BRITISH COLUMBIA

TILL GEOCHEMICAL EXPLORATION TARGETS, REDSTONE AND LOOMIS LAKE MAP AREAS (NTS 93B/04 AND 05), CENTRAL BRITISH COLUMBIA

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BRITISH COLUMBIA GEOLOGICAL SURVEY

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INTRODUCTION

Presented here are results of a till geochemical survey completed in the Redstone and Loomis Lake map areas (NTS 93B/04 and 05; Figure 1). The main objective of this survey is to assess the mineral potential of an area where bedrock outcrop is limited. The goal of this study is to provide to the mineral exploration community new, regional-scale, geochemical data that will help guide exploration efforts in this drift-covered area.

The study area falls within the mountain pine beetle impacted zone, which has been a focus of provincial and federal economic diversification initiatives. This study is a collaborative effort with the Geological Survey of Canada (Natural Resources Canada). Sample preparation and analytical determinations were provided by their Mountain Pine Beetle program.

This study compliments recently completed bedrock mapping and mineral potential assessments immediately to the east in NTS 93C/01, 08, and 09 (Milhaynuk et al., 2008a, b, 2009a, b). This study also builds on previously conducted surficial mapping and till geochemistry surveys in NTS 93C/01, 08, 09, and 16 (Giles and Kerr, 1993; Proudfoot, 1993; Lett et al., 2006). Integrating interpretations of data presented here with other historic geological and geochemical data collected by the British Columbia Geological Survey (BCGS), Geological Survey of Canada (GSC) and Geoscience BC (GBC), will provide a powerful tool for companies exploring in the study area.

LOCATION AND PHYSIOGRAPHY

The study area is located approximately 150 km west of Williams Lake, BC (Figure 1), within the Fraser Plateau, a subdivision of the Interior Plateau physiographic region (Holland, 1976). Located approximately 100 km east of the Coast Mountains, and 90 km west of the Fraser River valley, this area can be described as being flat to gently rolling and having a relatively undissected upland (Figure 2). The exception to this is the broad flat valley of Chilcotin River, and its larger tributaries (e.g. Chilanko and Chilko rivers), that are incised below the plateau surface. The subtle topography of the plateau is largely attributed to the sub-horizontal, Late Oligocene to Pleistocene-age Chilcotin Group basalt flows that are thought to underlie much of it. Mantling these basalt flows is a package of glacial drift (Tipper, 1971; Holland, 1976).

Valleys settings have thick sequences of Quaternary, and locally pre-Late Wisconsinan, sediments while the upland or plateau surface is dominated by till deposits. At 1377 m, Mount Alexis is the highest named peak in the study area. North of Temapho Lake, the plateau surface rises to just over 1500 m in elevation in a series of unnamed peaks and ridges (Figure 1). For the most part, bedrock outcrop is limited to higher ground, meltwater channel sides, and scarps which define the larger Chilanko, Chilcotin, and Chilko river valleys.

Highway 20 is the main transportation corridor through the study area. The study area is accessed by a dense network of Forest Service roads that branch off Highway 20.

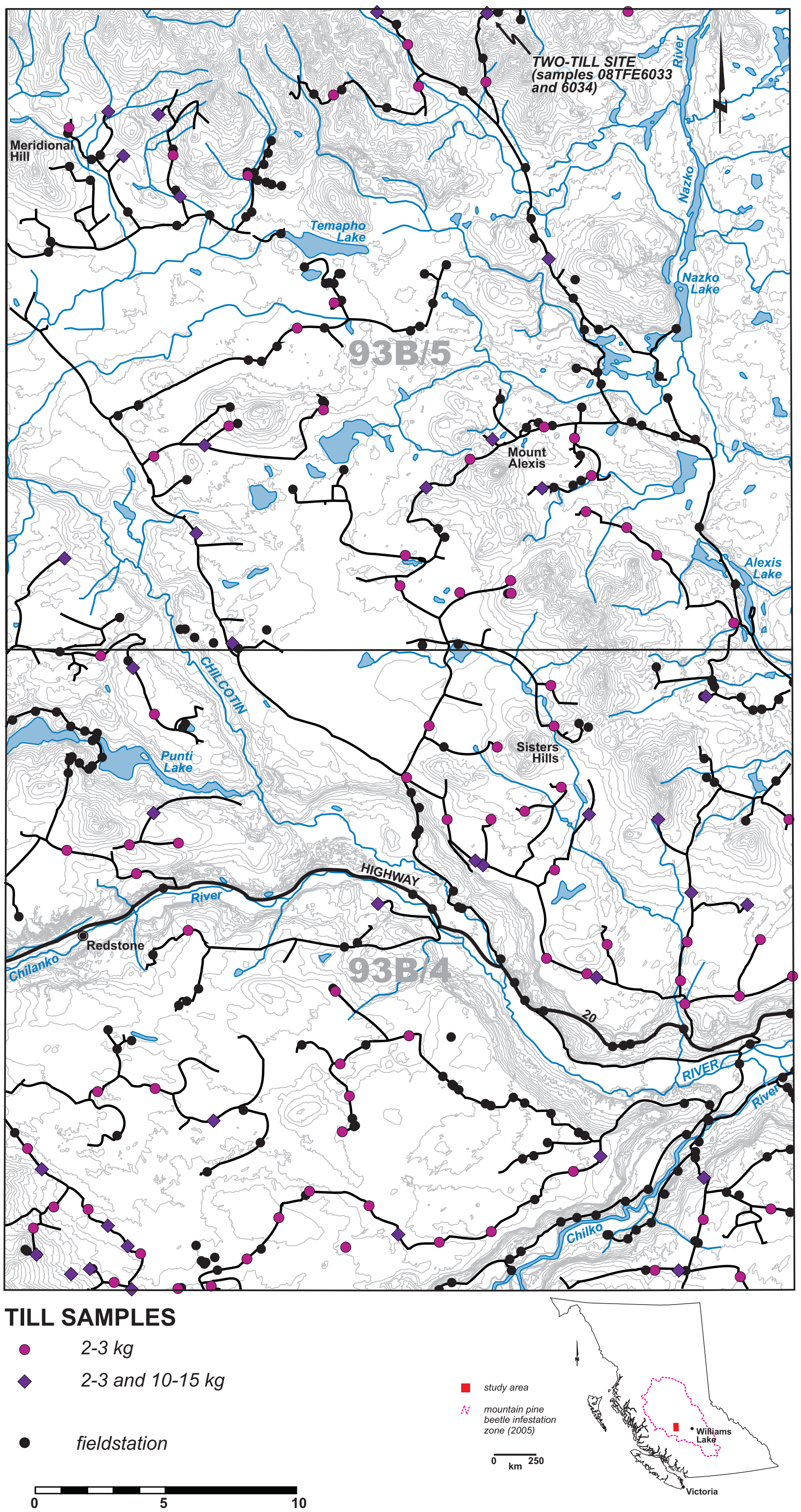

Figure 1. Location of study area. Included here are locations of field stations and till samples. The road-cut where two tills units were observed is shown.

Figure 2. View of study area looking south towards Mount Alexis (centre of background). Note the flat to gently rolling topography in foreground, a typical surface expression of basal till deposits in the study area.

BEDROCK GEOLOGY

The bedrock geology was first described by Tipper (1959). This work was compiled by Massey et al. (2005) and recently studied in greater detail locally by Ferri and Riddell (2006) and Riddell and Ferri (2008) as part of an assessment of oil and gas potential of the Nechako Basin. Adjacent to the study area, a current regional bedrock mapping and mineral potential assessment in NTS 93C/01, 08 and 09 has yielded new occurrences of metallic mineralization (Milhaynuk et al., 2008a, b, 2009a, b).

The study area is situated within the Stikine Terrane, close to its eastern contact with the Cache Creek Terrane (Monger et al., 1991). The main geological subdivisions found in the study area, as summarized from Tipper (1959), Diakow et al. (1997) and Massey et al. (2005), are as follows. The oldest rocks are found in the westernmost portion of NTS 93B/04 and belong to the Early to Middle Jurassic Hazelton Group (Figure 3). Locally they are composed of andesite and basalt with related tuff, breccia and volcaniclastic deposits, which resulted from subaerial and submarine volcanism. Submarine sedimentary rocks, associated with activity in an island arc, are also locally present. These are all overlain by a sedimentary succession of fluvial conglomerate, sandstone and siltstone from the Early and Late Cretaceous Skeena Group (Figure 3). These rocks are locally exposed in the Chilko River valley, south and southwest of Sisters Hills, and northwest of Temapho Lake.

Subduction-related arc volcanism resumed within the Stikine Terrane in the Late Cretaceous, changing to a continent margin setting with subaerial volcanism in the Paleogene. Paleogene assemblages include the Ootsa Lake and Endako groups (Figure 3). Eocene volcanic deposits of the Ootsa Lake Group are widespread at Sisters Hills, and underlie topographically higher terrain in much of the northern portion of NTS 93B/05. The volcanics are of a diverse succession, ranging from rhyolite to basalt, and were mapped in detail to the west by Mihalynuk et al. (2008a, b). They include maroon-brown basalt flows and breccia, acicular hornblende dacite flows, maroon and grey flow-banded rhyolite, and vitreous black dacite. In NTS 93C, conglomerate is locally found lying at the base of the Ootsa Lake Group, unconformably overlying the older Jurassic Hazelton Group.

Within the study area, Eocene to Oligocene volcanic rocks of the Endako Group unconformably overlie the Ootsa Lake Group. They occupy higher ground in the northern portion of NTS 93B/05 and to the northeast of Sisters Hills. The volcanics consist mainly of inclined, massive to crudely stratified andesite to basaltic andesite flows. Although the flows can include vesicular and amygdaloidal varieties, characteristically they are dense, black and aphanitic.

The youngest rock unit consists of basalt flows and associated volcaniclastic rocks that unconformably overlie older rock units and are correlated with the Late Oligocene to Pleistocene Chilcotin Group (Figure 3). These rocks consist of distinctly layered, subhorizontal, relatively thin flows, commonly with colonnades associated with shield-like volcanic centres interpreted to occur north of the study area (Mihalynuk et al., 2008a). When compared to other basalt within the study area, they differ and are

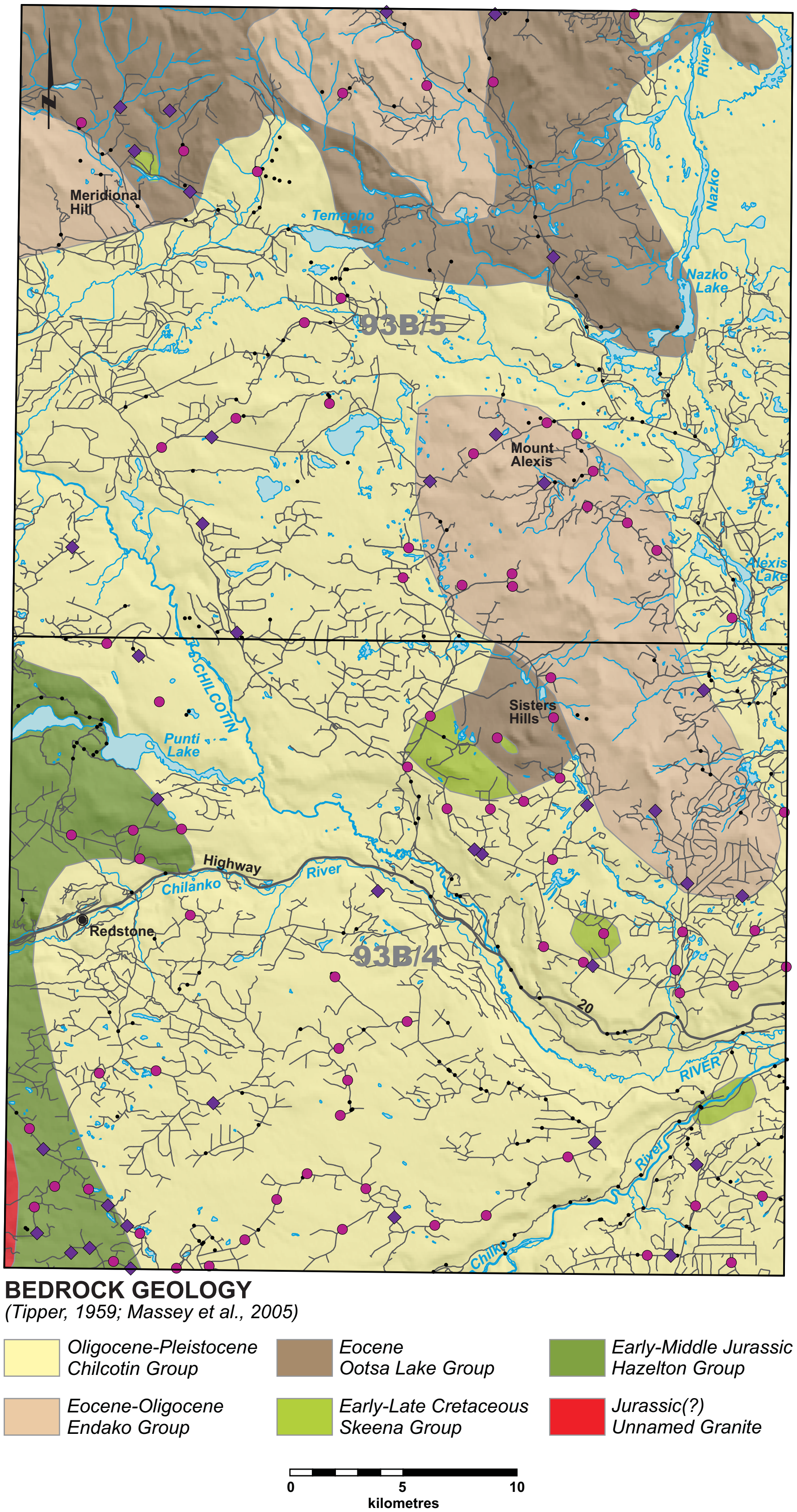

Figure 3. Bedrock geology of the study area. See text for descriptions of map units. Trace element till sample sites (2 to 5 kg) are shown with ● while sample sites with trace element and heavy mineral till samples (2 to 5 kg and 10 to 15 kg) are shown with ◆. Locations of routine field stations are shown with · .

dark brown to grey, highly vesiculated, and contain unaltered phenocrysts of olivine and feldspar. Fine-grained, less vesiculated varieties have a felted grey-brown texture.

