

ISKUT RIVER - TELEGRAPH CREEK: NEW EXPLORATION OPPORTUNITIES IN THE BC REGIONAL GEOCHEMICAL DATABASE

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KEYWORDS: Regional stream sediment surveys, archival samples, gold, drainage basins, reanalysis.

INTRODUCTION

This project has been supported by funding from the BC and Yukon Chamber of Mines, Rocks to Riches program.

A primary aim of large-scale (typically 1 sample per 12 to 15 km²) stream sediment surveys is to identify areas of high mineral potential where mining companies and individuals can focus their search for new deposits. The regional geochemical survey (RGS) in British Columbia has covered almost 70% of the province with stream sediment, moss mat sediment, lake sediment, lake water and stream water samples collected at an average density of 1 sample per 13 square kilometers from over 40 000 sites. Upgrades to the RGS database are made by the addition of information from new surveys and from the analysis of archival samples for additional elements using new or improved analytical methods. Continual interpretation of existing and new data can reveal new exploration targets. For example, recent follow up of a RGS anomaly resulted in the discovery of new mineralization at the Sickel-Griz Au-Ag occurrence in the Toodogone River area (Stealth Minerals November 6th News Release).

During the past year rising metal prices and the presence of the operating Eskay Creek mine has stimulated mineral exploration activity in the Iskut River area. This area has been the subject of BC Energy and Mines mapping programs during 2003 (Alldrick *et al.*, 2004). Archived stream sediment samples from 930 RGS sites in the western half of the Iskut River and Telegraph Creek NTS map sheets (NTS 104 B and G) bordering the Bowser sedimentary basin were re-analysed by inductively coupled plasma mass spectrometry. The aim of the re-analysis, funded by a grant from the BC and Yukon Chamber of Mines (Rocks to Riches program), was to generate additional multi-element data to help identify new exploration targets. This paper briefly reviews the new RGS data for the Iskut River region and shows the distribution of selected elements. Areas where the sediment geochemistry suggests a higher potential for different types of mineral deposit are identified.

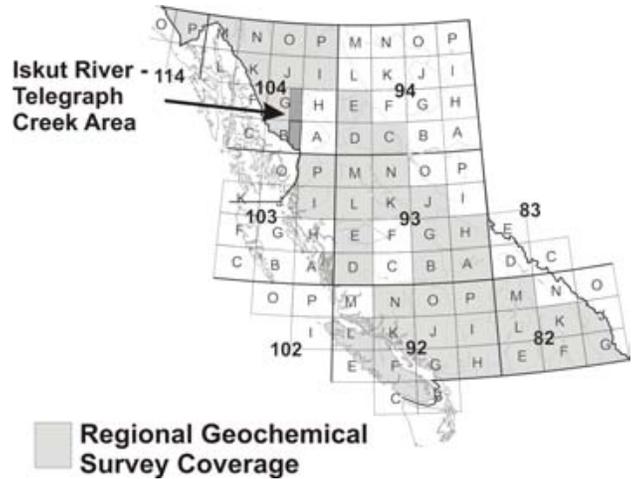


Figure 1. Archival re-analysis project area

ISKUT RIVER AREA

The Iskut River and Telegraph Creek Map sheets have been covered by regional geochemical surveys in 1987 (Matysek *et al.*, 1988a and b, Day and Matysek, 1989). The archived sediment samples selected for re-analysis are from an area of roughly 8000 square kilometers in these map sheets (Figure 1). Major populations centers in the region are Stewart, Telegraph Creek and Dease Lake (Figure 2).

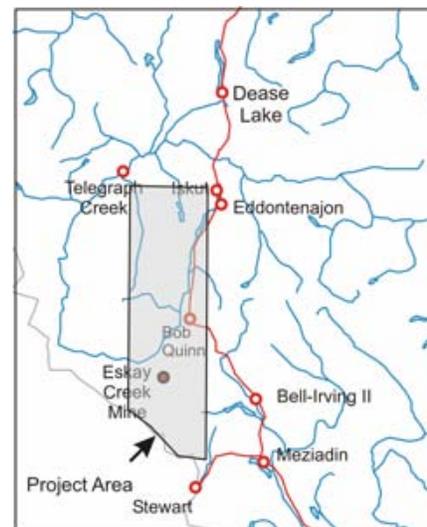


Figure 2. Major centers and roads

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The region is crossed by the Tahlan Highlands and Klastiline Plateau and is drained by the Iskut River. Much of the bedrock in this area is concealed beneath ice fields and surficial deposits. Geological units of the Stikine tectonic terrane underlie the eastern part of the Iskut River-Telegraph Creek map sheets. The three most extensive of these units are the Triassic Stuhini Group, the Lower Jurassic Hazelton Group and the Middle Jurassic Bowser Lake Group. The Stuhini Group consists predominantly of volcanoclastic rocks with subordinate mafic to felsic flows. Fossiliferous conglomerate or sandstone at the base of the Hazelton Group rest unconformable on the Stuhini Group. Above the clastic sediments are andesitic to dacitic flows, sills and volcanoclastic rocks. This unit is succeeded by a predominantly felsic volcanic flows, tuffs and breccias with a younger sedimentary strata ranging from sandstone to limestone. The youngest Hazelton Group unit is a bimodal volcanic assemblage with minor sedimentary rocks. Significant precious and base metal mineralization occurs in Stuhini and Hazelton group rocks. Stratigraphically above the Hazelton Group are marine and terrestrial sandstones and conglomerates of the Bowser Lake Group. Neogene volcanic flows of the Mount Edziza Complex partially cover Mesozoic rocks. Intrusive rocks that are related to mineralization range from olivine gabbro (e.g. Nickel Mountain) to granodiorite (e.g. Mitchell Pluton) to feldspar porphyry (Gabrielse and Yorath, 1992).

