HIGHLIGHTS OF A REGIONAL SOIL AND TILL SURVEY FOR BASE METALS IN CENTRAL LABRADOR

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ABSTRACT

A regional soil and till survey was conducted in the Wilson Lake and Seal Lake areas of central Labrador to investigate Ni–Cu and Cu anomalies in lake sediment and lake water. The Wilson Lake area is within the Grenville Province and is predominantly underlain by granulite-facies paragneiss. The Seal Lake area is located within the Central Mineral Belt and is underlain by Mesoproterozoic rocks of the Seal Lake Group including siltstone, shale, quartzite, subaerial basalt flows and gabbro sills, all of which have been regionally metamorphosed to greenschist facies. About 418 samples of predominantly C-horizon till were collected from 3 grids covering 105 km² at a density of 4 sites per km². Analyses of site duplicates indicate that data from B- and C-horizons are very similar for many elements of economic interest, particularly for As, Cr, Ni and Pb. This suggests that for these elements, data from soils may be compared directly with data from till. Copper and most rare-earth-elements are depleted in the B-horizon relative to the C-horizon. In the Wilson Lake survey, a strong, linear, Ni–Mg anomaly extends for at least 14 km in an east–west direction, suggesting the presence of an unmapped mafic component of the paragneiss. The mineral potential of this feature is unknown. In the Seal Lake area, a cluster of high Cu values from till in the central part of the northern grid provides a focus for further exploration. Results from the southern Thomas River grid are disappointingly low in view of the high Cu content in two small lakes within the grid. The cause of these lake anomalies remains unexplained.

INTRODUCTION

This report summarizes the highlights of a regional soil and till survey conducted in 1999 in the Wilson Lake and Seal Lake areas of central Labrador (Figure 1; McConnell, 2001). The survey was the final phase of a two-year program to investigate regional base-metal anomalies in reconnaissance lake-sediment data. The first phase consisted of a high-density lake-sediment and water survey covering 4 areas of central Labrador (McConnell, 2000a, b). From this work, the Wilson Lake and Seal Lake areas were selected for the till survey. The detailed lake survey revealed an area of anomalous Ni in sediment and water extending from the western part of NTS map area 13E/7 to the eastern part of NTS map area 13E/6. The area is underlain by paragneiss although mafic intrusive rocks are found nearby. Some ground was staked in the general vicinity following the Voisey's Bay Cu–Ni discovery in 1994.

The Seal Lake area has received more exploration attention and many minor Cu occurrences have been reported. The lake survey highlighted some of these known occurrences but also identified areas of high Cu in lake sediment and water outside of the known areas of mineralization. Two areas were selected for till surveying. The first and larger
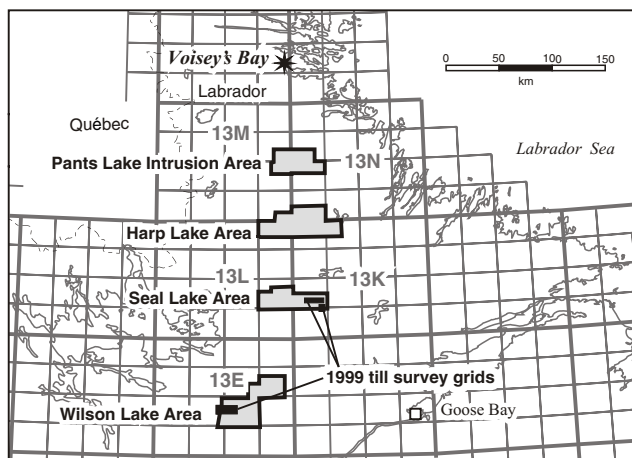
Figure 1. *Location of 1998 follow-up lake surveys and 1999 till survey grids.*

area lies between Seal and Wuchusk lakes and is mapped as underlain by gabbro and siliciclastic rocks. It was chosen because of anomalous Cu in lake water and elevated values in sediment. It has not received as much exploration attention as areas to the south of Seal Lake where most Cu mineralization has been discovered. A second smaller till survey was conducted in the Thomas River area to investigate two

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very high values of Cu in lake sediment – 241 and 1273 ppm. This area is also underlain by gabbro and siliciclastic rocks. Several minor occurrences of Cu mineralization are known within one kilometre of the grid area.

PREVIOUS WORK

The earliest geochemical work reported from the Wilson Lake area includes stream-sediment and heavy-mineral surveys conducted by BRINEX Limited in 1969 but summarized in unpublished company reports. Some of these data were used and published by Callahan (1980). A regional lake-sediment and water survey using a sample density of about 1 per 13 km^2 was conducted in 1982 by the Geological Survey of Canada (Friske *et al.,* 1993a). This survey revealed anomalous Ni in lake sediment in the present Wilson Lake survey area. The regional-lake survey in the Seal Lake area showed elevated values of Cu and Ni (Friske *et al.,* 1993b and 1993c). The most recent work in both areas is a high-density lake-sediment and water survey conducted by the Geological Survey of Newfoundland and Labrador at a sample density of about 1 per 5 km^2 (McConnell, 2000a, b). In the Wilson Lake area, these data revealed a broad zone of elevated Ni in both sediment and water in eastern NTS map area 13E/06 and western NTS map area 13E/07. In the Seal Lake survey area, high values of Cu in sediment and water were present; in several instances these were associated with known Cu mineralization.

GEOLOGY AND MINERALIZATION

Wilson Lake Area

The survey area is located in the northern Grenville Province and is underlain by rocks of the Wilson Lake Allochthon, predominantly 1680 to 1660 Ma granulite-facies paragneiss (Disappointment Lake gneiss) and lesser amounts of mafic gneiss, derived from gabbronorite and/or diorite. Although not shown within the survey area, minor ultramafic intrusive rocks have been noted (Thomas, 1993). The most recent field mapping is that of Thomas (1993) and Thomas *et al.* (2000) at 1:100 000 scale. The area has received only modest exploration attention, mostly by BRINEX Limited in the 1950s, and again in the mid 1990s following the Voisey's Bay Ni–Cu–Co discovery. The several minor base-metal occurrences known in the general area are described in the Geological Survey's Mineral Occurrence Database System (Stapleton and Smith, 2000). None are located in the immediate survey area although two outcrops of minor sulphide mineralization were noted during the conduct of this survey. Nickel–chromium mineralization in dunite is reported 8 km west of the soil grid (Thomas, 1993).

Seal Lake Area

This area is located within the Central Mineral Belt and is underlain by Mesoproterozoic rocks of the Seal Lake Group including siltstone, shale, quartzite, subaerial basalt flows and gabbro sills that have been regionally metamorphosed to greenschist facies (Wardle, 1993). The two survey grids are underlain by three units: an intrusive gabbro forming the Naskaupi Sills and the Wuchusk Lake and Whiskey Lake units composed of shale, siltstone and quartzite.

