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A GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM IN MACNICOL, TUSTIN, BRIDGES, AND DOCKER TOWNSHIPS, DISTRICT OF KENORA, ONTARIO

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Critical Reader

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CONTENTS

NOTICE

A previous paper by Coker, Geological Survey Paper 79-18, was incorrectly titled. The title shoud read:

A Geochemical Orientation Survey for Uranium of the Montreal River Area, District of Algoma, Ontario.

not

A Geological Orientation Survey for Uranium of the Montreal River Area, District of Algoma, Ontario

A GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM IN MACNICOL, TUSTIN, BRIDGES, AND DOCKER TOWNSHIPS, DISTRICT OF KENORA, ONTARIO

Abstract

Detailed geochemical studies were carried out in 1975 to determine the distribution and dispersion patterns of uranium, the base metals, and associated elements in bedrock, surficial overburden, and lake and stream waters and sediments. Sampled media were selectively analyzed by a variety of techniques for: Zn, Cu, Pb, Ni, Co, Ag, Mn, As, Mo, Fe, Hg, Sr, Ba, Ti, Al, Ca, Mg, K, V, Cr, Be, La, Y, and U.

Multielement regional distribution patterns in both lake waters and sediments provide information indicative of pegmatitic uranium mineralization, disseminated sulphide mineralization, chemical variations in bedrock lithologies, and differences in aquatic physicochemistry. A definite value was found in interpreting hydrogeochemical dispersion patterns in terms of elemental associations based on trace and minor element assemblages outlined for known mineralization, bedrock lithologies and different aquatic physicochemistry within the study area.

Reconnaissance exploration for uranium and base metal mineralization can be carried out utilizing lake sediments at sample densities of one sample/13 km² and 2 to 5 km², respectively. Lake waters can provide auxiliary data, particularly in the search for uranium. Detailed exploration can be accomplished using lake waters and sediments. The use of stream waters and sediments for mineral exploration in this area was not worthwhile nor was the chemistry of the overburden indicative of the underlying bedrock lithology.

Résumé

En 1975, on a effectué des études géochimiques détaillées pout déterminer le mode de distribution et de dispersion de l'uranium, des métaux communs et des éléments associés que l'on rencontre dans la roche en place, les terrains de couverture, et les eaux et sédiments lacustres et fluviatiles. On a analysé de fanon sélective différents échantillons prélevés par divers moyens, en particulier pour identifier les éléments suivants: Zn, Cu, Pb, Ni, Co, Ag, Mn, As, Mo, Fe, Hg, Sr, Ba, Ti, Al, Ca, Mg, K, V, Cr, Be, La, Y, et U.

Dans les eaux et sédiments lacustres, le mode de distribution des groupes d'éléments, à l'échelle régionale, nous a donné certaines informations, indiquant l'existence de minéralisations uranifères de type pegmatitique, de minéralisations en sulfures disséminés, ainsi que des variations de la composition chimique de la roche en place, et des variations physiques et chimiques des milieux aqueux. On a obtenu des résultats très concluants, en interprétant les modes de dispersion hydrogéochimique suivant les assemblages d'éléments secondaires et d'éléments-traces caractérisant une minéralisation donnée, la lithologie de la roche en place et diverses propriétés physiques et chimiques de l'eau, tels qu'observés dans la région étudiée.

On peut effectuer l'exploration de reconnaissance des minéralisations en uranium et en métaux communs, en prélevant des échantillons de sédiments lacustres, dans la proportion de un pour 13 km², et de deux pour 5 km² respectivement. L'examen des eaux lacustres peut fournir des données supplémentaires, en particulier lors de la recherche de l'uranium. On peut réaliser l'exploration détaillée en considérant les sédiments et les eaux lacustres. Dans cette région, il ne s'est pas avéré utile d'analyser les eaux et sédiments fluviatiles lors de l'exploration minérale, et la chimie des terrains de couverture ne s'accordait pas avec la lithologie de la roche en place sous-jacente.

INTRODUCTION

A geochemical orientation survey to determine the distribution and dispersion patterns of uranium, the base metals, and associated elements in bedrock, surficial overburden and lake and stream waters and sediments was carried out in the townships of MacNicol, Tustin, Bridges and Docker, Kenora District (52 F/13), Ontario (Coker, 1975).

The survey was designed to permit testing of geochemical methods with regard to their responses to typical geological and environmental influences within the southern portion of the Superior Province of northwestern Ontario. The information obtained will be used to assess the effectiveness of geochemistry for reconnaissance surveys in these and similar nearby terrains as a basis for future regional surveys.

Acknowledgments

Assistance in the field during 1975 was provided by S. Earle. Preparation of base maps and the computer listings in the appendixes was carried out by C. Crosby. D. Ellwood provided guidance with computer programming. Sample preparation at the GSC was carried out by P. Lavergne and S. Earle. Analyses carried out within the GSC were performed by A. Jones, R. Horton, G. Gauthier, and E. Moore.

DESCRIPTION OF THE STUDY AREA

Location and Access

The study area comprises the townships of MacNicol, Tustin, Bridges, and Docker, an area of 370 km² in the District of Kenora, Ontario. The area is located approximately 46 km east of Kenora and 19 km west of Vermilion Bay. The Trans-Canada Highway (Highway 17) runs approximately east-west through the centre of the study area. A number of secondary roads run north and south from Highway 17.

Physiography

In general, the topography is moderately rugged throughout most of this heavily forested (coniferous with subordinate deciduous trees) area. Relief seldom exceeds 45 m with maximum relief being in the order of 90 m. Exposures of bedrock are abundant and drainage is relatively good.

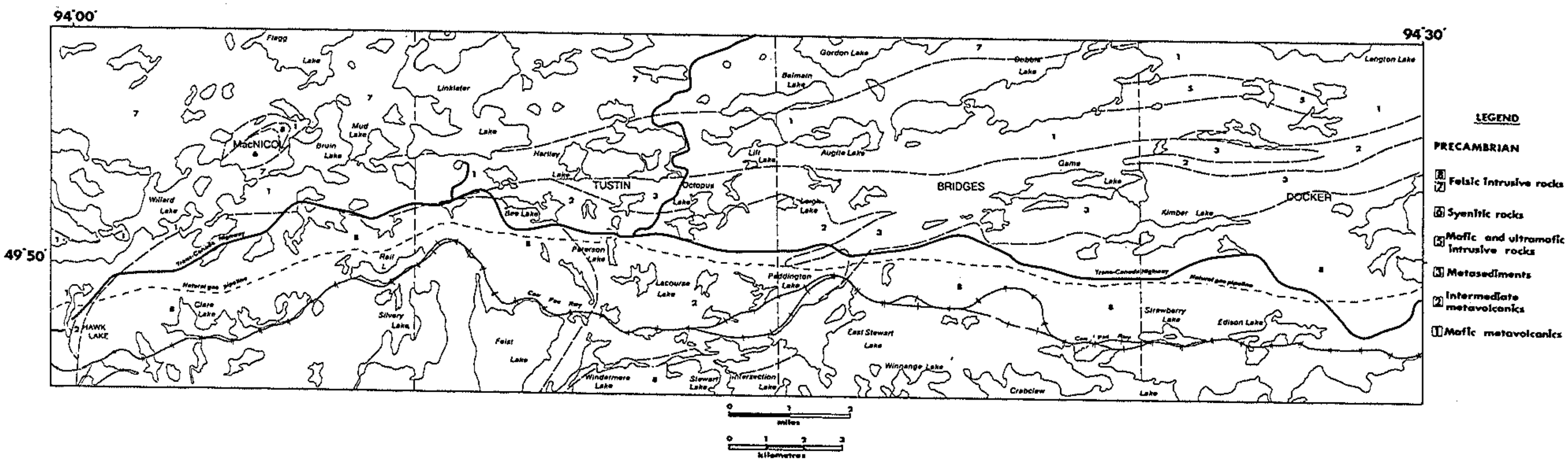


Figure 1. Generalized geology (after Pyrslak, 1967).

General Geology

The geology of the area has been mapped recently by Pryslak (1976). A generalized version of the geology, after Pryslak (1976), is illustrated in Figure 1.

The bedrock comprising the east-west trending "greenstone" belt is Archean in age. The metavolcanic sequence varies in composition from mafic to intermediate and includes flows and pyroclastic material. Intimately associated with the metavolcanics are metasediments consisting predominantly of greywacke and minor quantities of calc-silicate gneiss, massive calc-silicate rocks of uncertain origin, and iron formation. The metavolcanic-metasedimentary sequence is intruded by sills, dykes, and irregular bodies of rock that vary in composition from felsic to intermediate. The batholiths adjacent to the metavolcanic-metasedimentary belt comprise several intrusive units, and range in composition from felsic to intermediate.

Pleistocene glacial deposits (predominantly unsorted sand, gravel, and boulders), cover a large amount of the bedrock in the northern part of the area. These deposits have undergone significant erosion by glacial lake action.

Mineralization

Metallic mineralization in the area consists mainly of concentrations of sulphide and uranium minerals. The sulphides, consisting mainly of pyrrhotite and pyrite, but with minor concentrations of galena, sphalerite, chalcopyrite, molybdenite, and minerals containing nickel and cobalt, are associated mainly with metasediments and intermediate volcanics, and possibly with ultramafic rocks. The sulphide occurrences in the area are described by Pryslak (1976) but to date no economic occurrences have been discovered. All uranium mineralization presently known in the area is associated with pegmatites. Mineralized pegmatites can be identified by yellow to yellow-green secondary minerals, commonly beta-uranotite and uranophane, developed on weathered surfaces and in fractures in the pegmatite. Uraninite has been identified as the most common primary radioactive mineral although occurrences of uranothorite, allanite, and tantalite have also been reported (Chisholm 1950; Satterly 1955; and Pryslak, 1976). It has also been noted that the most highly radioactive areas are invariably associated with biotite-rich zones, apatite-rich zones, and/or magnetite-rich zones in the pegmatites. The distribution of uranium in the pegmatites is generally very erratic; economic concentrations are rare but an exception is the New Campbell Island Mines Ltd. property, on the northwest shore of Richard Lake, which has undergone limited underground exploration by means of two adits. This property has recently undergone reassessment (Northern Miner, February 10, 1977). Uranium occurrences in the area were described in detail by Chisholm (1950), Satterly (1955), and Pryslak (1976).

Nonmetallic mineral occurrences of beryl and mica are also known in the region (Pryslak, 1976). The only recorded production in the area is of industrial minerals, namely building stone, and crushed rock used for ballast by the Canadian Pacific Railway Company.

The prime objective of the study was to correlate surficial geochemical responses against known geology, primarily, with regard to the occurrence of uranium in the area.

