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Publications in this series have not been edited; they are released as submitted by the author.

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ABSTRACT

This report releases the field database and analytical results from a targeted till sampling survey completed during 8 days in 2014 over NTS 76H and 76I as part of the Geological Survey of Canada's GEM-2 Thelon tectonic zone project, mainland Nunavut. The survey covers parts of the Thelon tectonic zone and adjacent Slave craton, and crosses the western end of the MacAlpine Moraine System. Quaternary field observations were recorded at 55 field stations; 28 of these included the collection of surface till samples. Samples were analyzed mainly for matrix geochemistry, gold grain counts, indicator mineral picking of the sand fraction, and pebble lithology analysis. The interpretation of till provenance and the implications for mineral exploration and economic potential will be provided elsewhere (McMartin, in prep.).

INTRODUCTION

The Geological Survey of Canada completed in 2014 a targeted till sampling survey as part of the GEM-2 Thelon tectonic zone multidisciplinary geological mapping project (Berman et al., 2015a) in order to provide a Quaternary geological framework that would contribute to the evaluation of mineral resources in the this area of mainland Nunavut (GEM-2 Rae Area of Interest). The study area, which straddles parts of the Thelon tectonic zone and adjacent Slave craton, is covered by variable thicknesses of Quaternary sediments in an area of continuous permafrost, and lies between the Queen Maud Gulf Migratory Bird and Thelon Game sanctuaries (Fig. 1). The targeted till survey builds on a ~500-km long bedrock and surficial geology transect south of Queen Maud Gulf completed in 2012 as part of GEM-1 Frontier's Chantrey Project (Berman et al., 2013, 2015a; McMartin et al., 2013); it focuses on follow-up till sampling, boulder prospecting and ice-flow indicator mapping at two till geochemical anomalies (McMartin et al., 2013) and one stream sediment anomalous area (McCurdy et al., 2013), as well as the collection of surficial geology observations and till samples along two 80-km transects perpendicular to the MacAlpine Moraine System (MMS) to document regional glacial transport in the area. This report provides a brief overview of the bedrock and Quaternary geology of the study area, as well as a description of the field and analytical methods, and releases the field database and analytical results from the 2014 till sampling survey. The interpretation of the data and a discussion on glacial transport in the study area will be provided in McMartin (in prep.).

Location

The study area lies between latitudes 65° and 67° and longitudes 104° and 106° south of Queen Maud Gulf and includes parts of the Overby Lake (NTS 76I) and Duggan Lake (NTS 76H) map sheets (Fig. 1). The area lies within the Queen Maud Gulf Lowland and Garry Lake Lowland Ecoregions of Canada and drainage is towards the Arctic Ocean via the Ellice and Back rivers (Fig. 2). Physiography is characterized by a broad, level to gently sloping upland towards Queen Maud Gulf with elevations decreasing northeastward from 371 m asl south of Ellice River to 160 m in the northeast corner of NTS 76I (Fig. 2). In the southern part of the study area, the terrain slopes gently towards the Back River plain that reaches as low as 180 m asl in the east. Local relief is low and characterized by gently rolling hills and upland plateaus, interspersed by shallow linear valleys that reach the two main river valleys. The area has a mean annual temperature of approximately -11°C (summer mean of 6°C; winter mean of -27°C) and a mean annual precipitation of 125-275 mm (http://ecozones.ca). It is underlain by continuous permafrost with low ice content and a shrub tundra vegetation cover. Turbic and Static Cryosols are the dominant soils developed on surficial deposits.

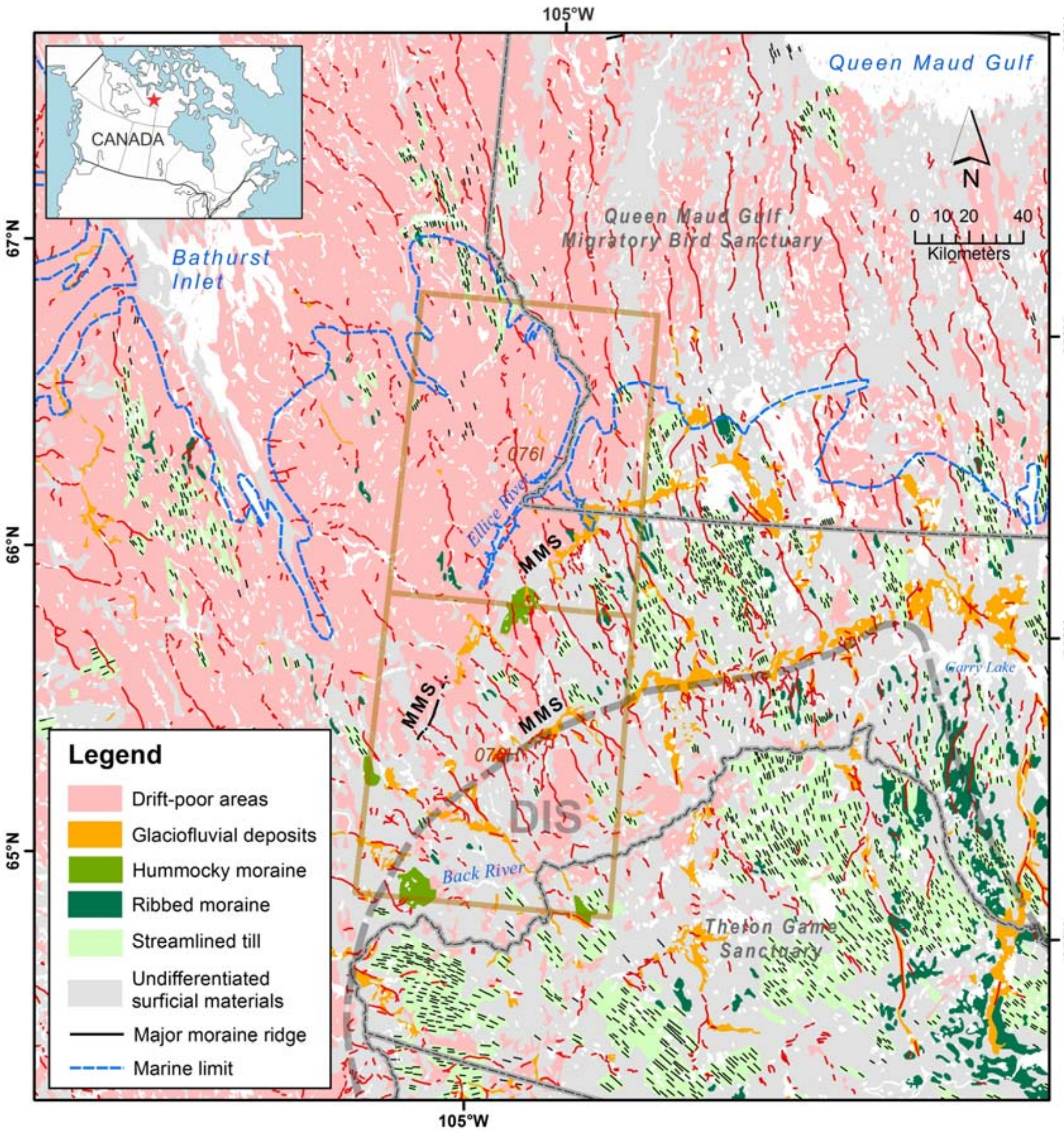

Figure 1. Location of study area in mainland Nunavut (NTS 76H and 76I: brown outline). Regional Quaternary map (from Aylsworth and Shilts, 1989) shows surficial sediments and major glacial features. Esker ridges (red) and streamlined landforms (black) are also shown. Approximate location of marine limit is modified from Prest et al. (1968). MMS: MacAlpine Moraine System; DIS: approximate limit of Dubawnt ice stream landscape (from Stokes and Clark, 2003).

