National Geochemical Reconnaissance Program in Northwestern British Columbia: Bowser Lake (NTS 104A) Regional Geochemical Survey

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INTRODUCTION

This paper describes a reconnaissance scale regional stream sediment-water survey carried out over the Bowser Lake map sheet (NTS 104A) as part of the National Geochemical Reconnaissance (NGR) program. Since 1974, this program has generated high quality stream and lake sediment and surface water data from geochemical surveys carried out across Canada. In British Columbia the NGR Program, known as the Regional Geochemical Survey (RGS), has covered roughly 70% of the province with stream sediment and stream water sampling at an average sample density of one sample per 13 km^2. In the process just over 45,000 samples have been collected and analyzed for up to 50 elements including gold copper, molybdenum and zinc. The existing NGR-RGS survey coverage, including the most recent Bowser Lake survey area, is shown in Figure 1.

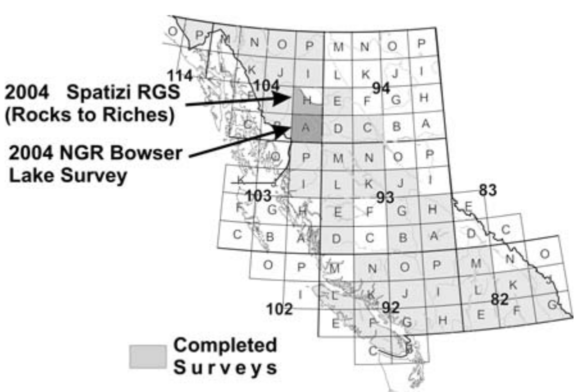

Figure 1. NGR survey coverage in British Columbia and location of 2004 surveys.

Figure 1 also shows a stream sediment survey carried out to NGR specifications over the adjacent Spatsizi Lake map sheet (NTS 104H). This survey is described by Jackaman (this volume).

Mineral exploration in northwest British Columbia will benefit from publication of the Bowser Lake survey results because it completes NGR sampling coverage of the area linking existing regional geochemical surveys of NTS 104B (Iskut River), 103P (Nass River) and 94D (McConnell Creek). Moreover, the stream sediment data produced will extend regional geochemical trends for Ni and Hg that have been recently identified by Alldrick *et al.* (2004) from contoured element maps.

BOWSER LAKE SURVEY

Prominent physiographic features of the Bowser Lake map sheet are the Skeena Mountains in the east and the Coast Range Mountains in the west. Between these two northwest-trending mountain ranges is the Nass Basin, an irregularly shaped area of low relief drained by the Nass River and its tributaries (Holland, 1964). Much of the area is underlain by the Bowser Basin, a Middle Jurassic to Middle Cretaceous sedimentary basin formed on Stikinia terrane after its amalgamation with ancestral North America. Jurassic to Cretaceous deltaic sedimentary rocks forming the basin are represented by the Bowser Lake, Skeena and Sustut Groups (Ferri *et al*., 2004). In the western part of the map sheet, the Bowser Lake Group rests on fine-grained clastic sedimentary and volcanic rocks of the Early to Middle Jurassic upper Hazelton Group. Geological mapping by Alldrick *et al.* (2004) identified the Salmon River Formation as the gradational contract between Hazelton and Bowser Lake strata. There is also an inlier of Hazelton Group rocks in the Oweeggee Dome surrounding Delta Peak to the north of Bowser Lake.

Stikinia volcanic and sedimentary rocks surrounding the basin are metallogenically well endowed and host the

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world-class Eskay Creek gold mine in addition to several past-producing gold-copper mines and 170 documented MINFILE smaller precious and base metal mineral prospects. Three previously operating copper-gold-silver mines, the Red Cliff, Goat and Roosevelt in the Stewart mining camp are located in the southwestern part of NTS 104A. These subvolcanic vein type deposits, produced over 9000 g of gold, 1.8 million g of silver and 40,000 kg of copper. The area also has potential for alkalic porphyry Cu-Mo-Au-Ag deposits similar to Red Chris in NTS 104H and new epithermal VMS deposits in Stikina rocks similar to those that host the Eskay Creek deposit to the west in NTS 104B.

There is a sequence of Early to Middle Jurassic black carbonaceous sediments (Upper Hazelton Group) at the base of the Bowser Basin. These rocks indicate an anoxic environment favourable for the formation of sedimentary exhalative type base metal deposits (Ferri, pers comm, 2004).

Stream sediment and water samples were collected by helicopter and along roads in July 2004 from 1028 sites at an average density of one sample per 13.2 km^2 over an area of 13,560 km^2 in NTS 104A. All water samples were analyzed in the field for pH and conductivity. In addition, 217 of the water samples from the survey were filtered and acidified in the field for later trace metal analysis. The minus 80 mesh (<0.177 mm) fraction of the sediment samples will be analyzed for up to 50 elements by instrumental neutron activation analysis (INAA), aqua regia digestion-inductively coupled plasma mass spectrometry (ICPMS) and loss on ignition by a gravimetric method (GRAV). Elements, detection limits and the methods used for analysis are listed in Table 1. Figure 2 shows location of the stream sediment samples.

