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Manitoba

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Cover photo: A large, southwest-trending (into photo), streamlined bedrock outcrop protrudes into Snyder Lake.

Abstract

Quaternary geological investigations were undertaken in the Snyder–Grevstad lakes area, situated in the far northwestern corner of Manitoba, as part of the Manitoba Far North Geomapping Initiative. In conjunction with detailed bedrock mapping, this work provides a modern geoscience knowledge base tailored toward current and future mineral exploration and/or infrastructure development. This report includes all till-sample analyses (major- and trace-element matrix geochemistry, carbonate, grain size, colour, clast lithology) and a re-release of the mapped ice-flow indicators (formerly DRI2011002). Emphasis in the discussion is placed on drift-exploration results, including a study of uranium dispersal from a known occurrence.

TABLE OF CONTENTS

Page

TABLES

FIGURES

APPENDICES (on CD-ROM)

Introduction

The Manitoba Geological Survey's (MGS) Far North Geomapping Initiative, supported by the Geological Survey of Canada's (GSC) Geo-mapping for Energy and Minerals (GEM) Multiple Metals–Northeast Manitoba Project, was initiated in 2008 to address the geoscience knowledge deficit in Manitoba's far north. This region is a remote, predominantly drift-covered area that last saw systematic geological work more than 25 years ago. Therefore, in an effort to stimulate and support private-sector investment in mineral exploration in this region, the project's multidisciplinary team (federal, provincial and university-based collaborators) has focused its mapping activities on areas of high mineral potential, such as the Snyder Lake area in Manitoba's far northwest and the area covered by the GEM Northeast Manitoba Project (Trommelen et al., 2010).

During the 2011 field season, Quaternary studies involving surficial geological and ice-flow indicator mapping and till geochemical sampling were conducted in conjunction with bedrock geological mapping over an area of about 600 km^2 surrounding Snyder and Grevstad lakes (Figure 1). The objectives of the Quaternary component are to 1) compile a surficial geology map at 1:50 000 scale suitable for property-scale exploration (Trommelen, 2011c); 2) interpret the glacial and deglacial history at regional and local scales (e.g., Trommelen, 2011a); 3) conduct a regional till-sampling program to establish regional till compositions as a means of determining background and threshold element concentrations, sediment-landform relationships and glacial-dispersal distances and directions; and 4) conduct a uranium-in-till dispersal study from a known uranium occurrence (informally named Pitchblende ridge[1]; Avery, 2010).

The purpose of this report is to release the till-composition and ice-flow indicator (Trommelen, 2011b) datasets collected as part of the Quaternary studies, to assist with the application of drift prospecting in the Snyder Lake study area. The report also includes the regional physiographic and geological setting; regional interpretation of ice-flow chronology and subglacial dispersal; and detailed descriptions of the till-sampling methods, laboratory procedures and QA-QC for the analytical data. Till sampling, together with the new surficial geological framework, should be an effective exploration tool in this region.

Regional setting

The study area is located in northwestern Manitoba (Figure 1), between 59°19'W and 59°30'W latitude and 102°N and 101°30'N longitude. Elevation varies from 380 to 430 m asl. Local relief is up to 60 m. Numerous lakes and wetlands are present throughout the hummocky bouldery terrain that is interspersed with swaths of streamlined terrain. The drift cover is generally thick and bedrock outcrops are rare. Where present, the regional northeast trend of bedrock ridges typically coincides with the main ice-flow orientation, which has enhanced

[1] Location of "Pitchblende ridge", which is informally named in the text and figures of this report, is LAT 59.326 and LONG -101.775.

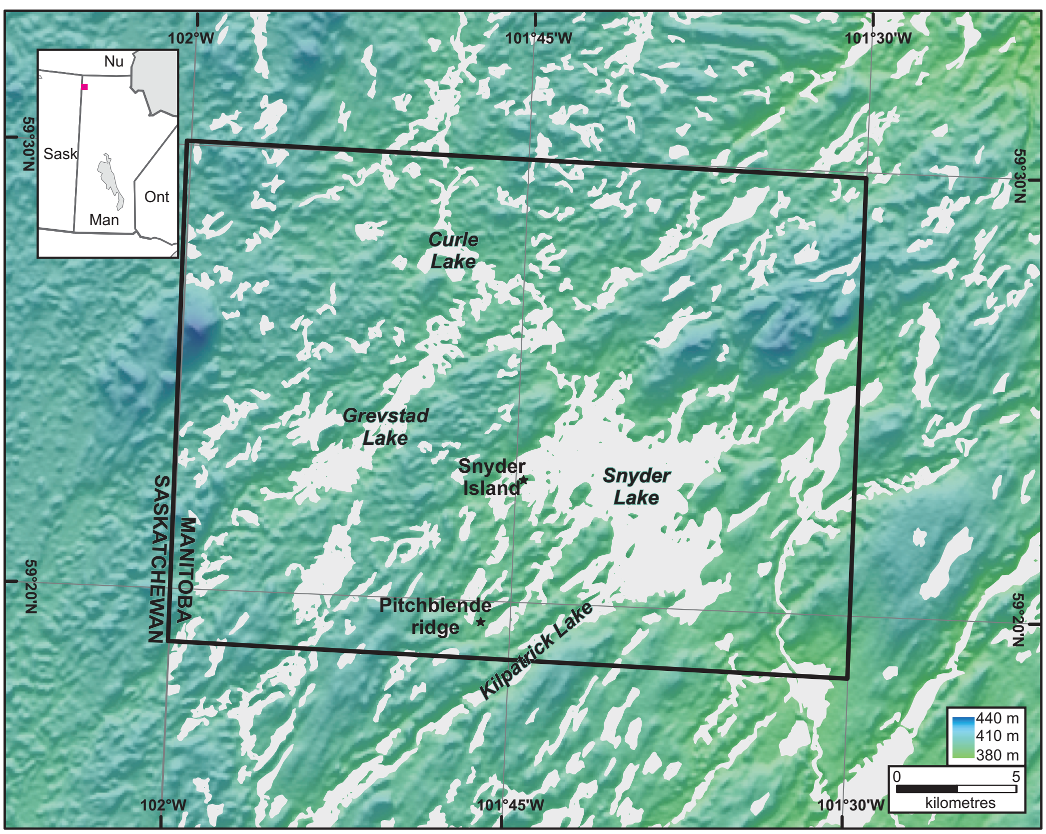

Figure 1: Location of the Snyder–Grevstad lakes map area (black rectangle) in northwestern Manitoba. The background image was generated using the radar-derived digital-elevation data from the Shuttle Radar Topography Mission dataset (United States Geological Survey, 2002). A hill-shade model has been added with transparency effect to enhance relief.

the bedrock ridges and eroded subparallel linear lake basins. The region falls within the zone of extensive discontinuous permafrost (Sladen, 2011), and permafrost was encountered beneath organic deposits. Periglacial features, such as mud boils and peat plateaus, are rare but present.

Bedrock geology

The Snyder Lake area is largely underlain by northeast-trending, medium- to upper-amphibolite grade metasedimentary rocks of the Paleoproterozoic Wollaston Supergroup. The Wollaston Supergroup unconformably overlies and is infolded with Archean granitic gneisses of the southeastern Hearne craton margin. Southeast and northwest of Snyder Lake, the Wollaston Supergroup sedimentary succession is flanked by intrusive rocks of likely Neoarchean age that were metamorphosed at upper amphibolite– to granulite-facies conditions.

The western portion of the study area, along the northwest shore of Grevstad Lake, consists of multiphase tonalite to granite orthogneiss with lesser, fine-grained amphibolite gneiss. South and southeast of Snyder Lake, inliers of granitic gneiss occupy the core of structural domes within the Wollaston metasedimentary succession (Figure 2). The intrusive cores are dominated by medium-grained, strongly foliated to gneissic granodiorite and tonalite. Toward the margin with the metasedimentary rocks, the orthogneiss appears to be more heterogeneous, comprising layered granite and granodiorite to diorite with biotite±garnet, separated by quartzofeldspathic layers (Kremer et al., 2011).

Metasedimentary rocks of the Wollaston Supergroup exposed in the study area consist largely of interlayered psammitic to pelitic paragneiss, which forms a continuous sequence that extends from southeast of Snyder Lake to the eastern shore of Grevstad Lake (Figure 2). Layering in paragneiss units, defined in outcrop by centimetre- to metre-scale compositional banding, is possibly reflective of primary sedimentary bedding. Discontinuous horizons of calcsilicate rocks and marble are

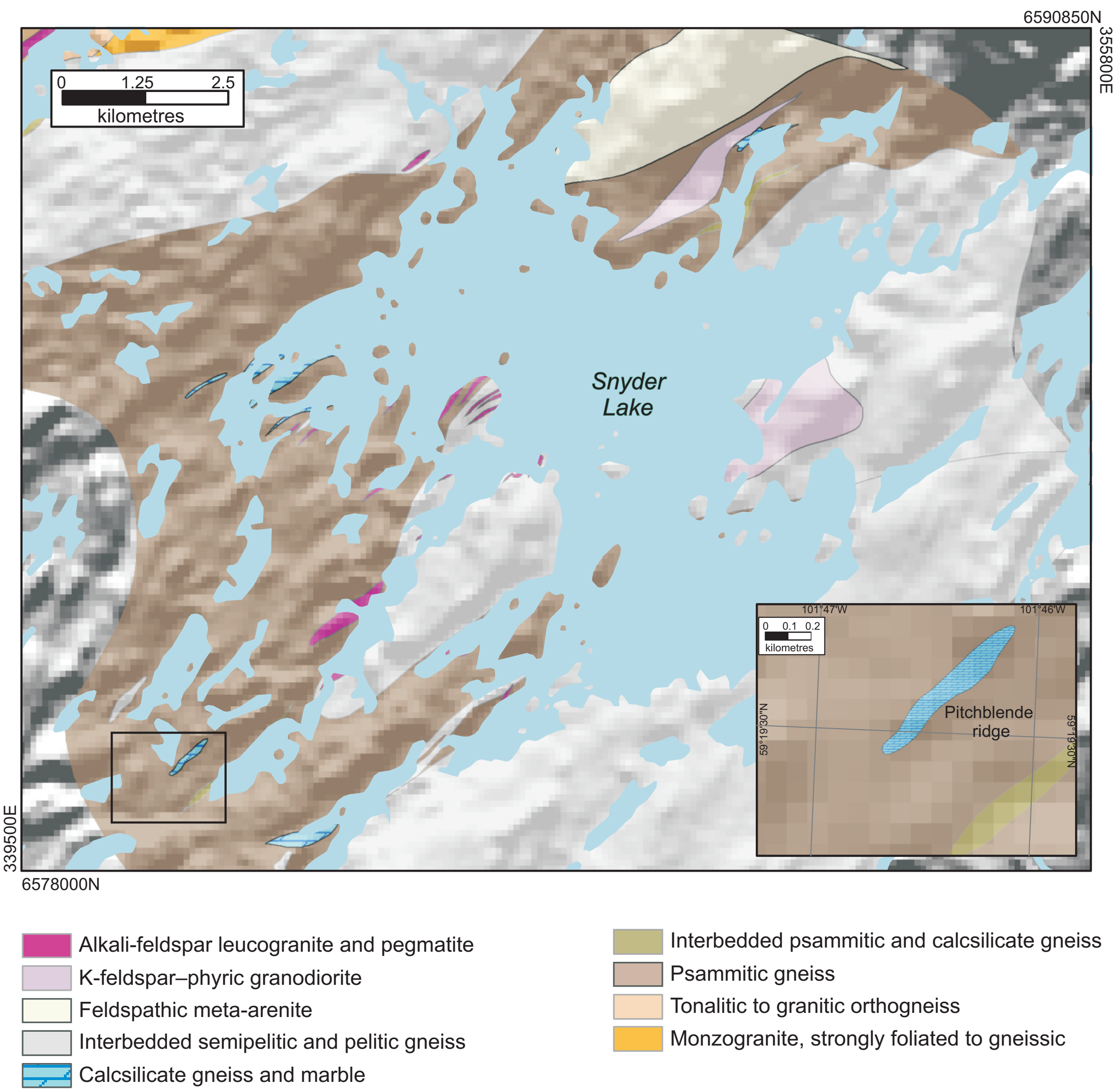

Figure 2: *Bedrock geology of the Snyder–Grevstad lakes area, northwestern Manitoba (modified after Kremer and Böhm, 2011). The inset square is an enlargement of the Pitchblende ridge area in the southwest corner.*

locally dispersed throughout the succession. Two of these exposures (Pitchblende ridge and Snyder Island; Figure 1), where calcsilicate rocks are intensely metasomatized, have known uranium mineral occurrences (Avery, 2010). For the most part, metasomatized calcsilicate rocks display highly variable grain sizes and textures (fine grained, pegmatoid, fragmental), and consist of varying amounts of calcic and sodic amphibole and clinopyroxene, scapolite, calcite, titanite, graphite, garnet and rare uraninite (Kremer et al., 2011).