Geological maps by Tipper (1959) and Massey et al. (2005) show that upwards of 70% of the study area is underlain by Chilcotin Group basalts (Figure 3). Although the areal extent of these rocks within the Nechako Plateau is certainly significant, recent work by Mihalynuk et al. (2008a, b, 2009a, b) and Andrews and Russell (2007) demonstrate that this cover may not be as widespread or thick as originally thought. This is positive for mineral exploration and drift prospecting, as these recent studies report significant thickness variations and even windows through Chilcotin Group flow sequences exposing older more prospective basement units.

Massive granite occupies the southwest corner of NTS 93B/04 (Figure 3). It is likely a phase related to the quartz-first granodiorite, of the Chilanko intrusive complex, mapped by Mihalynuk et al. (2009b) to the west in 93C/01. Mihalynuk et al. (2008a, 2009a) report a positive correlation between intrusive bodies and intrusion-hosted veins with copper mineralization. As this is the only known intrusive body within the study area, a higher density of till samples was collected down-ice, to the northeast, in order to investigate a potential association with mineralization.

Mineral Occurrences and Exploration Targets

There are no known metallic mineral occurrences within the study area. To the west and northwest, however, historic gold and silver prospects are known within the eastern portion of NTS 93C (Chili, MINFILE 093C 011; Chilcotin River East and West, MINFILE 093C 013 and 093C 014; Baez, MINFILE 093C 015; Clisbako, MINFILE 093C 016), as well as newly discovered copper (Punky, Orovain, Vampire, and Gumbo) and gold and silver showings (Pyro). Lett et al. (2006) and Mihalynuk et al. (2008a) provide summaries of these occurrences. Most recently, Mihalynuk et al. (2009a) report on newly discovered showings of Cu-Ag with minor Au mineralization in NTS 93C/01 - Fit, Ejowra, and ET showings.

Elements discussed in this report were chosen based on typical element associations with volcanogenic massive sulphide (VMS; Au, Ag, Zn, Cu, Pb), alkalic (Cu, Au, Ag) and calc-alkalic porphyry (Cu, Mo), mesothermal and epithermal vein (Au, Ag, Pb, Zn), and skarn (Au, Cu) deposit types; potential exploration targets within Stikine Terrane (Dawson et al., 1991).

QUATERNARY GEOLOGY

The Quaternary geology of the study area was first described by Tipper (1971) in a glacial features map at 1:250 000 scale. The BC Ministry of Environment, Lands and Parks (1976a, b) produced 1:50 000 scale soils and landforms maps for NTS 93B/04 and 05. Other Quaternary geological studies have been conducted in the region in areas adjacent to NTS 93B (e.g., Giles and Kerr, 1993; Proudfoot, 1993; Levson and Giles, 1997; Mate and Levson, 1999; Mate and Levson, 2000; Plouffe, 2000; Plouffe and Levson, 2001).

Most recently, Ferbey et al. (2009) and Vickers and Ferbey (2009) discuss the

Quaternary geology of the study area. Detailed descriptions of pre-glacial, Late Wisconsinan glacial, and Holocene sediments are provided there. As part of that work, detailed sedimentological and stratigraphic descriptions were conducted at 266 fieldstations within the study area (Figure 1). Most Quaternary exposures were the result of logging-related activity (e.g., roadcuts and borrow and gravel pits) but also included natural exposures (e.g., valley sides and meltwater channels, tree throws) and hand-dug soil pits. Exposures ranged from a few to several tens of metres in height. In the case of hand-dug soil pits, depth only occasionally exceeded 1 m below surface.

The following is a summary of observations presented and data collected by Ferbey et al. (2009), with a focus on Late Wisconsinan tills.

Late Wisconsinan Tills

The dominant surficial material found in the study area is diamict. Based on physical characteristics such as matrix texture and proportion, modal clast size and clast shape, and surface expression, the sediments are divided into two genetically separate units. The first, and likely dominant in terms of areal extent, is a grey, sand-rich, gravelly diamict. In this diamict, characteristics such as vertical jointing, subhorizontal fissility and compaction or overconsolidation are not observed. Clast shape is commonly subangular to subrounded and modal clast size is small pebble but ranges from granule to large pebble. The unit is clast rich compared to the second diamict described below and the proportion of matrix is typically 55 to 75%. Near surface (in the upper 1 to 2 m), this matrix can be oxidized and clasts, in particular intrusive rock types, can be weathered. The lower contact of this diamict, observed in only a few localities, is gradational downward into a grey, silt-rich, overconsolidated diamict. Minimum thickness is approximately 1 m and ranges up to several metres in some areas.

The surface expression of this sand-rich, gravelly diamict, as observed in aerial photographs and in the field, is distinctive. The upper surface is typically undulating to hummocky and commonly has pebble to boulder-sized clasts sitting at surface. The physical and geomorphological characteristics are consistent with till of englacial or supraglacial origin. The transport history of this till facies can be complex and so this facies is not sampled for till geochemistry. Windows through this facies to an underlying silt-rich, overconsolidated diamict are occasionally found. This underlying material is an ideal sample medium for a till geochemical survey.

The underlying silt-rich, overconsolidated diamict is grey and is the other commonly occurring diamict within the study area. This diamict is massive; vertical jointing and subhorizontal fissility are locally well developed. Matrix proportion ranges from 65 to 85%. Modal clast size is small pebble and ranges from granule to large pebble. Clast shape is typically subangular to subrounded but locally, down-ice from larger river valleys, there can be a concentration of rounded, subdiscoidal to spherical clasts and a more sandy textured matrix. These clasts and sand are interpreted to have been incorporated by the Cordilleran Ice Sheet as it moved across existing valley fill sequences.

This diamict can occur at surface or underlie the englacial or supraglacial till unit described above. Its surface expression is also distinctive and can be rolling or ridged (e.g., in the case of fluted, drumlinized or crag-and-tail terrain) or a more subtle variation of the bedrock surface it blankets. At some sites, this basal till directly overlies grooved and striated Chilcotin Group basalt flows. The texture, primary structures and degree of consolidation of this unit are consistent with those of subglacially derived diamict (Dreimanis, 1989) and this unit is interpreted as basal till.

On the northern boundary of 93B/05, in a 7 m road cut through a flute, two distinct till units were observed (Figure 1). The upper till unit is very similar to the basal till described above. The silt-rich, grey diamict exposed here, however, is only moderately consolidated and while subhorizontal fissility is present, vertical jointing was not observed (Figure 4). Directly underlying this unit is a moderately dense diamict with well defined vertical jointing and subhorizontal fissility, giving this unit a blocky structure (Figure 5). What is most unique about this lower diamict unit, interpreted as a basal till, is its reddy-brown colour. This is the only known exposure of this till unit in the study area. Its colour is attributed to the maroon-coloured Ootsa Lake volcanics that occur in the up-ice direction from which it is likely derived. Samples of each of these tills was collected for geochemical analyses (sample 08TFE6033 from upper till, 148 cm below surface; sample 08TFE6034 from lower till, 511 cm below surface). Although distinctive, it is not known whether these tills are the product of two separate glacial events, a change in ice-flow direction during the same glacial event (and therefore provenance), or perhaps a change in depositional environments during the same glacial event.

Other Pre- and Late Wisconsinan, and Holocene Sediments

Pre-Late Wisconsinan stratified sands and gravels and tephras occur in the study area (believed to be the first observation of pre-Late Wisconsinan sediments in the area) and are overlain by Late Wisconsinan advance-phase glaciofluvial gravels and till. These older sediments occur in only one location, approximately 2 km east of Redstone. Late-glacial ice-marginal and retreat-phase glaciofluvial sands and gravels commonly occur within and adjacent to meltwater channels and as terrace and outwash deposits in the larger river valleys such as Chilanko, Chilcotin, and Chilko. A complex melwater channel systems exists in the eastern portion of 93B/5 and hosts the Alexis and Nazko lakes system. Surficial materials in these systems range from moderately-well sorted silty-sands to cobble-sized gravels. It has been proposed that this meltwater channel system was the outlet for a Late Wisconsinan glacial lake that occupied the Chilcotin River valley (Tipper, 1971).

The glaciolacustrine sediments associated with this ice-dammed lake dominate the larger river valleys such as Chilanko, Chilcotin and Chilko, and many of their tributaries. These sediments are typically parallel-laminated and bedded silts and fine sands. They are commonly deeply gullied and can be associated with

Figure 4. Sandy-silt, grey coloured basal till. This is the upper till unit observed on the northern border of 93B/05. Photo taken at sample site 08TFE6033, 148 cm below surface.

Figure 5. Clayey-silt, reddy-brown coloured, basal till. Note well-developed jointing and subhorizontal fissility. This is the lower till unit observed on the northern border of 93B/05. The reddy-brown hue is attributed to the colour of its source rock, Ootsa Lake group volcanic rocks that occur up-ice of this exposure. Photo taken at sample site 08TFE6034, 511 cm below surface.

valley-side mass-wasting events. Upstream of the confluence of Chilcotin and Chilanko rivers is large-scale esker complex composed of sand and pebble to cobble-sized gravel ridges that are up to 50 m high and continuous for 2 km.

Glacial units are typically capped on steeper valley slopes by Holocene colluvial deposits. The parent material of these deposits can be pre-existing glacial sediments or can be Chilcotin Group basalt flows that have moved downslope from bedrock scarps that rim the sides of larger valleys (e.g. Chilanko, Chilcotin, Chilko valleys). Holocene organic deposits also occur in the study area and are typically found bordering small lakes or flooring some of the larger glaciofluvial meltwater channels and channel systems.

ICE-FLOW HISTORY

The study area was covered by the Cordilleran Ice Sheet during the Late Wisconsinan Fraser glaciation (Tipper, 1971; Ferbey et al., 2009). The occurrence of crag-and-tail features on higher ground within the northern and southeast parts of NTS 93B/04 (>1330 m) and 093B/05 (>1400 m), and the northeast-tapering drift tail of an unnamed peak in the southwest part of 093B/04 (Figure 6), provide a minimum elevation for this ice of approximately 1500 m. The consistent orientation of these landform-scale features with striations, grooves and other drumlins and flutings at lower elevation shows that at least during the glacial maximum ice movement through the study area was relatively unaffected by topography (Figure 7). A minor deflection can be observed when comparing ice-flow indicators occurring in the southwest to those in the northwest and north, a result of the interaction of northeast-flowing ice from the Coast Mountains with westward-flowing ice from the Cariboo Mountains. The confluence and turning of these two ice-flows most likely occurred during the Late Wisconsinan glacial maximum to the east of this map area, near the Fraser River valley (Tipper, 1971).

Both bidirectional (e.g., flute) and unidirectional (e.g., drumlin, crag-and-tail) landform-scale ice-flow indicators, in various topographic settings, can be observed in aerial photographs and on the ground. In both cases, the features trend 035° (in the northeast portion of the study area) to 055° (in the southwest portion of the study area) (Figure 7). The preservation and definition of these features can vary; excellent examples can be observed where topographic features are oriented perpendicular to regional ice flow. For example, on the east side of the upper Chilcotin River valley (upstream of its confluence with Chilanko River), clear, well-defined drumlins and crag-and-tail features up to 60 m across can be observed in the valley bottom for 850 m up the valley side onto the plateau surface. Excellent examples of crag-and-tail features occur on much of the higher ground in the vicinity of Sisters Hills. Smaller, outcrop-scale features such as striations and grooves are rare. Where observed, these, and outcrop-scale roches moutonnées, consistently trend 048° to 052° (Figure 7). The orientations of ice-flow indicators observed as part of this study are in general agreement with areas to the west in NTS 93C (Giles and Kerr, 1993; Proudfoot, 1993; Lett et al., 2006) and with data and interpretations presented by Tipper (1971), and show that the last recorded ice-flow direction

Figure 6. View of unnamed peak in southwest NTS 93B/04 (looking northwest). Note the drift tail of this crag-and-tail that tapers towards the northeast.

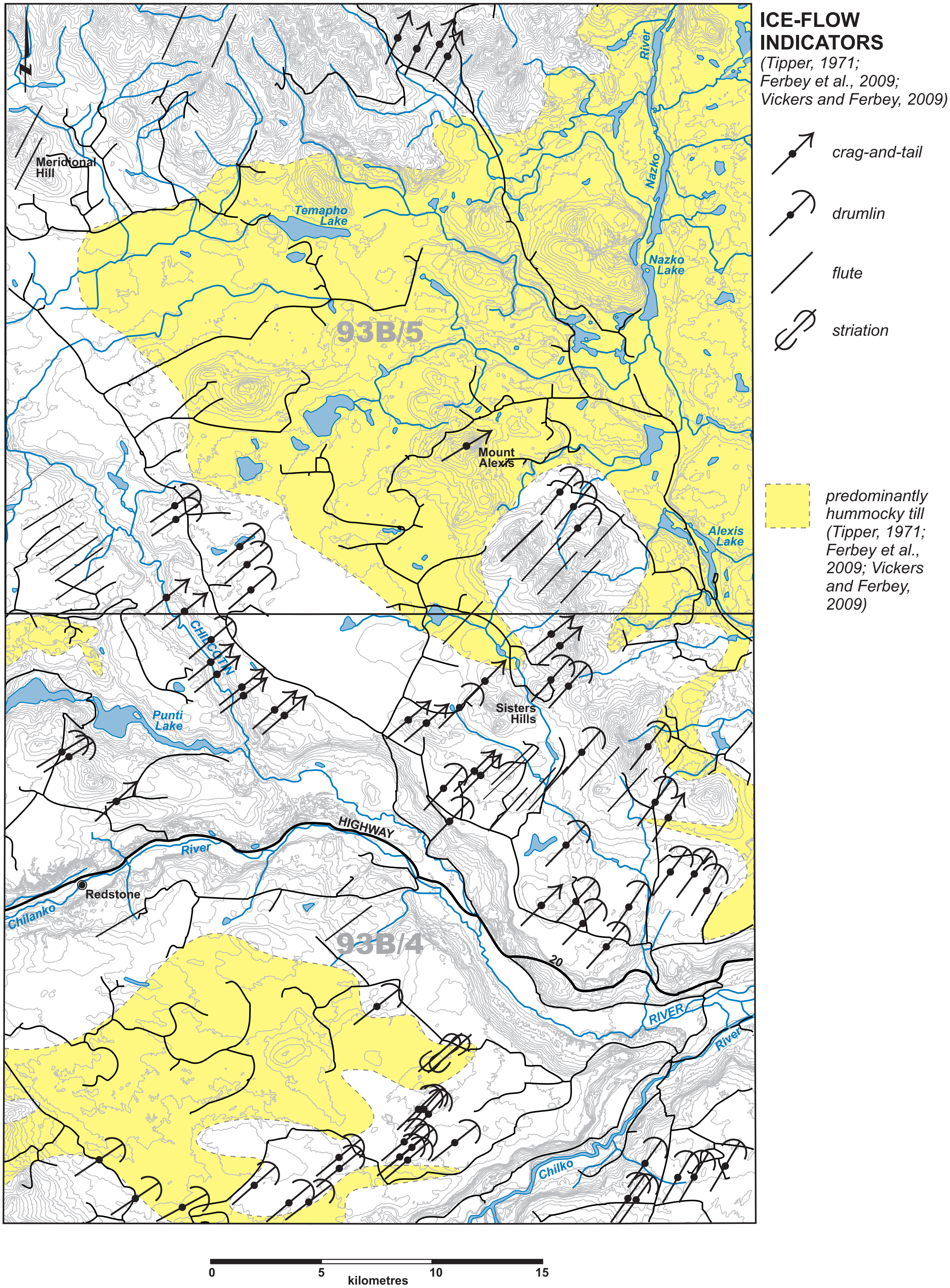

Figure 7. Summary of ice-flow indicators for the study area. Areas of hummocky till (englacial or supraglacial origin) are shown in yellow.

through the study area was towards the northeast.

