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Glacial Dispersal of Trace Elements in Wisconsinan Till in the Dot Lake-MacLellan Mine Area, Manitoba

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INTRODUCTION

Objectives

This study was undertaken to define dispersal trends of trace elements for a single till sheet in an area of thin till, shallow overburden and low relief. Specifically, this information should provide an understanding of: 1) the origin of the till, the distance of glacial transport and the rate of dilution of the till components, 2) the effect of the topography on glacial erosion and dispersal, and 3) the best sample medium and analytical methods, thereby aiding mineral explorationists wishing to use overburden geochemical techniques in their search for mineralization in this region.

Study Area

Investigations were undertaken in the MacLellan Mine-Dot Lake area because: 1) the till is ubiquitous and generally thin, 2) the Quaternary stratigraphy is relatively simple, 3) there is only one direction of glacier transport, 4) bedrock geology is relatively well known and 5) there is easy access from Highway 391 and the mine road.

The initial orientation survey was conducted in 1982 and 1983, down ice from the MacLellan Au-Ag deposit for a distance of, about 4 km (Fig. 1). The MacLellan deposit, formerly known as the Agassiz deposit, is situated 7 km northeast of the town of Lynn Lake. The sample area was expanded in 1984 and 1985 to include the Dot Lake area (Fig. 2) in an effort to trace the mineralization to the west, and to provide background data for the geochemical vegetation surveys being undertaken in that area (Fedikow, in prep.).

Detailed till sampling was also undertaken along the Agassiz Metallotect, east of the MacLellan Mine, to test the conceptual model of glacial dispersal established at the mine and to map till geochemical anomalies. Till sampling was carried out in hand-dug holes over a distance of about 50 km between Dot Lake and Nickel Lake. The results of the sampling east of the MacLellan Mine been published previously (Nielsen and Graham, 1985, and Nielsen and Fedikow, 1986).

Physiography

The Dot Lake-MacLellan Mine area slopes gently toward the southeast (Fig. 3). The highest point, situated south of Dot Lake and west of the access road, is at an elevation of 370 m (1215 ft.). The lowest point is along Keewatin River, in the east, at an elevation of 323 m (1060 ft.). Keewatin River flows across the area from Dot Lake in the north and leaves the area in the east. The area along the river has the lowest relief, hills being generally less than 12 m (40 ft.) high. Highest relief is southeast of Dot Lake, where hills reach heights of 30 m (100 ft.).

Methods

Till samples were collected from hand-dug pits and backhoe pits. The hand-dug pits were generally about 1 m deep whereas the backhoe pits were 1-3 m deep. As the depth of oxidation varies considerably, oxidized samples were collected even from some of the deeper holes. Elsewhere, unoxidized till occurs close to the surface.

Because of known compositional differences among various size grades of till, several fractions were selected for analysis.

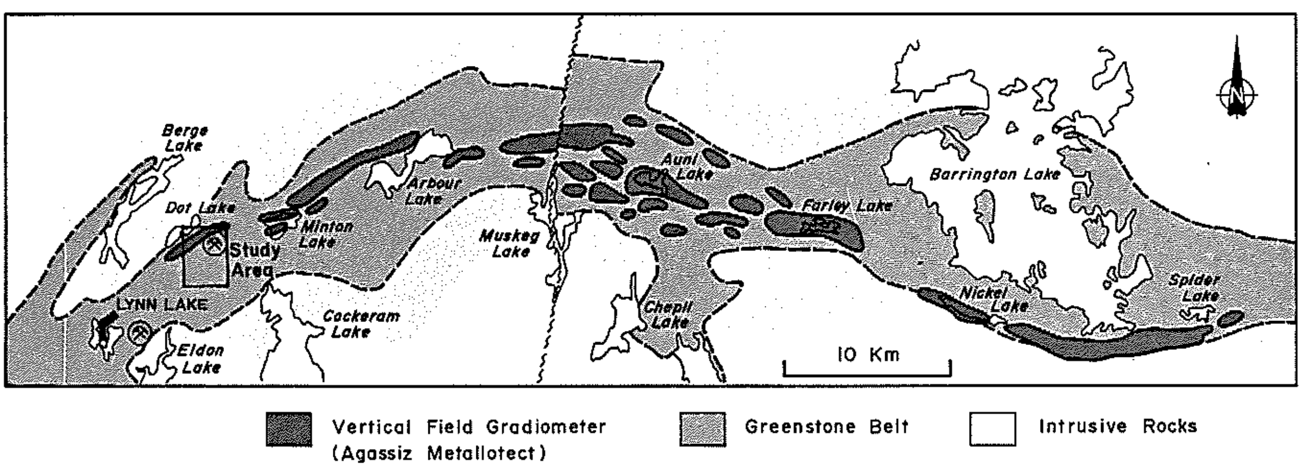


Figure 1: Location map showing the study area and the Agassiz Metallotect.

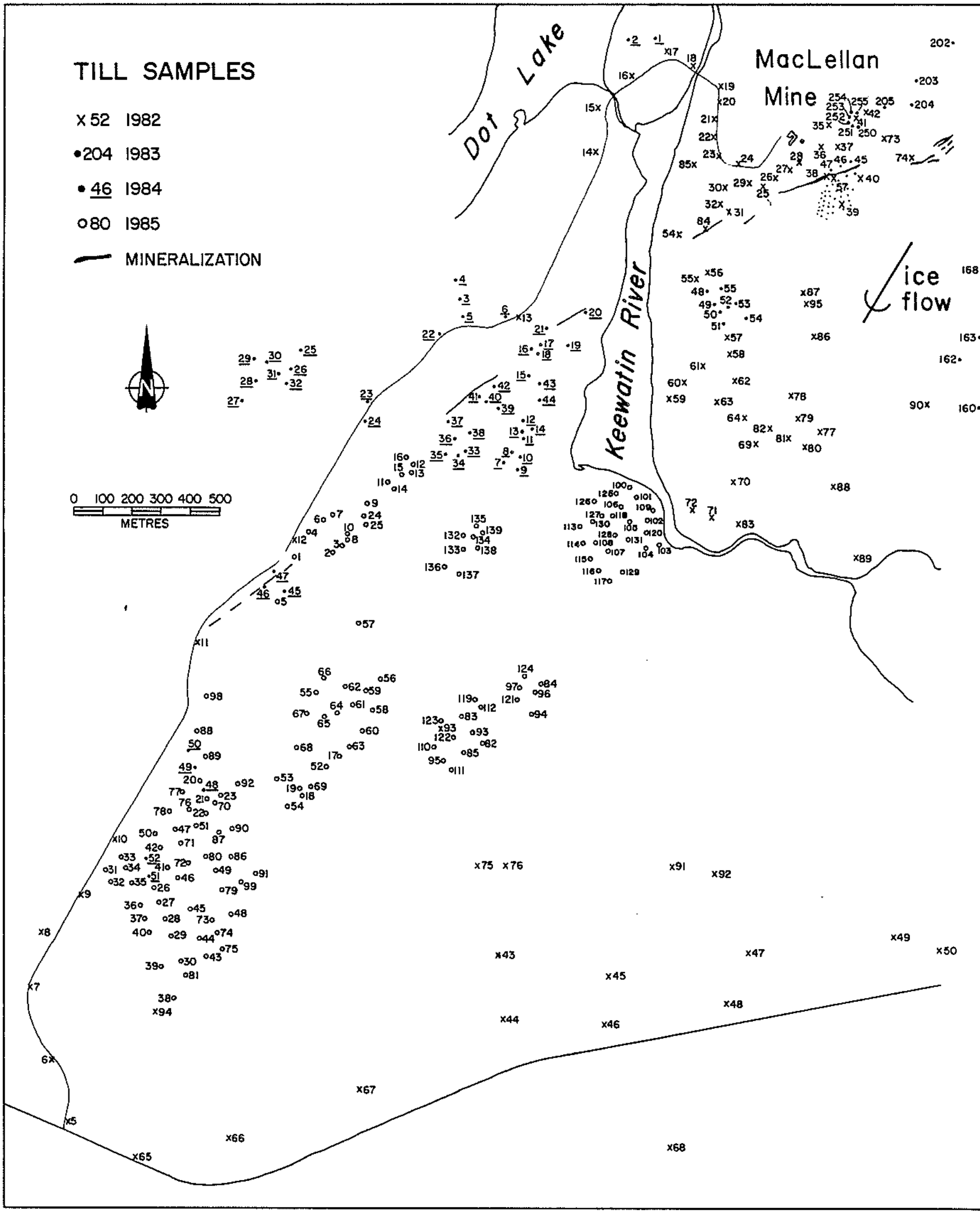


Figure 2: Till sampling sites in the MacLellan Mine-Dot Lake area.

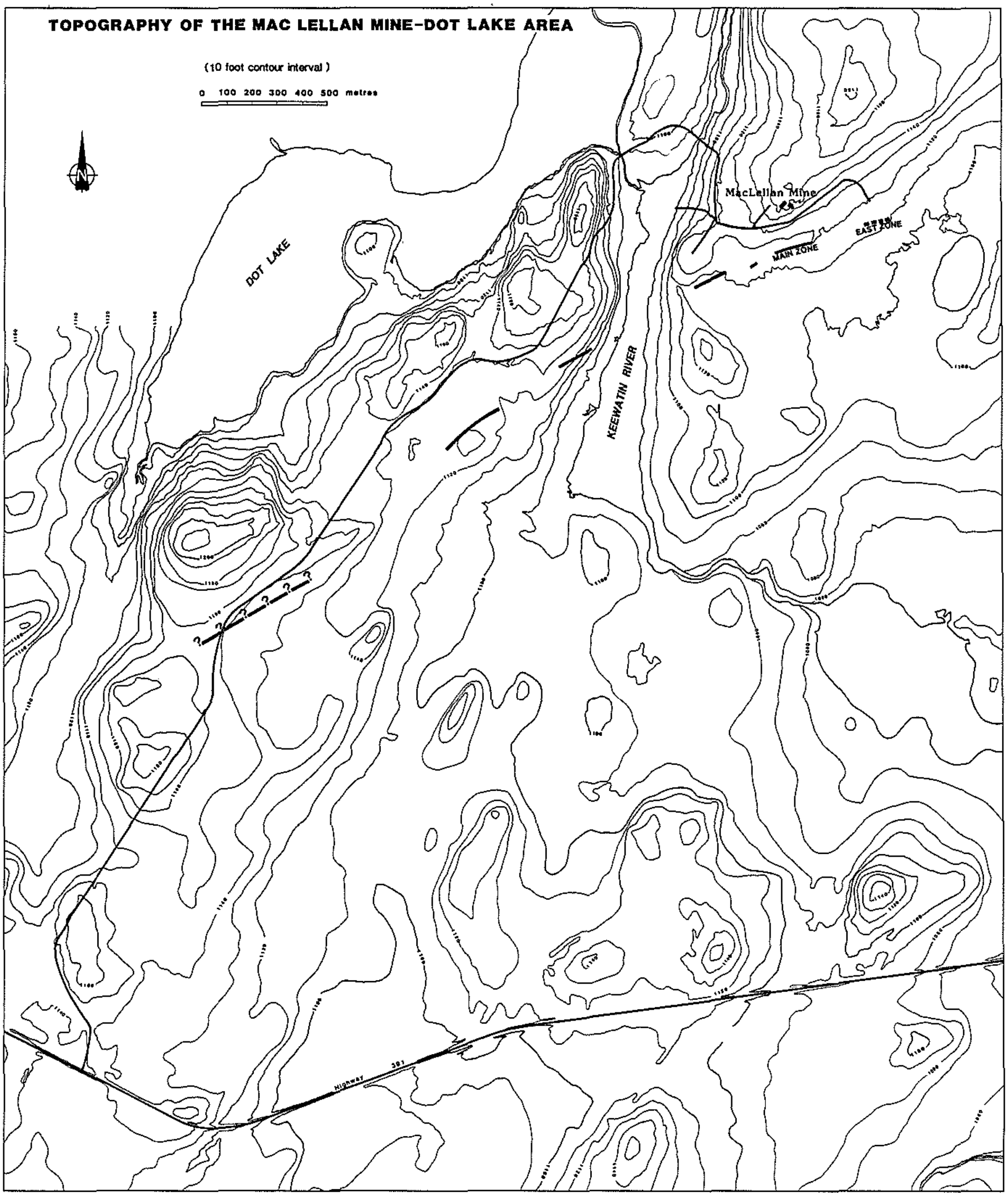


Figure 3: Topography of the MacLellan Mine-Dot Lake area (unpublished map, Sherritt Gordon Mines).

Pebbles

The 4-16 mm size fraction of selected samples was used to determine the lithologic composition of the till. Approximately 300 clasts were identified in each of the 92 samples collected in 1982.

Clay-sized fraction

The clay-sized fraction of all samples was concentrated by centrifuging following the procedure outlined in Nielsen and Graham (1985). The reasons for using the clay-sized fraction are well documented elsewhere (Shilts, 1975, 1976, 1977, 1984; Klassen and Shilts, 1977; and Di-Labio et al., 1982). The clay-sized fraction, which received no prior treatment, was analyzed for copper, lead, zinc, nickel, cobalt, chromium, iron, manganese and arsenic by Bondar-Clegg & Co. Ltd. in Ottawa and in the Manitoba Energy and Mines Analytical Laboratory.

Heavy mineral fraction

Heavy minerals (S.G. > 2.96) were concentrated from the fine sand fraction using a shaker table and heavy liquids. The heavy mineral concentrating and visible gold grain counts were done under contract to Overburden Drilling Co. Ltd. in Ottawa, except for the 1982 samples. Those samples were processed at the MacLellan Mine site on a shaker table supplied by Sherritt Gordon and passed through heavy liquid (S.G. = 2.96) at the Manitoba Department of Energy and Mines Laboratory. The heavy mineral concentrates, minus the magnetic fraction, were crushed to -200 mesh and submitted for geochemical analysis. Copper, lead, zinc, nickel, cobalt, chromium, iron, manganese, arsenic and gold were analyzed by Bondar-Clegg & Co. Ltd., in Ottawa and in the Manitoba Energy and Mines Analytical Laboratory.

Silt and clay fraction

The less than 63 micron fraction (silt plus clay) of 30 samples was analyzed by neutron activation to check the compositional difference of the various size grades and the possibility of using fractions other than the heavy mineral and clay-sized fractions for geochemical analysis.

Geochemistry

The concentrations of copper, lead, zinc, nickel, cobalt, chromium, iron and manganese were determined by atomic absorption spectrophotometry after hot nitric-hydrochloric acid extraction. Arsenic was determined colorimetrically after nitric-perchloric acid digestion. Gold in the heavy mineral fraction was analyzed by fire assay and atomic absorption using an approximately 20 g sample.

Gold and arsenic were determined on the silt and clay fraction by neutron activation of a 10 g sample, obtained by sieving a small amount of sample through a 63 micron stainless steel screen.

The lower detection limit for all the elements is 1 or 2 ppm, except for iron and gold which have lower detection limits of 0.1 per cent and 5 ppb, respectively. The lower detection limit for gold on the 1982 samples, determined by fire assay and DC plasma, was 1 ppb.

Textural analysis

Six till samples were sieved at 1 phi intervals for material coarser than 63 microns and pipetted at 1 phi intervals for material between 63 and 4 microns. Standard laboratory techniques outlined by Folk (1968) were used.

BEDROCK GEOLOGY

The study area, which includes the MacLellan Au-Ag deposit (formerly the Agassiz deposit) and a number of smaller gold occurrences to the west of the MacLellan deposit, occurs within the Lynn Lake greenstone belt, an east-trending sequence of rocks 160 km long and 63 km wide. This greenstone belt is characterized by variably metamorphosed volcanic, sedimentary and intrusive rocks with an Aphebian age of deposition, intrusion and metamorphism (Clark, 1980). The sedimentary and volcanic rocks have been assigned to the Wasekwan Group (Bateman, 1945) and are unconformably overlain by Sickle Group sandstone and conglomerate (Norman, 1933). Regional metamorphism in the belt attained upper greenschist to upper amphibolite conditions.

Gilbert et al. (1980) subdivided the Lynn Lake greenstone belt into an older Southern belt and a younger Northern belt, based on lithological and chemical criteria. The Southern belt is characterized by greater than 2000 m of tholeiitic, aphyric and porphyritic basalt, overlain by discontinuous units of sedimentary rocks in the western portion of the belt and a variety of mafic, intermediate and felsic rocks elsewhere. The Northern belt rocks are chemically distinct from those of the Southern belt and comprise tholeiitic basalt and andesite, interlayered with high alumina (> 18% Al_2O_3) basalt and andesite. The Northern belt has been subdivided into six main sections and from stratigraphic bottom to stratigraphic top these subdivisions are:

Division E: (450 m) basaltic tuff, flows and flow breccia;

Division D: (900-3300 m) basaltic flows, breccia and tuff with subordinate intermediate and felsic equivalents;

Division C: (350 m) greywacke, siltstone, conglomerate with subordinate mafic volcanic flows, breccia tuff;

Division B: (450-2000 m) basalt and andesite breccia and tuff with subordinate felsic flows and breccia;

Division A: (2500 m) rhyolite, with subordinate mafic to intermediate rocks.

The host rocks to the stratabound MacLellan Au-Ag deposit occur within Division D. These rocks comprise steeply dipping clastic and chemical sedimentary rocks, interlayered with high Mg-Ni-Cr (MgO = 96.10%, Ni = 800 ppm, Cr = 2000 ppm) basalt and basaltic tuff previously described as picrite (Fox and Johnson, 1981). Laterally restricted, thin (8-10 cm), finely laminated oxide (magnetite-chert), sulphide (pyrite-pyrrhotite-biotite) and silicate (chlorite-amphibole-garnet-magnetite) facies iron formations are interlayered with the sedimentary and volcanic units. The volcanic and sedimentary units range in thickness from 8 cm to 10 m and have been subjected to an early episode of folding, followed by brittle deformation and subsequent penetrative deformation. This deformation has produced a lensoidal or lobate stratigraphy accompanied, in part, by diffuse zones of disseminated gold-bearing iron and base metal sulphide mineralization and accompanying alteration. Auriferous solid sulphide (pyrite, pyrrhotite, sphalerite, arsenopyrite, galena + chalcopyrite) to near solid sulphide (25-50% sulphide) layers up to 0.3 m thick are present in the deposit. In addition, the host stratigraphy is crosscut by a series of deformed gold-bearing carbonate-quartz-sulphide veins. Gold and silver mineralization in the deposit occurs as 20-30 micron-sized particles associated with pyrrhotite, arsenopyrite, galena, pyrite, sphalerite, ilmenite and magnetite at grain boundaries, mantling individual sulphide and oxide minerals and infilling fractures. Visible native gold is rare.

The MacLellan host stratigraphy is flanked to the north and south by massive and fragmental aluminous (> 18% Al_2O_3) basalt and thin units of quartz- and feldspar-phyric pyroclastic volcanic rocks. This stratigraphy persists westward to the Dot Lake area where it is overlain by sulphide-bearing greywacke and oxide iron formations, interlayered with massive, porphyritic and fragmental basalt. These sulphide zones occur at several levels in the stratigraphic sequence and contain gold. However, to date, exploration activity by Sherritt Gordon Mines Ltd. has revealed that none of the zones is economic. Diorite, granodiorite and granite intrude the volcano-sedimentary sequence, south of Dot Lake.

The high Mg-Ni-Cr basalts and the interlayered clastic and sedimentary rocks are characterized by a coincident magnetic and electro-magnetic geophysical signature that has been traced by airborne INPUT and gradiometer surveys and intermittently observed in the field for 70-75 km. The zone has been termed the Agassiz Metallotect and the associated gold mineralization has been described by Fedikow et al. (1986). The MacLellan Au-Ag deposit is described in detail by Fedikow (1986).

SURFICIAL GEOLOGY

Stratigraphy

The northwestern part of Manitoba and adjacent parts of Saskatchewan have been glaciated several times. Two tills have been identified in parts of northwestern Saskatchewan (Sopuck et al., 1986, Schreiner, 1986) but, to date, there is evidence of only one glaciation in the Lynn Lake area.

The bedrock is mantled by a till sheet of variable thickness, deposited by the main Keewatin ice flow (Fig. 4). This ice flow, toward approximately 195° (180-230°) is attributed to the Late Wisconsinan glaciation (Fig. 5A). The variation in striae direction (Fig. 5B and C) is attributed to slight changes in the ice flow, related to deglaciation and to topographic effects. The deflection of striae around bedrock projections indicates the ice sheet was relatively thin and easily diverted by small obstructions.

The till is overlain by deep-water glacial Lake Agassiz silt and clay and nearshore sand and gravel sediments. Black spruce bog, including fens, and collapsed peat plateaus constitute the most widespread surficial deposits.

Till deposits

Till occurs as a sheet of relatively uniform thickness overlying the bedrock and in crag and tail structures (Fig. 6). The crag and tail hills commonly 0.2-0.5 km wide and 0.5-1.0 km long (Fig. 3) comprise bedrock knolls up to 10 m high and thick accumulations of till on the down-ice or lee side.

The unoxidized till matrix, typically pinkish grey (Munsell colour 5 YR 8/1), is relatively homogeneous with a sandy-silt texture (Fig. 7). The clast content is variable and some pits terminated prematurely because of cobbles and boulders. The clay content is generally between 5 and 10 per cent (Fig. 8). Normal and reversed grading of the clasts indicate that much of the till was deposited as debris flows. However, the degree of compaction, the strong fabric (not measured), evidence of shearing and the abundance of striated clasts indicate the till was transported at or near the glacier base.

The pebble fraction (4-16 mm) consists primarily of distantly travelled material derived from the granite terrane north of the Lynn Lake greenstone belt. The results

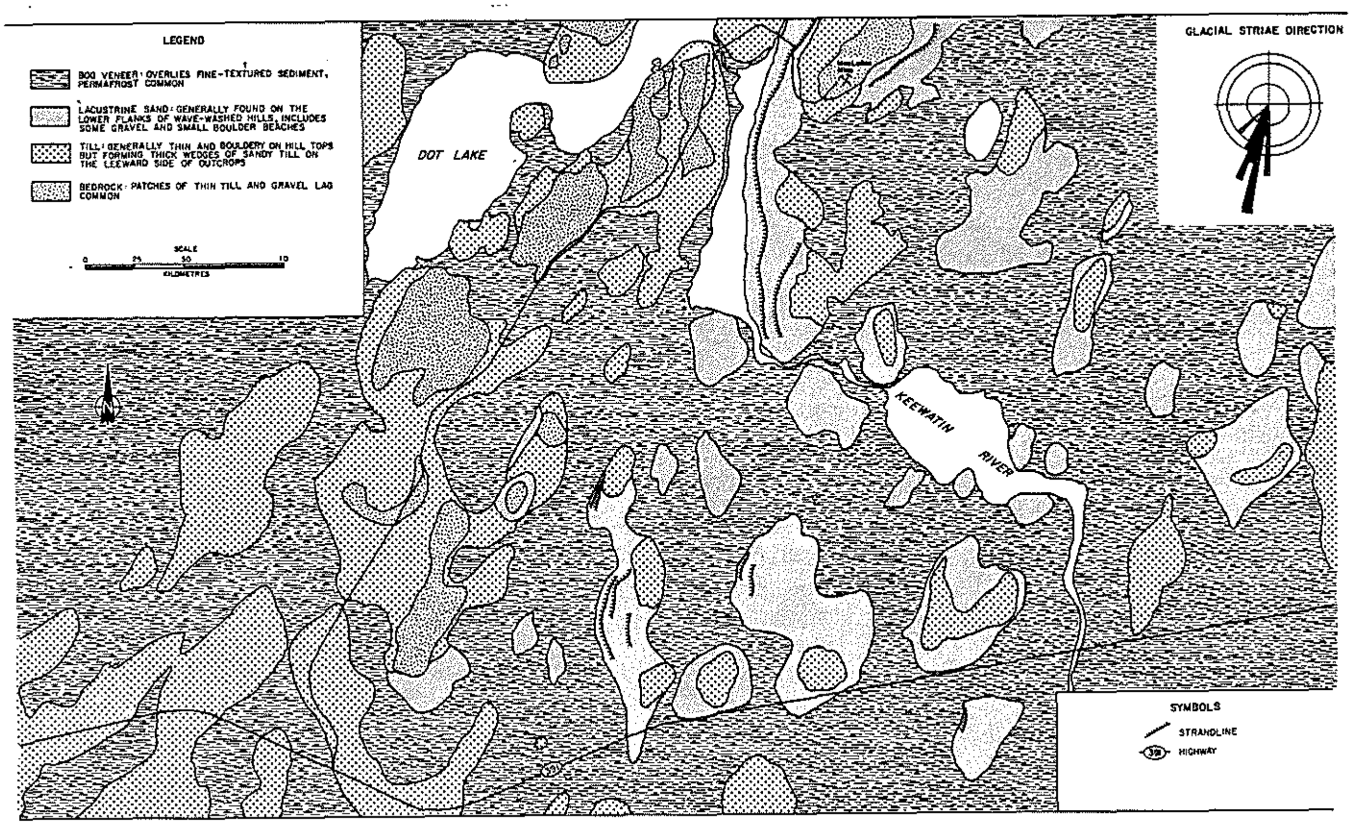
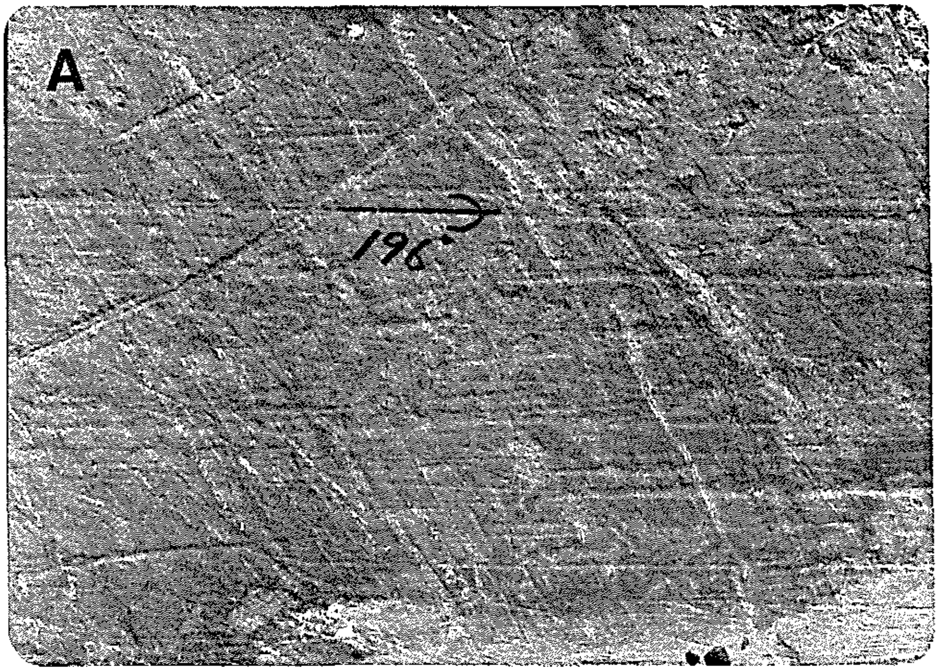


Figure 4: Surficial geology of the MacLellan Mine-Dot Lake area.



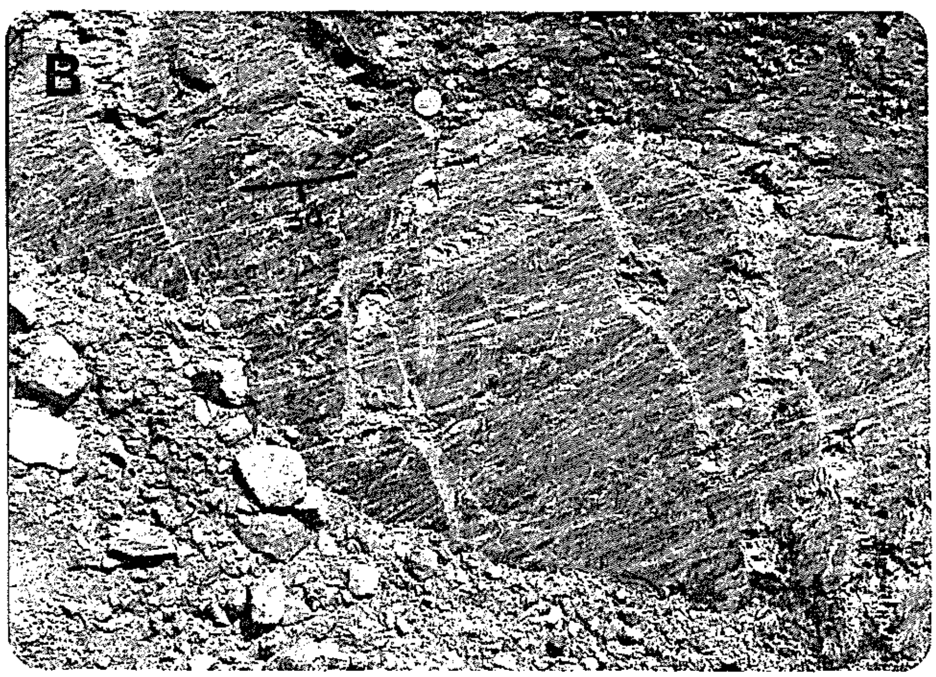


Figure 5: (A) Striations orientated parallel to the regional trend (196°) on a horizontal bedrock surface, approximately 1 km west of the study area.
(B) Striae deflected towards 230° on an inclined bedrock surface at site 82-55.