Feldspathic arenite occurs north of Snyder Lake and correlates with a magnetic high on aeromagnetic maps (Figure 2). Feldspathic arenite is fine to medium grained, light pink, massive to crudely bedded and composed of quartz, feldspar, biotite and accessory magnetite (Kremer et al., 2011).

All metasedimentary rocks in the Snyder Lake area are intruded by Paleoproterozoic bodies with compositions ranging from leucocratic alkali-feldspar granite and granitic pegmatite to granodiorite. The intrusions range from centimetre-scale veinlets to large dikes greater than 10 m thick, up to larger bodies several hundred metres wide (Figure 2).

Uranium mineralization reported by CanAlaska Uranium Ltd. is not limited to a single lithology but has been found to occur in various rocks, including calcsilicate, metasedimentary gneiss and granitic rocks, throughout the Snyder Lake area, where it is presumed to be associated with regional structural features (Avery, 2010).

Quaternary geology

The study area was repeatedly glaciated by ice flowing from the Keewatin Sector of the Laurentide Ice Sheet, during the Quaternary. The region was likely ice free around 8500 C^{14} years BP (Dyke, 2004) and was not transgressed by postglacial Lake Agassiz (Klassen, 1983).

The distribution of the various tills and other glacial and postglacial deposits, as well as ice-flow indicators, is shown on Figure 3 and on the 1:50 000 scale surficial geology map for

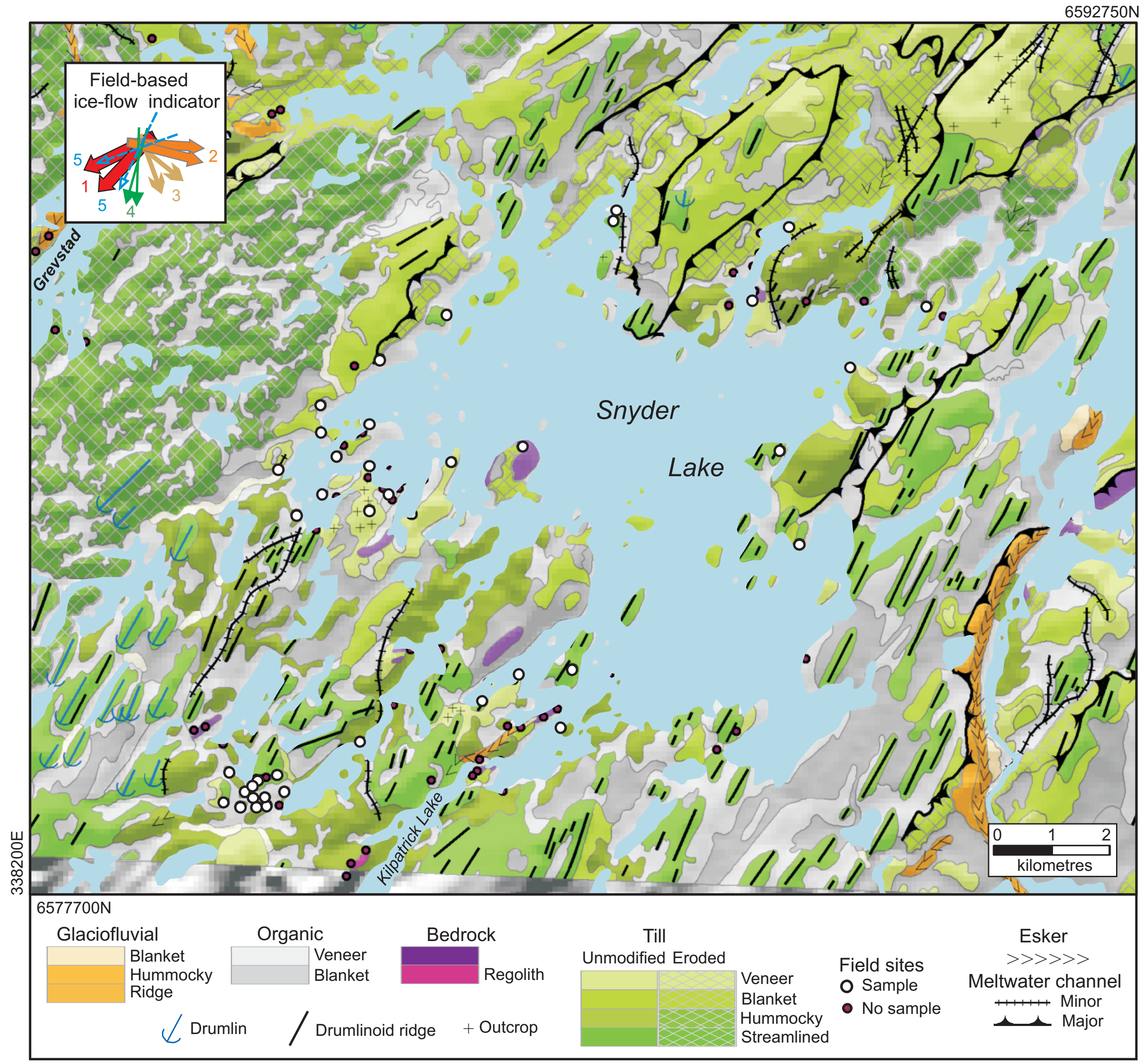

***Figure 3:** Surficial geology of the Snyder Lake area, Manitoba (modified after Trommelen, 2011c), showing locations of till-sample sites. The field-based indicators inset depicts the simplified chronologic ice-flow history for the region.*

this area (Trommelen, 2011c). Detailed descriptions of these sediments and the surficial geology of the Snyder–Grevstad lakes area is provided in Trommelen (2011a). The regional Quaternary geology for northwestern Manitoba is available in Dredge et al. (1982) at 1:250 000 scale and Dredge et al. (1985, 1986) at 1:500 000 scale.

Ice-flow history

The Snyder–Grevstad lakes area contains evidence of at least five different ice-flow phases, recorded in the streamlined landform record (Trommelen and Ross, 2010; Trommelen, 2011c) and the small-scale erosional ice-flow indicator record (striae, grooves, crescentic gouges, chattermarks, roches moutonnées, rock drumlins and crag-and-tail features; Appendix 1; Figure 4).

Most larger scale features, such as rock drumlins and roches moutonnées, document an early, well-preserved, widespread, southwest (220–250°) flow direction. This ice-flow phase is regionally extensive (Dredge et al., 1986; Campbell, 2001, 2002a; Smith, 2006; Smith and Kaczowka, 2007; Avery, 2010) and correlated to the pre–Late Wisconsinan. The next ice-flow phase, preserved as chattermarks at two regions along the north and east shores of Snyder Lake (Figure 4), is to the east-southeast (85–110° and 125–140°). Regionally, rare east- to east-southeast-trending ice-flow indicators have been documented in Saskatchewan (Campbell, 2002b; Smith, 2006; Smith and Kaczowka, 2007) and northern Manitoba (59°45'N and 102°W; Dredge et al., 1985), and are also thought to be pre–Late Wisconsinan. Crosscutting relationships in the Snyder Lake area indicate that this is the second regional ice-flow phase. It is possible that these striations indicate ice flow from an ice divide centred farther west in the south-central part of the former District of Mackenzie (Dredge et al., 1986).

Thirdly, ice flowed southeasterly across the region, documented by scattered chattermarks, gouges, striae and grooves oriented between 138 and 160°. Next, most field sites indicate

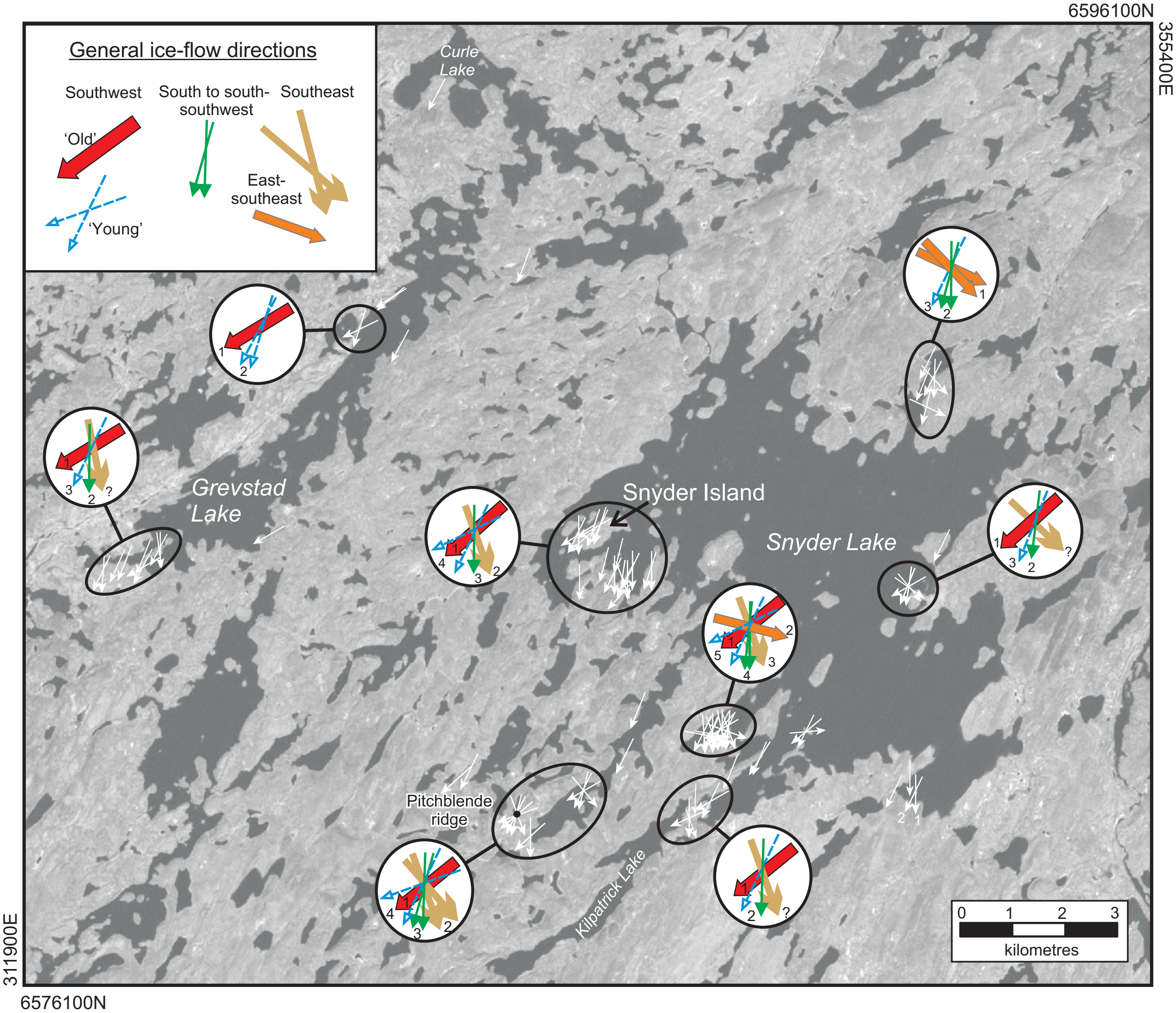

Figure 4: Erosional ice-flow indicators (striae, chattermarks, grooves, roches moutonnées, rock drumlins) of the Snyder Lake area, Manitoba, as presented in Trommelen (2011a). Numbers denote the relative age of indicators at each circled site. The data are available in Appendix 1.

a shift in ice flow over time, from southeast to southwest. At multiple field sites, ice-flow indicators with a southerly trend (175–195°) are crosscut by dominant ice-flow indicators trending south-southwest (200–212°). Most drumlins in the region were also formed during this major south-southwest ice-flow phase. These observations are consistent with published reconstructions suggesting major shifts of the Wisconsinan Keewatin Ice Divide eastward (McMartin and Henderson, 2004). Lastly, young southwest to west-southwest ice-flow occurred in the area, as evidenced by rare fine striae (220–240°) at outcrops recently cleaned of overburden.

