

# QUEST-South Geochemical Database Upgrades: New Survey and Sample Reanalysis Data, Southern British Columbia (NTS 082E, L, M, 092H, I, J, O, P)

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## Introduction

The QUEST-South Project is the third of a series of large-scale regional geochemical studies that have been sponsored by Geoscience BC since 2007 (Figure 1). Each of these projects (QUEST, QUEST-West and QUEST-South) has included a number of important initiatives such as infill sampling and the reanalysis of archived sediment pulps. Project results have significantly improved the availability of existing geochemical data for each of the study areas and have made a major contribution of new data to the provincial geochemical dataset. Covering a total area of over 275 000 km<sup>2</sup>, over 5000 drainage sediment samples have been collected and 20 000 sediment samples from previous surveys have been reanalyzed using current laboratory methods. The work not only produced a vast array of geochemical information, it also complements other geoscience initiatives, such as airborne geophysical surveys funded by Geoscience BC that are also aimed at promoting and stimulating exploration interest in the project areas.

Located in southern BC, the QUEST-South Project includes a compilation of existing data, new infill sampling and reanalysis of archived samples. Stream-based sampling and the collection of basal till samples have been conducted in order to improve overall sample site coverage of parts of the study area. In addition, reanalysis work has targeted over 9000 sediment samples that had been saved from previous surveys completed in the late 1970s and early 1980s. The availability of this new geochemical information for over 10 000 samples will represent the largest single infusion of data to the provincial geochemical database since its inception in the 1970s. Results of the work will help stimulate mineral exploration as well as complement other geoscience research and data mining activities

**Keywords:** mineral exploration, geochemistry, multi-element, reconnaissance, reanalysis, stream sediment, stream water, basal till, Thompson Plateau

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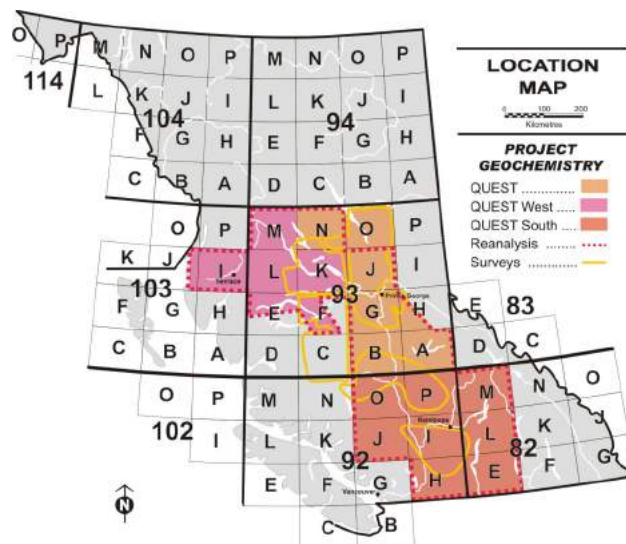


Figure 1. Location of the QUEST, QUEST-West and QUEST-South Project areas, British Columbia.

for an area that is considered to have potential for future mineral deposit discoveries.

## QUEST-South Project Area

The QUEST-South Project includes NTS 1:250 000 map sheets 082E, L and M plus 092H, I, J, O and P (Figure 2). Covering over 120 000 km<sup>2</sup>, the area extends south from the Fraser Plateau and contains a large part of the Thompson Plateau, the Okanagan and Shuswap highlands and parts of the Coast, Cascade and Monashee mountain ranges. Examples of several distinct physiographic features can be found in the region such as rugged mountains, heavily forested rolling hills and semi-arid grasslands. The communities of Kamloops, Merritt, Princeton, Lillooet, Kelowna and Vernon are located in the area as well as expanses of private land, cattle ranches and rangeland, Indian reserves and designated park land. Relatively recent expanded highway development, cattle farming and logging activities have increased the local road network, providing improved access to many parts of the survey area.

