

Geological Survey of Canada Open File 1643
(64E, parts of 74A and 74H)
CANADA – SASKATCHEWAN MINERAL DEVELOPMENT AGREEMENT (1984 – 1989)

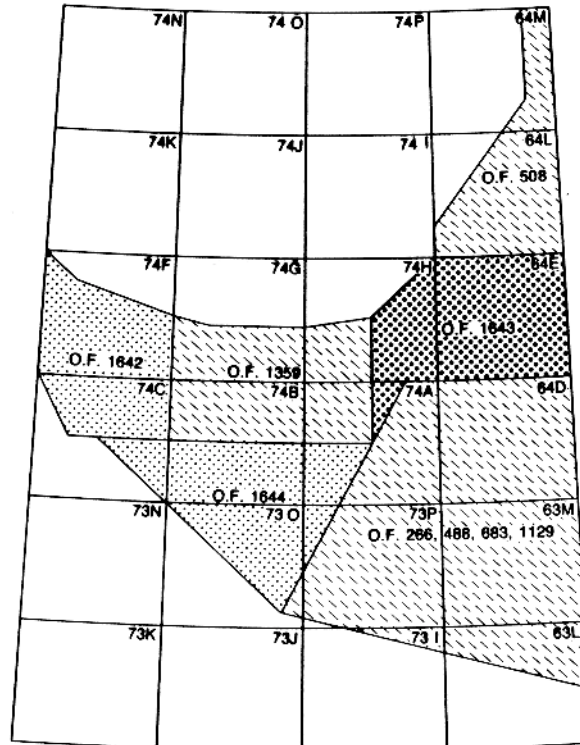
REGIONAL LAKE SEDIMENT AND WATER GEOCHEMICAL DATA, NORTHEASTERN SASKATCHEWAN



Project Director: E.H.W. Hornbrook
Project Coordinator: P.W.B. Friske
Subproject Leaders: J.J. Lynch, H.R. Schmitt
Members: S. Cook, C.C. Durham, A. Galletta, H. Gross, M. McCurdy, D. Wright

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REGIONAL LAKE SEDIMENT AND WATER GEOCHEMICAL DATA, SASKATCHEWAN 1988,
GSC OPEN FILE 1643, NGR 108-1988,
NTS 64E; PARTS OF 74A, 74H



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX
TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS
SYSTEME NATIONAL DE REFERENCE CARTOGRAPHIQUE
ET INDEX DES CARTES ATTENANTES PUBLIEES PAR
LA COMMISSION GEOLOGIQUE DU CANADA

Open File 1643 represents a contribution to the Canada – Saskatchewan Mineral Development Agreement (1984-1989), 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, SASKATCHEWAN 1988, GSC OF 1643, NGR 108-1988, NTS 64E; PARTS OF 74A, 74H

Geological Survey of Canada Open File 1643
Regional Lake Sediment and water Geochemical Reconnaissance Data
North-East Saskatchewan, consisting of parts of NTS 64E, 74A and 74H

INTRODUCTION

Open File 1643 is one of three open files (1642, 1643, 1644) covering parts of northern Saskatchewan which were sampled in 1978, 1984 and 1985 respectively and previously published as Open Files 556, 1106 and 1213. The new open files represent additional analyses of archived lake sediment material for 28 elements by instrumental neutron activation.

The reconnaissance survey was originally undertaken in 1984 by the Geological Survey of Canada in conjunction with the Saskatchewan Department of Energy and Mines under the Canada - Saskatchewan Mineral Development Agreement (1984 - 1989).

The data base of the survey contributes to a national geochemical reconnaissance and are 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 and archived analysis programs.

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: Marshall, Macklin Monaghan Ltd., Toronto, Ontario
E.H.W. Hornbrook
W.B. Coker

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

Analysis: Barringer Magenta Ltd., Rexdale, Ontario (1984)
Barringer Magenta (Alberta) Ltd., Calgary Alberta (1984)
Bondar Clegg and Company Ltd., Ottawa, Ontario (1988)
J.J. Lynch

H.R. Schmitt coordinated and edited open file production.