The proximity of the study area to accumulation centres such as the Coast and Cariboo mountains resulted in a complex late-glacial and deglacial history. To the west, a late-glacial readvance was identified by Tipper (1971), Giles and Kerr (1993) and Proudfoot (1993) and named the Anahim Lake advance. Piedmont lobes, fed by valley glaciers originating in the Coast Mountains to the west, flowed on to the Fraser Plateau and fanned out to the north, east and southeast. Based on differential ice-flow directions and the occurrence of pitted and kettled terrain, a limit of this advance has been placed within the eastern portions of NTS 93C (Tipper, 1971; Giles and Kerr, 1993; Proudfoot, 1993). A similar readvance is thought to have occurred east of the study area. There, ice advanced west out of the Cariboo Mountains and fanned out on to the Fraser Plateau. Lateral overflow channels and intersections of drumlinoid forms associated with this readvance, and those associated with the northeasterly flow of the Cordilleran Ice Sheet during the Late Wisconsinan glacial maximum, indicate that this readvance crossed and extended up to 30 km west of the Fraser River valley (Tipper, 1971). It has also been proposed that a late-glacial advance, named the Kleena Kleene, occurred down Kleena Kleene, Tatlayoko, Tatla and Chilko valleys. Along the Tatla Lake valley, an elevation limit of approximately 1200 m has been suggested for this advance (Tipper, 1971).

Given the complex nature of late-phase glacial conditions it is not unreasonable to assume that the early stages of Late Wisconsinan glaciation, during the lead-up to the glacial maximum, were similarly complex. This would of course have an effect on the detrital transport of underlying bedrock lithologies and whether at the glacial maximum the Cordilleran ice sheet was consuming pre-existing Late-Wisconsinan glacial sediments or bedrock, or some combination thereof. This complex early-glacial history of the study area could have resulted in an attenuation of geochemical signatures of drift-covered bedrock lithologies.

Deglaciation was dominated by thinning and downwasting of ice masses (cf. Fulton, 1991). This resulted in higher ground being exposed first, leaving valleys choked with stagnant ice. Hummocky till, glaciofluvial deposits and eskers (in valley settings and on the plateau surface) support this interpretation. In the northern part of the study area, these deglacial features are likely related to the Cordilleran Ice Sheet during the waning stages of the Fraser glaciation. In the southern portions of the study area, however, it is unclear whether they are related to retreat of the Cordilleran Ice Sheet or to the later Kleena Kleene readvance. The occurrence of lateral meltwater channels and a rare recessional moraine suggest that there was some minor component of marginal retreat during deglaciation.

TILL GEOCHEMICAL SURVEYS

Basal till, a first derivative of bedrock (Shilts, 1993), is transported in a relatively linear fashion parallel to ice-flow direction, down-ice from its bedrock source. The contrast between elevated and background geochemical values is clear and the area represented by till samples with elevated values can be more extensive than that of their bedrock source. The geochemical patterns found in basal till produce a regional signature which is in contrast to that of residual soils and bedrock-derived colluvium, which typically reflect more local geochemical variations in bedrock (Levson, 2001a). The relatively simple transport history of basal till can make it an effective tool for tracing elevated geochemical values back to their bedrock source.

Till geochemical surveys have not been conducted within the study area. Till samples were collected, however, within NTS 93C/01, 08, 09 and 16 to assess the mineral potential of these areas (Giles and Kerr, 1993; Proudfoot, 1993; Lett et al., 2006). Three areas highlighted by Lett et al. (2006) as being prospective have since been discovered to host mineralization (Mihalynuk 2008a, b, 2009a, b). Plouffe and Ballantyne (1993), Plouffe and Ballantyne (1994), Plouffe (1997) and Plouffe et al. (2001) conducted till geochemistry surveys to the north and south of the study area. To the north of the study area, in the Fawnie Creek map area (093F/03), Cook et al. (1995) conducted a comparative study on the ability of regional lake sediment and till geochemistry surveys to identify known mineral occurrences. In this study, till geochemistry identified all seven known prospects in the study area with >95th percentile element concentrations. Nine of eleven potential new geochemical prospects presented in the study were also identified with till samples, which had >95th percentile concentrations of multiple elements.

METHODOLOGY

While conducting a till geochemistry program, it is imperative that the sample medium is correctly identified. This ensures consistency between sample sites and understanding of the origin and mode of sediment transport and deposition (Levson, 2001a). To this end, sedimentological data, such as texture, colour, thickness, primary and secondary structures, density, matrix percentage, clast mode, shape and presence of striae, were collected at each sample site in order to ensure the proper discrimination of basal till from other sediment types such as colluvium, debris flows and glaciolacustrine diamict. As well, at each sample site, notes were made on the type of exposure sampled, terrain map unit, sample site geomorphology (e.g., topographic position, aspect, slope, drainage), stratigraphy, and type and thickness of soil horizons present. This information can be critical when interpreting resultant geochemical data.

Clasts in till were examined in detail at most sites; data such as lithology, angularity, size, presence of striae, and occurrence of mineralization were recorded. From these data, inferences on clast provenance were made. These same data can provide additional insight into local, covered bedrock units.

Interpretation of trace element, heavy mineral, and clast lithological data, from basal tills, must always take into account transport direction (i.e. ice-flow history) as the bedrock source of elevated clast, mineral, and (or) element values is some distance in the up-ice direction.

Sample Collection

As part of this study, 117 basal till samples (2 to 3 kg) were collected for major, minor and trace-element geochemical analyses, while 38 basal till samples (10 to 15 kg) were collected for analysis of heavy mineral concentrates and for gold grain counts. Sample sites were selected to optimize spatial coverage, taking into account ice-flow direction and availability of appropriate sample material.

The average till sample density for the survey is one sample per 15 km^2. This is lower than other regional-scale till geochemistry surveys conducted in central British Columbia, which have sample densities of approximately one sample per 5 to 10 km^2 (Levson, 2002; Levson and Mate 2002; Lett et al., 2006). The lower density is mainly due to the absence of appropriate sample media in the study area and to limited access (e.g., deactivated Forest Service roads, private land). Till samples were collected mainly from roadcuts but also from soil pits and gullies (Figure 8). Average sampling depth was 100 cm below surface, but ranged from 45 to 511 cm.

Sample Preparation and Analysis

Till samples collected for major, minor and trace-element analyses were sieved to produce a silt- plus clay-sized fraction (<0.063 mm) and sieved, decanted and centrifuged to produce a clay-sized fraction (<0.002 mm). This sample preparation was conducted at the Geological Survey of Canada's Sedimentology Laboratory (Ottawa), following procedures outlined by Girard et al. (2004). 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 liquid separation techniques.

For the 2 to 3 kg samples, minor and trace-element analyses (37 elements) were conducted on splits of the silt- plus clay-sized (<0.063 mm) and clay-sized (<0.002 mm) fractions, respectively, by inductively coupled plasma mass spectrometry (ICP-MS), following an aqua regia digestion. Major and minor element analyses were conducted on a split of the silt- plus clay-sized (<0.063 mm) 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 by Acme Analytical Laboratories Limited, Vancouver, BC.

Also as part of this project, a split of the silt- plus clay-sized (<0.063 mm) fraction was analyzed for 35 elements by instrumental neutron activation analysis (INAA) at Becquerel Laboratories Incorporated, Mississauga, ON. Additionally, INAA determinations were conducted on bulk heavy mineral concentrates produced from the 10 to 15 kg samples.

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

Figure 8. Example of a sample site in NTS 93B/05 (08TFE6026). Note blocky structure of basal till. This sample was collected 85 cm below surface.

Element	Detection Limit
Ag	2 ppb
Al	0.01 %
As	0.1 ppm
Au	0.2 ppb
B	20 ppm
Ba	0.5 ppm
Bi	0.02 ppm
Ca	0.01 %
Cd	0.01 ppm
Co	0.1 ppm
Cr	0.5 ppm
Cu	0.01 ppm
Fe	0.01 %
Ga	0.1 ppm
Hg	5 ppb
K	0.01 %
La	0.5 ppm
Mg	0.01 %
Mn	1 ppm
Mo	0.01 ppm
Na	0.001 %
Ni	0.1 ppm
P	0.001 %
Pb	0.01 ppm
S	0.02 %
Sb	0.02 ppm
Sc	0.1 ppm
Se	0.1 ppm
Sr	0.5 ppm
Te	0.02 ppm
Th	0.1 ppm
Ti	0.001 %
Tl	0.02 ppm
U	0.1 ppm
V	2 ppm
W	0.1 ppm
Zn	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
Ag	2 ppm
As	0.5 ppm
Au	2 ppb
Ba	50 ppm
Br	0.5 ppm
Cd	5 ppm
Ce	5 ppm
Co	5 ppm
Cr	20 ppm
Cs	0.5 ppm
Eu	1 ppm
Fe	0.2%
Hf	1 ppm
Ir	50 ppb
La	2 ppm
Lu	0.2 ppm
Mo	1 ppm
Na	0.05%
Ni	10 ppm
Rb	5 ppm
Sb	0.1 ppm
Sc	0.2 ppm
Se	5 ppm
Sm	0.1 ppm
Sn	100 ppm
Ta	0.5 ppm
Tb	0.5 ppm
Te	10 ppm
Th	0.2 ppm
Ti	500 ppm
U	0.2 ppm
W	1 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.

data, including calculated visible gold (ppb) are presented in Appendix D.

QUALITY CONTROL

Field duplicates (taken at a randomly selected sample site) are used here to measure the combined sample site and analytical variability. Analytical duplicates (a random sample split after sample preparation but before analysis) are used here to assess both within sample and analytical variability. Reference standards (certified Canada Centre for Mineral and Energy Technology (CANMET) and in-house standards developed by the Geological Survey of Canada (GSC)) were used here to assess analytical accuracy. These quality control procedures have been implemented to assess the reliability of analytical determinations. In any geochemical survey it is critical to differentiate between geochemical trends that are a product of contrasts in bedrock lithologies from those that are a product of random and systematic sampling or analytical errors (Levson, 2001a).

For this study, 14 field duplicate (FDUP) samples were collected (i.e., 7 duplicate pairs). In Appendices A to B, FDUP 10 identifies the first sample collected at a field duplicate sample site while FDUP 20 is the second sample collected at the same sample site. Thirteen analytical duplicates and four reference standards were inserted into the sample sequence before analysis.

Copper, Mo, Pb, Zn, Ag, Ni, and Hg by ICP-MS and 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.

High correlation coefficients (R^2>0.8) indicate good reproducibility, and suggest a relatively high degree of sampling and analytical precision. In the case of Pb and Zn 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).

The majority of R^2 values for ADUP samples are higher than those for FDUP samples (i.e. Mo, Cu, Ag, Sb, As, and Cr). This is to be expected as variability within a specific sample should be less than variability at a sample site. In general, R^2 values of ADUP samples are high (seven of nine elements have R^2>0.9). The exception to this are Pb ADUP values (R^2=0.647) which appear to be the most variable of any of the elements in either of the duplicate datasets. Certified values for CANMET standards used in this study, and values determined for this study, are presented in Table 3.

