TILL GEOCHEMISTRY OF THE NADINA RIVER MAP AREA (093E/15), WEST-CENTRAL BRITISH COLUMBIA

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ABSTRACT

A regional-scale till geochemical survey conducted in the Nadina River map area (093E/15) has identified four areas of geochemical interest - Shelford Hills southeast, Short Portage Lake area, Tagetochlain Lake area, and upper Nadina River valley. In the context of local bedrock lithologies and locations of known mineral occurrences, these areas were highlighted based on trace element determinations of Cu, Mo, Pb, Zn, Ag, Ni, and Hg by aqua regia ICP-MS, and Au, As, Sb, and Cr by INAA, and gold-grain counts (normalized to table feed weight). Net transport direction of basal tills in the region is thought to be west (252°-306°). As part of any follow up on these till geochemical data, detailed outcrop-scale investigation of ice-flow indicators should be conducted. The complexity of the region's ice-flow history, and variability in till thickness, suggests that there could be local variation in net transport direction and distance.

INTRODUCTION

This report presents results from a till geochemical survey conducted within the Nadina River map area (093E/15). Located within the Tahtsa Lake district, approximately 100 km south of Houston, British Columbia (Figure 1), this area has high potential to host porphyry Cu±Mo and polymetallic vein-style (including Au) mineralization. This district, and areas immediately adjacent to it, have a rich mineral exploration history and at present host a producing porphyry Cu-Mo mine (Huckleberry Mine Ltd.) and numerous developed Cu±Mo prospects (e.g., Berg, Lucky Ship, Whiting Creek; MacIntyre, 1985). This district also hosts epithermal vein and perhaps volcanogenic massive sulphide (VMS) style mineralization, as suggested by past producers such as Equity Silver and Emerald Glacier mines (MacIntyre, 1985; MacIntyre et al., 2004; Alldrick et al., 2007).

Currently there are large areas of unstaked ground within, and adjacent to, the northern and northeastern portion of the Tahtsa Lake district. Much of this area is covered with

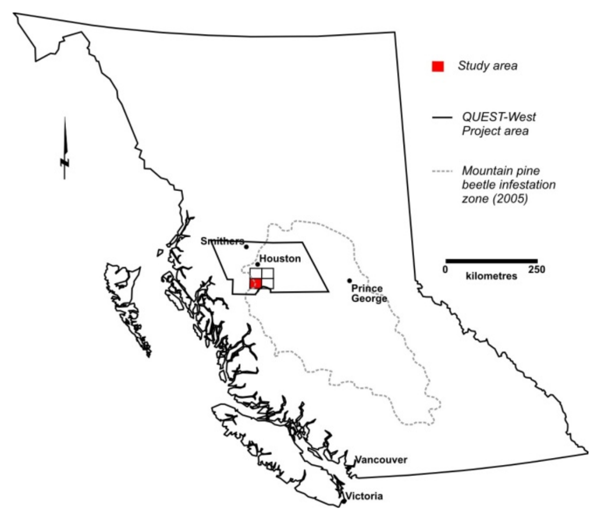

Figure 1. Location of study area in west-central British Columbia.

glacial drift and continuous bedrock outcrop is limited to the higher peaks and their flanks. Till geochemical surveys are an effective method for assessing the metallic mineral potential of areas covered with glacial drift and are ideally suited to assessing the potential for new mineralization in the district. Till geochemical surveys are also well suited for following up on airborne geophysical data such as those recently acquired by

Geoscience BC for the QUEST-West Project area (Kowalczyk, 2009). The Nadina River map area falls within the QUEST-West Project area and the mountain pine beetle infestation zone.

The main objective of this survey is to assess the mineral potential of an area where bedrock outcrop is limited. The goal of this project is to provide to the mineral exploration community a high-quality, regional-scale, geochemical data set that can be used to help guide exploration efforts. Integrating interpretations of these data with other geochemical and geophysical data being collected by Geoscience BC in the QUEST-West Project area, and historic data that have been collected by the British Columbia Geological Survey (BCGS) and the Geological Survey of Canada, will provide a powerful tool for companies exploring in this drift-covered area.

STUDY AREA

The study area is located in west-central British Columbia, approximately 100 km southwest of Houston, in NTS map area 093E/15 (Figure 1). It is accessible by Forest Service, private and abandoned mine and mineral exploration roads. Quaternary sediments were studied in detail within 093E/15 while a regional-scale glacial history and ice-flow study was conducted within 093E/15 and 16. The majority of till samples were collected within 093E/15. Additional till samples were collected within portions of 093E/11, 14, and 16 to take into account study area's complex ice-flow history.

The majority of the study area is situated in the Nechako Plateau, a subdivision of the Interior Plateau. The Nechako Plateau is an area of low relief with flat or gently rolling topography (within the study area, 880 to 944 m asl) most of which is covered by a package of glacial sediments (Holland, 1976). Although bedrock outcrop is relatively uncommon, some exposures can be found at the stoss (i.e., up-ice) end of crag-and-tail forms, along lake shorelines, on higher ground within Shelford and Mosquito hills (1494 and 1402 m asl, respectively), and on local small-scale erosional remnants that stand above the plateau surface to the west and northwest of Shelford Hills (Figure 2). Bedrock outcrop can also be found in the upper reaches of the Nadina River valley and within road-cuts associated with newly constructed forestry roads.

The very southwest corner of the study area is situated in the Tahtsa Ranges, a northwest-trending belt of non-granitic mountains that range in elevation from 2100 to 2431 m (Holland, 1976). These mountains are situated between the Nechako Plateau to the east and the Coast Mountains to the west. While the majority of hills and mountains within the Nechako Plateau are forested, the Tahtsa Ranges extend up into subalpine and alpine environments.

Small lakes are common within the study area and can be interconnected forming lake chains. The largest lake within the study area is Ootsa Lake, which is part of an interconnected series of large lakes (i.e., Tahtsa, Ootsa, Whitesail, Eutsuk, Tetachuk, and Natalkuz lakes) that make up the Nechako Reservoir. Nadina River flows in an arc through the north-central part of the study area, connecting Nadina Lake to Francois Lake, and is the largest river in the study area.

BEDROCK GEOLOGY

The bedrock geology of the study area was first described and mapped by Hedley (1935) and was included in subsequent mapping by Duffell (1959). The main

Figure 2. Subdued topography of the southwest corner of the study area. View is towards the east with Mosquito Hills in the background. Note red coloured pine trees in middle of photograph, indicating that mountain pine beetles have moved through the area.

geological subdivisions found in the study area, as summarized from Woodsworth (1980), MacIntyre (1985), MacIntyre et al. (1994), and Diakow (2006), are as follows. The Tahtsa Lake district lies within the Stikine terrane, just east of the Coast Crystalline Belt (Monger et al., 1991). The western part of the study area is underlain mainly by Early to Middle Jurassic Hazelton Group volcanic and sedimentary rocks (Figure 3). In places, these rocks are unconformably overlain by Early Cretaceous Skeena Group marine sedimentary rocks and local basalt to andesite flows. These rocks are in turn unconformably overlain by felsic pyroclastics, felsic flows, and younger basaltic flows of the Early to Late Cretaceous Kasalka Group volcanics. Small to medium-sized, Late Cretaceous to Early Tertiary stocks have intruded these volcanic piles and sedimentary packages. Elsewhere in the region, there is a strong positive relationship between the location of intrusive lithologies (in particular porphyritic intrusions like those of the Late Cretaceous Bulkley suite) and the locations of Cu, Mo, Au, Pb, Zn, and (or) Ag mineralization (Carter, 1981; MacIntyre, 1985).

In the most eastern part of the study area, Eocene Ootsa Lake Group felsic volcanics dominate. Younger, and less widespread, Eocene to Lower Miocene Endako Group basaltic and alkaline volcanic rocks do also occur locally. An approximation of the areal extent of Quaternary sediment cover has been included in Figure 3 and is represented by a light grey transparent overlay and black dashed line.

Significant contributions towards the understanding of the region's metallogenesis, in particular porphyry Cu-Mo deposits, have been made by Carter (1981), and MacIntyre (1985). Other detailed work has been conducted on specific metallic mineral deposits adjacent to the study area (e.g., Panteleyev 1981; Cyr et al., 1984; Jackson and Illerbrun, 1995;) and additional geologic information on local mineral occurrences and claims is available in the BCGS Assessment Report Indexing System (ARIS).

More recently MacIntyre (2001), MacIntyre et al. (2004), Alldrick (2007a, b), and Alldrick et al. (2007) have investigated the mineral potential of mid-Cretaceous rhyolites of the Rocky Ridge Formation. This work suggests that these rhyolites have potential to host VMS-type deposits. While rhyolites do occur within the study area, they have been assigned to the younger, Eocene Ootsa Lake Group. Limited outcrop, a scarcity of observable field relationships, and a lack of geochronologic control make it difficult to assess whether these rhyolites are in fact Eocene in age or older and perhaps equivalent to Rocky Ridge Formation rhyolites.

Mineral Occurrences

There are five documented mineral occurrences within the study area (Figure 3). Tets (Cu-Zn-Pb-Ag; MINEFILE 093E 084) and Shelford Hills (Zn-Pb-Au; MINFILE 093E 085) are vein-type showings while Rip (Cu-Mo; MINFILE 093E 092), Dilys (Cu; MINFILE 093E 094) and Hill (Cu-Au-Zn; MINFILE 093E 097) are porphyry-type showings. Although there is no MINFILE occurrence associated with it, there is a claim block in the southwest corner of the study area, centered on Mosquito Hills (Figure 3). Known as the Rox claims, mineralization here consists of sulphide and precious metal-bearing veinlets predominantly hosted in Middle Jurassic Smithers Formation sedimentary rocks. Mineralization is likely associated with either a porphyry, polymetallic vein, or epithermal system (Ogryzlo, 2003; Lane,

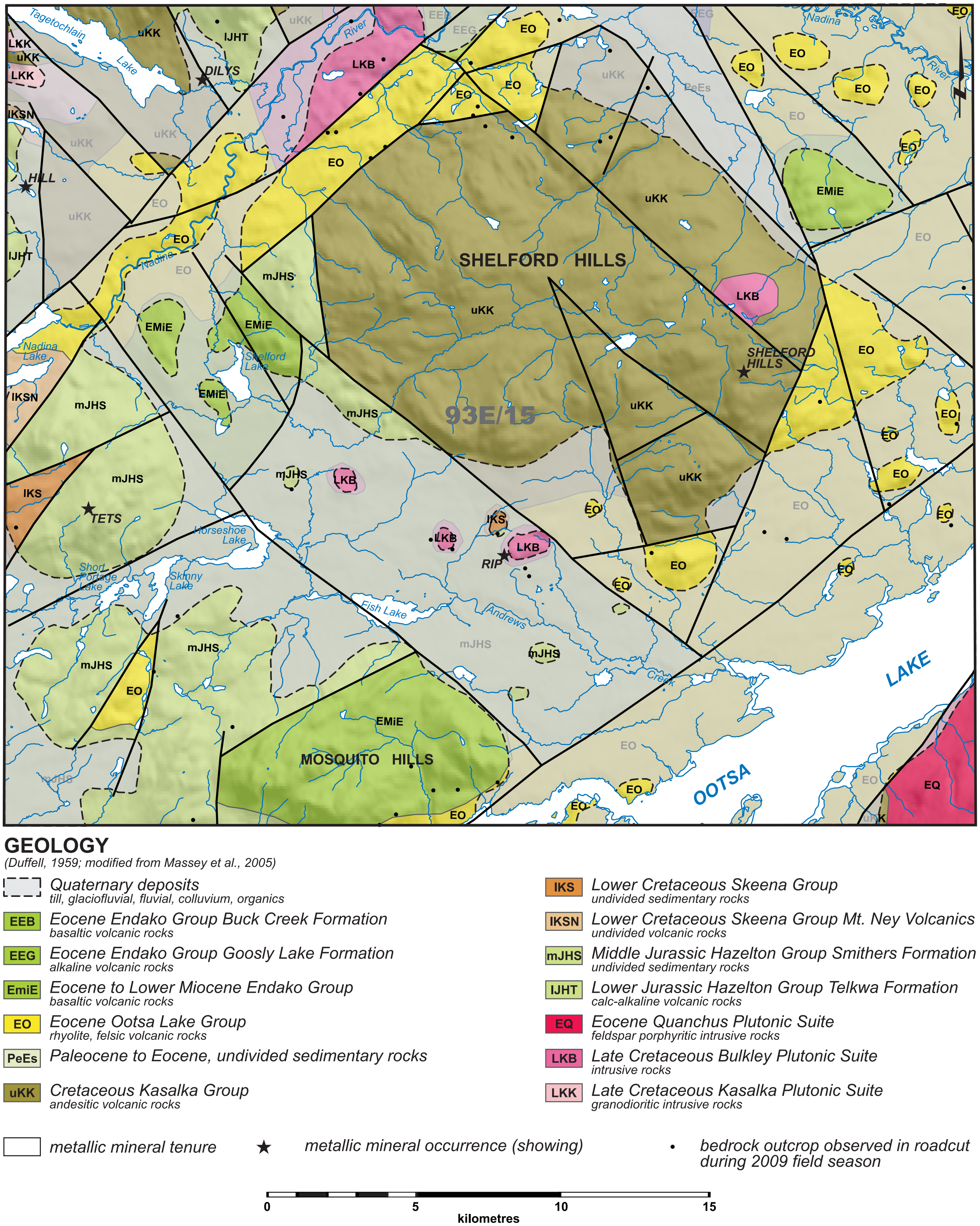

Figure 3. Bedrock geology of the Nadina River map area (093E/15). Quaternary sediment cover is approximated by the light grey transparent overlay and black dashed line. Bedrock contacts have been extended beneath this transparent overlay.

2008). Immediately west of Tahtsa Reach Road this claim block butts against a claim block held by Huckleberry Mine Ltd. This adjacent block extends to the west and is continuous from the mineral lease that covers the Huckleberry mine-site.

The region has a rich exploration history and is well endowed with metallic mineral deposits. Adjacent to the study area are noteworthy past producing mines and one still in operation. Approximately 20 km to the southwest of the study area is Huckleberry mine, a producing porphyry Cu-Mo mine with a production rate of approximately 17 000 tonnes per day ore. Average grades for 2008 were 0.316% Cu and 0.006% Mo. Mine life is expected to extend to the end of 2011(Imperial Metals, 2009). Another 9 km northwest of Huckleberry mine is the past producing Emerald Glacier mine, a Pb-Zn-Ag-Au vein deposit. This mine operated intermittently between 1951 and 1968 and produced 2.6 million g Ag, 1,524 g Au, 891 t Zn, and 766 t Pb (MINFILE, 2010). Approximately 26 km to the northeast of the study area is Equity Silver, a past producing Ag-Cu-Au mine, which was in production from 1980 to 1994. Combined mine production here was 33.8 million tonnes grading at 64.9 g/t Ag, 0.4% Cu, and 0.46 g/t Au (MINFILE, 2010). Developed prospects in the region such as Berg (porphyry Cu-Mo), Whiting Creek (porphyry Cu-Mo), and Lucky Ship (porphyry Mo) also demonstrate the potential for ore grade bedrock to occur within the region. In all instances mentioned here, ore-grade bedrock is closely associated with Late Cretaceous and younger plutonic rocks. Intrusive suites of similar age and composition do exist within the study area.

QUATERNARY GEOLOGY

Previous Quaternary geology work conducted with the study area is limited to soils and terrain mapping. Researchers with the British Columbia Ministry of Environment were the first to map the area, producing a 1:50 000-scale soil and landform map (Young, 1976). Singh (1998) has completed the most recent mapping within the study area, a terrain classification map. Directly south and adjacent to the study area, Ferbey and Levson (2001a, b, 2003), and Ferbey (2004) conducted a detailed study of the Quaternary geology and till geochemistry of the Huckleberry mine region. Included in this work was surficial geology mapping and detailed sedimentological descriptions for Quaternary sediments in the vicinity of Huckleberry mine. Also included in this work was an investigation into the region's ice-flow history.

Quaternary geological studies have been conducted in areas adjacent to the study area. To the north and northwest, Clague (1984), Tipper (1994), Levson (2001a), and Levson et al. (2002) discuss the Quaternary geology and geomorphic features of portions of NTS 093L, M and 103I, P. To the northeast, Plouffe (1996a, b) mapped the surficial deposits, and described the Quaternary stratigraphy, of the west half of NTS 093K. Mate (2000) conducted a similar study to the southeast in NTS map area 93F/12.

Surficial Geology

During the 2009 field season surficial materials were described at 131 sites within the study area (Ferbey, 2010). Observations were made at road and stream cuts, discontinuous exposures along Ootsa Lake, and in hand-dug pits. Data collected at each site included map unit, topographic position, slope aspect and angle, and sedimentological characteristics such as texture, structure, lateral and vertical variability, lower contacts, and relationships with adjacent sediment types.

