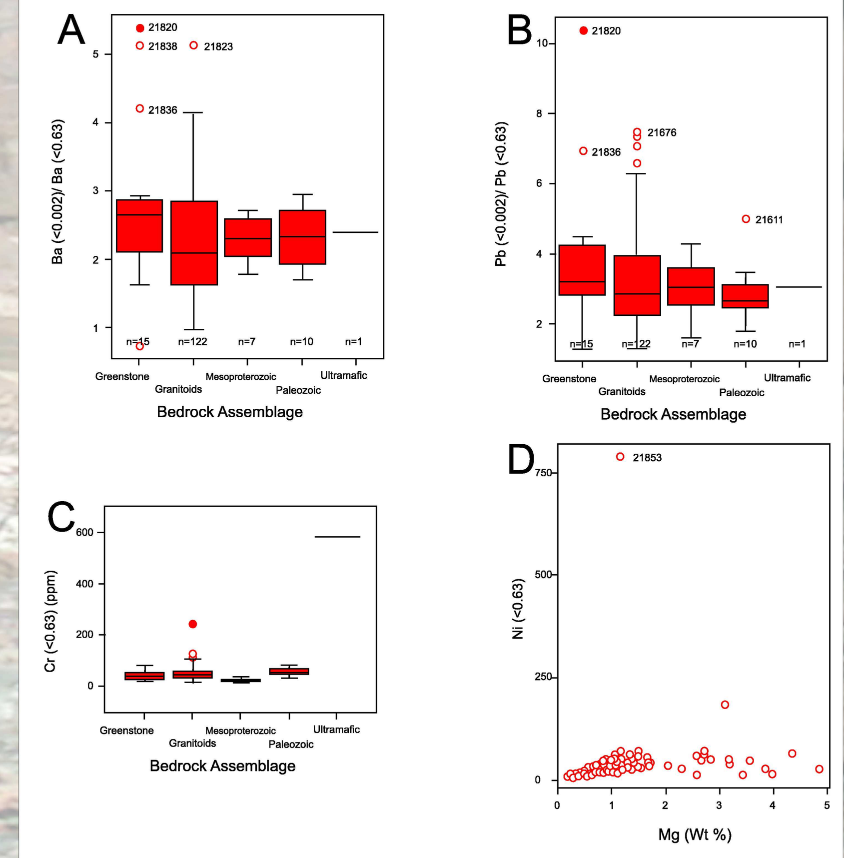


Figure 5: Box and whisker plots of till geochemistry results

Till sample site

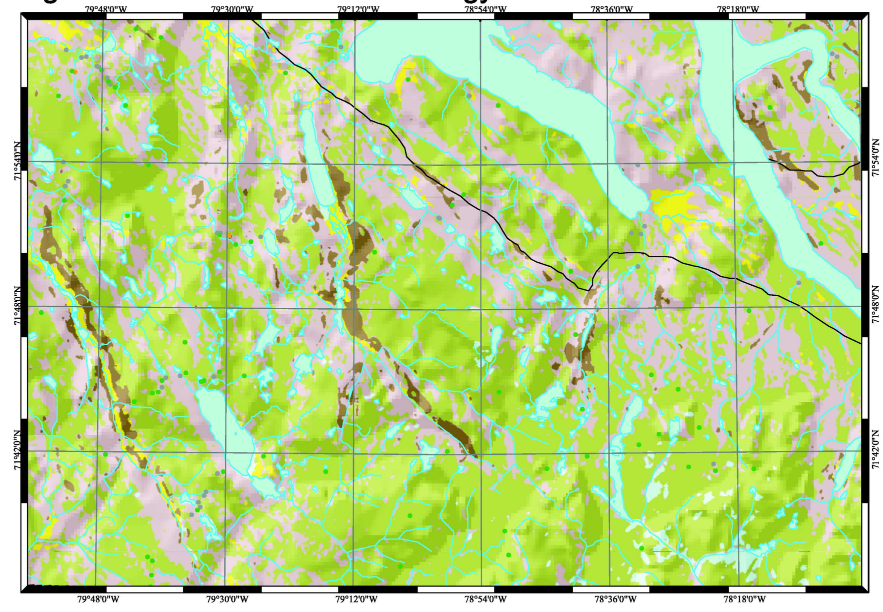
Looking north (down-ice flow) from komatiite ridge, note high percentage of komatiite boulders (weathered orange)

