Putting It All Together — Surficial Geochemistry Maps for Large Areas of Canada

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INTRODUCTION

The Geological Survey of Canada (GSC), under the National Geochemical Reconnaissance (NGR) Program, has been carrying out systematic regional lake and stream sediment surveys, mainly in the Canadian Cordillera and Canadian Shield, since 1973 (Friske and Hornbrook, 1991). Analytical results for over 200 individual surveys are available in both printed and digital form. Provincial organisations in Québec, Nova Scotia, Newfoundland, Ontario and British Columbia have also carried out regional sampling programs. Additional Canadian coverage is provided by soil surveys carried out by the GSC to create a mineralogical and geochemical database for prairie tills in Manitoba, Saskatchewan and Alberta (Garrett, 1994).

The GSC has published regional compilations for a number of elements in Labrador and Ontario. A series of 16 maps graphically illustrating NGR lake and stream sediment data for Labrador has been issued at 1:1 000 000 scale, and a similar series derived from NGR lake sediment data for Ontario is in progress. Series based on New Brunswick and Yukon data are planned.

Work started in 1996 on national compilations illustrating relative concentrations of elements (copper, zinc, and mercury) in drainage sediments and soils for the areas shown in Figure 1. For this series a number of other sets of regional geochemical data (Table 1) were examined and made compatible with the digital NGR data.

Provincial data for Québec include analytical data from over 80 000 lake sediment sample sites. Stream sediment data available from the province are currently being reviewed. Digital data were obtained from the Québec Ministry of Energy and Resources. Samples were collected between 1965 and present (Kirouac, 1990).

The Newfoundland Department of Mines and Energy made available an analytical data set complete for 31 elements from over 17 000 organic lake sediments collected between 1973 and 1981. Lake sediment and water surveys cover the entire island, an area of 112 000 km^2 (Davenport *et al.*, 1994).

Analytical data for over 2800 lake samples and approximately 8200 stream samples collected from 1971 to 1987 (Lombard, 1991) were obtained from the Nova Scotia Department of Mines and Energy. The combination of lake and stream sediment surveys represents complete coverage over the province of Nova Scotia. Lake sediment samples are a subset of approximately 3400 samples collected from southern Nova Scotia in 1978–79 with a sampling density of about onesite per 7.9 km^2 over an area of 27 000 km^2 (Rogers and Lombard, 1990).

The Prairie data set (Figure 1), collected in 1992, comprises analytical results from 978 of 1273 samples of A-horizon soils over 850 000 km^2 of Manitoba, Saskatchewan and Alberta and the immediately adjoining American states (Garrett, 1994). The sampling density is approximately one site per 800 km^2.

DATA PRESENTATION

Regional

Relative concentrations of elements in sediments or waters at sampling sites are illustrated with two types of graphic images, shaded contour plots and proportional spot plots. Contour plots depict broad regional trends. Analytical data are $\log_{10}$ transformed to a 1.0 km^2 cell size generated from the irregularly spaced sample sites. To smooth the data, a low-pass filter consisting of a 3-cell by 3-cell moving window calculates the mean of nine equally weighted values over the neighbourhood and assigns this value to the central cell. This filter is passed over the grid six times. Proportional spot plots represent elemental concentrations at specific sites. The maximum spot is set based on the 98th percentile value. The smallest spots represent minimum values. Values between the minimum and maximum correspond to diameters fitting an exponential curve $y=x^z$, where z equals some value, usually between two and five, that best illustrates the contrast between anomalous and background areas. Bedrock geology is used as a background on the proportional spot maps, facilitating a visual evaluation of the relationship between geology and element distributions.

National

National geochemical compilation maps consist of a number of different data sets collected and analysed by different methods. In order to make each set compatible with NGR data, analytical values are first $\log_{10}$ transformed and site co-ordinates converted to a Lambert Conformal Projection using distance units of metres. A grid is produced by interpolating the irregularly spaced sample site data to a regular grid with