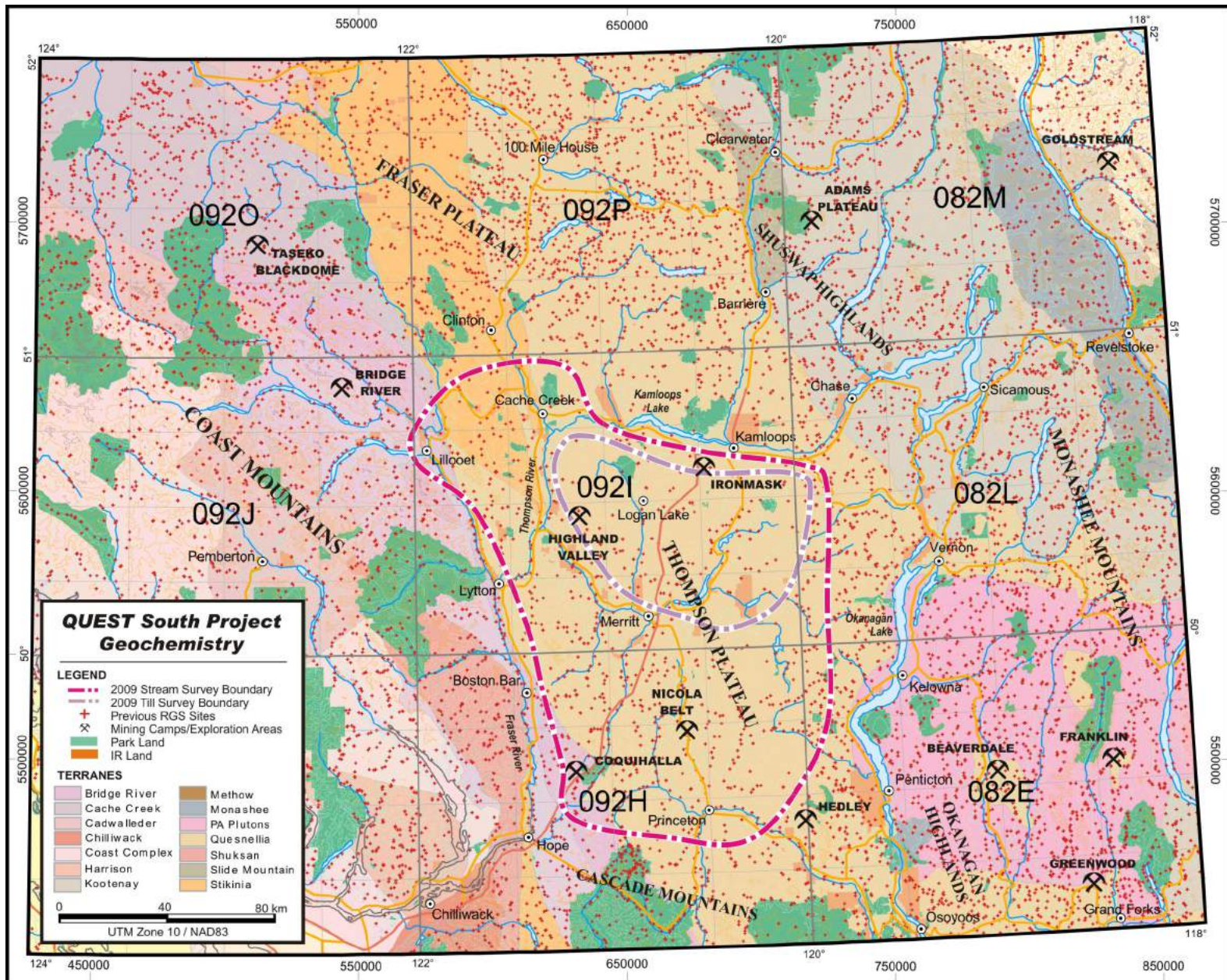


Figure 2: Detailed map of the QUEST-South study area, southern British Columbia.

The infill sampling work was contained within the boundaries of the overall project area and covers a 14 000 km<sup>2</sup> area primarily focused on the Thompson Plateau. This area is characterized by a gently rolling upland of low relief (Figure 3) that averages between 1200 and 1500 m, and in areas of more resistant rock, heights of over 1800 m are common (Holland, 1976). The higher elevations of the plateau include late Tertiary erosion surfaces that have been cut by the Thompson, Similkameen and Okanagan rivers and their tributaries. Other important hydrological features include Okanagan and Kamloops lakes.

Underlying the region are a number of prospective geological environments including the Quesnel and Stikine terranes. According to Holland (1976), the area contains a very diverse range of rocks that include stocks of granitic rock that have intruded sedimentary and volcanic formations of Paleozoic age as well as flat-lying early Tertiary lavas that blanket large areas of the older rock. The region was occupied by Pleistocene ice and a thick mantle of drift cover, and other evidence of glacial processes, can be noted throughout most of the region (Bobrowsky et al., 2002).