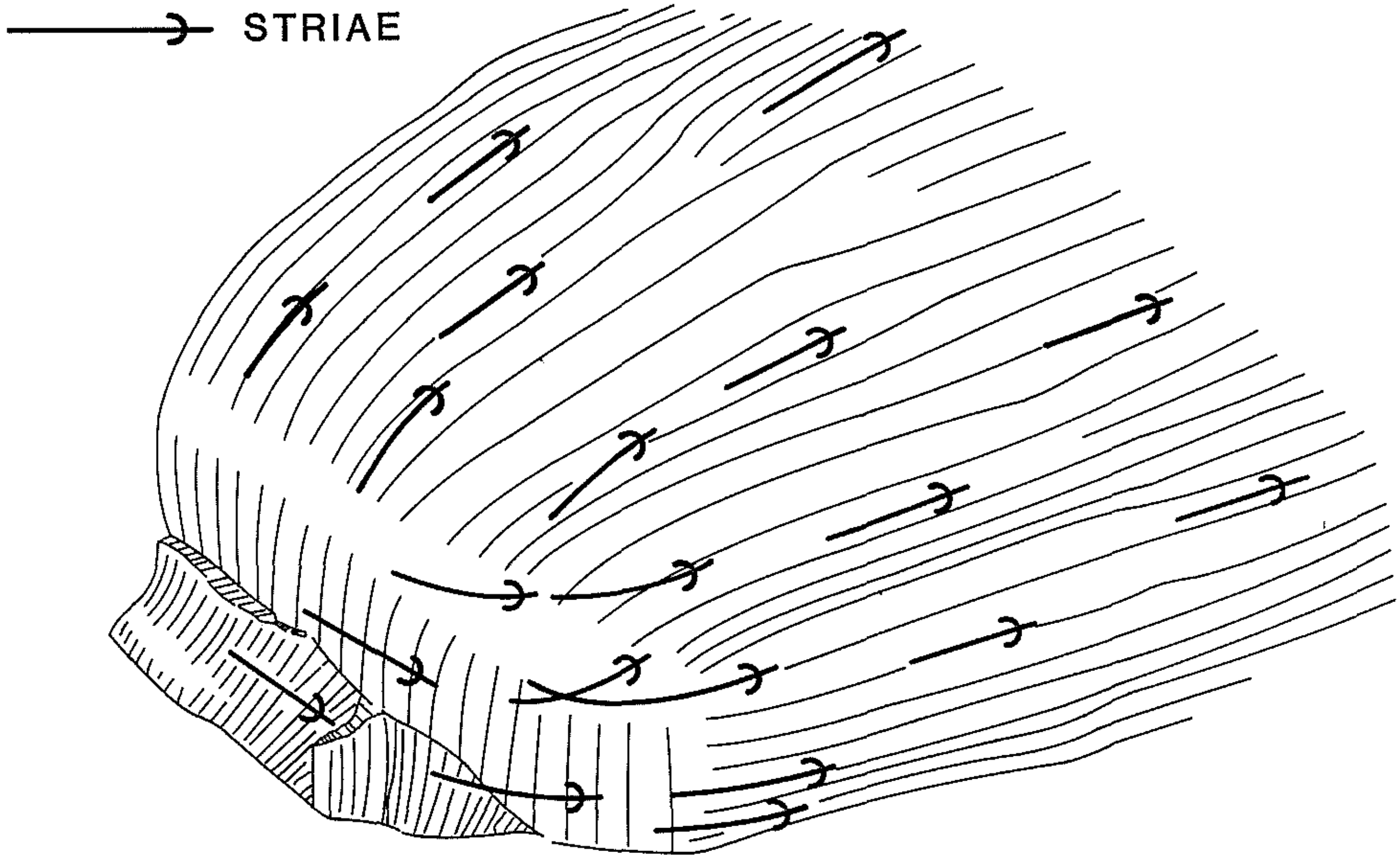


Figure 5 (C): Schematic diagram showing striations deflected around a bedrock projection.

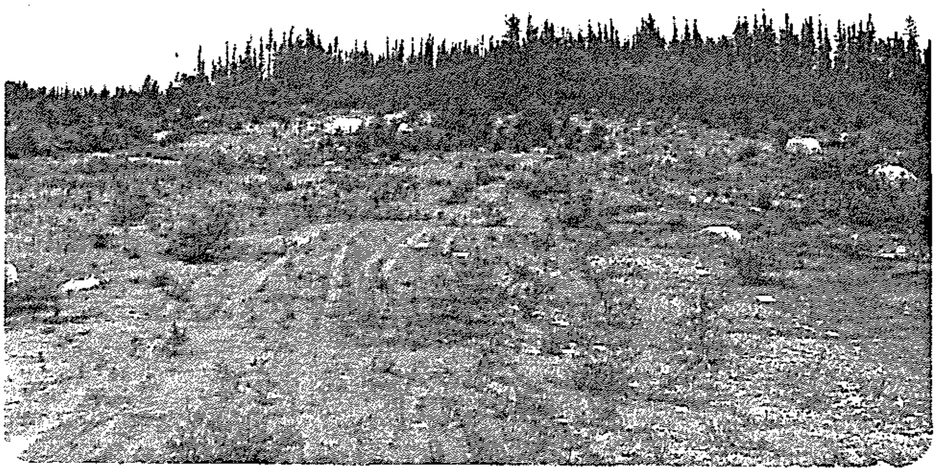


Figure 6: Crag and tail structure at site 82-44. The bedrock obstruction or crag is tree covered. The till from the tail (foreground) has been quarried for road fill.

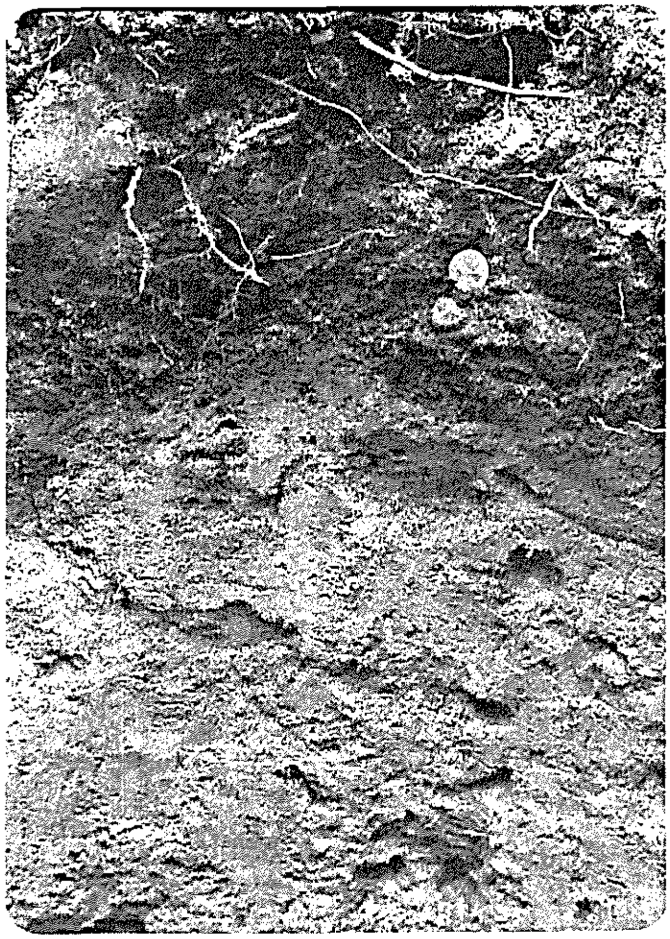


Figure 7: Typical sandy till with relatively few clasts at site 82-76.

of pebble counts on the l982 till samples are listed in Appendix I. Local bedrock clasts range between 2 and 48% and average about 10%. This is obvious in the field where most of the boulders and blocks appear to be distantly derived Wasekwan greywackes and granites (Fig. 9). The source of these erractics is approximately 4 km to the north of the MacLellan Mine. These findings are similar to those reported at Farley Lake (Nielsen and Graham, 1984) and have been confirmed in the Dot Lake area by Girard (1986).

In several pits the till showed mottled structures, resulting from differences in the silt and clay content, and is thought to be due to shearing. This is well illustrated in a small borrow pit, 1.0 km east of sample 82-50, just outside the sample area (Fig. 10). The same two till facies may be seen in pit 82-8 where they are not mixed (Fig. 11). At this site, located on the down-ice side of a bedrock obstruction, the lower facies is more sandy and bouldery than the overlying facies. Some sorted inclusions of the lower sandy facies have been incorporated into the upper, more fissile, facies (Fig. 11). Elsewhere, in pits 82-8, 82-26, 82-41, 82-42, 82-57 and 82-71 the till overlies up to 0.7 m of sand or silt that, in turn, overlies bedrock (Fig. 12).

The abundant distantly transported material, striated pebbles, compaction, fissility, presence of water sorted sediment, variation in texture, stratification, grading of the coarse fraction and the accumulation of till on the down-ice side of bedrock obstructions, suggest the till was eroded from bedrock obstructions, transported in part englacially and deposited by basal lodgement and melt-out. The method of glacial erosion and englacial transport is shown in Figure 13. Rock debris was eroded (abraded, quarried) from the stoss side of obstructions, accompanied by pressure melting and the release of water. The eroded sediment moved over the obstruction if the shear strength between the ice and sediment was greater than the shear strength between the sediment and the underlying substrate. Meanwhile, the water flowed around the obstruction under pressure and into cavities occurring on the lee or down-ice side of the obstruction. The pressure release caused the water to freeze to the base of the glacier as regelation ice. Sediment formerly found at the base of the ice thus became englacial.

As the regelation process continued, sediment moved higher in the ice profile. If a dirt band impinged on another obstruction, pressure melting occurred, again with the release of sediment. This sediment was pushed or washed into the lee-side cavity and deposited as flow till (with graded bedding) or as stratified meltwater sediment (Fig. 14). Whether erosion or deposition occurred at any particular bedrock obstruction was determined by local factors, such as the size of the obstruction, the presence of previously deposited till, whether a dirt band made contact with the substrate and substrate roughness.

Some material transported englacially may have made its way to a superglacial position as a result of shearing (Fig. 13), thus accounting for the occurrence of much of the distantly transported material. A model of glacial erosion, transport and deposition in the Lynn Lake area is summarized in Figure 15. This model suggests that locally derived debris, transported at the base of the ice, should occur near the bedrock surface. This is difficult to determine in this area as the sampling pits are shallow. However, in some pits, such as 82-28, more locally derived till was encountered at depth. Differences in composition of the two samples from this site is due to provenance and not pedogenic processes. The model is also supported by the results from overburden drilling in the Farley Lake area, where distantly transported till overlies more locally derived till at depth (N. Briggs, pers. comm. 1986).

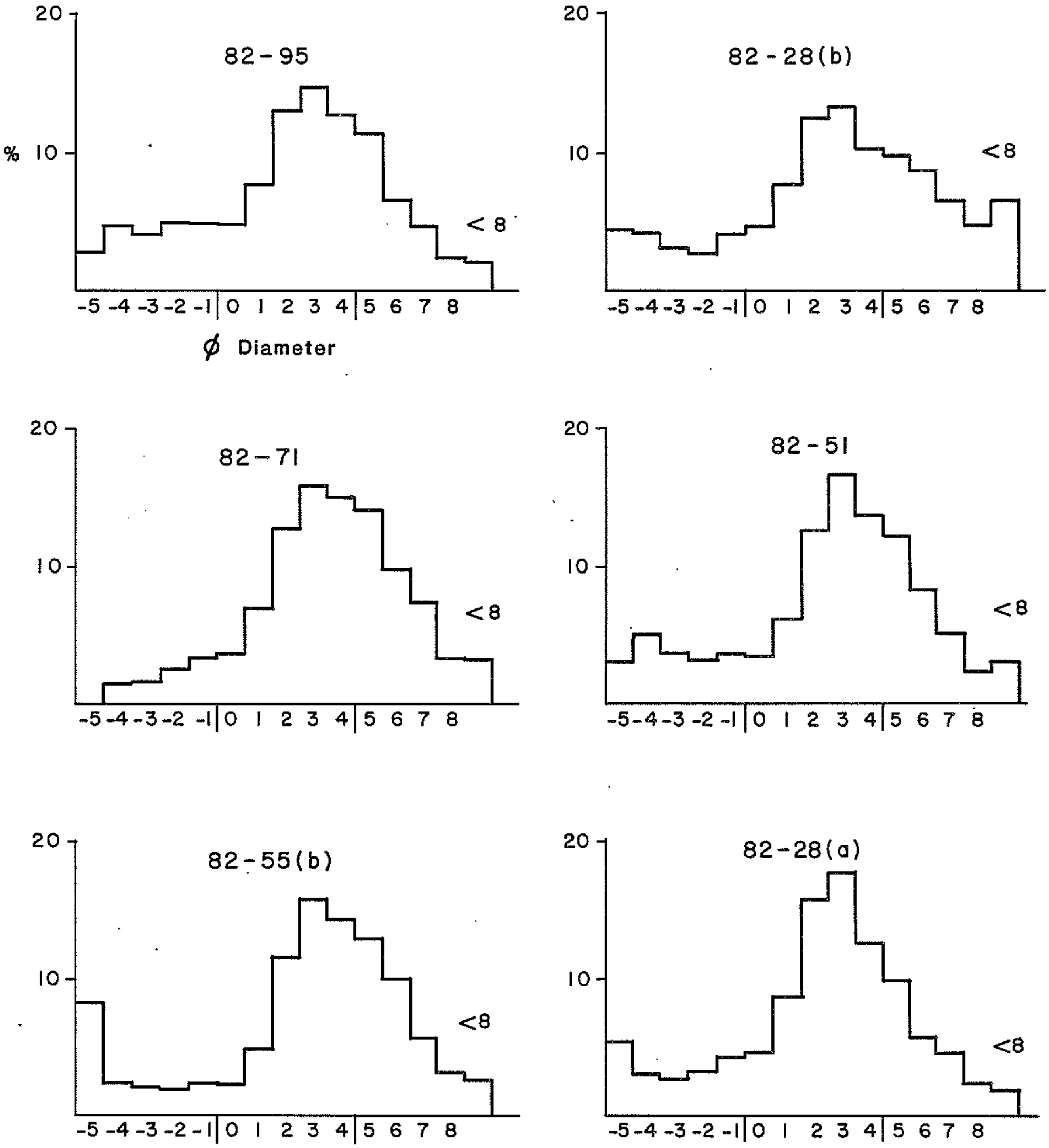


Figure 8: Histograms showing the grain size distribution of selected till samples.

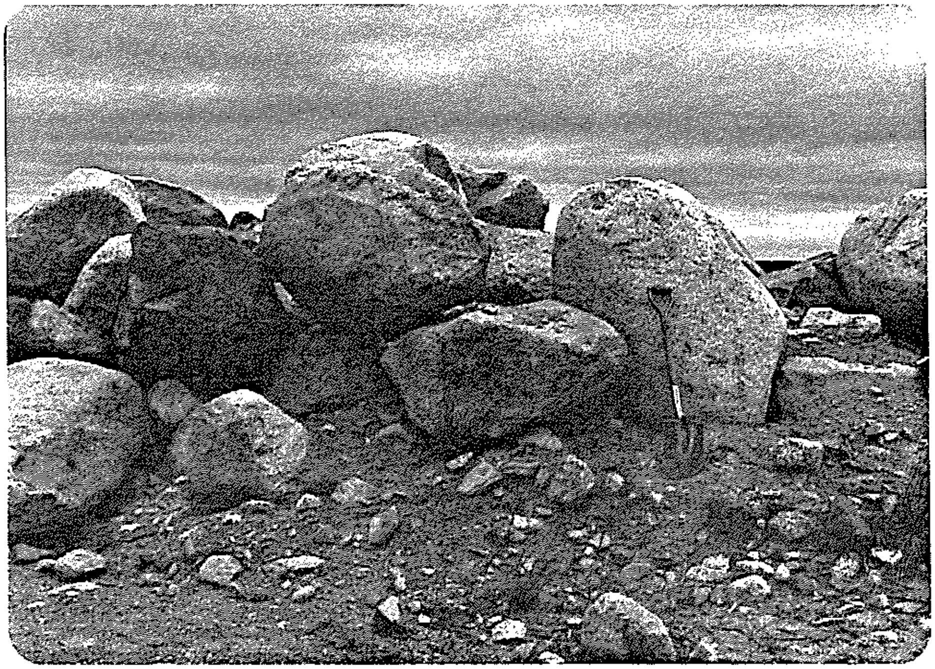


Figure 9: Far-travelled "granite" boulders piled in the borrow pit at site 82-68. Only the dark amphibolite boulder at the left was locally derived.

Figure 10: Mottled till produced by variations in the silt and sand content. Quarter for scale.

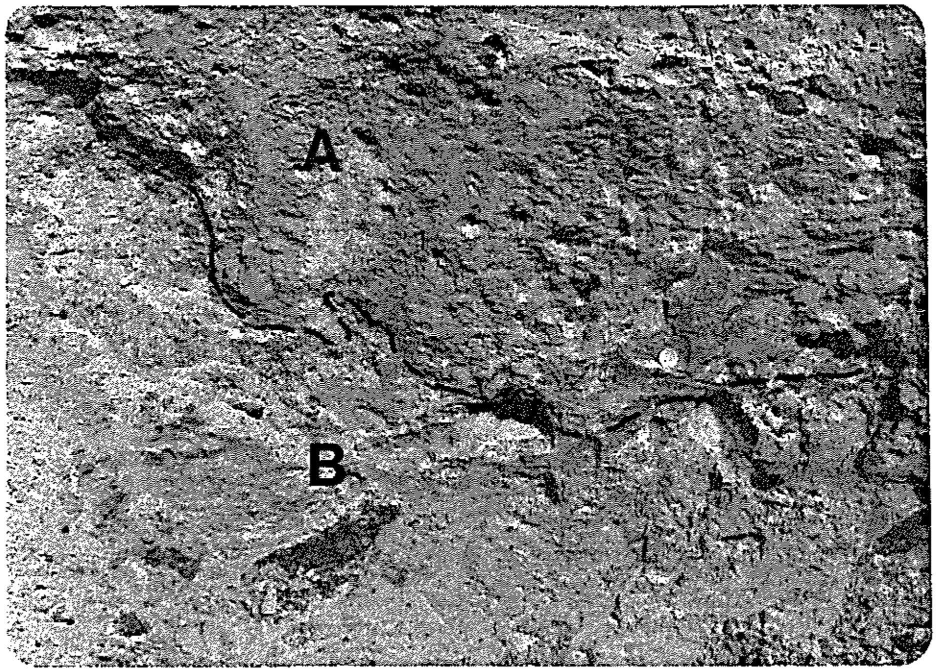


Figure 11: Silty till (A) overlying sandy till (B) at site 82-8. Dime for scale.

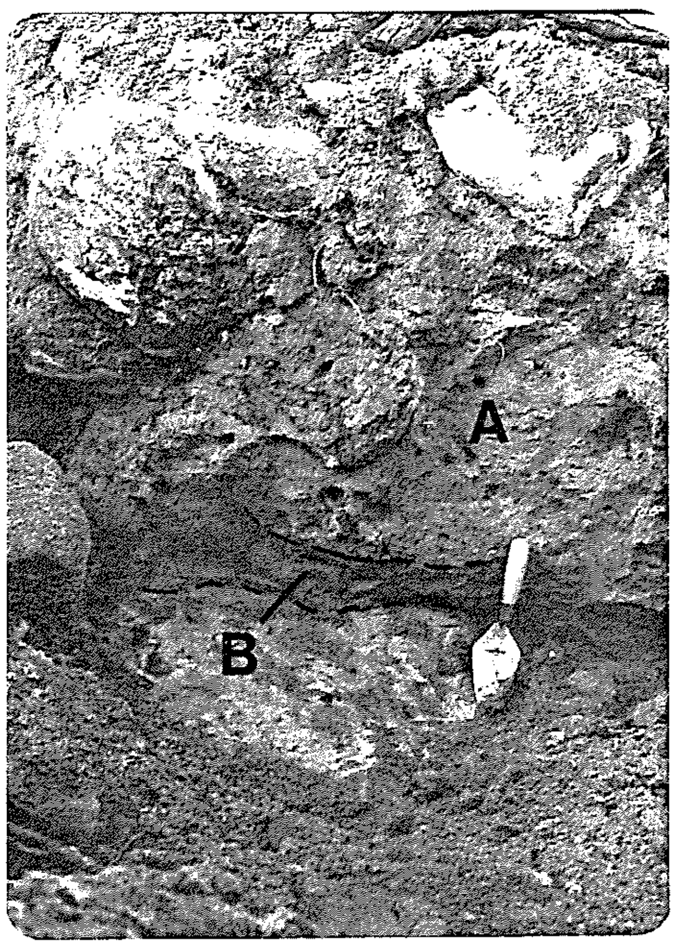


Figure 12: Thin bouldery till (A) overlying a thin silt layer (B) on bedrock at site 82-13.

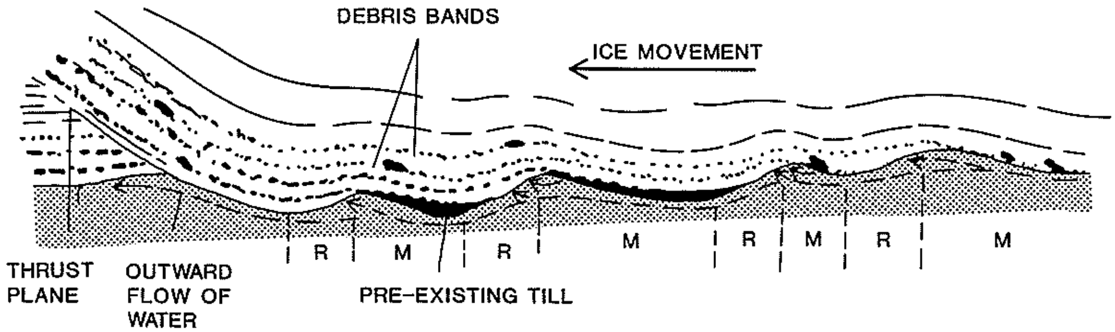


Figure 13: Mechanism for the englacial incorporation of subglacial debris at bedrock projections. R and M are zones of regelation and melting, respectively. Redrawn from Boulton (1970).

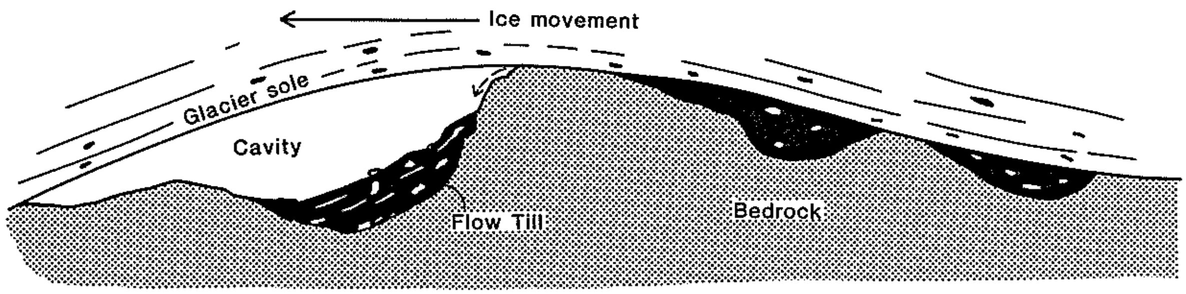


Figure 14: Section showing lodgement till deposited on the stoss side and lee-side till deposited on the down ice side of a bedrock obstruction (Redrawn from Boulton, 1971).

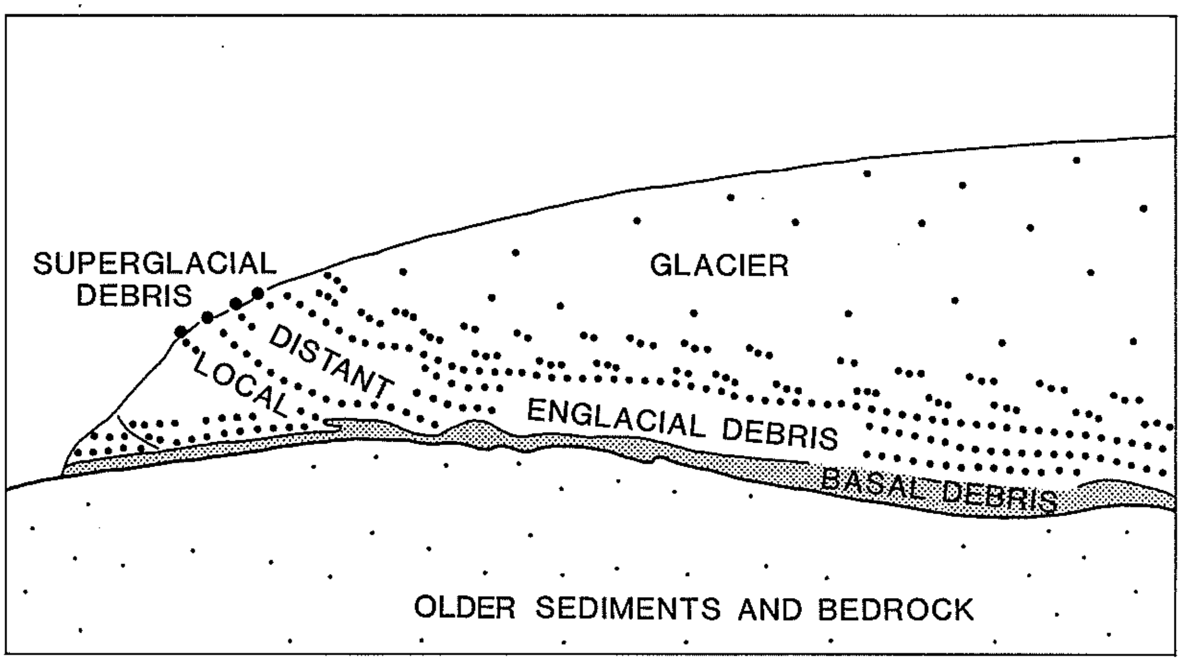
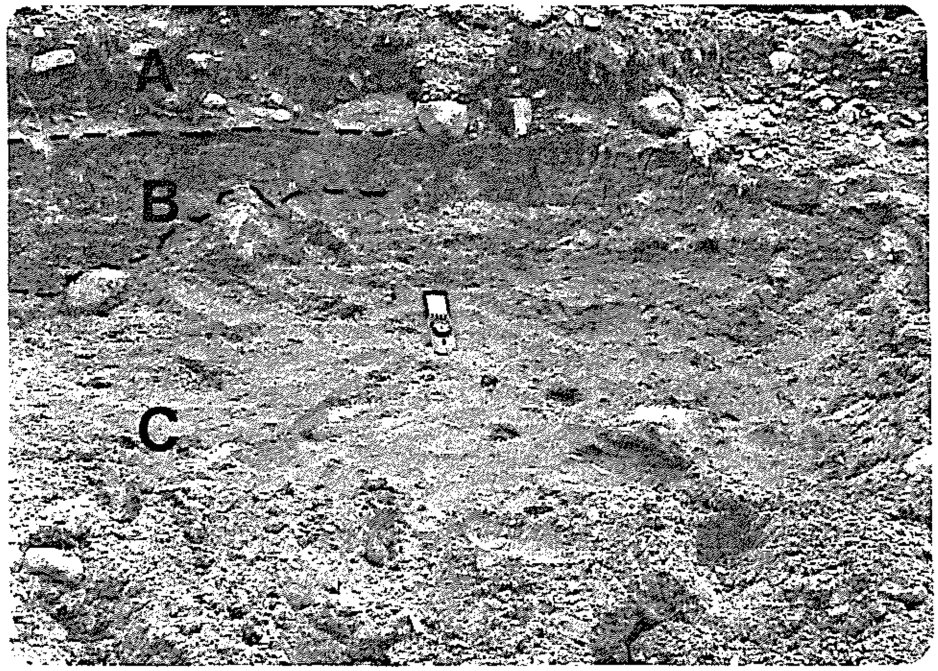


Figure 15: Schematic radial section of an ice sheet terminus showing the transport and provenance of lodgement, englacial and superglacial till. Simplified from Dreimanis (1976).

Figure 16: Overburden stratigraphy in the MacLellan Mine-Dot Lake area. Nearshore glaciolacustrine sand and gravel (A) overlies deep water glaciolacustrine clay (B) that in turn overlies stoss side lodgement till (C) at site 82-55. Note the mottling in the till resulting from shearing and highlighted by textural variation.



Glaciolacustrine Deposits

In low-lying areas, the till sheet is mantled by brownish grey glaciolacustrine silt and clay (Fig. 16). The clay is thickest under the bog veneer covering the low-lying areas and pinches out on the flanks of hills. Texturally, the glaciolacustrine sediment consists of clay and fine silt, although coarser material may also be present.

The glaciolacustrine sediment was deposited in proglacial Lake Agassiz, after the northward retreat of the ice margin. Carbonate clasts constitute a significant proportion of the coarse fraction in the clays, indicating the source of the ice-rafted detritus was ice flowing west from Hudson Bay. A Labradorean or Hudsonian source for the clay is also indicated by the brownish colour, which is similar to the colour of the till matrix of Late Wisconsinan tills in Hudson Bay Lowland (Nielsen et al., 1986).

Figure 17: Regressive gravel lag formed when Lake Agassiz drained from the area. (Site 82-64).

Littoral Deposits

Topographic high areas are generally covered or encircled by littoral sand or gravelly sand deposits (Fig. 16). These areas may be recognized by the flat surface and open bush, consisting of open pine forest with a ground cover of lichen (*Cladonia*). In places, terraces are well developed but beaches with recognizable berms are rare. These relatively well sorted sediments were deposited during the regression of Lake Agassiz across the region.

During the regression of Lake Agassiz, the till sheet was eroded extensively and became mantled with a boulder lag (Fig. 17). The hilltops first became shoals when they were exposed to wave base. The till matrix, washed into low-lying offshore regions, accumulated over deep-water clay deposits. As the water level continued to drop, the hilltops became subaerially exposed and shoreline processes continued to modify the surrounding slopes. Previously deposited littoral sediment was eroded and minor terrace scarps formed.

Organic Deposits

Black spruce bog and fen cover an estimated 60 per cent of the area (Fig. 4). The majority of the bogs are relatively shallow and are found overlying Lake Agassiz clay deposits. Fedikow et al. (1984) indicate that the majority of 344 peat cores, collected from the Farley Lake area, average less than a metre in length and that most of the cores terminated in clay. Palsa bogs in the Lynn Lake area, however, have 5 or more metres of peat.

Orientation Survey

Lateral Variation

Glacial dispersion of the various trace elements is discussed first for the detailed orientation survey carried out in 1982 and 1983, in the area adjacent to the MacLellan deposit. Elements with dispersal patterns related to the ice flow were subsequently used in the more extensive Dot Lake survey, carried out in 1984 and 1985. Tungsten and antimony analyses of the heavy mineral fraction and mercury, molybdenum, uranium, tungsten, antimony and silver analyses of the clay-sized fraction were performed on some of the initial samples collected (Table 1) but, as the concentrations were at or below the detection limits or, in the case of mercury, hard to interpret and expensive to perform, analyses of these elements were discontinued.

The Main Zone orebody at the MacLellan deposit is about 10-15 m wide and has a strike length of about 300 m at the surface.