Regional geology

Bedrock geology

The till geochemical survey spans the boundary between the eastern Slave craton and the Thelon tectonic zone (TTZ) on the western flank of the Rae craton (Fig. 3). The TTZ comprises a series of pronounced, north- to NNE-striking magnetic anomalies that extend ~500 km from the MacDonald fault to Queen Maud Gulf. The TTZ has been postulated to represent a continental arc built on the western flank of Rae craton and subsequently intensely deformed during collision with, and indentation of the Slave craton (Hoffman, 1988). Alternative models propose that the TTZ formed in an intracontinental setting either after crustal thinning (Thompson et al., 1989) or within an interior mountain belt far removed from an active plate boundary (Chacko et al., 2000; Schultz et al., 2007).

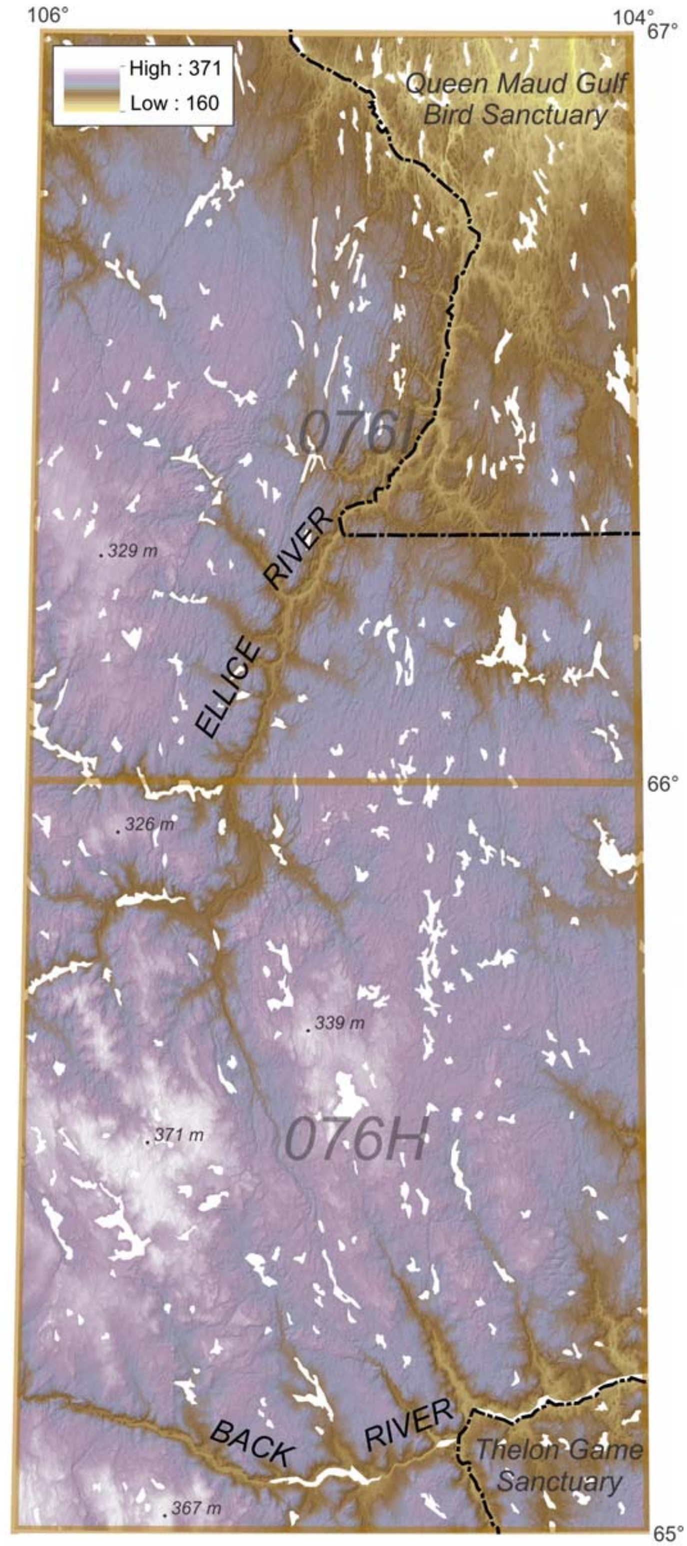

Figure 2. DEM of the study area generated from CDED 1:250,000 topography.

