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Glacial Dispersion and Till Geochemistry Around the Lar Cu-Zn Deposit, Lynn Lake Greenstone Belt, Manitoba

By E. Nielsen and G.G. Conley

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Winnipeg, 1991

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INTRODUCTION

Basal till geochemical programs in the Lynn Lake area were initiated under the Canada-Manitoba Interim and Mineral Development Agreement 1984-1989 to evaluate till as a medium for geochemical exploration. Detailed till sampling has been undertaken around known mineral occurrences to determine the distance and mode of glacial transport, deposition, geochemical characteristics of the till, (including post-glacial diagenetic alteration), sample spacing and analytical procedures (Nielsen and Graham, 1985; Nielsen and Fedikow, 1987).

Although much emphasis has been placed on studies around known gold occurrences (Nielsen, 1982, 1983; Nielsen and Graham, 1984, 1985), work was undertaken around the Lar Cu-Zn deposit, situated 55 km southwest of Lynn Lake because:

1. the bedrock geology has been mapped recently (Elliott, 1984, 1986);
2. a relatively large base metal deposit giving a higher geochemical response in the till is a better indication of down-ice glacial dispersal than a much smaller gold occurrence; and
3. the extent of the mineralization is not well known and till sampling may clarify problems concerning the possible western extension of the deposit.

PREVIOUS WORK

Studies in the Lynn Lake area indicate till sampling for the purpose of geochemical exploration may be successfully undertaken from hand-dug pits in areas of shallow till (Nielsen and Fedikow, 1987; Kaszycki *et al.*, 1988). Nielsen and Fedikow (1987) further indicate that a sample spacing as small as 100 m may be adequate to detect mineralization. Elsewhere, till geochemical anomalies may be defined using a sample spacing of several kilometres (Kaszycki *et al.*, 1988). The main factors affecting the size of glacial dispersion train being the size and topography of the source area (Nielsen and Fedikow, 1987).

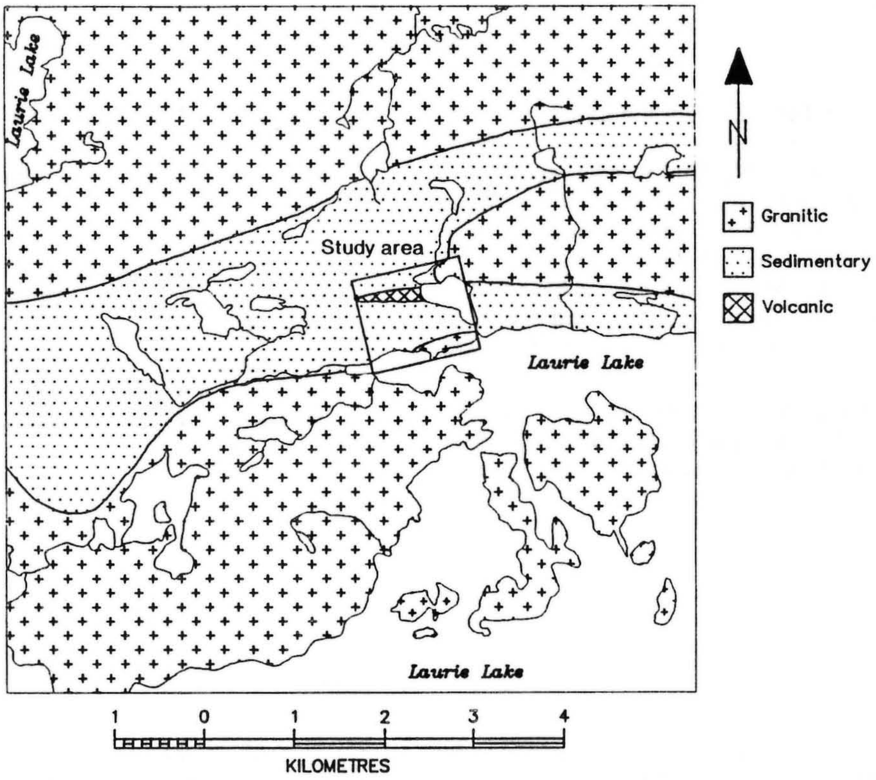


Figure 1: Location map and regional geology. (simplified from Gilbert et al., 1980).

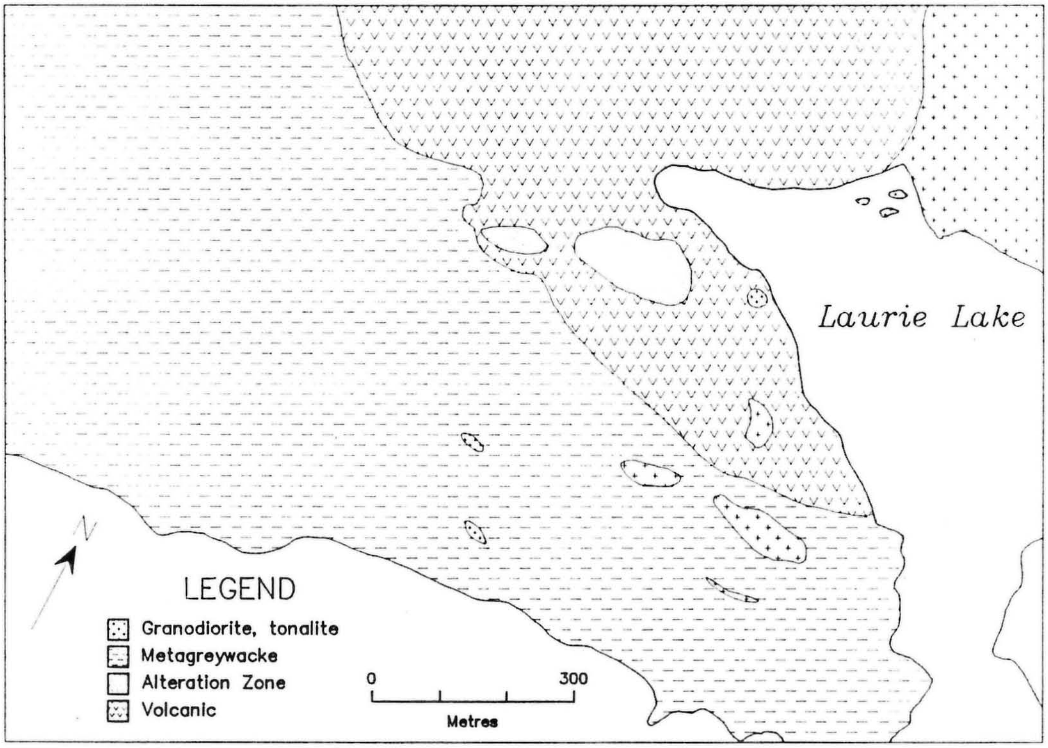


Figure 2: Detailed geology of the Lar Cu-Zn deposit. From Elliott (1984).

BEDROCK GEOLOGY

The bedrock geology of the Laurie Lake area was mapped by Milligan (1960) and updated by Gilbert *et al.*, (1980). These regional studies established that Wasekwan Group rocks of the Lynn Lake Greenstone Belt, in the Laurie Lake area, comprise a sequence of metavolcanic rocks to the north and greywacke to the south of the mineralization (Fig. 1). They further established that extensive areas of tonalite and granodiorite outcrop 1.5 km north and 0.4 km northeast of the Lar deposit. Elliott (1984, 1986) undertook detailed mapping of the bedrock geology and a study of the alteration zone associated with the Lar massive sulphide Cu-Zn deposit. Elliott (1986) mapped two areas where the alteration zone outcrops; an eastern zone measuring approximately 100 m by 200 m and a smaller western zone measuring about 30 m by 100 m (Fig. 2). Analysis of surface samples and drill core samples (Fig. 3) allowed Elliott (1986) to map a zone of magnesium enrichment that characterizes the alteration zone, but trace element concentrations were only reported in table form. Maps of the whole rock and trace element geochemistry of Elliott's (1986) surface bedrock samples (Fig. 4A-I) reveal significant variation in TiO_2, FeOT, MgO, Cu, Zn, Sr, Ba and Au concentrations.

These anomalies are centered approximately on one or both of the alteration zones. Lead is depleted over the eastern zone, but shows higher concentrations in the western part of the west zone. Elliott (1986) indicated that the massive sulphide mineral assemblage consists of pyrrhotite-pyrite ± sphalerite ± chalcopyrite ± magnetite ± with either of the first two minerals dominating.

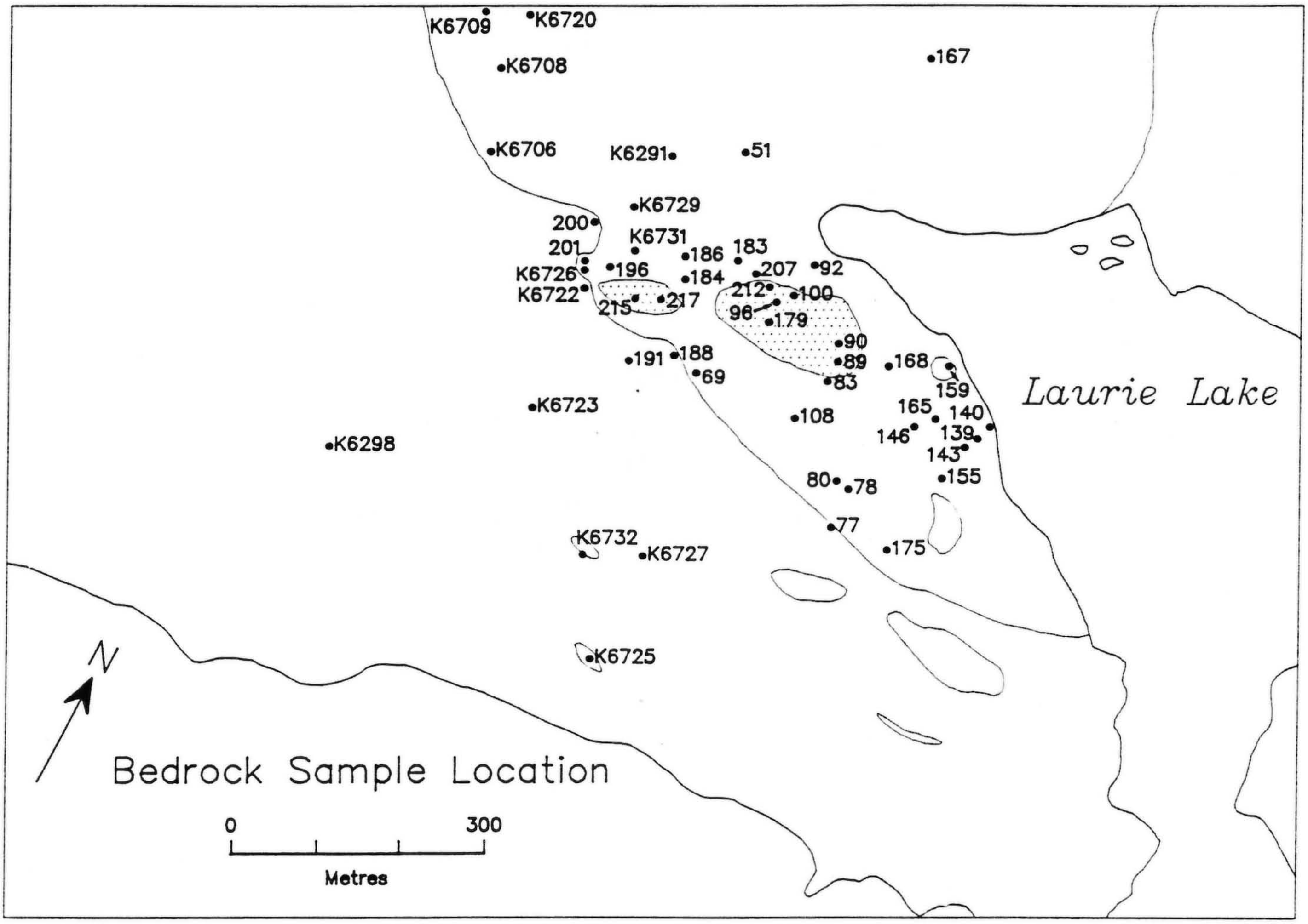
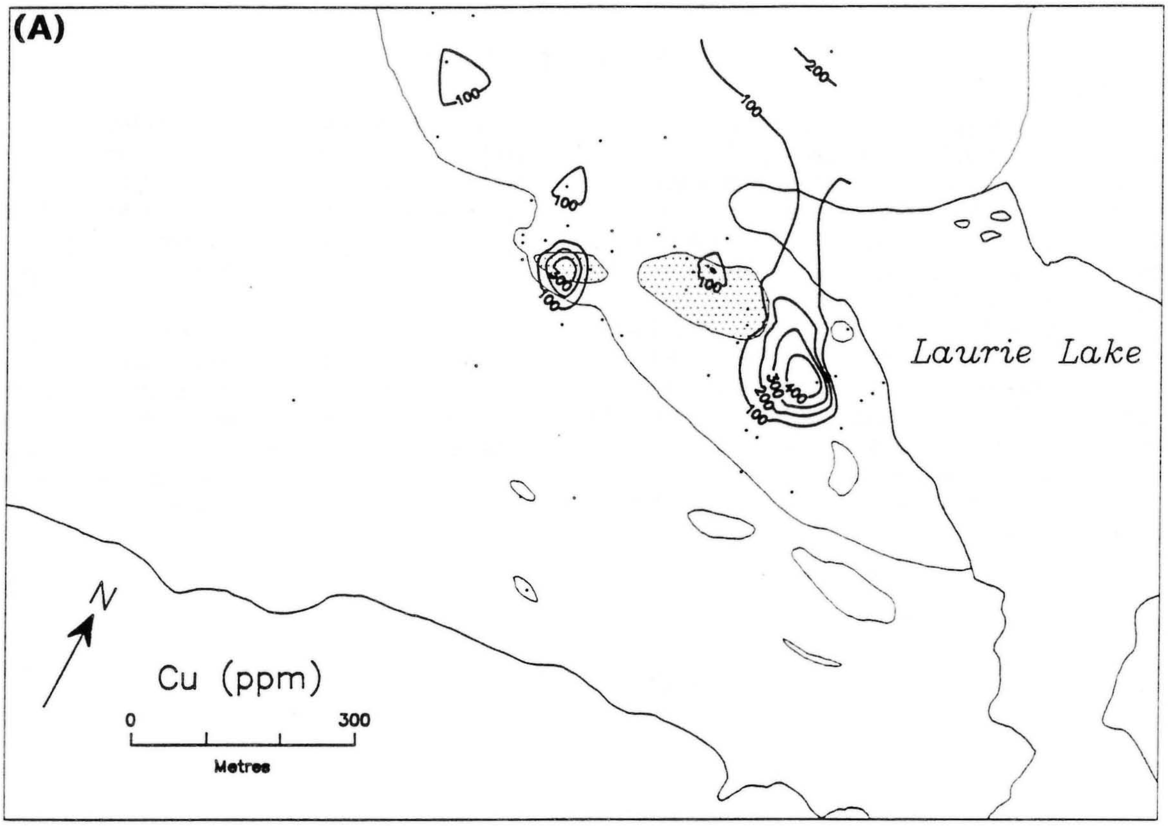


Figure 3: Location of bedrock samples collected and analyzed by Elliott (1986).



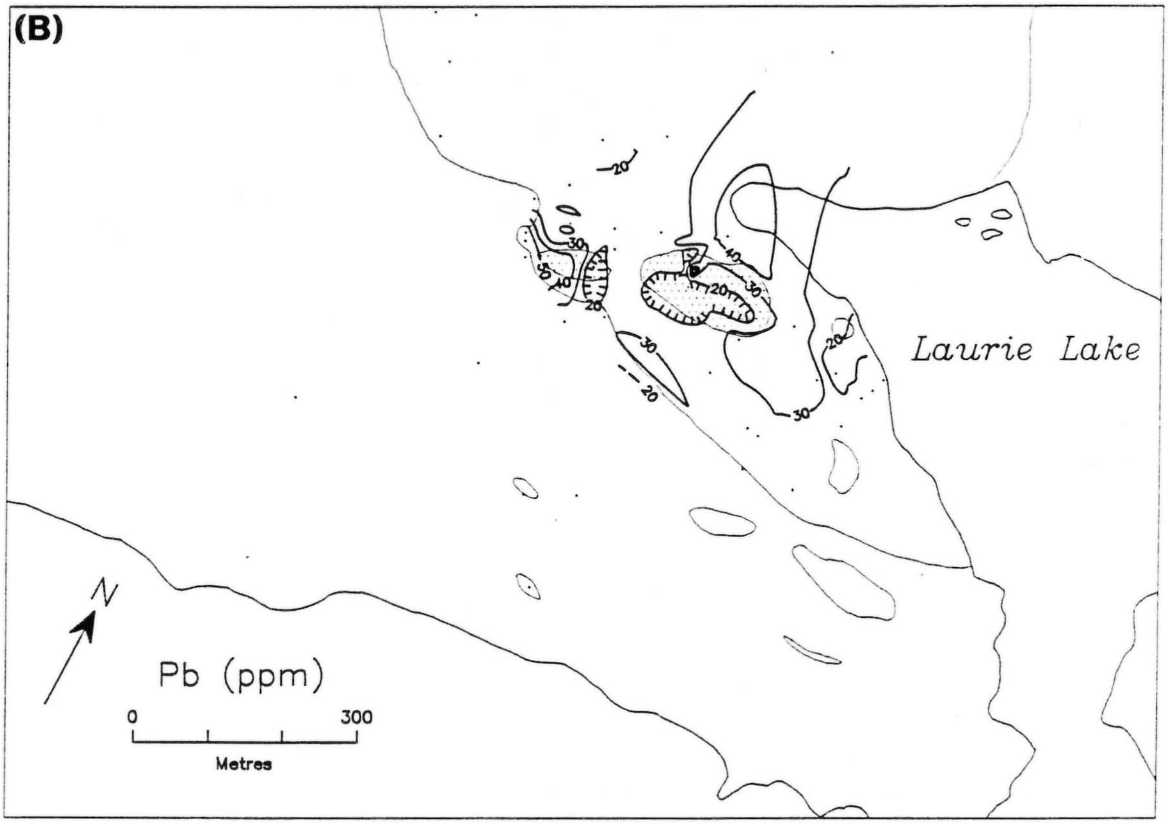
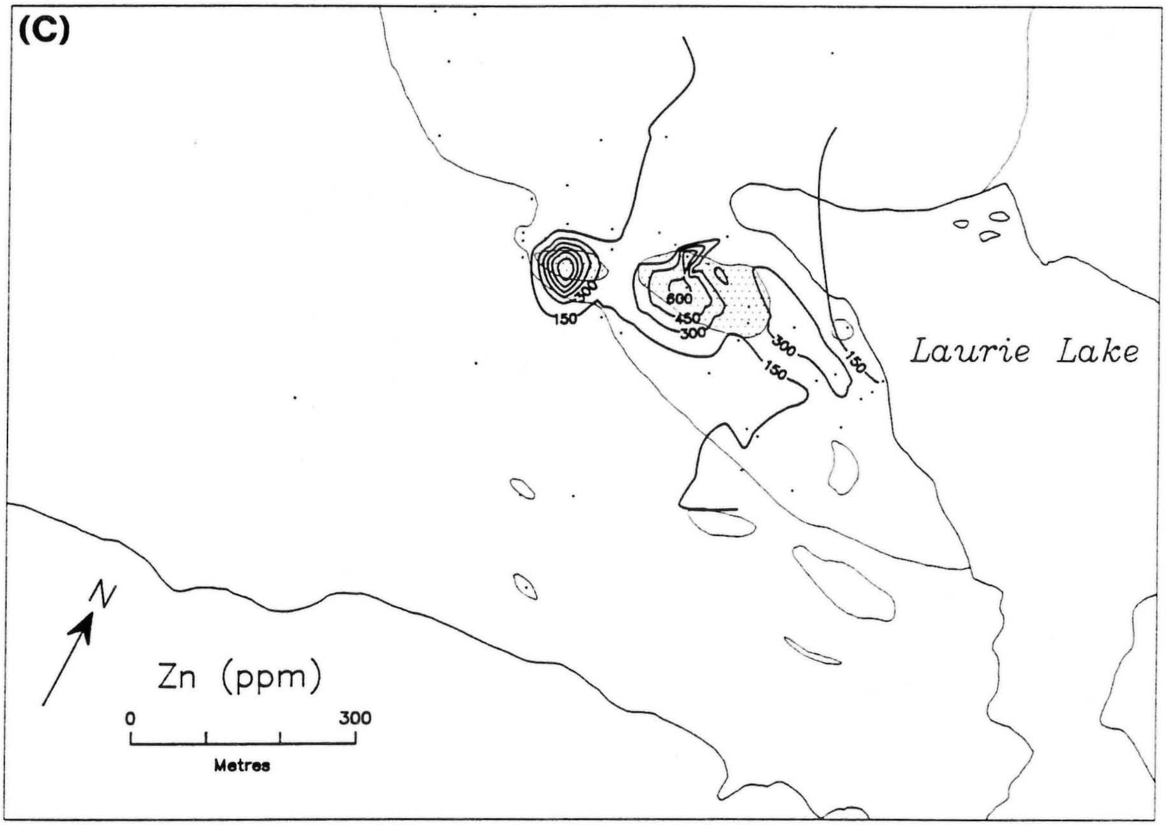
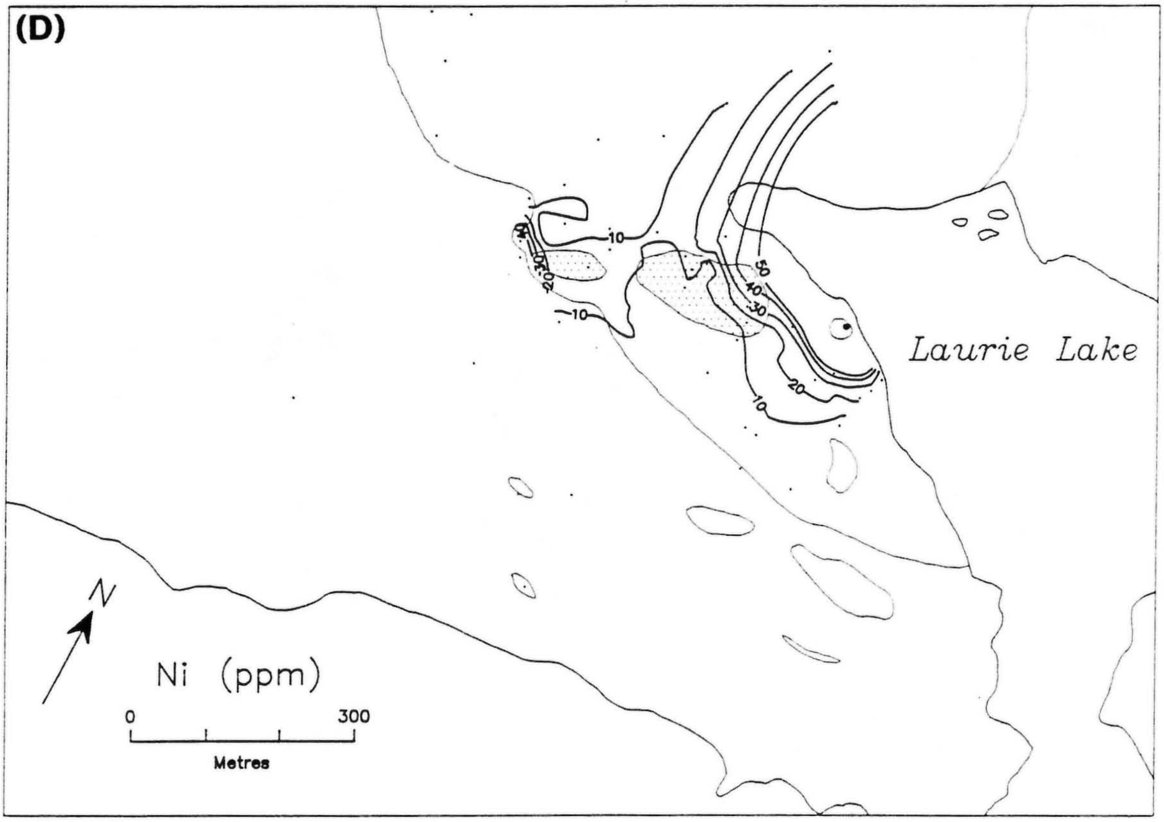
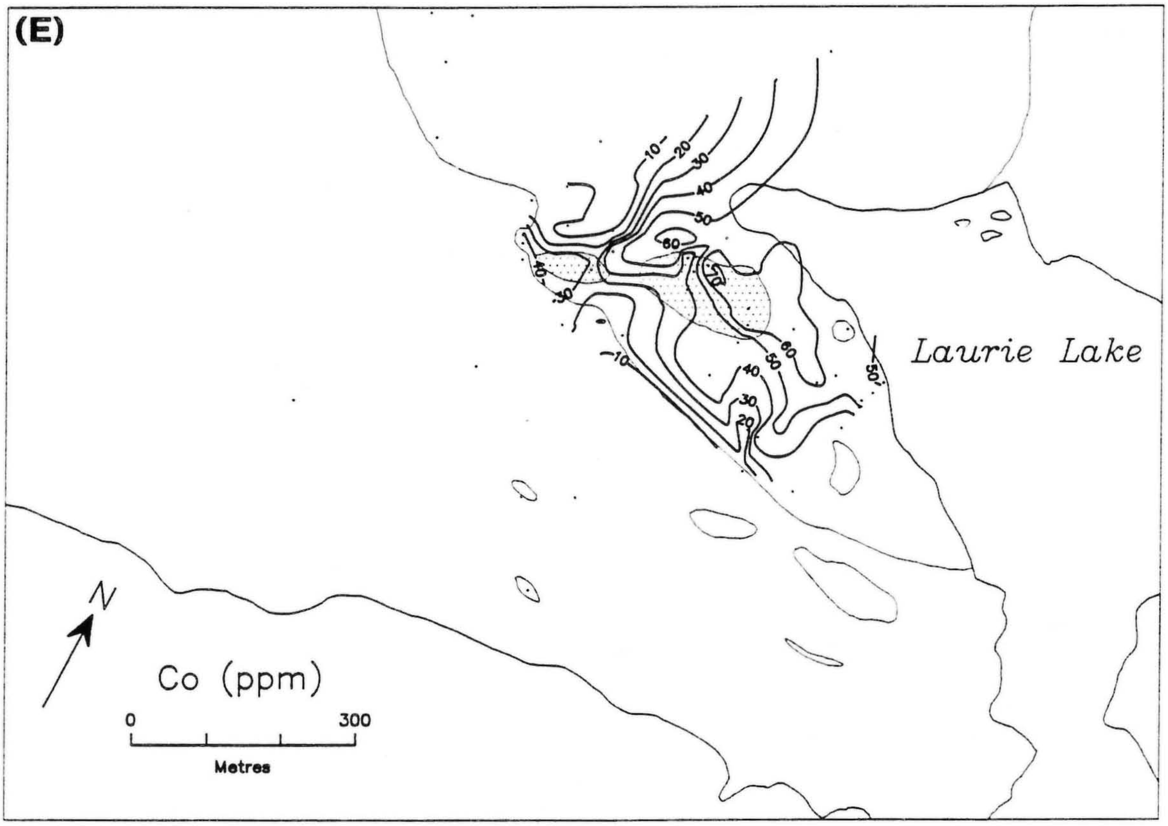
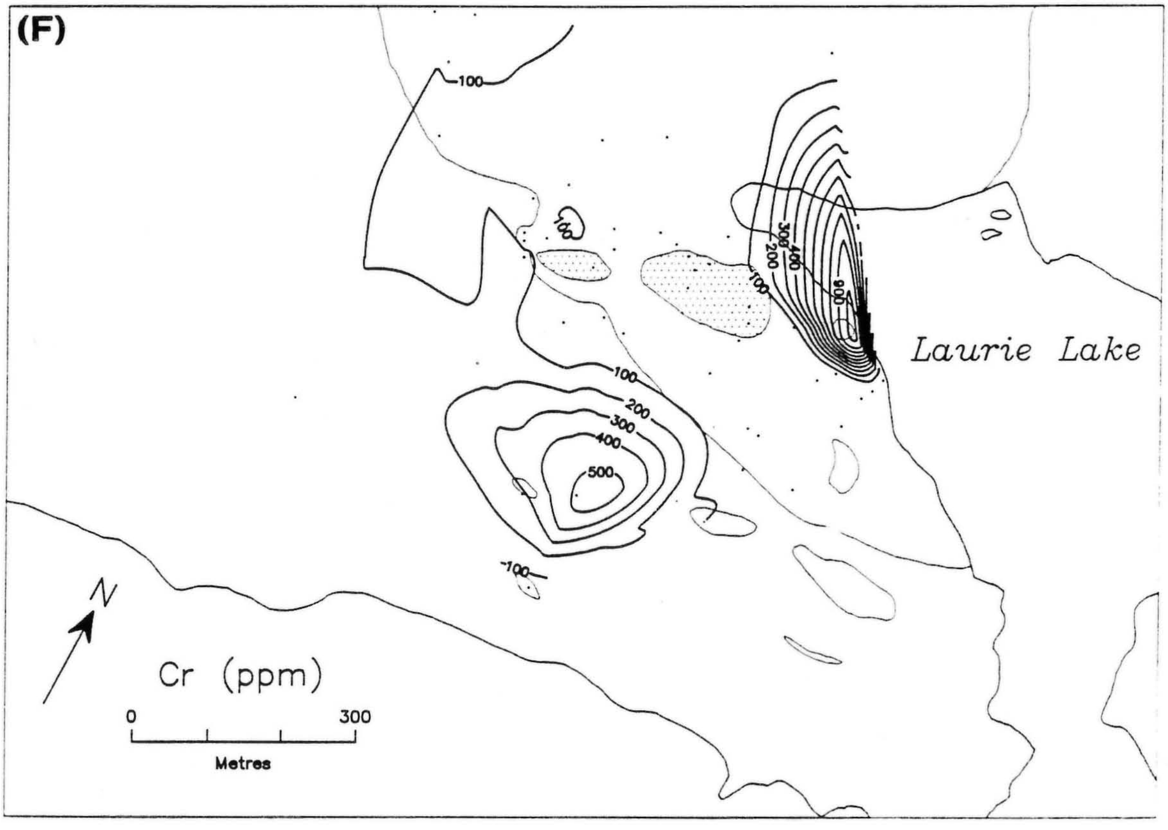


