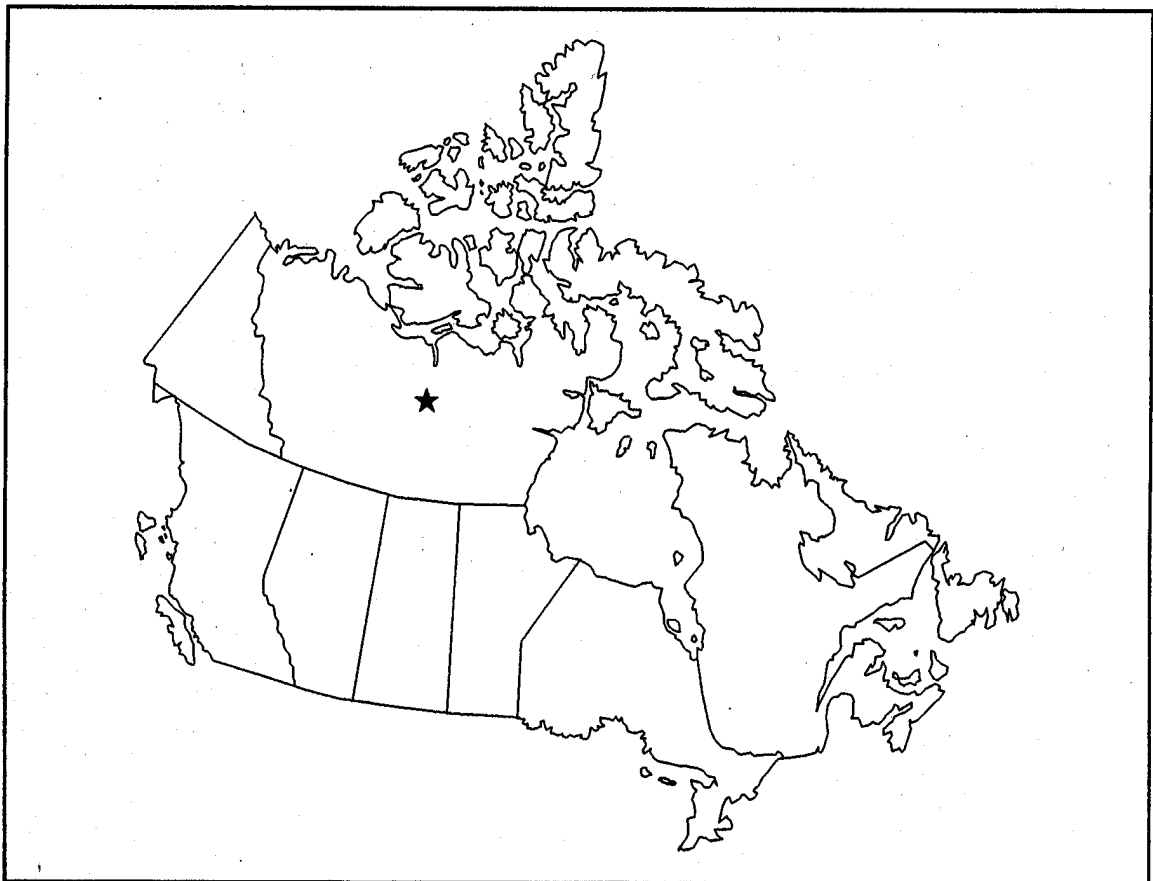


**REANALYSIS OF SELECTED LAKE SEDIMENT  
SAMPLES FROM THE BEAR-SLAVE OPERATION,  
NORTHWEST TERRITORIES  
NTS 76B (NORTHWEST) AND 76D (NORTHEAST)**