There are over 230 showings and occurrences of copper mineralization in the surveyed area (Stapleton and Smith, 2000). Mineralization commonly occurs as chalcocite, bornite, native copper and chalcopyrite. Several of the more thoroughly explored prospects note the presence of anomalous silver values. Most of the exploration for these occurrences took place in the 1950s by Frobisher Limited and later in the 1970s by BRINEX Limited. Little work has taken place since the release of regional lake-sediment data for the area. The most comprehensive summary of the nature of the Seal Lake Group geology and associated mineralization is that of Brummer and Mann (1961). They note that the mineralization occurs in quartz–carbonate veins and/or shear zones, mostly within amygdaloidal basalt, diabase and clastic (meta)sedimentary rocks including quartzite, shale, slate, argillite and phyllite. Wilton (1996) regards the copper mineralization to be the result of a single mineralizing event in which copper-rich fluids penetrated zones of weakness such as shear zones and contacts during Grenville deformation.

SURFICIAL ENVIRONMENT

During the Wisconsinan, ice flow in central Labrador was easterly but varied locally. In the Wilson Lake area, glacial striae indicate two flow directions – an earlier northeasterly flow and a later southeasterly one (Klassen and Thompson, 1993). This left a thin veneer of till, often drumlinized, over much of the region. In the Seal Lake area there is evidence of three ice-flow directions – an early northeastward one, a middle flow to the east and a late flow to the southeast. Till thickness over the Seal Lake Group supracrustal rocks is between 2 and 3 m.

SAMPLE COLLECTION, PREPARATION AND ANALYSES

A total of 418 soil–till and 16 rock samples were collected. Glacial flow from the west is likely to have developed geochemical dispersal trains trending easterly from any mineralized zones or areas of metal enrichment. Generally, sampling was conducted along lines oriented at approximately right angles to glacial flow to maximize the likeli-

hood of intersecting any dispersal trains. To further enhance the likelihood of intersecting anomalous dispersion and of obtaining at least one sample reflecting any concealed mineralization, lines were more widely spaced than were the samples along the lines. Lines were located 1 km apart and samples collected every 200 m along the lines. Wherever possible, C-horizon till was collected. This material is nearly unweathered and has a simpler geochemical history compared to B-horizon soil – the more standard exploration medium. In some cases where soils were shallow, the parent till was oxidized all the way to bedrock and only B- or BC-horizon material was available. The major drawback to collecting till instead of soil is that it is considerably more time consuming to obtain. Typically, hand-dug pits to a depth of 60 to 70 cm are required instead of the 25 to 40 cm typical for B-horizon soil. However, because the samples were relatively widely spaced, a substantial amount of time was required to access each site hence the additional time spent on collecting a better sample was justified. In all, 226 samples of C-horizon, 77 samples of BC-horizon and 115 samples of B-horizon were collected.

As a check on the relative merits of the two media in this part of Labrador, site-duplicate samples (but not horizon duplicates) from both B- and C-horizons were collected at 15 sites. The median depth of the B-horizon in these samples was 30 cm and the median depth of the C-horizon was 60 cm. Samples of typical bedrock as well as outcrops of sulphide mineralization discovered during the field work were obtained as well.

Soil samples were partially sun-dried in the field and further oven dried at 60°C at the Geological Survey's geochemical laboratory. One in 20 was selected as a laboratory duplicate and split in a riffle splitter. Each sample was then sifted in a stainless steel sieve to <180 μm. As a check on quality control, a laboratory standard of known composition and a split of a sample were included within each batch of 20 samples.

Samples were analyzed for 47 elements and loss-on-ignition. These elements and the four methods employed are listed in Table 1. Several elements (e.g., Fe, Ba, Co, Ni, etc.) were analyzed by more than one method. In some cases, clearly preferred methods are indicated.

DESCRIPTION AND DISCUSSION OF RESULTS

INFLUENCE OF SAMPLE DEPTH AND SOIL HORIZON

Prior to evaluating the overall results of the survey, it is worth considering whether the horizon sampled (B, BC or

Table 1. Analytical methods for soil/till samples

ELEMENTS	DIGESTION/ METHOD	PREPARATION
[Ag], As, Au, Ba, Br, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Mo, Na, Nd, [Ni], Rb, Sb, Sc, Sm, Ta, Tb, Th, U, W, Yb, [Zn], [Zr]	1. Neutron Activation Analysis (INAA)	5 to 10 g in shrink-wrapped vial (total analysis)
As, A1, Ba, Be, Ca, Ce, Co, Cr, Cu, Dy, Fe, Ga, K, La, Li, Mn, Mg, Mo, Na, Nb, Ni*, Pb, P, Rb, Sc, Sr, Ti, V, Y, Zn*, Zr*	2. Inductively Coupled Plasma Emission Spectroscopy (ICP-ES)	HF-HClO$_4$-HCl (total digestion)
Ag*	6. Atomic Absorption Spectroscopy (AA)	HNO$_3$
F	9. Fluoride-ion selective electrode	Fusion with Na$_2$CO$_3$-KNO$_3$ flux

NOTES: * indicates preferred method of analysis, [ ] indicates less favoured method of analysis.

To enable the user to readily distinguish the method of analysis for a given element, a suffix is attached to the element symbol when used in statistical summaries and tables. The key to the suffixes is as follows:
1. Neutron activation analysis (INAA).
2. ICP-ES/after HF-HClO$_4$-HCl digestion.
6. AA/after HNO$_3$ digestion.
9. Fluoride-ion selective electrode after fusion with flux of 2:1 Na$_2$CO$_3$:KNO$_3$.
Thus, for example, Zn2 is zinc analyzed by ICP/HF-HClO$_4$-HCl whereas Zn1 is zinc analyzed by INAA.

C) has a significant influence on the analytical results. One method of determining this is to make some simplifying assumptions and let sample depth act as a proxy for horizon; i.e., the deeper the sample the more likely it represents less weathered material and more closely it represents the parent till. Table 2 lists the Spearman correlation coefficients for elements vs. depth from the two survey areas. Some elements having analyses of questionable quality have been omitted. Coefficients have been sorted by increasing value for the Wilson Lake area. Coefficients >|0.17| are significantly correlated at the 99% confidence level. At the Wilson Lake area, 10 of 45 elements are so correlated: in order of increasing correlation, Be, Dy, Y, Rb, Ca, Na, K and Sr are positively correlated and Br and Mo are negatively correlated. At Seal Lake, 13 elements correlate significantly with depth: Yb, P, Cu, Nd, Tb, Be, La, Sm, Mn, Ce, Y and Dy are positively correlated and Mo is negatively correlated. The correlations for these elements, although significant, are weak, all being <|0.3|. Generally, the rare-earth-elements show significant correlations at both areas but of the base and precious metals considered in this report, only Cu at Seal Lake is likely affected.

Another method of assessing the association between soil horizon and element content is to compare results from site duplicate samples where B- and C-horizons were sampled at the same site. Six elements – As, Cr, Cu, Mg, Ni and Pb – were selected for consideration here because of their use as either direct indicators of mineralization or for mapping concealed bedrock. Scatterplots of the these elements are shown in Figure 2 in which the B-horizon and C-horizon fields are separated by a 45° line. It is apparent that, except for Cu, the data from the two horizons correlate strongly as indicated by Spearman correlation coefficients >0.7. The elements As and Cr show no preference for either horizon as seen by the fairly even distribution of points in both the B- and C-horizon fields. Nickel and Pb show a weak enrichment in the C-horizon. Copper shows a strong enrichment in the C-horizon and Mg a moderate one.