A total of 78 till samples were collected from 41 holes in an approximately 3 ha area north and south of this zone. The sampling area is bounded by black spruce bog on the east, south and west. Eleven holes terminated on bedrock which outcrops in places. Striations orientated between 195° and 220° on the mineralized bedrock indicate the ice flow was approximately 40° to the strike of the mineralization. About 200 m east of the Main Zone is another mineralized zone termed the East Zone. This zone is situated near the edge of the bog and it was not possible to sample in that area.

Figure 18 shows the dispersal pattern for copper, lead, zinc, nickel, cobalt, chromium, iron, manganese, arsenic, silver and mercury in the clay-sized fraction. The contour intervals on these diagrams were determined by inspection.

Copper ranges between 40 and 186 ppm and forms two lobate anomalies more than 150 m long. The anomaly consists of nine samples with copper values above 100 ppm. The two lobes of the copper anomaly are separated by an area with relatively low values between 40 and 56 ppm. Its lobate nature is similar to that of other elements and may be attributed to chemical variations in the source area, to processes related to glacial erosion or deposition, or to postglacial alteration. Lead abundances range between 10 and 193 ppm. Three samples collected north of the mineralization have abundances between 14 and 17 ppm. The dispersal is lobate with an anomaly extending 120 m down ice from the mineralization. The dispersal pattern is similar to that of copper. Zinc abundances range from 33 to 556 ppm. Anomalous values above 115 ppm form a lobate pattern, similar to that of the other elements. Nickel abundances range from 31 to 861 ppm. Determinations on the three samples north of the mineralization range between 36 and 43 ppm. The anomaly extends to the edge of the sample area and into the bog. The anomaly is lobate, and similar to those of the other elements.

Cobalt abundances range from 9 to 44 ppm with 10 samples containing more than 25 ppm. The anomalous zone is 50-60 m wide, parallel to the mineralization. Chromium abundances range from 47 to 136 ppm; for three samples taken north of the mineralization, the range is between 47 and 56 ppm. The main anomalous zone is ribbon-shaped and extends from the east end of the Main Zone down ice for about 150 m. There is no apparent reason for the high concentration of chromium at the western end of the Main Zone.

The dispersal of iron is difficult to explain. North of the mineralization, iron concentrations range between 3.3 and 3.4% and south of the ore zone values range between 2.8 and 7.3%. The distribution pattern of iron, south of the mineralization, is believed to have been modified by post-depositional weathering processes.

The disperal of manganese, ranging from 110 to 1100 ppm, is similar to the distribution of cobalt. The main anomaly adjacent to the mineralization is 30 to 60 m wide. A second ribbon-shaped anomaly, not connected to the main anomaly, extends down ice for a distance of 70 m and disappears into the bog. Silver values range from 0.1 to 2.4 ppm, with 13 samples above 1 ppm. The main anomaly extends from the east end of the Main Zone, down ice for a distance of 180 m. Smaller scattered anomalous values occur beyond the main anomaly. The location, orientation and shape of the silver anomaly is similar to the chromium dispersal. The eastern source of the silver anomaly is consistent with higher sulphide and silver concentrations in the East Zone but the ice flow is such that the East Zone could not be the source. It may be that the east end of the Main Zone, adjacent to the East Zone, is also enriched in silver, although this remains to be determined. Mercury determined on 26 samples ranges between 5 and 195 ppb. The three samples collected north of the mineralization range from 5 to 10 ppb. A large anomaly, consisting of seven samples with values above 100 ppb, starts 90 m from the mineralization and extends under the bog, in the down-ice direction. The anomaly is ribbon-shaped and at least 120 m long. The orientation is similar to the chromium and silver anomalies and appears to originate from the east end of the Main Zone. The East Zone is known to have relatively high mercury concentrations but, as with chromium and silver, this is an unlikely source of the dispersion train. Arsenic concentrations range from 4 to 648 ppm and form a well

TABLE 1

RESULTS OF SILVER, MOLYBDENUM, MERCURY, URANIUM AND TUNGSTEN ANALYSES OF SELECTED SAMPLES FROM THE ORIENTATION SURVEY.

Sample Number	Ag (ppm)	Mo (ppm)	Hg (ppb)	Ufl (ppm)	W (ppm)
83-40-10-20	1.0	2			<2
83-40-20-30	0.4	2			<2
83-40-30-40	<0.1	5			<2
83-40-40-50	0.2	4			<2
83-40-50-60	<0.1	2			<2
83-40-60-70	<0.1	2			<2
83-40-70-80	0.2	1	45		<2
83-40-80-90	0.1	2	30	1.0	<2
83-40-90-100	0.7	2	50		<2
83-40-100-110	2.3	1			<2
83-10	<0.1	2	25	<0.2	<2
83-10-20-30	0.2	4	110	3.4	<2
83-11A	<0.1	1	50	2.8	<2
83-11B	2.0	1	75	1.3	<2
83-12	2.2	5	195		<2
83-12A	0.8	1		2.3	<2
83-12B	<0.1	1	40	<0.2	<2
83-13	0.1	2		<0.2	<2
83-14	0.1	4			<2
83-14-15-30	0.4	4			<2
83-15	0.3	3		2.0	<2
83-16	0.6	2	85		<2
83-17	0.4	3			<2
83-17A	0.6	1			<2
83-17B	2.4	3			<2
83-18	0.1	<1		<0.2	<2
83-19	0.2	4			<2
83-19-20-35	0.1	3			<2
83-20	0.9	1	80	1.0	<2
83-21	0.1	1			<2
83-22	<0.1	3		2.1	<2
83-22-10-30	2.0	5			<2
83-22-30-50	0.2	1			<2
83-23	0.1	3		4.1	<2
83-24	0.9	1			<2
83-24-20-40	1.1	2			<2
83-25	0.4	1			<2
83-26	0.3	1	100		<2
83-26-20-40	1.1	2	150		<2
83-27	0.1	1	120	2.9	<2
83-28	0.3	1		1.8	<2
83-29	0.1	<1	30	1.2	<2
83-29-10-20	0.5	3	160		<2
83-29-30-40	1.2	2			<2
83-30	1.0	1	100	1.1	<2

TABLE 1 (CONT'D.)

Sample Number	Ag (ppm)	Mo (ppm)	Hg (ppb)	Ufl (ppm)	W (ppm)
83-31	0.2	1	50	2.1	<2
83-31-20-30	0.9	2	90	1.9	<2
83-31-35-50	0.4	2			<2
83-32	1.2	1			<2
83-32-20-40	0.8	1			<2
83-33	0.3	<1		1.0	<2
83-33-20-30	1.2	2			<2
83-33-40-50	0.3	1	105		<2
83-34	0.1	1	30	3.0	<2
83-34-15-30	0.1	2			<2
83-34-35-50	0.1	1			<2
83-35	1.0	1			<2
83-36	0.7	<1			<2
83-37	0.3	<1	60		<2
83-37-30-40	0.2	1	70		<2
83-37-50-70	0.4	1			<2
83-38	0.2	<1	30	<0.2	<2
83-39	0.2	<1	25	<0.2	<2
83-39-20-30	0.4	2		1.2	<2
83-39-50-60	0.3	1		<0.2	<2
83-40	0.5	1	65		<2
83-41	0.3	2	35		<2
83-42	0.2	1	15	<0.2	<2
83-43	0.4	1	15	1.1	<2
83-44	1.9	1		0.7	<2
83-45	0.2	2	10	<0.2	<2
83-46	0.2	1	10		<2
83-47	0.2	1	5	0.7	<2

defined lobate anomaly at least 150 m long, extending under the swamp. Samples from north of the mineralization range from 4 to 21 ppm. The shape of the anomaly is similar to that of the other elements.

The dispersal of copper, lead, zinc, nickel, cobalt, chromium, iron, manganese, arsenic and gold in the heavy mineral fraction is shown in Figure 19. The dispersal patterns of most of these elements is similar to the patterns derived from the analysis of the clay-sized fraction, with the exception of chromium, manganese and gold. The dispersal pattern of chromium, iron and manganese show high values in areas coincident with low values of copper, lead, zinc, nickel, cobalt and arsenic in the clay-sized fraction. This further suggests that the lobate configuration shown in many of the diagrams is a function of the composition of the mineralized source. There is nothing in the depositional zone, e.g. depth to bedrock, till thickness, or topography, to suggest a glaciological control, or excessive postglacial leaching of the till. The abundance of gold ranges from 3 to 15 000 ppb. Samples from north of the mineralization have values ranging from 40 to 72 ppb. The anomaly defined by values above 100 ppb gold forms a single wide ribbon extending more than 150 m to the southwest.

Vertical Variation

The optimum sampling depth was determined by collecting multiple samples in several test pits. The samples included highly oxidized and leached portions of the upper soil profile down to relatively unweathered parent material. The results of these studies are shown in Figure 20 and listed in Appendices II and III. Copper, lead, zinc, nickel, iron and manganese concentrations in the clay-sized fraction increase sharply at a depth of 50-60 cm and attain maximum values at about 1 m (Fig. 20). Cobalt does not show any vertical variation and chromium is slightly enriched at the top of the profile. In

Figure 18: Sample locations and dispersal patterns of copper, lead, zinc, nickel, cobalt, chromium, iron, manganese, arsenic, silver and mercury in the clay-sized fraction of till samples collected down ice from the MacLellan deposit.

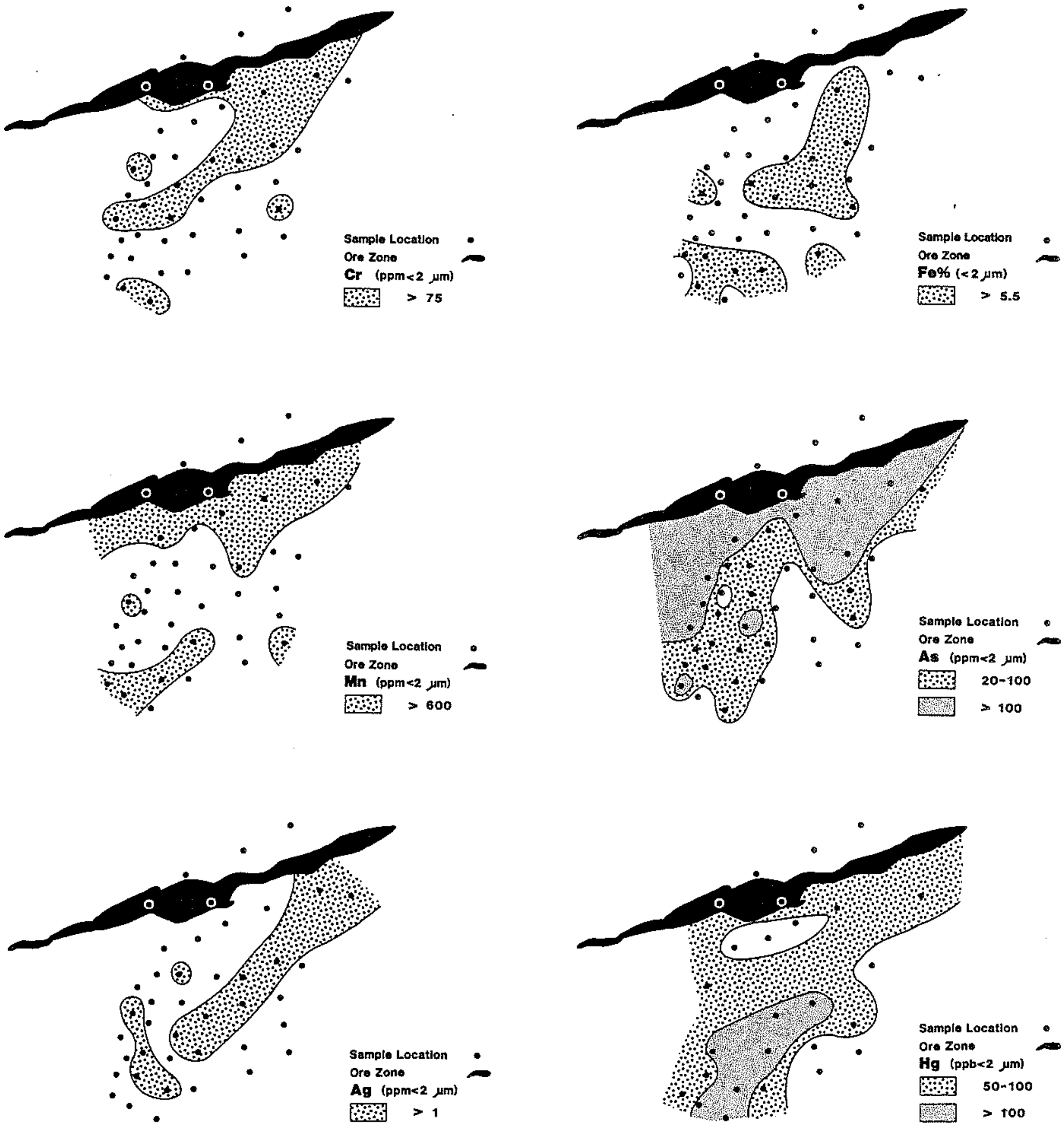


Figure 18: (Cont'd.) Sample locations and dispersal patterns of copper, lead, zinc, nickel, cobalt, chromium, iron, manganese, arsenic, silver and mercury in the clay-sized fraction of till samples collected down ice from the MacLellan deposit.

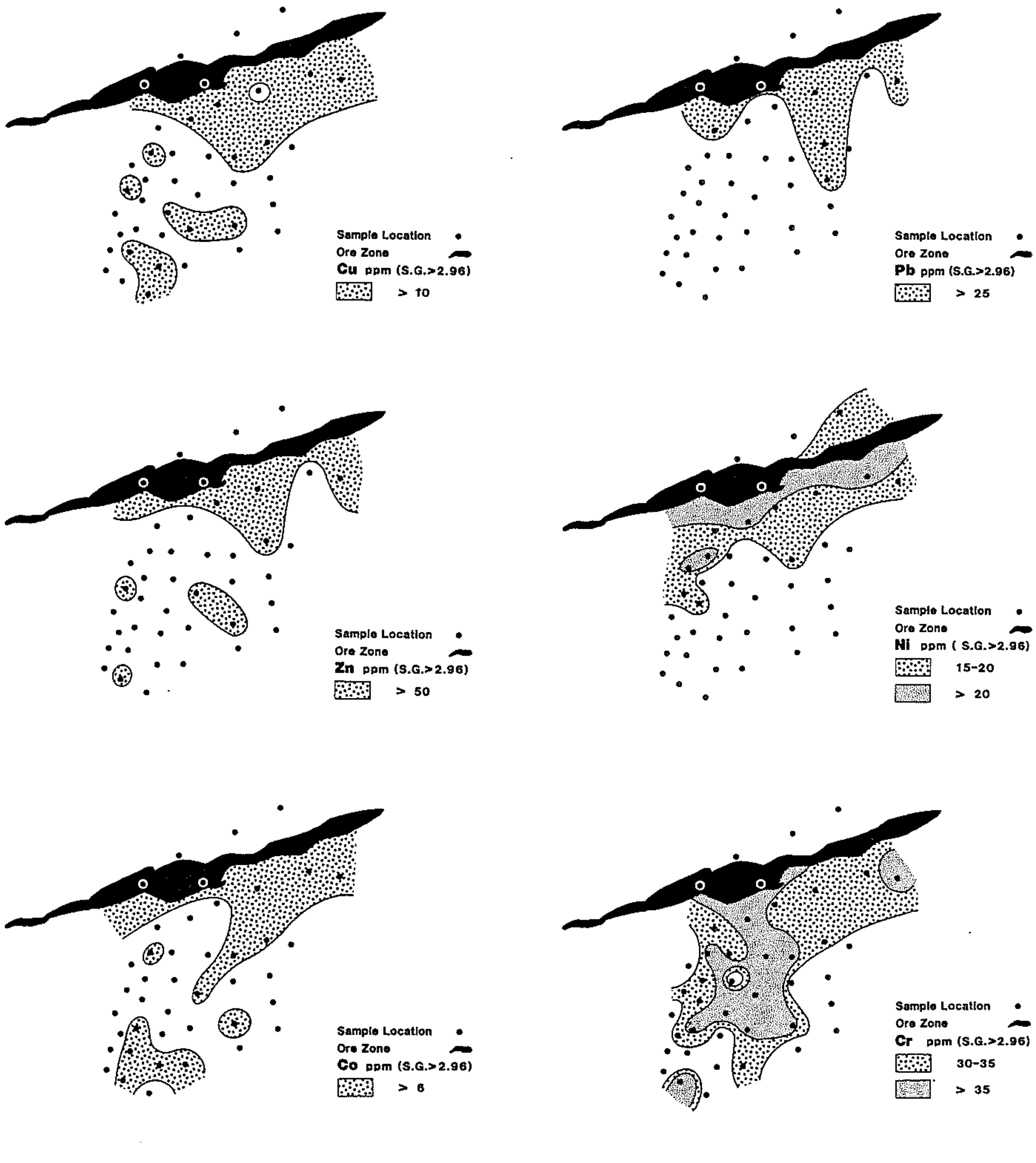


Figure 19: Dispersal patterns of copper, lead, zinc, nickel, cobalt, chromium, iron, manganese, arsenic and gold in the heavy mineral fraction, down ice from the MacLellan deposit.

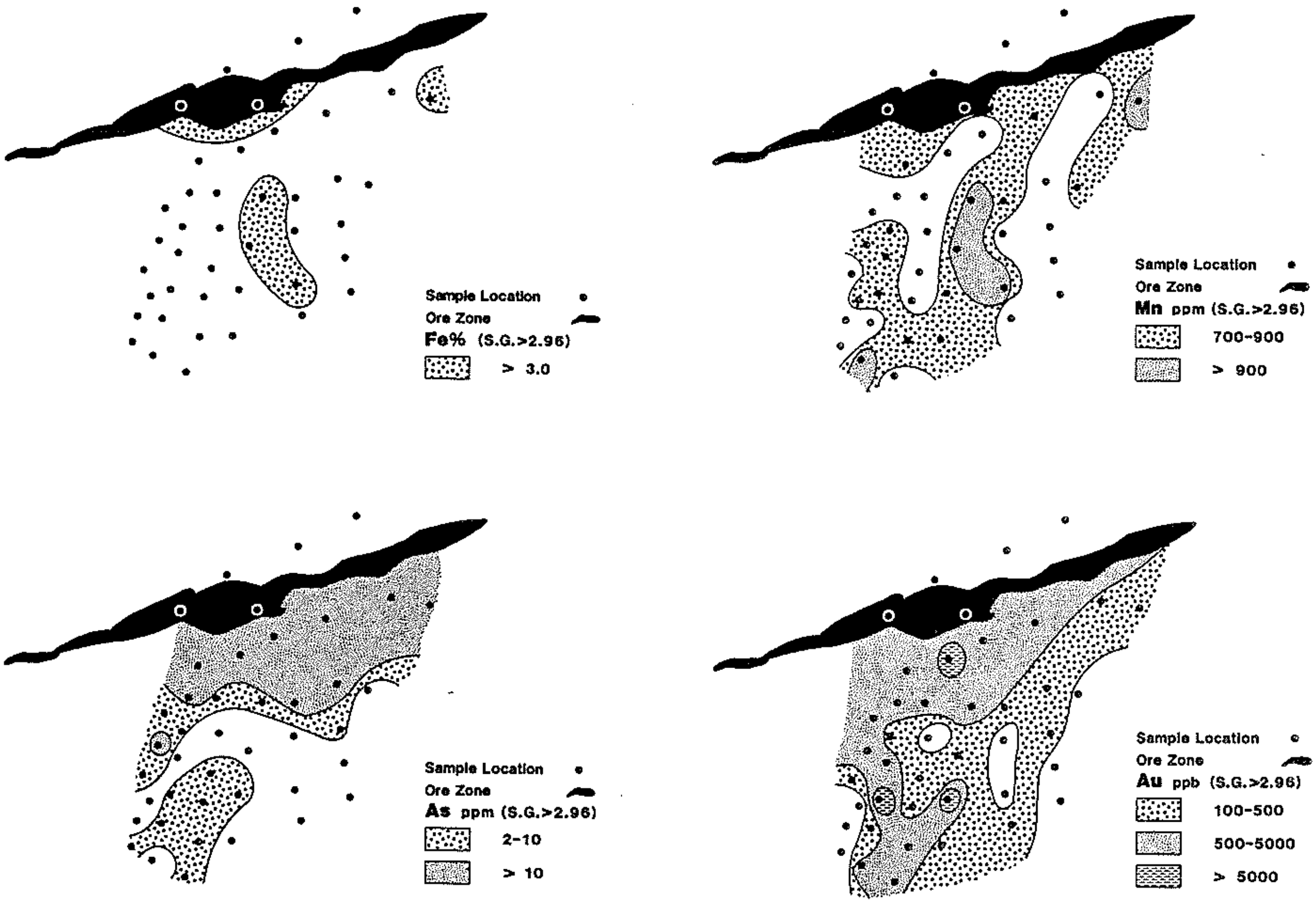


Figure 19: (Cont'd.) Dispersal patterns of copper, lead, zinc, nickel, cobalt, chromium, iron, manganese, arsenic and gold in the heavy mineral fraction, down ice from the MacLellan deposit.

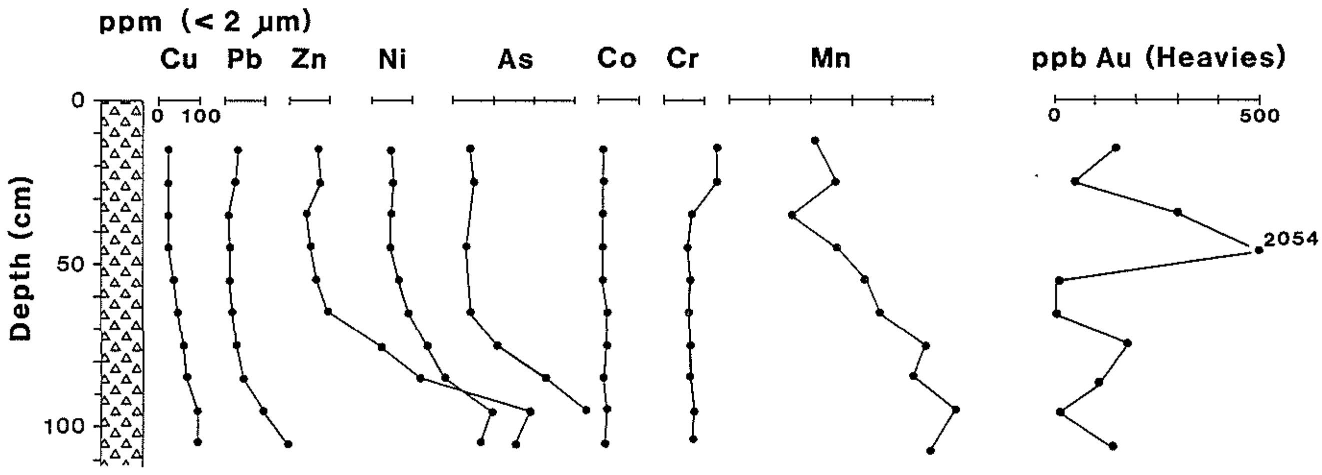


Figure 20: Vertical variation in the trace element content of the clay-sized fraction and gold content of the heavy mineral fraction at sampling site 83-40.

the heavy mineral fraction the same general increase in cation concentrations with depth is apparent. Gold concentrations are variable with the highest values occuring at a depth of about 40 cm, reflecting the provenance and not the pedogenic process affecting the concentration of the other elements.

These results indicate that the highest cation concentrations are found in relatively unweathered grey till. Unweathered till can conveniently be sampled from hand-dug pits, at depths ranging between 50 and 110 cm. In some areas the depth of oxidation is deeper and, in places with permafrost, the depth of oxidation may be much less. Gold concentrations in the heavy mineral fraction do not appear to be affected by pedogenic processes and both oxidized and unoxidized samples reflect the provenance equally well.

Partitioning

Six samples with high gold concentrations were sieved into ten size fractions ranging from 4 mm to less than 2 microns, to determine the size fraction that gives the highest anomaly to background contrast (Table 2). Figure 21 illustrates the variation in elemental concentrations with grain size. The highest values are obtained by analyzing the clay-sized fraction and supports the conclusions of Shilts (1984) and others.

Gold was not analyzed in the less than 2 micron fraction because of the difficulty in concentrating sufficient sample. However, there does not appear to be any relationship between gold concentration and grain size in the other fractions (Fig. 22). The highest gold values were obtained by analyzing the heavy mineral concentrate, which was not partitioned in the above-described manner.

Regional Survey

Dot Lake - MacLellan Mine area

The frequency distribution of the geochemical data for the till samples collected in the Dot Lake - MacLellan Mine area, including the data from the orientation survey, is presented in Figures 23 and 24. The data are listed in Appendices II and III.

The 1982 heavy mineral data are anomalously high, compared to the data on the samples collected in subsequent years. This may be due to different sample preparation or possibly contamination from the MacLellan Mine site, where the samples were prepared. The frequency distribution of the heavy mineral data, excluding the 1982 samples, is shown in Figure 25. Comparing Figures 24 and 25 indicates copper, lead, zinc, cobalt, chromium and iron are noticeably higher in the 1982 samples than those collected in subsequent years and account for the prominent bimodal distribution of many of the diagrams in Figure 24. Nickel, manganese, arsenic and gold do not appear to have been affected.

The summary statistics and correlation matrices for the analyses on the clay-sized and heavy mineral fractions are listed in Tables 3 and 4 respectively.

Threshold values have been determined for each element in the clay-sized and heavy mineral fractions graphically, by plotting the cumulative frequency using a

TABLE 2
RESULTS OF GEOCHEMICAL ANALYSES OF DIFFERENT SIZE FRACTIONS OF SELECTED TILL SAMPLES.

Sample Number	Size Fraction	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	Ni (ppm)	Mn (ppm)	Ag (ppm)	Fe (%)	Au (ppb)	As (ppm)
83-12-15-30	4-2	5	3	18	2	7	85	0.1	1.0	<5	<2
83-12-15-30	2-1	3	2	14	1	4	39	<0.1	0.6	<5	<2
83-12-15-30	1-.5	3	<2	8	1	3	27	<0.1	0.5	<5	<2
83-12-15-30	.5-.25	3	<2	5	1	3	19	<0.1	0.4	<5	<2
83-12-15-30	.25-.13	4	<2	7	1	3	16	<0.1	0.5	<5	<2
83-12-15-30	.13-.06	5	3	10	2	4	18	<0.1	0.4	<5	<2
83-12-15-30	.06-.04	5	<2	10	1	5	16	<0.1	0.6	<5	<2
83-12-15-30	<.04	5	<2	6	2	5	21	<0.1	0.7	<5	<2
83-12-15-30	Bulk <4	4	<2	14	1	4	20	<0.1	0.6	<5	<2
83-12-15-30	.13-.06 (split)	4	<2	16	2	4	16	<0.1	0.5	<5	2
83-26	4-2	41	3	20	1	11	350	<0.1	1.7	<10	10
83-26	2-1	37	5	24	1	11	590	<0.1	1.3	10	10
83-26	1-.5	30	<2	16	1	9	275	<0.1	1.1	<5	7
83-26	.5-.25	26	3	16	1	8	128	<0.1	0.8	<5	4
83-26	.25-.13	23	3	15	1	7	68	<0.1	0.9	<5	2
83-26	.13-.06	45	2	19	1	11	72	<0.1	1.3	<5	3
83-26	.06-.04	50	6	26	1	12	73	<0.1	1.2	20	5
83-26	<.04	32	6	18	1	13	70	<0.1	1.0	10	4
83-26	Bulk <4	35	4	19	1	13	175	<0.1	1.1	<5	4
83-26	.13-.06 (split)	45	4	22	1	14	84	<0.1	1.3	<5	4
83-28	4-2	13	27	35	1	13	176	<0.1	1.2	<5	5
83-28	2-1	13	16	25	1	11	97	<0.1	0.9	<5	3
83-28	1-.5	10	10	20	1	12	86	<0.1	0.9	5	2
83-28	.5-.25	9	3	20	1	11	58	<0.1	0.6	<5	2
83-28	.25-.13	9	2	20	1	13	35	<0.1	0.5	<5	2
83-28	.13-.06	11	<2	21	1	11	33	<0.1	0.5	<5	2
83-28	.06-.04	9	5	17	1	9	26	<0.1	0.5	<5	2
83-28	<.04	10	4	11	<1	10	32	<0.1	0.7	<5	2
83-28	Bulk <4	11	4	21	<1	13	43	<0.1	0.6	<5	2
83-28	.13-.06 (split)	10	4	21	1	12	30	<0.1	0.5	5	2
83-30	4-2	54	9	54	1	19	205	<0.1	1.4	15	18
83-30	2-1	55	17	52	1	15	175	0.1	1.2	20	20
83-30	1-.5	40	5	30	1	11	93	<0.1	0.8	10	13
83-30	.5-.25	29	5	25	<1	8	55	<0.1	0.5	<5	4
83-30	.25-.13	24	4	23	1	8	39	<0.1	0.4	10	4
83-30	.13-.06	34	3	34	<1	10	48	<0.1	0.4	10	6
83-30	.06-.04	43	4	45	1	10	58	<0.1	0.6	55	6
83-30	<.04	40	9	37	1	14	76	0.2	0.8	20	13
83-30	Bulk <4	38	6	38	1	11	70	<0.1	0.7	5	12
83-30	.13-.06 (split)	36	3	35	1	9	43	<0.1	0.5	10	5
83-42	4-2	25	5	52	1	37	127	0.1	1.4	<10	16
83-42	2-1	26	5	47	1	44	120	<0.1	1.2	65	30
83-42	1-.5	21	4	37	1	46	94	0.1	0.7	20	21
83-42	.5-.25	11	2	20	1	25	54	<0.1	0.3	5	8
83-42	.25-.13	9	5	22	1	15	39	0.1	0.2	30	7
83-42	.13-.06	9	4	30	1	16	47	<0.1	0.3	15	8
83-42	.06-.04	9	6	27	<1	15	47	<0.1	0.4	10	8
83-42	<.04	10	4	20	1	16	51	<0.1	0.4	20	8
83-42	Bulk <4	13	5	29	1	20	58	<0.1	0.4	10	9
83-42	.13-.06 (split)	9	3	28	1	15	42	<0.1	0.3	10	9

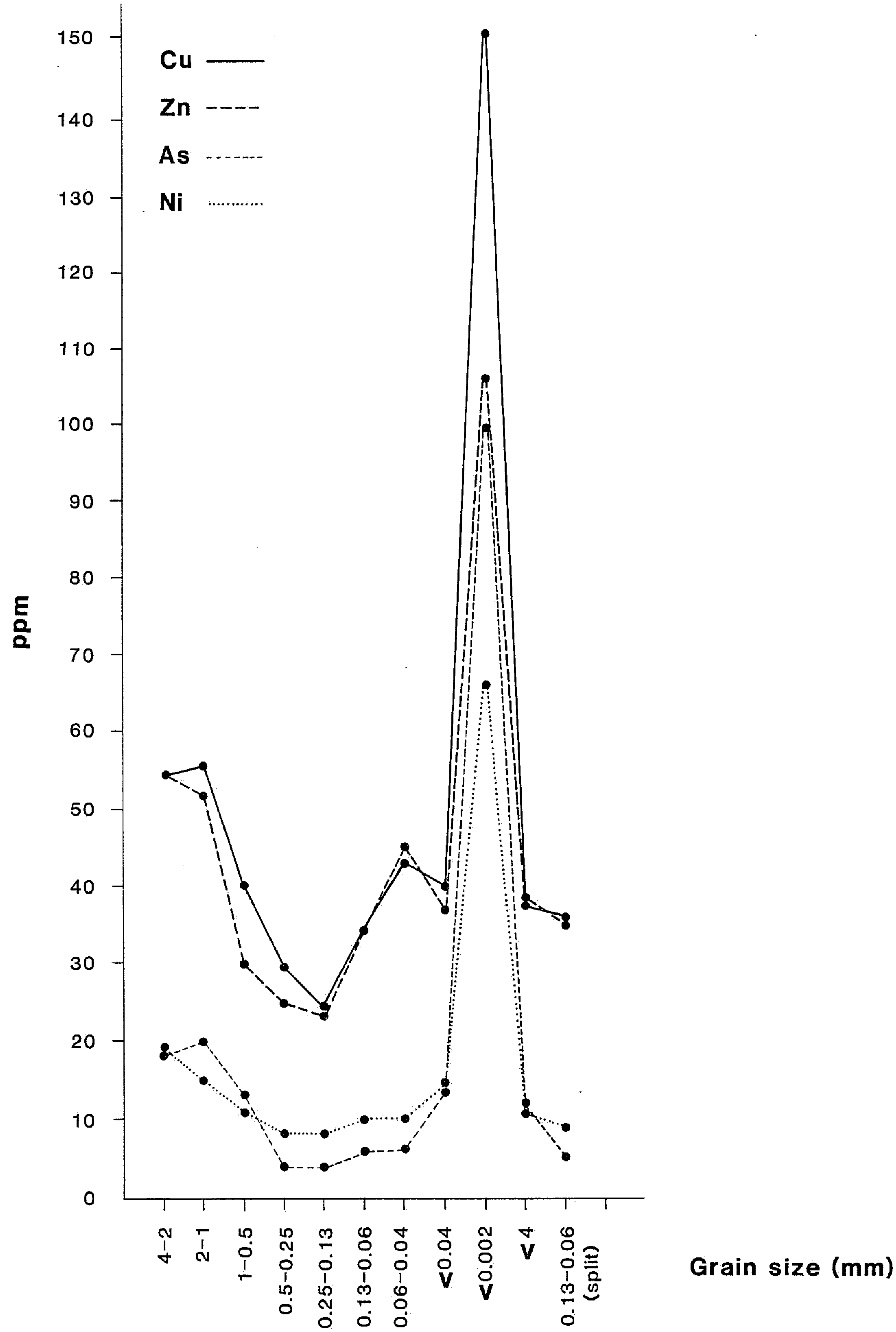


Figure 21: Variation in trace element content with grain size for sample 83-30.

