

HIGHLIGHTS OF A DETAILED LAKE-SEDIMENT AND WATER SURVEY FOR PGE, GOLD AND BASE METALS IN WESTERN LABRADOR

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ABSTRACT

During 2002, a helicopter-borne, high-density lake-sediment and water survey was conducted in western Labrador over portions of NTS map areas 23A, 23G and 23H. The area was selected for its potential to host Cu–Ni, PGE and Au mineralization. Sampling was preferentially directed to lakes underlain by the Ossok Mountain intrusive suite, which consists of metamorphosed and deformed gabbro and lesser amounts of norite, gabbro, and olivine gabbro and norite. Areas underlain by two other groups of mafic rocks, the Shabogamo Gabbro and the Beaver Gneiss were also included in the survey. Samples were collected from 509 sites at a sample density of one per 4.4 km². Some exploration has been done in the region and six occurrences of copper ± nickel mineralization and six of pyrite have been identified previously. The area has been glaciated, with till being the most widespread glacial sediment. The prevailing ice-flow direction was towards the south-east.

Samples of lake sediment were analyzed for 48 unique elements plus loss-on-ignition and the lake water was analyzed for conductivity, pH, SO₄ and 25 elements. Summary statistics, including correlation analysis and histograms were calculated to aid in the data interpretation and symbol maps of Au, Cu, Ni, Pd, and Pt are presented to visually illustrate distribution. These maps indicate several anomalous sites for Au, PGE, Cu and Ni; some of the samples are associated with known mineralization, but most are not.

INTRODUCTION

A lake-sediment and water survey was conducted over areas underlain by units of the mafic Ossok Mountain intrusive suite (1850 km²) in NTS map areas 23A/13, 14 and 15, 23G/01 and 08 and 23H/01-08 (Figure 1). In addition, areas of mafic rocks represented by the Shabogamo Gabbro (300 km²) and Beaver Gneiss (65 km²), which underlie minor portions of the survey area, were also sampled. The area was selected for its potential for hosting Ni–Cu–Co and platinum-group elements (PGE) mineralization. A previous reconnaissance geochemical survey indicated elevated levels of Cu and Ni, but PGE were not analyzed (Friske *et al.*, 1993a, b). This survey fills in a geologically important area with a considerably higher sample density and a larger suite of analyses than is available with the reconnaissance survey data.

This report summarizes the highlights of this survey. For a more detailed discussion of the results, see Open file report Lab/1397 (McConnell, 2005).

LOCATION, ACCESS AND PHYSIOGRAPHY

The survey area is located in western Labrador and includes parts of NTS map areas 23A/13, 14 and 15, 23G/01 and 08 and 23H/01, 02, 03, 04, 05, 06, 07 and 08. The Labrador City–Churchill Falls part of the Trans-Labrador Highway transects the survey area. Private roads related to the drainage diversion structures provide additional access. Float plane service is available from Labrador City/Wabush. The western boundary of the survey is about 60 km east of Labrador City/Wabush and the eastern boundary extends to within a few kilometres of the town of Churchill Falls. The area is one of variable relief having a mix of low, boggy sections, considerable sections of moderate relief and some rugged zones probably controlled by bedrock. The area is forested and has numerous ponds and lakes.

PREVIOUS GEOCHEMICAL SURVEYS

The area was included in the Labrador reconnaissance scale surveys (Friske *et al.*, 1993a, b). These low-density

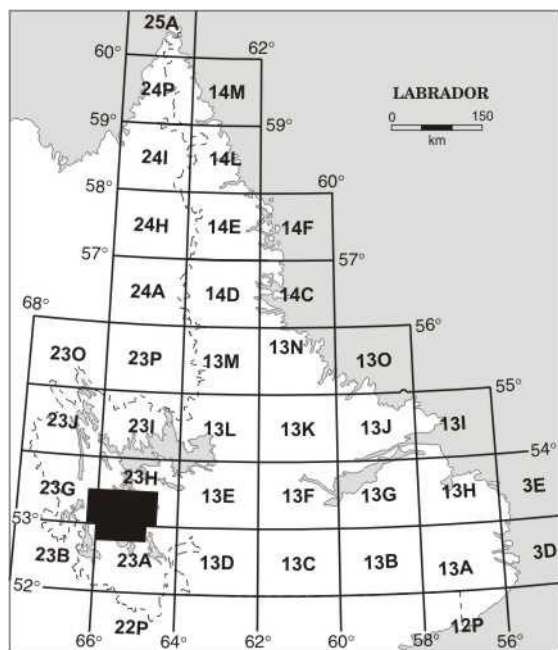


Figure 1. Location of lake-sediment and water survey for PGE, gold and base metals in western Labrador.

lake surveys (1 sample per 14 km²) were conducted in 1979, 1982 and 1984. Sediment analyses include 41 elements, as well as U, F and pH analyses of water, but not PGE. Elevated levels of Cu and Ni were noted over much of the mafic terrane.

The only Labrador lake-sediment survey for PGE was done in the Wilson Lake and Pants Lake area (McConnell, 2002). Results of this study showed high PGE values in sediment that were spatially associated with known occurrences of sulphide/PGE mineralization at Pants Lake.

GEOLOGY AND MINERALIZATION

Most of the survey area lies within the Lac Joseph Terrane (Rivers and Chown, 1986) and the most easterly portion is underlain by the Churchill Falls Terrane (Connelly and Nunn, 1988; Nunn, 1990). James (1994) describes the Lac Joseph Terrane in this area as consisting predominantly of amphibolite- to granulite-facies paragneiss, mafic intrusive rocks and variably deformed granitic rocks of several ages. High-grade metamorphism and deformation resulted from the Labradorian Orogeny (ca. 1660 to 1600 Ma). Unlike the Lac Joseph Terrane, which escaped the most severe metamorphic effects of the Grenvillian Orogeny (ca. 1000 Ma), the Churchill Falls Terrane underwent high-grade metamorphism and deformation during this period.

Areas underlain by three groups of mafic rocks were sampled during this survey. The oldest, and aurally most

restricted is a lower Proterozoic mafic supracrustal gneiss, possibly derived from a mafic volcanic protolith that James (1994) tentatively correlates with the Beaver Gneiss found in the Goose Bay area. The principal group of rocks surveyed belong to the Labradorian-age Ossok Mountain intrusive suite, which consists principally of metamorphosed and deformed gabbro and lesser amounts of norite, gabbro, and olivine gabbro and norite (James, *op. cit.*). The third group of rocks is the circa 1450 Ma Shabogamo Gabbro (Connelly and Heaman, 1993; James, *op. cit.*). In the survey area, rocks of this group occur principally in NTS map areas 23H/5, 6 and 7 and they often show cumulate layering and consist mostly of olivine gabbro, gabbro and minor occurrences of troctolite.

There are 12 sulphide occurrences known in the area (Geological Survey of Newfoundland and Labrador, 2005) including six of pyrite and six of copper ± nickel. The Wynne showing in NTS map area 23A/14 is the most noteworthy, and in addition to copper includes associated nickel, cobalt, chromium and silver. It is hosted by an ultramafic unit of the Ossok Mountain intrusive suite.

SURFICIAL GEOLOGY

The most recent surficial mapping in the area is contained in two publications. All of the area is covered at 1:1 000 000 scale (Klassen *et al.*, 1992) and most of the area is mapped at 1:250 000 scale (Klassen and Paradis, 1990). The 1992 map shows most of the area classified as “till” consisting predominately of poorly sorted diamict. Lesser areas of ribbed moraine and esker deposits complete most of the remaining surficial coverage. One consistent direction of glacial flow is apparent from northwest to southeast as expressed in striae, esker development and other flow indicators. The more detailed mapping indicates that most of the till is 1 to 5 m thick, and that there are numerous areas of till veneer that are less than 1 m in thickness. The 1:250 000 scale mapping also outlines areas of organic deposits not shown on the more generalized map.

SAMPLE COLLECTION

Samples of organic lake sediment and lake water were collected from 509 sites. Approximately one site in 20 was sampled in duplicate. These samples were collected about 50 m apart. Generally, smaller lakes were sampled in this survey than was the case for the reconnaissance survey, in which the objective had been to obtain a more regional geochemical perspective. Normally, the centre of the lake (or if apparent from the air, the central basal portion of the lake) was sampled. On some deep lakes (>25 m), no sample was retrieved in lake centres and a sample from a shallower site closer to shore was obtained. The collection procedure

involves landing a float-equipped, 206-B Jet Ranger helicopter on the lake surface and dropping a weighted tubular sampler fitted with a nylon rope for retrieval. A butterfly valve in the bottom of the tube opens upon impact with the sediment and closes upon retrieval, trapping the contained sediment. Samples are stored in water-resistant Kraft paper bags. Markings on the rope permit determination of the sample depth. Other observations made during sampling include GPS coordinates of the site, the nature of vegetation surrounding the lake, sediment colour, texture and composition and water colour.

Samples of lake water were collected before the sediment sampler was dropped to avoid water contamination. Samples were collected in purified, 125 mL Nalgene bottles. These were filled by immersing the bottles about 40 cm below the lake surface. Prior to sampling, the bottles were acid leached in the laboratory, and washed with distilled and deionized water. Sampling of a typical site took about one minute between touchdown and takeoff.

