REGIONAL TILL COMPOSITION OF THE WAGER BAY AREA, NUNAVUT: IMPLICATIONS FOR GLACIAL HISTORY AND MINERAL EXPLORATION

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Introduction

The region north of Wager Bay in mainland Nunavut, northwest of Hudson Bay (Fig. 1), includes extensive Quaternary glacial and post-glacial sediments underlain by continuous permafrost. It lies within the western Churchill Geological Province where active precious and base metal exploration is ongoing. The central part of this region overlaps Ukkusiksalik National Park, which is protected from mineral exploration and development. The Geological Survey of Canada (GSC) recently completed a combined surficial geological mapping activity (1:100,000 scale) and regional-scale till geochemical survey (10-km spacing) in this region as part of the Geo-mapping for Energy and Minerals (GEM-1) Program. The objectives of this work were to provide an improved understanding of the glacial history and an evaluation of mineral and park resources (i.e. Campbell & McMartin 2014; McMartin et al. 2013, 2015). This paper presents an interpretation of till provenance, as well as a discussion on some of the key implications for mineral exploration.

Regional context

Surficial mapping shows conspicuous northward-trending crag-and-tail and other streamlined landforms composed of a poorly sorted, massive, silty sand diamicton (till), with variable clast content. These landforms indicate a prevailing northward direction of ice flow from a centre of outflow lying south of, or along Wager Bay. The largest landforms and early striations converge northward into Committee Bay, and are thought to result from active ice streaming during the last glaciation (Dredge 2002). More subtle but pervasive north to north-northwestward streamlined landforms and associated striations overprint the largest landforms. Together with large north-flowing meltwater corridors, they formed during deglaciation as the ice retreated from the Chantrey Moraine System. In the east towards Repulse Bay and Roes Welcome Sound, weakly fluted till, late striations and east-flowing meltwater corridors are associated with a major ice-flow reversal and drawdown into Repulse Bay during late deglaciation. Patches of cold-based ice preserved relict, weathered and fresh glacial landscapes throughout deglaciation.