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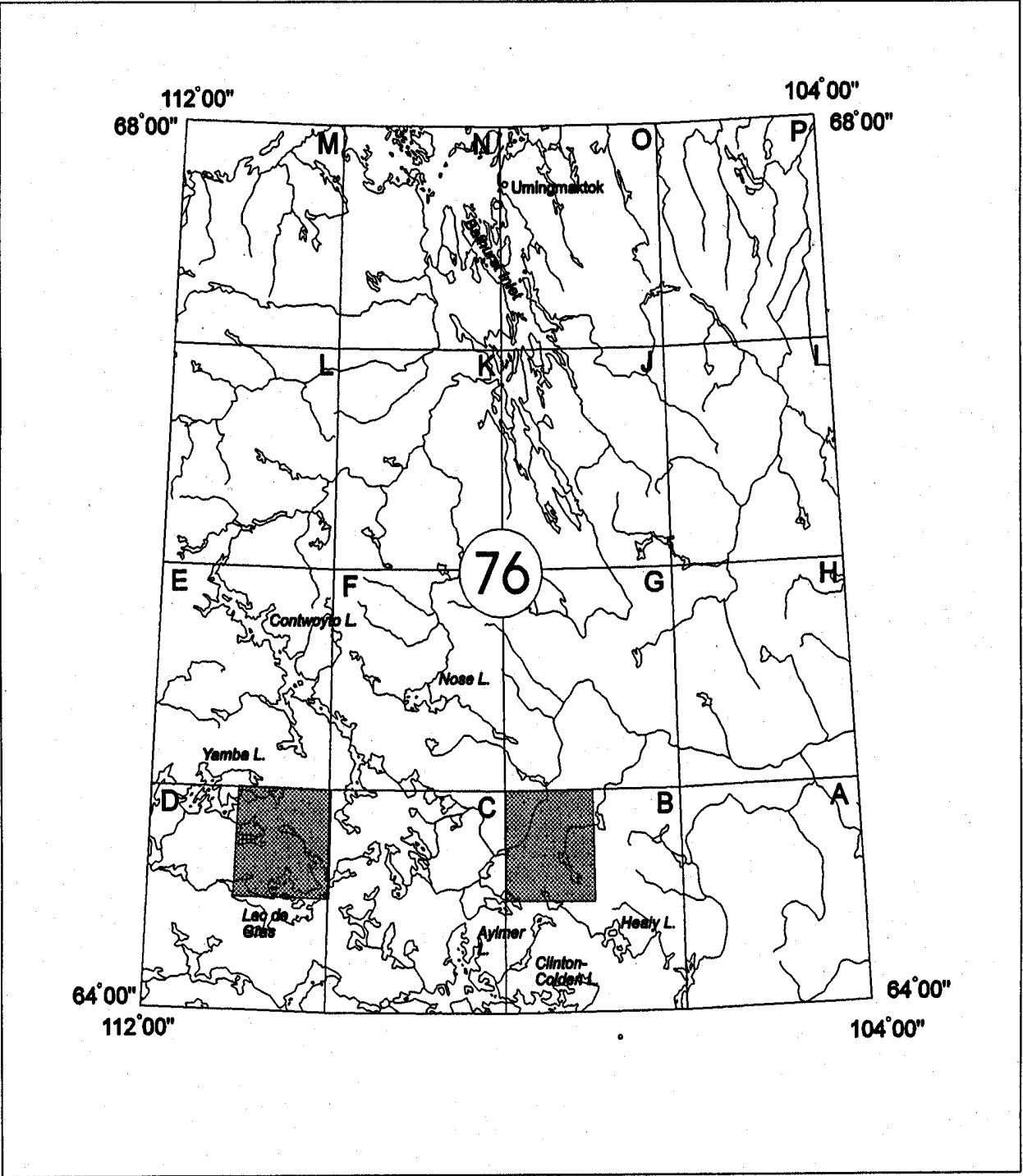
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Recommended citation:

Kjarsgaard, B., Friske, P.W.B., McCurdy, M.W., Lynch, J.J., Day, S.J., Durham, C.C. 1992: Reanalysis of selected lake sediment samples from the Bear-Slave Operation, Northwest Territories (NTS 76B NW and 76D NE), Geological Survey of Canada, Open File 2578.

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REANALYSIS OF SELECTED LAKE SEDIMENT  
SAMPLES FROM THE BEAR-SLAVE OPERATION,  
NORTHWEST TERRITORIES  
NTS 76B (NORTHWEST) AND 76D (NORTHEAST)



National topographic System reference and index map  
showing areas (grey shading) covered by this release.

