
A compilation of quality control data from Geoscience BC RGS Initiatives

Data Presentation and Metadata

Geoscience BC Report 2018-15

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Project Summary

Since 2005, a total of 13031 regional geochemical survey (RGS) stream sediment, lake sediment and till samples have been collected by Geoscience BC managed programs. These, and an additional 43107 previously archived multi-media samples, have been analyzed for up to 60 elements by a number of techniques including instrumental neutron activation (INAA), aqua regia inductively coupled argon plasma mass spectroscopy (AR-ICPMS) and lithium borate fusion-inductively coupled argon plasma emission/mass spectroscopy (LB-ICPES/MS).

The accuracy and precision of these data are scrutinized by assessing the results of multi-element analysis from sample-site duplicate, analytical duplicate, reference standard samples imbedded with the routine RGS samples using a quality control protocol established by the Geological Survey of Canada and the British Columbia Geological Survey (McCurdy et al., 2014; Ballantyne, 1991; Friske and Hornbrook, 1991).

This document describes the quality control database that has been generated from the multi-element geochemical analysis of samples collected by regional surveys and sample reanalysis initiatives supported by Geoscience BC. Table 1 list the field surveys and table 2 list the reanalysis projects included in this compilation. A bibliography of the reports used in this compilation is provided in Appendix A.

Table 1. List of Geoscience BC sponsored field surveys conducted since 2005, showing survey type, sample material collected, name of commercial laboratory plus analytical methods used. Abbreviations: ICPMS, inductively coupled argon plasma mass spectroscopy; INAA, instrumental neutron activation.

SURVEY REPORT	SURVEY NAME	SURVEY YEAR	SURVEY TYPE	SAMPLE TYPE	LAB & METHOD
GBC REPORT 2008-03	QUEST	2007	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENT	ACME - ICPMS
GBC REPORT 2008-11	TERRACE	2008	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENT	ACME - ICPMS
GBC REPORT 2009-05	QUESTWEST	2008	SAMPLE REANALYSIS	ARCHIVED STREAM & LAKE SEDIMENT	ACME - ICPMS
GBC REPORT 2010-04	QUEST SOUTH	2009	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENT	ALS CHEMEX - ICPMS/ICPES
GBC REPORT 2011-02	NORTH BC	2010	SAMPLE REANALYSIS	ARCHIVED STREAM & LAKE SEDIMENT	ACME - ICPMS
GBC REPORT 2011-04	VANCOUVER ISLAND	2010	SAMPLE REANALYSIS	ARCHIVED MOSS SEDIMENT	ALS CHEMEX - ICPMS/ICPES, FIRE ASSAY
GBC REPORT 2012-05	QUEST NW	2011	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENT	ACME - ICPMS
GBC REPORT 2012-06	QUEST NW	2011	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENTS	BECQUEREL - INAA
GBC REPORT 2013-04	SEBC - 082K	2012	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENT	ACME - ICPMS
GBC REPORT 2013-06	MCLEOD LAKE	2012	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENTS	BECQUEREL - INAA
GBC REPORT 2013-09	SEBC - 082F	2012	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENT	ACME - ICPMS
GBC REPORT 2013-12	NVI TILL	2013	SAMPLE REANALYSIS	ARCHIVED TILL PULPS	ACME - ICPMS
GBC REPORT 2014-03	NVI MOSS	2013	SAMPLE REANALYSIS	ARCHIVED MOSS-MAT SEDIMENTS	BECQUEREL - INAA
GBC REPORT 2015-09	TREK TILL ARCHIVE	2014	SAMPLE REANALYSIS	ARCHIVED TILL PULPS	BEREAU VERITAS - ICPMS & ICPES/MS
GBC REPORT 2017-04	BC RGS 2016	2016	SAMPLE REANALYSIS	ARCHIVED STREAM SEDIMENT	ACME - ICPMS

Table 2. List of Geoscience BC sponsored sample reanalysis initiatives conducted since 2006, showing original survey type, sample material collected, name of commercial laboratory plus analytical methods used. Abbreviations: ICPMS, inductively coupled argon plasma mass spectroscopy; INAA, instrumental neutron activation.