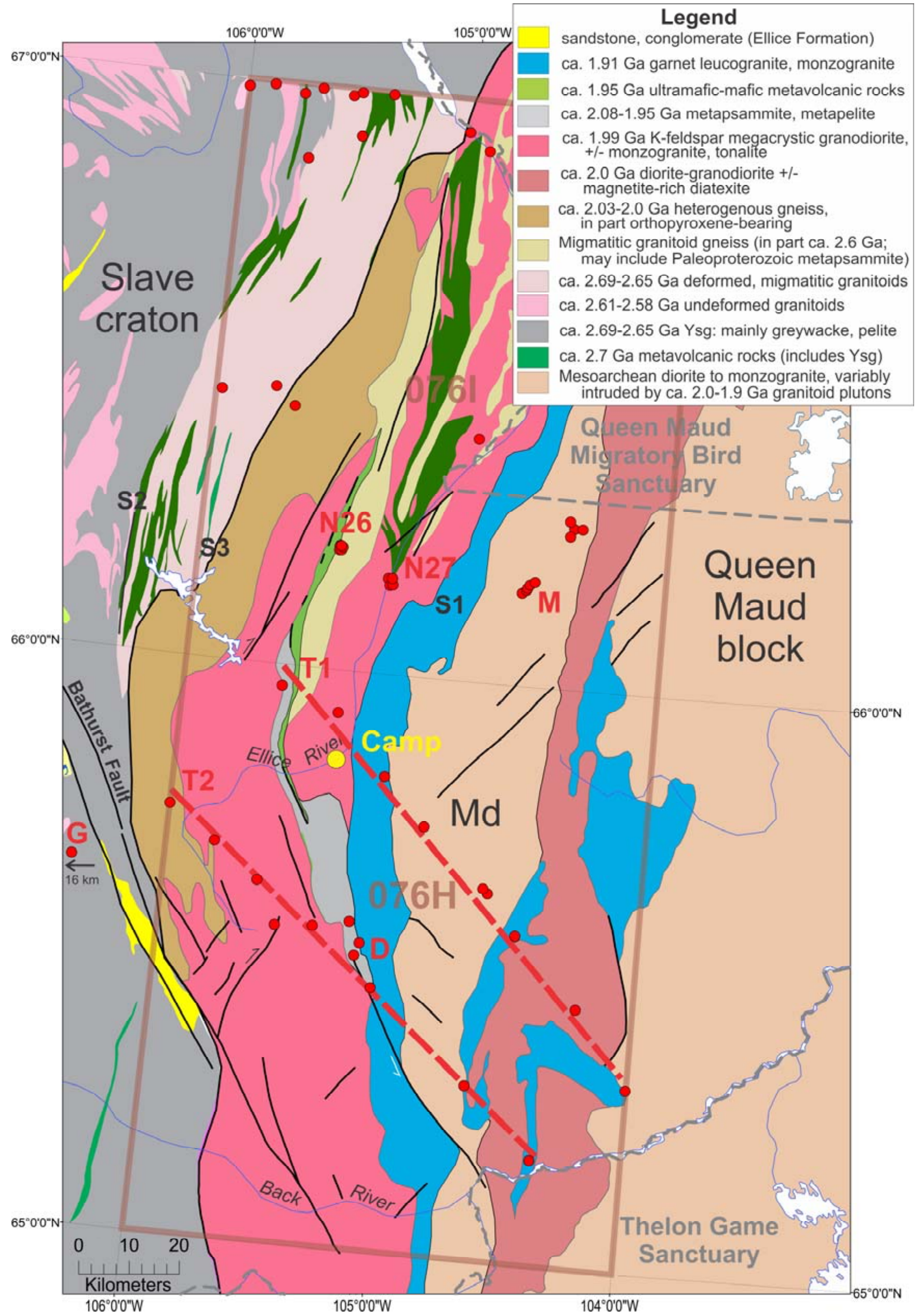

Figure 3. Simplified bedrock compilation map of the study area (NTS 76H and 76I; incorporating modifications of Frith, 1982 and Thompson, 1986), showing Quaternary field stations (red dots). D, N26 and N27: reinvestigated 2012 till and stream sediment anomalous areas; T1 and T2: till transects; G: Goose deposit sample; M: moraine sample; S1, S2, S3: alternative bedrock suture zones; Ysg: Yellowknife supergroup; Md: Mesoarchean domain (see text).

The eastern Slave craton is dominated by metasedimentary and metavolcanic rocks of the Yellowknife Supergroup intruded by 2.61 – 2.58 Ga granitoids (Frith, 1982; Thompson et al., 1986). Metamorphic grade increased eastward from lower- to upper-amphibolite facies during both Neoarchean and Paleoproterozoic (Thelon orogeny) events. This gradient culminates northeast of the Bathurst fault (Fig. 3), where the proportion of supracrustal rocks decreases as deeper crustal levels expose migmatitic granitoid gneisses interspersed with thin metavolcanic belts (Thompson et al., 1986).

The western Rae craton consists largely of Mesoarchean upper amphibolite to granulite facies granitoid rocks of the Queen Maud block (QMb; Fig. 3). A thin belt of ca. 2.0 Ga metagranitoid rocks (Davis et al., 2014) separates a Mesoarchean crustal domain (Md; Fig. 3) that may have rifted off the Queen Maud block (Berman et al., 2015b). In several places, these plutonic rocks are associated with magnetite-bearing diatexites (Berman et al., 2015a, b) which may be the source rocks of a significant Au anomaly in this region (McCurdy et al., 2013; in prep.).

The extent of Rae and Slave craton within the TTZ has not been well established. The pronounced, >100 km long magnetic low on the west side of the Mesoarchean domain (Md, Fig. 3) largely comprises variably strained garnet leucogranite that potentially formed from melting of Rae margin sediments (Berman et al., 2015b). This would put the edge of the Rae craton (S1, Fig. 3) ~ 60 km east of the boundary based on the distribution of Yellowknife Group supracrustal rocks (S2, Fig. 3; Thompson, 1992) and ~ 40 km east of a Slave-Rae suture (Culshaw, 1991; Hoffman and Hall, 1993) corresponding to the western limit of Paleoproterozoic granulite-facies gneiss (S3; Thompson et al., 1986; Fig. 3). The upper amphibolite to granulite facies region between alternate suture locations S1 and S3 is marked by a pair of prominent magnetic highs consisting of ca. 1.99 Ga metaplutonic rocks intrusive into high-grade gneisses as old as 2.03 Ga (Davis et al., 2014). The pedigree of the crustal domain between these two belts is presently unknown, but a ca. 2.59 Ga age of monzogranite gneiss (Davis et al., 2014) suggests affinity with the Slave craton. This crustal domain hosts a 1.95 Ga ultramafic to mafic metavolcanic belt (Davis, unpublished data; Berman et al., 2015b) which is spatially associated with pronounced geochemical anomalies (e.g. Ag, Pb, Cu, Zn, Ni, U; McCurdy et al., 2013), and interstratified with well foliated Paleoproterozoic psammitic rocks at anomalously low metamorphic grade (lower amphibolite facies) compared to surrounding rocks.

Timing constraints on the structural evolution of the region are not precisely established. In the eastern Slave craton Neoarchean NW-striking, high-strain foliations are rotated into concordance with the north to north-northeast strike of steeply dipping foliations and high-strain zones within the TTZ. Northwest-vergent thrusting of granulite-facies gneiss onto the Slave craton (S2, Fig. 3) is considered to have accompanied thin-skinned shortening of Goulbourn Group rocks in the eastern Slave craton (Culshaw, 1991). Subsequent transpression was associated with southeast-vergent thrusting and dominantly dextral kinematics, except for ductile deformation in the vicinity of the Bathurst fault (Culshaw, 1991). Brittle deformation on this fault accommodated southward extrusion of crustal blocks during indentation of the Slave craton.

Quaternary Geology

During the last Wisconsin glaciation, the study area was affected by Keewatin Sector Ice of the Laurentide Ice Sheet (e.g. Dyke and Prest, 1987). Consistent striae, glacially-moulded bedrock surfaces and streamlined landforms indicate regional ice flow towards the north to northwest into Queen Maud

Gulf and Bathurst Inlet and require that a major outflow center existed southeast of the study area, presumably associated to various positions of the Keewatin Ice Divide (KID). The KID was active and dynamic throughout the last glaciation until final deglaciation and had a major influence on the sediment distribution, landform patterns and glacial dispersal trains of mainland Nunavut west of Hudson Bay (e.g. Shilts, 1980; Aylsworth and Shilts, 1989; McMartin and Henderson, 2004). The study area also lay in the region of the M'Clintock Ice Divide (MID) located over M'Clintock Channel and believed to have impinged over the Arctic Ocean mainland coast (e.g. Dyke et al., 1982; Dyke, 1984). The MID was thought to represent a major dispersal centre during the height of the last glacial episode (and a pre-cursor to the KID) by Dyke (1984) although recent geomorphological mapping over the northwestern margin of the Laurentide Ice Sheet suggests short-lived ice divide episodes in M'Clintock Channel separated by major ice streaming events from the Last Glacial Maximum through deglaciation (Stokes et al., 2009).

