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Geochemical and Mineralogical Data for Stream Sediment and Proximal Till Sites, Ellice River Area, Nunavut (Parts of NTS 76-H and NTS 76-I)

M.W. McCurdy and I. McMartin

2017

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ABSTRACT

This report releases the field database and analytical results from a targeted stream sediment and till sampling survey completed during six days in 2016 over parts of NTS 76-H and 76-I as part of the Geological Survey of Canada's GEM-2 Thelon tectonic zone project, southeast of Bathurst Inlet, mainland Nunavut. The survey covers parts of the Thelon tectonic zone and adjacent Slave craton, and crosses the terminus of the Dubawnt Lake ice stream.

Field observations and geochemical data from 39 stream sampling stations are published in spreadsheet format. Mineralogical data derived from heavy mineral concentrate samples collected at 17 of the 39 stream stations are included with this report. Surface till samples were collected at 11 field stations proximal to stream stations. Matrix geochemistry, indicator minerals, clast lithology and grain size distribution were determined in till samples. Field observations and till compositional datasets appear in separate spreadsheets in the appendices. A preliminary interpretation of the combined datasets with implications for mineral potential in three follow-up areas is presented at the end of the report.

INTRODUCTION

Till sampling transects and regional stream sediment, indicator mineral and water geochemical surveys were carried out around the Ellice River, southeast of Bathurst Inlet, in the central part of the Kitikmeot administrative region of Nunavut in 2012 and 2014 as part of GEM-1 and GEM-2 projects (McCurdy et al., 2013, 2016; McMartin et al., 2013; McMartin and Berman, 2015). A discussion on glacial transport in the study area and the composition of glacial sediments across the Dubawnt Lake ice stream was provided in McMartin (2017). This report consists of field observations and analytical data for 65 elements in stream silts by a partial method of analysis (modified *aqua regia* digestion) and for 35 elements by a total method (Instrumental Neutron Activation) from 39 follow-up stream stations visited in 2016 (Fig. 1). Till samples collected adjacent to 11 stream sediment stations were analyzed for geochemistry by modified *aqua regia*, near-total four-acid digestion (59 elements) and lithium tetraborate fusion (49 variables). Indicator minerals observed in heavy (>3.2 specific gravity) mineral concentrates in bulk (10-15 kg) samples collected at 17 of the 39 stream stations and at all till stations are included in this report. Analytical results and field observations form part of a larger national geochemical database (Adcock et al., 2013) used for resource assessment, mineral exploration, geological mapping, and environmental studies.

Targeted stream sediment and surface till sampling in 2016 focused on following up three geochemically anomalous areas (Figs. 1; 2a, b, c). Previous sampling in Area 1 (Fig. 2a) identified a Cu-Pb-Ni-Zn-Ag (with chalcopyrite, molybdenite, pyrite, and gahnite) stream sediment anomaly in northwestern NTS 76-I associated with Slave supracrustal rocks (McCurdy et al., 2016). A Cu-Pb-Zn-As-sulphide till and stream sediment anomalous area (Area 2: Fig. 2b) was documented in central NTS 76-H southwest of Duggan Lake (McCurdy et al., 2013, 2016; McMartin and Berman, 2015). In Area 3 (Fig. 2c), a Au anomaly in the silt and heavy mineral fractions of stream sediments was identified within a single watershed draining into the Back River in southeastern NTS 76-H (McCurdy et al., 2013). The sampling involved the collection of stream silt samples for geochemistry from 14 stations and an additional bulk stream sediment sample for indicator minerals from eight of these stations in Area 1, silt and bulk sediment samples from two stations in Area 2, and an additional seven bulk stream sediment samples from 23 stream silt-sampling stations in Area 3. Surficial geological field observations were recorded at 45 locations; two separate till samples were collected adjacent to 11 stream sediment sample stations (Figs. 2a, b, c) to

determine matrix geochemistry, indicator minerals, clast lithology and grain size distribution. This report provides a preliminary interpretation of the GEM-1 and GEM-2 datasets for mineral potential evaluation in the three follow-up areas.

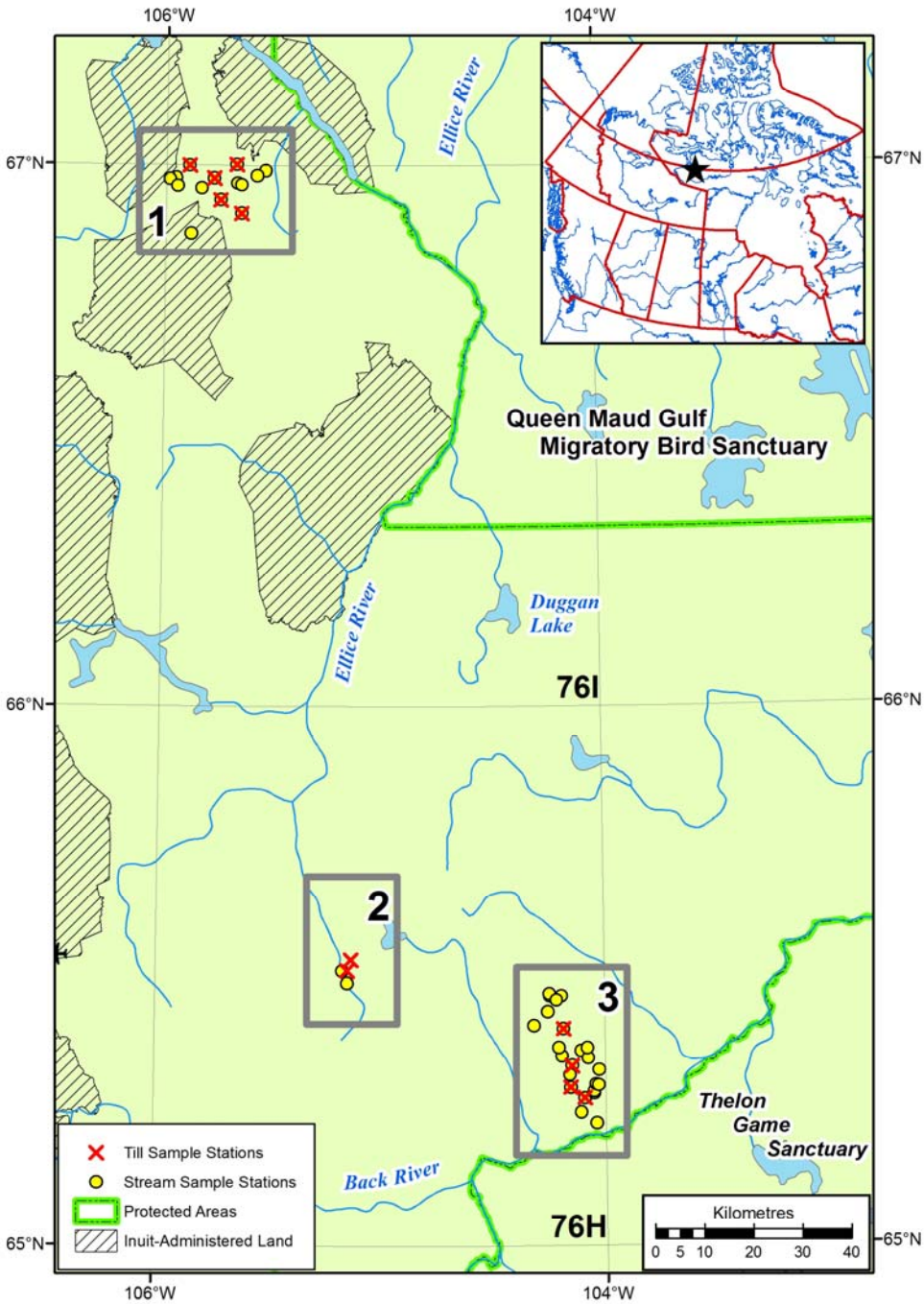
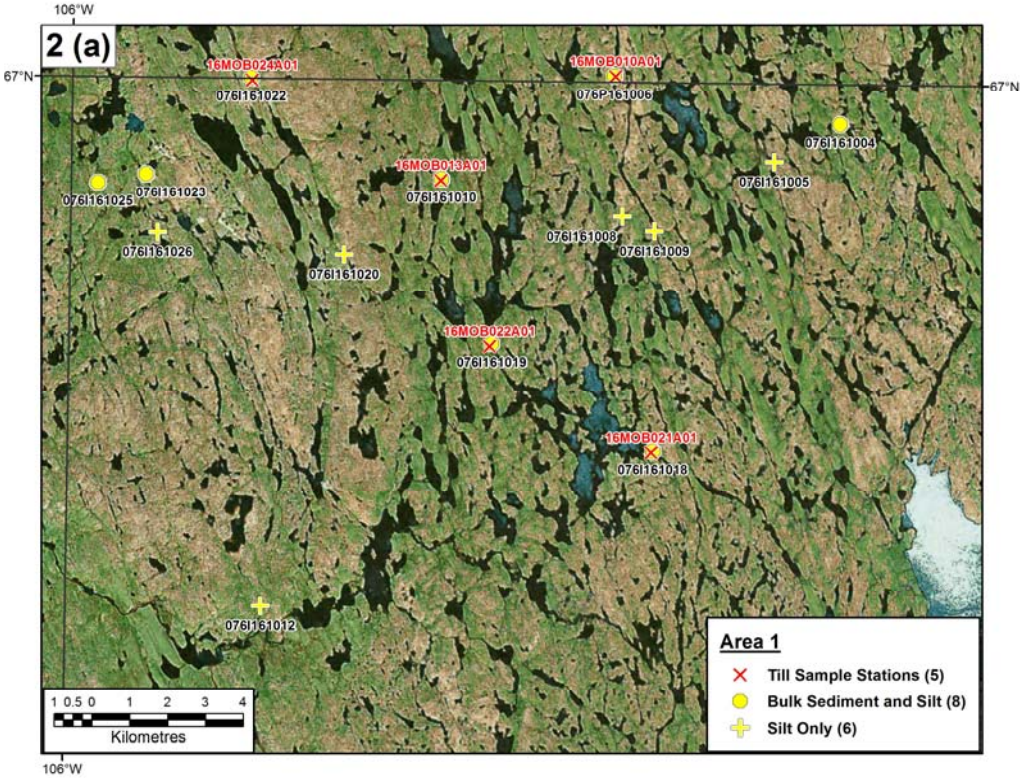
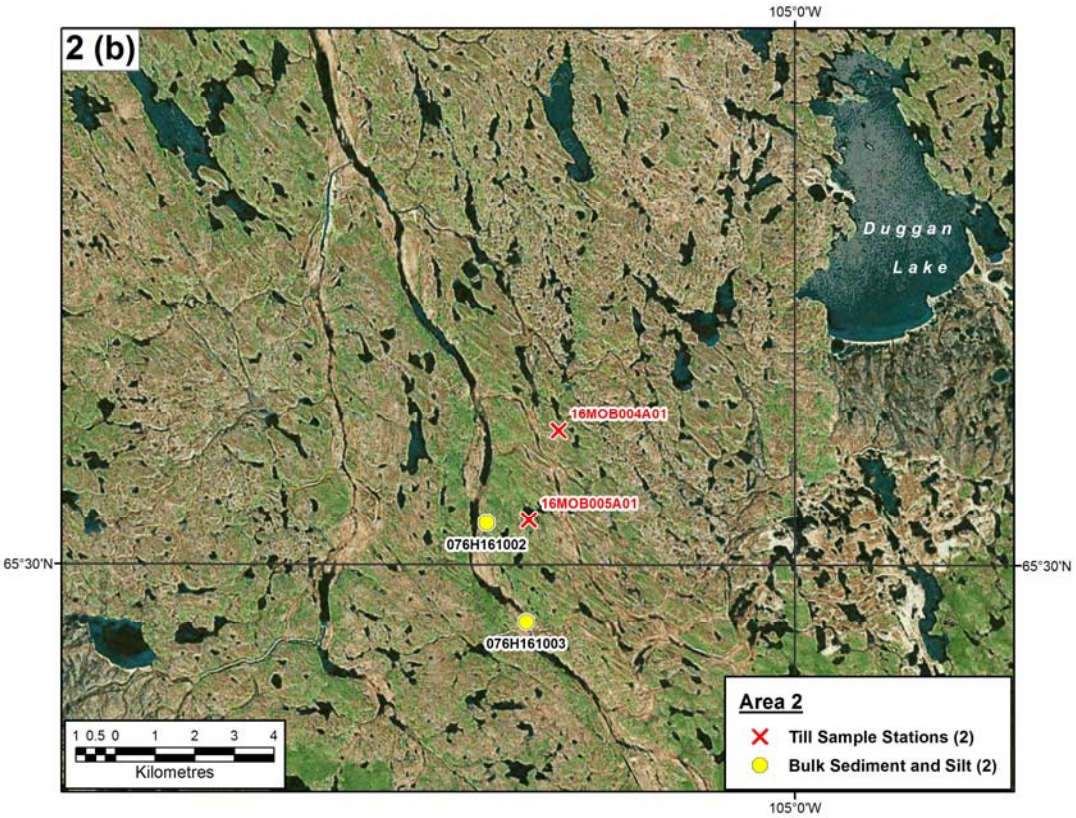