Within the eastern half of NTS 104 B and G there are a number of past-producing mines and significant advanced prospects in addition to the Eskay Creek gold mine. These are examples of the following BC mineral deposit profiles edited by Lefebvre and Höy, (1996):

- **Calc alkaline porphyry (L04).** Mineralization at the Spectrum (MINFILE 104G 036) deposit consists of pyrite, chalcopyrite, pyrrhotite, galena, sphalerite and arsenopyrite in altered Stuhini Group sedimentary and volcanic rocks. The deposit is estimated to contain 504,800 tonnes grading 9.6 g/t Au. East of the Spectrum is the GJ (MINFILE 104G 034) where chalcopyrite and pyrite occur in siliceous sediments of the Stuhini Group and a granodioritic pluton. At the Kerr prospect (MINFILE 104B 191) chalcocite, pyrite, chalcopyrite, copper and gold are disseminated in silicified-sericitized volcanic rocks of the Hazelton Group Unuk River Formation. Reserves are estimated to be 140.8 million tonnes grading 0.36 g/t Au and 0.75% Cu. Pathfinder elements for this deposit type are Cu, Mo, Au and Ag with varying Bi, W, B and Sr levels. There may be a Pb, Zn, Mn, V, Sb, As, Se, Te, Co, Ba, Rb and Hg lithochemical halo surrounding the mineralized core zone.
- **Intrusive-related Cu-Ni (M02).** The E and L deposit (MINFILE 104B 006) consists of pyrrhotite, pentlandite and chalcopyrite hosted by

the Nickel Mountain olivine gabbro stock. Estimated reserves are 2.9 million tonnes of 0.62 % Cu and 0.8 % Ni with traces of Pd and Pt. Key pathfinders for this deposit type are Cu, Ni, Au, Ag, Pt, Pd and Co.

- **Epithermal and Mesothermal Au-Ag veins (H05, I01).** At the Big Missouri Mine (MINFILE 104B 150) hydrothermally altered Hazelton Group volcanic rocks and granodiorite of the Texas Creek Plutonic suite host high-sulphide base metal-rich Au and low sulphide Au-rich veins. Estimated geological reserves are 1.7 million tonnes grading 2.2 g/t Au. At the Hank prospect (MINFILE 104G 107) pyrite, chalcopyrite, galena and sphalerite occur with carbonate and barite in veins cutting Stuhini Group volcanic rocks. Estimated reserves are 0.5 million tonnes grading 2.2 g/t Au. Pathfinder elements for this deposit type are Au, Ag, Zn, Pb, Cu, As, Sb, Ba, F and Mn with varying Te, Se and Hg.
- **Massive Sulphide – Besshi VMS (G04).** Mineralization at the Granduc Mine (MINFILE 104B 021) consists of massive pyrite, chalcopyrite, pyrrhotite, magnetite, galena, sphalerite, bornite, cobaltite and arsenopyrite in volcanic and sedimentary units of the Hazelton Group Unuk River Formation. Pre-production ore reserves were estimated to be 39.3 million tonnes grading 1.73 % Cu. Pathfinder elements are for this deposit type are Cu, Zn, Ag, Se, Mn and Mg. The Co:Ni ratio is greater the one.
- **Massive Sulphide – Sub aqueous hot-spring (G07, G06).** The most prominent mineralization style at the Eskay Creek mine (MINFILE 104B 008) is massive and disseminated stibnite, pyrite, tetrahedrite, realgar, cinnabar and arsenopyrite in mudstone between rhyolite and basalt units of the Hazelton Group. Reserves are estimated to be over 2.94 million tonnes of ore grading 43.25 g/t Au and 1926 g/t Ag equivalent. Key pathfinder elements are for this deposit type are Au, Ag, Cu, Pb, Zn, Co, As, Sb and Hg.

In addition, there are a number of deposits in the area where there are several styles of mineralization. For example, at the Sulphurets Gold deposit (MINFILE 104B 182) quartz-albite altered Unuk River andesite contains pyrite, chalcopyrite and minor bornite. The highest gold values occur in the most silicified rock. Reserves are estimated to be over 54.8 million tonnes of ore grading 1.02 g/t gold and 0.55 %Cu. This deposit demonstrates both porphyry (L04) and intrusion vein (I02) styles of mineralization. Recent exploration at the Foremore (MINFILE 104G 148) has focused on float boulders of chalcopyrite-sphalerite massive sulphide containing up to 1.5 g/t Au. This occurrence has been tentatively classified as a Kuroko massive sulphide.

