LAKE-SEDIMENT AND SOIL SURVEYS FOR PLATINUM-GROUP METALS IN CENTRAL LABRADOR AND THE VOISEY'S BAY AREA

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ABSTRACT

A study was undertaken to determine whether Pd and Pt mineralization in Labrador is reflected in the geochemistry of surficial sample media. Samples of lake sediment and soil were collected during surveys of areas having known, or high potential for, $Ni \pm Cu \pm PGM$ mineralization; these samples were analyzed for Pt and Pd by fire-assay extraction followed by inductively-coupled-plasma-emission-mass-spectrometry. Subsets of lake-sediment samples collected in 1998 in the Wilson Lake and Pants Lake Intrusion (PLI) areas were selected for PGM analysis on the basis of their Ni and Cu chemistry and proximity to known mineralization. B-horizon soil samples collected in 1995 over the Baikie showing, a Ni-PGM prospect in the Florence Lake greenstone belt, and over a part of the Voisey's Bay Ni-Cu-Co deposits were also analyzed for PGM.

The Wilson Lake area, underlain by paragneiss and mafic gneiss, has high values of Ni and Cu in follow-up lake-sediment data and several known sulphide occurrences, and has been little explored. Forty-two samples were selected from this area. The Pants Lake Intrusion area contains the best known analogue of Voisey's Bay style mineralization in Labrador. Nickel-copper-cobalt mineralization is widespread, occurring in the basal portion of the layered, sheet-like, gabbroic Pants Lake Intrusion. Palladium and Pt values up to 794 ppb and 109 ppb, respectively, have been reported from high-grade sulphide intersections. Typically, the PGM values in disseminated mineralization are much lower. The Baikie showing is a small Fe-Ni-Cu sulphide occurrence in a talc-carbonate schist. Grab samples with metal contents as high as 2 percent Ni and 1020 ppb Pd have been reported. Samples from 82 soil sites from a grid around the showing were analyzed for PGM. A total of 45 soil sites were sampled in the Voisey's Bay area of which 27 were analyzed for PGM. Palladium and Pt values up to 824 ppb and 12 ppb respectively were found. The Pd values are surprisingly high in light of the low PGM values reported from the deposits.

Results of the study indicate that PGM levels are detectable and symbol plot maps reveal dispersion patterns that are spatially correlated with known and suspected mineralization. Both lake sediment and soil geochemistry provide useful approaches to exploration for these type of deposits.

INTRODUCTION

Interest in exploration for platinum-group metals (PGM) has increased in recent years. This report describes the results of surficial geochemical surveys for PGM, both in areas of known mineralization and in areas of potential mineralization. Survey results and the methodology described will be of use to explorationists, particularly in Labrador. The lake-sediment surveys were conducted in 1998 primarily for Ni–Cu mineralization. Based on the resulting geochemical data and knowledge of the geology, samples were selected from within two of the areas, the Wilson Lake and Pants Lake Intrusion (PLI) areas, and analyzed for PGM, particularly platinum (Pt) and palladium (Pd). Soil samples were collected in 1995 from a grid across the Baikie Cu–Ni–PGM showing in the Florence Lake area

and from the Voisey's Bay Ni–Cu–Co deposits. In all cases, PGM data show enrichment patterns that are spatially correlated with known or suspected mineralization. The location of the surveys is shown in Figure 1.

PREVIOUS GEOCHEMICAL SURVEYS

Reconnaissance-scale lake sediment and water sampling was undertaken in these areas from 1978 to 1983 by the Geological Survey of Canada in conjunction with the Newfoundland and Labrador Department of Mines and Energy as part of a project of complete regional-scale sampling of Labrador. Samples were collected at an average density of 1 per 13 km² in the survey. The data from these surveys were released as open-file reports that include data listings of about 42 analyses for each sediment sample and



Figure 1. Locations of lake-sediment and soil surveys for *PGM* study.

three analyses for water samples, and descriptions of analytical procedures and 1:250 000 scale maps of sample locations and gold distributions. The Wilson Lake area has anomalous Ni in lake sediment in the 1982 reconnaissance survey (Friske et al., 1993a). The reconnaissance data from the PLI area has several lakes with anomalous Ni (Friske et al., 1993b, c). The area around the Baikie showing has elevated values of Ni and Cu in lake sediment in the regional and detailed surveys (Friske et al., 1993d, e). Detailed lakesediment and lake-water surveys in the Wilson Lake and PLI areas indicate anomalous levels of Ni and Cu (McConnell, 2000) and enriched or anomalous levels of PGM (McConnell, 2002). The Voisey's Bay deposits are anomalous in the regional geochemical lake-sediment surveys both in Ni (five sites) and, to a lesser extent, Cu. No detailed lake surveys have been conducted over the area. Soil sampling in the vicinity of the Baikie showing indicated a prominent, but aerially restricted Ni anomaly (McConnell, 1996) and PGM anomaly (McConnell, 2002).

