



**EAGLE BAY PROJECT: REGIONAL HYDROGEOCHEMICAL SURVEY
AND GEOCHEMICAL ORIENTATION STUDIES
(82M/4 AND 5)**

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INTRODUCTION

Geological Survey Branch staff conducted two exploration geochemistry programs as part of the Eagle Bay project (Figure 1). These included a regional stream water geochemistry (hydrogeochemical) survey and a detailed soil and biogeochemical orientation study of the significant mineral deposit types in the region. These activities were co-ordinated with 1:50 000 scale surficial mapping (Dixon-Warren *et al.*, 1997), a regional till geochemistry survey (Bobrowsky, *et al.*, 1997) and mineral deposit studies (Hoy, 1997). The project area corresponds to a region of previous Geological Survey Branch bedrock mapping (Schiarizza and Preto, 1987) covering NTS map sheets 82M/04, 05 and 12 (Figure 2).

The Eagle Bay project area hosts Devonian-Mississippian age rocks of the Eagle Bay Assemblage which are identical in many respects to rocks hosting the Kuroko-type volcanogenic massive sulphide deposits (Kudz Ze Kayah and Wolverine) recently discovered in the Yukon. The known deposits in the survey area, including the Homestake (MINFILE 82M 025), Twin Mountain (MINFILE 82M 020) and Rea Gold (MINFILE 82M 191) deposits, are highly similar to these Yukon examples and provide excellent targets for exploration. In addition, Cambrian-age Eagle Bay Assemblage rocks in the south-east corner of the project area host several significant SEDEX Pb-Zn-Ag and Besshi Cu-Zn-Ag deposits. Details of these deposits are reported in Schiarizza and Preto (1987).

However, the extensive overburden cover and the relatively small size of the target deposits are obstacles to new mineral discoveries. This suggests that geochemical exploration techniques can play a significant role in detecting new mineralization.

The goals of the Eagle Bay Exploration Geochemistry program are to:

- Produce regional stream water geochemistry maps of major and minor elements.
- Determine critical exploration geochemistry parameters for massive sulphide exploration in overburden covered areas.

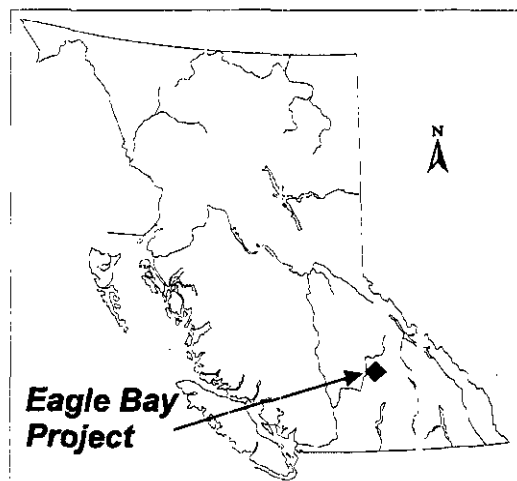


Figure 1. Location of the Eagle Bay Project

HYDROGEOCHEMICAL SURVEY

Stream water surveys offer the advantage of detecting subtle anomalies derived from groundwater sources. The sources may be from concealed or buried mineralization. Critical to the success of a hydrogeochemical survey is the use of an analytical method that provides a low detection limit for the elements of interest. The declining cost of inductively coupled plasma mass spectrometry (ICP-MS) has provided an analytical technique that can provide detection limits in the parts per trillion (ppt) range. To date, few regional stream water geochemical surveys have been conducted in British Columbia. Recently, the Geological Survey Branch released Regional Geochemical Survey (RGS) data on the Gataga area that included ICP-MS data on waters collected during the survey (Jackaman, *et al.*, 1996). In a related study, Lett *et al.* (1996) released data on spring water chemistry from mineralized and non-mineralized seepages in the Gataga area.

The Eagle Bay hydrogeochemical survey is a pilot project to test the applicability of regional stream water geochemistry as an exploration tool in British Columbia. Data from this survey can also be utilized as a baseline database for environmental assessments and reclamation activities.

METHODOLOGY

SAMPLE COLLECTION

Sample collection was carried out from late-June to late August of 1996. A total of 257 stream water samples were systematically collected from 218 sites (Figure 2). Considerable effort was taken to collect all samples upstream of known anthropogenic disturbances such as bridges or culverts on logging roads. Streams of 1 to 2 kilometres in length were the preferred target. However, in some cases streams of greater or lesser length were sampled. Field duplicate samples were routinely collected in each analytical block of twenty samples.

Collected surface water samples were stored in two 250 millilitre polyethylene bottles. Each bottle was rinsed thoroughly with stream water before sample collection. Precautions were taken to exclude suspended solids when possible. One bottle of each pair was immediately refrigerated after collection to retard any chemical changes. Field measurements of pH, Eh, conductivity and temperature were taken at each site. Field observations regarding sample media, sample site and local terrain were also recorded. An aluminum tag inscribed with the sample identification number was fixed to a permanent object at each sample site.