TABLE 1.
DETECTION LIMITS FOR ICP/MS AND AAS
DETERMINED ELEMENTS

	Units	ICP/MS	AAS
Ag	ppb	2	100
Al	%	0.01	
As	ppm	0.1	1
B	ppm	1	
Ba	ppm	0.5	
Bi	ppm	0.02	
Ca	%	0.01	
Cd	ppm	0.01	0.1
Co	ppm	0.1	2
Cr	ppm	0.5	
Cu	ppm	0.01	2
Fe	%	0.01	0.01
Ga	ppm	0.2	
Hg	ppb	5	5
K	%	0.01	
La	ppm	0.5	
Mg	%	0.01	
Mn	ppm	1	5
Mo	ppm	0.01	1
Na	%	0.001	
Ni	ppm	0.1	2
P	%	0.001	
Pb	ppm	0.01	2
S	%	0.02	
Sb	ppm	0.02	1
Sc	ppm	0.1	
Se	ppm	0.1	
Sr	ppm	0.5	
Te	ppm	0.02	
Th	ppm	0.1	
Ti	%	0.001	
Tl	ppm	0.02	
U	ppm	0.1	
V	ppm	2	5
W	ppm	0.2	
Zn	ppm	0.1	2

Sample Analysis

A total of 945 archive RGS samples (including field duplicates) and 36 samples of 8 different geochemical standards were analysed by leaching a 1 gram of the sample with a HCl-HNO₃-H₂O (2:2:2 v/v) mixture at 95°C for one hour and then measuring the concentration of 37 elements in the diluted solution by inductively coupled plasma mass spectrometry (ICP/MS). ACME laboratories, Vancouver, analysed the archived samples. Detection limits for elements by ICP/MS and also those by the aqua regia digestion-atomic absorption spectrometry (AAS) used in 1987 (Matysek *et al.*, 1988) are shown in Table 1.

The percent relative standard deviation (% RSD) was determined by repeat (typically 4) ICP/MS analyses of the CANMET geochemical standards STSD 1, 2 and 4; LKSD 1,2,3 and 4 and an internal standard. Only Au, B, S, Sb, Te, Th, Ti and W have percent RSD values

exceeding 7.5% in 6 of the 8 standards. The lower precision for these elements can be explained by concentrations in a standard close to detection limit. For Au, the large percent RSD values may also reflect the small sample used for analysis and the uneven distribution of Au in the reference material (Clifton *et al.*, 1969).

Results for elements determined by ICP/MS are similar to those obtained by AAS and reported by Matysek *et al.* (1988). For example, the correlation coefficient for As, Ag, Cd, Cu, Co, Mo, Mn, Ni, Pb and Zn by the two techniques is greater than + 0.9; for Fe, Sb and V it is greater than + 0.8 and for Hg the correlation coefficient is +0.76. A scatter plot (Figure 1) for Hg shows that the lower correlation coefficient is due to a small number of samples where there is a large difference in Hg determined by the two methods.

TABLE 2. SUMMARY STATISTICS FOR
ELEMENTS BY ICP/MS (*FIRE ASSAY-AAS)

	Units	Mean	95%ile	Max
Ag	ppb	237	798	3931
Al	%	1.61	2.35	5.72
As	ppm	17.0	53.5	446.0
Au*	ppb	28	104	5300
B	ppm	3	7	52
Ba	ppm	177.2	401.3	1528.0
Bi	ppm	0.19	0.62	6.02
Ca	%	0.98	2.59	25.36
Cd	ppm	0.70	2.45	15.28
Co	ppm	18.5	29.9	52.0
Cr	ppm	43.6	98.0	516.4
Cu	ppm	58.42	140.65	909
Fe	%	3.96	5.72	8.89
Ga	ppm	5.4	8.3	16.9
Hg	ppb	111	281	3755
K	%	0.09	0.19	1.17
La	ppm	12.8	33.1	140.9
Mg	%	1.13	1.81	4.41
Mn	ppm	951	1728	10993
Mo	ppm	2.98	10.03	68
Na	%	0.045	0.123	2.169
Ni	ppm	53.4	139.8	349.8
P	%	0.103	0.181	0.305
Pb	ppm	13.38	35.75	300
S	%	0.19	0.67	5.67
Sb	ppm	1.38	4.37	45.61
Sc	ppm	5.5	9.5	13.4
Se	ppm	1.2	3.6	21.0
Sr	ppm	53.5	119.0	503.7
Te	ppm	0.08	0.24	1.93
Th	ppm	1.9	5.0	45.6
Ti	%	0.087	0.281	0.758
Tl	ppm	0.13	0.39	2.33
U	ppm	1.0	3.3	57.4
V	ppm	70	132	219
W	ppm	0.29	0.90	65.70
Zn	ppm	130.6	306.7	1829.9

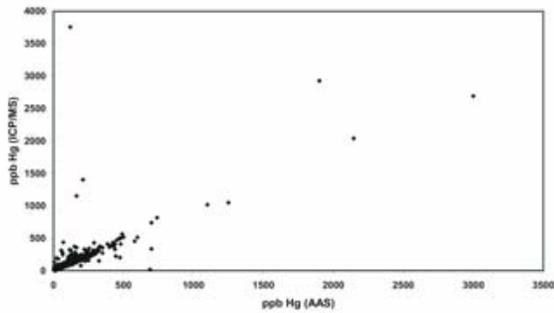


Figure 3. Correlation between Hg by ICP/MS and AAS

The correlation coefficient for Au by ICP/S compared to Au by fire assay-AAS finish reported by Matysek *at al.* (1988) is + 0.14. Again, the poor correlation of Au determinations by the two methods reflects heterogeneous distribution of larger Au grains in the sediment combined with the small sample size used for the ICP/MS analysis. For this reason references to Au in this paper are to values determined by fire assay-AAS finish.