ANALYSES

Lake sediment was analyzed using five methods for 48 unique elements plus loss-on-ignition. In addition, 13 of these elements were analyzed using a second method for a total of 60 separate determinations. The methods of analyses are tabulated in Table 1. Elements that are analyzed using two methods, one of which gives preferable results for reasons of improved detection limit or precision, are distinguished by an asterisk. All analyses except FA-ICP-MS and INAA were performed in the geochemical laboratory of the Department of Natural Resources. The FA-ICP-MS analyses and the INAA analyses were performed by ActLabs. 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 most tables and figures. The key to the suffixes to each element is as follows:

1. Neutron activation analysis (INAA); 2. ICP-ES after HF-HClO₄-HCl digestion; 6. Silver by AA after HNO₃ digestion; 9. Fluoride-ion selective electrode; and 27. ICP-MS analysis after fire assay fluxing, fusing and digestion in HNO₃-HCl.

In the foregoing, "ICP-ES" refers to inductively coupled plasma-emission spectrometry, "AA" is atomic absorption spectrometry and "ICP-MS" is inductively coupled plasma mass spectrometry. Thus, Zn2 is zinc analyzed by ICP-ES/HF-HClO₄-HCl, whereas Zn1 is zinc analyzed by INAA.

Lake water was analyzed for conductivity, pH, SO₄ and 25 elements using the methods noted in Table 2.

DATA QUALITY

To ensure the reliability of the analytical data, three means of determining data accuracy and precision were employed. During sample collection, pairs of site duplicates for sediment and water samples were obtained from 11 lakes to give an appreciation of within-lake data variation. The duplicate samples were taken about 50 m apart. At the analytical stage, a standard of known composition was inserted within every batch of 20 samples and a sample split, or laboratory duplicate, was similarly included. For sediment, international reference standards composed of lake-sediment material were used, notably LKSD-1, LKSD-2, LKSD-3 and LKSD-4. For water, standards used were both naturally occurring water and synthetic standards created in the laboratory to predetermined compositions. The results of these standards were monitored and found to be satisfactory for most elements. No previous analyses of PGE are available for these standards.

Site duplicates are useful because they give an appreciation of overall data variance occurring at both the sampling and analytical stages. Since they consist of samples from the survey itself, they may reveal limitations in the data that are specific to the area and which may not show up in the reference standards. Scatter plots of 48 variables for sediment analyses along with the Spearman correlation coefficient (r^2) are shown in Figures 2a and b; the higher the value, the better the correlation. A comparison of coefficients for the same element by different methods is a useful way to select the more reliable method. For example, Cr1 gives a better correlation than Cr2. On the other hand, ICP is better for Ca, Mo and Co. Some plots, e.g., Au1, appear to have fewer than 11 points. This is because several points are coincident, being less than the detection limit. One "flyer" was omitted from the plots of Au27, Pd27 and Pt27. Despite the very low absolute quantities of these elements, the correlations are quite strong suggesting the sampling is representative.

Scatter plots of selected data from site duplicates in water are shown in Figure 3. In general, the correlations are stronger between water duplicates than between sediment duplicates. This is not surprising, in as much as water is a more homogeneous medium than sediment and, unlike sediment, it is not prone to compositional modifications within a lake due to variations in depth, LOI, Fe/Mn oxide scavenging and bottom currents. Most elements have very strong correlations (>0.9) with some others being less satisfactory, but still useful (e.g., Ni, 0.36). Analyses of Mo, Pb and Ti appear to be of limited use in this area particularly for values near the detection limits.

Table 1. Analytical methods for lake-sediment samples

ELEMENTS	METHOD	DIGESTION/ PREPARATION
Pd, Pt, Au	Fire Assay-Inductively Coupled Plasma Emission-Mass Spectrometry (FA-ICP-MS)	5 g fluxed and fused; HNO ₃ -HCl digestion
(Ag), As, Au, Ba, Br, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Mo, Na, (Ni), Nd, (Rb), Sb, Sc, Sm, (Sr), Ta, Tb, Th, U, W, Yb, (Zn), (Zr)	Neutron Activation Analysis (INAA)	5 to 10 g in shrink-wrapped vial. (total analysis)
Al, (As), Ba, Be, Ca, Cd, Ce, Co, Cr, Cu, Dy, Fe, Ga, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni*, Pb, Rb*, Sc, Sr*, Ti, V, Y, Zn*, Zr*	Inductively Coupled Plasma-Emission Spectrometry (ICP-ES) ¹	HF-HClO ₄ -HCl (total digestion)
Ag*	Atomic Absorption Spectrometry (AA) ²	HNO ₃
F	Fluoride-ion specific electrode with digital ion analyser ²	2:1 Na ₂ CO ₃ :KNO ₃ flux, fusion
Loss-on-ignition (LOI)	Gravimetric using muffle furnace raised to 500°C	

* Indicates preferred method of analysis; () indicates less favoured method of analysis; use alternative.

¹ Finch, 1998; ² Wagenbauer et al., 1983.

Table 2. Analytical methods for lake-water samples

ANALYSIS	METHOD	PREPARATION
pH	Corning combination pH electrode	None
Conductivity	Corning conductivity sensor	None
Ca, Fe, K, Mg, Mn, Na, Si, SO ₄	ICP-emission spectroscopy ¹	Filtration (0.45 m) and HNO ₃ acidification
Al, Ba, Be, Co, Cr, Cu, Li, Mo, Ni, P, Pb, Sr, Ti, V, Y, Zn	ICP-ultrasonic nebulizer ¹	Filtration (0.45 m) and HNO ₃ acidification
As	ICP-ultrasonic nebulizer ¹	Filtration (0.45 m) and HNO ₃ acidification; H-H ₂ O ₂
F	Fluoride-ion specific electrode with digital ion analyser	

¹ Finch, 1998

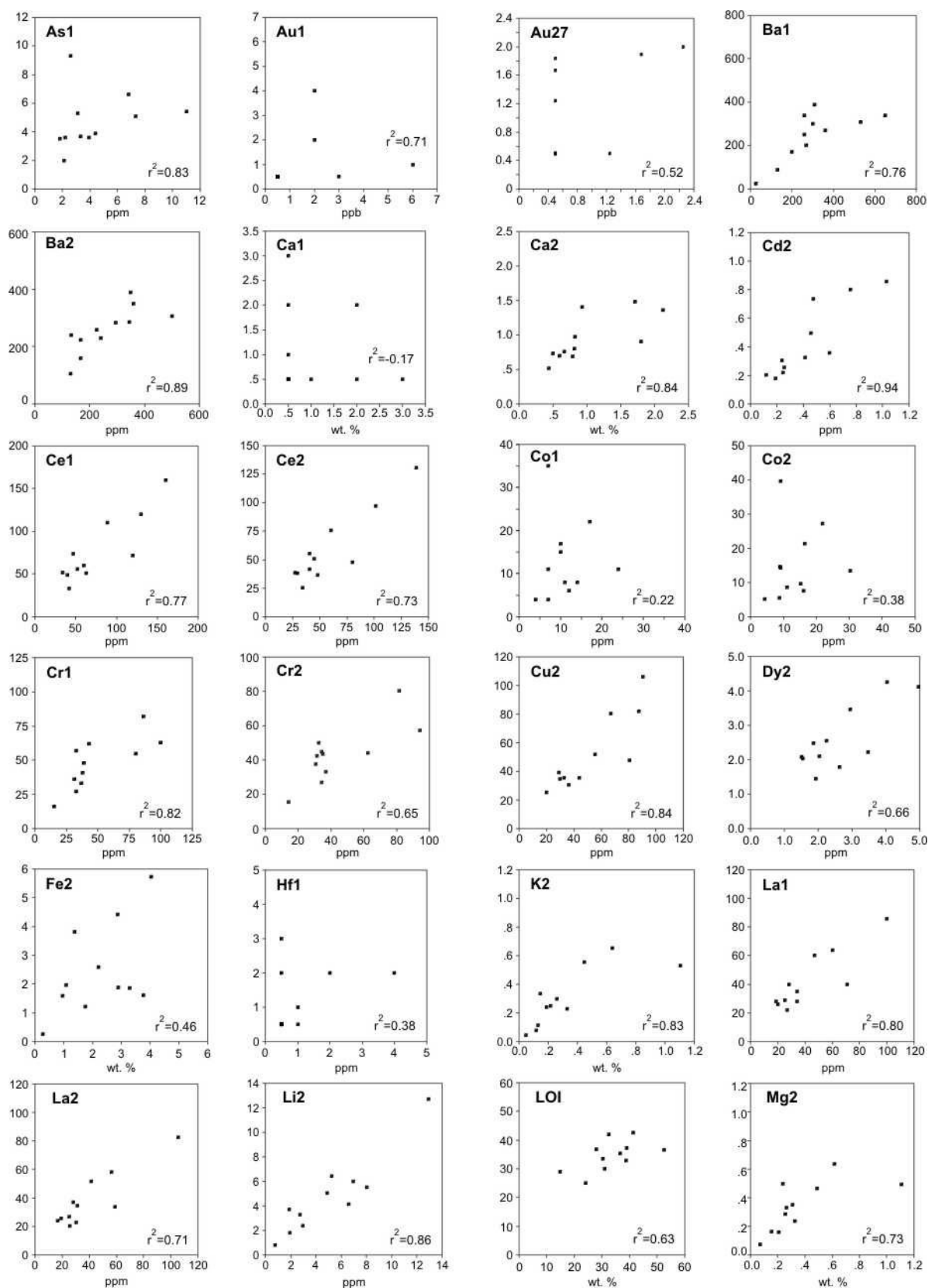


Figure 2a. Scatter plots of As1, Au1, Au27, Ba1, Ba2, Ca1, Ca2, Cd2, Ce1, Ce2, Co1, Co2, Cr1, Cr2, Cu2, Dy2, Fe2, Hf1, K2, La1, La2, Li2, LOI and Mg2 in site duplicates of lake sediment.

