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Geochemical and Heavy Mineral Data, Surficial Sediment Sampling Program, Separation Lake Area, Northwestern Ontario.

Table of Contents

List of Figures

List of Tables

ABSTRACT

Humus and "B" and "C" horizon till samples were collected as part of a Quaternary geology mapping and drift geochemistry program in the Separation Lake greenstone belt area, northwestern Ontario. These samples were collected for geochemical, gold grain and heavy mineral (metamorphosed magmatic sulphide indicator mineral) analysis.

Samples were collected for orientation and regional surveys. The purpose of the orientation surveys was to characterize the geochemical and heavy mineral response in tills samples over specific types of mineralization. Mineralization sites included gold, volcanogenic sulphide, magmatic sulphide and rare-element pegmatite.

Observations from these orientation surveys are then applied to the geochemical and heavy mineral data derived from the regional survey in order to highlight areas of potential exploration. Several sample sites of interest are highlighted in this report. These include: 10 gold; 16 base metal; 3 pegmatite; and 3 sample sites with other interesting element assemblages. Further work is required to assess the potential of these areas.

INTRODUCTION

Study Location

The Separation Lake greenstone belt is located just east of the Ontario-Manitoba border, 60 km north of the town of Kenora and 90 km south of Red Lake (Figure 1). The study area covers approximately 2.5, 1:50 000 scale NTS sheets, including: 1) the Umfreville Lake map sheet (NTS 52 L/7) bounded by longitudes 94o30'W, 95o00'W and latitudes 50o15'N, 50o30'N; 2) the Separation Lake map sheet (NTS 52 L/8) bounded by longitudes 94o30'W, 94o00'W and latitudes 50o15'N, 50o30'N; 3) the eastern third of the Ryerson Lake map sheet (NTS 52 L/6) bounded by longitudes 95o00'W, 95o09'10"W and latitudes 50o15'N, 50o30'N; and 4) the northern third of the Whitedog Lake and Lount Lake map sheets (NTS 52 L/2; 52 L/1) bounded by longitudes 94o45'25"W, 94o15'40"W and latitudes 50o10'37"N and 50o15'N.

Purpose

The purpose of this report is to summarize the geochemical and mineralogical properties of humus and till samples. Areas of interest for gold, base metal and pegmatite (rare element) exploration are highlighted.

This project defines the type and distribution of overburden materials within the study area, including physical and geochemical properties. Surficial geology was mapped at 1:50 000 scale and drift compositional studies were carried out at both detailed (property) and regional scales. Compositional studies focussed primarily on the geochemical, mineralogical and lithological properties of till within the region. This type of information may be used to guide exploration, by defining geochemical targets for gold, base metals, pegmatites (rare elements) and diamond.

Orientation surveys were carried out at 4 sites (Figure 1). Samples of humus, "B" and "C" horizon till were collected both up-ice and down-ice of different types of known mineralization, in an effort to characterize the geochemical and heavy mineral signatures associated with each. Results of orientation surveys were then used to guide interpretation of regional data, in order to highlight any new areas of potential mineralization.

This work compliments bedrock mapping and mineral deposit evaluation projects in the region conducted simultaneously by the Ontario Geological Survey. These projects include: mapping of the Separation Lake greenstone belt (Blackburn and Young 1993); mapping of the surrounding Winnipeg and English River subprovinces (Beakhouse 1993, 1994); mineral evaluation of the metasedimentary rocks at the Bug Lake copper occurrence (Parker 1993, 1994); and mapping and mineral potential evaluation of the Separation Lake pegmatite field (Breaks 1993; Breaks and Tindle 1994).