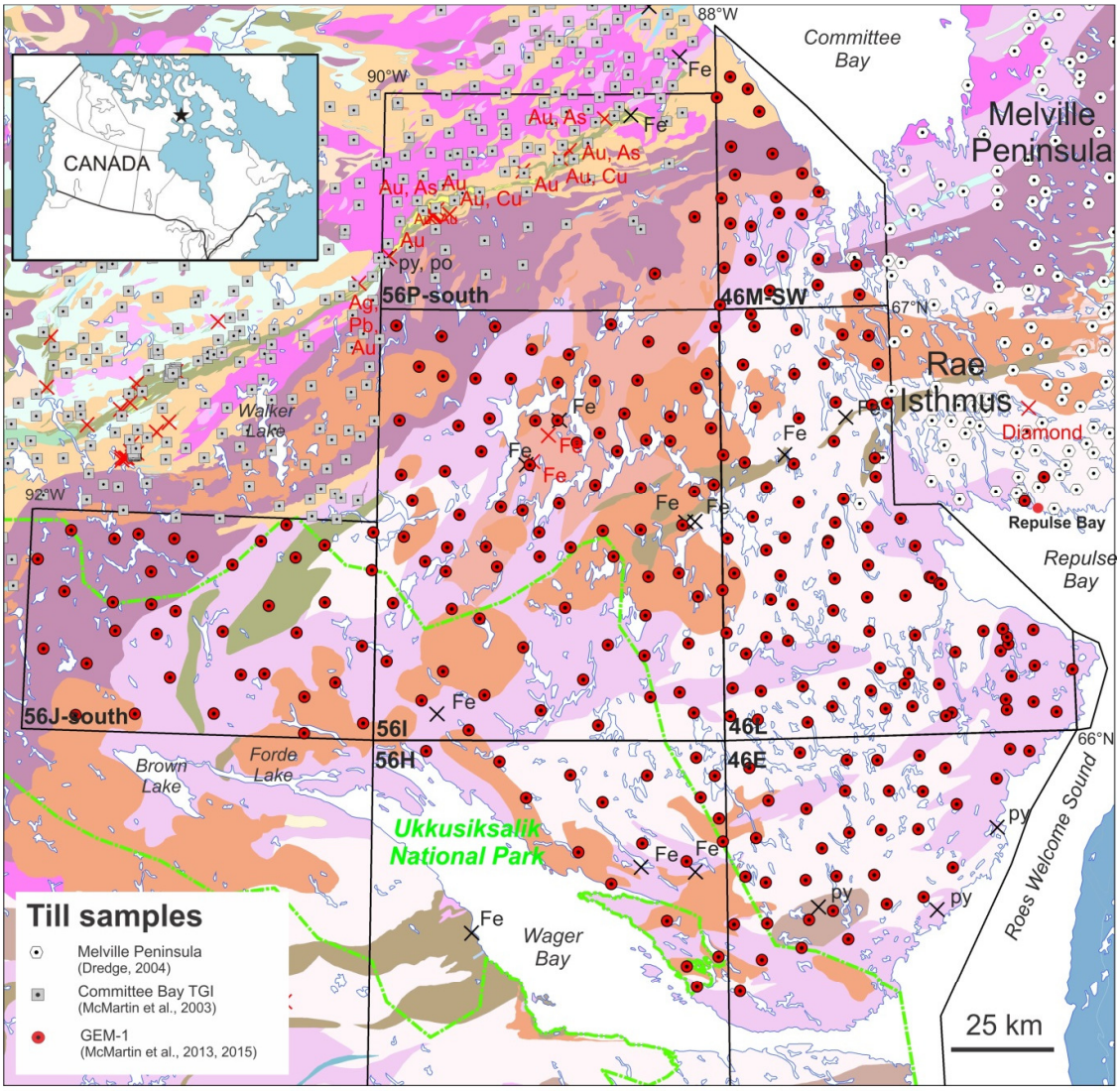

Figure 1. GEM-1 till samples collected north of Wager Bay. Samples collected by the GSC as part of previous surveys outside the study area are also shown. Bedrock geology map (from Skulski et al. unpublished) and mineral occurrences (from Heywood 1967 and NUMIN) underlie the sample locations.

Methodology

Till samples were collected in Cy-horizon material from hand dug pits in frost boils (average depth of 30 cm). In total, 306 till samples were collected in a 31,000 km^2 area north of Wager Bay (Fig. 1). At each site, small (~3 kg) and large (~13 kg) samples were collected. Analytical results on the small samples include till matrix texture and colour (<2 mm), carbon and carbonate contents (<0.063 mm), as well as till matrix geochemistry (<0.063 mm) using ICP-MS modified aqua regia digestion, ICP-MS 4-acid digestion, and ICP-ES/MS lithium borate fusion. Precious metal grain counts, indicator mineral picking and pebble count analyses were completed on the large samples. The complete results and detailed field and analytical procedures are provided in McMartin et al. (2015).

Results

Several significant regional glacial dispersal patterns and geochemical trends are recognized by integrating the GEM-1 analytical results with field work observations and geological mapping, and previous work in adjacent areas. For example, a NNE-trending, 35 km-long ultramafic dispersal train characterized by elevated Ni-Cr-Co-Cu±Mg±V concentrations, high chromite and forsterite grain counts and the presence of large ultramafic boulder erratics near its head is found in the western part of the region south of Walker Lake (Fig. 2A). The ultramafic boulders include slightly altered to heavily weathered pyroxenite.

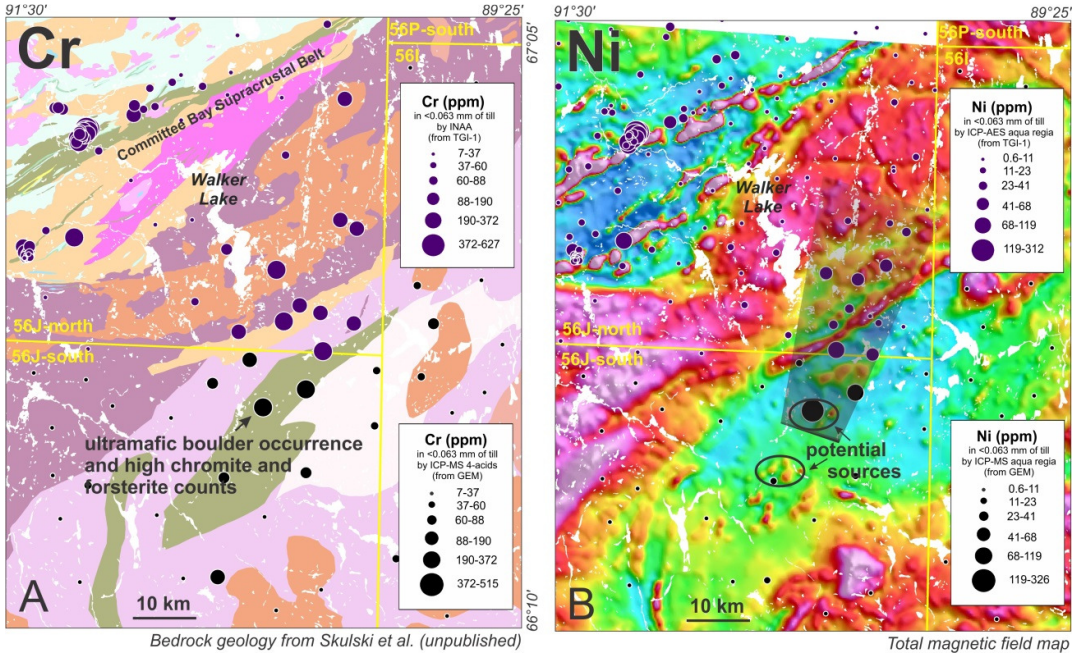

Figure 2. A) Cr and B) Ni concentrations in the <0.063 mm fraction of surface till, Walker Lake area. TGI project results outside the study area are also shown (from McMartin et al., 2003). Legend for bedrock geology is shown on Fig. 1. Total magnetic map shows highly magnetic (red) to non-magnetic rocks (blue).