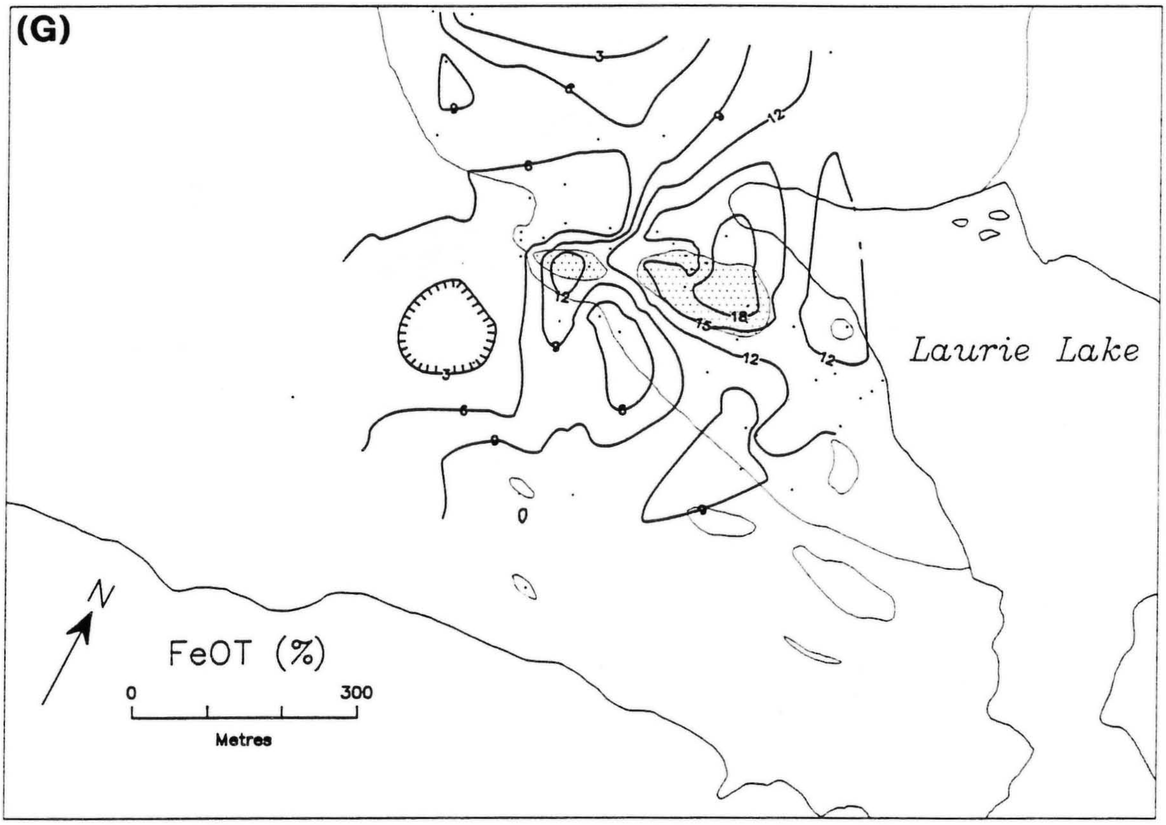
Figure 4: Distribution of (A) copper, (B) lead, (C) zinc, (D) nickel, (E) cobalt, (F) chromium, (G) iron, (H) manganese and (I) gold in bedrock samples in the area of the Lar deposit. Data from Elliott (1986).

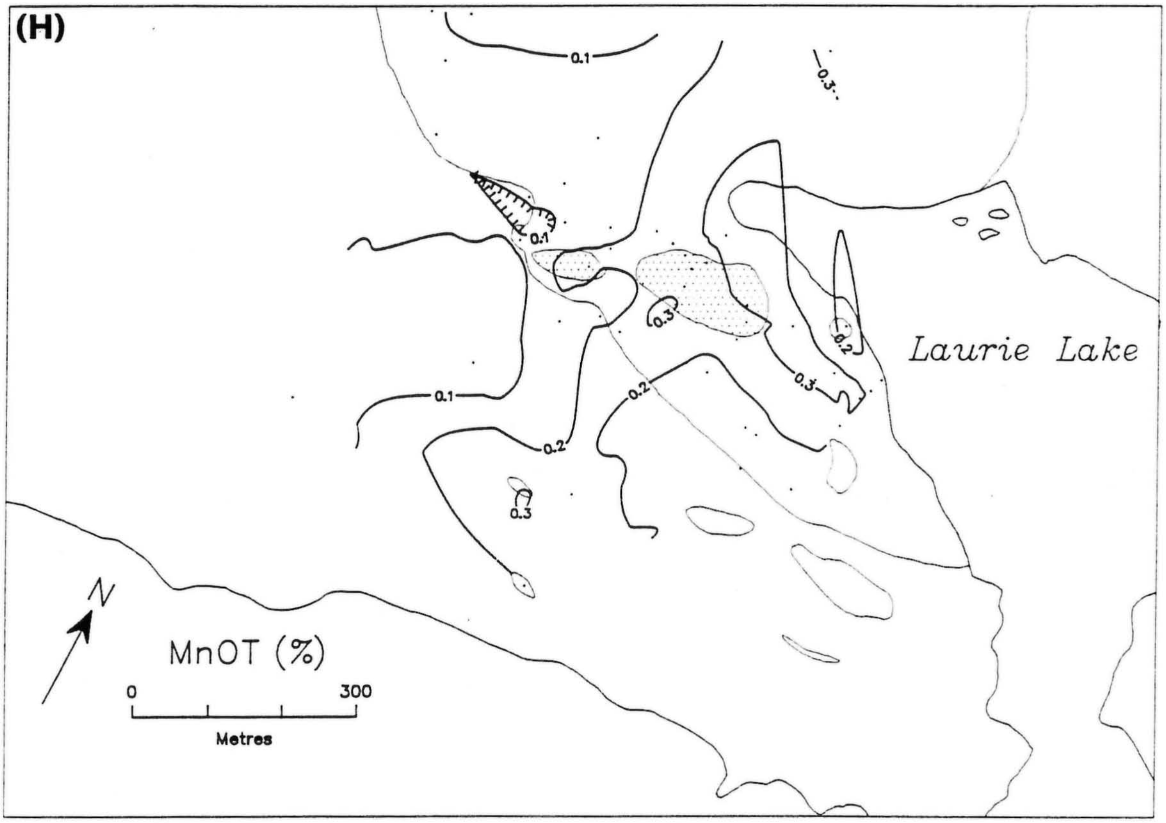

(C)
Laurie Lake
Zn (ppm)
N
0
300
Metres
150
300
450
600

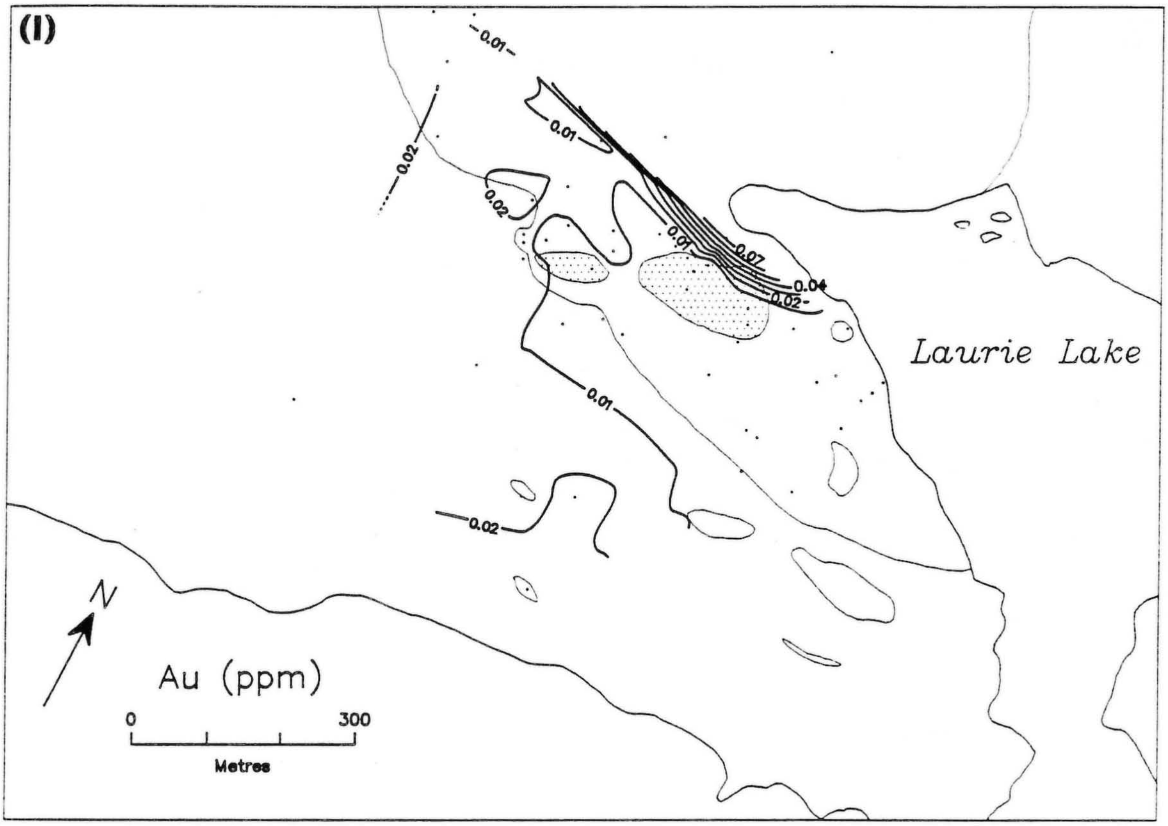

(D)
Laurie Lake
Ni (ppm)
N
0
300
Metres
10
20
30
40
50


(E)
Laurie Lake
N
Co (ppm)
0
300
Metres
10
20
30
40
50
60
70
80
60
50
40
30
20
10


(F)
Laurie Lake
N
Cr (ppm)
0
300
Metres
100
200
300
400
500
900


(G)
3
6
9
12
15
18
Laurie Lake
N
FeOT (%)
0
300
Metres


(H)
0.1
0.2
0.3
Laurie Lake
N
MnOT (%)
0
300
Metres


(I)
0.01
0.02
0.01
0.02
0.01
0.07
0.04
0.02
0.01
0.02
Laurie Lake
N
Au (ppm)
0
300
Metres

SURFICIAL GEOLOGY

Physiography

In contrast to areas further east, such as the Dot Lake-MacLellan Mine area, the relief around the Lar deposit is somewhat higher. The Lar deposit is situated near the crest of a hill, approximately 30 m above Laurie Lake. The hill slopes steeply to the north of the deposit and gently toward Laurie Lake, 0.5 km to the south.

Ice-Flow Direction

The general ice-flow direction throughout the region is southerly. Striations were not found within the sampling area, but are abundant on the islands in the northern part of Laurie Lake (Fig. 5). Striation directions vary between 180° and 210°, but the most common direction is toward 190°. There is some evidence of topographic deflection of the ice around bedrock knolls.

Approximately 12 km north of the Lar deposit, a prominent esker trending 195° changes direction to 210° near Gasse Lake, and finally to 230° at the northwest shore of Laurie Lake, 5 km north west of the deposit (Kaszycki, *et al.*, 1986). This indicates a late glacial shift in the ice-flow direction toward the southwest.

Stratigraphy

There is little overburden stratigraphy in the area. Bedrock is mantled by a till sheet of variable thickness estimated to be generally less than 2 m thick. However, bedrock outcrops are not uncommon (see Elliott, 1984) although only 24 of the 80 holes dug in the area terminated on bedrock. The till sheet is covered with a boulder lag attributed to erosion during regression of Lake Agassiz. Deep water Lake Agassiz clay overlies till at site 25 and near shore sandy gravel overlies till in holes 78 and 80. Sample 67 is Lake Agassiz sand.

The coarse clastic fraction of the till in sample pits 15 and 20 is reverse graded and is attributed to deposition by debris flows either in subglacial cavities or in a subaqueous proglacial environment.

Swampy terrane is common on the southwest facing slope of the hill bearing the deposit and was the main constraint to sampling in much of the area down-ice from the alteration zone.

Felsenmeer or frost-shattered bedrock that forms generally in areas of shallow outcrops and poor drainage, occurs in places near the mineralization (Fig. 6).

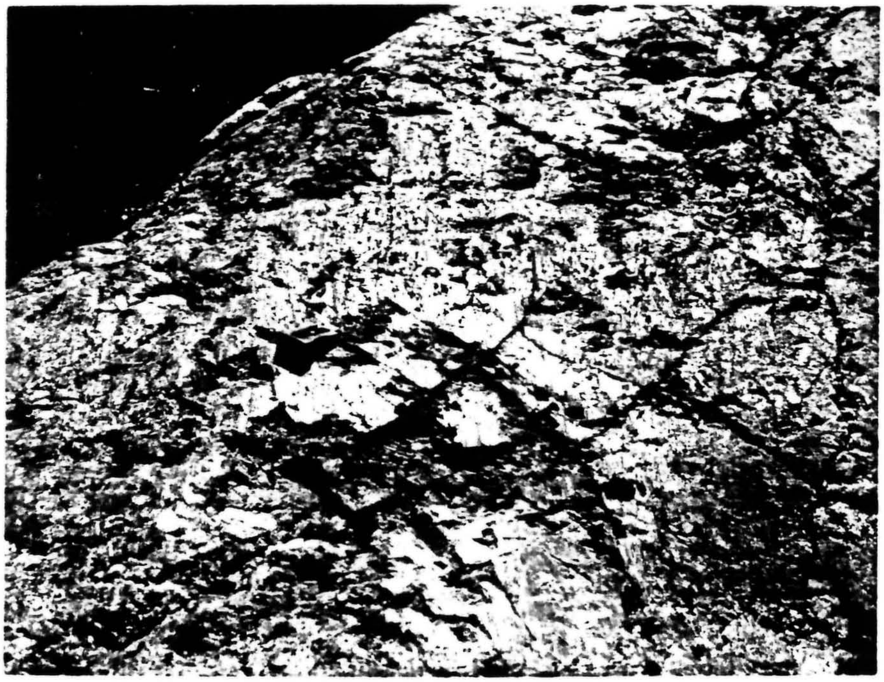


Figure 5: Polished and striated bedrock outcrop on an island in Laurie Lake indicating ice flow toward 210°. Note the pencil sharpener for scale.