The dominant surficial material found in the study area is an overconsolidated, grey to brown coloured diamicton with a silt-rich matrix. It is typically massive and matrix supported, and in many examples vertical jointing and subhorizontal fissility are well developed (Figure 4). Matrix proportion varies from 70 to 80% and modal clast size is small pebble but locally can include boulder sized material and larger. Clast shape is typically subangular to subrounded. In lower valley settings, it occurs as thick units (>2 m thick) that typically overlie glacially eroded and polished bedrock. On hill flanks and in higher elevation settings, it occurs as thinner units (up to 2 m thick), including veneers (< 1 m thick), that discontinuous and closely associated with locally derived diamicts (e.g., colluviums) and bedrock. The surface expression of this diamicton most often conforms to underlying bedrock topography but also can be streamlined, as seen in the drumlinized and fluted terrain between the south and southeast flanks of Shelford Hills and the northern shore of Ootsa Lake. These characteristics are consistent with those of a subglacially derived diamicton (Dreimanis, 1989). This unit is interpreted to be a basal till, the ideal sample medium for a till geochemistry survey.

Glaciofluvial sands and gravels can also be found within the study area. Sandy, pebble to cobble-sized gravels occur in fan-like features at the mouths of gulleys that head in higher ground such as Shelford and Mosquito hills. These are related to meltwater draining off this high ground from stagnant ice. Similar sized gravels also occur within late-glacial to de-glacial drainage systems (now abandoned) as outwash plains and esker-like ridges (e.g., in the Fish Lake area and south through the Andrews Creek area towards Ootsa Lake). Silt and clay-rich glaciolacustrine and lacustrine sediments only rarely occur within the study area. Thick organic units are, however, common along the shorelines of smaller lakes and in low lying areas that separate these smaller lakes when they occur in chains.

Ice-flow History

Ferbey and Levson (2001a, b) and Ferbey (2004) built on previous work by Stumpf et al. (2000) that indicated there was an ice-flow reversal in west-central British Columbia during the Late Wisconsinan glacial maximum. During the onset of glaciation ice flowed radially from accumulation centres such as the Coast Mountains towards central-British Columbia. Sometime during the glacial maximum, however, the ice-divide over the Coast Mountains migrated east into central British Columbia resulting in an ice-flow reversal. Glaciers were then flowing west across some parts of the western Nechako Plateau, over the Coast Mountains and towards the Pacific Ocean. Eastward ice-flow resumed once the ice divide migrated back over the axis of the Coast Mountains (due to general climate warming), and continued until the close of the Late Wisconsinan glaciation.

Stumpf et al. (2000) propose that the location of this glacial maximum ice divide is east of the study area indicating that the study area would have experienced an ice-flow reversal during the glacial maximum. Evidence for this ice flow reversal in the region is seen in macro-scale glacial landforms (e.g., crag-and-tails, roches moutonnées) and micro-scale ice-flow indicators (e.g., rat-tails, roches moutonnées) on bedrock outcrop in valley

Figure 4. Silt and clay-rich, overconsolidated diamicton, interpreted as a basal till. Moderately well developed vertical jointing and subhorizontal fissility give this basal till a blocky appearance. Pick for scale (65 cm).

bottoms and at higher elevation sites (i.e., >1500 m asl; Figure 5). This ice-flow reversal is also detectable in trace element till geochemical data from Huckleberry mine (Ferbey and Levson, 2007).

During the 2009 field season ice-flow data were observed and recorded at 33 field stations (Ferbey, 2010). These data were used to supplement an additional 120 field stations, and 207 moderately well to well-preserved streamlined landforms measured in aerial photographs, presented and discussed by Ferbey and Levson (2001b). The majority of bedrock outcrop studied in the field is located on the lower flanks of hillslopes exposed in road cuts. In these exposures outcrop-scale features such as striations, grooves and rat-tails were studied and measured. Landform-scale features such as crag-and-tail ridges and roches moutonnées were also measured.

Orientations of the features studied in 2009 indicate that there are two dominant ice-flow directions in the study area – 054°-096° and 252°-306° (Figure 6). These values are in agreement with those presented by Ferbey and Levson (2001a, b) and Ferbey (2004) and confirm that there was an ice-flow reversal within the study are during the Late Wisconsinan. Orientations of ice flow indicators around Shelford Hills indicate that the Cordilleran ice sheet was, at least locally, deflected around this topographic obstruction.

TILL GEOCHEMISTRY SURVEY

Till geochemical surveys can detect known sources of mineralization and identify new areas of geochemical interest where drift dominates and bedrock outcrop is scarce (e.g., Levson et al., 1994; Cook et al., 1995; Sibbick and Kerr, 1995; Plouffe, 1997; Levson, 2002; Ferbey, 2009). Basal till, the sample medium used in these surveys, is ideal for these assessments as it is a first derivative of bedrock (Shilts, 1993), in most cases it has a relatively simple transport history, is deposited directly down-ice of its source, and produces a geochemical signature that is areally more extensive than its bedrock source (Levson, 2001b).

Directly south and adjacent to the study area, Ferbey and Levson (2001a) and Ferbey (2004) conducted a detailed till geochemistry survey of the Huckleberry mine region. These studies demonstrate a clear relationship between till samples elevated in Cu, Mo, Au, Ag, and Zn and Cu-Mo ore zones at Huckleberry mine and smaller-scale polymetallic vein occurrences on the mine property. Lateral and vertical variability in trace element concentrations in till at Huckleberry mine provide further evidence for an ice-flow reversal in the region during the Late Wisconsinan glacial maximum (Ferbey and Levson, 2007). These results suggest that interpreting trace element geochemical data from tills or soils in this region, in particular transport direction, can be complex.

Data from a till geochemical transect conducted by Ferbey and Levson (2010) over the Copper Star porphyry Cu-Mo-Au occurrence, located approximately 45 km southwest of Houston, BC, are in agreement with these interpretations and demonstrate short westward dispersal on the order of 10's m. This short transport distance is attributed not only to the area's complex ice-flow history (i.e., two distinct and near-opposing ice-flow directions) but also to the proximity of bedrock to surface or the thickness of till units. Levson and Giles (1995), Paulen (2001), Levson (2002), and Ferbey and Levson (2010) suggest that there is a general relationship between till thickness and detrital transport distance,

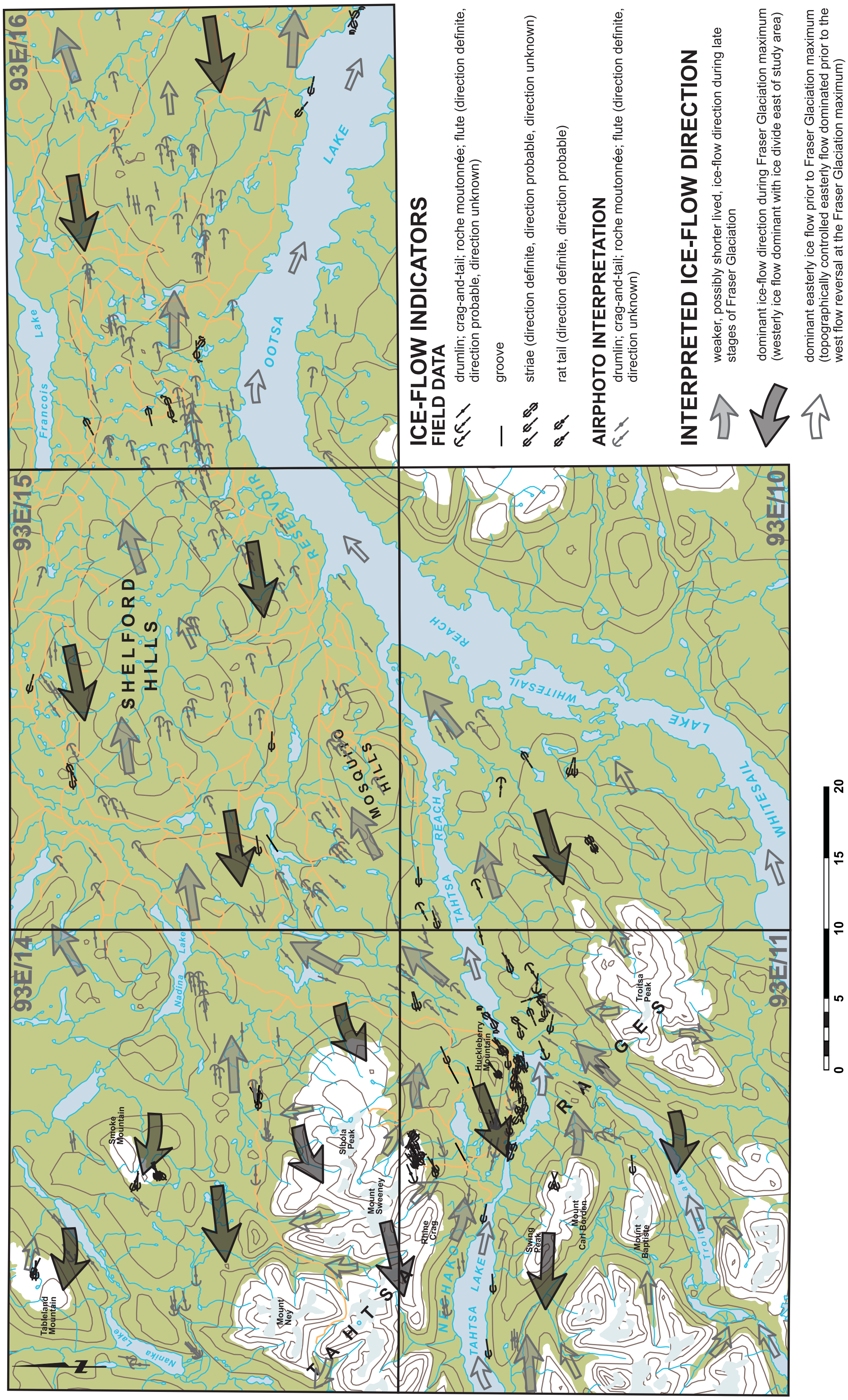

Figure 5. Ice-flow history of the Tahtsa Lake – Ootsa Lake region (after Ferbey and Levson, 2001b).

Figure 6. Photograph of moderately well preserved rat tails on an outcrop of Skeena Group conglomerate. In the centre of this photograph is a large rat tail indicating ice-flow towards the west-southwest. Note that just above it and to the right is a smaller rat tail indicating ice-flow towards the east. This outcrop is located on the southern flank of Shelford Hills, north of Andrews Creek, and is the only outcrop of Skeena Group conglomerate observed within the study area.

with an increase in till thickness resulting in an increase in transport distance.

Plouffe and Ballantyne (1993), Plouffe (1995), Plouffe et al. (2001), and Levson and Mate (2002) have also conducted till geochemistry surveys to the east of the study area, in NTS map areas 093F and K. Using percentile plots of precious-metal, base-metal, and pathfinder element concentrations, and (or) gold-grain counts, each of these surveys identifies prospective ground where there are no known mineral occurrences.

Sample Media

During the 2009 field season, 2-3 kg till samples were collected at 84 sample sites for major, minor, and trace element geochemical analyses (Figures 7 and 8). An additional 16 till samples, each weighing 10-15 kg, were collected for heavy mineral separation and gold-grain counts (Figure 7). These larger samples were collected at sites where an adequate amount of sample material was exposed. Given that net transport direction in the study area was likely affected by an ice-flow reversal during the Late Wisconsinan glacial maximum, till samples were collected outside of 093E/15 to take into account possible east and west transport of basal till.

Till sample density for this survey is 1 sample/14 km^2. For simplicity, areas inaccessible by truck (e.g., Shelford Hills), and areas where till does not occur, were included in this calculation. Unweathered till in the study area typically occurs >1 m below surface and so the majority of till samples were collected at this depth or lower.

Sample Preparation and Analyses

Till samples collected for major, minor, and trace element analyses were sieved, and decanted and centrifuged, to produce silt plus clay-sized (<0.063 mm) and clay-sized (<0.002 mm) fractions. This sample preparation was conducted at Acme Analytical Laboratories Ltd. (Vancouver, BC). Heavy mineral samples were sent to Overburden Drilling Management (ODM; Nepean, ON), where heavy mineral (0.25 to 2.0 mm) and gold-grain (<2.0 mm) concentrates were produced using a combination of gravity tabling and heavy liquids.

On the 2-3 kg samples, minor and trace element analyses (37 elements) were conducted on splits of the silt plus clay and clay-sized fractions, respectively, by inductively coupled plasma mass spectrometry (ICP-MS), following an aqua regia digestion. Major element analyses were conducted on a split of the silt plus clay-sized fraction only using inductively coupled plasma emission spectrometry (ICP-ES), following a lithium metaborate/tetraborate fusion and dilute nitric acid digestion. This analytical work was conducted at Acme Analytical Laboratories Ltd. (Vancouver, BC).

Also as part of this project, a split of the silt plus clay-sized fraction (<0.063 mm) was analyzed for 35 elements by instrumental neutron activation analysis (INAA) at Becquerel Laboratories Inc. (Mississauga, ON). Neutron activation analyses for elements such as Au, Ba and Cr complement those produced by aqua-regia ICP-MS as they are considered to be a near-total determination and hence more representative of rock-forming and economic mineral geochemistry. Additionally, INAA determinations were conducted on bulk

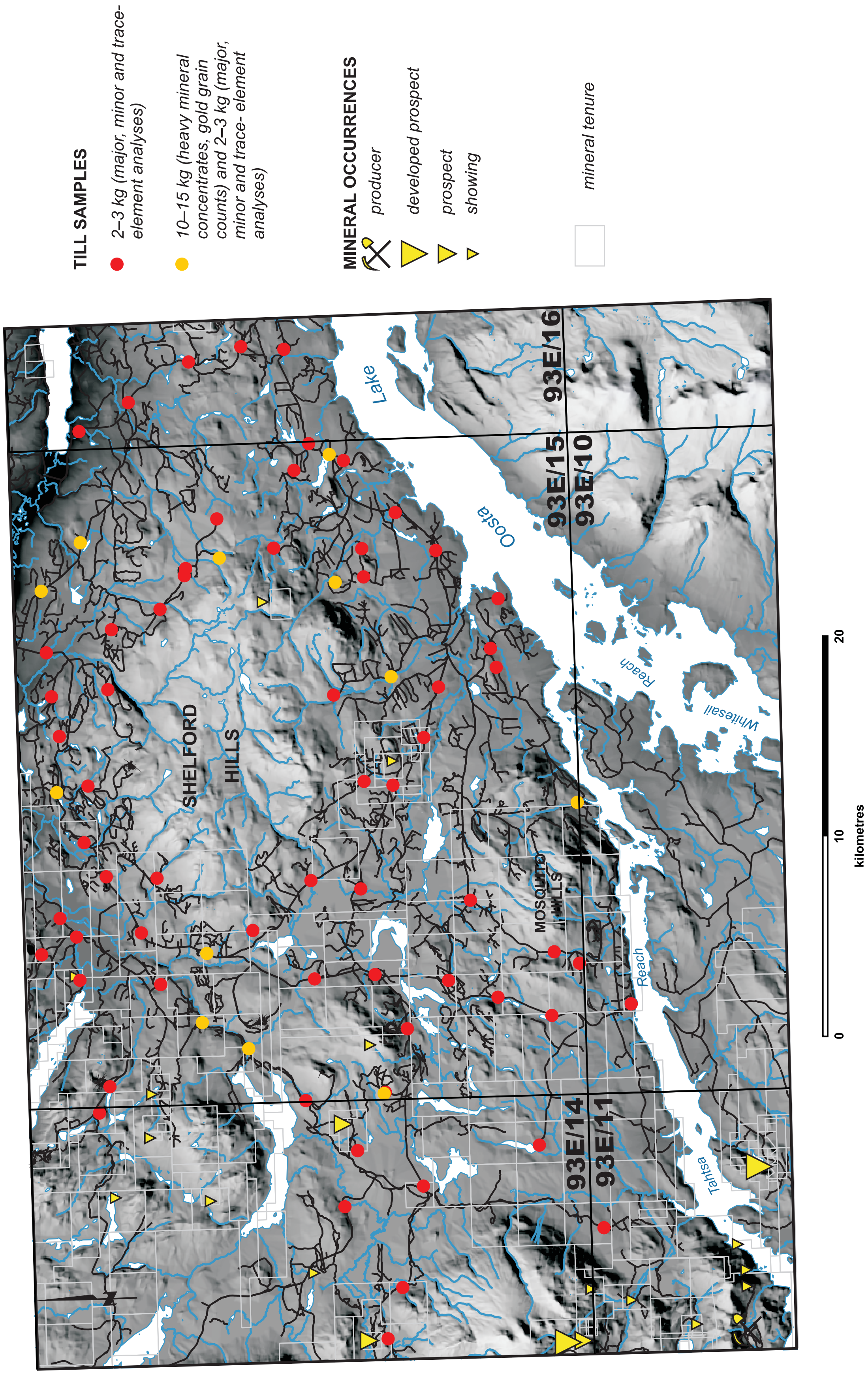

Figure 7. Till sample locations.

