

New Targets and Trends Identified in Data from the British Columbia, Canada, Regional Geochemical Survey



Just how effective are large, reconnaissance scale geochemical surveys for finding new mineral resources? The Province of British Columbia regional geochemical survey (RGS) aims to identify areas of bedrock with higher geochemical values indicating a greater mineral potential. Outlining areas of higher mineral potential using RGS data allows mining companies and individual prospectors to better focus their exploration activities. Geological Survey of Canada (GSC) sample collection and analysis standards established when the GSC's national geochemical reconnaissance (NGR) program was originally started in 1974 have been adopted by the RGS. The seamless geochemical database, created by maintaining these standards, has been confidently used, not only for mineral exploration, but also for environmental monitoring and land use evaluation. At an average density of one sample per 13 km² it is unlikely that the RGS will detect the geochemical expression of every mineral occurrence. However, there have been recent examples in British Columbia where prospecting follow up of subdued stream sediment Au values has resulted in the discovery of significant precious metal mineralization.

Ideally reconnaissance scale geochemical sampling should be able to detect element variations over a range of contrasting surface environments. British Columbia's climate ranges from a temperate, high rainfall zone along the coast, to continental semi arid conditions in the interior of the province. Topography varies from high mountain ranges to undulating plateaus. Landforms commonly reflect the effects of continental and alpine glaciation and much of the bedrock is concealed beneath a complex veneer of glacial sediment. Stream sediment is the preferred RGS sample media. Over 50,000 stream sediment and water samples, covering over 70 percent of the province, have been collected since the RGS program was started in 1976. Moss is often sampled as an alternative to drainage sediment in mountains because finer textured material is often depleted in fast flowing streams, but is captured by the moss. Lakes are numerous in low relief, swampy areas where streams are absent or poorly developed, thus Lake-bottom organic sediment sampling is often more feasible in these areas for reconnaissance surveys. More detailed

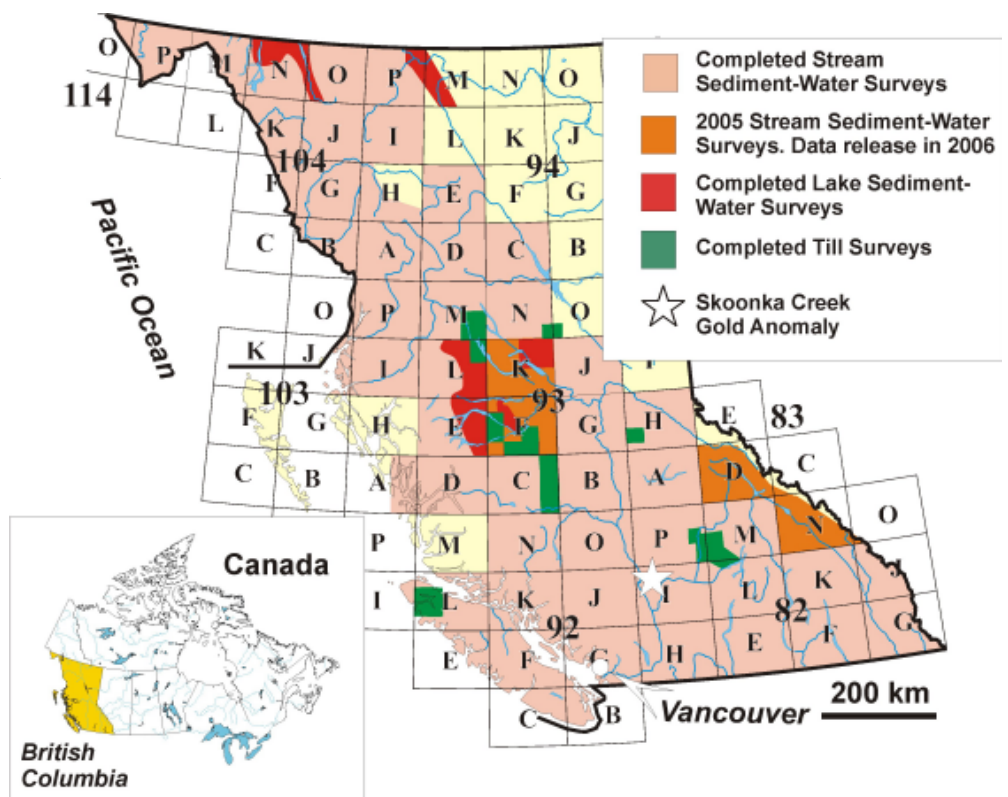


Figure 1. Regional Geochemical Survey coverage in British Columbia, Canada and the location of the Skoonka Creek mineral property.

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till and heavy mineral sampling is used to complement reconnaissance scale sediment surveys for better defining exploration targets. Orientation surveys help refine geochemical survey techniques for different styles of mineralization (Lett and Jackaman, 2000; Lett and Friske, 2006). Figure 1 (see page 1) shows the RGS coverage by the different types of geochemical surveys in British Columbia.