Methods

Field-data collection

Boat-supported fieldwork was conducted by M. Trommelen in the summer of 2011, alongside bedrock-geology map crews. At each of the 131 sites visited (Figure 2), site, geomorphic and terrain characteristics, map unit and geological interpretation were recorded in addition to location co-ordinates. The site information is included in Appendix 2.

Ice-flow indicator mapping

The orientation and relative age of erosional ice-flow indicators (Figure 4), documented at 53 sites in the study area, include micro-scale nondirectional indicators (striations and grooves) and directional indicators (chattermarks, crescentic gouges and stoss-lee relationships). Macro-scale features encountered in the study area include roches moutonnées and rock drumlins. Detailed attention was paid at all outcrops to record rare and protected ice-flow indicators, in addition to the dominant indicators. Where crosscutting patterns were found, the relative ages of flows were determined when possible. Detailed ice-flow indicator measurements for the 53 sites are found in Appendix 1, originally released as Trommelen (2011b).

Till sampling

A till-sampling survey was conducted on a local to detailed scale in the vicinity of Snyder Lake. In total, 41 till samples of ~2 kg each were collected within an area of ~140 km^2 (Figure 3) for matrix major- and trace-element geochemical, grain size, carbonate and organic carbon content, Munsell colouring and lithological analyses. Site location and description, sample information (e.g., sample material, sample depth and soil horizon) and additional comments related to the sample and/or site are provided in Appendix 3. The surface till samples (40–60 cm depth) were collected with a shovel and trowel from the B, B/C or C soil horizon in hand-dug pits. Where present, samples were collected from mud boils in an attempt to sample the least oxidized and most representative material. Sample sites were chosen primarily based on availability of till with a fine matrix, with two subsets of samples around Snyder Island and Pitchblende ridge collected for dispersal analysis. Till of good quality for geochemical analyses (not too wet or too sandy [ablation]) was difficult to find.

A field duplicate was collected at one site, to test sediment heterogeneity and field variability. The field duplicate was taken from the same sample pit approximately 10–20 cm lower than the original sample. The duplicate sample was bagged separately and given a unique sample number.

Pitchblende ridge dispersal study

Two outcrops with uranium mineralization, at Pitchblende ridge southwest of Snyder Lake (Figures 1, 5), were chosen as the site for a local study of uranium dispersal in till. This study provides an example of uranium-in-till concentration for a known showing, and attempts to constrain the direction and distance of glacial dispersal. The main Pitchblende ridge outcrop is a short crag-and-tail landform that trends toward 230° for ~30–40 m. The crag is a strongly metasomatized calcsilicate outcrop with uranium and rare earth element mineralization (Avery, 2010), whereas the tail consists of silty sand to sandy silt till with uraninite-bearing cobbles and boulders at surface. A second outcrop of mineralized calcsilicate felsenmeer occurs 65 m to the west of the Pitchblende ridge crag (Trommelen, 2011a). For the most part, the calcsilicate rocks consist of varying amounts of calcic and sodic amphibole and clinopyroxene, with small amounts of scapolite, calcite, titanite, graphite, garnet and rare uraninite (Kremer et al., 2011).

Laboratory and analytical procedures

The samples were prepared at the GSC Sedimentology Laboratory following procedures described by McMartin and McClenaghan (2001) and Girard et al. (2004).

Approximately 1 kg of each till sample was air dried and dry sieved, using a stainless steel 230 mesh screen, to obtain the <63 µm fraction for geochemical analyses and carbonate content determinations. The remainder (<800 g) of the original samples was archived at the GSC. All remaining geochemical <63 µm fraction pulps were archived at the GSC.

Till-matrix textural analysis

Textural analyses of the samples were completed by the GSC Sedimentology Laboratory. The matrix textural results for all samples were calculated as weight percent sand, silt and clay of the <2 mm fraction and are presented in Appendix 4.

The procedure for grain-size analysis of the till samples includes sand-silt-clay, and complete grain-size analysis of the <2 mm size fraction, as outlined by Girard et al. (2004). Approximately 200–300 g of each sample were used. The classes of sizes greater than 63 µm were determined using wet sieving (to obtain the >45 µm to <2 mm size fraction), followed by dynamic digital-image processing using a CAMSIZER® particle-size-analysis system. The classes of sizes smaller than 63 µm were determined using a Lecotrac LT-100 particle-size analyzer.

Till-matrix colour determination

The till samples were submitted to the GSC Sedimentology Laboratory for dry soil-colour determination. Soil colour of geological samples is described using a standardized system of colour standards and terminology known as the Munsell Soil Colour Chart, a colour-order system that has gained international

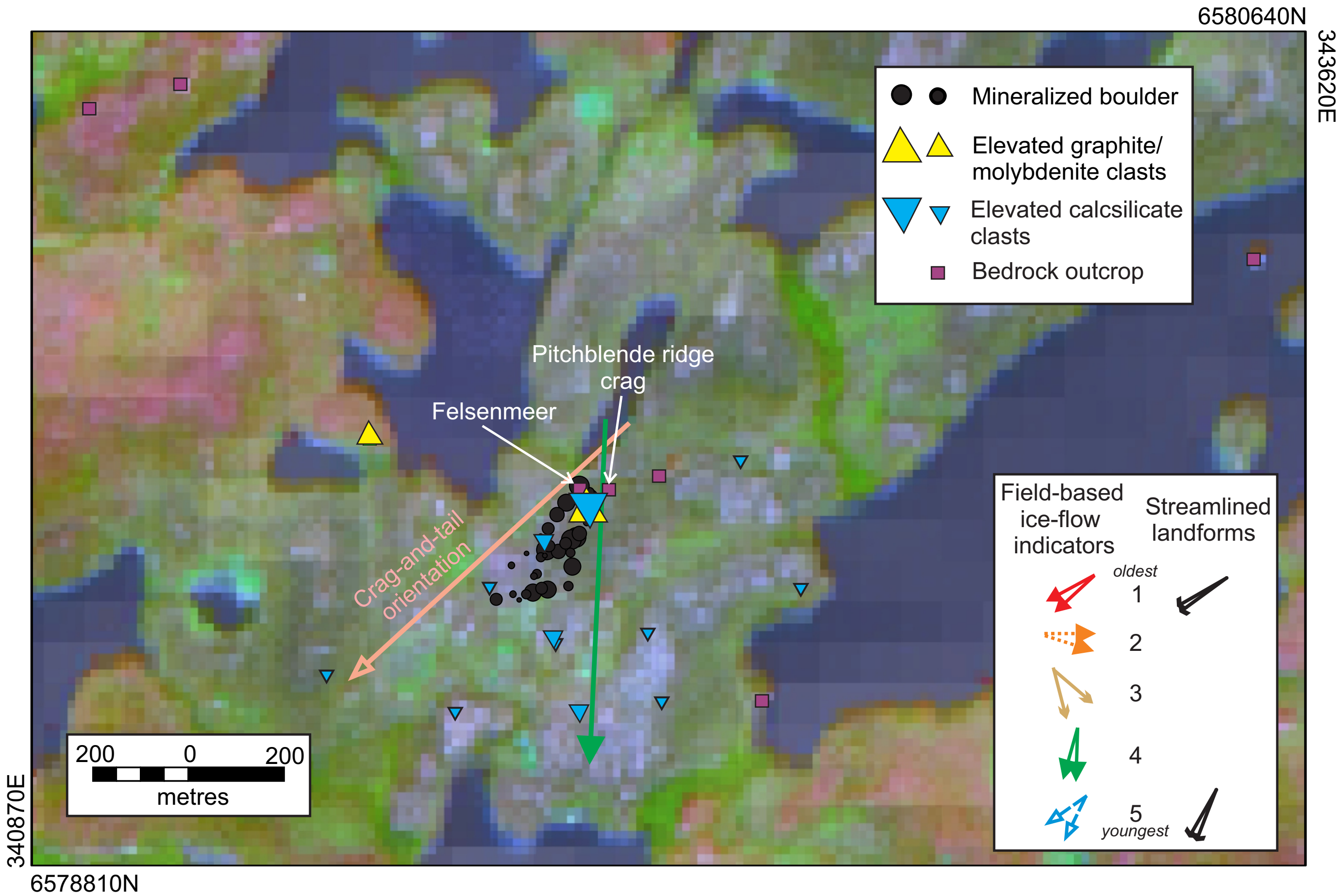

Figure 5: *Dispersal studies in the Pitchblende ridge area (location in Figure 1) focused on dispersal from the Pitchblende ridge crag and a felsenmeer outcrop (labelled) where uranium showings are present. Locations of mineralized boulders were plotted as part a boulder-dispersal study presented in Trommelen et al. (2011a), while till sample data are presented herein.*

acceptance and is widely used for colour determination of geological samples. Soil colour is one of the initial physical properties analyzed in the GSC Sedimentology Laboratory and is performed on the dry bulk sample.

Munsell soil colour was determined using an SP64 Series X-Rite portable sphere spectrophotometer linked to Color iControl software. When Munsell values are obtained using the software, results are generated for the following colourimetric systems: CIE XYZ, CIE Yxy, CIE L*a*b*, Hunter Lab, CIE L*c*h°, CMC, CIE94, Whiteness and Yellowness per ASTM E313-98, Metamerism Index and DIN 6172 + AATCC Gray Scale. Results cannot be restricted solely to the Munsell soil colour subgroup. The colour determinations of the samples are provided in Appendix 5.

Till-matrix carbonate analyses

Analyses of the carbonate content and calcite-dolomite ratio of the <63 µm size fraction of the till matrix were carried out at the GSC Sedimentology Laboratory in a two-step process using the CM 5014 coulometer. Total CO_2 associated with the carbonate content is first measured, followed by determination of the CO_2 associated with calcite. The difference between the two measurements is used to characterize the amount of CO_2 associated with the presence of dolomite. Depending on the expected CO_2 content, the sample size ranges from 0.02 to 0.50 g.

Total carbonate is determined by decomposition of the carbonate minerals using hot dilute hydrochloric acid, evolving the carbonate carbon in the form of carbon dioxide. The gaseous carbon dioxide is bubbled to react with a solution of ethanolamine. Through the use of a coloured indicator that fades as the ethanolamine is consumed, a potential is applied to electrodes to replenish the ethanolamine being consumed by redox reaction. The Faraday law is used for the calculation, whereby each Faraday corresponds to 1 µg of CO_2.

The calcite fraction of the carbonate minerals is also determined by decomposition as described above. The dolomite fraction is the difference between total carbonate carbon and the calcite fraction.

The samples were first screened for inorganic carbon content to prevent saturation of the analytical instrument and determine the size of sample required for the calcite-dolomite analysis. The determination of inorganic carbonate content involves a LECO (Lincoln Electric Holdings, Inc.) CR-412 carbon analyzer that relies on combustion of the sample. The released CO_2 is determined by infrared detection. A sample split is ashed at 500°C for 1 hour to remove the organic carbon. The inorganic carbon is determined on the residue. The results include loss-on-ignition (LOI) at 500°C, which is expressed as % weight loss of the dry weight. Loss-on-ignition helps to give a measure of the degree to which the sample geochemistry has been modified by postdepositional weathering. Inorganic carbon is a useful provenance indicator for tills as well as the presence of a buffering agent that could affect the sample geochemistry.