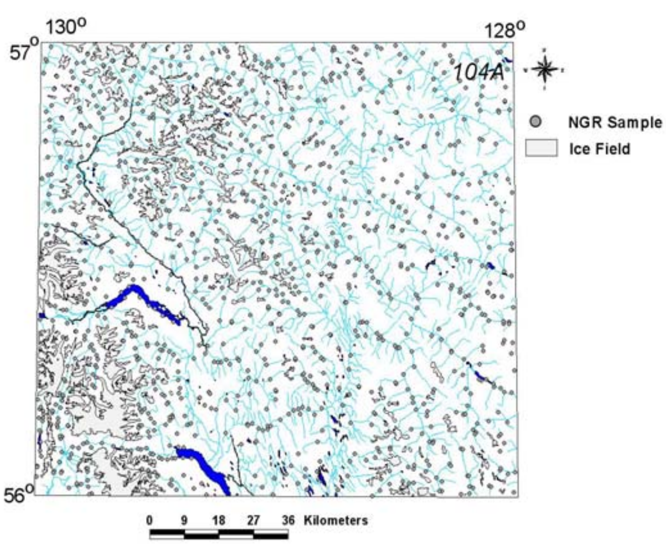

Figure 2. NGR sample sites in NTS 104A.

TABLE 1. ELEMENTS DETERMINED IN STREAM SEDIMENTS

Element	Detection	Units	Method
Aluminum	0.01	%	ICPMS
Antimony	0.02/0.1	ppm	ICPMS / INAA
Arsenic	0.1/0.5	ppm	ICPMS / INAA
Barium	0.5/50	ppm	ICPMS / INAA
Bismuth	0.02	ppm	ICPMS
Bromine	0.5	ppm	INAA
Cadmium	0.01	ppm	ICPMS
Calcium	0.01/1	%	ICPMS / INAA
Cerium	5	ppm	INAA
Cesium	0.5	ppm	INAA
Chromium	0.5/2	ppm	ICPMS / INAA
Cobalt	0.1/5	ppm	ICPMS / INAA
Copper	0.01	ppm	ICPMS
Europium	1	ppm	INAA
Gallium	0.2	ppm	ICPMS
Gold	0.2/2	ppb	ICPMS / INAA
Hafnium	1	ppm	INAA
Iron	0.01/0.2	%	ICPMS / INAA
Lanthanum	0.5/2	ppm	ICPMS / INAA
Lead	0.01	ppm	ICPMS
Lutetium	0.2	ppm	INAA
Magnesium	0.01	%	ICPMS
Manganese	1	ppm	ICPMS
Mercury	5	ppb	ICPMS
Molybdenum	0.01	ppm	ICPMS
Nickel	0.1	ppm	ICPMS
Phosphorus	0.001	%	ICPMS
Potassium	0.01	%	ICPMS
Rubidium	5	ppm	INAA
Samarium	0.1	ppm	INAA
Scandium	0.1/0.2	ppm	ICPMS / INAA
Selenium	0.1	ppm	ICPMS
Silver	2	ppb	ICPMS
Sodium	0.001/0.02	%	ICPMS / INAA
Strontium	0.5	ppm	ICPMS
Sulphur	0.02	%	ICPMS
Tantalum	0.5	ppm	INAA
Tellurium	0.02	ppm	ICPMS
Terbium	0.5	ppm	INAA
Thallium	0.02	ppm	ICPMS
Thorium	0.1/0.2	ppm	ICPMS / INAA
Titanium	0.001	%	ICPMS
Tungsten	0.2/1	ppm	ICPMS / INAA
Uranium	0.1/0.2	ppm	ICPMS / INAA
Vanadium	2	ppm	ICPMS
Ytterbium	2	ppm	INAA
Zinc	0.1/50	ppm	ICPMS / INAA
Fluorine	10	ppm	ION
Loss on Ignition	0.1	%	GRAV

DETAILED GEOCHEMISTRY

A detailed stream geochemical study was carried out jointly with the Geological Survey of Canada. Bulk stream sediment samples where collected from 34 sites from which heavy mineral concentrates (HMC) were prepared. These focused on the area of the Eskay Creek Mine and regions underlain by Hazelton Group rocks. The objective of the study is to

1. Characterize the HMC dispersal train related to the Eskay mineralization and compare it to the standard silt response. Do the HMC provide an aerially more extensive and/or stronger geochemical signature that the silts?
2. Provide guidelines to the exploration community on the use of HMC.
3. Highlight the type of information that can garnered from HMC, *e.g.*, kimberlite indicator minerals (KIM) and mineralogy of the HMC, which provides information on source material and can help explain silt anomalies.
4. Re-sampling historical RGS sites in the Telegraph Creek map sheet to determine long-term geochemical variability and the source of unexplained sediment mercury and nickel anomalies.

