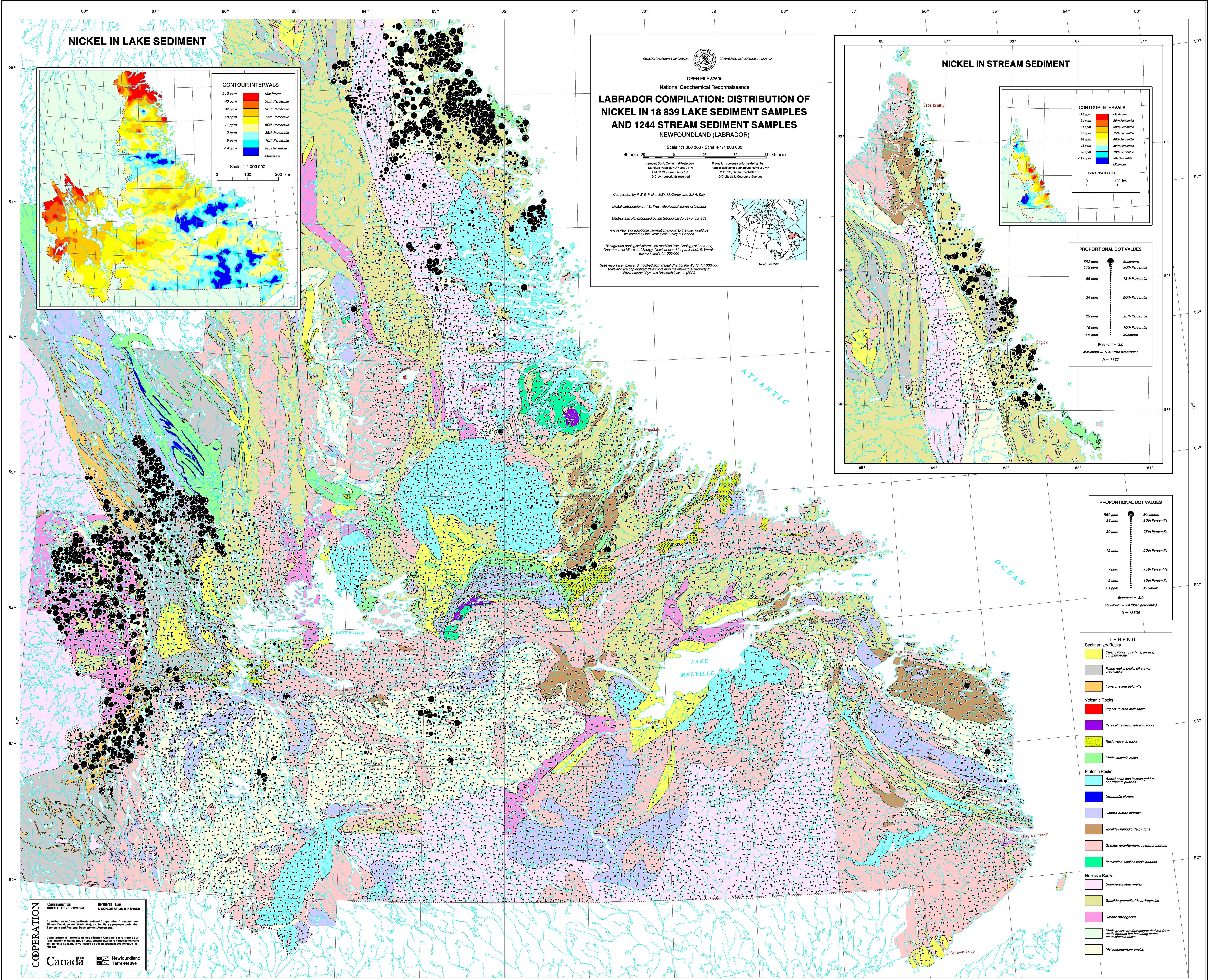
Natural Resources Canada / Ressources naturelles Canada



GEOLOGICAL SURVEY OF CANADA — COMMISSION GÉOLOGIQUE DU CANADA

OPEN FILE 3260b

National Geochemical Reconnaissance

LABRADOR COMPILATION: DISTRIBUTION OF NICKEL IN 18 839 LAKE SEDIMENT SAMPLES AND 1244 STREAM SEDIMENT SAMPLES

NEWFOUNDLAND (LABRADOR)

