BC GEOLOGICAL SURVEY GEOFILE 2005-17

THE REGIONAL GEOCHEMICAL SURVEY DATABASE ON CD

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INTRODUCTION

The following is a general outline of the regional geochemical survey program collection, preparation and analytical methods. The British Columbia Ministry of Energy and Mines has been involved in reconnaissance-scale stream sediment and water surveys since 1976. This program has generated high quality stream and lake sediment and surface water data from geochemical surveys carried out across Canada. In British Columbia the National Geochemical reconnaissance (NGR) program, known as the Regional Geochemical Survey (RGS), has covered roughly 70 percent of the province with stream sediment and stream water sampling at an average sample density of one sample per 13 square kilometres. In the process just over 45,000 samples have been collected and analyzed for up to 50 elements including gold copper, molybdenum and zinc. As part of the NGR program, the BC RGS continues to maintain sample collection, preparation and analytical standards established by the Geological Survey of Canada. The current BC RGS coverage is showin in Figure 1.

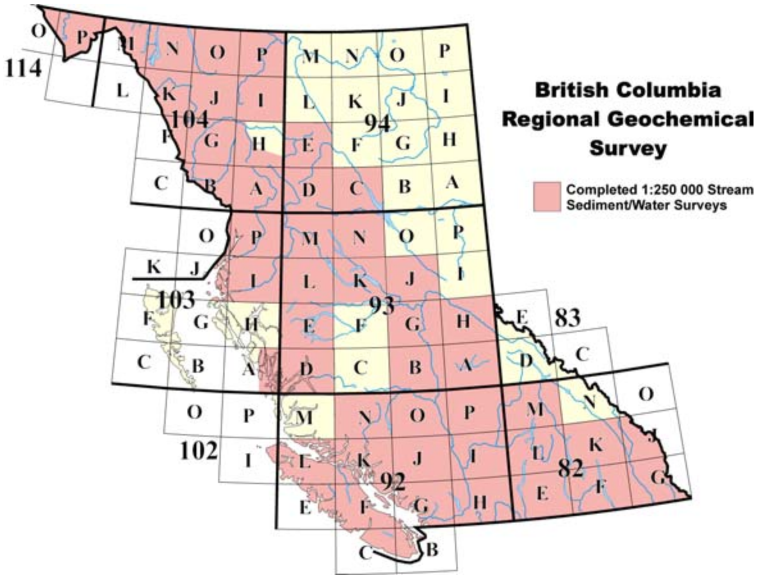

Figure 1. 2005 RGS Coverage

RGS SAMPLE COLLECTION

Reconnaissance-scale drainage sediment and water surveys in British Columbia are typically conducted during the summer months. Regions surveyed are based on NTS 1:250 000 map sheets and often evaluates areas in excess of 10,000 square kilometres. Samples are systematically collected at a average density of one sample site every 13 square kilometres. Field duplicate samples are routinely collected in each analytical block of twenty samples.

On average, targeted primary and secondary drainage basins have catchment areas of less than 10 square kilometres. A small number of samples have been collected from streams with basin areas that are less then 1 square kilometre or greater than 25 square kilometres. In general, the remaining unsurveyed areas represent broad valley floors which are characterized by meandering river channels or swamps that do not provide appropriate stream sediment material. Some stream networks bounded by surveyed drainages may have been intentionally excluded from sampling to maintain the intended sample density of the survey. Designed to provide cost effective regional geochemical data, the RGS program does not define the geochemistry of every first or second order stream within a map area.

Sediment samples weigh approximately 1 to 2 kilograms and are obtained from the active (subject to annual flooding) stream channel and placed in kraft paper bags. Samples are composed of fine-grained material mixed with varying amounts of coarse sand, gravel and organic mater. Contaminated or poor-quality sample sites are avoided by choosing an alternate stream or by sampling a minimum of 60 metres upstream from the source of contamination. Clean surface water samples are collected in 250 millilitre bottles. Standard field observations regarding sample media, sample site and local terrain were also recorded.