STATISTICAL ANALYSES

Summary Statistics

To quantify the range and distribution characteristics of the analytical data and permit comparison between the two survey areas, median, minimum and maximum values for the Wilson Lake and Seal Lake analytical data are tabulated in Table 3. From this it is apparent that Cr, Ni, Sr, Th, Ba and Mg are considerably more abundant in the Wilson Lake data than in Seal Lake, and Sb, As, Li, U and Cu are more abundant in the data from Seal Lake.

Table 2. Spearman correlation coefficients for elements with sample depth at Wilson Lake area (N=214) and Seal Lake area (N=203); coefficients are sorted for the Wilson Lake area

	Wilson	Seal
LOI	-0.27	-0.23
Br1	-0.26	-0.08
Mo2	-0.18	-0.15
W1	-0.10	0.01
Hf1	-0.09	-0.09
Ce1	-0.09	0.27
Ta1	-0.08	0.11
Th1	-0.08	0.16
Nd1	-0.08	0.19
La1	-0.08	0.21
Tb1	-0.07	0.21
Sm1	-0.07	0.23
Al2	-0.06	-0.05
Zr2	-0.05	0.06
Au1	-0.04	0.12
Zn2	-0.03	0.10
Li2	-0.03	0.07
F9	-0.03	0.13
As1	-0.02	0.01
Nb2	-0.01	0.10
Fe2	-0.01	-0.03
Cs1	-0.01	-0.11
Fe1	0.00	-0.03
Ti2	0.00	-0.04
V2	0.00	-0.09
Co2	0.01	0.15
Sc2	0.01	0.14
U1	0.02	0.05
Sb1	0.03	0.11
Ba1	0.03	0.02
Cr1	0.03	0.01
Yb1	0.04	0.18
Mg2	0.04	0.07
Ni2	0.05	0.10
Pb2	0.10	0.04
Cu2	0.15	0.19
P2	0.17	0.19
Mn2	0.17	0.24
Be2	0.18	0.21
Dy2	0.21	0.29
Y2	0.21	0.27
Rb2	0.22	0.08
Ca2	0.24	0.14
Na2	0.25	0.15
K2	0.27	0.07
Sr2	0.29	0.09

Correlations >|0.17| are significant at the 99% confidence level
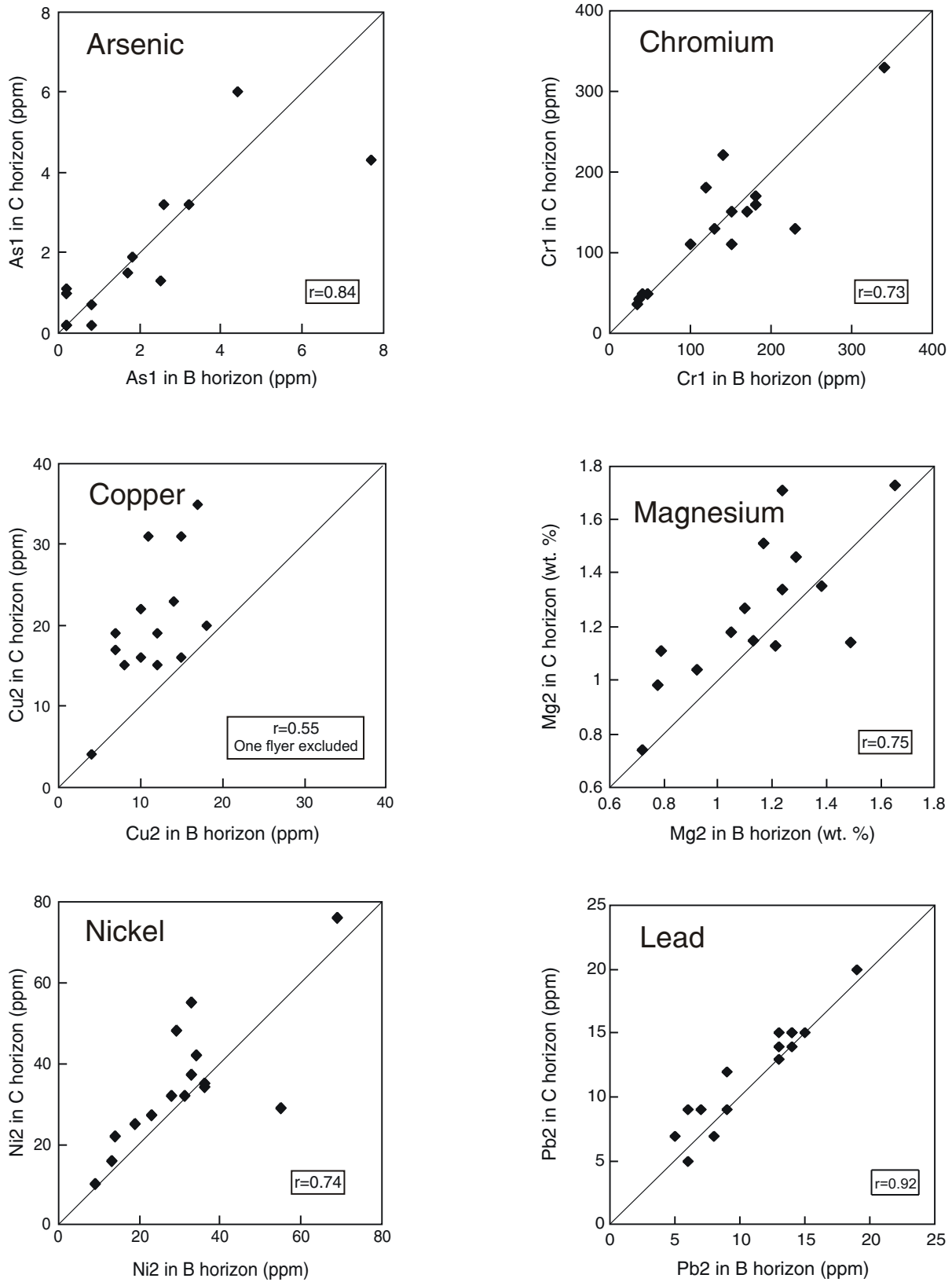
Figure 2. *Scatterplots of As1, Cr1, Cu2, Mg2, Ni2 and Pb2 in B- and C-horizons of site duplicates.*

Table 3. Median, minimum and maximum values of selected soil data at Wilson and Seal lakes areas

