PRELIMINARY REPORT ON THE APPLICATION OF CATCHMENT BASIN ANALYSIS TO REGIONAL GEOCHEMICAL SURVEY DATA, NORTHERN VANCOUVER ISLAND (NTS 92L/03, 04, 05 AND 06)

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INTRODUCTION

Meaningful techniques for presenting geochemical data from regional stream sediment surveys have long been a difficulty for explorationists. Contouring and image analysis methods can create artifacts which misrepresent the data whereas its display as point values may not portray the spatial variation inherent to the data set. Further, the geochemistry of a stream sediment sample is often most influenced by the geology of the sediment source area. Coding the sample site by its underlying geology may not accurately represent the site and may result in the misidentification of anomalies.

An effective solution to this problem is to utilize the catchment basin of each sample site to define its zone of influence (Bonham-Carter and Goodfellow, 1986). This method can be used to:

- Define the actual areal coverage of a survey.
- Reclassify the geological influence on each sample based on its source area.
- Redefine the thresholds which separate anomalous from background populations.

Bonham-Carter and Goodfellow (1986) successfully used this method to predict the presence of lead-zinc occurrences using stream sediment data in the Nahanni River area (NTS 105I) of the Yukon and Northwest Territories. In a related study, Bonham-Carter *et al.* (1987) compared a variety of methods for representing the geology within each catchment basin in the Cobequid Highlands, Nova Scotia.

Catchments sampled in the course of the Regional Geochemical Survey (RGS) program in the 92L/SW (NTS 92L/03, 04, 05 and 06) map area have been digitized in order to evaluate this method. This area was selected for the following reasons:

- Bonanza Group rocks, the primary target for mineral exploration in the region, are the most areally extensive lithology in 92L/SW (Figure 1).
- Regional Geochemical Survey coverage within this area is typical for northern Vancouver Island.
- 92L/SW is a relatively unexplored, frontier area with poor access and is therefore amenable to the use of Regional Geochemical Survey data for definition of exploration targets.

REGIONAL GEOLOGY AND MINERALIZATION

The 92L/SW map area is underlain primarily by Lower Jurassic Bonanza Group volcanic and volcaniclastic rocks and Triassic basalts of the Karmutsen Formation (Muller *et al.*, 1974). Upper Triassic limestones of the Quatsino Formation and limy to clastic sediments of the Parsons Bay Formation are exposed in the eastern section of the map area; Parsons Bay Formation also outcrops in the western edge of 92L/SW. To the southwest, Jurassic to Cretaceous sediments of the Pacific Rim Complex form the Brooks Peninsula. Granitoid intrusives of the Island Plutonic Suite are exposed throughout the map area (Nixon *et al.* 1993).

One hundred and two mineral occurrences are known in the 92L/SW map area (Hulme *et al.*, 1993). The major types of known metallic deposits are iron and copper skarns, precious metal epithermal systems and copper-molybdenum porphyries. Six of these occurrences are past producers, including the Merry Widow camp and the Yreka mine. The only active operation at present is the Benson Lake limestone quarry, located east of Victoria Lake.

REGIONAL GEOCHEMICAL SURVEY

The 92L/SW map area was sampled as part of RGS 23 (NTS 92L/102I) in 1988 (Gravel and Matysek, 1989). Moss-mat sediments and stream waters were collected

