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Stream Sediment and Water Geochemistry of the Khutze River Area

NTS 103H/1, 2, 7

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STREAM SEDIMENT AND WATER GEOCHEMISTRY

OF THE

KHUTZE RIVER AREA

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INTRODUCTION

This report presents new analytical data for 43 different elements from a regional drainage sediment and water geochemistry survey (Figure 1) conducted by the British Columbia Geological Survey Branch in the Khutze River area during 1999. The survey covers parts of three 1:50,000 NTS map sheets in the Douglas Channel (NTS 103H) area of B.C.'s central coast: 103H/01 (Khutze River), 103H/02 (Butedale) and 103H/07 (Ursula Channel). Details on the geology and mineral potential of this segment of the Coast Mountains is described by Pinsent (2000).

Sample collection, preparation and analytical procedures conform to established standards of the National Geochemical Reconnaissance (NGR) and Regional Geochemical Survey (RGS) programs. Analytical results and field observations compiled by the RGS program in British Columbia are used in the development of a high-quality geochemical database suitable for mineral exploration, resource assessment, geological mapping and environmental studies. Funded under the government's Corporate Resource Inventory Initiative (CRII), this survey is part of the Ministry of Energy and Mines' contribution to the Central Coast Land Resource Planning process.

REPORT FORMAT

This report is divided into the following sections:

- Introduction and survey methodology.
- Listings of field observations and analytical data (Appendix A).
- Summary statistics (Appendix B).
- Element and sample location maps (Appendix C).
- Analytical and field data are included on diskette in comma-delimited format.

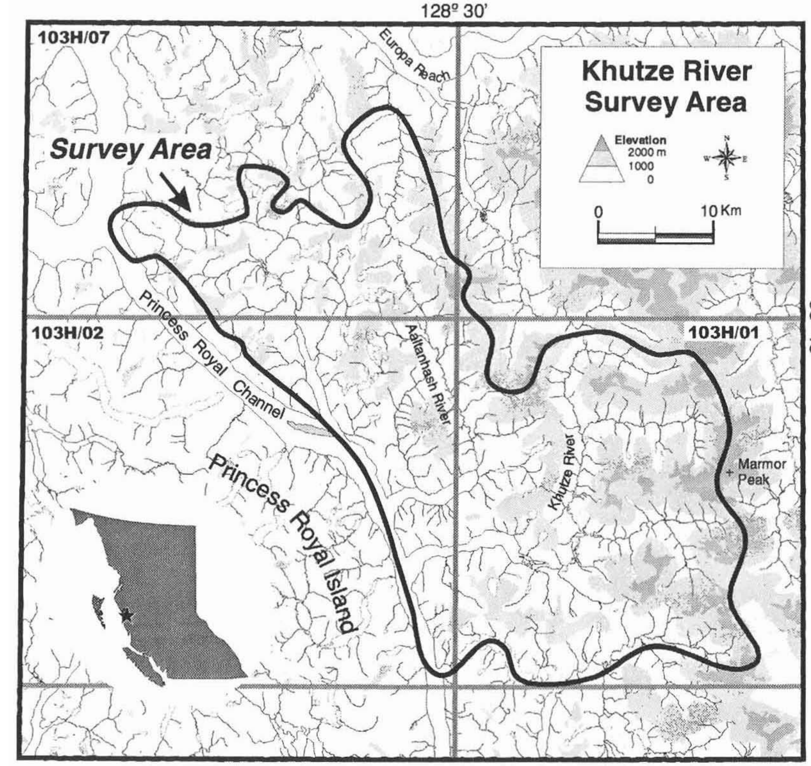

Figure 1. Location map of Khutze River survey area.

SURVEY METHODOLOGY

Sample Collection

Helicopter-supported sample collection was carried out during the summer of 1999. A total of 117 drainage sediment and 116 stream water samples were systematically collected from 111 sites. Average sample site density was 1 site per 8.6 square kilometres over the 950 square kilometre survey area. Field duplicate samples (6 total pairs) were routinely collected in each analytical block of twenty samples.