Figure 1 Till and stream sediment samples were collected in 2016 from three areas of mineral potential identified from previous surveys in 2012 and 2014 (McCurdy et al., 2013, 2016; McMartin and Berman, 2015).


2 (a)
106°W
67°N
16MOB024A01
076I161022
16MOB010A01
076P161006
076I161004
076I161005
16MOB013A01
076I161010
076I161025
076I161023
076I161026
076I161008
076I161009
076I161020
16MOB022A01
076I161019
16MOB021A01
076I161018
076I161012
Area 1
Till Sample Stations (5)
Bulk Sediment and Silt (8)
Silt Only (6)
1 0.5 0 1 2 3 4
Kilometres


2 (b)
105°0'W
Duggan
Lake
16MOB004A01
16MOB005A01
076H161002
65°30'N
076H161003
Area 2
Till Sample Stations (2)
Bulk Sediment and Silt (2)
1 0.5 0 1 2 3 4
Kilometres

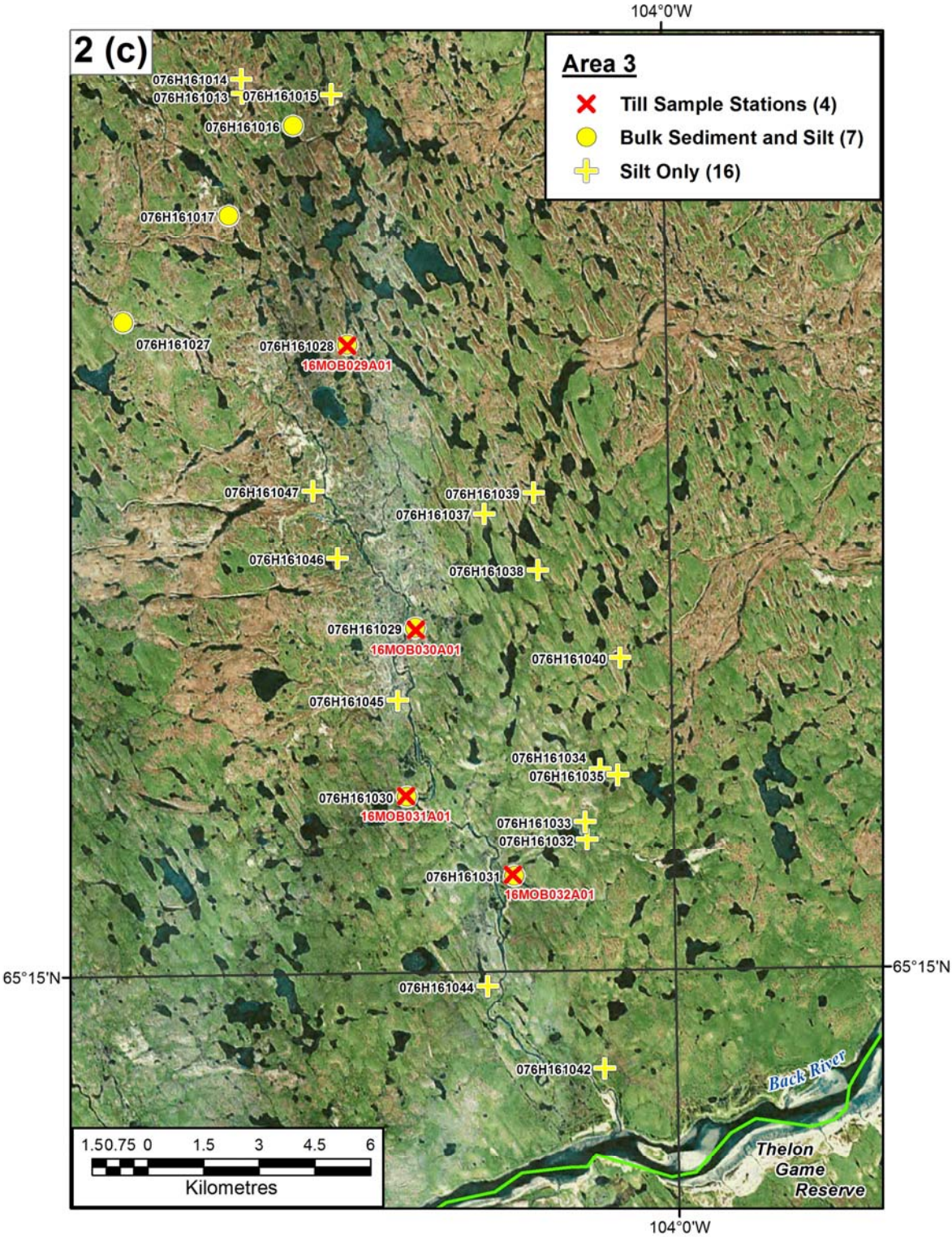


Figure 2 Till and stream sediment sample location maps for Area 1 (2 (a)), Area 2 (2 (b)) and Area 3 (2 (c)) using LANDSAT imagery (U.S. Geological Survey, 2017) as a base.

SAMPLE COLLECTION

Stream Sediments (Silts)

At each site, a synthetic cloth bag (18 cm x 32 cm) was two-thirds filled with silt or fine sand collected from the active stream channel (Fig. 3a). The silt sample was collected before the bulk sediment sample. Commonly, the sampler collected silt by hand from various points in the active channel while moving upstream, over a distance of 5 to 15 m. If the stream channel was found to consist mainly of clay, coarse material or organic sediment from which suitable sample material is scarce or absent, moss mat from the stream channel, which commonly contains trapped silt, may have been added to the sample. A pair of silt samples, at a site picked at the discretion of the sampler (generally based on ease of collection) and assigned sequential sample numbers, was collected at one site within each sequence of 20 samples as field duplicates. The first sample of the pair is referred to as the 'First Field Duplicate' in the appendices and the second is referred to as the 'Second Field Duplicate'. Routine (non-duplicate) field samples are referred to as 'Routine' samples in the appendices. Field observations were digitally recorded on a tablet using a standard form developed jointly by the GSC and the Northwest Territories Geological Survey.

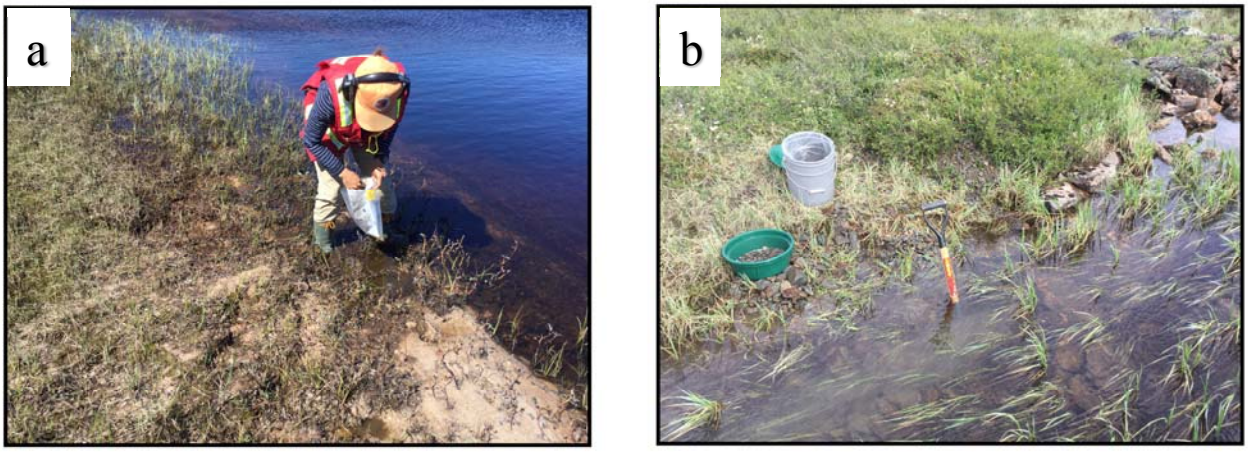


Figure 3 Pre-labelled synthetic cloth bags are used to collect samples of stream silts (3a). A bulk sample, for the recovery of heavy minerals, is collected by wet-sieving coarse-grained stream sediment using a US Sieve Series 12-mesh (1.68 mm) sieve in a plastic pail lined with a polyethylene sample bag (3b). The gold pan is used for adding water for wet sieving, not for heavy mineral concentrate panning.

Heavy Mineral Concentrates

Ideal sites for the collection of bulk stream sediments for the recovery of heavy minerals fraction are located at the upstream ends of mid-channel boulder bars and behind mid-stream boulders (Prior et al., 2009). Material was collected by shovel from one (preferred) or more holes dug in the stream bed commonly to depths of a few 10's of centimetres (Fig. 3b). A 22.7 litre (5-gallon) plastic pail was lined with a heavy-duty (4-Mil) polyethylene bag measuring 46x61 cm (18x24 inches). Material was wet-sieved into the pail through a U.S. Sieve Series 12-mesh (1.68 mm) stainless steel sieve until a sample weight of 10-15 kg was attained. The bag lining the pail, labelled with the sample number, was taped shut with black plastic (electrical) tape and placed into a second bag, also labelled with the sample number, and taped.

