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Ontario Geological Survey
Open File Report 6046

Results of Regional Till Sampling for Kimberlite and Base Metal Indicator Minerals, Shebandowan Greenstone Belt, Northwestern Ontario

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by

A.F. Bajc and D.C. Crabtree

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Abstract

A project of Quaternary geological mapping and regional till sampling was undertaken over the Shebandowan greenstone belt during the 1998 and 1999 field seasons. The results of gold grain and geochemical analyses were published previously in Ontario Geological Survey Open File Reports 5993 and 6012. This report contains the results of indicator mineral processing for base metals and diamonds.

Quaternary mapping helped to characterize the surficial materials present within the study area and to reconstruct the ice flow history associated with these deposits. This information provided a framework by which the regional materials compositional datasets could be interpreted. The regional sampling program provided information on the background concentrations of various indicator minerals present in till.

Few kimberlite indicator minerals were recovered as part of the regional till sampling program over the Shebandowan greenstone belt. The apparent random distribution of grains coupled with the lack of supporting mineral species at any given site suggests that the grains form part of a regional background population likely derived from distant sources to the northeast. The dataset suggests that this region has reduced potential for the discovery of kimberlite-hosted diamonds. Stream and esker sampling programs are recommended to more fully evaluate the region.

The MMSIM® dataset clearly delineates a number of base metal exploration targets. These are defined, in many instances, by multiple indicator mineral species and supported by till geochemistry. Higher density till sampling and prospecting is recommended within these anomalous areas to determine their significance and possibly refine exploration targets.

A complete digital dataset, consisting of locational information, heavy mineral assemblages, microprobe data and metamorphic/magmatic massive sulphide indicator mineral results is being released in conjunction with this report as Ontario Geological Survey Miscellaneous Release-Data 69 (Bajc and Crabtree 2001).

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Results of Regional Till Sampling for Kimberlite and Base Metal Indicator Minerals, Shebandowan Greenstone Belt, Northwestern Ontario

A.F. Bajc[1] and D.C. Crabtree[2]

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Introduction

The Shebandowan greenstone belt, which is located immediately north and west of the city of Thunder Bay, has a rich history of mineral exploration and mining spanning well over 100 years. The belt is host to a variety of precious and base metal mineral deposit types. Past producers include: the Shebandowan Ni-Cu-PGE mine; the North Coldstream Cu-Au-Ag mine; the Creswell and Rabbit Mountain group of silver deposits; and the Ardeen Au mine which was northern Ontario's first gold producer. Exploration activity within the belt has currently subsided, largely in response to the depressed prices of gold and base metals and the inability of junior mining companies to raise funds for exploration.

In response to this recent decline in mining and mineral exploration activity within the belt, the Ontario Geological Survey initiated a 2 year program of Quaternary geology mapping and drift geochemistry to further evaluate the mineral resource potential of the Shebandowan belt. This was accomplished by detailed (1:50 000 scale) Quaternary geology mapping and regional humus and c-horizon till sampling. Quaternary mapping was undertaken to document the distribution and character of the various Quaternary deposits within the study area and to reconstruct the ice flow history associated with these deposits. This information is essential for the successful implementation of mineral exploration programs utilizing drift prospecting techniques and surficial geochemistry.

During the 1998 field season, Quaternary mapping and regional humus and c-horizon till sampling were conducted over the eastern half of the belt within the area covered by the Sunshine (52A/12) and Kakabeka Falls (52A/5) 1:50 000 scale National Topographic System (NTS) map sheets (Figure 1). The results of this work are partially summarized in Ontario Geological Survey Open File Report 5993 (Bajc 1999a). Mapping and sampling was extended westward into the Shebandowan (52B/9) and Burchell Lake (52B/10) 1:50 000 scale NTS map areas during the 1999 field season. The results of this work are partially summarized in Ontario Geological Survey Open File Report 6012 (Bajc 2000) and Ontario Geological Survey preliminary map P.3417 (Bajc 1999b). The results of heavy mineral processing presented in these reports and maps were restricted primarily to the gold grain datasets with limited discussion of the base metal indicator minerals. This report summarizes the results of the heavy mineral processing of till samples collected over the entire Shebandowan greenstone belt. Microprobe data for significant indicator minerals related to kimberlite exploration is also presented to assist with the evaluation of the area for hosting kimberlitic diamonds.

Regional Geology

BEDROCK GEOLOGY

A comprehensive summary of the bedrock geology of the study area is presented in papers by Sutcliffe (1991), Williams (1991) and Williams et al. (1991) as well as in numerous Ontario Geological Survey maps and reports. The study area contains 3 distinct bedrock domains (Figure 2). The centrally-located Wawa Subprovince, within which the Shebandowan greenstone belt occurs, is fault-bounded to the north by metasedimentary and felsic intrusive rocks of the Quetico Subprovince and unconformably overlain to the south by Paleoproterozoic metasedimentary rocks of the Animikie Group (Gunflint and Rove formations).

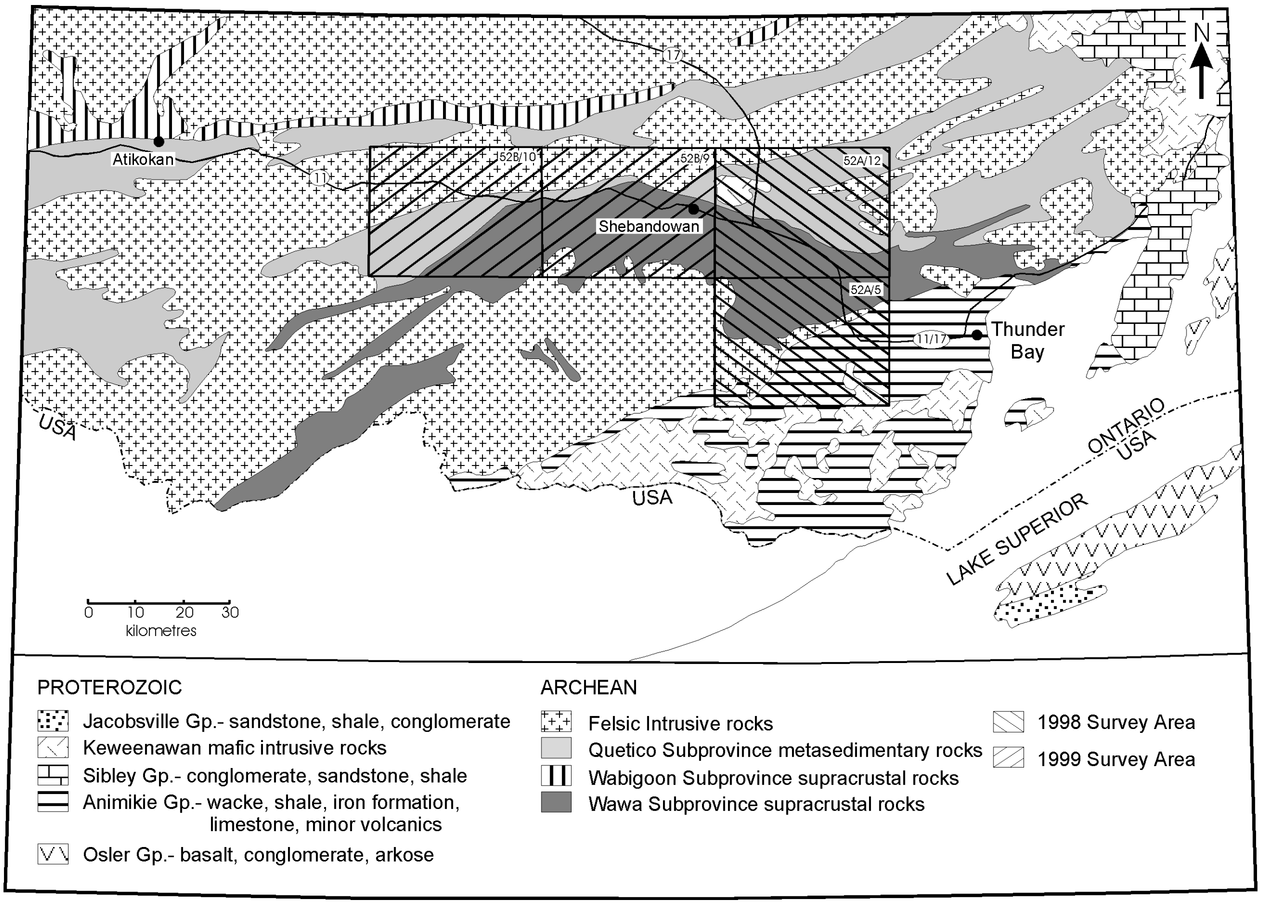

Figure 1. Location map of study area including regional bedrock geology.

Metasedimentary rocks of the Quetico Subprovince consist primarily of turbiditic wackes, arkoses and quartz arenites and their associated paragneisses and migmatites. Post- to syndepositional felsic plutons consisting of feldspar-megacrystic granite, granodiorite to tonalite and monzonite comprise a notable proportion of this domain. Narrow, elongate lenses of tholeiitic, mafic metavolcanic rocks and associated gabbroic rocks occur locally within the Quetico Subprovince (Brown 1995, Osmani 1997).

Metasedimentary rocks of the Gunflint and Rove formations (Animikie Group) were deposited within a large basin that extends into Minnesota, Wisconsin and Michigan (Sutcliffe 1991). The Gunflint Formation contains a basal unit of conglomerates that rest unconformably on the Archean basement and is overlain by interbedded argillites, argillite tuffs, cherts, algal cherts, jasper, carbonates, ferruginous carbonates, hematite, magnetite taconite and silicate taconite. The overlying Rove Formation consists of black, locally pyritic shales and grades upward into interbedded black shale and arkosic greywackes. Mesoproterozoic "Logan" diabase sills intrude the Rove Formation and form the resistant cap rocks of large mesas in the southern part of the map area. Silver mineralization occurs locally along normal faults that intersect the contact between Rove Formation shales and Logan diabase sills. Notable silver deposits occur in the southeastern corner of the Kakabeka Falls NTS map area, in the vicinity of Badger and Beaver mountains (Creswel or Rabbit Mountain group of deposits) and Silver Mountain. Accessory minerals in these deposits include: acanthite; pyrite; sphalerite; marcasite; galena; calcite; quartz; barite; and fluorite (Franklin et al. 1986).

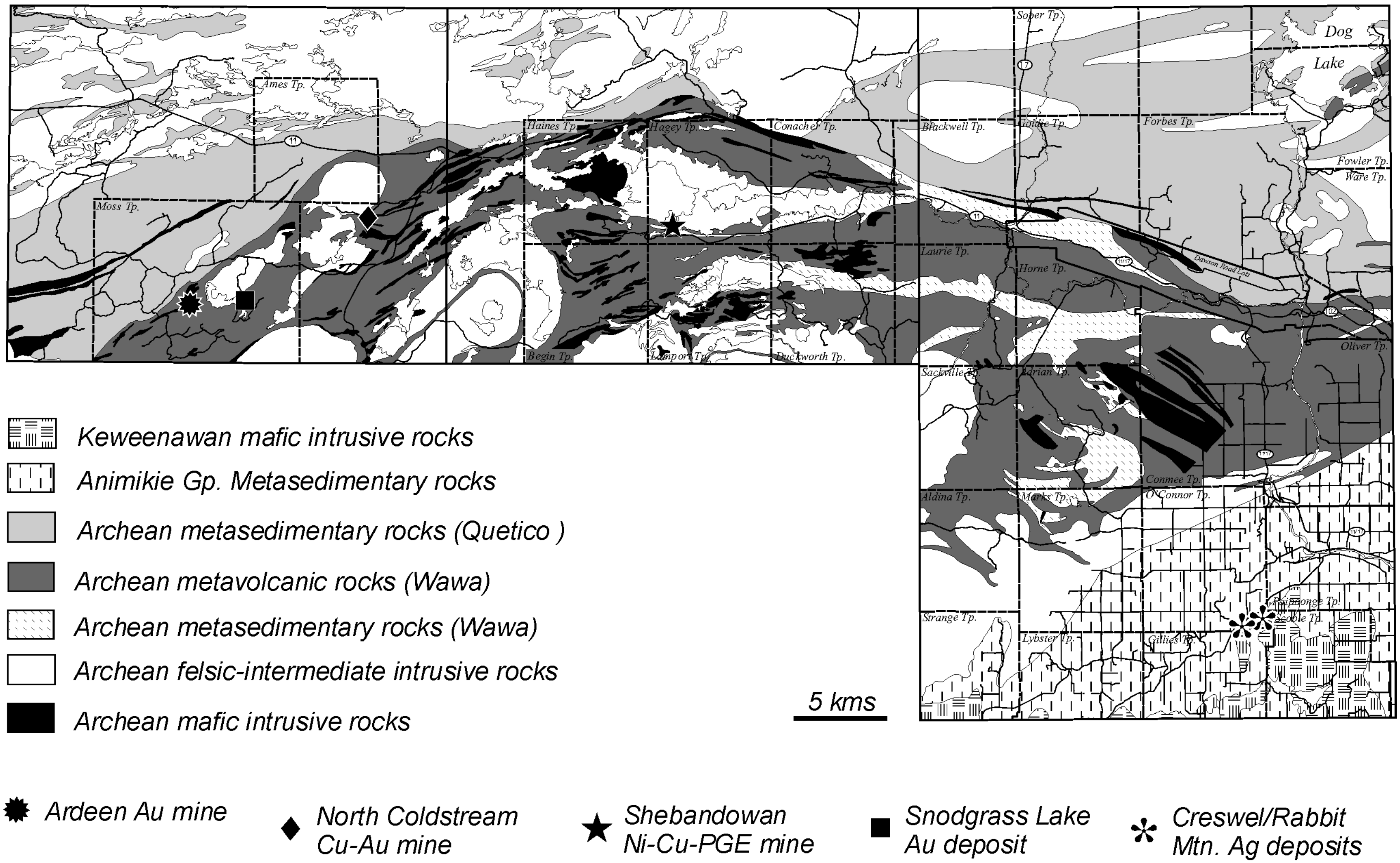

Figure 2. Bedrock geology of the study area highlighting the location of important past producing mines and mineral reserves.

Supracrustal rocks of the Shebandowan greenstone belt can be subdivided into 2 contrasting packages of metavolcanic and metasedimentary rocks: 1) an older suite of mafic to felsic metavolcanic rocks belonging to the Greenwater assemblage; and 2) a younger suite of metasedimentary and metavolcanic rocks belonging to the Shebandowan assemblage. The Greenwater assemblage consists primarily of tholeiitic basalts with intercalated intermediate to felsic metavolcanic rocks and minor komatiites (Corfu and Stott 1998). Mineralization at the Shebandowan, North Coldstream and Ardeen mines are all contained within Greenwater assemblage rocks. Ni-Cu-Pt-Co mineralization at the Shebandowan mine is hosted by a gabbro-peridotite sill. Cu-Au-Ag mineralization at the North Coldstream mine is hosted by a highly silicified gabbro. Gold mineralization at the Ardeen mine occurs in composite quartz veins developed along the Pele and Ardeen fault systems. Advanced exploration in the form of a decline ramp and bulk sample was undertaken at the Snodgrass Lake Au prospect in central Moss Township during the mid-1980s. Gold mineralization occurs in sheared felsic metavolcanic rocks and in sheared and fractured diorite, gabbro and quartz-feldspar porphyries. The Haines gabbro-anothosite complex represents one of the larger mafic intrusions within the belt. The intrusion, which is crudely layered, is host to a number of Ni-Cu-PGE occurrences.

The younger, Shebandowan assemblage both unconformably overlies (i.e., fault contact) and intrudes the Greenwater assemblage. It consists of alkalic metavolcanic and intrusive rocks (tuff, breccia, syenite, lamprophyre, quartz and feldspar porphyry, granodiorite and diorite) as well as metasedimentary rocks (arkoses, wackes, conglomerates and oxide-facies iron formation) (Schneiders et al. 1998). This assemblage is interpreted as representing an intracratonic basin assemblage similar to the Timiskaming assemblage of the Abitibi subprovince.

Most gold occurences in the eastern portion of the Shebandowan greenstone belt display a close spatial association with rocks of the Shebandowan assemblage. The style of gold mineralization is not unlike that which occurs in such prolific mining camps as Timmins and Kirkland Lake. Gold mineralization is commonly associated with both large scale and subsidiary structures and structurally-controlled intrusions. Mineralization occurs in sheeted and *en echelon* quartz veins, stockwork zones and vein breccias as well as in stocks, dikes and sills of felsic to mafic composition. Gold is also commonly associated with: sulphide-rich, quartz-veined replacement zones in oxide facies iron formation; silica-flooded, hydrothermally-altered zones; and iron-carbonate and pyrite-rich zones commonly associated with shear and permeable zones. Associated alteration and accessory minerals include: iron carbonate; silica; potassic feldspar; sericite; hematite; chlorite; calcite; pyrite; arsenopyrite; tourmaline; and green mica (Schneiders et al. 1998). Notable exploration programs within the current study area are highlighted in recently published annual volumes of the Resident Geologist's Report of Activities.

GLACIAL GEOLOGY

The study area is characterized by several contrasting physiographic regions, each defined by a unique suite of overburden conditions. Most of the Burchell Lake and Shebandowan NTS map areas as well as parts of the Sunshine and Kakabeka Falls NTS map areas are characterized as bedrock-dominated terrains. Local accumulations of thick drift occur in morainic belts, glaciofluvial complexes and narrow, structurally-controlled depressions within these uplands.

Thicker deposits of till and/or glaciofluvial and glaciolacustrine sediments occur within the Sunshine and Kakabeka Falls NTS map areas. A northern lowland, here referred to as the "Kaministikwia basin", occupies the valleys of the Oskondaga, Matawin, Shebandowan and Kaministikwia rivers. A southern basin is centred on the valleys of the Whitefish and Kaministikwia rivers. In the northern basin, thick deposits (several tens of metres) of glaciofluvial and glaciolacustrine sediments drape a rugged Archean bedrock surface producing a gently rolling landscape with sporadic bedrock outcrops. The low relief observed within the southern basin is a reflection of not only the flat-lying Proterozoic sediments that underlie the region, but the extremely thick glaciolacustrine deposits that have infilled deep valleys along the Whitefish and Kaministikwia rivers. Overburden thicknesses along these valleys exceed 60 m in places.

The erosional and depositional features preserved within the study area record a complex history of ice flow events associated with the Wisconsinan glaciation (Figure 3). The entire study area was affected by southward to southwestward flowing "northern" ice during the Wisconsinan glaciation. Striae associated with this event generally range between 190° and 220°. In the southern half of the Sunshine map area, there is widespread evidence for an older ice flow event towards 160°. The age and significance of this event is not known.

Pauses in the general retreat of the "northern" ice lobe resulted in the formation of large, arcuate, recessional moraines in northwestern Ontario. The Brule Creek Moraine, which traverses Aldina and Marks townships in the west-central portion of the Kakabeka Falls NTS map area, represents one of these stillstand positions (Figure 3). This moraine has been traced westward into the Shebandowan and Burchell Lake map areas where it is defined by a discontinuous belt of morainic ridges composed of till and associated ice-contact stratified deposits. West of the study area, the Brule Creek Moraine has been correlated with the Eagle Finlayson Moraine (Zoltai 1965). A large ice-contact delta built off of this moraine along the south shore of Burchell Lake is graded to an upper level of glacial Lake Agassiz. The upper topset surface of the delta occurs at an elevation of 457 to 472 m asl (1500 to 1550 feet asl). To the east of Marks Township, the Brule Creek Moraine has been overridden and obscured by a younger glacial advance (Figure 3). Isolated buried deposits of ice-contact stratified glaciofluvial deposits of northern provenance and possibly associated with the Brule Creek Moraine occur in south-central Conmee and west-central Oliver townships.

A second major moraine of northern affinity, (Dog Lake Moraine) is situated in the northeastern corner of the Sunshine map area in the vicinity of Dog Lake (Figure 3). Unlike the Brule Creek Moraine, this moraine was constructed following a minor readvance of the "northern" ice lobe. Glaciolacustrine sediments underlying till north of the moraine support a readvance. In the vicinity of Dog Lake, the moraine is fronted by a lobate, flat-topped, glaciofluvial plain believed to be deltaic in origin. The elevation of this plain (460 m asl) defines the level of Glacial Lake Kaministikwia, a large glacial lake which occupied the Kaministikwia basin. Distinctive red clays, associated with this glacial lake can be found throughout the basin up to, but not above, this elevation.

Glacial Lake Kaministikwia was topographically-supported on its southern flanks by an upland in the northwestern corner of the Kakabeka Falls NTS area as well as by glacial ice advancing out of the Superior basin and whose terminal position is defined by the Marks Moraine (Figure 3). The Marks and Dog Lake moraines are correlative and merge east of the study area along the interlobate McKenzie Moraine. Striae associated with the advance of the Superior lobe range from 340° in the northeast to 240° in the southwest, attesting to the lobate nature of the Superior lobe. This advance is correlated with the Marquette stadial, a late-glacial surge event that resulted in much of the Superior basin being reoccupied by glacial ice about 9.9 ka BP. With the exception of the northeast corner of the Kakabeka Falls area, the Superior lobe advanced into a glacial lake, referred to as "Glacial Lake O'Connor" (Zoltai 1963). Numerous sections along the Whitefish River expose thick sequences of glaciolacustrine rhythmites beneath a fine-textured Superior lobe till. Shorelines of this glacial lake have not been identified.

Till of northern (Patrician) provenance has been observed throughout the entire study area. On Archean terrane, beyond the limits of the Superior lobe, the till is generally less than a few metres thick and has a silty sand texture with low to moderate stone-content. Till cover is significantly more extensive over the east-central part of the Shebandowan NTS map area where thicknesses of 5 to 10 m are not uncommon. Unoxidized till generally has an olive-grey to buff-grey colour. The till often contains a high proportion of clasts that are locally-derived. Faceted and striated clasts within the till indicate deposition by ice flowing

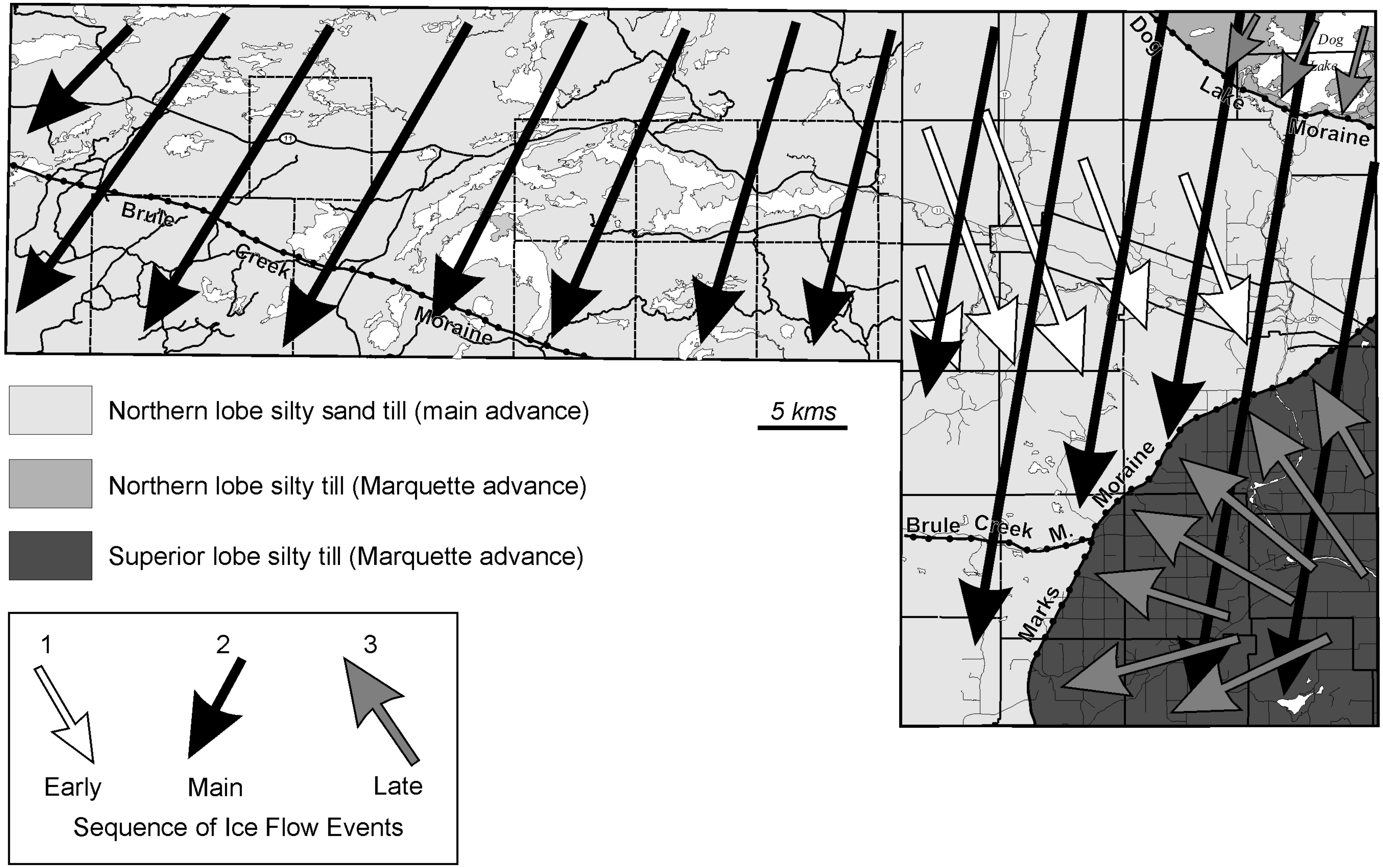

Figure 3. Regional ice flow patterns, moraines and surface till units of the study area.

towards the south-southwest. Many exposures of this northern till contain remnant clasts of Sibley Group metasediments. These distinctive, reddish-coloured siltstones occur most commonly east of Thunder Bay on the Sibley Peninsula and to a lesser extent, northeast of the study area in the Lake Nipigon basin. Sibley Group clasts in northern till are likely derived from the Nipigon basin, 70 km to the northeast. The non-magnetic heavy mineral concentrates (HMCs) of northern tills are rich in clinopyroxenes derived from Nipigon diabase within this same area.

Northern till is buried beneath variable thicknesses of glaciolacustrine deposits and Superior lobe till within the Whitefish-Kaministikwia lowland. In this area, the till is significantly finer-textured owing its fineness to the underlying shales and argillites of the Rove and Gunflint formations. Stony till, of presumed northern provenance, exposed at water level along Whitewood Creek in east-central O'Connor Township, contains abundant striated and faceted boulders indicating ice flow toward the southwest.

Superior lobe till is easily recognized by its fine-texture and high proportion of Animikie Group metasedimentary clasts in the pebble fraction. Even in areas underlain by Archean terrane, as occur in the northeast corner of the Kakabeka Falls area, Superior lobe till contains only a small proportion of the underlying rock types in the pebble fraction. This has important implications for programs of mineral exploration utilizing till as a sample medium. The colour of the unweathered till ranges from dark grey, to brown to reddish-brown. Sections of till, containing layers with all 3 colours have been observed in Oliver and Gillies townships and probably reflect the melting out of debris bands derived from different bedrock sources. Superior lobe till also varies markedly in texture. In Oliver Township, near the community of Murillo, Superior lobe till is silty and charged with shales of the Gunflint Formation. The till in this region is fluted and has been observed to reach thicknesses of 7 to 8 m. Similarly, to the south in Scoble and Gillies townships, Superior lobe till is silty and charged with clasts of Rove Formation shale and Logan diabase. Along the Whitefish River valley, the till has a silty to clayey matrix and contains less than 5% clasts. This is primarily due to the thick deposits of glaciolacustrine silts and clays that were overridden and incorporated into the basal debris layers of the advancing Superior lobe.

Methods

SAMPLE COLLECTION

Over 380 c-horizon till samples were processed for their kimberlite indicator mineral (KIM) and metamorphosed/magmatic massive sulphide indicator mineral (MMSIM®) content. Sample density is highest over supracrustal rocks of the Shebandowan greenstone belt (1 sample per 7 km^2) and diminishes over Quetico Subprovince rocks to the north and Proterozoic metasedimentary and mafic intrusive rocks to the southeast (Figure 4, Appendix A). Details of sample collection are contained in Ontario Geological Survey Open File Reports 5993 and 6012 (Bajc 1999a, 2000).