Scale 1:1 000 000 - Échelle 1/1 000 000

Kilometres 25 0 25 50 75 Kilomètres

Lambert Conic Conformal Projection	Projection conique conforme de Lambert
Standard Parallels 49°N and 77°N	Parallèles d'échelle conservée 49°N et 77°N
CM 62°W, Scale Factor 1.0	M.C. 62°, facteur d'échelle 1,0
© Crown copyrights reserved	© Droits de la Couronne réservés

Compilation by P.W.B. Friske, M.W. McCurdy, and S.J.A. Day

Digital cartography by T.D. West, Geological Survey of Canada

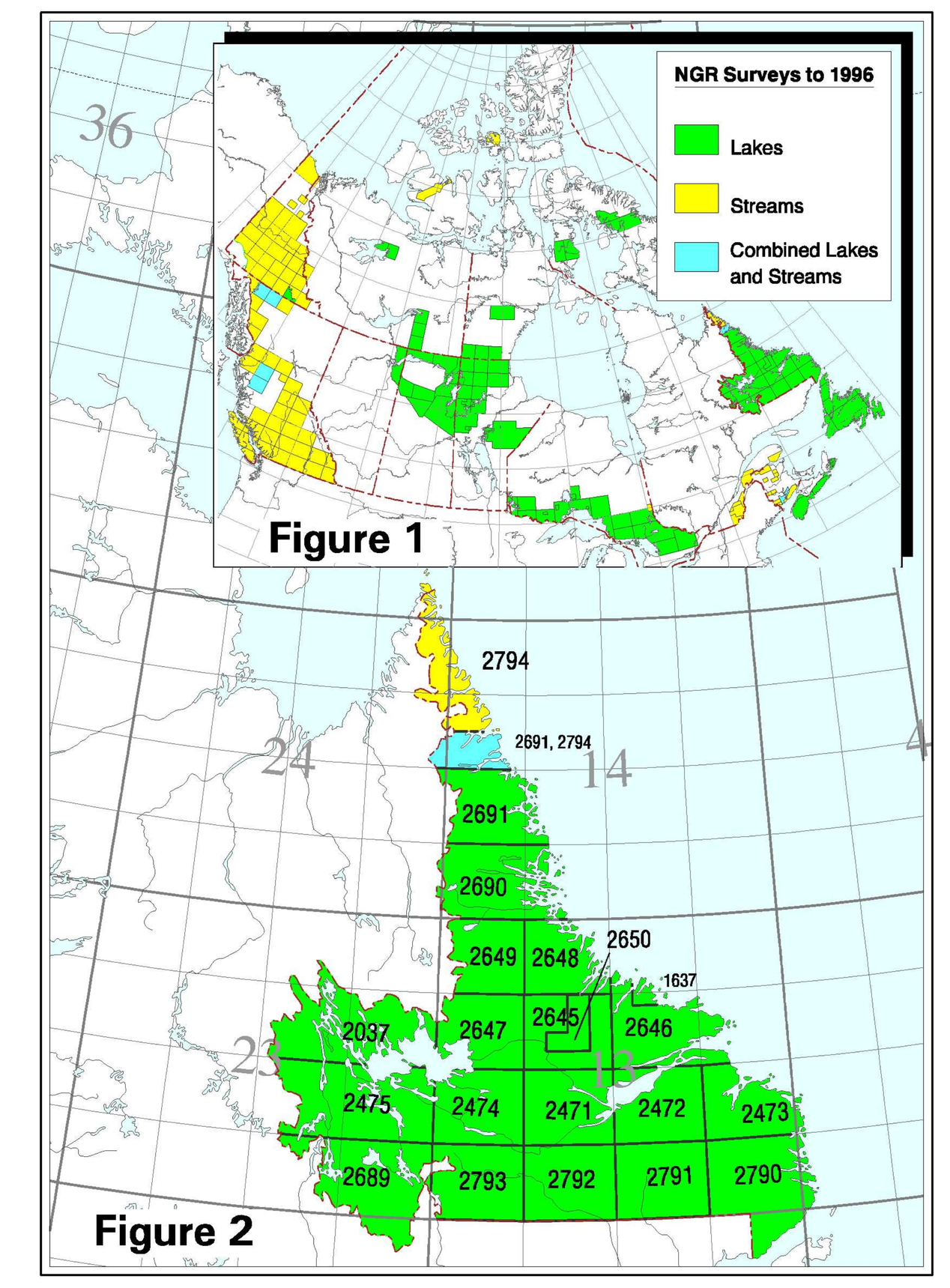
Electrostatic plot produced by the Geological Survey of Canada