Surface Till

Samples were collected on flat till surfaces adjacent to stream sediment sites in Cy-horizon material from hand dug pits in active frost boils, at an average depth of 27 cm. At each site, one small sample (~3 kg) and one large sample (mean=11.3 kg; range=8.6-13.5 kg) were collected in plastic bags. The location and description of the till samples are presented in **Appendix03 Till Sample Field Observations.xls.**

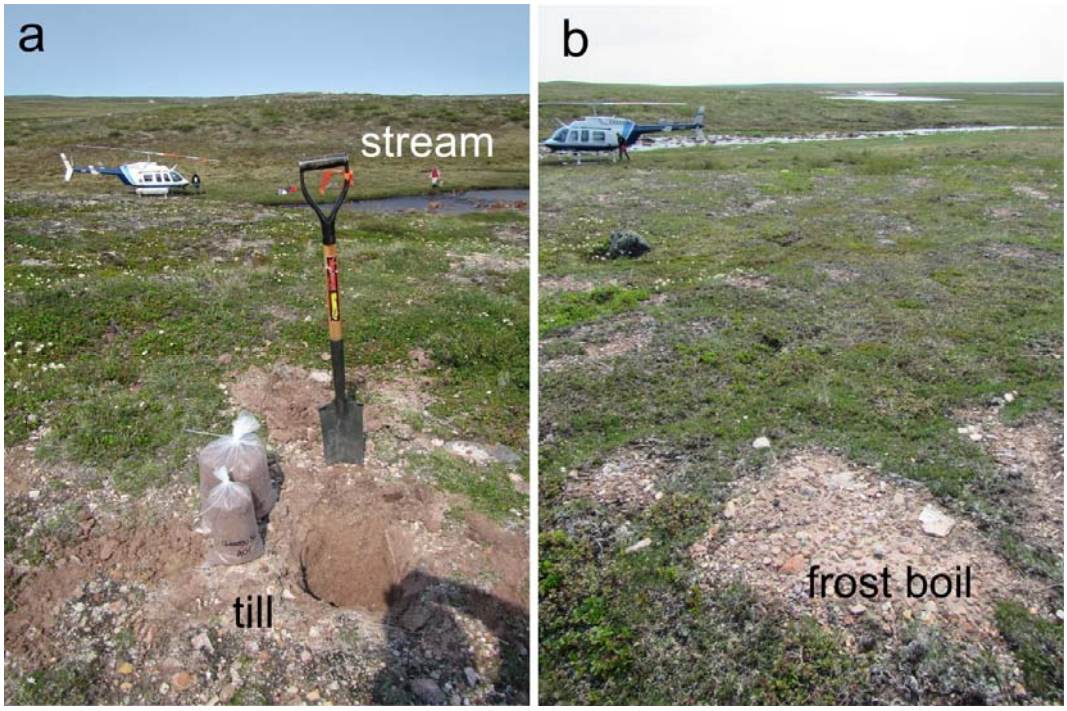


Figure 4 Paired till and stream sediment sampling sites: a) sample sites about 20 m apart along unnamed stream in NTS 76-H; b) site of a till sample in an active frost boil north of the Back River.

SAMPLE PREPARATION

Stream Sediments (Silts)

The synthetic cloth bags containing the silt samples were drip-dried in the field before being placed into plastic bags, taped with electrical tape and shipped directly to the GSC Sedimentology Laboratory in Ottawa, where they were unpacked and air-dried to completion at temperatures below 40ºC. After drying, samples were disaggregated and sieved through a minus 80-mesh (177 µm) screen (Girard et al, 2004). An aliquot sample of a Certified Reference Material (CRM) and an analytical duplicate sample were inserted into each block of twenty samples. An analytical duplicate sample is a split from a Routine Sample or a Field Duplicate and analyzed using the same methods as the routine samples.

Stream Sediments (Bulk Sand-Sized Fraction for Heavy Mineral Concentrates)

Samples were processed at Overburden Drilling Management Limited (ODM), Ottawa, Ontario. Before processing, a 500-g character split sub-sample was collected from each sample and archived. The bulk sediment samples were then progressively reduced by a range of laboratory procedures to concentrate heavy minerals. Initially a low-grade shaking table concentrate was prepared from each of the samples. Gold grains, sulphides and other mineral grains were recovered at this stage by panning and were counted: gold grains were measured and classified as to degree of wear (reflecting distance of transport). The

concentrate from tabling was separated in methylene iodide diluted with acetone to S.G. 3.2 to recover heavy minerals including Cr-diopside and olivine. Magnetite was removed after the heavy liquid separation and the remaining concentrate cleaned with oxalic acid to remove iron-oxide staining. The dried concentrate was sieved into several size fractions, (<0.25 mm, 0.25 to <0.5 mm, 0.5 mm to <1.0 mm, 1.0 mm to 2.0 mm). The <0.25 mm fraction was archived and the 0.25 to 0.50 mm fraction was sorted with a Carpco® drum magnetic separator into strongly (0.6 amp), moderately (0.8 amp), weakly (1.0 amp) and non-paramagnetic (>1.0 amp) fractions. A flow sheet outlining the processing procedures can be seen in Figure 5. Heavy mineral concentrate data are presented in an Excel® workbook included with this report: Appendix 3 GSC OF 7887 HMC DATA.xlsx.

Surface Tills

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 (~11.3-kg) till samples were shipped to 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 for heavy mineral concentrates are summarized in Figure 5. 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).

ANALYTICAL PROCEDURES FOR STREAM SILT SAMPLES

Instrumental Neutron Activation (INA) Analysis

Samples were analysed at Maxxam (formerly Becquerel Labs), Mississauga, Ontario. Weighed and encapsulated samples were packaged for irradiation along with certified reference materials, field and analytical duplicates. Samples and quality control insertions were irradiated together with neutron flux monitors in a two-megawatt pool type reactor. After a seven-day decay period, samples were measured with a high-resolution germanium detector. Typical counting times were 500 seconds. Elements determined by INA analysis are listed below in Table 1.

Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) and Other Analyses

Samples were analysed at Bureau Veritas Commodities Canada Limited (BVCC), Vancouver, using a proprietary 'AQ250 – Ultratrace by ICP Mass Spec.' package with the optional extended packages for rare earth elements (+REE) and precious metals Pt and Pd (+PGM). For the determination of 65 elements listed in Table 2, a 0.5 gram sample was leached with a modified aqua regia solution ($HCl:HNO_3$, 1:1). The sample solution was analysed by inductively coupled plasma - mass spectroscopy.

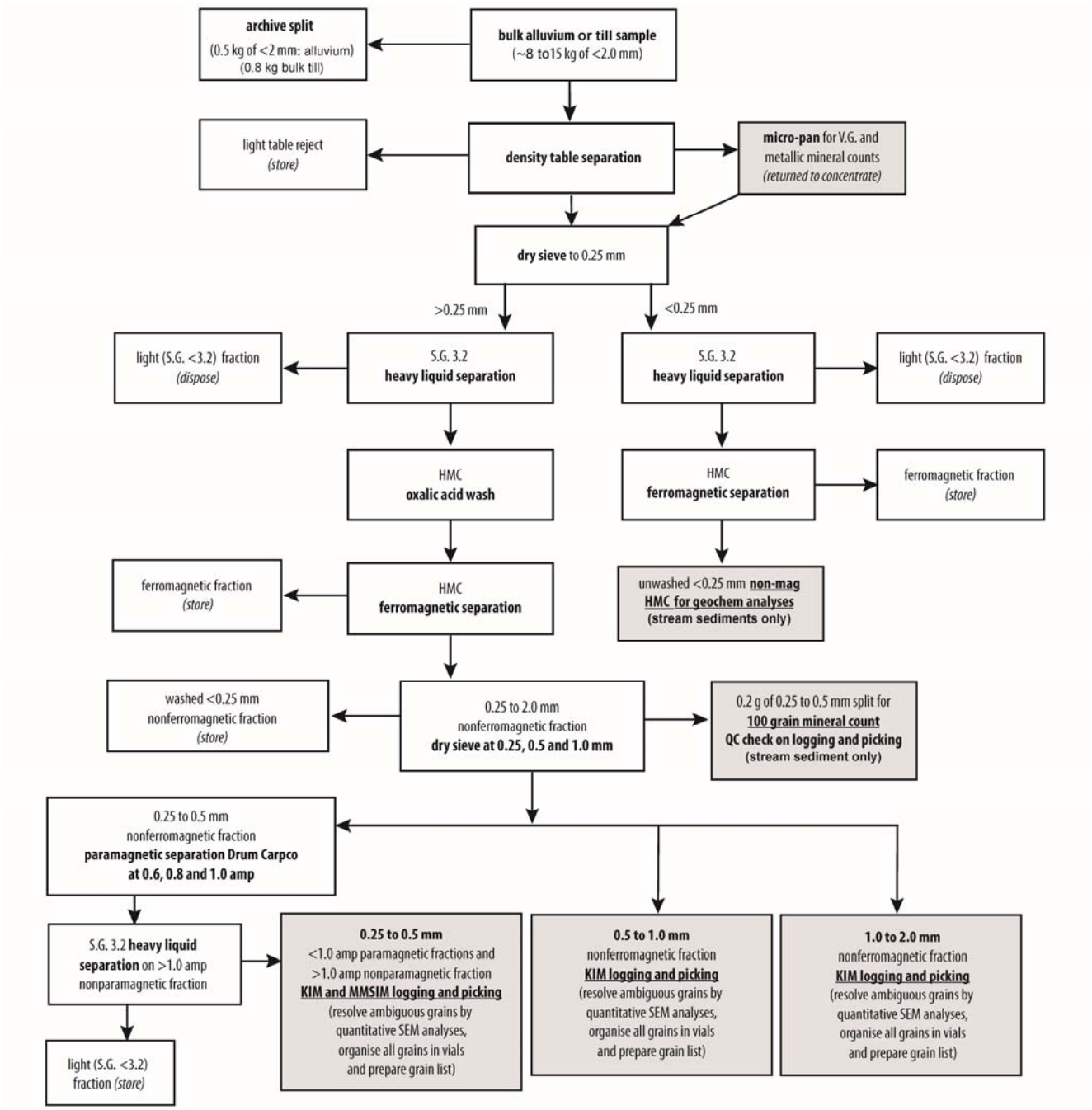


Figure 5 Standard sediment processing flow sheet used at Overburden Drilling Management Ltd. for indicator minerals in bulk stream sediment and till samples, modified from Averill, S.A. and McClenaghan, M.B., 1994.

Table 1 Elements determined by INA analysis of stream silt samples.