PROCESSING AND ANALYSIS

Heavy mineral processing of 10 kg bulk, c-horizon till matrix (-5 mm) samples was performed by Overburden Drilling Management Limited of Nepean, Ontario. All samples submitted as part of the 1998

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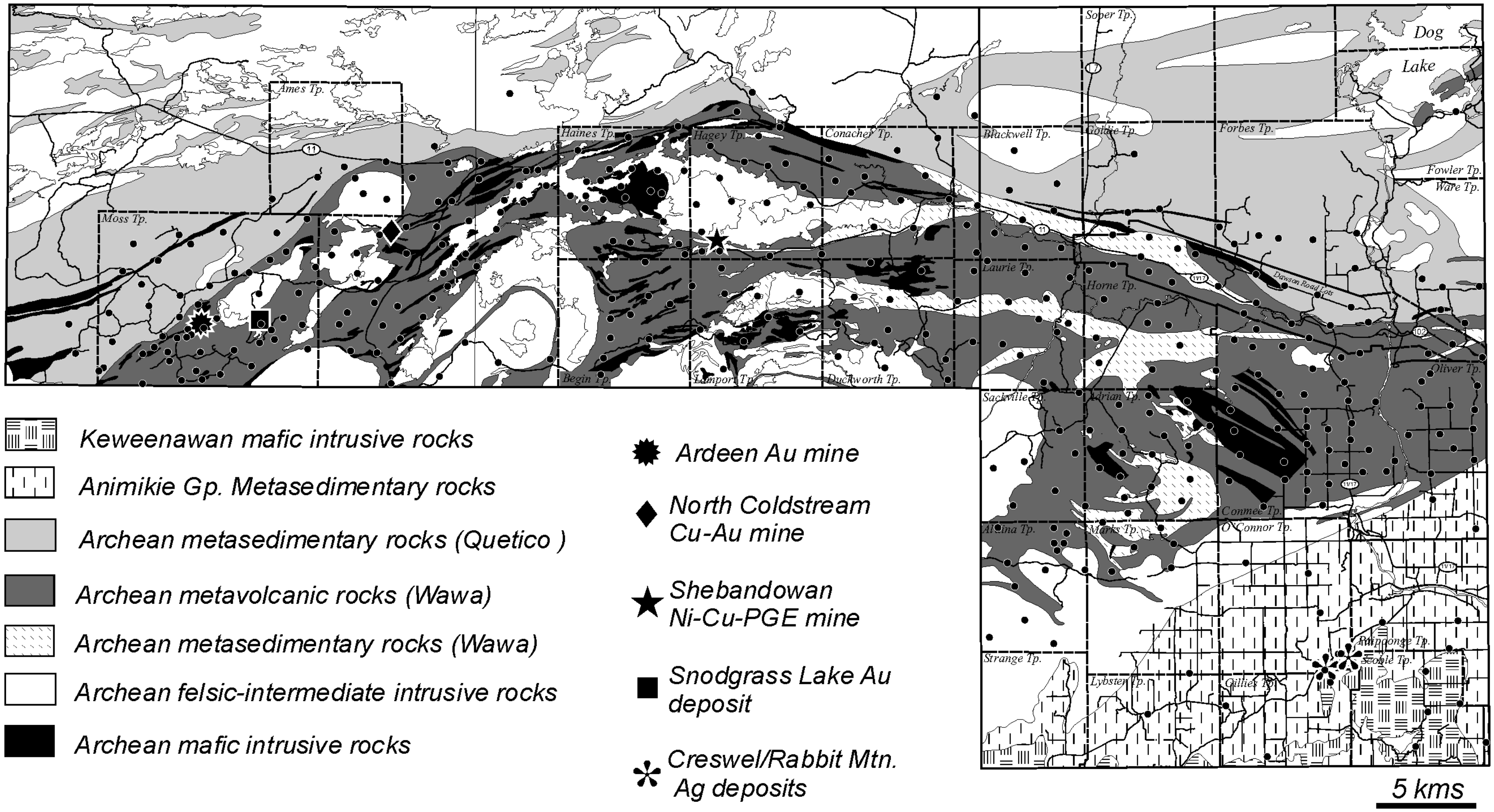

Figure 4. Location of till samples collected as part of the regional till sampling survey.

and 1999 field programs (688 samples) were initially processed for their gold grain content by single-pass, wet gravity tabling. The gold grain count of samples containing 10 or more "tabled grains" (i.e., grains observed on the table) was refined by panning the "table concentrate". The "table concentrate" was further concentrated to >3.2 S.G. using density-dependent settling in methylene iodide. Just over one-half of the heavy mineral concentrates (HMCs) were subsequently processed for their KIM and MMSIM® content. Ferromagnetic minerals were isolated from the HMCs using an automagnet. The non-ferromagnetic fraction was dry sieved at 0.25, 0.5 and 1.0 mm. The –0.25 mm fraction was not examined. A paramagnetic separation was performed on the 0.25 to 0.5 mm and 0.5 to 1.0 mm fractions using a Carpco paramagnetic separator. This separation assisted with the segregation of KIMs and MMSIMs® as well as isolating undesirable grains of clinopyroxene which accounted for a significant proportion of the nonferromagnetic fractions which, when present, reduced picking efficiency considerably. KIMs and selected/representative MMSIMs® isolated from these fractions were stored in vials and shipped to the Ontario Geoscience Laboratories (OGL) for microprobe analysis.

Kimberlite Indicator Minerals

Indicator minerals associated with kimberlite are listed in Table 1 and consist of: 1) 3 species of garnets, namely, peridotitic Cr-pyrope, eclogitic pyrope-almandine and megacrystic Cr-poor pyrope; 2) Mg-ilmenite; 3) chromite; and 4) chrome diopside. Mg-rich olivine (forsterite) and orthopyroxene (enstatite) often occur in association with, although not strictly limited to, kimberlite (Averill 1999). The chemistry of several of these mineral species can provide valuable information on the potential fertility of their source kimberlites (Gurney and Moore 1993; Fipke et al. 1995; Morris et al. 2000). This information will be summarized in the discussion of results.

Table 1. Kimberlite indicator minerals, their end member chemical formulae and associated geochemical criteria by which they are evaluated.

Indicator Mineral	Chemical Formula	Definition
peridotitic high-Cr pyrope	$Mg_3Al_2Si_3O_{12}$	CaO-Cr_2O_3 binary plot (Dawson and Stephens 1975)
megacryst low-Cr pyrope	$Mg_3Al_2Si_3O_{12}$	Na_2O-TiO_2 binary plot (Schultze 1999)
eclogitic pyrope-almandine	$Fe_3Al_2Si_3O_{12}$	Na_2O-TiO_2 binary plot (Schultze 1999)
Mg-ilmenite	$FeTiO_3$	MgO-Cr_2O_3 binary plot (Gurney and Moore 1991)
chromite	$(Fe,Mg)(Cr,Al)_2O_4$	TiO_2-Cr_2O_3 and MgO-Cr_2O_3 binary plots (Fipke et al. 1995)
chrome diopside	$Ca(Mg,Cr)Si_2O_6$	Cr2O3-Al2O3-Na2O ternary plot (Morris et al. 2000)
Mg-rich olivine (forsterite)	Mg_2SiO_4	Forsteritic Number-SiO2 binary plot
orthopyroxene (enstatite)	$(Mg,Fe)_2Si_2O_6$	-

Metamorphosed/Magmatic Massive Sulphide Indicator Minerals

Indicator minerals associated with metamorphic/magmatic massive sulphide deposits can be subdivided into 3 main groupings. These include: 1) heavy minerals formed by recrystallization of volcanosedimentary massive sulphide deposits and their alteration halos during high-grade regional metamorphism; 2) heavy minerals generated by thermal metamorphism and metasomatism (skarns and griesens); and 3) heavy minerals formed by alteration processes associated with the separation of Ni-Cu sulphides from ultramafic magmas and komatiites (Averill 1999). Indicator minerals associated with each of these groupings are listed in Table 2.

Table 2. List of indicator minerals commonly associated with base metal mineralization (from Averill 1999). Shaded areas indicate mineral species presence.

Indicator Mineral	MVMS	Mag Ni-Cu	Skarn	Greisen
anthophyllite	■			
barite	■			
cassiterite				■
chalcopyrite	■	■	■	■
chromite		■		
cinnabar	■			
corundum	■			
Cr-rutile	■	■		
dumortierite	■			
fluorite				■
forsterite olivine			■	
franklinite	■			
gahnite	■			
grossular			■	
hercynite		■		
johannsenite			■	
knebelite olivine			■	
kyanite	■			
loellingite	■	■		
low-Cr diopside		■		
Mg-spinel	■			
Mn-epidote	■			
native gold	■		■	
olivine		■		
orthopyroxene	■	■		
PGE alloys		■		
rammelsbergite		■		
sapphirine	■			
scheelite			■	
sillimanite	■			
sperrylite		■		
spessartine	■			
staurolite	■			
topaz				■
tourmaline	■			■
uvarovite		■		
vesuvianite			■	
willemite	■			
wolframite				■

MVMS: *metamorphosed volcanosedimentary massive sulphide mineralization.*
Mag Ni-Cu: *magmatic nickel-copper massive sulphide mineralization.*

Results and Interpretation

The non-magnetic heavy mineral concentrates of both Superior and northern provenance tills collected and analyzed for KIMs and MMSIMs® are dominated by the mineral pigeonite, a brown, Ca-poor clinopyroxene that is gradational to Ca-poor augite (Appendix B). This mineral is so abundant that it has resulted in heavy mineral concentrates with unusually high weights for samples collected from the shield terrane of Ontario. Weights of the -2 mm non-magnetic heavy mineral concentrate (>3.2 S.G.) derived from samples initially weighing 10 kg, commonly exceed 300 or 400 g. Weights in the range of 40 to 50 g are more typical of samples collected from Archean greenstone belts of Ontario.

The pigeonite is most likely derived from laterally extensive sills of Nipigon and Logan diabase that outcrop approximately 70 km northeast of and at the southeast corner of the study area (Figure 5). It has been identified in lithic fragments of olivine diabase that were picked from the coarser fractions of the non-magnetic heavy mineral concentrates (0.5-2.0 mm). Nipigon and Logan diabase is composed of 40 to 50% pyroxene (S. Averill, Overburden Drilling Management, personal communication, 1998) and is therefore the likely source. The local Archean bedrock on the other hand, generally contains less than 0.5% heavy minerals and probably doesn't contribute greatly to the oversized concentrates.

Because of the extreme dilution of the non-magnetic heavy mineral concentrates with pigeonite, it is not recommended that heavy mineral geochemistry be performed for exploration purposes. Very subtle variations related to local geological conditions present in the geochemical signature of the concentrate would most likely be overwhelmed by the composition of the pyroxene. The evaluation of mineral potential based on the isolation of KIMs and MMSIMs® from the heavy mineral concentrate is effective since every indicator mineral grain is noted and/or extracted and analyzed geochemically.

KIMBERLITE INDICATOR MINERALS

Regional heavy mineral surveys form an important component of diamond exploration programs in glaciated regions of the world. In Ontario, the most common sediments sampled in heavy mineral surveys include fluvial and glaciofluvial deposits (i.e., stream sediments, eskers and outwash deposits), beach deposits and till. The premise behind sampling these first and second order derivative sediments is that the signal of kimberlite, a common host rock for diamonds, will be significantly larger than the kimberlite pipes themselves. Fluvial and glaciofluvial deposits provide a much broader picture of the diamond potential of a given region than do till sampling surveys. The results presented in this report are derived almost exlusively from basal till samples collected as part of the regional sampling program. The results should therefore be interpreted with caution in that the sampling density is probably not at a high enough level to adequately evaluate the region for its diamond potential.

Diamonds commonly form in upper mantle-derived peridotite and eclogite where it is sampled by kimberlitic magma prior to its ascent to the surface in a kimberlite pipe. In addition to diamond, a number of other xenocrysts, that occur at a much higher concentration, are brought to surface in the kimberlite magma where they are eroded and redistributed by glacial and non-glacial processes. Xenocrysts associated with peridotitic source rocks include Cr-pyrope garnet, chromite and Cr-diopside. Pyrope-almandine garnets occur as xenocrysts in eclogitic source rocks. A megacrystic suite of xenocrysts, consisting of Mg-ilmenite and Cr-poor pyrope garnets is derived from the kimberlitic magma itself. These xenocrysts are considered important KIMs although not to the same extent as those associated with the peridotitic and eclogitic suite. Table 1 lists the important kimberlite indicator minerals, their end member chemical formulae and geochemical criteria by which they are evaluated.

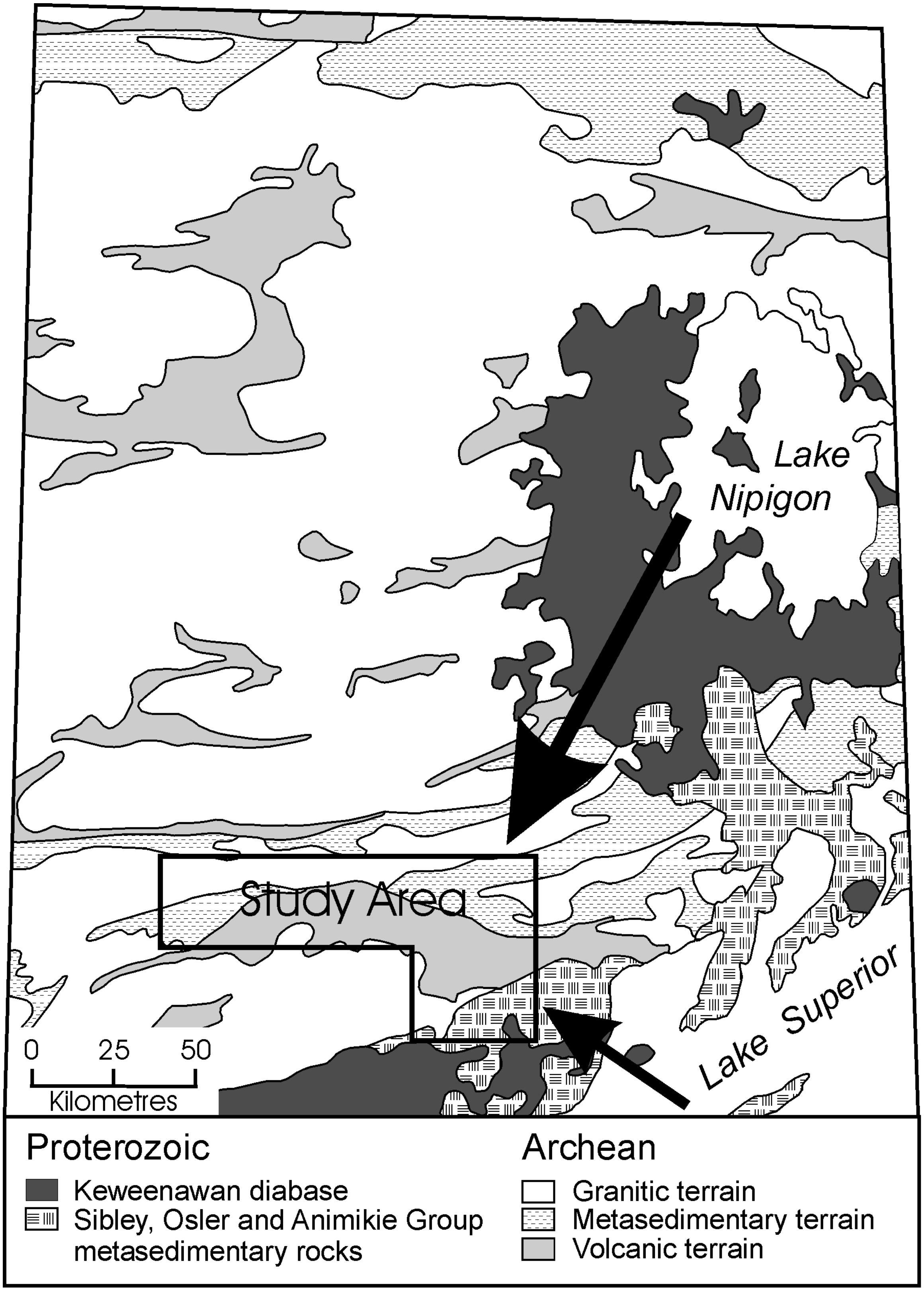

Figure 5. Regional bedrock geology highlighting the position of Proterozoic-aged diabase with respect to regional ice flow (arrows).

Peridotitic Suite

CR-PYROPE GARNETS

A high proportion of garnet xenocrysts recovered from kimberlites in South Africa and North America are derived from peridotite (Schultze 1999). Eighty-five percent of the peridotitic Cr-pyropes that occur as inclusions in diamond are Ca-depleted, Cr-enriched and of harzburgitic composition. These xenocrysts are referred to as "G10 garnets" and are one of the most valuable indicators of diamondiferous kimberlite. More calcic, Cr-pyrope garnets of kimberlitic affinity are referred to as "G9 garnets" and rarely occur as inclusions in diamond. These garnets are derived from peridotite of lherzolitic composition.

Only 2 pyrope garnets were recovered as part of the regional sampling program (samples 98-AFB-149 and 98-AFB-009). Both of them fall well within the G9 field of the CaO-Cr_2O_3 binary diagram of Dawson and Stephens (1975) (Figure 6). Sample 98-AFB-149, which was collected from east-central Oliver Township and consists of Superior lobe till derived from the southeast, contained one of the G9 pyrope garnets. The other grain was recovered from sample 98-AFB-009, which was collected from east-central Blackwell Township and consisted of till of northern provenance.

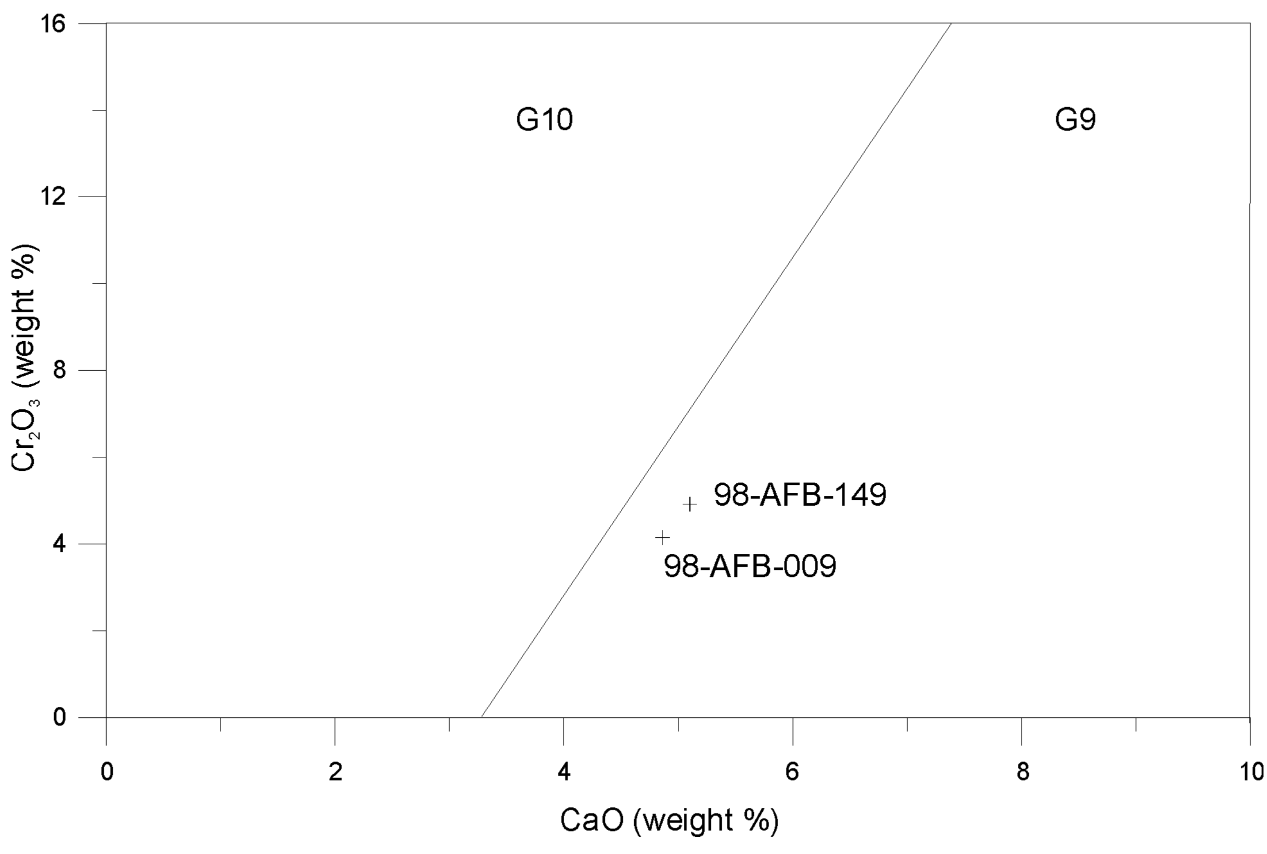

Figure 6. CaO-Cr_2O_3 binary plot for pyrope garnets (from Dawson and Stephens 1975).

CHROMITE

Chromite that occur as inclusions in diamond are easily distinguished from crustal chromites by their elevated Cr_2O_3 and MgO contents. These "inclusion field" chromites contain greater than 61 wt % Cr_2O_3 and 12 to 16 wt % MgO (Gurney 1984, Fipke et al. 1995). They are also characterized by very low TiO2 contents, generally occuring at less than 0.6 wt %. Lawless (1974), Sobolev (1977) and Dong and Zhou (1980) have suggested a Cr_2O_3 threshold of 62.5 wt % for chromites associated with diamond. A Cr_2O_3-TiO_2 binary diagram (Figure 7a) is useful for identifying those chromites unique to kimberlite and lamproite (Fipke et al. 1995).

Approximately 350 representative chromite grains, of an estimated 4600 counted as part of the heavy mineral processing, were microprobed at the Ontario Geoscience Laboratories. A chromite grain isolated from sample 98-AFB-286 plots in the field unique to kimberlite and lamproite on Figure 7a (Fipke et al. 1995). This sample was collected from the northwest corner of Horne Township and consists of northern-derived till. A second chromite grain isolated from sample 98-AFB-084 plots just outside the diamond intergrowth field on the Cr_2O_3-MgO binary plot (Figure 7b) of Fipke et al. (1995). This sample was collected from east-central Adrian Township and consists of northern-derived till. A chromite grain isolated from sample 98-AFB-238 also plots just outside of the diamond inclusion field of this diagram. It contains 56 wt % Cr_2O_3 and over 15 wt % MgO. This sample was collected from the southwestern corner of Adrian Township. It was isolated from a sample of ice-contact stratified sand and gravel of northern provenance.

CHROME DIOPSIDE

The chromium content of chrome diopside has historically been used to distinguish xenocrysts of kimberlitic affinity from those derived from crustal rocks. Dawson and Stephens (1975) suggested a Cr_2O_3 cutoff of 1.45 wt % whereby those chrome diopsides with Cr_2O_3 contents above this value are likely to be derived from kimberlite. Subsequent studies of chrome diopsides isolated from kimberlite in the Kirkland Lake-Cobalt area of northeastern Ontario have returned ranges of Cr_2O_3 between 0.03 and 3 wt % (Sage 1996). A ternary plot of Cr_2O_3-Al_2O_3-Na_2O (Figure 8) devised by Morris et al. (2000) defines a field of chrome diopside composition with kimberlitic affinity. Chrome diopside grains from this field contain a narrow range of Na_2O with variable Cr_2O_3 and Al_2O_3 concentrations.

Nearly 90 percent of the 830 chrome diopside grains (734 grains) isolated as part of the regional sampling survey were microprobed at the Ontario Geoscience Laboratories. Four of these grains contained Cr_2O_3 contents in excess of 1.45 wt %. These include samples 98-AFB-172 in southwestern Conmee Township, 98-AFB-190 in south-central Horne Township, sample 98-AFB-257 in southwestern Conmee Township and sample 99-AFB-183 in the Upper Shebandowan Lake area. Only a single chrome diopside grain plots in the kimberlite field of the Cr_2O_3-Al_2O_3-Na_2O ternary diagram (Figure 8) as proposed by Morris et al. (2000). This sample (99-AFB-233) was collected from central Moss Township at the west end of the greenstone belt. Several chrome diopsides plot just outside of the kimberlite field. These include 2 grains from site 98-AFB-231 in south-central Aldina Township and a single grain from site 99-AFB-239 in southwestern Moss Township.