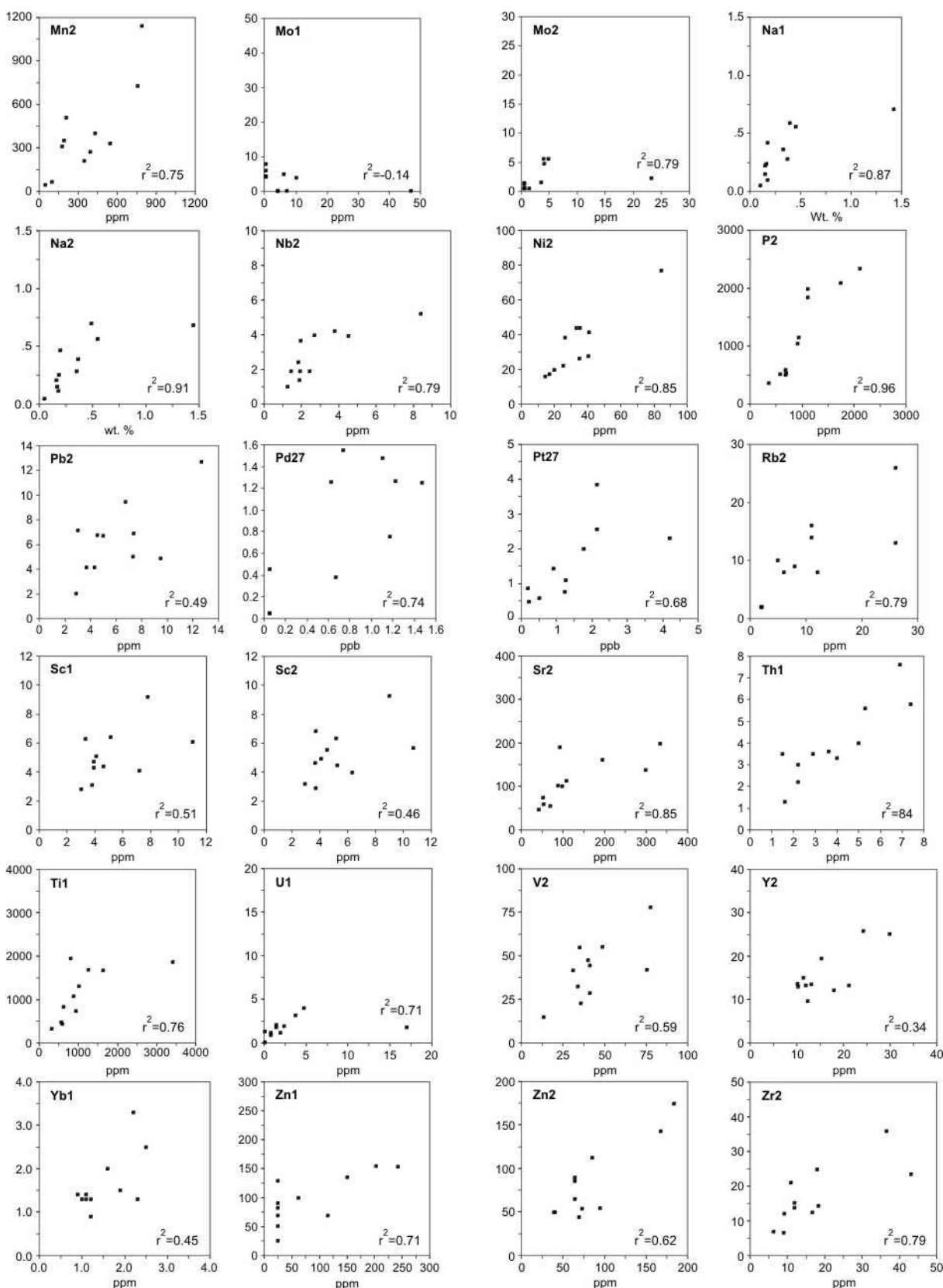


Figure 2b. Scatter plots of Mn2, Mo1, Mo2, Na1, Na2, Nb2, Ni2, P2, Pb2, Pd27, Pt27, Rb2, Sc1, Sc2, Sr2, Th1, Ti1, U1, V2, Y2, Yb1, Zn1, Zn2 and Zr2 in site duplicates of lake sediment.

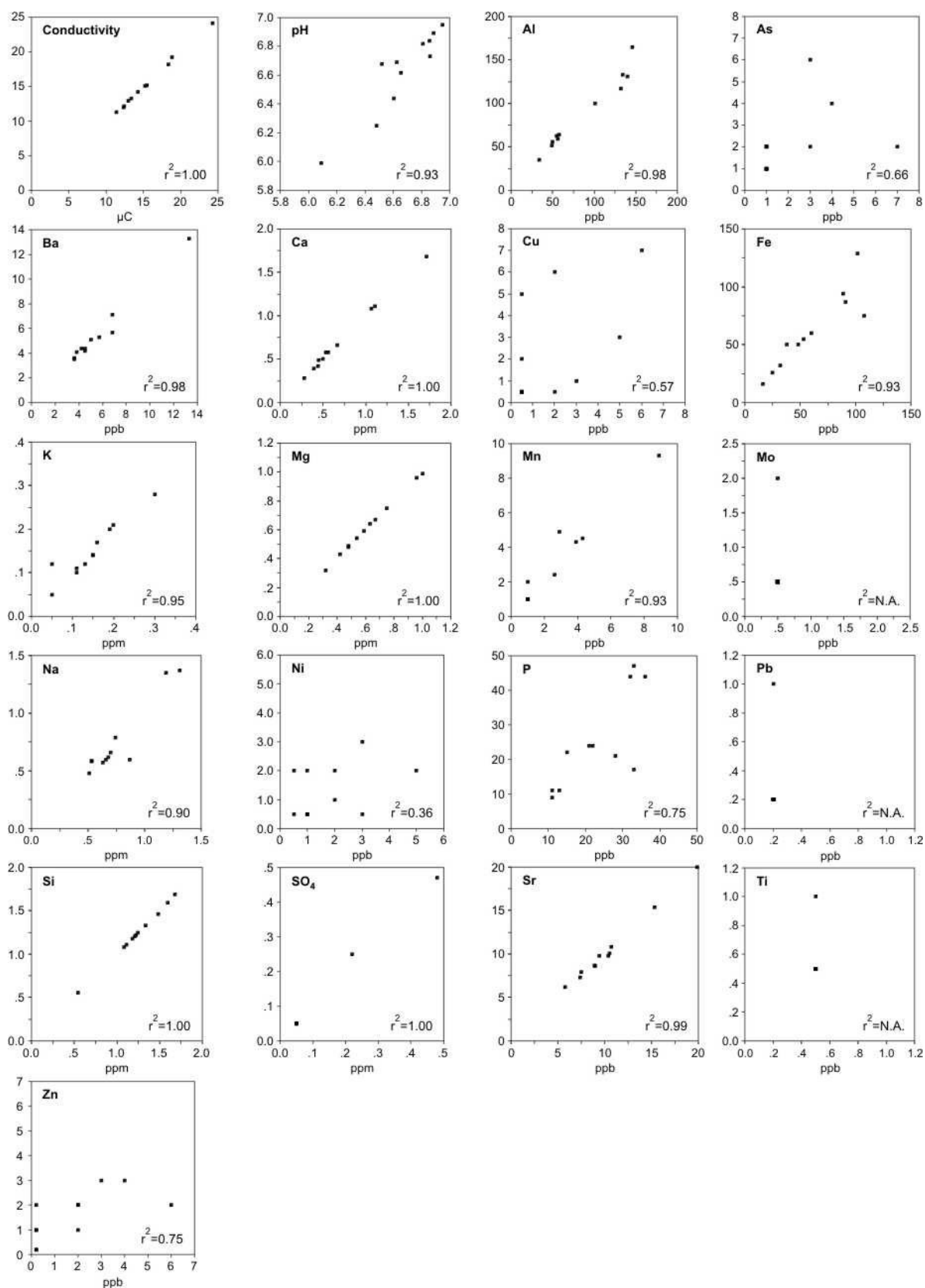


Figure 3. Scatter plots of conductivity, pH, Al, As, Ba, Ca, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Si, SO₄, Sr, Ti and Zn in site duplicates of lake water.

Table 3. Summary statistics for selected lake-sediment analytical data. Element values in ppm unless otherwise indicated (N=506; for Au27, Pd27 and Pt27, N=505) (Key to suffix for each element, see section on Analyses.)