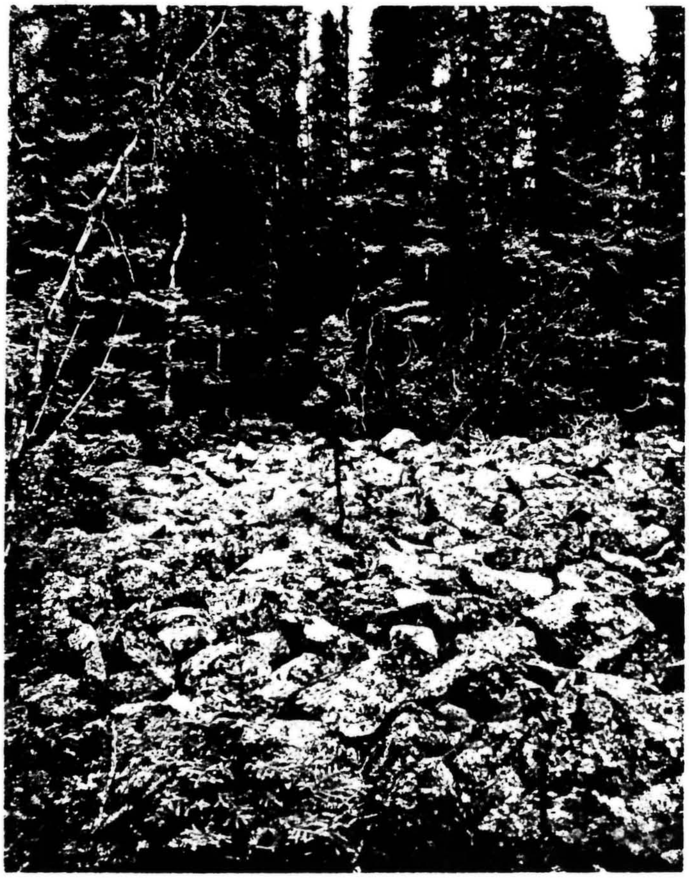


Figure 6: *Felsenmeer formed by permafrost in an area of near surface bedrock and poor drainage south of the alteration zone. The small tree in the centre of the photograph is about 1 m high.*

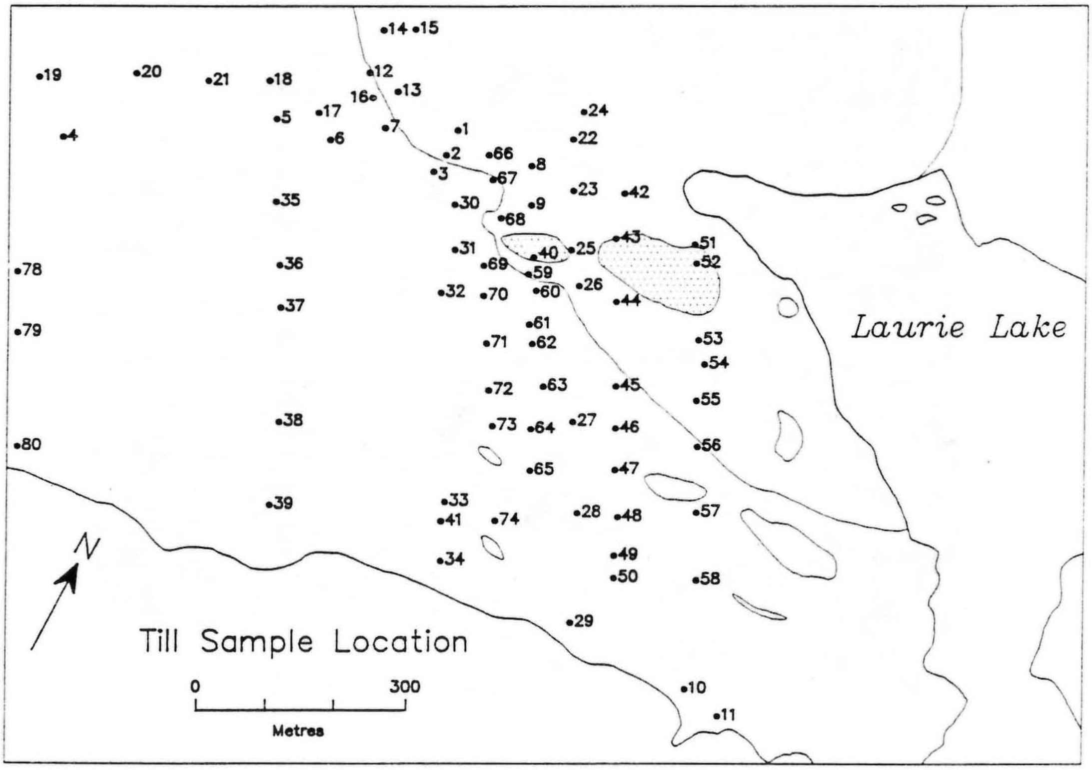


Figure 7: *Location of till sampling sites.*

METHODS

Field Methods

A sample spacing of 50 to 100 m established at Dot Lake-MacLellan Mine and Farley Lake (Nielsen and Fedikow, 1987; Nielsen and Graham, 1985) was used. A total of 128 till samples were collected from 80 hand-dug holes (Fig. 7). Holes ranged between 0.5 and 1.3 m in depth. Six holes terminated in permafrost.

Samples consisted of 2 to 6 kg of slightly to heavily oxidized till. Although it was desirable to sample grey unoxidized till, in most cases it was impossible to dig through the oxidized zone. Munsell colours of the wet till matrix of selected samples are brownish in colour. Detailed vertical sampling at 10 to 20 cm intervals was carried out at 15 randomly selected sites (Fig. 8).

Laboratory Methods

Approximately 500 g of the bulk sample was used for separating the <2 micron fraction and approximately 100 g was used for separating the <63 micron. The rest of the sample was stored for future reference or analysis. Petrographic analyses were carried out on the pebbles from the bulk samples.

The 500 g split of the bulk samples was disaggregated in 1 litre of distilled water using a milkshake mixer. The silt and clay fraction was decanted into a 1 litre centrifuge bottle and centrifuged at 750 rpm for three minutes. The <2 micron fraction was decanted into another one litre centrifuge bottle and centrifuged at 2300 rpm for 15 minutes. After decanting the water the <2 micron fraction was scraped from the bottle, dried, crushed and submitted for geochemical analysis. The reasons for using the clay-sized fraction are documented in Shilts (1975, 1976, 1977), Klassen and Shilts (1977) and summarized by DiLabio *et al.*, (1982) and Shilts (1984).

Approximately 100 g of sample was dry sieved on a 230 mesh epoxied stainless steel screen to concentrate 10 g of sediment <63 microns. The sample was submitted for neutron activation analysis. The lithology, of approximately 300 clasts between 4 and 16 mm in diameter, was determined on one sample from each of the 80 sites.

The clay-sized fraction of the sample received no prior treatment. Cu, Pb, Zn, Ni, Co, Cr, Fe and Mn were analyzed by atomic absorption spectrophotometry after hot nitric-hydrochloric acid extraction.

The lower detection limits for all the elements was 1 or 10 ppm, except Fe, which has a lower detection limit of 500 ppm.

The <63 micron fraction was analyzed for Au+33 elements by Bondar-Clegg & Co. Ltd. in Ottawa. The elements and their respective lower detection limits are listed in Table 1.

In addition, the <2 micron fraction of six till samples with variable trace element concentrations was analyzed by x-ray diffraction to determine the mineral composition and residence sites of anomalous metals.

Table 1
Analytical procedure and detection limits

<63 micron Neutron Activation			<63 micron Neutron Activation			<2 micron Atomic Absorption		
Sodium	0.02	pct	Tellurium	10	ppm	Copper	1	ppm
Scandium	0.2	ppm	Cesium	0.5	ppm	Lead	2	ppm
Chromium	20	ppm	Barium	50	ppm	Zinc	1	ppm
Iron	0.2	pct	Lanthanum	2	ppm	Nickel	1	ppm
Cobalt	5	ppm	Cerium	5	ppm	Cobalt	1	ppm
Nickel	10	ppm	Samarium	0.10	ppm	Chromium	3	ppm
Zinc	100	ppm	Europium	1	ppm	Iron	500	ppm
Arsenic	0.5	ppm	Terbium	0.5	ppm	Manganese	10	ppm
Selenium	5	ppm	Ytterbium	2	ppm	Arsenic	2	ppm
Bromine	0.5	ppm	Lutetium	0.2	ppm			
Rubidium	5	ppm	Hafnium	1	ppm			
Zirconium	200	ppm	Tantalum	0.5	ppm			
Molybdenum	1	ppm	Tungsten	1	ppm			
Silver	2	ppm	Iridium	50	ppb			
Cadmium	5	ppm	Gold	2	ppb			
Tin	100	ppm	Thorium	0.2	ppm			
Antimony	0.1	ppm	Uranium	0.2	ppm			

Figure 8: Location of subsamples and stratigraphy at Site 40 situated on the alteration zone. Marking pencil is 15 cm long.

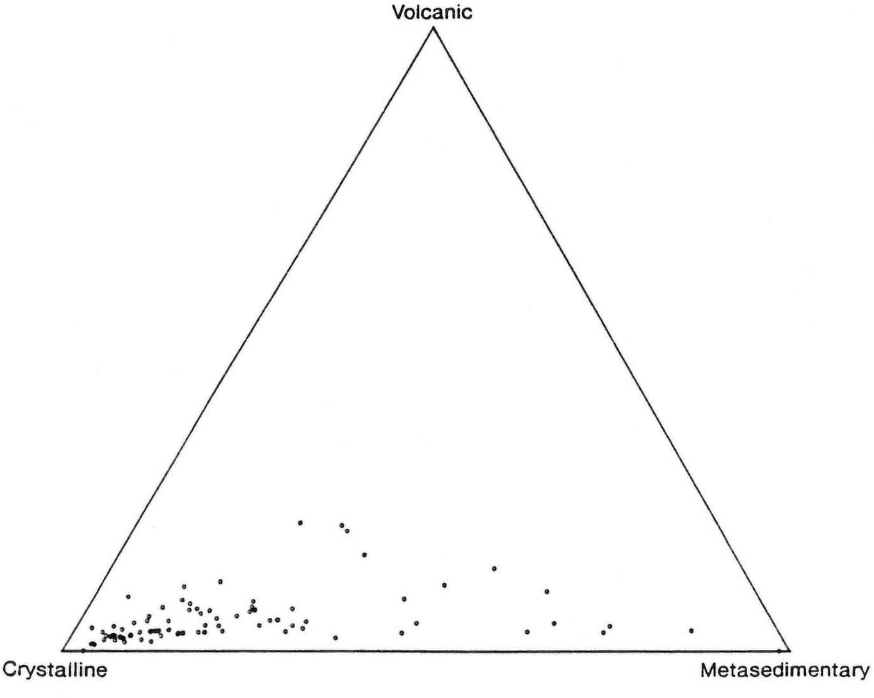


Figure 9: Ternary diagram showing relative proportions of crystalline (granodiorite and tonalite), metasedimentary and intermediate and mafic volcanic clasts in the 4 to 16 mm size fraction.

RESULTS

Petrographic Analysis

The pebble fraction comprises crystalline (granodiorite and tonalite), volcanic and metagreywacke lithologies. Crystalline erratics originating from the extensive granodiorite and tonalite terrane, up-ice from the area, compose more than 60 per cent of the pebbles in all but 14 of the 81 samples (Fig. 9). The abundance and distribution of intrusive clasts reflect both the large source area and the south-southwesterly ice flow across the area (Fig. 10).

Locally derived volcanic rocks compose only a small percentage of the coarse fraction of the till. Only eight samples have more than 10 per cent locally derived volcanic clasts. The concentration of volcanic pebbles is highest over the volcanic bedrock and along the lower flank of the hill, adjacent to the north shore of Laurie Lake (Fig. 11).

Geochemistry

Silt-clay (<63 micron) fraction

Figures 12A-E show the distribution patterns for Zn, Fe, As, Au and Sb in the silt + clay fraction. A complete listing of the analytical data for the <63 micron fraction is presented in Appendix I.

The distribution of Zn and Fe show anomalous concentrations over both the east and west anomalies. Au, As and Sb anomalies, on the other hand, are centered on sample 25, situated at the eastern end of the west anomaly. There is no indication of a glacial dispersion fan towards the south or southwest, in spite of the fact that a single sample of the mineralized outcrop collected approximately 10 m north of till sample 40 (Fig. 7), was found to be anomalous in Ni, Co, Cr, As, Ag, Se, Br, Sb, Mo, Cd and U relative to the till samples (Appendix I). Au and Zn are highly anomalous for this outcrop sample with values of 3010 ppb Au and 5300 ppm Zn.

Clay-sized (<2 micron) fraction

The frequency distribution of the geochemical data for the <2 micron fraction is presented in Figure 13. The geochemical data is listed in Appendix II. Summary statistics and correlation matrix are shown in Tables 2 and 3 respectively. Threshold values have been determined graphically for each element by plotting the cumulative frequency on probability paper (Fig. 14). These threshold values and those determined in the regional till survey by Kaszycki and DiLabio (1986) are listed in Table 4.

Regional variation

The distribution of Cu, Pb, Zn, Ni, Co, Cr, Fe, Mn and As in the till around the Lar deposit are shown in Figure 15A-I.

Cu, Pb, Zn and Ni show some dispersion southwest of both the east and west zones. Cu and Zn values above 100 ppm are found up to 400 m southwest of the west zone, but less than 150 m south of the east zone.

Highly anomalous Pb values occur over, and southwest of the west zone, a pattern similar to that of Cu and Zn in this area. The east zone has no associated Pb anomaly in the till, consistent with Pb distribution in the bedrock. Ni and Co are slightly anomalous in samples 5, 16, 17, 18 and 21 in the northwest part of the sampling area, a pattern similar to that shown by Cu, Pb and Zn. Around the alteration zone, Ni, Co, Cr and Mn are depleted relative to the surrounding till. Fe is found in anomalous concentrations over both the east and west zone, but shows little evidence of down-ice glacial dispersion. Samples 25 and 40 from over the west zone, and sample 51 from the north margin of the east zone are anomalous in As. The only other sample anomalous in As is sample 26, situated between, and slightly south of, the two mineralized zones. It is unlikely that this anomaly is due to glacial transport as the east zone is relatively poor in As.

Vertical variation

The vertical variation in trace element content in detail sampled hand-dug holes is shown in Figure 16. Of the six profiles shown, only those for sites 25 and 40 contain anomalous concentrations of trace elements. Cu, Zn, Ni, Co and Mn concentrations in pits off the mineralization increase with depth with the highest values occurring at the bottom. Pb, Cr, Fe and As are variable through the upper metre of the till sheet. Over the alteration zone at site 40 (Fig. 8), the upper 55-60 cm of the section is a highly oxidized clast supported lag deposit formed by *in situ* washing and subsequent deflation of the till. The clasts appear to be distantly travelled tonalite and granodiorite (Fig. 8). The lower half of the section is relatively unweathered sandy till. Cu, Ni, Co, Cr and Mn concentrations first increase with depth through the highly oxidized layer. Ni, Co, Cr, and Mn decrease to the bottom of the hole whereas Cu increases and reaches a maximum at the base of the section. Pb and Fe have high concentrations at the top of the profile, but drop off quickly before increasing and reaching their maximum values at the base. Highly mobile Zn, that has the highest concentrations at the top of the section, decreases toward the base.

Section 25, also located over the alteration zone, exposes approximately 45 cm of Lake Agassiz beach sand overlying 15 cm of deep water Lake Agassiz clay. The underlying till is oxidized. The geochemical profile in this section is similar to that of section 40. The pronounced increase in concentration of Zn (Fe to a lesser degree) at the top of both sections is believed to be due to postglacial weathering of either the underlying bedrock or the sulphide-rich till. The soluble products of this weathering may have been transported to the surface by biogenic processes and subsequently became enriched in humus and the upper part of the solum.

Residence sites

Of the six samples analyzed by x-ray diffraction, three are anomalous in trace elements and three representative of background levels. Samples 25 and 51 contain elevated concentrations of Cu, Pb, Zn, Fe and As, whereas sample 43 is anomalous in Cu, Pb and Zn. The six samples are characterized by the presence of quartz and feldspar (albite, microcline or orthoclase). Samples 30 and 43 contain clinoamphibole (probably tremolite) and samples 25 and 51 contain jarosite ($KFe_3(SO_4)_2(OH)_6$). Phyllosilicate minerals, which are often the residence sites of leached cations in oxidized till samples (Shilts and Kettles, 1990 and references therein), were not detected. Anomalous concentrations of Fe probably reside in the jarosite. As no phyllosilicate minerals are associated with the anomalously high concentrations of Cu, Pb, Zn or As, these elements probably reside in amorphous oxides and hydroxides. This indicates the geochemical anomaly in the till, over and adjacent to the deposit, is hydromorphic in origin, i.e. due to build-up in the regolith of cations released by postglacial weathering of either the sulphide deposit itself or the clastic components of the till derived from the deposit. Alternatively, these cations are bound to the surfaces of silicate minerals.

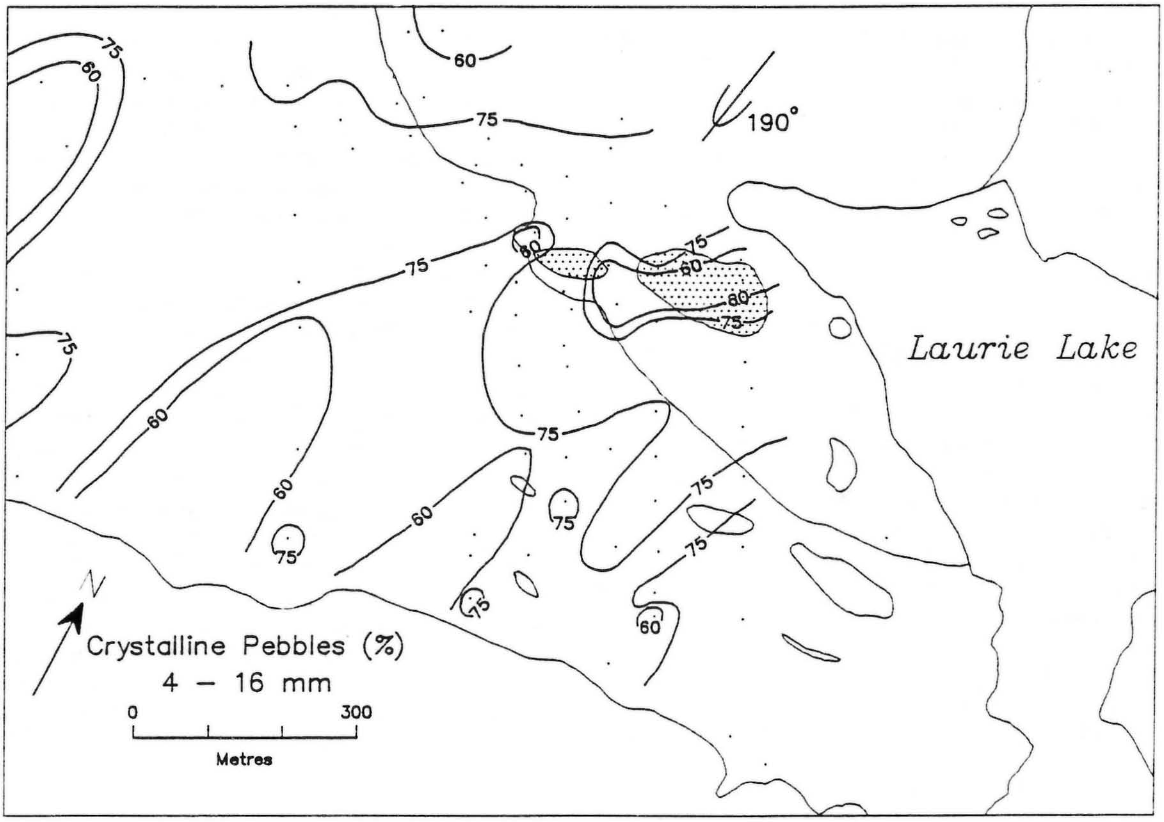


Figure 10: Distribution of crystalline (granodiorite and tonalite) erratics in the 4 to 16 mm size fraction.

Table 2
Summary statistics for the clay-sized fraction geochemical data

Variable:	Cu	Pb	Zn	Ni	Co	Cr	Fe	Mn	As
Observations:	128	127	128	128	126	128	128	128	115
Minimum:	15	2	18	1	2	18	1055	34	2
Maximum:	1840	2910	590	98	37	154	22400	1530	824
Mean:	183.0	84.2	124.2	28.7	14.2	61.7	6065.0	302.4	18.9
Std. err. mean:	22.8	31.7	10.0	1.4	.6	1.7	372.8	15.5	8.4
Std. deviation:	257.8	357.7	113.6	15.4	7.1	19.3	4217.6	175.9	90.3
Kurtosis:	15.2	49.7	6.1	3.3	.9	4.7	4.8	18.5	64.9
Skewness:	3.5	6.9	2.5	1.1	.6	1.3	2.2	3.0	7.9

Table 3
Pearson linear correlation matrix for the clay-sized fraction geochemical data

	Cu	Pb	Zn	Ni	Co	Cr	Fe	Mn	As
Cu	1.0000	.5246	.6958	-.2182	-.2564	-.2529	.6341	-.2163	.4474
Pb		1.0000	.4260	-.2706	-.2271	-.2832	.4644	-.2162	.9385
Zn			1.0000	-.1095	-.0583	-.2002	.5374	-.0528	.3225
Ni				1.0000	.7340	.3745	-.4305	.3897	-.2628
Co					1.0000	.1421	-.3752	.6289	-.2447
Cr						1.0000	-.1325	-.0477	-.3053
Fe							1.0000	-.2478	.3931
Mn								1.0000	-.2168
As									1.0000

Table 4
Threshold values for the 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		90th percentile	95th percentile
Cu ppm	100	109	134
Pb ppm	20	18	20
Zn ppm	100	166	190
Ni ppm	50	56	65
Co ppm	26	-	-
Cr ppm	80	108	123
Fe pct	5.0	5.7	6.1
Mn ppm	480	730	805
As ppm	10	15	24

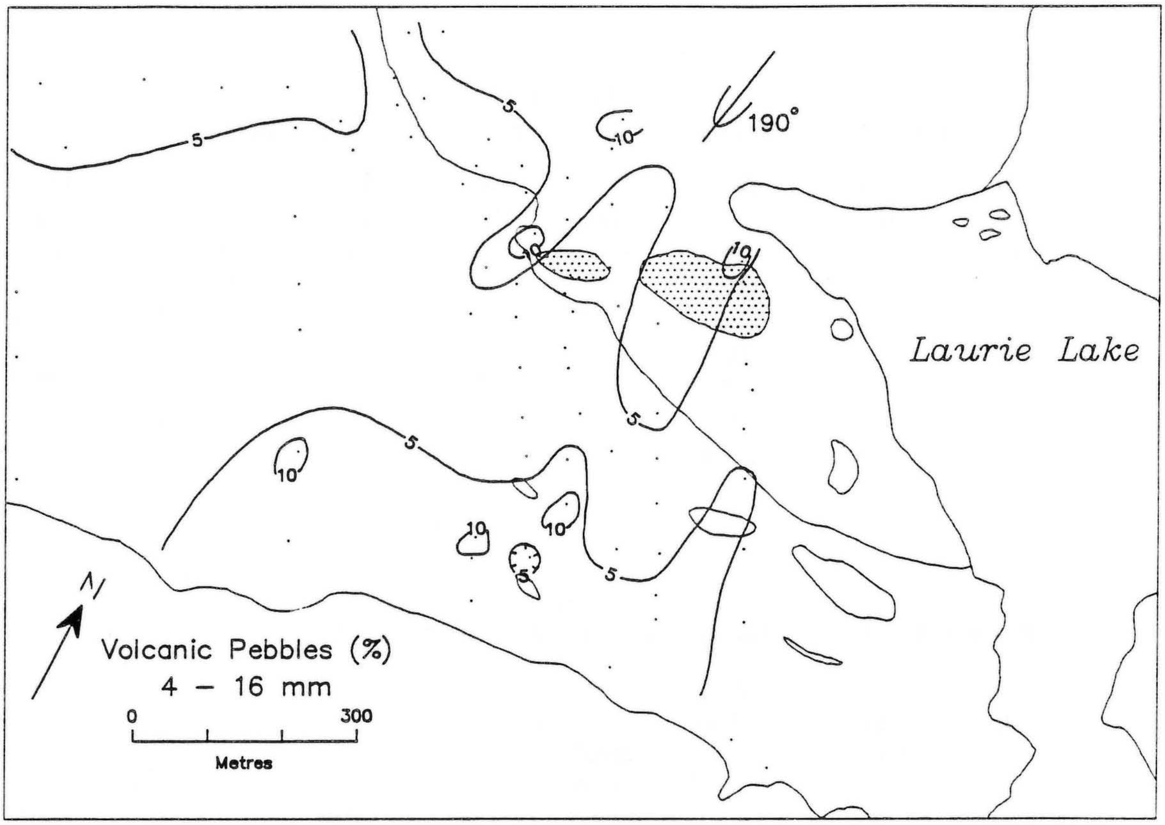


Figure 11: *Distribution of intermediate and mafic volcanic clasts in the 4 to 16 mm size fraction.*