Any revisions or additional information known to the user would be welcomed by the Geological Survey of Canada

Background geological information modified from Geology of Labrador; Department of Mines and Energy, Newfoundland (unpublished), R. Wardle (comp.), scale 1:1 000 000

Base map assembled and modified from Digital Chart of the World, 1:1 000 000 scale and are copyrighted data containing the intellectual property of Environmental Systems Research Institute (ESRI)

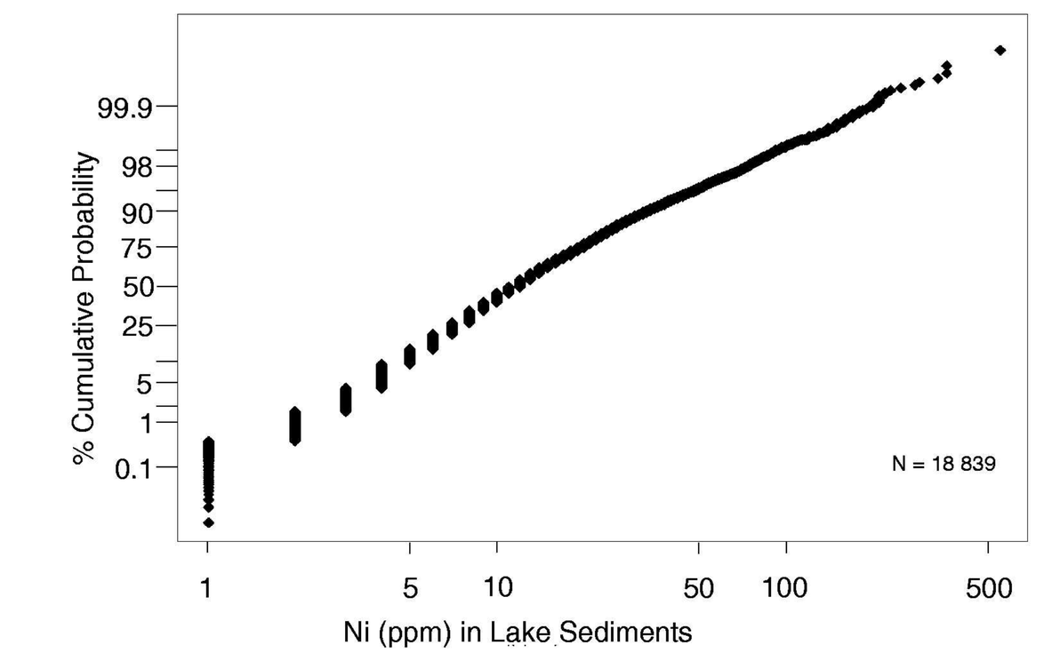
LOCATION MAP

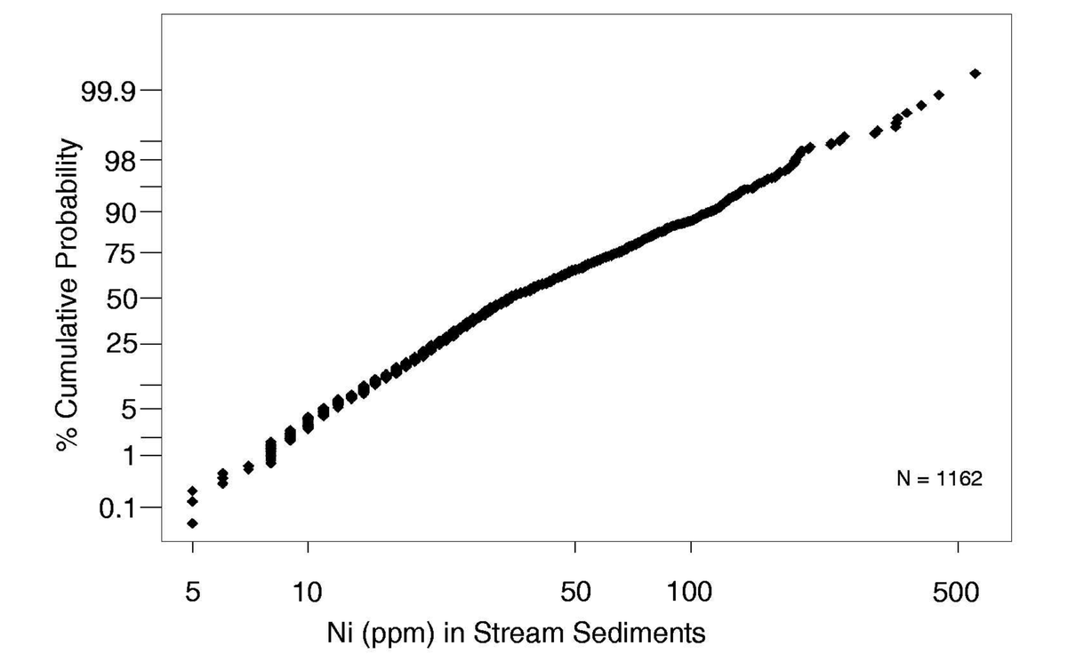


SUMMARY STATISTICS FOR SELECTED ELEMENTS

	Cu	Hg	LOI	Ni	Pb	U	Zn
Lake sediments							
Number of Values	18 839	18 716	18 830	18 839	18 839	18 852	18 839
Detection Limit	2	10	1	2	2	0.2	2
Units	ppm	ppb	pct	ppm	ppm	ppm	ppm
Analytical Method	AAS	HY-AAS	Grav	AAS	AAS	NADNC	AAS
Mean	26.4	82.2	27.4	17	2.5	3.8	89.1
Std Deviation	23.9	53	14.1	19.2	4.74	10.7	123.5
Median	20	70	27.8	12	<2	1.9	73
Minimum Value	<2	<10	<1	<2	<2	<0.2	2
5th Percentile	***6***	***28***	***5.4***	***4***	***<2***	***0.4***	***27***
10th Percentile	8	30	8.6	5	<2	0.6	34
25th Percentile	12	50	17.6	7	<2	1	48
50th Percentile	***20***	***70***	***27.8***	***12***	***<2***	***1.9***	***73***
75th Percentile	32	100	35.4	20	3	3.6	108
90th Percentile	50	144	43.6	33	5	7.4	154
95th Percentile	***67***	***180***	***49.5***	***49***	***7***	***11.9***	***190***
98th Percentile	96	230	59.3	74	10	21.8	260
Maximum Value	450	900	98.5	550	365	926	13 500
Stream sediments							
Number of Values	1162	1159	1104	1162	1162	1131	1162
Detection Limit	2	10	1	2	2	0.2	2
Units	ppm	ppb	pct	ppm	ppm	ppm	ppm