This report is available as hard copy or in digital format. The digital data, available separately as MR-D 21, are grouped into the following files:

a) A text file containing descriptive information (readme.TXT; ASCII);

b) Eighteen graphics files (SEPFIG1- 18; .cdr) representing report figures (see Table of Contents, this report);

c) Eight ascii.txt files representing report tables (SEPTAB1- 8; see Table of Contents, this report); and

d) Nine ASCII text files summarizing data: SEPAPPA: Sample numbers, UTM coordinates and material types; SEPAPPB: Material geochemical standards and duplicates; SEPAPPC: Humus geochemistry; SEPAPPD: Till "B" horizon geochemistry; SEPAPPE: Till "C" horizon geochemistry; SEPAPPF: Till pebble lithologies; SEPAPPG: Detailed till gold grain data; SEPAPPH: Detailed metamorphosed magmatic/ massive sulphide indicator minerals data; and SEPAPPI: Till gahnite geochemistry.

This report follows the same format except that the 9 ascii.txt file summarizing all data is not included.

REGIONAL GEOLOGY

Bedrock Geology

The map area is located within the Superior Province of the Canadian Shield and straddles both the English River and the Winnipeg River subprovinces (Figure 1). The English River Subprovince is an east-trending linear belt, approximately 800 km long with a maximum width of 50 km; it comprises the northern two-thirds of the map area. It is characterized by highly metamorphosed and migmatized sedimentary rocks. Strongly peraluminous granitoid rocks are associated with migmatization (Breaks et al. 1978). Other plutonic rocks, which form stocks and batholiths, are unrelated to the migmatization process (Blackburn et al. 1992).

The Winnipeg River Subprovince trends eastward over 300 km with a maximum width of 50 km, and covers the southern third of the map area. Rock types in this subprovince consist primarily of massive granodioritic to granite plutons. These plutons intrude highly metamorphosed and deformed tonolite to granodiorite with subordinate inclusions of metavolcanic rocks (Beakhouse 1991). Granitic pegmatitic dikes are locally abundant and locally uraniferous (Blackburn et al. 1992).

The English River and the Winnipeg River subprovinces are separated by a segment of mafic volcanic rocks known as the Separation Lake greenstone belt. In the study area, this greenstone belt is approximately 5 km in width and extends from west to east a distance of 45 km. This segment comprises part of a belt that extends discontinuously from the Manitoba-Ontario border eastward to Lac Seul, a distance of over 100 km. The belt is composed of metavolcanic rocks and, to a lesser extent, metasedimentary rocks metamorphosed to amphibolite grade. The metavolcanic rocks are dominated by massive and pillowed mafic flows with subordinate felsic pyroclastic rocks including tuff and lapilli tuff.

Metasedimentary rocks comprise a minor component of the greenstone belt. These rocks consist of chemical metasedimentary and clastic metasedimentary units (including polymictic conglomerate). The chemical metasedimentary unit is a magnetite- bearing ironstone, found at 2 stratigraphic levels within the metasedimentary sequence. In addition, clastic metasedimentary rocks, composed of feldspathic arenite to wacke, are found at 2 stratigraphic levels within the belt. The polymictic conglomerate contains mafic to felsic volcanic, medium-grained granitoid and quartzose clasts. This unit overlies the mafic and felsic volcanic rocks at the eastern end of the belt.

Quaternary Geology

Quaternary geology of the Separation Lake area is described by Morris (1992, 1993a, 1993b, 1994a, 1994b). Ice flow indicators suggest that flow varied between 202o and 240o, with a mean orientation of 224o. Striae are most commonly observed on the south shore of lakes or on the up-ice side of fresh bedrock surfaces. Chattermarks, small grooves and whalebacks are less pervasive.

Significant deposits of glacial sediment are uncommon within the map area. Till occurs most commonly as a thin, discontinuous veneer (less than 1 m thick) draping the bedrock surface. Thick till deposits masking the bedrock surface are rare, but do occur as localized patches found on the lee side of bedrock highs or within bedrock depressions.

Regionally, till is characterized by a silty sand matrix that is slightly sticky when moist. Subangular to angular clasts are common and angular clasts are often striated. Fresh till effervesces slightly with 10% HCl, suggesting a minor amount of carbonate present in the matrix.

Till may be massive or exhibit internal structures ranging from thin, platy beds (fissility) to flow structures. Massive to fissile till has been observed only on the stoss side of bedrock highs. Till exhibiting flow structures most commonly occurs on the down-ice or lee side of bedrock highs.