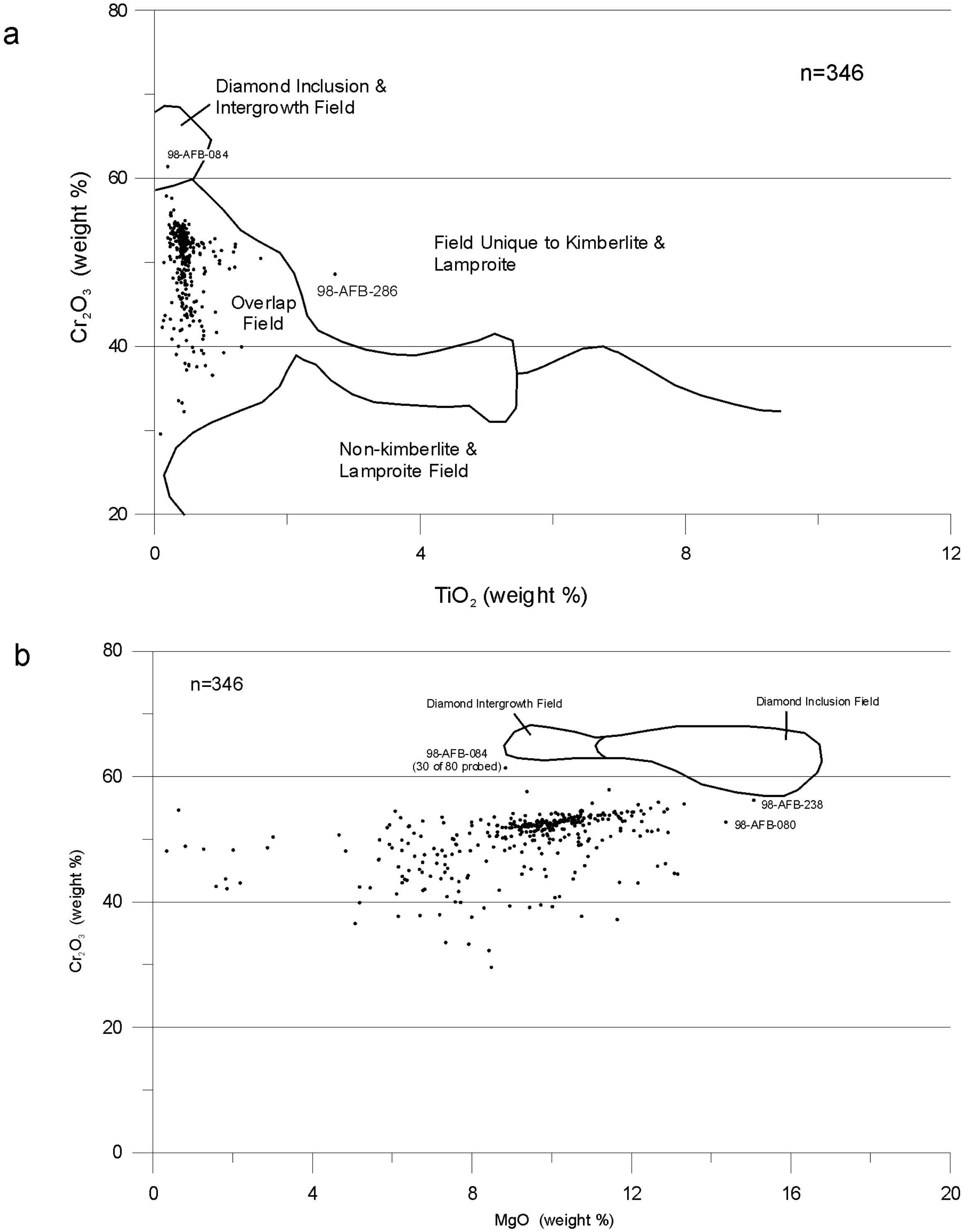

Figure 7a. Cr_2O_3-TiO_2 binary plot for chromite; **7b.** Cr_2O_3-MgO binary plot for chromite (from Fipke et al. 1995)

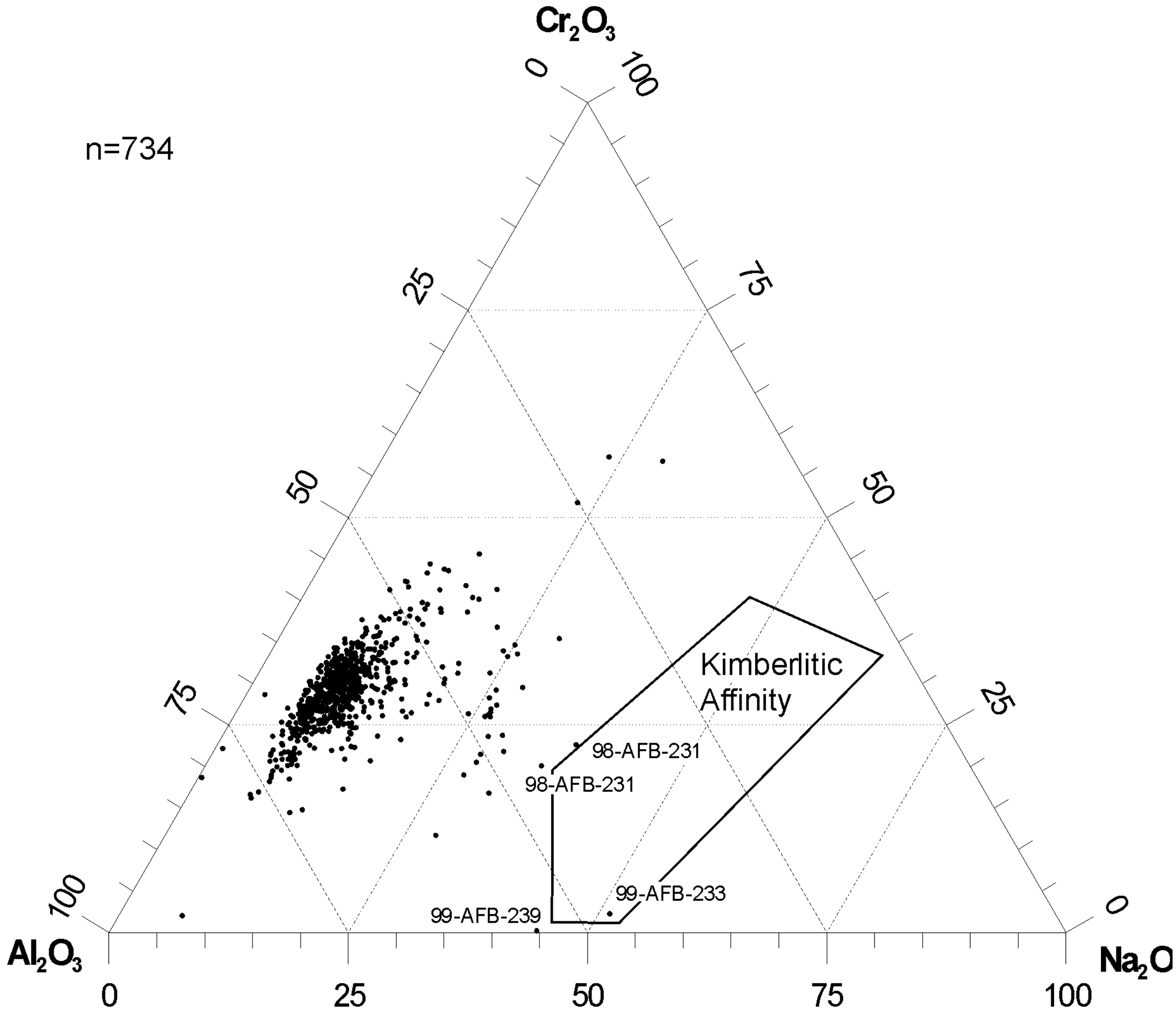

Figure 8. Cr_2O_3-Al_2O_3-Na_2O ternary plot for chrome diopside (from Morris et al. 2000). Cr_2O_3, Al_2O_3 and Na_2O normalized to 100%.

Eclogitic and Megacrystic Suite

ECLOGITIC GARNETS

Eclogitic garnets, also referred to as pyrope-almandines, occur far less frequently as xenocrysts in kimberlite than do peridotitic garnets. Their occurrence can be quite significant in that Na-enriched varieties occur in diamond eclogites. Diamond-bearing eclogitic xenoliths typically display significantly higher diamond concentrations than diamond-bearing peridotitic xenoliths (Schultze 1999). As such, the eclogitic xenoliths should be considered extremely important. Garnets recovered from diamond eclogites typically contain greater than 0.07 wt % Na_2O and often contain elevated TiO_2 contents. These are referred to as Group I eclogitic garnets (Figure 9). Those with less than 0.07 wt % Na_2O are referred to as Group II. Although these Group II eclogitic garnets are considered KIMs, they are not associated with diamondiferous eclogites.

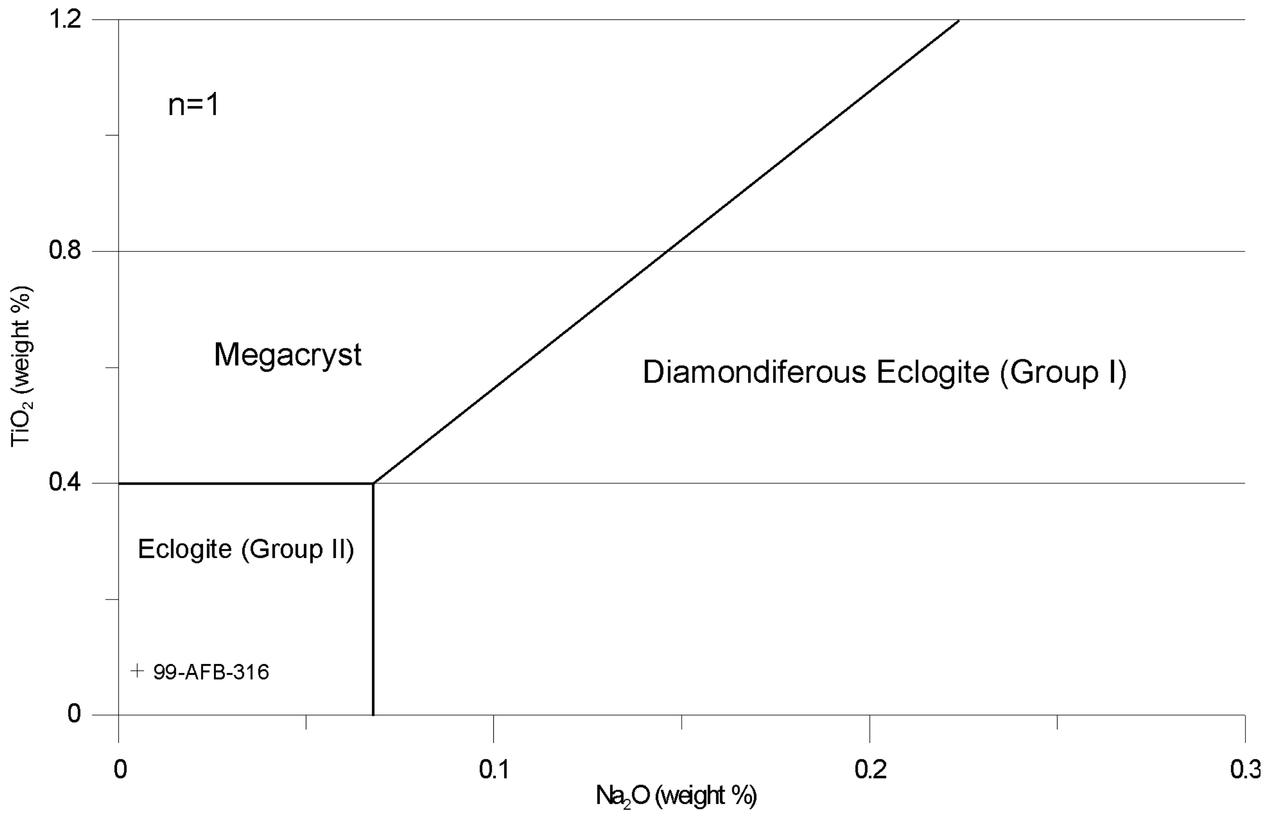

Figure 9. TiO_2-Na_2O binary plot for eclogite/megacryst garnets (from Schultze 1999).

A single grain assigned to the Group II eclogitic field of the Na_2O-TiO_2 binary plot was recovered from sample site 99-AFB-316 (Figure 9). This grain was recovered from a sample of northern-derived till collected in the southwestern corner of Moss Township.

CR-POOR PYROPE/MEGACRYST GARNETS

Cr-poor pyrope/megacryst garnets belong to the megacrystic suite of xenocrysts and are derived from kimberlitic magma. In spite of being the most dominant orange, mantle-derived garnet in most kimberlites, this suite of garnets has no genetic connection to diamonds (Fipke et al. 1995). Cr-poor megacryst garnets also contain elevated Na_2O and TiO_2 contents making them difficult to distinguish from Group I, diamondiferous eclogite garnets. They are, however, easily distinguished on a TiO_2-Na_2O diagram where they plot into distinct fields. No Cr-poor pyrope/megacryst garnets were recovered from the regional sampling survey.

MG-ILMENITES

Mg-ilmenites form a second species of the megacrystic suite. Ilmenites formed within kimberlitic magma are termed picroilmenites and generally contain between 4 and 15 wt % MgO (McCallum and Vos 1993). If the ilmenite contains greater than 2 wt % Cr_2O_3, then there is an even higher probability that the grain was derived from kimberlitic magma. A Cr_2O_3-MgO binary plot devised by Gurney and Moore (1991) is useful for the determination of redox conditions under which the rising magma was subjected. Magma rising under oxidizing conditions will contain ilmenites with MgO contents of less than approximately 8.0 wt % and will therefore favour diamond resorption. Ilmenites with MgO contents of greater than 8.0 wt % and falling within the reduced field will favour diamond preservation (Figure 10).

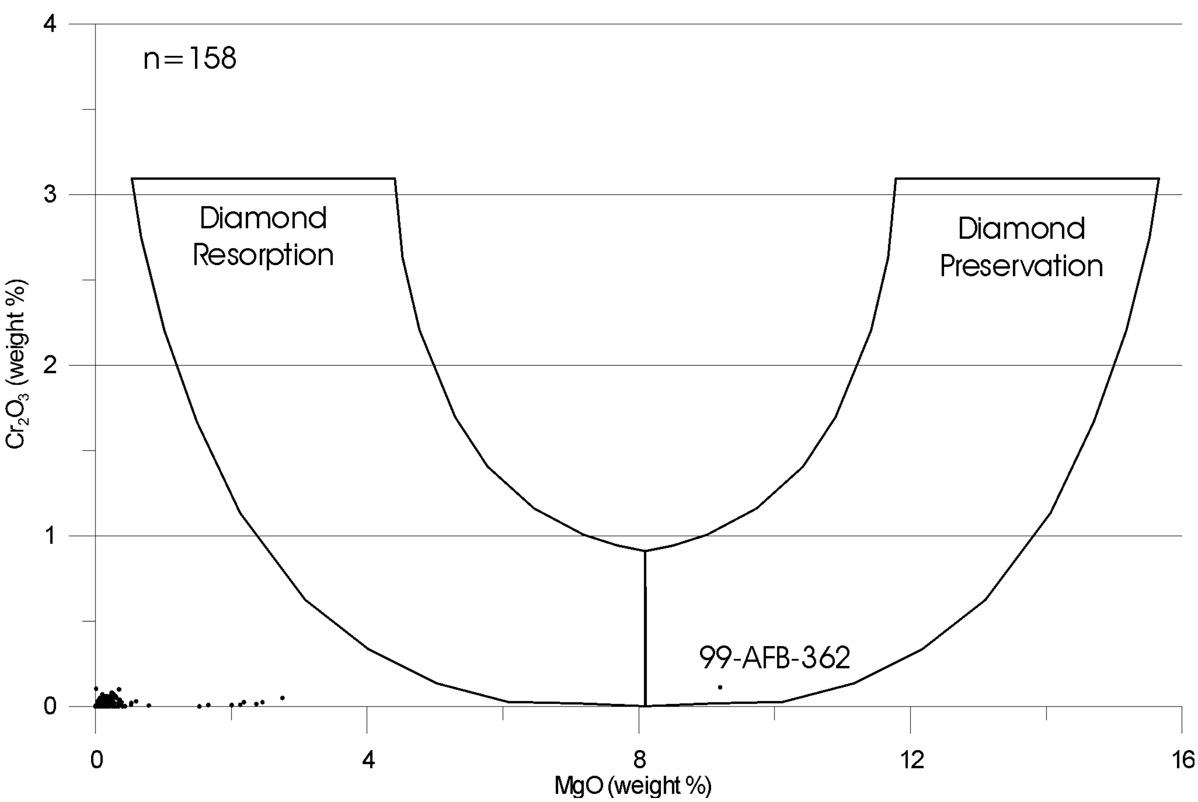

Figure 10. Cr_2O_3-MgO binary plot for Mg ilmenites (from Gurney and Moore 1991).

One-hundred and fifty-eight ilmenites were isolated from the heavy mineral concentrates and submitted to the Ontario Geoscience Laboratories for microprobe analysis. The results of these analyses are presented on an MgO-Cr_2O_3 binary diagram displaying reducing and oxidizing fields for the kimberlite magma (Figure 10). Only one grain plots within the reduced field. This grain was isolated from a sample of northern-derived till collected from the northwest corner of Conacher Township. This grain contains only 0.11 wt % Cr_2O_3 and is therefore probably not derived from kimberlitic magma.

Other Kimberlite Indicator Minerals

OLIVINES

The Fo value of olivine can provide useful information regarding its host lithology (Figure 11). Olivines derived from kimberlite in the Attawapiskat and Kirkland Lake clusters are typically forsteritic or Mg-rich and yield Fo values of greater than 87%. Komatiitic olivines display similarly high forsteritic values. Their CaO content is generally higher than those derived from kimberlitic sources. CaO concentrations commonly exceed 0.1 weight percent in komatiitic olivines.

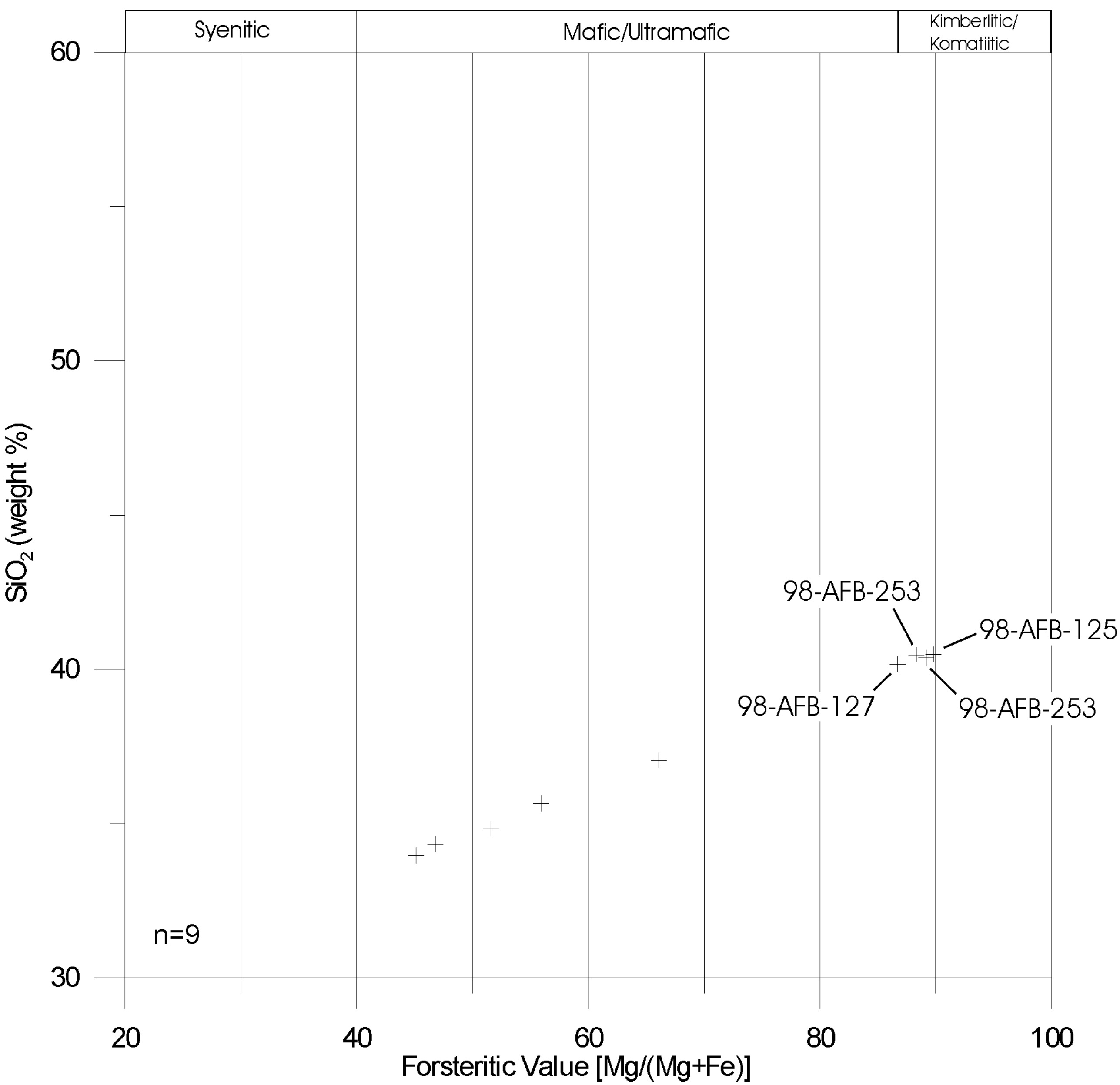

Figure 11. Binary plot of SiO_2 versus the forsteritic value for olivines.

Only 9 grains of olivine were isolated and submitted for microprobe analysis. Four of these grains yielded forsteritic values of 87% or higher (Figure 11). These include a single grain in sample 98-AFB-125 from east-central Fowler Township, 2 grains from sample 98-AFB-253 in west-central Conmee Township and a single grain from sample 98-AFB-127 in north-central Oliver Township. The CaO content of these grains ranges between 0.2 and 0.3 wt %, suggesting a non-kimberlitic source. Forsteritic olivines recovered from sample 98-AFB-253 appear to be derived from mapped rocks of mafic and ultramafic composition supporting this hypothesis.

Summary of KIM Results

Few kimberlite indicator minerals were recovered as part of the regional till sampling program over the Shebandowan greenstone belt (Table 3). The apparent random distribution of grains (Figure 12) coupled with the lack of supporting mineral species at any given site suggests that the grains form part of a regional background population likely derived from distant sources to the northeast. The dataset suggests that this region has reduced potential for the discovery of kimberlite-hosted diamonds. Stream and esker sampling programs are recommended to more fully evaluate the region.

Table 3. Summary of kimberlite indicator mineral results.

Sample #	# Grains	Mineral Species	Comment
98-AFB-149	1 grain	Pyrope Garnet	G9 pyrope garnet
98-AFB-009	1 grain	Pyrope Garnet	G9 pyrope garnet
98-AFB-084	1 grain	Chromite	Marginal diamond intergrowth field onCr_2O_3-MgO binary plot
98-AFB-286	1 grain	Chromite	Field unique to kimberlite and lamproite on Cr_2O_3-TiO_2 binary plot
98-AFB-172	1 grain	Chrome Diopside	>1.45 wt % Cr_2O_3
98-AFB-190	1 grain	Chrome Diopside	>1.45 wt % Cr_2O_3
98-AFB-257	1 grain	Chrome Diopside	>1.45 wt % Cr_2O_3
99-AFB-183	1 grain	Chrome Diopside	>1.45 wt % Cr_2O_3
99-AFB-233	1 grain	Chrome Diopside	Field with kimberlitic affinity on Cr_2O_3-Al_2O_3-Na_2O ternary diagram
99-AFB-316	1 grain	Eclogitic Garnet	Group II on TiO_2-Na_2O binary plot
99-AFB-362	1 grain	Picroilmenite	>8 wt % MgO

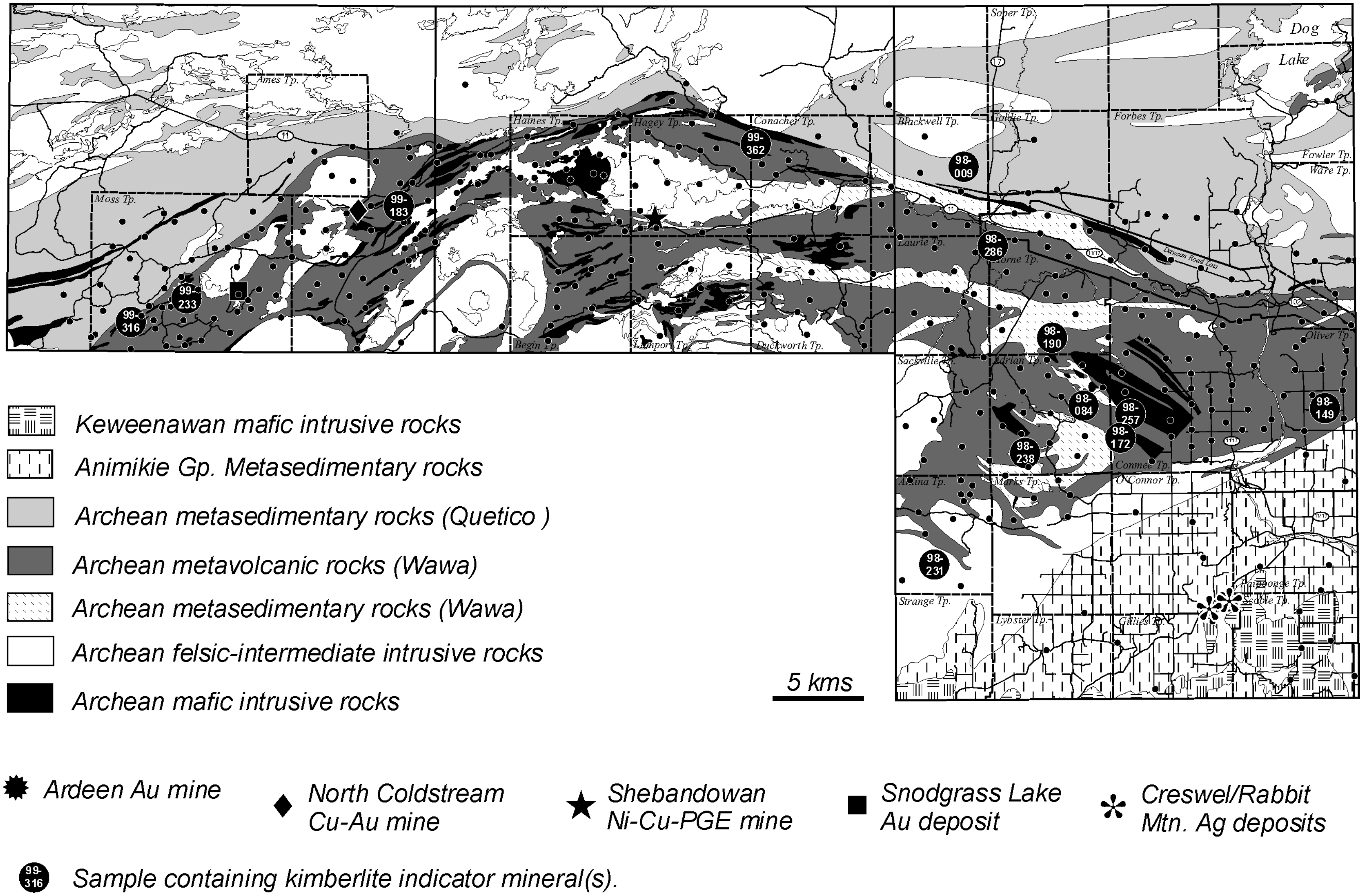

Figure 12. Summary diagram highlighting the regional distribution of kimberlite indicator minerals. Sample numbers keyed to Table 3.

METAMORPHIC/MAGMATIC MASSIVE SULPHIDE INDICATOR MINERALS (MMSIMS®)

As mentioned previously, the suite of indicator minerals picked as part of the MMSIM® package target 3 main styles of mineralization, namely, those associated with high grade metamorphism of volcanosedimentary massive sulphide deposits and their alteration halos, those associated with thermal metamorphism and metasomatism as occur in skarns and greisens and those associated with magmatic Ni-Cu-PGE mineralization.

In the Shebandowan greenstone belt, those base metal indicator minerals of greatest interest are likely those associated with Ni-Cu-PGE sulphide mineralization. The belt is host to a past-producer of Ni-Cu-PGEs (Shebandowan Mine) and also contains abundant mafic to ultramafic host rocks favourable for this type of mineralization. The metamorphic grade of the belt ranges between lower greenschist and lower amphibolite and, only locally, reaches middle to upper amphibolite grade around the peripheries of late- to post-tectonic felsic intrusions (Williams et al. 1991). The metamorphic grade of the belt is therefore probably not at a high enough level for the generation of high-grade mineral assemblages associated with volcanosedimentary massive sulphide deposists and their alteration halos. Volcanogenic massive sulphide mineralization is therefore best indicated by the presence of ore-forming sulphide minerals such as chalcopyrite, sphalerite and galena as well as native gold. Most hydrothermal alteration zones in greenschist facies terranes are characterized by fine-grained, low-density minerals that are not isolated by the MMSIM® method (Averill 1999). Mineralization associated with thermal metamorphism and metasomatism may be of local importance. Appendix C contains a summary of the MMSIM® grain counts.

Ore-forming indicator minerals associated with magmatic Ni-Cu-PGE mineralization include chalcopyrite, chromite, sperrylite ($PtAs_2$) as well as a number of PGE alloys. Pyrrhotite and pentlandite are infrequently encountered. Most of the other indicator minerals associated with this type of mineralization form during the hybridization process during which Ni and Cu are separated from the silicate phase of a mafic-ultramafic magma. For example, the removal of large volumes of Fe from the silicate phase of a magma during the formation of Ni-Cu sulphides tends to result in the formation of Mg-rich olivines (forsterite) and Mg-rich orthopyroxenes (bronzite/enstatite). Chromium may also transfer from chromite to Fe-free minerals such as rutile, diopside and uvarovite; a garnet often associated with chromite-bearing serpentinites. If sufficient Fe is removed from the silicate melt, thereby inhibiting the formation of chromite, then gahnite, a zinc-rich spinel, may form with the excess Cr being accomodated in the diopside structure.

Chromite

Chromite is an important constituent of mafic and ultramafic rocks. It occurs most notably within peridotite, komatiite and their serpentinized counterparts. It forms during the early stages of magma crystallization and may therefore accumulate as distinct horizons within the magma chamber as a result of crystal sorting and settling. Such layered intrusions are prime hosts for Ni-Cu sulphide mineralization. Chromite may also accumulate at the base of channelized, komatiitic flows in association with Ni sulphide mineralization. The regional distribution of chromite in till may therefore provide valuable information on the location of potentially fertile mafic-ultramafic host rocks. These anomalies are further enhanced by the occurrence of additional indicator minerals such as chalcopyrite, chrome diopside, Cr-rich rutile and the platinum group minerals, most notably the arsenides.

