



# **REGIONAL LAKE SEDIMENT AND WATER GEOCHEMICAL DATA**

**NORTHERN FRASER BASIN, CENTRAL BRITISH COLUMBIA  
(PARTS OF NTS 93G, H, J, K, N & O)**

**REPORT 2008-5**

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## INTRODUCTION

As part of the 2007 QUEST Project, Geoscience BC funded an in-fill lake sediment and water survey plus the reanalysis of sample pulps from a previous lake survey (Jackaman and Balfour, 2008<sup>1</sup>). Results from this work will contribute to the geochemical coverage of the province, complement existing private and publicly available geoscience data sets and provide the mining and exploration community with new, high-quality geochemical information.

Geoscience BC Report 2008-5 includes results of the 2007 in-fill survey as well as original data and new inductively coupled plasma mass spectrometry (ICPMS) results from a 1995 survey previously conducted in the adjacent Stuart Lake area (Cook *et al.*, 1997<sup>2</sup>). The information has been provided in a variety of digital formats. PDF files include survey descriptions and details regarding methods, field and analytical data listings, summary statistics, sample location map, geology map and maps for individual metals. Raw digital data files used in the production process are included in XLS and DBF formats.

## SURVEY DESCRIPTION

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 (Photo 1). The upland surface of the plateau is favourably dotted with numerous lakes and ponds. Although much of the area had been surveyed using stream sediments,

<sup>1</sup>Jackaman, W. and Balfour, J.S. (2008): QUEST Project geochemistry: field surveys and data reanalysis, central British Columbia (parts of NTS 093A, B, G, H, J, K, N, O); in Geoscience BC Summary of Activities 2007, Geoscience BC, Report 2008-1, p. 7–10.

<sup>2</sup> Cook, S.J., Jackaman, W., McCurdy, M.W., Day, S.J. and Friske, P.W.B. (1997): Regional Lake Sediment and Water Geochemistry of part of the Fort Fraser Map Area, British Columbia (93K/9, 10, 15, 16); *B.C. Ministry of Employment and Investment*, Open File 1996-15.

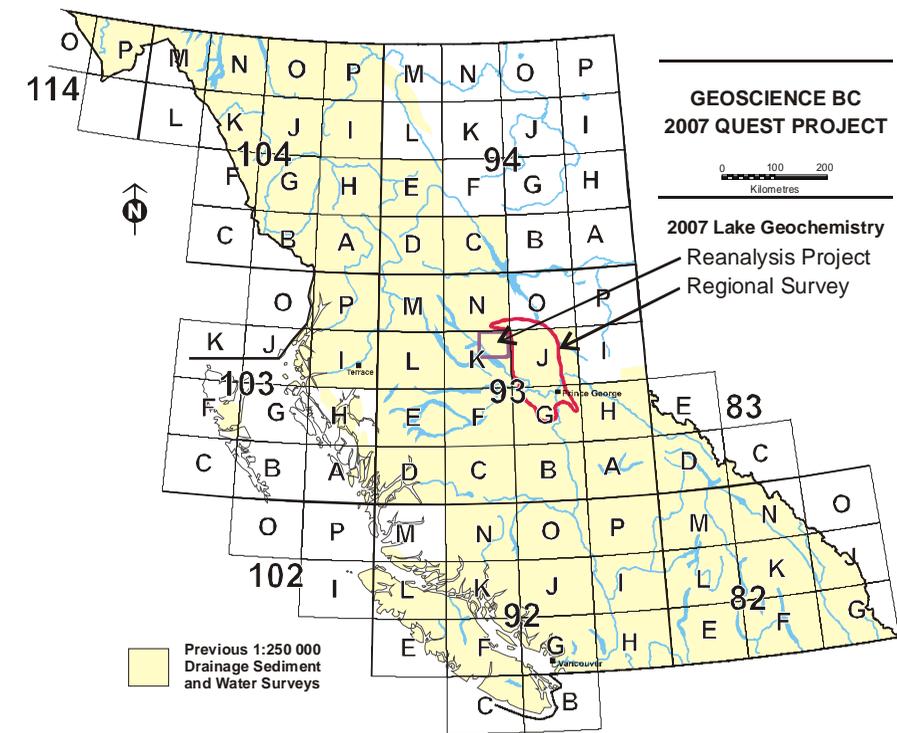


Figure 1. Location of survey areas in central British Columbia.

the characteristic low relief and disorganized drainage systems make lake sediments an ideal in-fill sample medium.