Element	Median	Mean Arithmetic	Mean Geometric	Standard Deviation Arithmetic	Standard Deviation Logarithmic	Minimum	Maximum
Ag6	0.1	0.2	0.1	0.20	0.36	<0.1	2.1
As1	3.9	4.7	3.7	3.57	0.33	<0.5	37
As2	<2	1.6	1.3	2.2	0.24	<2	31
Au1, ppb	<1	1.5	0.9	1.7	0.39	<1	10
Au27, ppb	<1	1.5	.9	2.4	0.34	<1	34.6
Ca2, wt. %	0.87	0.97	0.89	0.43	0.18	0.32	2.84
Cd2	0.3	0.4	0.3	0.18	0.21	<0.2	1.4
Co1	9	11	9	9	0.26	1	99
Co2	10	13	10	11	0.26	2	140
Cr1	40	46	40	26	0.24	<10	300
Cr2	38	43	39	20	0.21	12	117
Cu2	41	45	38	26	0.26	4	180
Fe1, wt.%	1.66	2.3	1.7	2.08	0.33	0.2	25.9
Fe2, wt.%	1.53	2.19	1.58	2.05	0.35	0.14	24.42
LOI, wt.%	34.6	34.1	31.0	11.60	0.23	1.89	70.51
Mg2, wt.%	0.30	0.39	0.31	0.29	0.30	0.06	1.59
Mn2	230	488	256	1687	0.41	32	33235
Mo1	<1	2.9	0.8	4.10	0.73	<0.5	29
Mo2	1	2.1	1.5	2.1	0.34	0.5	20.9
Ni2	25	28	26	12	0.16	8	107
Pb2	6	7	6	4	0.26	1	35
Pd27, ppb	0.5	0.9	0.4	1.87	0.55	<0.2	34.9
Pt27, ppb	1.2	1.5	1.1	1.58	0.39	0.1	22.5
Sb1	<0.1	0.1	0.1	0.19	0.57	<0.1	2.2
Ti2	1076	1467	1103	1198	0.33	196	7527
U1	1.8	2.5	1.5	4.29	0.51	0.1	87
Zn2	67	74	68	34	0.18	19	242
Lake area (km2)	0.09	0.25	0.10	0.72	0.51	0.01	10.9
Lake depth (m)	3.0	4.1	3.0	3.3	0.35	1	26

DESCRIPTION AND DISCUSSION OF RESULTS

STATISTICAL ANALYSIS

Summary Statistics

To quantify the range and distribution characteristics of the element populations, summary statistics have been calculated for a selection of sediment and water data. They are tabulated in Tables 3 and 4. The geometric means as well as arithmetic means are given because the distributions of most element populations are more nearly log-normal than normal.

Histograms

Histograms of Au1, Au27, Cr1, Cu2, Fe2, La2, Mg2, Ni2, Pd27, Pt27, Zn2, depth and loss-on-ignition in lake sediment are shown in Figure 4. Histograms of the lake-water variables pH, conductivity, Ca, Co, Cr, Cu, Fe, Mg, Ni, Si, SO₄ and Zn are shown in Figure 5. These figures may be useful to gain a sense of the nature and character of the various distributions. Note that the X-axis of all plots except LOI and pH have geometric scales to reflect the approximately log-normal distributions. The measurement units of pH are by definition log values.

Table 4. Summary statistics of lake-water data; element values in ppb unless otherwise noted (N=509)

Element	Detection Limit	Percentage of samples <D.L.	Median	Mean Arithmetic	Mean Geometric	Standard Deviation Arithmetic	Standard Deviation Logarithmic	Minimum	Maximum
Al	N.A.	0	75	84	69	47.0	0.31	1	295
Ba	N.A.	0	4.9	5.9	5	4.10	0.19	1.9	40.1
Be	0.1	96.9	<0.1	0.1	0.1	0.02	0.08	0.1	0.2
Ca	N.A.	0	0.80	0.89	0.72	0.56	0.30	0.04	4.63
Co	1	99.0	<1	<1	1	0.10	0.04	0.5	2
Cr	1	96.2	<1	<1	1	0.22	0.09	0.5	3
Cu	1	53.7	<1	2	1	1.92	0.42	0.5	10
Fe	10	1.5	46	77	49	113	0.38	5	1415
K, ppm	0.10	13.4	0.17	0.2	0.2	0.07	0.23	0.05	0.48
Li	1	99.2	<1	<1	1	0.22	0.06	0.5	4
Mg, ppm	N.A.	0	0.64	0.68	0.64	0.27	0.17	0.13	1.98
Mn	2	56.4	<2	2.3	1.7	2.31	0.30	1	26
Mo	1	95.6	<1	<1	1	0.27	0.11	0.5	2
Na, ppm	N.A.	0	0.69	0.75	0.72	0.22	0.12	0.37	1.64
Ni	1	38.2	<1	1.6	1.1	2.30	0.34	0.5	43
P	N.A.	0	22	23.9	21	12.5	0.23	2	93
Pb	1	96.2	<1	<1	0.2	0.92	0.21	0.2	17
Si, ppm	0.1	1.7	1.3	1.3	1.1	0.56	0.27	0.10	3.18
SO4, ppm	0.1	62.4	<0.1	0.1	0.1	0.08	0.27	0.05	0.48
Sr	N.A.	0	10.6	10.9	10.3	3.68	0.15	2.8	26.7
Ti	1	87.7	<1	<1	0.6	0.29	0.13	0.5	3
Y	1	100	<1	<1	0.2	0.00	0.00	0.2	0.2
Zn	1	30.5	2	2.7	1.4	3.26	0.59	0.2	34
Conductivity	N.A.	0	16.32	16.9	16.2	4.96	0.12	6.18	46.9
μS					1				
pH	N.A.	0	6.75		6.71	**	0.26	5.79	7.47

** pH is defined as a logarithmic value.

Correlation Analysis of Sediment Data

A matrix, in which Spearman correlation coefficients of some elements and variables that may be associated with PGE mineralization are listed against a large selection of variables analysed in lake sediments, is shown in Table 5. Some interesting correlations are seen. Pd27 only has moderate correlations with a few variables including Au27, (but not Au1), Cu2, Pt27 and depth. Pt27 shows a stronger correlation with Au27 but also not with Au1. The presence of Fe/Mn hydroxide scavenging is strongly suggested by the large coefficients these two elements have with several others. Fe has coefficients of >0.70 with Co, F9, Lu1, Mg2, Nb2, Yb1, Zn2 and Zr2. The coefficient between Fe and Mn is 0.90, the highest in the table between different elements. Loss-on-ignition has several strong, negative correlations (<-0.60) with mostly lithophile elements including; F9, Hf1, K2, Mg2, Nb2, Rb2 and Zr2. Depth shows moderate corre-

lations (>0.30) with some elements including Br1, Co, Cu2, Ni2, P2, Pd27, and Zn2.

All elements and variables that correlate significantly (>99% confidence level) with Pd27 and Pt27 are shown in order of increasing coefficient in Figures 6 and 7. Interestingly, most significant correlations with Pd27 are positive whereas most significant correlations with Pt27 are negative and with lithophile elements.

Correlation Analysis of Water Data

Spearman correlation coefficients were calculated for those analyses for which more than 35 percent of the samples exceeded the detection limit. They are shown in Table 6. Noteworthy correlations include some with Mg such as Ca (0.79) and pH (0.65). Together these suggest that in this mafic terrane, Mg analyses of water may reflect magmatic