Several clusters of samples containing anomalous numbers of chromite grains have been identified within the Shebandowan greenstone belt (Figure 13). Most of these are associated with known mafic-ultramafic host rocks. Three samples collected from southwestern Conmee Township and adjoining east-central Adrian Township (Anomaly A, Figure 13) contained anomalous chromite grain counts. Sample 98-AFB-084 contained an estimated 80 grains, sample 98-AFB-172 contained an estimated 165 grains and sample 98-AFB-257 contained an impressive 3500 grains. Olivine gabbros and serpentinites have been mapped within this area (Carter 1990; Rogers and Berger 1995) and are presumed to be the source rocks for these anomalous grain counts. Despite the lack of a supporting cast of indicator minerals, this anomaly is regarded as significant and worthy of follow-up work. Anomalous nickel, chromium, cobalt and cadmium till geochemistry within this area may indicate enhanced potential for nickel sulphide mineralization.

Two till samples collected from central Duckworth Township (99-AFB-356 and 285) contained anomalously high chromite grain counts (Anomaly B, Figure 13). Sample 356 contained an estimated 150 grains and sample 285 an estimated 100 grains. Sample 285 also contained 1 grain of uvarovite, a chromium-rich garnet commonly associated with serpentinite. A strong geochemical anomaly, defined by elevated to anomalous chromium, nickel and copper in till, also exists within this area. Unfortunately, geological mapping has failed to identify possible source rocks for the anomaly. Prospecting and higher density till sampling is recommended to further refine the exploration target.

Three samples collected from the extreme southwestern end of Upper Shebandowan Lake contained elevated to anomalous grain counts of chromite (Anomaly C, Figure 13). Samples 99-AFB-386 and 328 each contained approximately 40 grains of chromite and sample 99-AFB-190 contained 10 grains. Sample 328 also contained 5 grains of red rutile. Together this assemblage may indicate enhanced potential for Ni-Cu sulphide mineralization. The area is underlain by appropriate host rocks (mafic intrusive lithologies of gabbroic composition) and till samples collected from this area are geochemically anomalous in nickel, copper, chromium and cadmium. The significance of this anomaly should be further investigated by prospecting and the collection of additional till samples for geochemical determinations.

Three samples collected from west-central Haines Township (Anomaly D, Figure 13) contained elevated to anomalous numbers of chromite grains. Samples 99-AFB-325, 377 and 378 contained 40, 30 and 15 chromite grains, respectively. Sample 325 also contained 4 grains of red rutile. Till samples collected for geochemical determinations contain elevated to anomalous concentrations of nickel, copper and cadmium. These samples were collected from sites either over or immediately down-ice of the southern, fault-bounded contact of the Haines gabbro-anorthosite complex. Pegmatoid- and shear-hosted occurrences of copper, silver and PGEs are present within this part of the intrusion. Additional, higher-density till sampling is recommended to assist with the discovery of additional occurrences within this area.

Two samples collected from southwestern Adrian Township (Anomaly E, Figure 13) contained elevated to anomalous concentrations of chromite. Samples 98-AFB-237 and 238 contained an estimated 15 and 100 chromite grains, respectively. Supporting indicator mineral species were not recovered from these samples, however. Poor rock exposure within this area has prevented a meaningful interpretation for the anomaly. Gabbros and leucogabbros have, however, been observed in outcrops less than a kilometre northwest of the anomaly. Additional till sampling and prospecting is recommended within this area to further evaluate the significance of the anomalous chromite grain counts.

Isolated elevated to anomalous chromite grain counts were also obtained from numerous samples collected throughout the study area. In most cases, it would appear that the source rocks for the anomalies are of gabbroic composition. The chromite anomalies in central Begin Township may be associated with mapped polysutured/serpentinized flows of ultramafic composition (Osmani 1997).

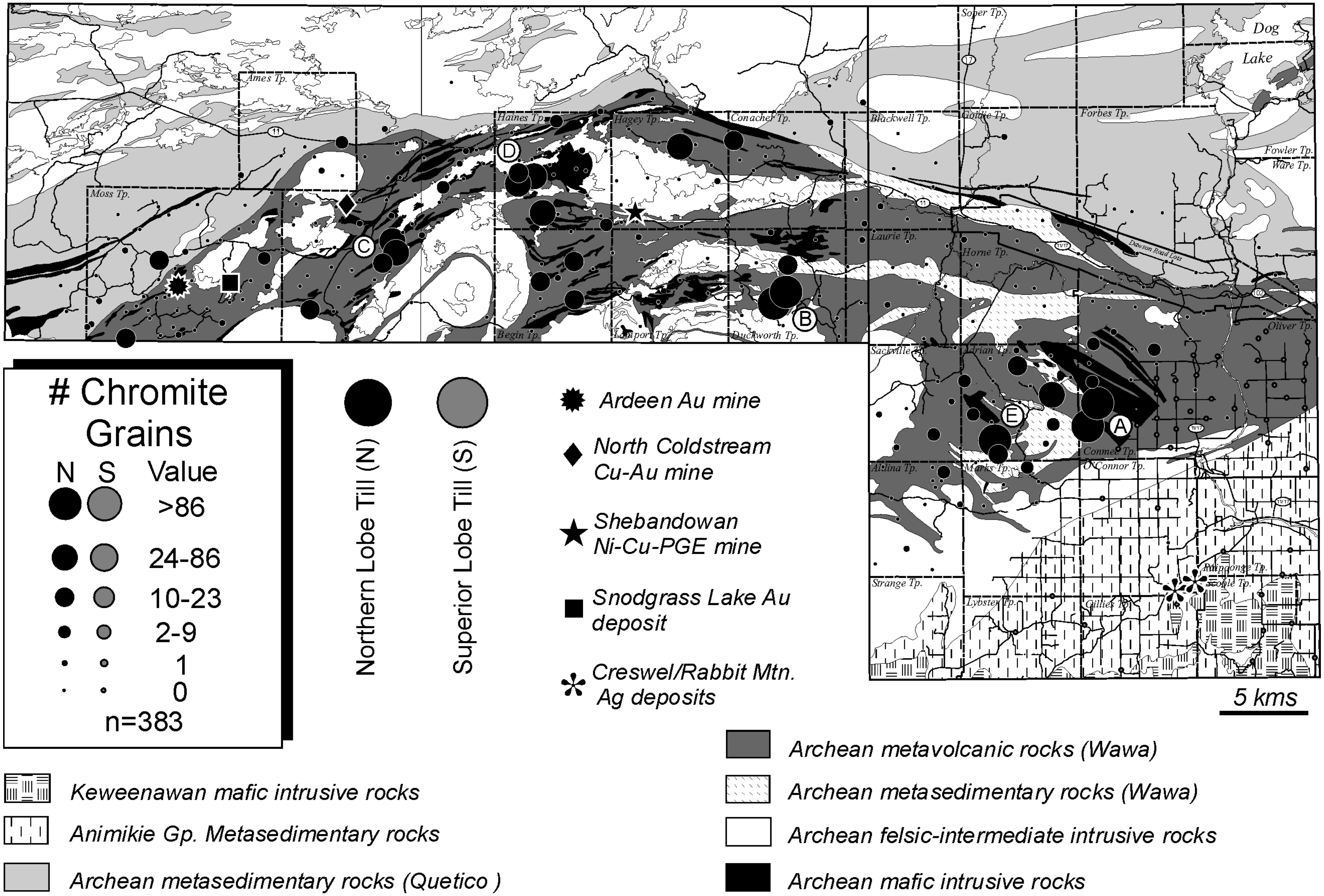

Figure 13. Regional distribution of chromite in till.

Surprisingly, few chromite grains were recovered from till samples collected in the immediate vicinity of the Shebandowan mine. Chromite horizons, reaching 3 m in thickness and containing up to 40 to 50 modal percent chromite, have been observed along 5 km of strike length in the vicinity of the deposit. The chromite-bearing horizons occur adjacent to the Crayfish Creek Fault and therefore probably occur in a recessive setting where processes of glacial erosion would have been less vigourous. The deposit lacks a geochemical signature as well, in support of this hypothesis.

Chrome Diopside

Five till samples collected in the immediate vicinity of the Shebandowan Ni-Cu mine do, however, contain anomalous concentrations of chrome diopside grains (Anomaly A, Figure 14). This is not unexpected in that Ni-Cu mineralization at the mine is believed to be hosted by sill-like bodies of peridotite whose main constituents are olivine and pyroxene (Osmani 1997). Cr-bearing diopside is also an important constituent of pyroxenitic and peridotitic horizons associated with a number of other Ni deposits, including those at Outokumpo, Finland and in the Thompson Nickel Belt of northern Manitoba (Averill 1999). The chrome diopside dispersal train originating at the Thompson Nickel Belt has been traced to the southwest, nearly 400 km, into southeastern Saskatchewan (Thorliefson and Garrett 1993). In our study, chrome diopside grain counts decline to background values within a few kilometres of the Shebandowan mine site. There is no apparent geochemical signature in till associated with the deposit. The reason for this is not known. This example clearly demonstrates the value of performing regional mineralogical surveys in addition to conventional geochemistry for mineral exploration. The Shebandowan deposit is clearly recognizable despite its poor geochemical response.

Elevated chrome diopside grain counts occur on Upper Shebandowan Lake in the vicinity of the Vanguard East and West base metal occurrences (Anomaly B, Figure 14). Sills of anorthositic gabbro occur in association with altered, mafic to intermediate metavolcanic rocks which host the Cu-Zn-Au-Ag mineralization. The chrome diopsides may have been liberated from these gabbros.

The till sample collected over the Vanguard West occurrence (99-AFB-175) also contained 46 grains of red rutile and an above average concentration of olivine (8%) in the non-magnetic HMC. Sample 99-AFB-383, which is the western-most sample of the chrome diopside anomaly, also contained 2 grains of red rutile. This mineral association of chrome diopside and red rutile may indicate an enhanced potential for magmatic Ni-Cu mineralization within this area as well (Averill 1999). Till geochemistry fails to support this hypothesis.

A cluster of samples extending southwesterly from the western end of Upper Shebandowan Lake toward Squeers Lake (Anomaly C, Figure 14) contain elevated to anomalous numbers of chrome diopside grains. As mentioned previously, the most northerly samples of this anomaly contain anomalous numbers of chromite grains. Of the southern samples, only 1 (99-AFB-331) contains additional indicators, namely, 8 red rutile grains to complement the 9 chrome diopsides. This area contains numerous sills of gabbro and leucogabbro as well as a few outcrops of peridotite. The area should be further evaluated for its Ni-Cu sulphide potential.

Isolated anomalous chrome diopside grain counts also occur throughout the remaining portions of the study area. The most notable anomaly was obtained from a sample collected from the south end of Greenwater Lake (Anomaly D, Figure 14). This sample (99-AFB-164) contained approximately 175 chrome diopside grains although lacked any supporting mineral species. The sample was collected from a rolling till plain situated approximately 400 m north of the Brule Creek/Eagle-Finlayson Moraine. Outcrops are not present in the immediate vicinity of the sample site. Pebbles isolated from the till sample are almost

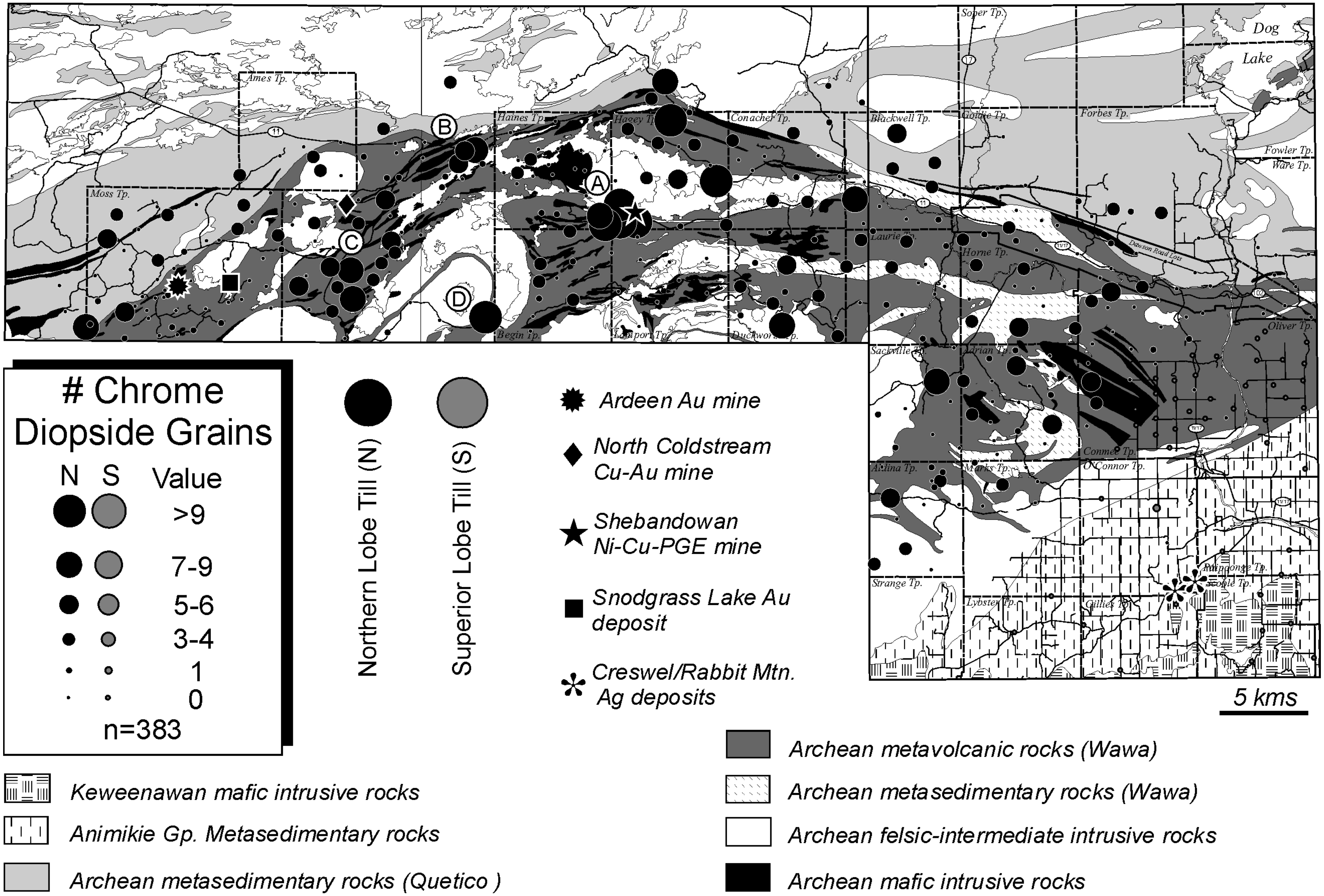

Figure 14. Regional distribution of chrome diopside in till.

exclusively of felsic-intermediate intrusive composition. One would not expect to recover a large number of chrome diopsides from felsic source rocks. Mafic intrusive rocks do, however, outcrop less than a kilometre to the southwest of the sample site. Geophysical information (AEM) suggests a northeasterly extension of mafic rocks beneath the sample site. Additional sampling and prospecting is recommended to follow-up this anomaly.

Chalcopyrite

Most till samples collected as part of the regional till sampling program do not contain chalcopyrite (Figure 15). Those samples that contain between 1 and 5 grains are probably part of a background population. It is interesting to note that numerous till samples collected over a broad area spanning Adrian, Conmee and Oliver townships contain between 1 and 5 chalcopyrite grains. Both northern and Superior lobe tills define this zone of elevated background. This may suggest that this region has enhanced potential, relative to surrounding areas, for base metal mineralization. Till sample 98-AFB-077, which was collected from west-central Conmee Township and is proximal to outcrops of serpentinite, contained 2 chalcopyrite, 5 chromite, 5 chrome diopside, 2 andradite and 1 red rutile grain. Despite the low chalcopyrite grain count, the mixed indicator mineral assemblage is considered interesting and possibly worthy of follow-up work. Higher density till sampling is recommended within this region of elevated background to determine whether the area does in fact contain enhanced potential for base metal mineralization

Three samples collected from the Burchell Lake area (Anomaly A, Figure 15) contained anomalous to elevated numbers of chalcopyrite grains as well as a number of accessory minerals. The non-magnetic HMC of sample 99-AFB-367 contained 13 chalcopyrite, 86 gold, 3 chrome diopside, 3 red rutile, 35% pyrite and 23 grains of gahnite, a zinc-rich spinel. These gahnites form a tight compositional cluster on a ZnO-MgO-FeO ternary diagram (Figure 16) containing 37.2-42.4 weight percent ZnO, 0.15-1.09 weight percent MgO and 2.68-5.81 weight percent FeO. This composition most closely approximates, although is clearly distinct from that of gahnites isolated from host rocks of the Mattabi base metal deposit (Morris et al. 1997). The Mattabi population generally contains lower ZnO and MgO values and higher FeO values.

Sample 99-AFB-364 contained 10 chalcopyrite, 53 gold and 1 red rutile grain. Sample 99-AFB-196 contained 2 chalcopyrite, 18 gold, 2 chrome diopside and 3 red rutile grains. This sample also contained approximately 8% olivine, well above the regional background of 2 to 3 percent. Samples collected from within this area are also extremely anomalous geochemically. They contain anomalous levels of Au, Sb, Mo, Ag and Cu, an association that is commonly associated with porphyry and/or epithermal type mineralization. The North Coldstream Cu-Au mine is situated at the northeast end of the lake and is hosted by silicified gabbro at or near a fault contact (Farrow 1994). Numerous showings, including the Hermia Lake Cu-Au occurrence, are situated around the periphery of the lake as well attesting to the potential for further discoveries of precious and base metals within this part of the belt.

Grains of chalcopyrite were also commonly encountered in Superior lobe till samples collected over the Rove Formation shales and/or in close proximity to the Logan diabase sills (Anomaly B, Figure 15). Sample 98-AFB-276 was collected from an exploration trench in the Rabbit Mountain area (Gillies Township) where the Creswel and Rabbit Mountain group of silver deposits is located. This sample contained 10 grains of chalcopyrite, 12 grains of sphalerite, approximately 30 grains of barite, 2 grains of flourite and approximately 95% pyrite in the non-magnetic heavy mineral concentrate. Franklin et al. (1986) have reported all of these minerals as accessories to vein-type silver deposits in the Thunder Bay area. A similar mineral assemblage was recovered from the base of a thick exposure of till in the Whitefish River valley.

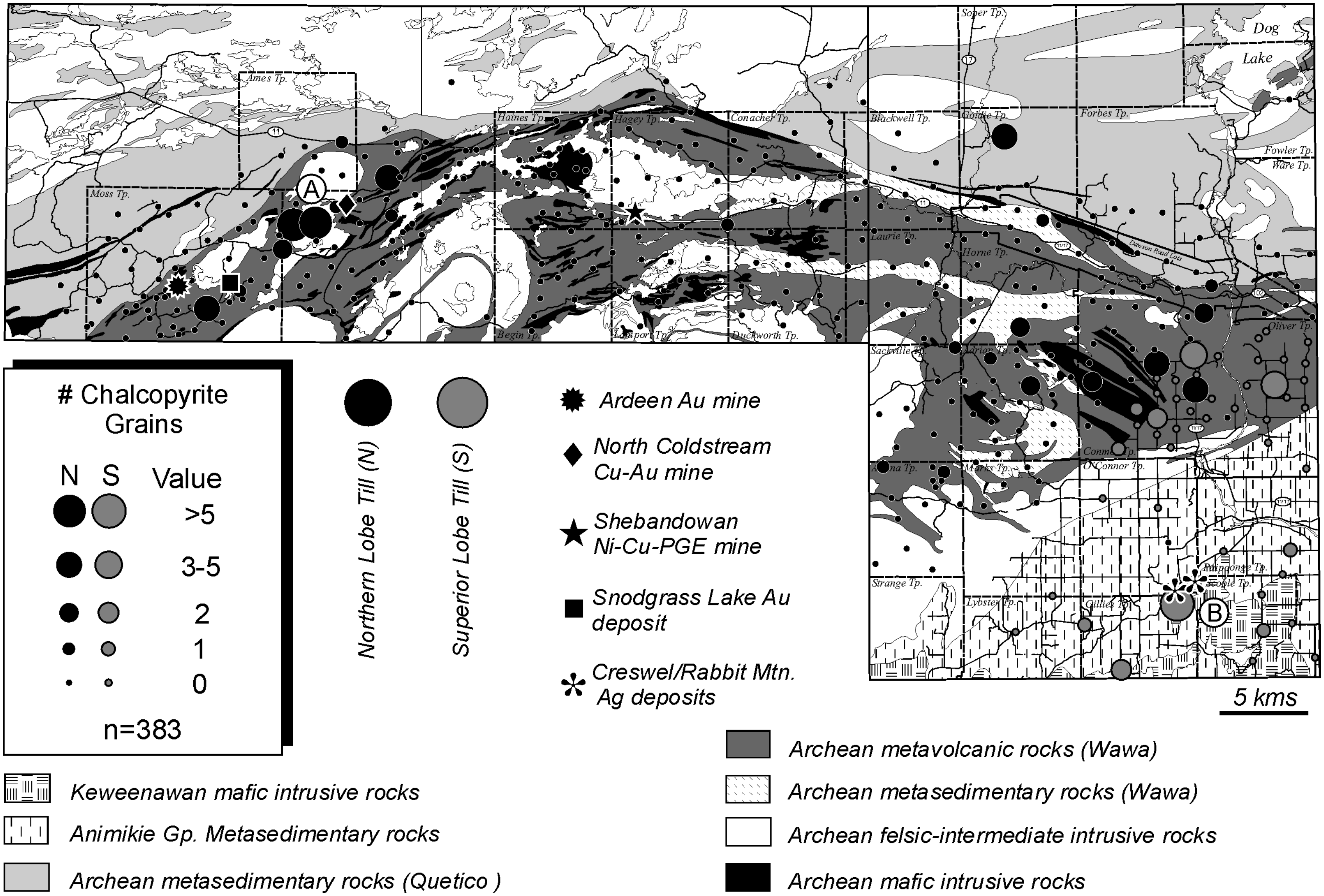

Figure 15. Regional distribution of chalcopyrite in till.

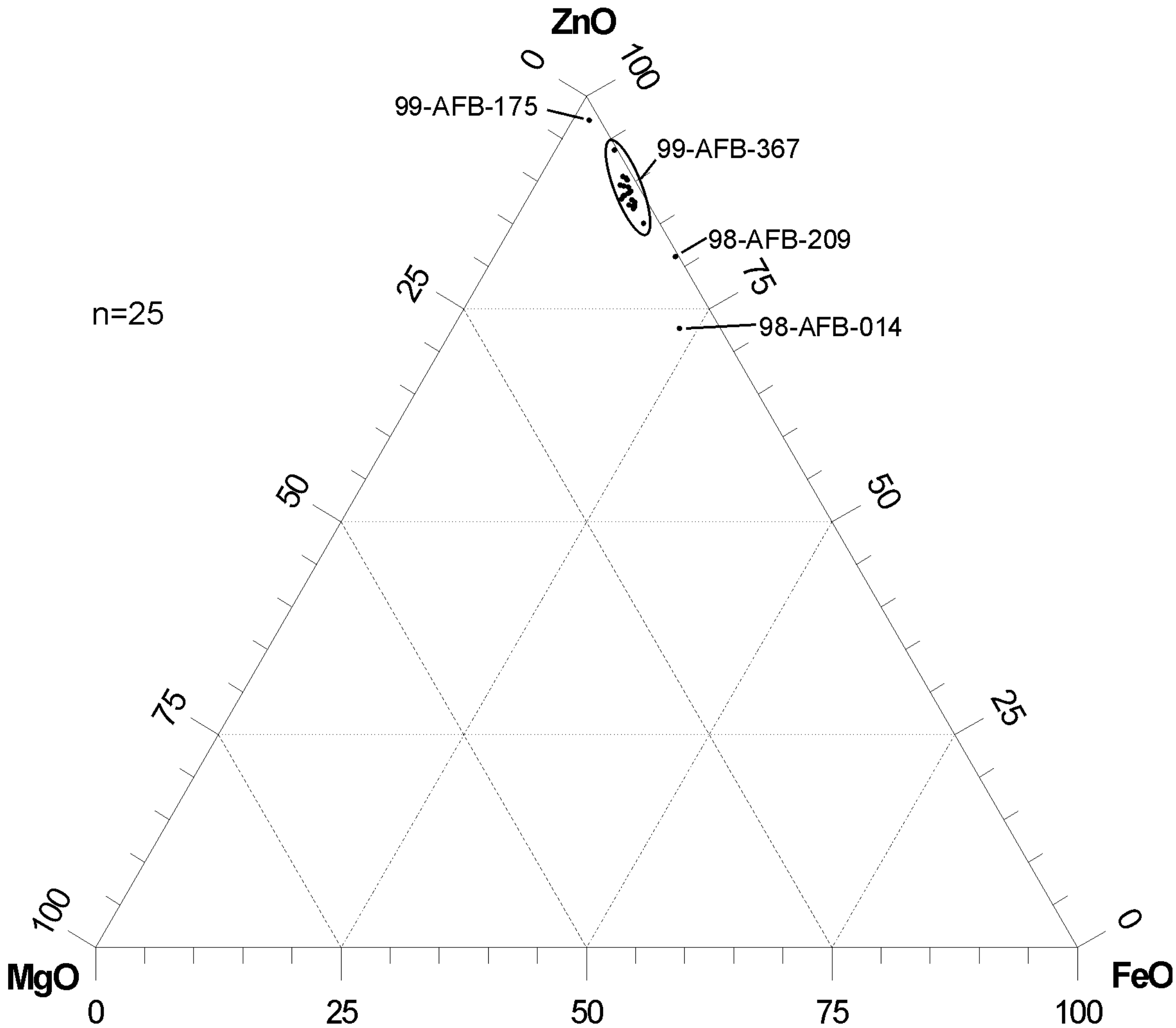

Figure 16. ZnO-MgO-FeO ternary diagram for gahnite (from Morris et al. 1997). ZnO, MgO and FeO normalized to 100%.

Sample 98-AFB-275 contained 1 grain of chalcopyrite, 10 grains of sphalerite, approximately 40 grains of barite, 3 grains of galena and approximately 98% pyrite. This assemblage may suggest the presence of additional vein-type sources of silver mineralization within the Whitefish River valley. Mineralogy of the non-magnetic heavy mineral fraction of till should be considered as a viable exploration tool for vein-type silver deposits within this region.