A.C. Galletta and D. Wright managed the digital geochemical data, provided computer processing support, and developed software to plot the open file, symbol and regional trend maps. 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.A. Gross developed microcomputer software to produce data listings and summary statistics

J. Yelle and F. Williams of the Geological Information Division supervised the preparation of open file base maps by Cartography Unit A-2.

M. McCurdy, S. Cook and C.C. Durham provided technical support and editing assistance.

J.C. Belec provided word processing support.

DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT

Helicopter supported sample collection was carried out during the summer of 1984.

Lake sediment and water samples were collected at an average density of one sample per 13 square kilometres throughout the 18,800 square kilometers of the north-east Saskatchewan survey area.

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

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 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).

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 RGR 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 5 to 10 g) is irradiated for 20 minutes in a neutron flux whose approximate density is 5.3×10^{11} neutrons/square cm/second. Counting is begun 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. 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, Fe, Cd, As and Sb a 1 gram sample was reacted with 6 mL of a mixture of 4 M 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, Fe and Cd were determined by atomic absorption spectroscopy using an air-acetylene flame. Background corrections were made for Pb, Ni, Co, and Ag and Cd.

Arsenic and Sb were determined by atomic absorption using a hydride evolution

method wherein the hydride (AsH_3 or SbH_3) 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 (As); 0.2 ppb (Sb).

Molybdenum and vanadium were determined by atomic absorption spectroscopy using a nitrous oxide acetylene flame. A 0.5 gram 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 was continued at 90°C for an additional 90 minutes. After cooling, 8 mL of 1250 ppm Al solution were added and the sample solution was diluted to 10 mL before aspiration. Detection limit = Mo - 2 ppm; V - 5 ppm.

Mercury was determined by the Hatch and Ott procedure with some modifications. The method is described by Jonasson et. al. (1973). A 0.5 gram sample was reacted with 20 mL concentrated HNO_3 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 10% w/v SnSO_4 in M H_2SO_4 . 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 were made at 253.7 nm. Detection limit = 10 ppb.

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 was left at this temperature for 4 hours, then allowed to cool to room temperature for weighing. Detection limit = 1.0 pct.

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, 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 to the exp. 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 BF_3 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.

Fluoride in lake water samples was determined using a fluoride electrode. Prior to measurement an aliquot of the sample was 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) was measured with a combination glass-calomel electrode and a pH meter.

Uranium in waters was 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) was 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 was used. Further, the reaction of uranium with Fluran can be delayed or sluggish; for this reason an arbitrary 24 hour time delay between the addition of the Fluran and the actual reading was incorporated into this method. In practice, 500 μL of Fluran solution were added to a 5 mL sample and allowed to stand for 24 hours. At the end of this period fluorescence readings were made with the addition of 0.0, 0.2 and 0.4 ppb U. For high samples the additions were 0.0, 2.0 and 4.0 (20 μL aliquots of either 55 or 550 ppb U are used). All readings were taken against a sample blank. Detection limit = .05 ppb.

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 twenty 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 used 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 methodology and interpretation.

LAKE SEDIMENT DATA LIST LEGEND AND DIGITAL FIELD RECORD FORMAT

Table 2 lists both the field and map information which is recorded at each sample site and is listed in the accompanying data listings, and the digital record format for the tape or diskette version of the open file. For the digital record A = alpha; X = numeric, unless indicated otherwise.

