

REGIONAL STREAM SEDIMENT AND WATER DATA, NORTHEASTERN YUKON TERRITORY

PARTS OF NTS 106E, 116G, 116H, 116I, 116J, 116O, and 116P

INTRODUCTION

This open file presents analytical and statistical data for 50 elements in stream sediments from 754 sites collected in 2000 from northeastern Yukon Territory. Loss-on-ignition in sediments, and fluoride, sulphate, uranium, conductivity, and pH values in waters from these sites are included in this report. The Yukon Territorial Government, under the Yukon Geology Program, provided financial support. The Geological Survey of Canada, Mineral Resources Division, provided financial and logistical support.

Analytical results and field observations contribute to building a national geochemical database for resource assessment, mineral exploration, geological mapping, and environmental studies. Sample collection, preparation procedures and analytical methods are strictly specified and carefully monitored to ensure consistent and reliable results regardless of the area, the year of collection or the analytical laboratory undertaking the analyses.

Regional geochemical surveys have been carried out since 1976 in Yukon Territory under the National Geochemical Reconnaissance (NGR) program. A total of 30 open files (Fig. 1) have been published or are in publication, covering approximately 368 130 km². Data for all open files are available on 3.5-inch diskettes, CD-ROM, or in the original published form, from:

Geological Survey of Canada Bookstore
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DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT

Stream sediments and waters were collected during the summer of 2000. Sample sites were distributed over an 18 000 km² survey area at an average of one sample per 24 km².

Sample site duplicate samples were routinely collected in each analytical block of twenty samples. Field observations were recorded on standard forms used by the Geological Survey of Canada (Garrett, 1974).

Site positions were marked on 1:250000 scale maps in the field and later digitized at the Geological Survey of Canada in Ottawa. Initial sample point coordinates were obtained from a Universal Transverse Mercator map projection using the NAD27 datum. Distance units are in metres.

Field-dried samples were air-dried and sieved through a minus 80-mesh (177 µm) screen. At that time, control reference and blind duplicate samples were inserted into each block of 20 sediment samples. For the water samples, only control reference samples were inserted into the block. There were no blind duplicate water samples.

Analytical data from analytical laboratories were monitored for reliability with standard methods used by the Applied Geochemistry and Mineralogy Subdivision at the Geological Survey of Canada.

ANALYTICAL PROCEDURES

Instrumental Neutron Activation Analysis (INAA)

Weighed and encapsulated samples are 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 with a high-resolution germanium detector. Typical counting times are 500 seconds. Elements determined by INAA include: Ag, As, Au, Ba, Br, Cd, Ce, Co, Cr, Cs, Eu, Fe, Hf, Ir, La, Lu, Mo, Na, Ni, Rb, Sb, Sc, Se, Sm, Sn, Ta, Tb, Te, Th, U, W, Yb, Zn and Zr. The sample weights are also reported. Elements and detection limits are shown in Table 1.

