

Bowser Basin Geochemical Survey, North-Central British Columbia: Anomaly Follow-up, 2005

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KEYWORDS: geochemistry, Bowser Basin, regional geochemical survey, gold anomaly, heavy minerals

INTRODUCTION

Reconnaissance-scale regional drainage surveys carried out as part of Canada's National Geochemical Reconnaissance (NGR) program routinely analyze the -80 mesh (<0.177 mm) fraction of sediment samples for trace elements. Standard sample preparation and analytical methods, maintained since the program was started in 1974, have minimized data levelling problems and have generated a large, uniform, high-quality stream and lake sediment geochemical database. Drainage sediment and water samples are collected at an average density of one sample per 13 km² in British Columbia as part of the NGR Program. This low-density sampling inevitably identifies areas of bedrock with higher geochemical values, indicating a greater mineral potential, but individual mineral occurrences may remain undetected. Sampling at a higher density or using a sediment heavy mineral concentrate (HMC) as a sample medium can increase the ability of low-density reconnaissance surveys to find individual mineral occurrences, but at a greater collection and analytical cost. Economical and practical methods that complement regional surveys to improve their success in discovering new mineral deposits in BC would clearly be attractive. The follow-up geochemical studies carried out jointly by the BC Geological Survey and the Geological Survey of Canada were therefore aimed at:

- characterizing the heavy mineral dispersal train related to polymetallic mineralization at the Eskay Creek Au mine and comparing it to the regional geochemical survey (RGS) silt response to establish if HMCs provide a spatially more extensive and/or stronger geochemical signature than the routinely collected silt;
- providing guidelines to the exploration community on the use of heavy minerals for drainage surveys;
- following up drainage sediment anomalies in the Bowser Lake area revealed by RGS results released in August 2005 (Friske *et al.*, 2005); and
- resampling historical RGS sites in northwestern BC to determine long-term geochemical variability and

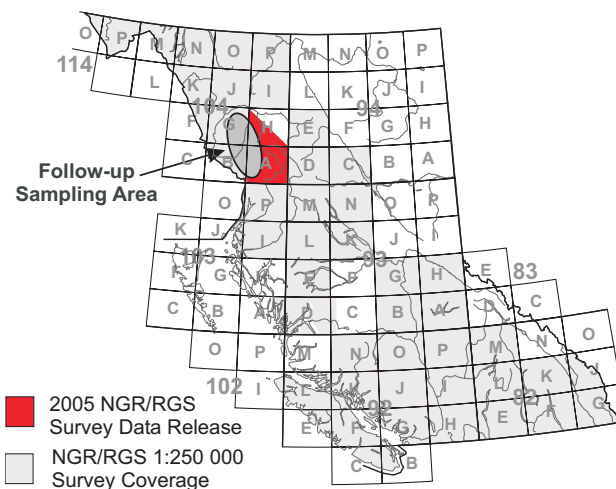


Figure 1. Location of the area covered by the 2005 regional geochemical survey (Friske *et al.*, 2005) and the follow-up sampling.

the source of unexplained sediment Hg and Ni anomalies.

Preliminary results of these studies are described in this paper.

Follow-up geochemical sample sites are located in the Bowser Lake (NTS 104A), Iskut River (NTS 104B), and Telegraph Creek (NTS 104G) map sheets (Fig. 1). This is an area of high topographic relief flanked by the Skeena Mountains in the east and the Coast Range Mountains in the west. The Nass Basin, an irregularly shaped area of low relief drained by the Bell-Irving – Nass rivers system, separates these two ranges. The eastern part of the Iskut River and Telegraph Creek sheets is drained by the Unuk River and its tributaries (Holland, 1964). Regional geology comprises the Bowser Basin, a Middle Jurassic to Middle Cretaceous sedimentary basin filled by deltaic sedimentary rocks represented by the Bowser Lake, Skeena and Sustut Groups (Ferri *et al.*, 2004) and volcanic epiclastic and sedimentary rocks of the the Jurassic Hazelton Group. Along the western margin of the basin, the Early to Middle Jurassic Salmon River Formation forms a gradational contact with Bowser Lake sedimentary rocks (Alldrick *et al.*, 2004, 2005). Hazelton Group volcanic and sedimentary rocks also outcrop within the Bowser Basin in the Oweegee Dome inlier surrounding Delta Peak, located northeast of Bowser Lake. Geology of the Oweegee Dome comprises green volcanic conglomerate overlain by green volcanic flows, brown-black siltstone, mudstone, limestone, felsic to intermediate lapilli tuff, tuff-breccia and crystal lithic tuff (Alldrick *et al.*, 2005). Typical of mineralization in these rocks is the Delta 2 showing (MINFILE 104A 166;