The results for carbonate content and LOI at 500°C are provided in Appendix 6. Loss-on-ignition at 1000°C, total carbon and total sulphur are part of the total-digestion analytical package of Acme Analytical Laboratories Ltd. (see 'Total digestion' section). The results for LOI at 1000°C are included in Appendix 7 and data for total carbon and sulphur are in Appendix 8.

Till-clast lithology

Clast lithology of the till samples was determined to help identify major directions of dispersal and till provenance. Clasts (>2 mm) were sieved from a portion of each till sample collected and further separated into clast-size fractions of 2–4 mm, 4–8 mm and 8–30 mm. The granules or pebbles within each clast-size fraction were then separated according to lithology by M. Trommelen using an optical microscope. An average of 736 clasts was counted for each till sample (2–4 mm av. = 485; 4–8 mm av. = 215; 8–30 mm av. = 36). In Appendix 9, the lithological class results are expressed as numbers of clasts in a separate table for each size fraction; the fractions were then summed (2 to 8+ mm) and expressed as a count-percent of the total number in another table. Proportional-symbol plots are presented in Appendix 10.

Clasts were separated into 19 rock types (Appendix 9; Figures 6, 7), categorized as follows:

- **Granitoid:** potassium-feldspar–quartz pegmatite; tonalitic to granitic orthogneiss and gneiss; granodiorite; granitoid and foliated granitoid
- **Metasedimentary:** psammitic and pelitic to semipelitic paragneiss (Figure 6c); amphibolite; psammite; pelite to semipelite; feldspathic meta-arenite
- **Uranium-associated:** graphite/molybdenite–bearing granitoid or schist; uraninite-bearing granitoid or calcsilicate; calcsilicate gneiss, marble and metasomatized calcsilicate rocks

Granitoid clasts are pink to white, with common quartz, potassium-feldspar and rare mica (Figure 6a, b). Granitic gneiss clasts are dark red to purple (Figure 7b). Granitoid clast shape is commonly subrounded and faceted. Metasedimentary clasts are dark grey to light grey, and range from 'dirty granitoid' with abundant mica, garnet and sillimanite (Figure 6d) to sandstone and siltstone (Figure 7a). Feldspathic meta-arenite clasts consist of pink to white, fine to coarse sand-sized grains. Clast shape varies from angular to subrounded, though most pelitic to semipelitic clasts are subrounded and faceted. Uranium-associated clasts include angular graphite/molybdenite– or uraninite-bearing clasts (Figures 6e, f, 7e, f), as well as calcsilicate rocks (Figure 7c, d). Calcsilicate rocks encompass a wide range of rock types with white, light pink or green matrices. The clasts may be partially eroded, with recessive and resistant parts (marble), or consist of larger diopside, calcite and/or wollastonite, tremolite and/or scapolite crystals.

The till samples collected contained an additional six rock types that are exotic to the map area (Figure 8). These include red quartz-pebble conglomerate (Figure 8a), red/purple metaconglomerate, metasedimentary or metavolcanic rocks (Figure 8b), green slate (Figure 8c), dark purple arenite with pink spots (Figure 8d), felsic diorite (Figure 8e) and an amygdaloidal intermediate volcanic clast (Figure 8f).

Geochemical analyses

'Total' digestion

For determination of the 48 elements or oxides listed in Table 1, a portion of the <63 µm size fraction for each sample was sent to Acme Analytical Laboratories Ltd. There, a 0.2 g sample was dissolved by mixing with 1.5 g of lithium metaborate ($LiBO_2$) and lithium tetraborate ($Li_2B_4O_7$) flux in a graphite crucible and fused in an oven at 980°C for 30 minutes. The bead was added to a solution of dilute (5%) nitric acid and mixed continuously until dissolved (~30 minutes). Analysis for major oxides and some trace elements was by inductively coupled plasma–emission spectrometry (ICP-ES). The same sample solution was analyzed for rare earth elements and refractory elements by inductively coupled plasma–mass spectrometry (ICP-MS).

For the determination of total C and total S, a 0.1 g sample was combusted with an induction flux (accelerator) in a ceramic sample holder at >1650°C in an induction furnace coupled to a LECO (Lincoln Electric Holdings, Inc.) infrared detector. Carbon and sulphur were measured by adsorption in an infrared spectrometric cell. Results are total and attributed to the presence of carbon and sulphur in all forms.

For the determination of loss-on-ignition (LOI), a 2 g sample was combusted at 1000°C and the weight difference was used to calculate the percentage of weight lost during combustion. Total digestion analytical results are presented in Appendix 11.

'Partial' (aqua regia) digestion

For determination of the 65 elements listed in Table 2, a portion of the <63 µm size fraction for each sample was sent to Acme Analytical Laboratories Ltd. There, a 30 g sample was leached with 6 mL/g of concentrated HCl, HNO_3 and demineralized water (2:2:2 v/v) at 95°C in a beaker for one hour. After cooling, the solution was made up to a final volume with 5% HCl. The ratio of sample weight to solution volume was 0.5 g per 10 mL. The sample solution was analyzed by inductively coupled plasma–emission spectrometry (ICP-ES) and inductively coupled plasma–mass spectrometry (ICP-MS). The analytical results are presented in Appendix 12.

Uranium fluorimetry

To compare digestion methods and to allow for comparison with historical analyses of uranium in till samples from Saskatchewan, a portion of the <63 µm size fraction for each

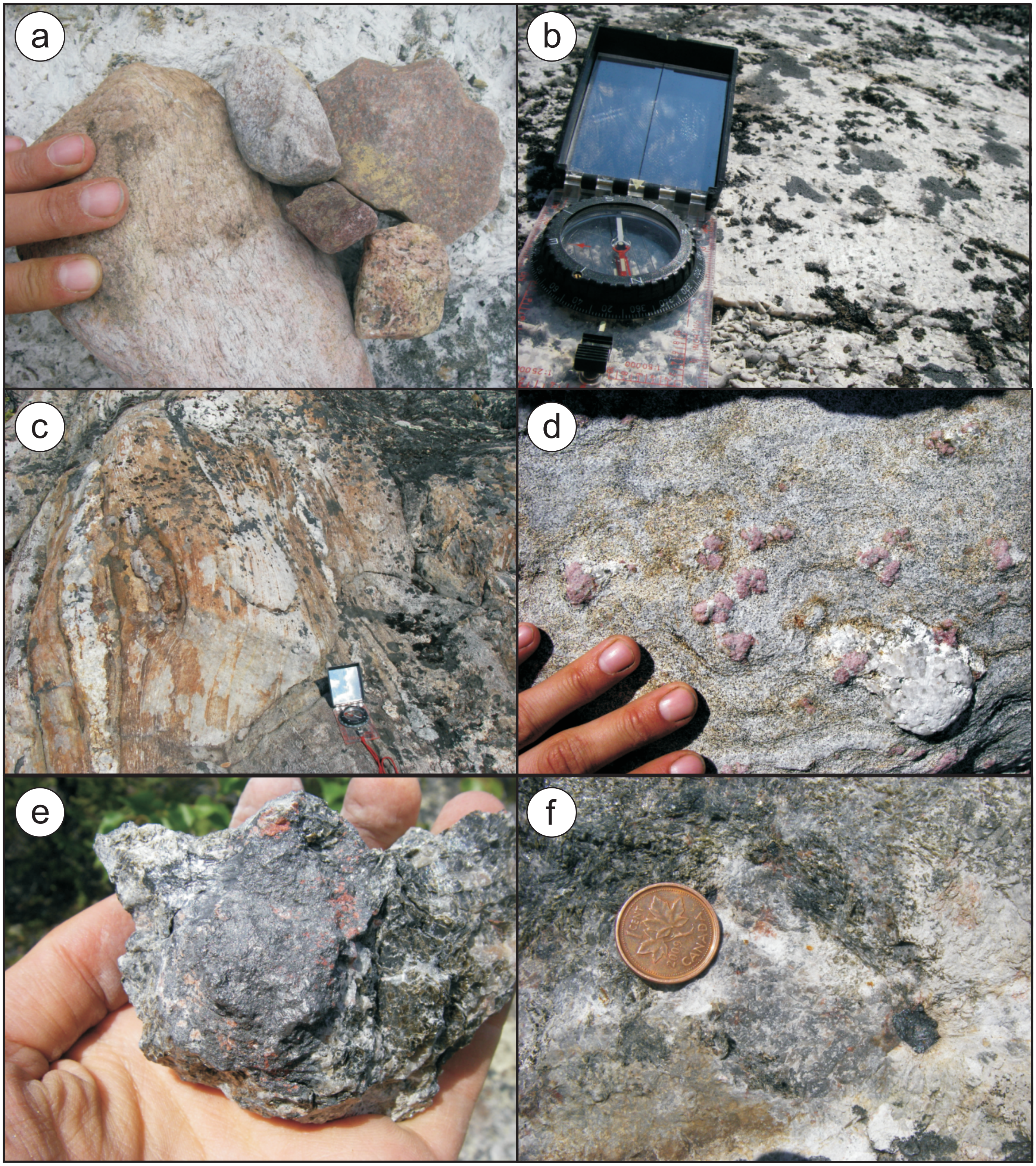

Figure 6: *Examples of the local bedrock types:* ***a)*** *granitoid clasts sitting on metasomatized calcsilicate bedrock at Pitchblende ridge;* ***b)*** *polished, very finely striated, white granitoid pegmatite;* ***c)*** *semipelitic paragneiss;* ***d)*** *sillimanite-garnet–porphyroblastic pelitic gneiss;* ***e)*** *calcsilicate clast with graphite/molybdenite;* ***f)*** *calcsilicate clast with rectangular resinous grey uraninite.*