Reconnaissance-scale mapping largely based on airphoto interpretation (Dredge and Kerr, 2013; St-Onge and Kerr, 2103), in addition to field observations collected as part of the GEM-1 Geo-mapping Frontiers' Chantrey Project (McMartin et al., 2013) and the current mapping activity, reveal distinct glacial landscapes and Quaternary sediments on either side of Ellice River, as well as below and above the post-glacial marine limit which extends to the upper reaches of Ellice River between 205 m and 210 m asl (Fig. 4). The region west of the river is dominated by glacially scoured bedrock containing shallow lake basins (Fig. 5a) and areas of thin till in lowlands (Fig. 5b). East of the river, much of the lowland regions below the post-glacial marine limit are covered by till veneers interspersed by areas of bedrock outcrops, and silty marine deposits forming extensive plains between drumlins. Above the post-glacial marine limit, widespread till veneer and streamlined till blanket are more common. In the southeast part of the Overby Lake map sheet and northern part of the Duggan Lake map sheet, clusters of eskers lead up to a discontinuous series of morainic deposits that form the most northern splay of the MacAlpine Moraine System (MMS; Figs. 4&6)(Blake, 1963; Falconer et al., 1965). Broad areas of coalescing glaciofluvial fans and deltas of sand and gravel deposits are aligned in front (northwest) of the morainic ridges (Fig. 5c-d). The southern splay of the MMS in the Duggan Lake map sheet is characterized by more subtle, although semi-continuous glaciofluvial outwash plains and terraces, but lacks the end moraine ridges of the northern splay (Figs. 4&6). The Duggan Lake map sheet is more commonly covered by thick till deposits (Fig. 4b), often streamlined (Fig. 5e) or hummocky, presumably correlated with the inferred terminus of the Dubawnt ice stream (i.e. Stokes and Clark, 2003). Northwestward trending subglacial meltwater corridors containing eskers, modified till, boulder lags, and local zones of scoured bedrock cross the entire area (Fig. 5f).

Early deep striae indicate a regional ice flow towards the north to north-northwest (Fig. 6). During deglaciation, ice flow shifted to the northwest as recorded by cross-cutting fine striae and sub-parallel streamlined landforms. As the ice front receded progressively to major ice recessional positions marked by the MMS, the flow shifted further to the west-northwest. Ice-flow indicators measured in the field in 2012 and 2014 are consistent with scattered striation measurements from previous work (Blake, unpublished, 1963; Kerr, 1994). The early northward flow is recorded all across Keewatin, and, together with opposite southerly flows south and southeast of the study area, indicate an early, major ice divide position lying east-west in Keewatin (e.g., McMartin and Henderson, 2004 - their phase B). The youngest flows to the end moraines correspond to the ice front configurations shown by Dyke (2004) at 8.2 and 8.0 ka BP. No evidence of westward or eastward flow of ice over the study area that would originate from a north-south trending ice divide (i.e. MID of Dyke, 1984) has been found over the area.

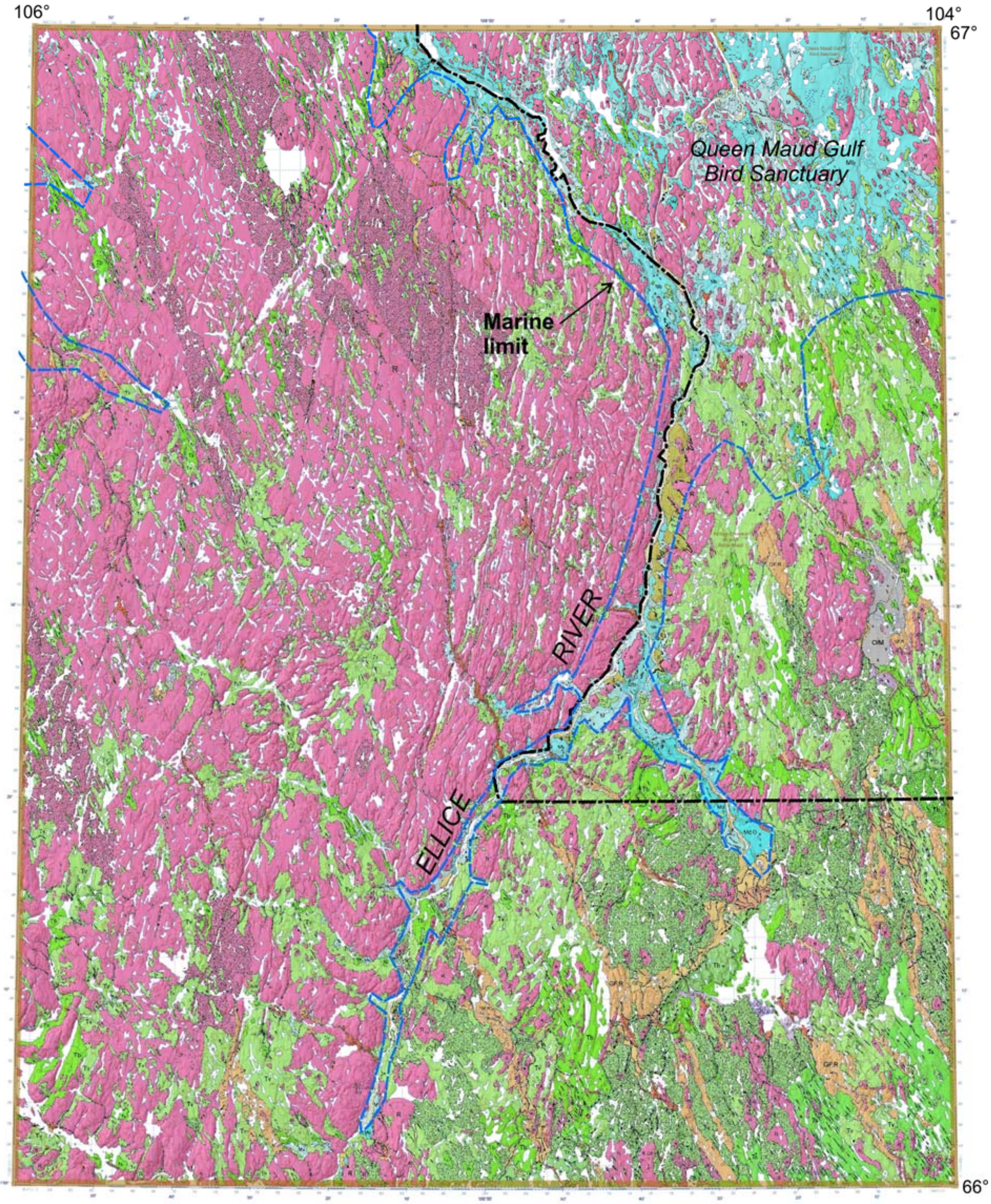

Figure 4. a) Surficial geology of the Overby Lake map sheet (NTS 76I) (Dredge and Kerr, 2013) over digital elevation model. Pink colors represent bedrock, green = till, orange = glaciofluvial deposits, blue = marine deposits and grey = organic deposits. Complete legend is given in the GSC map publication. Approximate location of marine limit is modified from Prest et al. (1968).

Figure 4. b) Surficial geology of the Duggan Lake map sheet (NTS 76H) (St-Onge and Kerr, 2013) over digital elevation model. Pink colors represent bedrock, green = till, orange = glaciofluvial deposits, purple = glaciolacustrine deposits and grey = organic deposits. Complete legend is given in the GSC map publication.