Lett and Jackaman, 2004, describe sample collection methods in more detail.

CODES FOR RECORDING SAMPLE INFORMATION

RGS digital data files containing recorded field observations and analytical data are provided in comma delimited format. Each line of data corresponds to one RGS sample and contains up to 95 fields of information.

The structure listed here has been standardized to include data fields for all surveys conducted since 1976. ***Surveys may not include data for all fields listed***:

- Missing field data and/or field data not collected as part of the survey are listed as 'blank', and
- missing and/or not determined analytical data are listed as '-1'.

EXPLANATION OF CODES FOR FIELD OBSERVATIONS

MASTER ID: Unique id number for total RGS data set. Consists of NTS map sheet designation, year, and sample id number.

NTS MAP-SHEET: National Topographic System (NTS).

COLLECTION YEAR: Year survey was conducted.

SAMPLE ID NUMBER: Unique id number for survey (i.e. 1002).

Field Party Number	1
Sequential Number	002

SAMPLE SITE LOCATION:

UTM (NAD27): sample site coordinates digitized from 1:50 000 NTS map sheets.

UTM (NAD83): converted from original NAD27.

Latitude and Longitude (decimal degrees): converted from NAD83 UTM coordinates.

ELEVATION: Elevation at the sample site (metres).

SAMPLE MATERIAL: Nature of media sampled.

1 - Stream Sediment
6 - Water and Sediment
7 - Moss Sediment
8 - Water and Moss Sediment

REPLICATE STATUS: Relationship of current sample to others.

00 - Routine sample site
10 - First of a field duplicate pair
20 - Second of a field duplicate pair

STREAM SOURCE:

0 - Unknown
1 - Groundwater
2 - Spring Run-off
3 - Glacier Melt Water

STREAM ORDER:

0 - Undefined
1 - Primary
2 - Secondary
3 - Tertiary
4 - Quaternary

STREAM TYPE:

0 - Undefined
1 - Permanent
2 - Seasonal
3 - Re-emergent

PHYSIOGRAPHY: General topography of sampled catchment area.

0 - Lowland Plain
1 - Muskeg, Swamp
2 - Peneplain, Plateau
3 - Hilly, Undulating
4 - Mountains, Mature
5 - Mountains, Youthful

DRAINAGE PATTERN:

0 - Poorly Defined
1 - Dendritic
2 - Herringbone
3 - Rectangular
4 - Interrupted
5 - Glacially Deranged
6 - Basinal
7 - Other

CONTAMINATION: Degree or type of human contamination.

0 - None
1 - Possible
2 - Probable
3 - Definite
4 - Mining
5 - Industrial
6 - Agriculture
7 - Domestic
8 - Forestry
9 - Burned

STREAM WIDTH: Width of the stream at the sample site in metres.

STREAM DEPTH: Depth of the stream at the sample site in centimetres.

STREAM FLOW RATE: Visual estimate of stream flow velocity.

0 - Stagnant
1 - Slow
2 - Moderate
3 - Fast
4 - Torrent

STREAM WATER COLOUR:

0 - Colourless
1 - Brown, Clear
2 - White Cloudy
3 - Brown Cloudy

BANK TYPE: General Nature of the bank material.

0 - Unknown
1 - Alluvial
4 - Glacial Outwash
5 - Bare Rock

2 - Colluvial
3 - Till
6 - Talus, Scree
7 - Organic

BANK PRECIPITATE: Presence of stain, weathering on rocks in the area surrounding the sample site.

0 - None, otherwise same codes as sediment colour.

SEDIMENT COMPOSITION: Bulk composition of the collected sample as a function of abundance of sand, fines and organics.

0 - Absent
1 - Minor < 33%
2 - Medium 33-67%
3 - Major >67%

SEDIMENT COLOUR: General colour of collected sediment.