Figure 8. Photograph of a typical till sample site. Shown is a 2-3 kg sample collected for major, minor, and trace element geochemical analyses. Pick for scale (65 cm).

heavy mineral concentrates produced from the 10-15 kg samples. Heavy mineral picking, scanning electron microscopy analyses on difficult-to-identify heavy mineral grains, and pebble counts may be conducted on these samples at a later date. Instrumental neutron activation analyses will dictate for which samples, if any, additional analyses are warranted.

Elements analyzed for by ICP-MS and INAA, and detection limits, are summarized in Tables 1 and 2, respectively. Geochemical determinations on the silt plus clay-sized fraction (<0.063 mm) by aqua regia ICP-MS are presented in Appendix A, while determinations for the same size fraction by INAA are presented in Appendix B. Although not discussed here, major element determinations on the silt plus clay-sized fraction (<0.063 mm) are presented in Appendix C. Gold-grain data, including calculated visible gold (ppb) are presented in Appendix D. Determinations on the clay-sized fraction (<0.002 mm) will be the subject of a future report.

Quality Control

Quality control measures for analytical determinations include the use of field duplicates, analytical duplicates, and reference standards. For each block of 20 samples submitted for analysis, one field duplicate (taken at a randomly selected sample site), one analytical duplicate (a sample split after sample preparation but before analysis), and one reference standard was included in INAA and aqua regia ICP-MS analyses. Reference standards used were a combination of certified Canada Centre for Mineral and Energy Technology (CANMET), and in-house BCGS, geochemical reference materials. Duplicate samples are used here to measure sampling and analytical variability, whereas reference standards are used to assess the accuracy and precision of the analytical methods.

For this study, 10 field duplicate samples were collected (i.e., five duplicate pairs). In Appendices A to C, FDUP10 identifies the first sample collected at a field duplicate sample site while FDUP20 is the second sample collected at the same sample site. Six analytical pairs and seven reference standards were also inserted into the sample sequence before analysis.

Copper, Mo, Pb, Zn, Ag, Ni, and Hg by ICP-MS and Au, As, Cr, and Sb by INAA, the main elements of interest for this study, were selected for quality control analyses. Figures 9 and 10 present scatterplots of trace element concentrations measured in field duplicates by ICP-MS and INAA, respectively. Figures 11 and 12 present scatterplots of trace element concentrations measured in analytical duplicates by ICP-MS and INAA, respectively. Table 3 presents certified and reference values for CANMET and BCGS standards used in this study.

With the exception of Cu, Ni, Hg, and Au, high field duplicate correlation coefficients (R^2>0.8) indicate good reproducibility and suggest a relatively high degree of sampling and analytical precision (Figures 9 to 10). In the case of Pb, Zn, Ag, As, and Sb, correlation coefficients of R^2>0.9 indicate an even higher degree of precision and suggest there is a more homogeneous distribution of these elements in the silt plus clay-sized fraction (<0.063 mm).

Correlation coefficients for Cu, Hg, and Ni suggest there might be a small degree of sample site variability in tills of the study area. In the case of Cu when the outlier with the largest departure from x=y is removed from the analysis (samples 09TFE6046 and 09TFE6047 with 53.33 and 44.32 ppm Cu,

Element	Detection Limit
Mo	0.01 ppm
Cu	0.01 ppm
Pb	0.01 ppm
Zn	0.1 ppm
Ag	2 ppb
Ni	0.1 ppm
Co	0.1 ppm
Mn	1 ppm
Fe	0.01 %
As	0.1 ppm
U	0.1 ppm
Au	0.2 ppb
Th	0.1 ppm
Sr	0.5 ppm
Cd	0.01 ppm
Sb	0.02 ppm
Bi	0.02 ppm
V	2 ppm
Ca	0.01 %
P	0.001 %
La	0.5 ppm
Cr	0.5 ppm
Mg	0.01 %
Ba	0.5 ppm
Ti	0.001 %
B	20 ppm
Al	0.01 %
Na	0.001 %
K	0.01 %
W	0.1 ppm
Sc	0.1 ppm
Tl	0.02 ppm
S	0.02 %
Hg	5 ppb
Se	0.1 ppm
Te	0.02 ppm
Ga	0.1 ppm

Table 1. Elements analyzed for by aqua regia ICP-MS, on the silt plus clay-sized fraction (<0.063 mm) of till samples, and associated detection limits.

Element	Detection Limit
Sb	0.1 ppm
As	0.5 ppm
Ba	50 ppm
Br	0.5 ppm
Cd	5 ppm
Ce	5 ppm
Cs	0.5 ppm
Cr	20 ppm
Co	5 ppm
Eu	1 ppm
Au	2 ppb
Hf	1 ppm
Ir	50 ppb
Fe	0.2%
La	2 ppm
Lu	0.2 ppm
Mo	1 ppm
Ni	10 ppm
Rb	5 ppm
Sm	0.1 ppm
Sc	0.2 ppm
Se	5 ppm
Ag	2 ppm
Na	0.05%
Ta	0.5 ppm
Te	10 ppm
Tb	0.5 ppm
Th	0.2 ppm
Sn	100 ppm
Ti	500 ppm
W	1 ppm
U	0.2 ppm
Yb	2 ppm
Zn	100 ppm
Zr	200 ppm

Table 2. Elements analyzed for by INAA, on the silt plus clay-sized fraction (<0.063 mm) of till samples, and associated detection limits.

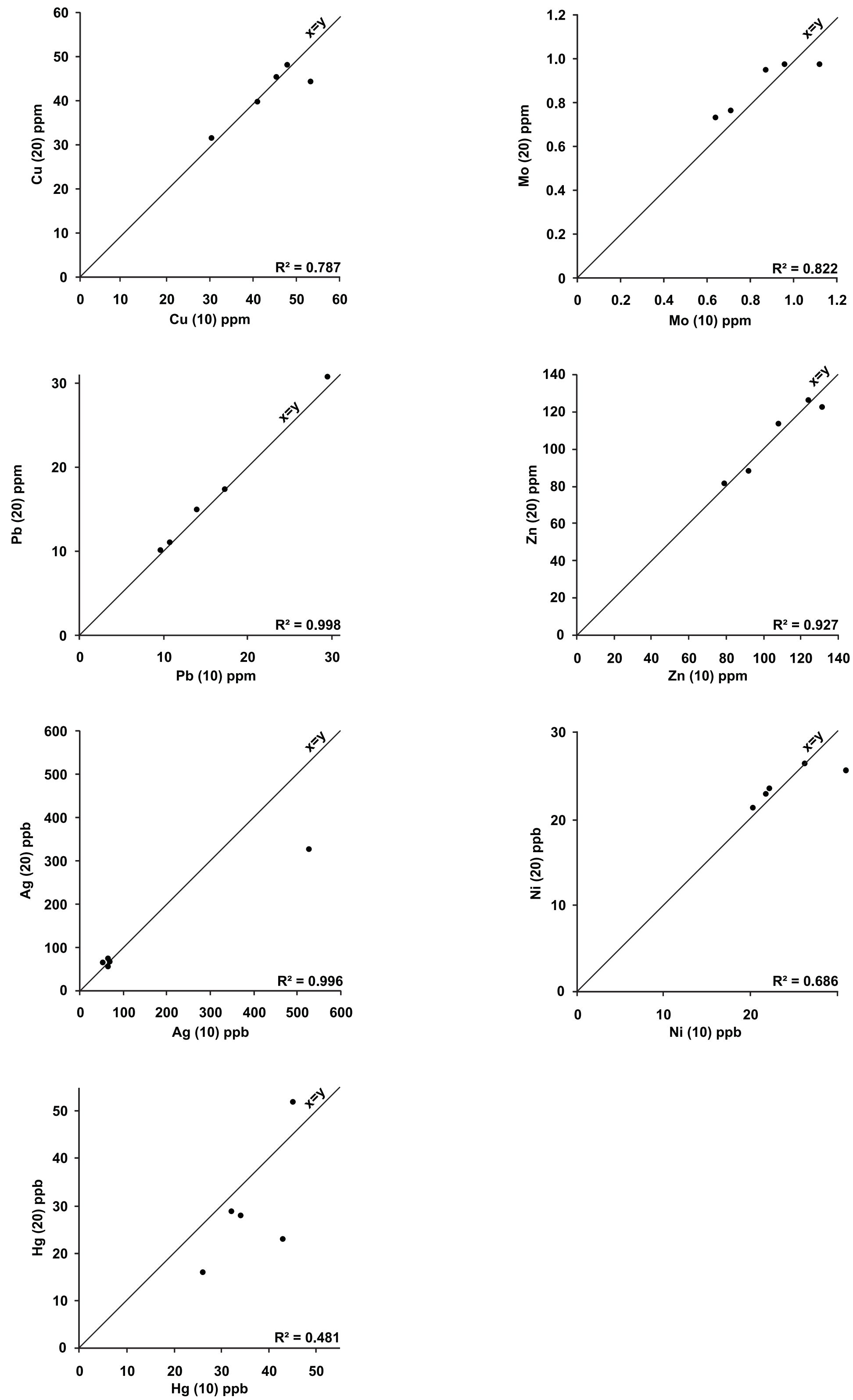

Figure 9. Field duplicate scatter plots for the Cu, Mo, Pb, Zn, Ag, Ni, and Hg determinations by aqua regia ICP-MS (n=5).

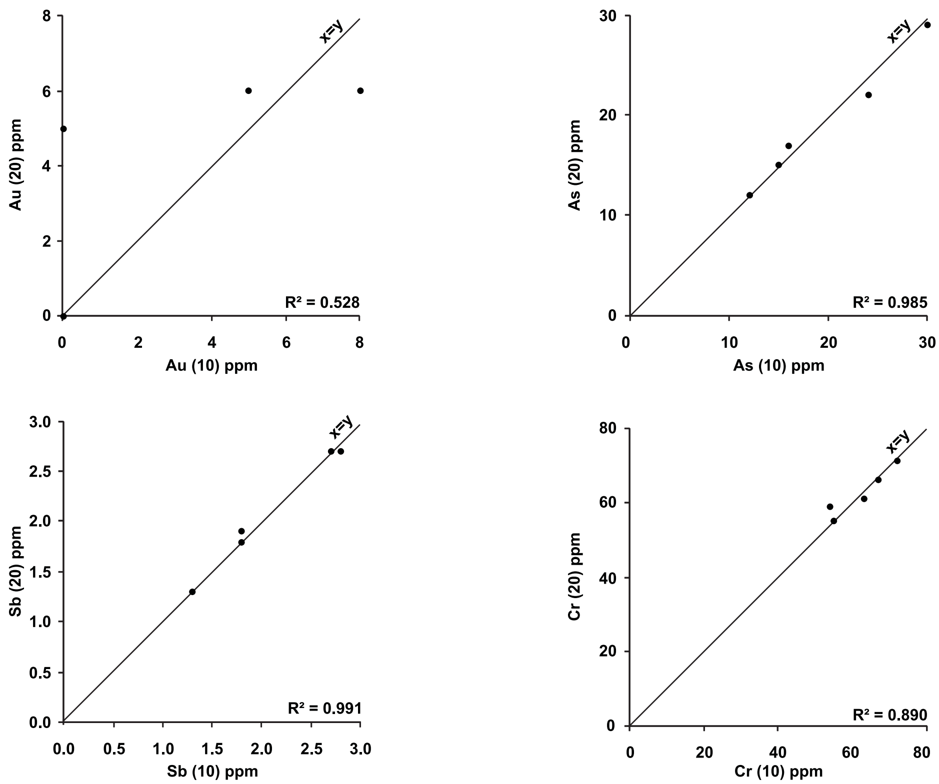

Figure 10. Field duplicate scatter plots for the Au, As, Sb, and Cr determinations by INAA (n=5).

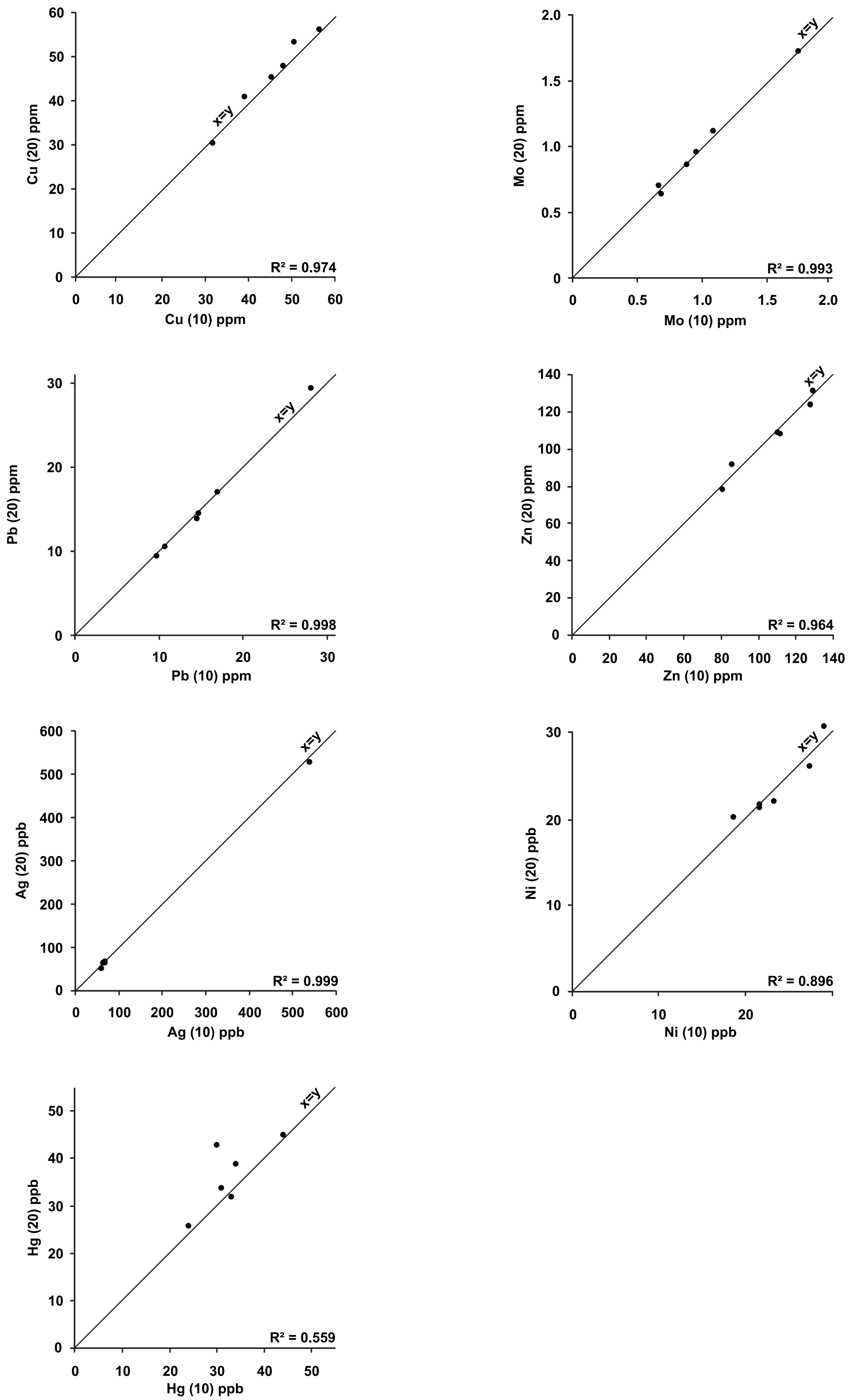

Figure 11. Analytical duplicate scatter plots for the Cu, Mo, Pb, Zn, Ag, Ni, and Hg determinations by aqua regia ICP-MS (n=6).