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Table 1. Summary of Analytical Data and Methods

Element	Detection Level (1985)	Detection Level (1988)	Method(s)
<u>Sediments:</u>			
Zn Zinc	2 ppm	100 ppm	AAS/INA
Cu Copper	2 ppm		AAS
Pb Lead	2 ppm		AAS
Ni Nickel	2 ppm	20 ppm	AAS/INA
Co Cobalt	2 ppm	5 ppm	AAS/INA
Ag Silver	0.2 ppm	2 ppm	AAS/INA
Mn Manganese	5 ppm		AAS
As Arsenic	1 ppm	0.5 ppm	AAS/INA
Mo Molybdenum	2 ppm	1 ppm	AAS/INA
Fe Iron	0.02 pct	0.2 pct	AAS/INA
Hg Mercury	10 ppb		AAS
LOI Loss-on-ignition	1.0 pct		GRAV
U Uranium	0.5 ppm	0.2 ppm	NADNC/INA
V Vanadium	5 ppm		AAS
Cd Cadmium	0.2 ppm	5 ppm	AAS/INA
Sb Antimony	0.2 ppm	0.1 ppm	AAS/INA
Na Sodium		0.02 pct	INA
Sc Scandium		0.2 ppm	INA
Cr Chromium		20 ppm	INA
Se Selenium		5 ppm	INA
Br Bromine		0.5 ppm	INA
Rb Rubidium		5 ppm	INA
Zr Zirconium		200 ppm	INA
Sn Tin		100 ppm	INA
Te Tellurium		10 ppm	INA

Table 1 - Continued

Element	Detection Level (1985)	Detection Level (1988)	Method(s)
Cs Cesium		0.5 ppm	INA
Ba Barium		50 ppm	INA
La Lanthanum		2 ppm	INA
Ce Cerium		5 ppm	INA
Sm Samarium		0.05 ppm	INA
Eu Europium		1 ppm	INA
Tb Terbium		0.5 ppm	INA
Yb Ytterbium		2 ppm	INA
Lu Lutecium		0.2 ppm	INA
Hf Hafnium		1 ppm	INA
Ta Tantalum		0.5 ppm	INA
W Tungsten		1 ppm	INA
Ir Iridium		50 ppb	INA
Au Gold		2 ppm	INA
Th Thorium		0.2 ppm	INA
<u>Waters:</u>			
F Fluoride	20 ppb		ISE
pH			GCM
U Uranium	0.05 ppb		LIF
Wt Test weight		± 0.01 g	GRAV

AAS Atomic absorption spectrometry

INA Instrumental Neutron Activation Analysis

GRAV Gravimetry

ISE Ion selective electrode

GCM Glass Calomel electrode and pH meter

LIF Laser-induced fluorescence

NADNC Neutron Activation delayed neutron counting

TABLE 2. DATA LIST AND DIGITAL FORMAT LEGEND
Record 1 – Field Data

FIELD RECORD	DEFINITION	TEXT CODE	DIGITAL RECORD COLUMN AND CODE
MAP	National topographic system (NTS): lettered quadrangle (1:250,000 scale or 1:50,000 scale). Part of sample number		1 - 6 "XXXXXX"
SAMPLE ID	Remainder of sample number: Year Field Crew Sample sequence number	19XX 1, 3, 5, 7 001 - 999	7 - 12 "XX " " X " " XXX"
UTM COORDINATES	Universal Transverse Mercator (UTM) Coordinate system; digitized sample location coordinates.		
ZN	Zone 7 to 22		13 - 14 "XX"
EASTING	UTM Easting in metres		15 - 20 "XXXXXX"
NORTHING	UTM Northing in metres		21 - 27 "XXXXXXX"
ROCK TYPE	Major rock type of lake catchment area: Precambrian Wollaston Domain Granite pegmatite Granite and alaskite Biotite granodiorite Quartz muscovite schist Calc-silicate gneiss Meta-arkosic gneiss Impure meta-quartzite Pelitic and psammopelitic gneiss Graphitic pelitic gneiss Mixed metasediments Metaquartzite Meta-arkose Amphibolite	WPEG WG WGDB WSH WCN WRN WRQ WPSN WPF WS WQ WR WV	"WPEG" "WG" "WGDB" "WSH" "WCN" "WRN" "WRQ" "WPSN" "WPF" "WS" "WQ" "WR" "WV"