	Wilson Median	Seal Median	Wilson Minimum	Seal Minimum	Wilson Maximum	Seal Maximum
Ag6	<0.1	<0.1	<0.1	<0.1	0.2	0.3
Al2	6.78	6.37	5.45	5.32	7.81	8.84
As1	<0.5	2.7	<0.5	<0.5	2.5	13
Au1, ppb	<1	<1	<1	<1	6	8
Ba1	790	500	280	220	1100	890
Be2	1.5	1.9	1.1	1.0	1.8	4.4
Br1	6.5	6.7	0.5	0.5	74	32
Ca2, wt.%	1.86	1.53	0.74	0.58	2.30	2.85
Ce1	93	76	47	31	150	150
Co2	15	13	7	6	41	39
Cr1	200	45	65	23	1800	230
Cs1	<1	1	<1	<1	3	3.0
Cu2	14	19	1	4	105	190
Dy2	4.1	4.2	2.5	1.8	5.6	10.5
F9	407	303	97	144	709	813
Fe, wt.% 1	4.12	3.70	2.17	1.69	11.1	7.25
Fe2, wt.%	4.38	4.00	2.26	1.87	10.81	7.72
Hf1	11	11	6	7	19	19
K2, wt.%	2.04	1.71	0.74	0.66	2.4	3.92
La1	56	40	31	20	87	88
Li2	9.0	12.9	4.6	5.7	14.1	31.1
LOI, wt.%	4.3	3.9	1.2	1.0	49.6	20.4
Mg2, wt.%	1.40	0.98	0.70	0.49	5.3	3.16
Mn2	730	542	402	275	1375	1247
Mo1	<1	<1	<1	<1	6	20
Na1, wt.%	1.97	1.99	0.78	0.76	2.44	2.47
Nb2	12	15	8	9	21	22
Ni2	42	18	12	7	255	89
P2	935	716	172	135	1542	1645
Pb2	11	9	1	1	17	52
Rb1	49	57	18	2	82	120
Sb1	<0.1	0.3	<0.1	<0.1	0.5	0.6
Sc1	13	10	8.7	6.6	21	19
Sm1	7.1	5.7	3.7	2.4	10	12
Sr2	397	229	157	82	454	409
Ta1	0.6	0.83	0.1	0.1	1.5	1.8
Tb1	0.9	0.83	0.2	0.2	1.4	2
Th1	9.7	5.8	5.2	3.3	21	12
Ti2	4983	5551	2788	3968	11786	10952
U1	1.0	1.4	0.1	0.1	1.9	17
V2	90	79	52	56	221	237
Y2	25	26	15	13	33	55
Zn2	48	53	26	28	77	101
Zr2	83	171	40	85	136	264
Depth (cm)	50	50	20	25	80	85

Note: data in ppm unless otherwise indicated

Histograms

Histograms of Au, Co, Cr, Cu, Mg and Ni for the two areas are shown in Figure 3. Axis dimensions are the same for a given element for both areas to facilitate comparison of distributions and log scales are used throughout. Histograms permit ready visualization of element distributions and also the presence of outliers or extreme values.

Correlation Analysis

Correlation coefficients show the strength of inter-element associations; i.e., the tendency for pairs of elements to vary sympathetically (positive correlations) or inversely (negative correlations) with each other in a given sample population. For example, if Au is associated with As (arsenopyrite) in an area, this relationship may show as a positive correlation. Iron and manganese (hydr)oxides frequently act as significant scavenging agents for many metals in soils and sediments. For some elements, this may be so extreme as to require normalizing, or even outright rejection, of the data involved. Spearman-ranked correlation coefficients have been calculated for several pairs of elements in the soil data. Spearman correlations make no assumptions about the nature or shape of the component populations.

Tables 4 and 5 present the coefficients between most of the elements analyzed and a selection of base metals, precious metals and a few others. Statistically, correlations $>|0.17|$ at Wilson Lake and $>|0.18|$ at Seal Lake are significant at the 99% confidence level. However, for practical purposes correlations of $<|0.6|$ generally do not call for adjustment of values when dealing with scavenging agents like Fe and Mn. That is, enough of the element signal is present that satisfactory results may be obtained by treating only the raw values. For elements with coefficients $>|0.6|$, procedures such as regression analysis may be employed to minimize the component of the signal due to scavenging. At Wilson Lake, neither Fe nor Mn appears to be strongly scavenging the base metals. The strongest correlations of interest include Ni2 and Mg2 ($r=0.96$), Ni2 and Cr1 ($r=0.89$) and Ni2 and Co2 ($r=0.89$) suggesting a lithological or mineralogical association. Similarly at Seal Lake, scavenging does not seem to be a problem but Ni–Co–Mg again has a strong association.

ELEMENT DISTRIBUTION IN SOIL AND TILL

Nickel in Wilson Lake Survey

Nickel is the element of most interest in the Wilson Lake survey area. A map of the distribution of Ni2 in till is shown in Figure 4 in which a pattern of high values forms a narrow, semi-continuous, 14-km-long, east–west-trending zone through the centre of the grid. A plot of Mg (McConnell, 2001) has a similar pattern suggesting that the Ni is associated with an unmapped mafic phase of the gneiss. Two pyrite mineralized outcrops and one locally derived sulphidic boulder are also indicated on the map. The outcrops do not have a close spatial relationship with the anomalous Ni values. The boulder is close to a site with moderately high Ni.

Copper in Seal Lake Survey

A map of the distribution of Cu2 in till is shown in Figure 5. Also shown are the three copper "prospects" and four "showings" that are known in the area (Stapleton and Smith, 2000). Two of the showings are in siliciclastic rocks and two in gabbro or "andesite". There are a further 107 "indications" of Cu that are not shown that consist mostly of Cu stains and smears along fractures in various rock types. The larger of the two grids encloses a region of anomalous Cu in lake sediment between Seal and Wuchusk lakes. No till sampling was conducted in the northern margin between the grid and Wuchusk Lake and the adjoining Naskaupi River due to a blanket of sand and gravel. Elsewhere the Quaternary cover appears to consist of locally derived till. Most of the highest Cu samples are located in the central part of the grid, overlying or near the clastic sedimentary unit. The highest sample, 190 ppm Cu, is located about 1.5 km east and down-ice of the sedimentary unit in an area presumably underlain by gabbro.

The low Cu response in till in the southern Thomas River grid is surprising in light of the fact that the two small lakes contained within the grid have Cu in lake sediment values of 241 and 1273 ppm Cu – amongst the highest recorded in the survey.