Thick glaciolacustrine deposits occur around the perimeter of large lakes, within some bedrock-controlled valleys and as isolated patches associated with minor moraine segments. This material varies in thickness, ranging up to 53 m (OGS 1988). These deposits are likely associated with glacial Lake Agassiz, which abutted the ice margin during glacial retreat (Fenton et al. 1983). Except in the extreme northeast, the entire area was inundated by glacial Lake Agassiz during deglaciation.

Valley-fill deposits range from ice-contact stratified drift to laminated silt and clay. Ice-contact stratified drift comprises interbedded flow till, gravel, coarse- and fine-grained sand. This material occurs at the northern end of several bedrock controlled valleys, around the perimeter of lake basins or as short moraine segments.

Within bedrock controlled valleys, ice-contact sediments commonly grade into course-grained glaciolacustrine deposits. Glaciolacustrine material is composed of moderate to well-sorted sand, occasionally draped or covered by silt and/or clay. Coarse-grained glaciolacustrine sediments occur at the terminus of some valleys, where well-defined subaquatic fans have been identified.

Most fine-grained glaciolacustrine sediment consists of grey, laminated silt and clay. Freshly exposed silt laminae react freely with 10% HCl. It is hypothesized that carbonate was derived from sediment transported from the Hudson Bay Lowland. Fine-grained deposits are usually greater than 1 m thick and can overlie other glacial materials.

SAMPLING METHODOLOGY

Sampling Media

Because till cover is very thin throughout the study area, "B" horizon till was initially chosen as the preferred sampling media. During the 1992 field season only "B" horizon till samples were collected. During the 1993 and 1994 field seasons humus, "B" and "C" horizon till samples were collected to facilitate multi-media comparisons.

At each site, approximately 50 gm of humus and 200 gm of "B" and "C" horizon till were collected. Depending upon availability, a 2 to 10 kg bulk sample of "C" horizon till was also collected. In addition, a minimum of 50 pebbles were collected from till at each sample site. Sample numbers, U.T.M. coordinates and material types are listed in its digital file MRD 21 (SEPAPPA).

Sampling Strategy

Orientation Surveys

Detailed sampling (200 m sample spacing) of humus, and "B" and "C" horizon till was carried out over several different types of mineralization in order to: 1) determine the geochemical and mineralogical signature of till associated with specific types of mineralization; and 2) characterize the scale and form of dispersal associated with various types of deposits. This information was then used to evaluate geochemical and heavy mineral signatures derived from the regional till sampling program. Characterization of the scale and form of dispersal from each mineralized site aids in tracing anomalous geochemical signatures in the regional survey back to source.

For each of the orientation surveys, sample sites within areas were determined by establishing a 200 m by 200 m grid over the site of known mineralization. The grid was established placed so that samples were collected up-ice, over and down-ice of the known mineralization. As many of the grid squares as possible were sampled. Table 1 summarizes the 4 orientation surveys completed in this study.

Regional Survey

Regional till sampling defines the distribution and relative concentrations of different elements, heavy minerals and pebble lithologies contained within "B" and "C" horizon samples of subglacial till. From this data regional background concentrations can be derived and anomalous values of various till constituents can be evaluated in terms of potential exploration targets.

For the regional sampling program, sample sites within areas were determined by placing a 5 km by 5 km grid over the map area. As many grid squares as possible were sampled.

ANALYTICAL METHODOLOGY

Geochemical Analysis

Analytical methods, multi-element suites and detection limits used pertaining to the geochemical analyses of humus, "B" horizon till and "C" horizon till are summarized in Tables 2 and 3. Standards and duplicate geochemical determinations are summarized in digital file MR-D 21 (SEPAPPB) as are geochemical results for humus and "B" and "C" horizon till samples (SEPAPPC, SEPAPPD and SEPAPPC respectively). Pebble data for each till sample site is also presented in digital file MR-D 21 (SEPAPPF).