1 - Red
2 - White, Buff
3 - Black
4 - Yellow
5 - Green
6 - Gray, Blue
7 - Pink
8 - Tan, Brown

SEDIMENT PRECIPITATE OR STAIN: Presence of any coatings on gravels, pebbles,boulders within the sample, or on stream bottoms at the sample site.

0 - None, otherwise same codes as sediment colour.

CHANNEL BED: Texture of channel bed.

1 - Boulders
2 - Fine Sand to Clay
3 - Sand and Gravels
4 - Organics

CHANNEL PATTERN:

1 - Shoots and Pools
2 - Braided
3 - Meandering
4 - Disturbed

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Additional field information for moss sediment samples
collected on Vancouver Island.

MOSS HEIGHT: Height of moss above stream bed in metres.

MOSS COLOUR:

1 - Light Green
2 - Dark Green
3 - Brown/Black

MOSS HEALTH:

1 - Alive
2 - Dead

MOSS HOST:

1 - Rock
2 - Friable Rock
3 - Log
4 - Decomposed Log

MOSS THICK: Thickness of moss-mat in centimetres.

DATE: Date sample collected, day/month.

RGS SAMPLE PREPARATION

At a field camp, sediment samples are air dried at a temperature range of 30°C to less than 50°C. Material finer than 1 millimetre is recovered by sieving each dried sample through a -18 mesh (<1 millimetre) ASTM screen. Field-dried sediment samples are shipped to a sample preparation laboratory for final sample preparation. The -80 mesh (<177 microns) fraction is obtained by dry sieving. Control reference material and analytical duplicate samples are inserted into each analytical block of twenty sediment samples. Any remaining -80 mesh sediment and a representative sample of +80 to -18 mesh fraction is archived for future analyses. Quality control reference standards are also inserted into each analytical block of twenty water samples.

RGS STREAM SEDIMENT ANALYSIS

Single element and parameter analyses

Antimony was determined by aqua regia digestion - hydride generation atomic absorption spectroscopy. A 0.5-gram sample was placed in a test tube with 3 millilitres of concentrated nitric acid and 9 millilitres of hydrochloric acid. The mixture was allowed to stand overnight at room temperature prior to being heated to 90°C for 90 minutes. The mixture was cooled and a 1-millilitre aliquot was diluted to 10 millilitre with 1.8M hydrochloric acid. The solution was analyzed for antimony by hydride generation atomic absorption spectroscopy as described by Aslin (1976).

Arsenic, bismuth and selenium were determined by aqua regia digestion - hydride generation atomic absorption spectroscopy. A 1-gram sample was digested with 3 millilitres of concentrated nitric acid for 30 minutes at 90°C. Concentrated hydrochloric acid (1 mL) was added and the digestion was continued at 90°C for an additional 90 minutes. A 1-millilitre aliquot was diluted to 10 millilitres with 1.5M hydrochloric acid in a clean test tube. The diluted sample solution was added to a sodium borohydride solution and the hydride vapour passed through a heated quartz tube in the light path of an atomic absorption spectrometer.

Barium was determined using energy-dispersive X-Ray fluorescence according to the method described by Bright (1983). A 5-gram sample is placed in a 10 millilitre plastic vial. The sample is exposed to a radioactive source and the intensities of X-rays emitted are measured. The amount of barium is measured by comparison to standards. Corrections are made for inter-element interference.

Chromium was determined on a 0.25-gram sample heated with a mixture of 2-millilitres of nitric acid, 2-millilitres of perchloric acid and 5-millilitres of hydrofluoric acid at 90 to 100°C until the solution is reduced to dryness. The residue was dissolved in 10-millilitres of 10% hydrochloric acid and analyzed for chromium by atomic absorption spectrometry using a nitrous oxide-acetylene flame and background corrections.

