

GEOLOGICAL SURVEY OF CANADA OPEN FILE 2179
(NTS 52A and 52H South)
CANADA–ONTARIO MINERAL DEVELOPMENT AGREEMENT (1985 – 1990)

**REGIONAL LAKE SEDIMENT AND WATER
GEOCHEMICAL RECONNAISSANCE DATA,
THUNDER BAY REGION, NORTHWESTERN ONTARIO**



INDEX MAP

Recommended citation:

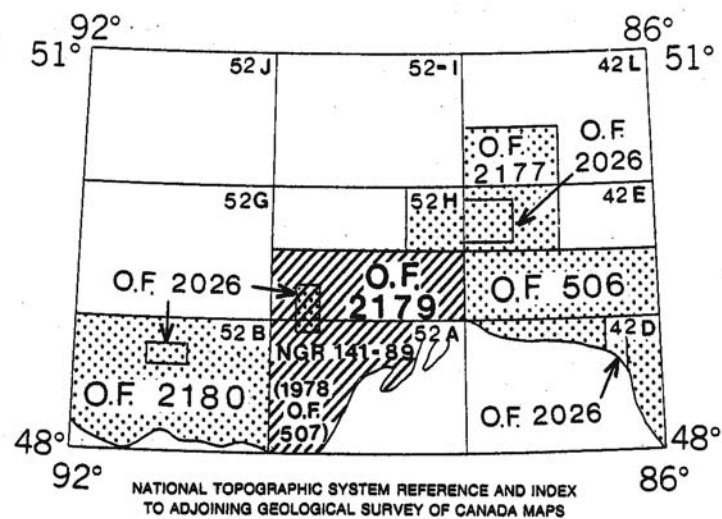
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1990: National Geochemical Reconnaissance Lake Sediment and Water Data, Thunder Bay Region, Northwestern Ontario (NTS 52A and 52H South) Geological Survey of Canada

Open File 2179

August, 1990

**NATIONAL GEOCHEMICAL RECONNAISSANCE
LAKE SEDIMENT AND WATER GEOCHEMICAL DATA
ONTARIO 1990
GEOLOGICAL SURVEY OF CANADA OPEN FILE 2179, NGR 141-1989
NTS 52A and 52H South**



Open File 2179 represents a contribution to the Canada – Ontario Mineral Development Agreement (1985-1990), a subsidiary agreement under the Economic and Regional Development Agreement. This project was funded and managed by the Geological Survey of Canada.

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**REGIONAL LAKE SEDIMENT AND WATER GEOCHEMICAL DATA, ONTARIO 1990,
GSC OPEN FILE 2179, NGR 141-1989; NTS 52A and 52H SOUTH**

INTRODUCTION

Open File 2179 contains new data for gold and 25 other elements obtained by re-analyzing lake sediments collected in 1977 from an area of northwestern Ontario around Thunder Bay. Original analytical data selected from Open File 507 (published in 1978) for 12 elements plus loss-on-ignition in sediments, and uranium, pH and fluoride values in concomitant waters, are also included in this open file.

The original reconnaissance surveys were carried out by the Geological Survey of Canada in conjunction with the Ontario Ministry of Natural Resources under the terms of the Canada-Ontario Agreement on a Uranium Reconnaissance Program. Funds for the determination of mercury in sediments at this time were provided by Fisheries and Environment Canada. Analyses of archive samples for Open File 2179 were undertaken under the Canada - Ontario Mineral Development Agreement (1985- 1990).

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

CREDITS

- E.H.W. Hornbrook directed the surveys.
- P.W.B. Friske coordinated the operational activities of contract and Geological Survey of Canada staff.
- Contracts were let to the following companies for sample collection, preparation, analysis and reanalysis, and were managed by the following staff of the Regional Geochemical Studies section:
- | | |
|---------------------|--|
| Collection (1977): | Marshall Macklin Monaghan
Toronto, Ontario
E.H.W. Hornbrook, W.B. Coker |
| Preparation (1977): | Golder Associates
Ottawa, Ontario
J.J. Lynch |
| Analysis (1977): | Chemex Labs
Vancouver, British Columbia

Barringer Research
Toronto, Ontario

Atomic Energy of Canada
Ottawa, Ontario
J.J. Lynch |
| Preparation (1990): | Bondar-Clegg & Company
Ottawa, Ontario
J.J. Lynch |

- | | |
|------------------|---|
| Analysis (1990): | Bondar-Clegg and Company
Ottawa, Ontario
J.J. Lynch |
|------------------|---|
- M. McCurdy edited open files and coordinated production.
- A.C. Galletta managed the digital geochemical data and provided computer processing support.