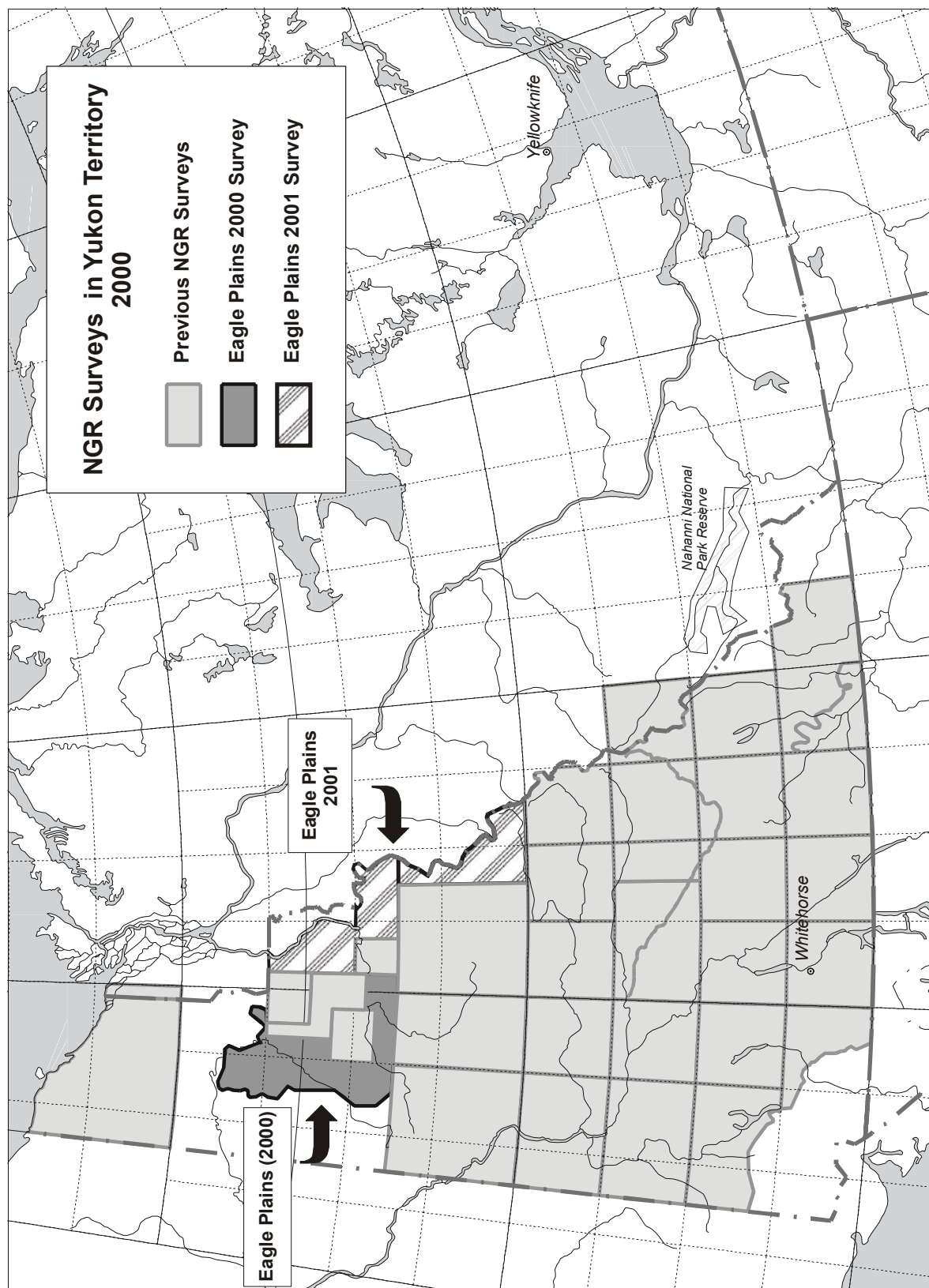


Figure 1: National Geochemical Reconnaissance survey coverage of Yukon Territory.

Data for Ag, Cd, Ir, Se, Sn, Te, Zn, and Zr are not published because of inadequate detection limits and/or precision.

Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Other Analyses

For the determination of 38 elements listed in Table 2, a one gram sample is leached with 6 ml of a mixture of HCl, HNO₃, and distilled, deionized water (2:2:2 v/v) at 95° C for one hour. The sample solution is diluted to 20 ml and analysed by inductively coupled plasma emission spectroscopy on a Jarell Ash instrument and inductively coupled plasma mass spectroscopy on a Perkin Elmer Elan instrument.

ELEMENT		DETECTION LEVEL	
As	Arsenic	0.5	ppm
Au	Gold	2	ppb
AuWt	Sample Weight	0.01	g
Ba	Barium	50	ppm
Br	Bromine	0.5	ppm
Ce	Cerium	5	ppm
Co	Cobalt	5	ppm
Cr	Chromium	20	ppm
Cs	Cesium	0.5	ppm
Eu	Europium	1	ppm
Fe	Iron	0.2	pct
Hf	Hafnium	1	ppm
La	Lanthanum	2	ppm
Lu	Lutetium	0.2	ppm
Na	Sodium	0.02	pct
Rb	Rubidium	5	ppm
Sb	Antimony	0.1	ppm
Sc	Scandium	0.2	ppm
Sm	Samarium	0.1	ppm
Ta	Tantalum	0.5	ppm
Tb	Terbium	0.5	ppm
Th	Thorium	0.2	ppm
U	Uranium	0.2	ppm
W	Tungsten	1	ppm
Yb	Ytterbium	1	ppm

Table 1. Elements in stream sediments determined by Instrumental Neutron Activation analysis. Lower detection limits are also shown.