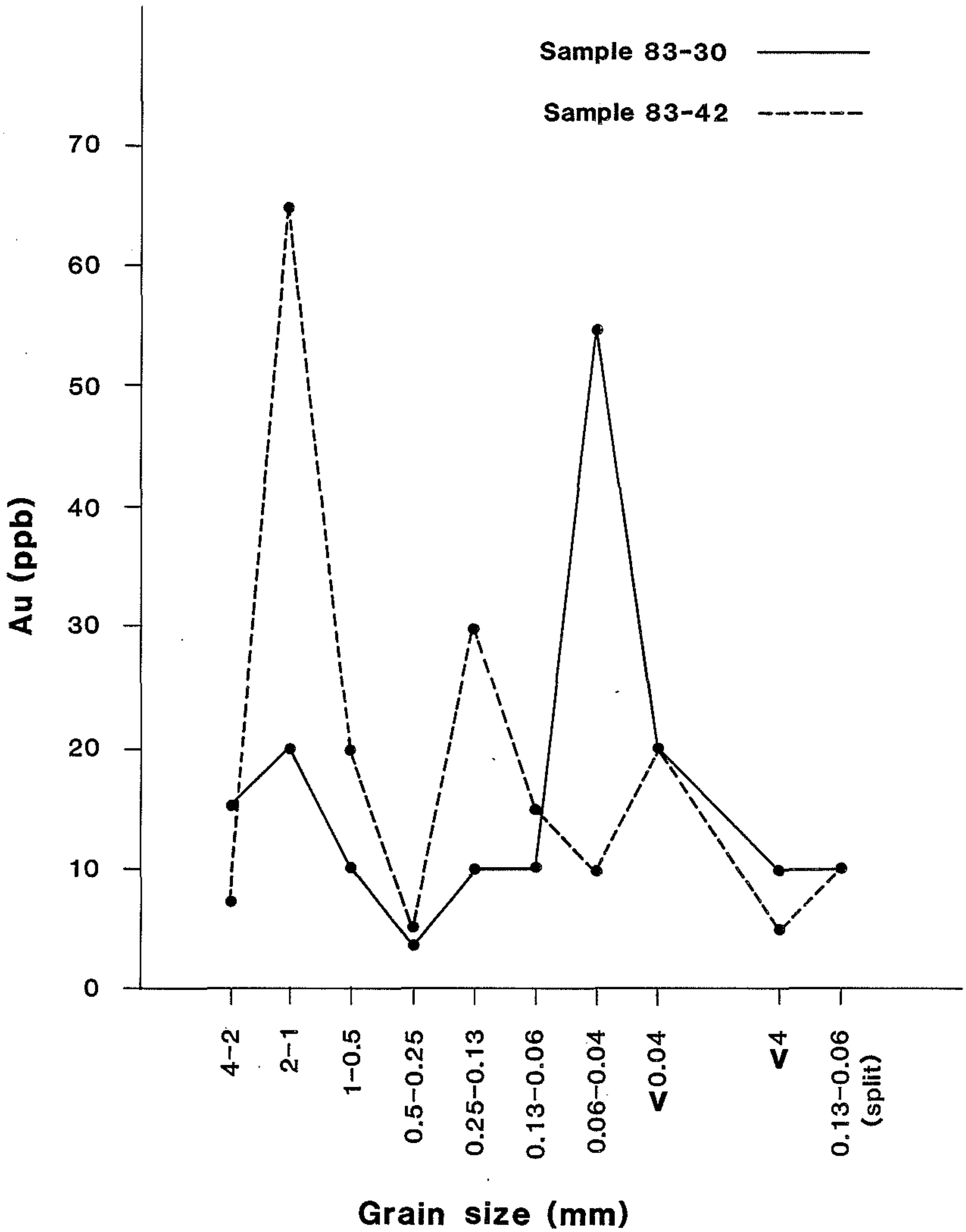


Figure 22: Variation in gold content with grain size.

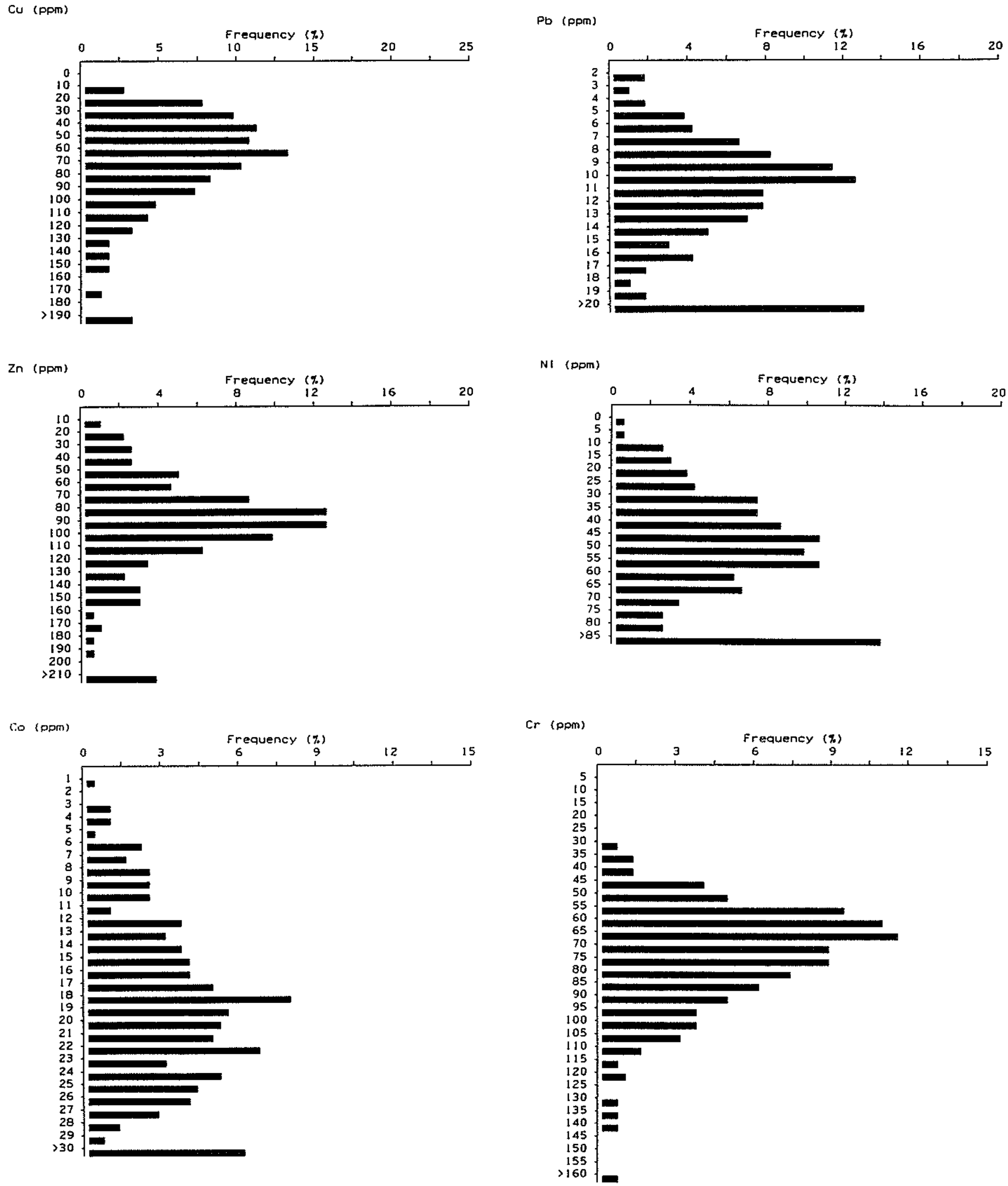


Figure 23: The distribution of element concentration in the clay-sized fraction of all the data.

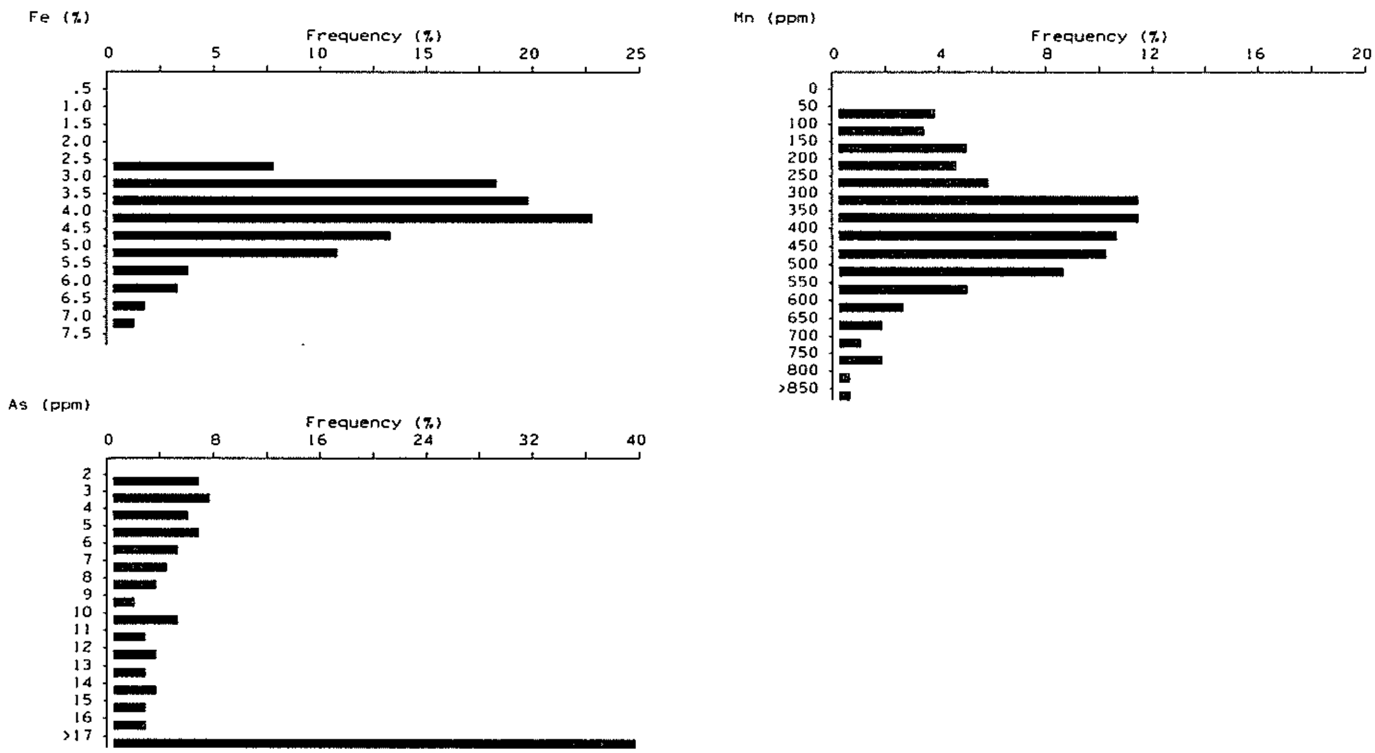


Figure 23: (Cont'd.) The distribution of element concentration in the clay-sized fraction of all the data.

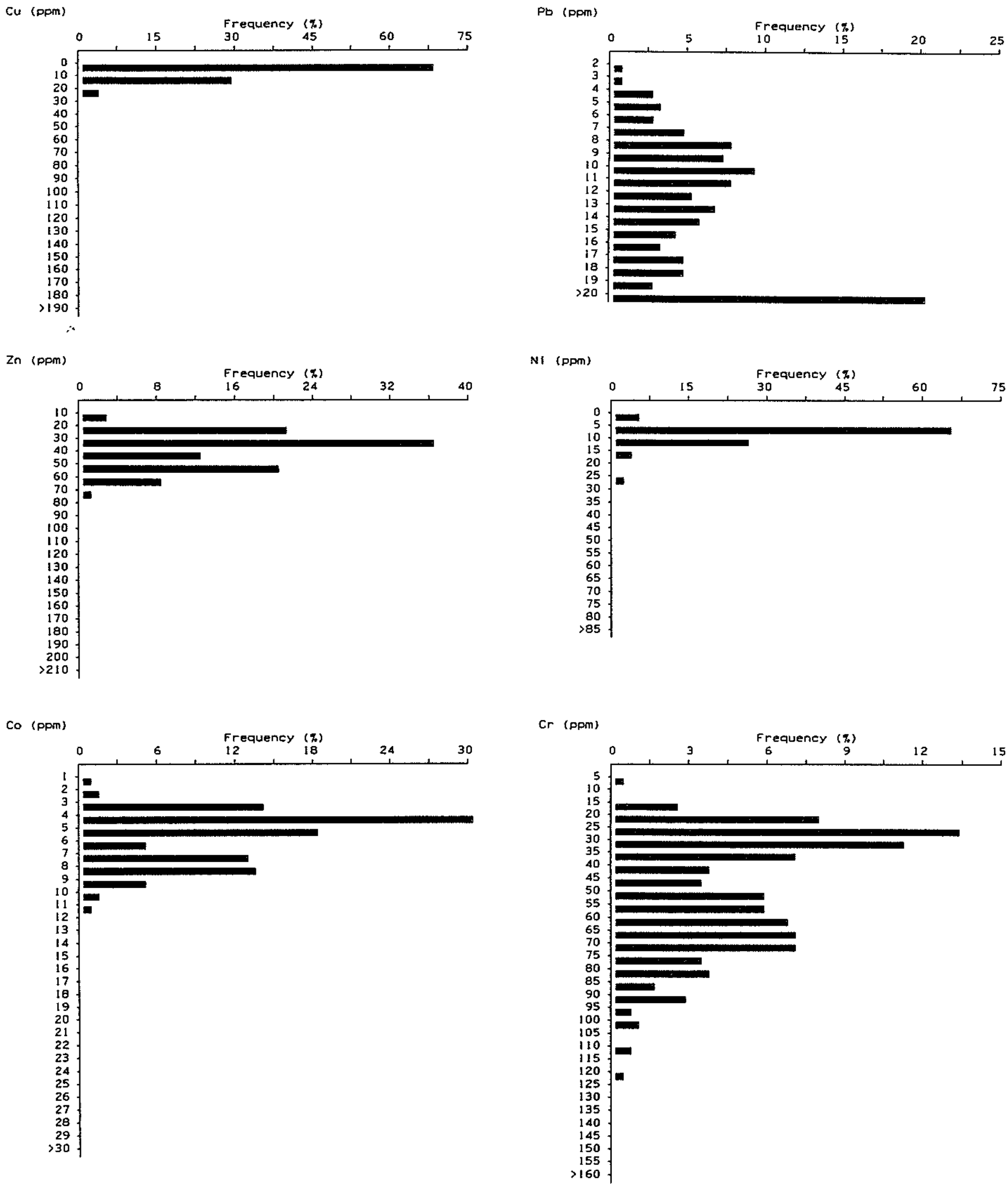


Figure 24: The distribution of element concentration in the heavy mineral fraction of all the data.

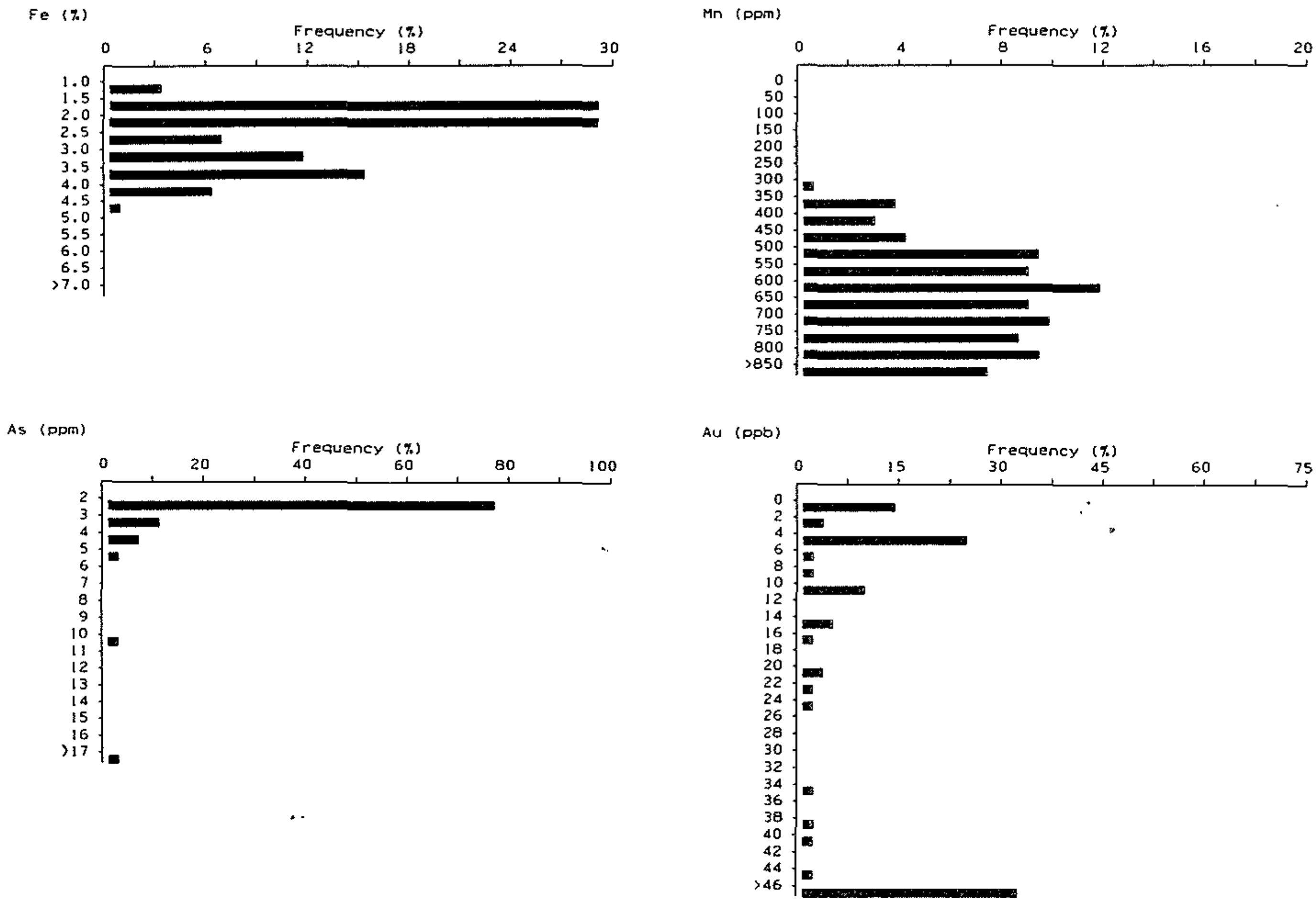


Figure 24 (Cont'd.): The distribution of element concentration in the heavy mineral fraction of all the data.

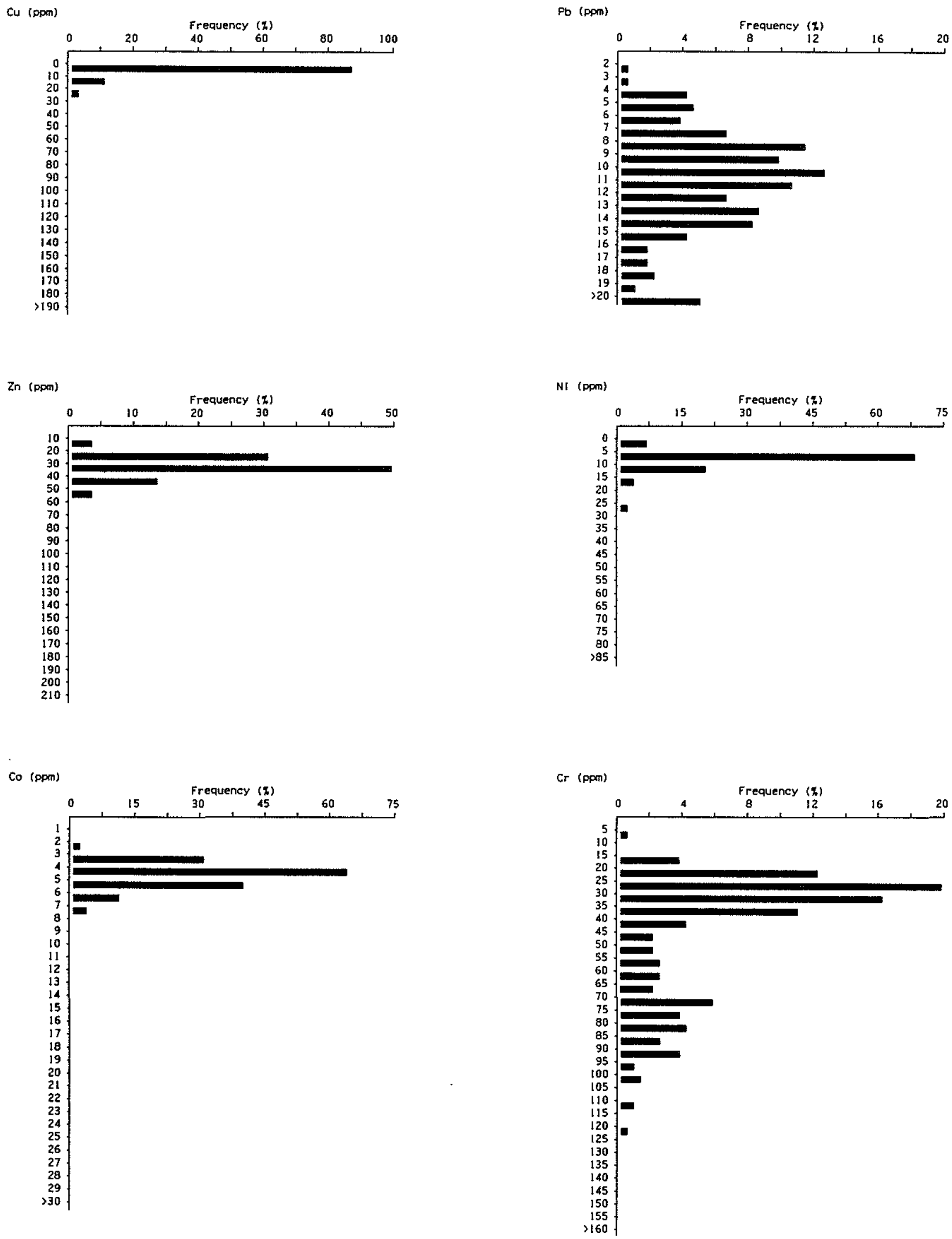


Figure 25: The distribution of element concentration in the heavy mineral fraction without the 1982 data.

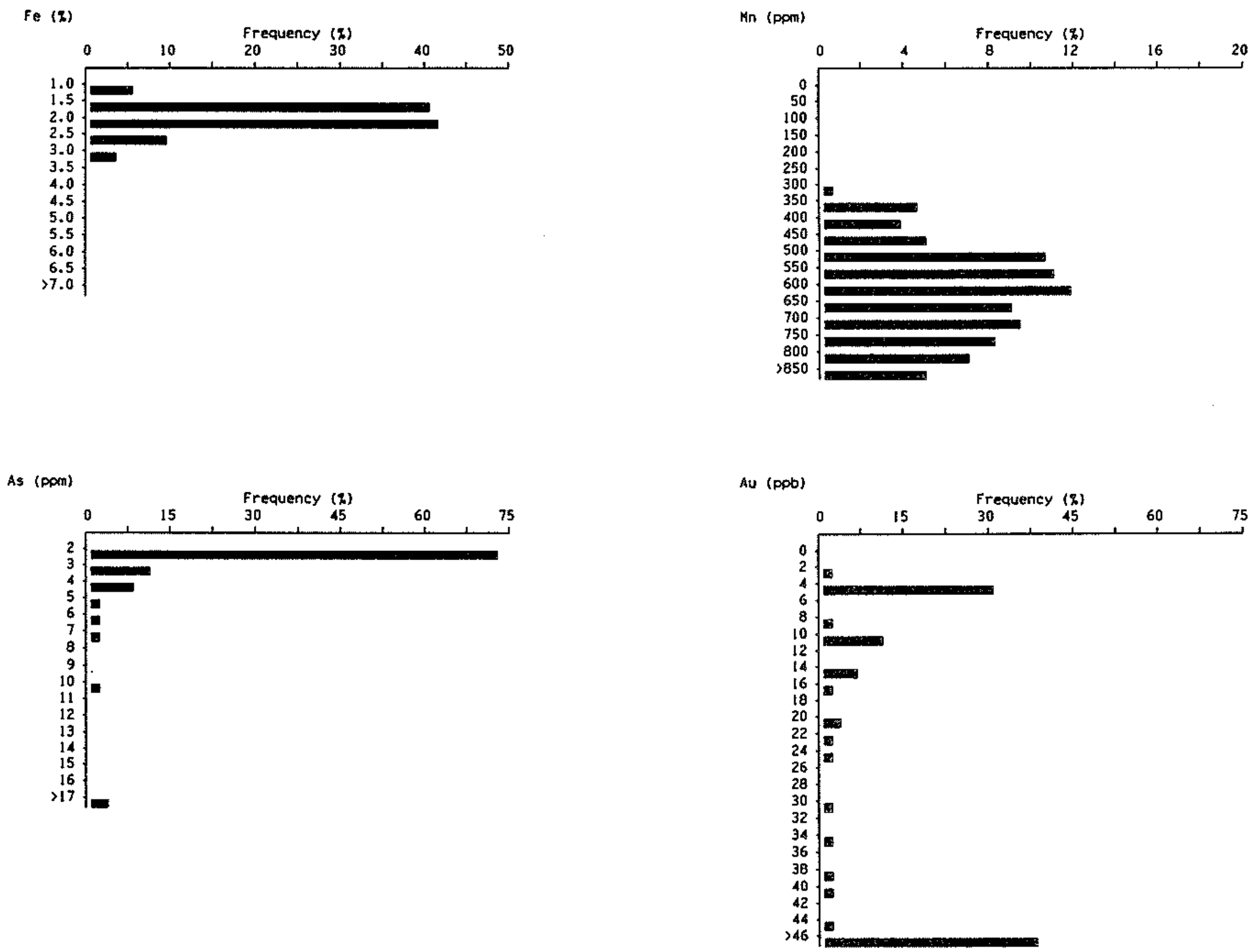


Figure 25 (Cont'd.): The distribution of element concentration in the heavy mineral fraction without the 1982 data.

TABLE 3

Variable:	Cu	Pb	Zn	Ni	Co	Cr	Fe	Mn	As
Observations:	420	418	420	420	420	415	301	420	400
Minimum:	12	2	14	1	1	31	2.5	50	2
Maximum:	666	193	747	861	99	301	19.1	6300	648
Mean:	77.9	15.3	104.1	64.2	19.1	75.6	4.3	410.7	35.3
Std. err. mean:	3.0	1.1	3.5	3.2	.4	1.1	.1	16.4	4.0
Std. deviation:	60.9	21.6	72.5	65.9	8.4	23.1	1.4	336.4	80.5
Skewness:	4.6	6.1	4.4	6.4	2.4	2.8	4.9	12.9	5.0
Kurtosis:	33.2	42.0	37.8	60.6	19.9	21.7	43.4	224.8	27.8

Table 3(A). Summary statistics for the clay-sized fraction geochemical data.