Table of Contents

INTRODUCTION ..... I-1

CREDITS ..... I-1

DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT ..... I-1

ANALYTICAL PROCEDURES ..... I-3

INTERPRETATION OF GOLD DATA..... I-4

SUMMARY OF ANALYTICAL DATA AND METHODS..... I-5

REFERENCES ..... I-5

FIELD OBSERVATIONS LEGEND ..... I-6

DATA LISTINGS.....A-1 to A-24

SUMMARY STATISTICS.....B-1 to B-63

SAMPLE LOCATION MAP (1:250 000 SCALE) ..... in pocket

**GSC OPEN FILE 2578**  
**REGIONAL LAKE SEDIMENT GEOCHEMICAL DATA, NORTHWEST TERRITORIES**  
**NTS 76B (Northwest) and 76D (Northeast)**

## INTRODUCTION

Open File 2578 contains new data for 42 elements obtained by reanalyzing near-shore lake sediments collected in 1972 from 217 sites southeast of Great Bear Lake in the Northwest Territories. Original analytical data for 25 elements in sediments are included with this report.

The Bear-Slave operation was one of the first reconnaissance-style surveys carried out by the Geological Survey of Canada. A total of 4 102 samples were collected within an area of 94 000 km<sup>2</sup> (one sample per 26 km<sup>2</sup>) over the central parts of the Bear and Slave Provinces of the Canadian Shield. The main objectives of the program were to:

1. Assist mineral exploration by outlining areas of anomalous element concentrations.
2. Delineate regional geochemical variations in the bedrock geology by relative elemental concentrations to determine the economic potential of certain rock types.
3. To record natural concentrations of selected elements, some of which are potentially toxic, in areas little influenced by human activity.

In addition, the feasibility of low density lake sediment surveys as a method for evaluating mineral potential in the Canadian Shield was examined.

A number of regional geochemical surveys have been carried out by the GSC in the Northwest Territories using centre lake bottom sediments as analytical material. A total of 15 open files have been published. Areas surveyed, with associated open file numbers, are shown in Fig. 1. Fig. 2 shows cross-Canada coverage. Data from all open files are available on 3.5 or 5.25 inch diskettes and in the original published form.

## CREDITS

The original survey was carried out under the direction of R.J. Allan, E.M. Cameron, and C.C. Durham, with staff from the GSC. Samples were prepared and analyzed by GSC staff supervised by J.J. Lynch.

P.W.B. Friske coordinated the activities of the contract and GSC staff under the reanalysis program.

Contracts were let to the following companies for sample reanalysis and managed by J.J. Lynch.

### X-ray Fluorescence

X-Ray Assay Laboratories  
Don Mills, Ontario

### Instrumental Neutron Activation Analysis

Activation Laboratories  
Ancaster, Ontario

M. McCurdy edited open files and coordinated open file production.

S.W. Adcock, S.J. Day, and L.A. Grignon provided computer processing support.

C.C. Durham provided technical services.

## DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT

Nearshore, inorganic, silty lake sediment and lake waters were sampled. To collect sediments, a 1.83 m (6 foot) post hole soil auger constructed of magnesium-zirconium alloy was used to sample at depths ranging from .305 m (1 foot) to 2.45 m (8 feet). Three Bell G4A helicopters were used to move sampling crews from lake to lake.

Samples were shipped damp to Ottawa and dried before being sieved to minus 250 mesh through stainless steel sieves. For a full description of sampling procedures, see Allen, et al. (1973).

For reanalysis, selected archive samples were split and shipped to laboratories for instrumental Neutron Activation and X-ray fluorescence analysis.