SAMPLING TECHNIQUES AND ANALYTICAL PROCEDURES

Sample Collection

Lake sediment samples were obtained using a Geological Survey of Canada sampler from a Hughes 500-C turbo helicopter. Surficial (top 5-10 cm) sediment at the sediment-water interface was avoided (Coker and Nichol, 1975). Organic-rich sediments were collected from the central-deepest part (profundal basins) of permanent lakes and ponds. The physical nature of the sediment did not vary much from lake to lake, commonly being a brown thixotropic gel sometimes having a hydrogen sulphide odour. No difficulty was experienced in collecting such samples.

Surface lake waters, which were generally very clear in colour, were collected directly into polyethylene bottles and acidified (250 µL of HNO_3 per 125 mL of water) on the day of collection.

Measurements of the surface and bottom water pH, dissolved oxygen content, temperature, and conductivity were made using a Martek Mark V Water Quality Analyzer. Unfortunately, the physicochemical conditions of the bottom waters were measured only at the first few sample sites due to an equipment malfunction. Lake water depth was also recorded at each sample site.

A number of standard observations, as well as the Martek data, were recorded on lake water (Appendix 2) and lake sediment (Appendix 3) field data cards for the corresponding sample taken at each sample site (Appendix 1). The lake sediment, lake water, stream water and sediment, bedrock and surficial overburden field data cards employed in this survey have been described by Garrett (1974).

Generally clear waters and inorganic clastic sediments were collected from the central portion of active stream channels (Appendix 1). Yellow to brown waters and organic-rich sediments were commonly obtained in slowly draining swampy stream channels. Stream waters were collected and treated exactly as were lake waters. A number of standard observations, including water pH, as measured using a Geological Survey model pH meter, was recorded on field cards for stream waters (Appendix 4) and stream sediments (Appendix 5).

Bedrock (composite chip) samples were collected from the various lithologies present in the area (Appendix 6). Various petrographic observations, as well as the average radioactivity over the exposed extent of the sampled outcrop measured using an Exploranium GRS-101 scintillometer, were recorded on field cards (Appendix 7).

At each bedrock sample site a surficial overburden sample was also collected (Appendix 6). Most overburden in the area is characterized by podzolic soil development except in swampy poorly-drained regions where gleysolic soil development is common. In most instances the B soil horizon was sampled. Standard observations were recorded on field cards (Appendix 8).

Preparation

Air drying generally resulted in the organic-rich lake and stream sediments becoming extremely hard. These samples were disaggregated, using a mortar and pestle and a ceramic ball mill, to obtain a fine powder which could pass a minus 80-mesh (180 µm) sieve. Lake sediment sample preparation was carried out by the staff of Golder Associates, Ottawa on a contractual basis with the Geological Survey of Canada. All other sample preparation was carried out in the Geological Survey laboratories.

Overburden and inorganic clastic stream sediment samples were dried and sieved through an 80-mesh (180 µm) sieve to obtain the minus 80-mesh (180 µm) fraction.

Bedrock samples were crushed to approximately 1 cm in size in a jaw crusher fitted with steel plates. The crushed material was coarse sieved to remove fines in order to prevent possible contamination due to metal chips from the jaw crusher. The sample was then ground to approximately 10 mesh size in a disc mill fitted with ceramic plates. The resultant material was coned and quartered to obtain a sample of about 10 to 15 grams. This sample was ground again to about 100 mesh (150 µm) (98%) by mechanical agitation in a small ceramic ball mill.

Analyses

Analyses of lake sediment samples for Zn, Cu, Pb, Ni, Co, Ag, Mn, As, Mo, Fe, Hg, and loss-on-ignition (L.O.I.) were carried out by Chemex Labs. Inc. in Vancouver, British Columbia and for U by Atomic Energy of Canada Ltd. in Ottawa.

A 1 g sample of minus 80-mesh lake sediment was digested in a test tube with 6 mL of a mixture of 4M HNO_3-1M HCl overnight. 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 cooled to room temperature and diluted to 20 mL with distilled water and mixed. The contents of Zn, Cu, Mn, Fe, Pb, Ni, Co, and Ag were determined by atomic absorption spectroscopy using an air-acetylene flame. Analyses for the last four elements were carried out using simultaneous, automatic background correction.

Arsenic in the lake sediment 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.

For molybdenum analyses a 500 mg sample of minus 80-mesh lake sediment was decomposed in 1.5 mL conc. HNO_3 at 90°C for 30 minutes. At this point 0.5 mL conc. HCl was added and the digestion was continued at 90°C for an additional 90 minutes. After cooling, 8 mL of a 1250 ppm Al solution were added and the solution was made up to 10 mL with distilled water. Mo was estimated by direct aspiration of the sample solution into the nitrous oxide-acetylene flame of an atomic absorption spectrophotometer.

Mercury content of the lake sediment samples was determined by the Hatch and Ott procedure, with some modifications, as described by Jonasson et al. (1973).

Loss-on-ignition (L.O.I.) was determined on a 500 mg sample of lake sediment by ashing during a three hour time-temperature controlled rise to 500°C. The organic carbon content of a lake sediment sample is proportional to the per cent weight loss-on-ignition (Coker and Nichol, 1975).

The delayed neutron activation method of analysis, by which the lake sediment samples were analysed for the total U, was developed by Atomic Energy of Canada Ltd., Commercial Products Division, and is described in some detail by Boulanger et al. (1975).

All other analytical work was carried out in the laboratories of the Geochemistry Subdivision Resource Geophysics and Geochemistry Division, Geological Survey of Canada, Ottawa.

A 50 mL aliquot of acidified water sample (lake and stream water) was extracted in 6 mL of MIBK with 3 mL of 1% APDC. The contents of Zn, Cu, Pb, Ni, and Co in the concentrate were estimated by atomic absorption spectrophotometry. The contents of Mn and Fe in the water samples were determined by direct atomic absorption spectrophotometry.

The fluorometric method of analysis for acid extractable uranium in lake and stream water samples, and in stream sediment, surficial overburden, and bedrock samples, was based on that described by Smith and Lynch (1969).

The Zn, Cu, Mn, Fe, Pb, Ni, and Co contents of the stream sediment and surficial overburden samples were estimated employing identical digestion, leach and atomic absorption spectrophotometric techniques, including background correction for Pb, Ni, and Co, as used by Chemex Labs for lake sediments.

A 1 g sample of prepared bedrock sample material (√100 mesh) was digested in a platinum dish with 7 mL of 50 per cent HF. This was taken to dryness and a mixture of 5 mL conc. HNO_3-2 mL conc. $HClO_4$ was added and evaporated until fumes of $HClO_4$ were produced. The resultant material was then taken up in 20 mL of 1M HCl. The contents of Zn, Cu, Fe, Mn, Pb, Ni, and Co were estimated by atomic absorption spectrophotometry using an air-acetylene flame. Analyses of the last three elements were carried out using simultaneous, automatic background correction.

Analyses of the Mo content of the stream sediment, surficial overburden, and bedrock samples were carried out in an identical manner to that employed by Chemex Labs for lake sediments.

The D.C. arc emission spectrographic method, used to analyze the lake sediment, surficial overburden, and bedrock samples for Sr, Ba, Mn, Ti, Al, Ca, Mg, Fe, K, Pb, Zn, V, Mo, Cr, Cu, Co, Ni, Be, La, and Y, is described by Timperley (1974).

Detection limits for the analytical methods used are given with the analytical data in the appendixes. The actual number used for reporting values below the lower detection limit (usually approximately one half the lower detection limit) and upper detection limit, (usually equal to upper detection limit) is also given. Analytical data for surface lake waters, lake sediments, stream waters, stream sediments, bedrock, and overburden are listed in Appendixes 2, 3, 4, 5, 7, and 8, respectively.

Evaluation of quality of the analytical data was based on a blind duplicate and reference control sample system. Each of these samples was present on a random 5 per cent frequency basis. In each block of 20 samples there were 17 routine field samples, one field duplicate sample, one blind duplicate, and one reference control sample. The field duplicate sample was collected at one of the 17 routine field sites, the blind duplicate is a split of one of the 18 field samples and the reference control sample is a split from one of several reference bulk samples available. Rejection or acceptance of data for each block of 20 samples was determined by statistical criteria involving the blind duplicate and reference control sample data. Rejected data were replaced by new data after repeat analyses.

RESULTS AND DISCUSSION

Lake Waters and Sediments

A summary of the analytical data for the surface lake water samples is presented in Table 1. Both physical and chemical measurements are given. As the surface lake water sample population is small (total sample population equals 41) no attempt has been made to transform the data before statistical analyses. Rather, by examination of the histograms and statistics of the total data population highly anomalous values for any individual parameter can be identified. These highly anomalous values (i.e. 3.8 for Cu, 5.7 for Ni, 742 for Fe, 61 for Mn and 0.64 for U) were removed to help normalize the data population for each individual parameter in order to prevent the final statistical computations (i.e. $\bar{x}$ and s) from being dominated by a few highly anomalous values.

The pH of the surface lake waters was found to be close to neutral (7.0) and varied little from lake to lake ($\bar{x}$ = 7.1, s = 0.3) in the area. Conductivity measurements of surface lake waters in the area are relatively low ($\bar{x}$ = 28 umhos/cm, s = 16 umho/cm). The lowest conductivity values commonly occur in lakes within granitic terrane and the highest values are concentrated within an area underlain by mafic metavolcanics, between Bee Lake in the east and just east of Willard Lake in the west. Surface lake waters are all relatively warm ($\bar{x}$ = 22°C) and oxygenated ($\bar{x}$ = 7.6 ppm dissolved oxygen).

The regional distributions of Zn, Cu, Pb, Co, Ni, Fe, Mn, and U in surface lake waters are illustrated in Figure 2. A series of regional trends have been outlined by this simplistic cluster analysis. Two of the major zones are: U encompassing and Ni peripherial to the numerous uranium occurrences, with minor sulphides in the Bee Lake – Bruin Lake region; and Zn, Ni and lesser Co and Pb in the Feist Lake – Lacourse Lake – East Stewart Lake region, an area underlain by intermediate metavolcanics containing minor sulphide occurrences. Several other far less extensive trends of Mn, Zn and Co, Cu, Co, Pb, U, and Fe and Mn are also present in the area.

By examining the correlations existing between the twelve measured surface lake water parameters (Fig. 3) it is possible to explain some of the variation in the trace element contents of the surface lake waters. The association of Mn with Fe, and of Fe with $\bar{O}_2$ (low amounts of dissolved oxygen) indicates the tendency of Fe, and to a lesser extent Mn, to remain in solution to relatively higher concentrations in waters with low amounts of dissolved oxygen. If the waters are enriched in oxygen, Fe and then Mn will tend to interact with oxygen, forming hydroxide and/or oxide precipitates, and be taken out of solution. Another association of interest is that of conductivity (Cond) with U, Cu, and Zn. At higher conductivities, usually indicative of increased carbonate content as bicarbonate, at the pH levels recorded (i.e. > 7.0), U and Zn can stay in solution as hydrated carbonate complexes.