GEOLOGY AND MINERALIZATION

Bedrock geology in the Wilson Lake and PLI areas is shown on the accompanying geochemical symbol maps. The source of the geological data is the 1:1 000 000-scale digital map of Wardle *et al.* (1997). Bedrock geology in the Voisey's Bay area is also shown on the accompanying geochemical symbol maps and is based on 1:50 000 scale mapping of Ryan and Lee (1995) and Lightfoot and Naldrett (1999).

WILSON LAKE AREA

The area is underlain by rocks of the Grenville Province consisting mostly of 1680 to 1660 Ma metasedimentary and mafic gneiss at amphibolite to granulite facies. Minor granitoid intrusives of the Trans-Labrador batholith and more extensive mafic intrusives (gabbro norite and lesser diorite) are also found. The area has received minor exploration attention and several mineral indications or showings are known in the map area including several with copper and pyrite–pyrrhotite (Davenport *et al.*, 1999).

PANTS LAKE INTRUSION AREA

The survey area is transected by the Nain-Churchill boundary. Most of the area is within the Churchill Province and is underlain predominantly by Paleoproterozoic metasedimentary and granitoid gneisses. These are intruded by the PLI, a Mesoproterozoic layered, sheet-like gabbroic body consisting of three major units. The PLI is not identified in the 1:1 000 000 scale map (Wardle et al., 1997); however, a simplified compilation after Kerr (1999) based on industry mapping at 1:50 000-scale is stamped over the 1:1 000 000 scale mapping. No attempt has been made to adjust the contacts between the two map scales. The area to the east of the Nain-Churchill boundary (east of Sarah Lake) is underlain by Archean tonalitic to granodioritic gneiss that has been intruded by Mesoproterozoic granitoid and anorthosite affiliates of the Nain Plutonic Suite and peralkaline granite of the Flowers River Igneous Suite. Nickel-copper-cobalt sulphide mineralization is confined to the basal portion of the PLI where it is widespread although varying in amount, and metal content and sulphide mineralogy is typically pyrrhotite-chalcopyrite-pentlandite. Kerr (op. cit.) reports that unpublished U-Pb dates make the intrusion contemporaneous with the Voisey's Bay intrusion, host of the Voisey's Bay deposits. Generally, Pd and Pt values are low, even in the mineralized portions of the PLI. Kerr (op. cit.) also reports PGM values from 14 drillhole intersections of disseminated sulphide zones in the PLI (Kerr, 2002); the highest Pd encountered was 96 ppb and the highest Pt was 55 ppb. Combined Ni-Cu values were in the range of 0.5 to 1.0 percent. The highest PGM values reported from the property are 794 ppb Pd and 109 ppb Pt from a highly mineralized intersection (Fitzpatrick et al., 1998).

BAIKIE Ni-Cu-(PGM) SHOWING

Wilton (1996) describes the Baikie showing as being the principal one of three mineralized zones occurring in a raft of talc–carbonate schist of ultramafic protolith in the Archean Florence Lake greenstone belt. The mineralization is exposed in a small (20 m²) outcrop. Sulphide mineralization includes pyrrhotite, pyrite, chalcopyrite and pentlandite (Brace, 1991). Grab samples of this mineralization are reported to contain up to 1020 ppb Pd (Reusch, 1987).

VOISEY'S BAY DEPOSITS

Nickel-copper-cobalt sulphide mineralization at Voisey's Bay is hosted by the troctolitic Voisey's Bay intrusion, part of the Mesoproterozoic Nain Plutonic Suite (Kerr, 2000). INCO estimates there are 128 million tonnes (Mt) of proven and estimated reserves grading 1.6% Ni, 0.85% Cu and 0.16% Co. The four most significant centres of mineralization recognized in the intrusion are, from west to east, the Reid Brook zone (17 Mt), the Discovery Hill zone (13 Mt), the Ovoid zone (32 Mt) and the Eastern Deeps zone (47 Mt). Only the Discovery Hill zone is exposed at surface. The Ovoid zone is concealed beneath surficial material and the Reid Brook and Eastern Deeps zones begin well below the surface. Grades at the Discovery Hill zone (1.0% Ni, 0.8% Cu and 0.09% Co) are somewhat lower than at the other zones. PGM values are reported to be quite low, <0.5 ppm total in massive sulphides (Naldrett et al., 2000). Less significant Ni-Cu-Co mineralization is also known to be associated with the 20-Ma younger troctolitic Mushuau intrusion (Li et al., 2000).