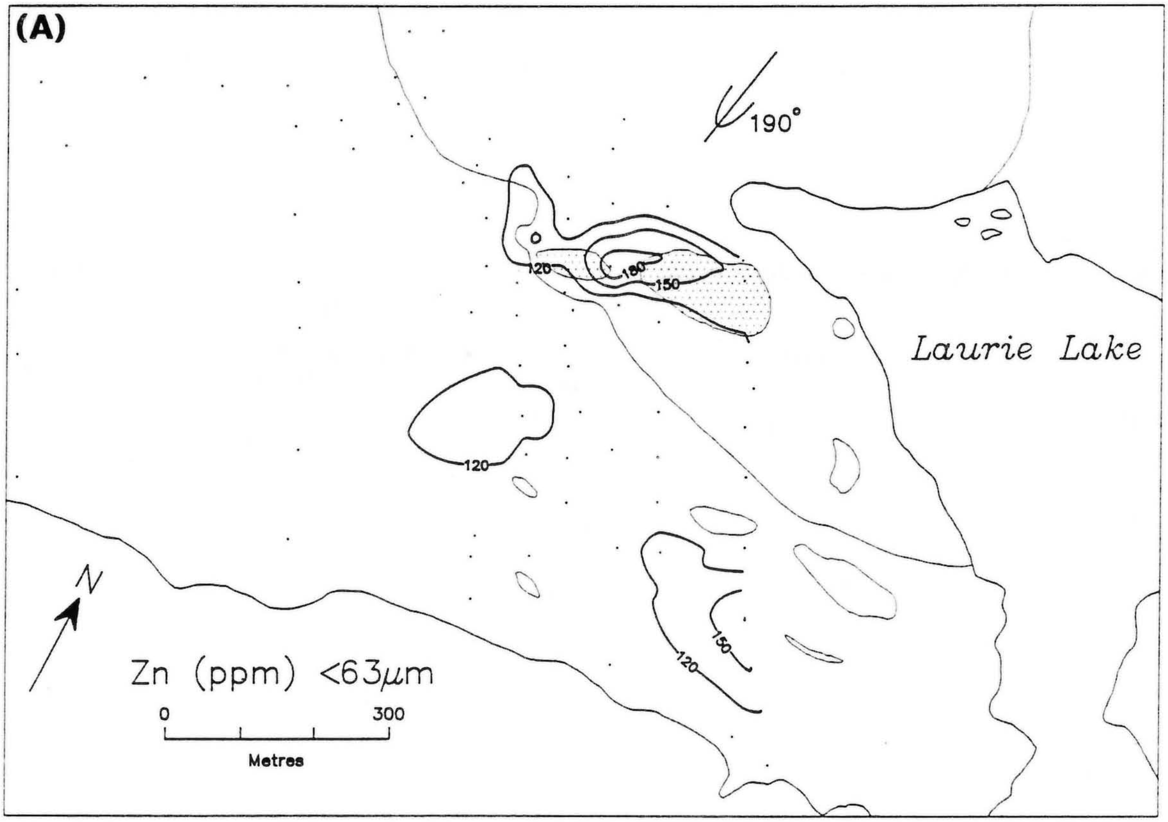
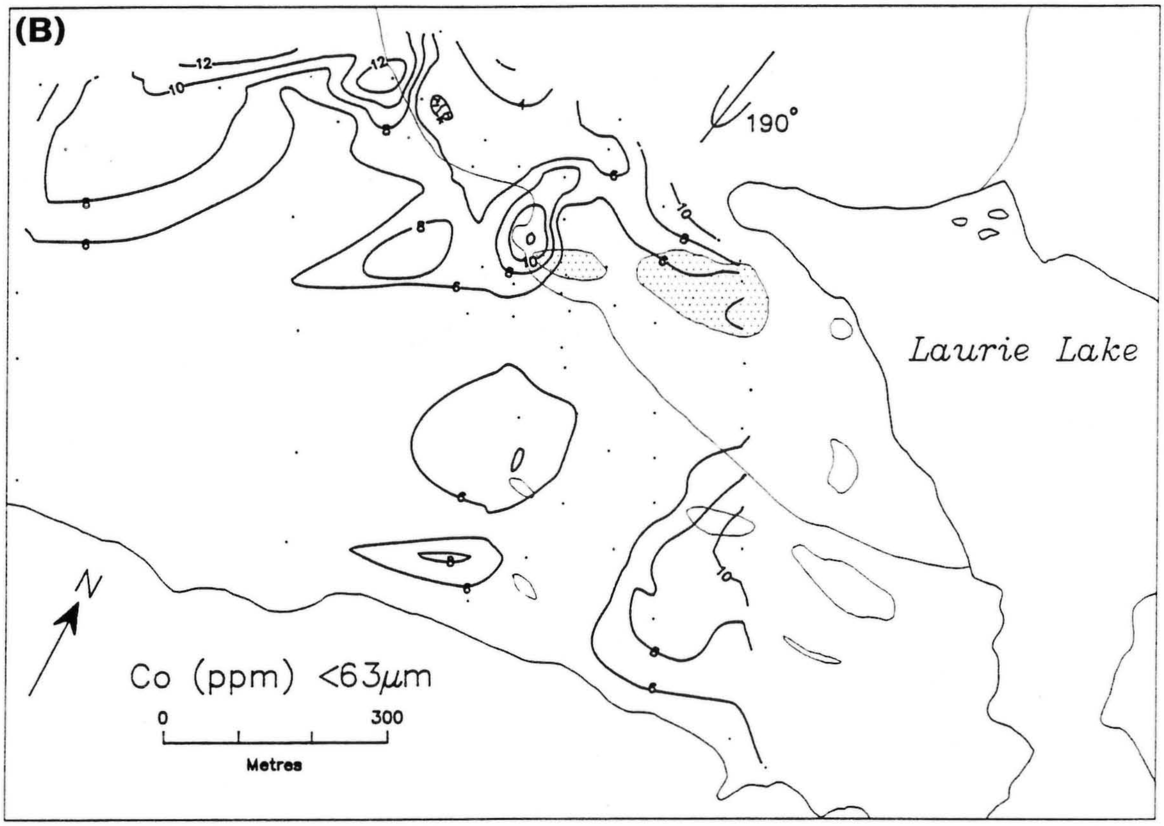
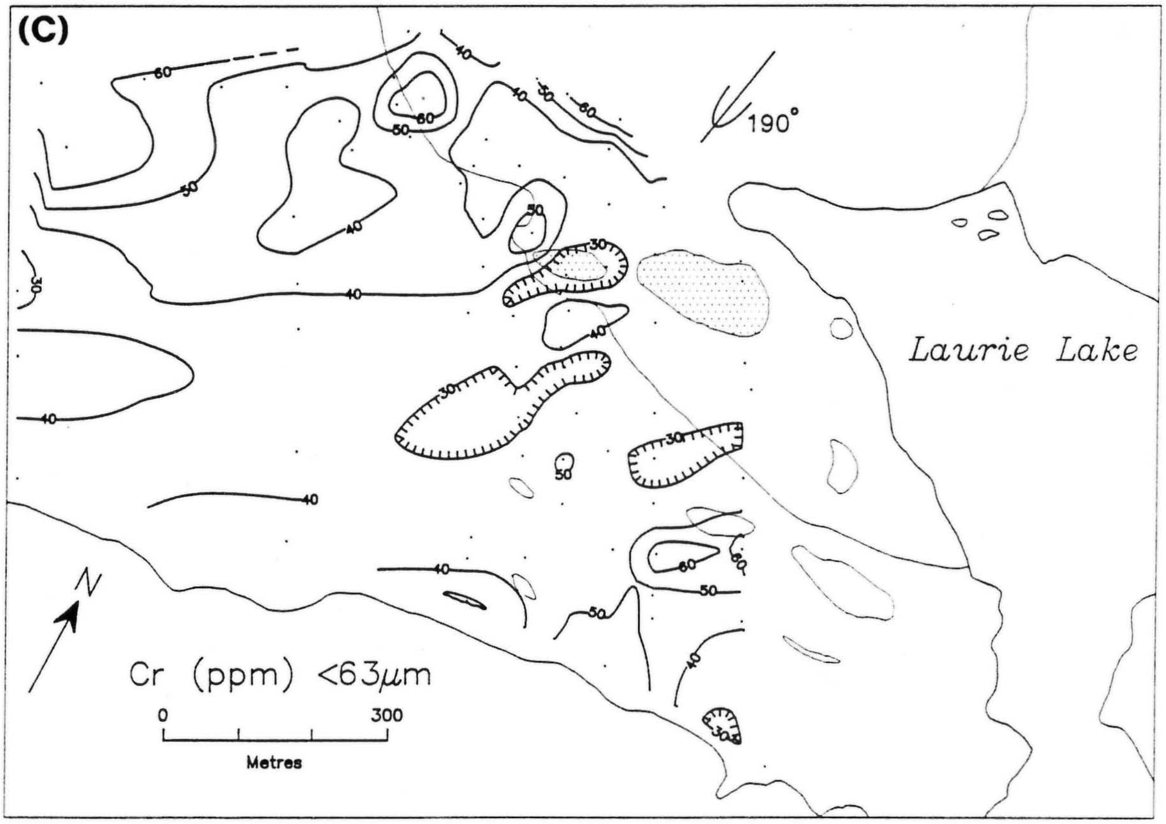
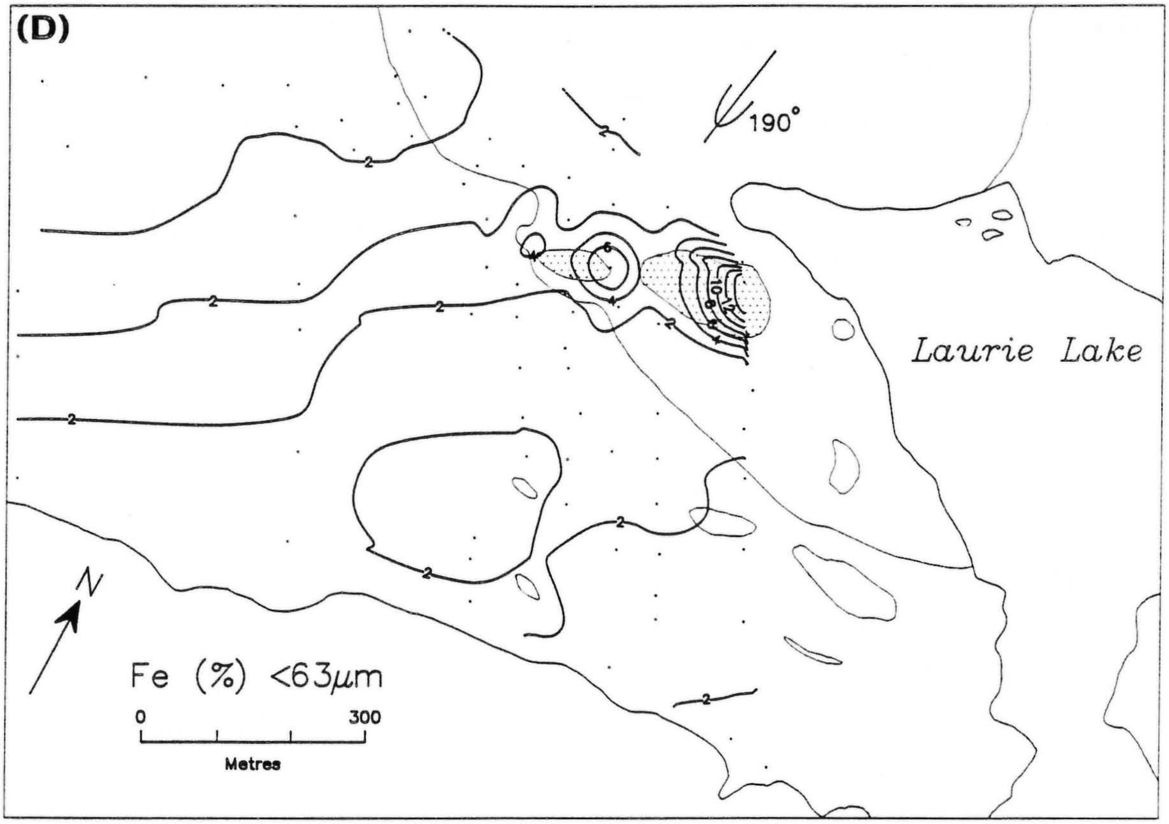
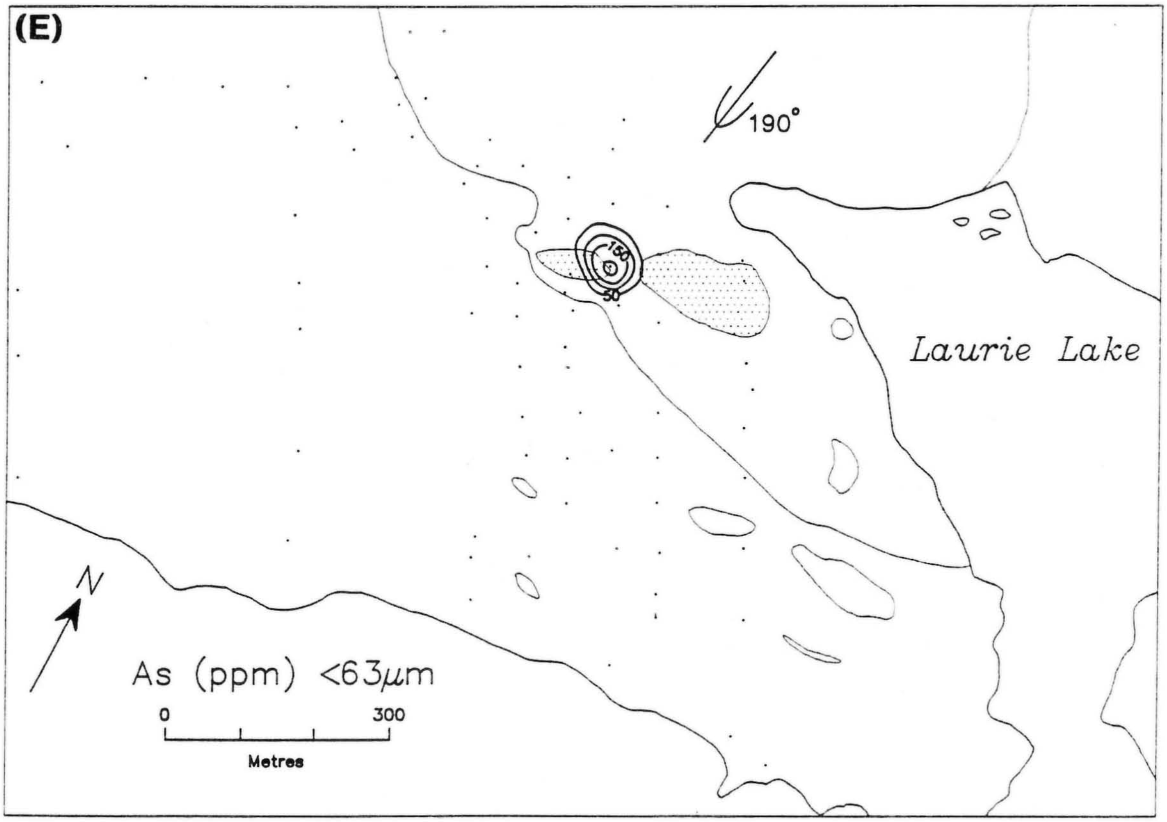


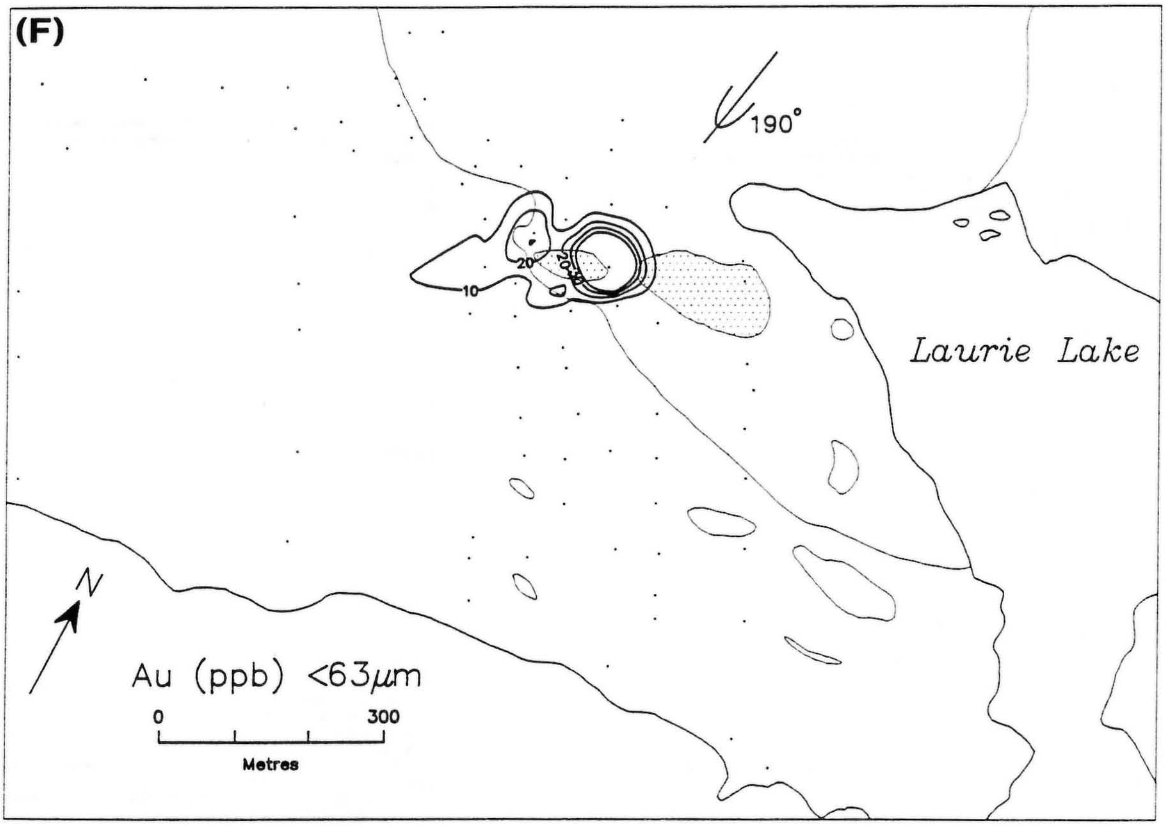
Figure 12: *Dispersal pattern for (A) zinc, (B) cobalt, (C) chromium, (D) iron, (E) arsenic, (F) gold and (G) antimony in the <63 micron fraction.*