Analytical Method	AAS	HY-AAS	Grav	AAS	AAS	INAA	AAS
Mean	45	30.9	8	52	7.8	2.3	63
Std Deviation	30	30.6	8.7	50	7.7	3.9	143
Median	39	20	5.4	34	6	1.6	48
Minimum Value	5	<10	<1	5	<2	<0.2	10
5th Percentile	***12***	***10***	***<1***	***11***	***<2***	***0.6***	***19***
10th Percentile	16	10	1.2	15	2	0.8	23
25th Percentile	24	15	2.6	22	3	1.1	33
50th Percentile	***39***	***20***	***5.4***	***34***	***6***	***1.6***	***48***
75th Percentile	57	40	10.6	64	9	2.4	72
90th Percentile	83	60	17	112	16	3.7	100
95th Percentile	***100***	***75***	***23.8***	***146***	***22***	***5.1***	***121***
98th Percentile	130	115	34.8	188	28	9	166
Maximum Value	308	410	78.4	552	98	81.2	4200

AAS - *atomic absorption spectrometry*
Grav - *gravimetric*
HY-AAS - *hybride evolution / atomic absorption spectrometry*
NADNC - *neutron activation / delayed neutron counting*
INAA - *instumental neutron activation analysis*





INTRODUCTION

Large areas of Canada have been covered by stream and lake surveys carried out under the National Geochemical Reconnaissance (NGR) program. The goal of this program is to establish and maintain a nationally consistent database of field and analytical data derived from drainage sediment and water samples. Toward this end, systematic surveys have been conducted since 1973. To date (1996), more than 200 surveys have been completed to NGR standards, representing over 190 000 sites covering 2.3 million km^2 throughout Canada (Figure 1). These were carried out mainly by the Geological Survey of Canada, either independently or in cooperation with provinces and territories, under various funding arrangements.