Although interesting in their own right, data from water samples are best viewed with complimentary sediment data (Table 2). Because of the small sample population (n = 41) the sediment data (Appendix 3) have had highly anomalous values removed (see Table 2) to help normalize the data population for each individual parameter. This is to prevent the final statistical computations (i.e. $\bar{x}$ and s) from being dominated by a few highly anomalous values.

Table 1

Surface Lake Waters

	n	$\bar{x}$	s	min	max[1]	max[2]
Temp. (°C)	41	22	0.5	21	23	
pH	41	7.1	0.3	5.9	7.5	
Cond (umhos/cm)	41	28	16	9	74	
O_2 (ppm)	41	7.6	0.7	6.5	9.9	
Zn (ppb)	41	2.6	1.5	0.2*	5.0	
Cu (ppb)	40	0.9	0.8	0.2*	3.8	2.8(1)
Pb (ppb)	41	4.5	3.8	2.0*	13.5	
Co (ppb)	41	6.7	2.0	3.0	10.4	
Ni (ppb)	40	1.7	1.1	1.0*	5.7	4.3(1)
Fe (ppb)	40	74	90	10*	742	469(1)
Mn (ppb)	40	10	10	5*	61	49(1)
U (ppb)	40	0.17	0.13	0.02*	0.64	0.48(1)

n = number of samples. (In some cases highly anomalous samples removed before final statistical parameters determined ie: Cu, Ni, Fe, Mn, and U)

$\bar{x}$ = arithmetic mean

s = standard deviation

min = minimum value (* indicates values equal to one half the lower detection limit)

max[1] = maximum value

max[2] = maximum value after highly anomalous samples removed (e.g. Fe: max[1] = 742, max[2] = 469 (1); the (1) indicates one value greater than 469 (i.e. 742) removed to normalize the data population before calculation of $\bar{x}$ and s values

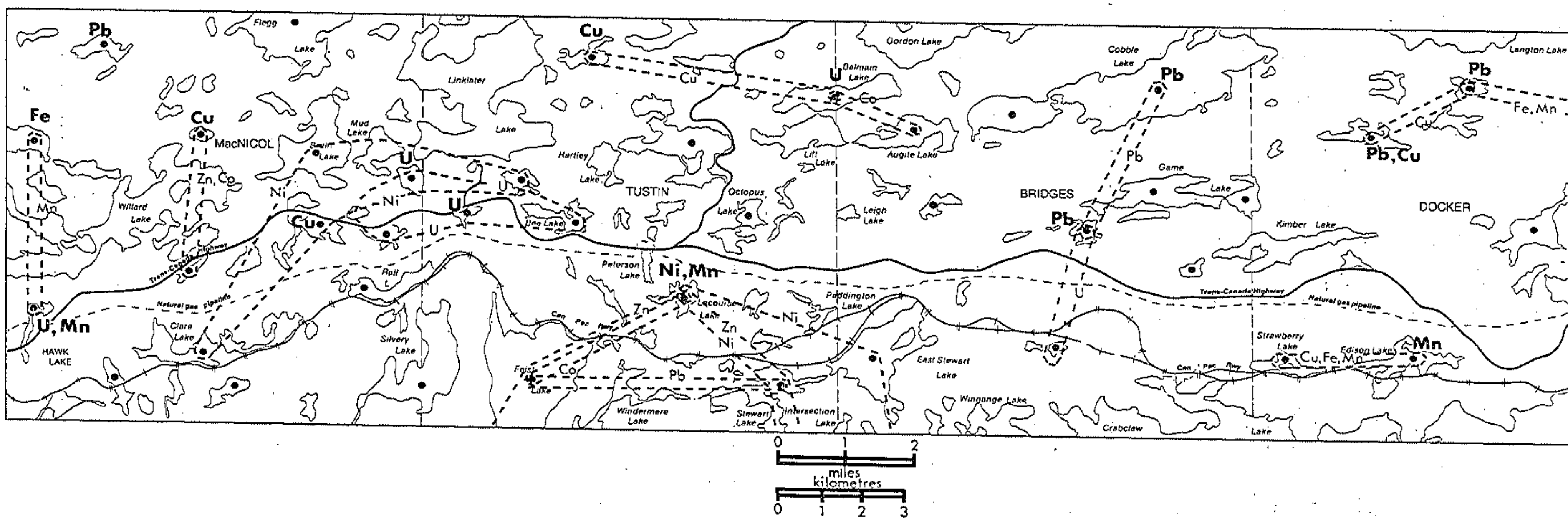


Figure 2. *Regional distributions of Zn, Cu, Pb, Co, Ni, Fe, Mn, and U in surface lake waters. When two or more adjacent samples have trace element concentrations in excess of the* $\bar{x} + 1\,s$ *level for a given element these samples are grouped together (eg. --U--, ---Fe, Mn--, -Pb-, etc). These* $\bar{x} + 1\,s$ *groupings, derived using an empirical form of cluster analysis, are indicative of regional trends in the trace element concentrations of the surface lake waters in the area. Within these trends or as isolated occurrences samples having trace element concentrations in excess of the* $\bar{x} + 2\,s$ *level for any element are indicated by:* ***Pb, U, Ni,*** *etc.*

Because of a malfunction in the water analyzer the physicochemical conditions of the bottom waters were measured in only the first nine lakes sampled. In general terms the lake bottom waters were found to be acid (pH = 4.1 to 6.0) and oxidizing (2.60 to 7.12 ppm dissolved oxygen), generally indicative of oligotrophic lakes. However, three of the lakes examined had very low levels of dissolved oxygen (0.14, 0.24 and 0.27 ppm dissolved oxygen) and were likely trending towards eutrophic or dystrophic conditions. Bottom water conductivities ranged from 4 to 50 umhos/cm and although one lake had relatively warm (22°C) bottom waters, most were cold (4 to 12°C).

The regional distributions of Zn, Cu, Pb, Ni, Co, Mn, As, Mo, Fe, Hg, and U in lake sediments are illustrated in Figure 4.

Exact correspondence of sediment and water data is missing although taken together the respective data reinforce each other and do direct attention to the most significant concentration of uranium occurrences in the area between Bee and Willard lakes. In general the sediment data seem to be more indicative of the geology and mineralization, as known, in the area. This is undoubtedly due to factors such as very low or undetectable levels of trace metals in the waters of the area and the inherent analytical problems in determining such low levels, varied physicochemical conditions in the lakes of the area, and the effects of organics on trace metal distributions.

Three major areas of interest are highlighted by the sediment data. The first, in the east part of the area between Octopus and Willard lakes is characterized by lake sediments with elevated levels of U in the west and Cu in the east. The centre of the area between Bee and Mud lakes has lake sediments with elevated levels of both Cu and U, as well as Zn, As, Co, Mn, and Fe. This trend is a reflection of the known uraniferous pegmatite occurrences between Bee and Willard lakes. The second area centres on Game Lake and is primarily characterized by lake sediments with elevated levels of Zn, Cu, Pb, Hg, and As with lesser Mo, Co, and Mn. These patterns are indicative of the numerous occurrences of sulphides in the metasediments in this area. The numerous small very low grade (see Pryslak, 1976) occurrences of uranium in pegmatites around Kimber Lake are not indicated by the lake sediments. Tied into Game Lake to the north, is the third major area of interest extending from Cobble Lake in the east westward to Balmain Lake. This area is characterized by lake sediments enriched in U, Ni, and Cu with lesser Co, Mn, and Mo, and is possibly coincident with the ultramafic intrusions present in the Cobble Lake-Lift Lake area.

Correlations existing between the measured lake sediment parameters (Fig. 5) can possibly explain some of the variation apparent in the trace element contents of the lake sediments. The associations of Cu and Hg, and to a lesser extent, Pb with loss-on-ignition, illustrates the affinity of

A.

	U	Mn	Fe	Ni	Co	Pb	Cu	Zn	O_2	Cond	pH	Temp.
Temp	.23	-.01	.13	.02	-.01	-.31	-.02	.45	-.39	.29	.38	
pH	.03	-.06	-.05	.20	.10	-.02	.12	.48	-.22	.45		
Cond	.32	-.01	-.06	.09	.27	-.25	.40	.39	-.13			
O_2	-.03	.07	-.32	-.24	-.04	.15	-.08	-.25				
Zn	-.08	-.14	-.10	.16	.28	-.09	.01					
Cu	-.00	-.07	-.16	-.07	.22	-.11						
Pb	-.22	-.13	-.11	.10	.13							
Co	.23	.18	-.07	.14								
Ni	.15	.05	.09									
Fe	.41	.56										
Mn	.21											
U												

n = 41

(- indicates a negative correlation)

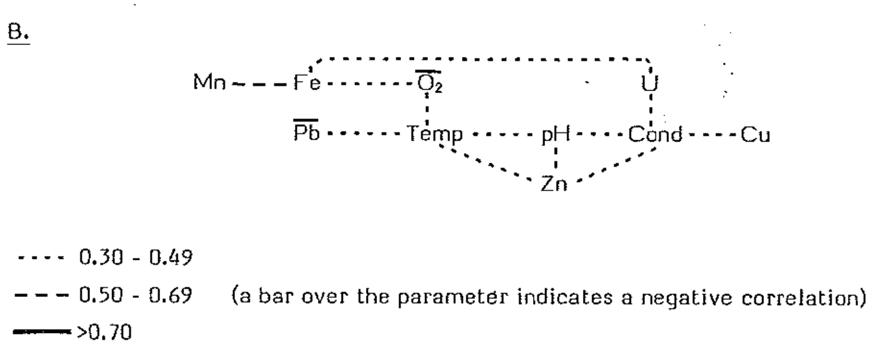


Figure 3. Correlation matrix and schematic representation of the significant chemical associatons in surface lake waters.

