# QUEST Project Geochemistry: Field Surveys and Data Reanalysis, Central British Columbia (parts of NTS 093A, B, G, H, J, K, N, O)

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## Introduction

During the 2007 field season, several exploration geochemistry activities were completed, as part of Geoscience BC's QUEST Project, in the Prince George area in central British Columbia (Figure 1). These included the reanalysis of 4940 sediment pulps from previous government-funded regional geochemical surveys conducted within the QUEST Project area (parts of NTS 093A, B, G, H, K, N), an infill lake sediment geochemical survey covering an area of more than 19 000 km$^2$ also within the QUEST Project area (parts of NTS 093G, J, K, N, O) and a reconnaissance-scale stream sediment geochemical survey of the Pine Pass area (NTS 093O).

When released in early 2008, this work will represent one of the largest infusions of publicly available geochemical information into the provincial geochemical database. The release will include field and analytical results for 7327 samples covering an area in excess of 95 000 km$^2$.

The results of these surveys will provide new regional drainage sediment and water geochemical information in an underexplored and geologically poorly understood region of central BC. The work will significantly enhance existing geochemical information and complement other geoscience initiatives such as the new electromagnetic and gravity surveys being flown as part of the QUEST Project. It also provides immediate economic opportunities to local service providers and potential long-term benefits from increased mineral exploration.

## QUEST Reanalysis Project

Administrators of the National Geochemical Reconnaissance (NGR) and BC Regional Geochemical Survey (RGS) programs had the foresight to preserve portions of samples collected during drainage sediment surveys completed from 1976 to 1985. The archived material has provided the opportunity to reanalyze samples using up-to-date analytical techniques. In the early 1990s, over 24 000 samples collected throughout BC from 1976 to 1985 were reanalyzed by instrumental neutron activation analysis (INAA) for gold and a number of other metals not previously determined (Jackaman et al., 1991; Jackaman, 1992). This type of work has provided important new analytical information at improved detection levels and has significantly enhanced the utility of the provincial geochemical database.

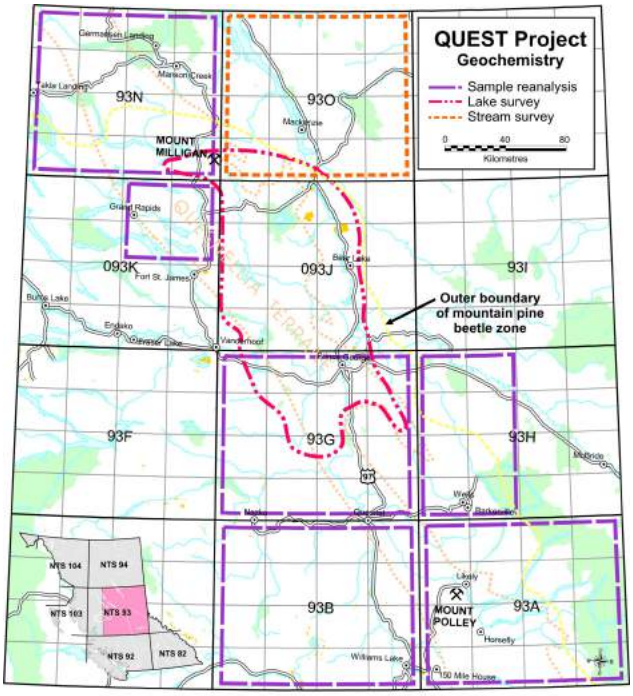


**Figure 1.** Location of survey areas in central British Columbia.

As part of the QUEST Project initiative, archived samples are now being reanalyzed by inductively coupled plasma mass spectrometry (ICP-MS). This technique will not only provide a wide range of new analytical information at improved detection levels, but also provide greater data compatibility with survey analytical methods currently being employed. A total of 4452 stream sediment pulps have been

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selected for this project and cover NTS map sheets 093A, B, G, H, N (Lett, 2005), plus 488 lake sediment pulps from NTS map sheet 093K (Cook et al., 1999). Samples from the 1985 survey completed in the McLeod Lake (NTS 093J) map sheet were reanalyzed by ICP-MS in 2006 (Lett and Bluemel, 2006). It should be noted that although efforts have been made to include all samples from the target survey areas, there are gaps in the data due to missing sample material.

Drainage sediment pulps from previous NGR and RGS programs are currently stored at facilities in Ottawa and Victoria. Custodians of the collection are Natural Resources Canada (NRCan) and the BC Geological Survey (BCGS). Most of the samples are stored by NTS map sheet designation in sample ID order and include original analytical duplicate and control reference samples. A total of 1 g of material was transferred from storage containers to prelabelled sample envelopes and shipped to Acme Analytical Laboratories Ltd. (Vancouver) for analysis. A complete list of elements and analytical detection limits is provided in Table 1.