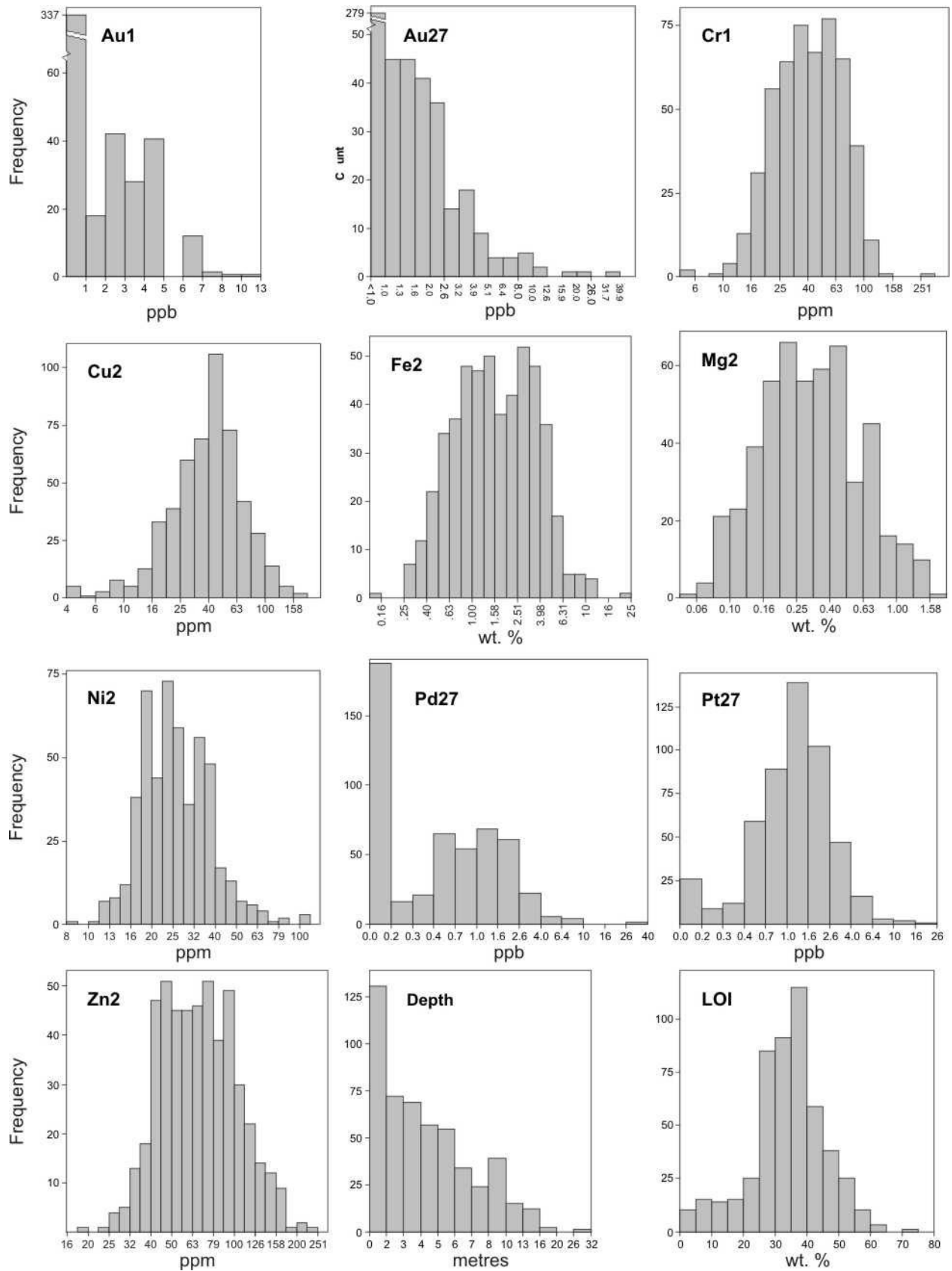


Figure 4. Histograms of Au1, Au27, Cr1, Cu2, Fe2, Mg2, Ni2, Pd27, Pt27, Zn2, depth and LOI in lake sediment (N=506).

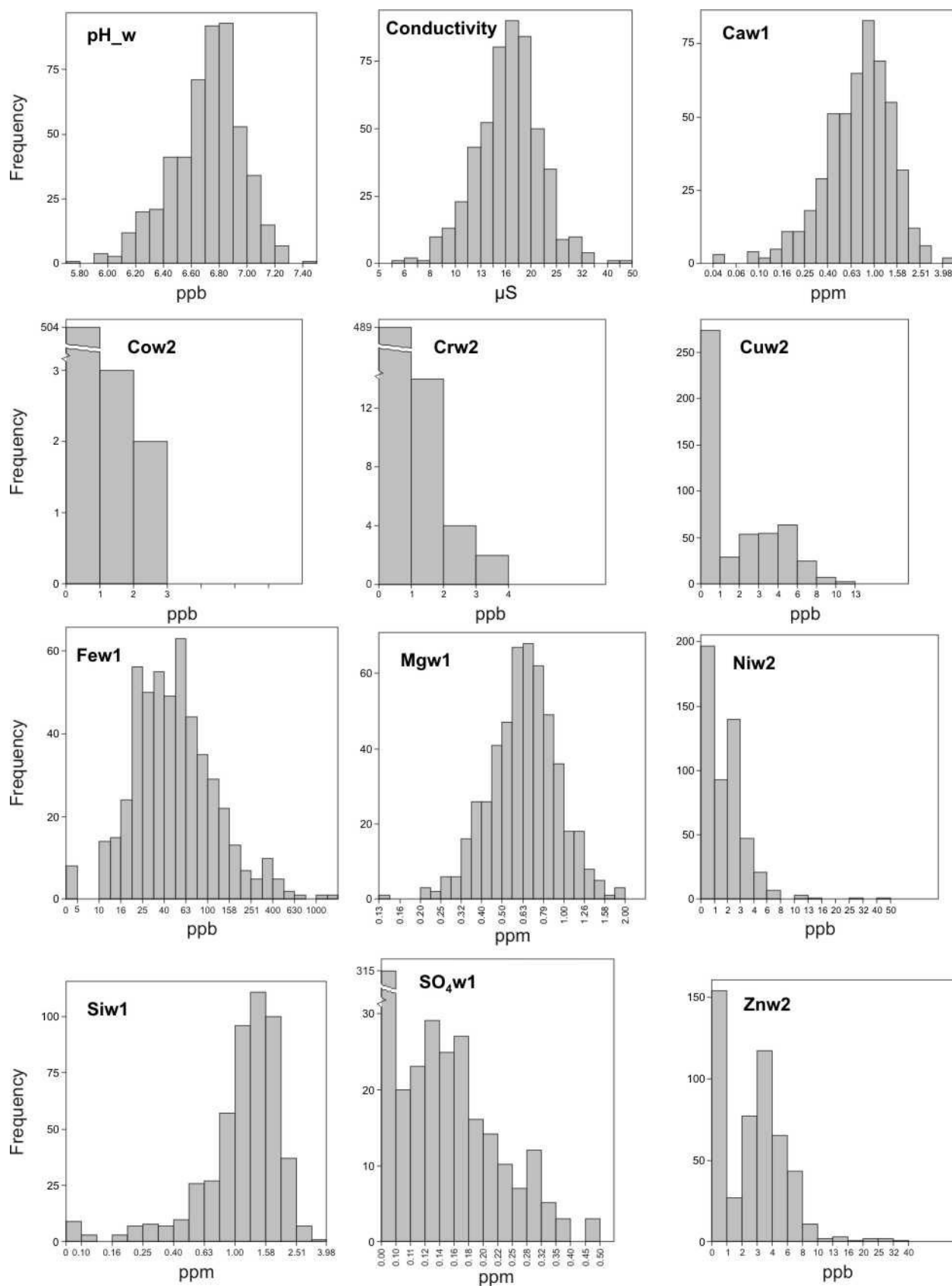


Figure 5. Histograms of pH, conductivity, Ca, Co, Cr, Cu, Fe, Mg, Ni, Si, SO₄ and ZN in lake water (N=509).

Table 5. Spearman correlation coefficients for selected elements and variables in lake-sediment data (N=505). Coefficients $>|0.12|$ are significant at the 99% confidence level (Key to suffix for each element see section on Analyses.)

	Pd27	Pt27	Au1	Au27	Co2	Cr1	Cu2	Fe2	Ni2	LOI	Depth
As1	0.18	-0.02	0.04	-0.06	0.17	0.18	0.05	0.21	0.14	-0.04	0.10
As2	0.16	0.07	-0.03	0.08	0.37	0.36	0.05	0.40	0.29	-0.16	0.23
Au1	0.00	-0.08	1.00	-0.12	-0.03	0.13	-0.04	-0.05	-0.00	0.07	0.04
Au27	0.37	0.47	-0.12	1.00	-0.03	-0.06	0.10	-0.06	0.03	0.13	0.12
Br1	0.27	0.10	0.09	0.07	0.04	-0.06	0.50	-0.03	0.12	0.50	0.58
Ca2	0.15	0.06	-0.06	-0.01	0.66	0.72	-0.01	0.67	0.47	-0.41	0.16
Cd2	0.23	0.09	0.07	0.02	0.37	0.20	0.46	0.22	0.40	0.26	0.34
Ce1	0.01	-0.17	0.01	0.01	0.51	0.48	0.25	0.54	0.43	-0.16	0.27
Ce2	-0.02	-0.20	0.02	-0.01	0.51	0.46	0.20	0.55	0.40	-0.18	0.24
Co1	0.18	0.11	-0.03	0.02	0.96	0.72	0.16	0.79	0.61	-0.30	0.35
Co2	0.15	0.05	-0.03	-0.03	1.00	0.73	0.11	0.83	0.61	-0.34	0.31
Cu2	0.33	0.23	0.13	0.10	0.11	0.05	1.00	-0.06	0.39	0.36	0.53
Dy2	0.01	-0.18	0.01	-0.01	0.55	0.55	0.19	0.59	0.49	-0.22	0.21
F9	-0.02	-0.13	-0.06	-0.08	0.67	0.81	-0.06	0.73	0.54	-0.62	0.13
Hf1	-0.08	-0.12	-0.09	-0.08	0.56	0.72	-0.29	0.65	0.34	-0.65	-0.00
K2	-0.07	-0.13	-0.06	-0.11	0.60	0.81	-0.17	0.70	0.45	-0.71	0.04
La1	0.00	-0.20	0.03	-0.00	0.45	0.43	0.24	0.50	0.43	-0.12	0.23
La2	-0.03	-0.23	0.03	-0.01	0.41	0.39	0.22	0.46	0.39	-0.10	0.19
Li2	-0.06	-0.13	-0.05	-0.09	0.57	0.77	-0.03	0.63	0.56	-0.63	0.08
LOI	0.19	0.16	0.07	0.13	-0.34	-0.50	0.36	-0.46	-0.09	1.00	0.09
Lu1	0.05	-0.16	0.03	-0.04	0.64	0.66	0.04	0.71	0.46	-0.33	0.21
Mg2	-0.02	-0.08	-0.06	-0.11	0.66	-0.09	0.86	0.71	0.56	-0.66	0.08
Mn2	0.12	-0.02	-0.03	-0.05	0.85	-0.02	0.80	0.90	0.50	-0.51	0.30
Mo2	0.16	-0.09	-0.02	-0.07	0.41	0.31	0.10	0.46	0.29	-0.04	0.30
Nb2	-0.01	-0.13	-0.06	-0.07	0.70	0.81	-0.15	0.81	0.44	-0.64	0.13
Nd1	0.02	-0.13	0.01	0.05	0.43	0.39	0.33	0.43	0.42	-0.06	0.25
Ni2	0.18	0.10	-0.00	0.03	0.61	0.64	0.39	0.48	1.00	-0.09	0.31
P2	0.32	0.15	0.02	0.06	0.58	0.57	0.45	0.54	0.43	-0.14	0.73
Pb2	-0.05	-0.13	-0.05	-0.10	0.59	0.67	-0.14	0.68	0.41	-0.52	-0.05
Pd27	1.00	0.48	0.00	0.37	0.15	0.13	0.33	0.07	0.18	0.19	0.36
Pt27	0.48	1.00	-0.08	0.47	0.05	-0.06	0.23	-0.07	0.10	0.16	0.21
Rb2	-0.15	-0.21	-0.08	-0.16	0.55	0.75	-0.17	0.64	0.42	-0.64	0.07
Sm1	0.03	-0.16	0.02	0.01	0.49	0.50	0.30	0.51	0.50	-0.13	0.26
Th1	-0.11	-0.28	0.02	-0.04	0.48	0.59	-0.03	0.59	0.42	-0.41	0.09
Y2	0.06	-0.17	0.01	-0.05	0.62	0.62	0.14	0.68	0.51	-0.25	0.22
Yb1	0.07	-0.16	-0.00	-0.01	0.65	0.68	0.02	0.72	0.47	-0.36	0.18
Zn2	0.13	0.00	0.00	-0.01	0.80	0.29	0.68	0.72	0.71	-0.21	0.35
Zr2	-0.07	-0.17	-0.06	-0.10	0.62	0.79	-0.20	0.73	0.49	-0.65	0.02
Depth	0.36	0.21	0.04	0.12	0.31	0.31	0.53	0.26	0.31	0.09	1.00