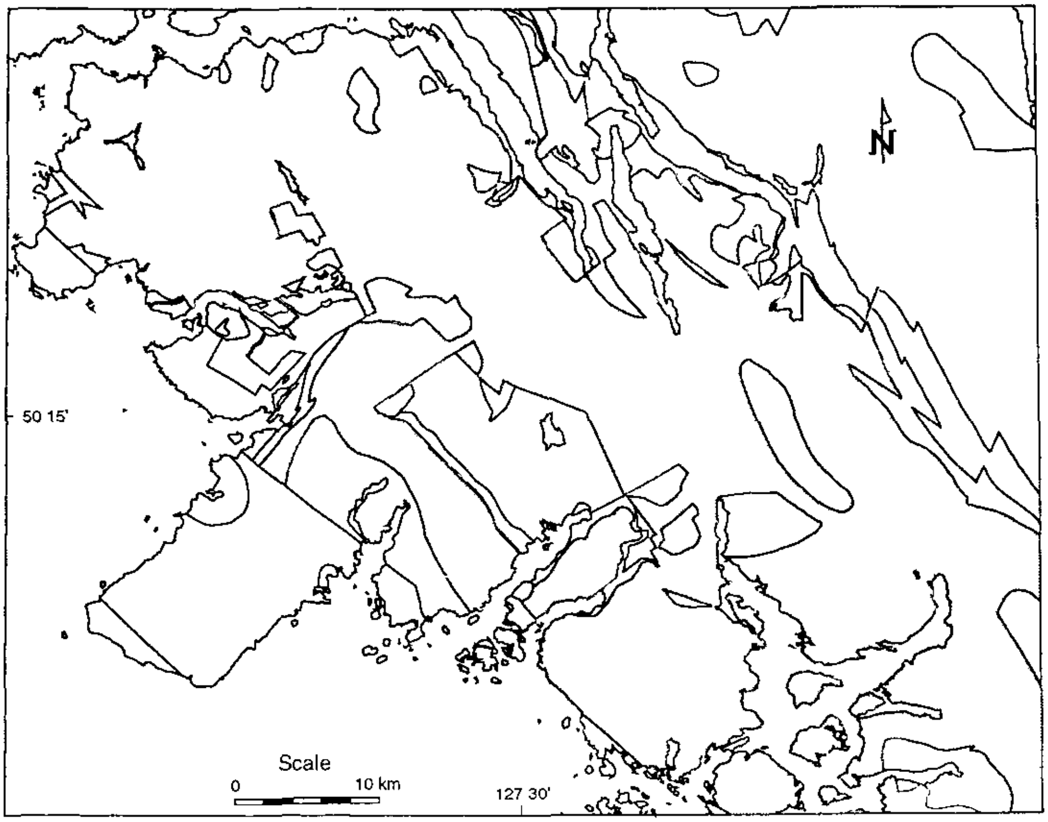

Figure 1. Distribution of Bonanza Group rocks (shaded pattern), 92L/SW.

from 294 first and second order drainages. The -80 mesh fraction of the sediment was analysed for a suite of 22 elements (Au, Cu, Zn, Pb, Ni, Co, Ag, Mn, Fe, Mo, U, Sn, W, Hg, As, Sb, Ba, Cd, V, F, Bi and Cr) and loss on ignition (LOI) using a variety of methods (see Matysek *et al.*, 1989). Stream waters were analysed for uranium, fluoride and pH. Quality control procedures followed those established by the Geological Survey of Canada (Garrett *et al.*, 1980) and used for every RGS. Results from this survey were released to the public in 1989.

METHODS

A catchment basin map of 92L/SW was produced from 1:50 000 scale topographic maps compiled and photo reduced to 1:100 000 scale. Catchment basins were delineated for 290 RGS sample sites by hand tracing the basin polygon onto a mylar overlay. Boundaries for catchment basins were defined by the topographic height of land which divided one drainage from another. Catchments which extended off the map sheet were truncated at the map edge.

The resulting polygons were then digitized at 1:100 000 scale, with each polygon labeled to correspond to its RGS sample number. On occasion, nested polygons were produced where two samples were taken from successive sites on the same stream; in these cases the downstream polygon was defined to end at the upstream sample site. Areas of each polygon were calculated during the digitizing procedure. The corresponding RGS data were joined to each digital polygon record for interpretation.