## ANALYTICAL PROCEDURES

### **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

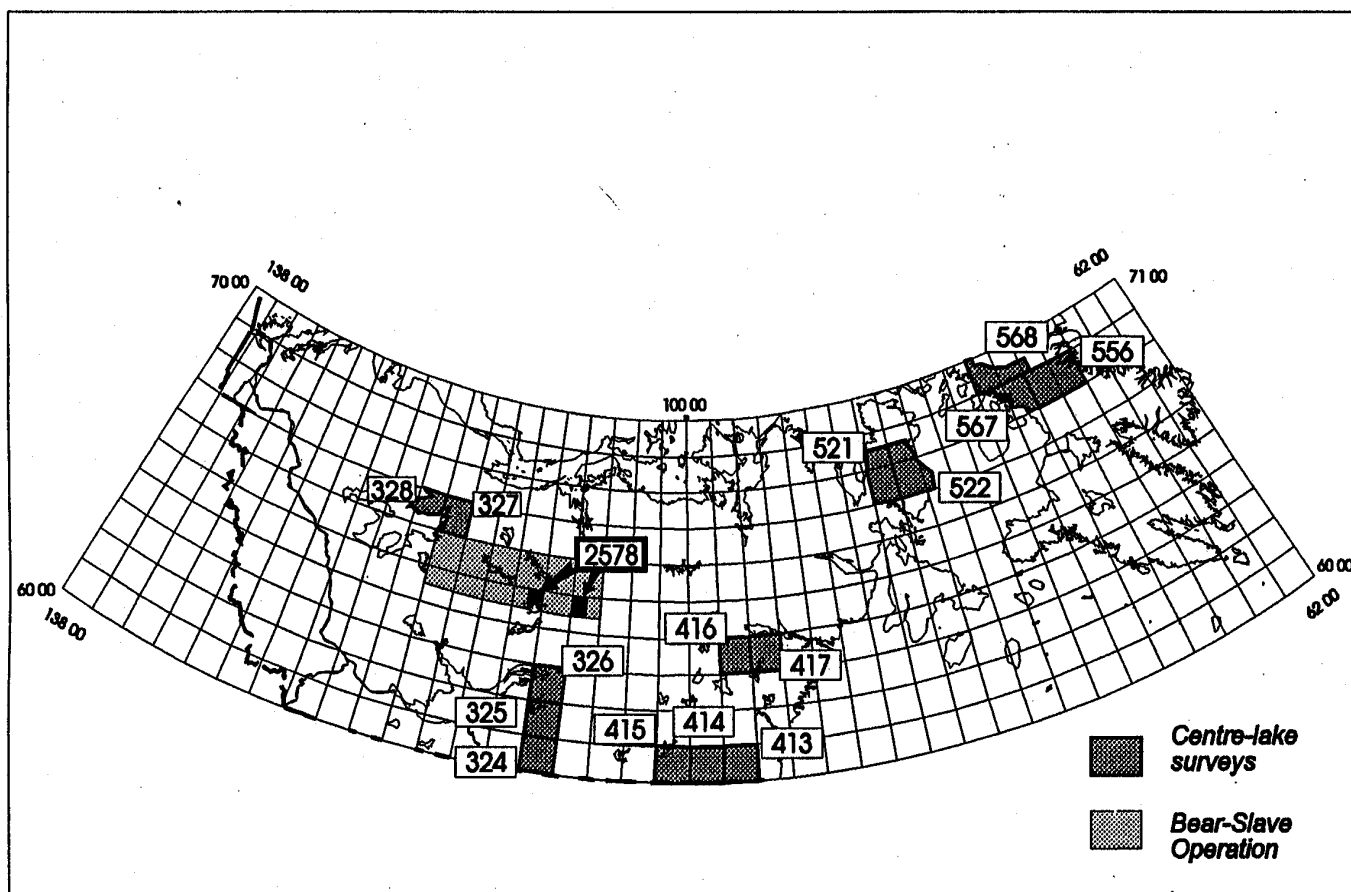


Fig. 1 Areas of the Northwest Territories covered by centre-lake bottom geochemical surveys, showing current GSC open file numbers. Area covered during Bear-Slave Operation (near-shore lake bottom sediments) is outlined.