SURVEY REPORT	SURVEY NAME	SURVEY YEAR	SURVEY TYPE	SAMPLE TYPE	LAB & METHOD
GBC REPORT 2006-04	ANAHIM LAKE / NECHAKO RIVER	2006	REGIONAL LAKE SURVEY	LAKE SEDIMENTS	ACME - ICPMS & BECQUEREL - INAA
GBC REPORT 2006-05	MID ROCKIES	2006	REGIONAL STREAM SURVEY	STREAM SEDIMENTS	ACME - ICPMS & BECQUEREL - INAA
GBC REPORT 2007-06	CARIBOO	2007	REGIONAL LAKE SURVEY	LAKE SEDIMENTS	ACME - ICPMS & BECQUEREL - INAA
GBC REPORT 2008-05	QUEST	2007	REGIONAL LAKE SURVEY	LAKE SEDIMENTS	ECOTECH - ICPMS & BECQUEREL - INAA
GBC REPORT 2008-07	PINE PASS	2008	REGIONAL STREAM SURVEY	STREAM SEDIMENTS	ECOTECH - ICPMS & BECQUEREL - INAA
GBC REPORT 2009-11	QUESTWEST	2008	REGIONAL LAKE & STREAM SURVEY	LAKE & STREAM SEDIMENTS	ECOTECH - ICPMS & BECQUEREL - INAA
GBC REPORT 2010-13	QUEST SOUTH	2009	REGIONAL STREAM & TILL SURVEY	STEAM SEDIMENTS & TILL	ECOTECH - ICPMS & BECQUEREL - INAA
GBC REPORT 2012-07	QUEST NORTHWEST	2011	REGIONAL STREAM SURVEY	STREAM SEDIMENTS	ACME - ICPMS & BECQUEREL - INAA
GBC REPORT 2013-11	NVI	2013	REGIONAL STREAM SURVEY	MOSS-MAT SEDIMENTS	ALS MINERALS - ICPMS & BECQUEREL - INAA
GBC REPORT 2014-10	TREK13	2013	REGIONAL TILL & LAKE SURVEY	TILL & LAKE SEDIMENTS	BEREAU VERITAS - ICPMS & ICPES/MS; BECQUEREL - INAA
GBC REPORT 2015-12	TREK14	2014	REGIONAL TILL SURVEY	TILL	BEREAU VERITAS - ICPMS & ICPES/MS; BECQUEREL - INAA
GBC REPORT 2016-05	WEST ROAD RIVER	2015	REGIONAL TREE-TOP SURVEY	SPRUCE TREE-TOP NEEDLES & TWIGS	BEREAU VERITAS - ICPMS

Quality Control Samples

Quality control samples were routinely used for both regional surveys and sample reanalysis projects (Table 3). Both types of geochemical data collection techniques utilized imbedded quality control samples that were sequentially placed within the sample sequence. Previous surveys include original sample-site, analytical duplicate samples and in some cases standard reference material that have been maintained and available for subsequent reanalysis work. Generally, a selection of fresh standard reference materials were used for new regional surveys and a combination of new and original standard reference materials were used for sample reanalysis initiatives (Table 4).

Table 3: Standard quality control protocols used for both new surveys and reanalysis projects. Each batch of consequentially numbered samples includes a sample site duplicate pair, an analytical duplicate sample, a standard reference sample and 17 routine samples. Abbreviations: GSC, Geological Survey of Canada; BCGS, BC Geological Survey; CCRMP, Canadian Certified Reference Materials Project.

Quality Control Sample	Definition	Batch Location
Sample-site duplicate	A second sample collected from the same field site location as a routine sample	Random position in batch of 20 samples, usually a sequentially numbered pair
Analytical duplicate	Spit of a lab processed sample into two separate sample pulps	A single split of a randomly selected routine sample placed in sequential order at start of each batch
Standard reference material	CCRMP and/or in-house material developed by GSC or BCGS	One sequentially numbered sample randomly inserted in batch of 20 samples
Routine samples	17 uniquely identified, individual samples collected from distinct field site locations	Make-up remaining positions in each batch of 20 samples

Table 4. Inserted standard reference materials used for regional surveys and reanalysis projects. Abbreviations: GSC, Geological Survey of Canada; BCGS, BC Geological Survey; CCRMP, Canadian Certified Reference Materials Project.

Standard Origin	Codes	Type	Size Fraction
GSC in-house standard reference material	GSC A, HK, Q, S1, S2, W, X, X2, Y, Y2, V, 9R	stream sediment	<0.177 mm or <0.074 mm
BCGS in-house standard reference material	RGS N1, NVI, RD, SQ	stream sediment	<0.177 mm
BCGS in-house standard reference material	RGS CL	lake sediment	<0.177 mm
BCGS in-house standard reference material	RGS TILL	till	<0.063 mm
CCRMP - CANMET certified material	STSD 1, 2, 4	stream sediment	<0.074 mm
CCRMP - CANMET certified material	LKSD 3, 4	lake sediment	<0.074 mm
CCRMP - CANMET certified material	TILL 1, 3, 4	till	<0.074 mm

Data Presentation and Metadata

Results of this compilation have been stored in twenty-seven Microsoft® Excel (XLSX) files. Each of the project files contain the raw quality control data that was used as part of the analytical work. Data for the quality control sample type and associated laboratory technique are stored as individual TABS (Table 5). Files also include a NOTES tab that summarizes the information being presented and provides the reference for each report and the Geoscience BC web link. Access to original report publications will provide specific details on survey methods and specifications plus published survey results.