Routine sediment sample collection, analysis and quality control

Systematically recording information about the sample site during the survey and maintaining strict quality control are key factors for ensuring the high quality RGS geochemical database. The present field data collection forms are designed for helicopter-supported surveys where careful collection and accurate information

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recording must be balanced by collection efficiency (Fig. 2). Routine quality control starts with randomly selected field duplicate samples taken at a frequency of one duplicate pair in every batch of 20 samples. Samples are preferably dried in the field and screened in the laboratory to minus 80 mesh (< 0.177 mm). Analytical duplicate samples and standard reference materials are randomly inserted into each batch of 20 prepared samples before analysis.



Figure 2. Helicopter supported stream sediment and water sampling in northwestern British Columbia. Roughly 2 kg of fine textured sediment is being collected from a stream bar in the active channel above the current low water level. Extremely high or low energy stream sites are avoided where ever possible so that the sample is representative of the sediment. A 250 ml bulk water sample is also being taken from the stream for later analysis of pH and other elements.

The minus 80 mesh fraction of sediment is analyzed by aqua regia digestion and inductively coupled plasma mass spectrometry (ICP-MS) to determine the following elements: Al, Ag, As, Ba, Bi, Cd, Ca, Cr, Co, Cu, Ga, Au, Fe, La, Pb, Mg, Mn, Hg, Mo, Na, Ni, P, K, Sb, Sc, Se, Sr, S, Te, Tl, Th, Ti, W, U, V and Zn. It is also analyzed by instrumental neutron activation (INAA) for: Au, Ag, Sb, As, Ba, Br, Cd, Ce, Cs, Cr, Co, Eu, Hf, Ir, Fe, La, Lu, Mo, Na, Ni, Rb, Sm, Sc, Se, Ta, Tb, Th, U, Yb, Zn and Zr.

Atomic absorption spectrophotometry (AAS) was employed after aqua regia digestion to determine metals present in earlier surveys. Sediment samples are also analysed for loss on ignition (LOI) at 500° C and for fluoride by a fusion-specific ion electrode method. Samples with anomalous Au contents are routinely checked by a second Au analysis. Unfiltered stream water samples are routinely analysed for pH, conductivity, uranium and fluoride. Selected water samples are filtered and acidified in the field and later analysed for trace and major elements by ICP-MS.

Geological trends and prospecting targets

British Columbia bedrock geology reflects periodic post Paleozoic collision and accretion of oceanic plates against the Precambrian North American continent to form a series of northwest trending tectonically distinct belts or terranes (Fig. 3). The rocks comprising each terrane host different types of mineralization. They can



Figure 3. Principal tectonic belts and metal mines in British Columbia.

also have a distinct geochemical signature that may be identified by variations in regional stream sediment geochemistry. Neutron activation results are perhaps best suited for detecting lithogeochemical patterns because the technique determines almost total element abundances. A number of REE that can help discriminate between terranes are also determined by neutron activation. La to Lu ratios plotted in Figure 4 highlight an area in southeastern British Columbia where volcanic and intrusive rocks may have been contaminated by older crustal rocks during tectonic evolution. Source areas for stream sediment with elevated La:Lu ratio have the potential to host skarn and Fe oxide Cu-Au deposits.

Among the more common styles of base and precious metal mineralization in British Columbia are volcanogenic massive sulphide, porphyry Cu-Au, porphyry Cu-Mo and epithermal Au deposits. Elevated As, Sb and Hg levels are commonly associated with epithermal Au mineralization.

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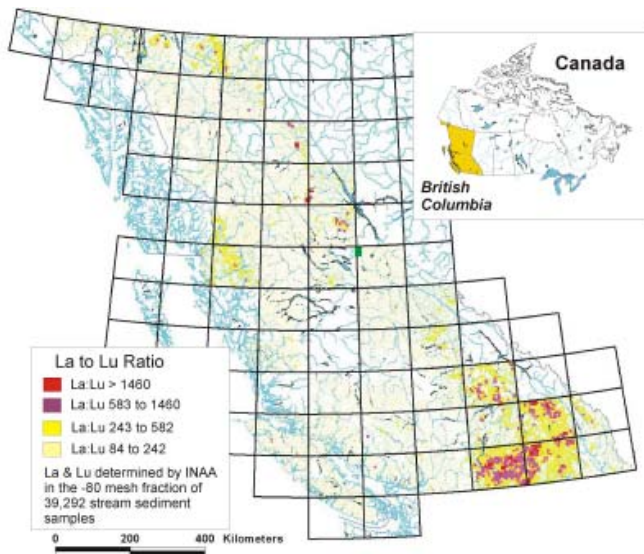


Figure 4. Lanthanum to lutetium ratio in RGS stream sediment samples as determined using INAA values. High neutron activation La:Lu ratios in southeast British Columbia may reflect contamination of intrusive rocks by crustal rocks during evolution.