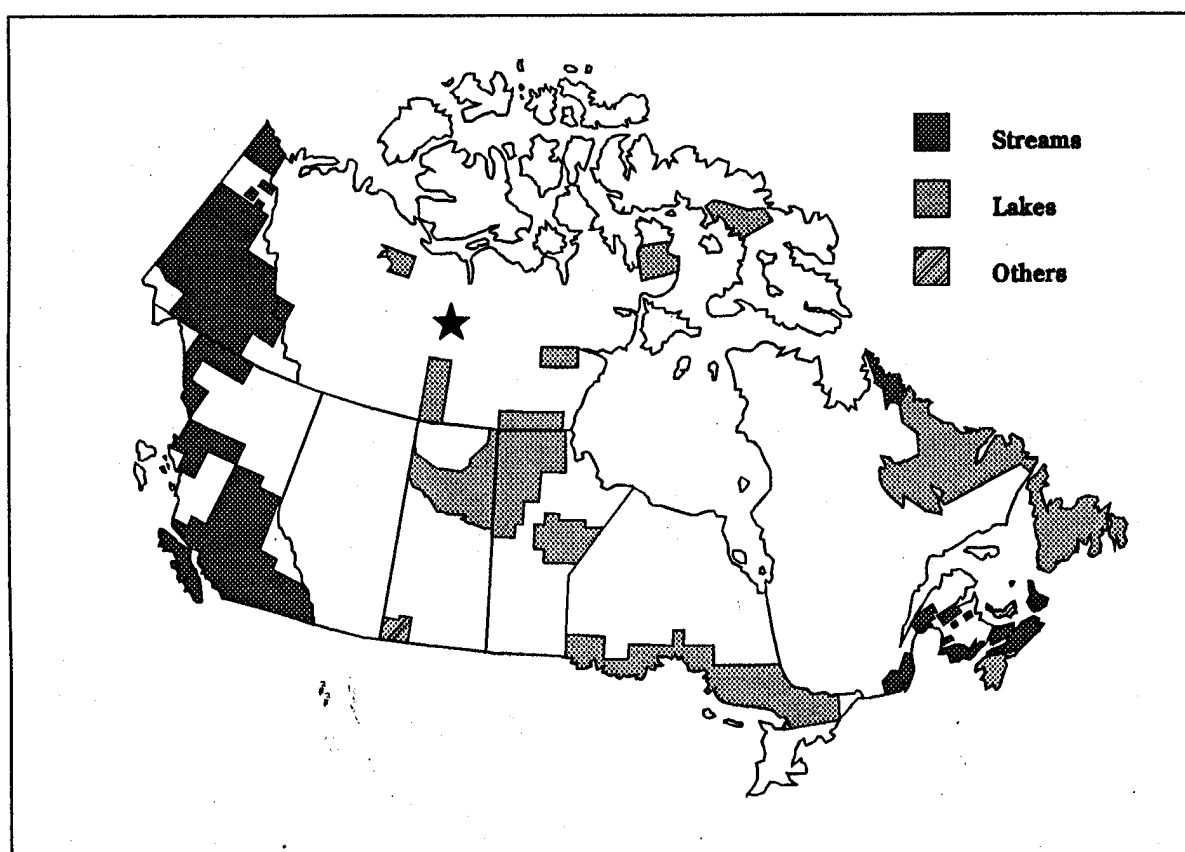


Fig. 2 Drainage surveys to National Geochemical Reconnaissance standards

with neutron flux monitors in a two-megawatt pool type reactor. After a seven day decay period, samples were measured on a high resolution germanium detector. Computer control was achieved with a Microvax II computer. Typical counting times were 500 seconds. Elements determined by INAA include: Au, Ag, As, Ba, Br, Ca, Co, Cr, Cs, Fe, Hf, Hg, Ir, Mo, Na, Ni, Rb, Sb, Sc, Se, Sn, Sr, Ta, Th, U, W, Zn, La, Ce, Nd, Sm, Eu, Tb, Yb and Lu. The sample weight was also reported. Data for Ag, Ca, Hg, Ir, Mo, Ni, Se, Sn, Sr and Zn were not published because of inadequate detection limits and/or precision.

### Loss on Ignition (LOI<sub>950</sub>)

A 2 g sample was roasted at 950° C for one hour, cooled in a desiccator and reweighed. the roasted sample was subsequently used for the XRF analysis.

### X-Ray Fluorescence (XRF)

Al<sub>2</sub>O<sub>3</sub>, Ba, CaO, Cr, Fe<sub>2</sub>O<sub>3</sub>, K<sub>2</sub>O, MgO, MnO, Na<sub>2</sub>O, Nb, P<sub>2</sub>O<sub>5</sub>, Rb, SiO<sub>2</sub>, Sr, TiO<sub>2</sub>, Y and Zr were determined from a disk formed by mixing a roasted sample (2 g original) with lithium tetraborate, fusing and moulding the molten flux. Analytical results were obtained by XRF.