SAMPLE COLLECTION

Samples of organic lake sediment were collected in 1998 during a high-density lake-sediment survey. 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 basinal 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, elevation, the nature of vegetation surrounding the lake, sediment colour, composition and water colour.

At the Baikie showing, B-horizon soil sampling was conducted along lines oriented approximately at right angles to glacial flow to maximize the likelihood of intersecting any dispersion train. The 300- by 450-m sampling grid was designed to completely enclose the known mineralization and to have most sample sites located down-ice from the showing. Soil samples closest to the showing were collected at 12 m intervals along lines spaced 50 m apart; more distance sites were spaced at 25 m intervals along lines spaced 100 m apart. Samples of B-horizon soil were collected from north–south-oriented grid lines over some of the Voisey's Bay deposits in 1995.

SAMPLE PREPARATION AND ANALYSES

Preparation

Lake sediments were partially air-dried in the field prior to shipping to the departmental laboratory for final ovendrying at 40°C. The samples were then disaggregated by mortar and pestle before being screened through a 180 micron stainless-steel sieve. The fine fraction was retained for chemical analyses. To monitor analytical precision, 5 percent of the samples were randomly selected, split and included as blind duplicates in all analytical procedures.

Soil samples were air-dried in the field, then returned to the Survey's geochemical laboratory and oven-dried at 60° C. 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.

Analyses

Lake sediment and soil were analyzed by four methods for 48 unique elements plus loss-on-ignition. In addition, 13 of these elements were analyzed by a second method for a total of 60 separate determinations. Only a few of these are discussed here. Platinum and Pd were analyzed by ActLabs using fire-assay-inductively-coupled-plasma-emissionmass-spectrometry (FA-ICP-MS). Other analyses reported here were done using inductively-coupled-plasma-emission-spectrometry (ICP-ES) in the geochemical laboratory of the Department of Mines and Energy.

DESCRIPTION AND DISCUSSION OF RESULTS

LAKE-SEDIMENT SURVEYS

Summary Statistics

To quantify the range and distribution characteristics of the element populations, summary statistics for a range of ore and associated elements and variables have been calculated for both of the lake-sediment areas (Tables 1 and 2).

Variable	Median	Mean (Arithmetic)	Mean (Geometric)	Standard Deviation (Arithmetic)	Standard Deviation (Logarithmic)	Minimum	Maximum
Co, ppm	11	16	12.93	11	0.28	4	45
Cu, ppm	28	31	26.15	18	0.26	9	69
Fe, wt.%	1.46	2.20	1.69	1.8	0.31	0.56	8.35
LOI, wt.%	34	35	32.29	10	0.20	3.8	48.1
Mg, wt.%	0.32	0.40	0.34	0.2	0.26	0.07	1.40
Mn, ppm	238	793	335.43	1908	0.46	88	11364
Ni, ppm	41	45	38.41	25	0.25	15	109
Pd, ppb	1	1.4	0.88	1.4	0.48	0.1	7
Pt, ppb	< 0.2	0.7	0.32	0.7	0.56	0.1	2.9
Lake Depth (m)	5	7.0	5.55	4.6	0.31	1	20
Lake area (km ²)	0.06	0.11	0.07	0.12	0.42	0.01	0.46

Table 1. Summary statistics for selected lake sediment data from the Wilson Lake area (N=38)

Table 2. Summary statistics for selected lake-sediment data from the PLI area (N=44)

Variable	Median	Mean (Arithmetic)	Mean (Geometric)	Standard Deviation (Arithmetic)	Standard Deviation (Logarithmic)	Minimum	Maximum
Co, ppm	13	21	16	19	0.32	5	110
Cu, ppm	11	17	13	13	0.31	4	70
Fe, wt.%	2.41	3.35	2.64	3.1	0.27	0.85	16.03
LOI, wt.%	22	22	19	9	0.24	3.8	43.2
Mg, wt.%	0.38	0.41	0.36	0.2	0.25	0.10	0.87
Mn, ppm	319	446	307	614	0.33	74	3780
Ni, ppm	22	32	24	31	0.33	7	165
Pd, ppb	< 0.2	1.6	0.2	6.4	0.65	0.1	41.8
Pt, ppb	< 0.2	1.5	0.1	8.5	0.49	0.1	56.2
Lake Depth (m)	4	4.4	3	3.3	0.39	0.5	12
Lake area (km ²)	0.05	0.37	0.07	1.26	0.69	0.01	7.93

Because most element populations are more nearly log-normal than normal, the geometric means as well as arithmetic means are given.