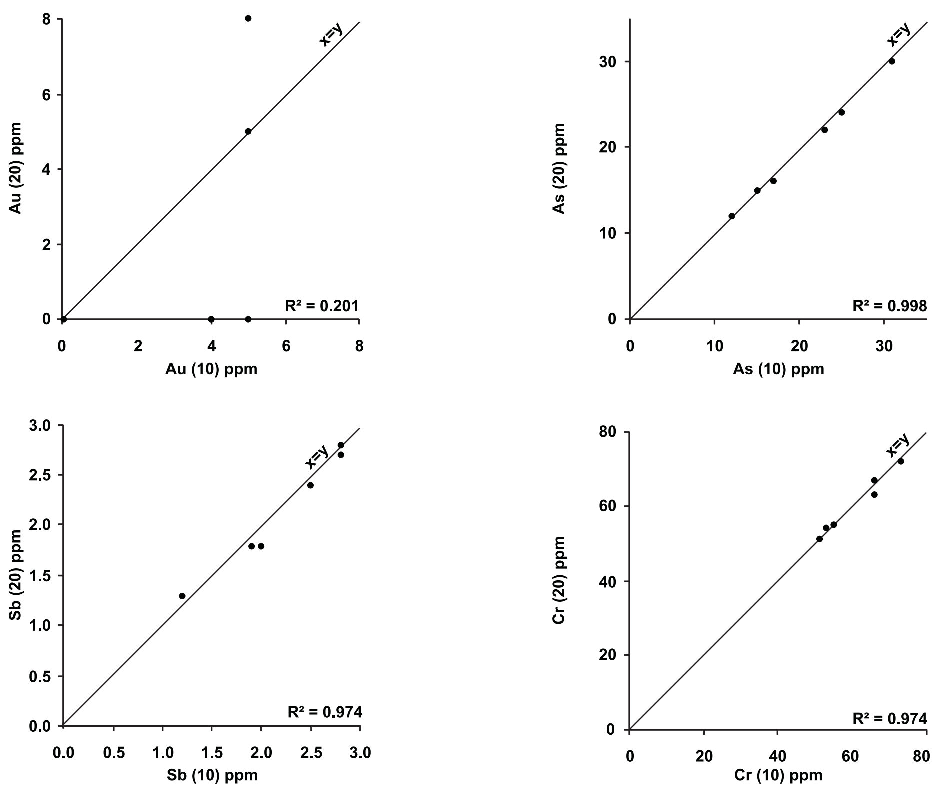

Figure 12. Analytical duplicate scatter plots for the Au, As, Sb, and Cr determinations by INAA (n=6).

a)

	Cu (ppm)	Mo (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppb)	Ni (ppm)	Hg (ppb)
Till-1							
this study	45.69	0.64	14.00	63.0	185	17.6	75
	45.56	0.63	13.95	60.2	185	17.0	73
	46.88	0.59	13.35	59.7	180	16.4	70
reference value	*47*	*2*	*12*	*70*	*200*	*18*	*92*
BCGS-1							
this study	170.95	0.77	197.30	330.5	1272	197.7	257
	168.39	0.76	191.62	325.2	1206	184.4	238
reference value	*165.96*	*0.86*	*213.04*	*345.8*	*1361*	*207.1*	*362*
BCGS-2							
this study	175.75	13.38	7.24	49.7	69	13.5	20
	163.15	12.06	6.83	46.8	65	12.5	19
reference value	*171.04*	*13.41*	*7.56*	*50.0*	*74*	*12.5*	*25*

b)

	Au (ppb)	As (ppm)	Sb (ppm)	Cr (ppm)
Till-1				
this study	19	18.0	8.0	65
	16	18.0	7.7	63
	14	17.0	7.5	63
reference value	*13*	*18*	*7.8*	*65*
BCGS-1				
this study	49	61.3	14.0	390
	30	58.3	14.0	380
reference value	*31*	*66.8*	*15.6*	*381*
BCGS-2				
this study	39	8.5	0.8	55
	33	7.6	0.8	54
reference value	*58*	*9.4*	*0.9*	*59*

Table 3. Summary statistics for standards used in this study. Determinations for a) Cu, Mo, Pb, Zn, Ag, Ni, and Hg are by aqua regia ICP-MS and b) Au, As, Sb, and Cr by INAA. Till-1 is certified by Canada Centre for Mineral and Energy Technology (CANMET). BCGS-1 and BCGS-2 are standards that have been developed in house by the British Columbia Geological Survey. The values presented for this study are single determinations by aqua-regia ICP-MS on the silt plus clay-sized fraction (<0.063 mm).

respectively), an R^2 value of 0.986 is produced. Removing this same sample from the analysis of Ni results in a similar increase in R^2 value. With such a small sample size (n=5 field duplicate pairs), poor reproducibility within one field duplicate pair can strongly influence correlation coefficients. In the case of Au, variabililty could be in part due to sample site variability but also could be attributed to the more ubiquitous nugget effect.

Correlation coefficients for analytical duplicate pairs are high with nine of 11 elements having R^2 values that approach or are >0.9 (Figures 11 to 12). Mercury (R^2=0.559) and Au (R^2=0.201) stand out as having the lowest precision in the analytical duplicate data set, similar to the field duplicate dataset. In the case of elements determined for by aqua regia ICP-MS, there is a consistent increase in R^2 values for analytical duplicate pairs when compared to R^2 values for field duplicate pairs (i.e., Cu, Mo, Pb, Zn, Ag, Ni, and Hg). This is to be expected as variability within a specific sample should be less than variability at a sample site. The same can be said for As and Cr values in field duplicate and analytical duplicate pairs determined by INAA.

In general, the analyses presented here of field duplicate and analytical duplicate samples suggests that there is good reproducibility for Cu, Mo, Pb, Zn, Ag, Ni, As, Sb, and Cr and that caution should be exercised if using Hg and Au data. Although not subjected to a similar rigorous, quantitative analysis, data presented in Table 3 show that there is also good reproducibility in certified and reference standards and that the analytical methods used demonstrate a reasonable degree of accuracy.

TILL GEOCHEMICAL DATA

Presented here are aqua regia ICP-MS determinations for Cu, Mo, Pb, Zn, Ag, Ni, Hg, and INAA determinations for Au, As, Sb, and Cr on the silt plus clay-sized fraction (<0.063 mm) of till samples. Also presented here are gold-grain counts (normalized to weight of table feed) from the <2.0 mm fraction of till samples.

Summary statistics for Cu, Mo, Pb, Zn, Ag, Ni, Hg, Au, As, Sb, and Cr are presented in Tables 4 and 5. Percentile class breaks used in the proportional symbol plots that follow (≤50, >50-70, >70-90, >90-95, >95-98, >98) are commonly used to categorize till geochemical data as they do not bias data classification (Plouffe and Ballantyne, 1993; Levson, 2001a; Levson, 2002; Levson and Mate, 2002; Lett et al., 2006; Plouffe et al., 2009). For these statistics and proportional symbol plots, the second sample collected at a field duplicate sample site (i.e., FDUP20; see Appendices A and B) has been removed from the data set. Therefore, for the remainder of this report, presentations and discussions will focus on samples with unique locations (n=79).

In till geochemical data median element concentrations are often considered to represent geochemical background levels of that element (Cook et al., 1995), while >95 percentile concentrations can be considered elevated. The following is a discussion on background and elevated values, and their spatial distribution, for the elements of interest.

Copper

Median Cu value for the study area is 38.92 ppm. The maximum value of 107.10 ppm (sample 09TFE6094) occurs in the northwest corner of the study area, southwest of Tagetochlain Lake (Figure 13). This sample is located approximately 1 km

	Cu (ppm) ICP-MS	Mo (ppm) ICP-MS	Pb (ppm) ICP-MS	Zn (ppm) ICP-MS	Ag (ppb) ICP-MS	Ni (ppm) ICP-MS	Hg (ppb) ICP-MS
detection limit	0.01	0.01	0.01	0.1	2	0.1	5
maximum	107.10	3.24	47.08	203.4	526	58.5	100
minimum	21.18	0.42	6.70	48.4	12	8.9	10
mean	42.87	0.95	16.55	100.4	66	20.9	31
median	38.92	0.85	13.84	96.4	50	19.5	28
n=	79	79	79	79	79	79	79

Table 4. Summary statistics for aqua regia ICP determinations on the silt plus clay-sized fraction (<0.063 mm) of till samples (n=79).

	Au (ppb) INAA	As (ppm) INAA	Sb (ppm) INAA	Cr (ppm) INAA
detection limit	2	0.5	0.1	20
maximum	37	41.0	3.8	100
minimum	2	11.0	0.9	39
mean	6	17.6	2.1	59
median	4	16.0	2.0	57
n=	79	79	79	79

Table 5. Summary statistics for INAA determinations on the silt plus clay-sized fraction (<0.063 mm) of till samples (n=79).

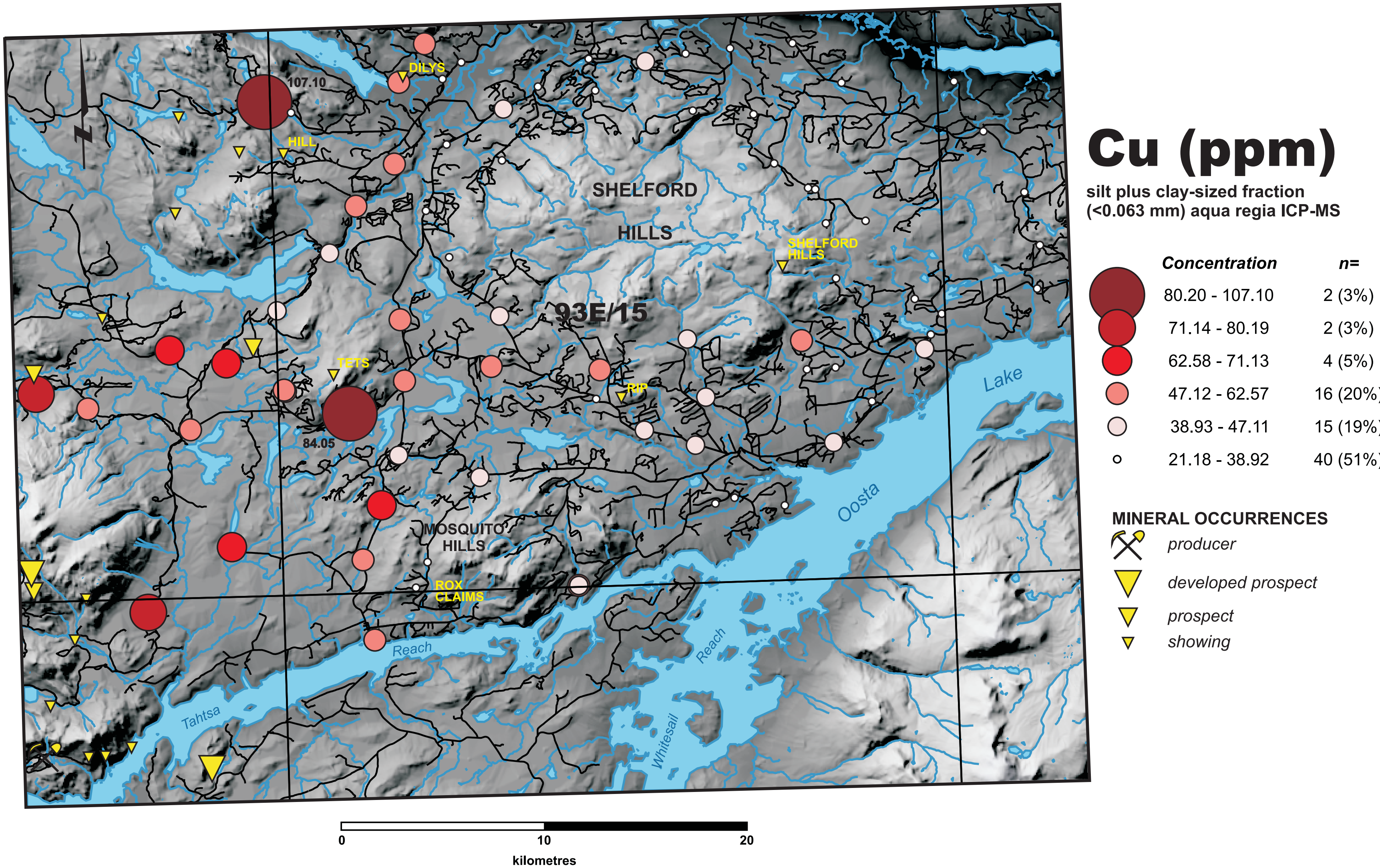

Figure 13. Proportional symbol plot for Cu values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

west of a mapped Late Cretaceous Kasalka Formation granodiorite and also contains the maximum Sb value for the study area and >95th percentile Au. The second highest Cu value (84.05 ppm Cu; sample 09TFE6082) occurs on the south flank of high ground located in the west-central portion of 093E/15, just south of the Tets Cu-Zn-Pb-Ag vein showing. This same sample contains the maximum Zn value for the study area (203.4 ppm Zn), the second highest Hg value (69 ppb Hg), and >95th percentile Ni and Cr concentrations.

Most samples in areas located north, northeast, and east of Shelford Hills have Cu concentrations are at or below background. Conversely, all samples with >90th percentile Cu concentrations occur south, southwest, and west of Shelford Hills.

Molybdenum

Median Mo for the study area is 0.85 ppm. The maximum value of 3.24 ppm (sample 09TFE6100) occurs on the southwest flank of Mosquito Hills, near the southern border of 093E/15 (Figure 14). This sample is located within the Rox claims where sulphide and precious metal-bearing veinlets are hosted within Middle Jurassic Smithers Formation sedimentary rocks. The second highest Mo value of 2.31 ppm (sample 09TFE6083) occurs 2.6 km west-southwest of the Tets Cu-Zn-Pb-Ag vein showing and 2.7 km south-southeast of the Pam Cu-Mo prospect (MINFILE 093E 088). This same sample has >95th percentile concentration of Zn.

Lead

Median Pb for the study area is 13.84 ppm. The maximum value of 47.08 ppm (sample 09TFE6053) occurs on the southern flank of Shelford Hills (Figure 15). Coincident with this maximum Pb value is the second highest Zn value (178.3 ppm Zn) in the study area. Approximately 2.5 km east-southeast of the Shelford Hills Zn-Pb-Au showing, the second highest Pb value occurs (41.08 ppm Pb; sample 09TFE6040). This same sample also contains >95th percentile Zn. Working north and west from here, along the upper east flank of Shelford Hills, >90th and >95th percentile concentrations of Pb also occur.

Zinc

Median Zn for the study area is 96.4 ppm. As previously mentioned the highest and second highest Zn values for the study area (203.4 and 178.3 ppm Zn) are coincident with maximum Cu and Pb, respectively (Figure 16). Similar to the spatial distribution of Pb, >95th percentile values of Zn occur on the eastern flank of Shelford Hills, east of the Shelford Hills Zn-Pb-Au showing.

Greater than 95th percentile Zn also occurs in a sample that is 2.6 km west of the Tets Cu-Zn-Pb-Ag vein showing (157.9 ppm Zn; sample 09TFE6083) and is coincident with the second highest Mo value of the survey area (2.31 ppm Mo).

Silver

Median Ag for the study area is 50 ppb. The two highest Ag values (526 and 256 ppb Ag; samples 09TFE6087 and 09TFE6091, respectively) occur in the upper reaches of the Nadina River valley where bedrock outcrop is sparse (Figure 17).

Coincident with the second highest Ag value are >95th percentile values of As and Sb and the maximum number of Au grains in a sample within the study area (2.0 grains/kg).