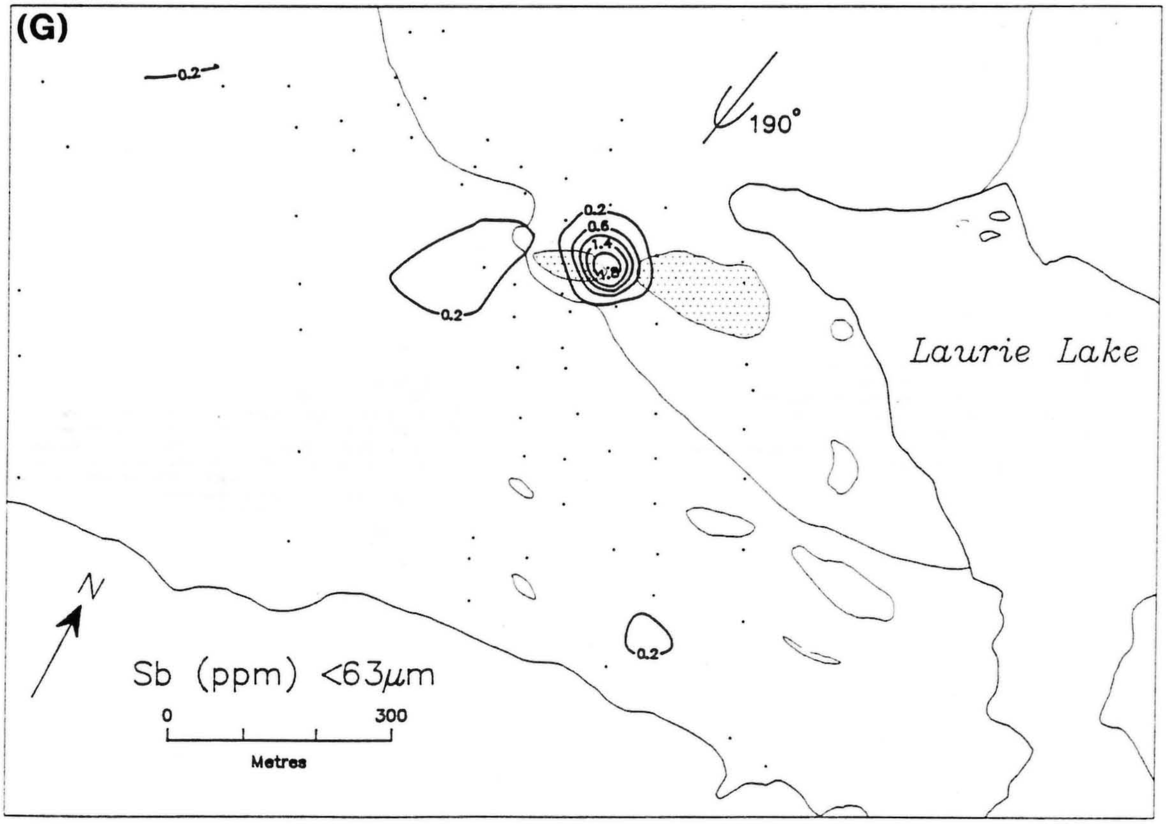

(B)
190°
Laurie Lake
N
Co (ppm) <63μm
0
300
Metres
12
10
8
6
4


(C)
190°
Laurie Lake
N
Cr (ppm) <63μm
0
300
Metres
60
50
40
30


(D)
190°
2
4
6
8
10
12
Laurie Lake
N
Fe (%) <63µm
0
300
Metres


(E)
190°
150
50
Laurie Lake
N
As (ppm) <63µm
0
300
Metres


(F)
190°
20
20
10
Laurie Lake
N
Au (ppb) <63μm
0
300
Metres


(G)
0.2
190°
0.2
0.6
1.4
1.8
0.2
Laurie Lake
0.2
N
Sb (ppm) <63μm
0
300
Metres

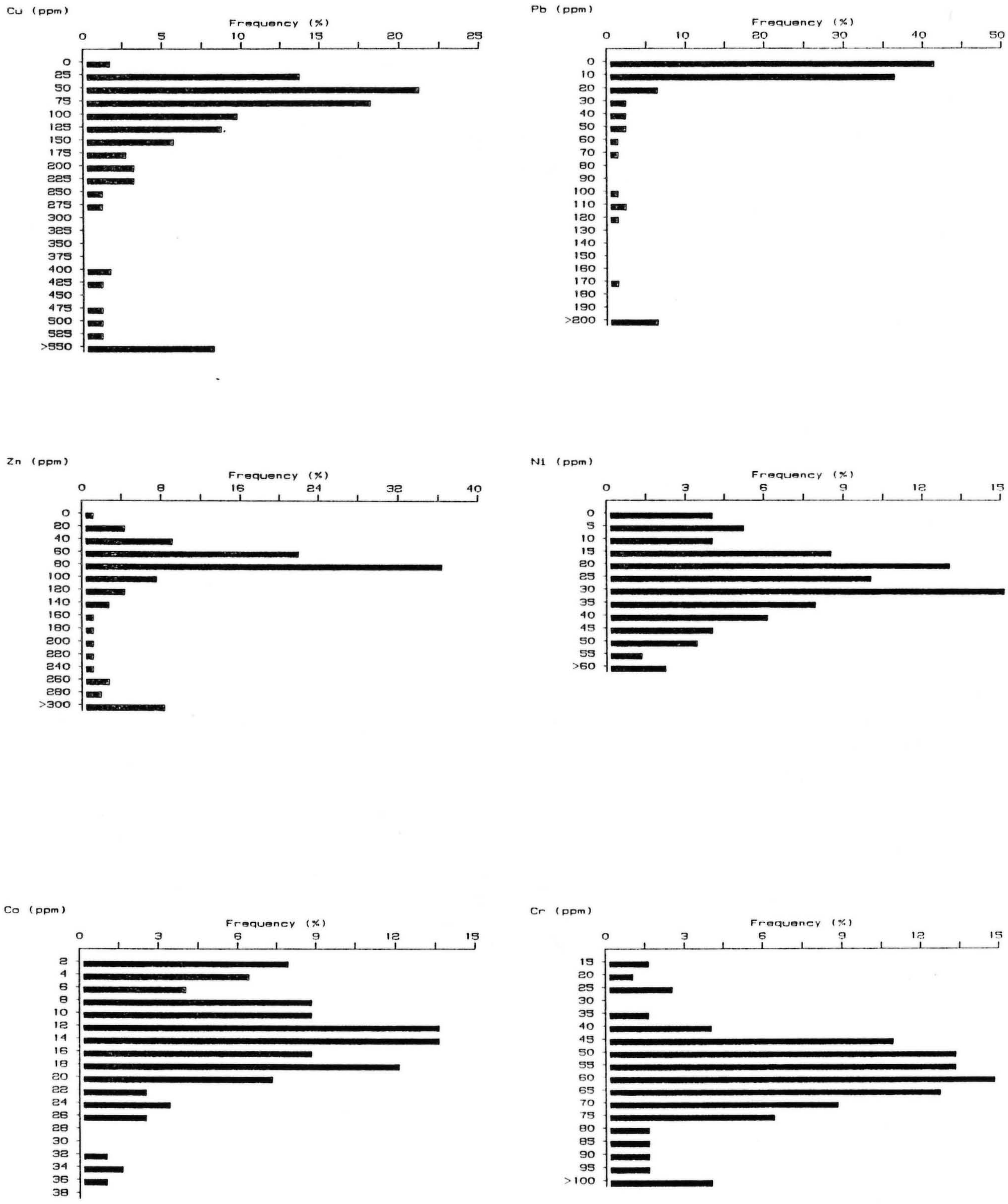
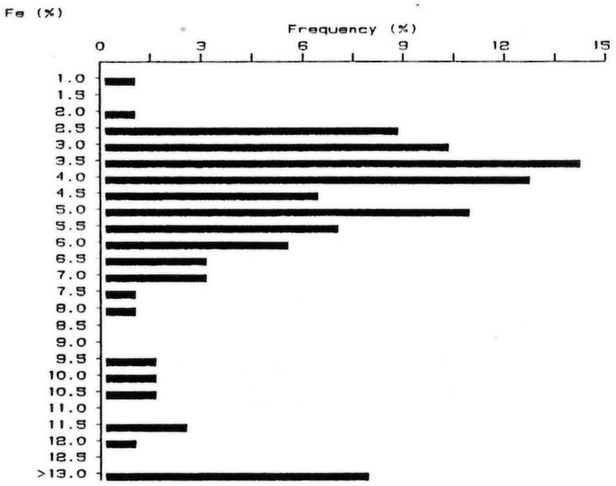
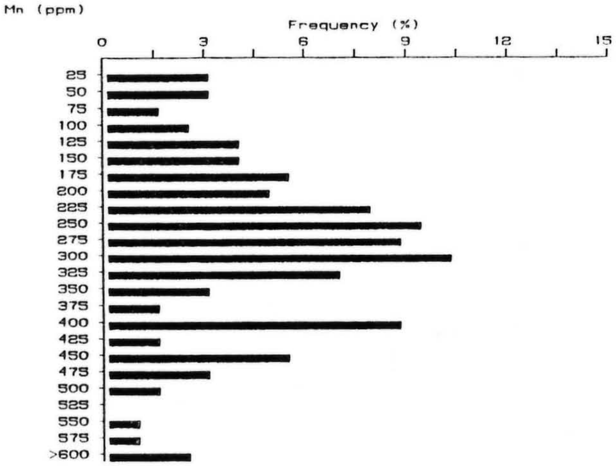
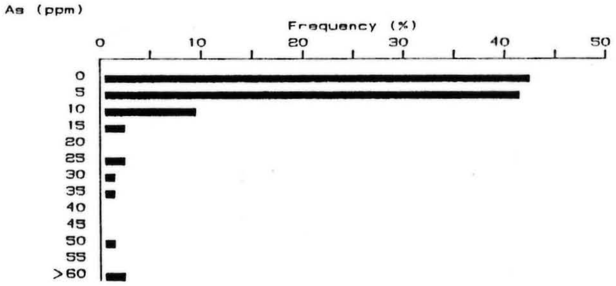


Figure 13: The distribution of element concentration in the clay-sized fraction.


Fe (%)
Frequency (%)
0
3
6
9
12
15
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
>13.0


Mn (ppm)
Frequency (%)
0
3
6
9
12
15
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
475
500
525
550
575
>600


As (ppm)
Frequency (%)
0
10
20
30
40
50
0
5
10
15
20
25
30
35
40
45
50
55
>60

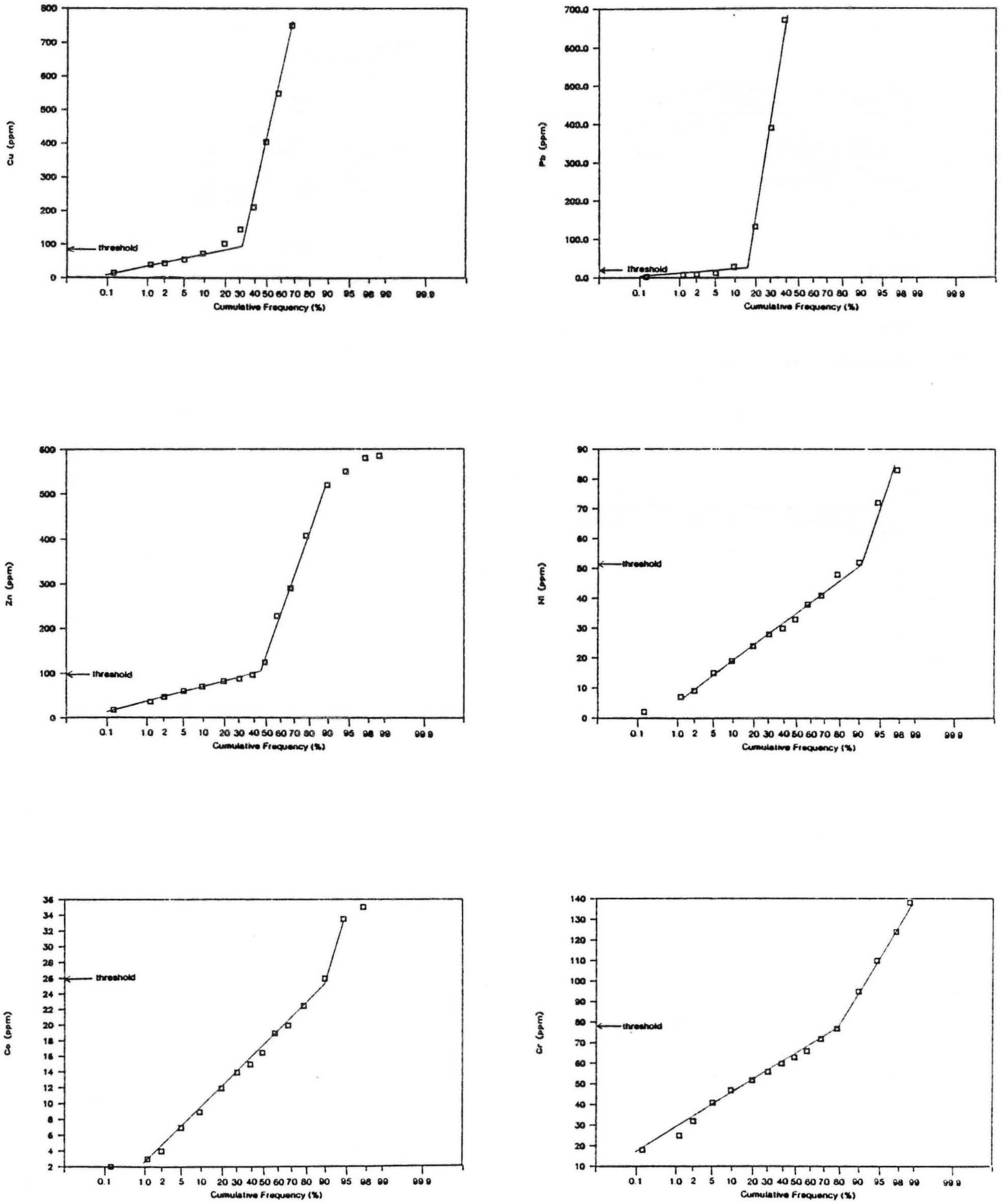
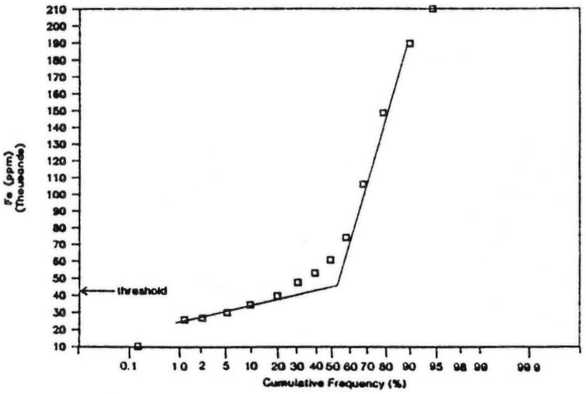
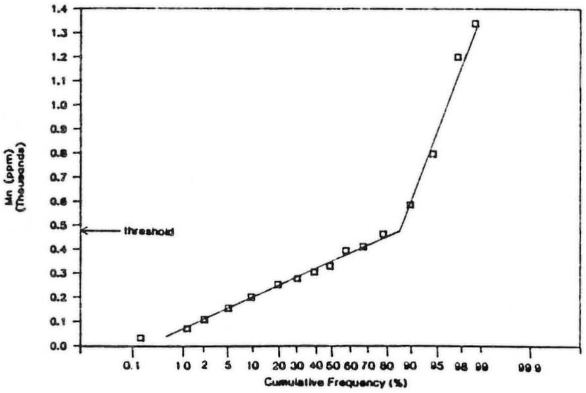
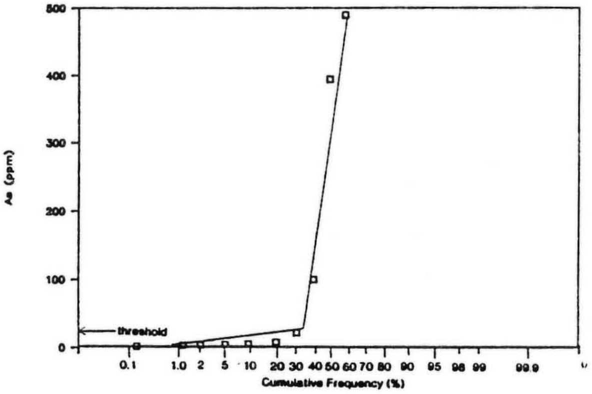


Figure 14: Cumulative frequency plots showing thresholds for the analysis of the clay-size fraction.


Fe (ppm) (Thousands)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
threshold
0.1
1.0
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.9
Cumulative Frequency (%)


Mn (ppm) (Thousands)
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
threshold
0.1
1.0
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.9
Cumulative Frequency (%)


As (ppm)
500
400
300
200
100
0
threshold
0.1
1.0
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.9
Cumulative Frequency (%)

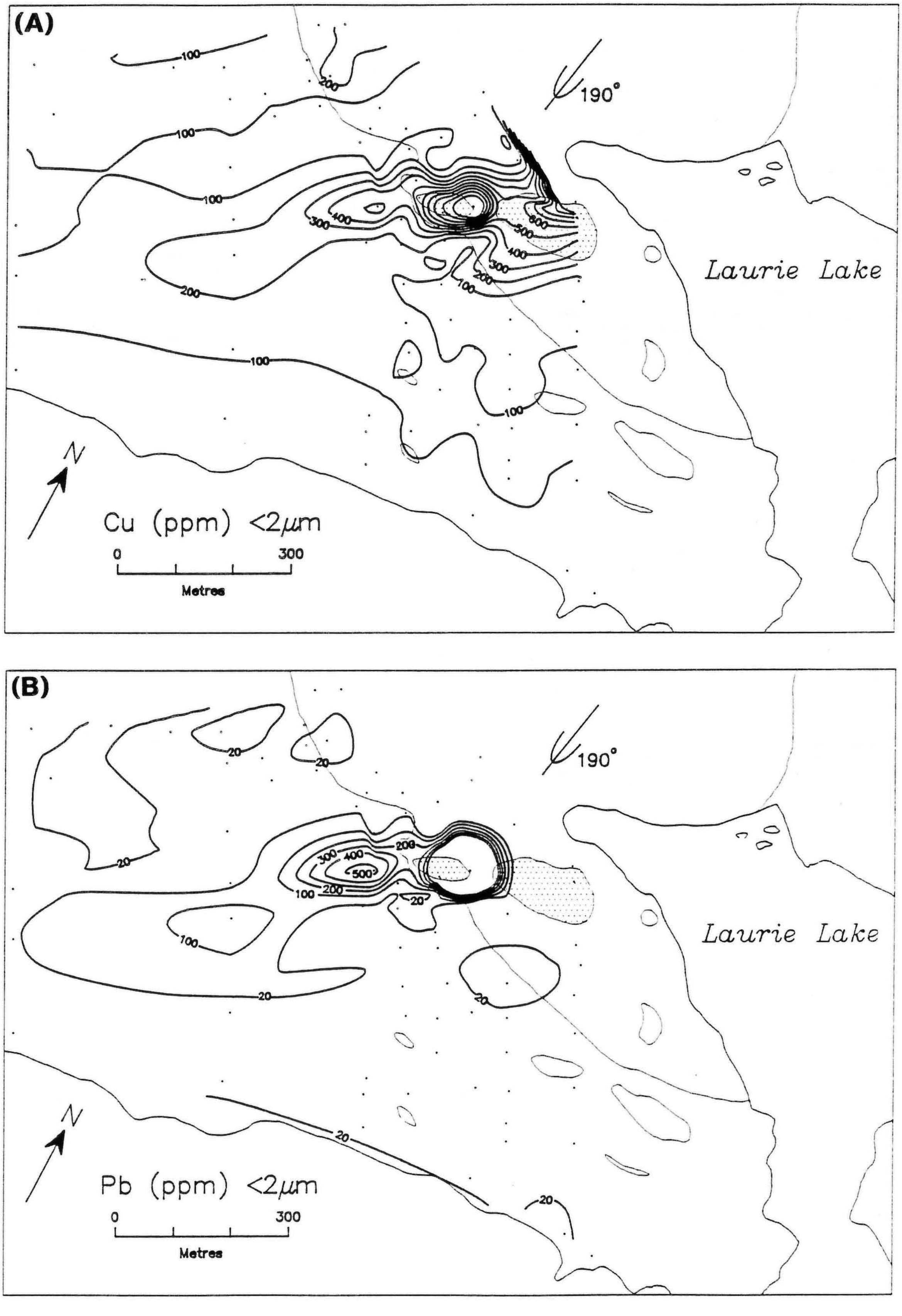
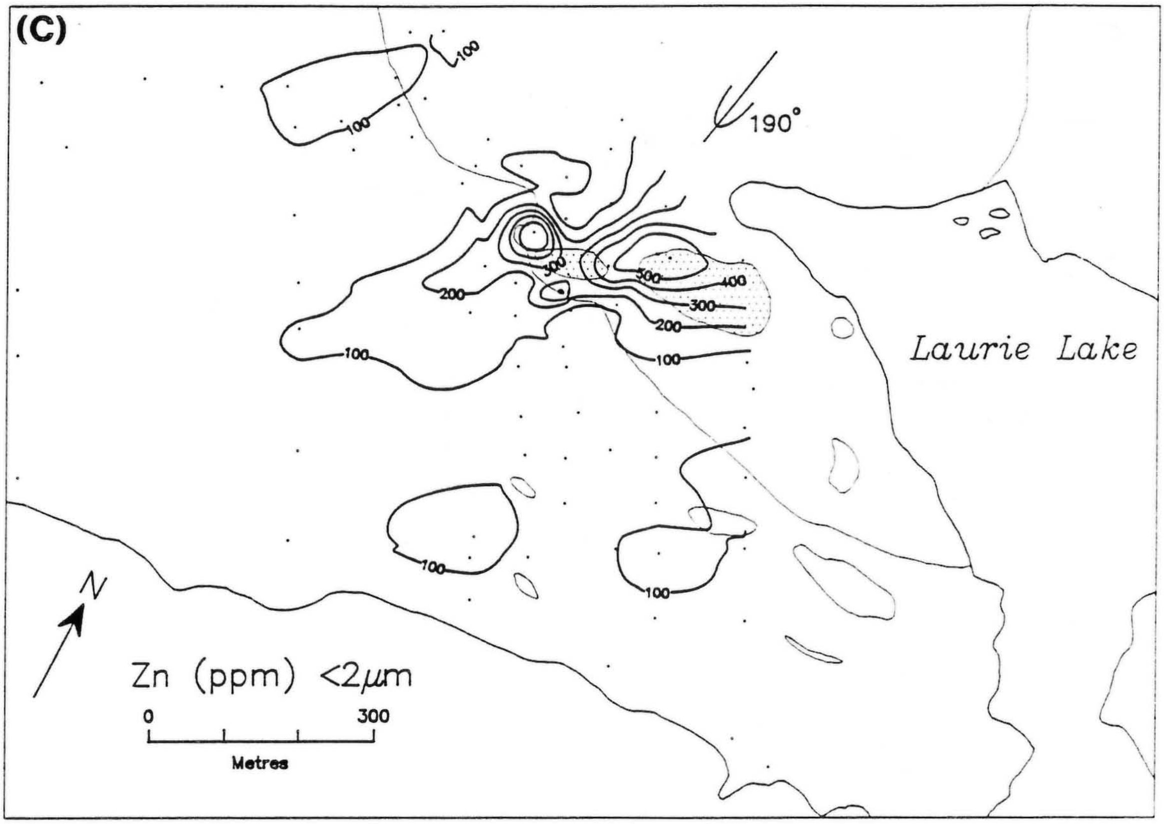
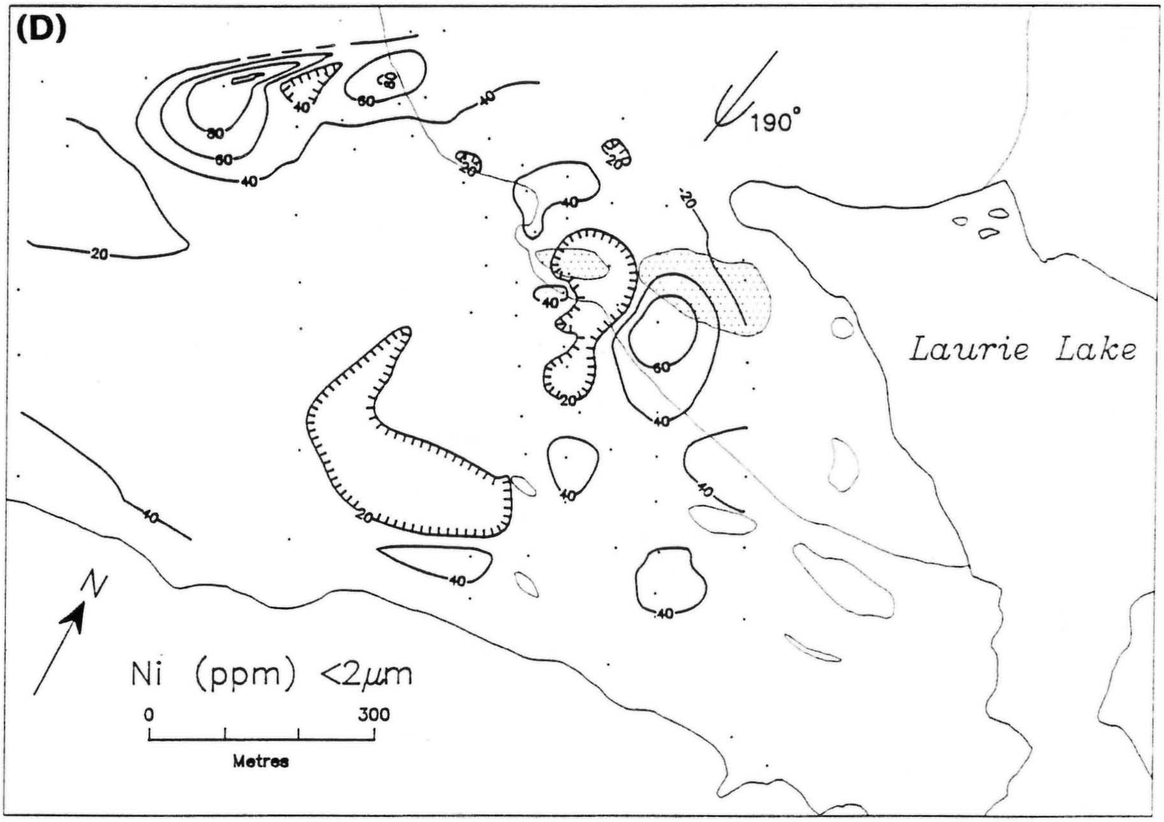
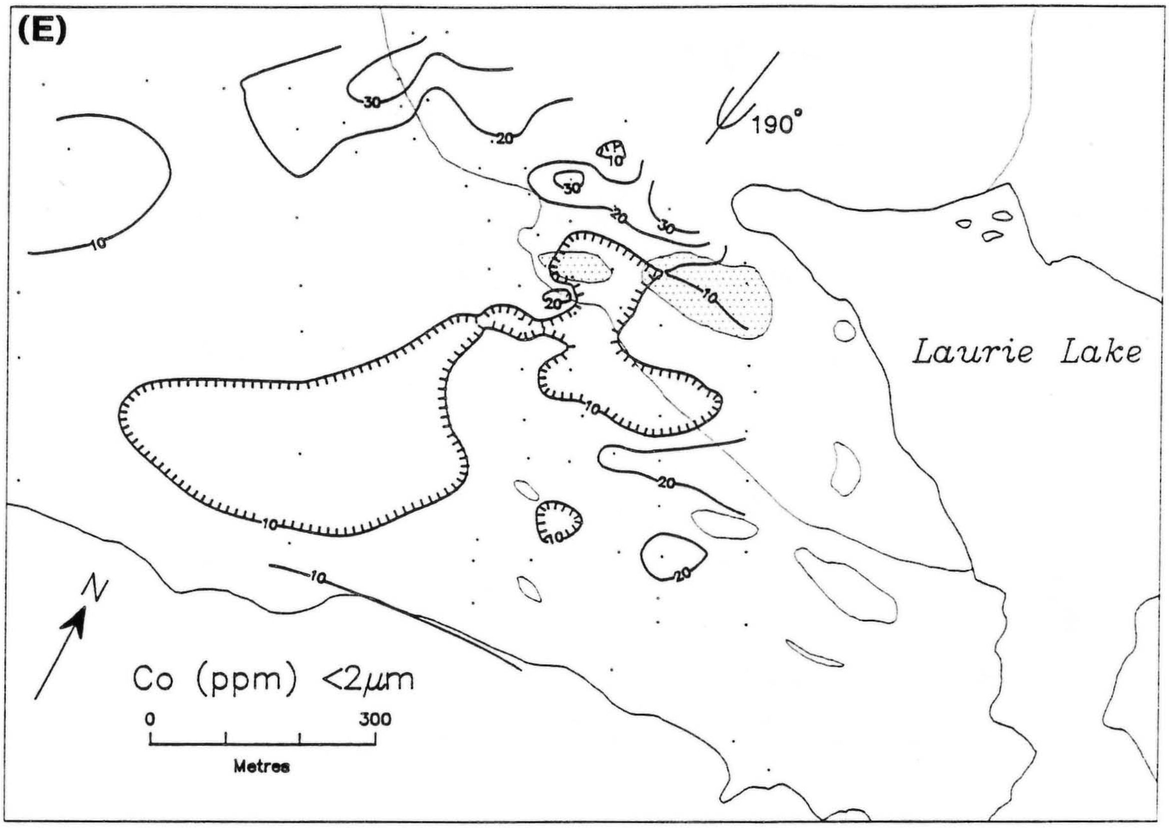
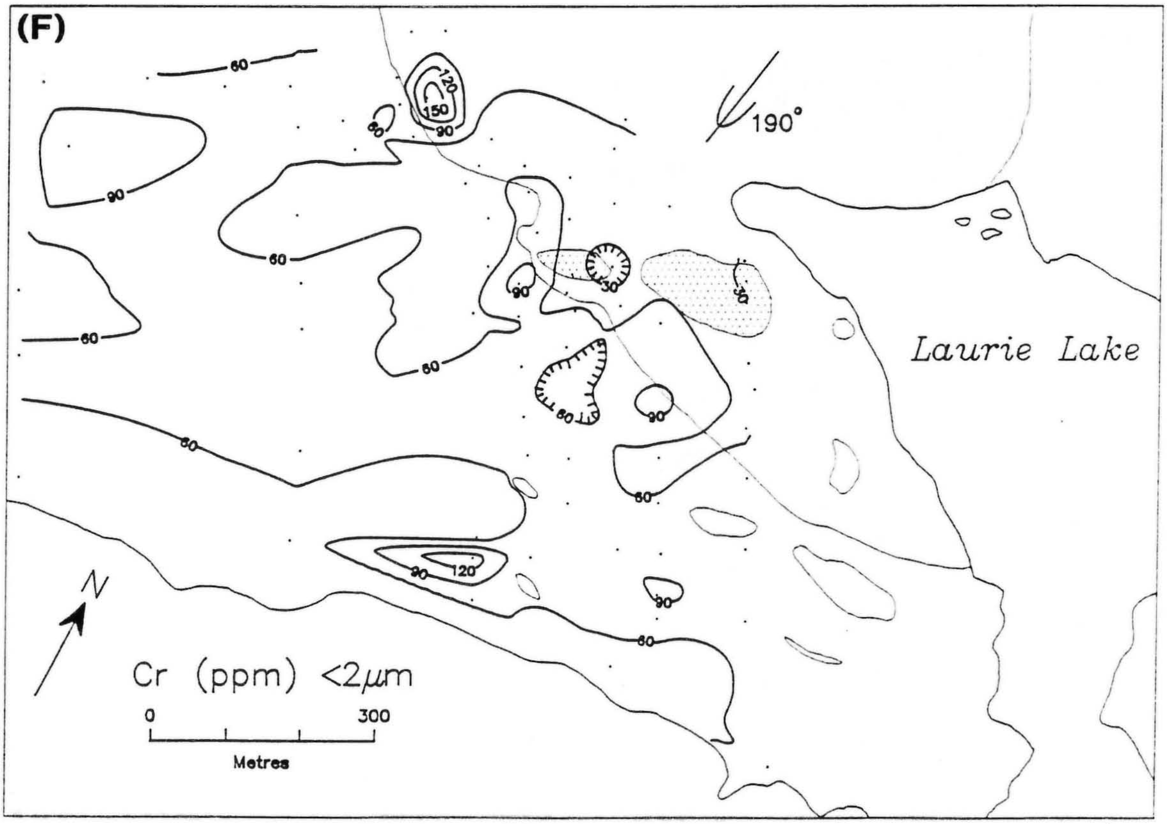