Variable	Detection Limit	Units of Measurement	Variable	Detection Limit	Units of Measurement
Ag	2	ppm	**Ni**	10	ppm
As	0.5	ppm	**Rb**	5	ppm
Au	2	ppb	**Sb**	0.1	ppm
Ba	50	ppm	**Sc**	0.2	ppm
Br	0.5	ppm	**Se**	5	ppm
Cd	5	ppm	**Sm**	0.1	ppm
Ce	5	ppm	**Sn**	100	ppm
Co	5	ppm	**Ta**	0.5	ppm
Cr	20	ppm	**Tb**	0.5	ppm
Cs	0.5	ppm	**Te**	10	ppm
Eu	1	ppm	**Th**	0.2	ppm
Fe	0.2	%	**Ti**	500	ppm
Hf	1	ppm	**U**	0.2	ppm
Ir	50	ppb	**W**	1	ppm
La	2	ppm	**Weight**	0.01	g
Lu	0.2	ppm	**Yb**	2	ppm
Mo	1	ppm	**Zn**	100	ppm
Na	0.02	%	**Zr**	200	ppm

Loss-on-ignition was determined at BVCC, Vancouver using a one-gram sample. Each sample, in a Leco® crucible, was placed into a 100º C muffle furnace and brought up to 500° C for one hour. The oven was then cooled to 100º C and the crucibles transferred to a desiccator followed by cooling to room temperature. The crucibles were re-weighed to determine the loss-on-ignition.

Concentrations of F were determined in 0.2 g sample splits at BVCC, Vancouver, using their proprietary 'GC840 – Trace Level F by specific ion electrode' method (Bureau Veritas Minerals, 2017).

Table 2 Variables in stream silts determined by Inductively Coupled Plasma – Mass Spectroscopy (ICP-MS) with a modified *aqua regia* digestion. Analytical methods other than ICP-MS are in brackets. 'ISE' is an abbreviation of 'ion specific electrode; 'GRAV' is an abbreviation of 'Gravimetric'.

Element	Detection Limit	Units of Measurement	Element	Detection Limit	Units of Measurement
Ag	2	ppb	**Mo**	0.01	ppm
Al	0.01	%	**Na**	0.001	%
As	0.1	ppm	**Nb**	0.02	ppm
Au	0.2	ppb	**Nd**	0.02	ppm
B	20	ppm	**Ni**	0.1	ppm
Ba	0.5	ppm	**P**	0.001	%
Be	0.1	ppm	**Pb**	0.01	ppm
Bi	0.02	ppm	**Pd**	10	ppb
Ca	0.01	%	**Pt**	2	ppb
Cd	0.01	ppm	**Pr**	0.02	ppm
Ce	0.1	ppm	**Rb**	0.1	ppm
Co	0.1	ppm	**Re**	1	ppb
Cr	0.5	ppm	**S**	0.02	%
Cs	0.02	ppm	**Sb**	0.02	ppm
Cu	0.01	ppm	**Sc**	0.1	ppm
Dy	0.02	ppm	**Se**	0.1	ppm
Er	0.02	ppm	**Sm**	0.02	ppm
Eu	0.02	ppm	**Sn**	0.1	ppm
F (ISE)	10	ppm	**Sr**	0.5	ppm
Fe	0.01	%	**Ta**	0.05	ppm
Ga	0.1	ppm	**Tb**	0.02	ppm
Gd	0.02	ppm	**Te**	0.02	ppm
Ge	0.1	ppm	**Th**	0.1	ppm
Hf	0.02	ppm	**Ti**	0.001	%
Hg	5	ppb	**Tl**	0.02	ppm
Ho	0.02	ppm	**Tm**	0.02	ppm
In	0.02	ppm	**U**	0.1	ppm
K	0.01	%	**V**	2	ppm
La	0.5	ppm	**W**	0.1	ppm
Li	0.1	ppm	**Y**	0.01	ppm
LOI (GRAV)	0.1	%	**Yb**	0.02	ppm
Lu	0.02	ppm	**Zn**	0.1	ppm
Mg	0.01	%	**Zr**	0.1	ppm
Mn	1	ppm			

ANALYTICAL PROCEDURES FOR TILL SAMPLES

Till matrix geochemistry

Approximately 30 g of the silt+clay-sized fraction (<0.063 mm) of till were analyzed at BVCC for a suite of trace, major and rare earth elements using 'ultratrace' ICP-MS with the optional extended package for precious metals Pt and Pd, following a modified aqua regia digestion (HCl-HNO_3, 1:1; 95°C) (Code AQ252_EXT: 53 elements) (Table 3). In addition, a separate 0.25 g split of the same fraction was analyzed using 'ultratrace' ICP-MS, multi-acids digestion (HNO_3-$HClO_4$-HF dissolved in HCl: Code MA250: 59 elements) (Table 4). Another 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 acid digestion (LF200: 49 elements + LOI) (Table 5). 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.) for datasets discussed below are presented in **\Till_datasets\Appendix04\Till Matrix Geochemistry.xls**.

Table 3 Variables in the <0.063 mm fraction till samples (30 g aliquots) determined by a modified aqua regia digestion, ICP-MS (BVCC Code AQ252-EXT).

Element	Lower Detection Limit	Units of Measurement	Element	Lower Detection Limit	Units of Measurement
Ag	2	ppb	**Na**	0.001	%
Al	0.01	%	**Nb**	0.02	ppm
As	0.1	ppm	**Ni**	0.1	ppm
Au	0.2	ppb	**P**	0.001	%
B	1	ppm	**Pb**	0.01	ppm
Ba	0.5	ppm	**Pd**	10	ppb
Be	0.1	ppm	**Pt**	2	ppb
Bi	0.02	ppm	**Rb**	0.1	ppm
Ca	0.01	%	**Re**	1	ppb
Cd	0.01	ppm	**S**	0.02	%
Ce	0.1	ppm	**Sb**	0.02	ppm
Co	0.1	ppm	**Sc**	0.1	ppm
Cr	0.5	ppm	**Se**	0.1	ppm
Cs	0.02	ppm	**Sn**	0.1	ppm
Cu	0.01	ppm	**Sr**	0.5	ppm
Fe	0.01	%	**Ta**	0.05	ppm
Ga	0.1	ppm	**Te**	0.02	ppm
Ge	0.1	ppm	**Th**	0.1	ppm
Hf	0.02	ppm	**Ti**	0.001	%
Hg	5	ppb	**Tl**	0.02	ppm
In	0.02	ppm	**U**	0.1	ppm
K	0.01	%	**V**	2	ppm
La	0.5	ppm	**W**	0.1	ppm
Li	0.1	ppm	**Y**	0.01	ppm
Mg	0.01	%	**Zn**	0.1	ppm
Mn	1	ppm	**Zr**	0.1	ppm
Mo	0.01	ppm			

Table 4 Variables in the <0.063 mm fraction till samples (0.25 g aliquots) determined by multi-acid digestion, ICP-MS (BVCC Code MA250).

Element	Lower Detection Limit	Units of Measurement	Element	Lower Detection Limit	Units of Measurement
Ag	20	ppb	**Nb**	0.04	ppm
Al	0.01	%	**Nd**	0.1	ppm
As	0.2	ppm	**Ni**	0.1	ppm
Ba	1	ppm	**P**	0.001	%
Be	1	ppm	**Pb**	0.02	ppm
Bi	0.04	ppm	**Pr**	0.1	ppm
Ca	0.01	%	**Rb**	0.1	ppm
Cd	0.02	ppm	**Re**	0.002	ppm
Ce	0.02	ppm	**S**	0.04	%
Co	0.2	ppm	**Sb**	0.02	ppm
Cr	1	ppm	**Sc**	0.1	ppm
Cs	0.1	ppm	**Se**	0.3	ppm
Cu	0. 1	ppm	**Sm**	0.1	ppm
Dy	0.1	ppm	**Sn**	0.1	ppm
Er	0.1	ppm	**Sr**	1	ppm
Eu	0.1	ppm	**Ta**	0.1	ppm
Fe	0.01	%	**Tb**	0.1	ppm
Ga	0.02	ppm	**Te**	0.05	ppm
Gd	0.1	ppm	**Th**	0.1	ppm
Hf	0.02	ppm	**Ti**	0.001	%
Ho	0.1	ppm	**Tl**	0.05	ppm
In	0.01	ppm	**Tm**	0.1	ppm
K	0.01	%	**U**	0.1	ppm
La	0.1	ppm	**V**	1	ppm
Li	0.1	ppm	**W**	0.1	ppm
Lu	0.1	ppm	**Y**	0.1	ppm
Mg	0.01	%	**Yb**	0.1	ppm
Mn	1	ppm	**Zn**	0.2	ppm
Mo	0.05	ppm	**Zr**	0.2	ppm
Na	0.001	%			

Table 5 Variables in the <0.063 mm fraction till samples (0.2 g aliquots) determined by lithium meta/tetraborate fusion and dilute nitric acid digestion,ICP-ES/MS plus LECO analyzer data for C and S (BVCC Code LF200). For LOI (Loss-on-ignition), a 2 g sample was combusted at 1000° C and the weight difference was used to calculate the percentage of weight lost during combustion.

Element/Oxide	Lower Detection Limit	Element/Oxide	Lower Detection Limit
Al_2O_3	0.01%	**Lu**	0.01 ppm
CaO	0.01%	**Mo**	1 ppm
Cr_2O_3	0.002%	**Nb**	0.1 ppm
Fe_2O_3	0.04%	**Nd**	0.3 ppm
K_2O	0.01%	**Ni**	20 ppm
LOI (1000°C)	0.1%	**Pb**	1 ppm
MgO	0.01%	**Pr**	0.02 ppm
MnO	0.01%	**Rb**	0.1 ppm
Na_2O	0.01%	**Sc**	1 ppm
P_2O_5	0.01%	**Sm**	0.05 ppm
SiO_2	0.01%	**Sn**	1 ppm
TiO_2	0.01%	**Sr**	0.5 ppm
Ba	1 ppm	**Ta**	0.1 ppm
Be	1 ppm	**Tb**	0.01 ppm
Ce	0.1 ppm	**Th**	0.2 ppm
Co	0.2 ppm	**Tm**	0.01 ppm
Cs	0.1 ppm	**U**	0.1 ppm
Cu	5 ppm	**V**	8 ppm
Dy	0.05 ppm	**W**	0.5 ppm
Er	0.03 ppm	**Y**	0.1 ppm
Eu	0.02 ppm	**Yb**	0.05 ppm
Ga	0.5 ppm	**Zn**	5 ppm
Gd	0.05 ppm	**Zr**	0.1 ppm
Hf	0.1 ppm		
Ho	0.02 ppm	**Total C (LECO)**	0.02%
La	0.1 ppm	**Total S (LECO)**	0.02%

Matrix colour and texture

Munsell colour codes were determined on dry samples (<0.063 mm) at the GSC Sedimentology Laboratory using a SP64 Series X-Rite® spectrophotometer. For textural analysis of the matrix, approximately 200-300 g from each 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 class 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 to 0.063 mm), silt (0.063 to 0.002 mm) and clay (<0.002 mm) fractions are presented in **\Till_datasets\ Appendix05 Till Sample Munsell Colour and Grain Size.xls**

Matrix carbon and organic contents

Total carbon was determined at GSC Sedimentology Laboratory on the <0.063 mm fraction with a LECO®CR-412 Carbon Analyzer instrument at 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 presented in **\Till_datasets\ Appendix06 Till Matrix Carbon and Organic.xls**

Clast lithology

The >2.0 mm material from the large till samples was wet-sieved to separate the 8 to 30 mm fraction for lithological analysis. Pebbles were visually examined using a binocular microscope (maximum 200) by ODM. Pebble classes can be grouped into the following four general lithological categories: 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 (i.e. cherty dolostones). Results presented in **Appendix07 Till Sample Clast Lithology.xls** include the number of clasts and the percentage (%) of the total in each class, 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 5 outlines the ODM sample processing procedures 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 pre-concentrate. After tabling and panning, the <2.0 mm pre-concentrate was sieved to 0.25 mm and the <0.25 mm is stored for archive while the 0.25 to 2.0 mm fraction is further refined using heavy liquid (methylene iodide - SG 3.2) and ferromagnetic (FM) separations. The 0.25 to 2.0 mm non-ferromagnetic (NFM) HMC fraction was then picked for indicator minerals.