The personal computer data base and software programs used for data entry, verification, processing and presentation in the publication of reports were designed and programmed by Harry Gross, Geochemical Data Manager for the Exploration Geochemistry Subdivision.

Sample location, gold value and symbol-trend maps were plotted by staff at the Geological Survey of Canada. Pat Doyle, C.C. Durham and Rob Phillips provided technical assistance.

DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT

- Helicopter-supported sample collection was carried out during the summer of 1977. Lake sediment and water samples were collected at an average density of one sample per 13 square kilometres throughout the 22,430 square kilometres of the northwestern Ontario survey.
- 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).
- The sample site positions were marked on appropriate 1:250 000 scale NTS maps in the field. These maps were digitized at the Geological Survey in Ottawa to obtain the sample site UTM coordinates.
- In Ottawa, field dried samples were air-dried, crushed, and ball-milled. The minus 80 mesh (177 micron) fraction was obtained and used for subsequent analyses. At this time, control reference and blind duplicate samples were inserted into each block of twenty sediment samples. For the water samples, only control reference samples were inserted into the block. There were no blind duplicate water samples.
- The sample site coordinates were checked as follows: a sample location map was produced on a Versatec plotter using the digitized coordinates; the original sample location map produced in the field was then overlain on the Versatec map; the two sets of points were checked for coincidence. The dominant rock types in the lake catchment basins were identified on appropriate geological maps used as the bedrock geological base on NGR maps.
- Thorough inspections of the field and analytical data were made to check for any missing information and/or gross errors.

Quality control and monitoring of the geochemical data was undertaken by a standard method used by the Exploration Geochemistry Subdivision at the Geological Survey of Canada.

ANALYTICAL PROCEDURES

Instrumental Neutron Activation Analysis (INAA)

The weighed sample (generally 10 to 40 g) is irradiated epithermally for 20 minutes in a neutron flux with an approximate density of 1×10^{11} neutrons/cm²/second. Counting begins seven days after irradiation. The counting time is somewhat variable (6 to 11 minutes) and is matrix dependent. Counting is done on a germanium-lithium co-axial counter. The counting data is accumulated on a VAX computer and is subsequently converted to concentrations. Numerous international reference samples are irradiated with each batch of routine samples. Elements determined by INA analyses include: Na, Sc, Cr, Fe, Co, Ni, Zn, As, Se, Br, Rb, Zr, Mo, Ag, Cd, Sn, Sb, Te, Cs, Ba, La, Ce, Sm, Eu, Tb, Yb, Lu, Hf, Ta, W, Ir, Au, Th, and U. The sample weight is also reported. Data for Zn, Se, Zr, Ag, Cd, Sn, Te, and Ir are not published because of inadequate detection limits and/or precision.

Atomic Absorption Spectroscopy (AAS) and Other Analyses

For the determination of Zn, Cu, Pb, Ni, Co, Ag, Mn and Fe, a 1 g sample was reacted with 6 mL of a mixture of 4M HNO₃ and M HCl in a test tube overnight at room temperature. After digestion, the test-tube was immersed in a hot water bath at room temperature and brought up to 90° C and held at this temperature for 2 hours with periodic shaking. The sample solution was then diluted to 20 ml with metal-free water and mixed. Zn, Cu, Pb, Ni, Co, Ag, Mn and Fe were determined by atomic absorption spectroscopy using an air-acetylene flame. Background corrections were made for Pb, Ni, Co and Ag.

Arsenic was determined colorimetrically using silver diethyldithiocarbamate. Decomposition was accomplished by heating a 1 gram sample with 20 mL of 6 M HCl at 90° C for 1.5 hours. Colorimetric measurements were made at 520 nm.

Molybdenum was determined by atomic absorption spectroscopy using a nitrous oxide acetylene flame. A 0.5 g sample was reacted with 1.5 mL concentrated HNO₃ at 90° C for 30 minutes. At this point 0.5 mL concentrated HCl was added and the digestion continued at 90° C for an additional 90 minutes. After cooling, 8 mL of 1250 ppm Al solution were added and the sample solution diluted to 10 mL before aspiration.

