

DETAILED SURVEY OF STREAM-SEDIMENT AND WATER GEOCHEMISTRY, NORTHERN LABRADOR

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ABSTRACT

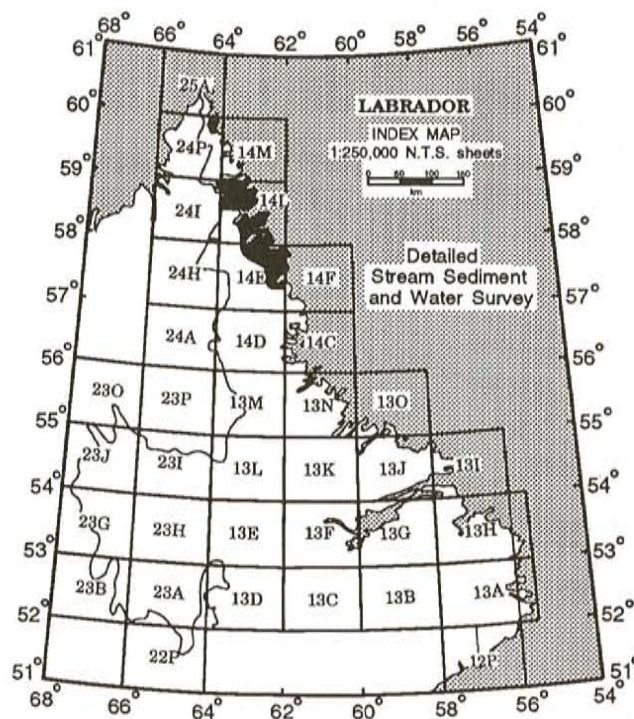
During the summers of 1991 and 1992, a stream-sediment, panned-concentrate and stream-water survey was conducted in areas of northern Labrador, mostly between Nachvak Fiord and Okak Bay, to follow-up geochemical anomalies identified from regional-scale lake-sediment and stream-sediment surveys. The $< 63 \mu\text{m}$ fraction of sediment was analyzed for 39 elements, and water samples for 22 elements. During the stream survey, several rock samples were also collected and new outcrops of base-metal mineralization discovered. Results of some sediment sample analyses are sufficiently high to suggest that they reflect mineralized zones within their associated catchment basins. Such analyses include the elements Zn, Cu, Ni and possibly Au. Other elements, in both stream sediments and waters, provide information about the geochemical nature of the bedrock that is additional to knowledge already gained from earlier bedrock mapping. Sediment analyses of Ni, Cr, Sr, Nb, Ba, Ta and the light rare-earth elements might be usefully combined to indicate the presence of kimberlites or lamproites—possible host rocks for diamonds.

INTRODUCTION

This report summarizes the results of a two-year geochemical survey conducted in northern Labrador. Results of the first year's work were presented in 1993 (McConnell, 1993; McConnell and Honarvar, 1993). A more thorough presentation of the data including colour maps has been released recently as an open file report (McConnell and Honarvar, 1994). Stream-sediment, panned-concentrate, stream-water and rock samples were collected in areas where previous reconnaissance-scale lake-sediment and stream-sediment surveys indicated elevated metal values, where detailed sampling had not been conducted and where, in the event of significant mineralization being discovered, access to coastal shipping seemed economically feasible. The project was undertaken to encourage mineral exploration in this little-explored area of the province by increasing our knowledge of geochemical dispersion patterns related to the bedrock and mineralization. Mineral deposits targeted in the study include those of Au, Cu, Ni, Zn, W, Mo and platinum-group elements.

LOCATION, ACCESS AND MINERAL RIGHTS DISPOSITION

The area covered by the stream survey is outlined in Figure 1. Sampling was done in the following NTS map areas: 14E (8, 9, 13 and 16), 14F (12 and 13), 14L (1, 2, 3, 4, 6,



are available to within 100 km of the southern part of the surveyed region. The field project was helicopter-supported from base camps in Hebron Fiord and Ramah Bay (Steckler River). Happy Valley—Goose Bay is the closest major supply centre, although Nain can provide essential foodstuffs and some equipment needs. Sea transportation (Marine Atlantic) from Goose Bay to Nain is inexpensive and generally begins in early July and runs to late October depending on ice conditions. An airstrip suitable for fixed-wing use is located at the radar base in Saglek, which is central to the area and a public airstrip is located in Nain. Permission to use the Saglek airstrip can be obtained from the Department of National Defence in Ottawa. Float plane, wheeled aircraft and helicopters are available for charter in Goose Bay. Nain has regularly scheduled twin-Otter service from Goose Bay. Fishing boats can be chartered in Nain or other coastal communities to position fuel, campstuffs or personnel along the coast. The area normally is navigable from mid-July to late fall.

The survey area is on crown land and available for prospecting. Exploration licences for land in Labrador can be obtained by application without the need for ground staking. Exploration interest in this part of Labrador has recently renewed, particularly for base metals and diamonds, and some ground is now under license but most is still open.

PREVIOUS GEOCHEMICAL WORK

Geochemical surveys have been made in the area by both government and industry. The first recorded is a stream-sediment survey focusing on Zn mineralization conducted by Esso Minerals over most of the Ramah Group of supracrustal rocks in 14L (MacLeod, 1984 and 1985).

A reconnaissance lake-sediment and water survey was conducted by the Geological Survey of Canada (GSC) in the southern part of the present survey area in 1985 encompassing NTS map areas 14M, 24P, 25A and the southern half of 14L and 24I (Hornbrook and Friske, 1986). Sample density was one per 13 km². Sediment was analyzed for loss-on-ignition (LOI) plus Ag, As, Cd, Co, Cu, F, Fe, Hg, Mn, Mo, Ni, Pb, Sb, U, V and Zn. These samples have since been re-analyzed by the GSC for 33 elements including Au, by neutron-activation analysis (Friske *et al.*, 1993). Lake water was analyzed for F, U and pH. In 1986, a reconnaissance geochemical survey using the same sample density was made in extreme northern Labrador in which, because of the scarcity of lakes, samples of stream sediment and stream water were collected (Hornbrooke and Friske, 1987). Stream sediment was analyzed for the same elements as lake sediment plus Au, Ba, Sn and W. Stream waters were analyzed for F, U and pH. To facilitate comparison of results from the two sample media, samples of both lakes and streams were collected in an overlap area consisting of the southern half of 14L and 24I. Davenport (1990) discusses the correlation of these data.

GEOLOGY

BEDROCK

The survey was conducted over areas underlain by rocks of both the Nain and Churchill (Rae) structural provinces. The bedrock geology for the southeastern part of the area is shown in Figure 2; also shown are the drainage basins sampled during 1991 and 1992. Most of the surveyed areas in the Nain Province are underlain by Archean quartzofeldspathic gneiss and lesser amounts of metavolcanic and metasedimentary supracrustal rocks and derivatives of mafic and ultramafic intrusives (Bridgewater *et al.*, 1978); the metamorphic grade ranges from amphibolite in the east to granulite in the west. Aphebian diabase dykes intrude much of area. Samples were also taken from streams draining an Early Proterozoic fluorite-bearing granite south of Okak Bay. Basement rocks in sampled drainage basins of the Churchill Province are typically Early Proterozoic granulite-facies paragneiss (Tasiuyak gneiss) and charnockitic orthogneiss.

The stratigraphically similar Ramah and Mugford groups have been correlated by Smyth and Knight (1978). They consist of sedimentary and volcanic rocks preserved as remnants of a Lower Proterozoic cover sequence on the Nain Craton. The Ramah Group is a 1.7-km-thick sequence of dominantly sedimentary rocks consisting of quartzite, shale, sandstone, dolomite, mudstone, chert and siltstone with a single volcanic unit and a few gabbroic sills (Morgan, 1975; Knight and Morgan, 1981). It has been metamorphosed to amphibolite facies. The Mugford Group consists predominantly of fine-grained siliciclastic sediments, carbonates and pyrite beds overlain by submarine subaerial mafic volcanic rocks, all metamorphosed to greenschist facies. The group forms the Kaumajet Mountains—a rugged and spectacular landmass rising precipitously from the sea along much of its length.