Cadmium, **cobalt**, **copper**, **iron**, **lead**, **manganese**, **nickel**, **silver** and **zinc** were determined by aqua regia digestion - flame atomic absorption spectroscopy. A 1-gram sample was reacted with 3 millilitres of concentrated nitric acid for 30 minutes at 90°C. Concentrated hydrochloric acid (1 mL) was added and the digestion was continued at 90°C for an additional 90 minutes. The sample solution was then diluted to 20 millilitres with metal-free water and mixed. The solution was analyzed for metals by atomic absorption spectroscopy using an air-acetylene flame. Background corrections were made for lead, nickel, cobalt and silver.

Fluorine was determined by specific ion electrode as described in Ficklin (1970). A 0.25-gram sample was sintered with a 1-gram flux consisting of 2 parts by weight of sodium carbonate and 1 part by weight of potassium nitrate. The residue was then leached with water and the sodium carbonate was neutralized with 10 millilitres 10% citric acid. The resulting solution was diluted to 100 millilitres with water to a pH of 5.5 to 6.5. Fluoride was measured using a fluoride ion electrode and a reference electrode.

Gold was determined by mixing a 10-gram sample with a flux composed mainly of lead oxide. The proportions of the flux components are adjusted depending on the nature of the sample. Silver is added to help collect the gold. The samples are fused at 1066°C until a clear melt is obtained. The resultant lead button containing the precious metals is then separated from the slag. Heating in a cuppelation furnace separates the lead from the noble metals. The precious metal beads that remain are irradiated in a neutron flux for 1 hour, cooled for 4 hours and counted by gamma ray spectrometry. Calibrations are carried out using standard and blank beads. Depending on the amount of sample available, lesser weights were sometimes used (minimum 5 grams). This resulted in a variable detection limit of 1 ppb gold for a 10-gram sample and 2 ppb for a 5-gram sample.

Molybdenum and **vanadium** were determined by aqua regia digestion - atomic absorption spectroscopy using a nitrous oxide acetylene flame. A 0.5-gram sample was reacted with 1.5 millilitres of concentrated nitric acid at 90°C for

30 minutes. Concentrated hydrochloric acid (0.5 mL) was added and the digestion continued for an additional 90 minutes. After cooling, 8 millilitre of 1250 ppm aluminium solution was added and the sample solution diluted to 10 millilitre before determination of molybdenum and vanadium by atomic absorption spectroscopy.

Mercury was determined by aqua regia digestion - flameless atomic absorption spectrometry. A 0.5-gram sample was reacted with 20 millilitres of concentrated nitric acid and 1 millilitre concentrated hydrochloric acid in a test tube for 10 minutes at room temperature and then for 2 hours in a 90°C water bath. After digestion, the sample was cooled and diluted to 100 millilitres with metal-free water. The mercury present was reduced to the elemental state by the addition of 10 millilitres of 10% weight per volume stannous sulphate in sulphuric acid. The mercury vapor was flushed by a stream of air into an absorption cell mounted in the light path of an atomic absorption spectrometer. Measurements were made at 253.7 nanometres. This method is described in detail by Jonasson *et al*. (1973).

Tin was determined on a 200-milligram sample heated with amonium iodide. The sublimed tin iodide was dissolved in acid and the tin determined by atomic absorption spectrometry.

Tungsten was determined using a 0.2-gram sample fused with 1-gram potassium bisulphate in a rimless test tube at 575°C for 15 minutes in a furnace. The cooled melt is leached with 10 millilitres concentrated hydrochloric acid in a water bath heated to 85°C. After the soluble material has completely dissolved, the insoluble material is allowed to settle and an aliquot of 5 millilitres was transferred to another test tube. Five millilitres of 20% stannous chloride solution is added to the sample aliquot, mixed and heated for 10 minutes at 85°C in a hot water bath. A 1-millilitre aliquot of dithiol solution (1% dithiol in iso-amyl acetate) is added to the test solution and the solution is heated for 4-6 hours at 80-85°C in a hot water bath. The solution is then removed from the hot water bath, cooled and 2.5 millilitres of kerosene is added to dissolve the globule. The colour intensity of the kerosene solution is measured at 630 nanometres using a spectrophotometer. This method is described by Quin and Brooks (1972).