Mercury was determined by the Hatch and Ott procedure with some modifications. The method is described by Jonasson *et al.* (1973). A 0.5 g sample reacted with 20 mL concentrated HNO₃ and 1 mL concentrated HCl in a test tube for 10 minutes at room temperature prior to 2 hours of digestion with mixing at 90° C in a hot water bath. After digestion, the sample solutions were cooled and diluted to 100 mL with metal-free water. The Hg present was reduced to the elemental state by the

addition of 10 mL of 10% w/v SnSO₄ in M H₂SO₄. The Hg vapour was then flushed by a stream of air into an absorption cell mounted in the light path of an atomic absorption spectrophotometer. Absorption measurements are made at 253.7 nm.

Loss-on-ignition was determined using a 500 mg sample. The sample, weighed into 30 mL beaker, was placed in a cold muffle furnace and brought up to 500° C over a period of 2 -3 hours. The sample remained at this temperature for 4 hours and was then allowed to cool to room temperature for weighing.

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). In brief, 1 gram sample was weighed into a 7 dram polyethylene vial, capped and sealed. The irradiation was provided by the Slowpoke reactor with an operating flux of 10^{12} neutrons/cm²/second. The samples were pneumatically transferred from an automatic loader to the reactor, where each sample was irradiated for 60 seconds. After irradiation, the samples were again transferred pneumatically to the counting facility where, after a 10 second delay, the sample was counted for 60 seconds with six BF₃ detector tubes embedded in paraffin. Following counting, the samples were automatically ejected into a shielded storage container. Calibration was carried out twice a day as a minimum, using natural materials of known uranium concentration.

Water Analyses

Uranium was determined by fission track analysis. 225 mL of water was acidified with 3 mL concentrated HNO₃. After a two week waiting period to ensure total dissolution of precipitated uranium, a 5 microlitre aliquot of the sample was removed, placed on a polycarbonate tape and dried. The tape was irradiated in a nuclear reactor at McMaster University for 1 hour at a flux of 10^{13} neutrons/sq cm/sec. The irradiated tape was etched with 25% NaOH solution and the fission tracks were counted with an optical counter fitted to a microscope. The number of tracks was proportional to the uranium concentration. Each tape contained its own calibration standards, blanks and sample duplicates.

Hydrogen ion activity (pH) was measured with a Beckman combination electrode and a Model 401 Orion specific ion meter.

Fluoride in lake water samples was determined using an Orion fluoride electrode and a Model 401 Orion specific ion meter.

Table 1 provides a summary of analytical data and methods.

PRESENTATION AND INTERPRETATION OF GOLD DATA

The following general 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.

Samples that have gold values that are statistically above approximately the 90th percentile, or those with LOI values below 10%, are normally analysed again in accordance with standard NGR procedures. There will be no repeat data published in Open File 2179 or Open File 2180 however, as insufficient material remained after the initial analyses.

To correctly interpret gold geochemical 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 include (Harris, 1982):

- (1) Gold occurs most commonly in the native form which is chemically and physically resistant. A significant proportion of the metal is dispersed in micron-sized particulate form, and the high specific gravity of gold results in 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 encountered from 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 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 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.

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

- (1) 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 variance;
- (c) analysis of a second subsample (blind duplicate) from one sample to measure and control short-term precision.

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 a complementary 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 appearing on the following pages preceding the analytical data for each sample site.

REFERENCES

- Boulanger, A., Evans, D.J.R. and Raby, B.F. (1975)** Uranium analysis by neutron activation delayed neutron counting; Proceedings of the 7th Annual Symposium of Canadian Mineral Analysts, Thunder Bay, Ontario, September 22-23, 1975.
- 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.
- Garrett, R.G. (1974)** Field data acquisition methods for applied geochemical surveys at the Geological Survey of Canada; Geol. Surv. Can. Paper 74-52.
- Harris, J.F. (1982)** Sampling and analytical requirements for effective use of geochemistry in exploration for gold; in Levinson, A.A., Editor, Precious Metals in the Northern Cordillera, proceedings of a symposium sponsored by the Association of Exploration Geochemists and the Cordilleran Section of the Geological Association of Canada, pp. 53-67.
- Jonasson, I.R., Lynch, J.J. and Trip, L.J. (1973)** Field and laboratory methods used by the Geological Survey of Canada in geochemical surveys; No. 12, Mercury in Ores, Rocks, Soils, Sediments and Water, Geol. Surv. Can. Paper 73-21.