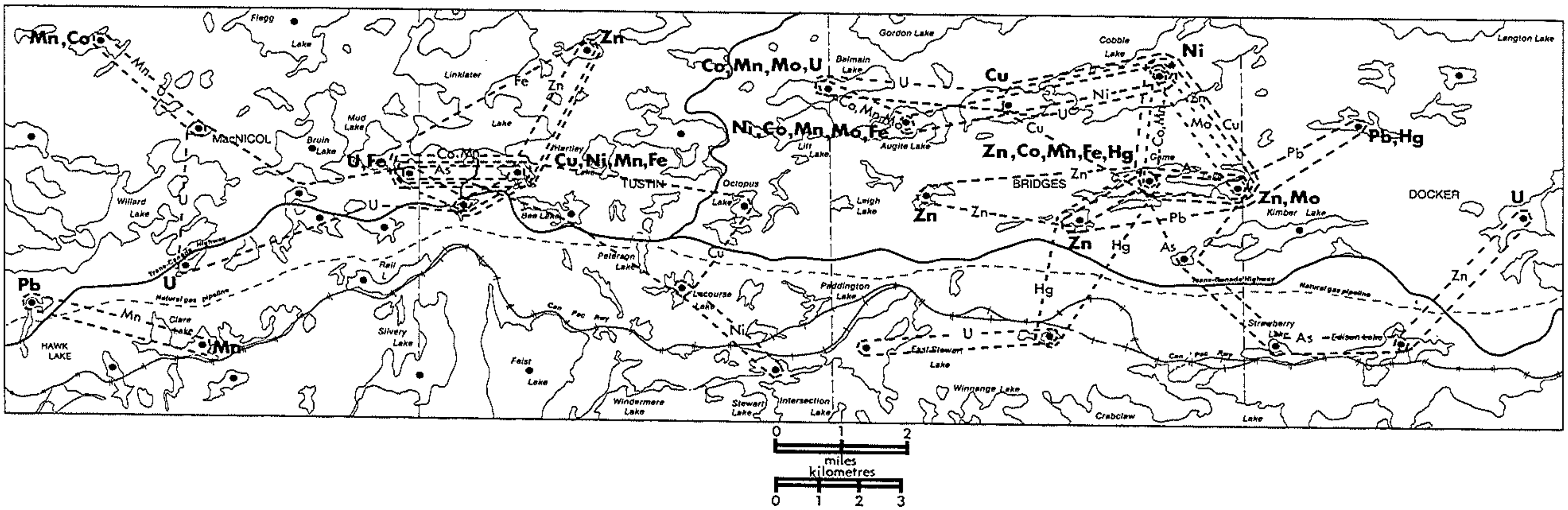


Figure 4. *Regional distributions of Zn, Cu, Pb, Ni, Co, Mn, As, Mo, Fe, Hg, and U in lake sediments. When two or more adjacent samples exceed $\bar{x} + 1s$ level for a given element, these samples are grouped together to illustrate regional trends (eg. —U—, —Ni, Co—). Samples with element concentrations in excess of the $\bar{x} + 2s$ level are indicated by* **Cu, U, Pb.**

these elements to form complexes with, and be concentrated by, organic matter. The level of concentration is a function of trace element availability (i.e. overburden, bedrock and/or mineralization) and the amount and type of organic matter present in the lacustrine and surrounding environments. The association of Zn, Cu, Hg and to a degree As is most likely due to the presence of sulphide mineralization such as occurs in the area between Game and Leigh lakes. The associations of Ni with Cu and of Ni with Co reflect the chemical influence on lake sediment composition of the ultramafic intrusive rocks in the area between Cobble and Lift lakes. Trace metal scavenging by Fe and Mn oxide and hydroxide complexes is indicated by the association of Fe, Mn, Co, Ni, Mo, and As. In cases where Fe and Mn compounds constitute a large part of the bottom sediment, the relative amount of organic material decreases as indicated by the association of Fe and Mn with negative loss-on-ignition.

Examination of the D.C. arc emission spectrographic data for lake sediments (Appendix 3) reveals that the distributions of other elements may also reflect bedrock lithology or mineralization in the area. Elevated levels of Cr in the sediments from lakes in the Lift Lake – Cobble Lake and the Silvery Lake – East Stewart Lake – Bee Lake areas are probably due to the presence of ultramafic intrusive and intermediate volcanic rocks respectively. Several of the lakes with notably high levels of Fe and Mn in their sediments also have relatively elevated levels of Ba, Sr, Al, and sometimes Ca. Several lakes having sediments with anomalous U concentrations, such as in Balmain Lake and between Bee and Mud lakes, also have elevated levels of V, La, and Y, which may be due to the combined influence of pegmatitic uranium mineralization and the intermediate and mafic metavolcanics in these areas.

Stream Waters and Sediments

Interpretation presented here for stream water data (Appendix 4) and sediment data (Appendix 5) from this area should be regarded as tentative. While lake basins are generally fairly well developed, interconnecting streams are not. Streams in the area are of two types: (1) those that flow at a slow to moderate rate, have generally clear water and inorganic clastic sediment; (2) those that flow very slowly, have clear to brownish water, organic-rich sediment, and are generally associated with a swampy regime and impeded drainage. There is a definite relationship between elevated metal levels, in both waters and sediments, and the presence of organic-rich sediments in streams (see Appendixes 4 and 5). The basic drawback to utilizing stream waters and sediments in mineral exploration in an area such as this is that it is impossible to obtain a consistent sample type (i.e. either all organic or all inorganic) at each sample site. Analytical data derived from mixed organic and inorganic sediments are generally impossible to interpret. The data must be separated into two classes and each group interpreted as a discrete sample medium. At the start of this study the idea was to collect both organic and inorganic sediments at each site to see which sediment type was a better indicator of mineralization, bedrock lithology, etc.; however, this was not practicable as both sediment types were seldom available at any given sample site.

Table 2

Lake Sediments

	n	$\bar{x}$	s	min	max[1]	max[2]
Zn (ppm)	37	86	21	46	392	144(4)
Cu (ppm)	40	41	16	18	98	72(1)
Pb (ppm)	39	11	4	1*	32	18(2)
Ni (ppm)	40	25	10	12	57	53(1)
Co (ppm)	39	13	5	4	45	28(2)
Mn (ppm)	38	478	266	190	34 500	1120(3)
As (ppm)	39	5.1	1.6	2.0	8.0	
Mo (ppm)	41	2	1	1*	6	
Fe (%)	40	2.19	1.27	0.80	8.00	6.00(1)
Hg (ppb)	38	112	43	35	290	210(1)
U (ppm)	39	17.7	10.2	2.3	74.5	41.6(2)
Loss-on-ignition (%)	41	32.5	13.1	3.6	57.4	

n = number of samples. (In some cases highly anomalous samples removed before final statistical parameters determined i.e.: Zn, Cu, Pb, Ni, Co, Mn, Fe, Hg and U)

$\bar{x}$ = arithmetic mean

s = standard deviation

min = minimum value (* indicates values equal to one half the lower detection limit)

max[1] = maximum value

max[2] = maximum value after highly anomalous samples removed (e.g. Mn: max[1] = 34 500, max[2] = 1120 (3); the (3) indicates three values greater than 1120 (i.e. 34 500, 1680, and 1680) were removed to normalize the data population before calculation of $\bar{x}$ and s values

Bedrock

The analytical data for bedrock samples (Appendix 7) are summarized in Table 3. Although bedrock sample populations are small, sometimes only one sample of a given rock type to a maximum of eight samples, some variation in metal concentrations between different bedrock lithologies is evident.

Relative to granitic rocks, intermediate metavolcanics, mafic metavolcanics, metasediments, and gabbro are enriched in Zn, Co, Ni (the one gabbro sample notably so), Fe, and Mn. Both lake waters (Fig. 2) in the intermediate metavolcanics in the Feist Lake – Lacourse Lake – East Stewart Lake area and lake sediments (Fig. 4) in metasediments centred around Game Lake and in the region of ultramafic intrusions in the Cobble Lake – Lift Lake area, yield trace metal patterns indicative of the enrichment of Zn, Co, Ni, Fe, and Mn in the associated bedrock lithologies (see discussion of lake water and sediment data). Granitic rocks in the area are relatively enriched in U and Pb, granite pegmatites particularly so. However, there is a large variation in U content and somewhat lesser variation in Pb content of barren (U = 1.2, 1.3 and 1.8 ppm; Pb = 27, 34, and 54 ppm) and enriched (U = 129.5 and 150.0 ppm; Pb = 52 and 56 ppm) pegmatites. The mineralized pegmatites in the Bee Lake – Willard Lake area are clearly indicated by U in both lake waters and sediments (Fig. 2, 4, respectively).

Examination of the D.C. arc emission spectrographic data for bedrock (Appendix 7) shows that in addition to the metals already examined intermediate and mafic volcanic, and metasedimentary rocks are relatively enriched in Ti, Ca, Mg, V, and Cr, the latter two types possibly in La and Y as well. Gabbros are enriched in Ca, Mg, and Cr; granites in Ba and possibly La; and granite pegmatites in Be and perhaps in La and Y. Some of these chemical characteristics are reflected in the associated lake sediments.

The degree to which the metal contents of the lake water and sediment reflect those in the bedrock lithologies with which they are associated depends on many factors. The nature of the bedrock itself, its mineralogy and grain size, the degree of exposure and susceptability to weathering and erosion comprise one factor. Superimposed on, and sometimes overshadowing, the chemical characteristics of the bedrock are the presence or absence of mineralization, its texture - disseminated, vein or massive, its nature (sulphide, oxide, carbonate, etc.) its exposure and susceptability to weathering and erosion, and its effect on the chemical environment (Eh and pH). In addition one must consider the nature of the overburden and of the lacustrine environment (as previously discussed). In total the relationship between the chemistry of the bedrock and that of the associated lake sediments is extremely complex requiring an awareness of the various physical and chemical processes operative in the various environments to properly interpret the lake sediment data and focus on areas of possible economic mineral potential.

Overburden

In general the analyses of overburden from the area provided little useful interpretive information. The overburden, being largely eroded and reworked by glacial lake action, is composed mainly of sandy ground moraine containing gravel and boulders. Chemically the overburden is relatively homogeneous and has generally low trace metal levels throughout the area (see Appendix 8). The underlying bedrock geochemistry is not reflected in the overburden with perhaps the exception of elevated levels of U in soils adjacent to some of the uraniferous pegmatites in the area.

Table 3

Bedrock

Rock type	n[1]	Zn ppm	Cu ppm	Pb ppm	Co ppm	Ni ppm	Fe %	Mn ppm	U ppm	Mo ppm
Granitic gneiss	3	39[2] 24-57[3]	10 9-13	25 21-30	8 4-14	18 6-33	1.55 1.00-2.60	300 145-588	1.0 0.6-1.3	2.7 2.3-3.1
Granite pegmatite	5	13 10-17	3 2-7	45 27-56	1 1-2	3 1-3	0.37 0.26-0.53	181 52-619	56.8 1.2-150.0	2.2 1.8-2.7
Granite	8	29 13-38	5 2-11	28 3-54	3 1-5	4 2-8	0.85 0.44-1.16	141 67-194	8.7 1.7-44.5	2.4 1.9-3.3
Granodiorite	3	38 37-41	5 3-6	24 20-26	3 2-4	4 2-5	1.02 0.95-1.16	202 184-233	1.7 1.5-2.0	2.9 2.6-3.3
Intermediate metavolcanics	8	80 70-109	32 13-58	12 7-14	31 24-47	94 34-191	4.92 2.96-7.86	925 421-2212	0.5 0.2-0.9	3.7 3.1-4.7
Mafic metavolcanics	8	90 69-126	54 24-90	9 4-12	38 23-51	78 20-128	6.78 3.96-12.85	1240 677-2269	0.5 0.1-1.8	4.1 3.1-6.2
Metasediments	1	90 -	45 -	14 -	24 -	127 -	3.18 -	550 -	0.7 -	3.2 -
Gabbro	1	71 -	67 -	4 -	66 -	305 -	7.36 -	1280 -	0.3 -	2.1 -

1 n = number of samples
2 39 = arithmetic mean
3 24-57 = range (minimum - maximum)

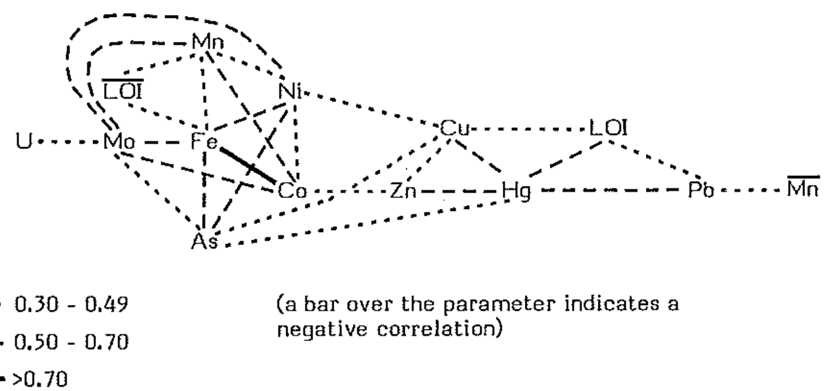
A.