Nickel

Median Ni for the study area is 19.5 ppm. The two highest Ni values (58.5 and 43.4 ppm; samples 09TFE6026 and 6025,

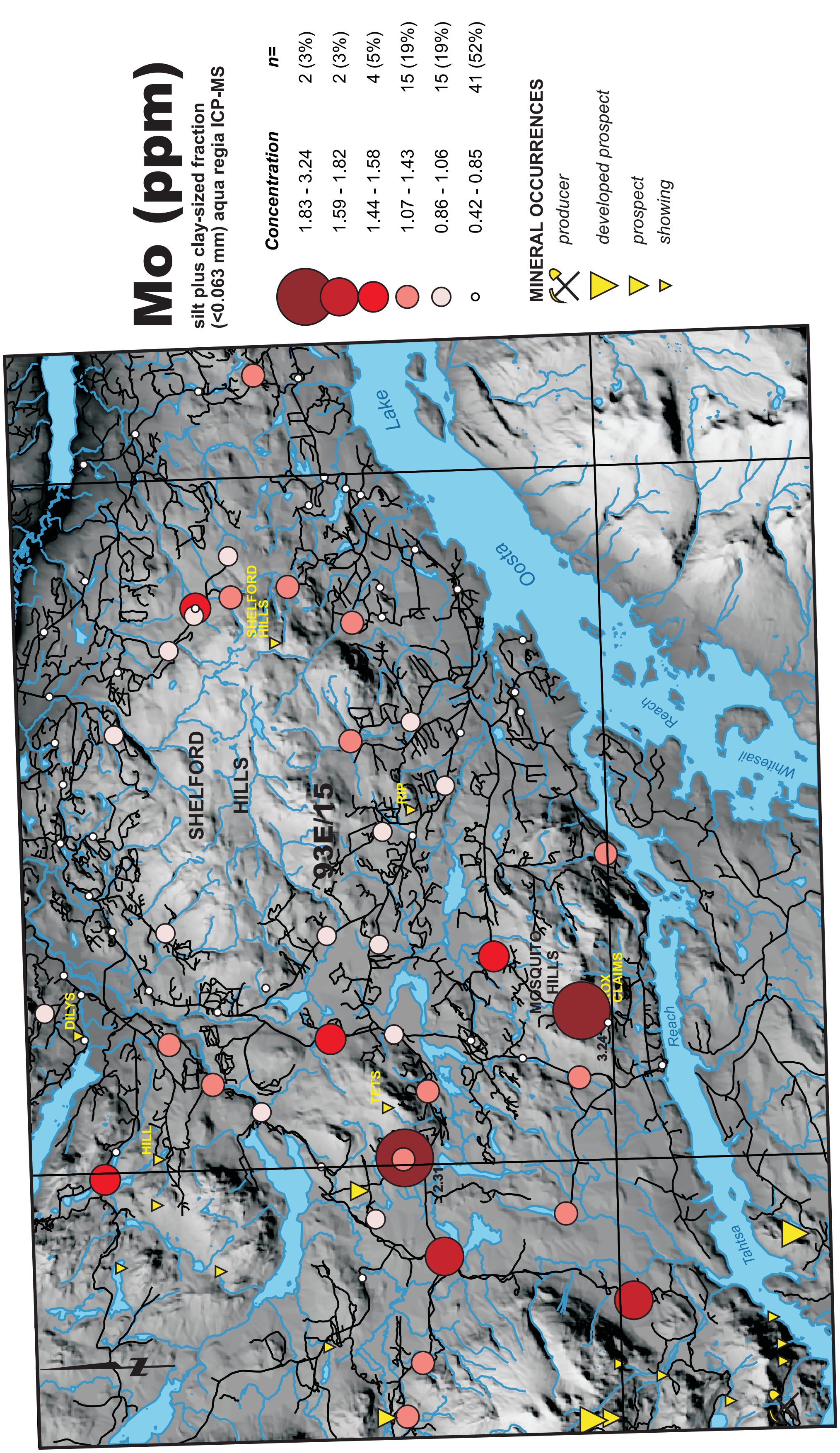

Figure 14. Proportional symbol plot for Mo values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

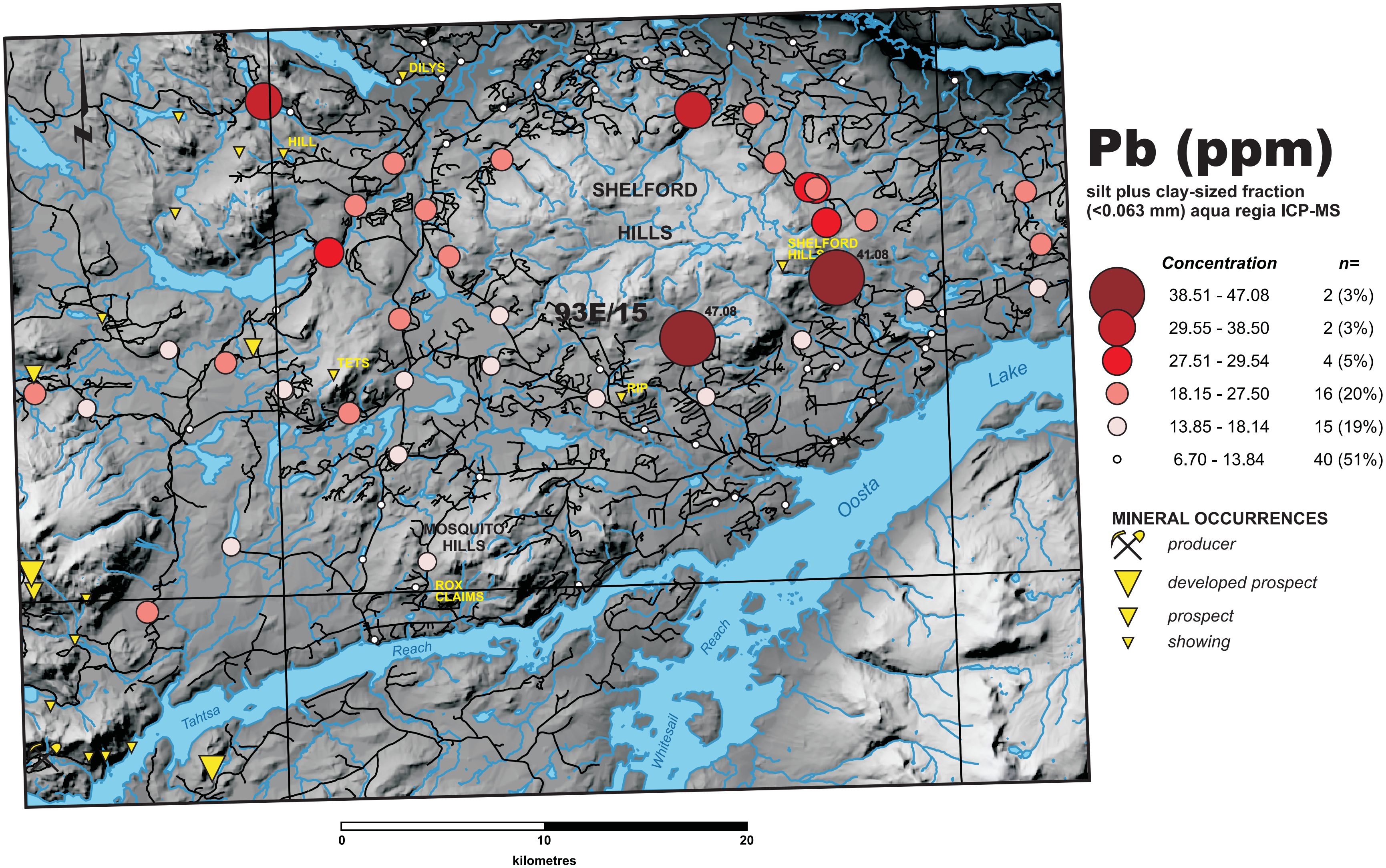

Figure 15. Proportional symbol plot for Pb values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

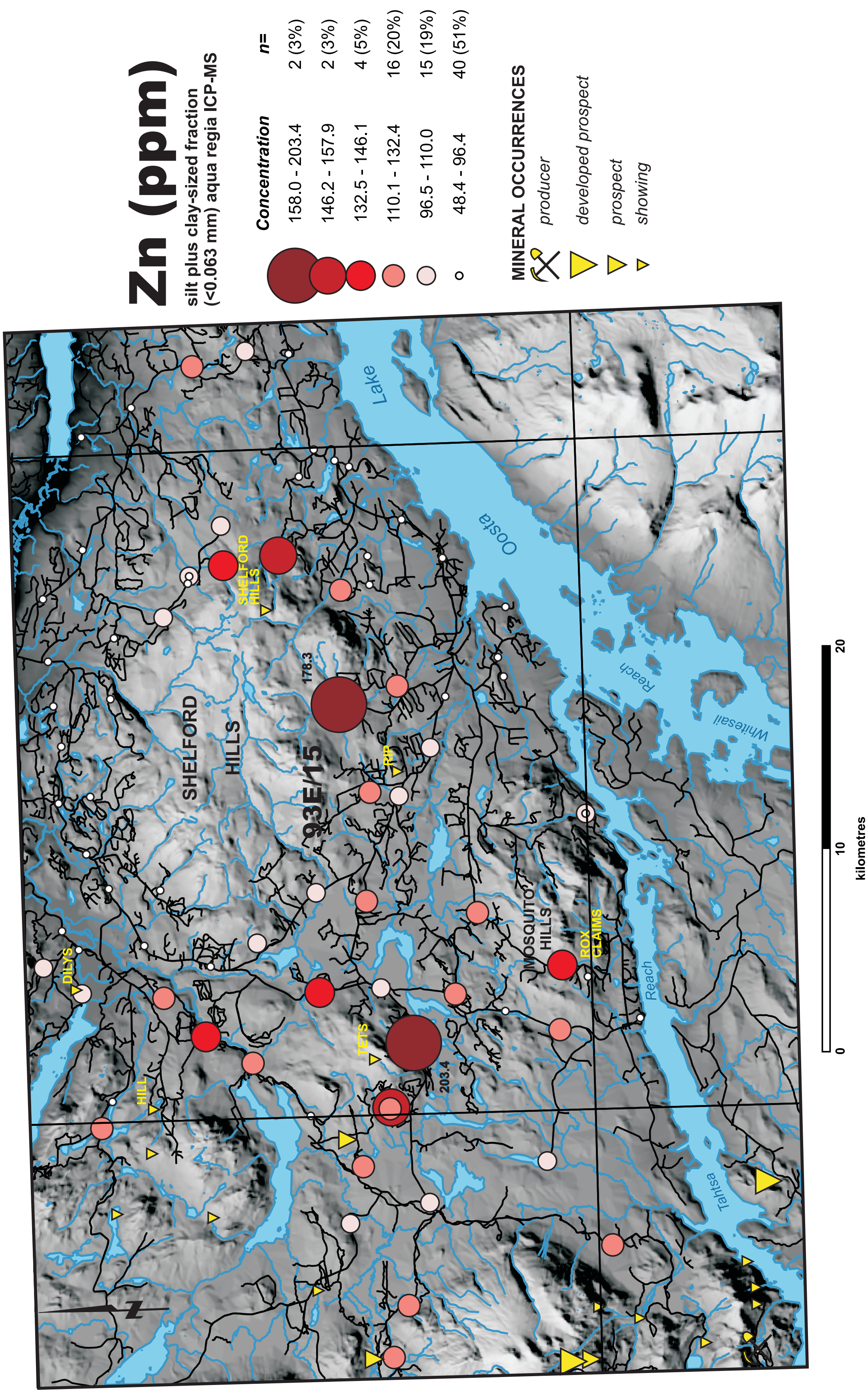

Figure 16. Proportional symbol plot for Zn values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

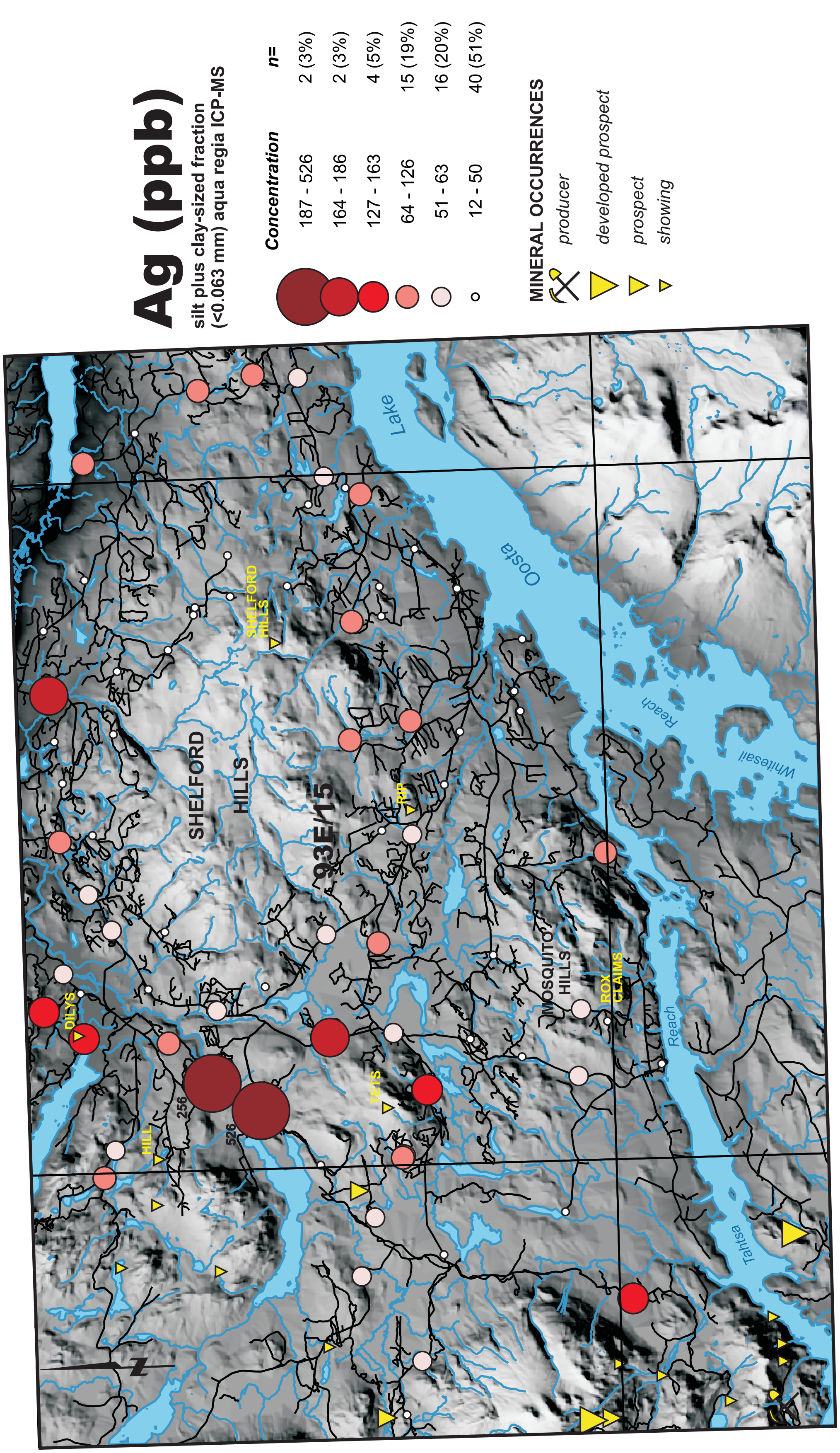

Figure 17. Proportional symbol plot for Ag values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

respectively) occur adjacent to one another in the northwest corner of 093E/15 (Figure 18). Sample 09TFE6026 also contains >95th percentile concentration of Hg. Located in between these two samples is the Dilys Cu showing. Late Cretaceous Bulkley intrusives occur approximately 2 km to the east.

Approximately 2.5 km south-southeast of the Tets Cu-Zn-Pb-Ag showing (sample 09TFE6082) >95th percentile Ni and Cr values occur which are coincident with the second highest Cu and Hg values (84.05 and 69 ppb, respectively) and maximum Zn (203.4 ppm Zn) for the study area. As with Cu and Cr, all >95th percentile concentrations of Ni are located west of Shelford Hills and north of Mosquito Hills.

Chromium

Median Cr for the study area is 57.0 ppm. The maximum value of 100 ppm (sample 09TFE6026) occurs approximately 300 m southwest of the Dilys Cu showing (Figure 19) and is coincident with the maximum Ni value for the study area (58.5 ppm Ni). The second highest Cr value occurs in the sourthwest corner of 093E/15 (94 ppm Cr; sample 09TFE6097), approximately 4 km northwest of Mosquito Hills. In general, >95th and >98th percentile values of Cr can be associated with elevated values of Cu, Ni and Hg in samples located near the western border of 093E/15, west of Shelford Hills and north of Mosquito Hills.

Mercury

Median Hg for the study area is 28 ppb. The maximum value of 100 ppb (sample 09TFE6016) occurs north of Shelford Hills, near the north-central border of 093E/15 (Figure 20). With the exception of this sample, >95th percentile Hg values occur in samples with >95th percentile concentrations of at least one of the elements Cu, Zn, Ni, and Cr. As discussed earlier, low correlation coefficients presented in the analysis of field and analytical duplicates suggest that the precision of Hg determinations is low. This should be kept in mind when interpreting Hg determinations presented here.

Gold

Median Au (by INAA) for the study area is 4 ppb. The >98th percentile values of 37 and 25 ppb (samples 09TFE6109 and 09TFE6086, respectively) both occur outside 093E/15, in the east-central portion of 093E/14 (Figure 21); sample 09TFE6086 is located approximately 1.5 km southwest of the Pam Cu-Mo prospect. It is worth noting that 32 of 79 samples collected for trace element determinations have Au values that are at or below detection limit for INAA (i.e., 2 ppb Au).

Gold-grain counts were conducted on 16 basal till samples. The maximum number of grains to occur in a sample (normalized to table feed weight) is 2.0 and occurs in sample 09TFE6092, in the upper reaches of the Nadina River valley (Figure 22). Coincident with this, and determined for on a separate sample collected at the same sample site, is the second highest Ag value for the study area and >95th percentile concentrations of As and Sb.