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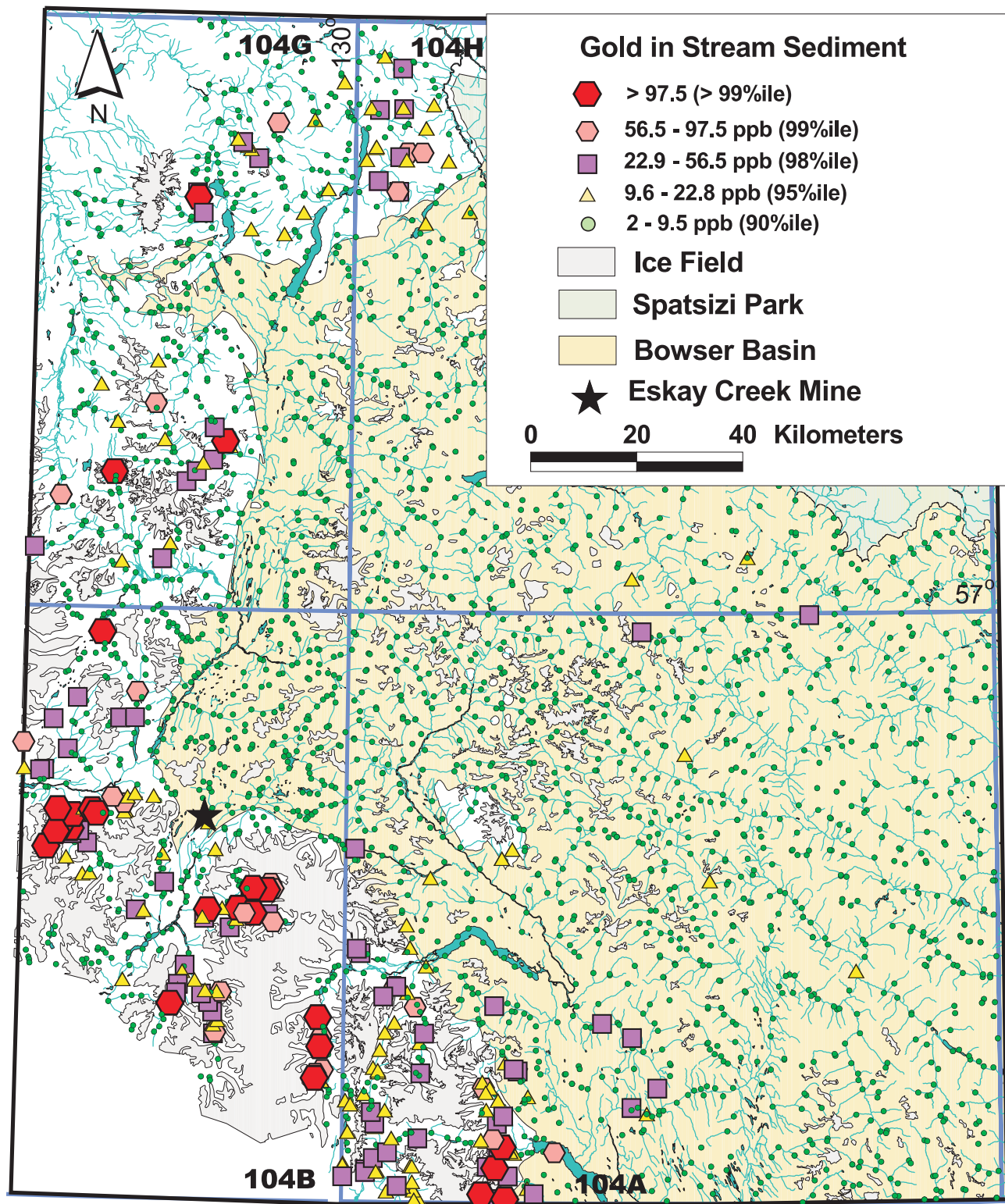


Figure 2. Gold in stream sediments from the Bowser Lake – Spatsizi River survey (Friskie *et al.*, 2005; Jackaman, 2005) and regional geochemical surveys covering the adjacent NTS maps sheets 104B and G. Symbols show concentrations at the 90th, 95th, 98th and 99th percentile levels.