Uranium was determined using a neutron activation method with delayed neutron counting. A detailed description of the method is provided by Boulanger *et al*. (1975). A 1-gram sample was weighed into a 7-dram polyethylene vial, capped and sealed. The irradiation was provided by the Atomic Energy of Canada's Slowpoke II reactor. Calibration was carried out once a day as a minimum, using natural materials of known uranium concentration.

Loss on ignition was determined using a 0.5-gram sample. The sample was weighed into a 30 millilitre beaker, placed in a cold muffle-furnace and heated to 500°C over a period of 2 to 3 hours. The sample was allowed to cool at room temperature for 4 hours before weighing.

Instrumental Neutron Activation Analysis (INAA)

Weighed and encapsulated samples were packaged for irradiation along with internal standards and international reference materials. Samples and standards are irradiated together with neutron flux monitors in a two-megawatt pool type reactor. After a seven day decay period, samples are measured on a high resolution germanium detector. Computer control is achieved with a Microvax II computer. Typical counting times are 500 seconds. Elements determined by thermal and/or epi-thermal INAA include: antimony, arsenic, barium, bromine, cadmium, cerium, cesium, chromium, cobalt, europium, gold, hafnium, iridium, iron, lanthanum, lutetium, molybdenum, nickel, rubidium, samarium, scandium, selenium, silver, sodium, tantalum, tellurium, terbium, thorium, tin, tungsten, uranium, ytterbium, zinc and zirconium. The sample weights are also reported. Data for some elements are not published because of inadequate detection limits and/or precision.

Inductively Coupled Plasma Mass Spectroscopy (ICPMS)

Sediment samples are analyzed for 37 elements (aluminum, antimony, arsenic, barium, bismuth, cadmium, calcium, chromium, cobalt, copper, gallium, gold, iron, lanthanum, lead, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, scandium, selenium, silver, sodium, strontium, sulphur, tellurium, thallium, thorium, titanium, tungsten, uranium, vanadium and zinc) by ICP-MS. The digestion involved leaching a 1 gram sample with 6 millilitres of hydrochloric acid, nitric acid and distilled, deionized water (2:2:2 v/v) at 95°C for one hour. The solution is diluted to 20 millilitres and analysed by inductively coupled plasma emission spectroscopy on a Jarell Ash instrument and inductively coupled plasma mass spectroscopy on a Perkin Elmer Elan 6000 instrument. Data for some elements are not published because of inadequate detection limits and/or precision.

RGS STREAM WATER ANALYSIS

pH of waters was measured by a combination glass-reference electrode and a Fisher Accumet pH meter using an aliquot of sample in a clean dry beaker.

Sulphate in waters was determined by a turbidimetric method. A 20-millilitre aliquot of the sample was mixed with barium chloride and an isopropyl alcohol - hydrochloric acid - sodium chloride reagent. The turbidity of the resulting barium sulphate suspension was measured with a spectrophotometer at 420 nanometres.

The determination of **fluoride** in waters involved mixing an aliquot of the sample with an equal volume of total ionic strength adjustment buffer (TISAB II solution). The fluoride was measured using a Corning 101 meter with an Orion fluoride electrode.

Uranium in waters was determined by laser-induced fluorescence analysis. A 5-millilitre sample was spiked with 0.5-millilitres of fluran solution for 24 hours and irradiated by a laser to induce fluorescence. Uranium was determined with a Scintrex UA-3 uranium analyzer.

Trace and Major Elements in filtered, acidified streasm waters from three map sheets (NTS 93D-103A, 93K and 104J) have also been analysed by inductively coupled plasma emission spectroscopy and inductively coupled plasma mass spectroscopy.