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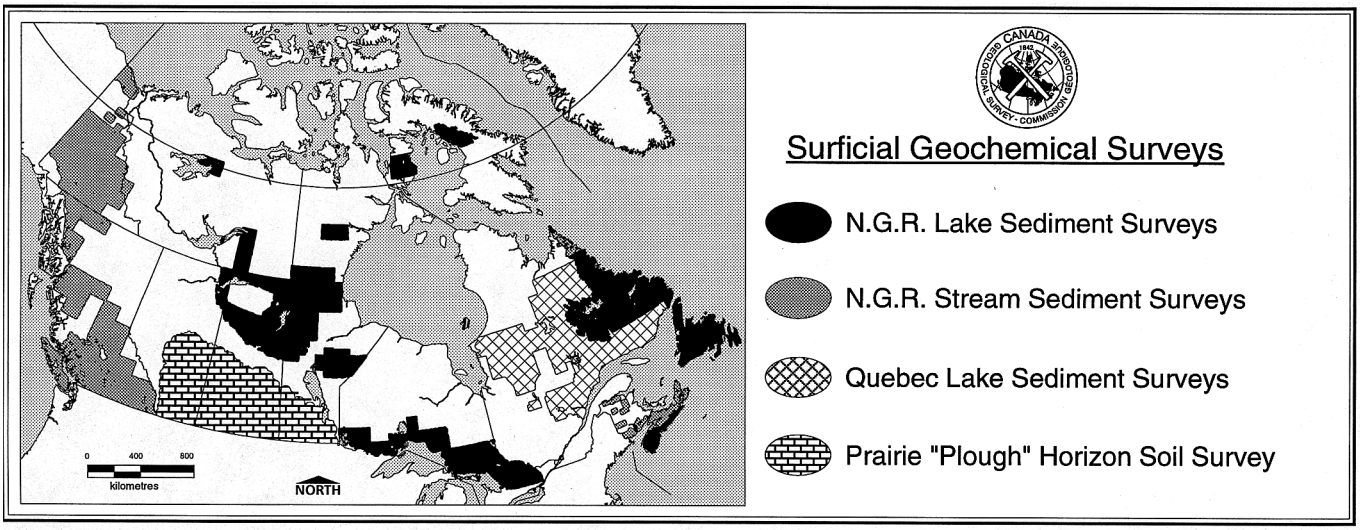

Figure 1: *Areas used in national compilations illustrating relative concentrations of elements in soils and sediments.*

cells 2500 m on a side. Data are smoothed using a moving average of points within a circular zone of influence (Bonham-Carter, 1994). Although an inverse distance weighting (IDW) algorithm is employed to calculate cell values, up to 15 sites within the maximum search radius of 15 000 metres are assigned equal weights. That is, the exponent (normally greater than one) used to calculate an increasing rate of decay from the centre of the zone of influence is one. For display purposes at a scale of 1:7 500 000, a cell size of 7500 metres is set. Separate grids based on the individual data sets (Table 1) are then assigned colours based on multiples of median value for ease of comprehension and to reduce boundary effects resulting from different sample media and different collection and analytical methods

DISCUSSION

Regional compilations for Labrador and Ontario clearly show the relation between elemental concentrations and geology. For the purposes of exploration, anomalous areas and even individual sites can be followed up in the original NGR open files. Elements are selected for release as regional compilations based on their value to mineral exploration, and include copper, nickel, zinc, mercury, uranium, lead, gold, arsenic, iron, chromium, ytterbium, molybdenum, antimony, barium and fluoride.

National geochemical compilations are the first step in a program to harmonise disparate sets of geochemical data. The eventual goal is to produce digital geochemical maps suitable for regional mineral exploration programs.

Large-scale patterns and relationships revealed on national and regional compilations may reflect similar patterns and relationships at a more local level. Additionally, target areas not suggested by other available geoscientific data may be outlined by geochemical data, especially in the many areas of Canada where information is only available at a regional level.

A good exploration program integrates all the relevant information available in order to outline suitable areas for detailed study. National, regional and local geochemical maps and data published by the GSC are a key part of any mineral exploration program.

Table 1: ***Summary of areas and number of sites for selected geochemical surveys in Canada.***

Surveys	Area [1] (km^2)	Number of data values (sites) Copper	Zinc	Mercury
NGR lakes	1 360 000	100 416	100 415	73 346
Island of Newfoundland lakes	112 000	17 025	17 025	–
Nova Scotia lakes	31 260	2 881	2 881	–
Québec lakes	665 200	80 492	80 511	–
NGR streams	941 320	79 378	79 374	61 411
Nova Scotia streams	37 870	8 219	8 216	–
Prairie "plough" horizon	690 000	978	978	–
Total	3 837 650	289 389	289 400	134 757

1. Area was determined from total area of contour coverage rather than survey area.

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