GEOLOGICAL SURVEY OF CANADA OPEN FILE 2360
(NTS 42D, 42E SOUTH)
CANADA-ONTARIO MINERAL DEVELOPMENT AGREEMENT (1985-1990)

REGIONAL LAKE SEDIMENT AND WATER GEOCHEMICAL RECONNAISSANCE DATA NORTHWESTERN ONTARIO

Recommended citation:
Friske,P.W.B., Hornbrook, E.H.W., Lynch, J.J., McCurdy, M.W., Gross, H., Galletta, A.C., Durham, C.C.
1991: National Geochemical Reconnaissance Lake Sediment and Water Data, Northwestern Ontario, (NTS 42D, 42E South) Geological Survey of Canada
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LAKE SEDIMENT AND WATER GEOCHEMICAL DATA
ONTARIO 1991
GEOLOGICAL SURVEY OF CANADA OPEN FILE 2360, NGR 147-1990
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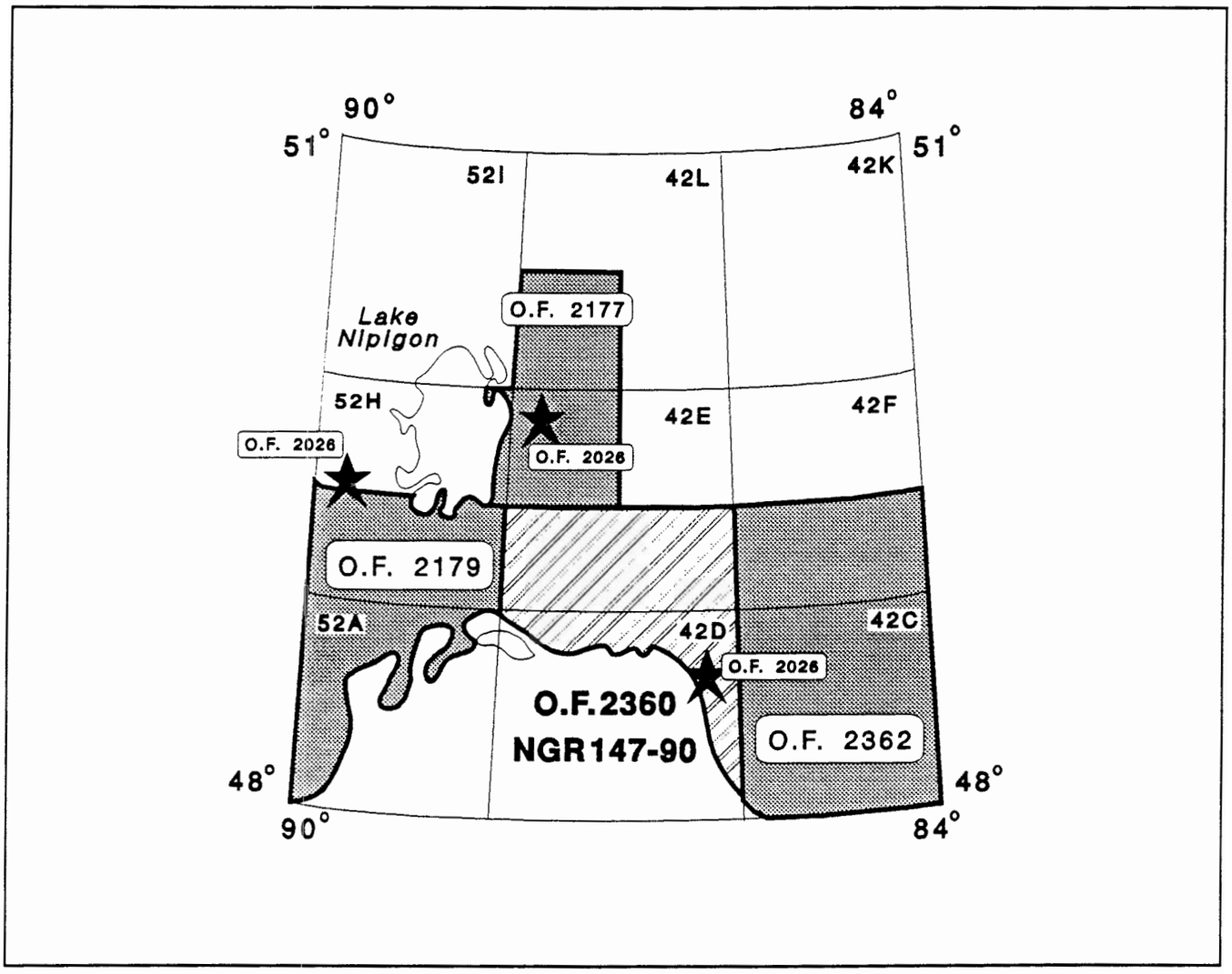

National Topographic System reference and index to adjoining GSC geochemical reconnaissance surveys

Open File 2360 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 1991, GSC OPEN FILE 2360, NGR 147-1990; NTS 42D, 42E SOUTH

INTRODUCTION

Open File 2360 contains data for gold and 25 other elements obtained by re-analyzing lake sediments collected in 1977 from an area in northwestern Ontario. Original analytical data selected from Open File 506 (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 (GSC) in conjunction with the Ontario Ministry of Natural Resources under the terms of the Canada - Ontario Agreement on a Uranium Reconnaissance Program. Fisheries and Environment Canada provided funds for the determination of mercury. Analyses of archive samples for Open File 2360 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, 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 original survey.