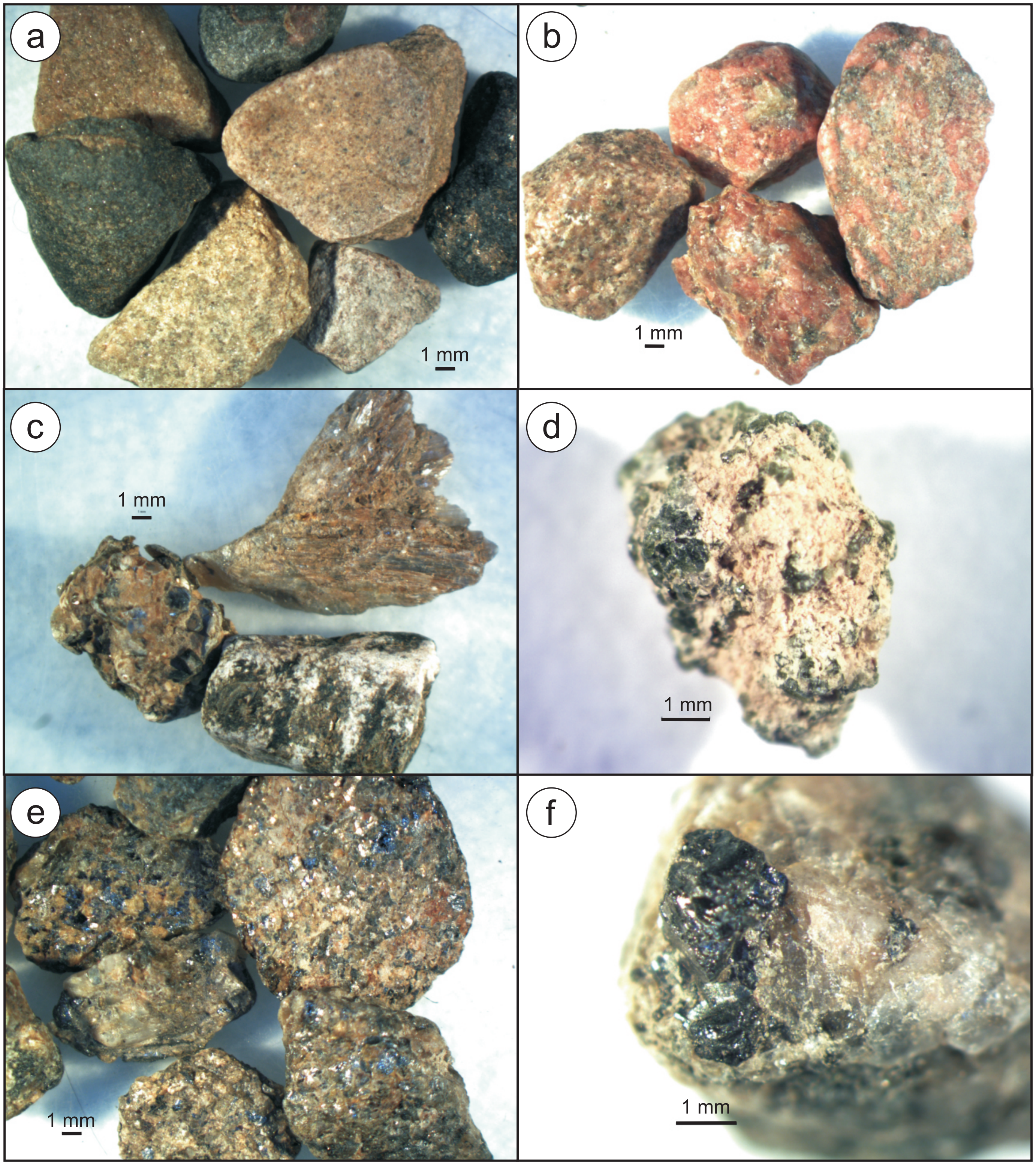

Figure 7: *Examples of local till-clast rock types, as seen under an optical microscope:* ***a)*** *pelitic to semipelitic clasts from site 86;* ***b)*** *gneissic felsic intrusive clasts from site 86;* ***c)*** *calcsilicate clasts from site 86;* ***d)*** *marble from site 68;* ***e)*** *schistose clasts with abundant graphite/molybdenite from site 86;* ***f)*** *granitoid clast with resinous grey uraninite from site 79.*

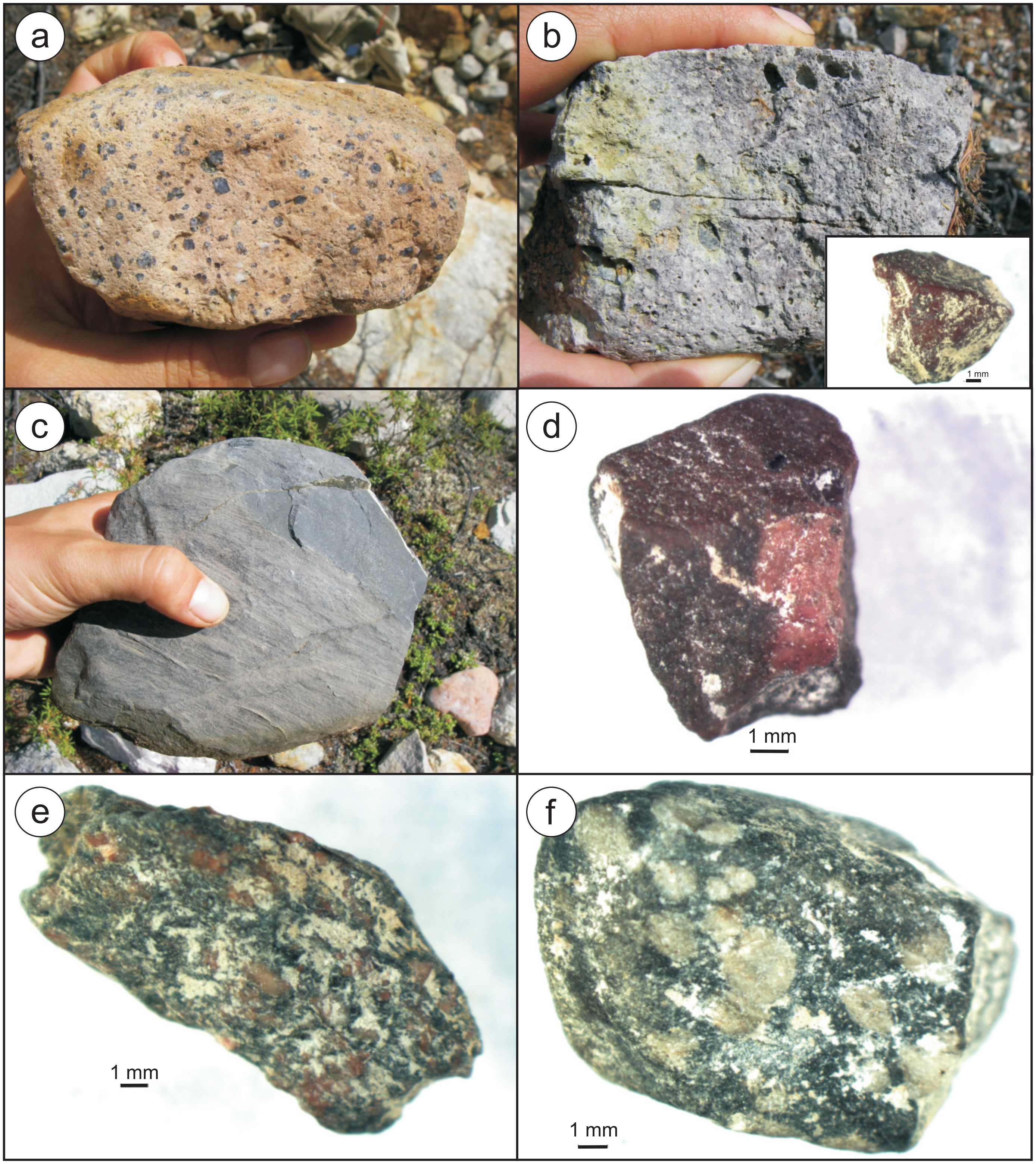

Figure 8: *Examples of clast types exotic to the field area:* ***a)*** *quartz porphyry;* ***b)*** *purple metavolcanic rock, with red metavolcanic rock in inset;* ***c)*** *green/black metapelite;* ***d)*** *dark purple arenite with pink spots;* ***e)*** *felsic diorite;* ***f)*** *amygdaloidal intermediate volcanic rock. Larger cobbles were noted in the field, whereas the smaller pebbles were noted during clast counts from the sieved fraction of till samples.*

Table 1: Lower detection limits for elements and oxides determined by 'total' digestion followed by inductively coupled plasma–emission spectrometry (ICP-ES) or inductively coupled plasma–mass spectrometry (ICP-MS).

Element/oxide	Lower detection limit	Element/ oxide	Lower detection limit
Al_2O_3	0.01%	Ho	0.02 ppm
CaO	0.01%	La	0.1 ppm
Cr_2O_3	0.00%	Lu	0.01 ppm
Fe_2O_3	0.04%	Mo	1 ppm
K_2O	0.01%	Nb	0.1 ppm
LOI (1000°C)	0.10%	Nd	0.3 ppm
MgO	0.01%	Ni	20 ppm
MnO	0.01%	Pb	1 ppm
Na_2O	0.01%	Pr	0.02 ppm
P_2O_5	0.01%	Rb	0.1 ppm
SiO_2	0.01%	Sc	1 ppm
TiO_2	0.01%	Sm	0.05 ppm
Total C (LECO)	0.02%	Sn	1 ppm
Total S (LECO)	0.02%	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		

sample was sent to the Saskatchewan Research Council's (SRC) Geoanalytical Laboratories. The SRC uses a partial digestion by HNO_3 and HCl that is weaker than conventional aqua regia ($3HCl:HNO_3$) and is designed to liberate only uranium in uranium oxides and loosely bound in weathered materials (Campbell, 2009). The lower detection limit is 0.05 ppm. The uranium results for total and partial digestion followed by fluorimetry are presented in Appendix 13.

Quality control for geochemical results

Reliability (accuracy and precision) of geochemical data returned from commercial laboratories was monitored by the laboratories by introducing analytical duplicates (BD), 'blanks' and control reference (CR) samples into the sample suites. In addition, the GSC Sedimentology Laboratory included two certified-reference-material samples ('TILL-4'), two lab duplicates and four silica-sand blanks. Certified reference materials were used to provide an indication of accuracy, and analytical-duplicate samples to evaluate analytical precision. Blanks were inserted to monitor potential contamination occurring during analysis. One field-duplicate pair was collected while sampling. Samples submitted to labs were randomized to spread any possible time-dependent errors (bias) at the laboratory between all samples. This was also done to randomize any systematic analytical drift across the survey area so that it could not be interpreted as a systematic spatial trend. Table 3 provides information on the number of each quality-control sample within each sample suite. Analytical data for certified reference standards, analytical and field duplicates, and blanks are included with this report in Appendix 14.

Table 2: Lower detection limits for elements determined by 'partial' aqua-regia digestion followed by inductively coupled plasma–emission spectrometry (ICP-ES) or inductively coupled plasma–mass spectrometry (ICP-MS).

Element	Lower detection limit	Element	Lower detection limit
Ag	2 ppb	Na	0.00%
Al	0.01%	Nb	0.02 ppm
As	0.1 ppm	Nd	0.02 ppm
Au	0.02 ppb	Ni	0.1 ppm
B	1 ppm	P	0.00%
Ba	0.5 ppm	Pb	0.01 ppm
Be	0.1 ppm	Pd	10 ppb
Bi	0.02 ppm	Pr	0.02 ppm
Ca	0.01%	Pt	2 ppb
Cd	0.01 ppm	Rb	0.1 ppm
Ce	0.1 ppm	Re	1 ppb
Co	0.1 ppm	S	0.02%
Cr	0.5 ppm	Sb	0.02 ppm
Cs	0.02 ppm	Sc	0.1 ppm
Cu	0.01 ppm	Se	0.1 ppm
Dy	0.02 ppm	Sm	0.02 ppm
Er	0.02 ppm	Sn	0.1 ppm
Eu	0.02 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	0.00%
Hg	5 ppb	Tl	0.02 ppm
Ho	0.02 ppm	Tm	0.02 ppm
In	0.02 ppm	U	0.05 ppm
K	0.01%	V	2 ppm
La	0.5 ppm	W	0.05 ppm
Li	0.1 ppm	Y	0.01 ppm
Lu	0.02 ppm	Yb	0.02 ppm
Mg	0.01%	Zn	0.1 ppm
Mn	1 ppm	Zr	0.1 ppm
Mo	0.01 ppm		

The variability and high values of the LOI at 1000°C may be the result of sample-media variability (i.e., oxidation state, degree of postglacial weathering, inclusion of organic material,

Table 3: Quality-control samples included with Snyder Lake till samples (n=41). Analytical duplicates (BD), control reference materials (CR) and blanks inserted at the GSC Sedimentology Laboratory are shown in brackets, while the remainder were inserted by Acme Analytical. Abbreviation: FD, field duplicates.

Analytical method	FD	BD	CR	Blank
$LiBO_2$ fusion 'total' digestion	1	2 (2)	6 (2)	3 (4)
Aqua regia 'partial' digestion	1	3 (2)	2 (2)	2 (4)
Uranium fluorimetry	1	2 (2)	3 (2)	0 (4)
LECO	1	2 (2)	4 (2)	2 (4)

clay-rich samples). The presence of any of these factors in a sample could affect the concentrations of some elements.

Tables 29–33 in Appendix 14 can be used to estimate the quality of analysis for almost every analyte found in Tables 1 and 2. Elements (or analytes) are grouped based on their position in the periodic table.

Accuracy

Accuracy of analytical data was monitored by inserting Canadian Certified Reference Material TILL-4 at two random locations within the analytical suite. TILL-4, consisting entirely of C-horizon till, was collected near Sisson Brook, New Brunswick and augmented with a molybdenite-bearing soil collected near Gatineau, Quebec (Lynch, 1996).

