

**GEOLOGICAL SURVEY OF CANADA OPEN FILE 1958
(52F)
CANADA – ONTARIO MINERAL DEVELOPMENT AGREEMENT (1985 – 1990)**

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



INDEX MAP

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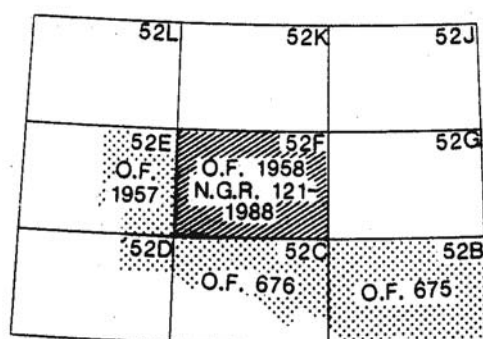
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August, 1989

NATIONAL GEOCHEMICAL RECONNAISSANCE
LAKE SEDIMENT AND WATER GEOCHEMICAL DATA
ONTARIO 1989
GEOLOGICAL SURVEY OF CANADA OPEN FILE 1958, NGR 121-1988
(52F)



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX
TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

Open File 1958 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 1989, GSC OF 1958, NGR 121-1988; 52F

Geological Survey of Canada Open File 1958
Regional Lake Sediment and Water
Geochemical Reconnaissance Data,
Northwestern Ontario, consisting of NTS 52F

INTRODUCTION

Open File 1958 is one of three regional geochemical open files covering parts of Ontario which were sampled in 1988 as part of the Canada - Ontario Mineral Development Agreement. Open file 1958 represents analyses of lake sediment material and waters for 24 elements.

The reconnaissance survey was undertaken in 1988 by the Geological Survey of Canada in conjunction with the Ontario Department of Mines under the Canada - Ontario Mineral Development Agreement (1985 - 1990).

The data base of the survey contributes to a national geochemical reconnaissance and is used for resource assessment, mineral exploration and geological mapping. Regional survey sample collection and preparation procedures, analytical methods and repeatability of results are therefore strictly specified and controlled. In this way, consistent data can be systematically obtained in different areas in different years from different analytical laboratories.

CREDITS

E.H.W. Hornbrook directed the survey.

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 and analysis and were managed by the following staff of the Exploration Geochemistry Subdivision:

Collection: SIAL Geophysique, Montreal,
P.Q.
C.C. Durham

Preparation: Golder Associates, Ottawa,
Ontario
J.J. Lynch

Analysis: Bondar-Clegg and Company
Ltd., Ottawa
Chemex Labs Limited
Vancouver, B.C. (waters and
Au)
J.J. Lynch

M. McCurdy coordinated production and edited open files.

A.C. Galletta managed the digital geochemical data and provided computer processing support.

Computing services were provided by the Computer Science Centre, EMR. The plotting was done by Canada Lands Data Systems staff at Environment Canada, Hull, Quebec.

H. Gross developed microcomputer software to produce data listings and summary statistics.

C.C. Durham, P. Doyle, H.R. Schmitt, and Rob Phillips provided technical assistance.

DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT

Helicopter and truck supported sample collection was carried out during the summer of 1988.

Lake sediment and water samples were collected at an average density of one sample per 13 square kilometres throughout the 16,100 square kilometres of the northwestern Ontario survey.

Sample site duplicate samples were routinely collected in each analytical block of twenty samples.

The field data were recorded by the field contract staff on standard lake sediment field cards (Rev. 74) used by the Geological Survey of Canada (Garrett, 1974).

In Ottawa, field dried samples were air-dried, crushed, ball milled and sieved. The minus 80 mesh (177 microns) fraction was 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.

On receipt, field and analytical data were processed with the aid of computers.

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.

The sample site coordinates were checked as follows: a sample location map was produced on a Calcomp 1051 drum plotter using the digitized coordinates; the field contractor's sample location map was then overlaid with the Calcomp 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

Atomic Absorption Spectroscopy (AAS) and Other Analyses

For the determination of Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe, Cd and As a 1 gram sample reacts 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 is 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 is then diluted to 20 mL with metal-free water and mixed. Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe and Cd are determined by atomic absorption spectroscopy using an air-acetylene flame. Background corrections are made for Pb, Ni, Co, Ag, and Cd.