RESULTS AND DISCUSSION

CATCHMENT BASIN AREAS

Figure 2 shows the distribution of RGS sites and their associated catchment basins. A histogram of the catchment basin area distribution is represented in Figure 3. Catchment basins range from 0.6 square kilometre to 20 square kilometres in area with a mean area on the order of 5 square kilometres. The modal area of the catchments falls within the 1 to 2 square kilometre range. Of the 290 RGS sites, 174 have drainage basins which cover an area of 5 square kilometres or less. Areal coverage of the RGS catchments totals 1417 square kilometres, or 54% of the 92L/SW land area. The remaining unsurveyed 46% of the map represents coastal areas lacking well defined drainages, broad valleys or, most importantly, drainages bounded by surveyed catchments which were intentionally excluded from the

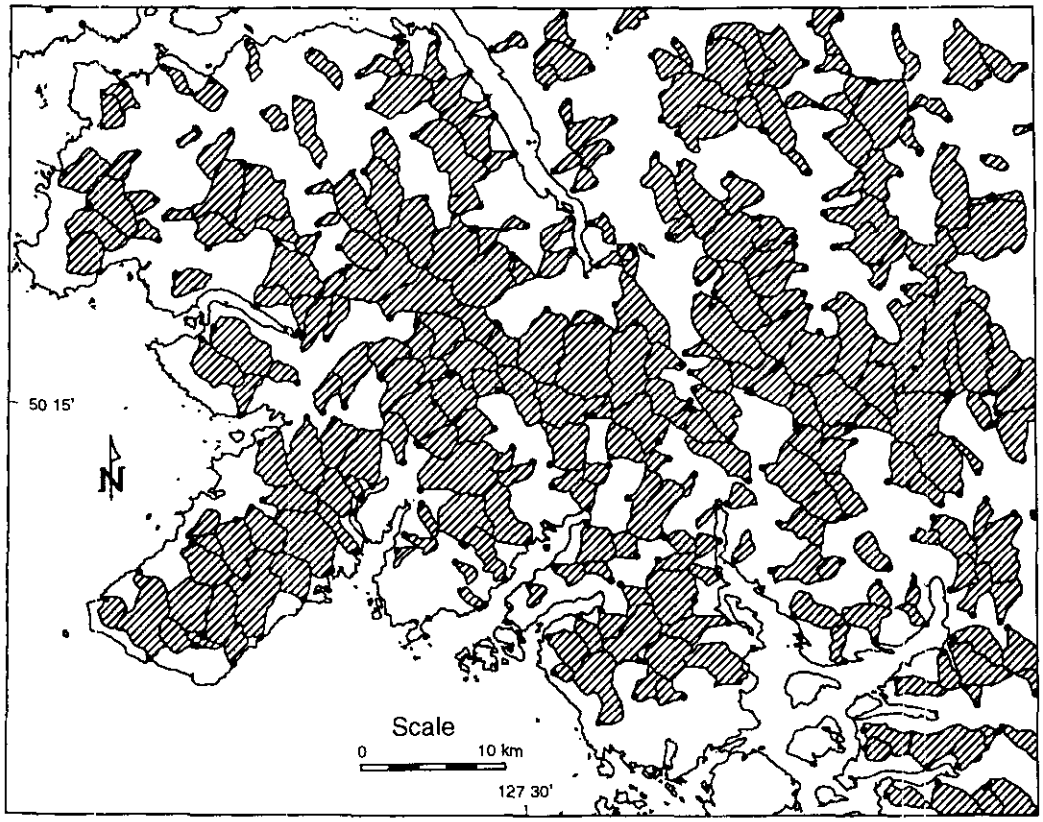

Figure 2. Distribution of RGS sites and associated catchment basins, 92L/SW.

sampling program. Exclusion of a catchment basin from the survey is a reflection of the intended sampling density of the RGS program. Designed to provide cost-efficient regional geochemical data, the RGS program does not define the geochemistry of every first and second order stream within a map area. It is entirely possible, therefore, that mineral occurrences in unsurveyed catchments may have been missed. Examination of regional anomalies or subtle geochemical patterns in drainages which bound these unsurveyed areas may help to identify prospective mineralized catchments.