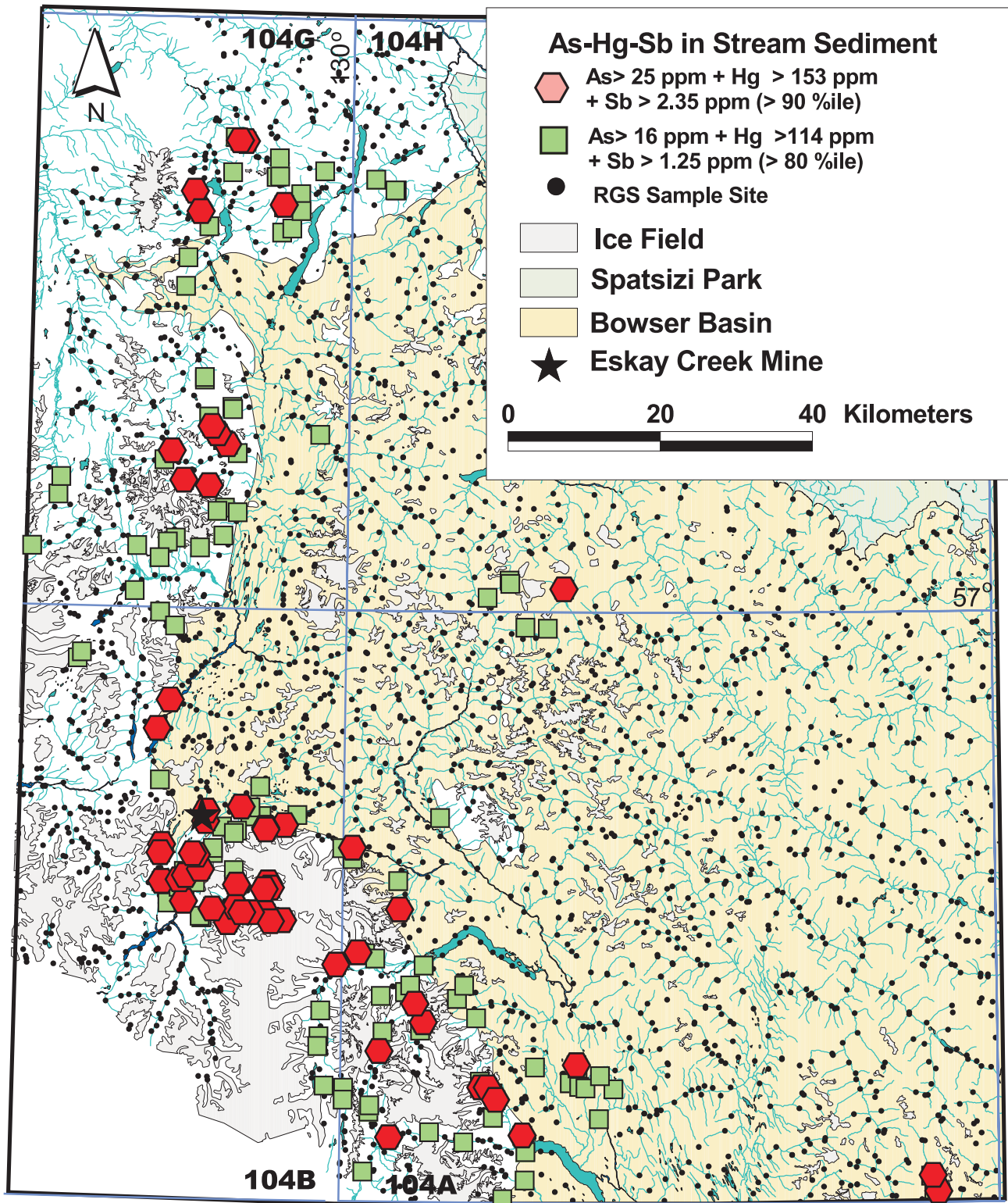


Figure 3. Multi-element anomalies, Bowser Lake – Spatsizi River survey and regional geochemical surveys covering the adjacent NTS maps sheets 104B and G. Symbols show samples with As, Sb and Hg all above the 90th and 95th percentile levels.

MINFILE, 2005), where disseminated pyrite and localized chalcopyrite, malachite, azurite and sphalerite occur in northeast-trending faults and shears.

Hazelton Group rocks also host the world-class Eskay Creek Au mine and several past-producing Au-Cu mines, such as the Red Cliff, Goat and Roosevelt, located in the southwestern part of NTS 104A. The area also has potential for alkalic porphyry Cu-Mo-Au-Ag deposits similar to Red Chris (MINFILE 104H 022), epithermal volcanogenic massive sulphide deposits and, possibly, sedimentary-exhalative Pb-Zn mineralization in Bowser Lake sedimentary rocks.

BOWSER LAKE – SPATSIZI RIVER REGIONAL SURVEY RESULTS

Results of a helicopter-supported stream sediment and water RGS completed in 2004 were released in August 2005 (Friske *et al.*, 2005). In total, 1463 stream sediment and 1458 water samples were collected from 1385 sites covering over 18 500 km² at a density of one sample per 13.5 km². Sediment samples were analyzed for Ag, Al, As, Au, Bi, Ba, Br, Ca, Cd, Ce, Co, Cr, Cu, Eu, Fe, Ga, Hf, Hg, K, La, Lu, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, S, Sb, Sc, Se, Sm, Sr, Ta, Tb, Te, Th, Ti, Tl, U, V, W, Yb and Zn by a combination of instrumental neutron activation analysis (INAA) and aqua regia digestion – inductively coupled plasma mass spectrometry (ICP-MS) and for loss-on-ignition (LOI). Water samples were analyzed for pH, conductivity, Cl, F, NO₃, SO₄ and U. Filtered and acidified water samples from 320 of the sites were also analyzed for 52 major and trace elements (Friske *et al.*, 2005; Jackaman, 2005).

Figure 2 is a symbol plot of Au in the –80 mesh fraction of stream sediment samples from this RGS and from surveys covering the adjacent NTS 104B and G map sheets (Matysek *et al.*, 1988a, b). Stream sediment Au anomalies, where values exceed the 99th percentile (>97.5 ppb), cluster in the southwestern and western parts of the surveyed area, where the rocks are predominantly Hazelton Group. Many of the Au anomalies correspond to areas of known mineralization, such as those draining the Sulphurets camp. There are a smaller number of weaker (22.9–56.5 ppb Au) anomalies in Bowser Basin drainages, and the largest cluster is located in the southern part of the Bowser Lake map sheet. Sulphide mineralization typical of the Eskay Creek deposit is typically enriched in Hg, As and Sb, among other elements. Drainage sample sites where As, Sb and Hg values all exceed the 80th and 90th

TABLE 1. STATISTICS AND CONTRAST FOR AU, AG AS AND HG IN –80 AND –230 MESH FRACTION OF STREAM SEDIMENT BASED ON GEOCHEMICAL DATA FOR 46 SAMPLES. CONTRAST = MAXIMUM/MEDIAN

Element	Mean	Median	Third Quartile	Maximum	95th Percentile	Contrast
Ag-80_MS	3752	264	686	>100000	2050	378
Ag-230_MS	4384	361	1098	>100000	3622	277
As-80_MS	46.2	17.0	40.8	623.5	161.6	37
As-230_MS	63.5	22.5	61.8	809.9	223.9	36
As-80_NA	10.8	13.5	30.8	91.6	67.7	7
As-230_NA	18.2	15.5	41.3	96.2	89.6	6
Au-80_MS	63.1	2.2	5.5	2138.5	45.8	972
Au-230_MS	140.8	1.8	6.9	4431.0	224.7	2461
Au-80_NA	178	6	14	5840	318	1062
Au-230_NA	236	8	25	6440	257	805
Hg-80_MS	2620	105	158	86756	2251	326
Hg-230_MS	3009	144	200	98406	2507	492