Gold

Native gold is considered an MMSIM® indicator mineral because it commonly occurs in association with volcanogenic massive sulphide or magmatic nickel-copper-PGE mineralization. The regional distribution of gold grains in till has been reported previously in Ontario Geological Survey Open File Reports 5993 and 6012 (Bajc 1999a, 2000). Figure 17 presents a summary diagram of the gold grain results. A number of generalizations can be made with regard to the gold grain information. Firstly, background levels of gold are much higher over the western half of the belt. This is likely a reflection of the contrasting style of gold mineralization within this region as well as the orientation of ice flow with respect to the regional strike of

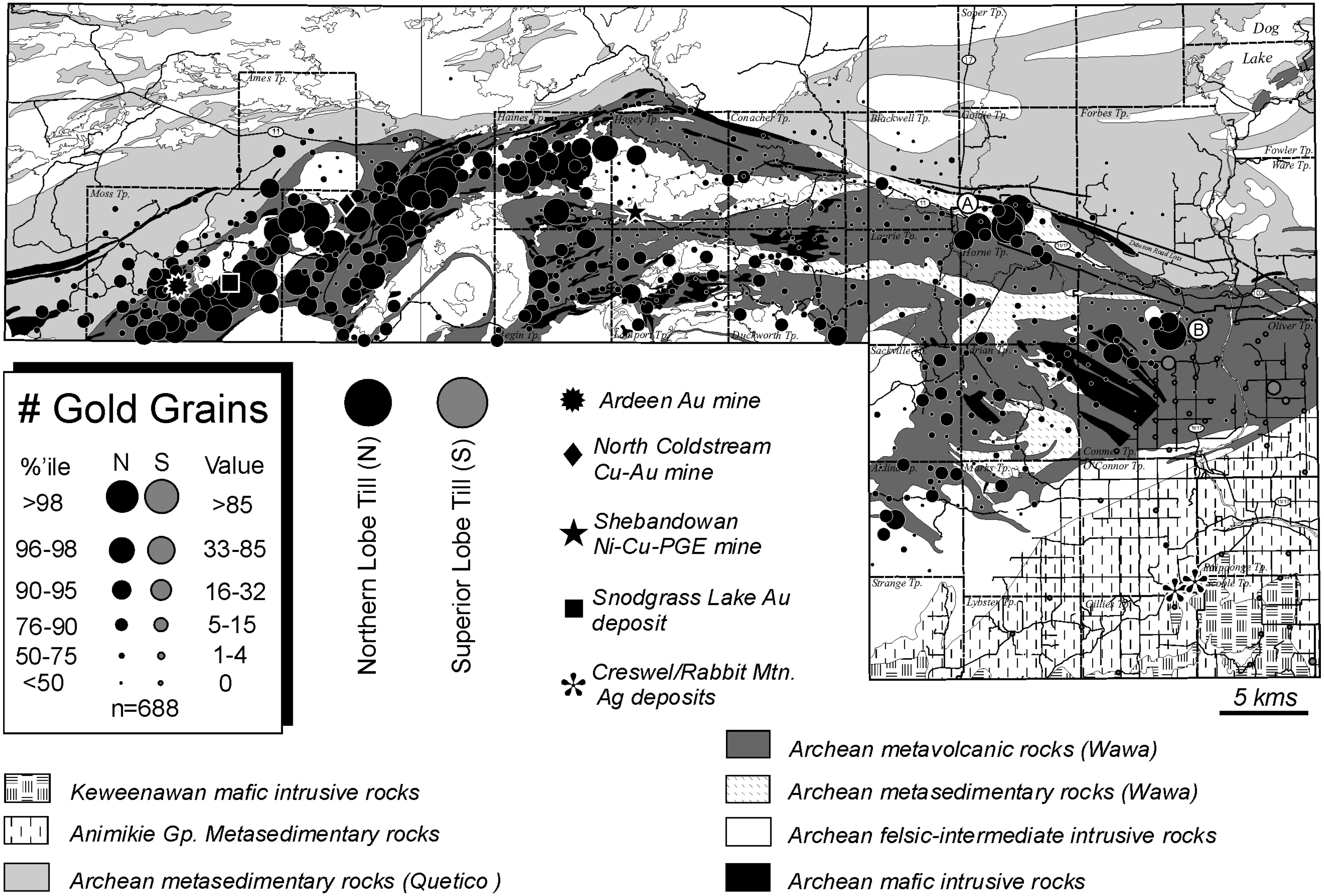

Figure 17. Regional distribution of gold grains in till.

the supracrustal rocks and associated structures. Most recovered gold grains have a diameter of less than 75µm. This is likely a reflection of the style of mineralization within this region (fine versus coarse gold). Most gold grains recovered from anomalous samples also display pristine and/or modified surface textures indicating a likely proximal source for the gold.

Discrete gold grain anomalies within the eastern half of the belt are associated with Shebandowan assemblage rocks. This assemblage is in many respects similar to the Timiskaming-aged metasedimentary and intrusive rocks of the Kirkland Lake area. Well defined anomalies occur at the west end of the Dawson Road Lots in the vicinity of the Bylund and Goldie occurrences (Anomaly A, Figure 17) as well as in north-central Conmee Township in the vicinity of the Tower syenite intrusion (Anomaly B, Figure 17). Several hundred gold grains, many of which exhibited pristine and/or modified surface textures, were isolated from numerous till samples collected over and adjacent to the Bylund and Goldie properties supporting the use of till as a sample medium for mineral exploration programs utilizing drift prospecting techniques. A till sample collected from an exploration trench east of the Sheppard and Godzic gold occurrences on the Goldie Property contained over 200 gold grains, 88% of which displayed pristine surface textures. A follow-up drill hole collared less than 50 m north of this sample intersected a highly brecciated and silicified syenite containing 1.7 g/t Au over 14.2 m (RJK Explorations Limited and Greater Lenora Resources Corporation, News Release, November 25, 1999). At the Tower syenite, a till sample collected from the southeastern corner of the intrusion contained 119 gold grains and approximately 300 grains of cinnabar, a mercury sulphide mineral. Cinnabar is rarely encountered in the heavy mineral concentrates of surface till samples collected in Ontario. It does, however, occur at such prolific gold mining camps as Hemlo and Red Lake. This till sample was also geochemically anomalous in tungsten. This association of gold with cinnabar and tungsten is consistent with a porphyry or epithermal model for mineralization within the intrusion.

In the western half of the belt, gold grain anomalies are defined by linear clusters of samples containing extremely high concentrations of gold grains. The predominant ice flow direction within this region is towards the southwest, parallel to the regional strike of the supracrustals and associated structures. This has resulted in narrow, linear anomalies, some of which are up to 5.5 km long. The Snodgrass Lake trend probably represents one of the most significant gold grain anomalies within the belt. The tenor of response associated with this anomaly is not unlike that which is observed in the vicinity of producing gold mines in other parts of the province. Multiple gold sources are suggested by the widely spaced nature of samples containing high proportions of pristine and/or modified grain shapes. Of particular significance are the spectacular gold grain counts that were obtained from a couple of samples collected east of the Snodgrass Lake deposit. One of the samples (99-AFB-299) contained nearly 1600 gold grains, 95 percent of which had either pristine and/or modified surface textures. The tenor of the gold grain response in this area suggests that additional work is warranted.

A highly anomalous cluster of samples on Upper Shebandowan Lake defines a second gold grain target worth further investigation. Historically, this area has received a great deal of attention from a base metal perspective resulting in the discovery of the Copper Island, Vanguard East and West and Whalen showings to name a few. The gold grain results for this area suggest that there is tremendous potential for the discovery of gold mineralization as well. Four samples collected from this area returned gold grain counts ranging between 136 and 384 grains. Higher density till sampling and prospecting is recommended within this region to further refine the location of possible source rocks for the gold grain anomalies.

Four other areas of elevated to anomalous gold grain counts have been identified in the western Shebandowan belt. These include a cluster of samples in the Burchell Lake area, where strong Au, Cu, Mo and Ag geochemical anomalies were obtained, the Firefly Lake and central Haines Township areas where anomalous chromite grain counts were obtained and the Ardeen Mine trend where numerous gold showings have been discovered over the past decade. All of these should be investigated further for their gold and base metal potential.

Summary of MMSIM® Results

The MMSIM® dataset clearly delineates a number of base metal exploration targets (Figure 18). These are defined, in many instances, by multiple indicator mineral species and supported by till geochemistry. Higher density till sampling and prospecting is recommended within these anomalous areas to determine their significance and possibly refine exploration targets. The patterns depicted by the indicator mineral assemblages associated with high metamorphic grade base metal mineralization are not supported by the regional geochemical and primary mineralogical (i.e., chalcopyrite, sphalerite, galena) datasets. As mentioned previously, this is probably attributed to the relatively low grade of metamorphism present within the belt.

Acknowledgements

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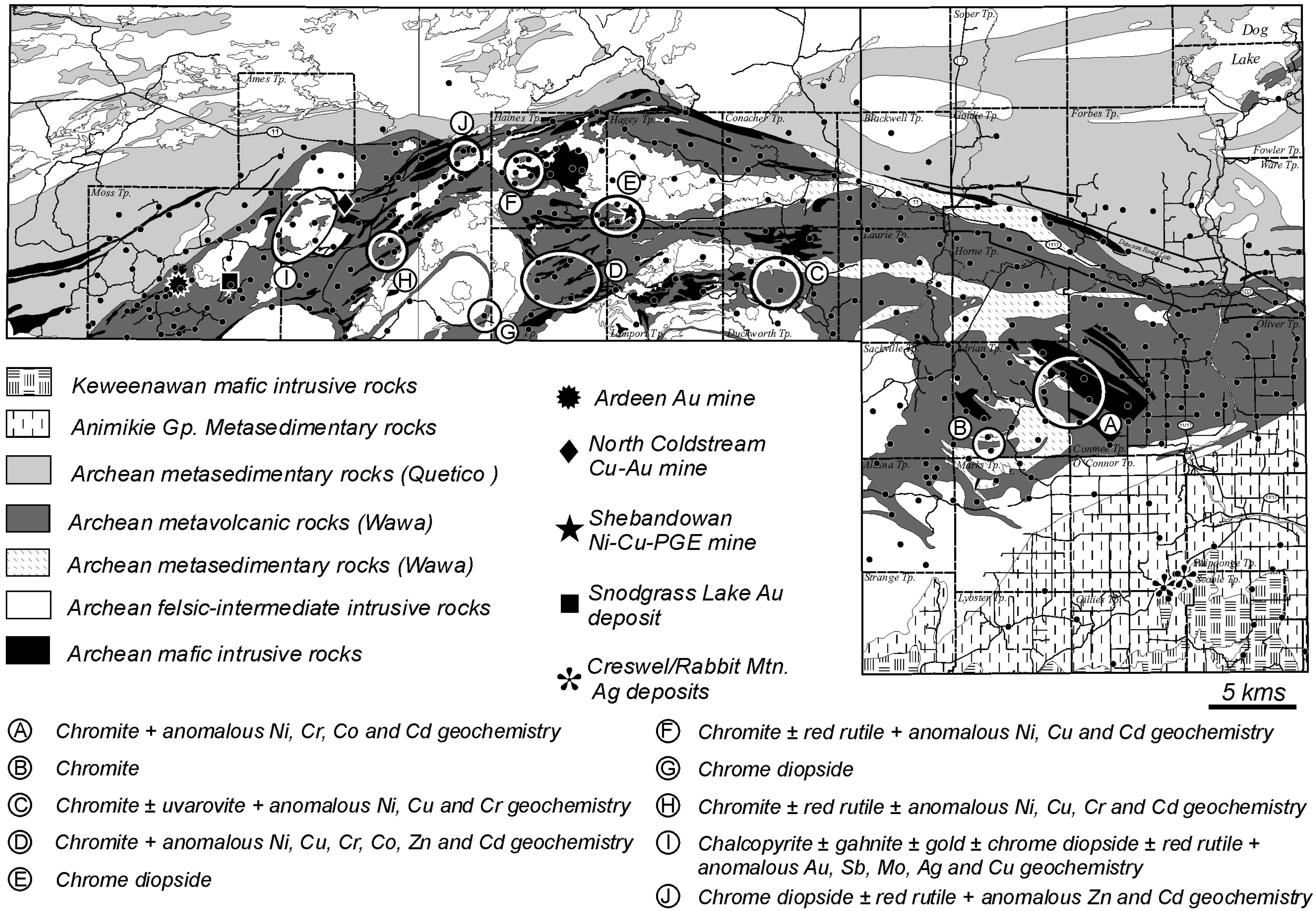

Figure 18. Base metal exploration targets defined by the indicator mineral dataset.

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Appendix A

Sample location information.

Sample #	Easting (Zone16) (NAD83)	Northing (Zone16) (NAD83)	Easting (Zone15) (NAD83)	Northing (Zone15) (NAD83)	Material Sampled	Ice Lobe
98-AFB-001	278716	5389527	720877	5389511	Till	Northern
98-AFB-003	281951	5388330	724197	5388572	Till	Northern
98-AFB-009	284585	5390858	726624	5391299	Till	Northern
98-AFB-013	281574	5393420	723421	5393617	Till	Northern
98-AFB-014	281091	5390537	723166	5390704	Till	Northern
98-AFB-015	290327	5392761	732200	5393647	Till	Northern
98-AFB-017	290471	5385248	732933	5386168	Till	Northern
98-AFB-020	296011	5382840	738646	5384201	Till	Northern
98-AFB-023	298742	5381499	741474	5383079	Till	Northern
98-AFB-026	304065	5379600	746932	5381603	Till	Northern
98-AFB-028	300857	5382654	743493	5384397	Till	Northern
98-AFB-029	303227	5381885	745916	5383815	Till	Northern
98-AFB-030	305641	5380871	748403	5382994	Till	Northern
98-AFB-031	306853	5379710	749703	5381931	Till	Northern
98-AFB-032	303078	5385918	745452	5387826	Till	Northern
98-AFB-034	306290	5386247	748629	5388406	Till	Northern
98-AFB-035	306058	5383695	748597	5385843	Till	Northern
98-AFB-036	298813	5383588	741381	5385167	Till	Northern
98-AFB-037	297325	5385875	739718	5387331	Till	Northern
98-AFB-038	299141	5386402	741488	5387999	Till	Northern
98-AFB-039	300573	5386132	742936	5387842	Till	Northern
98-AFB-040	296289	5387165	738584	5388536	Till	Northern
98-AFB-044	291137	5386648	733487	5387616	Till	Northern
98-AFB-046	291983	5388674	734172	5389703	Till	Northern
98-AFB-047	289661	5388516	731869	5389363	Till	Northern
98-AFB-051	285221	5383955	727800	5384467	Till	Northern
98-AFB-054	284680	5386152	727089	5386614	Till	Northern
98-AFB-056	281971	5384460	724520	5384715	Till	Northern
98-AFB-058	282036	5386317	724439	5386572	Till	Northern
98-AFB-059	279245	5385446	721725	5385484	Till	Northern
98-AFB-063	284102	5380024	726994	5380460	Till	Northern
98-AFB-065	286935	5379477	729860	5380137	Till	Northern
98-AFB-067	285498	5375533	728737	5376091	Till	Northern
98-AFB-068	287064	5377640	730133	5378315	Till	Northern
98-AFB-069	304913	5375408	748106	5377489	Till	Northern
98-AFB-070	305130	5374050	748429	5376151	Till	Northern
98-AFB-071	305157	5371188	748680	5373300	Till	Northern
98-AFB-075	299881	5372261	743335	5373957	Till	Northern
98-AFB-077	296697	5372226	740163	5373672	Till	Northern
98-AFB-078	291656	5362442	735902	5363521	Till	Northern
98-AFB-079	291909	5364185	736018	5365279	Till	Northern
98-AFB-080	291026	5365389	735044	5366410	Till	Northern
98-AFB-082	290472	5368421	734254	5369391	Till	Northern
98-AFB-084	293317	5371293	736865	5372477	Till	Northern
98-AFB-085	291580	5372095	735070	5373141	Till	Northern
98-AFB-086	290644	5370791	734239	5371767	Till	Northern
98-AFB-088	288508	5372645	731964	5373448	Till	Northern
98-AFB-091	285358	5362576	729612	5363162	Till	Northern
98-AFB-093	283897	5364588	727998	5365054	Till	Northern

Sample #	Easting (Zone16) (NAD83)	Northing (Zone16) (NAD83)	Easting (Zone15) (NAD83)	Northing (Zone15) (NAD83)	Material Sampled	Ice Lobe
98-AFB-094	283188	5364627	727288	5365038	Till	Northern
98-AFB-095	300104	5374785	743359	5376491	Till	Northern
98-AFB-098	298639	5376265	741783	5377852	Till	Northern
98-AFB-100	295568	5376692	738687	5378037	Till	Northern
98-AFB-102	288415	5384775	730920	5385535	Till	Northern
98-AFB-103	282455	5362693	726709	5363052	Till	Northern
98-AFB-105	279719	5363343	723930	5363486	Till	Northern
98-AFB-107	289011	5364058	733138	5364926	Till	Northern
98-AFB-109	312918	5377818	755899	5380521	Till	Northern
98-AFB-110	315055	5376769	758113	5379642	Till	Northern
98-AFB-111	313888	5379340	756748	5382114	Till	Northern
98-AFB-112	312179	5380389	754961	5383026	Till	Northern
98-AFB-113	315067	5381966	757717	5384826	Till	Northern
98-AFB-114	312372	5382026	755025	5384674	Till	Northern
98-AFB-115	310921	5382704	753525	5385236	Till	Northern
98-AFB-116	301244	5379866	744097	5381647	Till	Northern
98-AFB-118	300503	5378242	743486	5379969	Till	Northern
98-AFB-119	298654	5379569	741538	5381147	Till	Northern
98-AFB-120	297010	5378873	739954	5380324	Till	Northern
98-AFB-121	298322	5378286	741308	5379843	Till	Northern
98-AFB-122	290731	5380391	733574	5381346	Till	Northern
98-AFB-124	283955	5372808	727412	5373254	Till	Northern
98-AFB-125	313943	5394794	755589	5397531	Till	Northern
98-AFB-126	310541	5375207	753734	5377730	Till	Superior
98-AFB-127	311194	5375756	754342	5378329	Till	Superior
98-AFB-128	302637	5376500	745750	5378400	Till	Northern
98-AFB-131	284271	5388886	726466	5389308	Till	Northern
98-AFB-134	288488	5386944	730823	5387703	Till	Northern
98-AFB-135	293176	5385712	735593	5386843	Till	Northern
98-AFB-136	294456	5385257	736906	5386489	Till	Northern
98-AFB-137	291002	5384126	733551	5385091	Till	Northern
98-AFB-138	292656	5383285	735266	5384382	Till	Northern
98-AFB-140	306129	5377481	749156	5379651	Till	Northern
98-AFB-142	314593	5374724	757813	5377566	Till	Superior
98-AFB-143	314318	5372969	757676	5375794	Till	Superior
98-AFB-144	312544	5373363	755876	5376048	Till	Superior
98-AFB-145	310419	5373395	753754	5375914	Till	Superior
98-AFB-146	311698	5371311	755193	5373935	Till	Superior
98-AFB-147	309398	5371351	752896	5373795	Till	Superior
98-AFB-148	314147	5371579	757615	5374395	Till	Superior
98-AFB-149	312653	5370218	756231	5372920	Till	Superior
98-AFB-150	314121	5369316	757766	5372136	Till	Superior
98-AFB-151	310915	5368458	754636	5371029	Till	Superior
98-AFB-152	310957	5366562	754827	5369141	Till	Superior
98-AFB-153	307121	5373884	750427	5376142	Till	Superior
98-AFB-154	305306	5372401	748734	5374521	Till	Superior
98-AFB-155	306467	5370392	750048	5372609	Till	Superior
98-AFB-156	303559	5370504	747140	5372492	Till	Superior
98-AFB-157	303551	5372038	747012	5374022	Till	Superior

Sample #	Easting (Zone16) (NAD83)	Northing (Zone16) (NAD83)	Easting (Zone15) (NAD83)	Northing (Zone15) (NAD83)	Material Sampled	Ice Lobe
98-AFB-159	302049	5373465	745402	5375327	Till	Northern
98-AFB-160	302012	5372276	745458	5374139	Till	Superior
98-AFB-161	301975	5371026	745520	5372889	Till	Superior
98-AFB-162	301890	5368979	745595	5370842	Till	Superior
98-AFB-163	300234	5369799	743880	5371530	Till	Superior
98-AFB-164	300238	5368486	743986	5370220	Till	Superior
98-AFB-165	298591	5366594	742492	5368205	Till	Superior
98-AFB-166	301818	5367624	745629	5369485	Till	Superior
98-AFB-167	302914	5366513	746809	5368462	Till	Superior
98-AFB-168	303440	5368036	747215	5370022	Till	Superior
98-AFB-169	305952	5368791	749661	5370972	Till	Superior
98-AFB-171	293324	5368848	737064	5370040	Till	Northern
98-AFB-172	296163	5368588	739915	5370003	Till	Northern
98-AFB-174	302476	5378754	745413	5380635	Till	Northern
98-AFB-176	286163	5372751	729618	5373370	Till	Northern
98-AFB-178	285017	5371106	728604	5371640	Till	Northern
98-AFB-186	292253	5380154	735109	5381229	Till	Northern
98-AFB-189	293019	5378649	735992	5379788	Till	Northern
98-AFB-190	290931	5376975	734041	5377956	Till	Northern
98-AFB-193	312401	5357628	756966	5360344	Till	Superior
98-AFB-194	311670	5355640	756392	5358304	Till	Superior
98-AFB-195	309882	5354042	754734	5356571	Till	Superior
98-AFB-196	314053	5348660	759314	5351530	Till	Superior
98-AFB-197	312272	5351576	757310	5354298	Till	Superior
98-AFB-198	309910	5351081	754993	5353620	Till	Superior
98-AFB-199	308906	5348592	754186	5351059	Till	Superior
98-AFB-200	306884	5357760	751454	5360045	Till	Superior
98-AFB-201	303754	5355612	748500	5357658	Till	Superior
98-AFB-202	302374	5358673	746885	5360602	Till	Northern
98-AFB-205	304670	5369435	748331	5371514	Till	Superior
98-AFB-206	307683	5368765	751388	5371082	Till	Northern
98-AFB-207	308322	5369502	751968	5371867	Till	Superior
98-AFB-208	314005	5364281	758045	5367105	Till	Superior
98-AFB-209	279870	5387468	722189	5387549	S&G	Northern
98-AFB-211	280665	5382386	723381	5382545	Till	Northern
98-AFB-212	283437	5382518	726135	5382895	Till	Northern
98-AFB-213	284944	5380627	727785	5381127	S&G	Northern
98-AFB-214	282806	5381014	725623	5381345	Till	Northern
98-AFB-215	280091	5379317	723049	5379440	Till	Northern
98-AFB-217	281335	5378446	724358	5378670	Till	Northern
98-AFB-218	282962	5376386	726142	5376743	Till	Northern
98-AFB-221	281276	5370681	724908	5370924	Till	Northern
98-AFB-222	279004	5370297	722673	5370363	Till	Northern
98-AFB-223	280319	5367508	724202	5367685	Till	Northern
98-AFB-224	279136	5365951	723145	5366040	S&G	Northern
98-AFB-226	283223	5365739	727236	5366149	Till	Northern
98-AFB-228	280172	5361596	724518	5361780	Till	Northern
98-AFB-231	280786	5359111	725325	5359350	Till	Northern
98-AFB-232	278158	5357964	722795	5358002	Till	Northern

Sample #	Easting (Zone16) (NAD83)	Northing (Zone16) (NAD83)	Easting (Zone15) (NAD83)	Northing (Zone15) (NAD83)	Material Sampled	Ice Lobe
98-AFB-233	287302	5362369	731567	5363108	Till	Northern
98-AFB-236	286800	5365978	730783	5366667	Till	Northern
98-AFB-237	288677	5366577	732608	5367412	Till	Northern
98-AFB-238	288465	5367715	732307	5368530	S&G	Northern
98-AFB-239	285584	5367232	729473	5367822	Till	Northern
98-AFB-240	283436	5368444	727237	5368863	Till	Northern
98-AFB-242	286756	5369956	730428	5370630	Till	Northern
98-AFB-243	288234	5369258	731956	5370050	S&G	Northern
98-AFB-245	288487	5370943	732077	5371750	Till	Northern
98-AFB-246	290588	5373816	733946	5374779	Till	Northern
98-AFB-247	290556	5375092	733814	5376048	Till	Northern
98-AFB-249	293368	5374525	736663	5375704	S&G	Northern
98-AFB-251	288369	5374514	731680	5375301	Till	Northern
98-AFB-253	296926	5375346	740146	5376801	Till	Northern
98-AFB-254	296505	5373765	739850	5375192	S&G	Northern
98-AFB-255	294928	5372671	738363	5373978	Till	Northern
98-AFB-257	297035	5370445	740639	5371922	Till	Northern
98-AFB-259	287633	5382270	730337	5382976	Till	Northern
98-AFB-260	291541	5381799	734271	5382813	Till	Northern
98-AFB-264	304761	5377234	747811	5379298	Till	Northern
98-AFB-266	292646	5367284	736510	5368427	Till	Northern
98-AFB-268	301921	5374648	745182	5376497	Till	Northern
98-AFB-270	311117	5377228	754150	5379790	Till	Northern
98-AFB-271	297798	5380771	740591	5382279	Till	Northern
98-AFB-273	301633	5361575	745919	5363438	Till	Superior
98-AFB-274	297111	5362555	741333	5364061	Till	Superior
98-AFB-275	295185	5352184	740223	5353569	Till	Superior
98-AFB-276	302879	5353561	747788	5355543	Till	Superior
98-AFB-277	302532	5354470	747370	5356423	Till	Superior
98-AFB-278	298044	5348338	743374	5349958	Till	Superior
98-AFB-279	292636	5354682	737486	5355861	Till	Superior
98-AFB-280	282830	5357294	727505	5357698	Till	Northern
98-AFB-281	289464	5351836	734546	5352776	Till	Superior
98-AFB-282	283385	5364083	727527	5364510	Till	Northern
98-AFB-283	284129	5365299	728174	5365782	Till	Northern
98-AFB-286	286630	5384419	729169	5385040	Till	Northern
99-AFB-002	276671	5390081	718795	5389903	Till	Northern
99-AFB-006	269520	5390896	711604	5390153	Till	Northern
99-AFB-011	266072	5391478	708121	5390462	Till	Northern
99-AFB-014	261834	5393497	703738	5392143	Till	Northern
99-AFB-016	259404	5394760	701217	5393211	Till	Northern
99-AFB-018	257116	5396314	698814	5394580	Till	Northern
99-AFB-020	253454	5395667	695215	5393647	Till	Northern
99-AFB-022	249717	5394884	691552	5392573	Till	Northern
99-AFB-023	246746	5393573	688695	5391033	Till	Northern
99-AFB-024	242611	5394399	684509	5391531	Till	Northern
99-AFB-026	240184	5394415	682089	5391357	Till	Northern
99-AFB-027	237531	5393419	679523	5390156	Till	Northern
99-AFB-029	235594	5391948	677709	5388539	Till	Northern

Sample #	Easting (Zone16) (NAD83)	Northing (Zone16) (NAD83)	Easting (Zone15) (NAD83)	Northing (Zone15) (NAD83)	Material Sampled	Ice Lobe
99-AFB-030	233907	5392433	675990	5388889	Till	Northern
99-AFB-032	235680	5394693	677579	5391280	Till	Northern
99-AFB-033	239264	5395653	681075	5392518	Till	Northern
99-AFB-034	244938	5399254	686447	5396553	Till	Northern
99-AFB-039	278808	5396099	720454	5396070	Till	Northern
99-AFB-040	276036	5394589	717809	5394347	Till	Northern
99-AFB-043	276094	5397600	717630	5397353	Till	Northern
99-AFB-047	277874	5388138	720148	5388060	Till	Northern
99-AFB-051	273962	5388100	716251	5387715	Till	Northern
99-AFB-056	278489	5386097	720920	5386074	Till	Northern
99-AFB-057	278239	5384762	720777	5384723	Till	Northern
99-AFB-058	274391	5384949	716925	5384608	Till	Northern
99-AFB-062	274520	5380303	717419	5379986	Till	Northern
99-AFB-070	272010	5382952	714709	5382430	Till	Northern
99-AFB-075	271084	5388310	713365	5387698	Till	Northern
99-AFB-087	267179	5386488	709615	5385576	Till	Northern
99-AFB-092	268124	5381365	710960	5380543	Till	Northern
99-AFB-096	265328	5380923	708207	5379883	Till	Northern
99-AFB-099	263389	5386537	705834	5385327	Till	Northern
99-AFB-102	259739	5387057	702155	5385559	Till	Northern
99-AFB-103	258445	5387089	700863	5385490	Till	Northern
99-AFB-104	258486	5388518	700791	5386917	Till	Northern
99-AFB-105	268423	5391802	710438	5390970	Till	Northern
99-AFB-108	260772	5390651	702902	5389222	Till	Northern
99-AFB-112	256786	5387697	699162	5385966	Till	Northern
99-AFB-115	253243	5387980	695609	5385970	Till	Northern
99-AFB-116	251987	5388142	694344	5386033	Till	Northern
99-AFB-119	253030	5391266	695138	5389228	Till	Northern
99-AFB-120	257195	5386930	699630	5385233	Till	Northern
99-AFB-122	259812	5385803	702326	5384315	Till	Northern
99-AFB-127	258050	5381387	700917	5379776	Till	Northern
99-AFB-130	261201	5380380	704136	5379018	Till	Northern
99-AFB-136	254282	5380858	697203	5378953	Till	Northern
99-AFB-139	253013	5382717	695792	5380706	Till	Northern
99-AFB-141	254397	5384019	697070	5382112	Till	Northern
99-AFB-144	266509	5390139	708661	5389163	Till	Northern
99-AFB-146	263349	5390426	705489	5389201	Till	Northern
99-AFB-149	273126	5390172	715255	5389715	Till	Northern
99-AFB-151	264841	5393222	706757	5392105	Till	Northern
99-AFB-154	263543	5393117	705471	5391898	Till	Northern
99-AFB-158	254259	5386510	696736	5384584	Till	Northern
99-AFB-160	250905	5379630	693933	5377464	Till	Northern
99-AFB-161	250647	5378421	693771	5376239	Till	Northern
99-AFB-164	246999	5379725	690033	5377253	Till	Northern
99-AFB-166	264541	5395901	706247	5394752	Till	Northern
99-AFB-168	261460	5397178	703076	5395782	Till	Northern
99-AFB-169	262649	5398536	704154	5397229	Till	Northern
99-AFB-175	245878	5393538	687833	5390931	Till	Northern
99-AFB-177	242400	5393108	684400	5390229	Till	Northern