CONCLUSIONS

1. On the basis of element correlation with depth and by comparison of B- and C-horizon analyses of site duplicates, the difference, for many elements, between concentrations in B-horizon soils and C-horizon tills is modest. This suggests that for these elements, results from B-, BC- and C-horizon samples may be compared directly. In particular, the ore-related elements Ni, Cr, Pb, Zn and As seem little affected by depth or horizon. Copper, most of the rare-earth-elements and the "major" elements Ca, Na and K appear somewhat depleted in the B-horizon relative to the C-horizon and results of sampling mixed populations should be evaluated carefully.
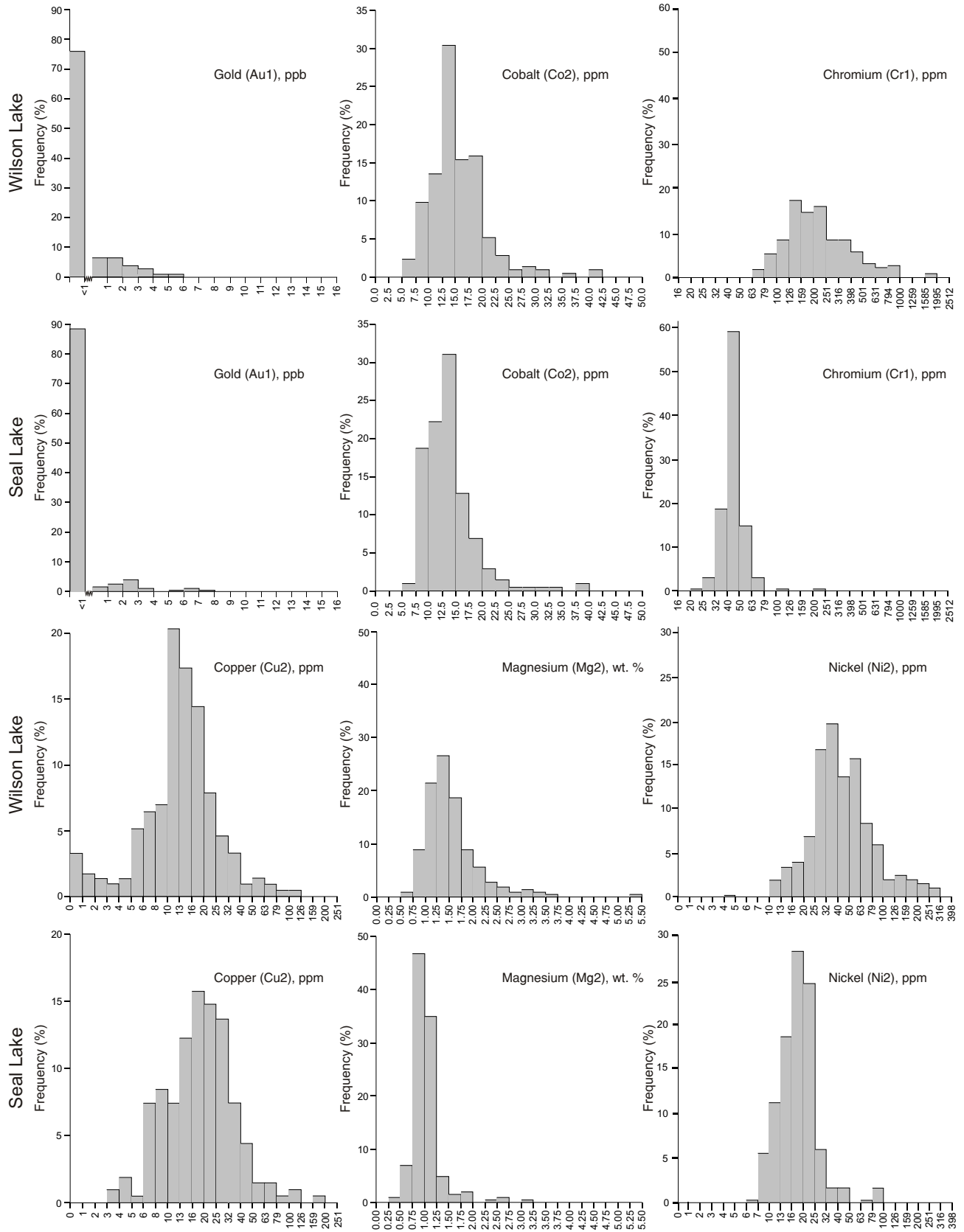
Figure 3. *Histograms of Au, Co, Cr, Cu, Mg and Ni in till in Wilson and Seal lakes areas.*

Table 4. Spearman correlations coefficients for selected elements, Wilson Lake survey, N=214

	As1	Au1	Cr1	Cu2	F9	Fe1	La1	Mg2	Mn2	Ni2	Pb2	Sb1	U1	Zn2	Depth	LOI
Al2	-0.04	-0.04	-0.40	0.43	0.37	-0.21	0.21	-0.12	-0.17	-0.20	0.00	0.05	-0.02	0.23	-0.06	-0.20
As1	**1.00**	-0.08	0.07	0.00	0.03	-0.01	-0.09	0.04	-0.03	0.02	0.00	-0.10	-0.01	0.04	-0.02	0.09
Au1	-0.08	**1.00**	0.08	0.05	0.05	-0.01	0.01	0.11	0.08	0.11	-0.08	0.01	-0.06	0.04	-0.04	-0.15
Ba1	-0.09	0.08	-0.03	0.32	0.33	-0.07	0.41	0.13	-0.00	0.07	0.30	0.03	0.03	0.23	0.03	-0.44
Be2	-0.03	-0.04	-0.42	0.14	0.13	-0.37	0.02	-0.27	-0.14	-0.29	0.18	0.16	0.26	-0.14	0.18	-0.39
Br1	0.04	-0.06	-0.10	-0.10	-0.23	0.04	-0.20	-0.19	-0.30	-0.17	-0.34	-0.06	-0.10	-0.15	-0.26	0.70
Ca2	-0.13	0.12	-0.30	0.34	0.18	-0.18	0.17	-0.13	0.18	-0.15	0.31	0.12	0.07	-0.08	0.24	-0.70
Ce1	-0.10	0.01	0.18	0.50	0.55	0.41	0.87	0.36	0.41	0.29	0.15	0.02	0.10	0.50	-0.09	-0.31
Co2	0.02	0.10	0.73	0.45	0.64	0.61	0.37	0.95	0.65	0.89	-0.20	-0.10	-0.16	0.82	0.01	-0.14
Cr1	0.07	0.08	**1.00**	0.17	0.29	0.54	0.20	0.84	0.43	0.89	-0.22	-0.11	-0.18	0.42	0.03	-0.01
Cs1	0.07	0.05	0.06	0.15	0.40	0.16	0.25	0.22	0.10	0.13	0.01	-0.11	0.08	0.41	-0.01	-0.04
Cu2	0.00	0.05	0.17	**1.00**	0.49	0.22	0.37	0.37	0.32	0.34	-0.08	-0.04	-0.14	0.41	0.15	-0.31
Dy2	-0.17	-0.05	-0.36	0.18	0.16	-0.01	0.30	-0.22	0.19	-0.26	0.37	0.17	0.26	-0.04	0.21	-0.39
F9	0.03	0.05	0.29	0.49	**1.00**	0.29	0.53	0.59	0.32	0.49	-0.01	0.01	0.09	0.78	-0.03	-0.17
Fe1	-0.01	-0.01	0.54	0.22	0.29	**1.00**	0.39	0.56	0.65	0.51	-0.11	-0.15	-0.11	0.56	0.00	0.10
Fe2	-0.07	0.04	0.46	0.16	0.21	0.87	0.24	0.52	0.76	0.48	-0.09	-0.08	-0.17	0.48	-0.01	0.09
Hf1	0.03	-0.07	0.02	-0.24	0.01	0.17	0.51	-0.03	0.04	-0.06	-0.06	0.08	0.27	0.04	-0.09	0.08
K2	-0.03	0.02	-0.20	0.27	0.27	-0.35	0.26	-0.04	0.03	-0.08	0.25	0.10	0.02	0.07	0.27	-0.73