TABLE 2. STATISTICS CALCULATED FROM SELECTED ELEMENT DATA IN –80 MESH FRACTION OF 37 STREAM SEDIMENT SAMPLES. ABBREVIATIONS: ICP-MS, AQUA REGIA DIGESTION – INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY; INAA, INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS; GRAV, LOSS-ON-IGNITION AT 550°C

Element	Units	Det. Limit	Method	Mean	Median	Third Quartile	Maximum
Ag	ppb	2	ICP-MS	4464	237	419	>100000
As	ppm	0.1	ICP-MS	28.1	15.5	36.7	167.5
As	ppm	0.5	INAA	15.7	19.0	42.0	91.6
Au	ppb	0.2	ICP-MS	76.9	2.2	4.8	2138.5
Au	ppb	2	INAA	223	7	21	5840
Ba	ppm	50	INAA	1392	1100	1500	3800
Bi	ppm	0.02	ICP-MS	0.19	0.11	0.16	1.72
Br	ppm	0.5	INAA	3.6	1.0	5.3	16.0
Cd	ppm	0.01	ICP-MS	1.95	0.57	0.86	18.14
Co	ppm	0.1	ICP-MS	18.2	17.4	21	25.8
Co	ppm	5	INAA	19	18	23	34
Cr	ppm	0.5	ICP-MS	41.9	30.9	54.8	103.4
Cr	ppm	2	INAA	149	120	210	630
Cu	ppm	0.01	ICP-MS	68.58	51.58	63.0	495.99
Fe	%	0.01	ICP-MS	4.37	4.18	4.82	7.46
Fe	%	0.02	INAA	5.30	4.90	5.90	9.20
Ga	ppm	0.2	ICP-MS	5.2	5.0	5.5	10.9
Hg	ppb	5	ICP-MS	3236	104	219	86756
LOI	%	0.1	Grav	5.45	4.30	6.80	14.50
Mn	ppm	1	ICP-MS	1036	942	1258	2057
Mo	ppm	0.01	ICP-MS	3.25	1.81	2.80	23.38
Ni	ppm	0.1	ICP-MS	60.9	57.3	94.9	147.3
Pb	ppm	0.01	ICP-MS	66.90	9.82	20.0	1453.11
S	%	0.02	ICP-MS	0.29	0.16	0.32	2.56
Sb	ppm	0.02	ICP-MS	29.18	1.34	3.59	762.60
Sb	ppm	0.1	INAA	40.5	2.3	6.8	1050.0
Se	ppm	0.1	ICP-MS	2.1	1.0	1.9	21.4
Te	ppm	0.02	ICP-MS	0.08	0.05	0.1	0.87
Th	ppm	0.1	ICP-MS	1.2	1.2	1.3	2.0
Th	ppm	0.2	INAA	4.1	3.9	4.9	8.0
Tl	ppm	0.02	ICP-MS	0.28	0.13	0.24	1.67
U	ppm	0.1	INAA	2.4	2.4	2.8	7.2
V	ppm	2	ICP-MS	65	54	70	191
Zn	ppm	0.1	ICP-MS	322.1	136.4	176.3	3763.2

TABLE 3. STATISTICS CALCULATED FROM SELECTED ELEMENT DATA FROM 35 HEAVY MINERAL CONCENTRATES ANALYZED BY AQUA REGIA DIGESTION ICP-MS AND 26 HEAVY MINERAL CONCENTRATES ANALYZED BY INAA. ABBREVIATIONS: ICP-MS, AQUA REGIA DIGESTION – INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY; INAA, INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS

Element	Units	Method	Median	Third Quartile	Maximum
Ag	ppb	ICP-MS	4499	8145	>100000
As	ppm	ICP-MS	241.5	484.5	1737.8
As	ppm	INAA	279.5	523.0	1570
Au	ppb	ICP-MS	437.4	2301.9	>100000
Au	ppb	INAA	3095	8438	161000
Ba	ppm	ICP-MS	31.4	76.7	4289.9
Ba	ppm	INAA	18250	32625	92100
Bi	ppm	ICP-MS	0.54	1.85	10.94
Cd	ppm	ICP-MS	2.59	8.34	310
Co	ppm	ICP-MS	79.1	113.15	577.9
Co	ppm	INAA	81	143	615
Cr	ppm	ICP-MS	21.3	52.7	258.7
Cr	ppm	INAA	500	1225	46100
Cu	ppm	ICP-MS	337.05	765.47	>10000
Fe	%	ICP-MS	16.28	25.25	40
Fe	%	INAA	28.7	33.3	41.4
Hg	ppb	ICP-MS	1869	5257	>100000
Mn	ppm	ICP-MS	1096	2162	25909
Mo	ppm	ICP-MS	9.9	16.34	101.45
Mo	ppm	INAA	6	10	87
Ni	ppm	ICP-MS	94	239.2	793.2
Ni	ppm	INAA	71	95	730
S	%	ICP-MS	5.79	10	10
Sb	ppm	ICP-MS	12.41	24.79	2000
Sb	ppm	INAA	21.8	52.7	33000
Se	ppm	ICP-MS	10.8	17.65	100
Te	ppm	ICP-MS	0.18	0.7	4.17
Tl	ppm	ICP-MS	0.5	1.28	19.61
V	ppm	ICP-MS	80	160	361
W	ppm	ICP-MS	0.9	4.8	58.3
W	ppm	INAA	4	15.5	98
Zn	ppm	ICP-MS	374.3	1077.8	>10000
Zn	ppm	INAA	460	1100	116000

percentile levels are identified in Figure 3. Data used to create this map were combined from those reported in RGS 58 (Friske *et al.*, 2005) and results of the 104B and G sediment sample reanalysis previously reported by Lett and Jackaman (2003). Although most sites with this element signature are from streams draining the Hazelton Group, there are several anomalous drainages in the southeastern part of the Bowser Lake sheet (NTS 104A) underlain by sedimentary rocks.