In Table 29 of Appendix 14, means and standard deviations of the accepted values for TILL-4, for which provisional values have been published by Lynch (1996), are shown with detection limits (DL), together with the average values for elements by total and partial digestions from two analyses of reference standard TILL-4. Accepted values were derived from unpublished data ($n \geq 10$) collected from recent projects at the GSC. Elements (or analytes) are grouped based on their position in the periodic table.

An indication of analytical accuracy is provided by comparing the means of the two analyses of TILL-4 with the accepted means and standard deviations in Table 29 of Appendix 14. For analytes for which an accepted mean exists, almost all analytes are within one standard deviation of the accepted mean. Poor repeatability may be an indication that analytical results are close to the detection limit for the element or analyte.

Precision

Precision is defined as the closeness of agreement between analytical duplicate samples analyzed by the same method (i.e., independent test results obtained using the same equipment within short intervals of time on duplicate project samples). There is an insufficient number of analytical duplicates for statistical purposes. Duplicate analyses by commercial laboratories analyze two aliquots of the same sample solution rather than separate aliquots from two duplicate samples.

Results

Till-matrix textural and colour analyses

The tills in the Snyder Lake area are commonly light brownish-grey to light yellowish-brown (oxidized) or light grey (Appendix 5), and consist of ~60% sand, ~39% silt and ~1% clay (with one standard deviation (σ); Table 4; Appendix 4). These values are similar to those for shield-derived till in northeastern Manitoba (64% sand, 31% silt, 4.7% clay; Campbell et al., 2012).

Table 4: Textural grain-size distribution for tills of the Snyder Lake area.

	Sand (%)	Silt (%)	Clay (%)
Maximum	77.25	75.06	3.85
Median	60.25	38.64	1.06
Minimum	24.34	22.11	0
1 standard deviation (σ)	10.62	10.35	0.75

All samples are texturally <2σ from the median, with the exception of a low amount of sand (24%) and a high amount of silt (75%) at site MT029. This site is located at the top of a 6 m high drumlin, within a meltwater corridor. Clay content is >2σ from the median at sites MT019 (2.9%; till veneer over bedrock) and MT041 (3.9%, till veneer over bedrock).

Duplicates run from two lab splits returned differences of 2.4% for sand, 4.4% for silt and 18.6% for clay (Appendix 4). This suggests that textural determinations of sand and silt are more precise than those of clay.

Till-clast dispersal

Clasts within till are derived from bedrock (Klassen, 1997) and, if specific source areas are known, this knowledge can assist with the delineation of glacial-transport directions and distances, as well as identification of unmapped bedrock units, including outliers. Glacial dispersal can be mapped at varying scales from regional (hundreds of kilometres) to local (1–10 km) to detailed (less than 1 km).

To determine clast-dispersal patterns within the field area, the 19 lithological classes were first grouped into four simplified classes (Table 5). These classes were then plotted spatially in ArcGIS using count-percentage proportional-symbol plots separating according to Jenks natural breaks (Appendix 10).

The sample size is too small to judge the effects of comminution on each rock type, but there are some interesting differences between clast fractions (Table 6). Granitoid and quartz clasts are more dominant in the smallest size fraction (2–4 mm), whereas metasedimentary clasts are predominant in the largest size fraction (8–30 mm). These differences indicate enhanced quarrying and short transport distances of the local metasedimentary bedrock (Appendix 14), with longer transport distances and more comminution of the local to regional granitoid and quartz clasts. Graphite- or molybdenite-bearing clasts are also predominant in the largest size fraction, which suggests short transport distances for these friable clast types.

Table 5: Simplified and original lithological classes for till-sample clasts from the Snyder Lake area.

Simplified class:	Granitoid	Metasedimentary	Uranium-associated	Exotic
Original class	K-feldspar–quartz pegmatite	Psammitic gneiss	Graphite- or molybdenite-bearing	Diorite
	Granitic gneiss	Amphibolite	granitoid or schist	Red quartz porphyry
	Granodiorite	Psammite	Granitoid with uraninite	Amygdaloidal intermediate volcanic
	Undifferentiated granitoid	Pelite to semipelite	Calcsilicate and marble	Green slate
	Foliated granitoid	Feldspathic meta-arenite		Purple arenite with pink spots
	Quartz			Dubawnt Supergroup

Table 6: Average count-percent of clasts per grain-size fraction for certain rock types in the Snyder Lake area.

Clast fraction	Granitoid	Metasedimentary	Graphite- or molybdenite-bearing	Uraninite-bearing	Calcsilicate and marble	Red/purple metasedimentary or metavolcanic (Dubawnt Supergroup)	Other exotic	Quartz
2–4 mm	55.8	30.3	0.72	0.01	3.7	0.06	0.14	9.3
4–8 mm	48.9	42.3	0.69	0.01	4.1	0.05	0.1	3.9
8–30 mm	41.6	53.8	1.22	0	2	0	0.14	1.2
2–30 mm	53.3	34.4	0.7	0.01	3.9	0.05	0.13	7.5

Detailed regional bedrock mapping is limited (Anderson et al., 2005; Böhm et al., 2008; Kremer et al., 2011) due to remote access and sparse outcrops. As such, the source of most 'exotic' rock types is unknown. The concentration of exotic rock types is an important part of the regional dataset, however, and will be used in the future to demarcate continental-scale clast dispersal. To the northwest, at Phelps Lake (north NTS 64M) in Saskatchewan, red/purple exotic metasedimentary, metavolcanic and metaconglomerate clasts are assigned to the Dubawnt Supergroup (Campbell, 2002a). Similar clasts, attributed to the Dubawnt Supergroup, have also been documented in northeastern Manitoba (310 km east; Campbell et al., 2012), the Cochrane River area (100 km southwest in NTS 64L; Smith, 2006) and the Fond Du Lac area (350 km west in NTS 74O5, 6; Campbell et al., 2006). The Dubawnt Supergroup outcrops in Nunavut (Peterson, 2006), approximately 350 km to the north-northwest. Unmetamorphosed to slightly metamorphosed conglomerate and sandstone of the Hurwitz Group (outcropping in the Northwest Territories and Nunavut) were also noted in the Phelps Lake area (Campbell, 2002a) but were not found in the current study area. Rare quartzite cobbles and boulders noted in the field may, however, be sourced from the Hurwitz Group—although closer quartzite exposures of the Wollaston Supergroup are present in the Kasmere–Putahow lakes area of northwestern Manitoba (Böhm and Anderson, 2006).

Map-area variability

Although distances and directions of transport have not been determined for all clast types, erratics and exotic detritus observed in the field provide evidence of local- to continental-scale transport. The majority of the till in the Snyder Lake area consists of locally to regionally sourced clasts (~99.82%), with an average of 0.18% exotic clasts (regionally to continentally sourced). There does not appear to be much local variation (Appendix 14), except where calcsilicate and graphite/molybdenite–bearing clasts are present. Calcsilicate and marble clasts are found in till samples throughout the study area at concentrations below 4.7% (Figure 9). Concentration is elevated at five sites, of which all except one (site MT071, 7.4%) are associated with mapped calcsilicate gneiss and/or marble rocks. Carbonate was present in the till matrix only at the sample site with the highest percentage of calcsilicate and marble clasts (site MT051, Appendix 6).

Discussion

While the main purpose of this report is to publicize data, a few interpretations regarding the field area are presented below.

Variability within one drumlin

Till samples were taken at a similar depth from the middle crest (MT033) and lower lee slope (MT034) of a parabolic drumlin that trends to 215°. The drumlin is 337 m long and 344 m wide, with a steep (~60°), 3 m high stoss slope and a gentler (45°) lee slope. Although the samples were taken only 175 m apart, the clast types are different (Table 7). Relative to the lee-slope sample, the crest sample contains fewer granitoid clasts, more metasedimentary clasts and rare calcareous or exotic clasts.

The drumlin is mapped as overlying feldspathic meta-arenite, with psammitic gneiss just to the north and west, and interbedded semipelitic and pelitic gneiss 1.5–2 km farther northwest (Kremer and Böhm, 2011). Detailed bedrock mapping ends only 3 km north of the drumlin, so the bedrock up ice of the mapped area is not well constrained. It is known, however, that granitoid and foliated granitoid basement rocks of the southeastern Hearne Craton outcrop to the northwest at Grevstad Lake (Kremer and Böhm, 2011).

Since metasedimentary rocks outcrop locally and granitoid rocks outcrop at some distance from the drumlin, the relative proportions of these two rock types may indicate that till from the lee slope of the drumlin is more distally derived (farther

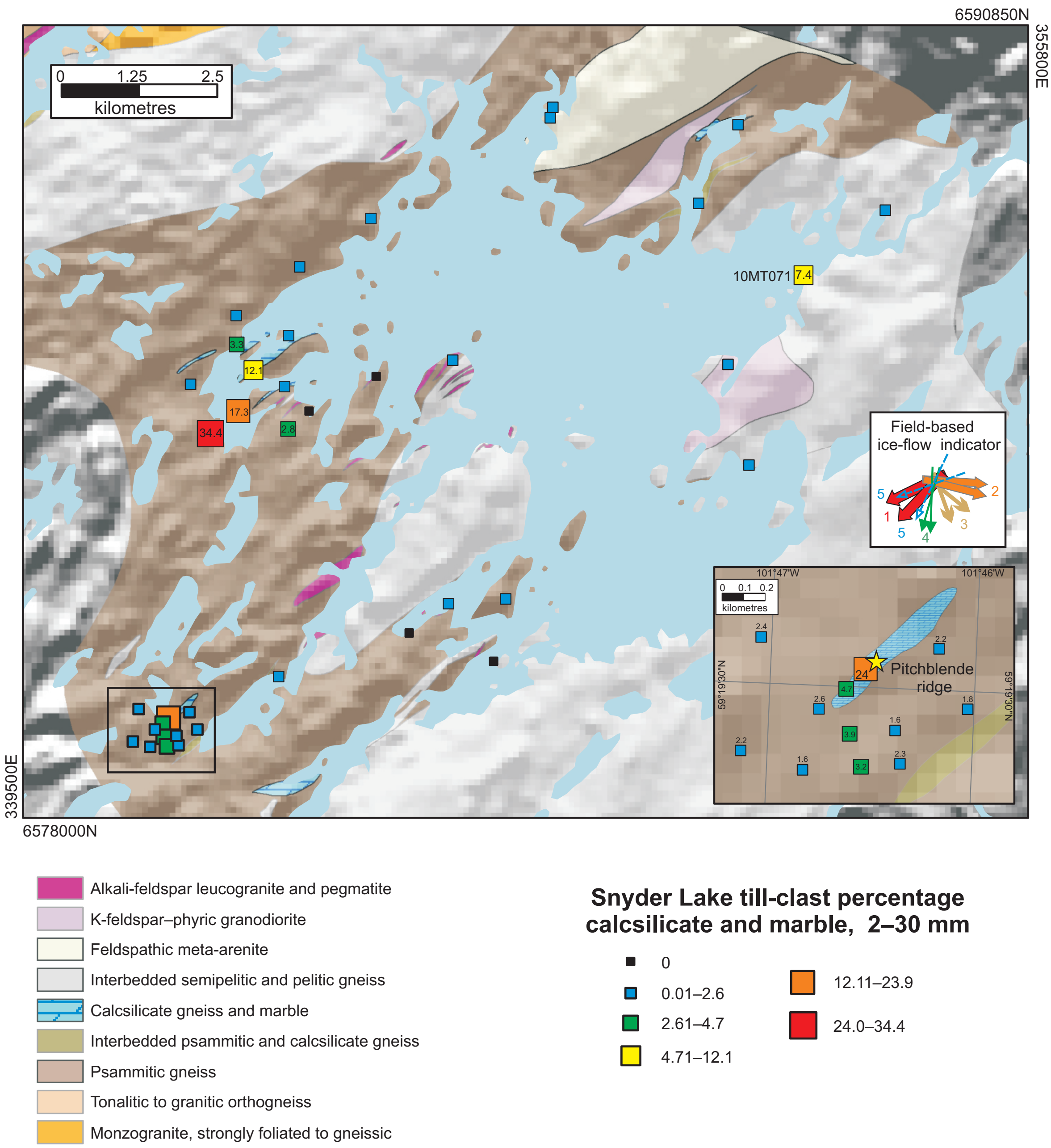

Figure 9: *Proportional-symbol plot of the count-percent of calcareous clasts within sieved till samples, superimposed on bedrock geology (modified after Kremer and Böhm, 2011). The lower-right inset is an enlargement of the Pitchblende ridge area in the southwest corner of the study area. The field-based indicators inset depicts the simplified chronologic ice-flow history for the region.*

Table 7: Simplified lithology and texture of two till samples taken from different places on the same parabolic drumlin, northwestern Snyder Lake area.