This pathfinder element signature in stream sediment can outline belts where there is a greater opportunity for discovering this type of deposit. Figure 5 shows the distribution of stream sediment samples with As and Sb and Hg values above the 90th and 95th percentiles. An especially strong As-Sb-Hg trend in northwestern British Columbia reflects the “Golden Triangle” where there are many Au occurrences including the world class Eskay Au-Ag mine (Fig. 5).

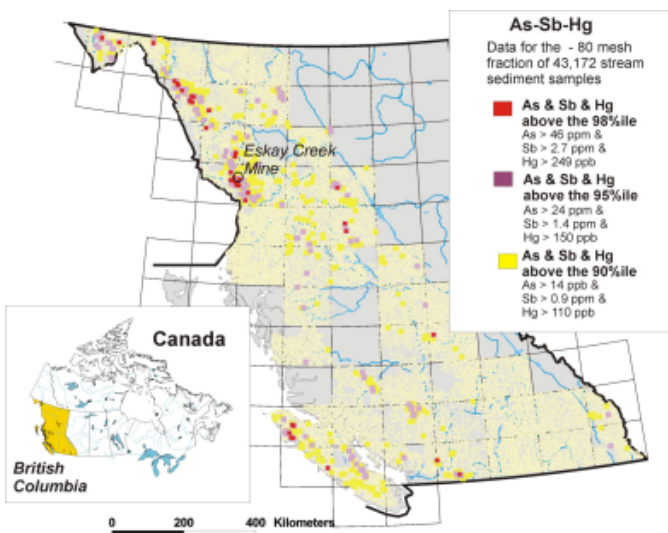


Figure 5. The As+Sb+Hg signature in RGS stream sediment samples. Arsenic and Sb have been determined by aqua regia digestion – AAS or ICP-MS. Mercury was determined by aqua regia digestion and cold vapour – AAS or ICP-MS. In northwestern British Columbia there are several significant Au deposits including the Eskay Creek Au-Ag mine.

One simple method for identifying new Au prospects using RGS geochemical data is to screen the database for samples with Au values above the 99th percentile (> 120 ppb Au) and with a similar Au value in the recheck analysis. Anomalous samples located on a mineral claim and < 3 km from a known mineral occurrence are also excluded. In mid March 2006 screening revealed that there were 23 RGS sites that met these criteria. Closer examination of the area surrounding these 23 anomalous samples using the BC Geological Survey MapPlace site (<http://www.em.gov.bc.ca/Mining/Geolsurv/MapPlace/>) showed that many of the sites were close to existing mineral claims or were in areas of active exploration.

Weaker geochemical anomalies may be less attractive as targets, but can also reflect the presence of a significant mineral occurrence. An example is the discovery of the Skoonka Creek Au property near Spences Bridge in southern British Columbia by a junior mining company, Almaden Minerals, in 2003. Prospecting in a tributary of Skoonka Creek where a value of 21 ppb Au in the stream sediment had been reported from a previously published government geochemical survey (Jackaman and Matysek, 1994) led to the discovery of quartz vein float containing over 55 ppm Au. Further prospecting resulted in discovery of mineralized quartz veins that are hosted by the Spences Bridge Group, a Cretaceous volcanic assemblage previously unexplored for Au. The discovery of the veins illustrates the value of re-examining previously published geochemical data. While the original RGS had been carried out in 1983, the samples were only analysed for Au by INAA in 1994 as part of an RGS archive sample re-analysis program. Almaden staff examined the weakly anomalous Au values in 2003 and focused their prospecting on the Skoonka Creek area. The location of the mineral property is shown in Figure 1 and a detailed map of the RGS stream sediment Au geochemistry in the area is shown in Figure 6.

Clearly low contrast reconnaissance scale sediment Au anomalies can be a useful guide to mineralization. A further screening of the RGS database was used to identify samples with Au in the 95 to 98-percentile range (17 to 40 ppb) with a similar Au value in the repeat analysis. Again, anomalous sites were excluded if located on a mineral claim and < 3 km from a known mineral occurrence. In addition, only sites with > 20 ppm As in