Sample Collection

Standard stream sediment, bulk sediment samples for the preparation of HMC and stream water samples were collected from 34 sites in NTS sheets 104A, 104B and 104G. The location of the sites where the samples were collected is shown in Figure 3. Ideal sites for the collection of sediments for the heavy mineral concentrate fraction are located at the upstream points of mid-channel bars. Material was collected from a single point where possible, or within close proximity otherwise. A five-gallon plastic pail was lined with a heavy-duty polyethylene plastic bag (18x24 inches, 4 Mil). Material was wet-sieved through a 12-mesh (1.68 mm) stainless steel sieve until a sample weight of 10 to 15 kg was attained (Plate 1). The sample was weighed in the pail before the opening was taped shut with black plastic (electrical) tape and placed into a second bag with a sample number and taped. Samples were shipped directly to a commercial laboratory for preparation and analysis.

Preparation of Heavy Mineral Concentrates

Bulk sediment samples were progressively reduced by different laboratory procedures to concentrate heavy minerals. Initially a 500 g character sample was taken and stored before a low-grade table concentrate was prepared from the remainder. Gold grains were observed at this stage and counted, measured and classified as to degree of wear (*i.e.*, distance of transport). The table reject was re-tabled to scavenge possible unrecovered kimberlite indicator minerals and magmatic massive sulphide indicator minerals. The concentrate from both tabling runs was separated in methylene iodide diluted with acetone to S.G. 3.20 to recover heavy minerals including Cr-diopside and forsterite olivine. Magnetite was removed after the heavy liquid separation and the remaining concentrate cleaned with oxalic acid to remove limonite stains. The dried concentrate was sieved into several size fractions, (<0.25 mm, 0.25 to <0.5 mm, 0.5 to <1.0 mm, ≥ 1.0 to 2.0 mm). The <0.25 mm fraction was kept for chemical analysis and the 0.25 to 0.50 mm fraction was sorted with a Carpco® drum magnetic separator into strongly, moderately, weakly and non-paramagnetic fractions.

Plate 1. Bulk stream sediment sample collection.

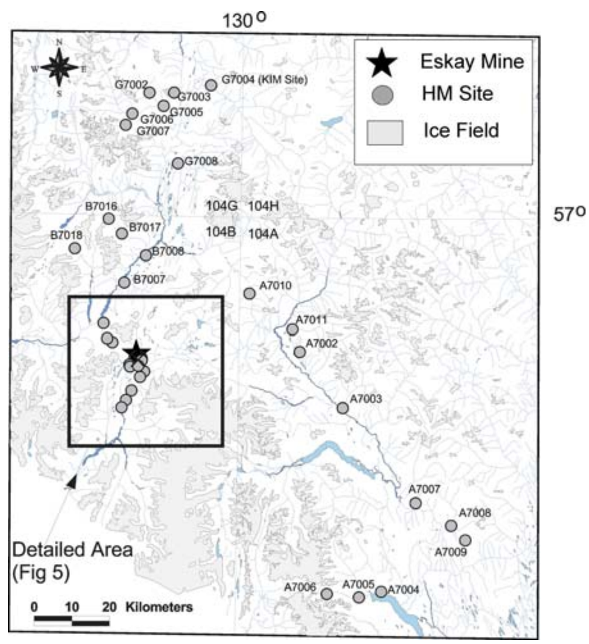

Figure 3. Heavy mineral sites.

Preliminary Results

A preliminary examination of the heavy mineral concentrates has revealed that several of them have a large number of gold grains (Fig. 4).

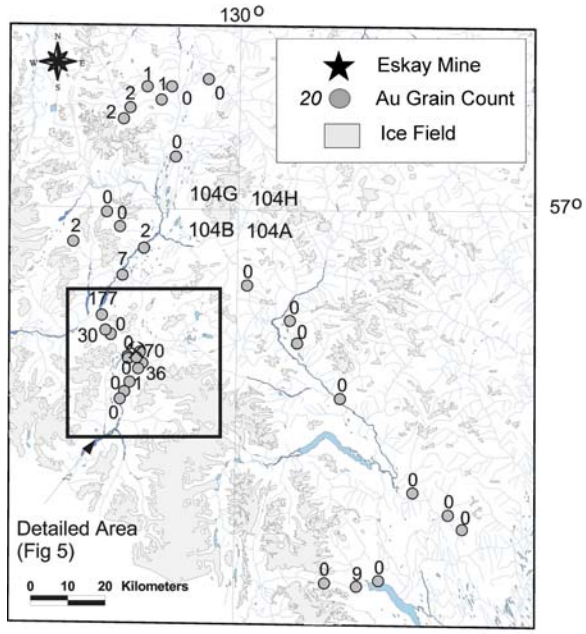

Figure 4. Gold grain counts in bulk stream sediment samples.