Arsenic is determined by atomic absorption using a hydride evolution method wherein the hydride (AsH₃) is evolved and passed through a heated quartz tube in the light path of an atomic absorption spectrophotometer. The method is described by Aslin (1976). Detection limit = 1 ppm.

Molybdenum and vanadium are determined by atomic absorption spectroscopy using a nitrous oxide acetylene flame. A 0.5 gram sample reacts with 1.5 mL concentrated HNO₃ at 90° C for 30 minutes. At this point 0.5 mL concentrated HCl is added and the digestion continues at 90° C for an additional 90 minutes. After cooling, 8 mL of 1250 ppm Al solution are added and the sample solution diluted to 10 mL before aspiration. Detection limit = Mo – 2 ppm; V – 5 ppm.

Mercury is determined by the Hatch and Ott Procedure with some modifications. The method is described by Jonasson *et al.* (1973). A 0.5 gram sample reacts with 5 mL concentrated HNO₃ and 0.3 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 are cooled and diluted to 100 mL with metal-free water. The Hg present is reduced to the elemental state by the addition of 10 mL 10% w/v SnCl₂ in 10% solution of HCl. The Hg vapour is 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. Detection limit = 10 ppb.

Loss-on-ignition is determined using a 500 mg sample. The sample, weighed into 30 ml beaker, placed in a cold muffle furnace and brought up to 500° C over a period of 2 - 3 hours. The sample is left at this temperature for 4 hours, then allowed to cool to room temperature for weighing. Detection limit = 1.0 pct.

Uranium is 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, a 1 gram sample is weighed into a 7 dram polyethylene vial, capped and sealed. The irradiation is provided by the Slowpoke reactor with an operating flux of 10^{**} 12 neutrons/sq cm/sec. The samples are pneumatically transferred from an automatic loader to the reactor, where each sample is irradiated for 60 seconds. After irradiation, the sample is again transferred pneumatically to the counting facility where after a 10 second delay the sample is counted for 60 seconds with six BF₃ detector tubes embedded in paraffin. Following counting, the samples are automatically ejected into a shielded storage container. Calibration is carried out twice a day as a minimum, using natural materials of known uranium concentration. Detection limit = 0.5 ppm.

Antimony is determined in lake sediments as described by Aslin (1976). A 500 mg sample is placed in a test tube; 3 mL concentrated HNO₃ and 9 mL concentrated HCl are added and the mixture allowed to stand overnight at room temperature. The mixture is heated slowly to 90° C and maintained at this temperature for at least 90 minutes. The solution is cooled and diluted to 10 mL with 1.8 M HCl. The antimony in an aliquot of this dilute solution is then determined by hydride evolution- atomic absorption spectrometry. Detection limit = 0.2 ppm.

Fluorine is determined in lake sediments as described by Ficklin (1970). A 250 mg sample is sintered with 1 g of a flux consisting of two parts by weight sodium carbonate and one part by weight potassium nitrate. The residue is then leached with water. The sodium carbonate is neutralized with 10 mL 10% (w/v) citric acid and the resulting solution is diluted to 100 mL with water. The pH of the resulting solution should be from 5.5 to 6.5. The fluoride content of the test solution is then measured using a fluoride ion electrode. Standard solutions contain sodium carbonate and citric acid in the same quantities as the sample solution. Detection limit = 40 ppm.

Gold is usually determined on a 10 g lake sediment sample; depending on the amount of sample available, lesser weights are sometimes used. This results in a variable detection limit: 2 ppb for a 5 g sample, 1 ppb

for a 10 g sample... The sample is fused to produce a lead button, collecting any gold in the sample, which is cupelled in a muffle furnace to produce a silver (dore) bead. The silver beads are irradiated in a neutron flux for one hour, cooled for four hours, and counted by gamma ray spectrometry. Calibration is carried out using standard and blank beads.

Fluoride in lake water samples is determined using a fluoride electrode. Prior to measurement an aliquot of the sample is mixed with an equal volume of TISAB II buffer solution (total ionic strength adjustment buffer). The TISAB II buffer solution is prepared as follows: to 50 mL metal-free water add 57 mL glacial acetic acid, 58 gm NaCl and 4 gm CDTA (cyclohexylene dinitrilo tetraacetic acid). Stir to dissolve and cool to room temperature. Using a pH meter, adjust the pH between 5.0 and 5.5 by slowly adding 5 M NaOH solution. Cool and dilute to one litre in a volumetric flask. Detection limit = 20 ppb.