SAMPLE PREPARATION AND ANALYSIS

At the field camp, a 100 ml portion of each refrigerated 250 ml surface water sample was filtered through a 0.45-micron cellulose nitrate filter paper into an I-Chem certified™ high-density polyethylene sample bottle. The filtered sample was then acidified to pH 2 to 3 with 50% ultra-pure nitric acid. The remaining 150 millilitres was retained for sulphate and fluoride analysis. At the Ministry laboratory, quality control reference standards and analytical blanks were inserted into each analytical block of 20 water samples.

Filtered and acidified water samples were analysed for trace and major elements by inductively coupled plasma mass spectrometer (ICP-MS) for 66 elements by Activation Laboratories (Ancaster, Ontario) using a Perkin Elmer Elan 6000 inductively coupled plasma mass spectrometer and an Perkin Elmer AS91 autosampler. Reported detection limits for each element and measured parameters are listed in Table 1.

Sulphate in waters was determined by a turbidimetric method. A 20 ml aliquot of the sample was mixed with barium chloride and an isopropyl alcohol - hydrochloric acid - sodium chloride reagent. The turbidity of the resulting barium sulphate suspension was measured with a spectrophotometer at 420 nanometres. The determination of fluoride in waters involved mixing an aliquot of the sample with an equal volume of total ionic strength adjustment buffer (TISAB II solution). The fluoride was measured using a Corning 101 meter with an Orion fluoride electrode.

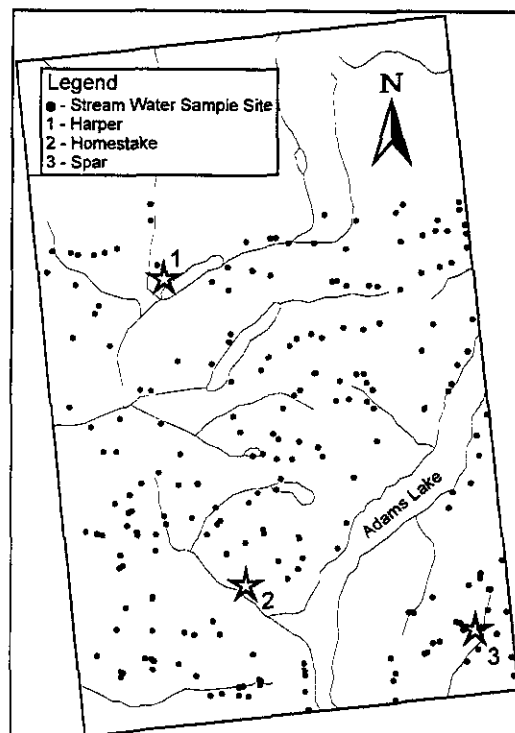


Figure 2. Regional hydrochemistry sample sites and orientation study locations.

Temperature, pH, Eh and conductivity were measured in the field using hand-held digital meters. pH measures the hydrogen ion activity of the sample; Eh is an estimate of the reduction-oxidation potential and is measured in millivolts (mv). Conductivity is an indication of the total dissolved load of ions within the streamwater and is measured in milliSiemens per second ($\mu\text{S}/\text{S}$). The pH, Eh and conductivity meters were placed in large mouth 250 ml polyethylene bottles rinsed clean and filled with stream water. Ambient temperature was maintained by placing each bottle out of direct sunlight and/or keeping the bottle within the stream flow. Readings were allowed to stabilize over approximately thirty seconds to one minute. Temperature was measured directly from the stream. All instruments were calibrated every 10-12 samples.

CATCHMENT BASINS

In accord with the methodology employed by the Regional Geochemical Survey program, catchment basins will be used to present the results of this survey. Catchment basins are defined by the topographic height of land that separates one stream from surrounding streams. These polygons are assumed to represent the metal determination of a sample collected at the catchment basin outlet. Catchment basins provide the most effective method for integrating stream geochemical data with other spatial databases.

GEOCHEMICAL ORIENTATION

Detailed geochemical orientation studies were conducted at three mineral occurrences in the Eagle Bay project area (Figure 2). These were selected as representative of the two common mineral deposit types for the region and included the Harper, Homestake, and Spar deposits. Summary details of each deposit are listed in Table 2.

The objective of the orientation study was to determine the effectiveness of various sample media in the detection of massive sulphide mineralization and to highlight critical pathfinder elements. Soil pits or profiles were excavated on lines that traversed the deposits. Samples were collected of the representative soil horizons, humus and forest litter. In addition, samples of common vegetation types were also collected. This included tree bark from Lodgepole pine (*Pinus contorta*) and Douglas fir (*Pseudotsuga glauca*), twigs from Subalpine fir (*Abies lasiocarpa*), and leaves from the shrubs of Sitka alder (*Alnus viridis*), Falsebox (*Paxistima myrsinites*), Saskatoon (*Amelanchier alnifolia*) and White-flowered Rhododendron (*Rhododendron albiflorum*).