FOLLOW-UP SAMPLING

Sample Collection

During the summers of 2004 and 2005, stream sediment, bulk sediment samples (for preparation of HMCs) and stream water samples were collected at 44 sites in NTS areas 104A, 104B and 104G. Information about the site,

such as sediment texture, drainage size and water flow was recorded. Sediment typical of that collected during a reconnaissance-scale geochemical survey was taken from mid and lateral bars in active stream channels at locations selected to avoid high or low-energy extremes. Where abundant, living moss attached to boulders and logs from just above the stream high-water mark was also collected. Stream sediment and moss samples were stored in high-wet-strength Kraft paper sample bags for shipment to a commercial laboratory.

Ideally, sediment for preparation of a HMC fraction was taken at the upstream point of midchannel bars. At each site, a 5 gallon plastic pail was lined with a heavy-duty polyethylene plastic bag (18 x 24 inches, 4 mil) and sediment was wet sieved through a 12-mesh (1.68 mm) stainless steel sieve until a sample weight of 10–15 kg was obtained. The sample was weighed in the pail before the opening was taped shut with black plastic tape and placed in a second bag.

Water was also collected at each site in a rinsed Nalgene® bottle, and the pH and conductivity were measured within twenty-four hours. Later, a portion of the water sample was filtered through a 0.45 µm glass-fibre filter and the filtered water acidified to pH 2 with ISTAR® nitric acid.

Sample Preparation and Analysis

Fine-textured sediment and moss samples were air dried and the –18 mesh (<1 mm) fraction recovered by gently disaggregating the sediment or by pounding the moss before dry sieving through a 1 mm stainless-steel screen. Part of the –1 mm fraction was then screened to –80 mesh ASTM (<0.177 mm) and another portion screened to –230 mesh (<0.063 mm). A control reference material and analytical duplicate sample were inserted into each block of 20 samples before analysis. Any remaining –80 and –230 mesh material was archived for future analysis.

Bulk sediment samples were progressively reduced by different laboratory procedures to concentrate the 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 retabled to scavenge possible unrecovered massive sulphide indicator minerals. The concentrate from both tabling runs was separated in methylene iodide diluted with acetone to sp gr 3.20 to recover heavy minerals. 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 mm to <0.5 mm, 0.5 mm to <1.0 mm, =1.0 mm to 2.0 mm), with the <0.25 mm (60 mesh) fraction being used for chemical analysis.

The –80 and –230 mesh fractions of the stream sediment and moss samples and the <0.25 mm nonmagnetic fraction of the HMC were analyzed for trace and minor elements by aqua regia digestion – inductively coupled plasma mass spectrometry (aqua regia ICP-MS) at Acme Analytical Laboratories Ltd., Vancouver and by instrumental neutron activation analysis (INAA) at Becquerel Laboratories, Mississauga, Ontario. Analytical amounts of the HMCs ranged from 0.1 to 15 g. The filtered, acidified portion of each water sample was analyzed by inductively coupled

TABLE 4. ENHANCED (>3RD QUANTILE) CONCENTRATIONS OF ELEMENTS IN THE –80 MESH FRACTION OF STREAM SEDIMENT AND ELEMENTS ELEVATED IN STREAM WATER SAMPLES COLLECTED IN 2004. ABBREVIATION: REE, RARE EARTH ELEMENTS (E.G, DY, ER, EU)

Year	Map Sheet	Site	Elements Enhanced (>3rd Quartile) in 80 Mesh Fraction of Sediment	Elements Elevated in Stream Water
2004	104A	7002	Mo	
2004	104A	7003		
2004	104A	7004		
2004	104A	7005	Pb, As, Bi	
2004	104A	7006	Cd, Pb	
2004	104A	7007		
2004	104A	7008		
2004	104A	7009		
2004	104A	7010		
2004	104A	7011	Mo	
2004	104B	7002	Au, Ag, Cd, Hg, Mo, Pb, Sb	Sb
2004	104B	7003	Cd, Pb	
2004	104B	7004	Bi	
2004	104B	7005	Au, As, Bi	
2004	104B	7006	Bi	
2004	104B	7007		
2004	104B	7008		
2004	104B	7009	Au, Ag, Bi, Cd, Cu, Hg, Mo, Pb, Sb, Zn	Sb
2004	104B	7010	Au, Ag, Bi, Cd, Cu, Hg, Mo, Pb, Sb, Se, Tl, Zn	Pb, Sb, Tl
2004	104B	7011	Au, Ag, Bi, Cd, Cu, Hg, Mo, Pb, Sb, Se, Tl, Zn	
2004	104B	7012	Au, Ag, Bi, Cd, Hg, Mo, Pb, Sb, Tl, Zn	Zn
2004	104B	7013	Ag, Bi, Cd, Hg, Mo, Pb, Sb, Zn	
2004	104B	7014	Cu, Hg, Pb	
2004	104B	7015	Au, Ag, Bi, Cd, Hg, Mo, Pb, Sb, Zn	Zn
2004	104B	7016		
2004	104B	7017	Au, Cu	
2004	104B	7018	As, Bi, Cu	
2004	104G	7002	Au, As, Cu, Hg, Sb	
2004	104G	7003		
2004	104G	7004		
2004	104G	7005	Au, Cd, Mo, Tl, Zn	
2004	104G	7006	Au, Cu, Mo	Al
2004	104G	7007	Au, Ag, Bi, Hg, Mo, Pb, Sb, Tl	Al, Cd, Cu, Zn, REE

plasma mass spectrometry at the Geological Survey of Canada, Ottawa.