**Table 1.** Detection limits for sediment samples analyzed by ICP-MS.

| Element | | Detection limit | Units |
|---|---|---|---|
| Aluminum | Al | 0.01 | % |
| Antimony | Sb | 0.02 | ppm |
| Arsenic | As | 0.1 | ppm |
| Barium | Ba | 0.5 | ppm |
| Bismuth | Bi | 0.02 | ppm |
| Cadmium | Cd | 0.01 | ppm |
| Calcium | Ca | 0.01 | % |
| Chromium | Cr | 0.5 | ppm |
| Cobalt | Co | 0.1 | ppm |
| Copper | Cu | 0.01 | ppm |
| Gallium | Ga | 0.2 | ppm |
| Iron | Fe | 0.01 | % |
| Lanthanum | La | 0.5 | ppm |
| Lead | Pb | 0.01 | ppm |
| Magnesium | Mg | 0.01 | % |
| Manganese | Mn | 1 | ppm |
| Mercury | Hg | 5 | ppb |
| Molybdenum | Mo | 0.01 | ppm |
| Nickel | Ni | 0.1 | ppm |
| Phosphorous | P | 0.001 | % |
| Potassium | K | 0.01 | % |
| Scandium | Sc | 0.1 | ppm |
| Selenium | Se | 0.1 | ppm |
| Silver | Ag | 2 | ppb |
| Sodium | Na | 0.001 | % |
| Strontium | Sr | 0.5 | ppm |
| Sulphur | S | 0.02 | % |
| Tellurium | Te | 0.02 | ppm |
| Thallium | Tl | 0.02 | ppm |
| Thorium | Th | 0.1 | ppm |
| Titanium | Ti | 0.001 | % |
| Tungsten | W | 0.1 | ppm |
| Uranium | U | 0.1 | ppm |
| Vanadium | V | 2 | ppm |
| Zinc | Zn | 0.1 | ppm |

## QUEST Lake Sediment Infill Survey

The 2007 QUEST Project geochemical survey covers the northeast corner of the Interior Plateau and is bounded by Mount Milligan in the north, Fort St. James in the west, Highway 97 to the east and Quesnel in the south. The relatively subdued topography varies from exposed grasslands to rolling hills covered with pine and spruce forests (Figure 2). The upland surface of the plateau is favourably dotted with numerous lakes and ponds. Although much of the area was the site of stream sediment survey, the characteristic low relief and disorganized drainage systems of the area make lake sediment an ideal infill sample medium. Methods and specifications utilized in the 2007 project are based on standard lake sediment geochemical survey strategies used elsewhere in Canada for the NGR program (Friske, 1991), as well as prior orientation studies and regional lake sediment surveys completed in BC (Cook, 1997; Jackaman, 2006, 2007).

Helicopter-supported sample collection was carried out in August 2007, during which 1962 lake sediment and water samples were systematically collected from 1854 sites. Average sample site density was one site per 9 $km^2$ over the 19 000 $km^2$ survey area. Field duplicate sediment and water samples were routinely collected in each analytical block of 20 samples. Combined with the existing stream sediment sampling, site density becomes one site per 5 $km^2$.

Lake sites were accessed using a float-equipped Bell Jet Ranger helicopter. The sampling crews collected sediment material with a torpedo-style sampler and water samples were saved in 250 mL bottles. Field observations and site locations were recorded for each site. Samples were successfully collected from most of the lakes targeted in the survey area. However, some of the smaller ponds were not sampled due to poor sampling conditions, and samples were not collected from several very large and deep lakes. In general, lake-bottom samples sent for analysis represent a 35 cm section of material obtained from immediately below the water-sediment interface. Samples typically consisted of organic gels (gyttja) with varying amounts of inorganic sediment and organic matter. Organic gels are the target sample medium as element concentrations tend to be higher and more consistent compared to concentrations in other media, high and consistent loss-on-ignition (LOI) content minimizes the influence of this factor on element distributions, and a relatively deep-water environment is chemically more stable than a shallow-water environment (Friske, 1991).