Table 5. List of XLSX spreadsheet tabs and description of tab labels. Abbreviations: ICPMS, inductively coupled argon plasma mass spectroscopy; INAA, instrumental neutron activation.

Tab	Tab Label	Description
1	NOTES	brief project summary
2	SURVEY FLD DUPS ICP	ICPMS sample site duplicate data
3	SURVEY BLD DUPS ICP	ICPMS analytical duplicate data
4	SURVEY STANDARDS ICP	ICPMS standard reference material data
5	SURVEY FLD DUPS INA	INAA sample site duplicate data
6	SURVEY BLD DUPS INA	INAA analytical duplicate data
7	SURVEY STANDARDS INA	INAA standard reference material data

Table 6 describes common spreadsheet headers used for each tab. Table 7 provides definitions of abbreviations and codes used in spreadsheet headers and cells. Complete listings of data associated with each analytical method are included in Tables 8, 9 and 10. Note that analytical information provided for each project may not include all the data listed in the tables.

Table 6. Common data field header codes used in each spreadsheet.

Code	Definition
ORDER	Sequential order of data records in the compilation.
REPORT	Report designation for the analytical results presented.
NAME	Project name of survey area.
SURVEYTYPE	Regional survey or sample reanalysis.
SURVEYID	Unique ID number listed for each data record.
LAB	Analytical laboratory conducting listed sediment analysis.
MTHD	Primary analytical method used.
YEARANLYS	Year samples were analyzed.
SAMPLETYPE	Stream, lake sediment; till; spruce needle, spruce twig.
SIZEFRACTN	Sediment fraction used for analysis.
FLD_DUP	FD1: first of field duplicate pair; FD2: second.
BLD_DUP	BD1: first of blind duplicate pair; BC2: second.
STANDARD	Name of control reference standard.

Table 7. Explanation of abbreviations used in spreadsheet headers and cells.

Abbreviation	Definition	Abbreviation	Definition
ICPMS	inductively coupled plasma–mass spectrometry	ICPES	inductively coupled plasma–emission spectrometry
INAA	instrumental neutron activation analysis	FA	fire assay
TOTAL/C	total carbon	TOTAL/S	total sulphur
ION	specific ion electrode	GRAV	gravimetric (weight difference)
PPM	parts per million	PPB	parts per billion
PCT	percent	WT	weight in grams
–	< method detection level	-9999	missing or data not reported

Table 8. Data listing for aqua regia inductively coupled argon plasma mass spectroscopy plus fluorine and loss on ignition. Abbreviations: ICPMS, inductively coupled argon plasma mass spectroscopy; INAA, instrumental neutron activation; FA, lead collection-fire assay; ION, specific ion electrode; GRV, gravimetric; PPB, parts per billion; PPM, parts per million; PCT, percent.

Element	Unit	Method	Element	Unit	Method		
Silver	AG	PPB	ICPMS	Strontium	SR	PPM	ICPMS
Aluminum	AL	PCT	ICPMS	Tellurium	TE	PPM	ICPMS
Arsenic	AS	PPM	ICPMS	Thorium	TH	PPM	ICPMS
Gold	AU	PPB	ICPMS	Titanium	TI	PCT	ICPMS
Boron	B	PPM	ICPMS	Thallium	TL	PPM	ICPMS
Barium	BA	PPM	ICPMS	Uranium	U	PPM	ICPMS
Bismuth	BI	PPM	ICPMS	Vanadium	V	PPM	ICPMS
Calcium	CA	PCT	ICPMS	Tungsten	W	PPM	ICPMS
Cadmium	CD	PPM	ICPMS	Zinc	ZN	PPM	ICPMS
Cobalt	CO	PPM	ICPMS	Beryllium	BE	PPM	ICPMS
Chromium	CR	PPM	ICPMS	Cerium	CE	PPM	ICPMS
Copper	CU	PPM	ICPMS	Cesium	CS	PPM	ICPMS
Iron	FE	PCT	ICPMS	Germanium	GE	PPM	ICPMS
Gallium	GA	PPM	ICPMS	Hafnium	HF	PPM	ICPMS
Mercury	HG	PPB	ICPMS	Indium	IN	PPM	ICPMS
Potassium	K	PCT	ICPMS	Lithium	LI	PPM	ICPMS
Lanthanum	LA	PPM	ICPMS	Niobium	NB	PPM	ICPMS
Magnesium	MG	PCT	ICPMS	Rubidium	RB	PPM	ICPMS
Manganese	MN	PPM	ICPMS	Rhenium	RE	PPB	ICPMS
Molybdenum	MO	PPM	ICPMS	Tin	SN	PPM	ICPMS
Sodium	NA	PCT	ICPMS	Tantalum	TA	PPM	ICPMS
Nickel	NI	PPM	ICPMS	Yttrium	Y	PPM	ICPMS
Phosphorus	P	PCT	ICPMS	Zirconium	ZR	PPM	ICPMS
Lead	PB	PPM	ICPMS	Palladium	PD	PPB	ICPMS/FA
Sulphur	S	PCT	ICPMS	Platinum	PT	PPB	ICPMS/FA
Antimony	SB	PPM	ICPMS				
Scandium	SC	PPM	ICPMS	Fluorine	F	PPM	ION
Selenium	SE	PPM	ICPMS	Loss on Ignition	LOI	PCT	GRV