Prior to indicator mineral examination and selection, the 0.25 to 2 mm NFM-HMCs recovered from till samples were dry sieved to 0.25 to 0.5 mm, 0.5 to1.0 mm and 1to 2.0 mm. The 0.25 to 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. 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 (MMSIM®s), 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 vials for further study. Because of their high abundance in some samples, only a few representative grains (20 to 30) of certain mineral species were picked for future analysis (i.e. bronzite, topaz, spessartine). Appendix08 Till Sample HMC Data.xls includes all raw grain counts from the visual identification of possible indicator minerals for the 0.25 to 2.0 mm NFM-HMCs in worksheets "KIM Data" and "MMSIM". The "MMSIM® Summary" sheet provides a summary of the MMSIM® data in a user-friendly format. Also included are 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.

Two 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 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 Appendix08 and are highlighted in grey. Expected hornblende/titanite-zircon assemblages with no specific indicator minerals were found in the two blanks. No gold, sulphides, PGMs, KIMs or MMSIM®s were found in the blank samples. All picking results for the two blank samples are presented in **\Till_datasets\Appendix08 Till Sample HMC Data.xls**.

QUALITY CONTROL FOR GEOCHEMICAL RESULTS (SILT SAMPLES)

Reliability (accuracy and precision) of analytical data returned from commercial laboratories was determined by incorporating field duplicates (FD pairs) within the sampling protocol, and including analytical ('blind') duplicates (AD), control reference materials (CRMs) in the sample suite submitted to the labs. Analytical data acquired between 2012 and 2016 in the course of this project for CRMs, analytical and field duplicates are included with this report in **Appendix 2 QUALITY CONTROL.xlsx.** Elements are grouped based on their position in the Periodic Table.

Accuracy

Accuracy of analytical data was evaluated by inserting two samples each of Canadian Certified Reference Materials STSD-1 and STSD-4 at random locations throughout the sample suite. STSD-1 consists of the -80 mesh (<177 micron) fraction of sediment collected from Lavant Creek, about 75 km southwest of Ottawa, ON (NTS 31-F). STSD-4 is a composite sample made up from stream sediments collected throughout NTS map sheet 31-F and 93-A and 93-B. All -80 mesh material was ball-milled and sieved through a -200 mesh (<74 micron) screen prior to homogenisation and bottling (Lynch, 1990).

In Appendix 2 (Quality Control), Worksheet 'Accuracy', the means and standard deviations (MEAN ± SD) for control reference standards STSD-1 and STSD-4 for which provisional values have been published by Lynch (1990, 1999) and Burnham and Schweyer (2004) are compared with the means for these elements determined by total and partial methods in Ellice River follow-up samples (Tables 10 and 11). Accepted values in square brackets are derived from published and unpublished data (n > 30) collected from recent projects at the GSC. The lower detection limits (LDL) for each element estimated by the commercial laboratories are also listed.

Several elements have concentrations below detection in both CRMs, including Pd (AR), Ag (INA), Cd (INA), Ta (AR), Ir (INA), Sn (INA), Se (INA), B (AR) and Te (INA). Zn (INA) and W (INA) are below detection in STSD-4 only. The mean concentrations of most of the remaining elements fall within two standard deviations of the accepted values, with the exceptions of Ti (AR), Zr (AR) and a number of other elements determined using a modified aqua regia digestion. This may be the result of elemental concentrations held within discrete, often refractory, minerals, including spinels, beryl, tourmalines, chromite, zircon, monazite, niobates, tungstates, topaz, tantalite and cassiterite (Crock and Lamothe, 2011).

For similar reasons, concentrations of a number of elements in CRMs are at or just above detection,

such as Zr (AR), Zr (INA), Mo (INA), Hf (AR), Re (AR), W (AR), W (INA), Se (AR), Lu (INA), Ge (AR), Sb (AR) and Te (AR), resulting in an RSD greater than 20 % in one or more CRMs. For Pt (AR), Au (AR) and Au (INA), RSD percentage will be relatively high (>20%) due to the difficulty of creating homogeneous standard materials (Harris, 1982).

QUALITY CONTROL FOR GEOCHEMICAL RESULTS (TILL SAMPLES)

Accuracy and precision of analytical data returned from commercial laboratories were determined by including one analytical duplicate, one primary standard (Till-4) and two 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. One analytical duplicate was prepared in the laboratory from sample 16MOB030A01 and labelled with a similar sample code (16MOB030A02). It was inserted at the beginning of the batch. Analysis of the primary standard was used to monitor analytical accuracy of the geochemical results. One standard was inserted randomly within the block of 11 samples and labeled with the same code as the previous sample except for one letter (e.g. 16MOB024B01). To monitor potential cross-contamination during the sieving process and to purge the sieves between sample batches, silica sand blanks were sieved and inserted at the beginning and end of the batch and submitted for geochemical analysis. The QA/QC statistics results discussed below are included in **Appendix04 Till Matrix Geochemistry.xls**

Precision

The results for the one laboratory duplicate sample 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 As and Bi (RSD = 10 to 15%), and even less so for Au (RSD = 17%). Boron, Be, Cd, Ge, Hg, Pd, Pt, Re, S, Sb, Se, Ta, Te, Tl and W levels are near or below the lower detection limit in the laboratory duplicate; 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 Cd, Ni and Ta (RSD = 10 to 20%). This method is consistently not precise for Ag, As, Sb, Sn and Te (RSD > 20%). Beryllium, Bi, Cs, In, Lu, Re, S, Se and Tm 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 meta/tetraborate fusion and dilute nitric digestion ICP-ES/MS analyses, reproducibility is good for most elements (RSD < 10%). This method is somewhat less precise for Cr2O3, Cu, Hf, W (RSD = 10 to 20%), and not very reliable for Zn (RSD = 99%). Precision for Cs, Mo, Ni 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 = 0%) while S is below the detection limit. LOI determinations are less precise in till (RSD = 15.7%).

Accuracy

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 Till-4 report sheets in Appendix 4. Mo, Pb and particularly Hg, are less accurate using this method. The accuracy in the ICP-MS analyses by 4-acid digestion is acceptable. The accuracy in the analyses by lithium meta/tetraborate fusion and dilute nitric digestion is good for most elements except for Be, Ce, Eu, Nd, Pb, Sr, Ta and Tb which are less reliable. The silica blank qtz-J29623 returned average values of 88.85% SiO2 and 11.0% LOI, which are slightly different than previously reported average values for this material (e.g. McClenaghan et al., 2015; McMartin et al., 2015). The aqua regia value for Silica Sand1 inserted at the beginning of the batch was

relatively elevated in Au (1.6 ppb); the 4-acids values were also above expected values for many elements, including Ba (4 ppm), Ce (0.46 ppm), Cu (1.6 ppm), Ga (0.12 ppm), Pb (0.37 ppm), Rb (0.9 ppm), W (1.4 ppm) and Zn (1.4 ppm), suggesting cross-contamination from metal-rich samples analyzed before the batch. Ga (1.5 ppm), Nb (1.3 ppm) and Pb (2 ppm) values by quenched fusion were also higher than expected in the Silica Sand1. More significantly, the Pb value by quenched fusion in the Silica Sand2 inserted at the end of the batch was really high (17 ppm) reflecting carry-over contamination or poor accuracy with this method.

HIGHLIGHTS

In 2016, targeted stream sediment and surface till sampling focused on following up three geochemically anomalous areas identified in 2012 and 2014 as part of GEM-1 and GEM-2 stream and till sampling surveys (McCurdy et al., 2013; McCurdy et al., 2016; McMartin and Berman, 2015). The following highlights and maps integrate the 2016 results with the GEM-1 and GEM-2 surveys in the three detailed areas (Fig. 6).

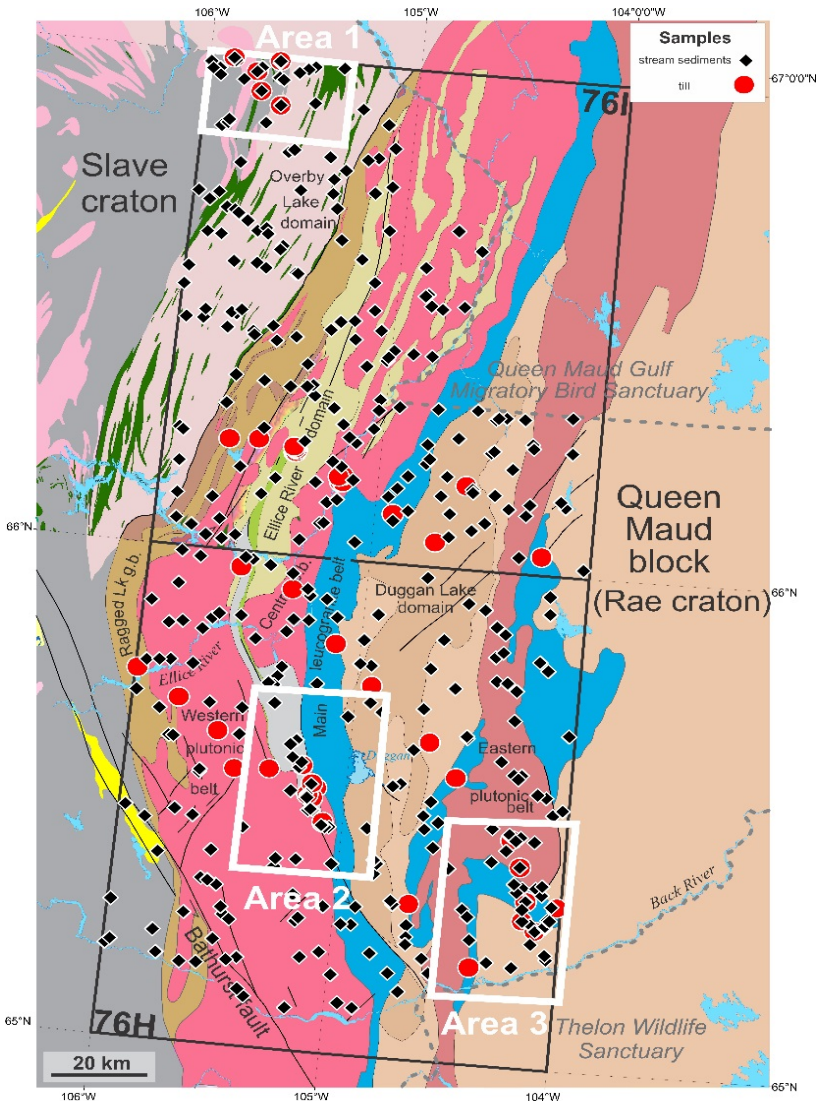


Figure 6 Simplified bedrock compilation map of the study area (updated from Berman et al., 2016), showing stream sediment (black diamonds) and till sample locations (red dots). The three areas outlined in white are discussed in the following sections.