	Zn	Cu	Pb	Ni	Co	Mn	As	Mo	Fe	Hg	LOI	U
U	-.13	.17	.07	-.04	.04	-.12	.17	.30	-.30	-.08	.18	
LOI	.13	.41	.37	-.19	-.26	-.33	.01	-.21	-.37	.54		
Hg	.57	.53	.55	.02	.20	-.23	.32	-.06	.04			
Fe	.13	.18	-.17	.50	.76	.63	.49	.55				
Mo	.03	.13	-.02	.50	.57	.62	.40					
As	.24	.33	.21	.31	.46	.13						
Mn	-.05	-.21	-.32	.47	.60							
Co	.34	.12	-.09	.40								
Ni	.11	.47	-.19									
Pb	.21	.25										
Cu	.32											
Zn												

n = 41

(- indicates a negative correlation)

B.



(a bar over the parameter indicates a negative correlation)

Figure 5. Correlation matrix and schematic representation of the significant chemical associations in lake sediments.

CONCLUSIONS

The application of geochemical methods and their responses to typical geological and environmental influences within the southern portion of the Superior Geological Province of northwestern Ontario has been demonstrated.

At the sampling densities employed both lake water and sediment analytical data provide information indicative of pegmatitic U mineralization, disseminated sulphide mineralization, bedrock lithology and the physicochemical nature of the lacustrine environment. Although the data are complex and at times difficult to interpret a definite value is found in interpreting hydrogeochemical dispersion patterns in terms of elemental associations which are based on a knowledge of trace and minor element assemblages related to known mineralization, bedrock lithology, and lacustrine physicochemistry in the study area.

Both waters and sediments provide meaningful data although each sample type has its own advantages. Whereas lake waters can be collected anywhere, lake sediments can yield further useful data on many additional elements, undetectable in waters, which may prove to be accessories in economic mineral assemblages or favourable host rocks. The areal extent of the lake sediment trace element distribution patterns indicates that reconnaissance scale sampling (1 sample/13 km^2) using lakes would be successful in locating most zones containing pegmatitic uranium mineralization in the area. However, sampling every 2 to 5 km^2 in the search for sulphide mineralization is preferable in this geologic terrane.

The use of stream waters and sediments for mineral exploration in this area did not prove worthwhile nor was the chemistry of the overburden present particularly indicative of that of the underlying bedrock lithologies. Clay deposits in the surrounding region are at present a definite restriction in the application of any type of regional or detailed geochemical methods.

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APPENDIX 1

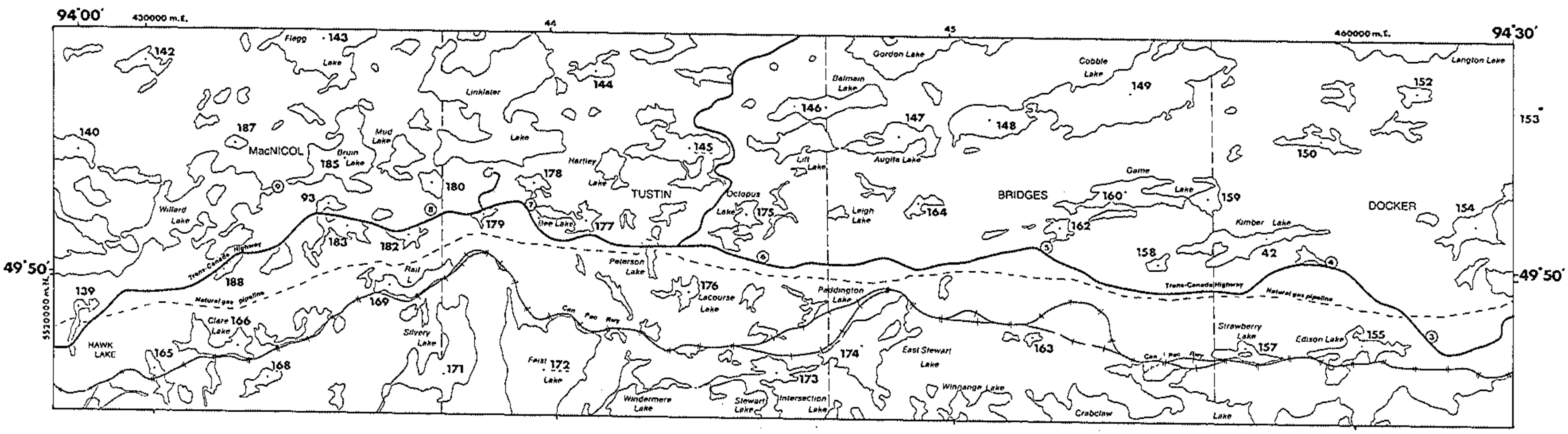
Sample numbers and locations for surface lake waters and lake sediments, and for stream waters and sediments, MacNicol, Tustin, Bridges and Docker Townships, Kenora District, Ontario

At each lake sample site a surface lake water (52F13 755XXX) and lake sediment (52F13 756XXX) sample were collected. Only the last three significant digits of each sample number are plotted at each site. The surface lake water and lake sediment samples have, therefore, the same last three digits at each site. Sample numbers underlined (eg. 9, 76, 163 etc.) indicate that while a water sample was obtained at the sample site no sediment was collected.

The field observations and analytical data for the lake water samples (identified by a 5 in digit eight of the eleven digit sample number – 52F13 755XXX) and the lake sediment sample (identified by a 6 in digit eight of the eleven digit sample number – 52F13 756XXX) are listed in Appendixes 2 and 3 respectively.

At each stream sample site a stream water (52F13 753XXX) and stream sediment (52F13 754XXX) sample were collected. Only the last three significant digits of each sample number are plotted at each site. The stream water and sediment samples have, therefore, the same last three digits at each site.

The field observations and analytical data for the stream water samples (identified by a 3 in digit eight of the eleven digit sample number – 52F13 753XXX) and the stream sediment sample (identified by a 4 in digit eight of the eleven digit sample number – 52F13 754XXX) are listed in Appendixes 4 and 5 respectively.



Sample Numbers and Locations for Surface Lake Waters and Lake Sediments (ie. 175), and for Stream Waters and Sediments (ie. ④), MacNicol, Tustin, Bridges and Docker Townships, Kenora District 52-F-13, Ontario.

0 1 2 miles

0 1 2 3 kilometres

Figure 1.1. Appendix 1; Sample numbers and locations for surface lake waters and lake sediments and for stream waters and sediments.

APPENDIX 2

Surface lake waters
Field observations and analytical data

GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM , MACNICOL,TUSTIN,BRIDGES AND DOCKER TOWNSHIPS , KENORA DISTRICT (52/F/13) , ONTARIO , 1975
SURFACE LAKE WATERS
ACIDIFIED (250 MICROLITRES OF NITRIC ACID PER 125 MILLILITRES OF WATER) ON DAY OF COLLECTION