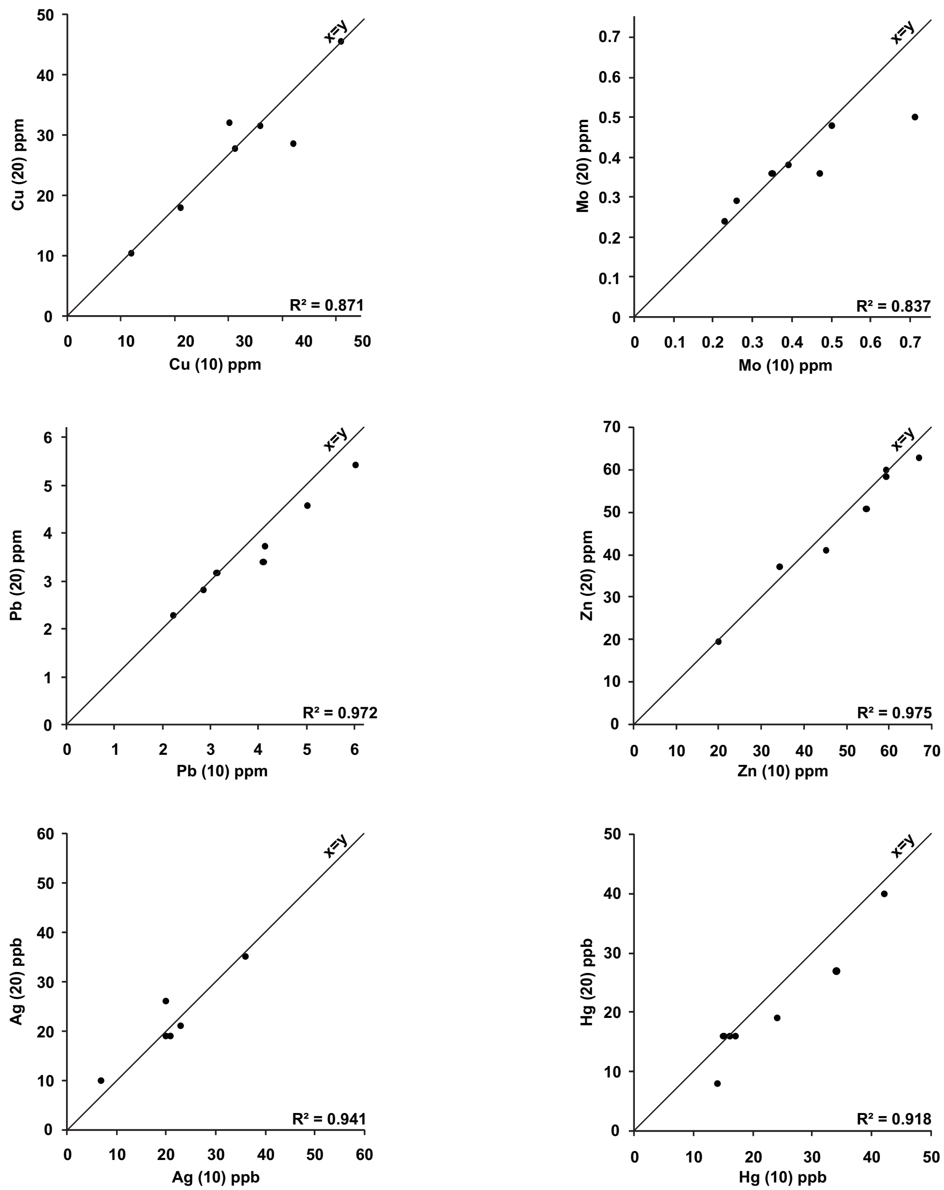

Figure 9. Field duplicate scatter plots for the Cu, Mo, Pb, Zn, Ag, and Hg determinations by aqua regia ICP-MS (n=7).

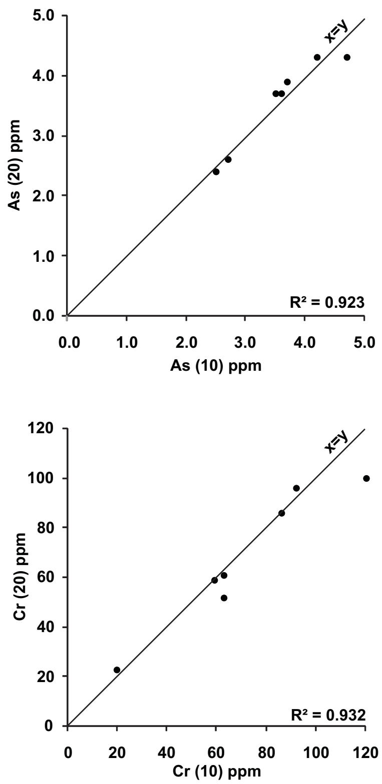

Figure 10. Field duplicate scatter plots for the As, Sb, and Cr determinations by INAA (n=7).

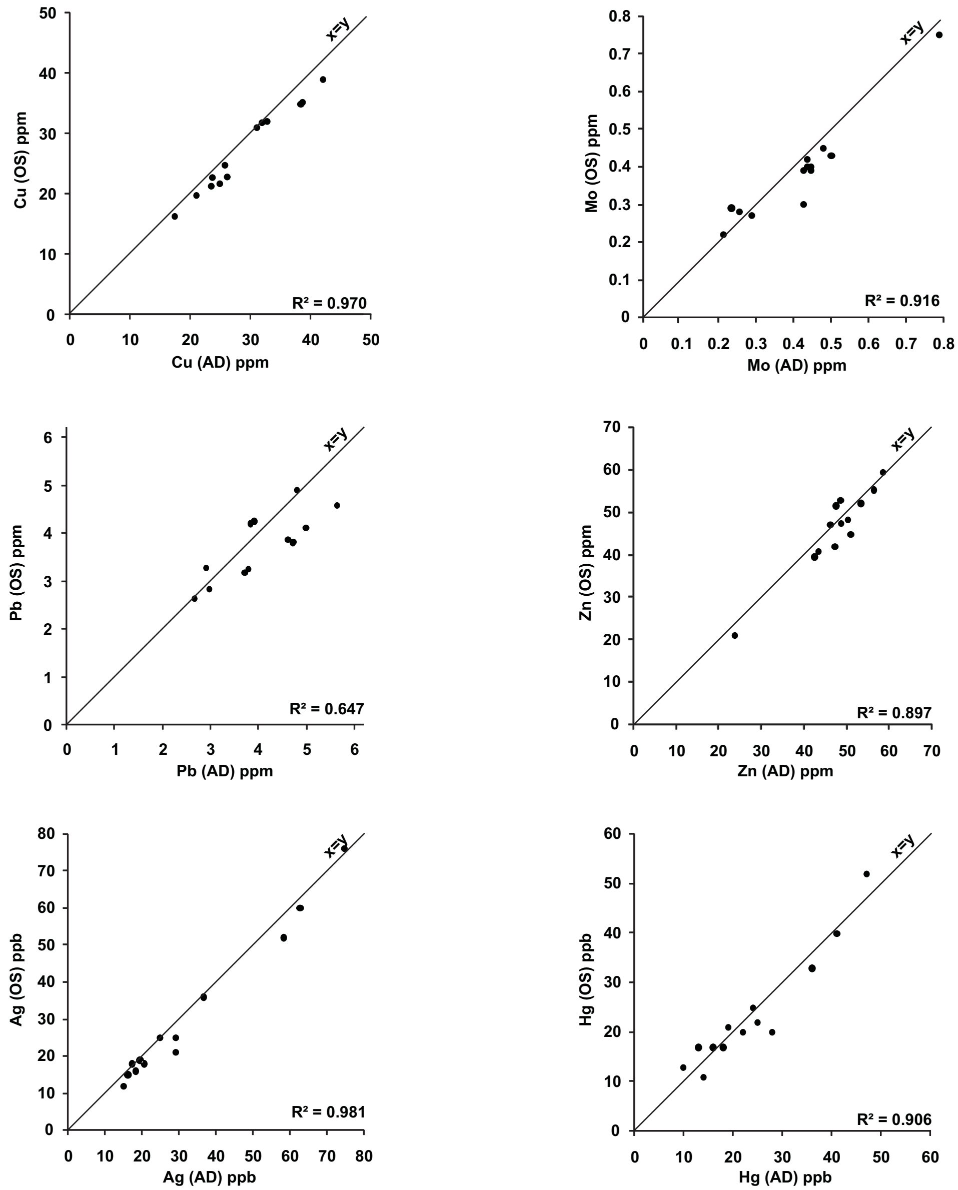

Figure 11. Analytical duplicate scatter plots for the Cu, Mo, Pb, Zn, Ag, and Hg determinations by aqua regia ICP-MS (n=13). In this figure the distinction is made between element values in the original sample (OS) and the analytical duplicate (AD).

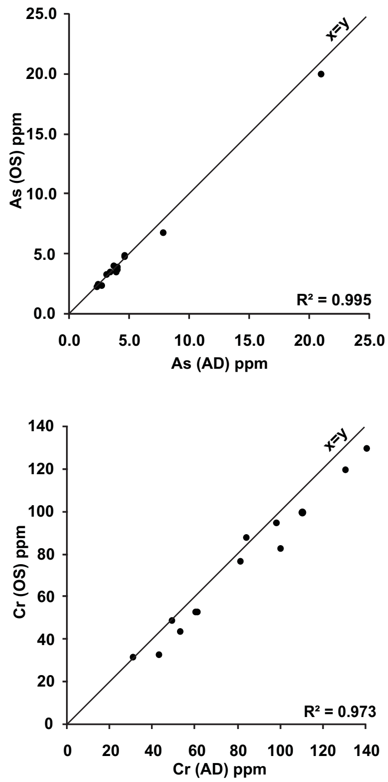

Figure 12. Analytical duplicate scatter plots for As, Sb, and Cr determinations by INAA (n=13). In this figure the distinction is made between element values in the original sample (OS) and the analytical duplicate (AD).

	Cu	Mo	Pb	Zn	Ag	Ni	Hg
UM-2							
this study	944.8	1.09	59.19	12	3.29	3219.2	0.111
certified value	950	n/a	n/a	n/a	n/a	2900	n/a
TDB-1							
this study	311.39	0.75	16.99	85.5	0.129	25.2	0.007
certified value	323	1.6	17	155	0.5	92	n/a

Table 3. Summary statistics for certified Canada Centre for Mineral and Energy Technology (CANMET) standards used in this study, UM-2 and TDB-1. All units are ppm. In cases where certified values are not available, "n/a" has been used. The values presented for this study are single determinations (by aqua-regia ICP-MS) not average values.

TILL GEOCHEMICAL DATA

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

Summary statistics for Cu, Mo, Pb, Zn, Ag, Ni, Hg, As, Cr, and Sb 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., FDUP 20; 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=117).

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 element values, and their spatial distribution, for the elements of interest.

Copper

Median Cu for the study area is 25.34 ppm. The maximum value of 46.45 ppm (sample 08TFE2045) occurs in the southeast corner of 94B/04, southeast of Chilko River (Figure 13). Adjacent to it is the sample with the second highest concentration of Cu (41.92 ppm; sample 08TFE2042). These same two samples have 94th and >98th percentile concentrations of Cr, respectively (120 and 160 ppm; Figure 22). Samples in this general same area are also elevated in Ni and Hg (Figures 18 and 19). This area is underlain by Chilcotin Group basalt flows and the only other mapped bedrock unit in this area is a small outcrop of Skeena Group sediments on

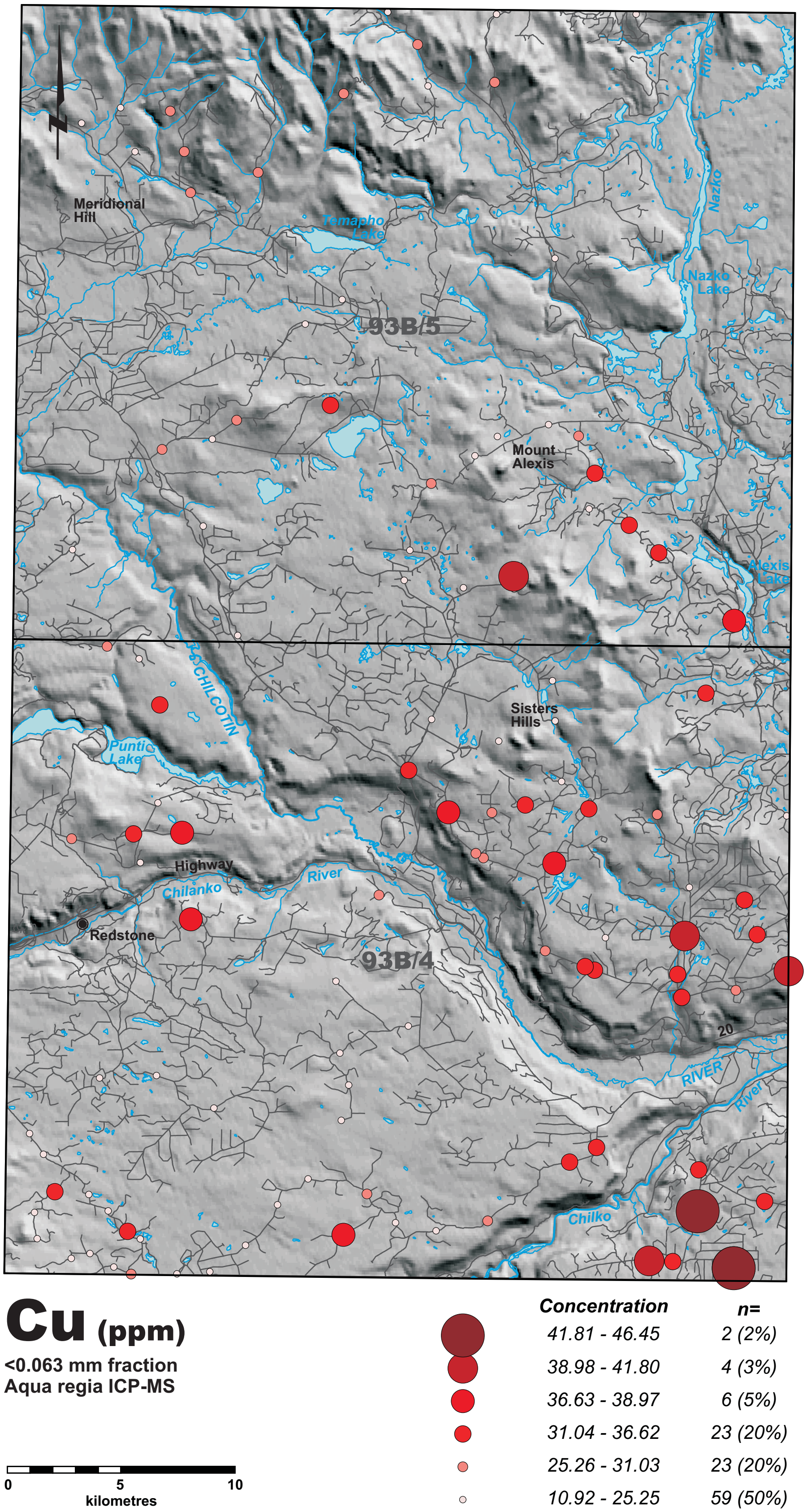

Figure 13. Proportional symbol plot for Cu values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

	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	46.45	0.82	8.73	67.6	89	64.0	186
minimum	10.92	0.12	1.67	16.5	7	5.3	5
mean	26.80	0.38	3.88	45.4	28	26.9	26
median	25.34	0.39	3.95	47.2	23	25.4	22
mode	23.26	0.39	4.00	38.9	18	10.1	14
n=	117	117	117	117	117	117	117

Table 4. Summary statistics for aqua regia ICP-MS data (n=117), for the silt plus clay-sized fraction (<0.063 mm).