Arsenic

Median As for the study area is 16.0 ppm. The maximum value of 41.0 (sample 09TFE6002) occurs on the west flank of Mosquito Hills, within the Rox claims (Figure 23). Arsenic concentrations north and northeast of Shelford Hills are at or below background for the study area. Greater than 90th percentile and >98th percentile concentrations of As occur west and southwest of Shelford Hills and can be

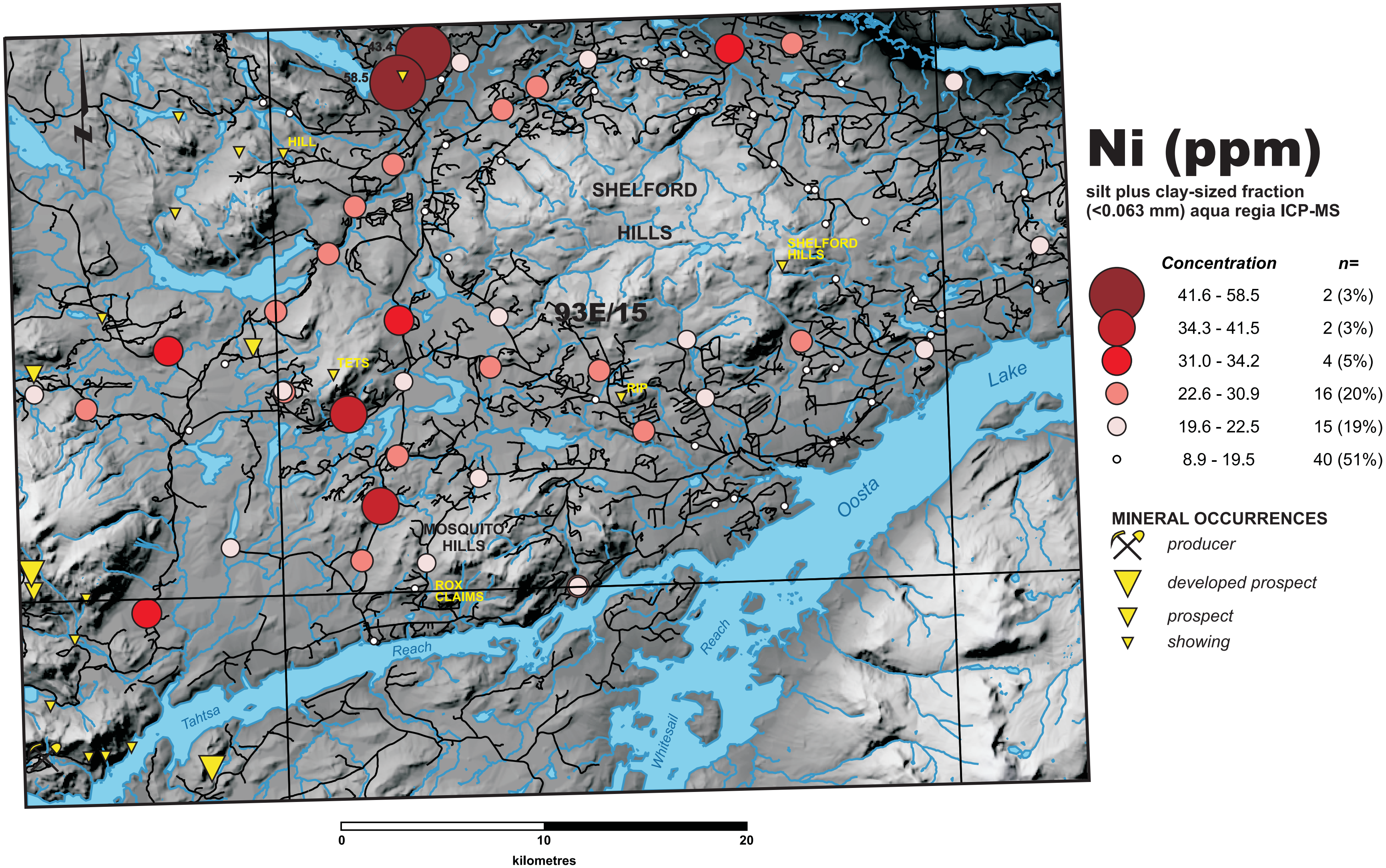

Figure 18. Proportional symbol plot for Ni values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

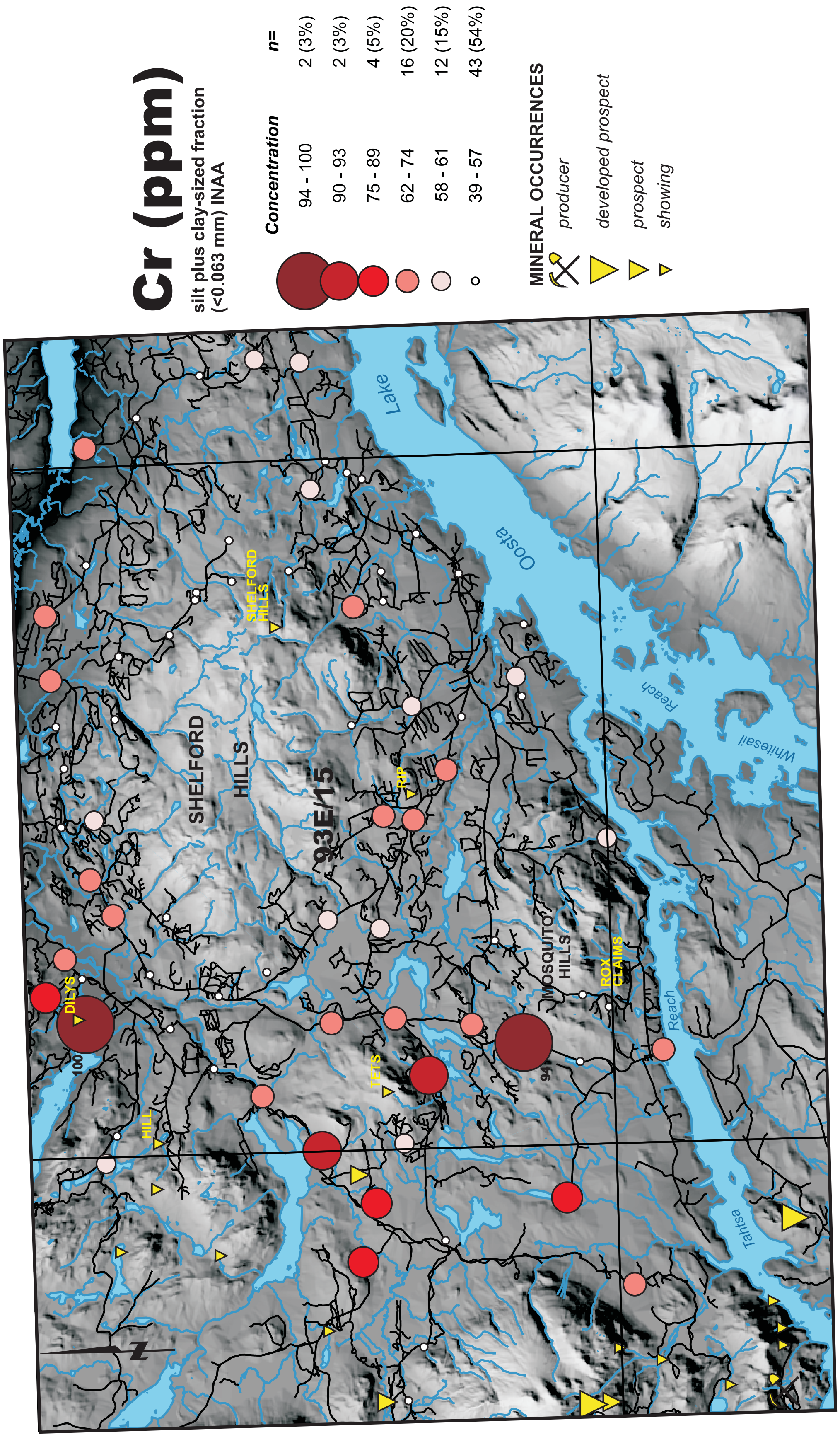

Figure 19. Proportional symbol plot for Cr values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

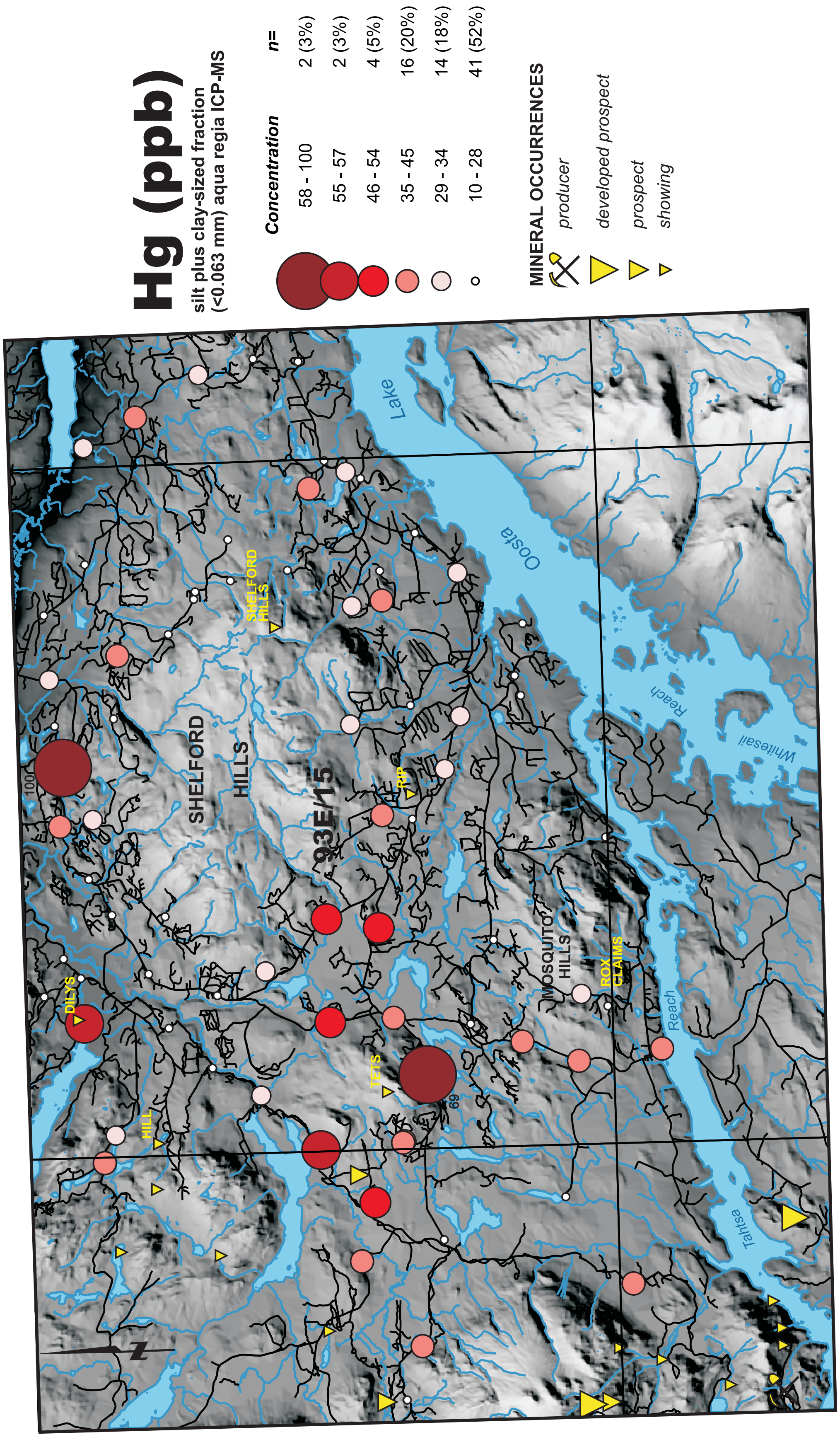

Figure 20. Proportional symbol plot for Hg values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

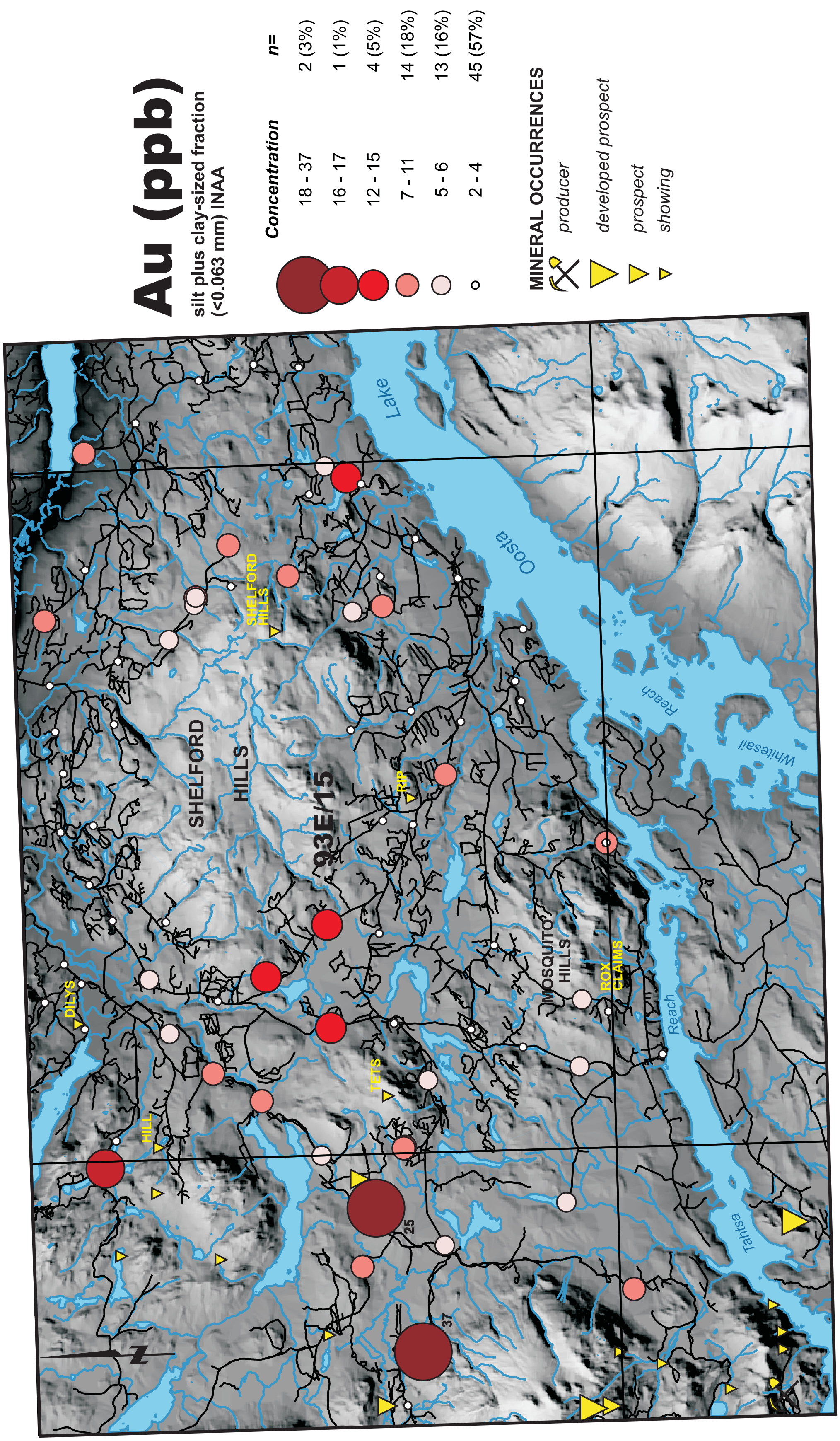

Figure 21. Proportional symbol plot for Au values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

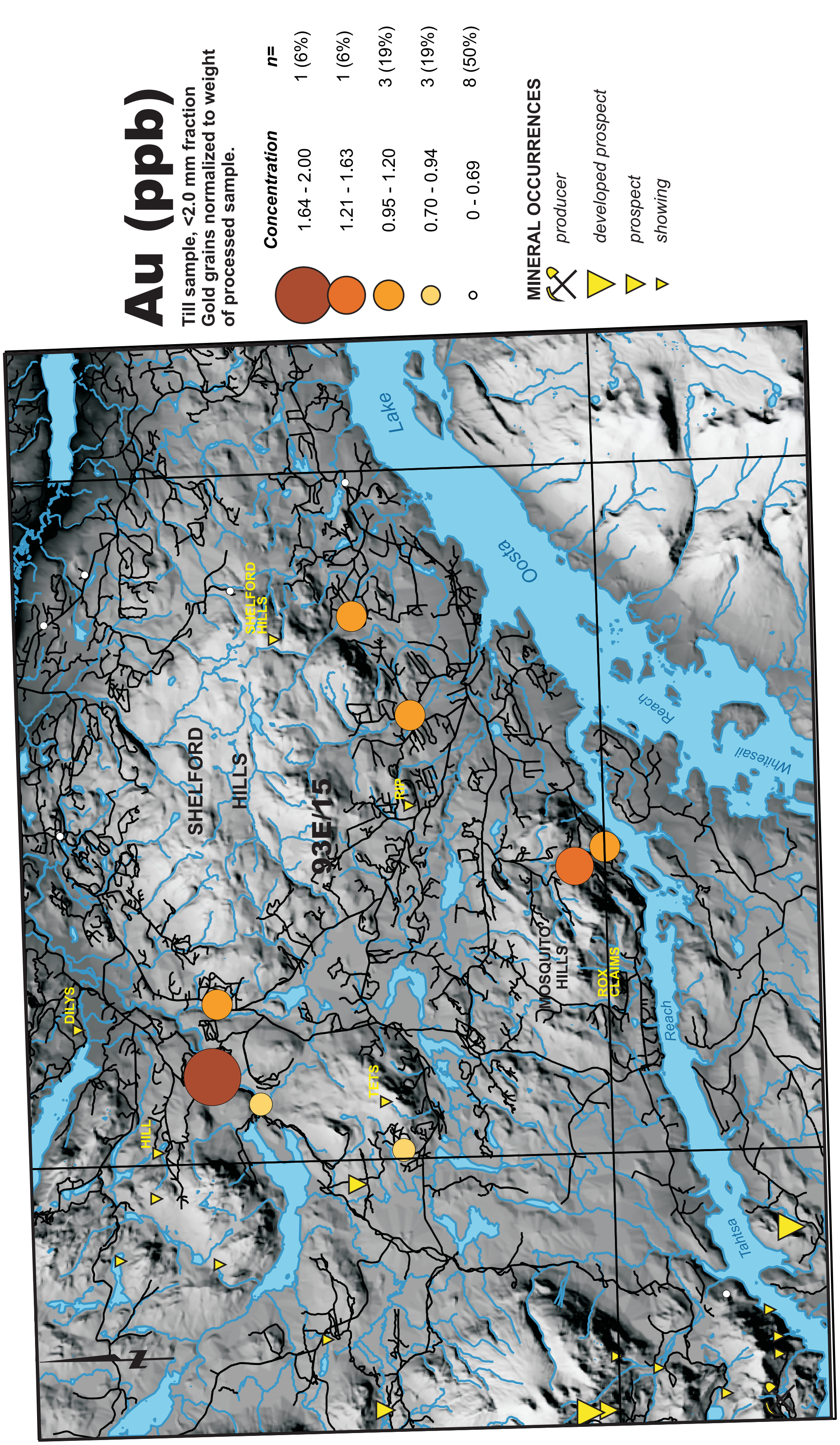

Figure 22. Proportional symbol plot for gold-grain counts (grains/kg) on the <2.0 mm fraction of till samples.