MAP SHEET	SAMPLE NUMBER	UTM COORDINATES ZONE	EAST	NORTH	CATCH[1] BASIN ROCK TYPE	COL[2]	TEMP DEG C	PH	COND uMHO CM	DIS OXY PPM	ZN PPB	CU PPB	PB PPB	CO PPB	NI PPB	FE PPB	MN PPB	U PPB
52F13	755042	15	457810	5520810		0	11	5.8	21	0.15	7.0	1.0	2.0	3.8	9.3	1917	463	0.16
52F13	755093	15	434370	5521800		0	06	7.2	23	0.34	6.0	0.8	2.0	1.0	6.4	284	217	0.64
52F13	755139	15	428200	5519400	MMVC	0	22	6.6	32	9.34	0.2	0.2	2.0	8.3	1.0	79	49	0.48
52F13	755140	15	428200	5523200	GRNS	0	22	6.5	12	6.80	1.1	0.2	2.0	5.6	1.0	469	21	0.16
52F13	755142	15	430000	5525500	GRNT	0	21	5.9	9	7.65	0.2	0.2	13.5	6.0	3.5	43	5	0.12
52F13	755143	15	434300	5526000	GRNS	0	21	6.5	13	8.00	0.2	0.2	2.0	3.0	1.0	10	5	0.02
52F13	755144	15	441200	5525200	GRNS	0	21	6.7	16	7.70	0.2	2.1	6.0	7.4	2.0	26	5	0.06
52F13	755145	15	443500	5523200		0	21	7.1	21	8.20	0.2	1.0	6.0	3.0	1.0	10	5	0.02
52F13	755146	15	447200	5524300	GRNT	0	21	6.6	17	7.80	0.2	2.8	2.0	9.0	1.0	35	5	0.44
52F13	755147	15	448800	5523500		0	21	6.8	21	9.94	2.8	1.1	2.0	9.0	1.0	28	5	0.20
52F13	755148	15	451000	5523900		0	21	7.0	20	7.30	0.2	0.2	6.0	7.4	1.0	22	5	0.24
52F13	755149	15	454200	5524400		0	21	7.4	30	7.93	1.1	0.6	12.5	5.6	2.0	34	5	0.08
52F13	755150	15	459200	5523300		0	21	7.3	24	7.90	2.0	2.0	9.5	5.6	1.0	134	15	0.08
52F13	755152	15	461600	5524400	MMVC	0	22	7.2	30	8.80	3.0	2.0	12.5	6.4	1.0	211	26	0.24
52F13	755153	15	465400	5523800	MSDM	0	22	7.1	29	6.50	2.5	0.2	2.0	5.6	3.5	742	31	0.64
52F13	755154	15	463100	5521100	GRNT	0	22	7.1	11	8.00	0.2	0.2	2.0	4.5	2.0	10	5	0.24
52F13	755155	15	460100	5518100	GRNT	0	22	7.1	40	7.25	1.1	2.0	2.0	4.5	1.0	184	34	0.16
52F13	755157	15	457200	5518100	GRNT	0	22	7.3	24	6.70	1.1	2.0	2.0	7.4	1.0	225	25	0.08
52F13	755158	15	455100	5520100	GRNT	0	22	7.1	18	7.30	1.1	1.1	6.0	9.0	1.0	118	19	0.08
52F13	755159	15	456400	5521800	MSDM	0	22	6.9	21	7.50	3.0	1.1	2.0	3.5	1.0	94	5	0.12
52F13	755160	15	454200	5522000	MSDM	0	22	7.1	25	7.50	3.8	1.7	2.0	3.5	1.0	54	5	0.10
52F13	755162	15	452700	5521100	MSDM	0	22	7.2	27	7.32	3.2	0.2	13.4	7.4	1.0	60	5	0.28
52F13	755163	15	452000	5518300	GRNT	0	22	7.0	9	7.35	3.0	0.2	2.0	5.8	1.0	152	5	0.28
52F13	755164	15	449200	5521700	MSDM	0	22	7.0	20	7.70	3.0	0.2	2.0	3.0	1.0	26	12	0.04
52F13	755165	15	430000	5517800	GRNT	0	23	7.4	29	7.00	4.0	0.5	2.0	8.2	1.0	36	5	0.20
52F13	755166	15	432000	5518200	GRNT	0	22	7.1	26	6.96	3.0	0.2	2.0	7.3	3.5	33	5	0.22
52F13	755168	15	432800	5517400	GRNT	0	22	6.8	10	6.70	4.0	0.2	6.0	7.3	1.0	103	15	0.16
52F13	755169	15	436000	5519900	GRNT	0	22	6.9	26	6.98	4.0	2.0	2.0	9.0	1.0	25	10	0.18
52F13	755171	15	437200	5517500	GRNT	0	22	7.1	10	7.85	4.0	0.2	2.0	7.3	1.0	10	5	0.02
52F13	755172	15	439800	5517400	GRNT	0	21	7.1	17	7.71	4.8	0.2	9.5	9.0	1.0	10	5	0.02
52F13	755173	15	445600	5517700		0	22	7.4	23	7.35	5.0	0.8	9.5	5.8	3.5	51	5	0.22
52F13	755174	15	447700	5518200		0	22	7.1	22	7.80	3.0	0.5	6.0	7.3	3.5	20	5	0.12
52F13	755175	15	445030	5521500	IMVC	0	22	7.2	31	7.50	5.0	0.6	2.0	5.8	2.3	10	5	0.02
52F13	755176	15	443400	5519600	IMVC	0	21	7.2	29	7.51	4.0	0.2	2.0	10.3	4.3	238	61	0.12
52F13	755177	15	440800	5521400		0	22	7.1	57	7.51	3.0	1.0	2.0	6.5	1.0	32	5	0.34
52F13	755178	15	439600	5522300	MMVC	0	22	7.2	30	7.35	3.0	1.1	10.0	3.0	3.5	69	5	0.04
52F13	755179	15	438300	5521500		0	22	7.3	63	7.62	3.0	1.8	2.0	7.4	2.0	133	5	0.46
52F13	755180	15	437100	5522300		0	22	7.3	57	7.20	4.0	1.1	2.0	7.4	3.5	41	5	0.44
52F13	755182	15	436400	5521000	GRNT	0	22	7.5	61	7.42	3.0	0.2	2.0	8.0	2.0	10	5	0.30
52F13	755183	15	434900	5521200	GRNT	0	22	7.4	36	6.83	3.0	2.7	2.0	10.4	5.7	30	5	0.20
52F13	755185	15	434800	5523000		0	22	7.3	22	7.64	3.2	0.2	7.5	5.7	3.5	10	5	0.16
52F13	755187	15	432200	5522400	GRNT	0	22	7.1	74	6.83	5.0	3.8	2.0	8.9	1.0	53	5	0.12
52F13	755188	15	431900	5520100	GRNT	0	22	7.1	57	7.67	5.0	0.8	2.0	8.9	1.0	10	5	0.08
Lower detection limits											0.5	0.5	5.0	2.0	2.0	20	10	0.04
Value recorded for the lower detection limit is equal to approximately one-half the actual detection limit											0.2	0.2	2.0	1.0	1.0	10	5	0.02

[1] Catchment basin rock type: Lake entirely within bedrock unit and drainage into lake also predominantly from within same bedrock unit.

GRNS - granitic gneiss
GRNT - granite
IMVC - intermediate metavolcanics
MMVC - mafic metavolcanics
MSDM - metasediments

[2] Colour:

0 - Clear
1 - Brown transparent
2 - White cloudy
3 - Brown cloudy

APPENDIX 3

Lake Sediments
Field Observations and Analytical Data

GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM , MACNICOL,TUSTIN,BRIDGES AND DOCKER TOWNSHIPS , KENORA DISTRICT (52/F/13) , ONTARIO , 1975
ORGANIC LAKE CENTRE SEDIMENTS
U BY NEUTRON ACTIVATION: ZN,CU,PB,NI,CO,AG,MN,AS,MO,FE AND HG BY ATOMIC ABSORPTION TECHNIQUES

MAP SHEET	SAMPLE NUMBER	UTM ZONE	COORDINATES EAST	NORTH	CATCH[1] BASIN ROCK TYPE	DEP M	COMP[2]	COLOUR[3]	(BOTTOM WATER CONDITIONS) TEMP DEG C	PH	COND uMHO CM	DIS OXY PPM	ZN PPM	CU PPM	PB PPM	NI PPM	CO PPM	AG PPM	MN PPM	AS PPM	MO PPM	FE %	HG PPM	LOI %	U PPM
52F13	756042	15	457810	5528810		9	--31	----1-	12	5.5	21	.14	77	19	10	18	11		221		1	1.50		44.0	21.
52F13	756093	15	434370	5521800		12	--31	----1-	7	4.5	22	2.60	78	22	8	23	9		364		2	1.15		43.7	28.0
52F13	756139	15	428200	5519400	MMVC	20	--31	----1-	4	4.6	50	.24	74	56	23	17	8	0.1	880	6.0	3	2.20	130	51.7	21.5
52F13	756140	15	428200	5523200	GRNS	5	--31	----1-	22	6.0	11	7.12	90	28	11	24	11	0.1	200	5.0	1	2.25	130	32.5	7.9
52F13	756142	15	430000	5525500	GRNT	23	--31	----1-	5	4.1	4	.27	72	18	6	17	25	0.1	1120	4.0	1	3.10	50	14.5	6.6
52F13	756143	15	434300	5526000	GRNS	38	--31	----1-	5	4.7	6	6.53	86	36	12	18	11	0.1	720	6.0	2	2.80	60	23.5	9.7
52F13	756144	15	441200	5525200	GRNS	12	--31	----1-	6	5.5	11	4.20	144	34	8	19	11	0.1	320	4.0	2	3.40	90	27.3	10.0
52F13	756146	15	447200	5524300	GRNT	25	--31	----1-	6	4.8	9	5.57	112	50	15	28	28	0.1	1000	6.0	5	3.30	115	19.8	74.6
52F13	756147	15	448800	5523500		21	--31	----1-	6	4.9	10	5.40	82	18	1	57	45	0.1	34500	6.0	6	8.00	40	5.8	8.3
52F13	756148	15	451000	5523900		28	--31	----1-					78	72	9	44	10	0.1	310	5.0	1	2.00	95	24.8	29.5
52F13	756149	15	454200	5524400		33	--31	----1-	Due to an equipment malfunction the remaining bottom water conditions could not be measured				108	60	13	50	19	0.1	840	6.0	3	3.20	70	16.1	30.6
52F13	756150	15	459200	5523300		8	--31	----1-					90	52	32	24	12	0.1	460	4.0	2	1.90	210	43.5	5.2
52F13	756152	15	461600	5524400	MMVC	4	--31	----1-					76	54	8	31	11	0.1	240	5.0	1	1.45	130	39.7	13.1
52F13	756153	15	465400	5523800	MSDM	5	--31	----1-					92	22	17	23	13	0.1	430	5.0	1	0.80	100	22.0	12.5
52F13	756154	15	463100	5521100	GRNT	18	--31	----1-					112	40	13	21	13	0.1	500	5.0	2	1.75	90	37.6	38.7
52F13	756155	15	460100	5518100	GRNT	9	--31	----1-					118	36	13	35	15	0.1	570	7.0	2	3.55	130	19.2	4.3
52F13	756157	15	457200	5518100	GRNT	3	--31	----1-					90	34	15	32	14	0.1	450	7.0	2	2.70	100	24.7	5.3
52F13	756158	15	455100	5520100	GRNT	4	--31	----1-					96	28	10	18	12	0.1	310	7.0	1	1.50	115	39.3	14.0
52F13	756159	15	456400	5521800	MSDM	8	--31	----1-					196	60	10	34	11	0.1	520	8.0	4	2.05	140	28.8	26.1
52F13	756160	15	454200	5522007	MSDM	30	--31	----1-					392	70	18	23	45	0.1	1680	8.0	2	5.30	290	32.0	10.1
52F13	756162	15	452700	5521100	MSDM	9	--31	----1-					324	54	16	31	10	0.1	230	4.0	1	1.50	155	30.8	14.1
52F13	756163	15	452000	5518300	GRNT	7	--31	----1-					102	32	12	19	15	0.1	250	5.0	2	1.65	180	44.4	28.4
52F13	756164	15	449200	5521700	MSDM	6	--31	----1-					324	50	11	27	11	0.1	370	4.0	1	1.05	150	50.7	6.9
52F13	756165	15	430000	5517800	GRNT	12	--31	----1-					84	32	11	15	8	0.1	490	4.0	1	1.55	170	33.1	13.0
52F13	756166	15	432000	5518200	GRNT	20	--31	----1-					82	22	10	12	15	0.1	1080	7.0	1	3.00	100	19.9	17.9
52F13	756168	15	432800	5517400	GRNT	7	--31	----1-					72	24	10	14	9	0.1	390	2.0	1	1.55	120	35.5	7.7
52F13	756169	15	436000	5519900	GRNT	12	--31	----1-					70	34	10	16	8	0.1	260	4.0	1	1.45	120	33.0	18.6
52F13	756171	15	437200	5517500	GRNT	20	-21-	---1--					64	28	6	23	11	0.1	350	2.0	1	2.10	35	3.6	2.3
52F13	756173	15	445600	5517700		17	--31	----1-					84	46	11	37	11	0.1	240	4.0	1	1.30	140	42.1	25.3
52F13	756174	15	447700	5518200		18	--31	----1-					86	24	7	26	14	0.1	570	5.0	2	2.30	40	14.8	29.7
52F13	756175	15	445000	5521500	IMVC	17	--31	----1-					80	64	13	33	9	0.1	280	6.0	2	1.45	115	36.5	5.8
52F13	756176	15	443400	5519600	IMVC	2	--31	----1-					94	60	6	35	20	0.1	190	4.0	3	1.20	130	57.4	19.3
52F13	756177	15	440800	5521400		21	--31	----1-					104	60	15	27	10	0.1	350	4.0	1	1.25	150	43.6	19.9
52F13	756178	15	439600	5522300	MMVC	25	--31	----1-					110	98	7	53	26	0.1	1680	7.0	2	6.00	180	35.5	16.4
52F13	756179	15	438300	5521500		17	--31	----1-					116	52	11	21	23	0.1	820	6.0	1	2.70	100	44.4	27.0
52F13	756180	15	437100	5522300		27	--31	----1-					76	66	14	25	19	0.1	810	7.0	2	5.90	125	38.3	41.6
52F13	756182	15	436400	5521000	GRNT	15	--31	----1-					72	54	8	17	8	0.1	310	3.0	1	1.15	100	43.1	22.6
52F13	756183	15	434900	5521200	GRNT	18	--31	----1-					68	44	10	19	6	0.1	260	3.0	2	1.45	80	39.2	29.4
52F13	756185	15	434800	5523000		15	--31	----1-					46	24	5	13	4	0.1	195	2.0	1	1.10	30	6.4	13.6
52F13	756187	15	432200	5523400	GRNT	15	--31	----1-					86	54	14	17	17	0.1	850	7.0	2	1.10	150	38.9	29.4
52F13	756188	15	431900	5520100	GRNT	18	--31	----1-					72	24	13	14	6	0.1	330	5.0	1	0.95	80	50.4	56.7
Lower detection limits													2	2	2	2	2	0.2	5	1.0	2	0.02	10	1.0	0.2
Value recorded for the lower detection limit is equal to approximately one-half the actual lower detection limit													1	1	1	1	1	0.1	2	0.5	1	0.01	5	0.5	0.1