The region has a history of successful exploration and mining that has been influenced by a number of notable mineral deposits. Currently there are over 3200 known mineral occurrences that include several significant operating and past-producing, precious- and base-metal mines as well as prospects (MINFILE, 2009). Of the 533 listed producing and past-producing mines, the porphyry Cu±Mo±Au Highland Valley copper mine (MINFILE 092ISW012; MINFILE, 2009) is recognized as one of the largest copper mining and concentrating operations in the world and has produced more than 2.8 Mt of copper concentrate since the early 1960s.

Regional geochemical surveys were first completed in the study area in 1977, 1978, 1980 and 1982 as part of the Na-



**Figure 3.** Typical gently rolling topography of the Thompson Plateau region, British Columbia.

tional Geochemical Reconnaissance (NGR) and BC Regional Geochemical Survey (BCRGS) programs. The government-funded work included the collection of stream-sediment and water samples from a total of 8071 stream-based sample sites. In the early 1990s, archived sediment pulps from these surveys were reanalyzed by instrumental neutron activation analysis (INAA) and results for gold and a range of pathfinder metals and rare earth elements was added to the provincial database (Lett, 2005).

### QUEST-South Sample Reanalysis

Drainage sediment pulps from previous government-funded surveys completed in the study area are currently stored at facilities in Ottawa, ON, and maintained by Natural Resources Canada (NRCan). Samples are stored in plastic vials organized by NTS map sheet designation and in order of sample identification numbers. Opportunely, the archive also includes original analytical duplicate and control reference samples that can be used to monitor and assess the accuracy and precision of any subsequent analytical work. On average, up to 30 g of the -80 mesh (180 µm) sediment fraction is available, but in some cases samples may be missing or there is insufficient material remaining in the storage vials.

After obtaining permission to access the archive from NRCan, sample materials from the QUEST-South study area were retrieved in May 2009. A 1–2 g portion of each sediment sample was carefully extracted from storage containers (Figure 4). Material from each vial was independently split and transferred to a Ziploc® bag labelled with the sample's original unique identification number. Once secured for shipping, the recovered material was delivered to ALS Chemex (North Vancouver, BC). At the lab, each sample was analyzed for 37 elements by inductively coupled plasma–mass spectrometry (ICP-MS) using an aqua-regia digestion. A complete list of the elements and associated detection levels are provided in Table 1.



**Figure 4.** Sample recovery of sediment pulps from archive storage facility in Ottawa, Ontario.

**Table 1.** List of elements and associated detection levels from inductively coupled plasma–mass spectrometry (ICP-MS) analysis using an aqua–regia digestion, QUEST-South Project areas.

Element	Detection levels	Units
Aluminum	0.01 to 25	%
Antimony	0.02 to 10 000	ppm
Arsenic	0.1 to 10 000	ppm
Barium	0.5 to 10 000	ppm
Bismuth	0.01 to 10 000	ppm
Boron	10 to 10 000	ppm
Cadmium	0.01 to 2000	ppm
Calcium	0.01 to 40	%
Chromium	0.5 to 10 000	ppm
Cobalt	0.1 to 10 000	ppm
Copper	0.01 to 10 000	ppm
Gallium	0.05 to 10 000	ppm
Gold	0.2 to 100	ppb
Iron	0.01 to 50	%
Lanthanum	0.2 to 10 000	ppm
Lead	0.01 to 10 000	ppm
Magnesium	0.01 to 30	%
Manganese	1 to 50 000	ppm
Mercury	5 to 100	ppb
Molybdenum	0.01 to 10 000	ppm
Nickel	0.1 to 10 000	ppm
Phosphorus	0.001 to 5	%
Potassium	0.01 to 10	%
Scandium	0.1 to 10 000	ppm
Selenium	0.1 to 1000	ppm
Silver	2 to 100	ppb
Sodium	0.001 to 10	%
Strontium	0.2 to 10 000	ppm
Sulphur	0.01 to 10	%
Tellurium	0.01 to 500	ppm
Thalium	0.02 to 10 000	ppm
Thorium	0.1 to 10 000	ppm
Titanium	0.001 to 10	%
Tungsten	0.05 to 10 000	ppm
Uranium	0.05 to 10 000	ppm
Vanadium	1 to 10 000	ppm
Zinc	0.1 to 10 000	ppm

### QUEST-South Infill Stream Drainage and Till Surveys

The 2009 QUEST-South infill sampling program covered approximately 14 000 km<sup>2</sup> and focused on a region that had received relatively limited coverage during earlier geochemical surveys (Figure 2). In parts of the study area, original sample site density was found to be less than one site per 20 km<sup>2</sup>. To address this deficiency, the target survey area offered many opportunities to access new stream sample sites (Figure 5) and basal till sites (Figure 6).