differentiation of the bedrock in the catchment basins. If so, Mg (and Ca and pH) analyses may provide a guide to areas of more mafic bedrock. Nickel's strongest correlation in the water data is with Mg (0.20) as well, also suggesting a differentiation trend. Another interesting correlation is that of Cu and Zn (0.48), the highest coefficient for both of these elements.

ELEMENT DISTRIBUTION IN LAKE SEDIMENT

Symbol plots of the distribution of the possible ore metals Au, Cu, Ni, Pd, and Pt are shown in Figures 8 to 12. Data were classified using natural breaks (Jenks's Optimization) to depict naturally occurring divisions in the data in the hope of reflecting geochemical or mineralogical processes. Sym-

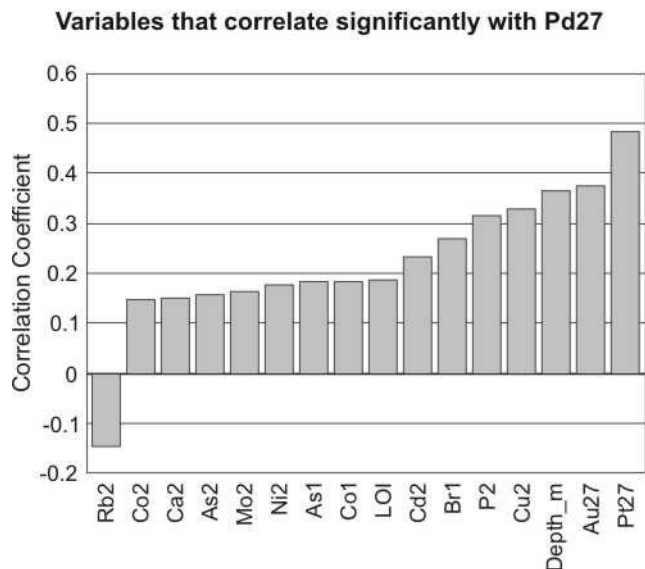


Figure 6. Correlation coefficients of variables that correlate significantly with Pd27.

bol sizes are proportional to class size to emphasize the higher values.

The distributions of the data from the two types of gold analysis show little similarity as suggested by the lack of correlation between the two in Table 5. The distribution of Au27 (Figure 8) shows some clustering—two of the highest samples are spatially associated with other elevated Au27 samples. One of the highest values (19 ppb) is part of a six sample cluster near the Wabush–Churchill Falls highway in NTS map area 23H/07 and is also near an occurrence of base-metal mineralization. A cluster of two samples (35 and 8.6 ppb) located 1.5 km apart is found in NTS map area 23H/02. A nearby sample has high Au1 (7 ppb). The third high sample (22 ppb) is isolated and is found in NTS map area 23H/03 – the nearest sample site to this is 4 km away. The only sample that has high gold in both types of analysis is in the southern part of NTS map area 23H/04. Au1 is 7 ppb and Au27 is 8 ppb.

Most of the highest Cu values (Figure 9) are found in 23H/5 and 23H/6 and some in 23H/8. The area underlain by Ossok Mountain intrusive suite in NTS map areas 23H/1 and 23H/2 is remarkably low in Cu.

The distribution of Ni values (Figure 10) differs notably from that of Cu. The largest cluster of high values is found in NTS map areas 23G/8 and 23H/5 in the area underlain by the Ossok Mountain intrusive suite. The next largest cluster in NTS map area 23A/15, is associated with units of the Beaver Gneiss, which also contains occurrences of sulphide

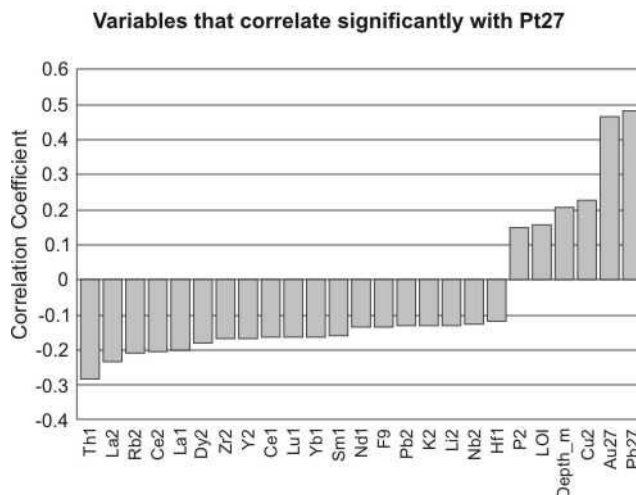


Figure 7. Correlation coefficients of variables that correlate significantly with Pt27.

mineralization. An isolated high Ni value (105 ppm) is in NTS map area 23H/2 and another is located near Cu/Ni mineralization in the Shabogamo Gabbro in NTS map area 23H/7.

The distribution of Pd is shown in Figure 11. The highest value sample (34.9 ppb) is located in NTS map area 23H/07 in a cluster of 4 samples having elevated Pd values and is also only about 4 km away from known base-metal mineralization and is underlain by Shabogamo Gabbro. The high value sample also has very high Pt and Au27. The four samples classified in the next-to-highest category are all located in the large bat-shaped area of the Ossok Mountain intrusive suite in 23H; the southernmost of these samples also has high Pt and Au27.

The distribution of Pt is shown in Figure 12. As with Pd, the most obvious target is the high-Pt sample forming part of a four sample cluster of elevated values in NTS map area 23H/07. Other elevated values are found in samples over the Beaver Gneiss, in the southernmost sample over the bat-shaped area of Ossok Mountain intrusive suite mentioned above and a sample located in NTS map area 23H.

CONCLUSIONS

1. Results from comparing data from site duplicates of lake sediments indicate that analyses of Pd and Pt are reproducible and representative of a given lake.
2. Dispersion of Pt and Pd appears unaffected by Fe/Mn oxide scavenging.

Table 6. Spearman correlations of water analyses having more than 35% of samples above detection limit. (N=509)