MINERALIZATION

Aside from those in the Ramah Group, there were few metallic mineral occurrences recorded within the survey area at the beginning of the project. Among these are four outcrops of Cu—Zn—(Pb) mineralization in Archean gneiss of Ramah Bay and Little Ramah Bay, disseminated chalcopyrite in the Tasiuyak gneiss west of Hebron Fiord and also west of Ugjuktok Fiord, molybdenite in a pegmatite near the border of the fluorite-bearing granite south of Okak Bay and minor galena in chert in the Mugford Group. Because the Ramah Group has been the subject of considerable mineral-exploration attention including a detailed stream-sediment survey by Esso Minerals, it was excluded from the present project except for the extreme northern portion, which was outside the boundary of Esso's program. It has been explored for sediment-hosted exhalative deposits by Esso (MacLeod, 1984 and 1985) who discovered several occurrences of Pb—Zn mineralization in the Reddick Bight dolomite. Meyer and Dean (1988) prospected it for Mississippi Valley-style mineralization in dolomite and most recently Wilton *et al.* (1993) considerably extended both the grade and number of

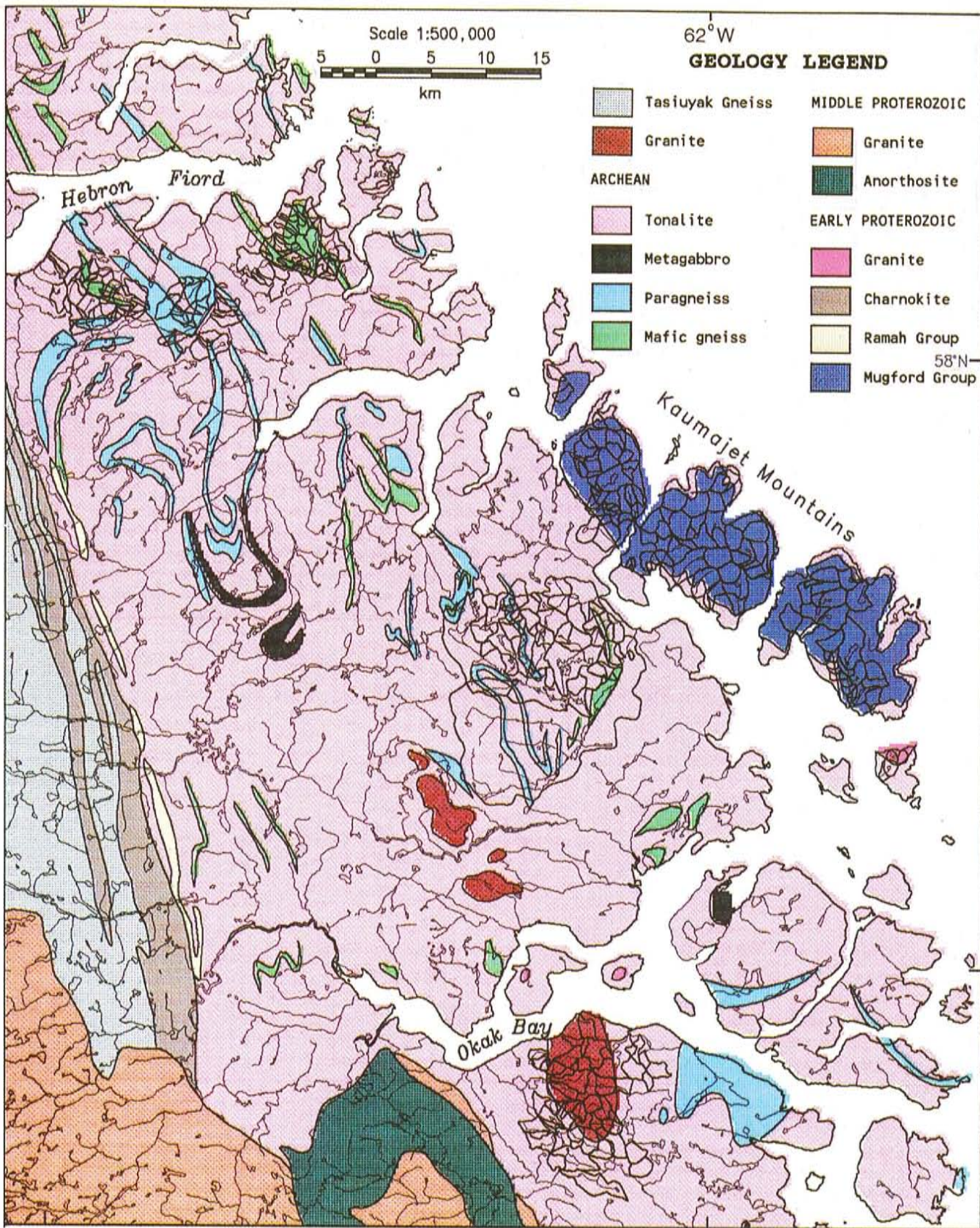


Figure 2. Geology and sampled drainage basins in the southeastern part of the survey area (geology modified from Ryan, 1990; Van Kranendonk et al., 1993).

known dolomite-hosted Pb–Zn occurrences. They also found additional sphalerite mineralization (Adams Lake) in float, likely from the same source described in McConnell and Honarvar (1993).

SURFICIAL ENVIRONMENT

Topographically, the area is rugged to mountainous. The Torngat Mountains occupy the central part of the area where relief ranges from sea level to a maximum of 1568 m at the top of Cirque Mountain. The Kaumajet Mountains in the southwest of the survey area form a spectacular landmass rising abruptly from the Labrador Sea. Elsewhere, relief is still considerable but glaciation has smoothed the features forming broad valleys and sweeping hills. Because of the severe topography, there are fewer lakes, particularly in the central and northern areas, than are found in most of the remainder of Labrador. Stream gradients are steep, resulting in fast-flowing streams. Consequently overbank sediment is generally absent or poorly developed but active sediment is surprisingly abundant.

The area was subjected to continental glaciation with ice movement generally being west to east. The absence of glacial erratics at higher elevations suggests some of the higher mountains were above ice level. Till cover is thin to absent except in the larger stream and river valleys where poorly sorted sand and gravel deposits, up to several metres in thickness, are common (Klassen *et al.*, 1992). The area is within the permafrost zone and frost boils and patterned ground are seen where till is sufficiently thick to permit their development. Felsenmeer is frequently encountered at higher elevations. Vegetation is typically sub-arctic. Except for the extreme south, the area is above the treeline affording easy walking. Dwarf willows and very rare stunted spruce may be found in sunny sheltered areas on the floors of large valleys.

SAMPLE COLLECTION

During the 1991 and 1992 field seasons, 610 stream-sediment, 115 pan-concentrate, 378 water and 75 rock samples were collected from areas that were considered to have above-average potential for gold, base-metal, granophile element and PGE mineralization. Panned concentrates (HMC) were taken from areas with gold and PGE potential and waters from areas targeted for base metals, and granophile elements.

A typical sample of active-sediment was composited from several locations in the stream bed using a spade. It was then washed through a 3 mm aluminum screen and this fine material retained in a waterproof kraft-paper sample bag. Sediment samples collected in 1991 were treated slightly differently from those collected in 1992 leading to an unexpected difference in retained organics and oxides with implications for analytical results. In 1991, to ensure obtaining sufficient sample material to yield an adequate quantity of <63 μm material for analysis, two bags of <3 mm sediment were usually taken at each site. To reduce the sample size, all the 1991 samples were then further wet-sieved at camp to <250 μm . This additional step had the effect of washing

away most of the organic matter and some of the iron and manganese oxides present as colloids or weakly bound surface coatings. In 1992, samples were only sieved at the collection site to 3 mm. Both sets of samples were subsequently dry-sieved to <63 μm but the omission of the wet-sieving step in the 1992 samples resulted in their having higher contents of organic matter and Fe–Mn oxides. Since some elements, particularly the base metals, show a fair to moderate correlation with organic content (as measured by loss-on-ignition) and with Fe–Mn oxides, these elements will tend to have marginally higher analyses in the samples from 1992 than in those from 1991.

Panned concentrates were collected by using a conical, heavy-mineral pan to collect about 30 to 50 g of heavy-mineral concentrate from approximately 3 to 4 l of <3 mm active sediment. Water samples were collected by filling in mid-stream, a clean, rinsed, 250 ml nalgene bottle. Waters were typically clear, colourless and free of visible organic or suspended matter. Fresh samples of representative bedrock and grab samples of mineralized rocks were taken at several locations.