La1	-0.09	0.01	0.20	0.37	0.53	0.39	**1.00**	0.33	0.36	0.27	0.04	0.07	0.21	0.43	-0.08	-0.27
Li2	0.13	0.00	0.17	0.36	0.67	0.23	0.22	0.47	0.23	0.36	-0.17	-0.11	0.04	0.75	-0.03	0.00
Mg2	0.04	0.11	0.84	0.37	0.59	0.56	0.33	**1.00**	0.59	0.96	-0.22	-0.10	-0.15	0.73	0.04	-0.11
Mn2	-0.03	0.08	0.43	0.32	0.32	0.65	0.36	0.59	**1.00**	0.52	0.03	-0.01	-0.10	0.53	0.17	-0.32
Mo2	0.08	0.04	-0.21	-0.13	-0.09	-0.19	-0.15	-0.25	-0.29	-0.23	-0.10	-0.11	-0.13	-0.14	-0.18	0.06
Na2	-0.08	0.02	-0.48	0.15	0.01	-0.50	0.02	-0.37	-0.16	-0.37	0.30	0.14	0.13	-0.28	0.25	-0.66
Nb2	-0.00	0.02	-0.16	-0.32	0.08	0.06	0.11	-0.13	0.10	-0.19	0.07	0.15	0.28	0.10	-0.01	0.07
Nd1	-0.07	-0.03	0.05	0.42	0.59	0.30	0.81	0.22	0.26	0.15	0.20	0.07	0.20	0.43	-0.08	-0.22
Ni2	0.02	0.11	0.89	0.34	0.49	0.51	0.27	0.96	0.52	**1.00**	-0.28	-0.08	-0.18	0.59	0.05	-0.10
P2	-0.03	0.10	-0.01	0.38	0.43	-0.03	0.34	0.10	0.19	0.11	0.10	0.13	0.20	0.10	0.17	-0.34
Pb2	0.00	-0.08	-0.22	-0.08	-0.01	-0.11	0.04	-0.22	0.03	-0.28	**1.00**	0.19	0.21	-0.08	0.10	-0.34
Rb2	0.03	-0.04	-0.34	0.14	0.27	-0.41	0.13	-0.18	-0.09	-0.24	0.35	0.15	0.22	0.05	0.22	-0.55
Sb1	-0.10	0.01	-0.11	-0.04	0.01	-0.15	0.07	-0.10	-0.01	-0.08	0.19	**1.00**	0.10	-0.10	0.03	-0.07
Sc2	-0.03	0.03	0.21	0.24	0.51	0.65	0.45	0.46	0.72	0.34	0.05	0.03	0.03	0.68	0.01	-0.05
Sm1	-0.05	-0.01	0.15	0.46	0.59	0.39	0.94	0.32	0.35	0.26	0.08	0.04	0.21	0.46	-0.07	-0.26
Sr2	-0.16	0.07	-0.30	0.22	0.10	-0.31	0.18	-0.20	0.01	-0.19	0.34	0.20	0.12	-0.20	0.29	-0.73
Ta1	0.10	0.01	0.00	-0.33	-0.18	0.06	-0.07	-0.13	-0.06	-0.12	0.08	0.03	0.04	-0.10	-0.08	0.12
Tb1	-0.10	-0.01	0.00	0.11	0.26	0.22	0.60	0.09	0.13	0.07	-0.03	0.14	0.18	0.19	-0.07	-0.10
Th1	-0.12	-0.03	0.14	0.32	0.42	0.47	0.77	0.25	0.40	0.16	0.32	-0.01	0.14	0.41	-0.08	-0.21
Ti2	-0.12	0.02	0.17	-0.22	-0.02	0.50	0.16	0.15	0.53	0.09	0.20	0.11	0.00	0.21	0.00	0.06
U1	-0.01	-0.06	-0.18	-0.14	0.09	-0.11	0.21	-0.15	-0.10	-0.18	0.21	0.10	**1.00**	-0.02	0.02	0.04
V2	-0.08	0.04	0.35	0.09	0.20	0.80	0.29	0.44	0.77	0.35	0.03	-0.02	-0.16	0.47	0.00	-0.01
W1	-0.06	-0.04	-0.02	-0.11	0.06	0.05	0.10	0.09	0.11	0.06	0.05	0.07	0.11	0.11	-0.10	0.11
Y2	-0.11	0.01	-0.38	0.18	0.12	-0.12	0.25	-0.26	0.17	-0.28	0.30	0.18	0.25	-0.15	0.21	-0.47
Yb1	-0.07	-0.07	-0.16	0.05	0.20	0.11	0.54	-0.10	0.19	-0.12	0.26	0.17	0.31	0.03	0.04	-0.33
Zn2	0.04	0.04	0.42	0.41	0.78	0.56	0.43	0.73	0.53	0.59	-0.08	-0.10	-0.02	**1.00**	-0.03	-0.01
Zr2	-0.02	-0.03	-0.34	-0.30	0.01	-0.28	0.16	-0.33	-0.14	-0.38	0.44	0.24	0.42	-0.15	-0.05	-0.14
Depth	-0.02	-0.04	0.03	0.15	-0.03	0.00	-0.08	0.04	0.17	0.05	0.10	0.03	0.02	-0.03	**1.00**	-0.27
LOI	0.09	-0.15	-0.01	-0.31	-0.17	0.10	-0.27	-0.11	-0.32	-0.10	-0.34	-0.07	0.04	-0.01	-0.27	**1.00**