Area 1 – Potential for base and precious metals

Previous sampling in Area 1 identified a Cu-Pb-Ni-Zn-Ag stream sediment anomaly in northwestern NTS 76-I associated with Slave supracrustal rocks (McCurdy et al., 2016). The same area showed relatively high counts of chalcopyrite, molybdenite, pyrite, and gahnite grains in the stream sediment heavy mineral separates. Elevated Cu and other base metals (Pb, Ni, Zn) in streams and tills collected in 2016 support data from stream silts analyzed in 2014 and suggest a base metal potential in the northwest part of NTS 76-I over Slave craton rocks. Chalcopyrite grains were also identified in multiple stream samples in the same area (Fig. 7).

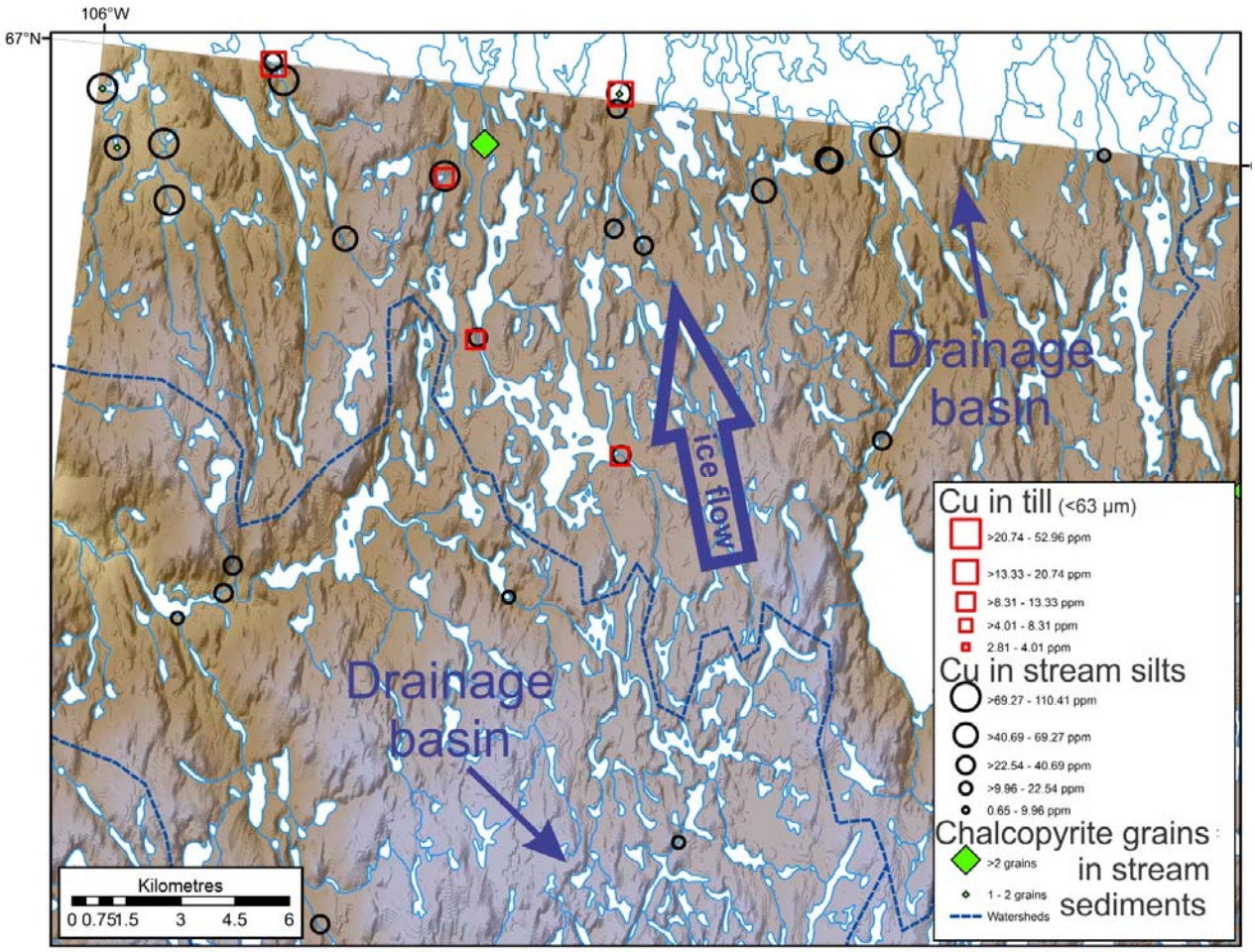


Figure 7 Cu (in ppm; modified aqua regia) in stream sediments (<0.177 mm) and till (<0.063 mm) over DEM in Area 1; chalcopyrite grains in stream sediments (0.25- 0.5 mm; raw counts) are also shown. Main flow direction within each drainage basin is indicated. Generalized ice flow direction is derived from surficial geology map (Dredge and Kerr, 2013).

The same area also showed anomalous Ag values in stream silts within north-flowing streams sampled in 2014 (McCurdy et al., 2016). These values were confirmed with follow-up stream and till sampling in 2016 (Fig. 8). Multiple gold grains (n=1 to 5) in both stream and till samples indicate a potential source or sources of precious metals within metasediments and/or metavolcanic rocks of the Slave craton (Fig. 8).

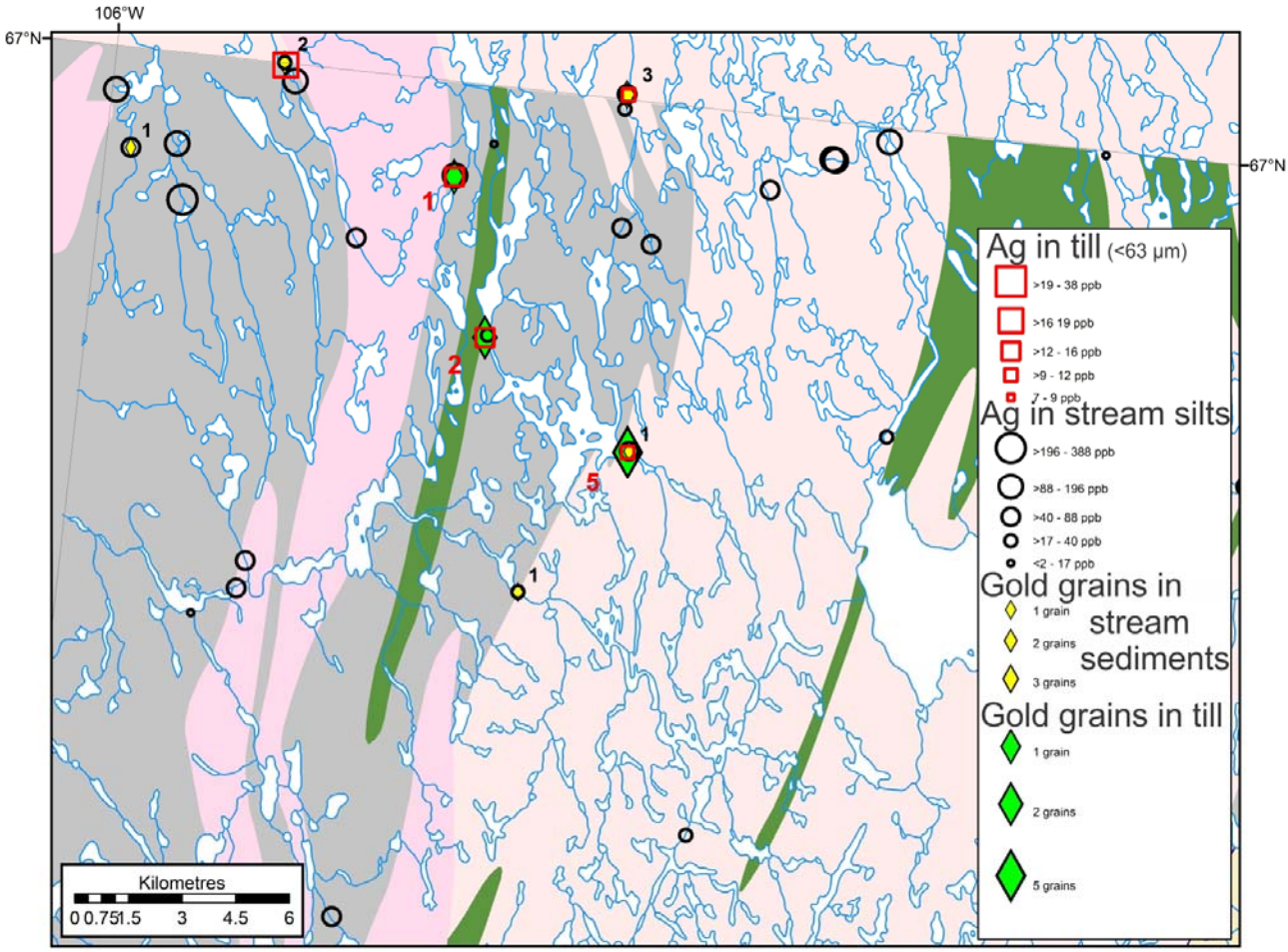


Figure 8 Ag (in ppb; modified aqua regia) and gold grains in stream sediments and till over bedrock map in Area 1 (geology updated from Berman et al., 2016). Small numbers beside sample sites indicate number of gold grains in till (red) and in stream sediments (black) within the HMCs (raw counts). Metasediments (grey) and metavolcanic rocks (dark green) of the Slave craton show some potential for base and precious metals in this area.