	Cu	Pb	Zn	Ni	Co	Cr	Fe	Mn	As
Cu	1.0000	.1081	.3692	.2876	.6139	.1435	.2916	.5790	.3127
Pb		1.0000	.5218	.3553	.1536	.0367	.1514	.0965	.5478
Zn			1.0000	.5459	.4785	.0186	.1370	.2623	.6062
Ni				1.0000	.3842	.1556	.0477	.1674	.4711
Co					1.0000	.0759	.0975	.7410	.2853
Cr						1.0000	.3427	-.0700	.1684
Fe							1.0000	.0863	.2277
Mn								1.0000	.1231
As									1.0000

Table 3(B). Pearson linear correlation matrix for the clay-sized fraction geochemical data.

TABLE 4

Variable:	Cu	Pb	Zn	Ni	Co	Cr	Fe	Mn	As	Au
Observations:	234	234	234	215	215	215	215	234	246	265
Minimum:	3	2	14	2	1	7	1.2	340	2	1
Maximum:	152	58	155	40	11	124	4.5	1050	34	15000
Mean:	8.4	11.3	33.5	8.7	4.3	44.8	2.1	650.2	3.4	298.6
Std. err. mean:	.7	.4	.8	.3	.1	1.7	.1	10.0	.3	75.4
Std. deviation:	11.2	5.9	12.0	4.4	1.1	24.9	.5	153.1	4.3	1227.4
Skewness:	9.8	3.6	5.6	3.3	1.3	1.0	1.6	.1	4.7	8.6
Kurtosis:	118.9	21.4	50.2	16.5	5.9	-.1	5.7	-.6	23.9	88.1

Table 4(A). Summary statistics for the heavy mineral geochemical data. The 1982 samples are not included.

	Cu	Pb	Zn	Ni	Co	Cr	Fe	Mn	As	Au
Cu	1.0000	-.0241	.1471	.0635	.4093	-.0778	.2327	-.1117	.2082	.0544
Pb		1.0000	.1394	.1898	.1274	.0293	-.0110	.2756	.2674	.1368
Zn			1.0000	.2930	.3060	-.1322	.2213	.1624	.2699	.0804
Ni				1.0000	.3808	.0641	-.0233	.0742	.2637	.2148
Co					1.0000	-.0843	.2682	.1495	.1424	.0217
Cr						1.0000	.2938	.5914	.0362	-.0779
Fe							1.0000	.4448	.1724	-.0136
Mn								1.0000	-.0130	.0194
As									1.0000	.0883
Au										1.0000

Table 4(B). Pearson linear correlation matrix for the heavy mineral data. The 1982 samples are not included.

probability scale (Fig. 26 and 27). Threshold values determined in the present study and those determined in the regional survey by Kaszycki and DiLabio (1986), are listed in Table 5.

Clay-sized fraction

Anomalous values of copper, lead and cobalt in the clay-sized fraction are shown in Figures 28, 29 and 30. The distribution of these elements, as well as those of zinc, iron and manganese (not shown), are patchy, difficult to interpret and show little indication of mineralization. The distribution of nickel and chromium (Fig. 31 and 32) shows anomalies 250 m long and 1.5 km wide, situated on and immediately down ice from the known mineralization on the west side of Keewatin River (Sherritt Gordon unpublished map). Arsenic distribution (Fig. 33) forms a glacial dispersion fan almost 2.5 km long and more than 0.5 km wide. The western side of the fan is open-ended and more detailed sampling may extend the anomaly to the west.

Heavy mineral fraction

The distribution of anomalous copper, nickel and arsenic values in the heavy mineral fraction is shown in Figures 34, 35 and 36. The distribution of these elements is patchy and difficult to interpret and shows little evidence of mineralization or glacial dispersion. Anomalous gold values (Fig. 37) form a well developed glacial dispersion fan, similar to the arsenic anomaly in the clay-sized fraction. The anomaly is 2.5 km long and up to 1 km wide, and extends down ice from the known mineralization on the west side of Keewatin River. The few samples collected along the mine road, in the area of the anomaly, indicate the dispersion fan is open to the west.

Silt and clay fraction

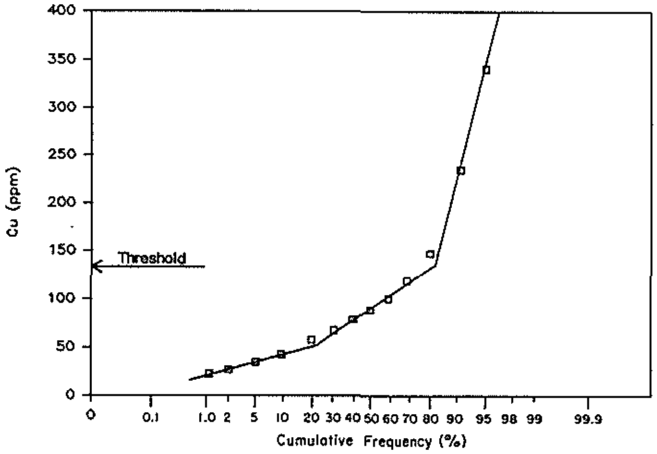
The less than 63 micron fraction of thirty samples, with gold values in the heavy mineral fraction between 5 and 8340 ppb, was analyzed by neutron activation. The results of the analysis are listed in Table 6. There is no apparent relationship between the two data sets and analysis of the less than 63 micron fraction did not reveal an anomaly in the area. Analysis of the less than 63 micron fraction by neutron activation does not appear to work in this area, although it has been shown to be successful in the Great Island area (Nielsen, 1987).

Visible Gold

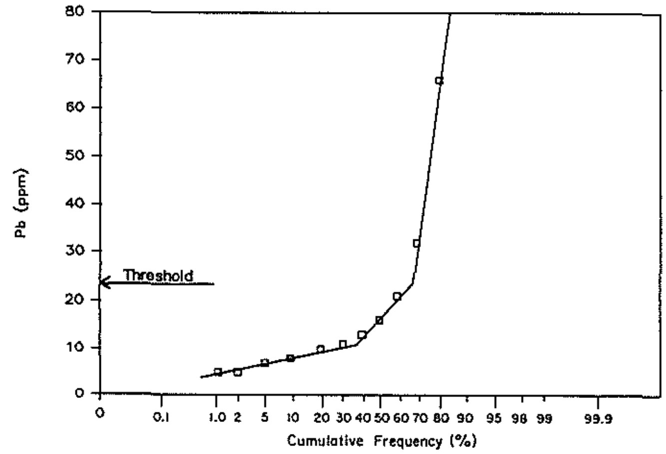
Visible gold was found in 14 samples. The size and characteristics of the gold grains are listed in Table 7 and their distribution is shown in Figure 37.

Only one sample, on the east side of Keewatin River, contained visible gold. None of the samples from the orientation survey, adjacent to MacLellan mineralization, contained visible gold. The number of samples with visible gold grains increases to the west and may reflect the distribution of larger gold grains in the source rock, although this remains to be determined.

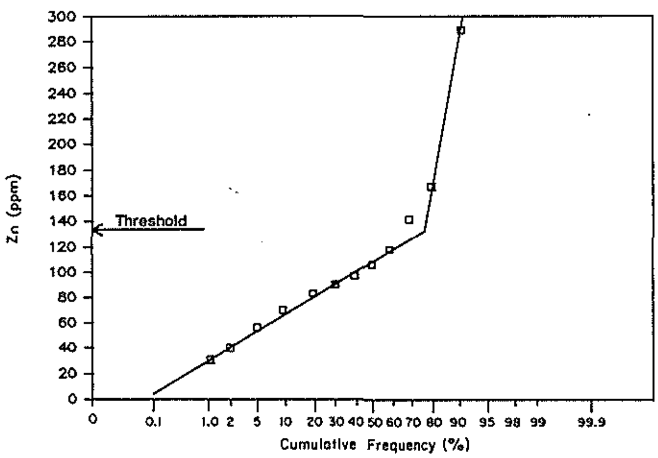
With the exception of one delicate gold grain in sample 84-16(c) the gold grains are all abraded or irregular in shape, indicating some glacial transport. The known mineralization trending southwest from Keewatin River (Fig. 37) is the most probable source of the visible gold.



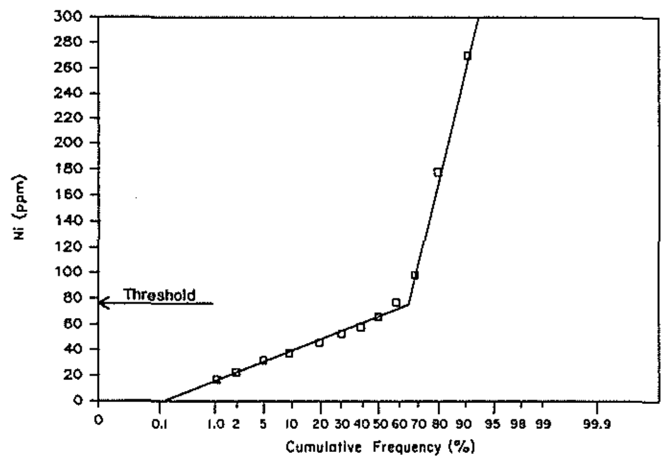
Cu (ppm)
Threshold
0 50 100 150 200 250 300 350 400
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9
Cumulative Frequency (%)



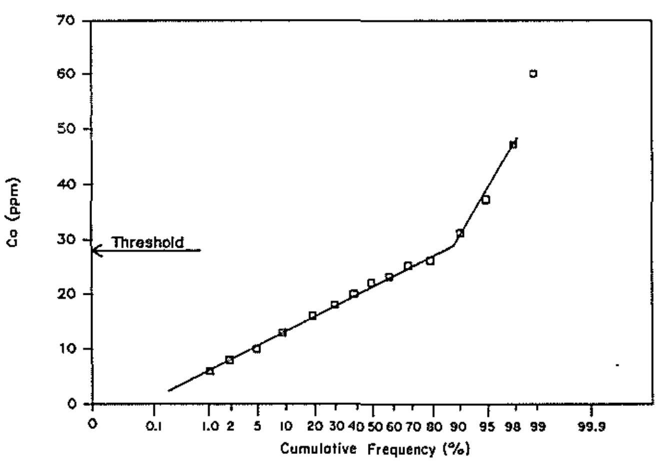
Pb (ppm)
Threshold
0 10 20 30 40 50 60 70 80
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9
Cumulative Frequency (%)



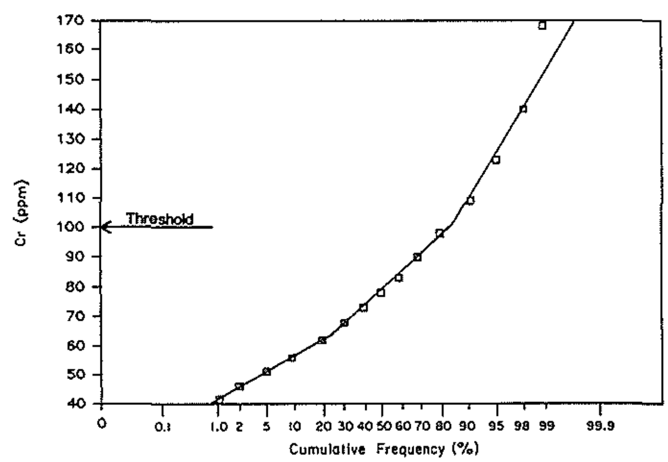
Zn (ppm)
Threshold
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9
Cumulative Frequency (%)



Ni (ppm)
Threshold
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9
Cumulative Frequency (%)



Co (ppm)
Threshold
0 10 20 30 40 50 60 70
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9
Cumulative Frequency (%)



Cr (ppm)
Threshold
40 50 60 70 80 90 100 110 120 130 140 150 160 170
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9
Cumulative Frequency (%)

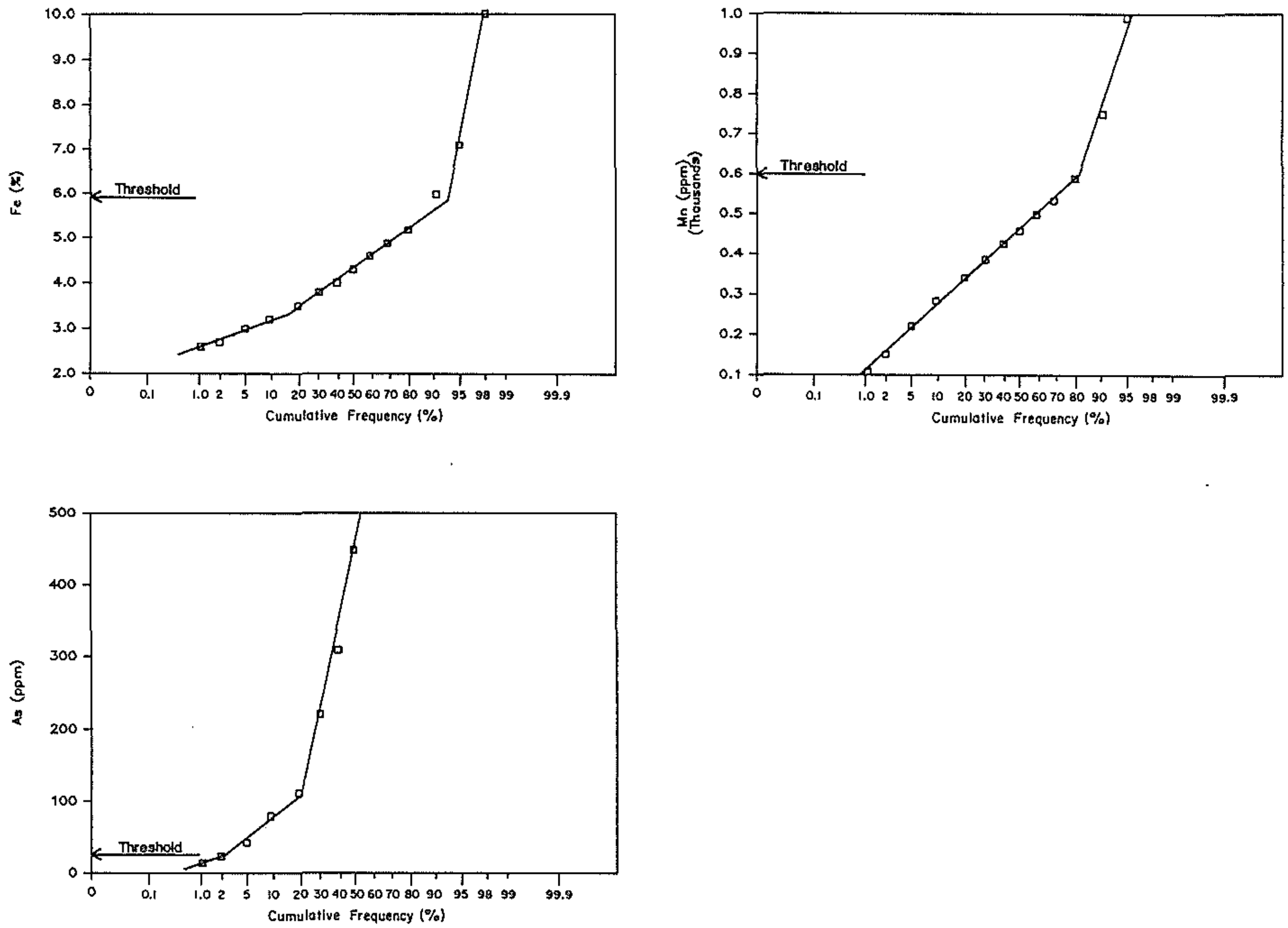
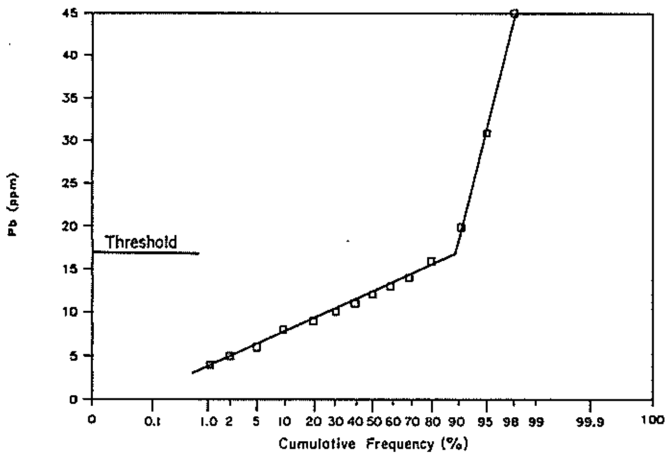
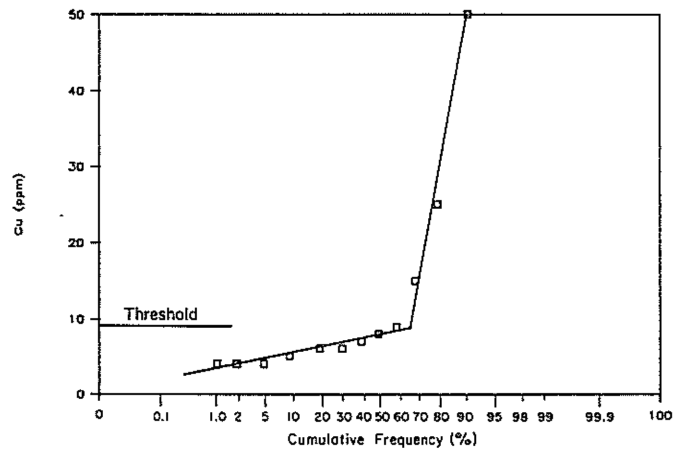
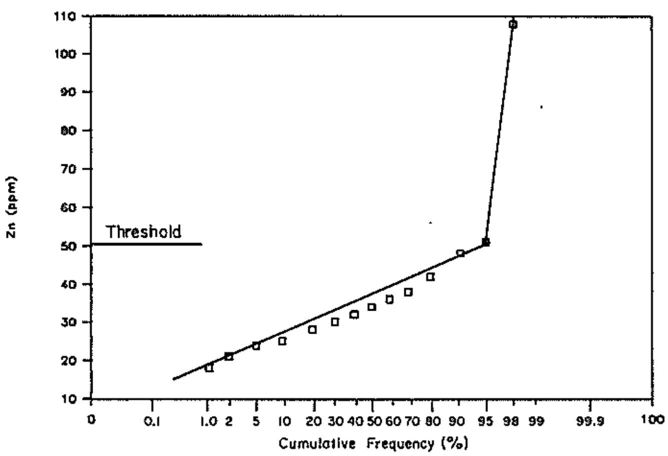
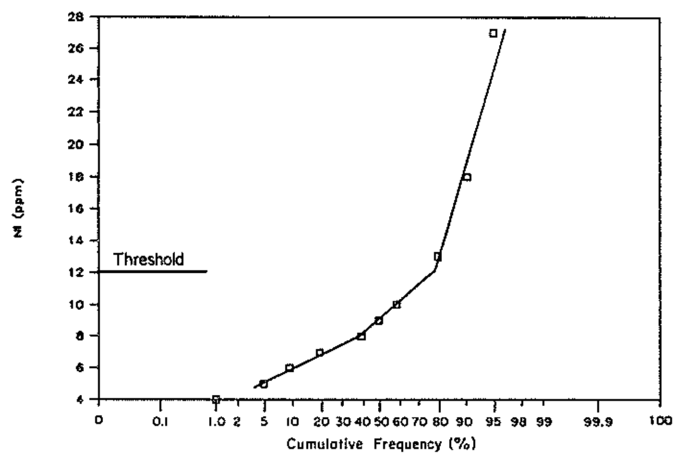


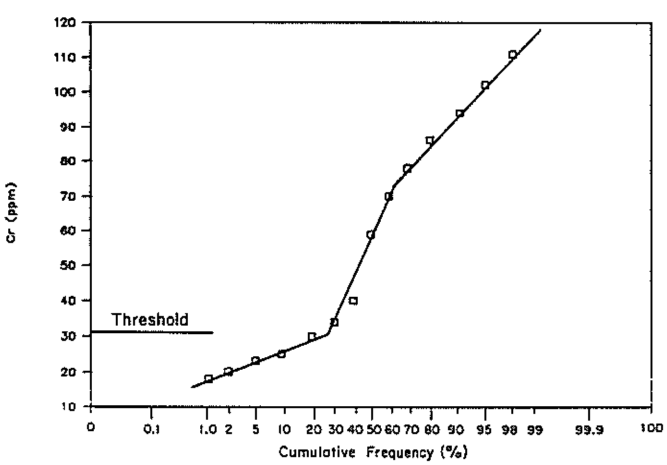
Figure 26: Cumulative frequency plots showing thresholds for the analysis of the clay-sized fraction.

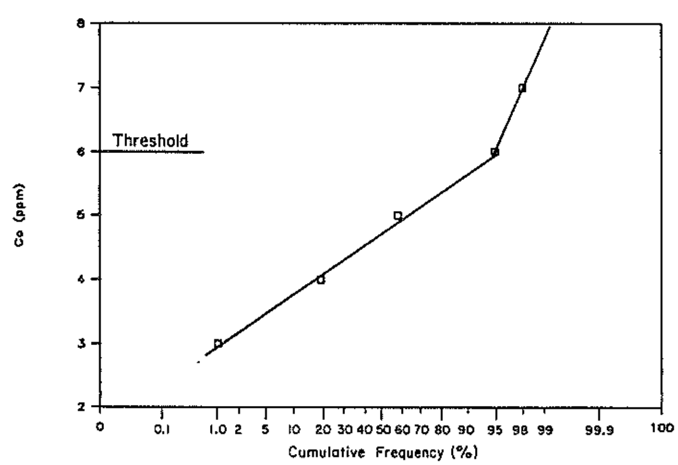

Pb (ppm)
0
5
10
15
20
25
30
35
40
45
Threshold
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9 100
Cumulative Frequency (%)


Cu (ppm)
0
10
20
30
40
50
Threshold
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9 100
Cumulative Frequency (%)


Zn (ppm)
10
20
30
40
50
60
70
80
90
100
110
Threshold
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9 100
Cumulative Frequency (%)


Ni (ppm)
4
6
8
10
12
14
16
18
20
22
24
26
28
Threshold
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9 100
Cumulative Frequency (%)


Cr (ppm)
10
20
30
40
50
60
70
80
90
100
110
120
Threshold
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9 100
Cumulative Frequency (%)


Co (ppm)
2
3
4
5
6
7
8
Threshold
0 0.1 1.0 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.9 100
Cumulative Frequency (%)

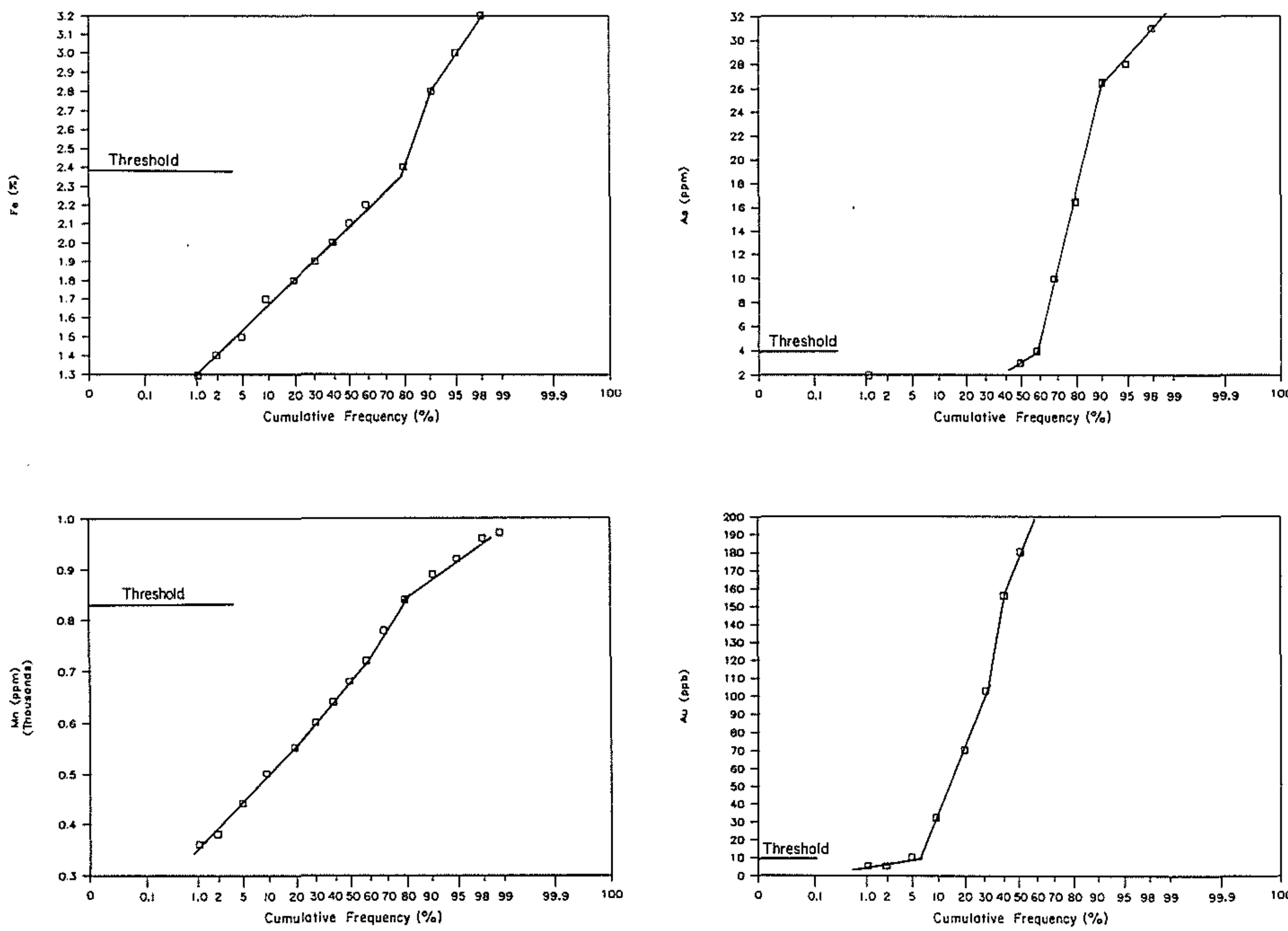


Figure 27: Cumulative frequency plots showing thresholds for the analysis of the heavy mineral data without the 1982 data.

TABLE 5

THRESHOLD VALUES FOR THE HEAVY MINERAL AND CLAY-SIZED DATA DETERMINED FROM CUMULATIVE PROBABILITY PLOTS, COMPARED TO THE 90TH AND 95TH PERCENTILES OF KASZYCKI AND DILABIO (1986)

	This Study			Kaszycki and DiLabio, 1986	
Element	Heavy minerals		Clay fraction	90th percentile	95th percentile
	All data	Without 1982 data			
Cu ppm	15	10	140	109	134
Pb ppm	27	17	25	18	20
Zn ppm	35	50	135	166	190
Ni ppm	12	12	78	56	65
Co ppm	5	6	28	-	-
Cr ppm	32	32	100	108	123
Fe %	2.2	2.4	6.0	5.7	6.1
Mn ppm	-	800	600	730	805
As ppm	4	4	20	15	24
Au ppb	10	10	-	-	-

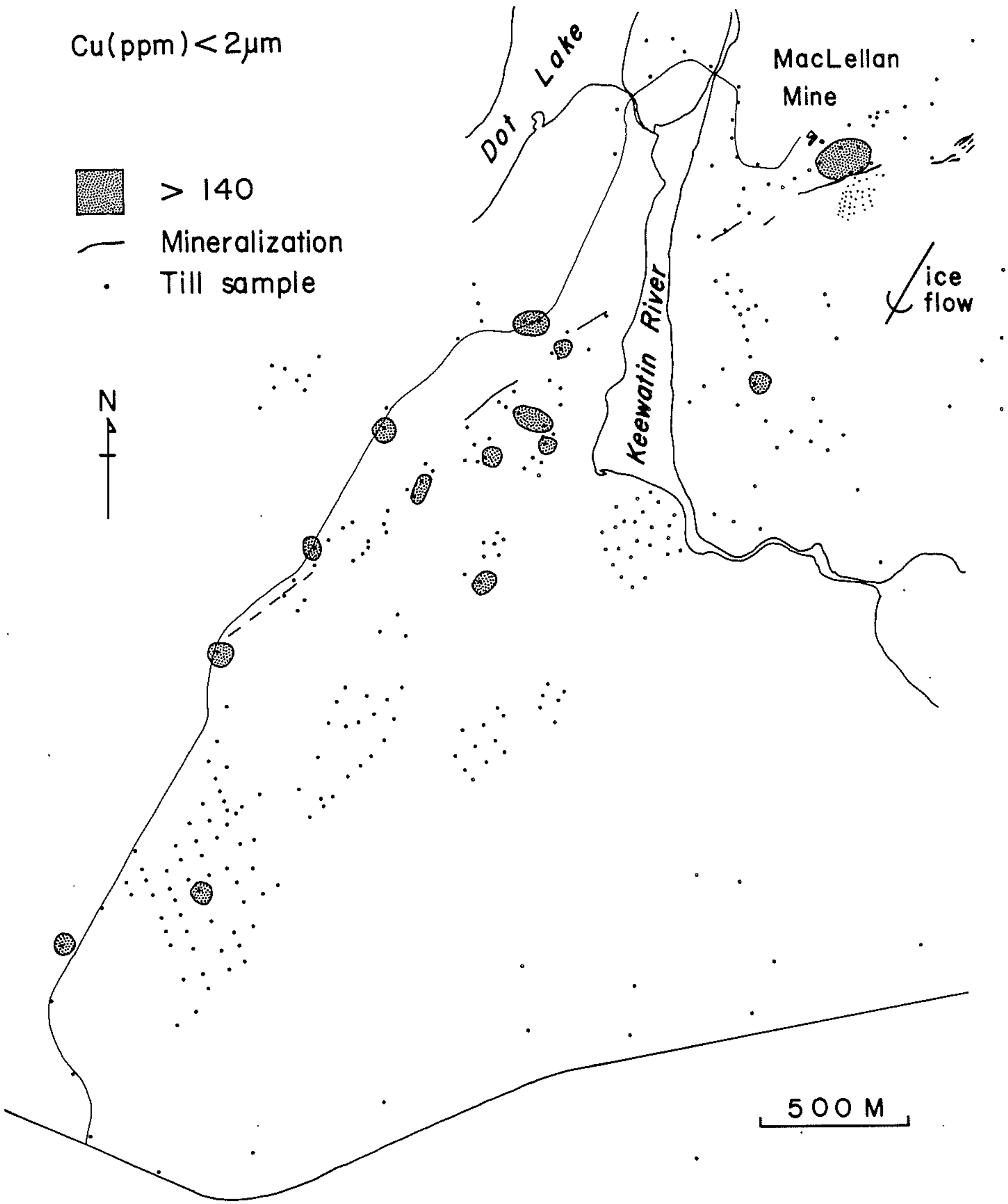


Figure 28: Distribution of copper above the threshold value in the clay-sized fraction.