RESULTS SUMMARY

The ICP/MS multi-element element data will be released as Ministry of Energy & Mines Geofile 2003-20 in January 2004. The geochemistry of key ore indicator metals (e.g. Au, Cu, Ag), selected new pathfinder elements (e.g. Se) and the relationship between element associations and different deposit types will be briefly discussed in this paper.

Summary statistics (mean, 95th percentile, maximum value) for the elements determined by ICP/MS and Au by fire assay-AAS are listed in Table 2. The stream sediment geochemistry of selected elements in the eastern half of the Iskut River and Telegraph Creek map sheets is displayed as catchment basin maps in which element variations are shown as colour coded concentrations at the 98th, 95th, 90th, 70th and 50th percentiles. Among the advantages of using catchment basins rather than symbols for displaying RGS sediment geochemistry are that the actual survey coverage and those basins that host actual mineral occurrences are better defined. It is also possible to more realistically estimate the influence of rock type on stream sediment chemistry using the catchment basin as the sediment source area and consequently better define anomaly thresholds based on geology (Matysek and Jackaman, 1996). Figure 4 outlines catchment basins for the RGS archive sample sites and show the location of major mineral deposits and MINFILE mineral occurrences.

Figure 5 shows the distribution of Au by fire assay-AAS finish in the RGS sediments. Most of the RGS sites where Au ranges from 264 ppb to 5300 ppb are south west of Eskay Creek and Sulphurets deposits and to the