Influence of catchment basin area on the sediment geochemistry appears to be minimal (Table 1). There are weak, yet statistically significant, correlations of catchment area with loss on ignition, manganese, fluoride, iron, chromium and vanadium (Figure 4). Negative correlations of catchment area with loss on ignition and manganese appear to be real. In general, there is an increase in the loss on ignition content of a sample with decreasing catchment area. Loss on ignition is a general measure of the organic content of moss-mat sediment whereas decreasing catchment area roughly corresponds to an increase in stream slope and stream energy. Increasing proportions of organic sediment imply that the amount of mineral sediment within a moss mat decreases with increasing stream energy.

Field observations confirm this finding, as moss mats in steep-gradient streams contain less than average mineral sediment and appear to have been washed clean by high-energy stream flow (W. Jackaman, personal communication, 1993).

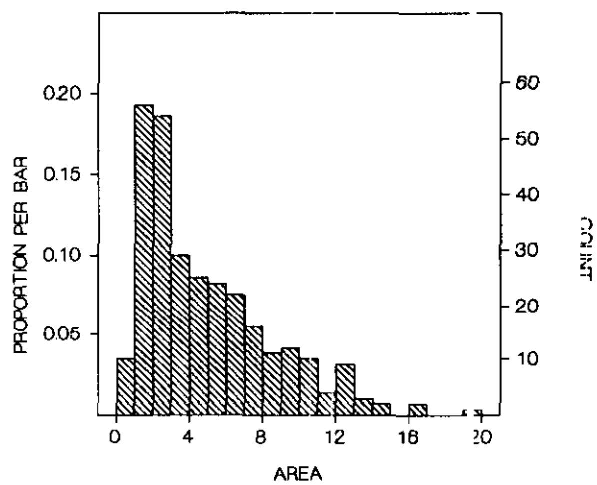

Figure 3. Distribution of catchment basin areas.

A negative correlation between manganese and catchment area and a high positive correlation between manganese and loss on ignition (r = 0.632) indicates that the winnowing of mineral sediment from mosses in high-energy streams does not preferentially remove manganese from moss mats. Smith (1986), in a study of the geochemical response of moss-mat vegetation to mineralization, concluded that manganese accumulation occurs mainly by biochemical reactions which incorporate manganese into the plant material.