TABLE 1. Summary of Analytical Data and Methods

ELEMENT		DETECTION LEVEL		METHOD
<u>SEDIMENTS:</u>				
Zn	Zinc	2	ppm	AAS
Cu	Copper	2	ppm	AAS
Pb	Lead	2	ppm	AAS
Ni	Nickel	2	ppm	AAS
Co	Cobalt	2	ppm	AAS
Ag	Silver	0.2	ppm	AAS
Mn	Manganese	5	ppm	AAS
As	Arsenic	1	ppm	COL
Mo	Molybdenum	2	ppm	AAS
Fe	Iron	0.02	pct	AAS
U	Uranium	0.5	ppm	NADNC
Hg	Mercury	10	ppb	CV-AAS
LOI	Loss-on-ignition	1	pct	GRAV
Na	Sodium	0.02	pct	INAA
Sc	Scandium	0.2	ppm	INAA
Cr	Chromium	20	ppm	INAA
Fe	Iron	0.2	pct	INAA
Co	Cobalt	5	ppm	INAA
Ni	Nickel	10	ppm	INAA
As	Arsenic	0.5	ppm	INAA
Br	Bromine	0.5	ppm	INAA
Rb	Rubidium	5	ppm	INAA
Mo	Molybdenum	1	ppm	INAA
Sb	Antimony	0.1	ppm	INAA
Cs	Cesium	0.5	ppm	INAA
Ba	Barium	50	ppm	INAA
La	Lanthanum	2	ppm	INAA
Ce	Cerium	5	ppm	INAA
Sm	Samarium	0.10	ppm	INAA
Eu	Europium	1	ppm	INAA
Tb	Terbium	0.5	ppm	INAA
Yb	Ytterbium	2	ppm	INAA
Lu	Lutetium	0.2	ppm	INAA
Hf	Hafnium	1	ppm	INAA
Ta	Tantalum	0.5	ppm	INAA
W	Tungsten	1	ppm	INAA
Th	Thorium	0.2	ppm	INAA
U	Uranium	0.2	ppm	INAA
Wt	Weight	0.01	g	-
Au	Gold	2	ppb	INAA
<u>WATERS:</u>				
F-W	Fluoride	20	ppb	ISE
pH	Hydrogen ion activity	-	-	GCM
U-W	Uranium	0.01	ppb	FTA

- AAS

- atomic absorption spectrometry
- COL

- colorimetry using silver diethyldithiocarbamate
- CV-AAS

- cold vapour (flameless) atomic absorption
- FTA

- fission track analysis
- GCM

- glass Calomel electrode and pH meter
- GRAV

- gravimetry
- INAA

- Instrumental Neutron Activation Analysis
- ISE

- ion selective electrode
- LIF

- laser-induced fluorescence
- NADNC

- neutron activation, delayed neutron counting

TABLE 2. Field Observations Legend

FIELD RECORD	DEFINITION	TEXT CODE
MAP SHEET	National Topographic System (NTS): lettered quadrangle (1:250,000 or 1:50 000 scale) Part of sample number	52A or 052H
SAMPLE ID	Remainder of sample number: Year Field crew..... Sample sequence number	77 1 or 3 001-999
REP STAT	Replicate status; the relationship of the sample to others within the analytical block of 20: Routine regional sample First of field duplicate..... Second of field duplicate.....	00 10 20
UTM	Universal Transverse Mercator (UTM) Coordinate system; digitized sample location coordinates.	
ZN	Zone (7 to 22)	
EASTING	UTM Easting in metres	
NORTHING	UTM Northing in metres	
ROCK UNIT	Major rock type of catchment area: diabase sedimentary rock..... argillite chert granite..... granite gneiss ultramafic..... conglomerate..... greywacke..... basic extrusive metavolcanic..... unknown	DIBS SMRK ARGL CHRT GRNT GRNG UNFC CGLM GRCK BEXV MVCC UKNN
LAKE AREA	The area of the water body sampled: Pond ¼ to 1 square kilometer 1 to 5 square kilometers..... greater than 5 square kilometers	pond .25-1 1-5 >5
LAKE DEPTH	Distance in feet from the surface of the lake to the bottom:.....	0 - 99
TERRAIN RELIEF	Relief of lake catchment basin: Low Medium..... High	Lo Med Hi
SAMPLE CONT.	Contamination; human or natural: None Work Camp Fuel..... Gossan	- Wo Ca Fu Go

FIELD RECORD	DEFINITION	TEXT CODE
SAMPLE COLOUR	Sediment sample colour; up to two colours may be selected: Tan Yellow..... Green Grey Brown..... Black	Tn Yl Gn Gy Br Bk
SUSP MATL	Suspended matter in water: None Heavy..... Light.....	- Hvy Lgt
Miscellaneous	Refers to 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 gm