SAMPLE PREPARATION AND ANALYSES

Stream sediments 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 <63 μm . The panned heavy-mineral concentrates were pulverized in an alumina shatterbox prior to analysis. One in twenty was split for a laboratory duplicate. Within 24 hours of collection, water samples were filtered through 0.45 μm filter paper using a manual vacuum pump and acidified with 2 ml of nano-pure HNO_3 . Rock samples were pulverized to <100 μm in a tungsten-carbide shatterbox in preparation for analysis.

The different sample types were analyzed by a variety of techniques that have been described in more detail previously (McConnell, 1993; Wagenbauer *et al.*, 1983). The stream sediment, panned concentrate and rock samples were analyzed by several methods for 39 elements. In addition, several rock samples were analyzed for Pt and Pd. Some elements were determined by more than one method. A suffix is attached to element names in the text to identify the analytical method. (e.g., Cu^4 for copper analysis by atomic absorption spectroscopy following *aqua regia* digestion). The list of elements, the method and the digestion procedure used for stream sediment, panned concentrate and rock analyses are summarized in Table 1.

Water samples were analyzed in the field for pH using a Corning combination pH electrode, for total dissolved solids (1991 samples only) and conductivity (1992 samples) using a Corning conductivity/TDS sensor. The filtered samples were analyzed by ICP-emission spectroscopy using standard nebulization for: Ca, Fe, K, Mg, Mn, Na, SiO_2 and SO_4 and by ICP using an ultrasonic nebulizer for: Al, Ba, Co, Cr, Cu, Li, Mo, Ni, P, Sr, Y and Zn.

Table 1. Analytical methods for stream-sediment, panned concentrate and rock samples

ELEMENTS	METHOD	DIGESTION/ PREPARATION
(Ag ¹), As ¹ , Au ¹ , Ba ¹ , Br ¹ , Ce ¹ , Co ¹ , Cr ¹ , Cs ¹ , Eu ¹ , Fe ¹ , Hf ¹ , La ¹ , Lu ¹ , Mo ¹ , Na ¹ , Ni ¹ , Rb ¹ , Sb ¹ , Sc ¹ , Sm ¹ , Ta ¹ , Tb ¹ , Th ^{1*} , U ¹ , W ¹ , Yb ¹ , (Zn ¹), (Zr ¹)	Neutron Activation Analysis (INAA)	5 to 10 g in shrink-wrapped vial (total analysis)
Ba ² , Be ² , Ce ² , Co ² , Cu ² , Dy ² , Ga ² , La ² , Li ² , Mn ² , Nb ² , Ni ² , Pb ² , Sc ² , Sr ² , (Th ²), Ti ² , V ² , Y ² , Zn ² , Zr ^{2*}	Inductively Coupled Plasma Emission Spectroscopy (ICP-ES)	HF-HClO ₄ -HCL (total digestion)
Cd ² , Cr ² , Mo ² , Rb ²	Atomic Absorption Spectroscopy (AA)	HF-HClO ₄ -HCl (total digestion)
Cd ⁴ , Co ⁴ , Cu ⁴ , Fe ⁴ , Mn ⁴ , Ni ⁴ , Pb ⁴ , Zn ^{4**}	Atomic Absorption Spectroscopy (AA)	HNO ₃ -HCl (3:1) (partial digestion)
Ag ^{6*}	Atomic Absorption Spectroscopy (AA)	HNO ₃
Au ¹⁷ , Pd ¹⁷ , Pt ¹⁷	Fire Assay / ICP Fluorescence	

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

DATA HANDLING

Field and analytical data were keyed into a database and manipulated with a variety of software packages. The catchment basins for each sample site and the geological base map were digitized using the ROOTS™ Digitizing System (Decision Images Inc. 1992). Most statistical analyses were done with SPSS/PC (1988) and cumulative frequency plots with UNISTAT (Nolan, 1990). The data were prepared for plotting with GEOSOFT (Geosoft Inc., 1991) and a Hewlett Packard electrostatic plotter was used to produce the colour maps.

The sediment and water data have been plotted elsewhere as 1:500 000-scale maps (McConnell and Honarvar, 1994) in which the drainage basins are colour-coded into five or six intervals, according to element concentration and superimposed on a base showing geology, drainage and coastline. The intervals for a given element were determined by examining the element's cumulative frequency plot and selecting four or five inflection points so as to separate the distribution into some of its component populations. The cumulative frequency plot is also displayed on each map.

DESCRIPTION AND DISCUSSION OF RESULTS

STATISTICAL ANALYSES

Data Quality

One method of assessing the quality of the data is to compare the analytical reproducibility of site-duplicate samples, i.e., data from pairs of samples collected within

several metres of each other in the stream. Twenty-seven pairs of site-duplicate sediment samples and 15 pairs of site-duplicate water samples were collected. Spearman rank correlation coefficients provide a measure of the total variation in the data that results both from differences in sample composition and from analytical error. Correlation coefficients were computed for the analytical data from the site duplicates and are presented as graphs in Figures 3 (sediment) and 4 (water). Coefficients are sorted by increasing value. Elements that range from non-correlated to strongly correlated are shown in Figure 3a and very strongly correlated elements are shown in Figure 3b. Two elements, W and Au, are not significantly correlated at the 99 percent confidence level. Tungsten appears to have no correlation whereas gold is poorly correlated at less restrictive confidence limits. The elements Eu¹ to Hf¹ have fair to good correlations and elements above Hf¹ may be regarded as having very good to excellent correlations.

Six elements in Figure 4 fall below the 99 percent confidence limit—Cr, Ni, Co, Be, Mn and P. All of these have relatively high detection limits with the majority of samples having no detectable concentrations. Fe has fair correlation at $r=0.58$. The remainder form two groups—Cu, Ti, K, Mo, Al and Zn have good correlations and pH to Ba have excellent correlations. All of the Y analyses and most of the Mo analyses are below detection limit for these samples and are therefore excluded.

Summary Statistics

The medians, means and ranges of most elements analyzed in stream sediment are given in Table 2. Because

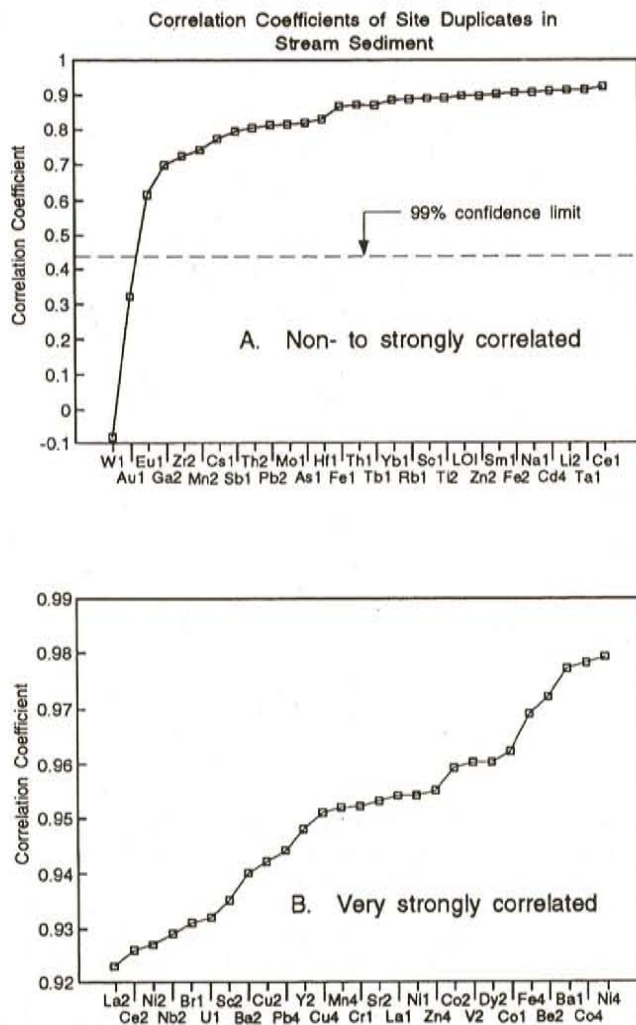


Figure 3. Spearman correlation coefficients of site-duplicate data for stream-sediment samples (N=27 pairs).