After drying, each sample was pulverized in a ceramic ring mill to approximately –150 mesh (100 µm), and two analytical splits were extracted from the material. To monitor and assess accuracy and precision of analytical results, control reference material and analytical duplicate samples were

**Figure 2.** Typical lake sample site, located north of Mount Milligan, British Columbia.

**Table 2.** Detection limits for sediment samples analyzed by instrumental neutron activation analysis (INAA), loss-on-ignition (LOI) and fluorine (F). Detection limits for fluoride, conductivity and pH of water samples.

| Element | | Detection limit | Units |
|---|---|---|---|
| Antimony | Sb | 0.1 | ppm |
| Arsenic | As | 0.5 | ppm |
| Barium | Ba | 50 | ppm |
| Bromine | Br | 0.5 | ppm |
| Cerium | Ce | 5 | ppm |
| Cesium | Cs | 0.5 | ppm |
| Chromium | Cr | 20 | ppm |
| Cobalt | Co | 5 | ppm |
| Europium | Eu | 1 | ppm |
| Gold | Au | 2 | ppb |
| Hafnium | Hf | 1 | ppm |
| Iron | Fe | 0.2 | % |
| Lanthanum | La | 2 | ppm |
| Lutetium | Lu | 0.2 | ppm |
| Rubidium | Rb | 5 | ppm |
| Samarium | Sm | 0.1 | ppm |
| Scandium | Sc | 0.2 | ppm |
| Sodium | Na | 0.02 | % |
| Tantalum | Ta | 0.5 | ppm |
| Terbium | Tb | 0.5 | ppm |
| Thorium | Th | 0.2 | ppm |
| Tungsten | W | 1 | ppm |
| Uranium | U | 0.2 | ppm |
| Ytterbium | Yb | 2 | ppm |
| Sample weight | Wt | 0.01 | g |
| Fluorine | F | 10 | ppm |
| Loss-on-ignition | LOI | 0.1 | % |
| pH | pH | | |
| Conductivity | CND | 0.01 | µS |

routinely inserted into each block of 20 sediment samples. The sediment samples will be analyzed for base and precious metals, pathfinder elements and rare earth elements by INAA and ICP-MS. Loss-on-ignition and fluorine will also be determined for sediment material. Fluoride, conductivity and pH will be determined for the water samples. A complete list of elements and analytical detection limits is provided in Tables 1 and 2.

## QUEST Stream Sediment Survey

A new reconnaissance-scale stream sediment and water survey of the Pine Pass area (NTS map sheet 093O) was completed in 2007. The survey was conducted by CME Managing Consultants Inc. and funding was provided by the Northern Development Initiative Trust. Methods and specifications utilized during the work were based on standard regional geochemical survey strategies used elsewhere in BC (Lett, 2005).

The survey area surrounds the community of Mackenzie and is dissected by the Rocky Mountain Trench. To the east, the survey area lies within the Foreland belt, which is composed equally of Upper Proterozoic and Paleozoic sedimentary rocks of the ancestral North America terrane. Lying in the Omineca belt, the southwest portion of the survey area is underlain by Upper Proterozoic and Paleozoic rocks of the Cassiar and Slide Mountain terranes. The survey area contains 50 documented mineral occurrences with coal and limestone being the primary types found (MINFILE, 2007).

In the western portion of the survey area, the Omineca Mountains are characterized by forested rounded summits and in the eastern portion are the moderately rugged mountains of the Hart Ranges and Rocky Mountain Foothills. Dissected by numerous actively flowing creeks and rivers, the area contains abundant sample sites to support a regional stream sediment and water survey. Fine-grained stream sediment is the preferred sample medium in these types of mountainous regions due to its widespread availability, ease of collection and its ability to provide representative geochemical data for the drainage basin upstream from the sample site.

Ground- and helicopter-supported sampling was conducted during August and September 2007. A total of 908 stream sediment and water samples were collected from 854 sites at an average density of one site per 12 $km^2$ over the 10 500 $km^2$ survey area. In general, 1–2 kg samples were collected from actively flowing primary or secondary drainages with catchment areas of less than 10 $km^2$. The –80 mesh (180 µm) fraction of the sediment samples will be analyzed for base and precious metals, pathfinder elements and rare earth elements by INAA and ICP-MS. Loss-on-ignition and fluorine will also be determined for sediment material. Fluoride, conductivity and pH will be determined for the water samples. A complete list of elements and analytical detection limits is provided in Tables 1 and 2.

## Release Details

Reconnaissance-scale drainage sediment and water surveys are recognized as an important mineral exploration tool. Results from these types of activities are directly responsible for follow-up mineral exploration that is valued in the millions of dollars and has been credited with the discovery of numerous mineral prospects. Data from the 2007 QUEST Project initiatives will stimulate mineral exploration by presenting new geochemical information for an underexplored area that is considered to have a high potential for future discoveries of copper and copper-gold deposits, such as those at the Gibraltar and Mount Polley mines.

Survey results will include survey descriptions and details regarding survey methods; analytical and field data listings; summary statistics; sample location maps; and maps for individual elements. The publications will be released on a CD as PDF files and will include all raw digital data files used in the production process. The digital data packages are currently scheduled to be released in January 2008.

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