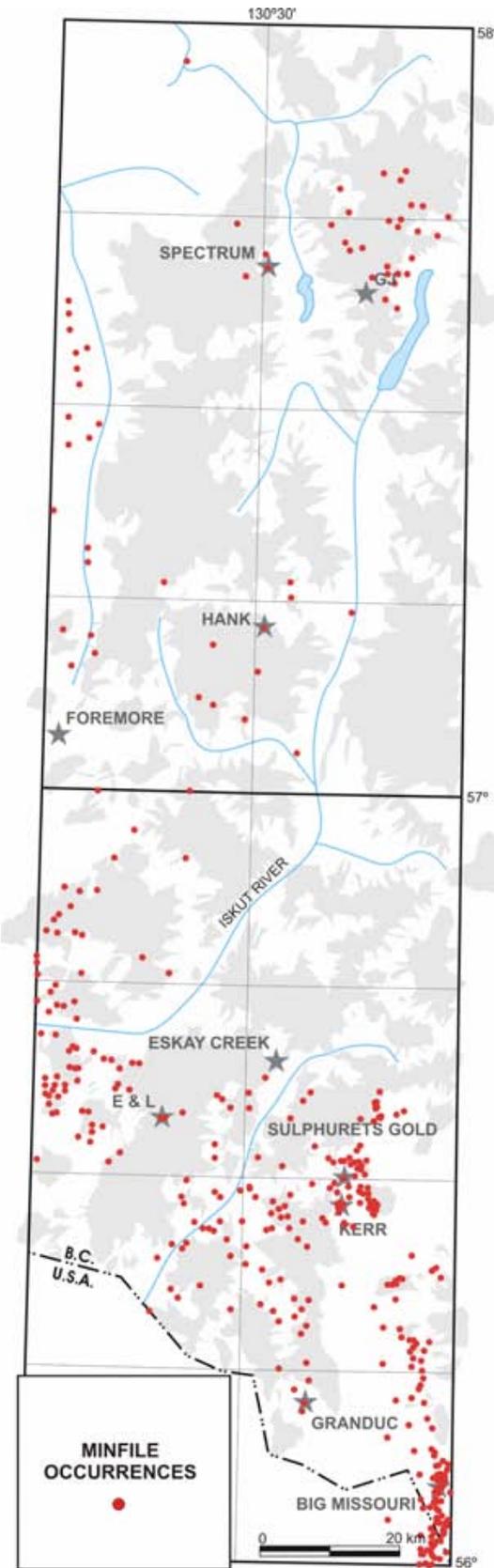


Figure 4. Major deposits and MINFILE occurrences

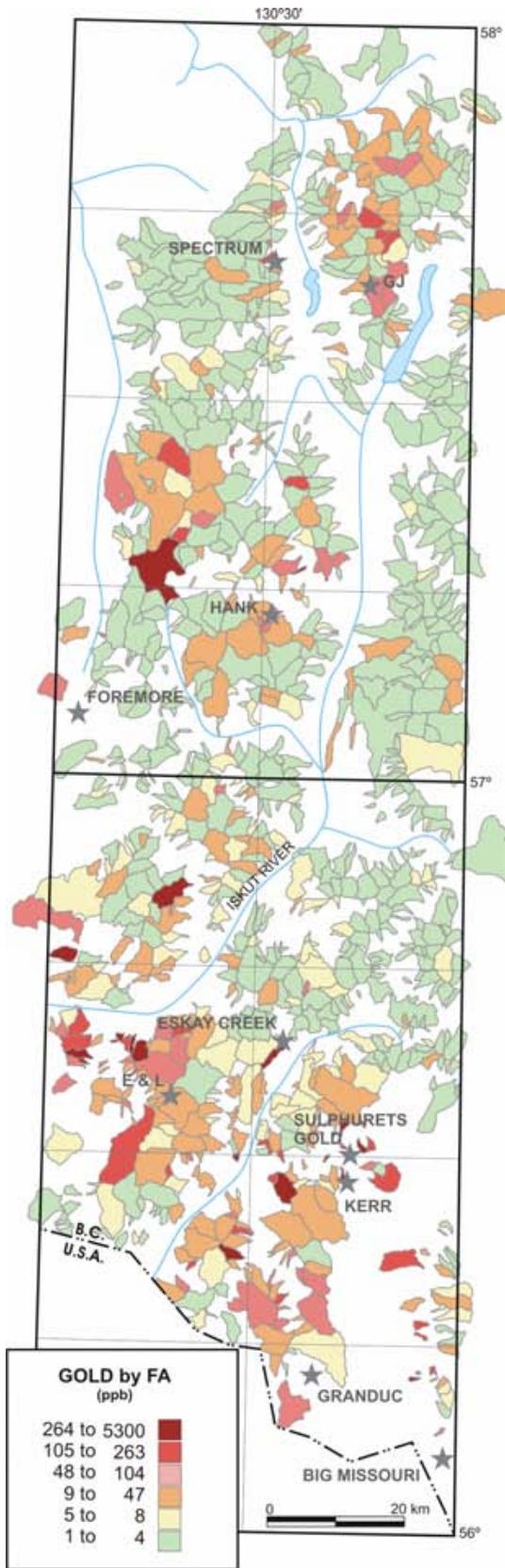


Figure 5. Gold in RGS samples.