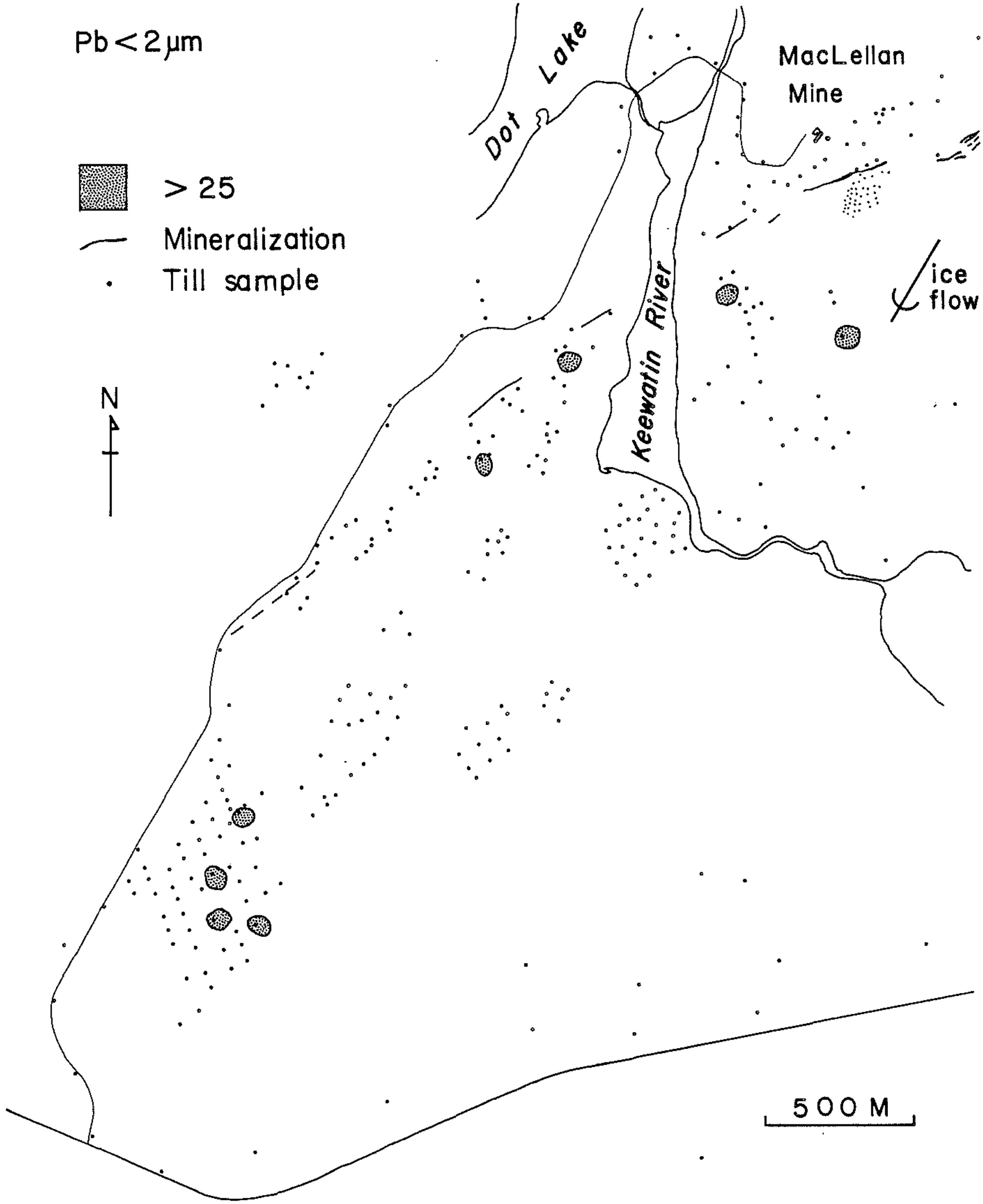


Figure 29: Distribution of lead above the threshold value in the clay-sized fraction.

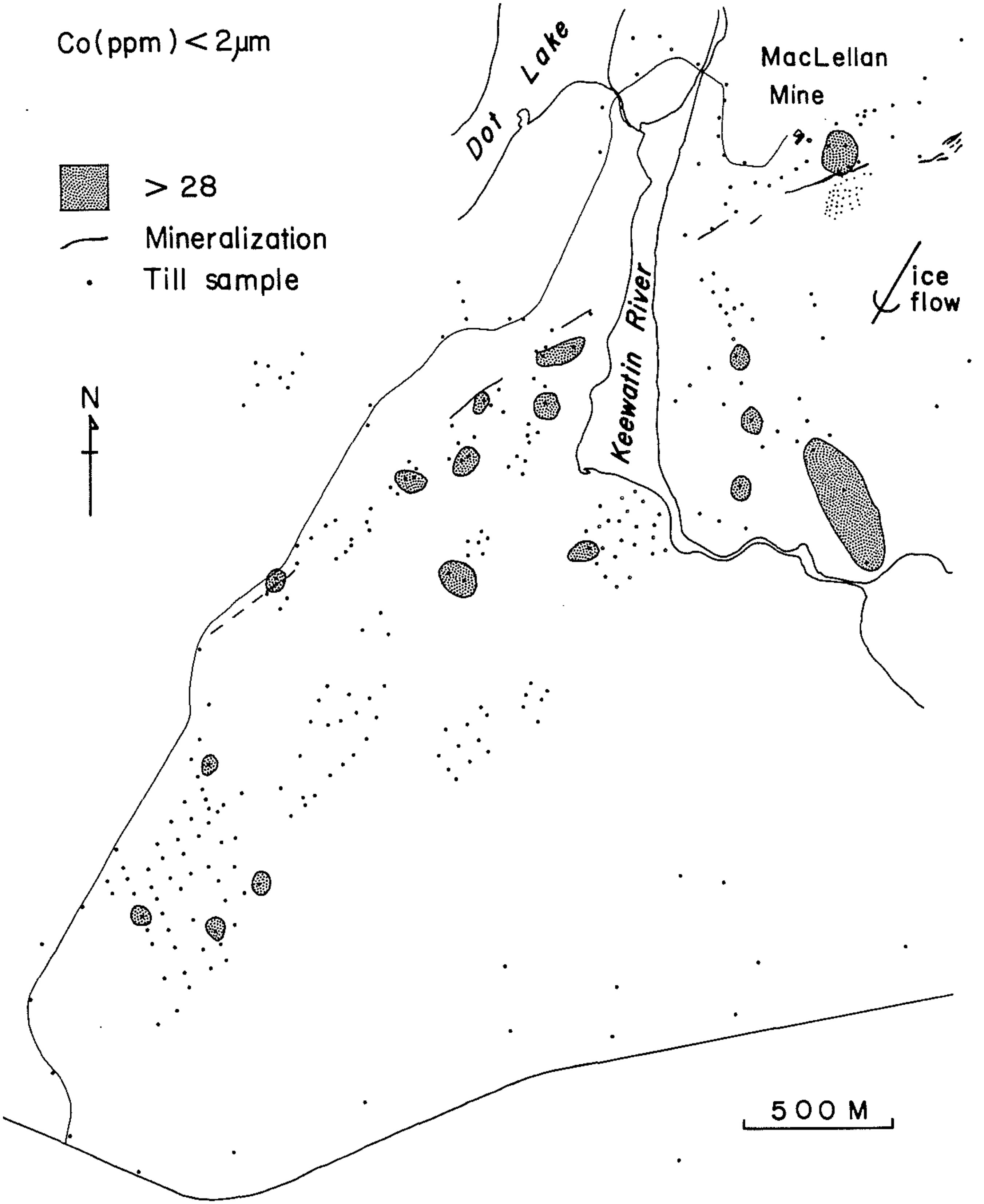


Figure 30: Distribution of cobalt above the threshold value in the clay-sized fraction.

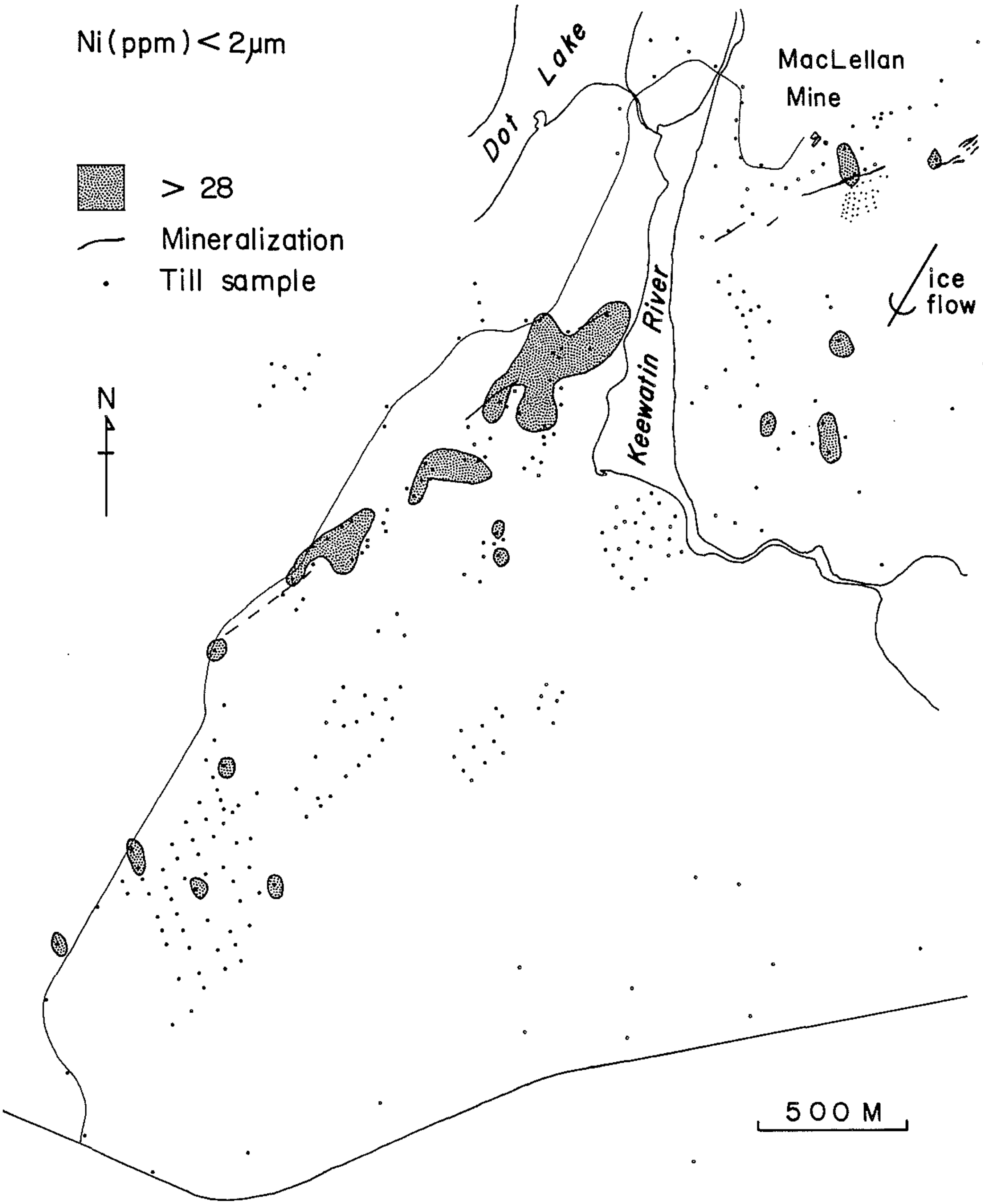


Figure 31: Distribution of nickel above the threshold value in the clay-sized fraction.

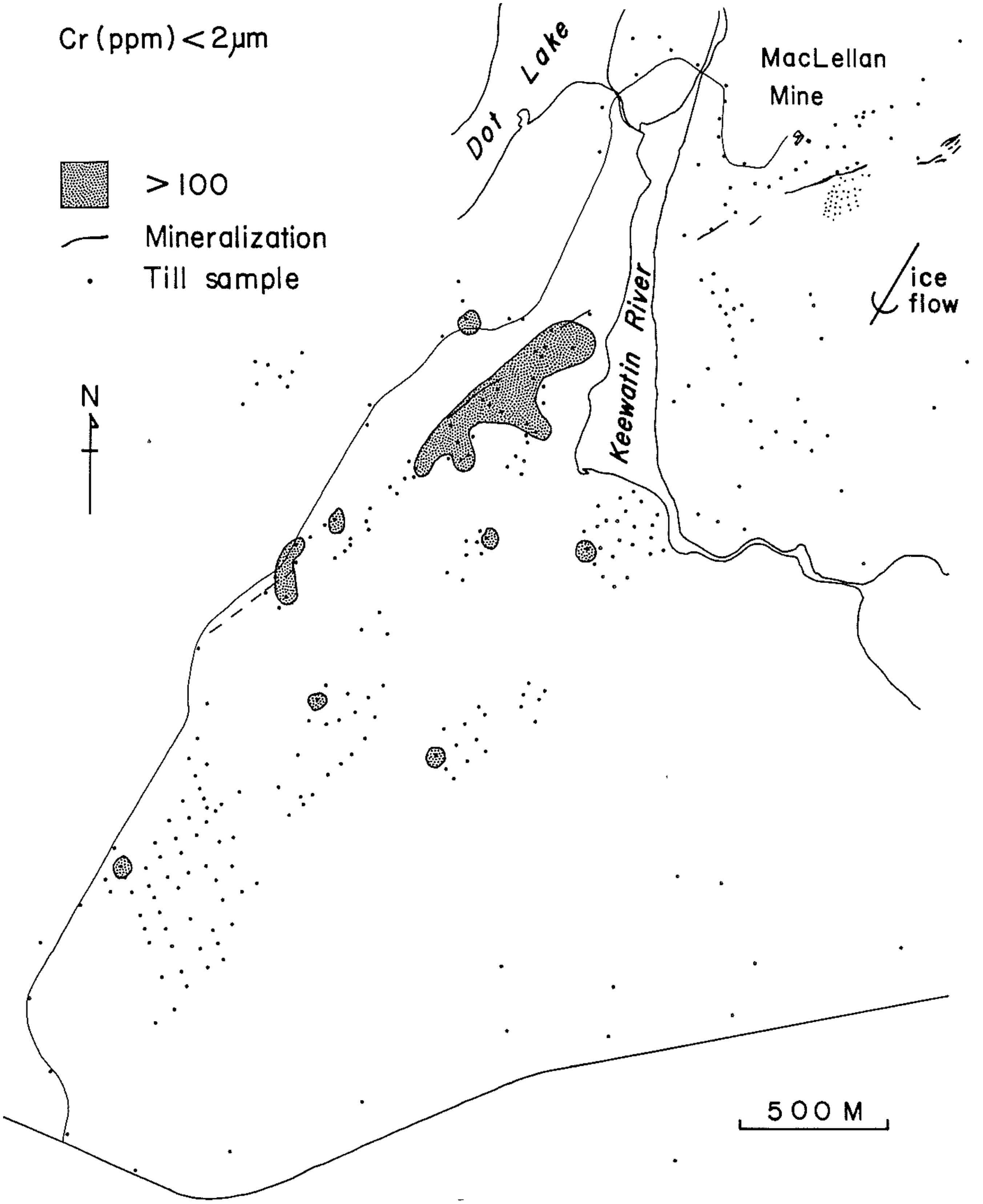


Figure 32: Distribution of chromium above the threshold value in the clay-sized fraction.

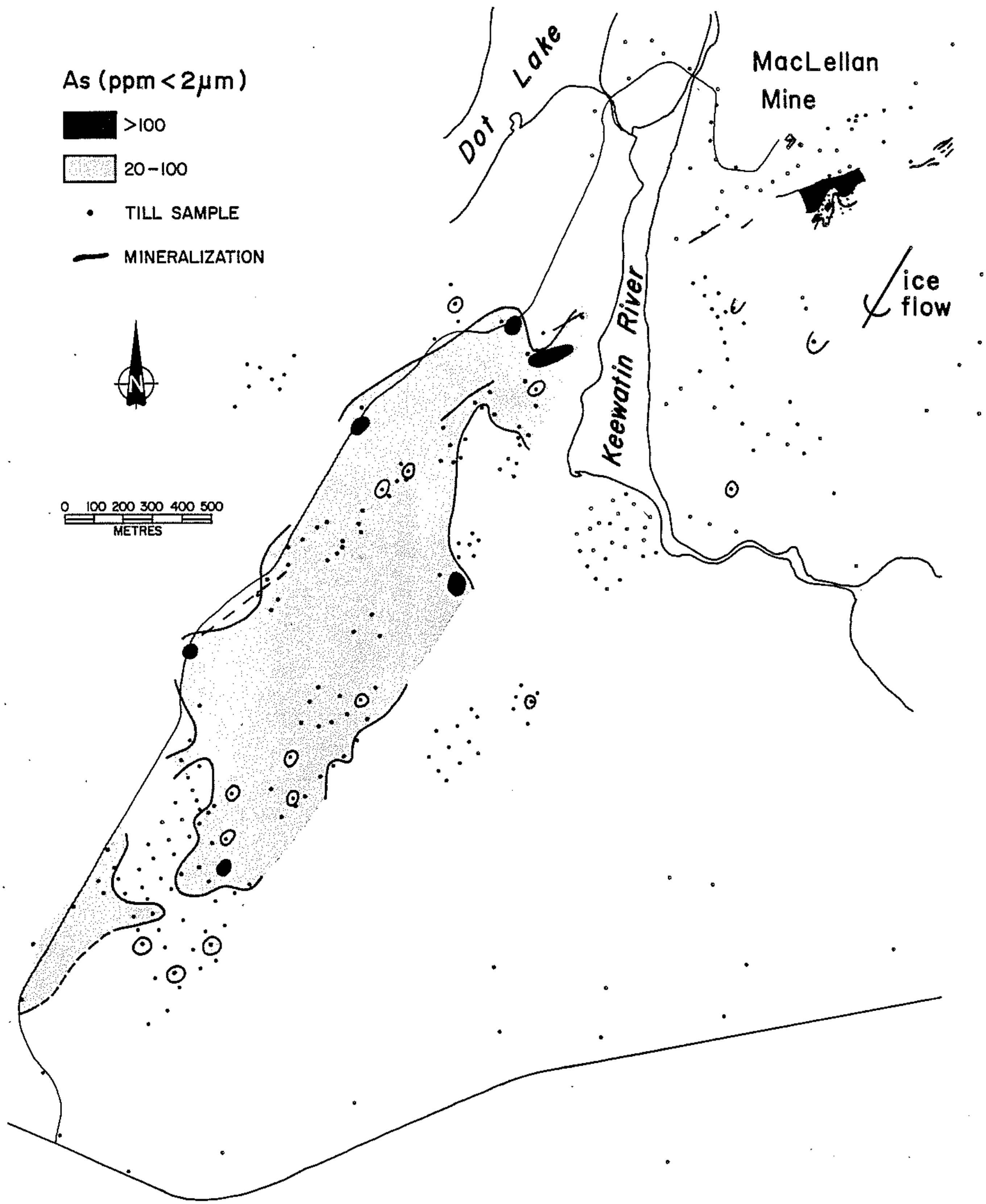


Figure 33: Distribution of arsenic above the threshold value in the clay-sized fraction.

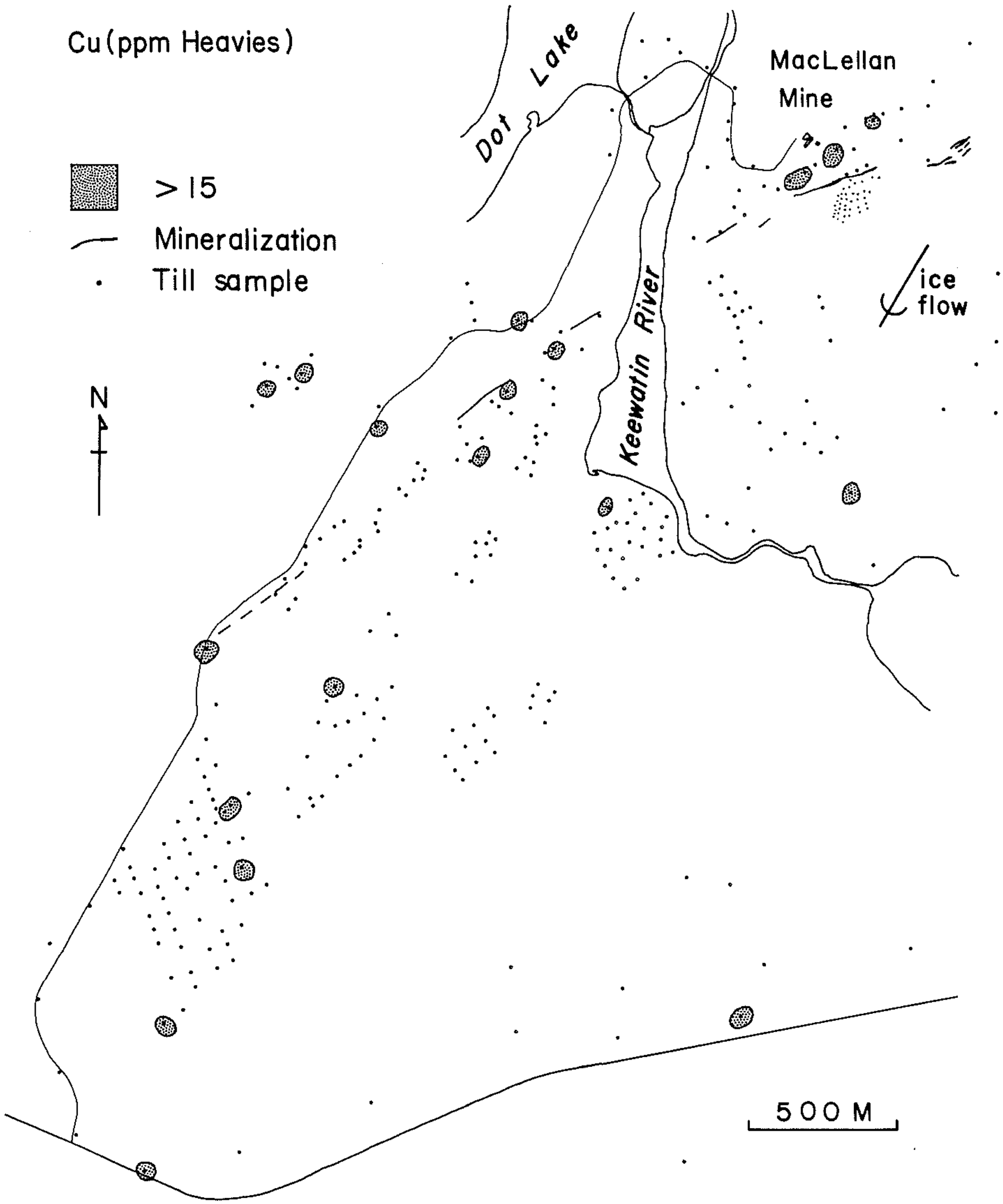


Figure 34: Distribution of copper above the threshold value in the heavy mineral fraction. The 1982 data are not included.

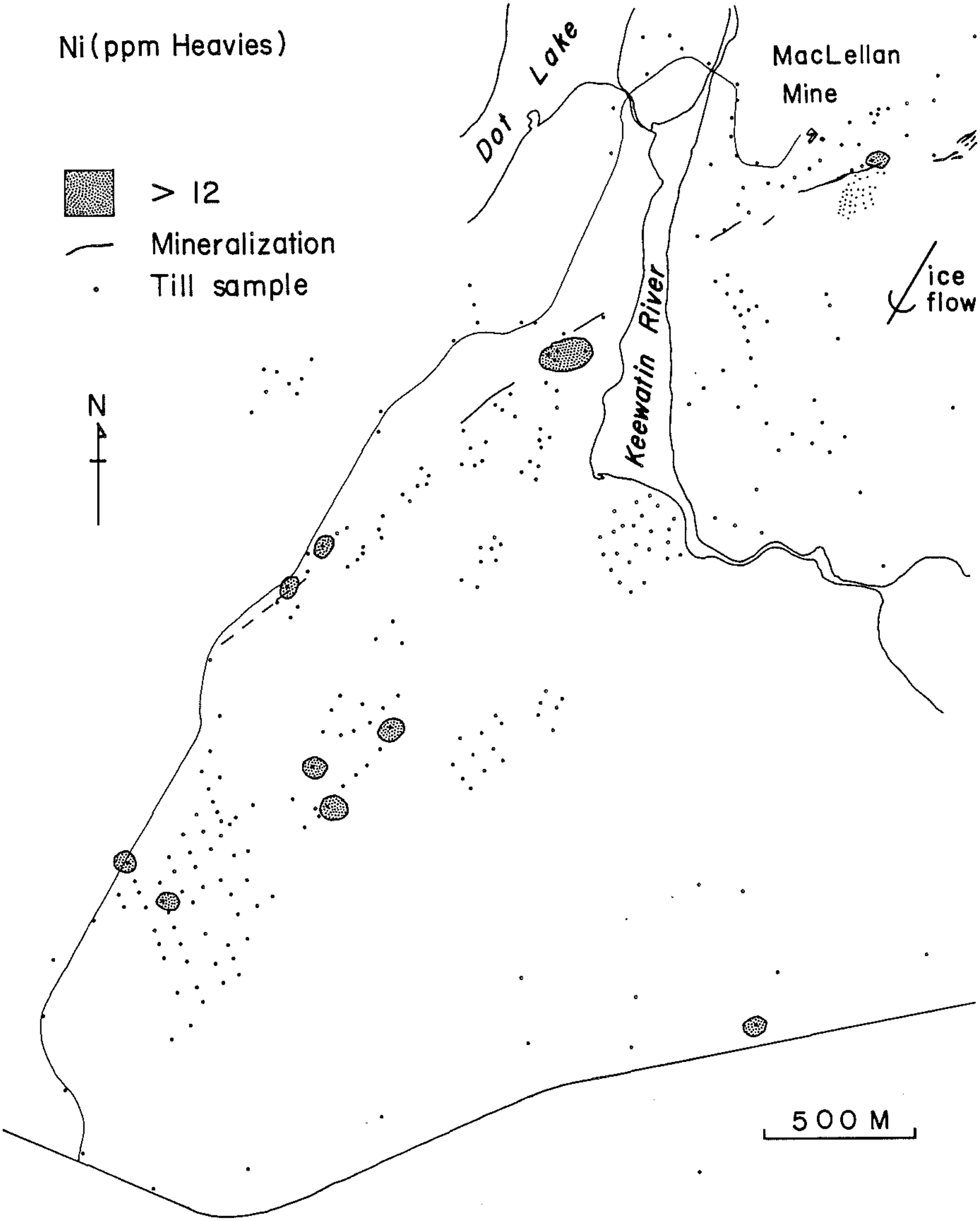


Figure 35: Distribution of nickel above the threshold value in the heavy mineral fraction. All data are included.

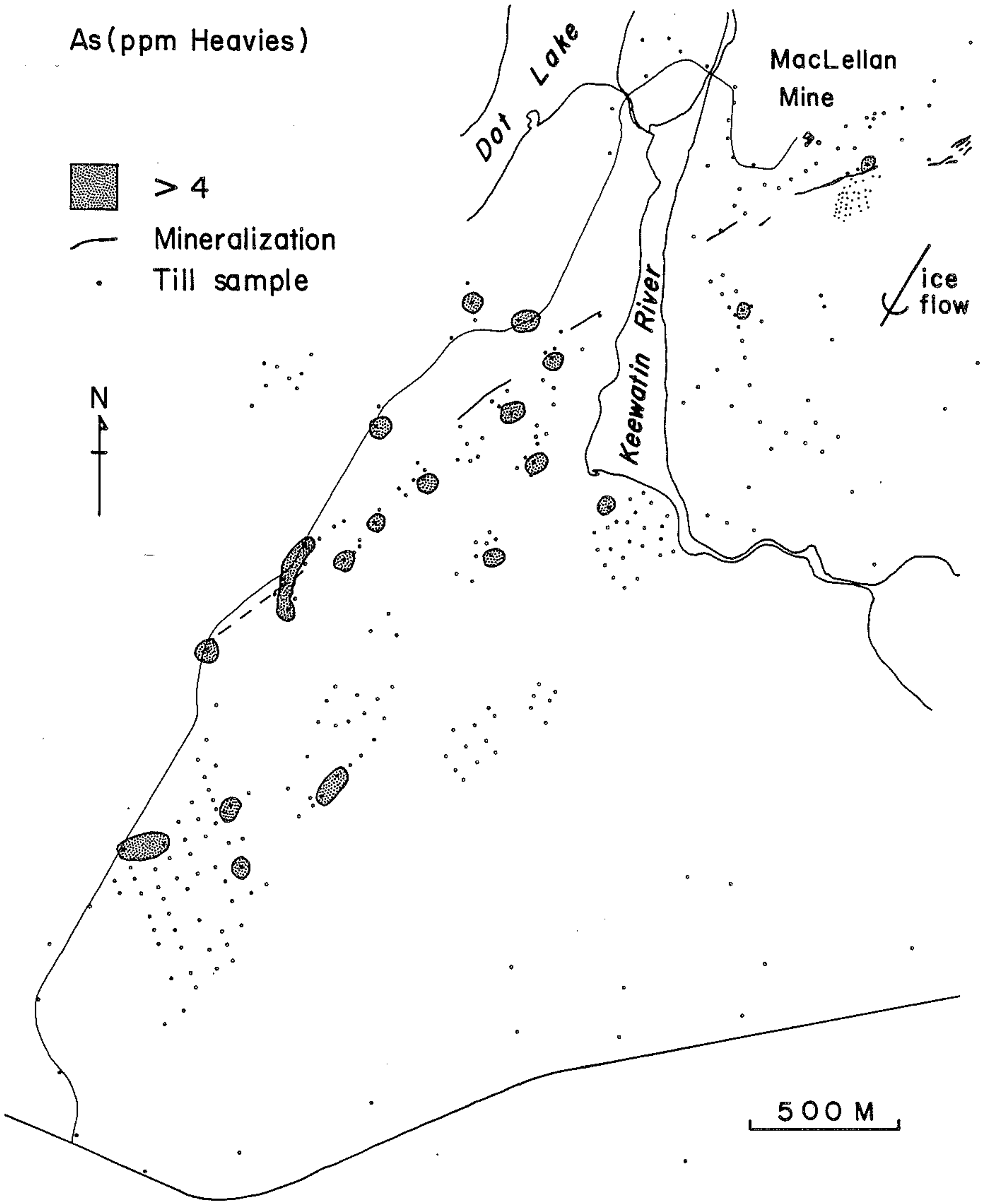


Figure 36: Distribution of arsenic above the threshold value in the heavy mineral fraction. All data are included.