	As (ppm) INAA	Sb (ppm) INAA	Cr (ppm) INAA
detection limit	0.5	0.1	20
maximum	20.0	1.0	180.0
minimum	1.5	0.2	20.0
mean	3.8	0.6	76.6
median	3.5	0.6	76.0
mode	3.5	0.6	130
n=	117	117	117

Table 5. Summary statistics for INAA data (n=117), for the silt plus clay-sized fraction (<0.063 mm).

Chilko River, just upstream of the Chilcotin River valley.

From here, extending to the north-northwest is a group of samples with above background concentrations of Cu, including three samples with >95th percentile Cu concentrations. Although 90th percentile concentrations do occur south and southeast of Mt. Alexis (within Endako Group volcanics), this trend begins to break down on the southern flanks of Sisters Hills (near the contact with Chilcotin Group basalts and Endako Group Volcanics). On the west half of the study area the spatial distribution of above-background Cu values does seem to be more random.

Molybdenum

Median Mo for the study area is 0.39 ppm. The maximum value of 0.82 ppm (sample 08TFE2511) occurs in the northwest corner of 93B/04, just north of Punti Lake (Figure 14). This same sample also has 98th percentile Ag concentrations (62 ppb; Figure 17). This area is underlain by Chilcotin Group basalt flows and is located down-ice of Hazelton Group andesites. The second highest Mo value (0.75 ppm; sample 08TFE2041) occurs due east of this sample, northwest of the Chilcotin River valley, <1 km down-ice of Skeena Group sediments. Samples with 95th percentile concentrations are dispersed throughout 93B/05. It is interesting to note the dominance of Mo values at or below background in the southern half of

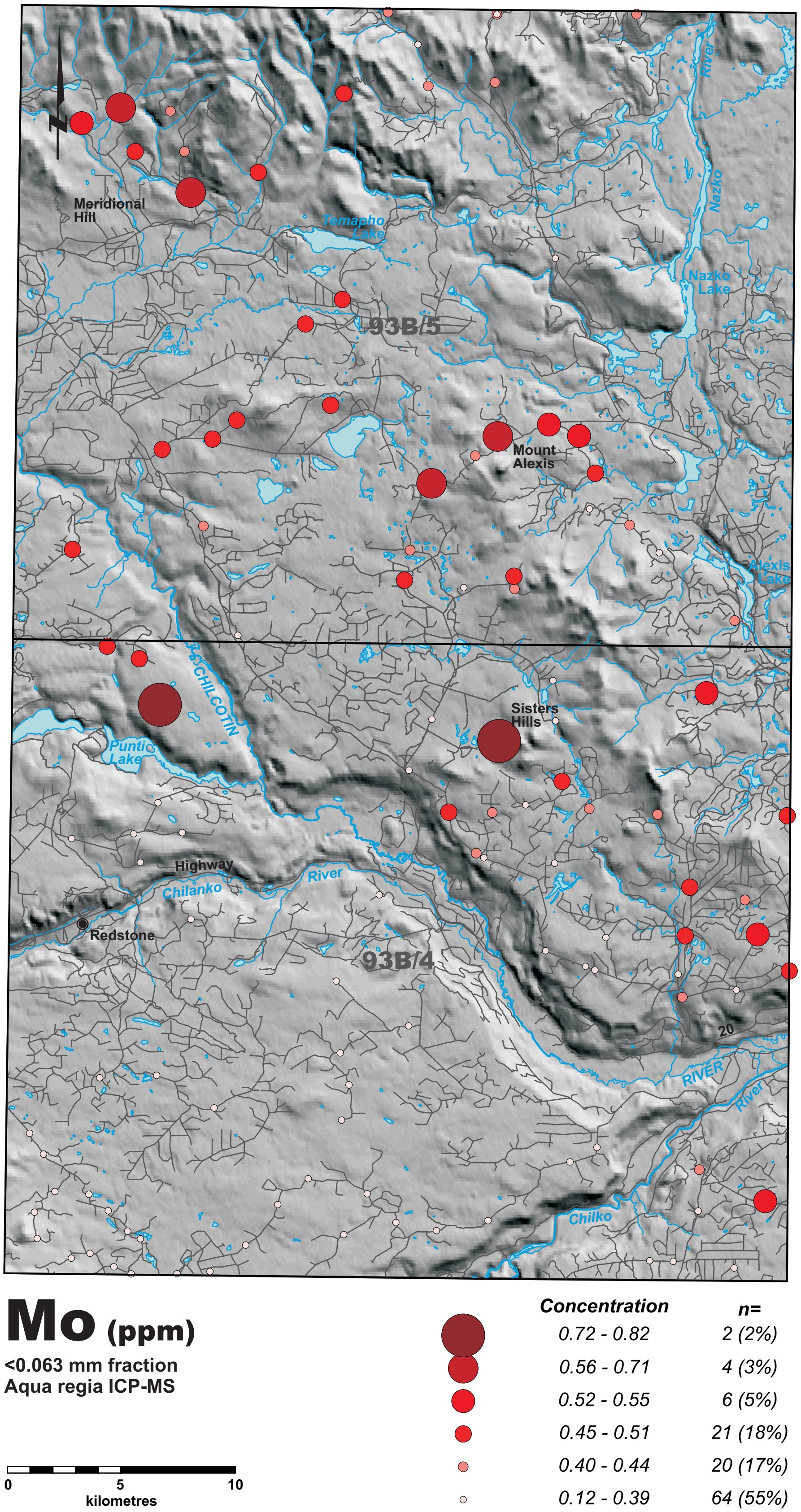

Figure 14. Proportional symbol plot for Mo values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

93B/04, south and southwest of the Chilanko and Chilcotin river valleys. This is a pattern that is repeated in Pb, Zn, Ni, and Cr values.

Lead

Median Pb for the study area is 3.95 ppm. The maximum value of 8.73 ppm (sample 08TFE6037) occurs on high ground in the north-central portion of 93B/05 (Figure 15). This same sample has 94th percentile Cr concentrations (120 ppm; Figure 22). The second highest Pb value (6.56 ppm; sample 08TFE6008) occurs to the south-southeast, just east of Mt. Alexis, where Pb values of 5.92 and 5.17 ppm also occur. Both of these samples are located down-ice of Endako Group volcanics, thought to be predominantly andesites. As with Mo, Zn, Ni, and Cr values (Figures 14, 16, 18, and 22) the majority of samples in the southwest portion of 93B/04 (southwest and south of Chilcotin and Chilanko rivers, respectively) have Pb values at or below background concentrations.

Zinc

Median Zn for the study area is 47.2 ppm. The maximum value of 67.6 ppm (sample 08TFE6509) occurs in the northwest corner of 93B/05, west-northwest of Temapho Lake (Figure 16). This same sample has 98th percentile Mo concentrations (0.56 ppm; Figure 14). It is located within Ootsa Lake Group andesites, approximately 1.5 km down-ice of Chilcotin Group basalts. The second highest Zn concentration (66.8 ppm; sample 08TFE2539) occurs northeast of Chilcotin River (southeast of Sisters Hills), upstream of its confluence with Chilanko River. As with Cu, Pb, Ni and Cr (Figures 13, 15, 19, and 22) there are samples located in the east-central portion of 93B/04 with 90th and 98th percentile concentrations of Zn. These samples are in contrast to samples located southwest of Chilanko River that have Zn concentrations at or below background values. Areas up-ice of these samples elevated in Zn are all underlain by Chilcotin Group basalt flows.

Silver

Median Ag for the study area is 23 ppb. The maximum value of 89 ppb (sample 08TFE6014) occurs in south-central 93B/05, within Endako Group andesites, 3.5 km down-ice of Chilcotin Group basalts (Figure 17). The sample with the second highest Ag value (85 ppb; 08TFE6514) occurs 16 km northwest of there, within Chilcotin Group basalts, and is surrounded by samples with Ag values at or below background.

With the exception of >98th percentile concentrations discussed above, all >90th percentile Ag concentrations occur in 93B/04. There are four neighbouring samples in east-central 93B/04 with values ranging from 52 to 60 ppb (samples 08TFE2029, 2028, 2032, and 2529), and three neighbouring samples in the southeast corner of 93B/04 with values ranging from 53 to 67 ppb. These same areas have been discussed above as having above background Cu, Pb, Zn, Ni, and Cr values (Figures 13, 15, 16, 18, 22).

Nickel

Median Ni for the study area is 25.4 ppm. The maximum value of 64.0 ppm (sample 08TFE2023) occurs in the southeast corner of 93B/04 on the west side of the Chilko River valley while the second highest Ni value occurs just to the southeast (sample 08TFE2042), on

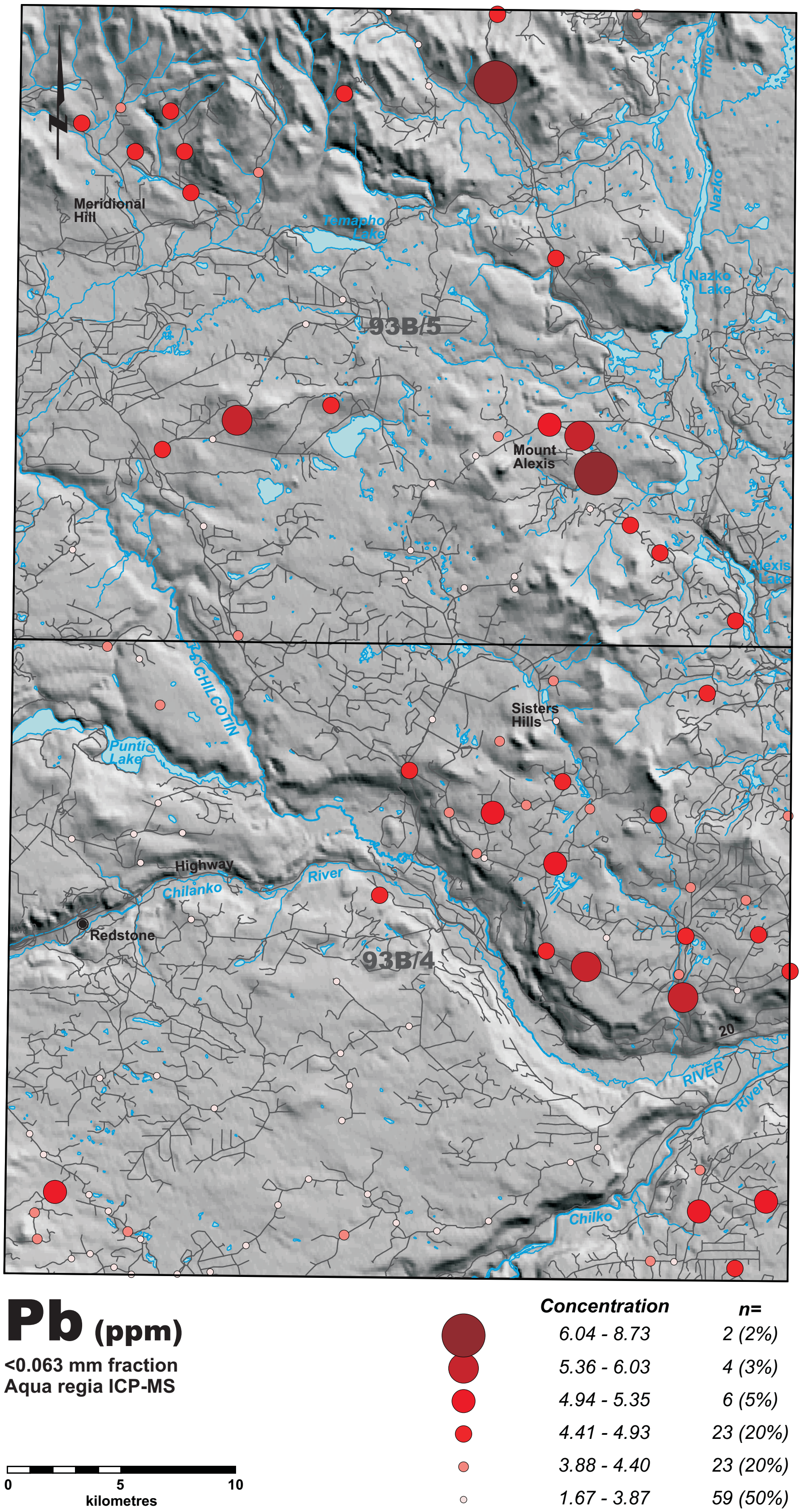

Figure 15. Proportional symbol plot for Pb values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

