





Large areas of Canada have been covered by stream and lake surveys carried out under the National Ballantyne, S.B. Geochemical Reconnaissance (NGR) program. The goal of this program is to establish and maintain a 1991: Stream sediment geochemistry in the Canadian Cordillera: conventional and future applications for 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 km² throughout Canada (Figure 1). These were carried out mainly by the Geological Survey of Cameron, E.M., and Ballantyne, S.B. Canada, either independently or in cooperation with provinces and territories, under various funding

1977: Reconnaissance-level geochemical and radiometric exploration data from the vicinity of the Rabbit 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 Coker, W.B. and Shilts, W.W. 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 zinc from 18 839 lake sites and 1244 stream sites in Labrador

Davenport, P.H., Christopher, T.K., Vardy, S. and Nolan, L.W. sampled between 1977 and 1986. Figure 2 shows the individual open files that make up the Labrador 1992: Geochemical mapping in Newfoundland and Labrador: its role in establishing geochemical baselines 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

Lake Surveys

Quality Control

Data Presentation

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<sup>2</sup> in size and greater than 3 metres deep, with a single Friske, P.W.B. 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 Friske P.W.B. 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.

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 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. 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 Garrett, R.G. or other channel obstructions. Obvious bank sediments, sand, pebbles, sticks, etc. are avoided. At some 1974: Field data acquisition methods for applied geochemical surveys at the Geological Survey of Canada; 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 Garrett, R.G., Banville, R.M.P. and Adcock, S.W.

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 Geological Survey of Canada (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 Hornbrook, E.H.W. and Garrett, R.G. developments in the field of analytical chemistry, and since 1973 Labrador lake and stream sediments 1976: Regional geochemical lake sediment survey east-central Saskatchewan; Geological Survey of 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). Zinc data are available for all samples. The analytical procedure used to determine zinc 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<sub>3</sub> 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<sub>3</sub> are added to 1.0 gram of sample in a test tube and 1990: Application of geochemical mapping techniques to a complex Precambrian Shield area in Labrador, 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 Lynch, J.J. metal-free water and mixed. Zinc, along with copper, nickel, lead, cobalt, silver, manganese, iron and 1990: Provisional elemental values for eight new geochemical lake sediment and stream sediment reference cadmium are then determined by AAS using an air-acetylene flame. The detection limit for zinc 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 zinc (Davenport et al., 1992; Lynch, 1990).

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 McConnell, J.W. and Batterson, M.J. 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 Meyer, W.T., Theobald, P.K. Jr. and Bloom, H. compilation for zinc without any significant boundary effects between the different surveys. A 10 ppm zinc

1979: Stream sediment geochemistry; in Geophysics and Geochemistry in the Search for Metallic Ores, ed. value from a lake sediment analyzed in 1977 is directly comparable to a 10 ppm zinc value determined in 1986, not only from Labrador, but from any NGR lake sediment survey across Canada.

Relative concentrations of zinc 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 zinc data. Actual values of zinc concentrations at specific sites are represented with proportional dot plots. Proportional dot plots Ramsey, M.H., Thompson, M. and Hale, M. display more detailed information and indicate the location of anomalous values. This style of presentation

1992: Objective evaluation of precision requirements for geochemical analysis using robust analysis of also facilitates the use of the bedrock geology as a background, allowing easy visual evaluation of the relationship between geology and zinc distribution. Contour plots were created using the IDW (inverse distance weighting) and FILTER functions within Rogers, P.J., Chatterjee, A.K. and Aucott J.W. ARC/INFO. Zinc data were converted to log<sub>10</sub> values, and interpolated to a 1.0 km<sup>2</sup> 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 zinc 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<sup>2</sup> 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 (260 ppm for lakes; 176 ppm for streams). Sites with zinc 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<sup>3</sup>. 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.

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