DETAILED SAMPLING RESULTS

Size Fraction Chemistry

Element concentrations in the –230 mesh size fraction of sediment samples are typically higher than in the –80 mesh fraction. For some elements, such as V and Cr, the difference in median for the two size fraction populations is in the order of 10%. Other elements, such as Au, Ag, As and Hg, have larger median differences (Table 1). Based on a population size of 46 samples, the Au median (INAA) for the –230 mesh fraction is 8 ppb, compared to 6 ppb for the –80 mesh fraction. Table 1 also compares anomaly contrast (maximum/median) for As, Ag, Au and Hg in the two size fractions. Arsenic contrast is almost identical for the two size fractions, whereas Au by aqua regia ICP-MS and Hg show a greater anomaly contrast for the –230 mesh fraction. Gold by INAA and Ag by aqua regia ICP-MS show larger

contrast for the –80 mesh fraction. Depending on the analytical method, the –230 mesh fraction may have an advantage for improving anomaly contrast for Au and Hg, but not necessarily for other elements. Also, there are limitations to using the –230 mesh fraction, such as the need to collect a larger sample for screening enough material for analysis and the problem of levelling geochemical data produced from the –80 and –230 mesh fractions.

Multielement Associations in Sediment and Heavy Mineral Concentrates

The multielement signature of stream sediment and HMC anomalies can help characterize the source mineralization. Tables 2 and 3 list 3rd quartile values for selected elements calculated from the combined 2004 and 2005 –80 mesh sediment data and the 2004 HMC results. The 3rd quartile, rather than the more traditional 95th percentile, has been used as a threshold because it may be a more realistic value, given the small number of samples. Detection limit and mean, median and maximum concentrations are given in Table 2 for elements determined by aqua regia ICP-MS

TABLE 5. ENHANCED (>3RD QUANTILE) ELEMENTS IN THE <0.25 MM FRACTION OF HEAVY MINERAL CONCENTRATES AND GOLD GRAIN COUNTS FROM SEDIMENT SAMPLES COLLECTED IN 2004. SHAPE OF GOLD GRAINS REFLECTS RELATIVE DISTANCE FROM A SOURCE

Year	Map Sheet	Site	Elements Enhanced (>3rd Quartile) in Sediment Heavy Mineral Concentrates	Number of Visible Gold Grains			
				Total	Reshaped	Modified	Pristine
2004	104A	7002		0	0	0	0
2004	104A	7003		0	0	0	0
2004	104A	7004		0	0	0	0
2004	104A	7005	Au, Ag, As, Bi, Pb, Tl	9	6	2	1
2004	104A	7006	Bi, Pb	0	0	0	0
2004	104A	7007	Cd, Mo, Se	0	0	0	0
2004	104A	7008	Bi, Cu, Mo, Se	0	0	0	0
2004	104A	7009	Cd, Zn	0	0	0	0
2004	104A	7010	Mo	0	0	0	0
2004	104A	7011	Hg	0	0	0	0
2004	104B	7002	Ag, Sb	0	0	0	0
2004	104B	7003	Hg	0	0	0	0
2004	104B	7004	Cd, Cu, Se, Zn	0	0	0	0
2004	104B	7005	As, Sb, Pb	30	20	4	6
2004	104B	7006	Au, Bi	177	145	9	23
2004	104B	7007	Au, Se, Bi	7	5	1	1
2004	104B	7008	Au, Ag, Cu	2	2	0	0
2004	104B	7009	Au, Ag, Bi, Cd, Cu, Hg, Mo, Pb, Sb, Se, Tl, Zn	70	19	13	38
2004	104B	7010	Au, Ag, Bi, Cd, Cu, Hg, Mo, Pb, Sb, Se, Tl, Zn	413	204	0	209
2004	104B	7011	Cd, Cu, Hg, Mo, Pb, Sb, Se, Tl, Zn	36	4	0	32
2004	104B	7012	Au, Ag, Cd, Hg, Mo, Pb, Sb, Tl, Zn	0	0	0	0
2004	104B	7013	Ag, Cd, Cu, Hg, Mo, Pb, Sb, Tl, Zn	1	1	0	0
2004	104B	7014	Cd, Cu, Mo, Pb, Sb, Tl	0	0	0	0
2004	104B	7015	Ag, As, Cu, Cd, Mo, Se, Zn	0	0	0	0
2004	104B	7016		0	0	0	0
2004	104B	7017	Sb	0	0	0	0
2004	104B	7018	As, Bi, Se	2	2	0	0
2004	104G	7002	Au	1	1	0	0
2004	104G	7003		0	0	0	0
2004	104G	7004		0	0	0	0
2004	104G	7005	Mo	1	1	0	0
2004	104G	7006	As	2	1	0	1
2004	104G	7007	Ag, As, Bi, Hg, Sb, Se, Tl	2	2	0	0

and INAA techniques. In the case of Ag, the maximum value of >100 000 ppb reflects concentrations in excess of the ICP-MS upper limit.