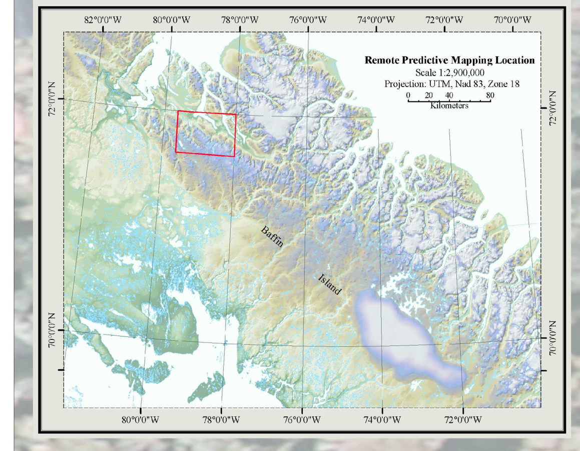
Looking SSE (up-ice flow) same komatiite ridge (right), note lack of komatiite boulders

Remote Predictive Mapping

To assist planning and execution of fieldwork in 2005, predictive surficial geology maps for NTS 37E and 37H will be produced using supervised classification techniques on Landsat and RADARSAT I data. If successful, the techniques applied to these areas may also be useful in contiguous regions of northern Baffin Island where similar terrain and geology exists. The predictive map (Fig. 6) was made using a maximum likelihood classifier on RADARSAT I data. Maximum likelihood classification calculates probability based on training regions, which represent specific ground cover, to assign pixels to a class. The training regions were created based on 2003 field season sample sites and the surficial geology map. The surficial geology map was produced by traditional methods. The surficial geology map legend has been simplified for easier examination of the effectiveness of this remote predictive mapping method.

Figure 6: Predictive Surficial Geology





LEGEND

- Rivers
- Lakes
- Bylot Supergroup and Crystalline Rock Boundary

SAMPLE SITES

- Till
- Alluvium
- Colluvium
- Other (Bedrock, Glaciofluvial, Glaciolacustrine, Marine Sediments)

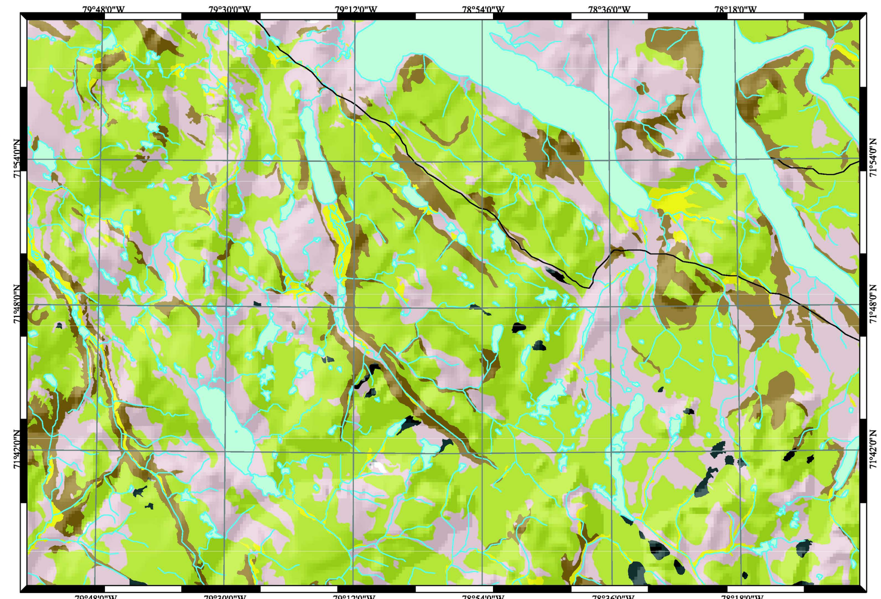
SURFICIAL MATERIAL

- Till
- Alluvium
- Colluvium
- Other (Bedrock, Glaciofluvial, Glaciolacustrine, Marine Sediments)
- Ice

5 2.5 0 5 10 15 20 Kilometers

Scale 1:250 000
UTM Zone 18, NAD 83

Figure 7: Simplified Surficial Geology



Till sample site

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