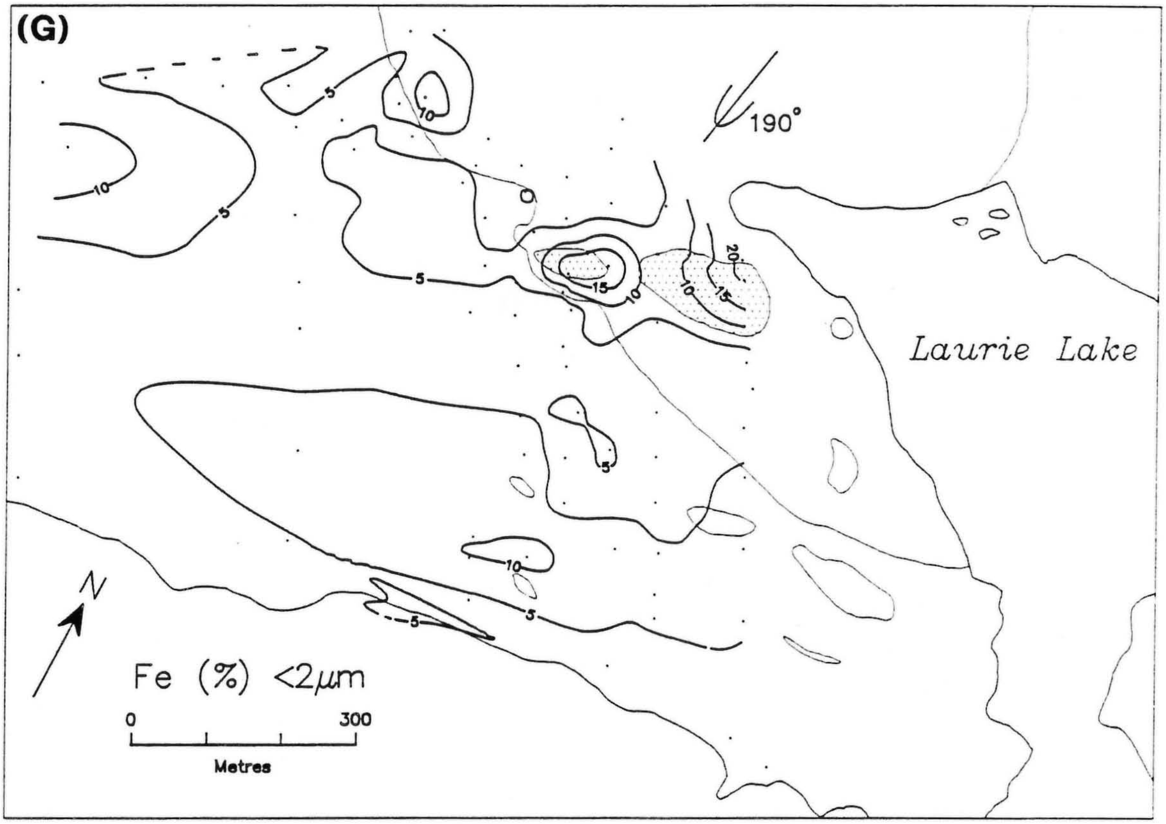
Figure 15: Dispersal patterns of (A) copper, (B) lead, (C) zinc, (D) nickel, (E) cobalt, (F) chromium, (G) iron, (H) manganese and (I) arsenic in the clay-sized fraction.

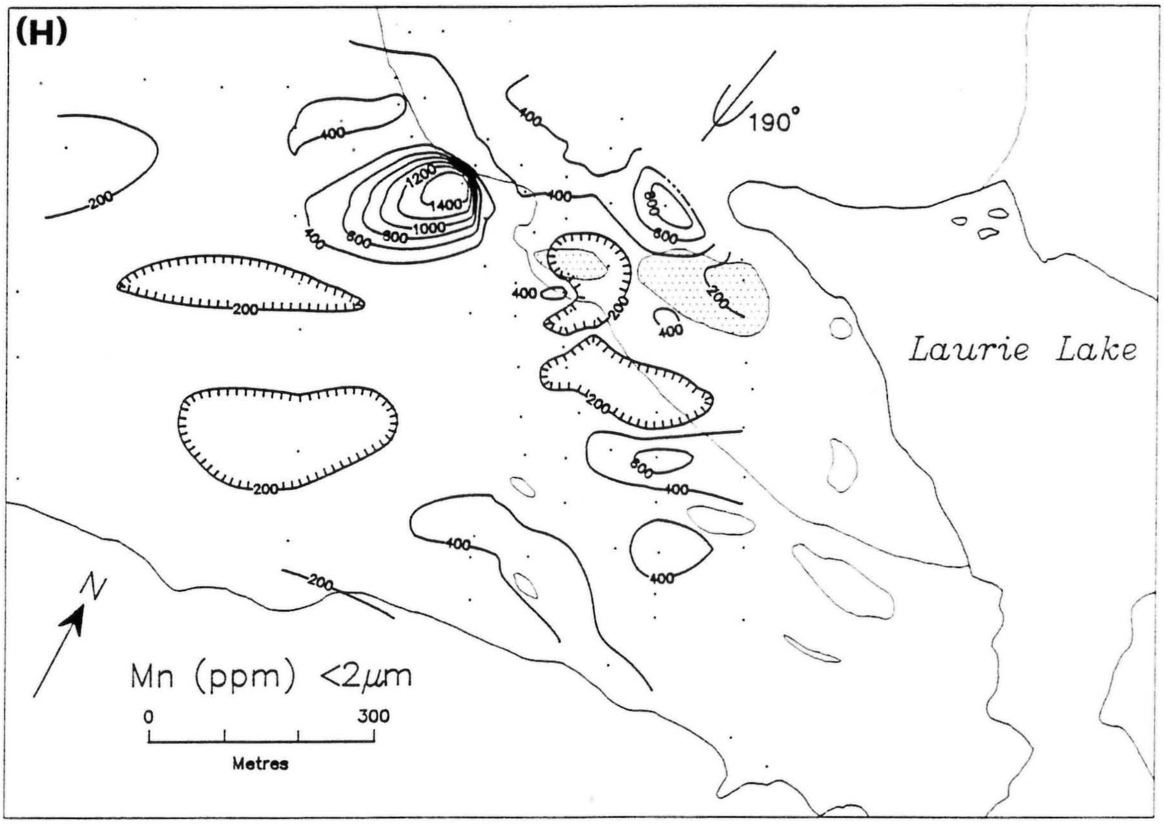

(C)
190°
Laurie Lake
100
200
300
400
N
Zn (ppm) <2µm
0
300
Metres

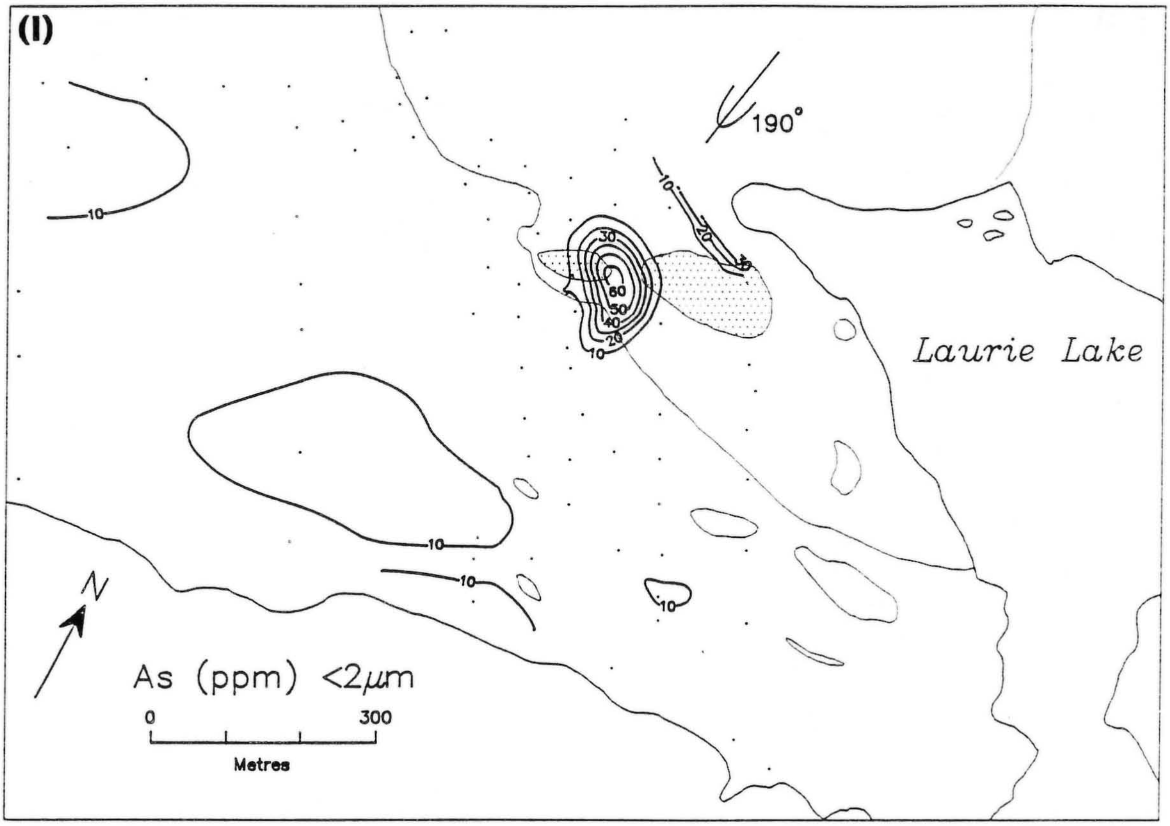

(D)
190°
Laurie Lake
20
40
60
80
N
Ni (ppm) <2µm
0
300
Metres

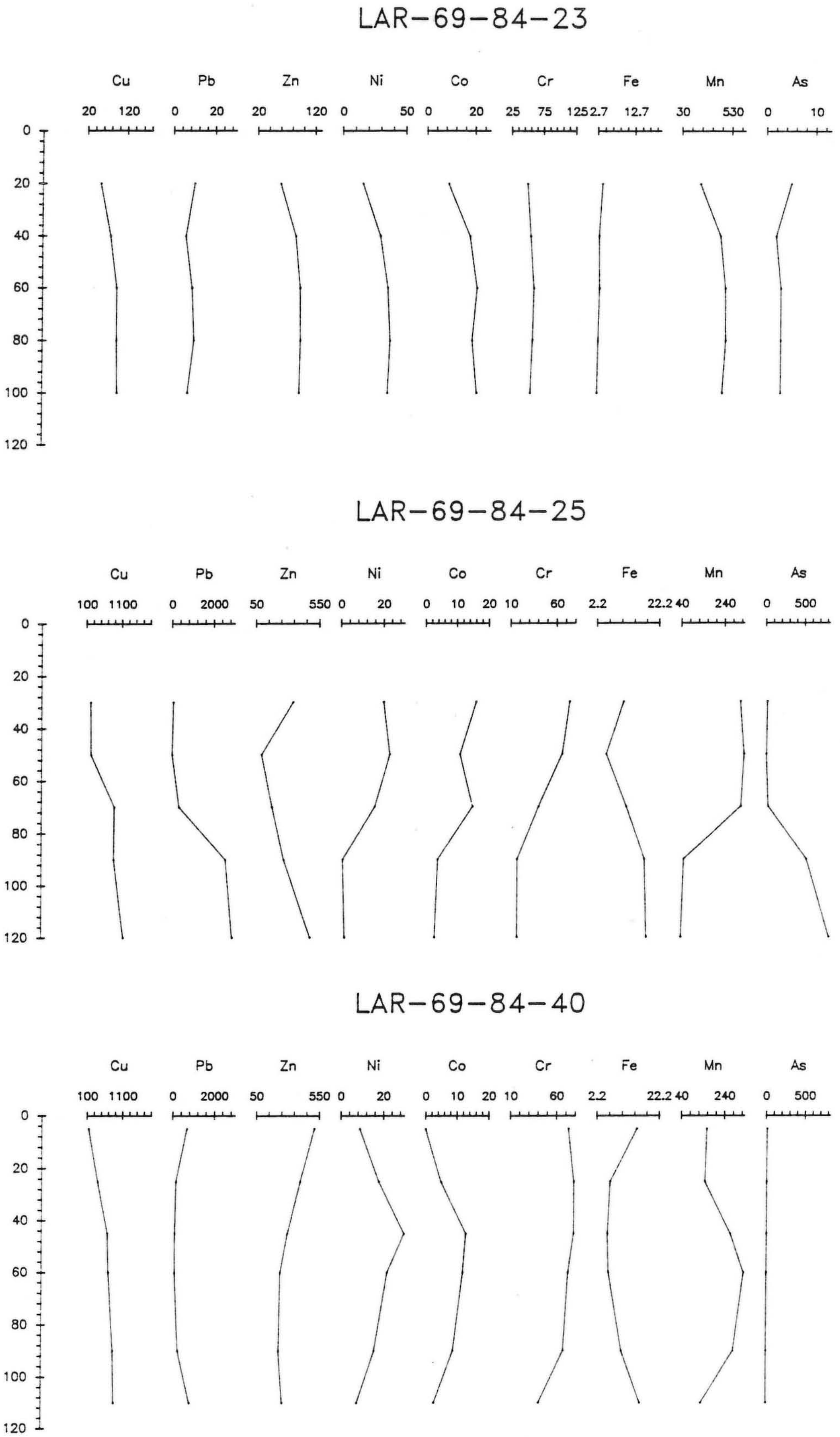

(E)
30
20
10
30
20
30
10
20
10
10
10
20
20
10
190°
Laurie Lake
N
Co (ppm) <2μm
0
300
Metres


(F)
60
120
150
90
60
90
60
60
90
30
30
60
60
90
60
60
90
120
90
60
190°
Laurie Lake
N
Cr (ppm) <2μm
0
300
Metres


(G)
190°
Laurie Lake
N
Fe (%) <2µm
0
300
Metres
5
10
15
20


(H)
190°
Laurie Lake
N
Mn (ppm) <2µm
0
300
Metres
200
400
600
800
1000
1200
1400


(l)
190°
Laurie Lake
10
20
30
40
50
60
N
As (ppm) <2µm
0
300
Metres

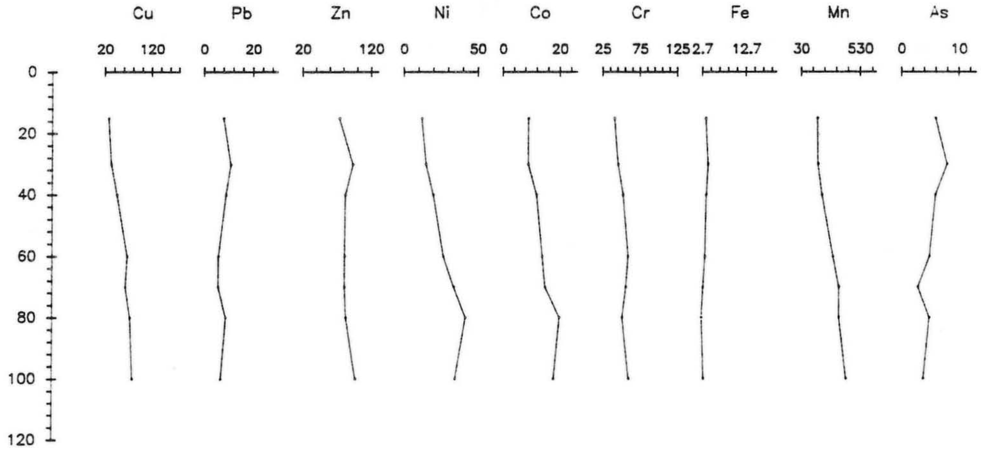

LAR-69-84-23

LAR-69-84-25

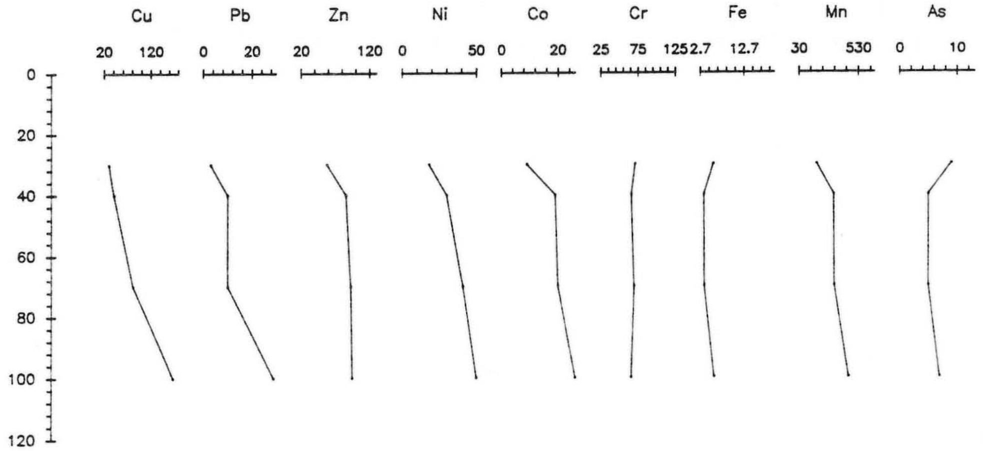
LAR-69-84-40

Figure 16: Vertical variation in trace element concentrations of the clay-sized fraction at selected sites.