### Atomic Absorption Spectroscopy (AAS) and Other Analyses

*The following descriptions of analytical procedures are adapted from Allan et al. (1973).*

For the determination of Zn, Ag, Mn, and Li, a 400 mg sample was reacted with a mixture of 6 mL of 4M HNO<sub>3</sub> and two drops concentrated HCl. The sample was shaken and placed in a water bath at 90° C for 1.5 hours. The sample was then diluted to 20 ml with metal-free water, shaken, and allowed to settle. The leach was analyzed on a Perkin-Elmer 303 atomic absorption spectrophotometer. A deuterium background correction was used in the Ag analysis. Ag was read at 328.1 mμ, Zn at 213.9 mμ, Li at 670.8 mμ, and Mn at 403.1 mμ.

Mercury in sediments was determined by leaching 500 mg of sample with 20 ml concentrated HNO<sub>3</sub>, 1 ml concentrated HCl, and 80 ml H<sub>2</sub>O at 95° C for 1.5 hours in a water bath. After cooling, 10 ml of 2.5% SnSO<sub>4</sub> was added to a 100 ml aliquot of the resulting solution. The Sample was aerated and the cold vapour analyzed at 253.7mμ for Hg using a Techtron A.A. 5 atomic absorption spectrophotometer.

Uranium was determined using 0.2 ml of the hot HNO<sub>3</sub> leach prepared for Zn, Ag, Mn, and Li analyses. The solution was placed on a Pt dish and evaporated to dryness. The residue was

burned for 1 minute above a Bunsen flame before the addition of 3 g of a K<sub>2</sub>CO<sub>3</sub>-Na<sub>2</sub>CO<sub>3</sub>-NaF flux. The sample was then fused for 10 minutes at 650° C, cooled in a desiccator, and the U concentration read on a Jarrell-Ash fluorimeter.

Arsenic was determined using a colorimetric method. Decomposition was accomplished by heating a weighed portion of minus 250 mesh material with 6M HCl at 90° C for 1.5 hours, followed by centrifuging. The arsenic in an aliquot of this solution was reduced to the trivalent state with KI and SnCl<sub>2</sub>, and evolved as AsH<sub>3</sub> with the addition of granulated Zn metal. The resulting gases (arsine and hydrogen) were bubbled through a solution of silver diethyldithiocarbamate. Colour intensity was determined at 520 nm using a Bausch and Lomb Spectronic 20 colorimeter and As values calculated from a calibration curve.

### Emission Spectrophotometry (ES)

For the determination of Ba, Be, Co, Cr, Cu, La, Mo, Ni, Pb, Sr, Ti, V, Y, and Zr, a 100 g sample was mixed with buffer (1 part Na<sub>2</sub>CO<sub>3</sub>, 7 parts graphite), and Pd and In (as internal standards). The mixture was packed into 3/16 inch diameter preformed electrodes, which were then burned in a direct current (dc) arc of 5 amperes for 10 seconds and 15 amperes for 50 seconds in an oxygen-argon atmosphere. An ARL 29000 Quantometer linked to a computer recorded the light emission from the dc arc for each of the elements. 'Volatile' metals, such as Cu, Pb, and Ag were measured during the initial stages of the burn while 'involatile' metals such as Be and Zr were measured towards the end of the burn. Natural silicates were used for calibration. Control standards were burned every tenth sample to check instrument drift.

### Optical Density (OD)

A qualitative estimate of the amount of organic carbon present as humic material in the minus 250 mesh fraction of sediment was made by determining the optical density of the diluted HNO<sub>3</sub> leach solution prepared for atomic absorption analysis. The leachate was allowed to settle for 2-3 days following the metal analyses before the colour intensity at 500 nm was determined using a Bausch and Lomb Spectronic 20 colorimeter.