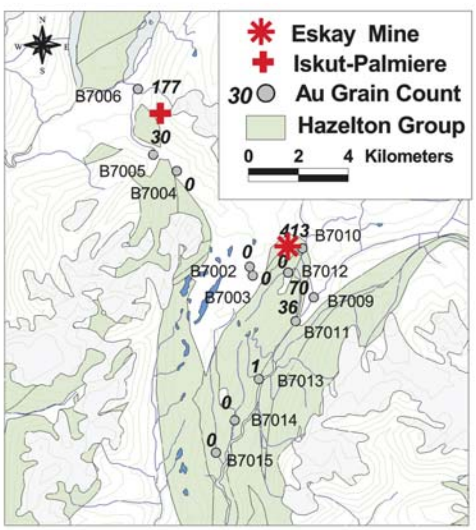

Figure 5. Detailed sampling around the Eskay Creek Mine.

Gold grains counts from the 34 samples ranged from 0 to 413 with a median value of 0. The Eskay Creek mineralized area is clearly outlined by the HMC gold grain counts. The highest value of 413 grains is from a site just east of the mine site (Fig. 5). A second sample (B7009) along this creek (approximately 3 km down drainage) is also highly anomalous containing 70 grains. Another distinct drainage to the southwest is also highlighted by the gold grain counts returning a value of 36 grains (Fig. 5).

Bulk stream sediment samples from two drainages northwest of the Eskay Mine have up to 177 gold gains in the sediment. The streams drain a low ridge on which is located the Iskut-Palmiere prospect. At this prospect Alldrick *et al.* (2005) report that " Realgar +/- orpiment is hosted in both black siliceous siltstones and in a cross-cutting quartz vein. This small outcrop is exposed in a north-draining creek, and lies stratigraphically above a thick dacite unit on the north side of Volcano (Palmiere Creek). Assays of two grab samples returned arsenic values greater than 1.0 percent with negligible associated precious metals". Less than 10 ppb gold was detected in sediment sampled during a previous regional geochemical survey (Matysek *et al.*, 1988b) from streams adjacent to the bulk sample sites.

Five of the heavy mineral samples were selected for kimberlite indictor mineral (KIM) processing. The samples yielded many KIM (mostly olivine) that are indicative of not only kimberlites, but also other rock types such mafic/ultramafic volcanics or intrusives. The total absence of pyrope garnet in the concentrate indicates that the source of the minerals is most likely <u>not</u> kimberlitic but rather mafic/ultramafic rock.

The KIM counts (Table 2) are preliminary "raw lab counts" and the mineralogy needs to be confirmed by probe work. For example, the three magnesium ilmenites identified in sample A7011 may, in fact, be ilmenite or chromite or some other phase. Site G7004 is closely spatially associated with alkalic and mafic volcanics (olivine basalt necks, breccia and pillow flows similar to the Maitland volcanics in 104H). The presence of these rock types would explain the olivine and would also be the cause of high Ni (>140 ppm) found in regional survey stream sediment samples by Matysek *et al.* (1988a). Similarly site G7006 is in a drainage basin that contains significant mafic volcanics. This illustrates how knowledge of heavy mineral concentrate mineralogy can be valuable for interpreting stream sediment geochemical data.

TABLE 2. KIM COUNTS IN HMC SAMPLES (GARNETS NOT DETECTED)

Site	Diopside	Ilmenite	Chromite	Forserite
A7005	0	0	55	0
A7011	0	3	8	3
B7007	0	0	4	0
G7004	0	6	1	78,019
G7006	2	1,505	10	10,402

CONCLUSIONS

- A regional stream sediment-water survey carried out over the Bowser Lake map sheet in July 2004 will produce new multi-element geochemical data from the analysis of samples from 1028 sites.

- Up to 413 gold grains were counted in heavy mineral concentrates collected from streams close to the Eskay Creek mine. Several streams southwest and northwest of the mine have lesser, but anomalous gold-grain counts.
- Abundant gold grains in the two creeks northwest of the Eskay Creek mine may reflect precious metal mineralization associated with the Iskut-Palmiere prospect. Background gold values were detected in sediment collected from these two creeks during a previous regional stream sediment survey.
- Although absence of pyrope garnet in the heavy mineral concentrates suggests an ultramafic rather that kimerlitic source, the abundant olivine in two of the samples is an explanation for high nickel values in stream sediment samples.
- Heavy minerals are effective for enhancing gold anomaly contrast in stream sediments and provide information for interpretating stream geochemical data.

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