	AlW2	AsW2X	BaW2	CaW1	CaW2	FeW1	FeW2	KW1	MgW1	MnW1	NaW1	NiW2	PW2	SiW1	SO ₄ W1	SrW2	VW2	ZnW2	pH_W	Conductivity
AlW2	1.00	-0.23	0.16	-0.23	0.24	0.22	-0.34	-0.12	-0.12	0.27	-0.15	0.07	-0.20	0.20	-0.13	-0.06	0.07	0.19	-0.40	-0.22
AsW2X	-0.23	1.00	0.01	0.09	-0.07	0.25	0.24	-0.02	-0.02	0.07	0.58	0.04	0.26	-0.03	0.21	0.09	0.03	0.01	-0.08	0.05
BaW2	0.16	0.01	1.00	0.59	-0.03	0.07	0.38	0.59	0.59	0.14	0.14	0.17	-0.10	0.27	0.24	0.35	0.00	0.08	0.31	0.58
CaW1	-0.23	0.09	0.59	1.00	-0.13	-0.14	0.63	0.79	0.79	-0.09	0.34	0.10	-0.15	0.42	0.52	0.61	-0.03	-0.05	0.69	0.95
CuW2	0.24	-0.07	-0.03	-0.13	1.00	0.15	-0.10	-0.16	-0.16	0.23	-0.22	0.17	-0.43	-0.09	-0.31	-0.27	0.30	0.48	-0.12	-0.15
FeW1	0.22	0.25	0.07	-0.14	0.15	1.00	-0.03	-0.10	-0.10	0.55	0.28	0.12	0.07	0.01	-0.16	-0.24	0.20	0.04	-0.36	-0.15
KW1	-0.34	0.24	0.38	0.63	-0.10	-0.03	1.00	0.49	0.49	-0.08	0.42	0.08	0.10	0.15	0.27	0.36	0.09	0.08	0.45	0.62
MgW1	-0.12	-0.02	0.59	0.79	-0.16	-0.10	0.49	1.00	1.00	-0.12	0.27	0.20	-0.06	0.37	0.41	0.47	-0.13	-0.14	0.65	0.90
MnW1	0.27	0.07	0.14	-0.09	0.23	0.55	-0.08	-0.12	1.00	0.04	0.04	0.05	-0.15	0.12	-0.16	-0.18	0.21	0.15	-0.25	-0.13
NaW1	-0.15	0.58	0.14	0.34	-0.22	0.28	0.42	0.27	0.27	0.04	1.00	0.15	0.43	0.30	0.54	0.39	-0.01	-0.09	0.15	0.35
NiW2	0.07	0.04	0.17	0.10	0.17	0.12	0.08	0.20	0.20	0.05	0.15	1.00	0.05	0.08	0.05	-0.04	0.06	0.20	0.11	0.16
PW2	-0.20	0.26	-0.10	-0.15	-0.43	0.07	0.10	-0.06	-0.06	-0.15	0.43	0.05	1.00	-0.06	0.26	0.07	-0.22	-0.11	0.02	-0.09
SiW1	0.20	-0.03	0.27	0.42	-0.09	0.01	0.15	0.37	0.37	0.12	0.30	0.08	-0.06	1.00	0.34	0.45	-0.10	-0.13	0.32	0.45
SO ₄ W1	-0.13	0.21	0.24	0.52	-0.31	-0.16	0.27	0.41	-0.16	-0.16	0.54	0.05	0.26	0.34	1.00	0.53	-0.15	-0.18	0.34	0.52
SrW2	-0.06	0.09	0.35	0.61	-0.27	-0.24	0.36	0.47	-0.18	-0.18	0.39	-0.04	0.07	0.45	0.53	1.00	-0.18	-0.17	0.40	0.59
VW2	0.07	0.03	0.00	-0.03	0.30	0.20	0.09	-0.13	0.21	-0.01	-0.01	0.06	-0.22	-0.10	-0.15	-0.18	1.00	0.21	-0.13	-0.09
ZnW2	0.19	0.01	0.08	-0.05	0.48	0.04	0.08	-0.14	0.15	-0.09	-0.09	0.20	-0.11	-0.13	-0.18	-0.17	0.21	1.00	-0.08	-0.08
pH_W	-0.40	-0.08	0.31	0.69	-0.12	-0.36	0.45	0.65	-0.25	-0.25	0.15	0.11	0.02	0.32	0.34	0.40	-0.13	-0.08	1.00	0.73
Conductivity	-0.22	0.05	0.58	0.95	-0.15	-0.15	0.62	0.90	-0.13	0.35	0.35	0.16	-0.09	0.45	0.52	0.59	-0.09	-0.08	0.73	1.00

Correlations > |0.12| are significant at the 99% confidence level.

(Note: following is same table as above with "Conductivity" column included). Spearman correlations of water analyses having more than 35% of samples above detection limit. (N=509)

- The highest Pd27 value sample (34.9 ppb) is located in NTS map area 23H/07 in a cluster of 4 samples that have elevated Pd values and is also about 4 km away from known base-metal mineralization and is underlain by Shabogamo Gabbro. The high value sample also has very high Pt and Au27. The four samples classified in the next-to-highest category are all located in the large bat-shaped area of the Ossok Mountain intrusive suite in NTS map area 23H. The southernmost of these samples also has high Pt and Au27.
- As with Pd, the most obvious Pt target is the 22.5 ppb sample forming part of a four-sample cluster of elevated values in NTS map area 23H/07. Other elevated values are found in samples over the Beaver Gneiss, in the southernmost sample over the bat-shaped area of the Ossok Mountain intrusive suite mentioned above and a sample located in NTS map area 23H/04.
- The distribution of data from the two gold analyses, Au1 and Au27, show little similarity. Several of the high Au27 samples are in clusters and one is near a base-metal occurrence.
- High Ni2 values are found both in clusters and isolated occurrences; one is adjacent to known base-metal mineralization.
- Most of the highest Cu2 values occur in the central area underlain by Ossok Mountain intrusive suite. A single very high sample is found in the northeast part of the survey. None of the highest samples is near known mineralization.
- Water analyses appear to reflect both rock type and possibly mineralization. Conductivity, pH, Ca and Mg seem to be the best indicators of bedrock lithology, whereas Cu and Ni may be useful guides to mineralization.

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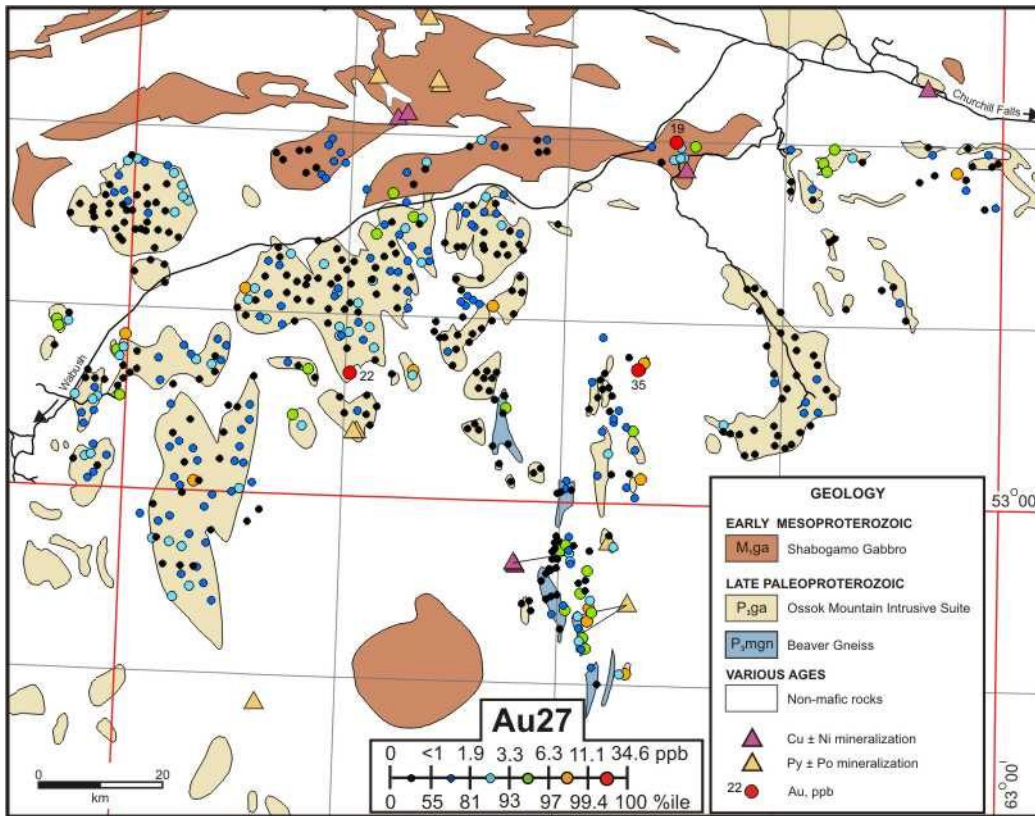


Figure 8. Gold (Au₂₇) in lake sediment.

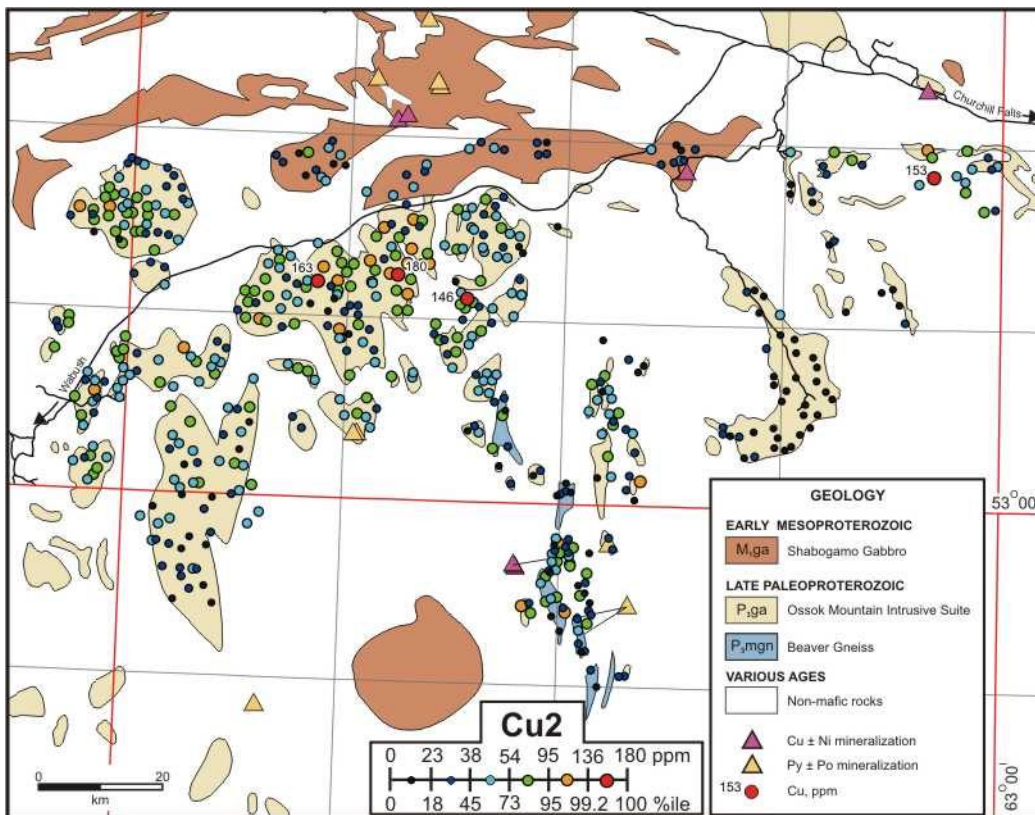


Figure 9. Copper (Cu₂) in lake sediment.