Optical density is a measure of the degree of opacity of any translucent medium, defined as the common logarithm of the opacity, i.e.;

$$\text{Transparency} = I_t / I_i$$

$$\text{Opacity} = 1 / \text{Transparency} = I_i / I_t$$

$$\text{Optical density} = \log_{10} (I_i / I_t)$$

where  $I_i$  = intensity of incident light  
 $I_t$  = intensity of transmitted light

Opacity is normally reported in *units of absorbance*: for this report, results are listed as **units of absorbance x 1000**. A full explanation of the method used to determine optical density is found in Lynch et al. (1973).

Table 1 provides a summary of analytical data methods

**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 this 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 analyzing samples which reflect the actual concentration level at a given site.

The correct 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 ppb range. Whereas gold concentrations of only a few ppm may represent economic deposits, background levels in stream and centre-lake sediments seldom 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, in areas where concentrations of gold in sediments are low, and/or grain sizes of the gold present relatively high require proportionally larger samples to

reduce the uncertainty between subsample analytical values and actual values. Conversely, as actual gold concentrations increase or grain size decreases, the number of gold particles to be shared in random subsamples increases and 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 analyze for a broad spectrum of elements, precludes the use of a significantly large sample weight for the gold analyses. Therefore, to obtain representative samples, grain size is reduced by sieving and ball milling of the dried sediments.

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, prospective follow-up areas may be indirectly identified by pathfinder element associations in favourable geology, although an analogous 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.

**FIELD DATA LEGEND**

Table 2 describes the field and map information listed on the following pages.

**REFERENCES**

Allan, R.J., Cameron, E.M. and Durham, C.C., (1973) Reconnaissance geochemistry using lake sediments of a 36 000-square-mile area of the northwestern Canadian Shield (Bear-Slave Operation, 1972); Geological Survey of Canada Paper 72-50.

Allan, R.J., Cameron, E.M. and Durham, C.C. (1973). Bear-Slave operation; Geological Survey of Canada Paper 73-1, Part A, p. 50-52.

Clifton, H.E., Hunter, R.E., Swanson, F.J. and Phillips, R.L. (1969) Sample size and meaningful gold analysis; U.S. Geological Survey Professional Paper 625-C.

Table 1. Summary of Analytical Data and Methods

ELEMENT/ATTRIBUTE		DETECTION LEVEL		METHOD
<u>Original Analytical Suite</u>				
Ag	Silver	0.2	ppm	AAS
As	Arsenic	0.5 to 1.0	ppm	COL
Ba	Barium	3	ppm	ES
Be	Beryllium	1	ppm	ES
Co	Cobalt	2	ppm	ES
Cr	Chromium	1	ppm	ES
Cu	Copper	1	ppm	ES
Hg	Mercury	5	ppm	AAS
La	Lanthanum	12	ppm	ES
Li	Lithium	2	ppm	AAS
Mn	Manganese	10	ppm	AAS
Mo	Molybdenum	0.2	ppm	ES
Ni	Nickel	2	ppm	ES
OD	Optical Density	10 units of absorbance		COL
Pb	Lead	2	ppm	ES
Sr	Strontium	2	ppm	ES
Ti	Titanium	7	ppm	ES
U	Uranium	0.2	ppm	FLU
V	Vanadium	3	ppm	ES
Y	Yttrium	5	ppm	ES
Zn	Zinc	2	ppm	AAS
Zr	Zirconium	25	ppm	ES
<u>Reanalysis Suite</u>				
As	Arsenic	0.5	ppm	INAA
Au	Gold	2	ppm	INAA
Ba	Barium	50	ppm	INAA
Br	Bromine	0.5	ppm	INAA
Ce	Cerium	3	ppm	INAA
Co	Cobalt	1	ppm	INAA
Cr	Chromium	5	ppm	INAA
Cs	Cesium	1	ppm	INAA
Eu	Europium	0.2	ppm	INAA
Fe	Iron	0.01	pct	INAA
Hf	Hafnium	1	ppm	INAA
La	Lanthanum	0.5	ppm	INAA
Lu	Lutetium	0.05	ppm	INAA
Na	Sodium	0.01	pct	INAA
Nd	Neodymium	5	ppm	INAA
Rb	Rubidium	5	ppm	INAA
Sb	Antimony	0.1	ppm	INAA
Sc	Scandium	0.1	ppm	INAA
Sm	Samarium	0.1	ppm	INAA
Ta	Tantalum	0.5	ppm	INAA
Tb	Terbium	0.5	ppm	INAA
Th	Thorium	0.2	ppm	INAA
U	Uranium	0.5	ppm	INAA
W	Tungsten	1	ppm	INAA
Yb	Ytterbium	0.2	ppm	INAA
Mass	Sample Weight	0.01	g	GRAV
Al <sub>2</sub> O <sub>3</sub>		0.01	pct	XRF
Ba		10	ppm	XRF
CaO		0.01	pct	XRF
Cr		10	ppm	XRF
Fe <sub>2</sub> O <sub>3</sub>		0.01	pct	XRF
K <sub>2</sub> O		0.01	pct	XRF
LOI <sub>950</sub>		0.01	pct	GRAV
MgO		0.01	pct	XRF
MnO		0.01	pct	XRF
Na <sub>2</sub> O		0.01	pct	XRF
Nb		10	ppm	XRF
P <sub>2</sub> O <sub>5</sub>		0.01	pct	XRF
Rb		10	ppm	XRF
SiO <sub>2</sub>		0.01	pct	XRF
Sr		10	ppm	XRF
TiO <sub>2</sub>		0.01	pct	XRF
Y		10	ppm	XRF
Zr		10	ppm	XRF