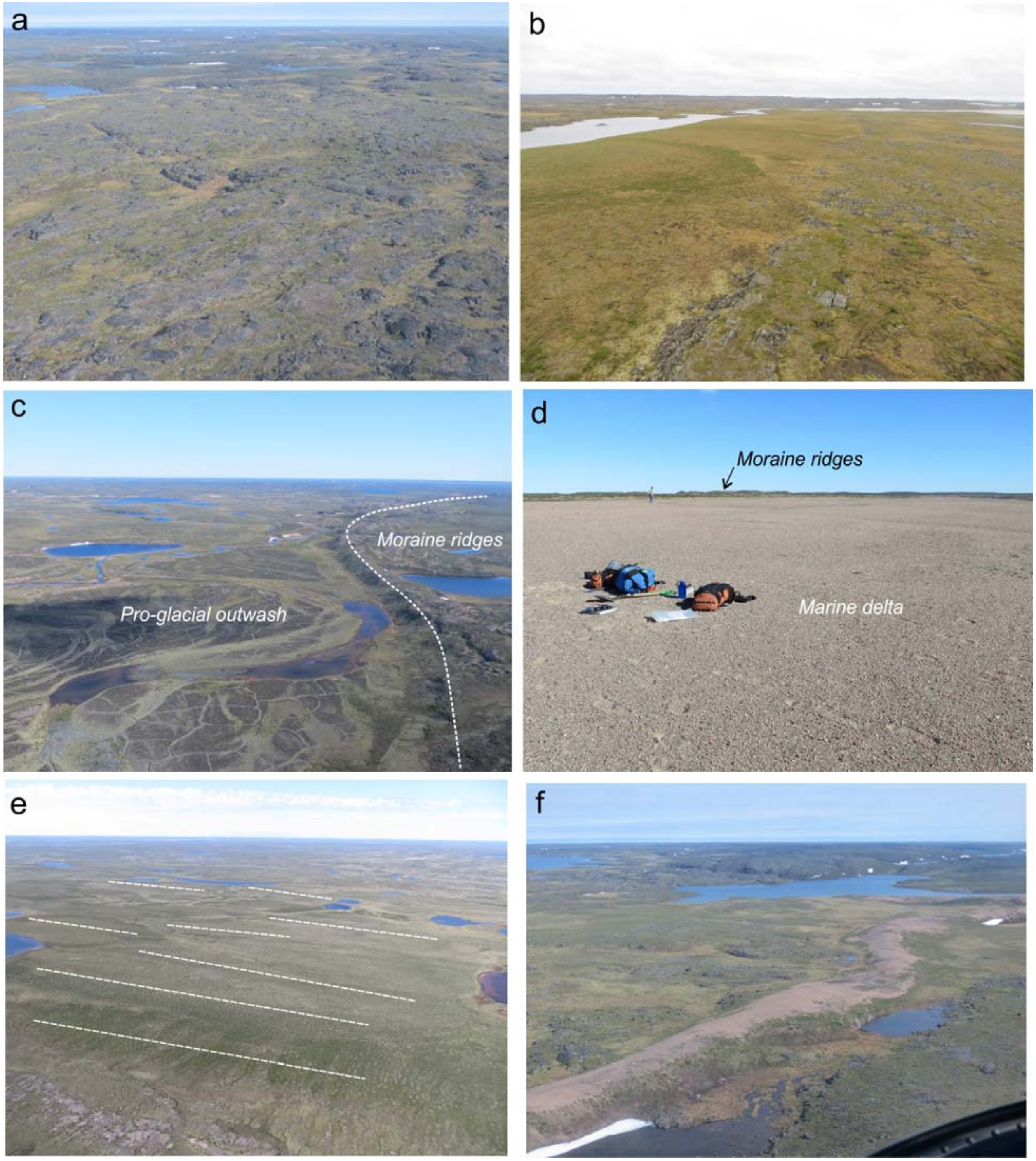

Figure 5. Photographs of a) glacially-scoured bedrock outcrops overlain by thin bouldery till west of Ellice River; b) grassy thin till in low areas west of Ellice River; c) proglacial outwash plain of sand and gravel deposits in front of major end moraine ridges of the MMS; d) marine deltaic sands deposited in front (northwest) of the MMS where the marine limit reaches the most northern morainic segment; e) northwestward streamlined forms developed in thick, Thelon sandstone-rich till north of Back River; f) esker ridge bordered by scoured thin till and boulder-covered bedrock in the southwest part of the NTS map 76I.

FIELD PROCEDURES

Field data collection

Field work was completed in 8 days from June 27th to July 4th in 2014. Access was by helicopter from a GSC tent camp on Ellice River (Fig. 3). Field work involved verifying the reconnaissance surficial geology maps (Dredge and Kerr, 2013; St-Onge and Kerr, 2013) by ground truthing and remote observations from the helicopter, measuring indicators of glacial flow at various sites, walking short traverses along prominent MacAlpine Moraine segments to identify appropriate sites for collecting age dating material, and till sampling at targeted sites. A total of 55 sites were visited (cf. Fig. 3) and are described in Appendix 1. The orientation and sense of 48 small-scale glacial erosional features on bedrock were measured from 31 sites (Fig. 6). Relative ages of striated facets were established at 11 sites. Ice-flow indicator measurement locations and descriptions are provided in Appendix 2.

Till sampling

In total, 28 till samples were collected in 2014, mainly to provide more detail on geochemical anomalies identified in 2012, or to characterize the regional glacial transport (provenance) across major glaciological features, i.e. within/outside ice stream landscapes and on either side of major ice retreat positions. Four till samples were collected up-ice (between south and southeast) of site 12NK-N026 ("N26" on Fig. 3) west of Ellice River where a Cu-Ag till geochemical anomaly was identified in 2012 (McMartin et al., 2013); three till samples were collected east of Ellice River, up-ice of site 12NK-N026 ("N27") where a native platinum grain occurrence was found in till in 2012 (McMartin et al., 2013); four till samples were collected in the vicinity of a sulphide grain and a Cu-Pb-Zn-Ag-REEs stream sediment anomalous area west of Duggan Lake ("D") identified in 2012 (McCurdy et al., 2013); one sample was collected 12 km down-ice (northwest) of the Goose gold deposit over the Slave craton ("G"). Till samples were also collected along two 80-km long transects perpendicular to the MacAlpine Moraines and extending into the Dubawnt ice stream terrain ("T1" and "T2"; cf. Fig. 3); one sample was collected directly on top of a prominent morainic ridge on the northernmost segment of the MMS in NTS 76I ("M"). Samples were carefully collected on flat till surfaces in Cy-horizon material from hand dug pits in active frost boils, at an average depth of 35 cm. At each site, one small sample (~3 kg) and one large sample (mean=11.5 kg; range=9.8-13.7 kg) were collected. One field duplicate was collected at a randomly chosen site to test site variability (less than 5 m apart). The routine sample and corresponding field duplicate were labelled with the same sample code except for one digit (e.g. 14MOB-M044A01 for the routine sample and 14MOB-M044A02 for the field duplicate). The location and description of the samples are presented in Appendix 3.