[1] See explanation Lake Waters

[2] The four columns are used to describe the bulk mechanical composition of the collected sediment on scales of 0 to 3 and 0 or 1.

The three size fractions are divided as follows and designated by columns.

1 – > 0.125 mm, sand
2 – < 0.125 mm, fines, silt and clay
3 – organics

The total of the first three columns must add to 3 or 4.

blank or 0 – absent
1 – minor, <33%
2 – medium, 33-67%
3 – major, >67%

The fourth column is used to record the presence of an organic gel or gyttja.

blank or 0 – absent
1 – present

[3] Up to two of the colours may be checked (1 in appropriate column.)

1 – tan	4 – grey
2 – yellow	5 – brown
3 – green	6 – black

GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM , MACNICOL,TUSTIN,BRIDGES AND DOCKER TOWNSHIPS , KENORA DISTRICT (52/F/13) , ONTARIO , 1975
ORGANIC LAKE CENTRE SEDIMENTS
THE DATA LISTED BELOW (SR TO Y) WERE ESTIMATED BY EMISSION SPECTROMETRY

MAP SHEET	SAMPLE NUMBER	SR PPM	BA PPM	MN PPM	TI PPM	AL %	CA %	MG %	FE %	K %	PB PPM	ZN PPM	V PPM	MO PPM	CR PPM	CU PPM	CO PPM	NI PPM	BE PPM	LA PPM	Y PPM
52F13	756042																				
52F13	756093																				
52F13	756139	58	478	734	1172	3.0	0.4	0.1	2.6	0.4	23	94	48	2.5	28	57	10	20	1.0	98	26
52F13	756140	72	292	127	1652	4.6	0.4	0.1	2.9	0.4	12	129	45	2.2	34	31	16	43	1.0	134	35
52F13	756142	277	578	+1800	2098	6.1	1.2	0.5	3.8	1.3	19	111	51	2.5	41	19	30	22	3.0	93	29
52F13	756143	183	501	839	2376	5.5	0.9	0.4	3.6	1.2	17	97	63	2.1	41	35	14	21	2.3	112	32
52F13	756144	202	477	376	234	5.0	1.1	0.3	4.2	1.3	15	136	50	2.5	45	36	14	25	1.0	108	37
52F13	756146	207	540	1121	2494	5.9	1.1	0.4	4.2	1.3	22	132	81	3.4	61	51	36	39	2.1	246	76
52F13	756147	477	+2100	+1800	2241	6.3	2.8	0.6	+15.0	3.1	31	139	23	7.0	57	31	50	58	3.2	33	15
52F13	756148	114	386	273	2093	5.2	0.9	0.6	2.9	1.0	14	102	51	2.0	118	66	13	55	1.0	72	33
52F13	756149																				
52F13	756150																				
52F13	756152	58	268	188	1536	3.9	0.6	0.3	2.0	0.6	11	114	38	1.0	45	54	14	34	1.0	52	19
52F13	756153	177	498	602	2692	6.0	1.1	0.6	3.5	1.3	24	117	63	2.1	54	25	18	30	2.2	50	21
52F13	756154	78	403	511	1641	4.4	0.5	0.2	2.3	0.6	18	161	50	2.3	38	45	17	26	2.7	89	33
52F13	756155	186	629	785	3552	6.5	1.1	1.0	4.6	2.0	23	130	92	2.3	80	37	24	46	2.2	75	29
52F13	756157	163	509	657	3198	5.9	1.0	0.8	3.4	1.4	23	114	68	2.8	66	36	21	40	2.5	68	26
52F13	756158	97	352	228	1690	3.8	0.7	0.2	2.2	0.6	13	126	42	2.0	34	38	17	25	1.0	65	21
52F13	756159	124	473	1319	2212	4.9	0.8	0.3	6.0	0.9	17	320	72	3.9	47	62	56	42	1.0	131	49
52F13	756160	75	342	419	1709	3.9	0.7	0.2	2.8	0.5	20	221	57	2.1	53	83	15	32	1.0	77	28
52F13	756162	93	344	122	1788	4.1	0.6	0.2	1.9	0.5	12	107	41	2.0	77	45	15	45	1.0	92	34
52F13	756163	113	383	219	2007	4.6	0.8	0.3	2.2	0.8	22	374	41	1.0	47	56	15	36	2.2	67	27
52F13	756164	59	232	311	1166	3.3	0.6	0.1	1.5	0.3	12	334	32	2.1	42	58	16	34	1.0	93	31
52F13	756165	130	420	510	1948	4.7	0.7	0.2	2.1	0.7	15	120	47	2.3	38	36	11	20	2.2	87	31
52F13	756166	236	568	1183	2155	5.8	1.2	0.3	4.1	1.3	18	99	60	2.4	47	25	22	20	1.0	85	33
52F13	756168	134	390	465	1835	4.7	0.8	0.3	2.3	0.7	17	103	54	2.0	38	30	13	20	2.1	74	31
52F13	756169	125	362	265	1797	4.6	0.6	0.2	2.1	0.7	15	108	34	2.0	41	34	11	21	2.1	96	34
52F13	756171	337	863	522	3176	6.8	1.5	0.8	3.3	2.2	18	102	84	2.3	67	30	16	55	1.0	46	19
52F13	756173	90	332	201	1750	4.3	0.5	0.3	1.7	0.5	13	153	31	2.2	64	46	13	38	2.1	87	33
52F13	756174	285	577	947	2684	6.2	1.4	0.7	3.3	1.7	20	114	60	2.6	65	25	21	35	2.6	52	24
52F13	756175	88	343	161	1583	3.7	0.6	0.1	2.0	0.6	14	102	38	1.0	48	68	13	39	1.0	83	29
52F13	756176	66	231	50	1214	3.1	0.6	0.1	1.5	0.1	10	115	30	2.1	31	61	24	39	1.0	113	44
52F13	756177	310	861	752	6397	6.7	2.1	1.1	5.8	2.0	21	185	126	3.1	63	133	22	23	1.0	64	62
52F13	756178	51	240	+1800	1709	3.8	0.5	0.3	6.3	0.4	17	182	54	3.6	63	95	24	65	1.0	144	54
52F13	756179	75	401	730	1348	3.2	0.9	0.1	3.1	0.2	13	148	60	2.2	35	52	27	23	1.0	108	39
52F13	756180	46	304	770	1214	3.6	0.3	0.1	6.2	0.3	18	102	74	3.6	58	66	23	31	1.0	177	57
52F13	756182	99	272	235	1485	3.6	0.6	0.2	1.6	0.5	10	110	40	1.0	38	53	11	19	1.0	112	33
52F13	756183	100	277	300	1635	3.7	0.5	0.2	1.5	0.5	20	117	36	1.0	35	48	10	19	1.0	108	33
52F13	756185	161	338	307	2184	4.5	0.8	0.4	2.4	0.7	14	126	42	2.1	50	38	10	27	1.0	107	38
52F13	756187	76	303	858	1482	3.9	0.5	0.1	2.6	0.5	16	111	65	2.2	37	52	21	23	2.0	181	46
52F13	756188	64	256	216	1376	3.2	0.4	0.1	1.3	0.4	14	97	32	1.0	27	26	9	19	1.0	67	25
Lower dection limits		30	50	100	100	0.5	0.2	0.2	0.2	0.2	2	25	10	2.0	10	4	2	4	2.0	10	10
		15	25	50	50	0.2	0.1	0.1	0.1	0.1	1	13	5	1.0	5	2	1	2	1.0	5	5
(Value recorded for the lower detection limit is equal to approximately one-half the actual lower detection limit)																					
Upper detection limits		1300	2100	1800	6500	10.0	4.0	8.0	15.0	9.0	100	1200	250	20.0	200	250	150	150	25.0	350	300

APPENDIX 4

Stream Waters
Field Observations and Analytical Data

GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM , MACNICOL,TUSTIN,BRIDGES AND DOCKER TOWNSHIPS , KENORA DISTRICT (52/F/13) , ONTARIO , 1975
STREAM WATERS
ACIDIFIED (250 MICROLITRES OF NITRIC ACID PER 125 MILLILITRES OF WATER) ON DAY OF COLLECTION

MAP SHEET	SAMPLE NUMBER	UTM ZONE	COORDINATES EAST	NORTH	ROCK[1] TYPE	STR[2] WIDTH M	WATER[3] DEPTH CM	BANK[4] TYPE	COL[5]	FLOW[6] RATE	PPT[7]	PH[8]	ZN PPB	CU PPB	PB PPB	CO PPB	NI PPB	FE PPB	MN PPB	U PPB
52F13	753003	15	461900	5518200	GRNT	2	5	4	1	1	0	6.8	2.0	1.0	5.2	1.0	3.4	831	34	0.12
52F13	753004	15	459400	5520100	GRNT	1	2	4	1	1	0	6.9	2.4	0.5	2.0	1.0	2.6	277	47	0.56
52F13	753005	15	452400	5520500	GRNT	2	5	3	1	2	0	6.4	4.2	1.4	2.0	5.5	1.0	198	17	0.22
52F13	753006	15	445700	5520200	IMVC	1	4	3	1	1	0	6.5	2.5	2.2	2.0	1.0	21.0	289	127	0.18
52F13	753007	15	439500	5521700	IMVC	1	2	3	1	1	0	7.1	7.3	2.2	2.0	5.0	3.4	62	6	0.36
52F13	753008	15	437000	5521500	MMVC	1	2	3	1	2	0	6.9	0.2	1.2	2.0	1.0	1.0	173	14	0.48
52F13	753009	15	433000	5522200	GRNT	5	4	3	0	2	0	6.8	1.5	0.2	2.0	1.0	1.0	10	5	0.12
Lower detection limits													0.5	0.5	5.0	2.0	2.0	20	10	0.04
Value recorded for the lower detection limit is equal to approximately one-half the actual detection limit													0.2	0.2	2.0	1.0	1.0	10	5	0.02

[1] The major rock-type of the catchment area or hydrological system is recorded.