Heavy Mineral Analysis

All bulk "C" horizon samples were processed to isolate gold grains, metamorphosed/magmatic massive sulphide indicator minerals (MMSIMs) and kimberlite indicator minerals. Sample processing data and kimberlite indicator mineral data have already been reported and will not be repeated here (Morris et al. 1995).

Detailed gold grain and MMSIM data are summarized in digital file MR-D 21 (SEPAPPG AND SEPAPPH). Figure 2 summarizes the procedure used to isolate gold grains and MMSIMs. The geochemistry of gahnite (an MMSIM), recovered from till samples was determined by microprobe analysis at the Ontario Geosciences Centre. The calibration routine and operating conditions for the microprobe are summarized in Morris et al.(1994). Gahnite grain geochemistry is also summarized in digital file MR-D 21 (SEPAPPI).

DATA PROCESSING

Geochemistry

Percentile statistics were applied to geochemical values from the humus, "B" and "C" horizon till samples collected from the orientation and regional surveys. Anomalous geochemical values were defined as those which occurred at or above the 95th percentile. Background concentrations were defined as 50th percentile values. These values are summarized for each survey in Tables 4 (gold and base metal) and 5 (rare element pegmatite). Data was plotted as proportional dot diagrams to evaluate element distribution and concentration with respect to bedrock geology.

Comparing both 95th and 50th percentile value from orientation surveys with those derived from the regional sampling program highlights several important relationships:

1) Background concentration for Au and As in humus at the Helder Lake orientation site are significantly above regional background and approach the 95th percentile values for the regional data set.

2) Background concentrations for As, Pb and Cu at Helder Lake are significantly above regional background in both "B" and "C" horizon till. Background concentration for Cu in the "C" horizon till is approximately equal to the 95th percentile concentration for the regional data.

3) The 95th percentile values of Co, Cu, Ni and Zn derived from "B" and "C" horizon till at Helder Lake, were also higher than those of the other orientation and regional surveys. As these elements are commonly associated with volcanogenic sulphide mineralization elevated concentrations may suggest the presence of this style of mineralization at Helder Lake.

4) Background concentrations for As, Pb and Zn at the Selwyn Lake orientation site are moderately to slightly elevated above regional background, likely reflecting known volcanogenic sulphide mineralization in the area. However, 95th percentile values for these elements at Selwyn Lake fall significantly below those for the regional data set.

5) Magmatic sulphide mineralization at Werner Lake is not geochemically distinguishable from regional background. Only the 95th percentile values of Co and Ni from humus samples collected in the Werner Lake survey are higher than those of the other orientation and regional surveys.

6) Rare element pegmatite mineralization at Separation Lake Rapids is characterized by high background concentration of Cu in both the "B" and "C" horizon till. This concentration is significantly above regional background and approaches or exceeds the 95th percentile concentrations for the regional data set. The 95th percentile values for all elements associated with mineralized pegmatite in the Separation Lake Rapid orientation survey, were not notably higher than those derived from the orientation or regional surveys. This would suggest that these elements are not unique to the pegmatites, possibly associated with other rock types within the area.

Heavy Minerals

Metamorphosed Massive Sulphide Indicator Minerals (MMSIMs)

MMSIMs include staurolite, anthophyllite, hypersthene, olivine, spessartine, red epidote or sapphirine, chromite, red rutile, ruby corundum and gahnite. These types of heavy minerals are often associated with sulphide deposits in high grade metamorphic terrane. In this environment, metamorphism has commonly disrupted sulphide conductivity and camouflaged Al-Mg- Mn-Cr alteration zones (S.Averill, Overburden Drilling Management Ltd., personal communication, 1996).

Of particular interest is gahnite. This mineral is useful in searching for polymetallic deposits in high grade metamorphic terrane due to its hardness (8) and stability in metamorphic rocks (Parr 1992). Although this mineral is rare, it has been reported in a number of polymetallic deposits (Chew 1977; Plimer 1977; Spry 1982; Williams 1983; Sheridan and Raymond 1984; Spry and Scott 1986 and Spry 1987a, 1987b). Gahnite was also successfully evaluated as an indicator mineral in glacial dispersal plumes from the Montauban polymetallic deposit in Quebec (Lalonde et al. 1994).