Consistent methods of sample collection, sample preparation and chemical analysis developed and employed at the GSC are the hallmark of NGR surveys (Friske and Hornbrook, 1991). Geochemical surveys carried out by the GSC or provincial/territorial agencies, shown in Figure 1, fulfil these criteria and qualify as NGR surveys.

At present, data for each NGR survey are available in hard copy and digital form. However, to simplify access to the voluminous amount of information, a digital database is being created using Microsoft ACCESS software. As entry of large contiguous blocks of data (e.g. all Labrador lake sediment and water data) is completed, geochemical maps and reports are being produced that display and summarize the data. The aim of this second generation of publications is to increase awareness of NGR data and enhance applications not only to mineral exploration but in other areas as well, such as public health and environmental studies.

This map summarizes the distribution of nickel from 18 839 lake sites and 1244 stream sites in Labrador sampled between 1977 and 1986. Figure 2 shows the individual open files that make up the Labrador compilation. Detailed, site-specific information is available in these open files.

SURVEY METHODOLOGY

A detailed description of the NGR survey methodology is given in Friske and Hornbrook (1991). Below is a brief summary, with particular reference to the Labrador lake and stream sediment and water surveys.

Sample Collection

Lake Surveys

Sample collection is carried out by two-person sampling crews in helicopters mounted on floats. An ideal sample comes from a lake less than 5 km^2 in size and greater than 3 metres deep, with a single central basin that is the focus of drainage in the area around the sample site.

Sediment is collected from a centre-lake profundal basin using a hollow-pipe, bottom-valved sampler (85 cm long x 10 cm diameter) attached to an external winch and rope system mounted on the fuselage of the helicopter. Generally, the full length of the sampler penetrates into the bottom sediment and the sample represents a 30 to 35 cm section from several tens of centimetres below the sediment-water interface. However, if relatively clastic-rich material is encountered, the sampler may not penetrate its full length, and some surface material is included. The ideal sample material is an organic-rich sediment *(gyttja)*, commonly a greenish-brown to grey thixotropic gel, but clay, marl and/or sandy samples may also be encountered. At each site, field observations such as lake size, lake depth and local relief are recorded.

Lake waters are routinely collected at all lake sediment sites. Rectangular wide-mouth polyethylene bottles (250 ml) are used to sample water from depths of 20 cm or more below the surface of the lake. The inclusion of suspended materials is avoided as much as possible.

Stream Surveys

A regional stream sediment and water survey was carried out in northern Labrador in 1986. A total of 1244 sites were sampled. This was the only major stream sediment survey carried out in Labrador by the GSC, although a small survey in the Makkovik area was completed in 1987. The results appeared in GSC Open File 1637.

Stream sediment surveys are typically undertaken in mountainous or hilly terrains where streams occur more frequently than lakes. Samples are collected from helicopters by two-person crews, a navigator/data recorder and a collector.

Ideal samples consist of silt (1/16 - 1/256 mm) gathered at a point on a primary or secondary stream just below a 'break', a point where the grade decreases, the flow of water slows, and sediments are deposited. After a 250-ml water sample is collected in a wide- mouth polyethylene bottle, sediments are gathered as much as possible from the active main channel, usually from the lee side of stationary rocks or other channel obstructions. Obvious bank sediments, sand, pebbles, sticks, etc. are avoided. At some sites, clumps of moss growing in the main channel are collected, as suitable sediments often accumulate within the root mass. Site characteristics (water depth, stream width, water colour, bank composition, unusual stains or precipitates, etc.) are noted and passed along to the navigator/data recorder by the collector.

Sample Preparation and Analysis

Both lake sediment and stream sediment samples are initially field-dried. Sample preparation for lake sediments consists of crushing the fully dried sample into small (5 mm or less) fragments, followed by further reduction in ceramic mills to -200 mesh. Stream sediments are sieved, and the -80 mesh portion (177 micron) reduced to -200 mesh in ceramic mills. Any material not milled or used in the analytical procedures is put into long-term storage.