Further east, a carbonate-rich, sandy silty till underlain by glacially-scoured Archean gneisses occurs on low-relief terrain south of Repulse Bay. In contrast to non-calcareous shield derived tills, the fine-grained till has a calcareous matrix (6 to 32% total carbonate), contains 1 to 12 % Ca (Fig. 3a) and 11 to 38% Paleozoic carbonate clasts in the 8-30 mm fraction (Fig. 3b). This calcareous till occurs in association with north-northwestward streamlined landforms and striations which converge north into the Rae Isthmus. The nearest up-ice (southern) carbonate sources are Paleozoic platform rocks that are present under Roes Welcome Sound and on Southampton Island, over 15 km from the most southern carbonate till site (Fig. 3b).

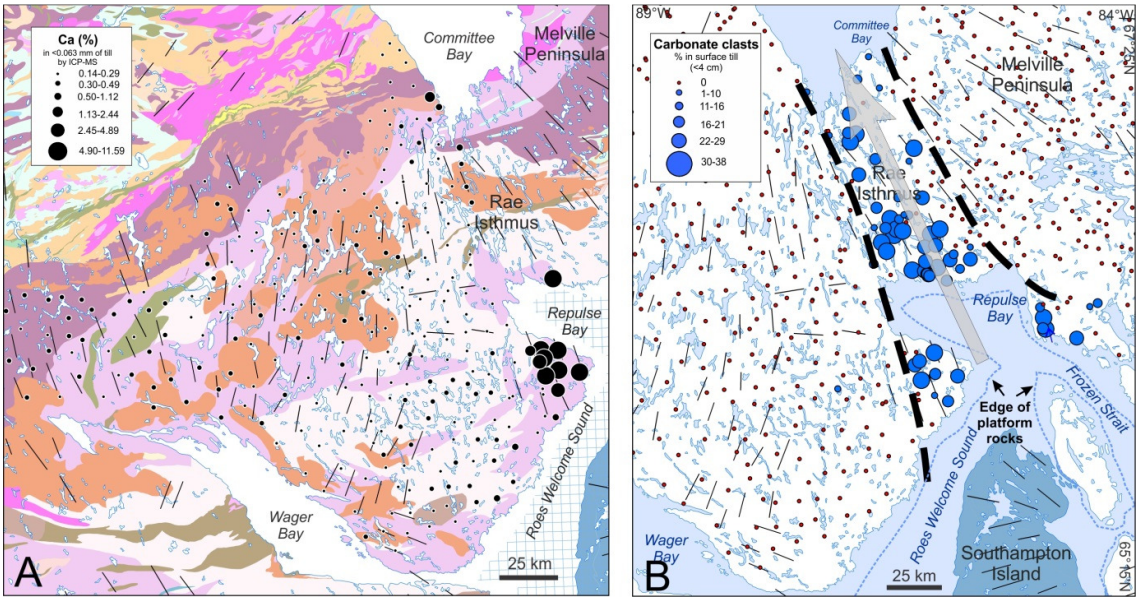

Figure 3. A: Calcium concentrations in GEM-1 surface tills (<0.063 mm fraction; modified aqua regia by ICP-MS). Legend for bedrock geology map is shown on Figure 1. **B: Regional distribution of carbonate clasts in till** (<4 cm) (Dredge, 2004; McMartin et al., 2003; McMartin et al., 2015). Large arrow indicates direction of glacial transport over the Rae Isthmus. Thick dashed lines show the limit of carbonate till. Short black lines are streamlined forms (from Fulton 1995).

Discussion

Although there is evidence of multiple ice flow directions in the area, the main and older ice-flow trend, which converges north (NNE to NNW) towards Committee Bay, appears to be the predominant direction of glacial transport in the study area. The source of the NNE-trending ultramafic dispersal train described above is likely located within 100's of metres of the boulder occurrence in undifferentiated supracrustal rocks of the Prince Albert Group, as suggested by the total magnetic field airborne map (Fig. 2B). However, the regional-scale sample spacing (10-km) may not have delineated the head of the dispersal train. There is another potential source up-ice approximately 8 km to the SSW.

The presence of carbonate till south of Repulse Bay extends the southern limit of the Rae Isthmus Ice Stream and indicates that the source area was in the Roes Welcome Sound area, not in Foxe Basin further east as previously suggested (e.g., Dredge 2002). The sharp boundary between shield-derived till and thick carbonate-rich till, as well as the weak indication of eastward dispersal or reworking of previously deposited sediments, suggests that generally the late deglacial flow towards Repulse Bay had minor influence on surface till composition.

Conclusions

The northern ice-flow phase appears to be responsible for the majority of till production and the most prominent streamlined forms in the study area. With the exception of the cold-based highland terrains near Wager Bay, this suggests warm-based conditions during the last glaciation, with fast flow in Rae Isthmus maintained by the convergence of ice from Melville Peninsula, Keewatin and Foxe Basin. The discovery of distally-derived till in ice stream landforms south of Repulse Bay has significant implications for mineral exploration; specifically for following up indicator mineral dispersal trains that are from more distal sources.

References

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