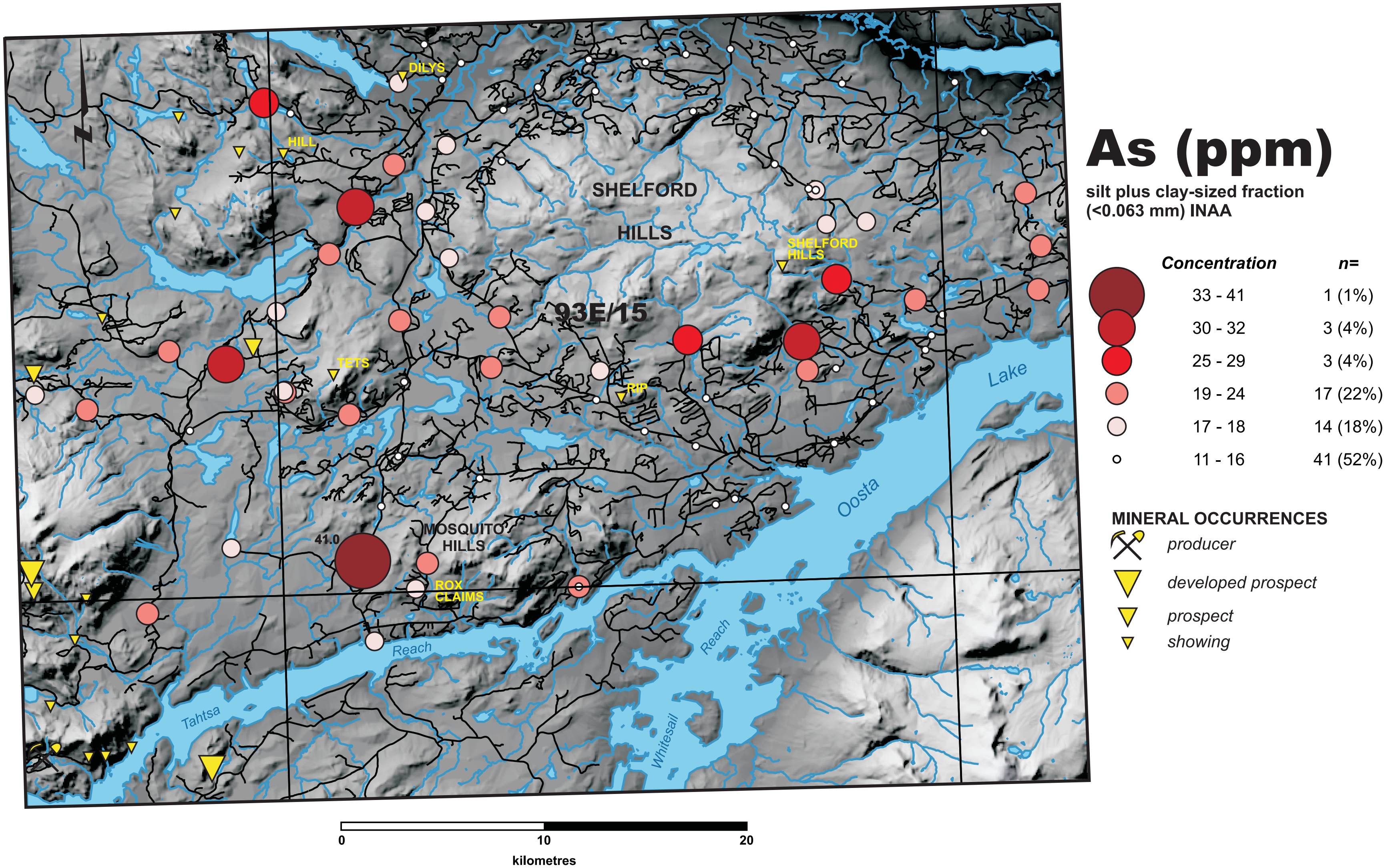

Figure 23. Proportional symbol plot for As values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

coincident with elevated values of Cu, Au, Ag, Pb, and Zn, as previously discussed.

Antimony

Median Sb for the study area is 2.0 ppm. The maximum value of 3.8 (sample 09TFE6094) occurs in the northwest corner of the study area, southwest of Tagetochlain Lake (Figure 24). This value is coincident with maximum Cu and >95th percentile Au (by INAA) and Pb. Greater than 95th percentile concentrations of Sb can occur with elevated Pb and Zn values (east flank of Shelford Hills) and elevated Ag and gold-grain counts (upper reaches of Nadina River valley).

QUATERNARY SEDIMENT COVER AND BEDROCK EXPOSURES

Observations made during the 2009 field season suggest that Quaternary sediment cover within the study area may not be as significant a hindrance to mineral exploration. In general, drift appears to be less areally extensive than was once thought. Also, a recent increase in logging activity has not only resulted in improved access to the study area, through the building of new roads, but has also resulted in the creation of new bedrock exposures. For example, a previously unmapped quartz diorite ridge was observed in a road-cut on the southeast flank of Shelford Hills (Figure 25).

Not only is drift less areally extensive than was once thought, it is also likely not as thick. It is relatively common to see small bedrock knobs (metres to a couple tens of metres across) extending through Quaternary cover to surface. Additionally, as observed in road-cuts, Quaternary cover may only be 1 to 2 m thick, with basal till directly overlying glacially eroded and polished bedrock. Exceptions can be found in some of the larger valleys like Nadina River valley, or in abandoned lateglacial and deglacial drainages such as the one that extends south from Fish Lake, down Andrews Creek, to Ootsa Lake. In these examples, valley fill and glaciofluvial sequences are typically thick and blanket much if not all underlying bedrock lithologies. These general observations could prove useful in guiding and interpreting data from future geological, geophysical and (or) geochemical surveys.

TRANSPORT DIRECTION OF TILLS

The complex ice-flow history of the study area has likely influenced detrital dispersal in basal tills of the study area. Although detailed till geochemical case studies (or orientation surveys) were not conducted within the survey area, others have been conducted in adjacent areas. These areas also experienced an ice-flow reversal during the Late Wisconsinan glacial maximum.

For example, 30 km northwest of the survey area at the Copper Star occurrence (porphyry Cu-Mo-Au) and 20 km southwest of the survey area at Huckleberry Mine, westward dispersal of Cu, Mo, Au, Ag, and Zn in till has been documented (Ferbey and Levson, 2007; Ferbey and Levson, 2010b). The short transport distance at Copper Star occurrence (10’s m from the bedrock source to the head of the dispersal train) is attributed not only the to the region’s complex ice-flow history but also to the thin till units there. At Huckleberry Mine, where till sequences >15 m thick occur, elevated element values can be detected 500 to 1250 m west-southwest of bedrock sources. Additionally, results of a soil geochemical survey conducted 30 km to the northeast of the survey area at Equity Silver Mine, show that southwestward dispersal of

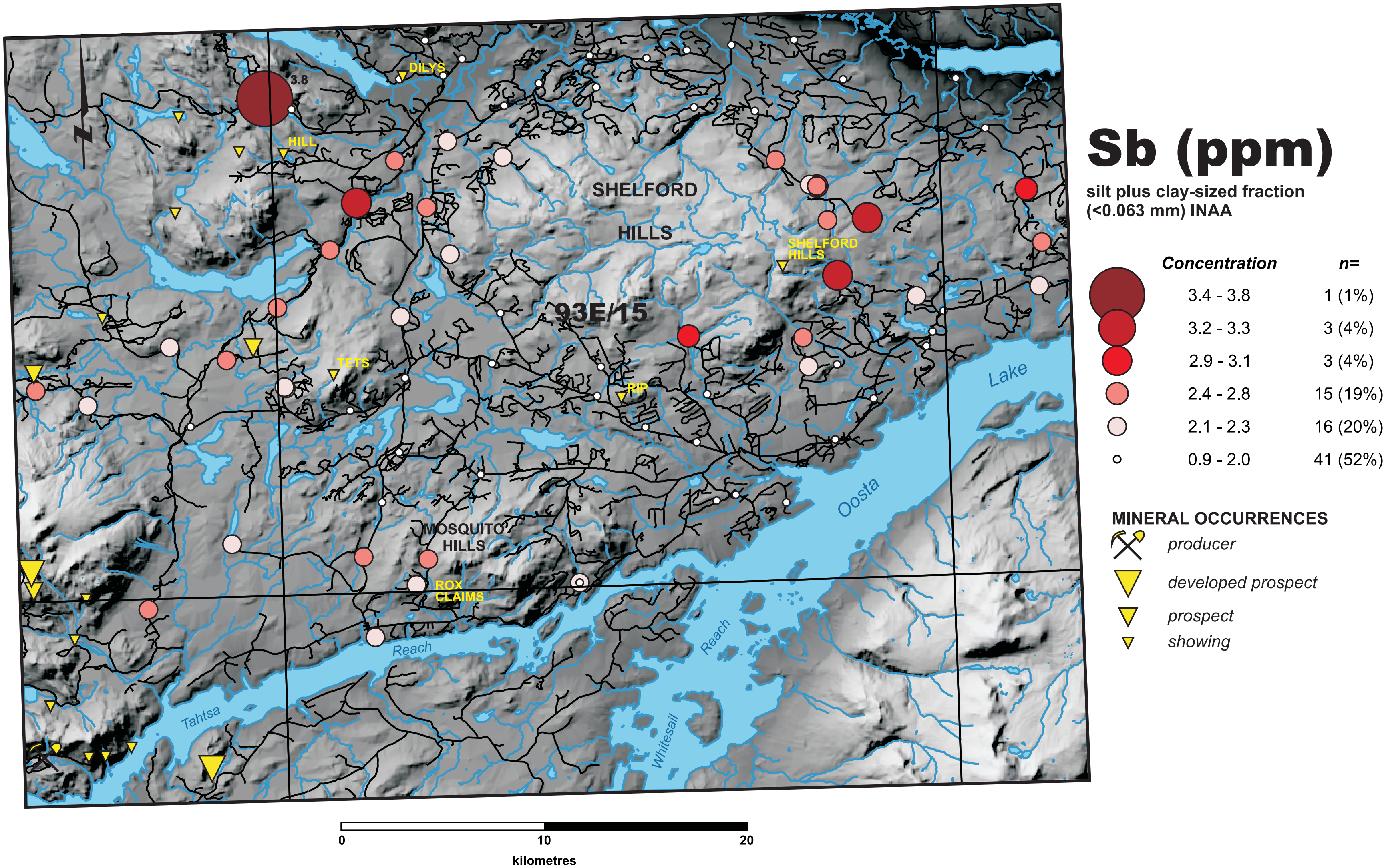

Figure 24. Proportional symbol plot for Sb values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in the study area.

Figure 25. New forestry roads have created new bedrock exposures. Shown here is an unmapped quartz diorite ridge observed in a road-cut on the southeast flank of Shelford Hills, approximately 6 km south-southeast of Shelford Hills mineral occurrence. Pick for scale (65 cm).

Ag dominates (Ney et al, 1972). Here, elevated Ag values in soils can be detected up to 1200 m southwest of ore-grade mineralization.

Based on the results of these geochemical surveys and the location of the study area relative to them, the proposed location of a Late Wisconsinan glacial maximum ice divide east of Shelford Hills (Stumpf et al., 2000), and the occurrence of west-southwest to west-northwest-indicating ice-flow features on the southwest flank of Shelford Hills (Figure 5), the dominant dispersal direction in tills of the study area is likely between west-southwest to west-northwest. As bedrock outcrop is limited within the study area, and there is some uncertainty around transport distance, it would be prudent to begin any follow-up on results presented here at bedrock outcrop closest to till samples of interest. This could be considered a starting point from which follow-up work would continue in the up-ice direction, or generally towards the east and northeast.

AREAS OF GEOCHEMICAL INTEREST

Four areas of geochemical interest have been identified using results presented in this study. In identifying these areas, consideration was also given to bedrock geology, locations of known mineral occurrences, and conductivity responses observed in helicopter-borne time-domain electromagnetic (EM) data acquired over Geoscience BC's QUEST-West Project area (Kowalczyk, 2009; Walker, 2009).

Figure 26 presents the locations of these areas of interest. Also included are off-time profiles from EM data acquired over the study area. Although a legend is included, the reader is directed to the original report and map for a more detailed presentation of these data and survey parameters (Walker, 2009). For the purpose of the discussion that follows, higher amplitude EM responses can correspond to more conductive bedrock lithologies while lower amplitude EM responses can correspond to less conductive (more resistive) bedrock lithologies (Walker, 2009).

At the time of publication only one of the four areas discussed here – Shelford Hills southeast – is located within open or unstaked ground. Although there is an area of open or unstaked ground northwest of the Short Portage Lake area – another area of geochemical interest – bedrock lithologies here are likely unrelated geochemically to element values found in tills north of Short Portage Lake. In all cases, follow-up work in the field is required to provide some insight into these elevated geochemical values and to assess their significance in the context of local bedrock lithologies.

Shelford Hills Southeast

The Shelford Hills southeast area has been highlighted based on Pb, Zn, As, and Sb values in three till samples located along the upper east and southeast flank of Shelford Hills (Figure 26). In sample 09TFE6053 the maximum Pb and Zn values for the study area occur, as does >90th percentile As. Sample 09TFE6040 contains >98th percentile Pb, >95th percentile Zn and Sb, and >90th percentile As values while >95th percentile As occurs in sample 09TFE6046. Farther north, in sample 09TFE6028, >90th Pb and Zn values occur, while >90th percentile Pb values occur in samples 09TFE6030 and 09TFE6032. With the exception of one small claim located immediately south of the Shelford Hills Pb-Zn-Au showing, Shelford Hills southeast is the only area discussed here that remains in open or unstaked ground.