The 2007 QUEST initiative also included the reanalysis of 488 archived lake sediment samples collected from the northeast corner of NTS map sheet 93K. The ICPMS analytical method has generated a wide range of new analytical information at improved detection levels, and provides greater data compatibility with survey analytical methods currently being employed. A total of 1-gram of archived material was retrieved from BC Geological Survey Branch storage facilities in Victoria. The



Photo 1. Typical lake sample site located north of Mount Milligan.

material was transferred to pre-labeled sample envelopes and shipped to Eco Tech Laboratory (Kamloops) for analysis.

## LAKE SAMPLE COLLECTION

Project methods and specifications are based on standard lake sediment geochemical survey strategies used elsewhere in Canada for the National Geochemical Reconnaissance (NGR) program (Friske, 1991<sup>3</sup>), as well as prior orientation studies and regional lake sediment surveys completed in BC (Cook, 1997<sup>4</sup>; Jackaman, 2006<sup>5</sup>).

<sup>3</sup> Friske, P.W.B. (1991): The application of lake sediment geochemistry; in mineral exploration; in Exploration Geochemistry Workshop, *Geological Survey of Canada*, Open File 2390, pages 4.1-4.20.

<sup>4</sup> Cook, S.J. (1993a): Preliminary report on lake sediment geochemistry in the northern Interior Plateau, Central British Columbia; in geological fieldwork 1992, *BC EMPR*, Paper 1993-1, pages 475-481.

<sup>5</sup> Jackaman, W. (2006): Regional drainage sediment and water geochemistry of part of the Nechako River and Anahim Lake map areas (NTS 93C and 93F); *Geoscience BC*, GBC Report 2006-4.

Helicopter-supported sample collection was carried out in August 2007, during which 1959 lake sediment and water samples were systematically collected from 1851 sites. Average sample site density is one site per 10 km<sup>2</sup> over the 18 000 km<sup>2</sup> survey area. Combined with existing drainage sediment data (Lett, 2005<sup>6</sup>) the overall density has been enhanced to one site per 6 km<sup>2</sup>. Field duplicate sediment and water samples were routinely collected in each analytical block of 20 samples.

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. 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 below the water-sediment interface. Samples typically consisted of organic gels with varying amounts of inorganic sediment and organic matter. Field observations and site locations were recorded for each site.

## LAKE SAMPLE PREPARATION

The bags containing the sediment samples were catalogued and drip-dried at a field camp. At the end of the field program, samples were shipped to a commercial lab, where they were air-dried at temperatures below 40°C. After drying, lake sediment samples were pulverized to approximately minus 150 mesh (100 µm) in a ceramic ring mill. To monitor and assess accuracy and precision of analytical results, control reference material and analytical duplicate samples were routinely inserted into each block of twenty sediment samples.

## LAKE SAMPLE ANALYSIS

The sediment samples were analyzed for base and precious metals, pathfinder elements and rare earth elements by ICPMS and instrumental neutron activation

<sup>6</sup> Lett, R.E.W. (2005): Regional Geochemical Survey Database on CD, *BC Ministry of Energy, Mines and Petroleum Resources*, Geofile 2005-17.

analysis (INAA). Loss-on-ignition and fluorine were also determined for sediment material. Fluoride, conductivity and pH were determined for the water samples. A complete list of elements and analytical detection limits is provided in Tables 1 and 2.

Table 1. Detection Limits: ICPMS.

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

Table 2. Detection Limits: INAA, F, LOI and Waters.

Element	D.L.	Unit	Method	Element	D.L.	Unit	Method		
Antimony	Sb	0.1	ppm	INAA	Samarium	Sm	0.1	ppm	INAA
Arsenic	As	0.5	ppm	INAA	Scandium	Sc	0.2	ppm	INAA
Barium	Ba	50	ppm	INAA	Sodium	Na	0.02	%	INAA
Bromine	Br	0.5	ppm	INAA	Tantalum	Ta	0.5	ppm	INAA
Cerium	Ce	5	ppm	INAA	Terbium	Tb	0.5	ppm	INAA
Cesium	Cs	0.5	ppm	INAA	Thorium	Th	0.2	ppm	INAA
Chromium	Cr	20	ppm	INAA	Tungsten	W	1	ppm	INAA
Cobalt	Co	5	ppm	INAA	Uranium	U	0.2	ppm	INAA
Europium	Eu	1	ppm	INAA	Ytterbium	Yb	2	ppm	INAA
Gold	Au	2	ppb	INAA	Sample Weight	Wt	0.01	gm	GRAV
Hafnium	Hf	1	ppm	INAA	Fluorine	F	10	ppm	ION
Iron	Fe	0.2	%	INAA	Loss on Ignition	LOI	0.1	%	GRAV
Lanthanum	La	2	ppm	INAA					
Lutetium	Lu	0.2	ppm	INAA	pH	pH			ISE
molybdenum	Mo	1	ppm	INAA	Fluoride	FW	20	ppb	ION
Rubidium	Rb	5	ppm	INAA	Conductivity	CND	0.01	uS	ISE