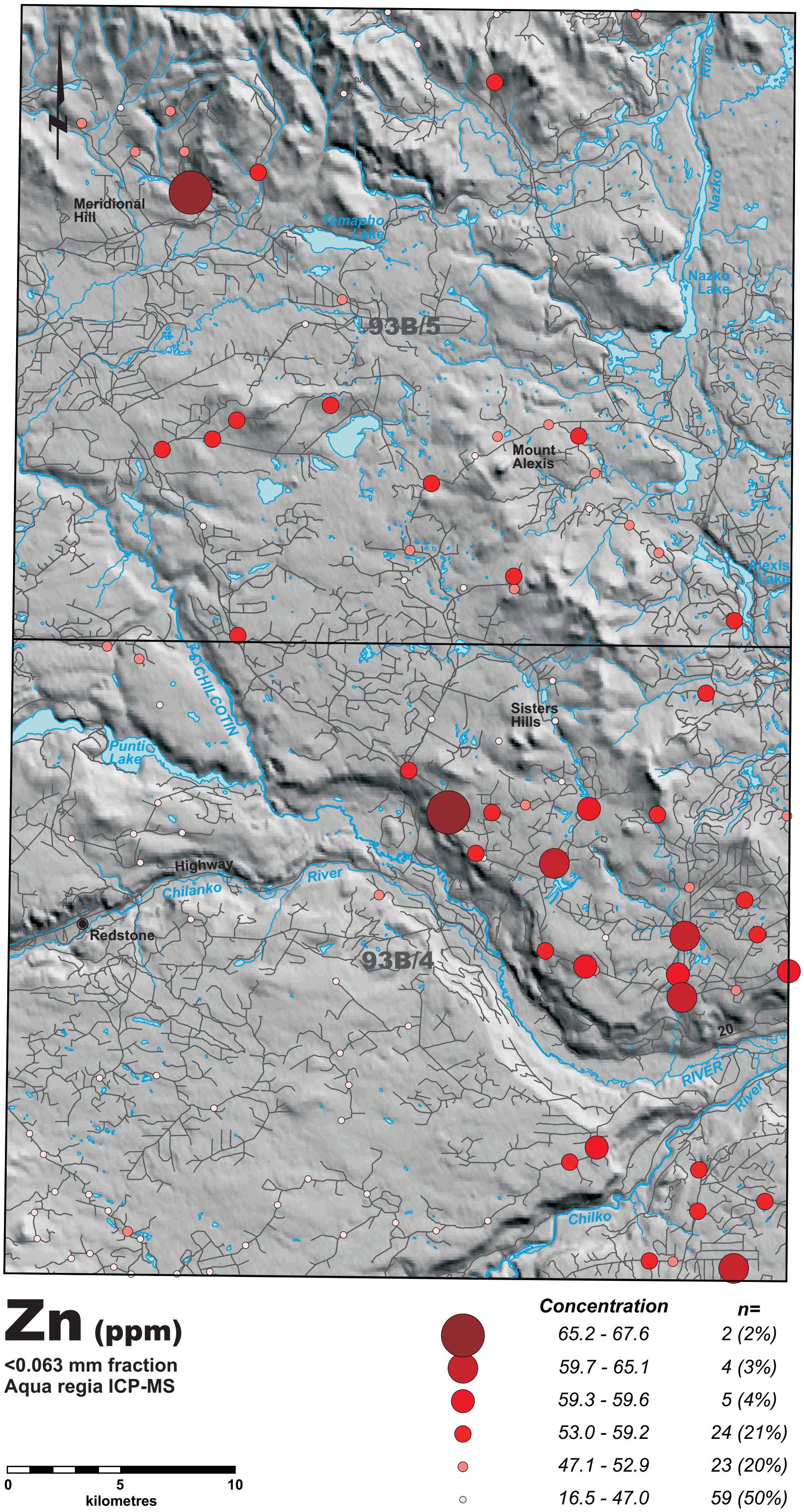

Figure 16. Proportional symbol plot for Zn values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

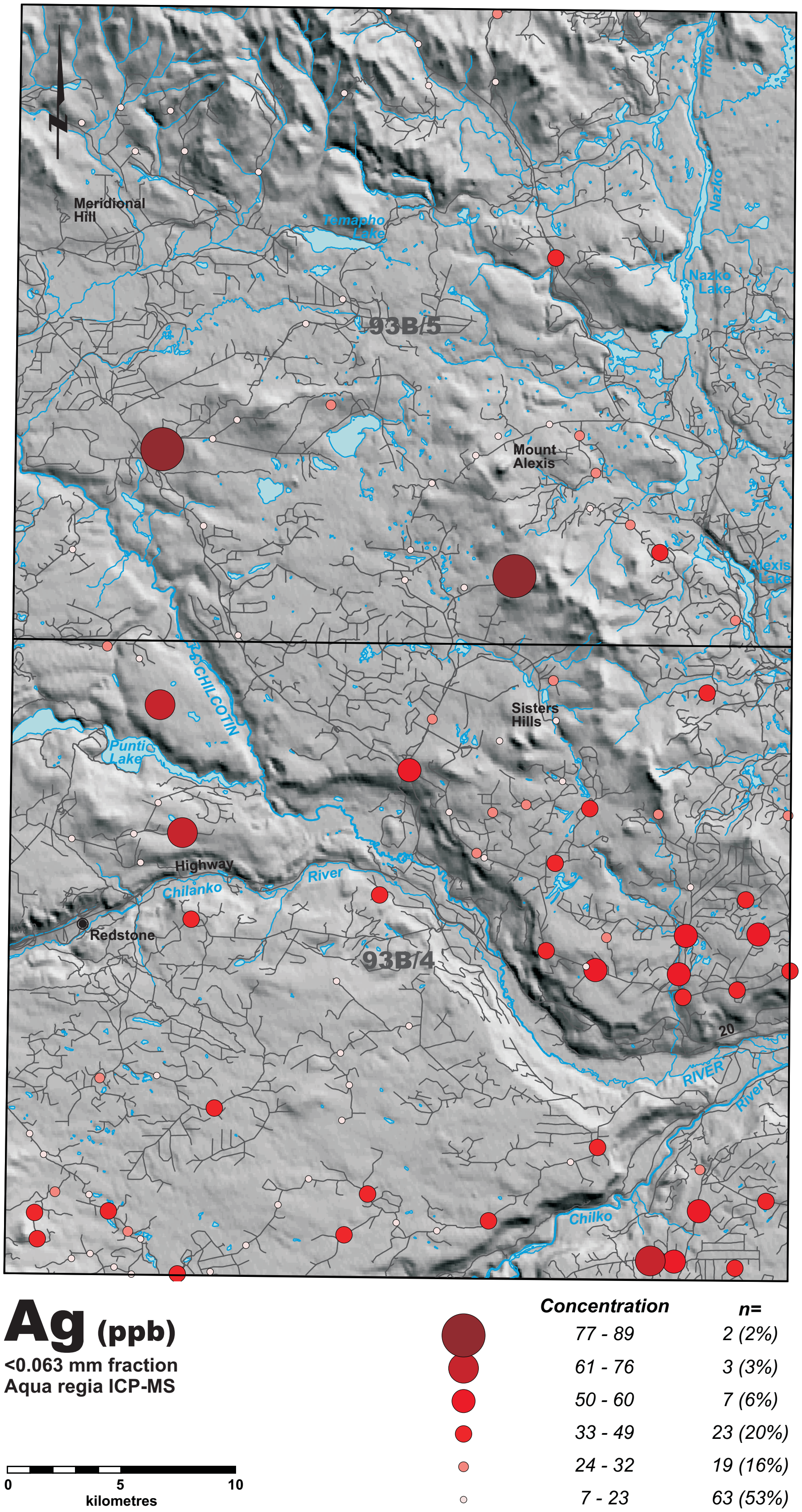

Figure 17. Proportional symbol plot for Ag values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

the opposite side of Chilko River (Figure 18). These same two samples have 95th and >98th percentile Cr values, respectively (150 and 160 ppm; Figure 22). Sample 08TFE2042 also has the maximum Hg value (186 ppb; Figure 19). In general, samples located in the southeast corner of 93B/04 are elevated in Ni (Figure 18). This area is underlain by Chilcotin Group basalt flows and there are no known mafic or ultramafic intrusives in the area. There is, however, a small outcrop of Skeena Group sediments on Chilko River, just upstream of the Chilcotin River valley.

From here there is a general trend of samples extending towards the northwest with above-background Ni values (Figure 18). There is a similar distribution of above-background values of Cu, Pb, Hg, and Cr (Figures 13, 15, 19, and 22).

As previously mentioned, the two till units observed in contact with one another, on the northern boundary of 93B/05, were sampled for geochemical analyses. Not only are these two basal tills different physically but also geochemically. Sample 08TFE6033 was collected from the upper grey coloured unit and contains 95th percentile Ni (50.8 ppm; collected 148 cm below surface), while sample 08TFE6034 was collected from the lower reddy-brown coloured unit and contains 70th percentile Ni (27.5 ppm; collected 511 cm below surface).

Mercury

Median Hg for the study area is 22 ppb. As previously mentioned, the maximum value of 186 ppb (sample 08TFE2042) occurs southeast of Chilko River, in the southeast corner of 93B/04 (Figure 19). This sample also has >98th percentile Ni concentrations (60.3 ppm; Figure 18) and is located within and down-ice of Chilcotin Group basalts.

As with Pb, Ni, and Cr (Figures 15, 18, and 22), there is a group of north-northwest trending samples that have above background concentrations of Hg. This group of samples begins in the very southeast corner of 93B/04 and extends to the northern flank of Mt. Alexis where it terminates at the second highest Hg value (116 ppb; sample 08TFE6504). Two other samples located to the east-northeast, on the east flank of Mt. Alexis, have 98th percentile concentrations of Hg (58 and 56 ppb). This area is underlain by Endako Group volcanics.

Arsenic

Median As for the study area is 3.5 ppm. The maximum value of 20.0 ppm (sample 08TFE2041) occurs in north-central 93B/04, on the west flank of Sisters Hills (Figure 20). This sample is directly underlain by Ootsa Lake Group andesites, and is located approximately 1 km down-ice of Skeena Group sediments. The second highest As value of 7.1 ppm (08TFE2506) occurs in the southwest corner of 93B/04, down-ice of a granitic body, the only mapped instrusive in the study area. This sample is also elevated in Sb (1 ppm; Figure 21) and is located near samples with 98th percentile concentrations of As and 90th percentile concentrations of Sb. It is interesting to note the low concentrations of some elements in samples of this same area. Here, Mo, Ni, and Cr values are at or below background concentrations.

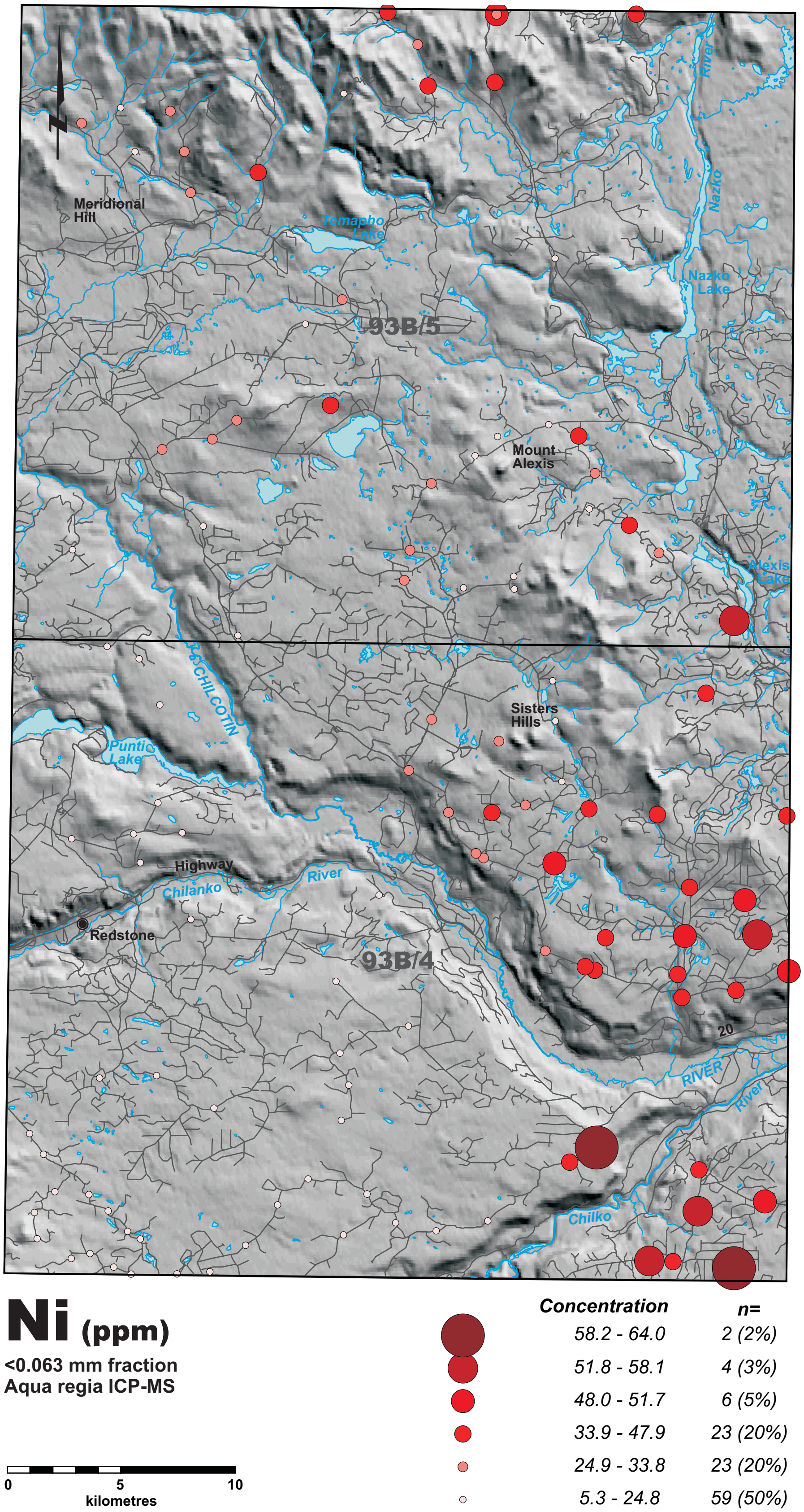

Figure 18. Proportional symbol plot for Ni values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