Gahnite, however, is not unique to polymetallic deposits within high grade metamorphic terrane. It is also found in pegmatite (Cerny et al. 1981; Cerny and Hawthorne 1982).

Little work has been done to differentiate gahnite within different source rocks based on mineral geochemistry (Batchelor and Kinnaird 1984). Data on gahnite geochemistry from known source rocks as derived both from the literature and from analytical work carried out in conjunction with this project has been plotted on a ternary diagram (Figure 3). Although preliminary, this work does suggest that distinct geochemical groupings do exist with respect to host rocks for gahnite. Although the range in gahnite geochemistry from various polymetallic deposits is quite large, there does appear to be a clear geochemical distinction between these gahnites and those derived from pegmatites in the Separation Lake area (low MgO 0- 20%; Figure 3).

The geochemistry of gahnites from till samples in the Separation Lake area has also been plotted on Figure 3 (shaded fields). Three distinct groups have been identified:

Group I: MgO 0-2%; ZnO 71-81%; FeO 18-28%. This group corresponds well with the geochemistry of gahnite recovered from the pegmatites in the study area.

Group II: MgO 5-18%; ZnO 42-56%; Fe 5- 18%. The relatively high percentage of FeO in these grains does not fit well with geochemistry reported for in situ gahnite reported from aluminous metasedimentary rocks in Wyoming (Frost 1973; ZnO 45%- 50%; FeO 45%-50% and MgO 4%- 10%) and Montauban, Quebec (Lalonde et al 1994; ZnO 35%-40%; FeO 40%-45% and MgO 20%- 25%).

Group III: MgO 2-15%; ZnO 62%- 86%; FeO 10%- 34%. This broad range of values partially spans the geochemical ranges of gahnite from several known polymetallic deposits in high grade metamorphic terrane (Broken Hill Australia; Mineral Ridge, Virginia, USA; Geco, Ontario, Canada).

Gold

In all, only 39 gold grains were recovered from "C" horizon till samples. Except for 2 pristine grains, all gold grains were either reshaped or modified (digital file MR-D 21, SEPAPPG). Reshaped or modified gold grains are thought to reflect longer distance of transport, whereas pristine gold grains indicate little reworking by glacial ice or other transport processes and hence a fairly local source (Averill 1988; DiLabio 1990).

ORIENTATION SURVEYS

Helder Lake

Within this survey area, known Au mineralization is manifest by anomalous Au concentrations in humus, "B" and "C" horizon till (sample 93LL591Tc, Figure 4). Arsenic values at this site are not anomalous, however, concentrations of Co, Pb and Zn are elevated. In addition to known mineralization, 2 other sites located in mafic volcanic terrane approximately 1 km down-ice of a mafic volcanic-gneiss contact, contain elevated values of As and Au in all sample media (samples 93LL501Tc and 93LL506Tc; Figure 4).

In this area, the concentration of gold grains in till is relatively low (digital file MR-D 21, SEPAPPG). Most of these grains are reshaped likely reflecting background concentrations associated with long transport distances. One pristine gold grain was recovered from sample 93LL591Tc, and may reflect local mineralization. One pristine grain was also recovered from sample 93LL501Tc, possibly suggesting local unknown mineralization, associated with mafic volcanic lithologies although the low number of grains does not appear to reflect significant Au mineralization.

Anomalous concentrations of Co, Cu, Ni or Zn were also observed within this survey area, in some or all media sampled (samples 93LL496Tc, 93LL501Tc, 93LL505Tb, 93LL511Tc, Figure 5; Table 4). This element assemblage suggests that gold grains and Au geochemistry may reflect potential volcanogenic sulphide mineralization, rather than Au mineralization.