Table 9. Data listing for lithium borate fusion-inductively coupled argon plasma emission/mass spectroscopy. Abbreviations: ICPEs, inductively coupled argon plasma emission spectroscopy; GRV, gravimetric; PPM, parts per million; PCT, percent.

Element	Unit	Method	Element	Unit	Method		
Silicon dioxide	SiO2	PCT	ICPES	Cobalt	CO	PPM	ICPES
Aluminium oxide	Al2O3	PCT	ICPES	Copper	CU	PPM	ICPES
Iron(III) oxide	Fe2O3	PCT	ICPES	Niobium	NB	PPM	ICPES
Magnesium oxide	MgO	PCT	ICPES	Nickel	NI	PPM	ICPES
Calcium oxide	CaO	PCT	ICPES	Scandium	SC	PPM	ICPES
Sodium oxide	Na2O	PCT	ICPES	Strontium	SR	PPM	ICPES
Potassium oxide	K2O	PCT	ICPES	Yttrium	Y	PPM	ICPES
Titanium dioxide	TiO2	PCT	ICPES	Zinc	ZN	PPM	ICPES
Phosphorus pentoxide	P2O5	PCT	ICPES	Zirconium	ZR	PPM	ICPES
Manganese oxide	MnO	PCT	ICPES	Loss on Ignition	LOI	PCT	GRV
Chromium(III) oxide	Cr2O3	PCT	ICPES	Sum	SUM	PCT	
Barium	BA	PPM	ICPES	Total/C	TOT/C	PCT	LECO
Cerium	CE	PPM	ICPES	Total/S	TOT/S	PCT	LECO

Table 10. Data listing for instrumental neutron activation. Abbreviations: INAA, instrumental neutron activation; GRV, gravimetric; PPB, parts per billion; PPM, parts per million; PCT, percent.

Element		Unit	Method	Element		Unit	Method
Silver	AG	PPM	INAA	Neodymium	ND	PPM	INAA
Arsenic	AS	PPM	INAA	Nickel	NI	PPM	INAA
Gold	AU	PPB	INAA	Rubidium	RB	PPM	INAA
Barium	BA	PPM	INAA	Antimony	SB	PPM	INAA
Bromine	BR	PPM	INAA	Scandium	SC	PPM	INAA
Calcium	CA	PCT	INAA	Selenium	SE	PPM	INAA
Cadmium	CD	PPM	INAA	Samarium	SM	PPM	INAA
Cerium	CE	PPM	INAA	Tin	SN	PPM	INAA
Cobalt	CO	PPM	INAA	Strontium	SR	PPM	INAA
Chromium	CR	PPM	INAA	Tantalum	TA	PPM	INAA
Cesium	CS	PPM	INAA	Terbium	TB	PPM	INAA
Europium	EU	PPM	INAA	Tellurium	TE	PPM	INAA
Iron	FE	PCT	INAA	Thorium	TH	PPM	INAA
Hafnium	HF	PPM	INAA	Titanium	TI	PPM	INAA
Mercury	HG	PPM	INAA	Uranium	U	PPM	INAA
Iridium	IR	PPB	INAA	Tungsten	W	PPM	INAA
Lanthanum	LA	PPM	INAA	Ytterbium	YB	PPM	INAA
Lutetium	LU	PPM	INAA	Zinc	ZN	PPM	INAA
Molybdenum	MO	PPM	INAA	Zirconium	ZR	PPM	INAA
Sodium	NA	PCT	INAA	Weight	WT	GM	GRV

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