Loss-on-ignition is determined using a 500 mg sample. The sample, weighed into a 30 ml beaker, is placed in a cold muffle furnace and brought up to 500° C over a period of two to three hours. The sample is held at this temperature for four hours, then allowed to cool to room temperature for weighing. The lower detection limit is 1.0 per cent.

Tin in stream sediments is determined by heating a 200 mg sample with NH₄I: the sublimed SnI₄ is dissolved in acid and the tin determined by atomic absorption spectrometry after solvent extraction of the tin into methyl isobutyl ketone containing trioctylphosphine oxide (TOPO). E.P. Welsch and T.T. Chao (1976) describe the method. The lower detection limit is 1 ppm.

ELEMENT		DETECTION LEVEL	
Ag	Silver	2	ppb
Al	Aluminum	0.01	pct
As	Arsenic	0.1	ppm
B	Boron	1.0	ppm
Ba	Barium	0.5	ppm
Bi	Bismuth	0.02	ppm
Cd	Cadmium	0.01	ppm
Ca	Calcium	0.01	pct
Co	Cobalt	0.1	ppm
Cr	Chromium	0.5	ppm
Cu	Copper	0.01	ppm
Fe	Iron	0.01	pct
Ga	Gallium	0.2	ppm
Hg	Mercury	5	ppb
K	Potassium	0.01	pct
La	Lanthanum	0.5	ppm
Mg	Magnesium	0.01	pct
Mn	Manganese	1	ppm
Mo	Molybdenum	0.01	ppm
Na	Sodium	0.001	pct
Ni	Nickel	0.1	ppm
P	Phosphorus	0.001	pct
Pb	Lead	0.01	ppm
S	Sulphur	0.02	pct
Sb	Antimony	0.02	ppm
Sc	Scandium	0.1	ppm
Se	Selenium	0.1	ppm
Sr	Strontium	0.5	ppm
Te	Tellurium	0.02	ppm
Th	Thorium	0.1	ppm
Ti	Titanium	0.001	pct
Tl	Thallium	0.02	ppm
U	Uranium	0.1	ppm
V	Vanadium	2	ppm
W	Tungsten	0.2	ppm
Zn	Zinc	0.1	ppm

Table 2. Elements in stream sediments determined by Inductively coupled plasma mass spectrometry. Lower detection limits are also shown.

Water Analyses

The pH of stream waters was determined using an Orion QuiKcheK® Pocket Meter with automatic temperature compensation, a range of 0.0 to 14.0 pH, resolution of 0.1 pH and an accuracy of 0.1 pH. Meters were calibrated using commercial buffer solutions with pH values of 4.0, 7.0 and 10.0.

Conductivity of stream waters was determined using an Orion QuiKcheK® Pocket Meter with automatic temperature compensation and a range of 1990 $\mu\text{S}/\text{cm}$, a resolution of 10 $\mu\text{S}/\text{cm}$ and a full-scale accuracy of $\pm 2\%$. Meters were calibrated using commercial conductivity standards.

Uranium in untreated waters was determined directly by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The lower detection limit is 0.05 ppb.

Sulphate (SO_4^{2-}) and fluoride (F^-) in untreated waters were determined directly by ion chromatography. The lower detection limit for both sulphate and fluoride is 50 ppb.

COMPARISON OF DATA PRODUCED BY TWO METHODS

Analytical results obtained by two methods are listed for several elements. Before attempting such a comparison some caution should be exercised.

Results for As, Ba, Co, Cr, Fe, La, Na, Sb, Sc, Th, U and W in sediments were obtained by ICP-MS using a partial extraction method with an HNO_3 – HCl digestion. Data for these elements obtained by INAA are 'total' data. Hence, ICP-MS data will likely be somewhat lower than the INAA data.

PRESENTATION AND INTERPRETATION OF GOLD DATA

The following discussion reviews the format used to present the gold geochemical data and outlines some important points to consider when interpreting these data. This discussion is included in recognition of the special geochemical behaviour and mode of occurrence of gold in nature and the resultant difficulties in obtaining and analysing samples reflecting the true concentration level at a given site.