This interpretation is supported by the relatively large number of samples containing gahnite grains in this area (Figure 6). The geochemistry of these gahnite grains fall within either Group II or Group III geochemical classifications (Figure 3), possibly reflecting polymetallic base metal mineralization. In general, where more than 1 gahnite grain was recovered from a sample, all grains fall within the same geochemical classification. Most of these "C" horizon till samples were collected over granitic terrane, less than 2 km down-ice from mafic volcanic terrane. In sample 93LL497, located with mafic volcanic terrane and less than 0.5 km down-ice from gneiss terrane, 4 gahnite grains were recovered, all of which fall within the Group II geochemical classification. This site also exhibits anomalous base metal concentrations.

In general, known gold mineralization at Helder Lake is relatively poorly defined in terms of overburden geochemistry. The only signature of this mineralization is elevated Au concentration and 1 pristine gold grain in sample 93LL591Tc. Elsewhere, however, there is an interesting association between elevated concentrations of As and Au (samples 93LL501Tc, 93LL506Tc, Figure 4), the location of base metal anomalies (Co, Cu, Ni, Zn in samples 93LL496Tc, 93LL501Tc, 93LL505Tb and 93LL511Tc) and the presence of gahnite (sample 93LL497) possibly reflecting potential volcanogenic sulphide mineralization. Although no such sulphide mineralization is reported for the Helder Lake area, these anomalies may be worth pursuing given the positive base metal geochemistry and the presence of gahnite. Sample sites with interesting gold and base metal element associations for the Helder Lake area are summarized in Table 6.

Selwyn Lake

Volcanogenic sulphide mineralization at Selwyn Lake is defined by elevated concentrations of Co, Cu, Ni, Pb and Zn in humus, and "B" and "C" horizon till samples (Figure 7). Samples 93UL226Tc and 93UL241Tc are located over known base metal mineralization and exhibit anomalous to elevated concentrations of most base metals. In general, the geochemical pattern in till appears to define a southeast trending zone of elevated base metal concentration (samples 93UL211Tc, 93UL226Tc, 93UL241Tc). This anomalous zone exhibits an abrupt and well defined up-ice (or northeastern) limit. To the southeast, a plume of elevated to anomalous concentrations of base metals (Co, Figure 7) extends up to several hundred metres down-ice. At this site, elevated background concentration of Co associated with known mineralization appears to be approximately 6 to 8 ppm and can be traced over 1 km from the source area.

Several gahnite grains were recovered from till samples collected in this survey (Figure 8). The geochemistry of these grains fall within all 3 geochemical groupings. Where more than 1 gahnite grain was recovered at a site, grains often fell within more than 1 classification. For example, sample 93UL242Tc located over one of the base metal targets, contains gahnite grains that fall within both Group I and III classifications. The sample site is located a short distance (<5 km) down-ice from a geologically diverse terrane consisting of mafic volcanic rocks hosting known volcanogenic sulphide mineralization, pegmatite and migmatite. This diversity of bedrock may explain the diversity of gahnite geochemistry in this area.

No significant As or Au geochemical anomalies were derived from humus or "B" and "C" horizon till samples. Only 5 reshaped gold grains were recovered from 4 samples. Sample sites with interesting base metal element associations from the Selwyn Lake area are summarized in Table 6.

Separation Lake Rapids

In this survey, 95th percentile values for elements associated with rare element pegmatites (Al, Ba, Be, Cr, Cs, K, La, Na, Rb, V, Zr) were significantly lower than those observed elsewhere throughout the region. Elements such as Al, Ba, Be and Cs derived from "C" horizon till did, however, highlight one pegmatite (Figure 9). However, the 95th percentile values associated with this pegmatite are lower than those observed in other orientation surveys in the area. These values, therefore, may not be useful discriminators of pegmatite at a regional scale and suggest that interpretation of regional geochemistry for rare element pegmatite mineralization should be based on sub- populations defined on the basis of bedrock lithology.