The existence of an NGR sample archive allows the GSC to take full advantage of improvements and developments in the field of analytical chemistry, and since 1973 Labrador lake and stream sediments have been analyzed and reanalyzed for a considerable range of elements. At all sites, data are available for Ag, As, Au, Ba, Br, Ce, Co, Cr, Cs, Cu, Eu, F, Fe, Hf, Hg, La, Lu, LOI (loss-on-ignition), Mn, Mo, Na, Ni, Pb, Rb, Sb, Sc, Sm, Ta, Tb, Th, U, W, Yb, and Zn. Vanadium and cadmium data exist for some areas, and stream sediment surveys include analytical data for Sn. All water samples were analyzed for U, F, and pH. Analytical procedures are a combination of Instrumental Neutron Activation analysis (INAA), atomic absorption spectrometry (AAS), and specific techniques. Data for the elements determined and the methods used are included in individual open files for each area (Fig. 1).

Nickel data are available for all samples. The analytical procedure used to determine nickel concentrations in lake sediments is virtually identical for all samples. A 1.0 gram sample is placed in a test tube; 6 ml of a 3:1 mixture of 4M HNO_3 and 1M HCl are added and the solution is allowed to stand overnight at room temperature. After digestion, the test tube is immersed in a water bath at room temperature, brought up to 90° C, and held at this temperature, with periodic shaking, for two hours.

For stream sediments, 3 ml concentrated HNO_3 are added to 1.0 gram of sample in a test tube and allowed to react overnight at room temperature. After digestion, the test tube is immersed in a water bath at room temperature, brought up to 90° C, and held at this temperature, with periodic shaking, for 30 minutes. One ml of concentrated HCl is added and heating continues for another 90 minutes.

At this point, both lake sediment and stream sediment sample solutions are diluted to 20 ml with metal-free water and mixed. Nickel, along with copper, zinc, lead, cobalt, silver, manganese, iron and cadmium are then determined by AAS using an air-acetylene flame. The detection limit for nickel is 2 ppm. Although this is a 'partial' extraction, studies have shown that for lake sediments this procedure is very nearly a 'total' extraction for many trace metals, including nickel (Davenport et al., 1992; Lynch, 1990).

Quality Control

One of the most important characteristics of NGR surveys is the structure of the sampling routine. Each block of 20 consecutive field numbers consists of 17 routine field samples, a field duplicate sample, a blind (analytical) duplicate sample and a control reference sample. The field duplicate sample is a separate sample collected at one of the 17 routine sites, at the discretion of the sampling team. One number, always the first in a block of 20 (i.e. 001, 021, 041, etc.) is reserved for a blind duplicate. The sample preparation laboratory splits a sample in the block, preferably one of the field duplicate samples, and places one of the splits into the blind duplicate position. A randomly pre- selected number within a block of 20 is reserved for a control reference sample. Control reference samples are lake or stream sediments with well-established analytical values.

Field duplicates, blind duplicates and control reference samples are incorporated in every block of 20 samples, and are used to monitor and control sampling and analytical variance. As a result of stringent quality control and consistency of analytical methods over time, it is possible to generate a regional compilation for nickel without any significant boundary effects between the different surveys. A 10 ppm nickel value from a lake sediment analyzed in 1977 is directly comparable to a 10 ppm nickel value determined in 1986, not only from Labrador, but from any NGR lake sediment survey across Canada.

Data Presentation

Relative concentrations of nickel in Labrador drainage sediments are illustrated with two types of graphic image created using ARC/INFO geographic information system (GIS) software. The smaller contour plots represent smoothed surfaces depicting broad regional trends in the nickel data. Actual values of nickel concentrations at specific sites are represented with proportional dot plots. Proportional dot plots display more detailed information and indicate the location of anomalous values. This style of presentation also facilitates the use of the bedrock geology as a background, allowing easy visual evaluation of the relationship between geology and nickel distribution.