TABLE 2
ORIENTATION STUDY SITES

Name	MINFILE	Type	Commodities
Harper	082M060	Kuroko	Cu, Pb, Zn
Homestake	082M025	Kuroko	Ag, Pb, Zn, Au, Cu, Ba
Spar	082M017	Sedex	Pb, Zn, Ag

Soil samples (-63 micron fraction) were analysed for 50 trace elements including Au, As, Ba, Co, Cu, Mo, Ni, Hg and Zn by thermal neutron activation and by aqua regia digestion-inductively coupled plasma emission spectroscopy (ICP). The soil samples were also analysed for 11 major oxides, loss on ignition (LOI), Ba, Ni, Sr, Zr, Y, Nb and Sc by lithium metaborate fusion-ICP. Dried humus, forest litter, tree bark, leaf and twig samples were macerated and part of the sample compressed into a briquette. A second portion of the macerated material was ashed at 480°C and the ash analysed for 30 trace elements by aqua regia digestion-ICP.

TABLE 1. STREAM WATER ANALYSIS

Element	Analytical Method	Detection Limit	Unit
pH	pH	0.1	pH
Eh	Eh	1	mv
Conductivity	Cond	10	µS/S
Temperature	T	0.1	C°
Sulphate	SO4 TURB	1	ppm
Fluoride	FW ION	20	ppb
Lithium	Li ICPMS	0.1	ppb
Sodium	Na ICPMS	0.1	ppb
Magnesium	Mg ICPMS	0.1	ppb
Aluminium	Al ICPMS	0.1	ppb
Silicon	Si ICPMS	1	ppb
Calcium	Ca ICPMS	1	ppb
Scandium	Sc ICPMS	0.01	ppb
Titanium	Ti ICPMS	0.01	ppb
Vanadium	V ICPMS	0.01	ppb
Chromium	Cr ICPMS	0.1	ppb
Manganese	Mn ICPMS	0.01	ppb
Iron	Fe ICPMS	0.1	ppb
Cobalt	Co ICPMS	0.001	ppb
Nickel	Ni ICPMS	0.001	ppb
Copper	Cu ICPMS	0.001	ppb
Zinc	Zn ICPMS	0.001	ppb
Gallium	Ga ICPMS	0.001	ppb
Arsenic	As ICPMS	0.01	ppb
Selenium	Se ICPMS	0.01	ppb
Bromine	Br ICPMS	1	ppb
Rubidium	Rb ICPMS	0.001	ppb
Sr	Sr ICPMS	0.001	ppb
Yttrium	Y ICPMS	0.001	ppb
Zirconium	Zr ICPMS	0.001	ppb
Niobium	Nb ICPMS	0.001	ppb
Molybdenum	Mo ICPMS	0.01	ppb
Ruthenium	Ru ICPMS	0.01	ppb
Palladium	Pd ICPMS	0.01	ppb
Silver	Ag ICPMS	0.001	ppb
Cadmium	Cd ICPMS	0.001	ppb
Indium	In ICPMS	0.001	ppb
Tin	Sn ICPMS	0.001	ppb
Antimony	Sb ICPMS	0.01	ppb
Tellurium	Te ICPMS	0.01	ppb
Iodine	I ICPMS	0.02	ppb
Cesium	Cs ICPMS	0.001	ppb
Barium	Ba ICPMS	0.001	ppb
Lanthanum	La ICPMS	0.001	ppb
Cerium	Ce ICPMS	0.001	ppb
Praseodymium	Pr ICPMS	0.001	ppb
Neodymium	Nd ICPMS	0.001	ppb
Samarium	Sm ICPMS	0.001	ppb
Europium	Er ICPMS	0.001	ppb
Gadolinium	Gd ICPMS	0.001	ppb
Terbium	Tb ICPMS	0.001	ppb
Dysprosium	Dy ICPMS	0.001	ppb
Holmium	Ho ICPMS	0.001	ppb
Erbium	Er ICPMS	0.001	ppb
Thulium	Tm ICPMS	0.001	ppb
Ytterbium	Yb ICPMS	0.001	ppb
Hafnium	Hf ICPMS	0.001	ppb
Tantalum	Ta ICPMS	0.001	ppb
Tungsten	W ICPMS	0.001	ppb
Rhenium	Re ICPMS	0.001	ppb
Osmium	Os ICPMS	0.001	ppb
Platinum	Pt ICPMS	0.001	ppb
Gold	Au ICPMS	0.001	ppb
Mercury	Hg ICPMS	0.01	ppb
Thallium	Tl ICPMS	0.001	ppb
Lead	Pb ICPMS	0.01	ppb
Bismuth	Bi ICPMS	0.001	ppb
Thorium	Th ICPMS	0.001	ppb
Uranium	U ICPMS	0.001	ppb

CONCLUSIONS

Results from these two geochemistry programs will be released to the public in early 1997. Data from the hydrogeochemical survey can be utilized in the exploration for new mineralization in the Eagle Bay Assemblage. The data will also provide a reliable environmental baseline database for any reclamation activities in the area. Information from the orientation studies can be applied to refining geochemical exploration models and techniques for VMS and SEDEX mineralization in the region.

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