Correlation Analysis

Table 3 lists Spearman correlation coefficients of Pd and Pt with several elements and variables measured in lake sediment. Elements were selected for inclusion on the basis of expected mineralogical or lithologic associations with PGM (i.e., Co, Cu, Mg and Ni) or to look for Fe/Mn oxide scavenging. 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. Iron and manganese (hydr)oxides frequently act as significant scavenging agents for many metals in lake sediments. For some elements, this may be so extreme as to require normalizing, or even outright rejection, of the data involved. 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 considering 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. Lake size, depth and organic content of the sediment as measured by loss-onignition can also influence the chemical composition of the sediment.

Correlations in the Wilson Lake area are surprisingly strong for Pd with several variables particularly Co and Cu, possibly reflecting an ultramafic association. Correlation

	Wilson	Lake* area	PLI** area		
	Pd	Pt	Pd	Pt	
Co	0.80	0.48	-0.05	0.03	
Cu	0.84	0.40	-0.12	-0.03	
Fe	0.72	0.51	0.16	0.06	
Mg	0.50	0.51	-0.16	0.17	
Mn	0.72	0.46	-0.11	0.22	
Ni	0.60	0.27	-0.26	-0.11	
Pd	1.00	0.52	1.00	0.27	
Pt	0.52	1.00	0.27	1.00	
Depth	0.78	0.54	0.17	-0.22	
LOI	0.04	-0.20	0.21	-0.28	

Table 3. Spearman correlation coefficients for Pd and Pt with selected elements and variables in lake sediment in the Wilson Lake area (N=38) and PLI area (N=44)

*Correlations >|0.42| are significant at the 99% confidence level.

**Correlations >|0.40| are significant at the 99% confidence level.

with Ni is only 0.6. Correlations in the PLI area are much weaker. This may be partly explained by the fact that many samples have no detectable PGM values. No variables have significant correlations with Pd or Pt in the PLI area.

Element Distributions

Distributions of Ni, Pt and Pd in lake sediment from the Wilson Lake and PLI areas are shown as symbol plots (Figures 2 and 3). Maps of Ni are included to show the geochemical context of the PGM sites and include most the samples from the 1998 survey.

The intervals used in the symbol maps of sediment were chosen by examining the respective cumulative frequency plots and selecting suitable inflection points. The inflection points separate natural groupings or subpopulations within the overall distribution. For Pd and Pt in the PLI area, too few samples have detectable values to create meaningful cumulative frequency plots, hence intervals were selected more subjectively. The geological base used in figures from both areas is derived from the digital 1:1 000 000 scale map of Wardle *et al.* (1997). The locations of mineralization are from the digital Mineral Occurrence Database (Davenport *et al.*, 1999). The topographic base depicts lakes originally rendered at 1:250 000 scale.

Wilson Lake Area

The distribution of Ni is shown in Figure 2. Most of the higher value samples form a loose cluster within a small area of NTS map area 13E/6 and the western part of NTS map area 13E/7. The area is mapped as being underlain by pelitic, migmatitic and metasedimentary gneiss. A soil survey was conducted over part of the Ni anomaly that further defined the anomaly in both Ni and Mg suggesting the presence of a mafic or ultramafic bedrock (McConnell, 2001). The highest Ni sample (109 ppm) is located about 10 km north of the cluster near two Cu occurrences, and was also analyzed for PGM.

None of the three highest Pt samples has Ni values from the highest Ni grouping, although several sites with elevated Pt and Ni are coincident. In contrast, two of three highest Pd sites also belong to the highest Ni group. One of the highest three Pt values is also coincident with a high Pd sample.

PLI Area

Nickel–copper–cobalt mineralization is widespread in the basal portion of the PLI. The seven most significant occurrences are shown in Figure 3. Note that the most northerly one (Northern Abitibi) is blind mineralization encountered at depth in a grid-drilling program; it has no surface expression. Because of the very sharp break in slope in the Ni cumulative frequency plot at 56 ppm and the observed correlation with known mineralization, it appears likely that all of the highest value Ni symbols (red) are reflecting mineralization. As well, it would appear that many of the orange symbols also reflect mineralization. Thus, it is probable that the two high Ni values (124 and 70 ppm) in NTS map area 13N/5 result from dispersion from unreported mineralization.