Sample #	Easting (Zone16) (NAD83)	Northing (Zone16) (NAD83)	Easting (Zone15) (NAD83)	Northing (Zone15) (NAD83)	Material Sampled	Ice Lobe
99-AFB-180	240352	5391589	682478	5388554	Till	Northern
99-AFB-181	239360	5391587	681490	5388475	Till	Northern
99-AFB-183	239162	5389775	681435	5386653	Till	Northern
99-AFB-187	239505	5388448	681881	5385358	Till	Northern
99-AFB-188	236037	5384093	678767	5380746	Till	Northern
99-AFB-190	238613	5384571	681297	5381425	Till	Northern
99-AFB-195	234695	5386043	677277	5382584	Till	Northern
99-AFB-196	230413	5386063	673008	5382268	Till	Northern
99-AFB-198	234364	5384430	677074	5380950	Till	Northern
99-AFB-199	234889	5382732	677729	5379300	Till	Northern
99-AFB-200	234384	5380765	677381	5377300	Till	Northern
99-AFB-202	235308	5378487	678480	5375102	Till	Northern
99-AFB-206	238863	5378828	681996	5375721	Till	Northern
99-AFB-208	240843	5381225	683781	5378265	Till	Northern
99-AFB-210	243202	5379654	686254	5376884	Till	Northern
99-AFB-213	232606	5394455	674535	5390802	Till	Northern
99-AFB-214	230620	5393795	672608	5389988	Till	Northern
99-AFB-215	227239	5392344	669353	5388277	Till	Northern
99-AFB-216	223547	5390077	665853	5385728	Till	Northern
99-AFB-217	224252	5387057	666792	5382775	Till	Northern
99-AFB-218	227461	5389854	669770	5385814	Till	Northern
99-AFB-220	226874	5387912	669337	5383833	Till	Northern
99-AFB-222	225301	5387053	667838	5382853	Till	Northern
99-AFB-226	228858	5385396	671512	5381481	Till	Northern
99-AFB-227	225958	5385481	668615	5381339	Till	Northern
99-AFB-232	222795	5383804	665596	5379420	Till	Northern
99-AFB-233	221811	5383146	664667	5378688	Till	Northern
99-AFB-234	220526	5382535	663434	5377978	Till	Northern
99-AFB-235	220878	5382696	663773	5378166	Till	Northern
99-AFB-237	222375	5386222	664988	5381796	Till	Northern
99-AFB-238	220073	5384032	662865	5379434	Till	Northern
99-AFB-239	218775	5382672	661679	5377977	Till	Northern
99-AFB-240	219830	5382503	662743	5377891	Till	Northern
99-AFB-241	219094	5381512	662087	5376846	Till	Northern
99-AFB-243	221483	5381392	664478	5376914	Till	Northern
99-AFB-245	223946	5381430	666928	5377145	Till	Northern
99-AFB-246	219197	5380851	662242	5376196	Till	Northern
99-AFB-247	220015	5379395	663171	5374809	Till	Northern
99-AFB-248	221514	5379394	664665	5374925	Till	Northern
99-AFB-249	222864	5379707	665985	5375343	Till	Northern
99-AFB-253	215083	5382456	658018	5377472	Till	Northern
99-AFB-254	214006	5380361	657109	5375301	Till	Northern
99-AFB-256	273038	5393822	714880	5393346	Till	Northern
99-AFB-260	270721	5385714	713207	5385082	Till	Northern
99-AFB-265	276941	5382610	719651	5382476	Till	Northern
99-AFB-268	212358	5381718	655361	5376524	Till	Northern
99-AFB-269	214360	5380580	657444	5375546	Till	Northern
99-AFB-272	211969	5383880	654804	5378647	Till	Northern
99-AFB-273	214940	5384566	657710	5379564	Till	Northern

Sample #	Easting (Zone16) (NAD83)	Northing (Zone16) (NAD83)	Easting (Zone15) (NAD83)	Northing (Zone15) (NAD83)	Material Sampled	Ice Lobe
99-AFB-274	217414	5386545	660019	5381729	Till	Northern
99-AFB-275	217873	5384949	660602	5380175	Till	Northern
99-AFB-276	275880	5378391	718924	5378187	Till	Northern
99-AFB-278	277925	5379587	720869	5379539	Till	Northern
99-AFB-279	275965	5376901	719126	5376708	Till	Northern
99-AFB-285	270745	5379839	713692	5379227	Till	Northern
99-AFB-287	271410	5377981	714501	5377428	Till	Northern
99-AFB-290	220187	5385611	662856	5381015	Till	Northern
99-AFB-291	216079	5387566	658610	5382641	Till	Northern
99-AFB-292	216953	5389536	659326	5384673	Till	Northern
99-AFB-293	220310	5390036	662631	5385434	Till	Northern
99-AFB-294	221137	5389324	663511	5384789	Till	Northern
99-AFB-295	218697	5388232	661165	5383510	Till	Northern
99-AFB-296	226006	5383254	668838	5379123	Till	Northern
99-AFB-298	225841	5381887	668780	5377748	Till	Northern
99-AFB-299	226739	5382769	669606	5378697	Till	Northern
99-AFB-300	227664	5383602	670462	5379601	Till	Northern
99-AFB-302	240246	5393622	682214	5390572	Till	Northern
99-AFB-303	236862	5387927	679288	5384632	Till	Northern
99-AFB-304	232344	5383800	675110	5380164	Till	Northern
99-AFB-305	231705	5382965	674539	5379283	Till	Northern
99-AFB-306	232460	5380992	675446	5377376	Till	Northern
99-AFB-307	229330	5381273	672305	5377410	Till	Northern
99-AFB-308	229016	5383066	671852	5379172	Till	Northern
99-AFB-310	226937	5382077	669858	5378024	Till	Northern
99-AFB-311	225167	5380205	668240	5376020	Till	Northern
99-AFB-312	221109	5380035	664211	5375533	Till	Northern
99-AFB-314	217155	5379288	660330	5374479	Till	Northern
99-AFB-315	218133	5381913	661099	5377170	Till	Northern
99-AFB-316	217266	5381460	660271	5376651	Till	Northern
99-AFB-317	234958	5389375	677277	5385924	Till	Northern
99-AFB-318	231680	5389765	673981	5386056	Till	Northern
99-AFB-322	270569	5392015	712561	5391351	Till	Northern
99-AFB-324	262970	5395321	704726	5394049	Till	Northern
99-AFB-325	250055	5390640	692223	5388371	Till	Northern
99-AFB-327	241951	5386751	684452	5383858	Till	Northern
99-AFB-328	239757	5385386	682373	5382327	Till	Northern
99-AFB-329	237873	5383225	680665	5380025	Till	Northern
99-AFB-331	236118	5381718	679034	5378385	Till	Northern
99-AFB-333	251477	5381078	694390	5378952	Till	Northern
99-AFB-334	251543	5382477	694346	5380351	Till	Northern
99-AFB-335	251715	5383936	694403	5381819	Till	Northern
99-AFB-336	258198	5390533	700347	5388903	Till	Northern
99-AFB-337	255699	5391472	697782	5389642	Till	Northern
99-AFB-338	254903	5391670	696973	5389777	Till	Northern
99-AFB-339	255726	5389396	697972	5387576	Till	Northern
99-AFB-342	257611	5384595	700227	5382939	Till	Northern
99-AFB-343	255939	5383350	698659	5381566	Till	Northern
99-AFB-345	259961	5383927	702622	5382457	Till	Northern

Sample #	Easting (Zone16) (NAD83)	Northing (Zone16) (NAD83)	Easting (Zone15) (NAD83)	Northing (Zone15) (NAD83)	Material Sampled	Ice Lobe
99-AFB-346	262354	5383636	705031	5382355	Till	Northern
99-AFB-348	263079	5382081	705875	5380862	Till	Northern
99-AFB-349	265429	5383795	708083	5382755	Till	Northern
99-AFB-352	259622	5378422	702716	5376943	Till	Northern
99-AFB-353	268029	5378965	711053	5378144	Till	Northern
99-AFB-354	269416	5383254	712099	5382528	Till	Northern
99-AFB-356	271771	5380739	714644	5380205	Till	Northern
99-AFB-360	275004	5391873	716993	5391558	Till	Northern
99-AFB-362	268007	5393428	709896	5392559	Till	Northern
99-AFB-364	231394	5388055	673829	5384330	Till	Northern
99-AFB-365	230177	5387232	672682	5383414	Till	Northern
99-AFB-366	233212	5386626	675753	5383048	Till	Northern
99-AFB-367	233224	5388123	675648	5384541	Till	Northern
99-AFB-370	259981	5392388	701977	5390892	Till	Northern
99-AFB-371	257410	5393039	699365	5391338	Till	Northern
99-AFB-372	255469	5393162	697420	5391309	Till	Northern
99-AFB-373	253585	5393368	695526	5391366	Till	Northern
99-AFB-374	251964	5393404	693908	5391274	Till	Northern
99-AFB-375	252742	5392102	694786	5390038	Till	Northern
99-AFB-376	251285	5392596	693295	5390416	Till	Northern
99-AFB-377	251408	5391202	693527	5389037	Till	Northern
99-AFB-378	250147	5391534	692244	5389268	Till	Northern
99-AFB-379	249020	5391594	691116	5389240	Till	Northern
99-AFB-380	250253	5392574	692268	5390313	Till	Northern
99-AFB-382	247301	5392406	689339	5389913	Till	Northern
99-AFB-383	245321	5392516	687358	5389868	Till	Northern
99-AFB-384	244183	5391487	686304	5388754	Till	Northern
99-AFB-385	245582	5391232	687718	5388609	Till	Northern
99-AFB-386	239492	5386355	682033	5383271	Till	Northern
99-AFB-387	240380	5387037	682864	5384021	Till	Northern
99-AFB-388	241188	5387699	683617	5384744	Till	Northern
99-AFB-389	241536	5390097	683776	5387161	Till	Northern
99-AFB-391	243511	5389386	685800	5386607	Till	Northern
99-AFB-392	243875	5390617	686065	5387862	Till	Northern
99-AFB-393	228086	5388452	670502	5384466	Till	Northern
99-AFB-394	229719	5390776	671947	5386909	Till	Northern
99-AFB-395	220647	5383115	663510	5378565	Till	Northern
99-AFB-396	221475	5384883	664195	5380391	Till	Northern
99-AFB-397	236926	5389870	679199	5386573	Till	Northern
99-AFB-399	233362	5393596	675356	5390005	Till	Northern

Appendix B

Heavy mineral assemblages.

Heavy mineral assemblages are listed, in order of prominence, those comprising greater than 15 to 20% of the 0.25 to 0.50 mm paramagnetic (<0.8 amp) fraction followed, after a forward slash (/), by minerals comprising greater than 15 to 20% of the corresponding non-magnetic (>1.0 amp) fraction.

Sample #	Heavy Mineral Assemblage
98-AFB-4001	Pigeonite/diopside-titanite assemblage
98-AFB-4003	Pigeonite/diopside-titanite assemblage
98-AFB-4009	Pigeonite/diopside-titanite assemblage
98-AFB-4013	Pigeonite/diopside-titanite assemblage
98-AFB-4014	Pigeonite/diopside-titanite assemblage
98-AFB-4015	Pigeonite/diopside-titanite assemblage
98-AFB-4017	Pigeonite/diopside-pyrite assemblage
98-AFB-4020	Pigeonite/diopside-titanite-apatite assemblage
98-AFB-4023	Pigeonite/diopside-titanite-apatite assemblage
98-AFB-4026	Pigeonite/diopside-titanite assemblage
98-AFB-4028	Pigeonite/epidote-diopside-titanite-apatite assemblage
98-AFB-4029	Pigeonite/diopside-epidote assemblage
98-AFB-4030	Pigeonite/diopside-titanite assemblage
98-AFB-4031	Pigeonite/diopside-titanite assemblage
98-AFB-4032	Pigeonite/titanite-diopside assemblage
98-AFB-4034	Hornblende-pigeonite/titanite (variably altered to leucoxene) diopside assemblage
98-AFB-4035	Pigeonite-hornblende/diopside-titanite assemblage
98-AFB-4036	Pigeonite/diopside-titanite-epidote assemblage
98-AFB-4037	Pigeonite/diopside assemblage.
98-AFB-4038	Pigeonite/diopside assemblage.
98-AFB-4039	Pigeonite/diopside-epidote assemblage
98-AFB-4040	Pigeonite/diopside-epidote assemblage
98-AFB-4044	Pigeonite/diopside-leucoxene (includes titanite) assemblage
98-AFB-4046	Pigeonite/diopside-staurolite assemblage
98-AFB-4047	Pigeonite/diopside-titanite assemblage
98-AFB-4051	Pigeonite/diopside-epidote assemblage
98-AFB-4054	Pigeonite/diopside-titanite-epidote assemblage
98-AFB-4056	Pigeonite/diopside-titanite assemblage
98-AFB-4058	Pigeonite/diopside-titanite assemblage
98-AFB-4059	Pigeonite/diopside-titanite assemblage
98-AFB-4063	Pigeonite/diopside-epidote assemblage
98-AFB-4065	Pigeonite-augite/diopside assemblage
98-AFB-4067	Pigeonite/epidote-diopside assemblage
98-AFB-4068	Pigeonite/diopside assemblage.
98-AFB-4069	Pigeonite-hornblende/diopside-titanite assemblage
98-AFB-4070	Pigeonite-hornblende/diopside-epidote assemblage
98-AFB-4071	Pigeonite-augite/epidote-diopside assemblage
98-AFB-4075	Pigeonite-augite/epidote assemblage
98-AFB-4077	Pigeonite/diopside-epidote assemblage
98-AFB-4078	Pigeonite/titanite-diopside assemblage
98-AFB-4079	Pigeonite/diopside-epidote assemblage
98-AFB-4080	Pigeonite/diopside-epidote assemblage
98-AFB-4082	Pigeonite/diopside-epidote assemblage
98-AFB-4084	Pigeonite/diopside-epidote assemblage
98-AFB-4085	Pigeonite/epidote-titanite assemblage
98-AFB-4086	Pigeonite-augite/diopside assemblage
98-AFB-4088	Pigeonite/diopside-epidote assemblage
98-AFB-4091	Pigeonite-augite/titanite-diopside assemblage
98-AFB-4093	Hornblende-almandine-pigeonite/diopside-titanite assemblage
98-AFB-4094	Almandine-pigeonite-hornblende/diopside-epidote-titanite assemblage
98-AFB-4095	Pigeonite-augite/diopside-epidote-titanite assemblage

Sample #	Heavy Mineral Assemblage
98-AFB-4098	Pigeonite-augite/diopside-epidote assemblage
98-AFB-4100	Pigeonite-augite/diopside-titanite assemblage
98-AFB-4102	Pigeonite/titanite-diopside assemblage
98-AFB-4103	Pigeonite/titanite-diopside assemblage
98-AFB-4105	Pigeonite/diopside-titanite assemblage
98-AFB-4107	Pigeonite/diopside-titanite assemblage
98-AFB-4109	Pigeonite-augite/diopside-titanite assemblage
98-AFB-4110	Pigeonite/apatite-titanite assemblage
98-AFB-4111	Pigeonite/diopside-titanite assemblage
98-AFB-4112	Pigeonite/diopside-epidote assemblage
98-AFB-4113	Pigeonite/apatite-titanite-diopside assemblage
98-AFB-4114	Pigeonite/epidote-diopside assemblage
98-AFB-4115	Pigeonite/diopside-titanite-apatite assemblage
98-AFB-4116	Pigeonite/diopside-titanite-apatite assemblage
98-AFB-4118	Pigeonite/epidote-diopside assemblage
98-AFB-4119	Pigeonite/diopside-epidote-titanite assemblage
98-AFB-4120	Pigeonite/diopside-epidote assemblage
98-AFB-4121	Pigeonite/diopside-titanite assemblage
98-AFB-4122	Pigeonite/diopside-titanite assemblage
98-AFB-4124	Pigeonite/diopside-titanite assemblage
98-AFB-4125	Pigeonite/titanite-apatite assemblage
98-AFB-4126	Pigeonite/diopside-titanite assemblage
98-AFB-4127	Pigeonite/diopside-epidote assemblage
98-AFB-4128	Augite-pigeonite/diopside-epidote assemblage
98-AFB-4131	Pigeonite/diopside-titanite assemblage
98-AFB-4134	Pigeonite/diopside-staurolite assemblage
98-AFB-4135	Pigeonite/diopside-titanite assemblage
98-AFB-4136	Pigeonite/diopside assemblage.
98-AFB-4137	Pigeonite/diopside assemblage.
98-AFB-4138	Pigeonite/diopside-titanite assemblage
98-AFB-4140	Pigeonite-hornblende/diopside-titanite assemblage
98-AFB-4142	Pigeonite/diopside assemblage.
98-AFB-4143	Pigeonite/epidote-diopside assemblage
98-AFB-4144	Pigeonite/epidote assemblage.
98-AFB-4145	Pigeonite/epidote-titanite assemblage
98-AFB-4146	Pigeonite/pyrite-diopside assemblage
98-AFB-4147	Pigeonite/diopside-titanite assemblage
98-AFB-4148	Pigeonite-fayalite/diopside-titanite assemblage
98-AFB-4149	Pigeonite/diopside-titanite assemblage
98-AFB-4150	Pigeonite/diopside-titanite assemblage
98-AFB-4151	Pigeonite/diopside assemblage.
98-AFB-4152	Pigeonite/diopside assemblage.
98-AFB-4153	Pigeonite/epidote-diopside-pyrite assemblage
98-AFB-4154	Pigeonite/diopside-titanite assemblage
98-AFB-4155	Pigeonite/diopside-titanite assemblage
98-AFB-4156	Pigeonite-fayalite/diopside assemblage
98-AFB-4157	Pigeonite/titanite-diopside assemblage
98-AFB-4159	Pigeonite/epidote-diopside-titanite assemblage
98-AFB-4160	Pigeonite/diopside assemblage.
98-AFB-4161	Pigeonite/diopside-titanite assemblage
98-AFB-4162	Pigeonite/titanite-diopside assemblage

Sample #	Heavy Mineral Assemblage
98-AFB-4163	Pigeonite/diopside-titanite assemblage
98-AFB-4164	Pigeonite/diopside-titanite assemblage
98-AFB-4165	Pigeonite/diopside assemblage.
98-AFB-4166	Pigeonite/diopside-titanite assemblage
98-AFB-4167	Pigeonite/diopside-epidote assemblage
98-AFB-4168	Pigeonite/epidote-diopside assemblage
98-AFB-4169	Pigeonite/diopside-titanite-epidote assemblage
98-AFB-4171	Pigeonite/diopside-epidote assemblage
98-AFB-4172	Pigeonite/diopside-epidote assemblage
98-AFB-4174	Pigeonite/diopside-epidote assemblage
98-AFB-4176	Pigeonite-/diopside-titanite-epidote assemblage
98-AFB-4178	Pigeonite/diopside-epidote-titanite assemblage
98-AFB-4186	Pigeonite/diopside-titanite assemblage
98-AFB-4189	Pigeonite/titanite-diopside-apatite assemblage
98-AFB-4190	Pigeonite/titanite-diopside assemblage
98-AFB-4193	Pigeonite/epidote-diopside assemblage
98-AFB-4194	Pigeonite/diopside assemblage.
98-AFB-4195	Pigeonite/diopside assemblage.
98-AFB-4196	Pigeonite/diopside-epidote assemblage
98-AFB-4197	Pigeonite/diopside assemblage.
98-AFB-4198	Pigeonite/diopside-titanite assemblage
98-AFB-4199	Pigeonite/diopside-titanite assemblage
98-AFB-4200	Pigeonite/diopside-epidote assemblage
98-AFB-4201	Pigeonite/diopside-titanite assemblage
98-AFB-4202	Siderite-pigeonite/pyrite assemblage
98-AFB-4205	Pigeonite/diopside-titanite assemblage
98-AFB-4206	Pigeonite/titanite assemblage.
98-AFB-4207	Pigeonite/diopside-titanite assemblage
98-AFB-4208	Pigeonite-goethite/diopside assemblage
98-AFB-4209	Pigeonite/titanite-diopside assemblage
98-AFB-4211	Pigeonite/titanite-diopside assemblage
98-AFB-4212	Pigeonite/diopside-titanite assemblage
98-AFB-4213	Pigeonite/diopside-titanite-staurolite assemblage
98-AFB-4214	Pigeonite/diopside-epidote-staurolite assemblage
98-AFB-4215	Pigeonite/diopside-titanite assemblage
98-AFB-4217	Pigeonite/staurolite-diopside assemblage
98-AFB-4218	Pigeonite/diopside-titanite assemblage
98-AFB-4221	Pigeonite/titanite-diopside assemblage
98-AFB-4222	Pigeonite/diopside-titanite assemblage
98-AFB-4223	Pigeonite/diopside-titanite assemblage
98-AFB-4224	Pigeonite/titanite-diopside assemblage
98-AFB-4226	Pigeonite/diopside assemblage.
98-AFB-4228	Pigeonite/titanite-diopside assemblage
98-AFB-4231	Pigeonite/titanite-diopside assemblage
98-AFB-4232	Pigeonite/diopside-titanite assemblage
98-AFB-4233	Pigeonite/titanite-diopside assemblage
98-AFB-4236	Pigeonite/diopside assemblage.
98-AFB-4237	Pigeonite/diopside-epidote assemblage
98-AFB-4238	Pigeonite/pyrite-diopside-epidote assemblage
98-AFB-4239	Pigeonite/diopside-titanite assemblage
98-AFB-4240	Pigeonite/diopside-epidote assemblage

Sample #	Heavy Mineral Assemblage
98-AFB-4242	Pigeonite/diopside-epidote assemblage
98-AFB-4243	Pigeonite/epidote-diopside assemblage
98-AFB-4245	Pigeonite/epidote-titanite assemblage
98-AFB-4246	Pigeonite/epidote-diopside assemblage
98-AFB-4247	Pigoeonite/diopside-titanite assemblage
98-AFB-4249	Pigeonite/diopside-titanite assemblage
98-AFB-4251	Pigeonite/epidote assemblage.
98-AFB-4253	Pigeonite/diopside-staurolite assemblage
98-AFB-4254	Pigeonite/diopside-titanite-epidote assemblage
98-AFB-4255	Pigeonite/epidote-diopside-titanite assemblage
98-AFB-4257	Pigeonite/epidote-diopside assemblage
98-AFB-4259	Pigeonite/diopside-titanite-staurolite assemblage
98-AFB-4260	Pigeonite/titanite-diopside-apatite assemblage
98-AFB-4264	Pigeonite/titanite-diopside assemblage
98-AFB-4266	Pigeonite/diopside-titanite assemblage
98-AFB-4268	Pigeonite/diopside-titanite assemblage
98-AFB-4270	Pigeonite/diopside assemblage.
98-AFB-4271	Pigeonite/diopside-titanite assemblage
98-AFB-4273	Pigeonite/epidote-diopside assemblage
98-AFB-4274	Pigeonite/titanite assemblage.
98-AFB-4275	Pigeonite/pyrite assemblage.
98-AFB-4276	Pigeonite/pyrite assemblage.
98-AFB-4277	Pigeonite/titanite-epidote-diopside assemblage
98-AFB-4278	Pigeonite/titanite-diopside assemblage
98-AFB-4279	Pigeonite/diopside assemblage.
98-AFB-4280	Pigeonite-hornblende/titanite-diopside assemblage
98-AFB-4281	Hematite-siderite/pyrite assemblage
98-AFB-4282	Hornblende-pigeonite-almandine/diopside-titanite-epidote assemblage
98-AFB-4283	Pigeonite/diopside assemblage.
98-AFB-4286	Pigeonite/diopside-titanite-staurolite assemblage
99-AFB-4002	Pigeonite/diopside-titanite assemblage.
99-AFB-4006	Pigeonite/diopside-titanite assemblage.
99-AFB-4011	Pigeonite/diopside-titanite assemblage.
99-AFB-4014	Pigeonite/diopside-titanite assemblage.
99-AFB-4016	Pigeonite/diopside-titanite assemblage.
99-AFB-4018	Pigeonite/diopside-titanite assemblage.
99-AFB-4020	Pigeonite/diopside-titanite assemblage.
99-AFB-4022	Pigeonite/diopside-titanite assemblage.
99-AFB-4023	Pigeonite/diopside-epidote assemblage.
99-AFB-4024	Pigeonite/diopside-titanite assemblage.
99-AFB-4026	Pigeonite/diopside-titanite-apatite assemblage.
99-AFB-4027	Pigeonite/diopside-titanite assemblage.
99-AFB-4029	Pigeonite-hornblende/titanite-epidote-diopside assemblage.
99-AFB-4030	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4032	Pigeonite/diopside-titanite assemblage.
99-AFB-4033	Pigeonite/diopside-apatite-titanite assemblage.
99-AFB-4034	Pigeonite/diopside-titanite assemblage.
99-AFB-4039	Pigeonite/diopside-titanite assemblage.
98-AFB-4040	Pigeonite/diopside-titanite assemblage.
99-AFB-4043	Pigeonite/diopside-titanite assemblage.
99-AFB-4047	Pigeonite/diopside-titanite assemblage

Sample #	Heavy Mineral Assemblage
99-AFB-4051	Pigeonite/diopside-titanite assemblage.
99-AFB-4056	Pigeonite-hornblende/titanite-diopside- epidote assemblage.
99-AFB-4057	Pigeonite/diopside-titanite assemblage.
99-AFB-4058	Pigeonite/diopside-titanite assemblage.
99-AFB-4062	Pigeonite/diopside-titanite assemblage.
99-AFB-4070	Pigeonite/diopside-titanite assemblage.
99-AFB-4075	Pigeonite/diopside-titanite assemblage.
99-AFB-4087	Pigeonite/diopside-titanite assemblage.
99-AFB-4092	Pigeonite/diopside-titanite assemblage.
99-AFB-4096	Pigeonite/diopside-titanite assemblage.
99-AFB-4099	Pigeonite/diopside-titanite assemblage.
99-AFB-4102	Pigeonite/diopside-titanite assemblage.
99-AFB-4103	Pigeonite/diopside-epidote assemblage.
99-AFB-4104	Pigeonite/diopside-epidote-titanite assemblage.
99-AFB-4105	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4108	Pigeonite/diopside-titanite assemblage.
99-AFB-4112	Pigeonite/diopside-epidote assemblage.
99-AFB-4115	Pigeonite/diopside-titanite assemblage.
99-AFB-4116	Pigeonite-hornblende/epidote-titanite-diopside assemblage.
99-AFB-4119	Pigeonite/diopside-titanite assemblage.
99-AFB-4120	Pigeonite/diopside-epidote-titanite assemblage.
99-AFB-4122	Pigeonite/diopside-titanite assemblage.
99-AFB-4127	Pigeonite/diopside-titanite assemblage.
99-AFB-4130	Pigeonite/diopside-titanite assemblage.
99-AFB-4136	Pigeonite/epidote-diopside-titanite assemblage.
99-AFB-4139	Pigeonite/epidote-diopside-titanite assemblage.
98-AFB-4141	Pigeonite/epidote-diopside-titanite assemblage.
99-AFB-4144	Pigeonite/diopside-titanite assemblage.
99-AFB-4146	Pigeonite/diopside-titanite assemblage.
99-AFB-4149	Pigeonite/diopside-titanite assemblage.
99-AFB-4151	Pigeonite/diopside-titanite assemblage.
99-AFB-4154	Pigeonite/titanite-diopside assemblage.
99-AFB-4158	Pigeonite/diopside-titanite assemblage.
99-AFB-4160	Pigeonite/epidote assemblage.
99-AFB-4161	Pigeonite-augite/epidote-diopside-apatite assemblage.
99-AFB-4164	Pigeonite-augite-hornblende/titanite- diopside assemblage.
99-AFB-4166	Pigeonite/diopside-titanite assemblage.
99-AFB-4168	Pigeonite/diopside-titanite assemblage.
99-AFB-4169	Pigeonite/diopside-titanite assemblage.
99-AFB-4175	Pigeonite/diopside-epidote assemblage.
99-AFB-4177	Pigeonite/diopside-epidote assemblage.
99-AFB-4180	Pigeonite-augite/diopside-epidote assemblage.
99-AFB-4181	Pigeonite/diopside-epidote assemblage.
99-AFB-4183	Augite-pigeonite/epidote assemblage.
99-AFB-4187	Augite/epidote-felted rutile assemblage.
99-AFB-4188	Augite-pigeonite/apatite-diopside-felted rutile assemblage.
99-AFB-4190	Augite-pigeonite-hornblende/epidote- diopside-leucoxene assemblage.
99-AFB-4195	Pigeonite-hornblende/apatite-titanite assemblage.
99-AFB-4196	Pigeonite-augite/epidote-titanite-diopside assemblage.
99-AFB-4198	Pigeonite-augite/diopside-apatite-titanite assemblage.
99-AFB-4199	Pigeonite-hornblende/epidote assemblage.