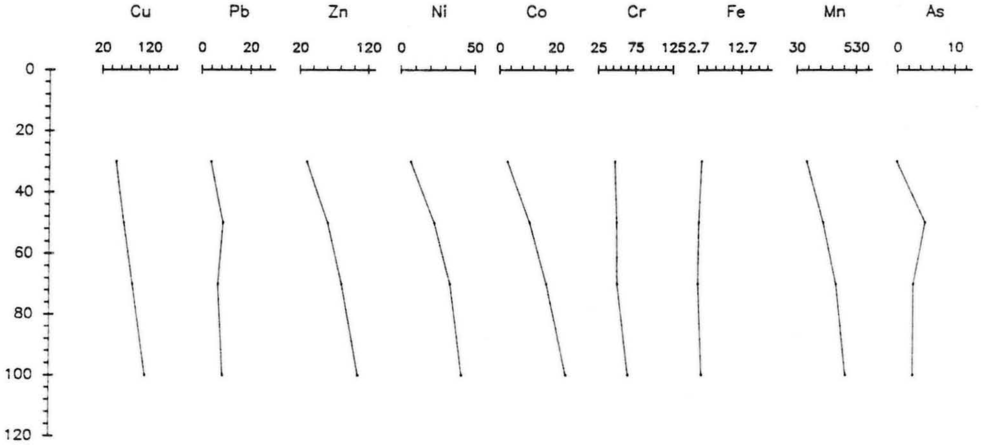
LAR-89-84-11



LAR-69-84-16



LAR-69-84-17



DISCUSSION

From the results presented it is possible to draw certain conclusions about the mechanisms responsible for the formation of the anomalous geochemical patterns outlined in the till. Two main processes are considered likely; namely syngenetic (mechanical glacial) dispersion, or epigenetic (hydromorphic) dispersion (Ek, 1974; Bolviken and Gleeson, 1979; Saarnisto, 1990). Three lines of evidence suggest that the elongated southwest-trending geochemical anomaly, defined by Cu, Pb and Zn in the <2 micron fraction, and to a lesser extent by Fe, Au and Sb in the <63 micron fraction, formed by glacial dispersion and was only slightly modified by hydromorphic processes:

1. the approximately 210° trend of the dispersion fan, though not parallel to the 190° trending local striae, is consistent with the regional trend and well within the range of late glacial ice flow as indicated by esker orientation (195-230°).
2. The extensive swampy terrane, over and to the south and west of the alteration zone, is indicative of the generally poor drainage. Although the exact drainage paths from these swamps are uncertain, the regional slope is north and south from the general area of the alteration zone. There is no evidence of geochemical dispersion downslope (south) of the alteration zone. Samples 66 and 8, situated north of the bedrock anomaly, are anomalous in Zn, which may indicate some hydromorphic dispersion to the north.
3. The dispersion patterns of volcanic and intrusive crystalline erratics are similar to the patterns shown by the trace elements.

CONCLUSIONS AND RECOMMENDATIONS

The geochemical anomalies mapped in the till around the Lar Cu-Zn deposit appear to be predominantly glaciogenic in origin. Although the two source areas measure approximately 100 m by 200 and 30 m by 100 m, the dispersion fan in the <2 micron fraction of the till, is only 300 to 400 m long. The anomaly in the <63 micron fraction is at most, about 100 m long. The pebble fraction, on the other hand, comprises mostly far travelled material derived from the tonalite and granodiorite terrane to the north. The high proportion of distantly travelled material is also reflected in the predominance of quartz and feldspar in the till matrix.

The glacial dispersion fan, although defined by relatively few samples, trends 210° to 220°, consistent with the direction of late glacial ice movement, but not parallel to the 190° ice flow recorded by striae in Laurie Lake. This highlights the need for understanding the regional glacial history before undertaking a property scale till geochemical exploration program.

The dispersion fan appears to have undergone extensive postglacial weathering as sulphide minerals could not be identified in the <2 micron fraction of the till matrix. Jarosite is the only hydromorphic mineral identified with certainty, suggesting that elements released during the weathering of sulphides occur in amorphous oxides on hydroxides or are bound to the surfaces of silicate minerals.

Trace element concentrations generally increase in samples collected down through the section. Relatively unweathered C horizon samples collected from hand-dug holes at depths of about 1 m in areas of shallow till give the best results. The anomaly to background contrast and the length of the geochemical anomaly are maximized by analyzing the <2 micron fraction. Analyses of the <63 micron fraction of the till matrix outlined geochemical anomalies directly over the alteration zone but show only minor glacial dispersion.

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Appendix I
Geochemical data for the <63 micron fraction

Sample Number	Na (%)	Sc (ppm)	Cr (ppm)	Fe (%)	Co (ppm)	Ni (ppm)	Zn (ppm)	As (ppm)	Se (ppm)	Br (ppm)
LAR-69-84-01	2.48	5.8	35	1.4	<5	<20	<100	0.5	<5	1.1
LAR-69-84-02	2.64	5.9	37	1.3	<5	<20	<100	<0.5	<5	1.6
LAR-69-84-03	2.63	6.0	41	1.5	6	<20	<100	0.6	<5	1.3
LAR-69-84-04	2.58	12.0	69	3.5	9	<20	<100	2.3	<5	1.1
LAR-69-84-05	2.72	8.4	40	2.1	6	<20	<100	0.7	<5	0.7
LAR-69-84-06	2.75	8.7	41	2.1	6	<20	<100	1.1	<5	2.4
LAR-69-84-07	2.58	7.5	47	2.2	7	<20	<100	1.0	<5	<0.5
LAR-69-84-08	2.80	6.5	38	1.6	9	<20	<100	0.6	<5	1.3
LAR-69-84-09	2.86	6.7	40	1.4	<5	<20	<100	<0.5	<5	1.4
LAR-69-84-10	2.82	6.5	27	1.5	<5	<20	<100	0.7	<5	1.3
LAR-69-84-11	2.69	6.0	39	1.4	6	<20	<100	0.9	<5	0.7
LAR-69-84-12	2.57	14.0	51	3.2	13	20	<100	1.3	<5	2.0
LAR-69-84-13	2.49	11.0	68	3.3	<5	<20	110	0.8	<5	1.4
LAR-69-84-14	2.72	11.0	54	2.3	10	<20	<100	0.6	<5	2.2
LAR-69-84-15	2.79	10.0	39	2.0	<5	<20	<100	0.6	<5	1.5
LAR-69-84-16	2.54	11.0	63	2.9	10	<20	<100	1.9	<5	1.0
LAR-69-84-17	2.80	8.8	34	2.1	<5	<20	<100	<0.5	<5	0.9
LAR-69-84-18	2.72	11.0	47	2.8	6	<20	<100	1.0	<5	0.9
LAR-69-84-19	2.53	10.0	63	2.4	5	<20	<100	1.5	<5	1.1
LAR-69-84-20	2.03	10.0	57	2.8	10	<20	<100	1.6	<5	1.7
LAR-69-84-21	2.60	8.1	49	2.1	9	<20	<100	0.6	<5	0.6
LAR-69-84-22	2.68	5.8	36	1.5	<5	<20	<100	0.7	<5	2.1
LAR-69-84-23	2.78	6.1	39	1.6	6	<20	<100	0.7	<5	0.9
LAR-69-84-24	2.22	10.0	68	2.6	8	<20	<100	2.2	<5	5.0
LAR-69-84-25	2.10	6.9	24	7.8	<5	<20	190	207.0	46	3.2
LAR-69-84-26	2.52	8.6	40	3.4	<5	<20	<100	12.0	<5	2.8
LAR-69-84-27	2.85	6.1	34	1.5	<5	21	<100	<0.5	<5	1.0
LAR-69-84-28	2.75	10.0	45	2.6	<5	<20	<100	1.0	<5	2.3
LAR-69-84-29	2.29	8.1	55	2.3	6	<20	<100	1.7	<5	2.1
LAR-69-84-30	2.60	6.1	34	1.2	6	<20	<100	0.7	<5	<0.5
LAR-69-84-31	2.39	10.0	49	3.7	7	<20	110	2.2	<5	2.9
LAR-69-84-32	2.54	7.4	34	1.8	5	<20	<100	1.1	<5	1.0
LAR-69-84-33	2.29	7.9	48	3.3	6	<20	100	1.0	<5	4.8
LAR-69-84-34	2.62	6.6	29	1.5	<5	<20	<100	0.7	<5	0.5
LAR-69-84-35	2.48	13.0	71	2.9	10	<20	<100	4.5	<5	3.0
LAR-69-84-35A	2.65	6.3	39	1.5	<5	<20	<100	0.6	<5	1.2
LAR-69-84-36	2.45	8.3	41	1.9	6	<20	<100	0.9	<5	2.1
LAR-69-84-37	2.54	8.0	34	2.1	<5	20	<100	0.9	<5	0.9
LAR-69-84-38	2.28	6.4	35	1.9	<5	<20	<100	1.7	<5	1.9
LAR-69-84-39	2.76	7.0	45	1.3	<5	<20	<100	0.7	<5	1.1
LAR-69-84-40	2.48	9.1	21	3.6	<5	<20	120	1.7	<5	1.1
LAR-69-84-41	2.60	8.7	44	2.8	8	<20	<100	0.9	<5	2.4
LAR-69-84-42	2.76	6.8	37	1.7	9	<20	<100	0.5	<5	1.9
LAR-69-84-43	2.84	8.4	37	2.8	6	<20	180	0.9	<5	1.7
LAR-69-84-44	2.78	6.6	37	1.5	<5	<20	<100	0.8	<5	1.4
LAR-69-84-45	2.40	4.7	37	0.7	<5	<20	100	<0.5	<5	0.8

Sample Number	**Na (%)**	**Sc (ppm)**	**Cr (ppm)**	**Fe (%)**	**Co (ppm)**	**Ni (ppm)**	**Zn (ppm)**	**As (ppm)**	**Se (ppm)**	**Br (ppm)**
LAR-69-84-46	2.84	6.4	27	1.6	<5	<20	<100	<0.5	<5	0.8
LAR-69-84-47	2.81	6.8	34	1.5	<5	<20	<100	<0.5	<5	1.2
LAR-69-84-48	2.42	10.0	62	2.3	8	<20	130	1.1	<5	0.9
LAR-69-84-49	2.70	10.0	48	2.8	8	<20	120	3.5	<5	2.4
LAR-69-84-50	2.09	11.0	48	3.3	9	<20	120	1.7	<5	1.9
LAR-69-84-51	2.34	11.0	33	7.2	9	<20	120	3.1	<5	2.6
LAR-69-84-52	1.50	7.8	40	16.0	<5	<20	150	1.8	<5	6.9
LAR-69-84-53	2.65	6.2	41	1.4	<5	<20	100	<0.5	<5	1.1
LAR-69-84-54	2.78	5.9	46	1.2	<5	<20	<100	0.6	<5	1.3
LAR-69-84-55	2.65	6.2	29	1.3	<5	<20	<100	0.9	<5	1.1
LAR-69-84-56	2.44	8.7	34	2.4	8	<20	<100	0.9	<5	1.4
LAR-69-84-57	2.49	9.4	61	2.5	11	<20	100	1.2	<5	3.8
LAR-69-84-58	2.11	10.0	41	2.7	8	<20	170	1.5	<5	1.1
LAR-69-84-59	2.70	7.8	32	1.8	5	<20	<100	1.3	<5	0.7
LAR-69-84-60	2.50	8.1	48	1.6	<5	<20	<100	1.0	<5	1.7
LAR-69-84-61	2.56	7.1	41	1.2	<5	<20	<100	0.6	<5	4.1
LAR-69-84-62	2.64	6.4	27	1.3	<5	<20	<100	0.7	<5	3.9
LAR-69-84-63	2.65	6.2	43	1.5	6	<20	<100	0.6	<5	2.0
LAR-69-84-64	2.54	8.0	51	1.8	6	<20	100	0.6	<5	1.6
LAR-69-84-65	2.47	6.9	45	1.6	<5	<20	<100	0.8	<5	1.9
LAR-69-84-66	2.57	6.1	38	1.4	<5	<20	120	0.5	<5	1.0
LAR-69-84-68	1.90	12.0	54	4.0	12	22	150	2.6	<5	3.6
LAR-69-84-69	2.53	8.8	30	2.5	7	<20	<100	1.6	<5	1.1
LAR-69-84-70	2.47	8.0	31	1.5	<5	<20	<100	1.2	<5	2.5
LAR-69-84-71	2.64	6.3	35	1.3	6	<20	<100	<0.5	<5	1.7
LAR-69-84-72	2.48	6.2	27	1.7	7	<20	140	0.8	<5	1.9
LAR-69-84-73	2.33	11.0	39	3.5	8	24	<100	1.2	<5	2.9
LAR-69-84-74	2.53	8.8	46	2.0	<5	<20	<100	1.1	<5	1.5
LAR-69-84-75	2.39	6.6	27	1.6	<5	<20	<100	0.9	<5	1.1
LAR-69-84-76	2.28	5.7	35	1.5	<5	<20	130	0.7	<5	<0.5
LAR-69-84-77	1.90	8.8	39	3.6	6	<20	<100	6.9	<5	6.3
LAR-69-84-78	2.52	6.5	28	1.4	<5	<20	<100	0.8	<5	0.9
LAR-69-84-79	2.51	7.8	47	2.2	<5	<20	<100	2.3	<5	2.1
LAR-69-84-80	2.64	6.5	33	1.8	<5	<20	<100	0.9	<5	1.6

Sample Number	Rb (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Cd (ppm)	Sn (ppm)	Sb (ppm)	Te (ppm)	Cs (ppm)	Ba (ppm)
LAR-69-84-01	74	810	<1	<2	<5	<100	<0.1	<10	0.9	970
LAR-69-84-02	69	660	<1	<2	<5	<100	<0.1	<10	1.3	920
LAR-69-84-03	66	430	<1	<2	<5	<100	0.1	<10	1.0	920
LAR-69-84-04	59	590	<1	<2	<5	<100	<0.1	<10	1.0	810
LAR-69-84-05	68	720	<1	<2	<5	<100	<0.1	<10	0.7	910
LAR-69-84-06	71	520	<1	<2	<5	<100	0.1	<10	0.9	890
LAR-69-84-07	80	410	<1	<2	<5	<100	0.1	<10	1.3	920
LAR-69-84-08	72	480	<1	<2	<5	<100	0.1	<10	0.8	930
LAR-69-84-09	71	640	<1	<2	<5	<100	0.1	<10	0.7	940
LAR-69-84-10	73	460	<1	2	<5	<100	<0.1	<10	1.0	930
LAR-69-84-11	69	370	<1	<2	<5	<100	0.1	<10	0.7	880
LAR-69-84-12	69	<200	<1	<2	<5	<100	0.1	<10	2.2	830
LAR-69-84-13	58	620	<1	<2	<5	<100	<0.1	<10	1.1	830
LAR-69-84-14	65	350	<1	<2	<5	<100	<0.1	<10	0.7	860
LAR-69-84-15	69	310	<1	<2	<5	<100	<0.1	<10	1.0	880
LAR-69-84-16	75	660	<1	<2	<5	<100	0.1	<10	1.5	920
LAR-69-84-17	71	510	<1	<2	<5	<100	<0.1	<10	1.0	910
LAR-69-84-18	69	310	<1	<2	<5	<100	0.1	<10	1.0	870
LAR-69-84-19	68	680	<1	<2	<5	<100	<0.1	<10	1.3	830
LAR-69-84-20	99	<200	<1	<2	<5	<100	0.2	<10	3.4	970
LAR-69-84-21	77	650	<1	<2	<5	<100	0.1	<10	1.4	910
LAR-69-84-22	62	530	<1	<2	<5	<100	<0.1	<10	0.8	900
LAR-69-84-23	81	450	<1	<2	<5	<100	0.1	<10	1.4	940
LAR-69-84-24	96	430	<1	<2	<5	<100	0.2	<10	2.7	860
LAR-69-84-25	63	420	30	8	<5	<100	2.1	<10	1.6	850
LAR-69-84-26	64	590	<1	<2	<5	<100	<0.1	<10	0.7	830
LAR-69-84-27	75	370	<1	<2	<5	<100	<0.1	<10	1.2	900
LAR-69-84-28	65	360	<1	<2	<5	<100	<0.1	<10	0.8	900
LAR-69-84-29	96	380	<1	<2	<5	<100	0.2	<10	2.6	850
LAR-69-84-30	69	480	<1	<2	<5	<100	0.2	<10	1.1	890
LAR-69-84-31	70	480	<1	<2	<5	<100	0.3	<10	1.5	850
LAR-69-84-32	87	380	<1	<2	<5	<100	0.2	<10	1.2	930
LAR-69-84-33	76	340	<1	<2	<5	<100	<0.1	<10	1.8	810
LAR-69-84-34	69	330	<1	<2	<5	<100	0.1	<10	0.8	860
LAR-69-84-35	42	<200	<1	<2	<5	<100	0.2	<10	1.3	660
LAR-69-84-35A	69	430	<1	<2	<5	<100	0.1	<10	1.1	870
LAR-69-84-36	64	300	<1	4	<5	<100	0.1	<10	1.4	820
LAR-69-84-37	70	540	<1	<2	<5	<100	0.1	<10	1.0	830
LAR-69-84-38	70	560	<1	<2	<5	<100	0.1	<10	0.9	880
LAR-69-84-39	68	410	<1	<2	<5	<100	<0.1	<10	0.8	940
LAR-69-84-40	75	330	<1	2	<5	<100	0.2	<10	1.1	1000
LAR-69-84-41	74	390	<1	<2	<5	<100	<0.1	<10	1.2	890
LAR-69-84-42	74	610	<1	<2	<5	<100	<0.1	<10	0.9	900
LAR-69-84-43	58	570	<1	<2	<5	<100	0.1	<10	1.1	940
LAR-69-84-44	66	490	<1	<2	<5	<100	<0.1	<10	1.1	920
LAR-69-84-45	91	410	<1	<2	<5	<100	<0.1	<10	1.6	950
LAR-69-84-46	69	460	<1	<2	<5	<100	<0.1	<10	0.6	940
LAR-69-84-47	77	600	<1	<2	<5	<100	<0.1	<10	0.7	900
LAR-69-84-48	83	410	<1	<2	<5	<100	0.1	<10	1.9	910

Sample Number	Rb (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Cd (ppm)	Sn (ppm)	Sb (ppm)	Te (ppm)	Cs (ppm)	Ba (ppm)
LAR-69-84-49	63	570	<1	<2	<5	<100	0.1	<10	1.5	900
LAR-69-84-50	93	<200	<1	<2	<5	<100	0.2	<10	2.7	830
LAR-69-84-51	63	390	<1	<2	<5	<100	<0.1	<10	1.5	840
LAR-69-84-52	53	<200	<1	<2	<5	<100	0.2	<10	2.2	710
LAR-69-84-53	68	500	<1	<2	<5	<100	<0.1	<10	1.1	870
LAR-69-84-54	73	390	<1	<2	<5	<100	<0.1	<10	0.7	900
LAR-69-84-55	67	470	<1	<2	<5	<100	<0.1	<10	0.8	870
LAR-69-84-56	63	460	<1	<2	<5	<100	0.2	<10	1.1	850
LAR-69-84-57	74	390	<1	<2	<5	<100	0.1	<10	1.2	940
LAR-69-84-58	81	600	1	<2	<5	<100	0.1	<10	2.5	870
LAR-69-84-59	65	340	<1	<2	<5	<100	0.1	<10	1.1	940
LAR-69-84-60	63	480	<1	<2	<5	<100	0.1	<10	0.9	840
LAR-69-84-61	69	490	<1	<2	<5	<100	0.1	<10	1.7	930
LAR-69-84-62	74	580	<1	<2	<5	<100	0.1	<10	1.3	870
LAR-69-84-63	63	320	<1	<2	<5	<100	0.1	<10	1.2	920
LAR-69-84-64	64	300	<1	<2	<5	<100	0.1	<10	1.5	880
LAR-69-84-65	67	610	<1	<2	<5	<100	0.1	<10	1.1	910
LAR-69-84-66	64	480	<1	<2	<5	<100	<0.1	<10	0.7	920
LAR-69-84-68	77	530	1	<2	<5	<100	0.2	<10	2.7	760
LAR-69-84-69	62	450	<1	<2	<5	<100	0.1	<10	0.8	850
LAR-69-84-70	68	500	1	<2	<5	<100	0.1	<10	1.2	820
LAR-69-84-71	69	560	<1	<2	<5	<100	<0.1	<10	0.8	920
LAR-69-84-72	63	300	<1	<2	<5	<100	<0.1	<10	0.6	870
LAR-69-84-73	57	380	2	<2	<5	<100	0.1	<10	1.3	820
LAR-69-84-74	59	630	<1	<2	<5	<100	<0.1	<10	0.8	870
LAR-69-84-75	61	480	<1	<2	<5	<100	<0.1	<10	0.6	860
LAR-69-84-76	63	520	<1	<2	<5	<100	0.1	<10	0.6	890
LAR-69-84-77	51	<200	2	<2	<5	<100	0.1	<10	1.5	700
LAR-69-84-78	66	510	<1	<2	<5	<100	0.1	<10	1.2	950
LAR-69-84-79	59	400	1	<2	<5	<100	0.1	<10	1.0	870
LAR-69-84-80	66	480	<1	<2	<5	<100	<0.1	<10	0.9	960