An appropriate interpretation of geochemical gold data from regional stream sediment or lake sediment surveys requires an appreciation of the unique chemical and physical characteristics of gold and its mobility in the surficial environment. Key properties of gold that distinguish its geochemical behaviour from most other elements (Harris, 1982) include:

1. Gold occurs most commonly in the native form, which is chemically and physically resistant. A significant proportion of the metal is dispersed in a micron-sized particulate form, and the high specific gravity of gold results in a heterogeneous distribution, especially in stream sediment and clastic-rich (low LOI) lake sediment environments. Gold distribution appears to be more homogeneous in organic-rich fluvial and lake sediments.
2. Gold typically occurs at low concentrations, in the parts per billion (ppb) range. Whereas gold concentrations of only a few parts per million (ppm) may represent economic deposits, background levels in stream and centre-lake sediments rarely exceed 10 ppb, and commonly are near the detection limit of 2 ppb.

These factors result in a particle sparsity effect wherein very low concentrations of gold are heterogeneously enriched or depleted in the surficial environment. Hence, a major problem facing the geochemist is to obtain a representative sample. In general, areas where concentrations of gold in sediments are low, and/or grain sizes of the gold present are relatively high, require proportionally larger samples to reduce the variability between subsample analytical values. Conversely, as actual gold concentrations increase, or grain size decreases, the number of gold particles to be split between random subsamples increases and the variability of results decreases (Clifton et al., 1969; Harris, 1982). The limited amount of material collected during the rapid, reconnaissance-style regional surveys and the need to analyse for a broad spectrum of elements, precludes the use of a significantly large sample weight for the gold analyses. Therefore, to obtain representative samples, sieving of the dried sediments is employed to reduce grain size.

The following control methods are currently applied to evaluate and monitor the sampling and analytical variability, which are inherent in the analysis of gold in geochemical media.

For each block of 20 samples:

- a) Random insertion of a standard reference sample to control analytical accuracy and long-term precision;
- (b) Collection of a field duplicate (two samples from one site) to measure sampling and analytical variance;
- (c) Analysis of a second subsample (blind duplicate) from one sample to measure and control short-term precision or analytical variance.

In summary, geochemical follow-up investigations for gold should be based on a careful consideration of all geological and geochemical information, and especially a careful appraisal of gold geochemical data and its variability. In some instances, pathfinder element associations in favourable geology may indirectly identify prospective follow-up areas, although an anomalous gold response due to natural variability may be lacking.

Once an anomalous area has been identified, field investigations should be designed to include detailed geochemical follow-up surveys and collection of large representative samples. Subsequent repeat subsample analyses will increase the reliability of results and permit a better understanding of natural variability which can then be used to improve sampling methods and interpretation.

ACKNOWLEDGEMENTS

Under the direction of P.W. Friske, staff from the Geological Survey of Canada carried out the collection of sediments and waters.

Contracts were let to the following companies for sample preparation and analysis:

Preparation: Bondar-Clegg
North Vancouver, British Columbia

Analysis: Acme Analytical Laboratories Inc.
Vancouver, British Columbia

Becquerel Laboratories Ltd.
Streetsville, Ontario

CanTech Laboratories Inc.
Calgary, Alberta

Staff of the Geological Survey of Canada,
Analytical Chemistry and Services Section,

determined concentrations of fluoride and sulphate in stream waters.

Staff of the Geological Survey of Canada, Regional Geochemical Studies Section, determined the conductivity and pH of stream waters.

The assistance of John Buckle and Danny Wright with sample collection, often under difficult conditions, is gratefully acknowledged.

FIELD DATA LEGEND

Table 3 describes the field and map information appearing on the following pages preceding the analytical data for each sample site.

REFERENCES

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1972: Dimensions and Areas of Maps of the National Topographic System of Canada, Department of Energy, Mines and Resources Technical Report No. 72-1, 28 p.

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1976: Determination of trace amounts of tin in geological materials by atomic absorption spectrometry; Anal. Chim. Acta., Vol. 82, p. 337-342.