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

Contracts were let to the following companies for sample collection, preparation, original analyses and reanalyses and were managed by Geological Survey of Canada staff as follows:

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 and coordinated open file production.

H. Gross and A.C. Galletta provided computer processing support.

Pat Doyle, C.C. Durham and Helena Karam 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 12 000 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.

Additional lake sediment material required for INAA analyses was taken from archive storage. Particle reduction was accomplished using a ceramic puck mill.

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 were 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 (up to 40 g) is irradiated epithermally for 20 minutes in a neutron flux with an approximate density of 1 x 10^{11} neutrons/cm^2/second. Counting begins seven days after irradiation. The counting time is somewhat variable (approximately 15 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 INAA 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 HNO_3 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 g sample with 20 mL of 6M 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 HNO_3 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.

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 original method is provided by Boulanger *et al.*(1975). In 1979, modifications related to the irradiation and counting times were introduced. In brief, a 1 gram sample was weighed in a 7 dram polyethylene vial, capped and sealed. The irradiation was provided by the Slowpoke reactor with an operating flux of 10^{12} neutrons/cm^2/second. The samples were pneumatically transferred from an automatic loader to the reactor, where each sample was irradiated for 20 seconds. After irradiation, the samples were again transferred pneumatically to the counting facility where, after a 10 second delay, the sample was counted for 20 seconds with six BF_3 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 HNO_3. After a two week waiting period to ensure total dissolution of any 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 before acidification of the sample for the uranium determination.

Fluoride in lake water samples was determined using an Orion fluoride electrode and a Model 401 Orion specific ion meter. Prior to measurement, an aliquot of the sample was mixed with an equal volume of a modified TISAB (total ionic strength adjustment buffer) solution. The modification consisted of adding 60 mL of 8 M KOH solution th the buffer. This permitted the reanalysis of fluoride in acidified water samples when required. When this analysis was required, acidified standard solutions were used for calibration.

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 analyzed again in accordance with standard NGR procedures. **There will be no repeat data published in Open File 2360 however, as insufficient material remained after the initial neutron activation analyses.**

TABLE 1. Summary of Analytical Data and Methods

ELEMENT		DETECTION LEVEL		METHOD
SEDIMENTS:				
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
Hg	Mercury	10	ppb	CV-AAS
U	Uranium	0.5	ppm	NADNC
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
WATERS:				
F-W	Fluoride	20	ppb	ISE
pH	Hydrogen ion activity	-	-	GCM
U-W	Uranium	0.01	ppb	FT

AAS - atomic absorption spectrometry
FT - fission track analysis
GCM - glass Calomel electrode and pH meter
GRAV - gravimetry
CV-AAS - cold vapour atomic absorption spectrometry
INAA - Instrumental Neutron Activation Analysis
ISE - ion selective electrode
NADNC - neutron activation, delayed neutron counting
COL - colorimetrically

The correct interpretation of 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 (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 fluviatile 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, proportionally larger samples are required 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 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, prospective follow-up areas may be indirectly identified by pathfinder element associations in favourable geology, although a analogous gold response due to natural variability may be lacking. Once an anomalous area has been identified, field investigations should by 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 by 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

Aslin, G.E.M. (1976) The determination of arsenic and antimony in geological materials by flameless atomic absorption spectrophotometry; Journal of Geochemical Exploration, Vol. 6, pp. 321-330.

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 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	042D or 042E
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: alkalic rock diabase chert granite granite gneiss granodiorite quartz feldspar porphyry migmatite ultramafic conglomerate greywacke schist garnet schist acid extrusive basic extrusive	 AKRK DIBS CHRT GRNT GRNG GRDR QZFP MGMT UMFC CGLM GRCK SCST GRSC AEXV BEXV
LAKE AREA	The area of the water body sampled: Pond 1/4 to 1 square kilometre 1 to 5 square kilometres greater than 5 square kilometres	 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	Tn
	Yellow	Yl
	Green	Gn
	Grey	Gy
	Brown	Br
	Black	Bk
SUSP MATL	Suspended matter in water:	
	None	-
	Heavy	Hvy
	Light	Lgt
Miscellaneous	Refers to missing data in any field	*
	no sample material for analysis	ns
	parts per million	ppm
	parts per billion	ppb
	percent	pct
	weight (of sample)	Wt
	gram	gm