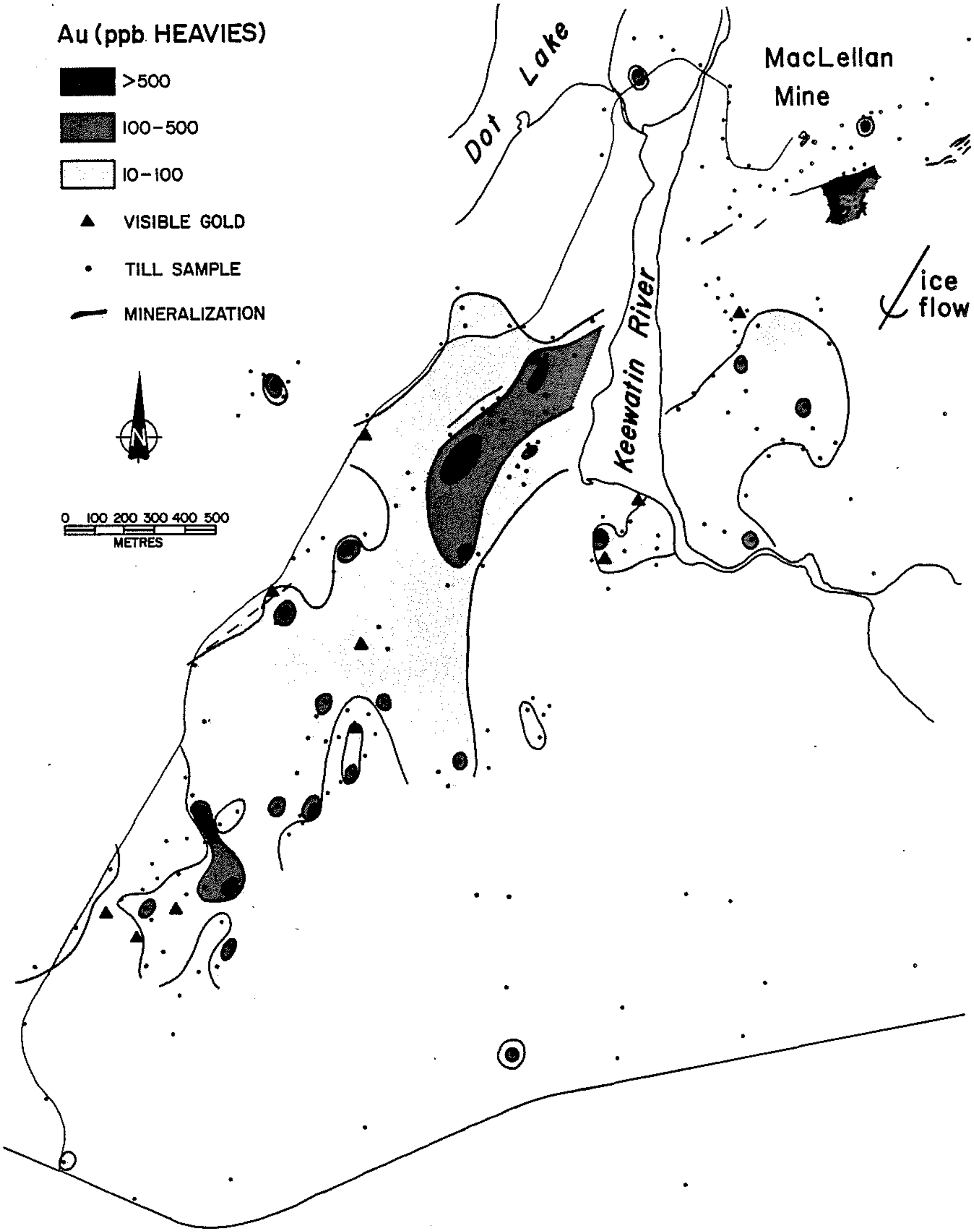


Figure 37: Distribution of gold above the threshold value in the heavy mineral data. All data are included.

TABLE 6

COMPARSION OF GOLD ANALYSIS ON THE HEAVY MINERAL FRACTION AND LESS THAN 63 MICRON FRACTION OF SELECTED TILL SAMPLES

Sample Number	Neutron Activation (< 63 um)	Fire Assay A.A. (S.G. > 2.96)
3	< 5	85
6(c)	< 5	40
11(c)	< 5	125
12(c)	< 5	5
12(b)	< 5	70
15(b)	< 5	175
15(d)	< 5	630
17(a)	< 5	45
17(c)	18	15
19(a)	32	295
19(b)	6	65
24(a)	8	15
24(b)	< 5	90
31(b)	< 5	1045
33(a)	7	485
34	25	945
35(a)	< 5	315
35(b)	< 5	145
36(a)	< 5	875
38	< 5	590
39(a)	< 5	435
39(b)	< 5	55
39(c)	< 5	65
39(b)	< 5	54
40(b)	< 5	180
43(a)	< 5	450
45(a)	< 5	1670
48(b)	< 5	8340
51(a)	< 5	60
51(b)	< 5	180

TABLE 7

CHARACTERISTICS OF VISIBLE GOLD GRAINS

Sample Number	Dimensions (in microns)	Grain Shape	Number of Grains
83-52	200 x 100	Abraded	1
84-16(a)	100 x 150	Abraded	1
84-16(c)	100 x 150	Delicate	1
84-24(b)	50 x 100	Irregular	1
84-47(c)	100 x 150	Irregular	1
84-48(b)	50 x 50	Abraded	1
	100 x 100	Abraded	1
	100 x 150	Abraded	1
	50 x 50	Irregular	2
	50 x 100	Irregular	1
	100 x 100	Irregular	2
	100 x 150	Irregular	1
	250 x 450	Irregular	1
85-32	125 x 125	Abraded	1
85-36	50 x 50	Abraded	1
	50 x 150	Abraded	1
85-46	50 x 75	Abraded	1
85-57	50 x 100	Abraded	1
85-61	100 x 100	Abraded	1
85-86	75 x 225	Irregular	1
	100 x 100	Irregular	1
85-100	75 x 125	Irregular	1
85-108	75 x 100	Abraded	1
85-130	125 x 150	Abraded	1

CONCLUSIONS AND RECOMMENDATIONS

The composition of the pebble fraction and the texture of the till indicate most of the till has undergone relatively long-distance glacial transport from the area north of the greenstone belt. The till was transported englacially and deposited by lodgment and subglacial melt-out on and around bedrock obstructions. Much of the till around bedrock obstructions was deposited as flow till in subglacial cavities that formed in the lee of obstructions. Geochemical variability in the till appears to be absent around the bedrock obstacles.

In spite of the low proportion of locally derived material in the till there is clear evidence of glacial dispersion from local sources.

Two distinctly different dispersion trains are found in the area. The dispersion train associated with the MacLellan deposit, though not entirely mapped because of widespread black spruce bog, is only 150-200 m long. The dispersion train associated with the extension of the MacLellan mineralization, west of Keewatin River, is up to 1.5 km long. The difference in length of the dispersion trains is believed to be due to differences in local topography in the two areas. At the MacLellan deposit, mineralization is situated on the south side of a large hill, rising 21 m (70 ft.) in the up-ice direction. Mineralization outcrops on the lee side of the hill and was, in part, protected from glacial erosion. West of Keewatin River, mineralization outcrops on the flank of a hill, on relatively level ground that was more exposed to glacial erosion (Fig. 3). Local relief and its relationship to outcropping of mineralization is believed to have affected the length of the dispersion train. When till sampling is undertaken in areas of shallow drift, care must be taken to evaluate the effect of topography. Sample spacing of 0.5 km would be sufficient to detect the overburden anomaly on the west side of Keewatin River, but would not give any indication of the mineralization at MacLellan Mine. A sampling interval of approximately 100 m is needed to detect short dispersion trains associated with mineralization outcropping in the "lee" of topographic obstructions, such as those found in the Lynn Lake area.

Vertical sampling indicates relatively unweathered drift may be sampled from hand-dug holes. The best results, when analyzing the clay-sized fraction, are achieved from samples collected at a depth of approximately 1 metre or more. Gold analysis of the heavy mineral fraction is variable through the profile and there appears to be little relationship between depth of sampling and gold content.

The clay-sized fraction gives the highest geochemical values of all the size fractions tested. Arsenic analysis of the clay-sized fraction and gold analysis of the heavy mineral fraction show well formed dispersion trains associated with the mineralization on both sides of Keewatin River and are the best indicators of gold in the area. Many of the other elements, in both fractions, show anomalies associated with the MacLellan deposit but these dispersion trains are generally shorter and more "patchy". Only nickel and chromium, in addition to arsenic in the clay-sized fraction, show any indications of mineralization on the west side of Keewatin River. The nickel and chromium anomalies are, however, very short.

The generally abraded to irregular shape of visible gold grains suggests they have undergone at least some glacial transport and were derived from the western extension of the MacLellan mineralization, on the west side of Keewatin River, and not from an unknown source in the vicinity of sample 84-48 as might be indicated by the distribution of visible gold and such elements as arsenic, gold and nickel in the heavy mineral fraction and possibly lead in the clay-sized fraction.

Analysis of the less than 63 micron fraction for gold and arsenic is not recommended in this area.

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APPENDIX I

PETROGRAPHIC COMPOSITION OF THE 4-16 MM SIZE FRACTION

Sample Number	Crystallines	Greywacke	Volcanics	n
69-82- 1	94	3	3	176
69-82- 2	93	2	5	210
69-82- 3	94	2	4	249
69-82- 4	95	2	3	243
69-82- 5	81	2	17	209
69-82- 6	87	1	12	238
69-82- 7	81	0	19	198
69-82- 8	81	1	18	207
69-82- 9	78	0	22	223
69-82-10	80	0	20	196
69-82-11	57	0	43	226
69-82-12	70	0	30	244
69-82-13	84	0	16	224
69-82-14	96	0	4	236
69-82-15 (a)	95	2	3	202
69-82-15 (c)	96	1	3	273
69-82-16	92	2	6	233
69-82-17 (c)	96	0	4	278
69-82-18	97	1	2	234
69-82-19	94	3	3	230
69-82-20	92	1	7	182
69-82-21	98	1	1	226
69-82-22 (b)	93	1	6	205
69-82-23	97	0	3	277
69-82-24 (a)	98	0	2	264
69-82-24 (b)	96	2	2	193
69-82-25	93	1	6	271
69-82-26 (a)	93	1	6	269
69-82-26 (b)	73	1	26	285
69-82-27	83	4	13	198
69-82-28 (a)	91	2	7	282
69-82-28 (b)	70	0	30	230
69-82-29	96	2	2	214
69-82-30	94	2	4	185
69-82-31 (b)	95	1	4	386
69-82-32	94	3	3	267
69-82-33	91	3	6	272
69-82-34 (a)	88	3	9	213
69-82-34 (b)	52	0	48	178
69-82-36	79	2	19	200
69-82-37	86	4	10	222
69-82-38 (a)	91	1	8	275
69-82-38 (b)	82	9	9	211
69-82-39	80	2	18	158
69-82-40	84	0	16	213
69-82-41	93	2	5	268
69-82-42	95	1	4	214
69-82-43	92	2	6	263

Sample Number	Crystallines	Greywacke	Volcanics	n
69-82-44	84	1	15	217
69-82-45	88	3	9	239
69-82-46	85	2	13	235
69-82-47	95	2	3	229
69-82-48	89	1	10	247
69-82-49	90	4	6	192
69-82-50	89	1	10	215
69-82-51	60	0	40	300
69-82-52	56	1	43	244
69-82-53	87	1	12	275
69-82-54	93	0	7	358
69-82-55	91	2	7	248
69-82-55 (b)	92	1	7	254
69-82-57	92	1	7	198
69-82-58	92	2	6	211
69-82-59	93	0	7	210
69-82-60	96	0	4	179
69-82-61	96	2	2	170
69-82-62	91	3	6	248
69-82-63	91	0	9	254
69-82-64	95	0	5	207
69-82-65	79	1	20	228
69-82-66	85	2	13	183
69-82-67	94	2	4	240
69-82-68	91	0	9	211
69-82-69	89	2	9	208
69-82-70	88	1	11	219
69-82-71	94	1	5	275
69-82-72	90	1	9	221
69-82-73	94	1	5	202
69-82-74	93	0	7	214
69-82-75	96	1	3	291
69-82-76	96	0	4	339
69-82-77	87	1	12	188
69-82-78	86	2	12	156
69-82-79	92	1	7	202
69-82-80	84	1	15	271
69-82-81	91	1	8	180
69-82-82	85	1	14	277
69-82-83	93	0	7	241
69-82-84	97	0	3	264
69-82-85	97	0	3	208
69-82-86	85	3	12	156
69-82-88	82	2	16	182
69-82-89	89	3	8	149
69-82-90	91	4	5	257
69-82-91	90	2	8	173
69-82-92	85	3	12	116
69-82-93	90	2	8	201
69-82-94	89	0	11	217
69-82-95	92	1	7	256

APPENDIX II

GEOCHEMICAL DATA FOR THE CLAY-SIZED FRACTION

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
82-5	93	9	109	64	22		3.8	520	9
82-6	127	9	195	55	18	95	6.0	565	10
82-7	85	10	116	65	22		3.8	555	44
82-8	152	15	172	85	21	80	5.2	535	43
82-9	123	10	144	68	21	92	5.3	570	51
82-10	123	14	111	98	27	84	4.2	610	49
82-11	340	14	230	135	23	81	6.0	580	238
82-12	234	9	216	92	26	102	6.2	550	45
82-13	200	8	85	78	18	63	4.2	335	142
82-14	83	12	142	59	18	70	4.6	475	2
82-15 B	42	14	150	53	22	75	5.2	620	3
82-15 C	88	8	123	58	20	68	4.0	435	<2
82-17 A	40	12	115	51	16	84	5.1	425	3
82-17 B	60	11	141	54	16	60	4.8	455	2
82-18	53	12	146	58	24	77	5.4	535	4
82-19	48	6	82	34	18	50	3.1	400	5
82-20	49	10	108	56	27	54	3.8	595	2
82-22 B	87	11	140	62	21	59	4.6	470	3
82-23	84	12	152	55	20	64	4.8	495	3
82-24 A	49	8	102	39	20	47	3.4	430	2
82-24 B	109	7	163	64	17	58	4.5	380	3
82-25	115	11	155	59	25	73	5.2	650	3
82-26 A	92	6	125	49	18	56	4.1	435	2
82-27	103	11	105	64	25	57	3.7	475	3
82-28 A	67	9	100	45	21	50	3.5	420	<2
82-28 B	158	12	138	52	22	76	6.0	465	11
82-29	65	10	100	46	25	56	3.5	535	<2
82-30	90	9	143	53	16	41	4.2	390	4
82-31 A	62	13	130	52	21	63	4.4	500	3
82-32	33	6	79	38	18	38	3.3	425	3
82-36	178	10	115	85	42		4.8	720	7
82-37	140	10	139	68	30	83	5.2	560	8
82-38 A	150	10	176	73	25	82	5.7	560	8
82-38 B	235	14	232	83	28	108	7.1	600	13
82-39	79	13	102	55	23	61	4.3	490	6
82-40	88	16	440	188	22	70	4.4	550	92
82-41	74	10	109	48	27	67	4.8	610	7
82-42	68	8	147	50	22	68	4.5	560	7
82-43	111	11	149	49	18	60	4.7	480	12
82-44	125	10	130	67	24	57	3.9	535	8
82-45	127	10	157	59	19	69	5.2	450	6
82-46	100	11	128	54	25	68	4.7	535	4
82-47	125	9	133	58	20	58	4.1	465	2
82-48	99	12	128	54	27	77	5.2	570	6
82-49	74	11	156	61	22	80	5.3	530	3
82-50	33	9	104	40	17	59	4.1	440	3
82-51	165	190	540	270	44	105	5.2	600	648
82-54	60	8	109	53	21	51	3.4	370	2

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
82-55 A	46	12	144	55	20	76	4.8	375	4
82-55 B	82	7	125	45	17	46	3.3	300	3
82-56 B	49	10	155	59	21	86	4.9	385	5
82-57	43	10	68	40	17		2.8	260	
82-58	123	13	152	66	32	60	4.3	530	13
82-59	66	13	121	44	27	61	4.0	450	14
82-60	90	9	145	52	23	61	4.0	475	14
82-61	66	12	125	50	23	61	4.1	440	8
82-62	157	9	167	72	22	62	4.4	390	15
82-63	120	10	154	58	22	59	4.3	385	7
82-64	108	9	158	106	34	65	3.8	425	6
82-65	85	4	215	56	18	48	3.0	275	10
82-66	108	8	139	70	25	56	3.4	425	51
82-67	47	13	92	34	21	46	3.4	430	5
82-68	112	9	146	59	26	79	4.9	385	9
82-69	82	10	98	65	22		3.6	305	9
82-70	69	15	113	61	28	74	4.3	280	22
82-71	113	11	135	67	21	54	3.8	390	10
82-72	42	8	78	28	13	35	2.6	260	6
82-73	130	11	178	70	26	80	5.3	500	6
82-74	63	5	127	109	24	58	3.5	375	7
82-76	64	9	96	53	25	53	3.3	300	4
82-77	115	10	128	77	27	57	3.6	430	3
82-78	130	16	104	75	23	79	4.8	240	11
82-79	98	12	110	87	24	63	4.3	370	5
82-80	113	11	110	80	30	63	4.2	405	11
82-81	68	10	84	46	20	55	3.7	300	6
82-82	104	20	174	61	21	56	4.2	380	12
82-83	35	8	53	30	15	35	2.5	275	4
82-84	56	10	136	70	22	69	4.7	455	4
82-85	52	10	111	45	19	54	3.8	360	3
82-86	53	33	109	84	24	70	4.5	365	79
82-88	82	10	120	58	30	73	4.6	400	6
82-89	117	14	120	76	31	79	5.1	480	6
82-90	49	9	97	48	22	60	3.9	320	4
82-91	68	11	97	48	18	65	4.4	315	5
82-92	63	9	115	54	26	75	4.7	375	6
82-93	72	8	85	49	19	46	3.2	245	10
82-94	34	13	103	42	20	67	4.3	470	6
82-95	83	9	113	68	26	66	3.9	345	5
83-10 1	33	20	31	22	7	90	7.7	167	18
83-10 2	111	19	150	62	22	89	5.1	990	18
83-11 A	55	19	424	83	15	65	3.6	300	40
83-11 B	242	14	238	94	35	108	6.7	750	100
83-12 A	74	48	76	186	24	66	4.9	480	38
83-12 B	144	21	137	132	18	90	5.1	750	238
83-12 C	16	16	17	14	3	79	5.2	50	13
83-13	85	39	128	238	16	86	3.5	235	27
83-14 1	22	12	24	24	6	77	5.0	90	10
83-14 2	48	15	75	55	14	61	3.7	325	10
83-15	77	36	102	158	14	72	4.1	300	80

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
83-16	124	41	143	861	27	83	4.3	490	166
83-17 A	152	64	352	202	37	51	4.2	840	389
83-17 B	231	83	747	365	58	88	8.9	920	603
83-17 C	21	16	31	37	8	61	4.3	150	
83-18	43	17	80	70	22	50	2.8	565	23
83-19 1	13	34	18	11	3	71	6.7	130	
83-19 2	38	24	72	48	10	56	3.6	280	42
83-20	84	35	128	74	24	78	5.0	970	140
83-21	40	15	96	127	16	94	4.5	340	102
83-22 1	24	24	17	13	3	95	5.2	51	
83-22 2	36	13	43	33	10	42	2.5	235	8
83-22 3	61	17	73	53	13	65	3.2	265	20
83-23	47	29	54	48	9	111	5.5	163	53
83-24 1	27	19	25	25	7	104	5.3	91	15
83-24 2	101	31	55	74	15	123	5.2	235	307
83-25	86	46	50	40	8	68	3.6	225	17
83-26 1	61	29	28	27	8	73	4.4	89	111
83-26 2	170	21	71	88	36	72	5.5	1100	68
83-27	79	24	56	31	9	85	3.1	162	54
83-28	41	27	33	50	10	89	4.6	110	18
83-29 1	20	19	18	16	4	107	5.7	68	13
83-29 2	28	22	24	22	6	116	6.6	84	10
83-29 3	40	11	60	48	11	64	3.2	240	6
83-30	150	67	106	66	19	73	4.5	750	99
83-31 1	26	18	21	19	8	74	5.6	90	16
83-31 2	38	18	35	27	8	70	4.7	158	12
83-31 3	54	15	66	44	12	58	3.7	280	12
83-32 1	38	20	22	48	16	106	5.8	325	28
83-32 2	170	46	150	174	30	136	5.5	630	157
83-33 1	18	16	22	16	12	91	7.3	88	10
83-33 2	27	14	35	22	8	73	4.1	150	9
83-33 3	42	19	69	38	13	67	3.8	265	16
83-34 1	39	14	56	46	14	71	4.4	340	
83-34 2	58	21	86	95	16	106	5.1	450	24
83-34 3	56	14	85	83	13	73	4.5	400	11
83-35	144	166	188	104	34	80	6.0	435	307
83-36	119	193	170	69	18	53	4.0	390	65
83-37 1	23	13	14	15	4	80	3.6	64	5
83-37 2	62	19	65	55	20	88	5.5	450	
83-37 3	85	25	88	76	23	87	5.6	470	28
83-38	71	14	110	75	14	69	4.0	960	14
83-39 1	16	26	21	14	4	80	4.0	68	13
83-39 2	26	24	32	23	6	67	4.6	145	24
83-39 3	68	14	77	52	15	59	3.6	380	19
83-40 1	22	32	70	44	10	130	3.8	210	43
83-40 2	24	28	74	54	12	131	4.8	260	51
83-40 3	25	10	40	45	10	69	6.0	155	
83-40 4	24	16	48	46	10	57	4.8	263	35
83-40 5	34	14	64	64	12	66	5.2	328	
83-40 6	48	20	90	92	20	61	4.5	364	42
83-40 7	60	28	221	137	19	64	4.5	480	110

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
83-40 8	66	46	318	178	16	63	4.1	455	215
83-40 9	92	97	590	293	20	73	4.4	550	323
83-40 10	93	154	556	270	17	69	3.9	490	
83-40 11	186	15	277	546	25	80	4.0	860	320
83-41	144	50	435	259	34	71	3.7	665	180
83-42	96	24	222	160	17	66	4.3	590	55
83-43	66	180	287	158	28	73	4.0	750	472
83-44	96	152	289	249	24	79	3.7	660	107
83-45	39	14	93	43	17	47	3.3	395	10
83-46	42	14	99	36	17	56	3.3	495	4
83-47	56	17	105	40	21	51	3.4	510	21
83-48	94	11	77	56	17	59		340	4
83-49	88	13	59	32	12	55		340	6
83-50	90	12	42	33	9	69		160	4
83-51	32	15	25	15	7	68		120	5
83-52	49	12	38	23	9	57		220	5
83-53	41	12	38	22	8	61		150	28
83-54	39	12	53	31	13	55		320	5
83-55	64	15	59	32	14	60		260	5
83-160	58	10	73	34	14	53		410	2
83-162	29	8	58	24	12	43		360	<2
83-163	37	9	54	25	16	45		480	2
83-168	56	13	71	28	18	46		520	2
83-202	35	8	51	28	1	49		180	5
83-203	81	13	119	34	18	85		700	7
83-204	23	17	30	12	6	57		150	8
83-205	49	7	30	17	6	52		180	9
83-250	27	5	63	26	12	36		360	2
83-251	47	9	70	30	12	47		390	7
83-252	24	9	66	23	14	40		380	2
83-253	28	8	40	31	9	48		170	2
83-254	54	10	73	34	20	48		560	8
83-255	43	9	61	34	9	78		220	3
84-1 1	16	16	37	5	3	53		83	4
84-1 2	23	10	76	35	13	68		210	5
84-1 3	33	7	96	45	22	63		338	2
84-1 4	65	10	115	50	25	69		519	2
84-2	78	9	103	69	24	88		374	2
84-3	56	12	111	56	24	92		549	47
84-5	74	15	117	52	24	114		348	10
84-6 A	32	8	48	14	5	48		120	37
84-6 B	85	<2	50	27	9	69		156	
84-6 C	171	5	107	53	23	98		333	41
84-7	86	10	114	53	26	86		526	19
84-8 A	25	16	41	11	6	77		73	13
84-8 C	99	11	91	53	21	87		412	15
84-9	74	11	108	58	21	96		540	11
84-10	109	12	94	69	23	88		387	21
84-11 A	27	13	56	24	9	66		184	8
84-11 B	34	12	66	26	13	55		321	5
84-11 C	75	12	107	54	26	80		519	3

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
84-12 A	21	10	43	11	7	108		65	10
84-12 B	94	11	89	51	19	85		334	11
84-12 C	146	13	113	87	25	110		366	80
84-13 A	39	10	60	20	10	82		137	6
84-13 B	58	13	81	47	22	65		445	7
84-14 A	32	13	37	14	7	114		67	15
84-14 B	82	12	95	57	22	73		421	49
84-14 C	97	10	109	68	25	74		486	35
84-15 A	24	16	51	30	14	102		116	19
84-15 B	26	9	65	46	20	110		214	19
84-15 C	41	11	72	63	19	99		303	24
84-15 D	50	8	90	98	21	94		439	32
84-16 A	29	12	50	28	8	143		107	21
84-16 B	40	7	80	80	20	120		303	13
84-16 C	53	6	92	95	24	134		392	13
84-17 A	28	10	79	51	19	140		214	10
84-17 B	60	7	95	89	26	168		292	6
84-17 C	66	7	94	132	26	117		382	8
84-18 A	77	25	96	60	24	95		582	184
84-18 B	89	12	131	360	42	116		686	296
84-19 A	52	11	93	88	26	109		249	106
84-19 B	62	5	89	111	29	98		424	20
84-20 A	33	2	77	39	13	69		203	90
84-20 B	43	<2	90	67	18	77		376	10
84-20 C	50	4	97	83	23	76		471	12
84-21	27	3	54	39	7	103		134	14
84-22	85	13	99	37	16	96		313	3
84-23 A	94	11	70	22	11	71		154	19
84-23 B	73	10	104	39	18	93		342	5
84-24 B	302	9	203	62	26	98		366	480
84-24 B	257	8	184	54	23	99		331	448
84-25	64	12	87	34	13	78		261	3
84-26	100	12	86	44	18	78		312	4
84-27	60	13	99	39	21	76		506	5
84-28	75	15	104	45	20	74		500	3
84-29	31	16	92	29	15	86		282	3
84-30 A	14	12	54	17	9	51		165	5
84-30 B	33	8	86	35	17	62		415	3
84-31 A	16	11	56	14	9	94		119	4
84-31 B	32	9	98	36	25	62		536	3
84-32	49	9	86	42	20	55		484	2
84-33 A	113	8	75	61	23	301		717	12
84-33 B	666	24	124	37	99	39		6300	14
84-34	109	26	196	83	31	136		792	59
84-35 A	41	9	44	16	6	100		102	22
84-35 B	73	8	85	96	24	80		337	41
84-36 A	40	17	86	44	15	120		202	39
84-36 B	64	9	93	55	18	93		354	15
84-37 A	28	8	50	27	8	105		104	32
84-37 B	78	10	100	65	25	88		457	45
84-38	73	9	90	47	27	93		418	9

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
84-39 A	124	9	52	27	8	120		93	73
84-39 B	194	6	58	41	8	112		121	86
84-39 C	435	5	84	75	15	102		308	22
84-39 D	313	5	153	121	21	91		408	13
84-40 A	35	9	38	15	6	135		66	
84-40 B	55	11	83	70	22	94		434	11
84-41	88	6	126	191	29	102		473	23
84-42 A	60	10	71	55	14	101		205	15
84-42 B	63	8	82	62	19	77		412	10
84-43 A	35	13	81	34	18	97		187	14
84-43 B	78	6	101	60	21	81		401	13
84-44 A	44	6	80	52	19	81		339	25
84-44 B	65	7	92	75	31	63		582	
84-45 A	41	8	65	33	13	76		192	24
84-45 B	97	8	97	68	24	102		343	29
84-46	66	<2	47	25	7	82		123	15
84-47 A	31	5	40	17	6	76		82	31
84-47 B	50	13	67	38	12	105		175	45
84-47 C	81	7	92	58	22	96		369	
84-47 D	133	9	146	113	39	104		634	62
84-48 A	121	11	80	58	18	92		177	
84-48 B	110	66	97	62	17	89		331	17
84-49	106	8	119	65	19	75		445	8
84-50	49	5	91	57	24	82		480	70
84-51 A	62	10	86	41	15	93		233	11
84-51 B	64	12	88	44	22	66		445	16
84-52 A	69	7	65	33	10	98		174	14
84-52 B	12	5	25	18	4	31		109	3
85-1	95	7	76	70	16	90	3.7	294	37
85-2	78	11	78	86	28	73	4.1	579	28
85-3	75	13	46	33	12	81	6.7	235	
85-4	101	6	76	377	26	100	4.6	248	18
85-5	74	6	76	45	17	62	3.5	360	34
85-6	91	7	95	150	27	83	4.3	509	23
85-7	86	10	92	87	24	102	4.5	459	36
85-8	58	8	42	31	18	72	3.7	509	37
85-9	58	8	52	69	17	86	4.2	346	19
85-10	72	8	73	63	15	69	4.0	294	30
85-11	54	19	56	46	11	73	3.6	184	14
85-12	54	3	86	81	21	84	4.4	396	14
85-13	106	6	94	75	31	80	3.8	516	78
85-14	176	7	74	112	17	84	4.2	369	17
85-15	560	8	154	112	47	98	8.0	702	22
85-16	130	2	92	208	16	100	4.1	536	28
85-17	27	7	92	39	19	77	4.2	391	12
85-18	119	12	98	61	23	85	4.2	528	89
85-19	61	5	87	49	17	61	3.2	393	16
85-20	102	9	92	67	22	77	3.7	498	9
85-21	96	10	94	65	19	66	3.3	452	7
85-22	61	9	74	31	15	57	5.1	327	36
85-23	99	0	115	1	19	32	19.1	451	55