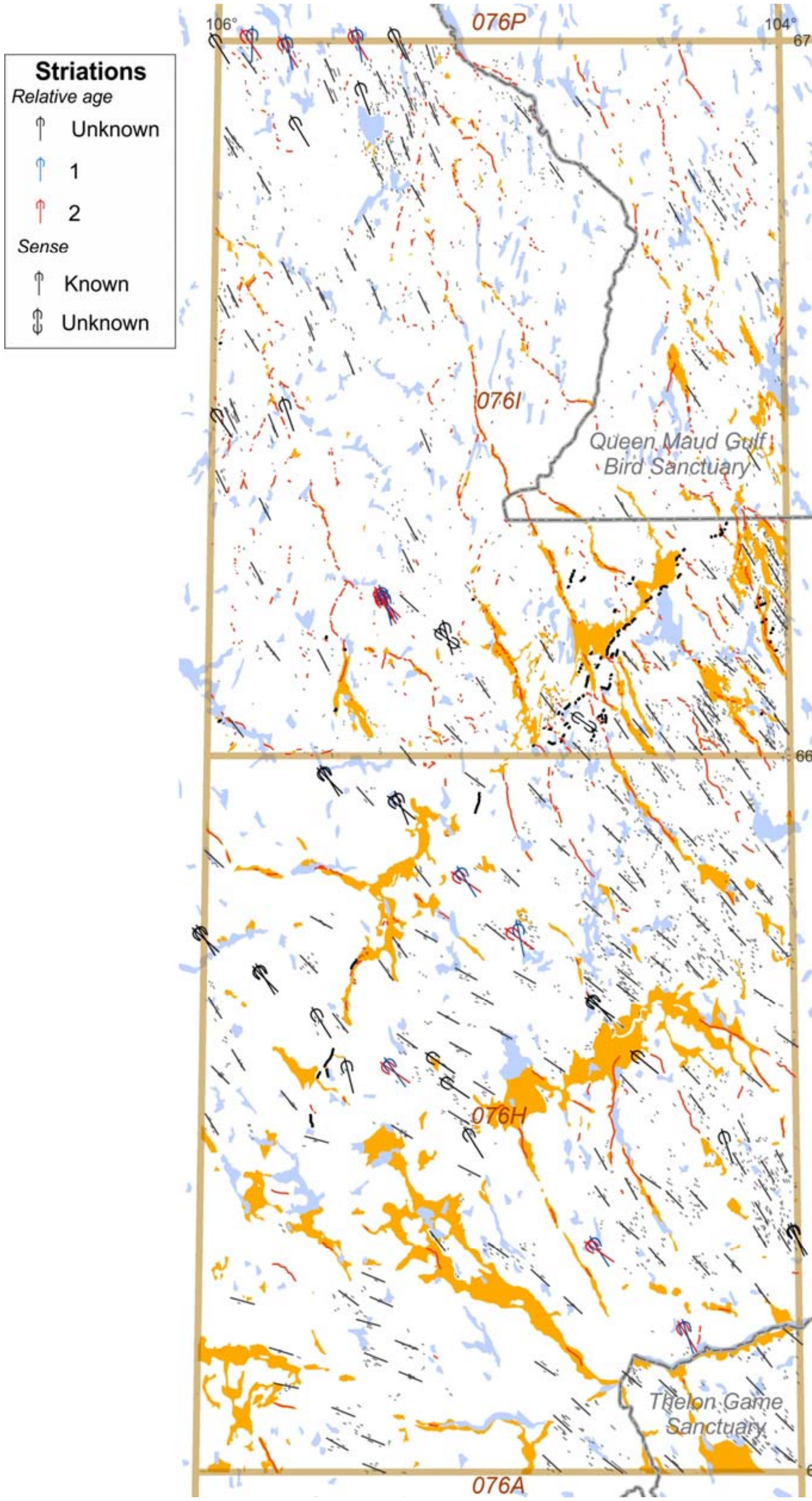

Figure 6. Map of small erosional ice-flow indicators (mainly striations) showing trends and relative ages at each site. Esker ridges (red), streamlined landforms (dark grey), morainic ridges (thick black) and undifferentiated glaciofluvial deposits (orange) are from Dredge and Kerr (2013) and St-Onge and Kerr (2013). Generalized trends of streamlined landforms are shown with thin black lines.

ANALYTICAL PROCEDURES

Sample preparation

A 2-kg split of all ~3-kg samples was air-dried and dry-sieved in GSC's Sedimentology Laboratory, Ottawa, using a stainless steel US standard No. 230 mesh screen to obtain the <0.063 mm size fraction using procedures outlined in Girard et al. (2004). The remainder (<800 g) of each 3-kg till sample was archived at the GSC, Ottawa. The large (~11.5-kg) till samples were shipped to Overburden Drilling Management Ltd (ODM), Ottawa, for processing and the production of heavy mineral concentrates. Samples were disaggregated in water and screened at 2 mm to produce a non-ferromagnetic heavy mineral concentrate for picking indicator minerals, which involved a two-step process with a shaking table and heavy liquids. The oversize (>2 mm) was wet-sieved to collect the 8-30 mm fractions for lithological analysis. Sample preparation and analytical procedures for all till samples are summarized in Figure 7. The analytical and QA/QC procedures follow the protocols for till samples collected as part of GEM projects (Spirito et al., 2011; McClenaghan et al., 2013).