Contour plots were created using the IDW (inverse distance weighting) and FILTER functions within ARC/INFO. Nickel data were converted to log_{10} values, and interpolated to a 1.0 km^2 grid surface from the irregularly spaced sample sites. The data were then further smoothed with the FILTER function, which passes a 3 X 3 filter over the grid. The 'low' option was used, which results in the 9 nickel values being weighted equally to calculate a new value for each grid cell. This filter was passed over the grid 6 times. The 1.0 km^2 cells were then assigned colours based on cell values to create contour maps.

Proportional dot plots were created using the SPOTSIZE function. The maximum spot diameter corresponds to the value of the 98th percentile (74 ppm for lakes; 188 ppm for streams). Sites with nickel values greater than or equal to the 98th percentile are represented by circles with the maximum diameter. The smallest diameter corresponds to the minimum value, set to 1 ppm (one-half detection limit). Values between the minimum and maximum correspond to diameters fitting an exponential curve $y=x^3$.

The geological base to this map depicts the geology of Labrador solely on the basis of rock type. It was prepared by R.J. Wardle of the Newfoundland Geological Survey, Department of Mines and Energy, Government of Newfoundland and Labrador, using unpublished material from a new 1:1 million geological compilation of Labrador currently in preparation. Geological boundaries demarcated by straight lines indicate limits of detailed mapping.

SELECTED REFERENCES

Ballantyne, S.B.
1991: Stream sediment geochemistry in the Canadian Cordillera: conventional and future applications for exploration; *in* Exploration Geochemistry Workshop, Geological Survey of Canada Open File 2390, Paper #6, pp. 6-1 to 6-74.

Cameron, E.M., and Ballantyne, S.B.
1977: Reconnaissance-level geochemical and radiometric exploration data from the vicinity of the Rabbit Lake uranium deposit; The Canadian Institute of Mining and Metallurgy Bulletin, Volume 70, p. 76-85.

Coker, W.B. and Shilts, W.W.
1979: Lacustrine geochemistry around the north shore of Lake Superior: implications for evaluation of effects of acid precipitation; Geological Survey of Canada, Paper 79-1C, p. 1-15.

Coker, W.B., Hornbrook, E.H.W. and Cameron, E.M.
1979: Lake sediment geochemistry applied to mineral exploration; *in* Geophysics and Geochemistry in the Search for Metallic Ores, ed., P.J. Hood; Geological Survey of Canada, Economic Geology Report 31, p. 435-477.

Davenport, P.H., Christopher, T.K., Vardy, S. and Nolan, L.W.
1992: Geochemical mapping in Newfoundland and Labrador: its role in establishing geochemical baselines for the measurement of environmental change; Current Research, Newfoundland Department of Mines and Energy, Geological Survey Branch; Report 92-1, p. 281-296.

Davenport, P.H. and Friske, P.W.B.
1993: Geochemical Atlases of Newfoundland and Labrador; Newfoundland Department of Mines and Energy, Report of Activities 1993, p. 6.

Davenport, P.H., Nolan, L.W. and Honarvar, P.
1994: The digital geochemical atlas of Newfoundland; Current Research (1994), Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 94-1, p. 279-299.

Friske, P.W.B.
1985: Regional geochemical reconnaissance: interpretation of data from the north shore of Lake Superior; Geological Survey of Canada, Paper 84-21, 38 p.

Friske P.W.B.
1991: The application of lake sediment geochemistry in mineral exploration; Geological Survey of Canada Open File 2390, Paper #4, p. 4-1 to 4-20.

Friske, P.W.B. and Coker, W.B.
1995: The importance of geological controls on the natural distribution of mercury in lake and stream sediments across Canada; Water, Air, and Soil Pollution, Volume 80, p. 1047-1051.

Friske, P.W.B. and Hornbrook, E.H.W.
1991: Canada's National Geochemical Reconnaissance programme; Transactions of the Institution of Mining and Metallurgy, Section B, Volume 100, p.47-56.

Friske, P.W.B., McCurdy, M.W., Day, S.J.A. and Adcock, S.W.
1994: National Geochemical Reconnaissance - Ontario compilation; Distribution of copper in 17 934 lake sediment samples; Geological Survey of Canada Open File 2959., map, scale 1:1 000 000.

Garrett, R.G.
1969: The determination of sampling and analytical errors in exploration geochemistry; Economic Geology, Volume 64, p. 568-569.

Garrett, R.G.
1974: Field data acquisition methods for applied geochemical surveys at the Geological Survey of Canada; Geological Survey of Canada, Paper 74-52, 36p.