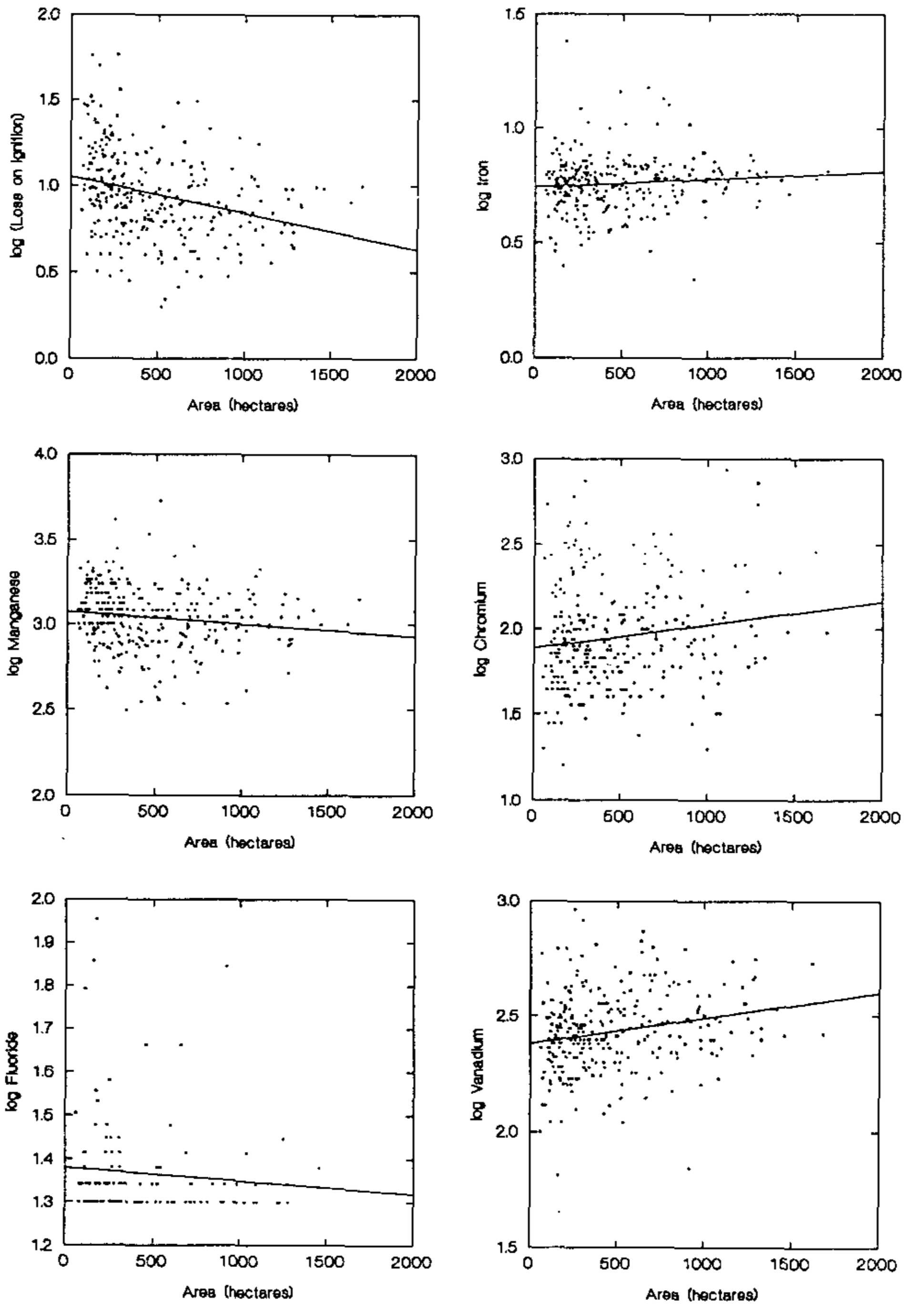

Figure 4. Scatterplots of significant correlations (>0.95) between RGS data and catchment area.