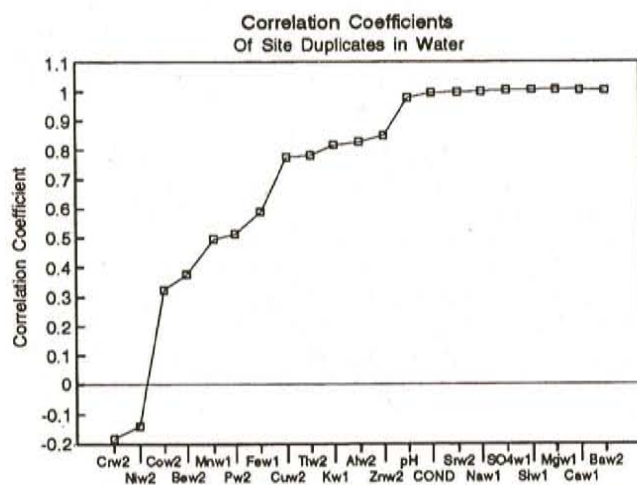


Figure 4. Spearman correlation coefficients of site-duplicate data for stream-water samples (N=15 pairs).

Table 2. Medians, geometric means, log₁₀ standard deviations and ranges of 1991 and 1992 active stream-sediment data (N=568 except N=232 for 1991 data and N=336 for 1992 data; LOI data are arithmetic; data are in ppm unless otherwise noted)

ELEMENT	MEDIAN	MEAN	STD. DEV.	RANGE	
As ¹	1.3	1.48	0.71	<.40	252
Au ¹ , ppb	<1.0	<1.7	0.37	<1.0	82
Ba ¹	570	525	0.25	25	1600
Ba ²	557	537	0.17	55	1378
Be ²	1.1	1.12	0.24	0.1	25.9
Cd ⁴	0.1	0.20	0.36	<0.1	4.4
Ce ¹	100	105	0.20	14	579
Ce ²	87	89	0.18	13	374
Co ¹	32	35	0.25	7.1	330
Co ²	34	36	0.25	7.1	330
Co ⁴	16	15	0.41	2	243
Cr ¹	213	219	0.27	26	4480
Cs ¹	0.75	0.71	0.47	<0.20	25.6
Cu ²	60	62	0.42	1	802
Cu ⁴	57	59	0.40	5	664
Dy ²	4.6	4.9	0.19	0.6	21.6
Eu ¹	1.6	1.38	0.32	<0.50	6.50
Fe ¹ , %	7.7	7.94	0.13	2.9	28.0
Fe ² , % (all)	7.36	7.41	0.14	0.34	26.22
Fe ² , % (1991)	7.70	7.59	0.16	0.34	17.80
Fe ² , % (1992)	7.20	7.41	0.11	2.75	26.22
Fe ⁴ , % (all)	2.51	2.45	0.28	0.48	16.60
Fe ⁴ , % (1991)	1.36	1.41	0.22	0.48	8.34
Fe ⁴ , % (1992)	3.35	3.55	0.19	1.20	16.60
Ga ²	23	42	0.20	5	54
Hf ¹	11.0	11.8	0.30	1.5	101.0
La ¹	54	54	0.20	6.8	301
La ²	41	42	0.20	6	175
Li ²	22.5	22	0.23	4.7	123
Mn ²	1224	1290	0.16	100	6987
Mn ⁴ (all)	264	240	0.54	17	5780
Mn ⁴ (1991)	83	83	0.38	17	621
Mn ⁴ (1992)	512	500	0.38	72	5780
Mo ¹	0.6	1.2	0.46	<0.5	58.5
Na ¹ , %	1.60	1.58	0.14	0.41	3.31
Nb ²	6	6.9	0.38	1	117
Ni ¹	83	78	0.50	5	1880
Ni ²	95	93	0.43	1	1756
Ni ⁴	57	58	0.43	4	1060
Pb ²	13	13.8	0.38	1	133
Pb ⁴	6	6.2	0.56	<1	118
Rb ¹	48	47	0.24	2	214
Sb ¹	0.052	0.06	0.59	<0.05	7.98
Sc ¹	23.0	24	0.13	10.8	74.7
Sc ²	21.5	23	0.14	1.9	58.4
Sm ¹	8.5	8.7	0.20	1.0	38.3
Sr ²	220	209	0.17	40	586
Ta ¹	0.88	0.98	0.33	0.10	10.0
Tb ¹	1.0	1.05	0.20	0.32	5.2
Th ¹	11.1	11.5	0.32	1.0	211
Ti ²	5478	5890	0.20	730	43470
U ¹	2.0	2.45	0.40	0.4	207.0
V ²	144	155	0.17	13	736
W ¹	<0.5	0.59	0.20	<1.0	7.2
Y ²	27	28	0.21	4	148
Yb ¹	2.4	2.29	0.36	0.20	16.0
Zn ²	141	150	0.18	16	775
Zn ⁴	77	74	0.35	11	780
Zr ²	128	126	0.23	16	601
LOI, % (1991)	2.0	2.1	1.14	0.4	8.1
LOI, % (1992)	10.3	11.0	6.06	1.6	51.3

Superscript numbers denote method of analysis as follows: 1=INAA; 2=ICP-ES; 4=partial digestion-AA

Table 3. Medians, geometric means, log₁₀ standard deviations and ranges of analytical data from stream water samples; element data are in ppb unless otherwise noted

ELEMENT	MEDIAN	MEAN	STD. DEV.	RANGE	NO. ANALYSES	
Al_w ²	14	16	0.48	<10	466	278
As_w ⁸	<0.10	<0.10	-	<0.10	0.27	347
Ba_w ²	2.0	1.6	0.37	<1.0	12.0	278
Be_w ²	<0.1	<0.1	-	<0.1	0.40	278
Ca_w ¹ , ppm	1.17	1.16	0.38	0.15	33.06	347
Co_w ²	<1	<1	-	<1	4	347
Cr_w ²	<1	<2	-	<1	3	347
Cu_w ²	<1	<1	-	<1	11	347
Fe_w ¹	7	8	0.63	<5	699	347
K_w ¹ , ppm	0.2	0.2	0.46	<0.1	13.5	347
Li_w ²	<1.0	<1.0	-	<1.0	2.0	278
Mg_w ¹ , ppm	0.266	0.316	0.35	0.053	19.37	347
Mn_w ¹	<2	<2	-	<2	21	347
Mo_w ²	<1	<1	-	<1	3	347
Na_w ¹ , ppm	1.06	0.96	0.34	0.09	11.43	347
Ni_w ²	<2	<2	-	<2	35	347
P_w ²	<5	<5	-	<5	190	278
Si_w ¹ , ppm	0.51	0.27	0.73	<0.06	6.07	347
SO ₄ _w ¹ , ppm	1.3	1.4	0.32	0.2	152.2	347
Sr_w ²	3.4	3.8	0.37	0.5	48.8	278
Ti_w ¹	<1.0	<1.0	-	<1.0	15.0	278
Y_w ²	<0.3	<0.3	-	<0.3	1.4	347
Zn_w ²	1.2	1.0	0.53	<0.3	40	347
Variable						
pH	6.75	6.73	0.43	4.93	7.99	317
CONDUCTIVITY (μS)	19.1	19.0	0.27	4.3	101.8	281

the wet-sieving step employed in sample preparation in 1991 (described above) resulted in substantially lower LOI, ferric iron (Fe⁴) and manganese (Mn⁴) values in the two sets of samples, the statistics for these data are given separately. The mean LOI content of the 1991 samples is 2.0 percent compared to 10.3 percent in 1992. Similarly, the mean Fe⁴ value in 1991 is 1.36 percent compared to 3.35 percent in 1992. The total iron as measured by Fe² is nearly the same in the samples for the two years—7.7 percent in 1991 and 7.20 percent in 1992. The effect of this difference in sample sieving on the resulting analyses is discussed further below under *Correlation Analysis*. The maximum values encountered in stream sediment for some elements are comparable to those encountered elsewhere in mineralized areas. These elements and their maximum values include Au (82 ppb), Cu⁴ (664 ppm), Ni⁴ (1060 ppm) and Zn⁴ (780 ppm). The ranges of REEs and of the lithophile elements Mo and W do not suggest the presence of mineralization.

The summary statistics for the water analyses for both years are provided in Table 3. Of the 22 elements analyzed, 11 had detectable concentrations in most of the samples. The maximum analytical values for Be, Co, Mo and Cr are close to the detection limit thus the analytical error for these

elements is large and the data of questionable reliability. Only five elements—Ca, Mg, Na, S (as SO₄) and Sr—were detectable in all samples. Because the element content of water is much more influenced by conditions other than bedrock composition than is that of stream sediment, it is more difficult to directly relate water analyses alone to mineralization.