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
85-24	90	10	82	53	14	75	4.3	298	26
85-25	137	8	100	49	16	88	4.9	337	43
85-26	15	10	69	22	13	47	2.8	400	3
85-27	79	13	95	47	22	72	3.5	532	20
85-28	48	12	96	42	17	65	3.2	396	12
85-29	92	16	84	59	15	70	3.8	309	16
85-30	56	11	79	47	16	62	3.4	318	21
85-31	58	9	101	52	19	86	3.8	631	24
85-32	54	8	83	42	19	91	4.7	350	23
85-33	113	10	97	80	23	109	4.4	440	59
85-34	60	16	90	49	22	65	3.1	585	7
85-35	52	14	78	36	15	67	3.8	383	15
85-36	34	9	94	44	37	87	5.3	1260	21
85-37	30	10	90	38	18	69	3.5	622	5
85-38	107	10	103	62	21	78	3.5	388	20
85-39	52	7	112	47	21	74	3.6	513	11
85-40	64	11	96	55	24	88	4.9	541	31
85-41	66	11	96	49	18	72	4.1	501	16
85-42	62	5	69	52	14	58	3.0	328	15
85-43	66	10	87	58	25	62	3.4	511	16
85-44	74	4	112	66	25	71	3.5	505	12
85-45	120	26	87	69	26	77	5.9	510	
85-46	152	17	88	86	26	88	4.7	440	
85-47	45	4	71	44	15	65	4.0	341	13
85-48	80	31	100	57	22	84	4.6	440	16
85-49	71	23	65	42	12	66	4.2	255	22
85-50	57	6	69	43	13	64	4.0	324	11
85-51	60		73	33	12	66	3.5	286	10
85-52	111	4	118	64	19	88	4.0	528	80
85-53	73	2	81	49	17	81	4.0	365	25
85-54	39	6	87	40	18	72	3.8	407	24
85-55	79	7	106	57	20	108	6.0	460	8
85-56	79	7	81	58	17	75	3.1	307	24
85-57	42	9	85	49	22	64	3.4	511	19
85-58	51	5	77	49	19	74	4.0	374	30
85-59	48	9	92	50	23	82	3.9	503	14
85-60	40	7	81	44	22	61	2.9	464	16
85-61	80	11	83	63	17	79	3.4	399	26
85-62	52	8	67	34	21	56	4.1	520	
85-63	36	5	86	44	22	69	3.8	420	21
85-64	85	4	81	58	19	78	4.1	418	33
85-65	69	10	72	42	12	61	3.1	254	18
85-66	79	13	87	60	16	63	3.4	359	27
85-67	77	10	108	63	24	79	5.0	566	29
85-68	78	12	109	65	25	83	3.8	286	18
85-69	87	8	98	61	22	78	3.8	618	57
85-70	42	29	76	24	10	74	12.7	250	98
85-71	66	7	76	38	12	74	3.8	283	18
85-72	75	32	86	66	18	74	4.2	407	44
85-73	93	18	101	74	31	68	3.7	770	
85-74	66	7	80	41	12	66	3.9	304	23

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
85-75	57	13	87	45	14	61	3.5	437	19
85-76	62	11	81	49	15	59	6.2	787	10
85-77	69	10	78	43	18	59	3.1	425	10
85-78	60	7	67	42	10	67	4.0	261	10
85-79	56	13	101	44	18	80	4.1	427	2
85-80	52	14	71	39	9	68	6.1	300	
85-81	73	13	95	59	20	68	3.2	542	14
85-82	17	11	78	23	10	55	3.0	357	5
85-83	94	16	68	33	12	63	4.2	248	7
85-84	37	14	90	36	18	70	3.3	379	5
85-85	70	16	99	43	24	58	3.0	472	7
85-86	100	7	165	51	22	78	5.5	611	608
85-87	133	9	119	42	27	89	7.0	553	25
85-88	79	12	87	52	19	70	3.4	353	14
85-89	99	13	106	239	35	75	3.3	690	10
85-90	35	11	74	29	11	59	4.1	281	12
85-91	92	16	108	98	28	96	5.2	569	37
85-92	77	7	87	48	16	73	4.0	294	15
85-93	44	10	90	35	18	57	2.6	381	3
85-94	73	8	117	50	27	64	3.1	456	2
85-95 A	79	3	85	50	14	69	3.9	280	18
85-95 B	84	10	98	48	20	61	3.2	493	18
85-96	67	10	89	48	15	69	3.7	324	23
85-97	69	6	116	47	16	61	3.3	450	5
85-98	92	7	92	77	19	93	4.5	340	28
85-99	61	10	91	50	25	60	2.9	444	12
85-100	92	8	119	56	19	60	3.3	517	3
85-101	60	6	103	36	17	64	3.2	462	3
85-102	34	9	87	33	18	54	3.0	457	4
85-103	37	9	89	34	20	50	2.6	465	4
85-104	56	9	86	41	19	42	2.6	420	4
85-105	56	10	93	46	22	56	3.0	396	5
85-106	42	9	84	41	18	64	3.3	301	7
85-107	31	15	85	35	15	54	2.7	309	3
85-108	33	7	80	37	14	52	2.8	350	4
85-109	49	11	89	40	15	60	3.1	335	7
85-110	50	12	150	59	18	106	5.2	425	7
85-111	135	6	147	56	19	90	5.1	458	7
85-112	78	9	102	52	27	56	2.8	519	4
85-113	47	9	98	44	18	61	3.1	327	4
85-114	73	21	118	67	31	101	5.0	548	8
85-115	52	21	125	59	25	100	5.0	550	8
85-116	36	14	89	36	17	48	2.7	336	3
85-117	71	13	93	56	18	59	3.0	354	4
85-118	58	10	98	45	25	57	2.8	518	2
85-119	46	12	91	35	21	49	2.6	446	5
85-120	54	16	87	36	13	58	2.7	304	16
85-121	24	14	104	32	14	69	3.3	441	6
85-122	104	14	111	73	26	69	2.9	377	12
85-123	57	17	105	51	20	87	3.7	418	8
85-124	58	11	107	56	26	60	2.8	498	6

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)
85-125	29	10	97	39	17	77	3.6	313	6
85-126	39	6	84	33	14	63	3.1	375	11
85-127	61	7	112	49	18	68	3.1	433	4
85-128	40	9	69	34	13	51	2.6	339	6
85-129	85	5	87	58	20	54	3.0	443	5
85-130	55	5	100	43	16	59	3.2	437	2
85-131	41	4	78	38	20	49	2.7	473	5
85-132	101	3	105	63	18	78	4.1	498	16
85-133	81	9	107	66	24	81	3.4	556	12
85-134	84	9	105	58	20	90	3.8	414	20
85-135	119	8	118	110	26	90	4.0	517	20
85-136	83	13	89	53	32	69	3.2	682	26
85-137	148	16	106	72	29	81	4.9	693	122
85-138	115	13	109	87	24	96	4.0	464	19
85-139	127	12	107	68	24	103	4.2	375	18

APPENDIX III

GEOCHEMICAL DATA FOR THE HEAVY MINERAL FRACTION

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)	Au (ppb)
82-5	8	20	55	9	8	59	3.6	1000	<2	23
82-6	9	16	65	10	9	80	4.0	1250	<2	<1
82-7	10	20	59	11	9	67	3.7	1100	3	9
82-8	10	17	59	11	9	68	3.5	1050	3	35
82-9	9	18	55	10	8	72	3.6	1050	2	19
82-10	11	20	55	12	9	63	3.6	1000	4	22
82-11	24	18	59	11	8	67	3.7	1050	10	38
82-12	10	17	50	9	8	50	3.2	830	4	<1
82-13	12	18	55	10	9	70	3.7	1200	5	1
82-14	10	18	51	11	8	53	3.3	960	<2	<1
82-15 A	9	15	48	8	8	44	3.2	830	<2	<1
82-15 C	11	17	50	8	7	49	3.1	860	<2	<1
82-16	13	21	63	10	8	75	3.6	1150	<2	<4
82-17 B	10	19	54	8	7	57	3.4	885	<2	<1
82-18	10	18	53	9	7	61	3.5	1000	<2	<1
82-19	9	19	54	9	7	59	3.5	1100	<2	<1
82-20	9	22	46	8	7	50	3.2	840	<2	<1
82-21	10	20	49	8	8	49	3.4	895	2	<1
82-22 A	14	28	58	10	8	53	3.4	815	<2	5
82-22 B	12	22	54	10	8		3.4	935		
82-23	12	20	54	9	8	72	3.6	970	<2	<1
82-24 A	7	30	41	7	7	45	3.2	780	<2	<1
82-24 B	7	21	51	9	7	57	3.6	985	<2	<2
82-25	14	17	64	9	8	70	4.0	1150	<2	<1
82-26 A	12	20	56	8	7	62	3.9	1100	<2	<1
82-26 B	22	12	57	9	8	69	4.3	1000	<2	<1
82-27	15	24	56	8	8	67	4.2	1200	<2	<1
82-28 A	9	19	50	8	7	51	3.4	870	2	3
82-28 B	13	13	54	10	8	43	3.4	740	2	68
82-29	9	20	56	10	8	65	3.9	1150	2	<1
82-30	8	21	51	8	7	60	3.8	950	2	<1
82-31 A	10	12	61	10	8	71	3.4	960	2	7
82-31 B	9	20	48	8	7	51	3.6	990	<2	<1
82-32	12	20	66	10	9	67	3.7	1100	2	<2
82-35	12	17	60	10	8	45	3.0	785	2	2
82-36	16	18	64	11	10	57	3.4	945	2	<1
82-37	12	20	60	9	9	56	3.6	985	<2	5
82-38 A	13	20	60	10	8	65	3.7	955	2	<1
82-38 B	15	16	47	9	7	51	3.1	750	<2	<1
82-39	19	23	65	11	10	70	4.1	1150	2	29
82-40	13	42	72	16	8	64	3.6	960	12	212
82-41	19	24	62	9	9	68	4.2	1200	<2	68
82-42	18	21	66	11	10	70	4.0	1200	2	4
82-43	10	22	58	9	9	65	3.8	985	3	<1
82-44	13	21	62	10	8	79	4.1	1200	<2	344
82-45	11	15	61	11	8	62	3.6	900	2	2
82-46	13	15	62	11	9	63	3.6	900	2	4
82-47	10	17	56	10	8	65	3.4	800	2	<1

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)	Au (ppb)
82-48	21	9	76	14	10	93	3.8	1000	2	7
82-49	10	20	62	10	8	65	4.2	980	2	<1
82-50	12	18	64	11	8	68	3.6	885	<2	1
82-51	15	32	59	15	8	55	3.2	765	23	429
82-54	13	22	55	8	7	58	3.7	960	2	<1
82-55	12	17	53	8	7	59	3.6	975	2	<1
82-55 B	14	25	61	8	8	72	3.9	1150	2	1
82-56	10	26	53	8	8	45	3.6	745	2	<1
82-57	9	25	52	8	8	48	3.7	840	2	1
82-58	14	21	57	9	8	50	3.8	830	2	3
82-59	10	25	50	8	7	53	4.0	900	3	1
82-60	11	17	63	11	8	71	3.8	960	2	<1
82-61	11	24	56	9	7	68	4.1	925	2	34
82-62	12	22	56	9	7	63	4.0	1100	<2	20
82-63	9	20	52	8	7	52	3.6	830	<2	1
82-64	10	21	51	9	7	46	3.6	850	<2	23
82-65	18	17	65	10	7	61	4.0	1150	<2	<1
82-66	17	20	63	9	8	64	4.0	1150	2	<1
82-67	10	26	60	9	7	65	4.6	1200	<2	<1
82-68	13	22	56	8	8	57	3.8	910	<2	<1
82-69	10	25	63	10	8	55	3.6	1000	<2	<1
82-70	13	17	54	9	7	68	3.1	920	2	<1
82-71	13	21	55	8	7	59	3.5	945	<2	<1
82-72	10	23	58	9	7	60	3.4	930	<2	4
82-73	12	21	65	10	9	73	4.2	1150	<2	5
82-74	11	23	60	11	9	60	3.9	875	<2	47
82-75	12	15	55	9	9	58	4.0	945	<2	<1
82-76	10	20	55	10	9	56	4.1	975	<2	<1
82-77	11	22	59	10	9	53	3.8	845	<2	66
82-78	11	21	52	9	8	75	3.8	890	<2	2
82-79	9	18	61	10	9	63	3.8	950	<2	20
82-80	12	19	54	9	8	65	3.7	890	<2	18
82-81	10	19	51	8	7	44	3.8	780	<2	2
82-82	10	36	52	8	7	62	3.3	750	<2	32
82-83	8	22	51	8	8	50	3.1	630	<2	236
82-84	11	20	51	9	8	64	3.3	665	<2	<1
82-85	9	17	54	8	8	65	3.5	745	<2	<1
82-86	13	20	52	8	7	53	3.1	635	2	8
82-87	8	18	46	6	7	54	3.1	635	<2	3
82-88	18	22	52	8	7	61	3.4	670	<2	<1
82-89	11	22	53	8	7	69	3.6	745	2	<1
82-90	13	16	59	9	8	82	3.6	810	<2	<1
82-91	11	20	42	7	7	53	2.8	545	<2	2
82-92	10	17	50	7	7	63	3.0	620	<2	<1
82-93	11	19	49	8	7		3.4	720		
82-94	23	19	59	8	7	81	3.6	735	<2	5
82-95	11	18	52	9	7	71	3.4	705	<2	<1
83-10 1	8	18	50	10	7	40	2.8	925	<2	1992
83-10 2	7	13	44	9	5	36	2.1	770	2	598
83-11 A	7	12	48	12	6	29	1.9	680	2	187
83-11 B	27	8	32	13	8	19	1.7	400	5	190

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)	Au (ppb)
83-12 A	7	19	42	13	6	36	2.2	820	2	167
83-12 1	7	13	32	10	4	25	1.9	715	3	15000
83-13	9	20	45	17	5	33	1.8	720	2	551
83-14 1	6	14	25	6	3	21	1.6	620	3	82
83-14 2	8	13	36	10	5	30	1.8	700	3	116
83-15	30	15	44	40	7	51	2.0	525	10	1667
83-16	8	13	31	23	5	29	1.6	365	7	870
83-17 A	17	18	56	18	5	35	2.2	785	17	1328
83-17 1	4	14	28	6	5	22	1.9	750	<2	84
83-18	6	15	45	11	5	34	2.3	860	<2	69
83-19 1	5	15	23	6	3	18	1.6	675	2	38
83-19 2	5	14	32	8	4	24	1.6	660	2	46
83-20	6	14	34	9	4	24	1.8	680	4	59
83-21	4	11	23	7	3	23	1.7	620	6	132
83-22 1	5	17	26	7	4	18	1.8	660	<2	162
83-22 2	7	11	31	8	4	26	2.2	640	2	1338
83-22 3	4	12	29	7	4	26	1.9	620	<2	253
83-23	6	17	26	9	3	20	1.7	590	2	34
83-24 1	6	14	24	9	4	25	1.9	570	<2	20
83-24 2	10	11	28	13	4	38	1.6	370	4	278
83-25	7	15	30	9	4	22	1.8	565	6	159
83-26 1	9	17	30	8	6	25	2.5	775	7	17
83-26 2	12	13	22	10	4	18	1.6	450	3	3649
83-27	50	20	27	9	3	22	1.7	490	4	928
83-28	8	20	34	11	5	38	3.0	1050	3	2968
83-29 1	4	13	48	9	6	40	3.1	890	<2	114
83-29 2	5	16	45	10	5	38	3.0	950	<2	8
83-29 3	6	13	51	12	7	44	3.0	905	<2	68
83-30	14	20	44	13	5	38	2.8	750	4	6409
83-31 1	5	18	29	8	4	26	2.4	790	<2	30
83-31 2	4	15	48	9	6	32	2.5	890	<2	155
83-31 3	6	15	44	10	7	34	2.6	850	<2	6
83-32 1	7	14	33	13	5	33	2.5	840	3	22
83-32 2	15	13	49	17	6	39	2.6	780	10	240
83-33 1	7	15	21	5	2	18	1.7	560	<2	22
83-33 2	4	12	32	9	4	25	1.8	600	<2	81
83-33 3	5	14	31	7	4	24	1.8	580	<2	35
83-34 1	4	10	25	9	4	23	1.7	590	2	10
83-34 2	4	8	29	9	4	27	1.7	580	2	103
83-34 3	5	11	27	8	4	25	1.5	530	<2	17
83-35	13	45	51	5	7	30	2.1	600	18	353
83-36	9	34	36	10	4	23	1.9	640	3	321
83-37 1	4	11	20	8	5	26	1.4	465	<2	16
83-37 2	6	11	30	8	5	28	1.8	600	<2	14
83-37 3	5	10	25	8	4	24	1.5	520	<2	13
83-38	6	11	35	9	5	29	1.8	650	<2	3
83-39 1	4	15	27	10	4	27	1.8	720	2	8
83-39 2	5	10	27	6	3	24	1.7	690	3	71
83-39 3	6	13	32	9	5	29	2.2	705	<2	1
83-40 1	3	11	30					640		150
83-40 2	4	16	34	9	4	31	2.2	890	3	59

Sample Number		Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)	Au (ppb)
83-40	3	4	16	39					800		295
83-40	4	4	13	36	10	6	30	2.2	870	4	2054
83-40	5	3	10	35					640		10
83-40	6	4	11	30	10	4	26	1.7	615	2	9
83-40	7	5	9	42					520		175
83-40	8	6	16	36	12	4	27	1.6	650	8	114
83-40	9	5	22	48					650		10
83-40	10	7	41	51	15	6	32	1.8	665	13	142
83-40	11	9	8	40					600		35
83-41		10	13	155	16	3	29	1.7	645	12	1567
83-42		16	14	42	27	5	36	1.8	610	11	5782
83-43		7	58	43	16	5	33	1.8	715	28	1280
83-44		16	17	42	26	6	34	1.8	610	23	437
83-45		7	30	42	15	4	27	1.7	650	2	72
83-46		5	13	31	7	5	21	1.7	675	<2	67
83-47		5	11	28	9	5	30	1.7	670	3	40
83-48		7	10	38					760		10
83-49		6	10	31					660		5
83-50		8	12	36					700		5
83-51		5	9	36					670		5
83-52		5	9	35					700		5
83-53		6	12	30					640		5
83-54		8	14	36					720		10
83-55		6	13	36					740		5
83-160		7	11	30					520		5
83-162		6	8	24					620		5
83-163		4	8	25					500		5
83-168		13	8	30					510		5
83-202		4	10	30					680		5
83-203		4	8	30					710		10
83-204		5	15	32					730		20
83-205		7	9	31					600		5
83-250		5	8	28	6	3	22	1.5	565	3	2
83-251		5	13	29	8	4	26	1.8	670	<2	5
83-252		4	11	31	8	5	26	1.8	705	<2	5
83-253		5	14	31	7	4	26	1.6	615	2	11
83-254		5	13	29	6	5	25	1.6	610	2	254
83-255		6	9	26	8	5	23	1.5	545	2	39
84-1	1	7	11	32	10	6	94	2.3	620	<2	15
84-1	2	4	11	29	9	4	102	2.2	780	<2	25
84-1	3	5	9	37	9	6	76	1.9	770	<2	<5
84-1	4	5	12	33	7	5	77	1.8	820	<2	10
84-2		6	14	35	8	4	75	1.9	850	<2	15
84-3		5	10	43	8	5	86	2.0	920	5	85
84-4		7	6	32	8	4	70	1.8	780	2	<5
84-5		8	11	37	8	5	94	2.3	880	<2	10
84-6	A	6	14	27	7	4	88	2.2	780	2	<5
84-6	B	8	10	35	9	4	86	2.1	820	<2	<5
84-6	C	19	8	48	10	5	82	3.2	840	26	40
84-7		6	11	27	8	4	78	1.8	770	2	30
84-8	A	6	12	23	5	4	94	2.3	850	<2	45

Sample Number		Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)	Au (ppb)
84-8	B	6	12	30	7	4	86	2.0	840	<2	<5
84-8	C	6	11	26	7	4	70	1.8	760	<2	10
84-9		7	12	30	8	4	90	2.2	920	<2	15
84-10		7	14	28	10	4	66	2.0	750	4	40
84-11	A	4	13	28	7	5	90	2.3	825	<2	10
84-11	B	5	10	33	10	4	72	2.1	840	<2	5
84-11	C	5	11	29	10	4	72	1.9	720	<2	125
84-12	A	5	14	16	7	3	74	2.2	440	<2	10
84-12	B	6	10	31	9	4	78	2.2	860	<2	70
84-12	C	6	10	38	10	4	76	2.2	950	<2	5
84-13	A	4	16	18	7	4	84	2.2	560	<2	15
84-13	B	6	10	32	10	4	62	2.0	800	<2	10
84-14	A	8	12	25	10	4	98	2.3	670	<2	70
84-14	B	6	9	28	8	4	60	1.8	800	<2	<5
84-14	C	5	9	39	8	5	82	2.2	960	<2	<5
84-15	A	5	13	23	8	3	74	2.1	680	<2	<5
84-15	B	4	14	31	8	3	88	2.4	970	<2	175
84-15	C	4	10	27	7	4	59	2.0	760	<2	10
84-15	D	7	12	35	10	3	81	2.0	900	2	630
84-16	A	5	14	24	9	3	78	2.0	720	<2	320
84-16	B	6	13	35	11	4	74	2.0	780	<2	270
84-16	C	6	12	32	12	4	74	2.1	870	<2	255
84-17	A	5	10	28	9	4	110	2.8	880	<2	45
84-17	B	8	5	35	27	6	90	1.9	580	<2	155
84-17	C	34	14	32	11	4	80	2.1	920	<2	15
84-18	A	7	8	30	13	5	67	2.0	765	4	190
84-18	B	7	11	26	18	5	70	2.0	715	5	795
84-19	A	7	14	32	13	5	92	2.6	800	10	295
84-19	B	7	11	34	11	5	84	2.2	900	<2	65
84-20	A	4	11	25	7	4	65	1.9	620	3	<5
84-20	B	4	14	27	6	2	80	2.2	835	<2	10
84-20	C	4	10	28	7	4	70	2.2	825	<2	<5
84-21		4	13	29	7	4	102	2.3	880	<2	<10
84-22		14	10	33	7	5	84	2.9	960	<2	<10
84-23	A	9	10	26	8	3	100	2.5	850	<2	<5
84-23	B	9	18	26	6	4	78	2.6	760	<2	<10
84-24	A	15	8	31	7	4	124	3.2	920	28	15
84-24	B	24	10	38	6	4	60	2.7	560	34	90
84-25		6	10	25	4	2	70	2.8	700	<2	<5
84-26		16	10	26	4	3	52	2.8	680	<2	<5
84-27		8	18	21	4	3	80	2.1	920	<2	<5
84-28		15	19	25	3	3	58	2.1	840	<2	<5
84-29		5	12	19	5	3	113	2.4	820	<2	<5
84-30	A	5	11	17	6	3	99	2.4	840	<2	<5
84-30	B	3	16	16	4	3	70	1.9	840	<2	<5
84-31	A									<2	<5
84-31	B									<2	1045
84-32		5	12	30	8	4	55	2.0	820	<2	20
84-33	A									<2	485
84-33	B	152	<2	31	4	11	22	3.2	530	<2	25
84-34										3	945

Sample Number		Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)	Au (ppb)
84-35	A									2	315
84-35	B	6	16	34	9	4	34	1.8	740	2	145
84-36	A									<2	875
84-36	B									<2	<5
84-37	A									<2	<5
84-37	B									<2	15
84-38										<2	590
84-39	A									4	435
84-39	B									3	55
84-39	C									2	65
84-39	D									<2	54
84-40		8	10	18	8	1	92	1.8	565	<2	180
84-41										<2	55
84-42	A									<2	55
84-42	B									<2	<5
84-43	A									<2	450
84-43	B									<2	15
84-44	A									<2	460
84-44	B									<2	15
84-45	A									2	1670
84-45	B									2	70
84-46										<2	<5
84-47	A									4	<5
84-47	B	6	4	31	6	4	58	1.7	480	2	20
84-47	C	8	4	35	12	4	64	1.7	490	4	<5
84-47	D									6	<5
84-48	A	9	11	14	6	3	68	1.9	410	2	10
84-48	B	8	12	25	7	3	58	1.6	580	<2	8340
84-49										<2	50
84-50										<2	5
84-51	A									<2	60
84-51	B									<2	180
84-52	A									<2	<5
84-52	B	5	31	24	5	4	60	1.7	560	<2	<5
85-2		8	9	38	9	4	30	2.0	660	4	<5
85-4		7	9	30	27	5	36	2.4	600	3	<5
85-5		8	7	48	8	5	36	2.5	860	4	10
85-6		9	4	31	9	4	27	2.1	680	3	5
85-10		6	7	32	8	5	30	2.0	510	2	1150
85-13		6	9	38	7	4	36	2.2	790	4	35
85-14		8	4	46	10	4	40	2.2	700	<2	45
85-16		8	10	30	11	5	28	2.1	580	2	65
85-17		5	6	36	7	4	32	1.9	700	3	<5
85-18		9	9	36	9	4	36	2.3	640	4	5
85-19		6	7	34	7	4	30	2.2	570	2	15
85-20		6	10	35	5	4	28	2.1	600	<2	110
85-22		6	5	30	4	3	23	2.2	540	2	<5
85-23		27	3	29	<2	3	7	4.5	360	9	<5
85-24		9	5	24	4	3	18	1.7	350	4	<5
85-26		5	10	30	4	3	26	2.1	540	<2	25
85-28		5	11	39	5	5	31	2.2	570	<2	20

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)	Au (ppb)
85-30	7	8	35	5	3	27	2.0	540	<2	<5
85-32	6	4	33	5	3	28	1.8	510	3	<5
85-34	6	8	40	7	5	32	2.2	620	2	10
85-36	6	9	35	6	4	28	1.9	500	3	<5
85-38	7	7	30	7	3	25	1.8	460	<2	<5
85-40	6	9	34	9	5	31	2.4	500	2	15
85-42	8	7	34	7	4	33	1.9	450	<2	5
85-44	6	9	34	7	4	25	2.0	550	<2	5
85-46	12	8	40	10	5	35	2.1	510	2	10
85-48	7	7	32	6	3	26	2.0	500	2	140
85-50	5	7	35	6	4	32	2.1	530	4	20
85-52	8	5	36	7	4	40	1.9	550	4	5
85-53	6	8	24	7	5	25	1.5	380	3	165
85-54	6	7	31	7	3	28	1.9	530	3	5
85-55	8	5	44	7	4	30	2.1	480	<2	10
85-56	6	7	32	7	3	27	1.7	370	<2	175
85-57	6	8	40	7	6	34	2.1	590	3	95
85-58	7	8	30	12	5	45	1.9	545	2	<5
85-59	5	7	30	8	5	33	1.8	550	<2	<5
85-60	6	8	51	10	5	45	2.4	780	2	5
85-61	8	11	26	10	4	35	1.4	440	2	25
85-62	5	6	24	6	3	18	1.2	420	<2	<5
85-63	5	7	25	9	4	26	1.3	340	2	140
85-64	8	4	26	10	4	32	1.3	380	2	<5
85-65	6	5	21	6	3	21	1.2	380	<2	20
85-66	6	5	32	8	3	28	1.5	520	<2	190
85-67	6	9	30	9	5	36	1.9	510	2	15
85-68	7	7	36	12	5	51	1.9	480	2	10
85-69	8	9	38	13	4	52	2.2	600	4	530
85-70	17	5	39	10	5	35	4.2	500	8	910
85-71	7	5	28	6	3	25	2.1	460	2	15
85-72	6	5	35	9	5	38	2.2	580	<2	45
85-74	6	9	34	7	4	35	2.1	600	<2	10
85-76	5	8	36	7	4	32	2.2	680	2	<5
85-78	5	9	41	7	4	37	2.5	660	2	<5
85-79	5	10	46	7	5	41	2.4	650	3	<5
85-80	5	8	38	6	4	34	2.3	640	3	165
85-84	3	8	36	5	5	30	1.9	570	2	10
85-86	28	4	36	5	3	18	1.4	360	18	770
85-88	7	9	40	7	4	35	2.4	600	<2	95
85-91	5	6	30	8	5	28	1.8	490	<2	90
85-92	5	10	41	7	4	36	2.3	650	<2	5
85-94	4	8	38	5	4	29	2.2	600	<2	35
85-96	5	10	32	6	4	28	2.1	500	<2	10
85-98	7	7	36	9	4	40	1.9	470	2	75
85-100	7	9	43	6	3	40	2.4	700	<2	5
85-102	3	11	25	4	3	21	1.5	400	<2	15
85-104	7	10	40	7	5	34	2.4	580	<2	5
85-106	4	6	24	4	3	20	1.3	350	<2	10
85-108	5	13	38	6	4	34	2.1	560	<2	95
85-110	12	30	34	8	5	24	1.8	440	<2	90

Sample Number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (%)	Mn (ppm)	As (ppm)	Au (ppb)
85-112	9	8	36	7	5	30	2.0	540	<2	<5
85-114	5	9	50	9	6	42	2.5	700	<2	<5
85-116	5	8	38	5	3	30	2.0	520	<2	<5
85-118	5	10	50	7	6	48	2.7	740	<2	<5
85-120	9	13	50	7	5	47	2.9	700	2	10
85-122	6	6	34	5	4	31	2.2	630	<2	300
85-124	7	7	33	5	4	28	1.9	590	<2	<5
85-126	21	9	35	7	6	24	1.5	440	15	<5
85-128	10	8	37	6	4	31	2.2	580	3	10
85-130	13	7	26	4	4	20	1.4	380	3	540
85-132	10	4	25	6	3	24	1.4	380	<2	550
85-134	5	4	21	6	4	22	1.5	430	<2	10
85-136	6	6	29	9	3	36	1.8	520	3	20
85-138	10	6	29	8	4	33	2.1	580	5	<5