Sample site	Granitoid[1]		Metasedimentary		Calcareous		Exotic		Sand (%)	Silt (%)	Clay (%)
	No.	%	No.	%	No.	%	No.	%			
MT033 (crest)	467	46%	539	54%	1	0.10%	0	0%	69.5	29.5	1.1
MT034 (lee)	439	67%	206	32%	4	0.60%	3	0.46%	75.1	24.8	0.1
Percent difference		*37*		*51*		*200*		*200*	*8*	*17*	*167*
Field-area median	*444*	*61%*	*267*	*34%*	*33*	*5%*	*1*	*0.18%*	*60.23*	*38.6*	*1.1*
Field-area standard deviation	*168*	*21%*	*167*	*18%*	*65*	*8%*	*3*	*0.38%*	*10.62*	*10.3*	*0.8*

[1] quartz clasts included

travelled) than till from the crest of the drumlin. This is substantiated by the presence of more calcareous and exotic clasts in lee-slope till (1.1% vs. 0.1%). Caution is advised in applying these observations to drift prospecting in this area, as they are based on only two samples from one drumlin. However, similar observations concerning contrasting till provenance on and within drumlins have been reported in Saskatchewan (Campbell and Flurry, 1999; Campbell, 2007).

Dispersal of uranium in till at Pitchblende Ridge

Pitchblende or uraninite in the Snyder Lake area appears to be associated with calcsilicate rocks at Pitchblende ridge and Snyder Island, although is also known to occur in other rock types (Avery, 2010). Dispersal analyses from Pitchblende ridge include boulder dispersal, calcsilicate and graphite/molybdenite till-clast dispersal, and uranium till-matrix dispersal, as outlined below.

A boulder-dispersal study (Trommelen, 2011a) at Pitchblende ridge determined that mineralized boulders (n = 34; based on scintillometer readings of >150 counts per second) were a mix of calcsilicate rocks (68%), leucogranite (26%) and pegmatitic granitoid (6%). The boulder study identified a diffuse dispersal fan 275 m long and 120 m wide, with a strong dispersal component toward 220° (ice-flow phase 5; Figure 3) and remnants of older dispersal components toward 140° and 180–195° (ice-flow phases 4 and 3, respectively).

Calcsilicate rocks exposed in outcrop at the Pitchblende ridge crag consist of up to 90% calcite and 10% scapolite, with hornblende, epidote and accessory titanite (Kremer et al., 2011). The highest count-percentage of calcsilicate and marble clasts is just down-ice (130 m) of the Pitchblende ridge outcrop, and trends 200–230° for at least another 165 m (Figure 9).

During the boulder study and bedrock thin-section analysis, it was noted that there also appears to be an association between uranium-bearing rocks and graphite and/or molybdenite. The graphite appears to act as a reductant and causes precipitation of uranium out of solution. Graphite/molybdenite–bearing clasts were noted in till samples from 16 sites (Figure 10). These sites are predominantly at or surrounding Pitchblende ridge, but some also occur in the northeastern part of the study area. Three of these sites at Pitchblende ridge likely contain a uraninite-bearing clast (Figure 10). The highest count-percentage of graphite/molybdenite–bearing clasts is just down-ice (130 m) of the Pitchblende ridge crag, with lower concentrations noted 500–700 m east, southeast, south, southwest and west of the outcrop (Figure 10). The maximum transport distance is unknown, although it is noted that the count-percent drops off to <1% within 500 m to the east-southeast and <300 m to the south or southwest. Ice-flow orientation studies (Figure 4) indicate that the graphite/molybdenite–bearing clasts to the west of the Pitchblende ridge crag (4.17% value on Figure 10) are not transported from the Pitchblende ridge crag and may indicate dispersal from unknown uranium mineralization.

Till matrix (<63 µm) geochemistry (aqua regia partial digestion)

Proportional-symbol plots of the concentrations of uranium and thorium in the <63 µm fraction of till matrix are presented in Figures 11 and 12, respectively. Plots of the other elements analyzed are presented in Appendix 15, except for B, Ge, Hg, In, Pd, Pt, Re, S, Sb, Se and Te, where results were mainly below detection limit. Individuals and companies are encouraged to undertake their own interpretation of the data, the following being a preliminary guide.

Uranium

Uranium (>6σ), thorium (>6σ), lead (>5σ) and silver (3σ) occur at anomalous concentrations (aqua regia) in sample MT58 (Figures 11, 12; Appendix 12, Table 26). This till sample was taken directly down-ice of the known uranium occurrence at Pitchblende ridge (Avery, 2010; Kremer et al., 2011), from the crest of a crag-and-tail feature that trends to 230°. The transport distance of uranium within the till matrix appears to be quite short, its concentration falling to near-background values (aqua regia partial digestion and ICP-MS [AR], <4.2 ppm; $LiBO_2$- $Li_2B_4O_7$ total digestion and ICP-MS [$LiBO_2$], 4.5 ppm; total digestion and uranium fluorimetry [UFl_t], 4.8 ppm; partial digestion and uranium fluorimetry [UFl_p], 2.67 ppm) within 250–300 m down ice. This short-distance dispersal train suggests that regional till geochemistry analysis is more likely to encounter the edge of a dispersal fan, if at all, and that any concentration above background should be considered significant. Sites with suspected 'elevated' concentrations should be subject to progressively more detailed sampling in up-ice directions, to efficiently aid in source determination. Thus, low (AR, <4.2 ppm) but elevated concentrations of U and Th in the till matrix may still indicate proximity to uranium potential in the Snyder Lake area.

Other samples with >90th percentile U include MT94, MT71 and MT25. Uranium concentration is elevated in these samples using all four methods (AR, $LiBO_2$, UFl_p and UFl_t; Table 8). Uranium concentration can be affected by clay and organic (LOI) contents; these values are given in Table 8 for the four sites of interest. The higher clay content at site MT71 (2.29%) suggests that the concentration of uranium may be somewhat diluted compared to the other sites. Clay concentration at sites MT19 (2.85%; AR, 2.2 ppm U) and MT41 (3.85%; AR, 1.8 ppm U) is also high.

Unlike at sites 58 and 94 (Figure 12), there is no known uranium occurrence near site 71 or 25. These sites also have somewhat higher uranium and thorium concentrations than the other known occurrence of uranium mineralization at Snyder Island. As such, the till geochemistry of these sites suggests there is likely unexplored uranium potential around the northwestern part of Snyder Lake.

Regional comparison

The range of uranium concentrations in the till matrix (<63 µm) is similar to that of till samples from the Nuclear Energy Agency–International Atomic Energy Agency Athabasca test area in Saskatchewan (near-total digestion, <2 to 36 ppm; Campbell et al., 2007), located ~130 km southwest of Snyder Lake. Similar values (up to 38 ppm) were also found in till sampled at the Midwest uranium deposit in Saskatchewan (UFl

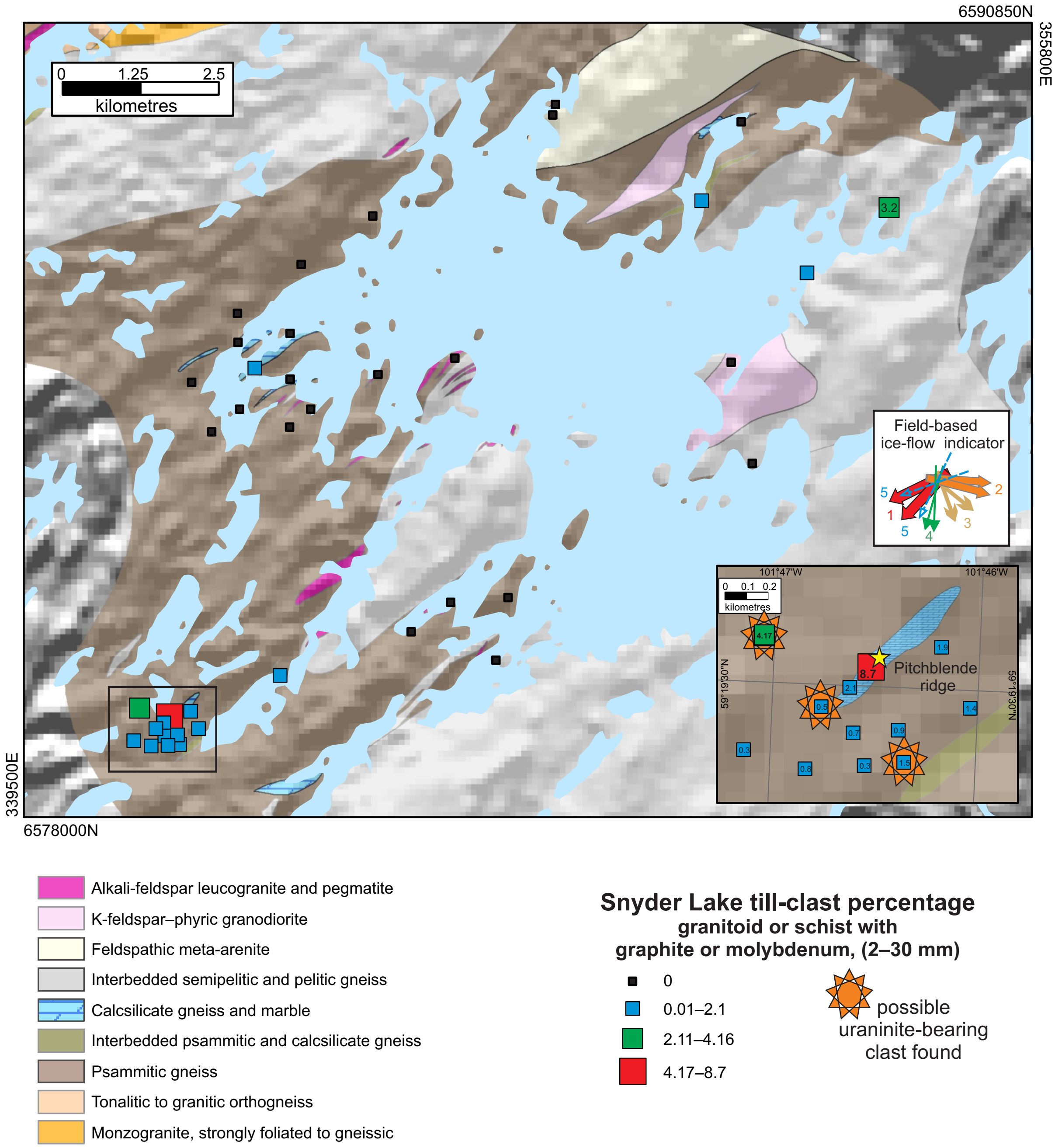

Figure 10: *Proportional-symbol plot of the count-percent graphite/molybdenite–bearing clasts within till samples, Snyder Lake area. The lower right inset is an enlargement of the Pitchblende ridge area in the southwest corner of the study area. Sites where possible uraninite-bearing clasts were mapped are highlighted. Pitchblende/uraninite is present in outcrop at Pitchblende ridge (yellow star). The field-based indicators inset depicts the simplified chronologic ice-flow history for the region.*

and neutron-activation analysis, <1 to 38 ppm; Simpson and Sopuck, 1983), located ~560 km southwest of Snyder Lake.