TABLE 2 - Continued

FIELD RECORD	DEFINITION	TEXT CODE	DIGITAL RECORD COLUMN AND CODE
ROCK TYPE) (continued)	Felsic granitoid gneiss Biotite-hornblende gneiss Diabase, gabbro Fluvial sandstone Conglomerate Cataclasite Rottenstone Domain Megacrystic granitoids Sheared granitoids Monzogranite Quartz monzodiorite Tonalite Amphibolite Pelitic gneiss Peter Lake Domain Mylonite Felsic gneiss Hornblende-biotite gneiss Mafic gneiss Granitic dykes Felsic granitoid Megacrystic granitoid Sheared PGP Mafic granitoids Layered metagabbro Quartzo-feldspathic gneiss Slate, biotite schist La Ronge Domain Granodiorite Quartz monzodiorite Unknown	WFN WFB DD MFC MFB X RGP RGPX RGM RBD RGT RMG RNG PX PGN PN PBN PBNG PG PGP PGPX PBG PBA POF PSL LGD LGM UKNN	"WAN" "WFB" "DD" "MFC" "MFB" "X" "RGP" "RGPX" "RGM" "RBD" "RGT" "RMG" "RNG" "PX" "PGN" "PN" "PBN" "PBN" "PG" "PGP" "PGPX" "PBG" "PBA" "POF" "PSL" "LGC" "LGM" "UKNN"
LAKE AREA	The area of the water body sampled: Pond ¼ to 1 sq km 1 to 5 sq km greater than 5 sq km	POND .25 - 1 1 - 5 > 5	32 - 35 "1 " " 1 " " 1 " " 1"

TABLE 2 – Continued

FIELD RECORD	DEFINITION	TEXT CODE	DIGITAL RECORD COLUMN AND CODE
LAKE DEP	Sample depth from surface of water body to lake bottom in feet	1 - 999	36 - 38 "XXX"
RS	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	"00" "10" "20"
RLF	Relief of the lake catchment basin: Low Medium High	Lw Md Hi	41 - 43 "1 " " 1 " " 1"
CNT	Contaminaton, human or natural: None Work Camp Fuel Gossan	Wo Ca Fu Go	48 - 51 " " "1 " " 1 " " 1 " " 1"
COLR	Sediment sample colour; up to two colours may be selected: Tan Yellow Green Grey Brown Black	Tn Yl Gn Gy Br Bk	52 - 57 "1 " " 1 " " 1 " " 1 " " 1 " " 1"
SUSP	Suspended matter in water: None Heavy Light	Hvy Lgt	58 - 59 " " "1 " " 1"
AGE	Stratigraphic age of dominant rock type in catchment basin: Proterozoic	04	"04"

Record 2 – Neutron Activation Analytical Data

FIELD RECORD	DEFINITION	UNITS	DETECTION LEVEL	DIGITAL RECORD COLUMN AND CODE
Na	Sodium in lake sediments	pct	0.02	16 – 21
Sc	Scandium in lake sediments	ppm	0.2	22 – 27
Cr	Chromium in lake sediments	ppm	20	28 – 33
Fe	Iron in lake sediments	pct	0.2	34 – 39
Co	Cobalt in lake sediments	ppm	5	40 – 45
Ni	Nickel in lake sediments	ppm	20	46 – 51
Zn*	Zinc in lake sediments	ppm	100	52 – 57
As	Arsenic in lake sediments	ppm	0.5	58 – 63
Se*	Selenium in lake sediments	ppm	5	64 – 69
Br	Bromine in lake sediments	ppm	0.5	70 - 75

Record 3 – Neutron Activation Analytical Data

FIELD RECORD	DEFINITION	UNITS	DETECTION LEVEL	DIGITAL RECORD COLUMN AND CODE
Rb	Rubidium in lake sediments	ppm	5	16 – 21
Zr*	Zirconium in lake sediments	ppm	200	22 – 27
Mo	Molybdenum in lake sediments	ppm	1	28 – 33
Ag*	Silver in lake sediments	ppm	2	34 – 39
Cd*	Cadmium in lake sediments	ppm	5	40 – 45
Sn*	Tin in lake sediments	ppm	100	46 – 51
Sb	Antimony in lake sediments	ppm	0.1	52 – 57
Te*	Tellurium in lake sediments	ppm	10	58 – 63
Cs	Cesium in lake sediments	ppm	0.5	64 – 69
Ba	Barium in lake sediments	ppm	10	70 – 75