Tables 4 and 5 list samples and corresponding elements that are above the 3rd quartile for the -80 mesh fraction (Table 4) and the <0.25 mm heavy mineral concentrate (Table 5). Also shown are elevated element levels in the filtered and acidified water samples (Table 4) and gold grain counts (Table 5). The number and morphology of gold grains in a sample are indicators of the proximity of the grain to the source. 'Pristine' grains are considered to be close to a source of Au mineralization, whereas 'reshaped' grains are considered to be more distant from a source.

Multielement associations are identified in Tables 4 and 5 for samples where concentrations exceed the 3rd quartile. Two samples, 104B7009 and 104B7010, with a large number of anomalous elements (*i.e.*, Au, Ag, Bi, Cd, Cu, Hg, Mo, Pb, Sb, Se, Tl, Zn) in both sediment and HMC are close to the Eskay Creek mine. Their location and other sample sites described in this paper are shown in Figure 4. An abundance of pristine gold grains in these samples reflects a short transport distance from the source. Sample 104B7010 has elevated Pb, Sb and Tl in the stream water in addition to anomalous metals in sediment.

Anomalous samples with smaller multielement suites may also reflect mineralization in their drainages. Southwest of the Eskay Creek mine are several sites (104B7011, 7013, 7014, 7015) with HMC and sediment geochemical signatures that include Ag, Hg, Mo, Sb, Tl and Zn. The similarity of this signature to that in sediment and HMCs from

TABLE 6. ENHANCED (> 3RD QUANTILE) ELEMENTS IN THE MINUS 80 MESH FRACTION OF STREAM SEDIMENT SAMPLES COLLECTED IN 2005

Year	Map Sheet	Site	Elements enhanced (> 3rd Quartile) in the minus 80 mesh fraction of sediment
2005	104A	1002	
2005	104A	1003	Mo
2005	104A	1004	Ag, Cd, Se, Tl
2005	104A	1005	
2005	104A	1006	Ag, Bi, Cd, Cu, Pb, Sb, Zn
2005	104A	1007	Ag, Bi, Cu, Pb, Zn
2005	104A	1008	Au, Ag, As, Bi, Cd, Cu, Pb, Sb, Zn
2005	104A	1009	Au, Ag, As, Bi, Cd, Cu, Pb, Sb, Zn
2005	104A	1010	Au, Ag, As, Bi, Cd, Cu, Pb, Sb, Zn
2005	104A	1011	Ag, As, Cd, Pb
2005	104A	1012	Au, Ag, As, Bi, Cd, Cu, Pb, Sb, Zn
2005	104A	1013	
2005	104B	1002	Bi