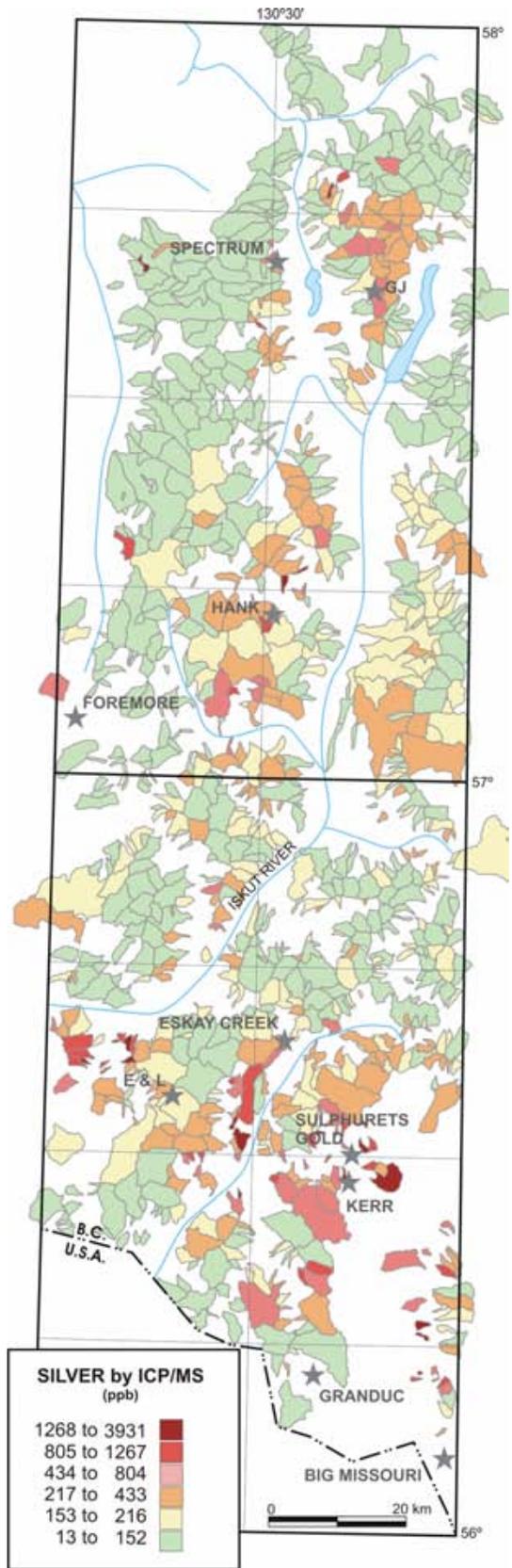


Figure 6. Silver in RGS samples

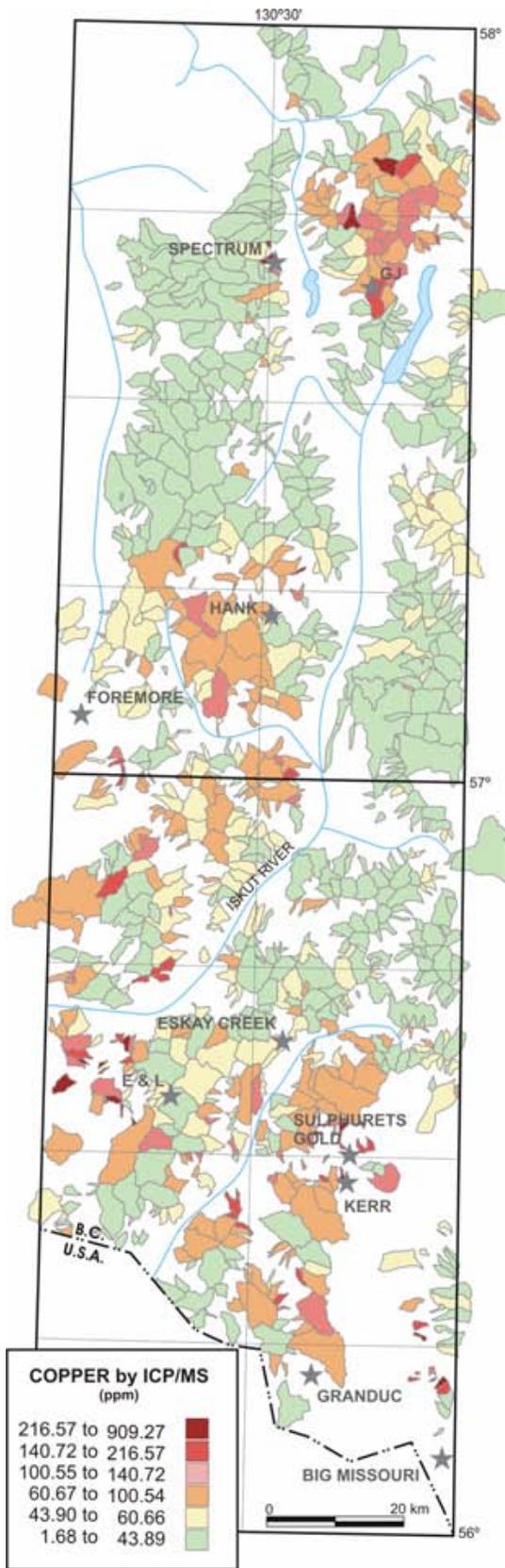


Figure 7. Copper in RGS samples

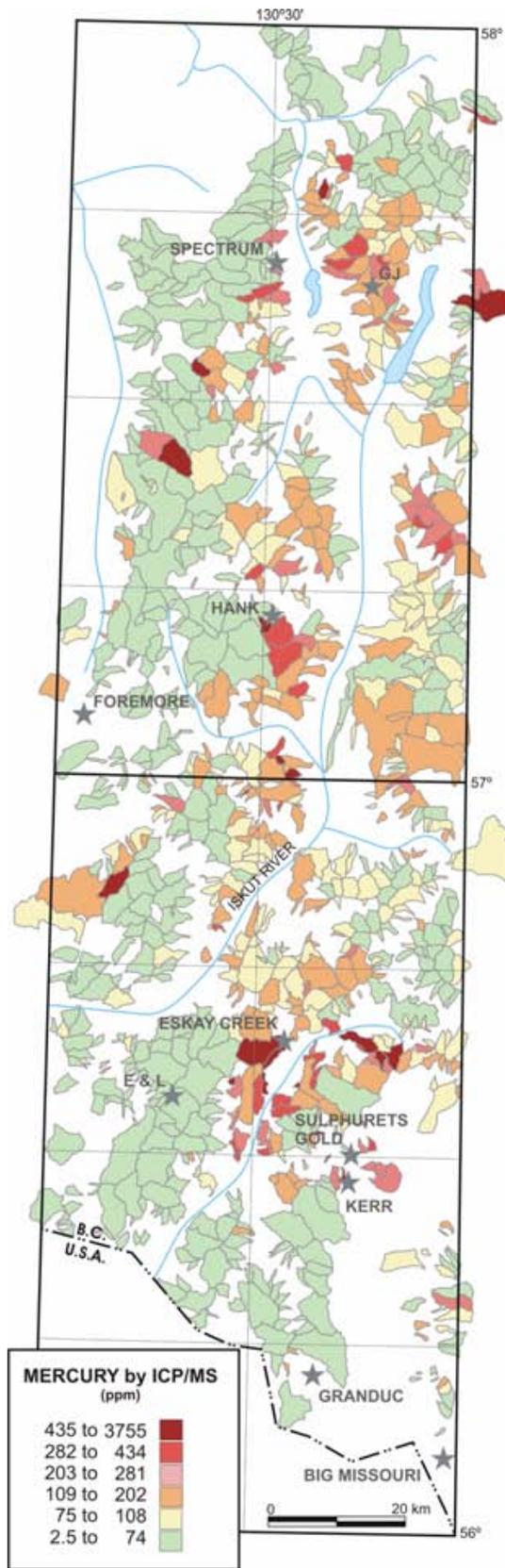


Figure 8. Mercury in RGS samples

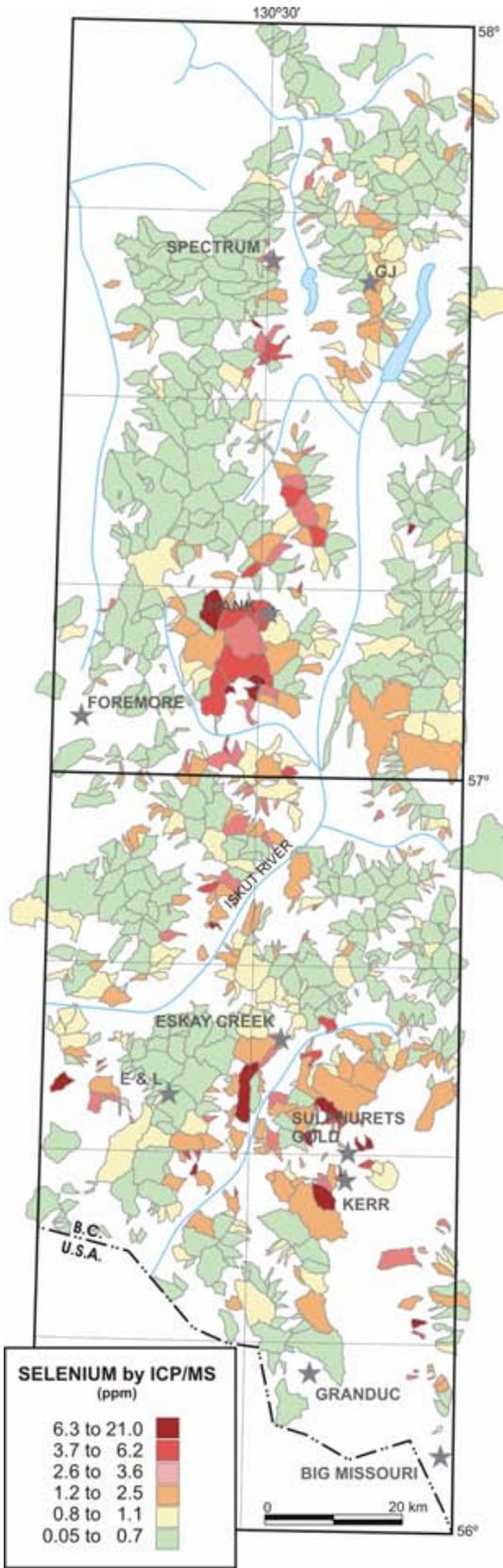


Figure 9. Selenium in RGS samples

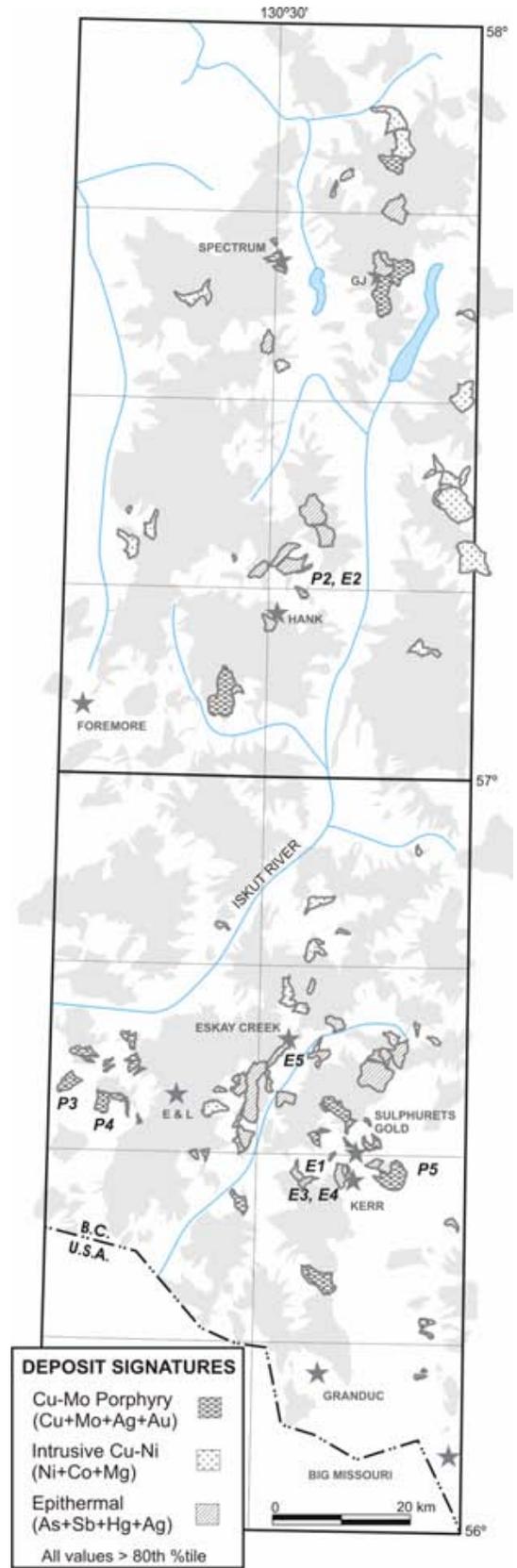


Figure 10. Deposit geochemical signatures

west of the Hank occurrence. The majority of anomalous Ag (> 805 ppb) values occur in samples along a south east trend from the E and L to the Kerr deposits (Figure 6). There are also isolated catchments with anomalous Ag to the north of the Hank and to the west of Spectrum occurrences.