Record 4 – Neutron Activation Analytical Data

FIELD RECORD	DEFINITION	UNITS	DETECTION LEVEL	DIGITAL RECORD COLUMN AND CODE
La	Lanthanum in lake sediments	ppm	2	16 – 21
Ce	Cerium in lake sediments	ppm	5	22 – 27
Sm	Samarium in lake sediments	ppm	0.05	28 – 33
Eu	Europium in lake sediments	ppm	1	34 – 39
Tb	Terbium in lake sediments	ppm	0.5	40 – 45
Yb	Ytterbium in lake sediments	ppm	2	46 – 51
Lu	Lutetium in lake sediments	ppm	0.2	52 – 57
Hf	Hafnium in lake sediments	ppm	1	58 – 63
Ta	Tantalum in lake sediments	ppm	0.5	64 – 69
W	Tungsten in lake sediments	ppm	1	70 - 75

Record 5 – Neutron Activation Analytical Data

FIELD RECORD	DEFINITION	UNITS	DETECTION LEVEL	DIGITAL RECORD COLUMN AND CODE
Ir*	Iridium in lake sediments	ppb	50	16 – 21
Au	Gold in lake sediments	ppb	2	22 – 27
Th	Thorium in lake sediments	ppm	0.2	28 – 33
U	Uranium in lake sediments	ppm	0.2	34 – 39
Wt	Tungsten in lake sediments	gram		40 – 45

Record 6 - Atomic Absorption Spectrometry and Other Data

FIELD RECORD	DEFINITION	UNITS	DETECTION LEVEL	DIGITAL RECORD COLUMN AND CODE
Zn - SEDS	Zinc in lake sediments	ppm	2	21 - 25
Cu - SEDS	Cerium in lake sediments	ppm	2	26 – 30
Pb – SEDS	Lead in lake sediments	ppm	2	31 - 35
Ni – SEDS	Nickel in lake sediments	ppm	2	36 - 40
Co – SEDS	Cobalt in lake sediments	ppm	2	41 – 45
Ag – SEDS	Silver in lake sediments	ppm	0.2	46 - 50
Mn – SEDS	Manganese in lake sediments	ppm	5	51 – 55
As – SEDS	Arsenic in lake sediments	ppm	1	56 – 60
Mo - SEDS	Molybdenum in lake sediments	ppm	2	61 - 65
Fe - SEDS	Iron in lake sediments	pct	0.02	66 - 70
Hg – SEDS	Mercury in lake sediments	ppb	10	71 – 75
LOI – SEDS	Loss-on-ignition	pct	1	76 - 79

Record 7 - Atomic Absorption Spectrometry and Other Data

FIELD RECORD	DEFINITION	UNITS	DETECTION LEVEL	DIGITAL RECORD COLUMN AND CODE
U - SEDS	Uranium in lake sediments	ppm	0.5	21 - 25
V – SEDS	Vanadium in lake sediments	ppm	5	31 – 35
Cd – SEDS	Cadmium in lake sediments	ppm	0.2	36 – 40
Sb – SEDS	Antimony in lake sediments	ppm	0.2	51 - 55

* Data not included in Open File release because of inadequate detection limit and/or precision.

Record 8 - Atomic Absorption Spectrometry and Other Data

FIELD RECORD	DEFINITION	UNITS	DETECTION LEVEL	DIGITAL RECORD COLUMN AND CODE
F - WATERS	Fluoride in lake waters	ppb	20	26 - 30
pH -WATERS	pH of lake waters			31 - 35
U - WATERS	Uranium in lake waters	ppb	0.05	36 - 40