Correlation Analysis

To examine inter-element associations in stream-sediment data, Spearman ranked correlation coefficients were computed for the data from each year for several elements of economic interest and are presented in Table 4. Iron and manganese (hydr)oxides and organic matter provide adsorption sites for some ionic species resulting in increased metal contents for samples containing higher than normal quantities of these phases. Of these three phases, only Mn⁴ in the 1991 data has a very strong correlation (>0.80) with any other elements, notably Co⁴, Ni² and Zn⁴. Moderately strong correlations (0.60 to 0.80) are observed for several elements in each year with both Fe⁴ and Mn⁴. Correlations with LOI for the listed elements range from no correlation to moderate for Zn⁴ (0.54 in 1991). Very strong element

Table 4. Spearman correlation coefficients of selected stream sediment data by year

ELEMENT	As ¹	Au ¹	Co ⁴	Cr ¹	Cu ²	Cu ⁴	Fe ²	Fe ⁴	LOI	Mn ⁴	Mo ²	Ni ²	Ni ⁴	Pb ⁴	Sb ¹
(i). 1991 data (N=232):															
As ¹	1.00	.30	.38	.00	.50	.51	.07	.47	.35	.31	.26	.32	.42	.49	.36
Au ¹	.30	1.00	-.04	-.07	.38	.41	.30	.16	.07	-.09	.28	-.10	.00	.07	-.01
Co ⁴	.38	-.04	1.00	.32	.49	.52	-.09	.79	.33	.93	.06	.83	.86	.59	.40
Cr ²	.00	-.07	.32	1.00	.06	.04	.10	.20	-.12	.34	-.38	.53	.54	.27	-.09
Cu ²	.50	.38	.49	.06	1.00	.96	.20	.61	.27	.36	.39	.36	.48	.43	.32
Cu ⁴	.51	.41	.52	.04	.96	1.00	.23	.65	.25	.38	.41	.34	.48	.43	.32
Fe ²	.07	.30	-.09	.10	.20	.23	1.00	.08	-.34	-.17	.21	-.24	-.07	-.03	-.12
Fe ⁴	.47	.16	.79	.20	.61	.65	.08	1.00	.36	.74	.29	.61	.64	.51	.37
LOI	.35	.07	.33	-.12	.27	.25	-.34	.36	1.00	.35	.29	.47	.37	.23	.23
Mn ⁴	.31	-.09	.93	.34	.36	.38	-.17	.74	.35	1.00	-.03	.84	.79	.57	.41
Mo ¹	.30	.28	.06	-.38	.39	.41	.21	.29	.29	-.03	1.00	-.06	.00	.03	.15
Ni ²	.26	-.10	.83	.53	.36	.34	-.24	.61	.47	.84	-.06	1.00	.92	.50	.31
Ni ⁴	.32	.00	.86	.54	.48	.48	-.07	.64	.37	.79	.00	.92	1.00	.53	.30
Pb ⁴	.42	.07	.59	.27	.43	.43	-.03	.51	.23	.57	.03	.50	.53	1.00	.43
Sb ¹	.49	.12	.40	-.09	.32	.32	-.03	.37	.23	.41	.15	.31	.30	.43	1.00
Zn ⁴	.36	-.01	.87	.16	.50	.53	-.12	.79	.54	.84	.14	.76	.77	.54	.43

Note: Coefficients $> |0.15|$ are significant at the 99% confidence level.

(ii). 1992 data (N=336):

As ¹	1.00	.30	.60	-.04	.63	.62	.45	.67	.30	.62	.04	.20	.23	.68	.75	.68
Au ¹	.30	1.00	.29	-.04	.38	.37	.25	.25	-.01	.21	.01	.06	.09	.25	.31	.27
Co ⁴	.60	.29	1.00	.29	.84	.84	.56	.72	.15	.76	-.05	.60	.64	.64	.67	.72
Cr ¹	-.04	-.04	.29	1.00	.16	.16	.09	.09	-.13	-.02	.06	.86	.84	.05	.08	-.04
Cu ²	.63	.38	.84	.16	1.00	1.00	.47	.67	.24	.61	-.10	.46	.51	.69	.74	.68
Cu ⁴	.62	.37	.84	.16	1.00	1.00	.46	.66	.23	.60	-.10	.46	.51	.69	.73	.67
Fe ²	.45	.25	.56	.09	.47	.46	1.00	.81	-.04	.61	-.04	.25	.25	.34	.43	.54
Fe ⁴	.67	.25	.72	.09	.67	.66	.81	1.00	.26	.82	.04	.35	.37	.64	.68	.79
LOI	.30	-.01	.15	-.13	.24	.23	-.04	.26	1.00	.33	.34	.02	.04	.38	.32	.39
Mn ⁴	.62	.21	.76	-.02	.61	.60	.61	.82	.33	1.00	.03	.26	.28	.63	.61	.79
Mo ¹	.04	.01	-.05	.06	-.10	-.10	-.04	.04	.34	.03	1.00	.09	.08	-.09	-.08	.00
Ni ²	.20	.06	.60	.86	.46	.46	.25	.35	.02	.26	.09	1.00	.98	.29	.32	.29
Ni ⁴	.23	.09	.64	.84	.51	.51	.25	.37	.04	.28	.08	.98	1.00	.34	.36	.32
Pb ⁴	.68	.25	.64	.05	.69	.69	.34	.64	.38	.63	-.09	.29	.33	1.00	.81	.77
Sb ¹	.75	.31	.67	.08	.74	.73	.43	.68	.32	.61	-.08	.32	.36	.81	1.00	.71
Zn ⁴	.68	.27	.72	-.04	.68	.67	.54	.79	.39	.79	.00	.29	.32	.77	.71	1.00

Note: Coefficients $> |0.12|$ are significant at the 99% confidence level.

correlations, aside from those with Fe⁴, Mn⁴ and LOI, include Cu² with Cu⁴ (0.96 and 1.00 in 1991 and 1992 respectively) indicating that virtually all Cu in the samples is present in easily soluble form. Ni² and Ni⁴ show a similar but weaker relationship. The other very strong correlations such as Co⁴ with Zn⁴ in both years and with Ni in 1991 and with Cu in 1992 are doubtlessly due in large part to their strong mutual correlations with Mn⁴. Nickel and Cr¹ are strongly correlated in 1992 despite Cr¹ having no significant correlation with Fe⁴ or Mn⁴ suggesting the presence of a primary lithologic association. Another strong correlation in the 1991 data that is only partly explained by their mutual correlation with Fe⁴ and Mn⁴ is Sb¹ with Pb⁴ (0.81). This correlation may also indicate a primary association.

Most of the stream-water samples were collected in 1992. As well, a larger suite of analyses was determined for that year's samples. For these reasons, the Spearman correlation coefficients were determined on the 1992 samples only (Table 5). Elements are included if they have a reasonable number of samples with detectable concentrations. The strongest correlations are for conductivity with Ca (0.94), Mg (0.89) and Na (0.88). Conductivity also correlates moderately strongly with Sr (0.79) and SO₄ (0.74). Not surprisingly, then, these elements also show a fairly strong correlation with each other (e.g., Ca with Mg is 0.85). The base metals Cu, Ni and Zn do not show much correlation with either pH or conductivity. Cu, Zn and Ba show moderate mutual correlation but Ni has no significant correlation with any other