Hydrogen ion activity (pH) is measured with a combination glass-calomel electrode and a pH meter.

Uranium in waters is determined by a laser-induced fluorometric method using a Scintrex UA-3 uranium analyser. A complexing agent, known commercially as fluran and composed of sodium pyrophosphate and sodium monophosphate (Hall, 1979) is added to produce the uranyl pyrophosphate species which fluoresces when exposed to the laser. Since organic matter in the sample can cause unpredictable behaviour, a standard addition method is used. In the past, there have been instances at the GSC where the reaction of uranium with fluran was either delayed or sluggish; for this reason an arbitrary 24 hour time delay between the addition of the fluran and the actual reading is incorporated into this method. In practice, 500 μ L of fluran solution are added to a 5 mL sample and allowed to stand for 24 hours. At the end of this period fluorescence readings are made with the addition of 0.0, 0.2 and 0.4 ppb U. For high samples the additions are 0.0, 2.0 and 4.0 (20 μ L aliquots of either 55 or 550 ppb U are used). All readings are taken against a sample blank. Detection limit = .05 ppb.

Alkalinity in waters is determined by titrating a 25 mL aliquot of the sample with 0.02 N H_2SO_4 using a Corning combination electrode and a Corning model 135 pH meter. The end point is pH 4.5 Detection level=1 ppm.

Calcium and magnesium in waters are determined by atomic absorption spectroscopy. The sample solution contains 1000 μ g/mL potassium and 2000 μ g/mL lanthanum. Potassium acts as a ionization buffer and lanthanum as the releasing agent.

Table 1 provides a summary of analytical data and methods.

PRESENTATION AND INTERPRETATION OF GOLD DATA

The following discussion reviews the format used to present the Au 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 Au in nature and the resultant difficulties in obtaining and analyzing samples which reflect the actual concentration level at a given site.

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

- (1) Au occurs most commonly in the native form which is chemically and physically resistant. A high proportion of the metal is dispersed in micron-sized particulate form. Gold's high specific gravity results in heterogeneous distribution, especially in stream sediment and clastic-rich (low LOI) lake sediment environments. Au distribution appears to be more homogeneous in organic-rich fluvial and lake sediment environments.
- (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 1 ppb.

These factors result in a particle sparsity effect wherein very low concentrations of Au are heterogeneously enriched in the surficial environment. Hence, a major problem facing the geochemist is to obtain a representative sample. In general, the lower the actual concentration of Au the larger the sample size, or the smaller the grain size required to reduce uncertainty over whether subsample analytical values truly represent actual values. Conversely, as actual Au concentrations increase or grain size decreases, the number of Au particles to be shared in 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 analyze for a broad spectrum of elements, precludes the use of a significantly large sample weight for the Au analyses. Therefore, to the extent that

sample representivity can be increased, sample grain size is reduced by sieving and ball milling of all samples.

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

- (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 control sampling variance;
 - (c) analysis of a second subsample (blind duplicate) from one sample to control short-term precision.
- (2) For both stream sediments and lake sediments, routine repeat analyses on a second subsample are performed for all samples having values that are statistically above approximately the 90th percentile of total data set. This applies only to gold analyses by fire assay preconcentration followed by neutron activation. **Such routine repeat analyses are not performed for INA analyses of archived samples.**
- (3) For lake sediments only, a routine repeat analysis on a second subsample is performed on those samples with LOI values below 10%, indicating a large clastic component. On-going studies suggest that the Au distribution in these samples is more likely to be variable than in samples with a higher LOI content. **Again, routine repeat analyses are performed only when the fire assay preconcentration/neutron activation method is used.**

Au data presentation, statistical treatment and the value map format are different than for other elements. Au data listed in the open file may include initial analytical results, values determined from repeat analyses, together with sample weights and corresponding detection limits for all analyzed samples. The gold, statistical parameters and regional symbol-trend plots are determined using the following data population selection criteria:

- (1) Only the first analytical value is utilized.
- (2) Au values determined from sample weights less than 10 g are excluded, except where determined by instrumental neutron activation analyses.