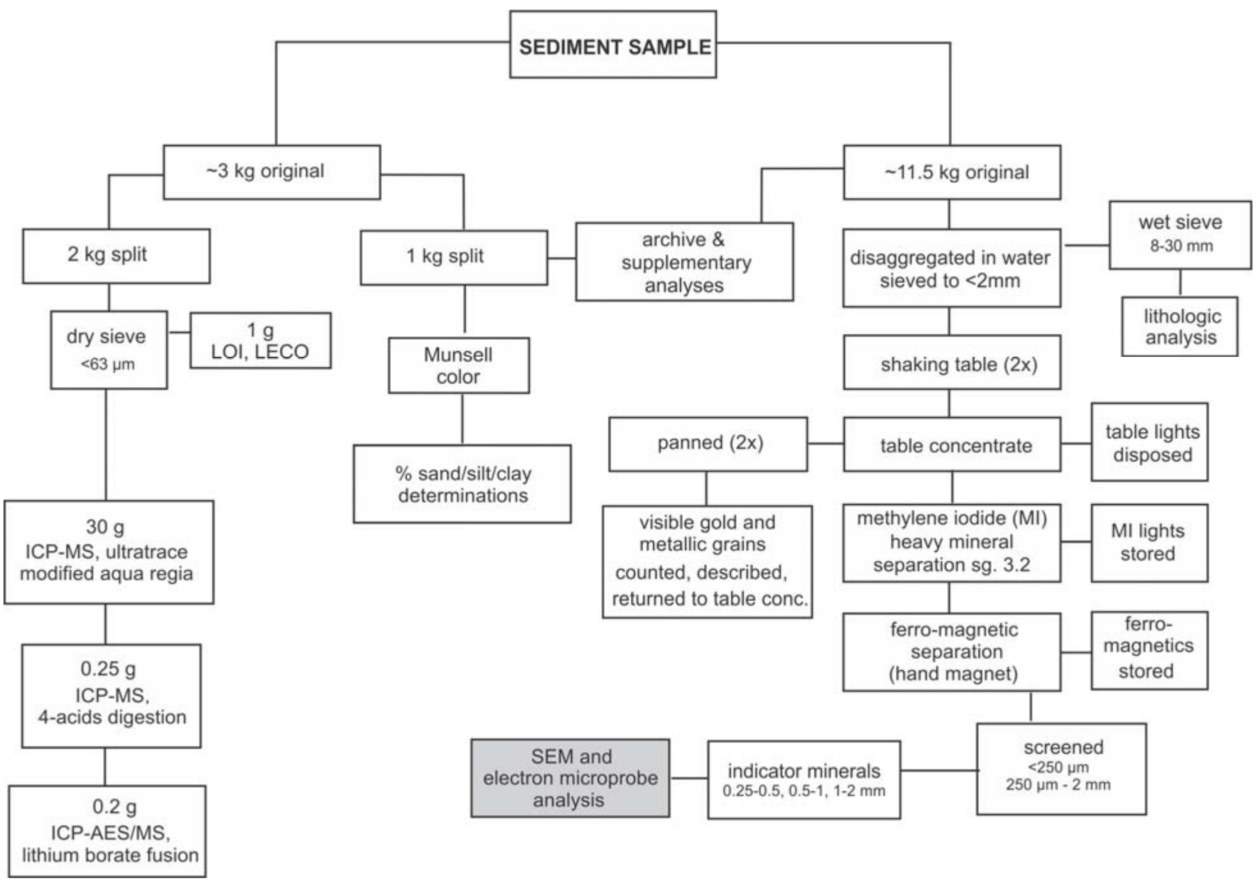

Figure 7. Flow sheet showing steps in till sample processing. SEM and electron microprobe data will be reported elsewhere (McMartin, in prep.).

Till matrix geochemistry

Approximately 30 g of the silt+clay-sized fraction (<0.063 mm) of till were analyzed at Bureau Veritas Commodities Canada Ltd. for a suite of trace, major and rare earth elements using ultratrace ICP-

MS, following a modified aqua regia digestion (HCl-HNO_3, 1:1; 95°C) (Group AQ252: 53 elements). In addition, a separate 0.25 g split of the same fraction was analyzed using ultratrace ICP-MS, 4-acids digestion (HNO_3-$HClO_4$-HF dissolved in HCl: Group MA250: 59 elements). Another separate 0.2 g split was analyzed for whole rock plus Cu, Mo, Ni, Pb, Sc and Zn analysis by ICP-ES, and for trace elements by ICP-MS following a lithium metaborate/tetraborate fusion and dilute nitric digestion (LF200: 49 elements + LOI). Carbon and S were analyzed by LECO as part of the same package (TC000). Detection limits, raw analytical data and data exportable into GIS formats (less than d.l. values= ½ d.l.) are given in Appendix 4.

Quality accuracy and quality control (QA/QC)

Accuracy and precision of analytical data returned from commercial laboratories were determined by including analytical duplicates, primary standards (Till-4) and silica blanks (qtz-J29623) within the sample suites submitted to the analytical laboratory. Analysis of laboratory duplicate samples was used to monitor analytical precision of the geochemical results. Two analytical duplicates were prepared in the laboratory from the field duplicate sample (14MOB-M044A02) and were labelled with a similar sample code (e.g. 14MOB-M044B02 and 14MOB-M044B03). The first laboratory duplicate was inserted at the beginning of the batch and the second was inserted in the middle. Analysis of primary standards was used to monitor analytical accuracy of the geochemical results. Two standards were inserted randomly within each block of 16 samples and labeled with the same code as the previous sample except for one letter (e.g. 14MOB-M023B01 and 14MOB-M037B01). To monitor potential cross-contamination during the sieving process and to purge the sieves between sample batches, silicic acid blanks were sieved at the beginning of each block of about 16 samples and submitted for geochemical analysis. The QA/QC statistics results discussed below are included in Appendix 4.

<u>Precision</u>

The results for the two laboratory duplicate samples indicate that the analytical precision is very good for most elements analyzed by ICP-MS after a modified aqua regia digestion (Relative standard deviation: RSD≤10%). This method is somewhat less precise for K (RSD=10.53%), and even less so for Au and Mo (RSD>20%). Boron, Cd, Ge, Hg, In, Pd, Pt, Re, S, Sb, Se, Ta, Te, Tl and W levels are near or below the lower detection limit in laboratory duplicates; therefore the precision cannot be properly evaluated. For the 4-acid digestion ICP-MS analyses, laboratory duplicates indicate that the analytical precision is also very good for most elements, but less precise for Ag and As (RSD=10-20%). This method is consistently not precise for Bi, Cd and Te (RSD>20%). Beryllium, Cs, In, Lu, Re, S, Sb and W levels in laboratory duplicates are near or below the detection limit for this method; therefore the precision cannot be properly evaluated for these elements. For lithium borate fusion and dilute nitric digestion ICP-ES/MS analyses, reproducibility is good for most elements (RSD<10%). This method is somewhat less precise for W (RSD=14%), and not very reliable for Be and Ta (RSD>20%). Precision for Cs, MnO, Mo and Sn cannot be properly evaluated since the results of the laboratory duplicate analysis are below or close to the lower detection limits. Carbon by LECO is reproducible (RSD<10%) while S is below the detection limit. LOI determinations are precise in till (RSD = 9.9%).

<u>Accuracy</u>

The accuracy in the ICP-MS analyses after the modified aqua regia digestion is good for most elements as results are generally within 10% of the mean of values from the provisional or informational analysis available for Till 4. Values above 10% of the mean are shown in red in the QA/QC report Till 4 sheets in Appendix 4. Arsenic, Bi, Co, Mn, Mo, Pb and particularly Hg, are less accurate using this method. The accuracy in the ICP-MS analyses by 4-acid digestion is generally acceptable. The accuracy in the analyses by lithium metaborate/tetraborate fusion and dilute nitric digestion is good for most elements except for Be, Ce, Co, Er, Eu, La, Lu, Mo, Nd, Sm, Sr, Ta, Tb, V and Yb which are irregularly less reliable. The silica blank qtz-J29623 returned average values of 90.36% SiO_2 and 9.5% LOI, which are slightly different than previously reported average values for this material (e.g. McClenaghan et al., 2015; McMartin et al., 2015). The four acids value for Silica Sand1 inserted at the beginning of the batch was elevated in Ag (22 ppb), above the expected value of <20 ppb. There is a possibility that this high Ag value may be the result of cross-contamination from metal-rich samples analyzed before the batch.

<u>Field site variability</u>

Results of the field duplicate sample collected within 5 m of the original sample indicate that the sediment is fairly homogeneous in composition at that site. A full measure of the variance due to sediment heterogeneity within a site versus between sites was not completed due to the single field duplicate pair (e.g. Garrett, 1983).