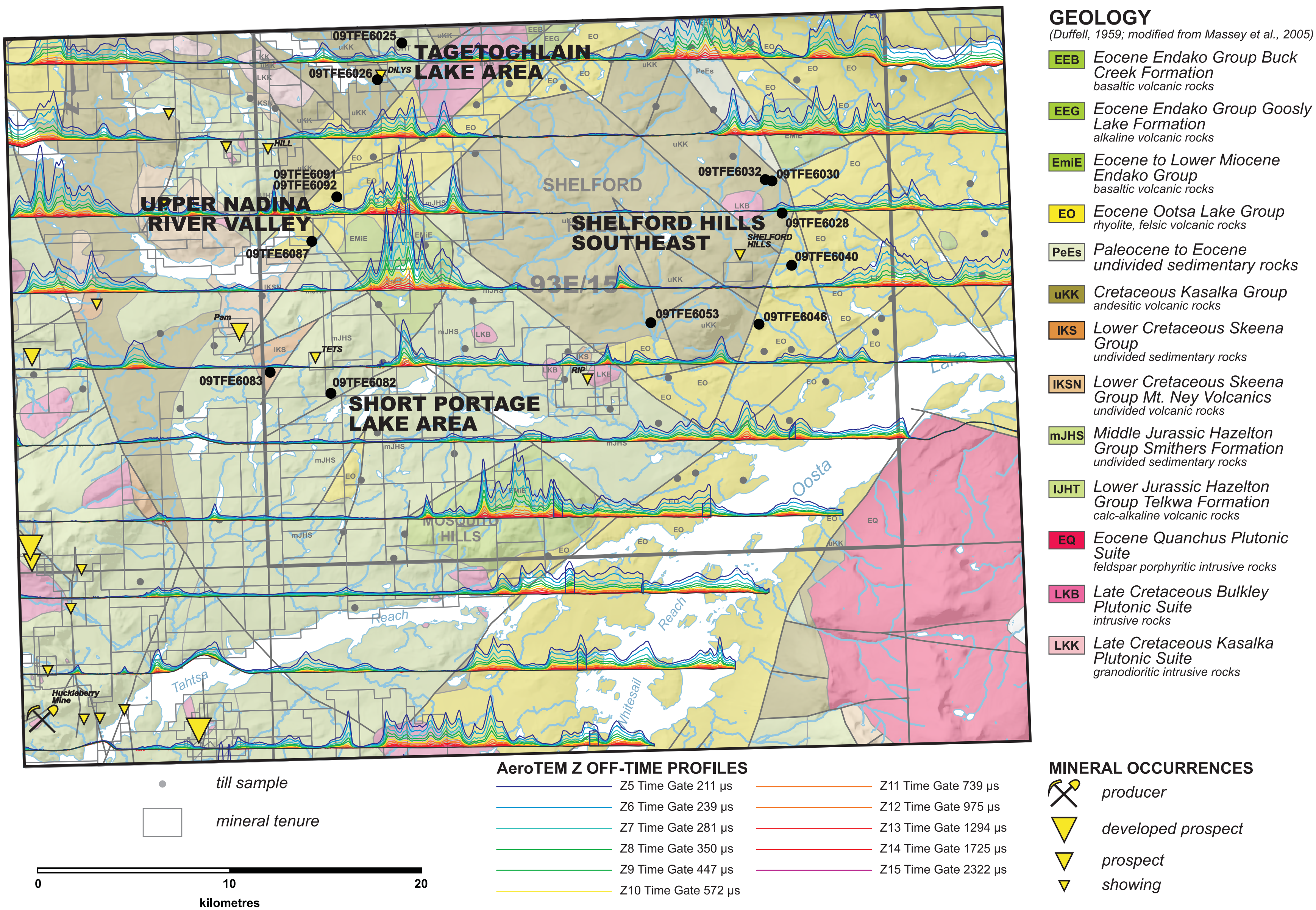

Figure 26. Areas of geochemical interest. Samples used to identify these areas are labelled. Also included here are helicopter-borne time domain EM data acquired for Geoscience BC's QUEST-West Project area. In these data, a higher amplitude EM response can correspond to more conductive bedrock lithologies while a lower amplitude EM response can correspond to less conductive (more resistive) bedrock lithologies.

Underlying these samples is Cretaceous Kasalka Group rhyolite to andesite flows and Eocene Ootsa Lake Group felsic volcanics. Located near the mid-point between samples 09TFE6040 and 09TFE6053 is the Shelford Hills Pb-Zn-Au showing. Mineralization here consists of disseminated pyrite, sphalerite, and galena. This mineralization is hosted within felsic volcanic units that have been intruded locally by gabbro to diorite and diorite to granodiorite stocks (Liskowich and Myers, 1989). At till sample site 09TFE6028, a subangular pyrite-rich granitic boulder was discovered at approximately 120 cm below surface, at the contact between basal till and overlying colluvium (Figure 27). Sample 09TFE6053 is thought to be off trend of west-southwest dispersal from the Shelford Hills showing. In general, it is thought that till units in the higher elevation portions of Shelford Hills are thin (<5 m) which could result in overall shorter detrital transport distances in till.

Although the significant majority of claims have since lapsed, the east half of Shelford Hills has been the focus detailed prospecting, bedrock mapping, and geochemical and geophysical surveys. The earliest recorded work in the area were soil and geophysical surveys conducted in 1969 by Kennco Explorations (Western) Limited (Ney, 1970a, b). This work was followed by an induced polarization survey conducted in 1973 by Black Giant Mines Ltd. (Baily and Klein, 1974), a soil geochemical survey conducted in 1983 by Canamax Resources Inc. (Goad, 1984), and bedrock geology mapping and rock geochemical sampling in 1984 by Riocanex Inc. (Cann, 1984). Most recently, Noranda Exploration Company Limited conducted detailed bedrock geology mapping, a soil geochemical survey, and follow-up on lineaments and a circular feature identified in satellite imagery (Liskowich and Myers, 1989). This earlier work consistently reports on elevated Zn, Pb, and Ag values (and low Cu and Mo values) in soils. Although disseminated and vein mineralization has been documented, as have local outcrops of unmapped intrusive lithologies, economic mineralization has not yet been discovered and Liskowich and Myers (1989) suggest further work is warranted. Any follow up work on data presented here should first begin with a thorough review of work previously conducted in the east Shelford Hills area.

A review of regional-scale helicopter- borne EM data should also be conducted (Kowalczyk, 2009; Walker, 2009). As seen in Figure 26, there is a low amplitude EM response over many mapped outcrops of Late Cretaceous Bulkley and Kasalka intrusives. A similarly low amplitude EM response can be seen over Shelford Hills. An examination of existing bedrock geology data (including that presented in assessment reports) shows that there are local outcrops of diorite to granodiorite around the periphery and on top of Shelford Hills. One possible interpretation of the low amplitude EM response over Shelford Hills is that the area is underlain by more resistive lithologies (perhaps granitic). A more detailed review of these EM data, and detailed follow up in the field, is required to support this possible interpretation.

Short Portage Lake Area

The Short Portage Lake area has been highlighted based on Zn, Cu, Hg, Cr, and Ni values in one till sample located 700 m north of Short Portage Lake (Figure 26). Contained in sample 09TFE6082 is the maximum Zn value for they study area and >98th percentile Cu and Hg, and >95th percentile Ni and Cr. This sample is located 2 km south-southeast of the Tets Cu-Zn-Pb-Ag showing and is off-trend of glacial

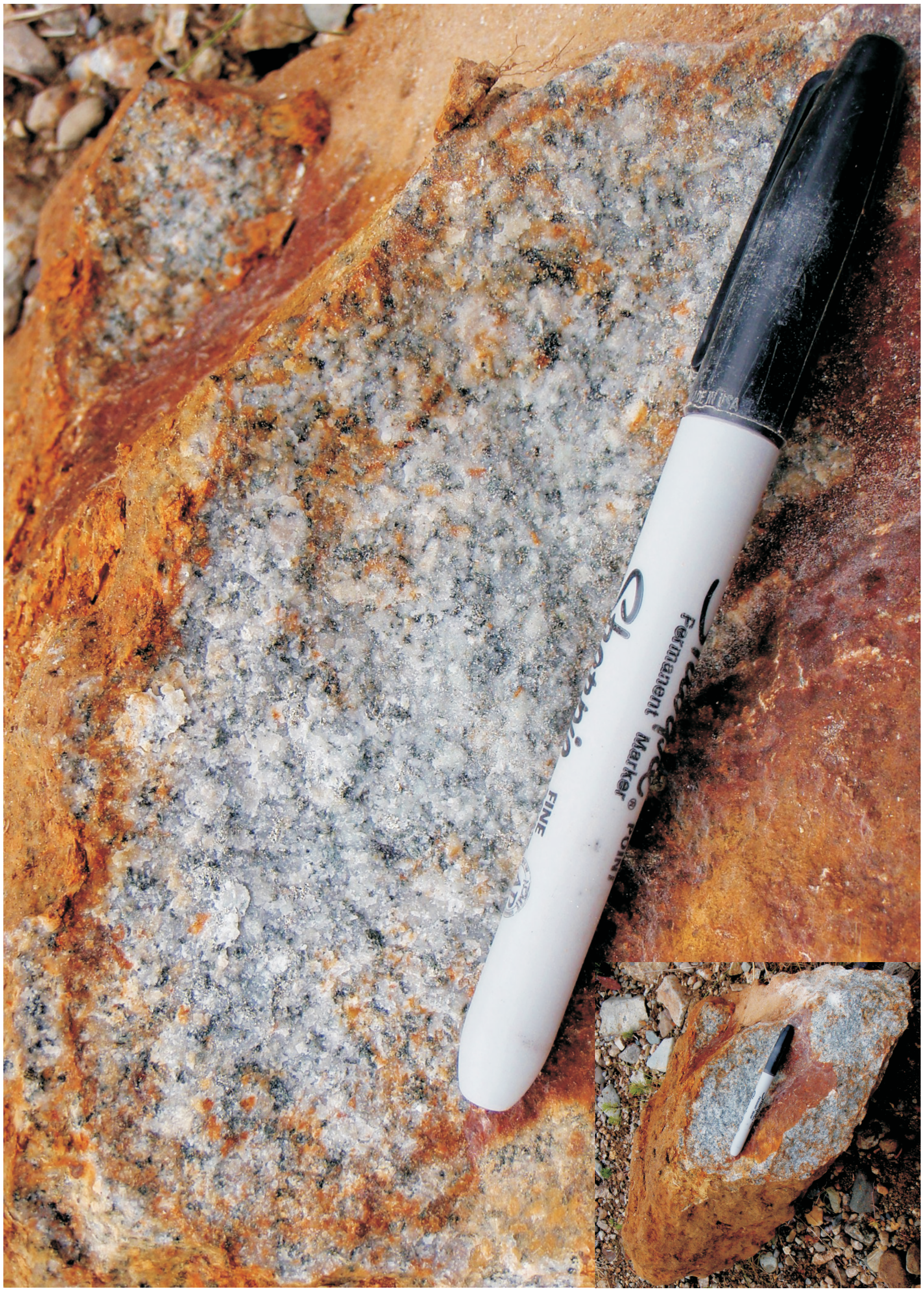

Figure 27. Photograph of subangular pyrite-rich granitic boulder observed at till sample site 09TFE6028.

dispersal from this showing. Approximately 2.5 km west-southwest of this showing, however, is sample 09TFE6083 which contains the second highest Mo value for the study area. This sample could be on-trend of west-southwest glacial dispersal from the Tets showing.

The Short Portage Lake area is underlain by an areally extensive unit of undivided Middle Jurassic Smithers Formation sedimentary rocks. Immediately to the west of the Tets showing, in the vicinity of sample 09TFE6083, is a wedge of undivided Lower Cretaceous Skeena Group sedimentary rocks. Chalcopyrite, sphalerite, bornite, and galena mineralization at the Tets Cu-Zn-Pb-Ag showing occurs in breccia zones and in fractures fills within the Middle Jurassic unit (Shelford, 1987). It is possible that the elevated values of Zn, Cu, and Hg in sample 09TFE6082 are related to an extension of this mineralized polymetallic vein system. It is not know, however, how elevated Ni and Cr values would be related to such a system or local host lithologies.

Sample 09TFE6082, and areas up-ice or towards the east and northeast, are located within existing mineral claims that are in good standing. Ground west of the Tets Cu-Zn-Pb-Ag showing, including ground in the vicinity and immediately up-ice of (east to northeast) sample 09TFE6083 remains open and unstaked.

Tagetochlain Lake Area

The Tagetochlain Lake area has been highlighted based on Ni, Cr, and Hg values in two till samples located east of Tagetochlain Lake (Figure 26). In sample 09TFE6026 the maximum value of Ni and Cr occur, as does >95th percentile concentration of Hg. In sample 09TFE6025, >98th percentile Ni and >90th percentile Cr occur. Both samples have >90th percentile concentrations of Ag.

Although the immediate area around these samples is underlain by Lower Jurassic Telkwa Formation calc-alkaline volcanics and Cretaceous Kasalka Group rhyolites and andesites, a Late Cretaceous Bulkley Suite intrusive has been mapped approximately 2 km to the east. It is not known if elevated element concentrations in these two samples are related to the Dilys Cu showing (or an extension of this mineralized system), the mapped intrusive to the east, or an as of yet unknown mineralized source.

At the Dilys showing, pyrite, chalcopyrite, and minor molybdenite occur as disseminations and fracture-fills (Timmins, 1980). A more detailed review of assessment reports associated with this showing may provide more insight into locally occurring bedrock lilthologies. It is worth noting that <90th percentile concentrations of Cu occur in these two till samples. Although the maximum Cu value for the study area occurs to the west-southwest in sample 09TFE6094, the 7 km distance between this sample and the Dilys showing makes a geochemical relationship between the two unlikely. In-fill sampling would be required to confirm this.

These two samples, and areas up-ice or towards the east and northeast, are located within existing mineral claims that are in good standing.

Upper Nadina River Valley

The upper Nadina River valley has been highlighted based on gold-grain and Ag, As and Sb values in three till samples located in the upper reaches of Nadina River, east of Nadina Lake (Figure 26). In sample 09TFE6087 the maximum Ag value for the study area occurs. In sample 09TFE6092, the maximum number of gold-grains occurs (normalized to weight of table feed), and in sample 09TFE6091, >98th percentile concentration of Ag, and >95th percentile concentrations of As and Sb. There is no known mineral occurrence up-ice of (east to northeast) or in the vicinity of these two till samples.

These samples occur within Eocene Ootsa Lake Group rhyolites and felsic volcanics and their Ag, As, Sb, and Au concentrations suggest that this rocks could locally host Au mineralization. Although the Nadina River has created bedrock exposures close to the active channel, an extensive cover of glaciofluvial sediments and till obscures bedrock outside of the active channel.

These three samples, and areas up-ice or towards the east and northeast, are located within existing mineral claims that are in good standing.

SUMMARY

To assess the mineral potential of the Nadina River map area (093E/15) 84 basal till samples were collected for major, minor, and trace element geochemical analyses while an additional 16 till samples were collected for separation and analysis of heavy mineral concentrates and gold-grain counts. Observations made during the 2009 field season suggest that Quaternary sediments within the study area are not necessarily as areally extensive nor thick as was once thought, and therefore may not be as significant a hindrance to mineral exploration in the region.

An analysis of Cu, Mo, Pb, Zn, Ag, Ni, and Hg determinations by aqua regia ICP-MS, and Au, As, Sb, and Cr determinations by INAA, in the context of local bedrock lithologies and locations of known mineral occurrences, has highlighted four areas as being of geochemical interest. These areas are:

- Shelford Hills southeast (identified using Pb, Zn, As, and Sb values in three till samples located along the upper east and southeast flank of Shelford Hills);
- Short Portage Lake area (identified using Zn, Cu, Hg, Cr, and Ni values in one till sample located north of Short Portage Lake);
- Tagetochlain Lake area (identified using Ni, Cr, and Hg values in two till samples located east of Tagetochlain Lake); and
- Upper Nadina River valley (identified using gold-grain and Ag, As, and Sb values in three till samples located in the upper reaches of Nadina River, east of Nadina Lake).

Detailed geochemical case studies conducted within the region at the Copper Star occurrence (porphyry Cu-Mo-Au), Huckleberry Mine (producing porphyry Cu-Mo mine) and Equity Silver Mine (past producing Ag-Cu-Au mine), and west-indicating ice-flow features measured in the study area (252°-306°), suggest that westward detrital dispersal of till likely dominates in the region. As part of any follow up on till geochemical data presented here, detailed outcrop scale investigation of ice-flow indicators should be conducted. The complexity of the region's ice-flow history, and variability in till thickness, suggests that there could be local variation in net transport direction and distance.

Mapped intrusive lithologies and metallic mineral occurrences around the periphery of Shelford Hills, reports of addition local and unmapped outcrops of diorite to granodiorite on top and along the southeastern flank of Shelford Hills, and a low amplitude EM response across this prominent topographic feature, suggest that the Shelford Hills area is deserving of follow up work in the field. The eastern half of Shelford Hills has received attention in the past and like the till geochemical data presented here (which has highlighted areas with elevated Pb, Zn, As, and Sb values), areas with elevated Zn, Pb, Ag concentrations have been identified. Any future work in the Shelford Hills area should first start with a thorough review of detailed geological, geophysical, and geochemical data presented in assessment reports for the area. New geophysical data for the region, and new bedrock exposures created along recently constructed forestry roads, suggest that new contributions can be made to what is already know about the area.

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