- (3) Au values less than the detection limit (<1 ppb) for 10 g samples are set to 0.5 ppb.

On the value map, repeat analysis values, where determined (not field duplicates), are placed in brackets following the initial value determination. All values determined on a sample less than 10 g are denoted by an asterisk. Actual sample weight can be determined from the text. Following are possible variations in data presentation on a value map:

*	No data
+ 27	Single analysis, 10 g sample weight
+ 27*	single analysis, < 10 g sample weight
+ 27 (14)	Repeat analysis, both samples 10 g
+ 27 (14*)	Repeat analysis, first sample 10 g, repeat < 10 g
+ <1	Single analysis, 10 g sample, less than detection limit of 1 ppb

In summary, geochemical follow-up investigations for Au 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 Au 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.

LAKE SEDIMENT DATA LIST LEGEND

Table 2 lists the field and map information which is recorded at each sample site and printed in the accompanying data listings.

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TABLE 2. FIELD DATA DESCRIPTIONS

TABLE 1. Summary of Analytical Data and Methods

Element	Detection level	Method(s)
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	AAS
Mo Molybdenum	2 ppm	AAS
Fe Iron	0.02 pct	AAS
Hg Mercury	10 ppb	AAS
LOI Loss-on-ignition	1.0 pct	GRAV
U Uranium	0.5 ppm	NADNC
V Vanadium	5 ppm	AAS
Cd Cadmium	0.2 ppm	AAS
Sb Antimony	0.2 ppm	AAS
F Fluorine	20 ppm	ISE
Au Gold	1 ppb	FA-NA
WATERS:		
F Fluoride	20 ppb	ISE
pH Hydrogen ion activity		GCM
U Uranium	0.05 ppb	LIF
Ca Calcium	0.5 ppb	AAS
Mg Magnesium	0.05 ppb	AAS
T-Alk Total Alkalinity	1 ppm	TIT

- AAS - Atomic absorption spectrometry
- GRAV - Gravimetry
- FA-NA - Fire assay preconcentration-neutron activation
- ISE - Ion selective electrode
- GCM - Glass Calomel electrode and pH meter
- LIF - Laser-induced fluorescence
- NADNC - Neutron Activation delayed neutron counting
- TIT - Titration

FIELD RECORD	DEFINITION	TEXT CODE
MAP SHEET	National topographic system (NTS): lettered quadrangle (1:250,000 scale) or (1:50,000 scale). Part of sample number.	031E, 031K or 031L
SAMPLE ID	Remainder of sample number: Year..... Field crew..... Sample sequence number.....	88 1,3,5 or 7 001 - 999
REP STAT	Replicate status; 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 TYPE	Major rock type of lake catchment area: Precambrian Diabase dykes..... Archean quartz monzonite, granodiorite trondjemite, quartz diorite, granite quartz and feldspar porphyries (rock units maybe massive, foliated, equigranular or gneissic)..... equigranular and porphyritic monzonite syenodiorite, syenite, diorite, quartz diorite..... gabbro, norite, diorite, anorthosite, anorthositic gabbro, peridotite, pyroxenite..... chemical metasediments, ironstone magnetite and pyrite ironstone, chert clastic metasediments, pebble and boulder conglomerate, sandstone, siltstone, argillite and derived schists migmatite, metatexite..... alkalic mafic metavolcanic flows, felsic to intermediate metavolcanics flows, tuff, agglomerate, breccia and migmatite..... mafic metavolcanics; massive and pillowed flows, tuff, agglomerate, breccia, amphibolite gneiss, migmatite.....	LPAD AGM AGY AUB AIF ACSP AMVA AMVF AMVB
ROCK AGE	Stratigraphic age of dominant rock type in catchment basin: Precambrian Archean	04 02
TERRAIN RELIEF	Relief of lake catchment basin: Low..... Medium..... High.....	Lo Med Hi

TABLE 2 – Continued

FIELD RECORD	DEFINITION	TEXT CODE
SAMPLE CONT.	Contamination; human or natural None Work Camp Fuel..... Gossan	- Wo Ca Fu Go
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 water: None Heavy..... Light	- Hvy Lgt
MISC.	Refers to missing data in any field	*