Conventional stream sediment or moss mat sediment samples weighing 1 to 2 kilograms were obtained from the active (subject to annual flooding) stream channel and placed in kraft paper bags. Samples were primarily composed of fine-grained material mixed with varying amounts of coarse sand, gravel and organic material. Contaminated or poor-quality sample sites were avoided by choosing an alternate stream or by sampling a minimum of 60 metres upstream from the source of contamination. Surface water samples were collected in 250 millilitre bottles; precautions were taken to exclude suspended solids when possible. Standard field observations regarding sample media, sample site and local terrain were also recorded. To assist follow-up, aluminum tags inscribed with the sample site identification number were fixed to permanent objects at each sample site.

Sample Preparation

Sediment samples were air dried at a temperature range of 30°C to less than 50°C. Material finer than 1 millimetre was recovered by sieving each sample through a -18 mesh (<177 µm) ASTM screen. The -80 mesh fraction was obtained by dry sieving. Control reference material and analytical duplicate samples were inserted into each analytical block of twenty sediment samples. Any remaining -80 mesh sediment and a representative sample of +80 to -18 mesh fraction was archived for future analyses. Quality control reference standards and analytical blanks were inserted into each analytical block of twenty water samples.

Sample Analysis

Analysis of stream sediment and water samples was conducted by contract laboratories in accordance with established National Geochemical Reconnaissance (NGR) analytical methods. Analytical methods are strictly specified and carefully monitored to ensure consistent and reliable results regardless of the region, year or analytical laboratory.

TABLE 1. ANALYTICAL SUITE OF ELEMENTS

Element		Analytical Method	Reported Detection Limit	Unit
Antimony	Sb	INAA	0.1	ppm
Arsenic	As	INAA	0.5	ppm
Barium	Ba	INAA	50	ppm
Bromine	Br	INAA	0.5	ppm
Calcium	Ca	INAA	1	%
Cerium	Ce	INAA	3	ppm
Cesium	Cs	INAA	1	ppm
Chromium	Cr	INAA	5	ppm
Cobalt	Co	INAA	1	ppm
Europium	Eu	INAA	0.2	ppm
Gold	Au	INAA	2	ppb
Hafnium	Hf	INAA	1	ppm
Iron	Fe	INAA	0.01	%
Lanthanum	La	INAA	0.5	ppm
Lutetium	Lu	INAA	0.05	ppm
Molybdenum	Mo	INAA	1	ppm
Neodymium	Nd	INAA	5	ppm
Rubidium	Rb	INAA	15	ppm
Samarium	Sm	INAA	0.1	ppm
Scandium	Sc	INAA	0.1	ppm
Sodium	Na	INAA	0.01	%
Tantalum	Ta	INAA	0.5	ppm
Terbium	Tb	INAA	0.5	ppm
Thorium	Th	INAA	0.2	ppm
Tungsten	W	INAA	1	ppm
Uranium	U	INAA	0.5	ppm
Ytterbium	Yb	INAA	0.2	ppm
Zinc	Zn	INAA	50	ppm
Antimony	Sb	AAS	0.2	ppm
Arsenic	As	AAS-H	0.2	ppm
Bismuth	Bi	AAS-H	0.2	ppm
Cadmium	Cd	AAS	0.2	ppm
Cobalt	Co	AAS	2	ppm
Copper	Cu	AAS	2	ppm
Iron	Fe	AAS	0.02	%
Fluorine	F	ION	40	ppm
Lead	Pb	AAS	2	ppm
Manganese	Mn	AAS	5	ppm
Mercury	Hg	AAS-F	10	ppb
Molybdenum	Mo	AAS	1	ppm
Nickel	Ni	AAS	2	ppm
Silver	Ag	AAS	0.2	ppm
Vanadium	V	AAS	5	ppm
Zinc	Zn	AAS	2	ppm
Loss on Ignition	LOI	GRAV	0.1	%
pH	pH	GCE	0.1	
Fluoride	FW	ION	20	ppb
Uranium	UW	LIF	0.05	ppb
Sulphate	SO4	TURB	1	ppm