RGS ACCESS DATABASE STRUCTURE

The RGS database comprises a number of Microsoft^{TM} Access tables linked by sample ID (Figure 1). Tables of selected parameters can be created using custom queries.

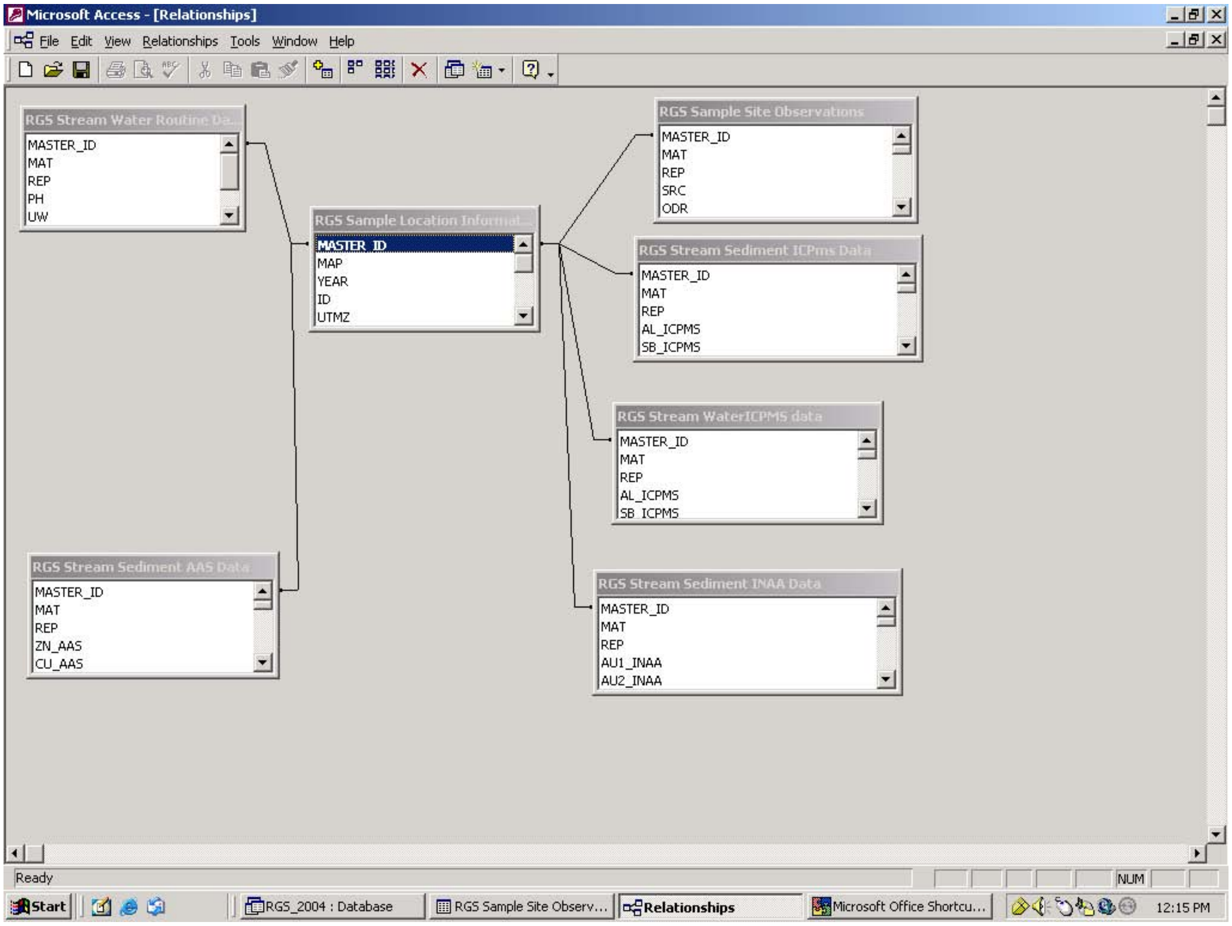

Figure 2. RGS Database Structure

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