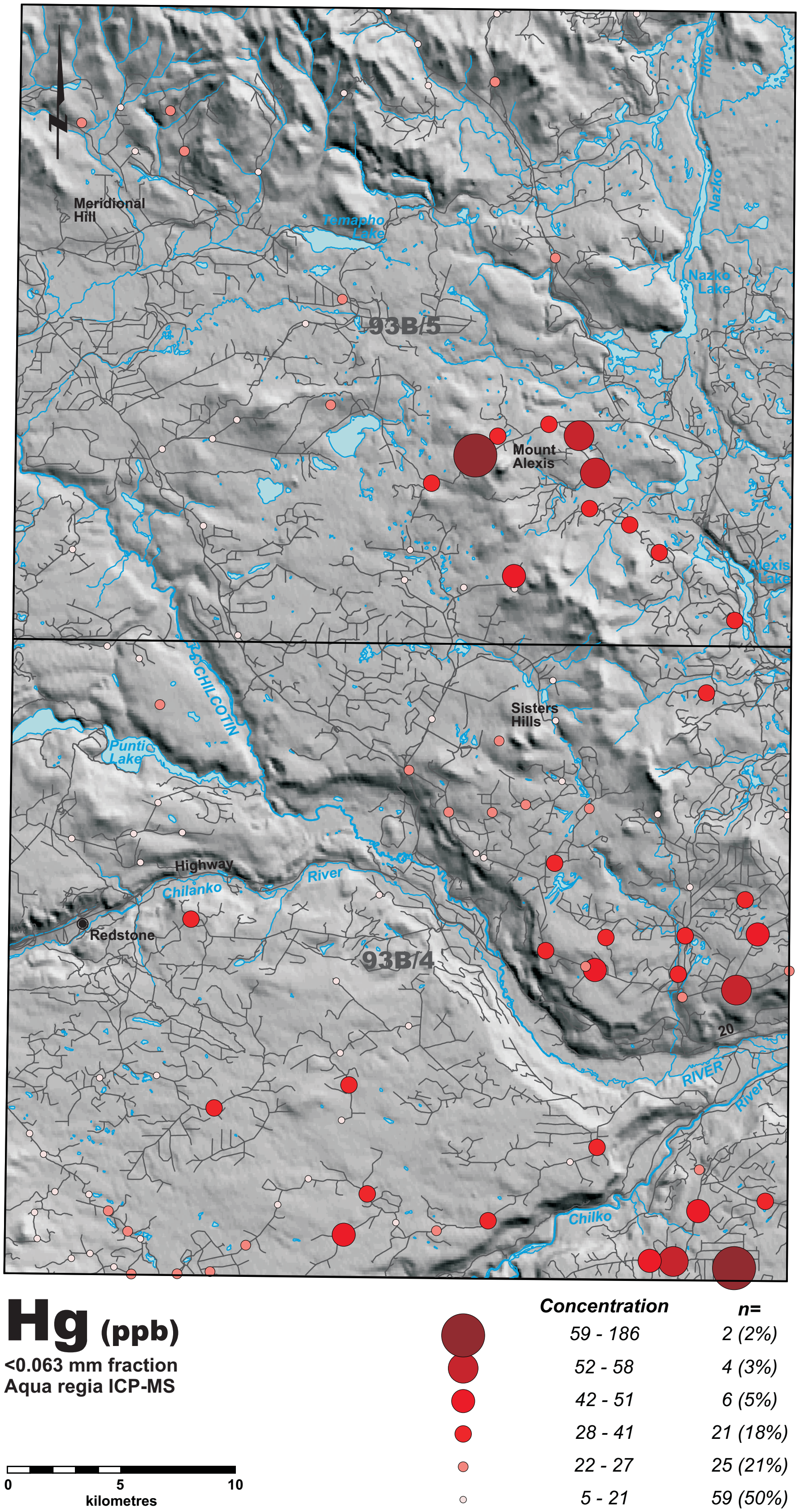

Figure 19. Proportional symbol plot for Hg values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

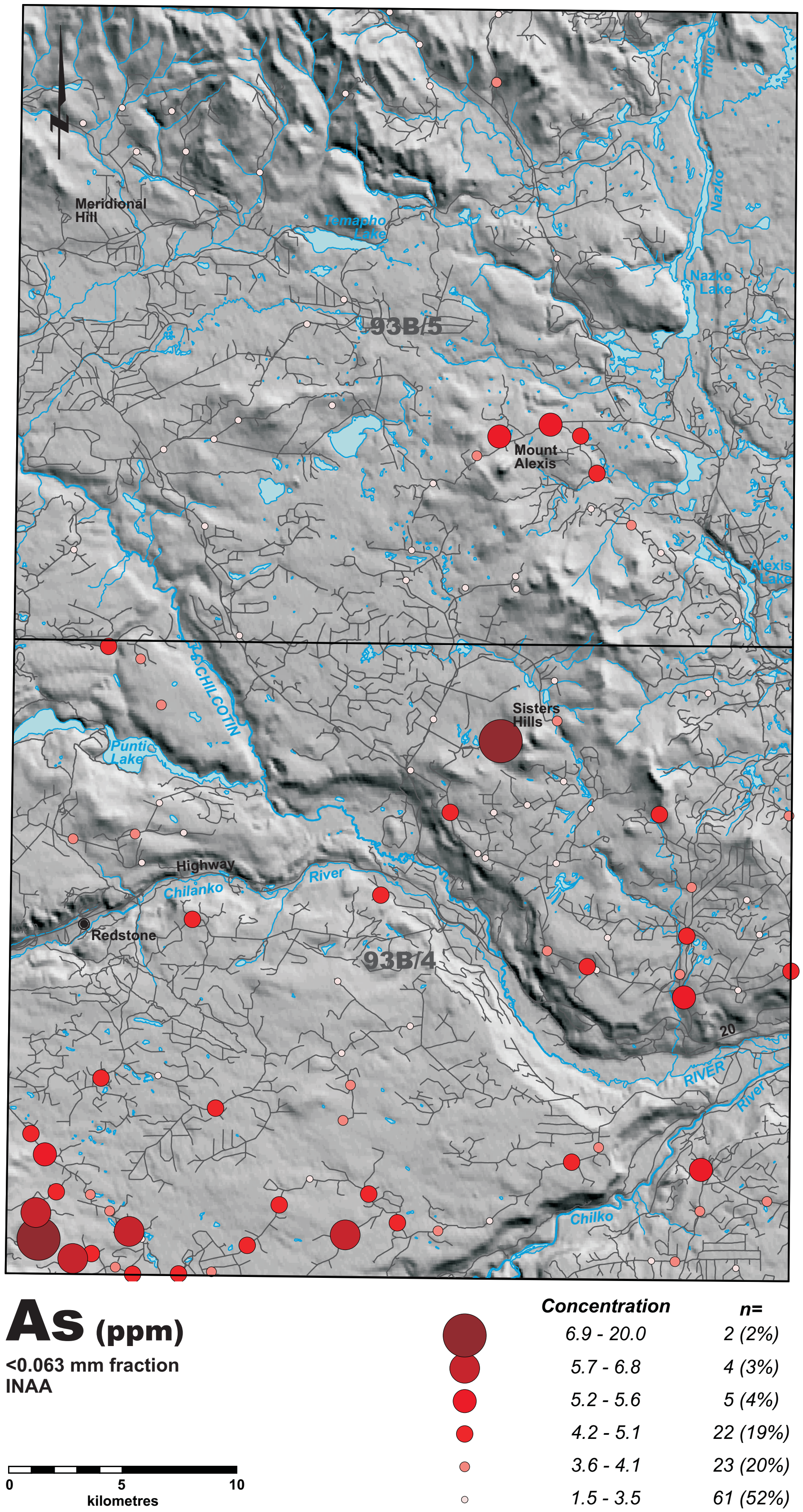

Figure 20. Proportional symbol plot for As values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

Antimony

Median Sb for the study area is 0.6 ppm. The maximum value of 1.0 ppm occurs in four samples (sample 08TFE2005, 2017, 2506, 2901) in the southwest corner of 93B/04, down-ice of a granitic body, the only mapped instrusive in the study area (Figure 21). Samples 08TFE2506 and 2901 also have >98th percentile (7.1 ppm) and 98th percentile (6.8 ppm) As concentrations (Figure 20). This area has the highest density of samples elevated in Sb. The majority of 93B/05, and much of the most northern part of 93B/04, has background level or below concentrations of Sb.

Chromium

Median Cr for the study area is 76.0 ppm. The maximum value of 180 ppm (sample 08TFE6519) occurs in north-central 93B/05, approximately 8 km north-northeast of Temapho Lake (Figure 22). Three neighbouring samples (samples 08TFE6002, 6004, and 6033) have >98th percentile Cr concentrations. Samples 08TFE6519, 6002, and 6004 are located within mapped Endako Group andesites, and are located approximately 6 km down-ice of mapped Ootsa Lake and Chilcotin group rocks. Sample 08TFE6033 is located within mapped Ootsa Lake Group rocks and is approximately 1 km down-ice of mapped Endako Group andesites Although this area has the highest density of adjacent samples with elevated Cr values, these same samples have near-background values for all other elements presented here. The only exception is sample 08TFE6037, located approximately 3.5 km to the southeast, which has the highest Pb concentration (8.73 ppm; Figure 15) in the study area.

The second highest Cr value of 160 ppm (sample 08TFE2042) occurs in the southeast corner of 93B/04, southeast of Chilko River. This same sample as the highest Hg (186 ppb; Figure 19) and second highest Cu (41.92; Figure 13) and Ni (60.3 ppm; Figure 18) values. Also in this same area are samples with >98th percentile Cu, 98th percentile Ni and Hg, and 95th percentile Cr values. On the northwest side of Chilko River is a sample with 150 ppm Cr (sample 08TFE2023; Figure 22). These samples are all located within mapped Chilcotin Group basalts.

As with Ni, Cr values in the two till units exposed on the northern boundary of 94B/05 are different. Sample 08TFE6033, collected from the upper grey unit, contains 98th percentile Cr (140 ppm; collected 148 cm below surface), while sample 08TFE6034, collected from the lower reddy-brown coloured unit, contains 50th percentile Cr (56 ppm; collected 511 cm below surface).

Visible Gold

The median value of visible Au grains (normalized to weight of sediment processed) is 0.21 grains/kg. The maximum value of 0.94 grains/kg (sample 08TFE2013) occurs in the southwest corner of 93B/04, down-ice of a granitic body, the only mapped intrusive in the study area (Figure 23). Samples with above background concentrations of As, Sb, and visible Au (0.22 to 0.53 grains/kg) also occur in this same area (Figures 20 and 21).

The second highest concentration of visible Au (0.78 grains/kg; sample 08TFE2020) occurs in south-central 93B/04, east of 08TFE2013. Located in

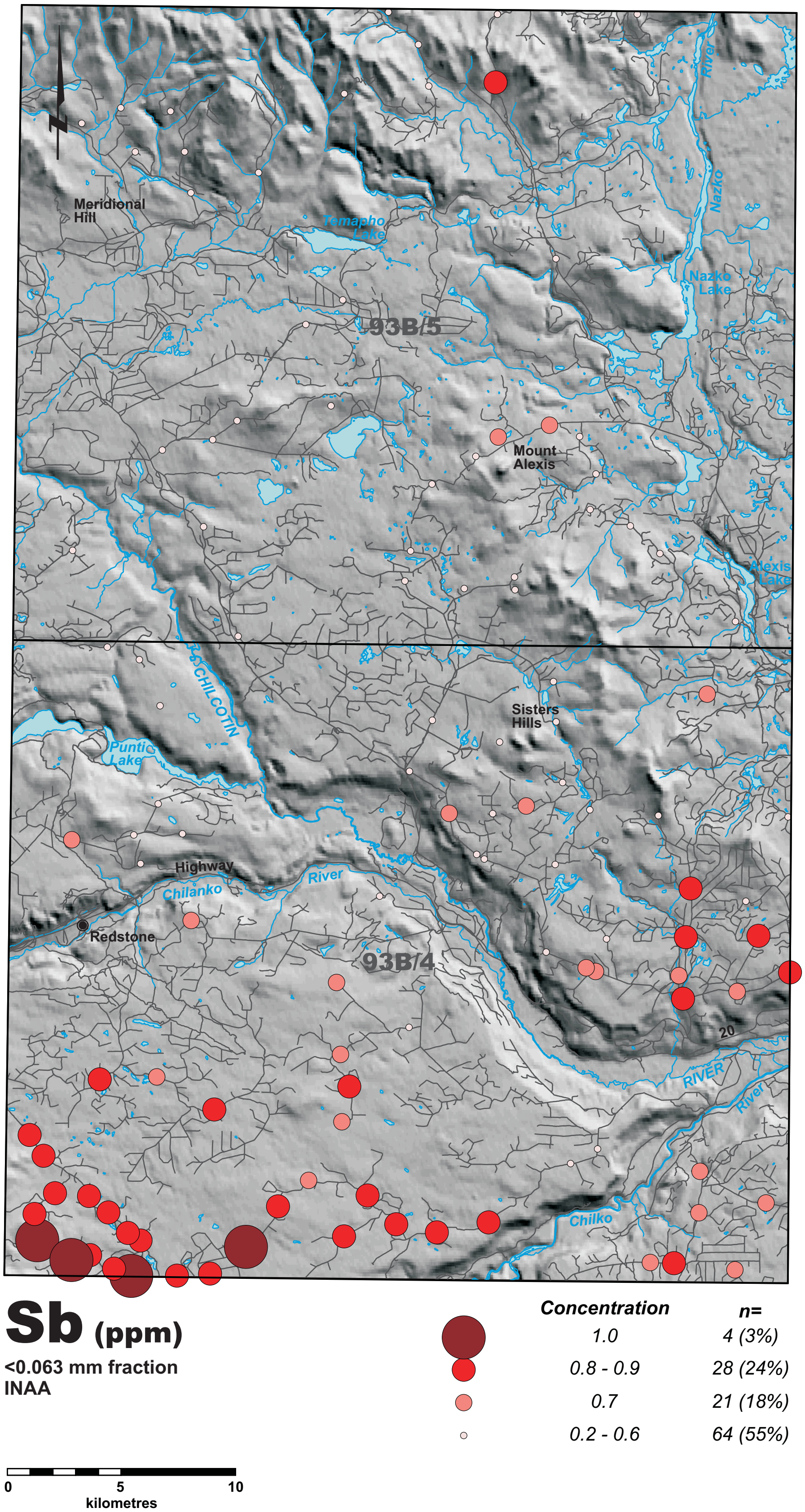

Figure 21. Proportional symbol plot for Sb values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