Correlations >|0.17| are significant at the 99% confidence level.

Table 5. Spearman correlations coefficients for selected elements, Seal Lake survey, N=203

	As1	Au1	Cr1	Cu2	F9	Fe1	La1	Mg2	Mn2	Ni2	Pb2	Sb1	U1	Zn2	Depth	LOI
Al2	-0.15	0.07	0.41	0.26	-0.03	0.20	-0.14	0.38	-0.01	0.43	-0.09	0.05	0.07	0.31	-0.05	0.28
As1	**1.00**	-0.04	-0.09	0.00	0.50	0.27	0.42	0.04	0.04	-0.09	0.11	0.30	0.35	0.00	0.01	-0.15
Au1	-0.04	**1.00**	0.07	0.22	0.10	0.03	0.08	0.14	0.10	0.21	0.02	-0.01	0.04	0.14	0.12	-0.13
Ba1	0.24	0.03	-0.11	0.04	0.29	-0.06	0.40	-0.16	-0.15	-0.16	0.09	0.25	0.32	0.04	0.02	-0.16
Be2	0.23	0.06	-0.22	0.26	0.49	0.06	0.78	0.05	0.27	0.12	0.55	0.35	0.34	0.55	0.21	-0.18
Br1	-0.18	-0.06	0.15	0.00	-0.34	0.17	-0.23	-0.03	-0.20	-0.00	0.16	0.01	0.04	0.13	-0.07	0.85
Ca2	-0.30	0.13	0.35	0.32	-0.10	-0.02	-0.20	0.39	0.42	0.45	-0.31	-0.26	-0.28	-0.04	0.14	-0.35
Ce1	0.46	0.06	-0.11	0.34	0.62	0.17	0.92	0.12	0.30	0.14	0.32	0.46	0.55	0.39	0.27	-0.37
Co2	-0.03	0.16	0.58	0.69	0.17	0.43	0.08	0.86	0.70	0.93	0.15	0.07	0.07	0.68	0.15	-0.10
Cr1	-0.09	0.07	**1.00**	0.33	-0.16	0.66	-0.21	0.54	0.42	0.58	-0.06	-0.10	0.04	0.38	0.01	0.15
Cs1	0.18	0.01	-0.02	0.08	0.32	0.25	0.36	0.15	0.11	0.06	0.37	0.26	0.35	0.42	-0.10	0.05
Cu2	0.00	0.22	0.33	**1.00**	0.22	0.20	0.26	0.61	0.46	0.70	0.24	0.12	0.12	0.49	0.19	-0.13
Dy2	0.28	0.12	-0.04	0.44	0.58	0.20	0.85	0.23	0.47	0.24	0.35	0.30	0.43	0.49	0.29	-0.31
F9	0.50	0.10	-0.16	0.22	**1.00**	0.11	0.69	0.26	0.26	0.11	0.21	0.31	0.40	0.33	0.13	-0.39
Fe1	0.27	0.03	0.66	0.20	0.11	**1.00**	0.14	0.44	0.43	0.36	0.18	0.12	0.20	0.44	-0.03	0.21
Fe2	0.24	0.01	0.64	0.21	0.09	0.94	0.08	0.50	0.50	0.40	0.17	0.13	0.16	0.46	-0.03	0.22
Hf1	-0.02	0.02	0.07	-0.17	-0.03	0.03	0.14	-0.17	0.13	-0.16	0.06	-0.04	0.17	-0.02	-0.09	-0.04
K2	0.35	0.00	-0.42	-0.01	0.67	-0.19	0.59	-0.01	0.02	-0.12	0.20	0.24	0.34	0.19	0.07	-0.44
La1	0.42	0.08	-0.21	0.26	0.69	0.14	**1.00**	0.04	0.25	0.02	0.38	0.38	0.51	0.35	0.21	-0.36
Li2	0.27	0.01	0.01	0.30	0.48	0.26	0.57	0.29	0.27	0.29	0.57	0.39	0.39	0.75	0.07	0.06
Mg2	0.04	0.14	0.54	0.61	0.26	0.44	0.04	**1.00**	0.61	0.88	0.10	0.13	0.11	0.58	0.07	-0.08
Mn2	0.04	0.10	0.42	0.46	0.26	0.43	0.25	0.61	**1.00**	0.57	0.29	0.05	0.06	0.60	0.24	-0.27
Mo2	-0.02	-0.05	-0.04	-0.05	-0.08	0.02	-0.07	-0.01	-0.07	-0.04	0.18	0.01	0.06	0.14	-0.15	0.43
Na2	0.19	0.02	-0.35	-0.03	0.39	-0.37	0.33	-0.16	-0.09	-0.23	-0.22	0.12	0.02	-0.33	0.14	-0.70
Nb2	0.16	-0.06	0.04	0.13	0.24	0.34	0.51	0.06	0.45	0.01	0.71	0.31	0.30	0.46	0.10	-0.05
Nd1	0.44	0.11	-0.16	0.24	0.66	0.16	0.95	0.06	0.22	0.04	0.35	0.41	0.53	0.32	0.19	-0.36
Ni2	-0.09	0.21	0.58	0.70	0.11	0.36	0.02	0.88	0.57	**1.00**	0.07	0.01	0.03	0.61	0.10	-0.09
P2	0.33	-0.05	-0.06	0.18	0.61	0.15	0.51	0.09	0.25	0.03	0.03	0.20	0.25	0.11	0.19	-0.26
Pb2	0.11	0.02	-0.06	0.24	0.21	0.18	0.38	0.10	0.29	0.07	**1.00**	0.31	0.26	0.55	0.04	0.15
Rb2	0.35	-0.03	-0.38	-0.10	0.60	-0.09	0.63	-0.11	0.04	-0.19	0.32	0.37	0.33	0.27	0.08	-0.35
Sb1	0.30	-0.01	-0.10	0.12	0.31	0.12	0.38	0.13	0.05	0.01	0.31	**1.00**	0.29	0.22	0.11	-0.02
Sc2	0.00	0.16	0.67	0.49	0.14	0.53	0.12	0.74	0.64	0.71	0.03	0.09	0.13	0.48	0.14	-0.17
Sm1	0.43	0.11	-0.09	0.34	0.66	0.21	0.96	0.14	0.29	0.14	0.30	0.40	0.55	0.38	0.23	-0.34
Sr2	-0.16	0.02	-0.08	-0.14	-0.01	-0.39	-0.08	-0.22	-0.09	-0.19	-0.40	-0.19	-0.18	-0.44	0.09	-0.48
Ta1	0.18	-0.03	-0.03	0.06	0.18	0.07	0.23	0.01	0.10	-0.04	0.01	0.08	0.08	0.00	0.11	-0.20
Tb1	0.23	0.14	0.04	0.31	0.46	0.26	0.76	0.19	0.33	0.21	0.33	0.29	0.52	0.42	0.21	-0.18
Th1	0.43	0.03	-0.04	0.23	0.59	0.26	0.82	0.04	0.14	0.03	0.42	0.42	0.57	0.43	0.16	-0.12
Ti2	-0.09	0.07	0.60	0.08	-0.24	0.46	-0.27	0.33	0.48	0.29	-0.06	-0.08	-0.04	0.14	-0.04	-0.02
U1	0.35	0.04	0.04	0.12	0.40	0.20	0.51	0.11	0.06	0.03	0.26	0.29	**1.00**	0.28	0.05	0.01
V2	0.08	0.04	0.72	0.18	-0.06	0.69	-0.26	0.62	0.55	0.49	0.02	-0.06	0.01	0.35	-0.09	0.15
W1	-0.00	0.11	0.07	0.04	0.09	0.03	0.10	0.05	0.12	0.05	-0.01	0.07	-0.01	0.09	0.01	-0.01
Y2	0.23	0.14	-0.05	0.42	0.57	0.18	0.84	0.22	0.52	0.22	0.42	0.26	0.40	0.49	0.27	-0.34
Yb1	0.38	0.07	-0.06	0.31	0.55	0.28	0.86	0.17	0.36	0.15	0.42	0.43	0.55	0.49	0.18	-0.24
Zn2	0.00	0.14	0.38	0.49	0.33	0.44	0.35	0.58	0.60	0.61	0.55	0.22	0.28	**1.00**	0.10	0.08
Zr2	0.10	0.03	-0.06	-0.00	0.24	0.14	0.53	-0.08	0.23	-0.07	0.48	0.23	0.37	0.35	0.06	-0.13
Depth	0.01	0.12	0.01	0.19	0.13	-0.03	0.21	0.07	0.24	0.10	0.04	0.11	0.05	0.10	**1.00**	-0.23
LOI	-0.15	-0.13	0.15	-0.13	-0.39	0.21	-0.36	-0.08	-0.27	-0.09	0.15	-0.02	0.01	0.08	-0.23	**1.00**