Sample Number	La (ppm)	Ce (ppm)	Sm (ppm)	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	W (ppm)
LAR-69-84-01	40	110	8.50	1	1.0	3	0.2	16	0.8	<1
LAR-69-84-02	39	110	7.80	<1	0.9	2	0.3	14	1.0	<1
LAR-69-84-03	42	110	7.90	<1	1.0	3	0.2	15	1.1	<1
LAR-69-84-04	35	89	7.00	<1	0.8	3	0.3	14	0.8	<1
LAR-69-84-05	42	120	8.10	<1	0.9	3	0.3	15	0.7	1
LAR-69-84-06	47	120	8.60	<1	1.0	3	0.3	17	0.7	<1
LAR-69-84-07	41	100	6.50	2	0.7	2	<0.2	12	1.1	<1
LAR-69-84-08	37	97	7.00	2	0.8	3	0.2	13	0.9	<1
LAR-69-84-09	38	110	7.10	1	0.8	2	<0.2	14	0.9	<1
LAR-69-84-10	36	96	6.90	<1	0.9	2	<0.2	14	0.8	<1
LAR-69-84-11	34	100	6.70	<1	0.9	3	0.2	13	1.0	<1
LAR-69-84-12	41	100	7.50	<1	0.9	3	<0.2	16	1.0	1
LAR-69-84-13	54	140	10.00	1	1.0	4	0.2	18	1.0	<1
LAR-69-84-14	40	110	8.20	<1	1.0	3	0.3	16	0.7	<1
LAR-69-84-15	34	96	7.20	<1	0.8	3	<0.2	13	0.8	<1
LAR-69-84-16	62	160	10.00	<1	1.0	4	<0.2	15	0.8	<1
LAR-69-84-17	40	110	7.60	<1	0.8	3	0.2	14	0.7	<1
LAR-69-84-18	37	88	6.80	<1	0.9	3	0.2	14	0.7	<1
LAR-69-84-19	38	100	7.60	<1	1.1	2	<0.2	14	0.6	<1
LAR-69-84-20	39	96	7.20	<1	0.8	2	<0.2	8	1.2	<1
LAR-69-84-21	39	96	7.10	<1	0.8	2	<0.2	14	0.8	<1
LAR-69-84-22	35	89	7.00	<1	0.9	3	<0.2	14	0.7	<1
LAR-69-84-23	40	110	7.90	<1	0.9	2	0.2	14	1.0	<1
LAR-69-84-24	44	100	6.80	<1	0.8	2	<0.2	10	1.1	<1
LAR-69-84-25	31	60	4.70	<1	<0.5	<2	<0.2	12	0.9	2
LAR-69-84-26	35	83	6.70	<1	0.9	2	0.3	14	0.9	<1
LAR-69-84-27	36	94	7.50	1	0.9	3	0.2	14	0.7	<1
LAR-69-84-28	38	92	7.00	1	0.9	3	<0.2	13	0.9	<1
LAR-69-84-29	40	100	6.50	<1	0.7	3	<0.2	10	1.2	<1
LAR-69-84-30	35	93	6.20	<1	0.6	2	<0.2	13	0.9	<1
LAR-69-84-31	50	110	8.00	<1	1.1	3	<0.2	15	1.1	<1
LAR-69-84-32	43	110	7.60	1	1.0	2	<0.2	11	0.9	<1
LAR-69-84-33	36	82	6.70	1	1.0	2	<0.2	11	0.9	<1
LAR-69-84-34	30	72	5.50	1	0.5	<2	<0.2	11	0.7	<1
LAR-69-84-35	70	180	13.00	1	1.3	3	<0.2	10	<0.5	<1
LAR-69-84-35A	43	110	8.10	1	0.8	3	0.2	14	1.0	<1
LAR-69-84-36	42	110	7.80	2	0.9	2	<0.2	15	0.6	<1
LAR-69-84-37	41	100	7.70	1	0.9	3	<0.2	17	1.0	1
LAR-69-84-38	31	77	6.30	<1	0.9	<2	<0.2	13	0.8	<1
LAR-69-84-39	24	64	5.40	<1	0.6	<2	<0.2	10	0.6	<1
LAR-69-84-40	68	120	7.00	<1	0.8	2	<0.2	13	1.0	<1
LAR-69-84-41	28	72	6.10	1	0.7	2	0.2	11	0.8	<1
LAR-69-84-42	34	98	6.70	<1	0.9	3	<0.2	12	0.7	<1
LAR-69-84-43	38	90	6.90	<1	1.0	2	<0.2	15	0.6	<1
LAR-69-84-44	38	95	7.50	<1	1.0	3	<0.2	14	0.7	<1
LAR-69-84-45	35	78	5.40	<1	0.6	2	0.2	15	0.9	<1
LAR-69-84-46	41	100	7.70	<1	0.9	3	<0.2	15	0.7	<1
LAR-69-84-47	43	110	8.00	<1	1.0	3	<0.2	16	<0.5	<1
LAR-69-84-48	52	120	8.90	1	0.9	3	<0.2	11	1.1	<1

Sample Number	La (ppm)	Ce (ppm)	Sm (ppm)	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	W (ppm)
LAR-69-84-49	31	72	5.80	2	0.9	<2	<0.2	9	0.6	<1
LAR-69-84-50	39	87	6.30	<1	0.9	<2	<0.2	10	1.1	<1
LAR-69-84-51	28	64	4.90	<1	0.7	2	<0.2	12	0.5	<1
LAR-69-84-52	29	43	4.40	<1	0.7	<2	<0.2	9	0.8	<1
LAR-69-84-53	37	91	7.00	<1	0.7	3	<0.2	14	0.6	<1
LAR-69-84-54	33	81	6.50	1	0.7	2	<0.2	13	0.7	1
LAR-69-84-55	36	84	6.80	<1	0.8	2	<0.2	14	0.7	<1
LAR-69-84-56	38	97	7.10	<1	0.8	3	<0.2	13	0.6	<1
LAR-69-84-57	40	74	7.70	<1	0.9	3	0.2	13	0.9	<1
LAR-69-84-58	36	63	5.70	<1	0.9	2	<0.2	9	0.9	<1
LAR-69-84-59	43	75	6.10	<1	1.0	3	0.2	14	0.6	<1
LAR-69-84-60	34	63	6.30	<1	1.0	3	<0.2	13	0.9	<1
LAR-69-84-61	46	86	7.60	<1	0.9	3	0.2	17	0.8	<1
LAR-69-84-62	38	72	6.40	<1	0.8	2	0.3	15	0.9	<1
LAR-69-84-63	38	64	6.50	<1	1.0	2	<0.2	14	1.0	<1
LAR-69-84-64	43	79	7.50	<1	1.0	3	<0.2	14	1.0	<1
LAR-69-84-65	41	75	7.20	<1	1.0	3	<0.2	13	1.0	<1
LAR-69-84-66	37	72	6.50	<1	0.8	3	<0.2	14	0.9	<1
LAR-69-84-68	36	63	5.30	<1	0.8	2	<0.2	10	1.1	1
LAR-69-84-69	42	83	6.70	<1	1.0	3	<0.2	16	0.9	<1
LAR-69-84-70	36	73	5.80	<1	0.6	3	<0.2	14	<0.5	1
LAR-69-84-71	44	88	7.00	<1	0.9	3	<0.2	16	0.8	<1
LAR-69-84-72	32	63	5.60	<1	<0.5	<2	<0.2	13	0.7	<1
LAR-69-84-73	43	88	7.40	2	0.9	3	<0.2	15	1.0	<1
LAR-69-84-74	33	67	6.30	<1	1.1	<2	0.2	13	0.9	1
LAR-69-84-75	34	71	6.10	<1	0.7	3	<0.2	13	0.6	<1
LAR-69-84-76	30	58	5.40	<1	0.9	<2	<0.2	13	0.9	<1
LAR-69-84-77	32	62	6.00	<1	0.8	<2	<0.2	12	0.7	<1
LAR-69-84-78	38	79	6.30	<1	1.0	3	<0.2	15	0.6	1
LAR-69-84-79	37	78	6.00	<1	0.9	2	<0.2	15	0.8	<1
LAR-69-84-80	40	76	6.40	<1	0.9	2	<0.2	15	0.6	<1

Sample Number	Ir (ppb)	Au (ppb)	Th (ppm)	U (ppm)	WT
LAR-69-84-01	<50	3	17.0	3.8	14.79
LAR-69-84-02	<50	<2	15.0	3.4	13.44
LAR-69-84-03	<50	<2	16.0	3.6	11.68
LAR-69-84-04	<50	4	15.0	3.7	11.50
LAR-69-84-05	<50	4	16.0	3.6	11.59
LAR-69-84-06	<50	2	18.0	3.7	11.75
LAR-69-84-07	<50	<2	16.0	3.4	12.16
LAR-69-84-08	<50	<2	13.0	3.0	11.62
LAR-69-84-09	<50	<2	15.0	3.0	12.68
LAR-69-84-10	<50	<2	14.0	3.0	12.74
LAR-69-84-11	<50	<2	13.0	2.9	12.30
LAR-69-84-12	<50	3	17.0	3.6	12.29
LAR-69-84-13	<50	7	19.0	4.6	9.74
LAR-69-84-14	<50	5	16.0	3.6	12.35
LAR-69-84-15	<50	5	12.0	2.9	11.99
LAR-69-84-16	<50	4	21.2	5.1	9.54
LAR-69-84-17	<50	<2	15.0	3.2	10.12
LAR-69-84-18	<50	6	15.0	3.1	11.02
LAR-69-84-19	<50	3	16.0	3.8	11.21
LAR-69-84-20	<50	5	19.0	4.0	6.20
LAR-69-84-21	<50	<2	16.0	3.5	9.81
LAR-69-84-22	<50	<2	13.0	2.9	12.80
LAR-69-84-23	<50	<2	15.0	3.5	12.40
LAR-69-84-24	<50	3	17.0	3.5	8.66
LAR-69-84-25	<50	555	11.0	3.3	9.69
LAR-69-84-26	<50	<2	14.0	3.1	11.41
LAR-69-84-27	<50	<2	14.0	2.9	13.31
LAR-69-84-28	<50	<2	14.0	3.1	9.23
LAR-69-84-29	<50	2	18.0	3.5	7.82
LAR-69-84-30	<50	<2	12.0	2.9	10.20
LAR-69-84-31	<50	17	20.2	4.1	9.16
LAR-69-84-32	<50	3	15.0	3.7	9.12
LAR-69-84-33	<50	<2	13.0	3.0	10.85
LAR-69-84-34	<50	<2	11.0	2.5	11.11
LAR-69-84-35	<50	10	21.3	6.4	9.82
LAR-69-84-35A	<50	<2	16.0	3.4	11.54
LAR-69-84-36	<50	3	17.0	3.9	11.34
LAR-69-84-37	<50	<2	18.0	3.6	10.97
LAR-69-84-38	<50	3	14.0	3.0	11.76
LAR-69-84-39	<50	<2	8.2	2.2	13.64
LAR-69-84-40	<50	19	16.0	4.0	10.43
LAR-69-84-41	<50	<2	10.0	2.5	11.22
LAR-69-84-42	<50	<2	13.0	2.9	10.91
LAR-69-84-43	<50	8	15.0	3.2	11.93
LAR-69-84-44	<50	<2	14.0	3.2	12.30
LAR-69-84-45	<50	<2	14.0	3.0	9.29
LAR-69-84-46	<50	<2	16.0	3.3	11.97
LAR-69-84-47	<50	3	16.0	3.5	13.14
LAR-69-84-48	<50	<2	16.0	4.0	9.16

Sample Number	Ir (ppb)	Au (ppb)	Th (ppm)	U (ppm)	WT
LAR-69-84-49	<50	8	12.0	2.7	9.64
LAR-69-84-50	<50	5	16.0	3.4	7.32
LAR-69-84-51	<50	5	12.0	2.7	10.01
LAR-69-84-52	<50	5	11.0	2.5	7.59
LAR-69-84-53	<50	<2	14.0	3.0	13.59
LAR-69-84-54	<50	<2	12.0	2.7	11.43
LAR-69-84-55	<50	<2	14.0	3.2	12.34
LAR-69-84-56	<50	<2	14.0	3.3	9.70
LAR-69-84-57	<50	4	17.0	3.9	9.84
LAR-69-84-58	<50	<2	15.0	3.3	7.92
LAR-69-84-59	<50	22	15.0	3.5	11.81
LAR-69-84-60	<50	<2	13.0	3.3	11.01
LAR-69-84-61	<50	<2	18.0	4.2	10.23
LAR-69-84-62	<50	<2	15.0	3.3	12.42
LAR-69-84-63	<50	<2	15.0	3.1	12.02
LAR-69-84-64	<50	2	16.0	3.5	13.00
LAR-69-84-65	<50	2	15.0	3.5	10.97
LAR-69-84-66	<50	<2	14.0	3.0	12.10
LAR-69-84-68	<50	29	18.0	3.6	7.80
LAR-69-84-69	<50	7	18.0	4.0	12.01
LAR-69-84-70	<50	6	15.0	3.2	10.86
LAR-69-84-71	<50	3	18.0	3.7	12.81
LAR-69-84-72	<50	3	13.0	2.9	11.10
LAR-69-84-73	<50	<2	18.0	4.1	12.30
LAR-69-84-74	<50	<2	13.0	2.9	12.60
LAR-69-84-75	<50	<2	14.0	3.2	12.38
LAR-69-84-76	<50	17	15.0	3.0	12.49
LAR-69-84-77	<50	2	16.0	3.4	9.18
LAR-69-84-78	<50	<2	16.0	3.4	11.90
LAR-69-84-79	<50	<2	15.0	3.3	11.93
LAR-69-84-80	<50	<2	16.0	3.4	12.79

Appendix II
Geochemical Data for the <2 micron fraction

Sample Number	Depth (cm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (ppm)	Mn (ppm)	As (ppm)
LAR-69-84-1		76	7	87	30	19	45	29400	416	3
LAR-69-84-2		39	19	61	19	12	48	30800	259	4
LAR-69-84-3		64	6	85	31	15	55	80500	1530	4
LAR-69-84-4		176	28	57	12	6	113	118330	127	17
LAR-69-84-5		155	7	106	45	26	68	47500	401	3
LAR-69-84-6		87	7	78	29	16	63	58500	308	7
LAR-69-84-7		55	14	77	29	16	65	31200	312	4
LAR-69-84-8		123	2	155	56	33	53	29150	476	<2
LAR-69-84-9		97	6	73	28	13	56	37000	265	5
LAR-69-84-10		48	24	69	32	13	60	42000	301	9
LAR-69-84-11	15	28	8	74	12	9	41	35500	170	6
LAR-69-84-11	30	34	11	94	15	9	46	41100	176	8
LAR-69-84-11	40	46	9	83	20	12	53	36850	211	6
LAR-69-84-11	60	68	6	82	27	14	60	34450	306	5
LAR-69-84-11	70	64	6	82	34	15	57	30050	358	3
LAR-69-84-11	80	74	9	84	42	20	52	26400	358	5
LAR-69-84-11	100	79	7	98	35	18	61	31550	419	4
LAR-69-84-12		143	9	112	80	35	77	51000	318	7
LAR-69-84-13	20	79	14	64	39	14	109	66000	134	7
LAR-69-84-13	40	144	23	84	49	22	76	55500	284	8
LAR-69-84-13	60	173	30	83	48	23	28	61250	225	<2
LAR-69-84-13		221	34	91	52	18	154	117000	207	6
LAR-69-84-14		134	9	87	33	25	60	60170	460	8
LAR-69-84-15		231	13	103	44	35	64	42000	586	5
LAR-69-84-16	30	30	3	58	18	9	71	57000	179	9
LAR-69-84-16	40	41	10	86	30	19	66	35300	324	5
LAR-69-84-16	70	82	10	93	41	20	70	36800	331	5
LAR-69-84-16	100	168	29	95	50	26	66	59500	450	7
LAR-69-84-17	30	50	4	31	7	3	48	36500	120	<2
LAR-69-84-17	50	67	9	62	23	11	51	30800	262	5
LAR-69-84-17	70	86	7	83	34	17	52	29600	374	3
LAR-69-84-17	100	113	9	107	42	24	67	38650	456	3
LAR-69-84-18		157	56	114	35	21	80	63000	345	7
LAR-69-84-19		225	9	99	35	15	78	61500	273	10
LAR-69-84-20		100	21	86	32	14	62	33750	313	7
LAR-69-84-21		129	9	80	98	19	82	38100	312	5
LAR-69-84-22		42	10	51	18	8	40	26500	255	4
LAR-69-84-23	20	53	10	60	16	9	50	40000	214	5
LAR-69-84-23	40	78	6	87	30	18	56	31900	418	2
LAR-69-84-23	60	94	9	95	36	21	61	33450	469	3
LAR-69-84-23	80	94	10	96	38	19	59	29800	473	3
LAR-69-84-23	100	96	7	94	36	21	56	27550	439	3
LAR-69-84-24		69	18	81	33	19	67	39000	267	7
LAR-69-84-25	30	219	68	343	20	16	74	106500	313	19
LAR-69-84-25	50	233	11	96	23	11	66	52000	330	7
LAR-69-84-25	70	899	360	181	16	15	41	116500	316	34
LAR-69-84-25	90	882	2590	274	1	4	18	176000	53	528

Sample Number	Depth (cm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (ppm)	Mn (ppm)	As (ppm)
LAR-69-84-25	120	1153	2910	483	2	3	18	182500	40	824
LAR-69-84-26		204	11	133	7	6	51	100500	192	54
LAR-69-84-27		102	3	95	38	21	60	51560	504	4
LAR-69-84-28		103	5	99	25	14	71	66000	338	7
LAR-69-84-29		55	11	77	30	15	55	35300	419	4
LAR-69-84-30	20	36	18	36	4	5	45	53500	55	6
LAR-69-84-30	40	66	18	64	18	12	58	50000	258	10
LAR-69-84-30	60	88	5	85	23	15	48	41000	403	2
LAR-69-84-30	100	93	10	95	23	18	40	22650	423	2
LAR-69-84-31		509	508	262	30	13	56	58000	259	7
LAR-69-84-32		188	16	152	22	10	59	38000	239	6
LAR-69-84-33	30	40	10	98	15	7	52	121000	298	10
LAR-69-84-33	50	54	11	126	19	14	55	95500	484	13
LAR-69-84-34		83	18	90	32	15	65	40800	287	15
LAR-69-84-35		69	15	71	24	16	51	40650	380	4
LAR-69-84-36		160	11	65	23	13	66	41500	176	4
LAR-69-84-37		266	129	102	23	14	62	37500	226	7
LAR-69-84-38		107	11	65	21	5	62	59000	185	13
LAR-69-84-39		101	15	80	30	11	55	48670	227	7
LAR-69-84-40	5	146	684	510	9	<1	73	149000	158	13
LAR-69-84-40	25	407	170	400	18	5	79	64500	150	11
LAR-69-84-40	45	687	118	299	30	13	79	56500	269	10
LAR-69-84-40	60	716	113	242	22	12	73	60500	329	8
LAR-69-84-40	90	849	286	232	16	9	68	102000	283	8
LAR-69-84-40	110	877	855	262	8	3	42	162500	134	12
LAR-69-84-41	10	45	15	88	9	20	36	176500	267	8
LAR-69-84-41	15	54	<2	95	12	11	50	196500	366	6
LAR-69-84-41	20	44	11	128	32	9	68	68000	332	5
LAR-69-84-41	60	55	18	109	48	17	125	97500	298	6
LAR-69-84-42		69	26	286	31	37	46	52500	915	3
LAR-69-84-43		492	116	590	32	12	52	74670	400	6
LAR-69-84-44		405	5	206	74	18	66	47500	400	3
LAR-69-84-45		15	49	22	41	<1	91	10550	43	2
LAR-69-84-46	20	56	7	43	10	4	59	51500	138	<2
LAR-69-84-46	40	56	7	55	20	8	57	47500	235	7
LAR-69-84-46	70	70	7	73	29	16	47	31500	501	4
LAR-69-84-46	100	86	9	83	37	23	49	30650	658	4
LAR-69-84-47	15	41	8	18	4	4	94	49000	34	6
LAR-69-84-47	50	72	7	41	4	5	110	131420	111	<2
LAR-69-84-47	70	82	8	59	23	14	59	46000	328	5
LAR-69-84-47	90	72	10	61	26	14	62	40000	344	5
LAR-69-84-48		121	11	142	41	24	75	53500	562	5
LAR-69-84-49		135	4	99	51	16	97	67500	310	12
LAR-69-84-50		128	7	88	39	17	66	54000	282	5
LAR-69-84-51	5	688	55	530	2	2	21	219000	59	26
LAR-69-84-51	50	1840	43	410	5	2	28	224000	90	38
LAR-69-84-52		810	9	400	8	2	26	206000	46	4
LAR-69-84-53		59	4	69	25	15	46	28650	406	3
LAR-69-84-54	20	21	10	29	7	3	61	74540	82	<2

Sample Number	Depth (cm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Cr (ppm)	Fe (ppm)	Mn (ppm)	As (ppm)
LAR-69-84-54	60	31	7	63	24	13	52	44000	233	<2
LAR-69-84-54	80	41	9	58	23	12	39	37000	310	<2
LAR-69-84-54	90	47	4	74	30	21	47	29750	448	3
LAR-69-84-55		79	7	78	40	19	50	26450	395	5
LAR-69-84-56		129	3	173	55	27	88	56000	465	6
LAR-69-84-57		146	2	95	28	14	63	57500	291	5
LAR-69-84-58		75	8	85	28	20	62	52000	235	5
LAR-69-84-59		545	106	412	50	24	45	61500	451	10
LAR-69-84-60		170	22	84	19	7	62	40000	159	5
LAR-69-84-61		206	18	91	24	10	72	40100	229	4
LAR-69-84-62		68	10	44	11	4	54	40700	134	4
LAR-69-84-63		59	8	71	26	13	56	51500	309	3
LAR-69-84-64		98	11	85	49	16	87	34750	289	2
LAR-69-84-65		152	7	70	39	10	75	43000	225	4
LAR-69-84-66		76	2	113	33	19	49	31600	497	3
LAR-69-84-67		134	12	100	45	19	72	50550	411	5
LAR-69-84-68		448	208	570	41	19	74	52000	278	4
LAR-69-84-69		279	71	130	33	13	97	49500	280	6
LAR-69-84-70		194	29	123	23	9	61	38000	205	6
LAR-69-84-71	20	49	18	28	14	2	72	72000	73	<2
LAR-69-84-71	60	57	15	49	19	8	54	41000	170	<2
LAR-69-84-71	80	61	10	57	21	8	57	39500	178	<2
LAR-69-84-71	90	86	17	84	38	13	66	41100	270	2
LAR-69-84-72		139	10	79	30	13	64	50500	245	4
LAR-69-84-73		244	4	79	26	12	71	73000	199	4
LAR-69-84-74		110	15	84	25	11	77	106000	480	3
LAR-69-84-75		92	11	87	40	19	69	36800	342	3
LAR-69-84-76		120	12	75	26	11	65	35000	220	<2
LAR-69-84-77		115	12	60	24	6	54	75500	111	25
LAR-69-84-78		51	7	63	26	11	47	25850	288	2
LAR-69-84-79		124	18	73	32	11	62	46000	216	<2
LAR-69-84-80		82	12	93	50	16	53	35000	257	7