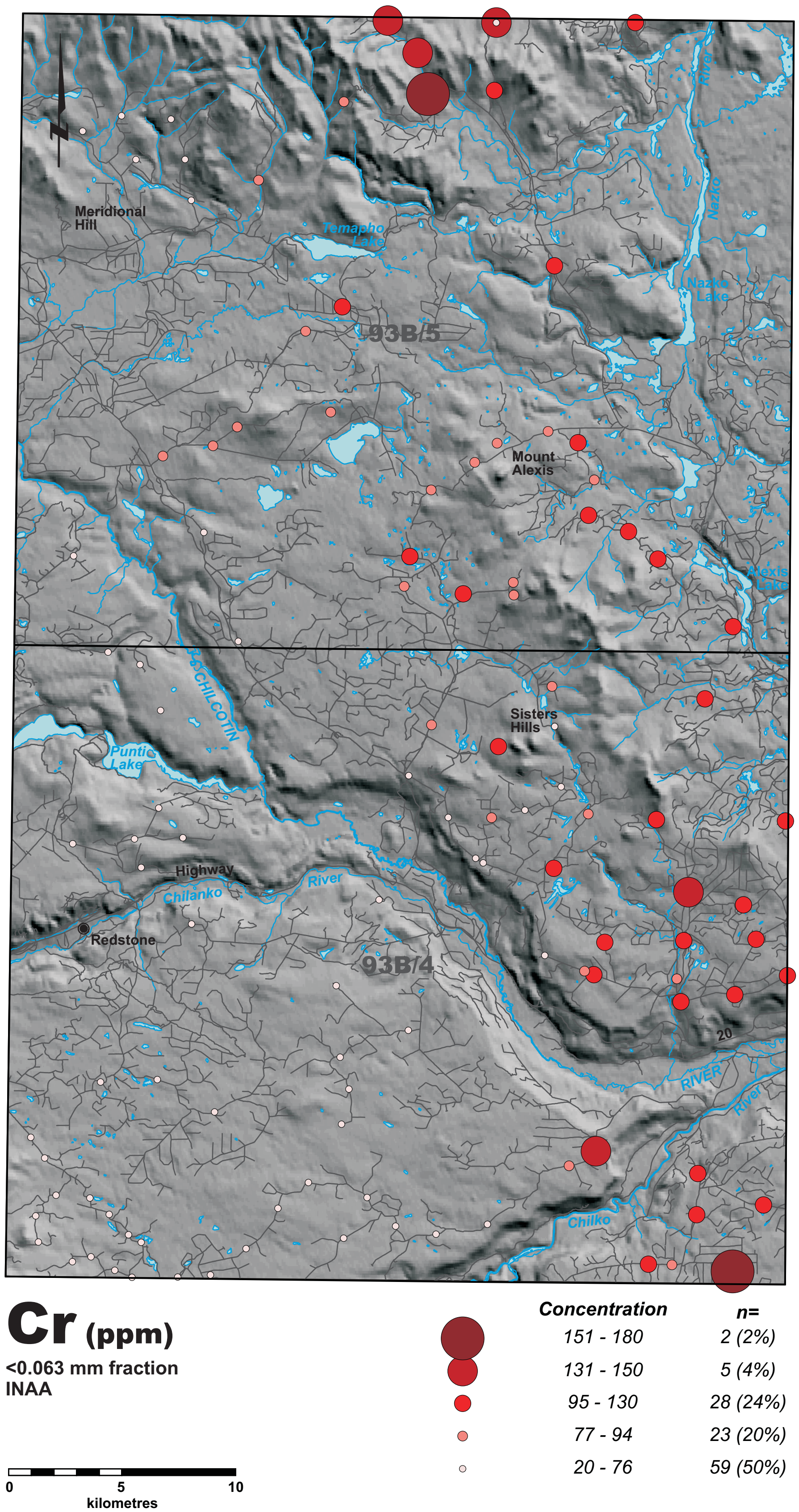

Figure 22. Proportional symbol plot for Cr values in the silt plus clay-sized fraction (<0.063 mm) of till samples collected in NTS map areas 93B/4 and 5.

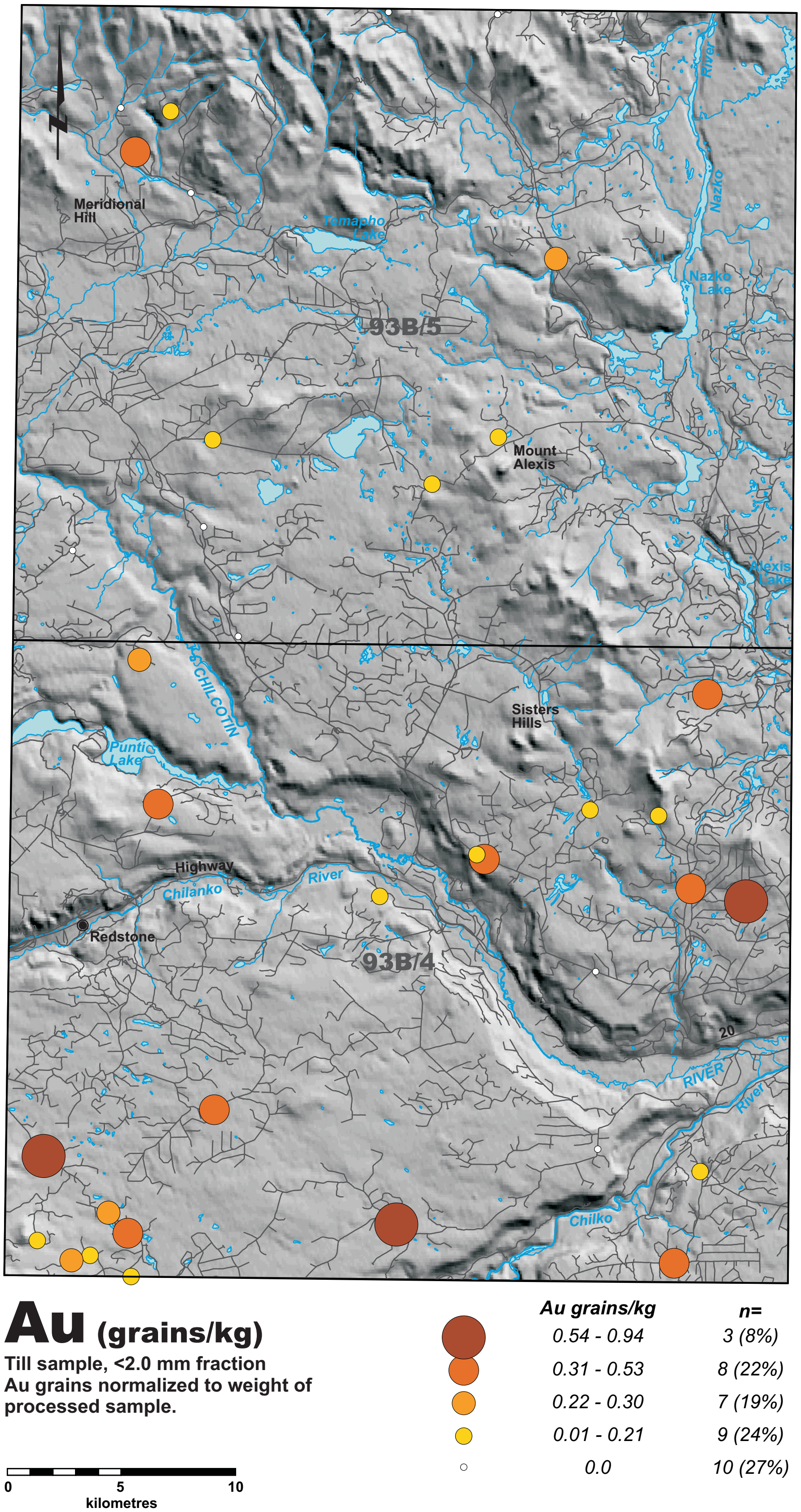

Figure 23. Proportional symbol plot for Au grain counts (grains/kg) on the <2.0 mm fraction of till samples, normalized to weight of sediment processed (i.e. table feed).

the east-central portion of 93B/04 is the other sample with >90th percentile concentration of Au grains (0.77 grains/kg; sample 08TFE2027). With the exception of a sample immediately west of it (sample 08TFE2528; 0.33 grains/kg), this sample is surrounded by others with visible Au concentrations at or below background.

TILL GEOCHEMICAL TRENDS

The single biggest challenge to using till geochemistry as a tool to assess the study area's mineral potential is the extensive cover of englacial or supraglacial till. This till facies is not a favourable sample medium for a till geochemical survey and samples of it were not collected for analysis. The following is a discussion of till geochemical trends in the study area.

In general, metal values in till samples collected within the study area are low in comparison to some other regional-scale till geochemistry surveys conducted in British Columbia (Table 6). For example, >98th percentile Cu in the study area would fall in <50th percentile Cu values for till samples collected within the Babine porphyry copper belt (Levson 2001b, 2002), a well established porphyry copper district. A complex glacial history for the early part of the Late Wisconsinan, made up of multiple advance-retreat cycles during the build-up to the glacial maximum, may be responsible for an attenuation of bedrock geochemical signatures in basal tills. Through the processes of inheritance and overprinting (Stea and Finck, 2001) it is possible that an aggradation of till units from successive glacial advances could result in an attenuation of element values up-section. Although this idea is not supported with Ni and Cr values in the two basal till units sampled on the northern boundary of 93B/05 (i.e. Ni and Cr values are higher in the uppermost till unit), it warrants further investigation.

	Cu (ppm)		As (ppm)		Sb (ppm)	
TILL GEOCHEMICAL SURVEY	median	max	median	max	median	max
[1]NTS 93C/01, 08, 09, 16	23	58	2.1	43	0.4	4.6
[2]NTS 93L/09, 16, 93M/01, 02, 07, 08	41	1550	15	130	1.4	30
[3]NTS 93F/05, 12	24	145	10.4	51	1.4	5.4
[4]NTS 92O/05, 12	43	3113	7	30	1.1	11
[5]NTS 93K, N	63	409	13	69.8	1.9	10.4
[6]NTS 93B/04, 05	25.34	46.45	3.5	20	0.6	1.0

[1] Lett et al. (2006).
[2] Levson (2001b, 2002).
[3] Levson and Mate (2002).
[4] Plouffe and Ballantyne (1994).
[5] Plouffe and Ballantyne (1993).
[6] This study.

Table 6. A comparison of median and maximum values for select elements from five different regional-scale till geochemical surveys conducted in central British Columbia to those of this study.

Commodity and pathfinder element values are, however, of the same magnitude as those reported by Lett et al. (2006) for map areas 93C/01 and 08, directly to the west (Table 6). In their report, based on till geochemical results, the Arc Mountain, Jorgen, Knoll, and Palmer creek, and Pyper Lake areas were highlighted as being prospective for metallic mineralization. These same areas were subsequently discovered to host Cu, Ag, and (or) Au mineralization at the Pyro, Orovain and Punky, and ET showings, respectively (Mihalynuk et al., 2008a, 2009a).

TILL GEOCHEMICAL EXPLORATION TARGETS

As with till samples discussed by Lett et al. (2006) to the west, there are relationships between commodities and pathfinder elements in tills of the study area. Some samples are elevated in more than one element and in some cases are located near other samples with elevated values. One such area is the southwest corner of 93B/04. Here the highest (0.94 grains/kg) and fourth highest (0.53 grains/kg) Au grain counts occur. Coincident with this are 95th and >98th percentile concentrations of As and Sb. These values occur down-ice of the only mapped intrusive in the study area, likely a continuation of the quartz-first granodiorite mapped by Mihalynuk et al. (2009a, b) immediately to the west in 93C/01, that is part of the larger Chilanko intrusive complex. This intrusive complex is of interest as newly discovered Cu mineralization at the Fit, ET, and Ejowra showings in 93C/01 are associated with it (Mihalynuk et al., 2009a). It is also likely that the Cu prospect CA (MINFILE 093C 009), in 93C/02, is associated with correlative rocks (Fleming, 1996; Mihalynuk et al., 2009a). Given ice-flow direction, these As, Sb, and visible Au values are likely not sourced from the ET showing itself. It is possible that they are sourced from a southeast continuation of it, or perhaps are from a different source altogether.

Another such area is the southeast corner of 93B/04 where till samples elevated in Cu, Ni, Cr, and Hg occur. Sample 08TFE2042 has the highest Hg concentration (186 ppb) and second highest Cu (41.92 ppm), Ni (60.3 ppm), and Cr (160 ppm) concentrations for the study area. Adjacent to this sample are others with >98th percentile Cu and >95th percentile Cu, Ni, and Hg. This area is mapped as Chilcotin Group basalts with a smaller area approximately 5 km north mapped as Skeena Group sediments. There are no known mafic or ultramafic bodies mapped in this area, nor immediately to the south in 920/13. It is interesting to note that the general northwest trend of above background values is similar for Ni and Cr.

The source for these elevated values is unknown. It is possible that there is an unmapped mafic or ultramafic unit that subcrops in the northern portion of 92O/13 (i.e. up-ice of these elevated till samples). Alternatively, mantle xenoliths within the local basalt flows could be the source of these elevated Ni and Cr values. Although mantle xenoliths have not been observed in Chilcotin Groups rocks in this part of British Columbia, xenoliths and xenocrysts have been identified to the northwest in the Miocene Cheslatta Lake Suite, a package of volcanic necks, dykes, and associated lava flows of similar age to the Chilcotin Group (Anderson et al., 2001). Mantle xenoliths have also been identified in the

Rayfield River area in what could be a distal portion of Chilcotin Group basalt flows (Canil et al., 1987).

The coincident elevated Cu and Hg values in the same area add some complexity to this interpretation and are perhaps more likely related to a mineralized system and (or) bedrock structure(s).

SUMMARY

In an effort to assess the mineral potential of 93B/04 and 05, 117 basal till samples were collected for major, minor and trace-element geochemical analyses, while an additional 38 basal till samples were collected for analysis of heavy mineral concentrates and for gold grain counts. Till sample density for this survey (one sample every 15 km^2) is lower than most other till geochemical surveys conducted in central British Columbia (one sample every 5 to 10 km^2) due to the dominance of an englacial or supraglacial till – an inappropriate till facies for a till geochemistry survey. Although challenging, this study does demonstrate that it is possible for till geochemical surveys to be completed in areas with similar physiographic and geological characteristics encountered in 93B/04 and 05.

Despite this low sample density, two areas with multi-site, multi-element anomalies have been identified. The first occurs in the southwest corner of 93B/04 and is defined by samples with elevated Au grain counts, and As and Sb concentrations. These samples were collected down-ice of a massive granite, the only known intrusion in the study area. Approximately 13 km west-northwest, in 93C/01, mineralization has been observed in association with what is likely a related phase of this same intrusion.

The second area occurs in the southwest corner of 93B/04 and is defined by samples with elevated Cu, Ni, Cr, and Hg values. These samples are located over and down-ice of Chilcotin Group basalt flows and the source for these elevated values is unknown. A possible explanation could be an unmapped subcropping mafic or ultramafic unit up-ice, towards the southwest. Alternatively, mantle xenoliths or xenocryts within local Chilcoton Group rocks could be responsible for this signature. The coincident Cu and Hg values add some complexity to this interpretation and are perhaps more likely related to a mineralized system and (or) bedrock structure(s).

Integration of data presented here with other available geological, geochemical and geophysical data may provide some insight into the source of these elevated commodity and pathfinder element values. Follow up field work, including detailed bedrock mapping, is required to assess the significance of these highlighted areas. Given the location of these areas (southern boundary of 93B/04), and ice-flow direction (northeast), this follow up work would take place in the study area and towards the south in 92O/13, southwest in 92N/16, and west in 93C/1.

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