Table 5. Spearman correlation coefficients of 1992 stream-water data ($N=275$)

	pH	Conductivity	Al	Ba	Ca	Cu	Fe	K	Mg	Mn	Na	Ni	P	Si	SO ₄	Sr	Ti	Y	Zn
pH	1.00	0.69	-0.03	0.22	0.74	0.08	0.16	0.18	0.68	-0.07	0.59	-0.09	-0.13	0.45	0.43	0.62	-0.09	0.15	-0.07
Conduc	0.69	1.00	0.21	0.37	0.94	0.26	0.28	0.40	0.89	-0.01	0.88	0.15	-0.06	0.59	0.74	0.79	0.03	0.25	-0.03
Al	-0.03	0.21	1.00	0.59	0.21	0.45	0.68	0.46	0.27	0.37	0.19	0.15	0.10	0.20	0.23	0.35	0.61	0.39	0.47
Ba	0.22	0.37	0.59	1.00	0.39	0.50	0.40	0.75	0.46	0.08	0.34	0.13	0.09	0.14	0.35	0.59	0.17	0.29	0.52
Ca	0.74	0.94	0.21	0.39	1.00	0.24	0.27	0.39	0.85	-0.01	0.76	0.10	-0.06	0.60	0.71	0.82	-0.02	0.26	-0.01
Cu	0.08	0.26	0.45	0.50	0.24	1.00	0.27	0.42	0.28	0.20	0.24	0.14	0.09	0.04	0.28	0.32	0.21	0.21	0.47
Fe	0.16	0.28	0.68	0.40	0.27	0.27	1.00	0.26	0.31	0.25	0.32	0.10	-0.12	0.28	0.20	0.27	0.63	0.26	0.29
K	0.18	0.40	0.46	0.75	0.39	0.42	0.26	1.00	0.43	-0.04	0.36	0.16	0.33	0.05	0.26	0.45	0.18	0.25	0.36
Mg	0.68	0.89	0.27	0.46	0.85	0.28	0.31	0.43	1.00	0.07	0.72	0.14	-0.01	0.63	0.74	0.86	0.08	0.21	0.03
Mn	-0.07	-0.01	0.37	0.08	-0.01	0.20	0.25	-0.04	0.07	1.00	-0.06	0.08	0.12	0.08	0.14	0.06	0.26	0.13	0.24
Na	0.59	0.88	0.19	0.34	0.76	0.24	0.32	0.36	0.72	-0.06	1.00	0.17	-0.15	0.45	0.56	0.61	0.08	0.29	0.04
Ni	-0.09	0.15	0.15	0.13	0.10	0.14	0.10	0.16	0.14	0.08	0.17	1.00	0.05	0.02	0.17	0.08	-0.00	-0.02	0.07
P	-0.13	-0.06	0.10	0.09	-0.06	0.09	-0.12	0.33	-0.01	0.12	-0.15	0.05	1.00	-0.14	-0.09	-0.01	0.07	0.03	0.10
Si	0.45	0.59	0.20	0.14	0.60	0.04	0.28	0.05	0.63	0.08	0.45	0.02	-0.14	1.00	0.58	0.64	-0.02	0.34	-0.17
SO ₄	0.43	0.74	0.23	0.35	0.71	0.28	0.20	0.26	0.74	0.14	0.56	0.17	-0.09	0.58	1.00	0.78	-0.00	0.14	-0.06
Sr	0.62	0.79	0.35	0.59	0.82	0.32	0.27	0.45	0.86	0.06	0.61	0.08	-0.01	0.64	0.78	1.00	-0.00	0.28	0.09
Ti	-0.09	0.03	0.61	0.17	-0.02	0.21	0.63	0.18	0.08	0.26	0.08	-0.00	0.07	-0.02	-0.00	-0.00	1.00	0.24	0.19
Y	0.15	0.25	0.39	0.29	0.26	0.21	0.26	0.25	0.21	0.13	0.29	-0.02	0.03	0.34	0.14	0.28	0.24	1.00	0.30
Zn	-0.07	-0.03	0.47	0.52	-0.01	0.47	0.29	0.36	0.03	0.24	0.04	0.07	0.10	-0.17	-0.06	0.09	0.19	0.30	1.00

Note: Coefficients $> |0.18|$ are significant at the 99% confidence level.

element. This lack may be due in part to its having relatively few samples above the detection limit.

ELEMENT DISTRIBUTION IN STREAM SEDIMENTS AND GOLD IN HEAVY-MINERAL CONCENTRATES

The descriptions in this section are based on examination of cumulative frequency plots and coloured element-distribution maps described above and published previously (McConnell and Honarvar, 1994).

Gold

Sixty-eight percent of all sediment samples and sixty-four percent of heavy-mineral concentrate samples (HMC) have no detectable gold (i.e., <2 ppb Au¹). Of the 104 sites that have samples of both sediment and HMC, 74 percent of the sediment samples and 65 percent of the HMC samples have no detectable gold. This relatively small improvement in the number of samples with measurable gold does not seem to warrant the additional time and expense required to collect the HMC samples and therefore these were not obtained in the second year of the survey. The distribution of Au in sediment, based on 568 samples, shows 3 population breaks, most substantially at 8 and 10 ppb corresponding to the 92nd and 96th percentiles. The distribution in HMC is based on only 111 samples and shows breaks at 4.3, 6.4 and 11 ppb corresponding to the 74th, 82nd and 93rd percentiles respectively. Most of the HMC samples were collected in the Churchill Province; all of the >6.4 ppb samples are underlain or immediately adjacent to Tasiuyak gneiss. Drainage basins

with high Au in HMC generally have high Au in active sediment as well. However, most of the basins with high gold values in sediment are from drainages without corresponding HMC samples. In particular, many of the streams draining Mugford Group rocks have elevated to high Au contents. Outside of these areas, there are a few high values in areas of Archean gneiss including an area of Ni-Cu sulphide mineralization discovered during this project and three samples from streams draining the Ramah Group where Zn mineralization was found in float.

Base Metals (Cu, Ni, Zn, Pb, Mo)

The distributions described for Cu, Ni, Zn and Pb are of analyses by AA following digestion in HCl-HNO₃ and for Mo is of analysis by INAA. The distribution of Cu in the southeastern portion of the survey area is shown in Figure 5. The cumulative frequency plot of Cu shows population breaks at 210, 260 and 300 ppm. When these values are used as intervals to group sample analyses, the resulting geochemical map reveals that all but one of the samples from the highest group and all but two from the next highest group are located along the northeast side of the Kaumajet Mountains from streams draining rocks of the Mugford Group. The other high Cu sample comes from an area of Archean gneiss immediately to the south of Hebron Fiord near where occurrences of Ni-Cu mineralization were discovered. The other moderately high Cu sample (>260 ppm) is from an area of Archean gneiss north of Okak Bay (Figure 5).

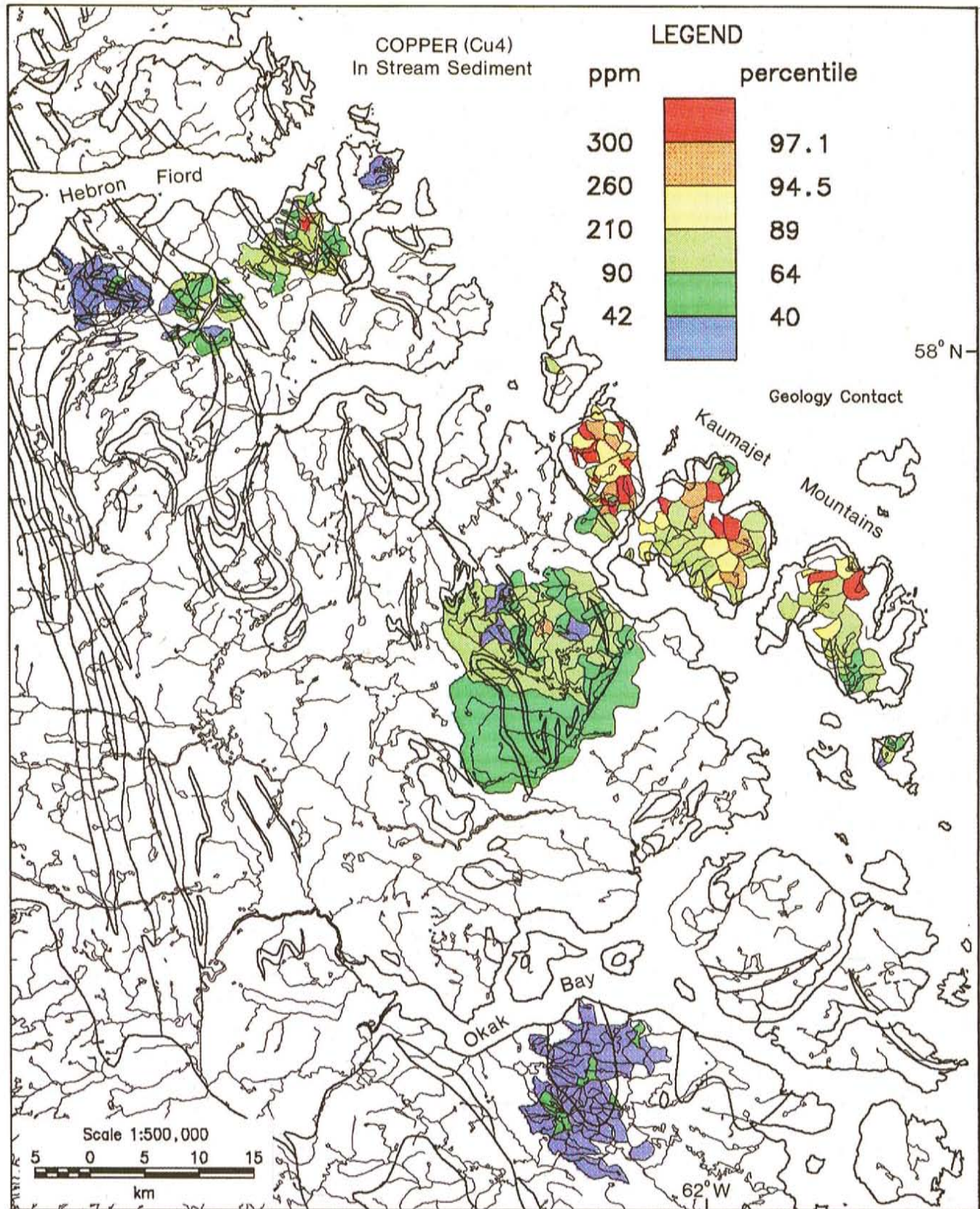


Figure 5. The distribution of copper (Cu⁴) in stream sediment in the southeastern portion of the survey area.