Multiple metals

Two till samples (MT71 and MT25) from the northeast quadrant of Snyder Lake consist of anomalously high (>99th percentile) concentrations of most analyzed elements (Appendices 11, 12), especially (3σ–4σ, AR) Ba, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ge, Hf, K, La, Li, Mg, Mn, Mo, Na, Ni, Pb, Pr, Rb, Sc, Se, Tb, Ti, Tl, Tm, V, Y, Zn and Zr. These elevated concentrations could be due to a combination of factors but indicate the presence of polymetallic-type mineralization, containing base metals, precious metals and rare earth elements, that may be skarn related.

Recommendations for future exploration

- Drumlins were generally avoided during till sampling due to the difficulty in digging through the clast-rich, sandy surface till, and the increased amount of sample material necessary to obtain a suitable amount of silt+clay matrix for analyses. Based on a comparison at one site, it may be possible to say that till from the lee slope of the drumlin is more distally derived (farther travelled) than till from the crest of the drumlin.

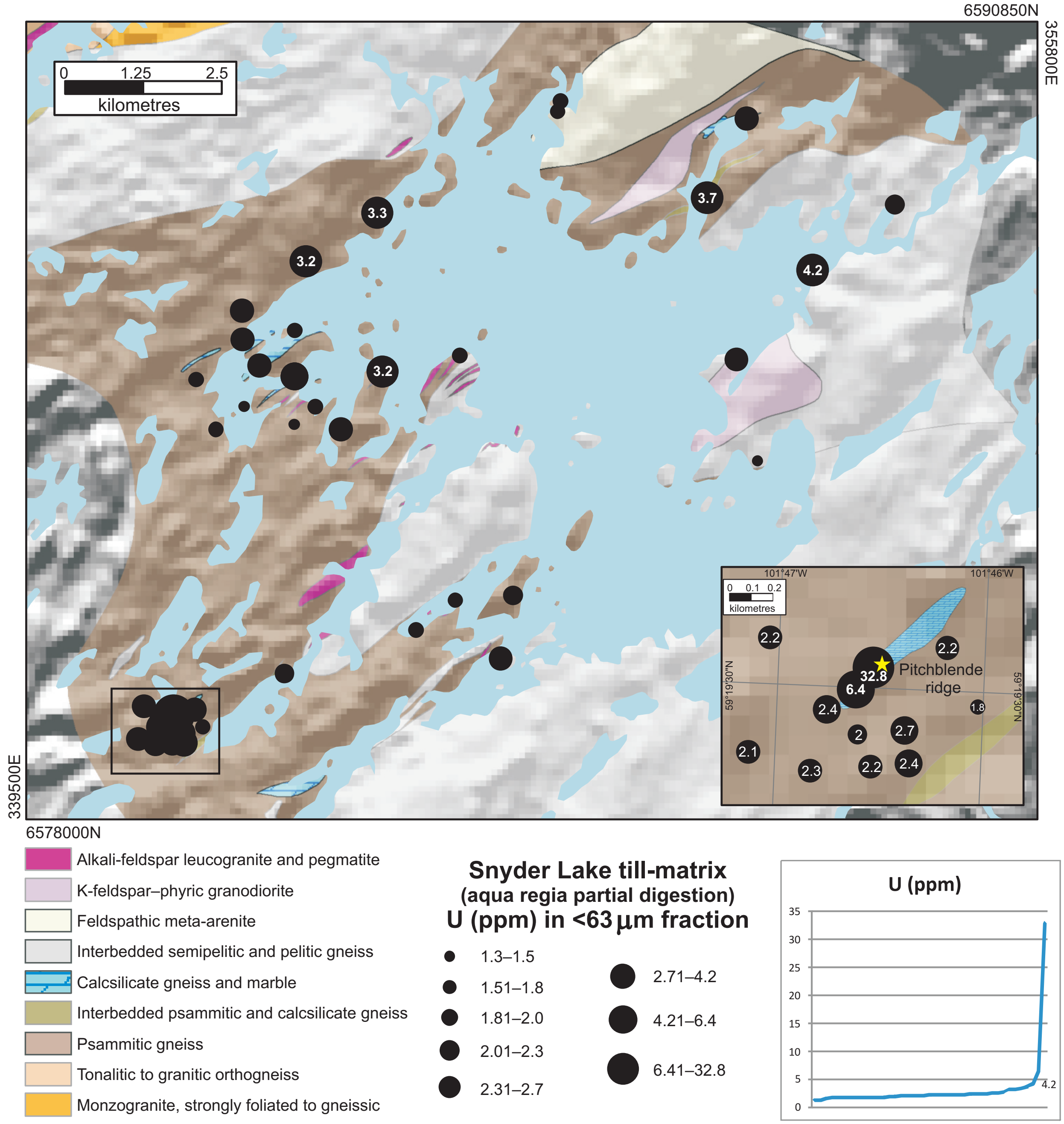

Figure 11: *Proportional-symbol plot of the partial digestion (aqua regia) uranium concentration (ppm) in the <63 µm fraction of till matrix, Snyder Lake area. Inset is an enlargement of the Pitchblende ridge area in the southwest corner of the study area.*

- Uranium in till appears to be associated with elevated concentrations of calcareous clasts, but not all calcareous bedrock contains high uranium. High uranium is better correlated with the increased concentration of reductant phases in the till, such as graphite/molybdenite–bearing clasts.
- Even though most of the area is draped by streamlined till, **the transport distance of subglacial detritus is short**. Uranium in the till matrix falls to near background values (AR, <4.2 ppm; $LiBO_2$, 4.5 ppm; UFlt, 4.8 ppm; UFl_p, 2.67 ppm) within 250–300 m down ice. The associated boulder dispersal train is 275 m long. The average transport distance of tracer clasts within till (calcareous and graphite/molybdenite) surrounding Pitchblende ridge generally corresponds with the uranium dispersal fan, although the count-percent values decrease to background within 500 m to the east-southeast and <300 m to the south or southwest. These results suggest that all drift-exploration methods are more likely to encounter the edges of a dispersal fan. **To determine source, elevated but low tracer concentrations should not be discounted but instead followed up by progressively more detailed sampling in up-ice directions.**
- The northeastern part of Snyder Lake (sites 11MT025, 11MT070, 11MT071) is a heavily drift-covered area that may contain unexplored uranium potential (and possibly other, polymetallic skarn-type mineralization potential?). These sites contain elevated concentrations of calcareous and graphite/molybdenite clasts, and highly elevated concentrations of a wide range of elements (>99th percentile):

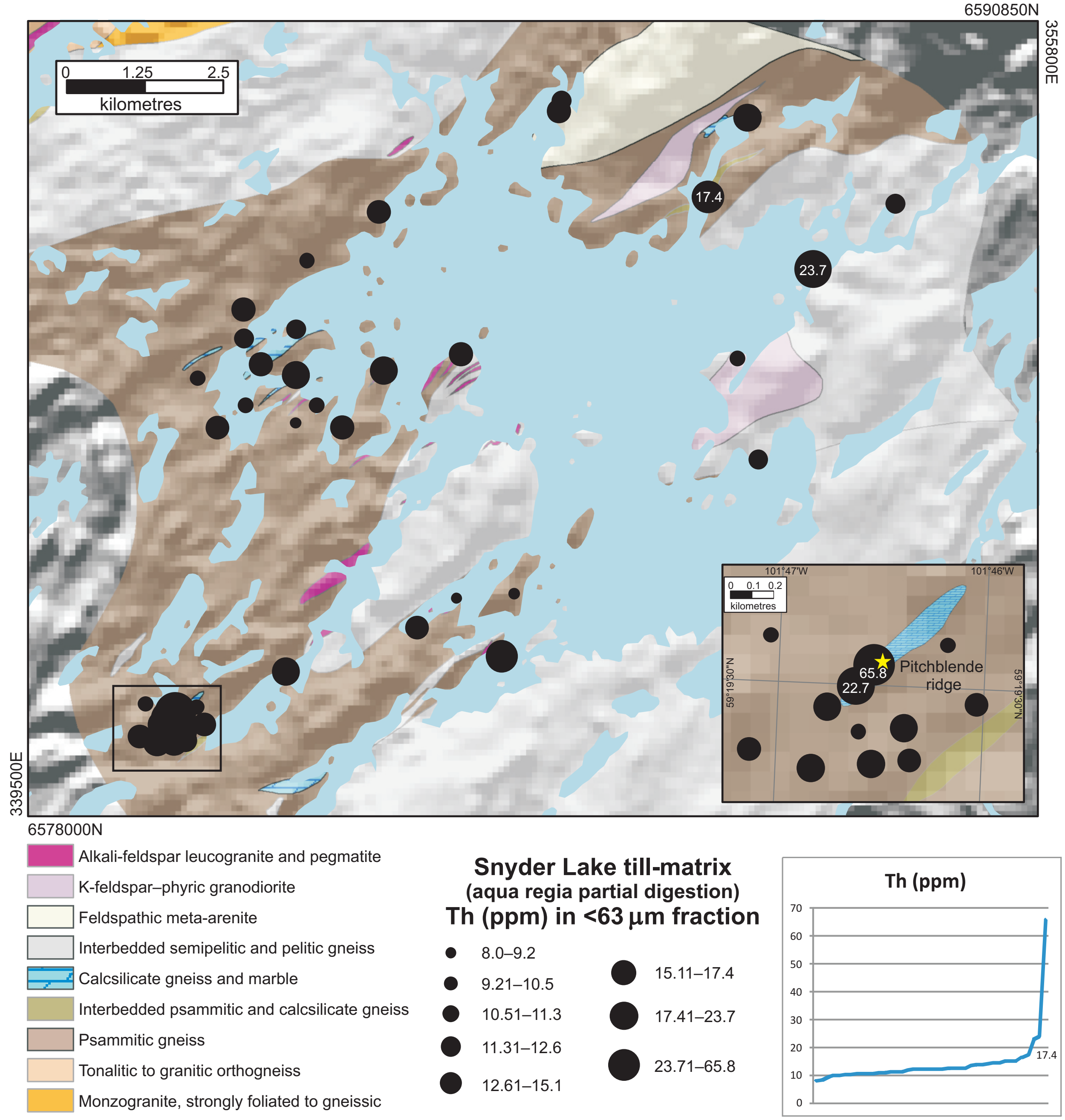

Figure 12: Proportional-symbol plot of the partial digestion (aqua regia) thorium concentration (ppm) in the <63 µm fraction of till matrix, Snyder Lake area. Inset is an enlargement of the Pitchblende ridge area in the southwest corner of the study area.

Table 8: Uranium and thorium concentrations in till samples with >95th percentile uranium. Uranium concentration is also known to be affected by the presence of clay and organic matter (analyzed by LOI), which are also shown for each sample. Abbreviations: AR, aqua regia partial digestion; $LiBO_2$, lithium-borate total digestion; UFI, uranium fluorimetry (partial and total).

Sample	U (AR; ppm)	Th (AR; ppm)	U ($LiBO_2$; ppm)	Th ($LiBO_2$; ppm)	UFI (partial; ppm)	UFI (total; ppm)	Clay (%)	LOI (%)
MT25	3.7	17.4	5.7	23.8	2.67	5.4	1.63	4
MT58	32.8	65.8	31.7	70.8	31.1	32.2	0.58	4.1
MT71	4.2	23.7	6.6	31.6	2.1	6.1	2.29	3.6
MT94	6.4	22.7	6.8	27.6	4.45	8.5	0	1.5
Avg. (n = 41)	3.06	13.97	4.4	18.5	2.1	4.5	1.18	2.8
σ (n = 41)	4.84	8.88	4.5	9.3	4.7	4.6	0.75	1

Ba, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ge, Hf, K, La, Li, Mg, Mn, Mo, Na, Ni, Pb, Pr, Rb, Sc, Se, Tb, Ti, Tl, Tm, V, Y, Zn and Zr.

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