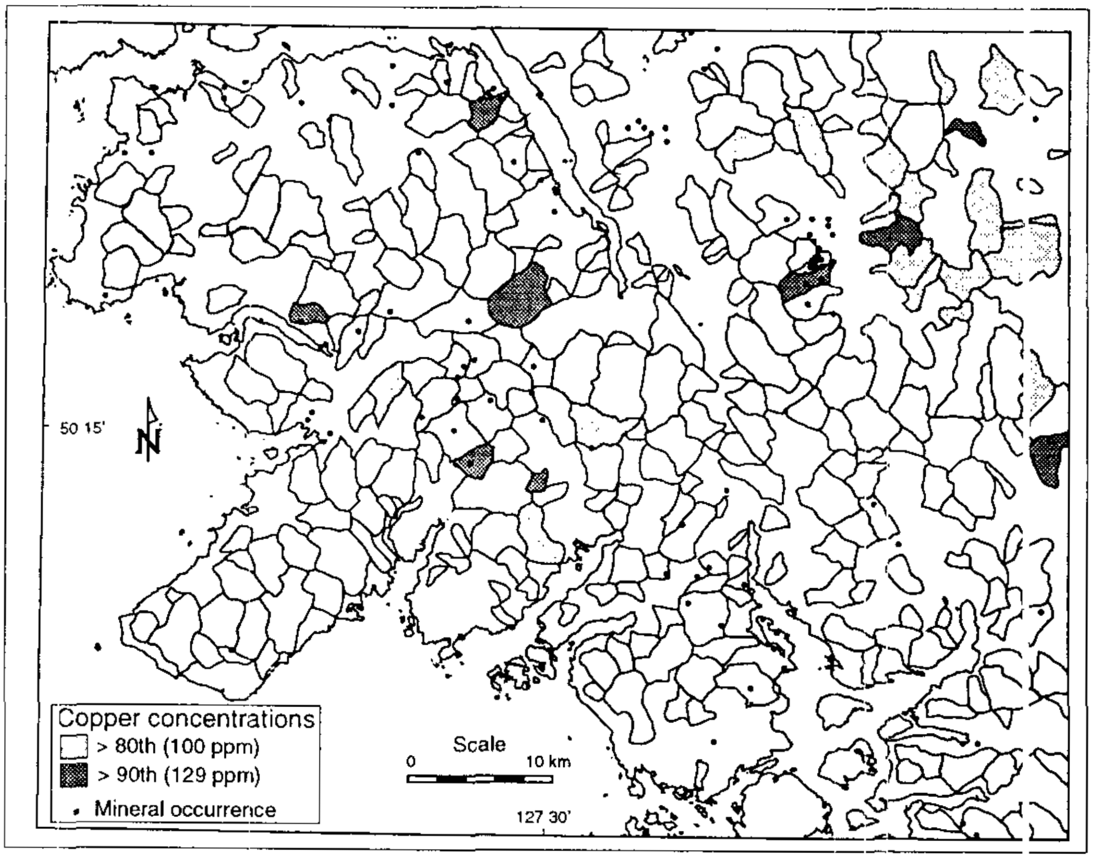

Figure 5. Location of mineral occurrences and catchment basins with copper concentrations above the 80th and 90th percentiles.