The distribution of Ni in sediment has little in common with that of Cu. The two highest population breaks occur at 275 ppm (94.7 percentile) and 350 ppm (97.4 percentile). Samples with these values occur in 4 areas: 1) along the base of the Mugford Group on both the east and west sides of the Kaumajet Mountains, 2) in an area of mafic and ultramafic gneiss southeast of Ramah Bay, 3) in an area of gneiss west of Ramah Bay and 4) in one sample from an area of Archean gneiss 15 km north of Nachvak Fiord. The area of Ni–Cu mineralization south of Hebron Fiord is only moderately higher than background. Samples collected over the Churchill Province are notably lower in Ni than those from the Nain Province.

The cumulative frequency curve for Zn has a pronounced break at about 300 ppm (96.7th percentile). Samples with Zn contents above this value are found in three areas: 1) streams draining the lower portions of the Mugford Group along the east and west sides of the Kaumajet Mountains, 2) four catchment basins draining rocks of the Ramah Group and 3) from an area mapped as charnockitic gneiss in the Churchill Province 35 km west of Hebron Fiord. The first two areas are both underlain by rocks known to host sulphide mineralization. Several occurrences of sphalerite have been documented from the Ramah Group (Wilton *et al.*, 1993) and zinc mineralized float was found at the time that one of the anomalous zinc in sediment samples was collected. The charnockitic area of anomalous Zn has never been prospected.

The distribution of Pb in sediment is somewhat similar to that of Zn. The cumulative frequency plot has a distinct break at 55 ppm (96.5 percentile). Samples with Pb values in excess of 55 ppm are found in 5 areas: 1) most are from the Mugford Group but, in most instances, not from the same streams that have high Zn contents, 2) two samples are from the Ramah Group just south of Nachvak Fiord, 3) one from a basin north of Nachvak Fiord, 4) one from Archean gneiss terrain west of the Kaumajet Mountains and 5) one from the charnockitic suite 35 km west of Hebron Fiord in a stream that also has very high Zn.

The eleven samples with the highest Mo contents (>17 ppm) are from three areas. Six are from the lower parts of the Mugford Group (or Mugford–Archean unconformity); in contrast, most of the basins draining rocks of the upper portions of the Mugford Group have very low Mo contents. Four are from basins draining rocks of the Ramah Group and one is from a stream draining a granite on Coopers Island, 5 km south of the Kaumajet Mountains. The relatively low levels of abundance do not suggest the presence of significant Mo mineralization.

Lithophile Elements

Many of the lithophile elements (e.g., Li, Be, Cr, Rb, Sr, Y, REEs, Zr, Nb, Ba, Hf, Ta, Th and U) share some common geochemical associations. One measure of this is the Spearman correlation coefficient. Because of the variations in geological terrane and in LOI and Fe₄ of the samples collected in the two field seasons, coefficients were

calculated separately for each year and the following values are averages. Cr, Li and, to a lesser extent Sr, behave differently from most of the other lithophiles considered here. Chromium (Cr¹) correlates negatively or insignificantly with all others in the group except with Li ($r=0.23$). Lithium is negatively or insignificantly correlated with the other elements except Ba and Rb. Strontium also stands apart having generally low or no correlations with most of the elements. With these exceptions most of the others have positive correlations with each other. The light REEs are very strongly correlated (e.g., La¹ with Ce¹, $r=0.96$). The light–heavy REE correlations are progressively lower with increasing separation in the periodic table (e.g., La¹ with Yb¹, $r=0.47$). Some other strong correlations include Th¹ with La¹ ($r=0.85$), Th¹ with Ce¹ ($r=0.85$) and Ta¹ with Dy¹ ($r=0.77$).

Element-distribution maps of the lithophile elements were plotted and are described briefly. Lithium is markedly depleted in the streams from the Churchill Province relative to the Nain Province. High Be² values are found over the two granites and in several sediment samples draining Mugford Group rocks. The distribution of high Cr¹ values is largely restricted to mafic and ultramafic terrane between Bear's Gut and Ramah Bay. Most of the high Sr² values are found in the anorthosite area south of Nachvak Fiord. The distribution patterns of light and heavy REEs differ in several respects. The lights (e.g., La, Ce) are concentrated in streams from charnockites west of Primo Lake and a few from the fluorite-bearing granite south of Okak Bay. Yttrium and the heavy REEs (e.g., Dy and Yb) are enriched throughout the sampled area of the Tasiuyak gneiss and from streams draining the fluorite-bearing granite. Zones of Zr² enrichment are widespread but are particularly concentrated in the charnockitic terrane west of Primo Lake that is also characterized by high values of light REEs. Except for a few highs from streams underlain by the fluorite-bearing granite, high Nb values are found in streams located in a north-northeast-trending zone underlain by Tasiuyak gneiss and charnokite between Primo Lake and the west end of Nachvak Fiord. High Ba values are restricted to streams draining rocks of the Churchill Province and the fluorite-bearing granite. With the exception of two samples, all high Hf¹ and Th¹ values are from streams in the Churchill Province draining gneiss and charnokite.

Elements Associated with Kimberlites and Lamproites

Rocks of the Nain and Hopedale blocks in Labrador are currently being explored for their diamond potential. This area shares many features in common with geological terranes where diamonds have been found recently, such as Greenland and the Northwest Territories (Ryan, 1993). Kimberlites and lamproites, the igneous host rocks for diamond deposits, have distinctive geochemistry. Many of the elements enriched in these rocks have been analyzed in the stream sediments. These include Ni, Cr, Sr, Nb, Ba, Ta and light REEs. Probably no single element would be of much help in locating such rocks, themselves small targets, but the presence of a combination of these elements might distinguish their presence.

ELEMENT DISTRIBUTION IN STREAM WATER

Twenty-two elements were analyzed in water. Of these, 11 had detectable concentrations in most samples. The distributions of pH and conductivity plus the elements Cu, Ni, Zn, SO₄, Sr, P, Ba, Na and Ca are described here. High values of pH (>7.2) are associated with streams draining mafic and ultramafic terrane, rocks of the Mugford Group particularly the siliciclastic units, the area adjacent to and over the fluorite-bearing granite south of Okak Bay, Ramah Group sedimentary rocks and scattered areas of Archean gneiss. The most acidic areas (pH <6.5) are underlain by Churchill Province gneiss and charnokite. Conductivity determinations were done only on water samples collected in 1992. All of the highest values (>70 μS) are from sites <1 kilometre from the sea and likely result from contamination by marine aerosols. Most of the next highest group are from streams adjacent to the fluorite-bearing granite.