Adhering to standards outlined by Ballantyne (1991) and used by the NGR and BCRGS programs, truck-supported stream-based sample collection was carried out from June to September 2009. A total of 800 stream-sediment and water samples were systematically acquired. The samples were collected from the active stream channel of first and second order drainages not previously sampled and from original sites where archived material was found to be missing. Field observations regarding location, sample information and site characteristics were recorded for each site. In addition, to assist follow-up activities, a tag was placed at each sample site that identified the project and unique sample site number.

To further augment the geochemical coverage of parts of the study area, basal till samples were also collected from 200 sites at an average density of one site per 4 km<sup>2</sup> over a 1000 km<sup>2</sup> area. Consideration of this sample media was motivated by orientation studies completed in the region by Bobrowsky et al. (2002), which concluded that the combi-



**Figure 5.** A typical second order stream, southern British Columbia.



**Figure 6.** A typical roadcut basal till sample site, southern British Columbia.

nation of basal till availability, a relatively thin overburden cover and a uniform ice-flow direction provided for an ideal sampling environment for reconnaissance-scale till geochemistry exploration programs.

In general, the collection of basal till samples was based on procedures developed during previous British Columbia Geological Survey (BCGS) and Geological Survey of Canada till programs conducted in the Canadian Cordillera (Levson, 2001). As part of this previous work, detailed surficial geological mapping and studies of ice-flow history are often conducted prior to the sampling program. Designed to provide preliminary and timely geochemical information for the study area, it was decided to forgo detailed Quaternary studies and proceed with the regional sampling of basal till as a complement to stream-based work as well as promoting the use of this sampling technique. It is strongly suggested that more comprehensive Quaternary research should be completed in order to properly interpret resulting till geochemical data.

Estwing Geo/Paleo Picks™ were used to expose undisturbed basal till material identified at roadcut exposures. The target material typically consisted of dense, matrix-supported, silt- and clay-rich, dark grey to brown diamicton with subrounded to subangular clasts. At each site, approximately 3 kg of the basal till material was collected at an average depth of 1.0 m. Field data was recorded on BCGS field data forms and a tag was placed at each sample site that identified the project and unique sample site number.

At Eco Tech Laboratory Limited (Kamloops, BC) the dried stream-sediment samples were sieved to -80 mesh (<177 µm) and basal till samples were sieved to -230 mesh (<62.5 µm). To monitor and assess accuracy and precision of analytical results, control reference material, analytical duplicate and field duplicate samples were included in each block of 20 samples. The sample pulps will be analyzed for base and precious metals, pathfinder elements and rare earth elements by ICP-MS and INAA. Loss-on-ignition and fluorine content will also be determined for stream and till material. Fluoride content, conductivity and pH will be determined for the raw streamwater samples.

## Data Release

Results of the reanalysis work are scheduled to be released to the public in January 2010 and the new infill survey results will be published in the late spring 2010. Prior to the release, project data will be carefully checked for analytical quality using inserted blind duplicate samples and control reference material. When the information is determined to be complete and accurate, the reanalysis data will be digitally merged with sample site location information, analytical results and field observations from the original survey's digital data reports and the new infill analytical data will be

compiled with its associated field information. The release packages will be made available from the Geoscience BC and BCGS websites and will include detailed descriptions of the work. The survey data will be distributed in a variety of digital formats. Project results will outline a number of exploration opportunities including prospective regional trends as well as individual sample anomalies. In combination with other geoscience information, careful assessments of the data will generate increased mineral tenure acquisition and encourage more detailed follow-up investigations.

## Project Summary

Adding value to the BC geochemical database has been one of the primary objectives of Geoscience BC's QUEST initiatives and other geochemical survey work. Since 2005, this has been successfully accomplished with the reanalysis of over 20 000 archived sediment pulps, 8800 new drainage sediment and water samples and in excess of 1000 till samples. This compilation of high quality, publically available geochemical information has infused a vast range of new multi-element data into the existing collection.

Recognized as a valuable exploration tool, the ongoing development of the database from a relatively limited analytical suite of elements has been accomplished utilizing a strong adherence to national standards combined with an interest by government agencies to produce and maintain a consistent and up-to-date exploration resource. Although the database remains a work in progress, its current condition is impressive. The collection currently includes close to 70 000 regionally distributed samples, covers close to 70% of BC and sample sites are attributed with up to 70 analytes. Information extracted from the database continues to complement exploration activities and has been successfully used to discover mineral prospects, re-evaluate previously explored regions and investigate newly identified prospective areas.

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