Sample #	Heavy Mineral Assemblage
99-AFB-4200	Pigeonite/epidote-diposide-fibrous rutile assemblage.
99-AFB-4202	Pigeonite-augite/diopside-titanite assemblage.
99-AFB-4206	Pigeonite-augite/diopside-titanite assemblage.
99-AFB-4208	Augite-pigeonite-hornblende/titanite- diopside-apatite-epidote assemblage.
99-AFB-4210	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4213	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4214	Pigeonite-augite/diopside-epidote-apatite assemblage.
99-AFB-4215	Pigeonite-hornblende-almandine/epidote- apatite-diopside assemblage.
99-AFB-4216	Pigeonite-augite/epidote-diopside-titanite assemblage.
99-AFB-4217	Pigeonite-augite-hornblende/epidote- diopside-titanite-zircon assemblage.
99-AFB-4218	Pigeonite/diopside-apatite-titanite assemblage.
99-AFB-4220	Pigeonite/diopside-titanite assemblage.
99-AFB-4222	Pigeonite/epidote-diposide-titanite assemblage.
99-AFB-4226	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4227	Pigeonite/titanite-diopside assemblage.
99-AFB-4232	Pigeonite/diopside-epidote-titanite assemblage.
99-AFB-4233	Pigeonite/diopside-epidote assemblage.
99-AFB-4234	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4235	Pigeonite-hornblende/epidote-titanite-diopside assemblage.
99-AFB-4237	Pigeonite-hornblende/epidote-titanite-diopside assemblage.
99-AFB-4238	Pigeonite-hornblende-almandine/apatite- titanite-diopside assemblage.
99-AFB-4239	Pigeonite-hornblende/apatite-titanite-diopside assemblage.
99-AFB-4240	Pigeonite/diopside-epidote assemblage.
99-AFB-4241	Pigeonite/diopside-titanite assemblage.
99-AFB-4243	Pigeonite/titanite-apatite-diopside assemblage.
99-AFB-4245	Pigeonite/titanite-epidote assemblage.
99-AFB-4246	Pigeonite/diopside-epidote-titanite assemblage.
99-AFB-4247	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4248	Pigeonite/titanite-diopside-epidote assemblage.
99-AFB-4249	Pigeonite/titanite-diopside assemblage.
99-AFB-4253	Pigeonite/titanite-diopside-apatite assemblage.
99-AFB-4254	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4256	Pigeonite/diopside-titanite assemblage.
99-AFB-4260	Pigeonite/diopside-titanite assemblage.
99-AFB-4265	Pigeonite/diopside-epidote-titanite assemblage.
99-AFB-4268	Pigeonite/diopside-titanite-apatite assemblage.
99-AFB-4269	Pigeonite/epdiote-diopside assemblage.
99-AFB-4272	Pigeonite/titanite-diopside-apatite assemblage.
99-AFB-4273	Pigeonite/diopside-epidote-apatite assemblage.
99-AFB-4274	Pigeonite/titanite-diopside-epidote assemblage.
99-AFB-4275	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4276	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4278	Pigeonite/diopside-titanite assemblage.
99-AFB-4279	Pigeonite/diopside-titanite assemblage.
99-AFB-4285	Pigeonite/diopside-epidote assemblage.
99-AFB-4287	Pigeonite/diopside-titanite assemblage.
99-AFB-4290	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4291	Pigeonite/diopside-titanite-epidote-apatite assemblage.
99-AFB-4292	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4293	Pigeonite/titanite-diopside-epidote assemblage.
99-AFB-4294	Pigeonite/diopside-epidote-titanite assemblage.

Sample #	Heavy Mineral Assemblage
99-AFB-4295	Pigeonite/diopside-titanite assemblage.
99-AFB-4296	Pigeonite/titanite-epidote-diopside assemblage.
99-AFB-4298	Augite/titanite-epidote-diopside assemblage.
99-AFB-4299	Pigeonite/pyrite-epidote-diopside assemblage.
99-AFB-4300	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4302	Pigeonite/diopside-titanite assemblage.
99-AFB-4303	Pigeonite-hornblende/diopside-titanite assemblage.
99-AFB-4304	Augite-pigeonite/apatite-titanite-diopside assemblage.
99-AFB-4305	Pigeonite-hornblende/epidote-diopside-titanite assemblage.
99-AFB-4306	Pigeonite-augite/diopside-epidote-felted rutile assemblage.
99-AFB-4307	Pigeonite/diopside-epidote-titanite assemblage.
99-AFB-4308	Pigeonite-hornblende/epidote-titanite-diopside assemblage.
99-AFB-4310	Pigeonite-hornblende/epidote-titanite-diopside assemblage.
99-AFB-4311	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4312	Pigeonite/titanite-epidote-diopside assemblage.
99-AFB-4314	Pigeonite/diopside-epidote-titanite assemblage.
99-AFB-4315	Pigeonite-hornblende/apatite-titanite assemblage.
99-AFB-4316	Pigeonite-hornblende/apatite-titanite assemblage.
99-AFB-4317	Pigeonite-hornblende/titanite assemblage.
99-AFB-4318	Augite-pigeonite-hornblende/titanite- diopside-apatite assemblage.
99-AFB-4322	Pigeonite/diopside-titanite-apatite assemblage.
99-AFB-4324	Pigeonite/diopside-titanite assemblage.
99-AFB-4325	Pigeonite/epidote-diopside assemblage.
99-AFB-4327	Augite/epidote-titanite assemblage.
99-AFB-4328	Pigeonite/epidote-felted rutile-diopside assemblage.
99-AFB-4329	Pigeonite/diopside-epidote-felted rutile assemblage.
99-AFB-4331	Pigeonite/epidote-diopside-titanite assemblage.
99-AFB-4333	Pigeonite/epidote-titanite assemblage.
99-AFB-4334	Pigeonite/epidote assemblage.
99-AFB-4335	Pigeonite/epidote-diopside-titanite assemblage.
99-AFB-4336	Pigeonite/titanite assemblage.
99-AFB-4337	Pigeonite/diopside-titanite assemblage.
99-AFB-4338	Pigeonite/diopside-epidote assemblage.
99-AFB-4339	Pigeonite/diopside-epidote assemblage.
99-AFB-4342	Pigeonite/diopside-epidote assemblage.
99-AFB-4343	Pigeonite/epidote-diopside assemblage.
99-AFB-4345	Pigeonite/diopside-epidote assemblage.
99-AFB-4346	Pigeonite-augite/diopside-epidote assemblage.
99-AFB-4348	Pigeonite/diopside-titanite assemblage.
99-AFB-4349	Pigeonite/diopside-titanite assemblage.
99-AFB-4352	Pigeonite/diopside-titanite assemblage.
99-AFB-4353	Pigeonite/diopside-titanite assemblage.
99-AFB-4354	Pigeonite/diopside-titanite assemblage.
99-AFB-4356	Pigeonite/diopside-titanite assemblage.
99-AFB-4360	Pigeonite/diopside-titanite assemblage.
99-AFB-4362	Pigeonite/diopside-titanite assemblage.
99-AFB-4364	Pigeonite-hornblende/titanite-diopside- epidote assemblage.
99-AFB-4365	Pigeonite-hornblende/titanite-diopside- epidote-apatite assemblage.
99-AFB-4366	Augite-pigeonite/epidote-pyrite assemblage.
99-AFB-4367	Augite-pigeonite/pyrite-diopside-epidote-titanite assemblage
99-AFB-4370	Pigeonite-augite/diopside-titanite assemblage.

Sample #	Heavy Mineral Assemblage
99-AFB-4371	Pigeonite/epidote-diopside-titanite assemblage.
99-AFB-4372	Pigeonite/diopside assemblage.
99-AFB-4373	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4374	Pigeonite/diopside-titanite assemblage.
99-AFB-4375	Pigeonite/epidote assemblage.
99-AFB-4376	Pigeonite/epidote-diopside-titanite assemblage.
99-AFB-4377	Pigeonite/epidote-diopside-felted rutile assemblage.
99-AFB-4378	Pigeonite/epidote-titanite assemblage.
99-AFB-4379	Augite-pigeonite-hornblende/epidote-diopside assemblage.
99-AFB-4380	Augite-pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4382	Pigeonite/epidote-felted rutile assemblage.
99-AFB-4383	Pigeonite/diopside-titanite assemblage.
99-AFB-4384	Pigeonite/epidote-diopside-titanite assemblage.
99-AFB-4385	Augite/epidote-diopside assemblage.
99-AFB-4386	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4387	Pigeonite/epidote-titanite assemblage.
99-AFB-4388	Pigeonite/epidote-felted rutile-diopside assemblage.
99-AFB-4389	Pigeonite-hornblende/epidote-diopside assemblage.
99-AFB-4391	Pigeonite/epidote-titanite assemblage.
99-AFB-4392	Pigeonite/felted rutile-epidote-diopside assemblage.
99-AFB-4393	Pigeonite/diopside-titanite-epidote assemblage.
99-AFB-4394	Pigeonite/epidote-titanite-diopside assemblage.
99-AFB-4395	Pigeonite/apatite-titanite-epidote assemblage.
99-AFB-4396	Pigeonite-augite/apatite-titanite-epidote assemblage.
99-AFB-4397	Augite/titanite assemblage.
99-AFB-4399	Pigeonite/diopside-epidote-titanite assemblage.

Appendix C

MMSIM® grain counts.

ABBREVIATIONS

KY: kyanite
SI: sillimanite
RR: red rutile
GA: gahnite
DC: chrome diopside
CO: corundum
EP: epidote
AN: andalusite
TO: topaz
UV: uvarovite
ST: staurolite
FA: fayalite
OPX: orthopyroxene
CR: chromite
SP: spessartine
GO: goethite
PY: pyrite
CPY: chalcopyrite
Tr: trace

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
98-AFB-4001	0	0	0	0	0	1	1	0	0	0	0	0	Tr	3	1	0	0	0	0	0	0
98-AFB-4003	0	0	0	0	1	1	0	0	0	0	0	0	Tr	2	0.5	0	0	0	0	0	0
98-AFB-4009	0	0	0	0	3	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
98-AFB-4013	0	0	0	0	5	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
98-AFB-4014	0	0	0	1	3	0	0	0	0	0	0	0	Tr	1	Tr	0	0	Tr	0	0	0
98-AFB-4015	0	0	0	0	1	0	0	0	0	0	0	0	Tr	3	Tr	1	0	0	0	5	0
98-AFB-4017	0	0	2	0	3	0	0	0	0	0	0	0	0.5	1	0.5	0	0	Tr	15	0	0
98-AFB-4020	0	0	0	0	1	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	Tr	0	0
98-AFB-4023	0	Tr	Tr	1	0	0	0	0	0	0	0	0	Tr	0.5	Tr	0	0	0	0	0	0
98-AFB-4026	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	0	0	0
98-AFB-4028	0	0	1	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	1 gr sapphirine
98-AFB-4029	0	Tr	1	0	0	0	0	0	0	0	0	0	Tr	3	Tr	0	0	0	0	0	0
98-AFB-4030	0	Tr	1	0	1	0	0	0	0	0	0	0	Tr	0.5	Tr	0	0	0	0	0	0
98-AFB-4031	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	1	Tr	0	0	0	0	1	0
98-AFB-4032	0	Tr	0	0	3	0	0	0	0	0	0	0	Tr	0.5	Tr	0	0	0	0	0	0
98-AFB-4034	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	0	0	0
98-AFB-4035	0	0.5	0	0	1	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	Tr	0	0
98-AFB-4036	0	Tr	3	0	2	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	0	0	0
98-AFB-4037	0	Tr	1	0	1	0	1	0	0	0	0	0	0.5	7	Tr	0	0	0	0	0	0
98-AFB-4038	0	Tr	1	0	3	0	2	0	0	0	0	0	Tr	3	Tr	0	0	0	0	0	0
98-AFB-4039	0	0	0	0	2	0	0	0	0	0	0	0	3	1	Tr	Tr	0	0	2	0	0
98-AFB-4040	0	Tr	0	0	2	0	0	0	0	0	0	0	0.5	2	Tr	0	0	0	0	0	0
98-AFB-4044	0	0	0	0	0	0	1	0	0	0	0	0	1	1	Tr	0	0	0	4	0	0
98-AFB-4046	0	Tr	0	0	1	0	0	0	0	0	0	0	2	1	Tr	0	0	0	Tr	0	0
98-AFB-4047	0	0	0	0	0	0	0	0	0	0	0	0	1	4	Tr	0	0	0	0	0	0
98-AFB-4051	0	Tr	1	0	2	0	0	0	0	0	0	0	4	2	1	0	0	0	0	0	0
98-AFB-4054	0	0	0	0	2	0	0	0	0	0	0	0	0.5	1	Tr	0	0	0	0	0	0
98-AFB-4056	0	0	0	1	4	0	0	0	0	0	0	0	1	Tr	Tr	0	0	0	0	0	0
98-AFB-4058	0	0	0	1	1	0	0	0	0	0	0	0	Tr	0.5	Tr	0	0	0	0	0	0
98-AFB-4059	0	Tr	0	0	2	0	0	0	0	0	0	0	Tr	1	Tr	0	0	0	0	0	0
98-AFB-4063	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	4	1	0	0	0	0	0	0
98-AFB-4065	0	Tr	0	0	1	0	0	0	0	1	0	0	5	2	Tr	Tr	0	0	Tr	0	0
98-AFB-4067	0	0	0	0	0	0	0	0	0	0	0	0	Tr	1	Tr	0	0	0	Tr	1	0
98-AFB-4068	0	0	0	0	3	0	0	0	0	0	0	0	1	3	0.5	0	0	0	Tr	0	0
98-AFB-4069	0	Tr	0	0	2	0	1	0	0	0	0	0	Tr	Tr	Tr	0	0	0	Tr	0	0
98-AFB-4070	0	Tr	0	0	0	0	0	0	0	0	0	0	1	1	Tr	0	0	0	Tr	5	0
98-AFB-4071	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	3	Tr	Tr	0	0	Tr	3	0
98-AFB-4075	0	Tr	2	0	0	0	0	0	0	0	0	0	0	2	Tr	0	0	0	0	0	0
98-AFB-4077	0	Tr	1	0	5	0	1	0	0	1	0	0	Tr	Tr	Tr	5	0	0	Tr	2	0
98-AFB-4078	0	0	0	0	0	0	0	0	0	0	0	0	Tr	3	5	0	0	0	Tr	0	0
98-AFB-4079	0	Tr	1	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4080	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	0.5	Tr	5	0	0	Tr	0	0
98-AFB-4082	0	0	0	0	2	0	1	0	0	0	0	0	Tr	1	Tr	0	0	0	Tr	0	0
98-AFB-4084	0	0	0	0	2	0	0	0	0	0	0	0	Tr	4	Tr	80	0	0	Tr	0	0
98-AFB-4085	0	Tr	2	1	0	0	0	0	0	0	0	0	Tr	10	Tr	0	0	0	Tr	2	0

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
98-AFB-4086	Tr	Tr	1	0	1	1	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4088	0	Tr	1	1	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4091	0	0	0	0	1	0	0	0	0	0	0	0	Tr	3	Tr	1	0	0	Tr	0	0
98-AFB-4093	Tr	0	0	0	3	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	Tr	0	0
98-AFB-4094	0	0	1	0	0	0	0	0	0	0	0	0	0.5	Tr	Tr	0	0	0	1	0	0
98-AFB-4095	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	3	Tr	0	0	0	Tr	0	0
98-AFB-4098	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	3	Tr	1	0	0	0	0	0
98-AFB-4100	0	Tr	1	0	3	1	0	0	0	0	0	0	Tr	1.5	Tr	0	0	0	0	0	0
98-AFB-4102	0	0	0	0	2	1	0	0	0	0	0	0	Tr	4	Tr	0	0	0	0	0	0
98-AFB-4103	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4105	0	0	0	0	5	0	0	0	0	0	0	0	1	2	Tr	Tr	0	0	0	0	0
98-AFB-4107	0	Tr	2	0	4	0	1	0	0	0	0	0	0.5	1	Tr	0	0	Tr	Tr	0	0
98-AFB-4109	0	Tr	1	1	1	0	0	0	0	0	0	0	Tr	5	Tr	0	0	0	0	0	0
98-AFB-4110	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4111	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
98-AFB-4112	0	0	1	0	0	1	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
98-AFB-4113	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	4	Tr	0	0	0	0	0	0
98-AFB-4114	0	0	0	0	1	0	0	0	0	0	0	0	0	3	Tr	0	0	0	0	0	0
98-AFB-4115	0	Tr	Tr	1	1	0	0	0	0	0	0	0	Tr	1	Tr	0	Tr	0	0	0	0
98-AFB-4116	0	Tr	0	1	3	0	0	0	0	0	0	0	Tr	1.5	Tr	0	0	0	Tr	0	0
98-AFB-4118	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	4	Tr	0	0	0	Tr	0	0
98-AFB-4119	0	Tr	0	0	6	0	0	0	0	0	0	0	Tr	3	Tr	Tr	0	0	Tr	0	0
98-AFB-4120	Tr	Tr	0	0	4	0	0	0	0	0	0	0	Tr	4	Tr	0	Tr	0	Tr	0	0
98-AFB-4121	0	Tr	1	0	1	0	0	0	0	0	0	0	1	2	Tr	Tr	0	0	0	0	0
98-AFB-4122	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	7	Tr	0	0	0	Tr	0	0
98-AFB-4124	0	Tr	0	0	7	1	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
98-AFB-4125	0	Tr	0	1	0	0	0	0	0	0	0	0	0	5	Tr	0	0	0	Tr	0	0
98-AFB-4126	0	Tr	0	0	0	0	0	0	0	0	0	0	0	10	Tr	0	Tr	0	Tr	0	0
98-AFB-4127	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	10	Tr	0	Tr	0	Tr	0	0
98-AFB-4128	0	Tr	0	1	1	0	0	0	0	0	0	0	Tr	5	0	0	Tr	0	0	0	0
98-AFB-4131	0	Tr	1	0	3	0	0	0	0	0	0	0	Tr	7	Tr	0	0	0	Tr	0	0
98-AFB-4134	0	0	0	0	1	0	0	0	0	0	0	0	8	6	Tr	0	0	0	Tr	0	0
98-AFB-4135	Tr	Tr	0	0	0	1	1	0	0	0	0	0	Tr	3	Tr	0	0	0	Tr	1	0
98-AFB-4136	Tr	Tr	0	0	1	1	0	0	0	0	0	0	0.5	1	Tr	0	Tr	0	Tr	0	0
98-AFB-4137	0	Tr	5	0	2	0	0	0	0	0	0	0	1	3	Tr	0	0	0	0	0	0
98-AFB-4138	0	0	2	0	0	0	0	0	0	0	0	0	Tr	7	1	0	Tr	0	Tr	0	0
98-AFB-4140	Tr	Tr	0	0	1	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	0	2	1 gr malachite
98-AFB-4142	0	0	0	0	0	0	0	0	0	0	0	0	0	8	Tr	0	0	0	0	0	0
98-AFB-4143	0	0	0	0	0	1	0	0	0	0	0	0	Tr	4	Tr	0	0	0	0	0	0
98-AFB-4144	0	0	0	0	0	0	0	0	0	0	0	0	Tr	8	Tr	0	0	0	0	0	0
98-AFB-4145	0	0	1	0	0	0	0	0	0	0	0	0	Tr	8	Tr	0	0	0	0	0	0
98-AFB-4146	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	0	1	0	0	0	45	5	1 gr bornite
98-AFB-4147	Tr	0	0	0	0	0	0	0	0	0	0	0	0	3	Tr	0	0	0	0	0	0
98-AFB-4148	0	0	0	0	0	0	0	0	0	0	0	0	Tr	15	Tr	0	0	0	0	0	0
98-AFB-4149	0	0	0	0	0	1	0	0	0	0	0	0	Tr	6	Tr	0	0	0	Tr	0	0

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
98-AFB-4150	0	0	0	0	1	0	0	0	0	0	0	0	0	2	Tr	0	0	0	Tr	0	0
98-AFB-4151	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	4	Tr	0	0	0	Tr	0	0
98-AFB-4152	0	0	0	0	0	0	0	0	0	0	0	0	Tr	5	Tr	0	0	0	Tr	0	0
98-AFB-4153	0	1	0	0	0	0	1	0	0	0	0	0	0	2	Tr	0	0	0	15	0	0
98-AFB-4154	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	Tr	0	0
98-AFB-4155	Tr	0	0	0	0	0	0	0	0	0	0	0	0	4	Tr	0	0	0	Tr	0	0
98-AFB-4156	0	0	0	0	0	0	0	0	0	0	0	0	Tr	15	Tr	0	0	0	Tr	0	0
98-AFB-4157	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	3	Tr	0	0	0	0	0	0
98-AFB-4159	0	Tr	1	1	0	0	0	0	0	0	0	0	4	3	Tr	0	0	0	0	3	0
98-AFB-4160	0	0	1	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4161	0	0	0	0	0	0	1	0	0	0	0	0	Tr	4	Tr	0	0	0	Tr	0	0
98-AFB-4162	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	2	0
98-AFB-4163	0	0	0	0	0	0	0	0	0	0	0	0	0	2	Tr	0	0	0	0	1	0
98-AFB-4164	Tr	0	0	0	0	0	0	0	0	0	0	0	Tr	1.5	Tr	0	0	0	0	0	0
98-AFB-4165	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Tr	Tr	0	0	0	1	0
98-AFB-4166	0	0	0	0	0	0	0	0	0	0	0	0	Tr	1	Tr	0	0	0	0	0	0
98-AFB-4167	0	0	0	0	0	0	0	0	0	0	0	0	Tr	0.5	Tr	0	0	0	8	0	0
98-AFB-4168	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	Tr	0	0	0	Tr	0	0
98-AFB-4169	0	0	0	0	0	0	0	0	0	0	0	0	0	4	Tr	0	0	0	Tr	0	0
98-AFB-4171	0	0	1	1	5	0	0	0	0	0	0	0	0.5	1	Tr	8	0	0	Tr	0	0
98-AFB-4172	0	Tr	2	0	1	0	0	0	0	0	0	0	Tr	1	Tr	165	0	0	Tr	0	0
98-AFB-4174	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	1	Tr	0	0	0	0	0	0
98-AFB-4176	0	0	0	0	4	0	0	0	0	0	0	0	Tr	0.5	Tr	3	0	0	Tr	0	0
98-AFB-4178	0	Tr	1	0	1	0	0	0	0	0	0	0	Tr	4	Tr	1	0	0	0	0	0
98-AFB-4186	0	Tr	0	0	1	0	0	0	0	0	0	0	0.5	1	Tr	0	0	0	Tr	0	0
98-AFB-4189	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	5	Tr	0	0	0	0	0	0
98-AFB-4190	0	Tr	1	0	5	0	0	0	0	0	0	0	1	1	2	0	0	0	0	2	0
98-AFB-4193	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	Tr	1	0	0	0	Tr	1	0
98-AFB-4194	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4195	0	0	0	0	0	0	0	0	0	0	0	0	Tr	3	Tr	0	0	Tr	0	0	0
98-AFB-4196	0	0	0	0	0	0	0	0	0	0	0	0	Tr	1	Tr	0	Tr	0	0	0	0
98-AFB-4197	0	0	0	0	0	0	0	0	0	0	0	0	Tr	0.5	Tr	0	0	0	0	0	0
98-AFB-4198	0	Tr	0	0	0	0	0	0	0	0	0	0	0	Tr	3	0	0	0	10	1	0
98-AFB-4199	0	0	0	0	0	0	0	0	0	0	0	0	Tr	4	Tr	0	0	0	0	0	0
98-AFB-4200	0	Tr	0	0	0	0	0	0	0	0	0	0	0	Tr	1	0	0	0	Tr	0	0
98-AFB-4201	0	0	0	0	0	0	0	0	0	0	0	0	Tr	4	Tr	0	0	0	0	0	0
98-AFB-4202	0	Tr	0	1	0	0	0	0	0	0	0	0	Tr	0	Tr	Tr	0	0	100	0	0
98-AFB-4205	0	0	0	1	0	0	0	0	0	0	0	0	0	2	Tr	0	0	0	Tr	0	0
98-AFB-4206	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	1.5	Tr	0	0	0	Tr	0	0
98-AFB-4207	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4208	0	0	0	0	0	0	0	0	0	0	0	0	Tr	3	Tr	0	0	3	Tr	0	0
98-AFB-4209	0	0	1	1	0	0	0	0	0	0	0	0	Tr	4	2	1	0	0	0	0	0
98-AFB-4211	0	Tr	0	0	4	0	0	0	0	0	0	0	Tr	Tr	1	0	0	0	0	0	0
98-AFB-4212	0	Tr	0	0	0	0	0	0	0	0	0	0	0.5	5	Tr	0	0	0	0	0	0
98-AFB-4213	Tr	Tr	1	0	0	0	1	0	0	0	0	0	2	0.5	Tr	0	0	0	Tr	0	0