Garrett, R.G., Banville, R.M.P. and Adcock, S.W.
1990: Regional geochemical data compilation and map preparation, Labrador, Canada; *in* Regional Geochemical Mapping, eds., A.G. Darnley and R.G. Garrett; Journal of Geochemical Exploration, Volume 39, p. 91-116.

Geological Survey of Canada
1987: Regional stream sediment and water geochemical reconnaissance data, northern Labrador (parts of NTS 14L, 14M, 24I, 24P, and 25A); Geological Survey of Canada Open File 1354; 25 maps, 113 p.

Hornbrook, E.H.W. and Garrett, R.G.
1976: Regional geochemical lake sediment survey east-central Saskatchewan; Geological Survey of Canada, Paper 75-41, 20p.

Johnson, M.G., Culp, L.R. and George S.E.
1986: Temporal and spatial trends in metal loadings to sediments of the Turkey Lakes, Ontario; Canadian Journal of Fisheries and Aquatic Sciences, Volume 43, p. 754-762.

Jonasson, I.R.
1976: Detailed hydrogeochemistry of two small lakes in the Grenville geological province; Geological Survey of Canada, Paper 76-13, 37 p.

Kerr, A. and Davenport, P.H.
1990: Application of geochemical mapping techniques to a complex Precambrian Shield area in Labrador, Canada; *in* Regional Geochemical Mapping, eds., A.G. Darnley and R.G. Garrett; Journal of Geochemical Exploration, Volume 39, p. 225-247.

Lynch, J.J.
1990: Provisional elemental values for eight new geochemical lake sediment and stream sediment reference materials LKSD-1, LKSD-2, LKSD-3, LKSD-4, STSD-1, STSD-2, STSD-3 and STSD-4; Geostandards Newsletter, Volume 14, Number 1, p. 153-167.

Maurice, Y.T.
1977: Geochemical methods applied to uranium exploration in southwest Baffin Island; The Canadian Institute of Mining and Metallurgy Bulletin, Volume 70, p. 96-103.

McConnell, J.W.
1988: Lake sediment and water geochemical surveys for rare-metal mineralization in granitoid terranes in Churchill Province, Labrador; Newfoundland Department of Mines and Energy, Open File Lab 772, 100 p.

McConnell, J.W. and Batterson, M.J.
1987: The Strange Lake Zr-Y-Nb-Be-REE deposit, Labrador: a geochemical profile in till, lake and stream sediment, and water; Journal of Geochemical Exploration, Volume 29, p. 105-127.

Meyer, W.T., Theobald, P.K. Jr. and Bloom, H.
1979: Stream sediment geochemistry; *in* Geophysics and Geochemistry in the Search for Metallic Ores, ed. P.J. Hood; Geological Survey of Canada, Economic Geology Report 31, p. 411-434.

Plant, J.A., Hale, M. and Ridgway, J.
1989: Regional geochemistry based on stream sediment sampling, Paper 31 *in* Proceedings of Exploration '87: Third Decennial International Conference on Geophysical and Geochemical Exploration for Minerals and Groundwater, ed. G. Garland; Ontario Geological Survey, Special Volume 3, p. 384-404.

Ramsey, M.H., Thompson, M. and Hale, M.
1992: Objective evaluation of precision requirements for geochemical analysis using robust analysis of variance; Journal of Geochemical Exploration, Volume 44, p. 23-36.

Rogers, P.J., Chatterjee, A.K. and Aucott J.W.
1990: Metallogenic domains and their reflection in regional lake sediment surveys from the Meguma Zone, southern Nova Scotia, Canada; *in* Regional Geochemical Mapping, eds., A.G. Darnley and R.G. Garrett; Journal of Gechemical Exploration, Volume 39, p. 153-174.

OPEN FILE
DOSSIER PUBLIC
3260b
GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA
OTTAWA
05/1996

Published 1996

Recommended citation:
Friske, P.W.B., McCurdy, M.W., and Day, S.J.A.
1996: National Geochemical Reconnaissance - Labrador compilation: distribution of nickel in 18 839 lake sediment samples and 1244 stream sediment samples, Newfoundland (Labrador). Geological Survey of Canada, Open File 3260b, scale 1:1 000 000

Canada