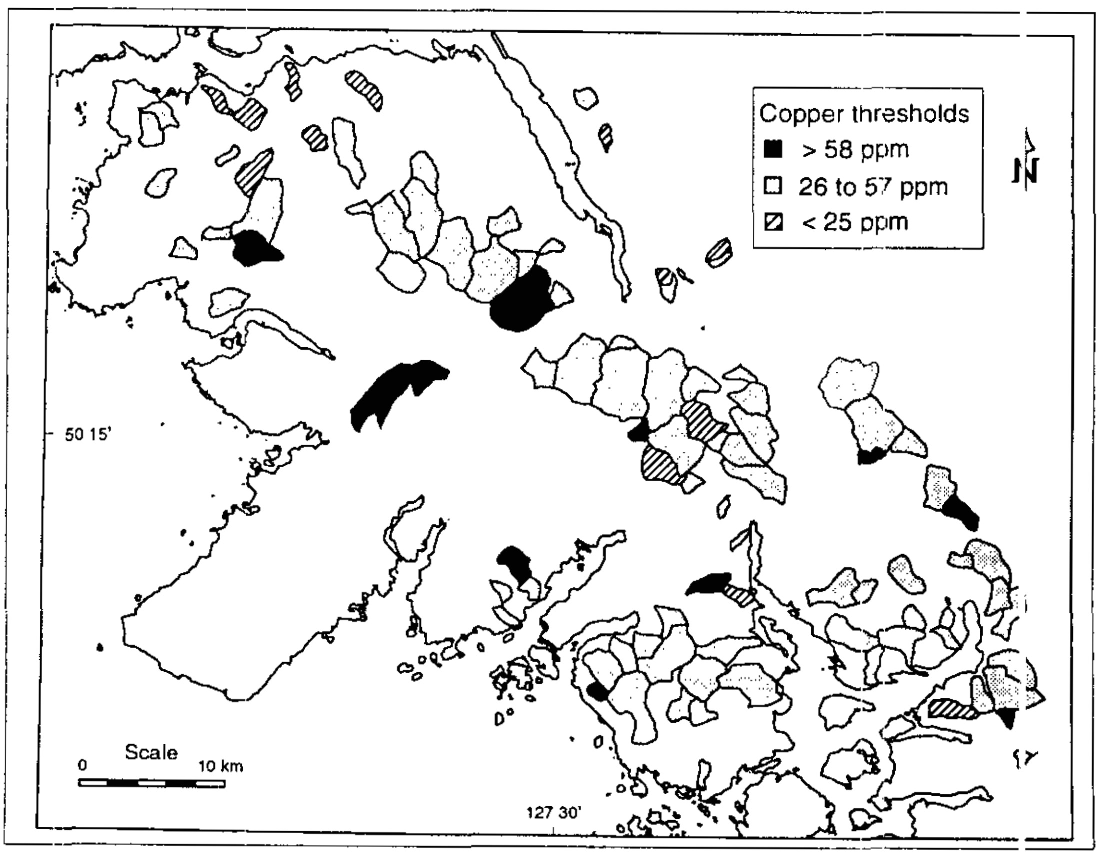

Figure 6. Redefined Bonanza Group copper thresholds for catchments underlain entirely by Bonanza Group rocks.

TABLE 1. PEARSON CORRELATIONS BETWEEN CATCHMENT AREA AND RGS DATA

	Area		Area
LOI	-0.289	Cd	0.010
Mn	-0.123	Au	0.015
F-w	-0.107	pH	0.025
Ba	-0.077	Co	0.026
Pb	-0.072	F	0.031
Bi	-0.061	U-w	0.033
W	-0.033	Cu	0.071
As	-0.030	Ni	0.079
Hg	-0.030	Fe	0.107
Sb	-0.027	Cr	0.137
Mo	-0.021	V	0.195
U	0.002		

N = 275 Rsig(.95) =0.099

Positive correlations between iron, chromium and vanadium with catchment area suggest that the proportion of lithic fragments within each sample tends to decrease with decreasing catchment area (Figure 4). This hypothesis is in agreement with the negative correlations found for loss on ignition and manganese. The negative correlation between fluoride and catchment area can be attributed to the presence of outliers in the fluoride data set (Figure 4).

CATCHMENT BASIN GEOCHEMISTRY

Figure 5 shows the distribution of catchment basins with copper concentrations above the 80th and 90th percentiles for the 92L/102I RGS data set. Source areas of these anomalous metal concentrations are readily visible, as are multiple-catchment anomalies in the northeast associated with the higher background copper concentrations of the Karmutsen volcanics. An overlay of mineral occurrences from the MINFILE database enables the rapid identification of anomalous catchments not associated with known mineralization (Figure 5). Roughly one-third of the mineral occurrences are located outside surveyed catchments. Less than 10% of the mineral occurrences are found in basins with copper concentrations above 100 ppm. As over 70% of the mineral occurrences in the 92L/SW map area contain significant copper-bearing mineralization (Hulme *et al.*, 1993), it is likely that either the geochemical response of these occurrences is not present or has been suppressed by the higher background copper concentrations in lithologies such as the Karmutsen volcanics.

In the 92L/SW map area, 99 catchments are underlain entirely by Bonanza Group rocks. Evaluation of these basins provides a more reliable estimate of background and threshold values due to the homogeneity of the catchment lithology. Based upon these catchment basins , threshold values for copper of 26 and 58 ppm were estimated using a probability plot. Projection of the upper threshold (58 ppm) onto the catchment basin map (Figure 6) highlights twelve drainages with anomalous copper concentrations.

Presence of multiple lithologies within a catchment basin presents another challenge for establishing thresholds. Regression methods have been employed by Bonham-Carter and Goodfellow (1986) and Bonham-Carter *et al.* (1987) to correct for the areal proportions of geologic units within a map area. Future work will focus on developing this methodology on a completed catchment basin map of 92L/102I.

CONCLUSIONS

Catchment basin maps provide an effective method of presenting regional geochemical stream sediment data. Influences of the catchment basin physiography on the geochemical response of a moss-mat sediment can be documented. Source areas for anomalous RGS sites can be easily discerned and their relationship to known mineralization or geological features quickly evaluated. Further, practical thresholds representing the actual geological distribution of a lithology can be estimated.

ACKNOWLEDGMENTS

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