Table 3. Field Observations Legend

FIELD RECORD	DEFINITION	TEXT CODE
NTS_Sht	National Topographic System (NTS); lettered quadrangle (1:250 000 or 1:50 000 scale)	106B, 106C, 106E, 106F, 106K, 106L
Year	Year of collection	2000
Samp_Num	Remainder of sample number: Field crew..... Sample sequence number	1 001-999
Rep_Stat	Replicate status; relationship of the sample to others within the survey: Routine sample site	0
	First of a site duplicate pair	1
	Second of a site duplicate pair	2
LongNad83	Geographic co-ordinate system (Datum = NAD83) digitized sample location longitude	
LatNad83	Geographic co-ordinate system (Datum = NAD83) digitized sample location latitude	
SampleTypes	Sample material collected: Stream bed sediment only	SedOnly
	Spring or sediment seep	SpgSedOnly
	Heavy mineral concentrate	HvMnCn
	Stream water only	Strm
	Natural groundwater, spring seep.....	GrWat
	Simultaneous stream sediment and water.....	Sed/Water
	Simultaneous spring or seep water and sediment.....	SpgSep/Sed
	Acidified water sample collected with routine sediment and water sample.....	Sed/Water/Acid
StmWidth(m)	Stream width in metres	
StmDepth(m)	Stream depth in metres	
Contamination	Contamination, human or natural: None.....	-
	Possible.....	Possible
	Probable.....	Probable
	Definite	Definite
	Mining activity.....	Mining
	Industrial sources	Industry
	Agricultural	Agricult
	Domestic or household	Domestic
	Forestry activities	Forestry
	Burned areas.....	Burn

BankType	Bank type; the general nature of the bank material adjacent to the sample site: Alluvial Colluvial (bare rock, residual or mountain soils) Glacial till Glacial outwash sediments Bare rock Talus scree Organic predominant (debris, peat, muskeg, swamp)	Alluv Colluv Till Outwash BareRock TalScr Organic
WaterColor	Water colour; the general colour and suspended load of the sampled water: Clear Brown transparent White cloudy Brown cloudy	Clear BnTrans WhCldy BnCldy
StreamFlow	Water flow rate: Stagnant Slow Moderate Fast Torrential	Stagnt Slow Modert Fast Torrnt
SampleColor	Predominant sediment colour: Red-brown White-buff Black Yellow Green Grey, blue grey Pink Buff to brown Brown Dark Brown	Rd-Bn Wh-Bf Black Yellow Green Gy-Blu Pink Bf-Bn Brown DkBrown
SedCompSFO	Sediment composition; description of the bulk mechanical composition of the collected sample on a scale of 1 to 3, the total of the column must add up to 3 or 4 or 5: Size fractions are divided as follows: Column 1 >0.125 mm (sand) Column 2 <0.125 mm (fines - organic silt, clay) Column 3 organic material Amount of size fraction: sum of amounts = 3 4 5 Absent 0 0 0 Minor <33% 25% 20% Medium 33-67% 50% 40%	0 1 2

	Major >67% 75% 60%	3
BottomPcpt	Precipitate or stain; the presence of any coatings on pebbles, boulders or stream bottoms: None Red-brown White or buff Black Yellow Green Grey Pink Buff to brown	None Rd-Bn Wh-Bf Black Yellow Green Grey Pink Bf-Bn
BankPcpt	Distinctive precipitate, stains or weathering on rocks in immediate area of catchment basin or stream bank: None Red, brown (eg., Fe) White, buff (eg., CO ₃ , Zn) Black (e.g., Fe, Mn, sulphides) Yellow (e.g., Pb, U, Fe, Mo, REE) Green (Cu, Ni, U, Mo, As, Fe) Bluish (Zn, P) Pink (Co, As)	None Rd-Bn Wh-Bf Black Yellow Green Blue Pink
StmPhysiog	General physiography of the drainage basin: Plain Muskeg, swampland Peneplain, plateau Hilly, undulating Mountainous, mature Mountainous, youthful (precipitous)	Plain Swamp Penpln Hilly Moun/M Moun/Y
DrainagePatrn	Drainage pattern: Poorly defined, haphazard Dendritic Herringbone Rectangular Trellis Discontinuous shield type (chains of lakes) Basinal Others	Poor Dendrc Herrbn Rectln Trellis Discnt Closed Other
StmType	Stream type: Undefined Permanent, continuous Intermittent, seasonal Re-emergent, discontinuous	Undfnd Permnt Interm Re-emerg
StmClass	Classification based on proximity to source: Undefined Primary Secondary Tertiary Quaternary	Undefined Primary Secondary Tertiary Quaternary

StmSource	Source of water: Unknown Groundwater Snow melt or spring run-off Recent precipitation Ice-cap or glacier meltwater	Unknown Ground Sp'gMelt RecRain Glacier
Miscellaneous	Missing data in any field no sample material for analysis parts per million parts per billion percent weight (of sample) gram	- ns ppm ppb pct Wt g