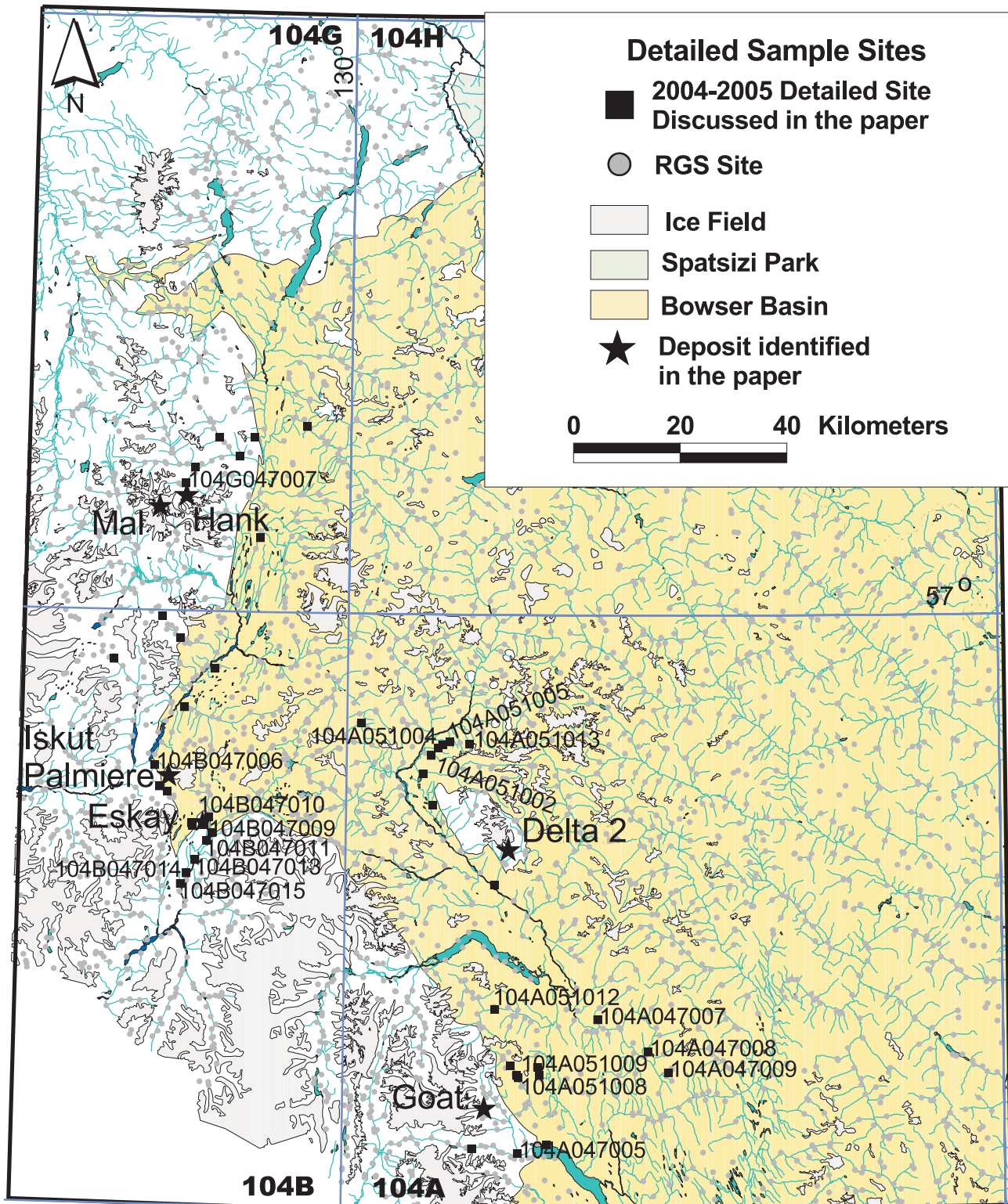


Figure 4. Mineral deposit and detailed sample locations discussed in the paper are identified on the map.

streams closer to the Eskay Creek mine suggests a similar epithermal mineral source for these anomalies. Northwest of the mine, sediment from a creek draining the area surrounding the Iskut Palmiere prospect contains 177 visible gold grains (Lett, et al., 2005). A more detailed examination of the chemistry and mineralogy of this sediment reveals a significant number of pristine gold grains in the HMC (*i.e.*, local source) and that Bi is the common anomalous element in both HMC and sediment. There are several single or multielement anomalies in the northwestern part of the follow-up survey area. Among them is sample 104G 7007, which has a distinct Au, Ag, As, Bi, Hg, Sb, Se and Tl association in sediment and HMC, and elevated Al, Cd, Cu, Zn and rare earth elements in the stream water. The source of this sediment-water geochemical anomaly may be Ag-Pb-Zn epithermal vein mineralization at prospects near the sample site, such as the Hank (MINFILE 104G07) and the MAL (MINFILE 104G147) prospects.

Sample 104A7005, located in the southwestern corner of the Bowser Lake map sheet (104A), has anomalous Au, Ag, As, Bi, Pb and Tl in the HMC and anomalous Pb, As and Bi in the sediment. This anomaly can be explained by geochemical dispersion from the past-producing Goat Ag-Pb-Zn-Au mine (MINFILE 104A02), located about 10 km upstream from the sample site. There are several sediment anomalies (*e.g.*, 104A 7007, 7008 and 7009) about 10 km northeast of the Goat deposit in an area underlain by Bowser Group sedimentary rocks. Among the elements characterizing these anomalies are Bi, Cd, Cu, Mo, Pb, Se and Zn. One possible source for these metals may be metal-rich shale.

Table 6 lists elements above the 3rd quartile for the -80 mesh fraction of sediment samples collected in 2005. Currently, no HMC or water geochemical data are available for the 2005 samples. However, water SO₄ was measured in the field using a Hach model SF-1 test kit. Several multielement anomalies defined by a 3rd quartile threshold are revealed in the -80 mesh fraction of the sediment. A number of these (*i.e.*, 2005104A 1008, 1009, 1012), located in the southwestern part of NTS 104A in an area underlain by Bowser Group sedimentary rocks, have a similar Au, Ag, As, Bi, Cd, Cu, Pb, Sb and Zn signature. There are currently no known sulphide mineral occurrences in the area. Among a cluster of anomalies in the northeastern part of the detailed survey area are one site (2005104A 1004) with a Ag, Cd, Se and Tl signature (Table 6), and three sites (2005104A 1002, 1005, 1013) with more than 50 ppm SO₄ in weakly alkaline water, but no corresponding elevated metal concentrations in the sediment. These samples are from streams draining the north side of the Oweege Dome. The Delta 2 showing (MINFILE 104A166) is roughly 10 km to the south, but no mineralization has been found in the immediate area of the water anomalies.

CONCLUSIONS

Recently published regional stream sediment survey data for the Bowser Basin – Spatsizi River area reveals that most of the Au and pathfinder As-Sb-Hg element anomalies are in streams draining Hazelton Group rocks. However, there are also several weaker anomalies in drainages within the sedimentary Bowser Basin. Although many of the Hazelton anomalies can be traced to known base-precious metal mineralization, those in the Bowser Basin are still unexplained.

Detailed geochemical studies reveal a multielement Au, Ag, Bi, Cd, Cu, Hg, Mo, Pb, Sb, Se, Tl and Zn signature in the sediments and HMCs from streams draining the area around the Eskay Creek Au mine. The pristine shape of gold grains suggests a relatively local source for the grains. Stream waters typically have elevated Sb levels. A smaller Ag, As, Bi, Hg, Sb, Se, Tl ± Au element association characterizes sediment and HMC anomalies in streams draining other areas with known mineralization to the north of the Eskay Creek mine.

Heavy mineral geochemistry and the use of a smaller size fraction (-230 mesh) complements routine reconnaissance-scale regional geochemical surveys based on analysis of the -80 mesh fraction.

ACKNOWLEDGMENTS

Advice and assistance from Brian Grant during the fieldwork was very much appreciated. The authors would also like to thank Derek Weismiller of Lakelse Air for helicopter support, and the manager and staff of the Bell 2 Lodge for their hospitality. Acme Analytical Laboratories Ltd., Vancouver prepared the stream sediment samples and Overburden Drilling Management, Nepean, Ontario processed the heavy mineral concentrates.

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