Area 2 – Potential for base metals

A Cu-Pb-Zn-As-sulphide till and stream sediment anomalous area was documented in central NTS 76-H southwest of Duggan Lake (McCurdy et al., 2013, 2016; McMartin and Berman, 2015). Resampling in 2016 was completed at four sites up-ice and up-stream of the anomaly (Fig. 9; Fig. 10, inset As map). Integrated results indicate separate signatures from two distinct sources. 1) A strong As±Bi-arsenopyrite-loellingite-hercynite±scheelite anomaly (Fig. 10) sourced in a magnetic high is squeezed between the metasediments of the Ellice River domain and the main leuco-granite belt, potentially indicative of contact metamorphic or Ni-Cu massive sulphide deposits. 2) A Cu-Pb-Zn-Ag±Mo±W-chalcopyrite-sphalerite-molybdenite anomaly (Fig. 11) is associated with the Ellice River domain, particularly mafic volcanic rocks.

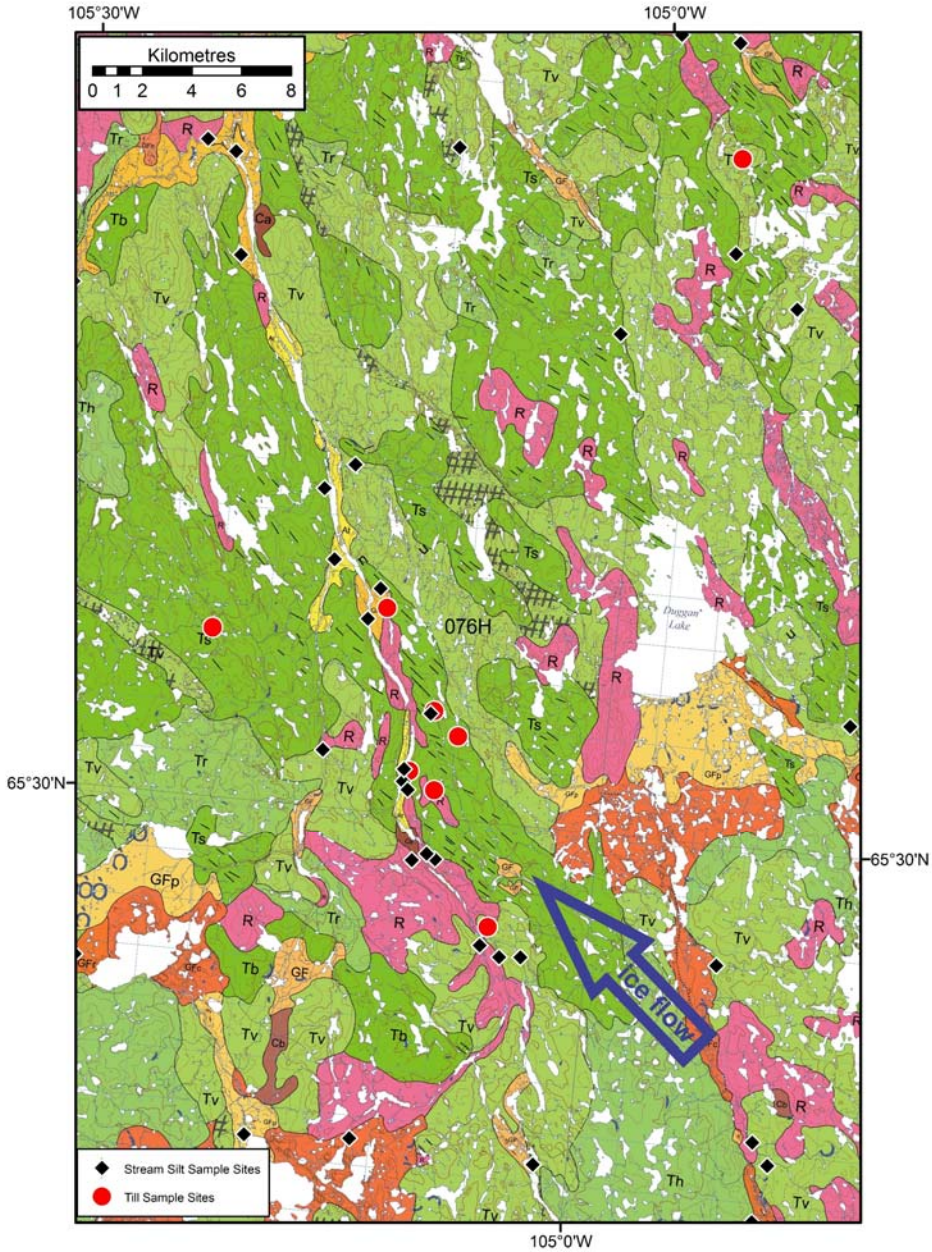


Figure 9 Location map of samples in Area 2 over the surficial geology (St-Onge and Kerr, 2013). Generalized ice flow direction is derived from surficial geology map. Tv=till veneer, Ts=streamlined till, Tb=thick till, Tr=ribbed till, Th=hummocky till, R=bedrock, GFp= glaciofluvial outwash plain, GFc=glaciofluvial ice contact, GF=undifferentiated glaciofluvial, At=alluvial terrace.

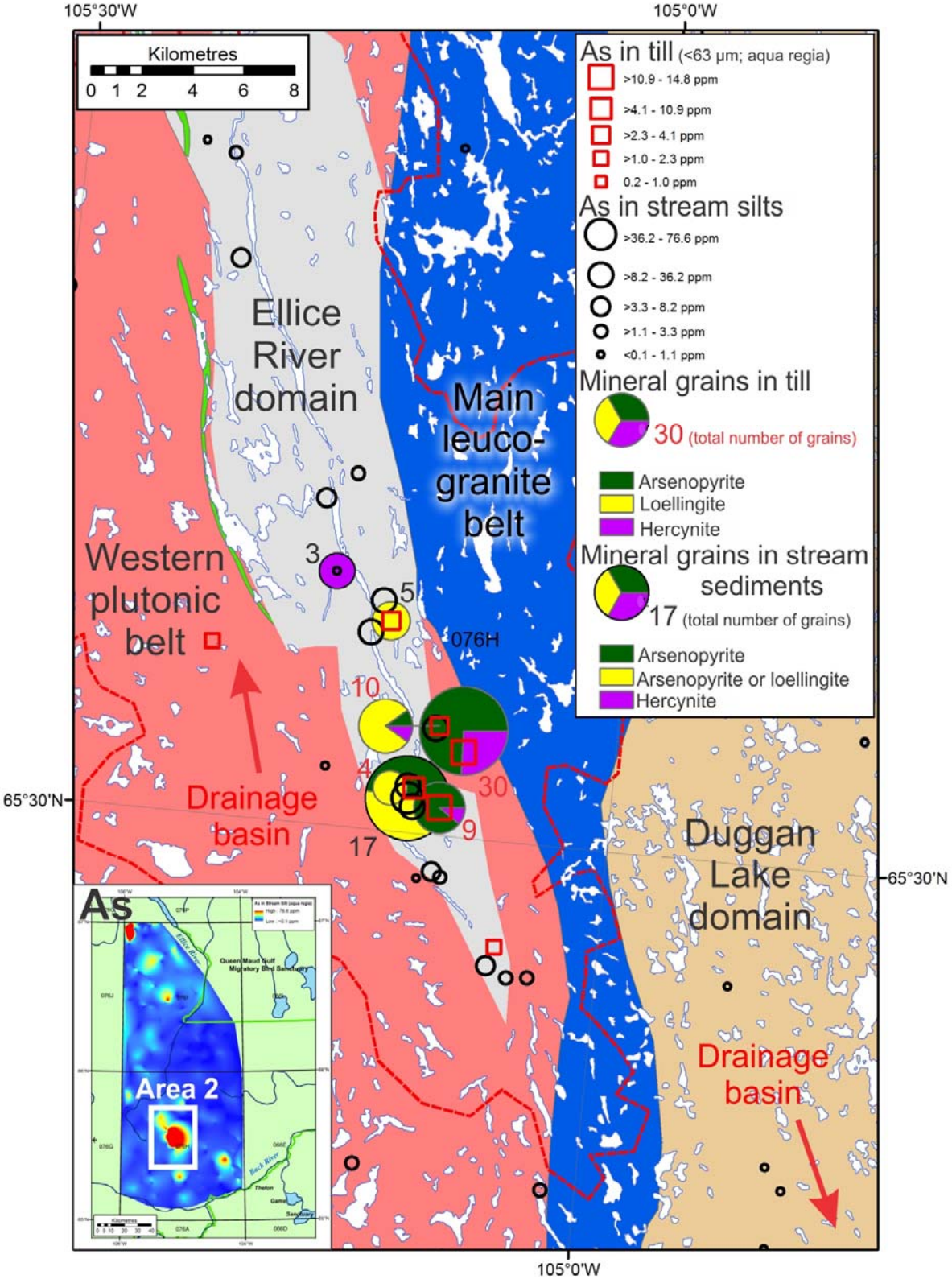


Figure 10 As (in ppm; modified aqua regia), arsenopyrite, loellingite and hercynite grains (0.25- 0.5 mm; raw counts) in stream sediments and till over bedrock map (geology updated from Berman et al., 2016) in Area 2; inset map shows As in stream silts over the entire study area. Small numbers beside sample sites indicate total number of mineral grains in till (red) and in stream sediments (black) within the HMCs (raw counts). Main flow direction within each drainage basin is indicated.