The base metals Cu and Ni have similar distributions and are quite distinct from that of Zn. The first two elements suffer from relatively high detection limits with fewer than half of the samples having detectable concentrations. All of the highest Cu values are from streams draining an area of Tasiuyak gneiss south of Ugjoktok Fiord. Elevated values (0.7 to 2.0 ppb) are distributed throughout the survey area although very few are from streams draining Mugford Group rocks, an area of high Cu in stream sediment. All but two of the highest Ni analyses in water (>9.5 ppb) are from streams draining the same area of Tasiuyak gneiss that has high-Cu analyses in water. The other two high-Ni samples are from a stream draining Mugford Group rocks and from a stream draining Archean gneiss south of Nachvak Fiord. The distribution of Zn in water displays very clear groupings in the cumulative frequency curve. Maps plotted using these intervals yield patterns in which analyses from entire areas fall nearly within a single interval (McConnell and Honarvar, 1994). For example, almost all streams draining the Mugford Group have very low values (<0.85 ppb Zn), most streams draining the granites have mid-range values (0.85 to 1.8 ppb), streams draining the Tasiuyak gneiss south of Ugjoktok Fiord have elevated to high (>13 ppb) Zn values and all streams draining the anorthosite near Noodleook Fiord have elevated values (3.9 to 8.3 ppb). Some of the streams with the highest Zn values, however, are from areas with otherwise background values. Two of these are streams in the Archean gneiss, south of Hebron Fiord, in the general area of some newly discovered sulphide occurrences where other streams have <0.85 ppb Zn. Another single sample anomaly occurs in the charnokite terrane west of Primo Lake. Another is from a stream draining suspected Zn mineralization in sedimentary rocks of the Ramah Group between Delabarre Bay and Nachvak Fiord.

The highest SO₄ analyses (>7.1 ppm) are from streams draining rocks of the Mugford Group, particularly samples collected low in the section, and from two areas of Ramah Group sedimentary rocks including one stream draining suspected Zn mineralization. Elevated values of SO₄ (3.8 to

7.1 ppm) are found in the area of high Cu, Ni and Zn in waters south of Ugjoktok Fiord, in streams draining the Mugford Group, in an area of Archean gneiss near sulphide mineralization south of Hebron Fiord, over the granite in the mouth of Okak Bay and in some streams adjacent to the fluorite-bearing granite.

Strontium displays distinctive distribution patterns. All samples in the highest, and most in the second highest category (>15 ppb), are from streams immediately adjacent to the granite south of Okak Bay. Analyses of phosphorous (P) suffer from a relatively high detection limit. All but three samples belonging to the two highest groupings (>22 ppb and >54 ppb) are from an area south of Hebron Fiord underlain by a mixture of metasedimentary, mafic and tonalite gneiss.

The streams with the highest Ba analyses (>7.5 ppb) are from two granite areas—the granite composing an island in the mouth of Okak Bay and the area adjacent to the fluorite-bearing granite south of Okak Bay. Most of the streams in the second highest group (> 5.8 ppb) are also from the same area near the fluorite-bearing granite and several are from streams draining Archean gneiss south of Hebron Fiord where sulphide mineralization was discovered in 1992.

Sodium and Ca distributions are quite similar in the middle and lower concentration ranges. All of the highest Na analyses (>4.1 ppm) and most of the second highest (>3.0 ppm) are from sites within 1 km of the sea. The highest Ca values are from three areas—streams draining the Mugford Group, streams draining the Ramah Group and two samples over the fluorite-bearing granite. Samples from sites in the Churchill Province generally have lower contents of Na and Ca than elsewhere.

MINERALIZED ROCK SAMPLES

Rocks suspected of being mineralized were sampled during the course of the stream survey. Analyses of most elements were reported previously (McConnell and Honarvar, 1993) but some are repeated here with the addition of some palladium, platinum and gold analyses by fire assay—ICP fluorescence performed by Chemex Laboratories of Vancouver. Table 6 lists all samples meeting any of the following analytical criteria: As^I >1000 ppm, Au^I >20 ppb, Au¹⁷ >20 ppb, Cu⁴ >1000 ppm, Mo² >100 ppm, Ni⁴ >2000 ppm, Pd¹⁷ >20 ppb, Pt¹⁷ >20 ppb and Zn⁴ >500 ppm. Samples 6242005 and 6242010 were from one of the most visually impressive showings—a zone of disseminated to semi-massive sulphides outcropping for a strike length of about 200 m with a thickness of 1 to 1.5 m. The mineralization is located in paragneiss in NTS 14L/02 just to the south of the mouth of Hebron Fiord. Sample 6242020 is from a similar mineralized zone about 1.5 km to the northwest. Another interesting sample is 6240016—a specimen of massive sulphides from NTS 24I/16 in the Churchill Province. The sample is from an outcrop of unknown strike extension with a thickness of about 1.5 m.

Table 6. Selected rock sample locations and analyses; gold and PGE data in ppb, all other in ppm

SAMPLE NUMBER	NTS	UTM EAST	UTM NORTH	As ¹	Au ¹	Au ¹⁷	Cu ⁴	Mo ²	Ni ⁴	Pd ¹⁷	Pt ¹⁷	Zn ⁴	ROCK DESCRIPTION
6240002	14L06	478300	6461550	1.2	15.0	22	307	4	105	24	2	31	sulphide-bearing granulite
6240007	14L03	472600	6441200	.2	14.0	14	1148	4	461	18	5	11	sulphide-bearing granulite
6240011	14L15	501350	6518510	.2	2.2	ND	12	1	2567	ND	ND	29	ultramafic
6240014	14M03	474050	6544030	3.0	1.0	ND	391	2	10	ND	ND	876	sulphide-bearing quartz vein
6240015	14M03	474050	6544030	64.0	39.0	30	6	88	7	26	10	6	graphitic schist
6240016	24I16	441590	6531150	2.9	39.0	16	59	143	467	4	2	11	massive sulphides
6240023	14M03	482750	6540500	.9	1.0	ND	7201	1	5	ND	ND	9	sulphide-bearing sandstone
6242005	14L02	523455	6436853	.5	3.9	6	2657	7	170	4	5	71	sulphide-bearing schist
6242007	14L02	523405	6436898	.6	1.0	44	416	6	309	1	10	39	sulphide-bearing gneiss
6242010	14L02	523440	6436868	.2	1.0	58	720	6	2023	12	2	78	sulphide-bearing schist
6242020	14L02	522590	6438100	.2	8.3	<20	1411	7	374	<20	<20	63	sulphide-bearing gneiss
6242026	14L02	526960	6436890	.2	1.0	<20	13	3	2923	<20	<20	24	metamafic
6242039	14M03	473750	6565450	.2	1.0	1	3	3	2007	1	2	43	ultramafic
6242041	14L02	525650	6438150	.2	1.0	1	3	4	2484	1	10	31	peridotite
6242042	14L02	523600	6441580	3440	18.0	12	369	6	635	10	50	112	sulphide-bearing gneiss

Note: - samples 6242005, -10 and -20 are from extensive mineralized zones
 -ND indicates not determined

CONCLUSIONS

The stream-sediment data obtained from this survey provide several direct guides for mineral exploration. Gold analyses are generally low in the survey area but some of the highest values are comparable to those found elsewhere in mineralized areas and some areas, such as portions of the Mugford Group, are clearly enriched in gold. These may warrant prospecting. There is insufficient improvement in the quality of the gold data from panned concentrates (HMCs) relative to data from the <63 µm fraction of active sediment to justify their collection.

Several areas are identified as prospective for base metals. Stream-sediment geochemistry clearly indicates that the Mugford Group is enriched in Cu. This, together with the presence of small occurrences of sulphide mineralization including chalcopyrite, leads to the recommendation for follow-up prospecting in this area. Two high-Cu analyses from Archean gneiss terrane are also worthy of attention. It is difficult to assess the significance of high Ni values in sediment. They may be due to either high background values in mafic and ultramafic rocks or to sulphide mineralization. The contrast in concentration of total Ni (Ni²) with *aqua regia* soluble Ni (Ni⁴) in the sample with the highest Ni suggests the presence of mostly silicate-held Ni. The high levels of Zn in some sediment samples are strongly suggestive of the presence of Zn mineralization in the associated drainage basins.

The lithophile elements, with the possible exception of Cr, are not present in levels indicative of mineralization. However, they depict a variety of patterns that may prove valuable in distinguishing bedrock geochemistry within areas that are geologically mapped as a single unit. In addition, stream-sediment analyses of Ni, Cr, Sr, Nb, Ba, Ta and the light-REEs might be used in combination to identify basins hosting kimberlites or lamproites.

Water analyses are more difficult than sediment analyses to relate directly to bedrock composition since many other factors such as mineral solubility, pH and Eh contribute to the overall concentrations in water. Nonetheless properly interpreted, they provide a wealth of information. The distribution of pH in water can be used to interpret possible rock types. Cu, Ni and Zn values are enriched in an area of Tasiuyak gneiss that also has high SO₄ values and might be worthy of prospecting. High Zn values in water are associated with a mineralized area in the Ramah Group and high values elsewhere may also reflect mineralization. Phosphorous suffers from a relatively high detection limit but the higher values are clearly associated with areas underlain by paragneiss and may be useful for mapping such rocks.

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