AAS atomic absorption spectroscopy
AAS-H hydride generation AAS
AAS-F flameless AAS
GCE glass combination electrode
INAA instrumental neutron activation analysis
LIF laser-induced fluorescence
ION specific ion electrode
TURB turbidimetric

SEDIMENTS - AAS

A split of each prepared sediment sample was analyzed by CanTech Laboratories Inc., Calgary, Alberta for 16 elements: zinc, copper, lead, silver, molybdenum, cobalt, mercury, iron, manganese, nickel, fluorine, cadmium, vanadium, bismuth, antimony and arsenic. Loss on ignition (LOI) was also determined. Stated analytical detection limits for each element are listed in Table 1. Those concentrations below the stated detection limits are presented in data listings as a value equivalent to the detection limit.

For the determination of cadmium, cobalt, copper, iron, lead, manganese, nickel, silver and zinc, a 1 gram sample was reacted with 3 millilitres of concentrated HNO_3 for 30 minutes at 90°C. Concentrated HCl (1 millilitre) 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. Element concentrations were determined by atomic absorption spectroscopy (AAS) using an air-acetylene flame. Background corrections were made for lead, nickel, cobalt and silver.

Mercury was determined by the Hatch and Ott procedure with some modifications. A 0.5 gram sample was reacted with 20 millilitres concentrated HNO_3 and 1 millilitre concentrated HCl in a test tube for 10 minutes at room temperature and then for 2 hours in a 90°C hot 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-to-volume $SnSO_4$ in H_2SO_4 The mercury vapour was then flushed by a stream of air into an absorption cell mounted in the light path of an atomic absorption spectrometer (AAS-F). Measurements were made at 253.7 nanometres. This method is described by Jonasson *et al.* (1973).

Molybdenum and vanadium were determined by aqua regia digestion - atomic absorption spectroscopy (AAS) using a nitrous oxide acetylene flame. A 0.5 gram sample was reacted with 1.5 millilitres concentrated HNO_3 at 90°C for 30 minutes. At this point 0.5 millilitres of concentrated HCl was added and the digestion continued for an additional 90 minutes. After cooling, 8 millilitres of 1250 ppm Al solution was added and the sample solution diluted to 10 millilitres before determination by AAS.

Arsenic and bismuth were determined by aqua regia digestion - hydride generation atomic absorption spectroscopy. A 1 gram sample was reacted with 3 ml of concentrated HNO_3 for 30 minutes at 90°C. Concentrated HCl (1 ml) was added and the digestion was continued at 90°C for an additional 90 minutes. A 1 ml aliquot was diluted to 10 ml with 1.5M HCl in a clean test tube. The diluted sample solution was added to a sodium borohydride solution and the hydride vapour aspirated through a heated quartz tube in the light path of an atomic absorption spectrometer (AAS-H).

Antimony was determined as described by Aslin (1976). A 0.5 gram sample was placed in a test tube with 3 ml concentrated HNO_3 and 9 ml HCl. The mixture was allowed to stand overnight at room temperature prior to being heated to 90°C and maintained at this temperature for 90 minutes. The mixture was cooled and a 1 ml aliquot was diluted to 10 ml with 1.8M HCl. This dilute solution was determined by hydride evolution-atomic absorption spectroscopy (AAS).

Fluorine was determined by specific ion electrode as described by Ficklin (1970). A 250 milligram sample was sintered with a 1-gram flux consisting of two parts by weight sodium carbonate and 1 part by weight potassium nitrate. The residue was leached with water. The sodium carbonate was neutralized with 10 millilitres 10% weight-by-volume citric acid, and the resulting solution diluted with water to 100 millilitres. Fluoride was then measured with a fluoride ion electrode (ION) and a reference electrode.

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 maintained at this temperature for 4 hours, then allowed to cool to room temperature before weighing (GRAV).