The largest cluster of RGS samples with anomalous Cu (> 216 ppm) values surround the GJ and are west of both the E and L and Hank occurrences (Figure 7). High Hg values (425 to 3755 ppb) occur mainly in samples immediately to the south west and to the east of the Eskay Creek mine (Figure 8). There is also a large area of anomalous Hg (> 282 ppb) east of the Hank and Spectrum occurrences. This Hg anomaly appears to extend east from the Telegraph Creek map sheet into the adjacent Bowser lake sheet. A cluster of sample sites with anomalous (> 3.7 ppm) Se values is present around the Sulphurets Gold and Kerr deposits (Figure 9). However, the largest sediment Se anomalous is west of the Hank occurrence. Samples with anomalous Se in this area typically have high S.

Different mineral deposit types can often be identified from the concomitant association of pathfinder elements in stream sediment. However, the precise discrimination between multi-element associations in RGS data is limited by a common association of many elements (e.g. Cu, Au) in different deposits and the contrasting geochemical mobility of elements (e.g. Zn, Au) in streams. Discrimination between different deposit types in the Iskut River area has been attempted by identifying RGS samples having common enhancement of several elements above their 80th percentile concentration. Element associations selected for three different deposit types are:

- As-Sb-Hg-Ag for epithermal and sub-aqueous hot spring massive sulphide deposits.
- Cu-Mo-Ag-Au for porphyry Cu-Mo deposits.
- Ni-Co-Mg for Cu-Ni intrusive deposits.

Catchment basins with these three signatures are shown in Figure 10. In some instances the multi-element associations effectively distinguish between different deposit types. For example Sulphurets Gold, Spectrum, Kerr and GJ are classified as Cu-Mo porphyry deposits whereas the Eskay Creek mine and Hank are identified as an epithermal deposits. However, the E and L occurrence was not classified as a Cu-Ni intrusive deposit by the sediment geochemistry. Catchment basins with enhanced Co, Ni and Mg are present east of the E and L occurrence and there are also those with a porphyry signature to the west. The apparent failure of the RGS to detect some of the known mineral occurrence reflects the low sample density. For example, there are no RGS sample sites on the west flowing streams from the area around the Foremore occurrence. This is a reminder that all regional geochemical surveys only detect some of the mineralized sites.

While there has been no attempt in this paper to critically evaluate all of the multi-element anomalies identified, the top five ranked porphyry Cu-Mo and epithermal targets are listed in Tables 3 and 4 and identified as numbers (e.g. *PI*, *E2*) on Figure 10. Decreasing Cu values for the porphyry class and decreasing Au for the epithermal class rank the targets. Several of the targets reflect anomalous drainages close to known mineralization such as deposits in the Sulphurets camp (104B871413) and the Eskay Creek mines (104B871395). Others targets are more remote for mineralized areas and have not been staked at the time this paper was written. One anomaly (sample 104G971347) is classified as both porphyry and epithermal. This shows that the preliminary classification could be refined including additional elements and/or adjusting thresholds.

CONCLUSIONS

Reanalysis of archived RGS stream sediment samples from the Iskut River area by acid digestion - ICP/MS has produced data for 20 additional elements. The new data demonstrate that:

- Many of the RGS Cu, Ag and Au anomalies in the Iskut River area reflect existing mineral deposits.
- There are also catchment basins where there are no mineral occurrences, but where the stream sediment has anomalous levels of deposit pathfinder elements such as Se and Hg.
- It is possible to distinguish between sediment anomalies that have been derived from epithermal Au-Ag, Cu-Mo porphyry and Cu-Ni intrusive deposits using RGS geochemistry. Although discrimination process needs refinement several new and possibly unstaked epithermal and porphyry exploration targets are identified. The location of the five top targets for these deposit types are listed in this paper.
- There are lower detection limits and acceptable precision for ore indicator and pathfinder elements such as Ag and Se. For most elements there is a close comparison between the results produced by acid digestion-ICP/MS and by acid digestion-AAS. However, existing RGS data for Au by fire assay-AAS finish is more reliable than ICP/MS because of the small sample used for the analysis. Data for most of the new elements can be used with confidence to enhance the RGS database.

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TABLE 3.
TOP 5 RGS SAMPLES WITH A CU-MO SIGNATURE. CU IN PPM. UTM ZONE 9.
SAMPLES IN BOLD WERE NOT STAKED AS OF DECEMBER 1ST 2003

RGS ID	UTM		Cu	Target
	E	UTM N		
104B8714	42433	626646	90	P
13	9	0	9	1
104G9713	41584	634987	49	P
47	8	5	2	2
104B8711	38197	627354	44	P
53	0	5	3	3
104B8711	39015	626859	40	P
33	1	6	3	4
104B8714	42097	626560	39	P
17	0	5	5	5

TABLE 4.
TOP 5 RGS SAMPLES WITH A AS-SB-HG-AG SIGNATURE. AU IN PPB. UTM ZONE 9. SAMPLES IN BOLD WERE NOT STAKED AS OF DECEMBER 1ST 2003

RGS ID	UTM E	UTM N	Au	Target
104B871431	418220	6261843	493	E1
104G871347	415848	6349875	454	E2
104B871435	421019	6260851	396	E3
104B871416	423596	6265209	383	E4
104B871395	412584	6278020	288	E5

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