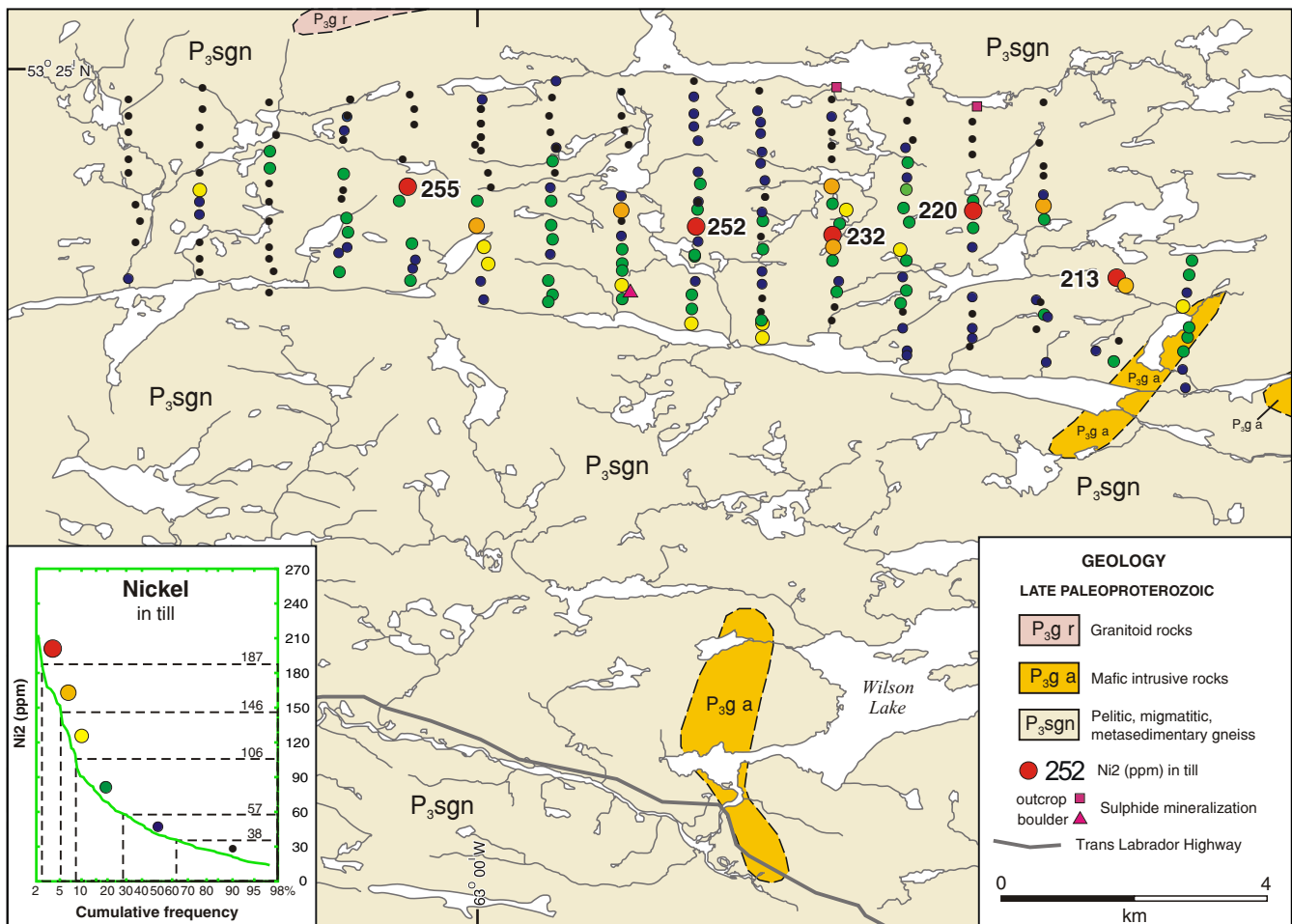Correlations >|0.18| are significant at the 99% confidence level.

Figure 4. *Ni2 in till, Wilson Lake area.*

2. Oxide scavenging of base metals is not a problem for interpreting data from the Wilson Lake or Seal Lake surveys.

3. In the Wilson Lake survey, a strong, linear, Ni–Mg anomaly extends for at least 14 km in an east–west direction, suggesting the presence of an unmapped mafic unit enclosed by paragneiss. The mineral potential of this feature is unknown. Two exposures of minor sulphide mineralization were discovered in the course of the survey.

4. In the Seal Lake area, a cluster of high Cu analyses from till in the central part of the main grid provides a focus for further exploration. Results from the Thomas River grid are disappointingly low in view of the high Cu content in two small lakes within the grid. The cause of these anomalies remains unexplained.

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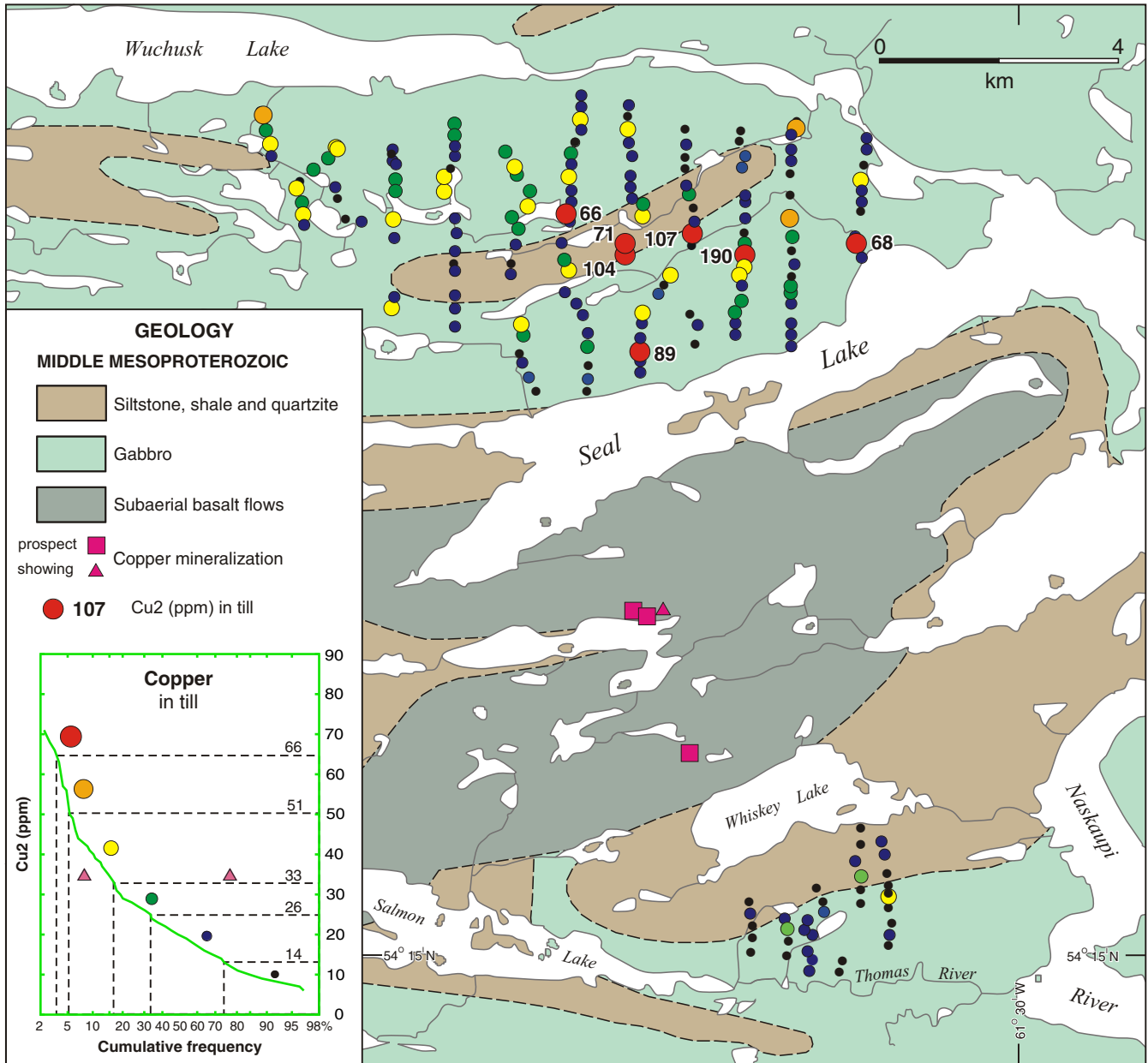1961: Geology of the Seal Lake area, Labrador. Geological Society of America Bulletin, Volume 72, pages 1361-1382.

Figure 5. *Cu2 in till, Seal Lake area*

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