SEDIMENTS - INAA

A split of each sample, which range from 7 to 31 grams (average 29 g), was analyzed for 29 elements (gold, antimony, arsenic, barium, bromine, calcium, cerium, cesium, chromium, cobalt, europium, hafnium, iron, lanthanum, lutetium, molybdenum, neodymium, nickel, rubidium, samarium, scandium, sodium, tantalum, terbium, thorium, tungsten, uranium, ytterbium and zinc) by Activation Laboratories, Ancaster, Ontario, using thermal instrumental neutron activation analysis (INAA). This technique involves irradiating the sample for 30 minutes in a neutron flux of $7x10^{11}$ neutrons/cm^2/ second. After a decay period of approximately 1 week, gamma-ray emissions for the elements were measured using a gamma-ray spectrometer with a high-resolution, coaxial germanium detector. Counting time was approximately 15 minutes per sample and the results were compiled on a computer and converted to concentrations. A complete list of elements and their stated instrumental detection limits are given in Table 1. Additional data for the six elements selenium, silver, mercury, nickel, iridium, tin and strontium were not published because of inadequate detection limits and/or poor precision.

WATERS

Routine unfiltered lake waters were analyzed for the standard RGS water analytical suite of pH, uranium, fluoride and sulphate at CanTech Laboratories, Inc., Calgary. Stated detection limits are given in Table 2.

Hydrogen ion activity (pH) was measured, on a separate sample aliquot, with a Fisher Accumet pH meter with glass-calomel combination electrode (GCE).

Uranium was determined by laser-induced fluorescence (LIF) using a Scintrex UA-3 uranium analyzer. A complexing agent, known commercially as Fluran and composed of sodium pyrophosphate and sodium monophosphate (Hall, 1979), is added to produce a uranyl pyrophosphate species which fluoresces when exposed to the laser. As organic matter in the sample can cause unpredictable behaviour, a standard addition method is used. A total of 500 microlitres of Fluran solution was added to a 5 millilitre sample and allowed to stand for 24 hours, as the reaction of uranium with the complexing agent may be delayed or sluggish. At the end of this period fluorescence readings were made with the addition of 0.0, 0.2 and 0.4 ppb uranium. For high-concentration samples, the additions were 0.0, 2.0 and 4.0 ppb uranium. All readings are taken against a sample blank.

Fluoride was determined by ion selective electrode (ION). A 20 millilitre aliquot of the sample was mixed with 20 millilitres of TISAB II (total ionic strength adjustment buffer) buffer solution. Fluoride was determined with an Orion fluoride electrode in conjunction with a Corning ion meter.

Sulphate was determined by a turbidimetric method (TURB). A 50 millilitre aliquot was mixed with barium chloride and an isopropyl alcohol-HCl-NaCl reagent, and turbidity of the resulting barium sulphate solution measured with a spectrophotometer at 420 nanometres.

DRAINAGE BASINS

Drainage basins are defined by the topographic height of land that separates a stream from surrounding streams and includes the total area in which water drains into a stream system outlet. Drainage basins were delineated from NTS 1:50 000 maps by hand tracing the drainage basin boundaries. This line-work was digitized and each resulting drainage basin polygon was labeled with its unique sample number. On occasion, nested polygons were produced where two samples were taken from successive sites on the same stream; in these cases the downstream polygon was defined to end at the upstream sample site. Corresponding field and analytical data were joined to each digital polygon and the area and perimeter were calculated using simple GIS subroutines. When presented on a map, these polygons are assumed to depict the metal determination of a single stream sediment or water sample collected at a site near the drainage basin outlet.

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Preparation:

Rossbacher Laboratories Ltd., Burnaby, B.C.

Sediment Analysis:

CanTech Laboratories Inc., Calgary, Alberta (AAS)
Activation Laboratories Ltd., Ancaster, Ontario (INAA)

Water Analysis:

CanTech Laboratories Inc., Calgary, Alberta

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