Eight gahnite grains were recovered from till samples collected in the Separation Lake Rapids survey (Figure 10). They all fall within the Group II geochemical classification. Although only a few gahnites were recovered and analyzed from local pegmatite, these in situ gahnites all fall within the Group I geochemical classification. Preliminary interpretation, therefore, suggests that there is not a relationship between gahnites recovered from till and the local pegmatites in this area.

Werner Lake

Mafic-utramafic hosted magmatic Co, Cu, Ni and PGE mineralization in this area is not well-defined in terms of surficial geochemistry. Only 1 site (sample 93UL699Tc) exhibits anomalous concentrations of Co, Cu and Ni associated with this type of mineralization (Figure 11). Samples 93UL698Tb and 93UL699Tc also contain anomalous concentrations of Au in "B" and "C" till horizons (Figure 12).

Only 2 gahnite grains were recovered from till in this area. Both grains fall into the Group III geochemical classification and are not thought to be related to local magmatic sulphide mineralization (Figure 13).

REGIONAL SURVEY

The regional distribution of Au concentrations in "B" horizon till is presented in Figure 14. In general, regional background concentrations for Au are extremely low (<3 ppb) as are the 95th percentile values (<7 ppb). The distribution of samples containing >3 ppb Au (90th percentile) is very sporadic and does not define any discernable pattern or trend with respect to known bedrock lithologies and/or structure.

Six "B" horizon sample sites contain anomalous Au concentrations that equal or exceed the 95th percentile value obtained in the orientation survey carried out over known gold mineralization at Helder Lake (Figure 14). There is also 1 sample site (93LL599Tc) from "C" horizon till that greatly exceeds the 95th percentile for Au as defined for "C" horizon till at Helder Lake. The location of the site has been added to Figure 14. All of these (except sample 93LL111Tb) are situated within granitic gneiss terrane: samples FL02 and FL05, collected over granitic terrane of the Fletcher Lake Batholith; sample 93LL599Tc, situated in gneissic terrane approximately 1 km down- ice of a granodiorite intrusion; sample 95WL45Tb, collected approximately 1 km down-ice from a granitic-mafic volcanic contact; sample RL02, located near a metasedimentary/migmatite contact; sample 92UL144Tb, located <1 km down-ice from granite/migmatite contact; and sample 93LL111Tb, located near a granite/migmatite contact.

Figures 15 and 16 illustrate the regional distribution of Cu and Zn, respectively, in the <63 micron size fraction of "C" horizon till. In general, higher background concentrations of Cu and Zn are associated with metasedimentary and granitic terrane of the English River Subprovince north of the Separation Lake greenstone belt. Elevated to anomalous concentrations of Cu and Zn appear to define the western extension of the Werner Lake Co zone and possibly reflect magmatic sulphide mineralization in that area. In the east central part of the region, elevated to anomalous concentrations of Cu and Zn appear to define a region of base metal enrichment associated with metasedimentary rocks. Coincident regional patterns in the distribution of gahnite grains in till may suggest potential for metamorphosed sulphide mineralization (Figure 17). Samples with interesting gold and base metal anomalies are summarized in Table 7.

Gahnites recovered from the regional till sampling program all fall within the Group III geochemical classification. This is of particular interest where there is more than 1 gahnite grain at a sample site (Figure 17; digital file MR-D 21, SEPAPPH). The consistency in geochemical composition suggests that all gahnite forming a regionally high background in this area is derived from a similar type of source. The presence of gahnite at a sample site, however, does not always coincide with anomalous base metal concentrations in till. Of the 5 regional sample sites containing significant multi element base metal concentrations, only 1 site (sample FL-13-94) contains 1 gahnite grain.

The regional distribution of La (Figure 18) and other anomalous elements (not shown) highlights areas with potential for rare element pegmatite mineralization. Humus and "B" and "C" horizon tills collected from samples Fl03, FL13 and 93LL638Tc all contain anomalous concentrations of elements associated with rare-element pegmatites. These sample sites are located within granitic terrane (Figure 18; Table 8).

Other sample sites exhibiting interesting multi-element geochemical anomalies are summarized in Table 8. Further work is required to more fully understand their significance.

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