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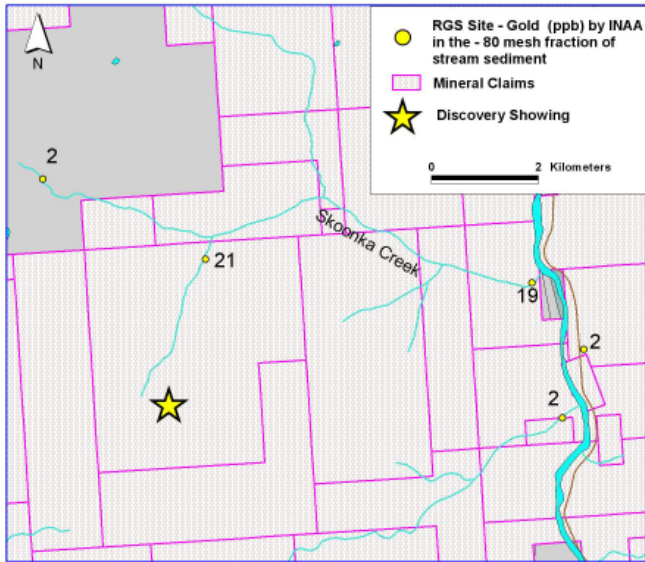


Figure 6. Skoonka Creek Claims showing the original RGS stream sediment sample location, as well as the location of subsequent discovery of the Au-rich quartz vein material.

the sediment were selected. A total of 36 sites meeting these criteria were identified and their locations are shown on Figure 7. Closer examination of the area around the 36 selected sites reveals that more than half of them have no known bedrock source of precious metal.

While there are other techniques of interpreting RGS survey data to identify prospecting targets in British Columbia (Smyth, 2005), simple screening based on criteria such as those described above can be very effective as a preliminary approach.

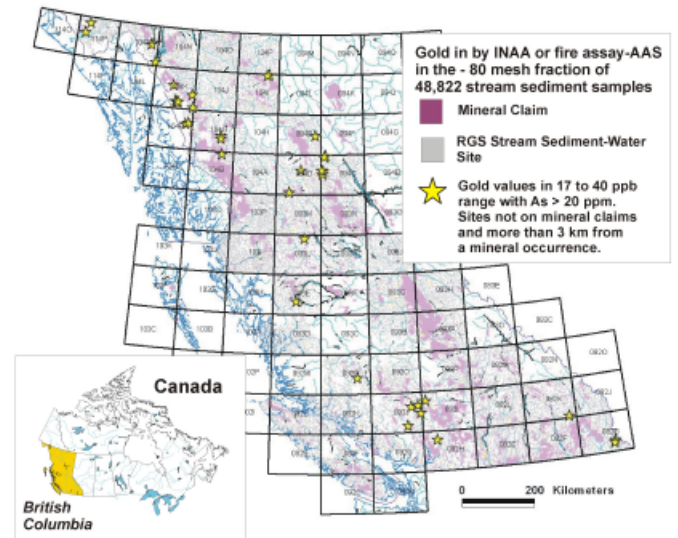


Figure 7. Thirty-six prospecting targets identified using the following criteria: 1) Gold values in the 17 to 40 ppb range with a similar Au value in the repeat sample; 2) are not located on a claim; 3) are > 3 km from a mineral occurrence; and 4) contain > 20 ppm As.

Adding value to the RGS

The British Columbia RGS has created a high quality geochemical database that helps identify areas of high mineral potential and also new prospecting targets. Current activities that will add value to the present RGS include:

- Conducting new regional geochemical surveys.
- Re-analysing archive geochemical samples by INAA and aqua regia digestion with ICP-MS.
- Conducting orientation studies designed to improve existing geochemical survey methods.
- Adding new information to the database.

There are several ways of gaining public access to RGS data. Digital data can be downloaded from the

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British Columbia Geological Survey Regional
Geochemistry page:

[http://www.em.gov.bc.ca/Mining/Geolsurv/Geochinv/
rgs.htm](http://www.em.gov.bc.ca/Mining/Geolsurv/Geochinv/rgs.htm)

ARC shape files that can imported into most
Geographic Information (GIS) software may be
downloaded from:

[http://www.em.gov.bc.ca/Mining/Geolsurv/MapPlace/
geoData.htm](http://www.em.gov.bc.ca/Mining/Geolsurv/MapPlace/geoData.htm)

Metadata for the RGS database can be viewed at:

[http://www.em.gov.bc.ca/Mining/Geolsurv/MapPlace/
Metadata/geochem_metadata.htm](http://www.em.gov.bc.ca/Mining/Geolsurv/MapPlace/Metadata/geochem_metadata.htm)

RGS values can also be viewed on the British
Columbia Geological Survey interactive MapPlace site in
combination with other geoscience themes such as
bedrock geology, topography, drainage, road and rail
routes, communities, parks, mineral occurrence
information from the MINFILE database, rock
geochemistry, and mineral tenure.

<http://www.em.gov.bc.ca/Mining/Geolsurv/MapPlace/>

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Ray Lett

British Columbia Geological Survey
Ministry of Energy, Mines & Petroleum Resources
5th Floor, 1810 Blanshard Street (PO 9333 STN PROV
GOVT)

Victoria, BC, Canada, V8W 9N3
Ray.Lett@gov.bc.ca 250-952-0396