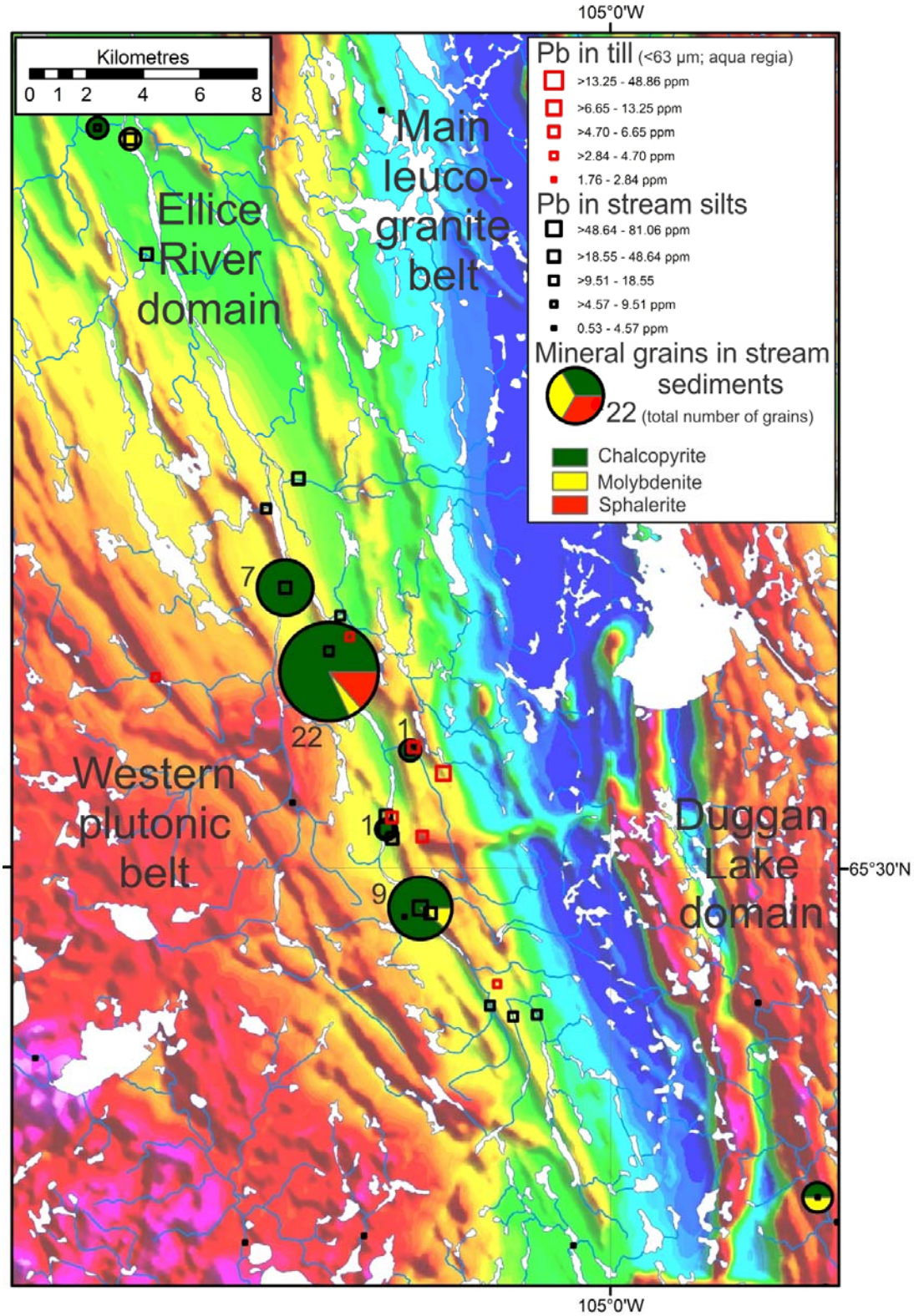


Figure 11 Pb (in ppm, modified aqua regia) in stream sediments (<0.177 mm) and till (<0.063 mm) over detailed aeromagnetic map in Area 2; selected sulphide grains in stream sediments (0.25- 0.5 mm; raw counts) are also shown (none in till). Cu and Zn show similar distributions.

Area 3 – Potential for gold

In Area 3, a Au anomaly in the silt fraction of stream sediments was identified within a single watershed draining south into the Back River in southeastern NTS 76-H (Fig. 12, Au inset map; McCurdy et al., 2013). Follow-up sampling in 2016 supports data from stream sediments collected in 2012 (Fig. 12). The distribution of Au in stream sediments decreases downstream, but glacial transport is in opposite direction and gold grains are all reshaped, therefore reflecting a complex transport history including perhaps recycling of exotic grains as part of the Dubawnt Lake ice stream flow (Fig. 13; McMartin, 2017). Field work in 2014 suggests that this anomaly may be sourced within the drainage basin in a region with metamorphosed iron formation at high grade.

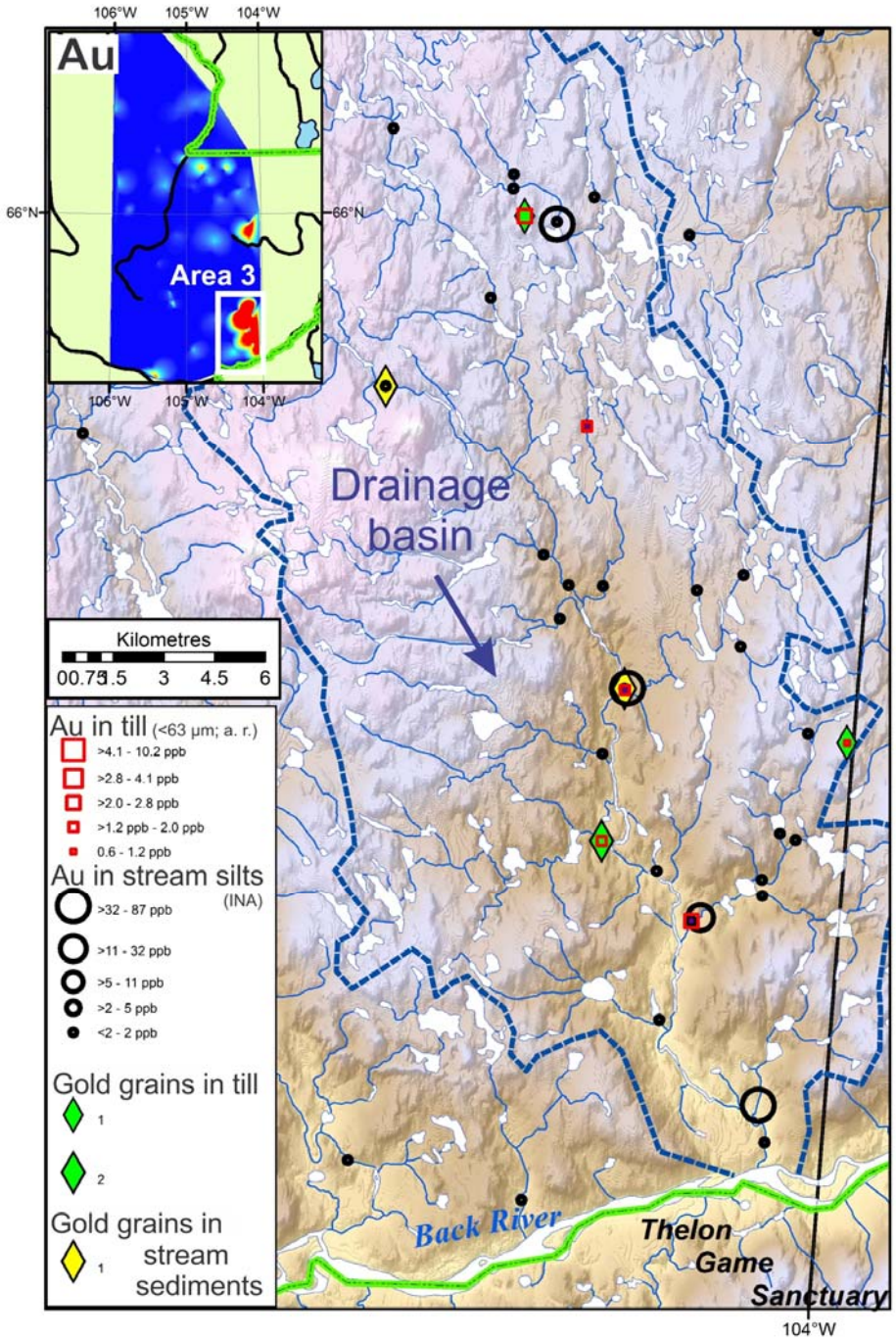


Figure 12 Au (in ppb) in stream sediments (<0.177 mm, INA) and till (<0.063 mm, modified aqua regia) over DEM in Area 3; gold grains (raw counts) are also shown. Inset map shows gold in stream silts over the entire study area (<0.177 mm, INA). Main flow direction within the anomalous drainage basin is indicated.

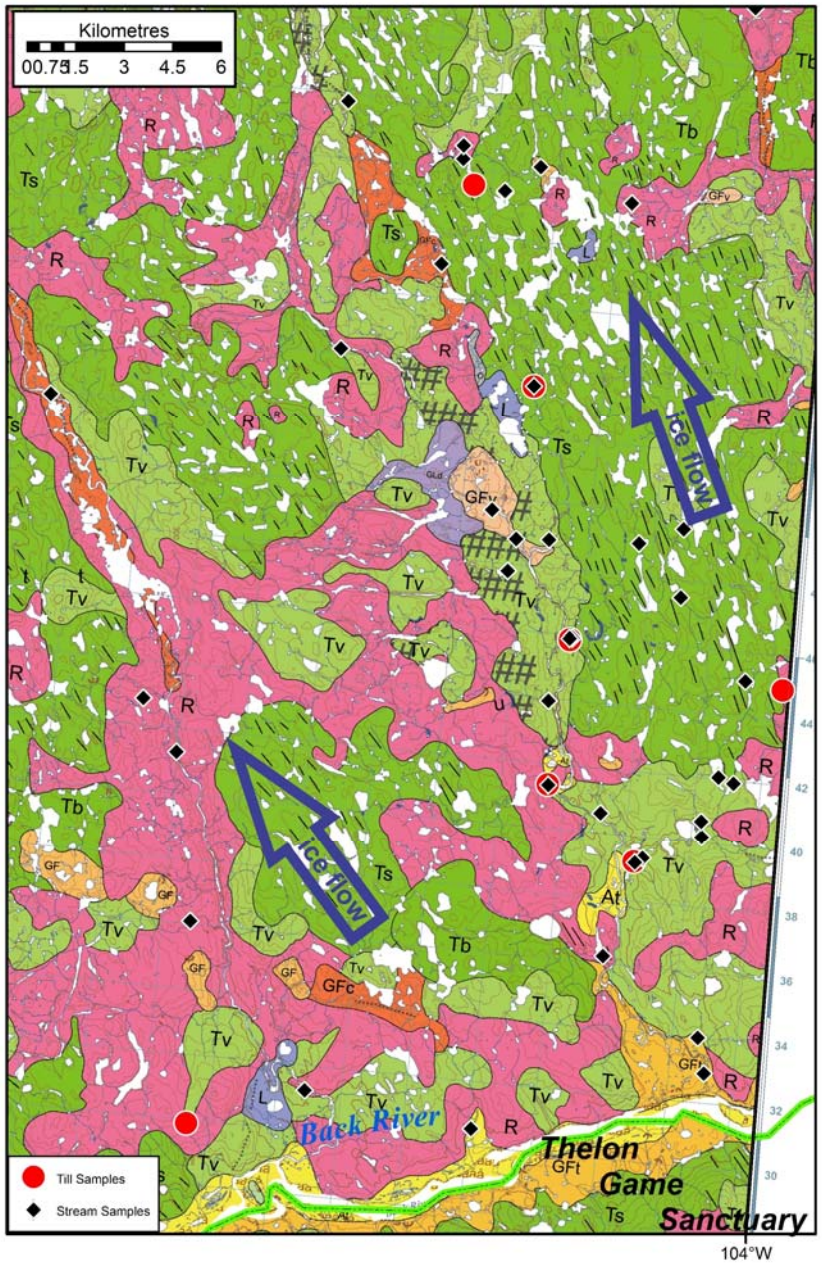


Figure 13 Location map of samples in Area 3 over the surficial geology (St-Onge and Kerr, 2013). Generalized ice flow direction is derived from surficial geology map. Tv=till veneer, Ts=streamlined till, Tb=thick till, R=bedrock, GFc=glaciofluvial ice contact, GFt= glaciofluvial terrace, GFv= glaciofluvial veneer, GF=undifferentiated glaciofluvial, GLd=glaciolacustrine delta, At=alluvial terrace.

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