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
98-AFB-4214	0	Tr	2	0	1	0	0	0	0	0	0	0	0.5	1	Tr	0	0	0	Tr	0	0
98-AFB-4215	0	Tr	1	0	2	0	0	0	0	0	0	0	Tr	2	Tr	1	0	0	0	0	0
98-AFB-4217	0	Tr	1	1	0	0	0	0	0	0	0	0	7	Tr	Tr	0	0	0	Tr	0	0
98-AFB-4218	0	Tr	0	0	2	0	0	0	0	0	0	0	1	10	Tr	0	0	0	0	0	0
98-AFB-4221	0	Tr	0	0	1	0	0	0	0	0	0	0	0.5	1	Tr	0	0	0	0	0	0
98-AFB-4222	0	0	0	0	2	0	0	0	0	0	0	0	Tr	3	Tr	1	0	0	Tr	0	0
98-AFB-4223	0	Tr	3	0	2	0	1	0	0	0	0	0	0.5	1	Tr	1	0	0	Tr	0	0
98-AFB-4224	0	0	3	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	1	0
98-AFB-4226	0	Tr	1	0	2	0	0	0	0	0	0	0	Tr	4	Tr	0	0	0	Tr	0	0
98-AFB-4228	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	1	Tr	0	0	0	0	0	0
98-AFB-4231	0	0	0	1	4	1	0	0	0	0	0	0	Tr	4	Tr	1	0	0	Tr	0	0
98-AFB-4232	0	Tr	0	0	3	0	0	0	0	0	0	0	Tr	3	Tr	0	0	0	0	0	0
98-AFB-4233	0	0	1	0	0	0	0	0	0	0	0	0	Tr	7	Tr	0	0	0	Tr	0	0
98-AFB-4236	Tr	0	2	0	2	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
98-AFB-4237	0	0	0	0	0	0	0	0	0	0	0	0	Tr	Tr	Tr	15	0	0	0	0	0
98-AFB-4238	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	2	Tr	100	0	0	30	0	0
98-AFB-4239	0	0	1	0	0	0	0	0	0	0	0	0	Tr	1	Tr	0	0	0	Tr	0	0
98-AFB-4240	0	0	0	0	1	0	0	0	0	0	0	0	Tr	8	Tr	3	0	0	1	0	0
98-AFB-4242	Tr	0	0	0	4	0	0	0	0	0	0	0	0.5	0.5	Tr	4	0	0	0	0	0
98-AFB-4243	0	0	1	0	1	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	0	0	0
98-AFB-4245	Tr	Tr	0	0	0	0	0	0	0	0	0	0	0	Tr	Tr	0	0	0	Tr	0	0
98-AFB-4246	0	0	0	0	6	0	0	0	0	0	0	0	Tr	1	Tr	10	0	0	0	0	0
98-AFB-4247	0	0	0	0	2	0	0	0	0	0	0	0	0.25	3	Tr	1	0	0	0	0	0
98-AFB-4249	0	Tr	0	0	1	1	0	0	0	0	0	0	Tr	9	Tr	0	0	0	Tr	0	0
98-AFB-4251	0	0	2	0	2	0	0	0	0	0	0	0	Tr	6	Tr	0	0	0	Tr	1	0
98-AFB-4253	0	Tr	0	0	0	0	0	0	0	0	0	0	0.25	2	Tr	3	0	0	0	0	0
98-AFB-4254	0	0	2	1	0	0	0	0	0	0	0	0	Tr	4	Tr	0	0	0	Tr	0	0
98-AFB-4255	0	0	1	0	0	0	0	0	0	0	0	0	Tr	Tr	1	0	0	0	Tr	0	0
98-AFB-4257	0	0	1	0	4	1	0	0	0	0	0	0	Tr	1	Tr	3500	0	0	Tr	0	0
98-AFB-4259	0	Tr	2	0	3	0	0	0	0	0	0	0	0.5	3	Tr	0	0	0	0	0	0
98-AFB-4260	0	Tr	1	0	4	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	Tr	0	0
98-AFB-4264	0	Tr	2	0	1	1	0	0	0	0	0	0	Tr	Tr	Tr	0	Tr	0	Tr	0	0
98-AFB-4266	0	Tr	1	0	1	0	0	0	0	0	0	0	Tr	1	Tr	1	0	0	0	0	0
98-AFB-4268	Tr	Tr	3	0	2	2	0	0	0	0	0	0	Tr	Tr	Tr	2	0	0	Tr	0	0
98-AFB-4270	0	Tr	1	0	0	0	0	0	0	0	0	0	Tr	3	Tr	0	0	0	Tr	0	0
98-AFB-4271	0	0.54	0	0	1	0	0	0	0	0	0	0	0.25	2	Tr	0	0	0	Tr	0	0
98-AFB-4273	0	Tr	0	0	2	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	Tr	0	0
98-AFB-4274	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Tr	0	0	0	0	0	0
98-AFB-4275	0	Tr	1	0	0	0	0	0	0	0	0	0	0	0	Tr	0	0	0	98	1	10 gr sphalerite; 3 gr galena; 40 gr barite
98-AFB-4276	0	Tr	1	2	0	0	0	0	0	0	0	0	Tr	0	1	0	0	0	95	10	12 gr sphalerite; 30 gr barite; 1 gr fluorite
98-AFB-4277	0	Tr	0	0	0	0	0	0	0	1	0	0	Tr	Tr	Tr	0	0	0	Tr	0	0

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
98-AFB-4278	0	0	0	0	0	0	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	0	2	0
98-AFB-4279	0	0	0	0	1	0	0	0	0	0	0	0	0	2	Tr	0	0	0	0	0	0
98-AFB-4280	0	0	0	0	0	0	0	0	0	0	0	0	Tr	3	Tr	0	0	0	0	0	0
98-AFB-4281	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	0	Tr	0	Tr	0	95	0	1 gr sphalerite
98-AFB-4282	0	Tr	5	0	2	1	0	0	0	0	0	0	Tr	Tr	Tr	0	0	0	Tr	0	2 gr arsenopyrite
98-AFB-4283	0	Tr	0	0	2	0	0	0	0	0	0	0	Tr	0.5	Tr	2	0	0	Tr	1	0
98-AFB-4286	0	Tr	0	0	3	0	0	0	0	0	0	0	0.5	2	Tr	1	0	0	0	0	0
99-AFB-4002	Tr	0	0	0	0	0	0	0	0	0	0	0	0	1	Tr	0	0	0	Tr	0	0
99-AFB-4006	Tr	0	0	0	1	0	0	0	0	0	0	0	Tr	5	0	0	0	0	0	0	0
99-AFB-4011	0	0	0	0	0	0	1	0	0	0	0	0	Tr	1	0	0	0	0	0	0	0
99-AFB-4014	0	Tr	0	0	4	0	0	0	0	0	0	0	0	7	Tr	0	0	0	Tr	0	0
99-AFB-4016	0	0	0	0	3	0	0	0	0	0	0	0	Tr	3	0	0	0	0	0	0	0
99-AFB-4018	0	0	0	0	0	0	0	0	0	0	0	0	0.5	4	0	1	0	0	Tr	0	0
99-AFB-4020	Tr	0	1	0	0	0	0	0	0	0	0	0	0.5	3	Tr	4	0	0	0	0	0
99-AFB-4022	0	Tr	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0
99-AFB-4023	0	Tr	0	0	8	0	0	0	0	0	0	0	5	5	Tr	0	0	0	Tr	0	0
99-AFB-4024	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	Tr	0	0
99-AFB-4026	Tr	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	Tr	0	0
99-AFB-4027	0	0	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	Tr	0	0
99-AFB-4029	0	0	0	0	1	0	0	0	0	0	0	0	Tr	2	0	0	0	Tr	Tr	0	0
99-AFB-4030	0	Tr	0	0	3	0	0	0	0	0	0	0	Tr	1	0	1	0	0	0	0	0
99-AFB-4032	0	Tr	1	0	1	0	0	0	0	0	0	0	0	2	Tr	2	0	0	Tr	1	0
99-AFB-4033	0	Tr	2	1	3	0	1	0	0	0	0	0	Tr	4	Tr	1	0	0	Tr	0	0
99-AFB-4034	Tr	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	0	Tr	0	0
99-AFB-4039	0	0	0	0	2	1	0	0	0	0	0	0	0	1	Tr	1	0	0	0	0	0
99-AFB-4040	0	0	1	0	2	0	0	0	0	0	0	0	Tr	3	0	1	0	Tr	0	0	0
99-AFB-4043	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
99-AFB-4047	0	Tr	0	1	9	0	0	0	0	0	0	0	Tr	3	Tr	0	0	0	0	0	1 gr native silver
99-AFB-4051	0	Tr	0	0	3	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0.5	0	0
99-AFB-4056	0	0	0	0	0	1	0	0	0	0	0	0	Tr	1	0	1	0	0	0	0	0
99-AFB-4057	0	Tr	0	0	3	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
99-AFB-4058	0	Tr	0	0	2	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
99-AFB-4062	0	Tr	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
99-AFB-4070	0	Tr	0	0	5	0	0	0	0	0	0	0	0	1	0	15	0	0	Tr	0	0
99-AFB-4075	0	Tr	1	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
99-AFB-4087	0	0	0	0	3	0	0	0	0	0	0	0	Tr	1	0	0	0	0	0	1	0
99-AFB-4092	0	Tr	1	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
99-AFB-4096	0	0	0	0	0	0	0	0	0	0	0	0	Tr	1	0	0	0	0	0	0	0
99-AFB-4099	0	0	0	0	2	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
99-AFB-4102	0	0	1	0	10	0	0	0	0	0	0	0	1	2	Tr	0	0	0	Tr	0	0
99-AFB-4103	Tr	0	1	1	16	0	0	0	0	0	0	0	0.5	2	0	0	0	Tr	0	0	0
99-AFB-4104	0	Tr	1	0	16	0	0	0	0	0	0	0	Tr	5	Tr	0	0	0	Tr	0	0
99-AFB-4105	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	Tr	0	0	0
99-AFB-4108	0	0	0	0	3	0	0	0	0	0	0	0	Tr	0.5	0	0	Tr	0	0	0	0
99-AFB-4112	0	Tr	0	0	8	0	0	0	0	0	0	0	Tr	6	Tr	0	0	0	Tr	0	2 gr safflorite

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
99-AFB-4115	0	0	1	0	2	0	0	0	0	0	0	0	Tr	2	0	0	0	0	0	0	0
99-AFB-4116	0	0	0	0	2	0	0	0	0	0	0	0	Tr	3	Tr	50	0	0	0	0	0
99-AFB-4119	0	0	0	1	1	0	0	0	0	0	0	0	Tr	2	0	0	0	0	Tr	0	0
99-AFB-4120	0	Tr	1	0	18	0	0	0	0	0	0	0	Tr	2	Tr	3	0	0	Tr	0	0
99-AFB-4122	0	0	0	0	1	0	0	0	0	0	0	0	Tr	0.5	0	1	0	0	Tr	0	0
99-AFB-4127	0	0	0	0	0	0	0	0	0	0	0	0	Tr	1	0	0	0	0	0	0	0
99-AFB-4130	Tr	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
99-AFB-4136	0	Tr	1	0	3	0	0	0	0	0	0	0	Tr	3	0	20	0	0	0	0	0
99-AFB-4139	0	0	0	0	1	0	0	0	0	0	0	0	Tr	2	0	1	0	0	0.5	0	0
99-AFB-4141	0	Tr	0	0	2	0	0	0	0	0	0	0	Tr	2	0	15	0	0	0	0	0
99-AFB-4144	Tr	Tr	0	1	13	0	0	0	0	0	0	0	Tr	1	Tr	1	0	0	0	0	0
99-AFB-4146	0	0	0	0	6	0	0	0	0	0	0	0	Tr	0.5	0	0	0	0	0	0	0
99-AFB-4149	0	0	0	0	2	0	0	0	0	0	0	0	Tr	1	0	0	Tr	0	0	0	0
99-AFB-4151	Tr	0	0	1	3	0	0	0	0	0	0	0	0	0.5	0	0	0	0	Tr	0	0
99-AFB-4154	Tr	0	0	0	0	0	0	0	0	0	0	0	Tr	5	Tr	50	0	0	0	0	0
99-AFB-4158	0	0	0	0	4	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0
99-AFB-4160	Tr	0	0	0	1	0	0	0	0	0	0	0	Tr	1	Tr	0	0	0	0	0	0
99-AFB-4161	0	0	0	0	1	0	0	0	0	0	0	0	Tr	3	0	0	0	0	Tr	0	0
99-AFB-4164	0	0	0	0	175	0	0	0	0	0	0	0	0	Tr	0	0	0	0	Tr	0	0
99-AFB-4166	0	Tr	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
99-AFB-4168	0	0	0	0	3	0	1	0	0	0	0	0	Tr	3	Tr	0	0	0	0	0	0
99-AFB-4169	Tr	Tr	0	0	9	0	1	0	0	0	0	0	0	2	0	0	0	0	Tr	0	0
99-AFB-4175	0	0	46	1	6	0	0	0	0	0	0	0	2	8	0	1	0	0	Tr	0	0
99-AFB-4177	Tr	Tr	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	Tr	0	0
99-AFB-4180	0	0	0	0	2	0	0	0	0	0	0	0	2	5	0	0	0	0	Tr	0	0
99-AFB-4181	0	0	6	0	2	0	0	0	0	0	0	0	1	2	Tr	0	0	1	5	3	0
99-AFB-4183	0	0	0	0	6	0	0	0	0	0	0	0	2	3	0	0	0	Tr	0	0	0
99-AFB-4187	0	0	16	0	1	0	0	0	0	0	0	0	Tr	3	Tr	1	0	2	0.5	1	0
99-AFB-4188	0	0	0	1	7	0	0	0	0	0	0	0	2	2	0	0	0	0	Tr	0	0
99-AFB-4190	0	Tr	0	0	4	0	0	0	0	0	0	0	2	2	0	10	0	Tr	Tr	0	0
99-AFB-4195	0	0	6	0	0	3	2	2	1	0	0	0	1	0.5	Tr	0	0	0	Tr	0	0
99-AFB-4196	0	0	3	0	2	1	0	0	0	0	0	0	Tr	8	0	0	0	Tr	3	2	0
99-AFB-4198	0	0	0	0	6	0	0	0	0	0	0	0	0.5	1	0	0	0	0	Tr	0	0
99-AFB-4199	0	0	0	0	3	0	0	0	0	0	0	0	1	2	Tr	0	Tr	Tr	2	0	0
99-AFB-4200	0	0	0	0	3	1	0	0	0	0	0	0	0.5	2	Tr	0	0	0	0	0	0
99-AFB-4202	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	3	0	0	0	0	0	0	0
99-AFB-4206	0	0	0	0	2	0	0	0	0	0	0	0	Tr	3	0	0	0	0	1	0	0
99-AFB-4208	0	0	0	0	0	0	0	0	0	0	0	1	Tr	0.5	0	0	Tr	Tr	Tr	0	0
99-AFB-4210	0	0	0	0	1	0	0	0	0	0	0	0	Tr	3	0	0	Tr	0	0	0	0
99-AFB-4213	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	0	0	0	0	Tr	0	0
99-AFB-4214	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	2	0	0
99-AFB-4215	0	Tr	0	0	4	0	0	0	0	0	0	0	Tr	0.5	0	1	0	Tr	0	0	0
99-AFB-4216	0	0.5	1	0	1	0	1	0	0	0	0	0	Tr	3	0	0	0	0	Tr	0	0
99-AFB-4217	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	3	0	0	Tr	Tr	Tr	0	0
99-AFB-4218	0	0	1	0	4	0	0	0	0	0	0	0	Tr	2	0	0	0	0	Tr	0	0

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
99-AFB-4220	Tr	0	0	0	3	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	Tr	0	0
99-AFB-4222	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
99-AFB-4226	0	0	0	0	1	0	0	0	0	0	0	0	Tr	3	0	2	0	0	1	0	0
99-AFB-4227	0	0	0	0	1	0	0	0	0	0	0	0	Tr	2	0	0	Tr	Tr	Tr	0	0
99-AFB-4232	Tr	0	2	1	0	0	0	0	0	0	0	0	0	5	Tr	0	0	0	0	0	0
99-AFB-4233	Tr	0	1	0	2	0	0	0	0	0	0	0	1	2	Tr	0	0	0	0	0	0
99-AFB-4234	0	0	0	0	1	0	0	0	0	0	0	0	Tr	4	0	0	0	0	0	0	0
99-AFB-4235	0	0	0	0	2	0	0	0	0	0	0	0	1	3	0	0	0	0	Tr	0	0
99-AFB-4237	0	0	0	0	2	0	1	0	0	0	0	0	Tr	2	Tr	1	Tr	Tr	0	0	0
99-AFB-4238	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	Tr	0	0
99-AFB-4239	0	0	1	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	Tr	Tr	0	0
99-AFB-4240	0	0	0	0	0	0	0	0	0	0	0	0	Tr	3	0	0	0	0	Tr	0	0
99-AFB-4241	Tr	0	2	0	0	0	0	0	0	0	0	0	Tr	2	0	0	0	0	Tr	0	0
99-AFB-4243	0	0	0	0	1	0	0	0	0	0	0	0	Tr	4	0	0	Tr	0	0	0	0
99-AFB-4245	0	0	0	0	0	0	0	0	0	0	0	0	Tr	4	0	0	0	Tr	6	5	0
99-AFB-4246	0	0	0	0	0	0	0	0	0	0	0	0	Tr	4	0	0	0	0	0	0	0
99-AFB-4247	Tr	Tr	0	1	0	0	0	0	0	0	0	0	Tr	2	0	0	0	0	1	0	0
99-AFB-4248	0	0	1	0	0	0	0	0	0	0	0	0	Tr	3	0	1	0	Tr	Tr	0	0
99-AFB-4249	0	0	0	0	2	0	0	0	0	0	0	0	Tr	4	0	0	Tr	0	0	0	0
99-AFB-4253	0	0	1	0	2	0	0	0	0	0	0	0	Tr	6	0	1	Tr	0	0	0	0
99-AFB-4254	0	Tr	0	0	7	0	0	0	0	0	0	0	Tr	10	Tr	1	0	0	Tr	0	0
99-AFB-4256	0	Tr	0	1	4	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
99-AFB-4260	0	0	1	0	1	0	0	0	0	0	0	0	Tr	3	0	1	0	0	0	0	0
99-AFB-4265	Tr	0	1	0	4	0	0	0	0	0	0	0	Tr	2	Tr	0	0	Tr	0	0	0
99-AFB-4268	Tr	0	0	0	0	0	0	0	0	0	0	0	Tr	3	0	0	0	0	0	0	0
99-AFB-4269	0	Tr	0	0	2	0	0	0	0	0	0	0	Tr	6	Tr	1	0	Tr	1	0	0
99-AFB-4272	Tr	0	0	0	0	0	0	0	0	0	0	0	Tr	2	0	0	0	0	0	0	0
99-AFB-4273	0	0	0	0	0	0	0	0	0	0	0	0	Tr	3	0	0	0	0	0	0	0
99-AFB-4274	0	0	1	0	0	1	0	1	0	0	0	0	Tr	4	0	1	0	0	0	0	0
99-AFB-4275	0	0	2	0	0	0	0	0	0	0	0	0	Tr	3	0	0	Tr	0	0	0	0
99-AFB-4276	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	0	0	Tr	0	0	0	0
99-AFB-4278	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	1	0	0	0	0	Tr	0	0
99-AFB-4279	0	0	0	0	4	0	0	0	0	0	0	0	Tr	3	0	0	0	0	Tr	0	0
99-AFB-4285	0	0	0	0	3	0	0	0	0	0	1	1	Tr	2	0	100	Tr	0	Tr	0	0
99-AFB-4287	0	0	0	0	7	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
99-AFB-4290	0	Tr	1	0	3	0	0	0	0	0	0	0	Tr	3	0	15	Tr	Tr	Tr	0	0
99-AFB-4291	Tr	0	0	0	6	0	1	0	0	0	0	0	Tr	2	0	0	Tr	Tr	0	0	0
99-AFB-4292	Tr	0	0	0	4	0	0	0	0	0	0	0	Tr	8	0	0	Tr	0	0.5	0	0
99-AFB-4293	0	0	0	0	0	0	0	0	0	0	0	0	Tr	5	Tr	0	Tr	0	0	0	0
99-AFB-4294	0	Tr	0	0	4	0	0	0	0	0	0	0	Tr	4	0	0	0	0	Tr	0	0
99-AFB-4295	0	0	0	1	1	0	0	0	0	0	0	0	Tr	2	0	0	0	0	0	0	0
99-AFB-4296	0	0	0	0	2	0	0	0	0	0	0	0	Tr	7	Tr	0	0	Tr	5	0	0
99-AFB-4298	0	0	0	0	0	0	0	0	0	0	0	0	Tr	5	0	0	0	Tr	1	0	0
99-AFB-4299	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	Tr	25	1	0
99-AFB-4300	0	0	0	0	0	0	0	0	0	0	0	0	Tr	0.5	Tr	0	Tr	1	Tr	0	0

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
99-AFB-4302	0	0	0	1	1	0	0	0	0	0	0	0	Tr	1	0	0	0	Tr	1	0	0
99-AFB-4303	0	0	1	0	4	0	0	0	0	0	0	0	0.25	6	0	1	0	Tr	Tr	0	0
99-AFB-4304	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	2	0	0	0	Tr	Tr	0	0
99-AFB-4305	Tr	0	1	0	5	0	0	0	0	0	0	0	2	3	Tr	0	0	Tr	0	0	0
99-AFB-4306	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	0	20	0	Tr	0.5	0	0
99-AFB-4307	0	0	0	0	1	0	0	0	0	0	0	0	Tr	3	0	0	0	Tr	10	0	0
99-AFB-4308	0	0	1	0	0	0	0	0	0	0	0	0	1	5	Tr	1	0	Tr	0	0	0
99-AFB-4310	0	0	4	0	1	0	0	0	0	1	0	0	Tr	5	Tr	0	0	1	0	0	0
99-AFB-4311	0	0	1	0	2	0	0	0	0	0	0	0	0.5	3	Tr	1	0	1	5	0	0
99-AFB-4312	0	0	0	0	2	0	0	0	0	0	0	0	Tr	3	0	0	0	Tr	Tr	0	0
99-AFB-4314	0	0	0	0	2	0	0	0	0	0	0	0	Tr	4	0	10	Tr	Tr	8	0	0
99-AFB-4315	0	0	0	0	1	0	0	0	0	0	0	0	Tr	2	Tr	0	0	0	0	0	0
99-AFB-4316	0	0	2	0	6	0	0	0	0	0	0	0	Tr	4	0	0	0	0	Tr	0	0
99-AFB-4317	0	0	1	0	1	0	0	0	0	0	0	0	Tr	0	1	0	0	0	Tr	1	0
99-AFB-4318	0	0	0	0	1	0	0	0	0	0	0	0	Tr	1	0	0	Tr	Tr	Tr	0	0
99-AFB-4322	0	0	0	0	0	0	0	0	0	0	0	0	Tr	1	0	0	0	Tr	0	0	0
99-AFB-4324	0	Tr	0	1	15	0	0	0	0	0	0	0	Tr	2	0	0	0	0	Tr	0	0
99-AFB-4325	0	0	4	0	1	0	0	0	0	0	0	0	Tr	1	Tr	40	0	2	2	0	0
99-AFB-4327	0	0	0	0	0	0	0	0	0	0	0	0	Tr	4	0	1	0	0	0	0	0
99-AFB-4328	0	0	5	0	4	0	0	0	0	0	0	0	1	2	Tr	40	0	1	0	0	0
99-AFB-4329	0	Tr	0	0	3	0	0	0	0	0	0	0	2	4	Tr	0	Tr	Tr	0	0	0
99-AFB-4331	0	0	8	0	9	0	0	0	0	0	0	0	Tr	3	0	0	Tr	Tr	10	0	0
99-AFB-4333	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	Tr	0	0
99-AFB-4334	0	0	0	0	3	0	0	0	0	0	0	0	Tr	10	Tr	20	Tr	Tr	0	0	0
99-AFB-4335	0	0	0	0	3	0	0	0	0	0	0	0	0	4	0	0	0	Tr	2	0	0
99-AFB-4336	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
99-AFB-4337	Tr	0	0	1	0	0	0	0	0	0	0	0	0	Tr	0	0	0	0	0	0	0
99-AFB-4338	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	3	Tr	0	0	Tr	Tr	0	0
99-AFB-4339	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	Tr	0	0
99-AFB-4342	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	Tr	0	0	0	0
99-AFB-4343	Tr	0	0	0	1	0	0	0	0	0	0	0	Tr	1	0	0	0	0	0	0	0
99-AFB-4345	Tr	Tr	1	0	1	0	0	0	0	0	0	0	Tr	1	0	0	Tr	0	0	0	0
99-AFB-4346	Tr	Tr	0	0	1	0	0	0	0	0	0	0	Tr	4	0	0	0	0	2	0	0
99-AFB-4348	0	Tr	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
99-AFB-4349	Tr	Tr	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
99-AFB-4352	0	Tr	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
99-AFB-4353	Tr	0	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0.5	0	0
99-AFB-4354	0	Tr	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	Tr	3	0	0
99-AFB-4356	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	150	0	0	Tr	0	0
99-AFB-4360	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	Tr	0	0	0
99-AFB-4362	Tr	0	0	0	3	0	0	0	0	0	0	0	0	2	0	20	0	0	0	0	0
99-AFB-4364	0	0	1	0	0	0	0	0	0	0	0	0	Tr	0.5	0	0	0	Tr	0.5	10	0
99-AFB-4365	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	Tr	Tr	0	0
99-AFB-4366	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	0	Tr	0	15	0	0
99-AFB-4367	0	0	3	23	3	0	0	0	0	0	0	0	Tr	3	0	0	0	1	35	13	0

Sample #	%KY	%SI	#RR	#GA	#DC	#CO	#EP	#AN	#TO	#GR	#TO	#UV	%ST	%FA	%OPX	#CR	%SP	%GO	%PY	#CPY	OTHER GRAINS
99-AFB-4370	0	0	2	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
99-AFB-4371	Tr	Tr	0	0	1	0	0	0	0	0	0	0	Tr	1	0	0	0	Tr	Tr	0	0
99-AFB-4372	0	0	0	0	1	0	0	0	0	0	0	0	Tr	1	Tr	1	Tr	Tr	0	0	0
99-AFB-4373	Tr	Tr	0	0	1	0	1	0	0	0	0	0	Tr	3	0	0	0	Tr	Tr	0	0
99-AFB-4374	0	0	0	0	1	0	1	0	0	0	0	0	Tr	10	Tr	0	0	Tr	0	0	0
99-AFB-4375	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	5	0	0	0
99-AFB-4376	0	0	3	0	3	0	0	0	0	0	0	0	Tr	Tr	0	0	Tr	0	0	0	0
99-AFB-4377	0	Tr	0	0	0	0	0	0	0	0	0	0	Tr	3	0	30	0	Tr	0	0	0
99-AFB-4378	0	0	0	0	4	0	0	0	0	0	0	0	Tr	5	Tr	15	Tr	Tr	0	0	0
99-AFB-4379	0	0	1	0	0	1	0	0	0	0	0	0	Tr	0.5	0	0	0	Tr	5	0	0
99-AFB-4380	0	0	0	0	1	0	0	0	0	0	0	0	Tr	4	0	0	0	0	Tr	0	0
99-AFB-4382	0	0	1	1	2	0	0	0	0	0	0	0	Tr	3	0	0	0	0	0	0	0
99-AFB-4383	0	0	2	0	6	0	0	0	0	0	0	0	Tr	2	0	1	0	0	0	0	0
99-AFB-4384	0	0	1	0	2	0	0	0	0	0	0	0	0.5	Tr	Tr	0	0	Tr	Tr	0	0
99-AFB-4385	0	0	0	0	0	0	0	0	0	0	0	0	Tr	0.5	0	0	0	0	5	0	0
99-AFB-4386	0	0	0	0	5	0	0	0	0	0	0	0	Tr	4	0	40	Tr	Tr	Tr	0	0
99-AFB-4387	Tr	0	0	0	0	0	0	0	0	0	0	0	0.5	Tr	0	0	0	Tr	0	0	0
99-AFB-4388	0	0	0	0	0	0	0	0	0	0	0	0	0.5	10	0	0	0	0	0	0	0
99-AFB-4389	Tr	0	0	0	1	0	0	0	0	0	0	0	0.5	3	0	0	0	0	0	0	0
99-AFB-4391	Tr	0	0	0	1	0	0	0	0	0	0	0	1	5	0	0	0	Tr	0	0	0
99-AFB-4392	0	0	0	0	2	0	0	0	0	0	0	0	Tr	7	0	2	0	Tr	3	0	0
99-AFB-4393	0	Tr	0	0	1	0	0	0	0	0	0	0	Tr	2	0	0	0	0	Tr	0	0
99-AFB-4394	0	0	1	0	0	0	1	0	0	0	0	0	Tr	3	0	0	0	Tr	0	0	0
99-AFB-4395	0	0	0	0	1	0	0	0	0	0	0	0	Tr	2	0	0	0	Tr	Tr	0	0
99-AFB-4396	0	0	0	0	0	0	0	0	0	0	0	0	Tr	2	0	0	0	0	Tr	0	0
99-AFB-4397	0	0	0	0	1	0	0	0	0	0	0	0	Tr	4	0	0	0	Tr	3	0	0
99-AFB-4399	0	0	0	0	4	0	0	0	0	0	0	0	Tr	1	0	0	0	0	0.2	0	0

Metric Conversion Table

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 023	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 90**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

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