Matrix colour and texture

Munsell colour codes were determined on dry samples at the GSC Sedimentology Laboratory using a spectrophotometer. For textural analysis of the matrix, approximately 200-300 g from a selection of 23 till sample was dry-sieved to obtain the <2 mm (-10 mesh) fraction of the samples. The size classes greater than 0.063 mm were determined using wet sieving followed by dynamic digital image processing using a CAMSIZER Particle Size Analysis System. The classes of sizes smaller than 0.063 mm were determined using a Lecotrac LT-100 Particle Size Analyser. The results of the matrix colour and textural determinations for the >2 mm size fraction, sand (2-0.063 mm), silt (0.063-0.002 mm) and clay (<0.002 mm) fractions are presented in Appendix 5.

Matrix carbon and organic contents

Total carbon was determined on the <0.063 mm fraction with a LECO CR-412 Carbon Analyzer instrument (1350°C) (Girard et al. 2004). Only the samples with Total C > 0.10% were analyzed for inorganic and organic carbon afterwards. Loss-on-ignition (LOI), an approximation of total organic content, was determined on the <0.063 mm fraction after heating a small portion at 500°C for one hour in an ashing furnace (Girard et al., 2004). Laboratory duplicates as well as in-house (12% standard) and CANMET (Till-2) standards were inserted for the till matrix carbon and LOI analysis. All results for the carbon and LOI analysis are given in Appendix 6.

Clast lithology

The >2.0 mm material from the large till samples was wet-sieved to separate the 8-30 mm fraction for lithological analysis. Pebbles were visually examined using a binocular microscope (minimum 27 clasts; maximum 200; average 181) by ODM. Pebble classes can be grouped into the following four general lithological classes: a) plutonic and high-grade metamorphic rocks (classes: 1-granitic rocks and orthogneiss, 2-paragneiss and paramigmatite, 3-metapelite/psammite/quartzite, 4-metachert and iron formation, 5-metagabbro, 6-amphibolite, 7-veins and tectonite (quartz vein), 8-veins and tectonite (shear zone)); b) greenstones (classes 9-undiferrentiated); c) unmetamorphosed Proterozoic rocks (classes: 10-Dubawnt unoxidized quartzite; 11-Dubawnt oxidized quartzite, 12-Dubawnt Pitz volcanics, 13-diabase, 14-greywacke); and d) any other distinctive lithologies. Results presented in Appendix 7 include the number of clasts and the percentage (%) of the total in each category, and the raw pebble counts from ODM.

Heavy mineral processing and indicator mineral picking

The large till samples were processed at ODM for recovery of the heavy mineral fraction and indicator mineral counting, including gold grains. Samples were processed in order from the least metal-rich to the most metal-rich based on field observations and location to minimize the potential for indicator mineral carryover between samples. Figure 7 outlines the sample processing flow sheet for the recovery of indicator minerals. Samples were disaggregated and sieved to obtain the <2 mm (matrix) fraction ("Table feed"), and then, processed using a double-run across a shaking table to ensure a complete recovery of all indicator minerals. The table pre-concentrate was then panned for gold grains and metallic indicator minerals; after counting, these minerals were then returned to the preconcentrate. After tabling and panning, the pre-concentrate was further refined using heavy liquid (methylene iodide - SG 3.2) and ferromagnetic (FM) separations. The <2 mm non-ferromagnetic (NFM) heavy mineral concentrates (HMC) were screened at 0.25 mm. The 0.25-2 mm NFM-HMC fraction was picked for indicator minerals. The total number of gold, sulphide and PGM grains recovered from the panning, and the weights of table feed, table pre-concentrates, NFM- and FM-HMCs are presented in Appendix 8.

Prior to indicator mineral examination and selection, the 0.25-2 mm NFM-HMCs recovered from till samples were dry sieved to 0.25-0.5 mm, 0.5-1 mm and 1-2 mm. The 0.25-0.5 mm sample fraction was further refined using a Carpco® electromagnetic separator to produce fractions with different paramagnetic characteristics to help reduce the volume of concentrate to be visually examined (Averill and Huneault, 2006). All fractions were examined under a stereoscopic microscope at ODM to determine the abundance of potential kimberlite indicator minerals (KIMs) and metamorphosed or magmatic massive sulphide indicator minerals (MMSIMs), and any other mineral indicating the presence of potential mineralization. For each sample, the entire concentrate in each of the three size fractions was examined. ODM performed checks on selected grains using SEM-energy dispersive x-ray spectrometer (EDS) to confirm mineral identification. Selected grains considered having possible KIM and MMSIM affinities were removed from the concentrate and stored in viles for further study. Because of their high abundance in some samples, only a few representative grains (20-30) of certain mineral species were picked for future analysis (i.e. bronzite, topaz, spessartine). Appendix 8 includes all raw grain counts from the visual identification of possible indicator minerals for the 0.25-2 mm NFM-HMCs in worksheets "KIM Data" and "MMSIM".

Three blank sand and gravel samples consisting of weathered Silurian-Devonian granite (grus; i.e. Plouffe et al., 2013a, 2013b) were inserted by the GSC at the beginning, in the middle and at the end of the sample batch to monitor potential cross-contamination introduced during heavy mineral separation. Data for the blank samples are listed in Appendix 8 and are highlighted in yellow. Expected hornblende/titanite-zircon assemblages with no specific indicator minerals were found in the blanks. No sulphides, PGMs, KIMs or MMSIMs were found in the blank samples. A comparison of the gold grain abundance between the original and the field duplicate samples indicates that gold grain counts are comparable but not identical (1 reshaped versus 4 reshaped gold grains). PGMs (0) and KIMs (0) and similar MMSIMs grain counts were measured. The variability of the gold and indicator mineral content between the original and the duplicate samples reflects a combination of sediment heterogeneity and the precision of the mineral separation and identification method. All picking results for the three blanks and the field duplicate samples are reported in Appendix 8.

SUMMARY

The Geological Survey of Canada completed a targeted till sampling survey in 2014 in the Thelon tectonic zone of mainland Nunavut south of Queen Maud Gulf as part of the GEM-2 Thelon tectonic zone project (NTS 76H and 76I). The field and analytical methods and results of this survey are provided here together with a brief overview of the bedrock and Quaternary geology of the study area. The results in terms of till provenance and implications for mineral exploration and economic potential will be presented separately. Quaternary field observations were recorded at 55 field stations; 31 of these included small-scale ice-flow indicator measurements. Targeted surface till samples were mainly collected at GEM-1 till and stream sediment anomalies, and along two 80-km long transects across various paleoglaciological domains, including within and outside the Dubawnt dispersal train and across two splays of the MacAlpine Moraine System. Analytical results include till matrix texture, colour, carbon and organic contents, pebble count analysis, as well as till matrix geochemistry performed on the <0.063 mm fraction using ICP-MS modified aqua regia digestion, ICP-MS 4-acid digestion, and ICP-ES/MS lithium borate fusion. Heavy mineral processing, precious metal grain counts and visual indicator mineral identification were completed for each till sample. QA/QC analysis was determined using field and analytical duplicates as well as control reference samples (blanks and standards). The analytical and QA/QC procedures follow the protocols for till samples collected as part of GEM projects (Spirito et al., 2011; McClenaghan et al., 2013; Plouffe et al., 2013a). All the field datasets and the complete analytical results are presented in a spreadsheet format easily importable in any geographic information system.

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