Only 11 percent of the samples from this area have detectable Pt, vs 29 percent for Pd. Consequently, the Pt distribution map is geochemically noisy and is only reliable at the high end of the range. The most significant site (56 ppb) is from the narrow part of the PLI where no mineralization is reported. This site also has the highest Pd value (42 ppb) as well as high Ni. Sediment from an adjacent pond has a very high Ni value (124 ppm) but unfortunately there was insufficient sample remaining to analyze for PGM. It is very probable that this area hosts unreported mineralization. The second anomalous Pd sample (10 ppb) is part of a cluster of four sites with elevated Pd values. Although shown as over-





Analysed for PGM

3E/9

Figure 2. Nickel, platinum and palladium in lake sediment, Wilson Lake area.



Figure 3. Nickel, platinum and palladium in lake sediment, PLI area.

Variable	Median	Mean (Arithmetic)	Mean (Geometric)	Standard Deviation (Arithmetic)	Standard Deviation (Logarithmic)	Minimum	Maximum
Co, ppm	11	12	12	4	0.12	7	27
Cu, ppm	20	27	22	22	0.27	7	133
Fe, wt.%	3.63	3.76	3.68	0.8	0.09	2.19	6.09
LOI, wt.%	13	15	13	8	0.25	3.2	3.0
Mn, ppm	460	468	459	112	0.09	285	1179
Ni, ppm	29	38	33	31	0.21	14	261
Pd, ppb	0.4	1.0	0.5	1.7	0.11	0.1	11.9
Pt, ppb	0.3	0.7	0.3	2.2	0.43	0.1	15.7

Table 4. Summary statistics for selected B-horizon soil data from the Baikie showing (N=82)

 Table 5. Summary statistics for selected B-horizon soil data from sites with PGM analyses from the Voisey's Bay deposits (N=27)

Variable	Median	Mean (Arithmetic)	Mean (Geometric)	Standard Deviation (Arithmetic)	Standard Deviation (Logarithmic)	Minimum	Maximum
Co, ppm	9	15	10	26	0.12	6	142
Cu, ppm	9	142	20	281	0.27	2	1098
Fe, wt.%	3.48	5.73	4.45	6.2	0.09	3.09	31.7
LOI, wt.%	6	7	7	3	0.25	2.7	14.7
Mn, ppm	592	645	625	200	0.09	515	1466
Ni, ppm	12	69	23	128	0.21	7	468
Pd, ppb	0.1	37	0.5	159	0.11	0.1	824
Pt, ppb	0.4	0.9	0.4	2.3	0.43	0.1	12.3

lying felsic intrusive rocks, unmapped outcrops of the PLI are known to occur in the area (A. Kerr, personal communication, 2001). Other elevated values (> detection limit) are found in sites overlying, or near, areas mapped as underlain by rocks of the PLI.

SOIL

Summary Statistics

The range and distribution characteristics of selected elements and variables for the B-horizon samples from the Baikie showing are summarized in Table 4. The corresponding summary for the Voisey's Bay samples is given in Table 5. Comparison of the two tables shows that the median value for all the possible ore metals except Pt is lower at Voisey's Bay than at the Baikie showing, likely reflecting the greater proportion of background sites at the Voisey's Bay area. The maximum values of all elements, except Pt, is higher however at Voisey's Bay.

Correlation Analysis

Correlations in the soil databases from both the Baikie and Voisey's Bay grids are very similar and suggest an association of PGM with the base-metal mineralization (Table 6). The non-PGM elements having the strongest correlations with Pd are Cu, Ni and Co in that order at both areas – likely reflecting a lithological–mineralogical association. The correlations with Pt are similar, although weaker.

Table 6. Spearman correlation coefficients for Pd and Ptwith selected elements and variables in B-horizonsoil over the Baikie occurrence (N=82) andVoisey's Bay deposits (N=27)

	2	5 1	· · ·			
	Baikie* Pd Pt		– Vois Pd	ey's Bay** - Pt		
	Tu	11	Iu	11		
Co	0.49	0.41	0.35	0.33		
Cu	0.76	0.49	0.61	0.45		
Fe	0.19	0.11	0.23	0.31		
Mn	0.18	0.24	0.00	0.18		
Ni	0.56	0.50	0.50	0.35		
Pd	1.00	0.65	1.00	0.70		
Pt	0.65	1.00	0.70	1.00		
Depth	0.00	0.02	0.00	0.03		
LOI	0.05	-0.06	0.40	0.17		

* Correlations >|0.30| are significant at the 99% confidence level.