**Friske, P.W.B. and Hornbrook, E.H.W.** (1991) Canada's National Geochemical Reconnaissance programme; *in* Transactions of the Institution of Mining and Metallurgy, Section B; Volume 100, p. 47-56

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**Lynch, J.J., Garrett, R.B. and Jonasson, I.R.** (1973) A rapid estimation of organic carbon in silty lake sediments; Journal of Geochemical Exploration, Vol. 2, p. 171-174.

**Spirito, W.A., Durham, C.C. and Cameron, E.M.** (1990) Release of digital file of regional lake sediment geochemical data for the Bear-Slave Operation, District of Mackenzie, Northwest Territories (76B-G, 86A-C, 86F-H, 64.5° – 66°N; 106° – 118°W); Geological Survey of Canada Open File 2239.

TABLE 2. Field Observations Legend

FIELD RECORD	DEFINITION	TEXT CODE
MAPSHEET	National Topographic System (NTS): lettered quadrangle (1:250 000 scale) Part of sample number	76B, 76C, 76D, 76G
SAMPLE ID	Remainder of sample number: Sample sequence number.....	1-9999
UTM	Universal Transverse Mercator (UTM) Coordinate System; digitized sample location coordinates.	
ZONE	Zone (7 to 22)	
EASTING	UTM easting in metres	
NORTHING	UTM northing in metres	
ROCK TYPE	Major rock type of catchment area: acidic volcanic ..... cordierite schist ..... greywacke ..... granodiorite ..... granite .....	AVCC CDSC GRCK CRDR GRNT
VEGETATION	Vegetation around lake coniferous ..... deciduous ..... grassy ..... moss ..... Combinations of numbers are used to denote mixtures of vegetation types, e.g., 13 = coniferous + grass.	1 2 3 4
RELIEF	Relief of lake catchment basin: Low ..... Medium..... High .....	3 2 1
WEATHER	Weather during collection : Clear ..... Rain .....	1 2
LAKE CONDITION	Lake surface conditions, noted as an indication of wind strength and its effect on the lake: glassy ..... rippy ..... choppy.....	1 2 3
LAKE AREA	Area of lake or estimated sample domain, such as a bay, in square kilometres	
LAKE BOTTOM	Lake bottom environment at sampling site (combinations of numbers are used to denote mixed condition ): rock..... sand..... clay ..... organic.....	1 2 3 4
SEDIMENT COMPOSITION	The proportions are indicated for sand, silt, clay, and organic, the total of the four numbers equalling 10.	

SEDIMENT COLOUR	The colour of the wet sediment (combinations of numbers are used to denote mixed colours): yellow ..... grey ..... brown ..... black..... white.....	1 2 3 4 5
WATER COLOUR	Water colour noted at sample site: clear ..... yellow ..... brown .....	1 2 3
WATER DEPTH	Water depth at sample site, in feet	
SUSPENDED MATERIAL	Suspended matter in water noted at sample site: light ..... heavy .....	1 2