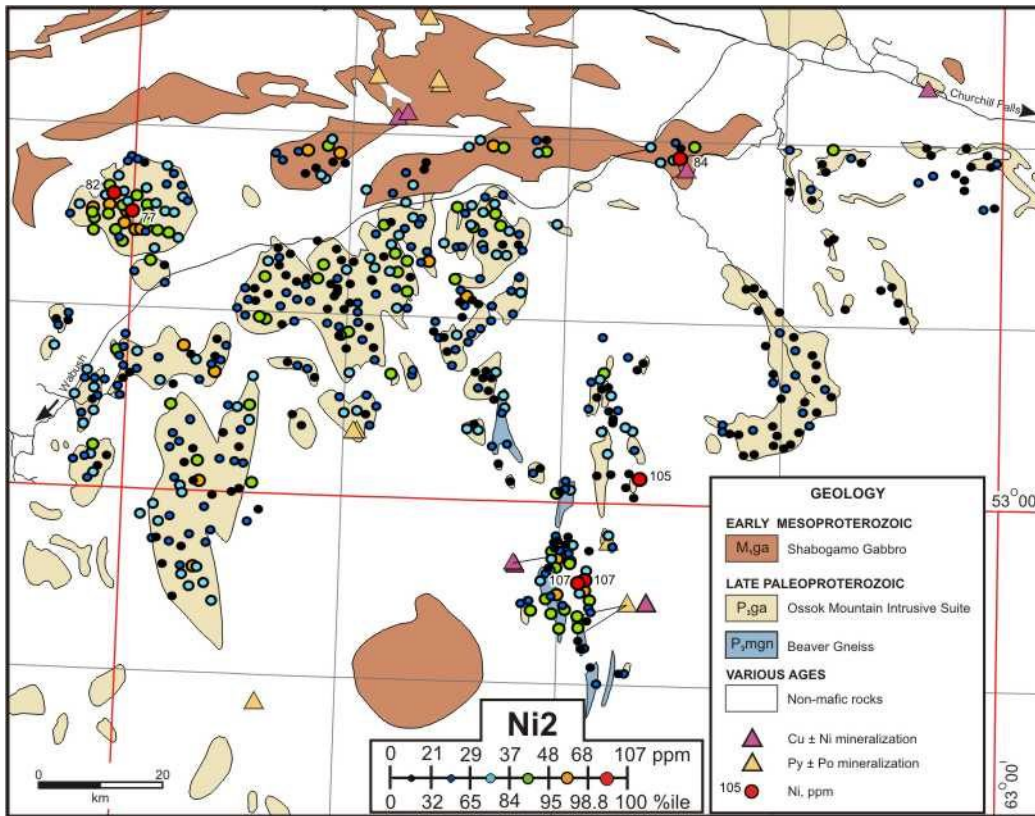


Figure 10. Nickel (Ni₂) in lake sediment.

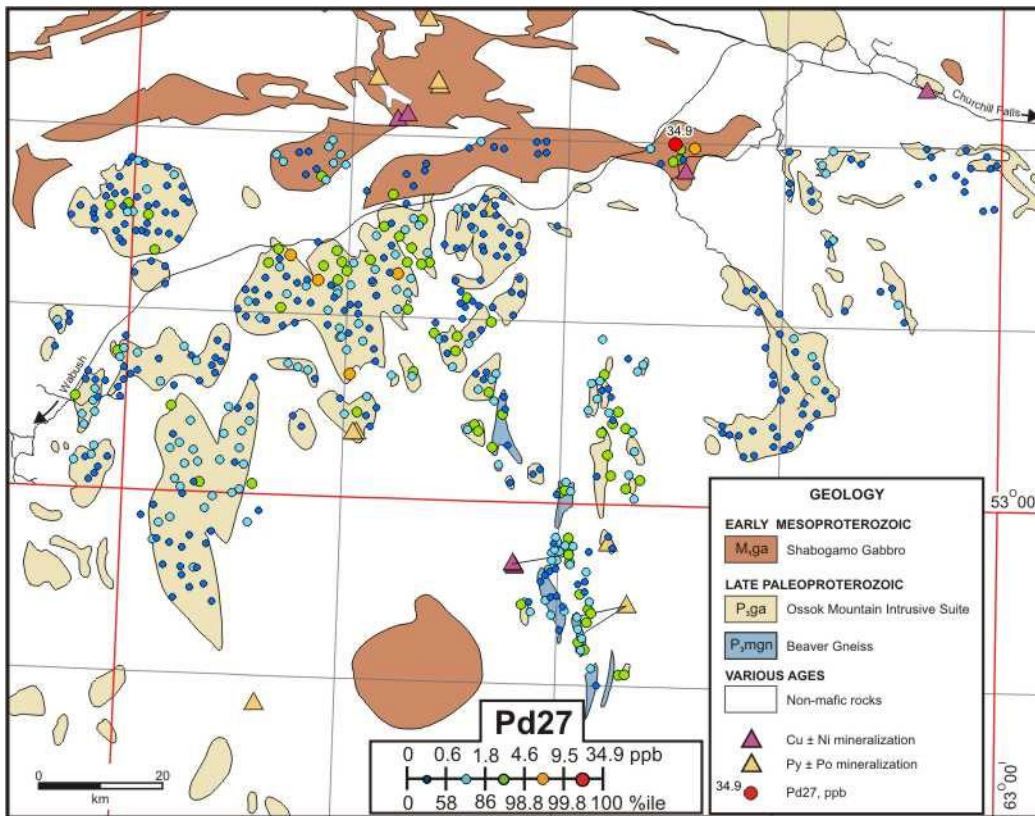


Figure 11. Palladium (Pd₂₇) in lake sediment.

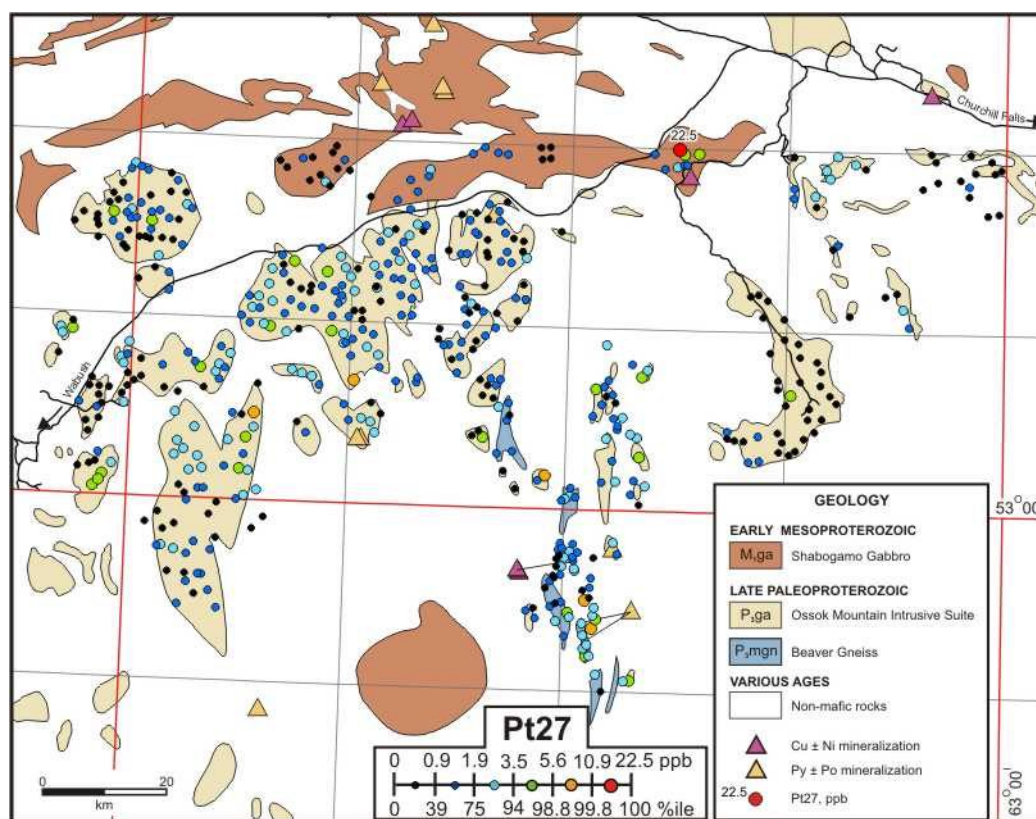


Figure 12. Platinum (Pt27) in lake sediment.

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