** Correlations >|0.49| are significant at the 99% confidence level.



Figure 4. Nickel, copper, platinum and palladium in soil, Baikie showing, Florence Lake area.

Element Distributions

Baikie Showing

The distributions of Ni, Cu, Pt and Pd in B-horizon soil are shown as symbol plots in Figure 4. The cumulative frequency plot of Ni shows a normal population distribution up to about 28 ppm, above which the distribution is marked by four distinct, and progressively larger, breaks as is shown by the change in symbol colours and size. All of the sites in the highest (red) classification and half of the sites in the next highest classification are in proximity to the known mineralization. A second area of green and orange symbols occurs in the northeast quadrant of the grid and may reflect dispersion from unrecognized mineralization. The distribution of Cu is similar to that of Ni in that most of the high values are close to the Baikie showing. The northeast quadrant, however, is not particularly anomalous. The second highest Cu site (90 ppm) is north of the Baikie showing and perhaps reflects other mineralization. It also has a high Ni value.

The dispersion patterns of Pt and Pd are very similar to each other although the Pd pattern is more discernible because more samples have values above the detection limit. The cumulative frequency plot of Pd shows 2 distinct breaks at 1.9 ppb and 3.1 ppb. Using these breaks to code the symbols results in a pattern of high values in proximity to the Baikie showing similar to that of Ni. Interestingly, the highest values are found in the northeast quadrant and in a site near the 90 ppm Cu value. The highest two sites correspond to the highest Pd sites.

Voisey's Bay Deposits

The distributions of Ni and Cu (Figure 5a) and Pt and Pd (Figure 5b) in B-horizon soil are shown as symbol plots.



Figure 5a. Nickel and copper in soil, Voisey's Bay deposits.



Figure 5b. Platinum and palladium in soil, Voisey's Bay deposits.

The mineralization associated with the Discovery Hill troctolite unit, part of the Voisey's Bay intrusion, is clearly anomalous in the soil data for all four elements. Anomalous dispersion is widespread for several hundred metres beyond the deposit both to the north and south but particularly to the south. This is probably due to downslope movement of till, likely following glaciation and before the till was stabilized by vegetation. This dispersion may have involved both particulate and dissolved phases of material. The two southernmost sites on the Discovery Hill sampling line are also anomalous in Ni, Cu and Pt despite being obtained from soil developed on alluvial material rather than till. This further suggests a groundwater transport mechanism or possibly a mixing of till with alluvium. Aside from the Discovery Hill deposit, there is little evidence of other mineralization in the soil geochemistry. Three of the five samples in the northeast part of the grid have variously elevated values of Ni, Cu and Pt. This may be related to localized mineralization in the Mushuau intrusion (troctolite and gabbro), which is known to host the Sarah occurrence about 3 km northwest of these samples.

CONCLUSIONS

The study investigated the distribution of Pd and Pt in lake sediment and soil in four areas of known or suspected PGM mineralization. Samples analyzed for PGM had been collected previously for Ni–Cu±Co exploration programs. Results of the study indicate that PGM levels are detectable and give dispersion patterns that are spatially correlated with mineralization. In particular:

- 1. In all areas and sample types, a greater percentage of samples have detectable Pd than Pt.
- 2. In all areas and sample types, Pd has a higher correlation with Cu than with Ni, although amongst the highest Ni and Cu samples, there appears to be a stronger correlation between Pd and Ni.
- 3. PGM distribution in lake sediment and soil does not appear to be significantly controlled by the presence of Fe–Mn oxides or by organic content.
- 4. In the PLI area, a lake-sediment sample having highly anomalous Pd and Pt is located over a narrow band of PLI and is likely related to unreported PGM mineralization. A second cluster of elevated Pd samples in the southwest suggests the presence of mineralization or unmapped PLI.
- 5. In the Wilson Lake area, anomalous sediment samples suggest a bedrock source enriched in PGM.

- At the Baikie showing, PGM values in B-horizon soils clearly reflect the known Ni–Cu–PGM mineralization and suggest other sources to the northeast.
- 7. At the Discovery Hill deposit at Voisey's Bay, Pd values in soil are clearly anomalous over the deposit and for several hundred metres away. The Pd values reported from this area (up to 824 ppb) are surprisingly high in light of the low PGM values reported from the deposits.

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