## Inductively Coupled Plasma Mass Spectrometry (ICPMS)

For the determination of 35 elements listed in Table 1, a 0.5-gram sample was leached with 3 ml of a mixture of HCl, HNO<sub>3</sub>, and distilled, deionized water (3:1:2 v/v) at 95°C for one hour. The sample solution was diluted to 10 ml and analysed by inductively coupled plasma mass spectroscopy on a Thermo-Electron X-series II instrument. Data for gold and boron was not published because of inadequate detection limits and/or precision.

## Instrumental Neutron Activation Analysis (INAA)

Weighed and encapsulated samples were packaged for irradiation along with internal standards and international reference materials. Samples and standards were irradiated together with neutron flux monitors in a two-megawatt pool type reactor. After a seven-day decay period, samples were measured with a high-resolution germanium detector. Typical counting times were 500 seconds. Elements determined by INAA are listed in Table 2. Data for silver, cadmium, iridium, nickel, selenium, tin, tellurium, titanium, zinc, and zirconium are not published because of inadequate detection limits and/or precision.

## Other Sediment Analysis

Loss-on-ignition was determined using a 1-gram sample. The sample, weighed into a crucible, was placed into a 1000°C muffle furnace for one hour. The crucibles were removed from the oven and cooled to 100°C and then transferred to a desiccator for cooling to room temperature. The crucibles were re-weighed, and the difference was reported as loss-on-ignition (GRAV).

To measure fluorine, a 0.25-gram sample was fused with 1-gram of sodium carbonate-sodium nitrate. After being leached with metal free water for 1 hour, 10 ml of 10% citric acid solution is added. Fluoride was measured using specific ion electrode analysis (ION).

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## Water Analysis

The pH of waters was determined using a Hanna Instruments pH/EC/TDS meter with automatic temperature compensation, a range of 0.00 to +14.0 pH, resolution of 0.01 pH and an accuracy of  $\pm 0.01$  pH. Meters were calibrated using commercial buffer solutions with pH values of 4.0, 7.0 and 10.0.

Conductivity of waters was determined using a Hanna Instruments pH/EC/TDS meter with automatic temperature compensation and a range of 4000  $\mu\text{S}/\text{cm}$ , a resolution of 1  $\mu\text{S}/\text{cm}$  and a full-scale accuracy of  $\pm 1\%$ . Meters were calibrated using commercial conductivity standards.

Fluoride in waters was determined by specific ion electrode analysis (ION).

## DATA PRESENTATION

Geochemical information compiled in this report includes field and analytical results from samples collected during a regional lake survey conducted in 2007 (N = 1959) and results from a 1995 survey (N=438) including new ICPMS data for 420 samples. Results from the survey have been determined to be accurate and complete. The data package has been prepared as a PDF document and presents survey results in three appendices that are described as follows:

**Appendix 'A':** Is a complete listing of site location information, field observations and analytical results for the 1995 and 2007 surveys. Tables preceding the data listings define codes used for field observations and underlying geology.

**Appendix 'B':** Presents summary statistics for individual elements and a more detailed summary based on the underlying bedrock geology determined at each sample site. The calculations have been determined from raw data and values reported by the labs at less than detection limit have been set to half the detection limit.

**Appendix 'C':** Includes a sample location map, simplified geology and mineral occurrence map and proportional symbol maps for each element. For most maps the symbol size and colour reflects data ranges that are based on the 30<sup>th</sup>, 50<sup>th</sup>, 70<sup>th</sup>, 90<sup>th</sup> and 95<sup>th</sup> percentiles as determined from the raw data. Maximum symbol size is assigned to values greater than the 95<sup>th</sup> percentile. Portraying high values with large, bold symbols, with background values represented by relatively smaller dots, helps highlight regional trends and anomalous sample sites.

The data summary presented in this package is not considered exhaustive. In order to accommodate more detailed assessments, raw digital data files have been included in XLS and DBF formats.

## ACKNOWLEDGMENTS

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Analysis:	Eco Tech Laboratory Ltd., Kamloops, BC Becquerel Laboratories Ltd., Mississauga, Ont

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