GRNT – granite
IMVC – intermediate metavolcanics
MMVC – mafic metavolcanics

[2] The width of the stream at the sample site is recorded to the nearest metre.

[3] The water depth is recorded to the nearest centimetre.

[4] The general nature of the bank material is described here.

1 – alluvial
2 – colluvial (bare rock, residual or mountain soils)
3 – glacial till
4 – glacial outwash sediments

[5] The general colour and suspended load of the water is noted.

0 – clear
1 – brown transparent
2 – white cloudy
3 – brown cloudy

[6] Water flow rate: 0 – stagnant
1 – slow
2 – moderate
3 – fast
4 – torrent

[7] Precipitate or stain: The presence of any coatings on pebbles, boulders or stream bottoms is recorded.

0 – none
1 – red, brown or black
2 – white or buff

[8] The pH of the stream water.

APPENDIX 5

Stream Sediments
Field Observations and Analytical Data

GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM , MACNICOL,TUSTIN,BRIDGES AND DOCKER TOWNSHIPS , KENORA DISTRICT (52/F/13) , ONTARIO , 1975
STREAM SEDIMENTS
U BY FLUORIMETRY ; MO,ZN,CU,PB,NI,CO,MN AND FE BY ATOMIC ABSORPTION TECHNIQUES

MAP SHEET	SAMPLE NUMBER	UTM ZONE	COORDINATES EAST	COORDINATES NORTH	ROCK[1] TYPE	STR[2] WIDTH M	WATER[3] DEPTH CM	BANK[4] TYPE	COL[5]	FLOW[6] RATE	PPT[7]	COMP[8]	PH[9]	MO PPM	ZN PPM	CU PPM	PB PPM	NI PPM	CO PPM	MN PPM	FE %	U PPM	LOI %
52F13	754003	15	461900	5518200	GRNT	2	5	4	1	1	0	121	6.8	0.3	16	4	6	8	5	60	0.48	1.7	2.8
52F13	754004	15	459400	5520100	GRNT	1	2	4	1	1	0	__3	6.9	1.1	34	8	11	13	9	184	0.69	29.6	46.2
52F13	754005	15	452400	5520500	GRNT	2	5	3	1	2	0	21_	6.4	0.5	110	10	7	13	13	315	1.31	4.1	8.2
52F13	754006	15	445700	5520200	IMVC	1	4	3	1	1	0	_13	6.5	1.4	42	23	11	74	17	251	0.77	10.9	45.1
52F13	754007	15	439500	5521700	IMVC	1	2	3	1	1	0	31_	7.1	0.5	38	8	7	12	5	174	0.82	3.7	2.3
52F13	754008	15	437000	5521500	MMVC	1	2	3	1	2	0	31_	6.9	0.8	22	9	6	12	5	120	0.75	5.2	1.4
52F13	754009	15	433000	5522200	GRNT	5	4	3	0	2	0	31_	6.8	0.5	16	6	6	13	5	74	0.52	1.3	1.7
Lower detection limits														0.3	2	2	2	2	2	10	0.02	0.4	1.0
Value recorded for the lower detection limit is equal to approximately one-half the actual lower detection limit														0.2	1	1	1	1	1	5	0.01	0.2	0.5

1 See explanation Stream Waters

2 The width of the stream at the sample site is recorded to the nearest metre.

3 The water depth is recorded to the nearest centimetre.

4 The general nature of the bank material is described here.

- 1 – alluvial
- 2 – colluvial (bare rock, residual or mountain soils)
- 3 – glacial till
- 4 – glacial outwash sediments

5 The general colour and suspended load of the water is noted.

- 0 – clear
- 1 – brown transparent
- 2 – white cloudy
- 3 – brown cloudy

6 Water flow rate:
- 0 – stagnant
- 1 – slow
- 2 – moderate
- 3 – fast
- 4 – torrent

7 Precipitate or stain: The presence of any coatings on pebbles, boulders or stream bottoms is recorded.

- 0 – none
- 1 – red, brown or black
- 2 – white or buff

8 The three columns are used to describe the bulk mechanical compositions of the collected sample on scales of 0 to 3.

The three size fractions are divided as follows and designated by columns.

- 1 – >0.125mm, sand
- 2 – <0.125mm, fines, silt and clay
- 3 – organics

The total of the columns must add to 3 or 4.

- 0 – absent
- 1 – minor, <33%
- 2 – medium, 33-67%
- 3 – major, >67%

9 The pH of the stream water.

APPENDIX 6

Sample numbers and locations for bedrock and overburden samples, McNicol, Tustin, Bridges and Docker townships, Kenora District, 52F/13, Ontario

At each site a bedrock, composite chip sample, (52F13 752XXX) and overburden (52F13 751XXX) sample were collected. Only the last three significant digits of each sample number are plotted at each site. The bedrock and overburden samples have, therefore, the same last three digits at each site.

The field observations and analytical data for the bedrock samples (identified by a 2 in digit eight of the eleven digit sample number - 52F13 752XXX) and the overburden samples (identified by a 1 in digit eight of the eleven digit sample number - 52F13 751XXX) are listed in Appendixes 7 and 8 respectively.

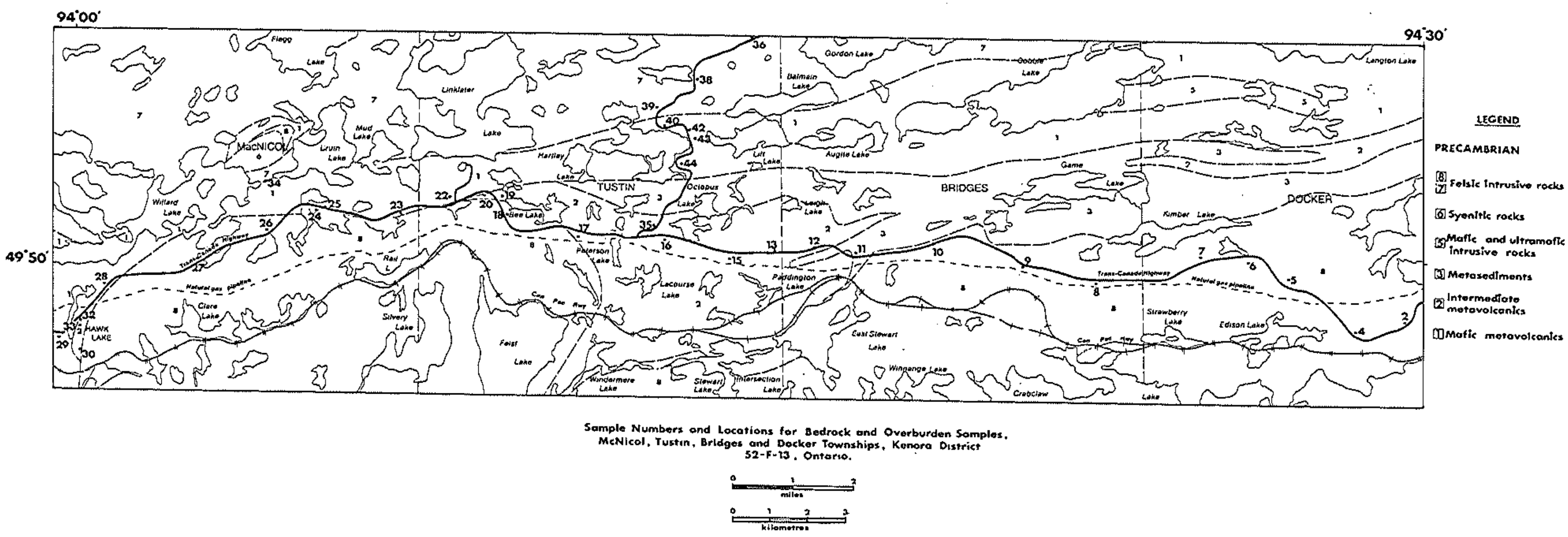


Figure 6.1. *Appendix 6; Sample numbers and locations for bedrock and overburden samples.*

APPENDIX 7

Bedrock (Composite Chip Samples)
Field Observations and Analytical Data

GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM , MACHICOL,TUSTIN,BRIDGES AND DOCKER TOWNSHIPS , KENORA DISTRICT (52/F/13) , ONTARIO , 1975
BEDROCK (COMPOSITE CHIP SAMPLES)
U BY FLUORIMETRY ; ZN,CU,PB,CO,NI,FE,MN, AND MO BY ATOMIC ABSORPTION TECHNIQUES

MAP SHEET	SAMPLE NUMBER	UTM COORDINATES ZONE	EAST	NORTH	ROCK[1] TYPE	AGE[2]	COL[3]	GR[4] SIZE	TEX[5]	BNO OR BED[6]	ALT[7]	RAD[8] ACT CPS	O/C LTH M	ZN PPM	CU PPM	PB PPM	CO PPM	NI PPM	FE PPM	MN PPM	U PPM	MO PPM
52F13	752002	15	463600	5518300	GRNS	01	0	7	1	5	0	100	35	36	9	30	4	16	18634	145	1.30	2.6
52F13	752004	15	462200	5517900	GRPG	01	0	8	1	5	0	150	30	11	2	27	1	3	3039	52	1.20	2.3
52F13	752005	15	460500	5519300	GRDR	01	0	6	0	0	0	65	40	37	6	20	3	4	11636	233	1.50	2.9
52F13	752006	15	459400	5520000	GRNT	01	0	6	0	0	1	150	30	25	2	3	3	3	7200	110	2.30	2.3
52F13	752007	15	458200	5520000	GRNT	01	0	6	0	0	0	150	30	35	4	29	2	2	10182	125	1.70	3.3
52F13	752008	15	455000	5519400	GRDR	01	0	7	1	0	0	60	35	41	3	25	4	2	9455	188	1.50	3.3
52F13	752009	15	453100	5520100	GRNT	01	1	6	1	6	1	60	30	35	4	16	5	8	11636	194	2.10	2.1
52F13	752010	15	451200	5520400	GRPG	01	9	9	3	0	0	250	30	15	2	52	1	3	5280	78	129.50	1.8
52F13	752011	15	448800	5520200	GRPG	01	0	9	3	0	0	150	25	17	2	34	1	3	2645	87	1.80	2.1
52F13	752012	15	447900	5520300	IMVC	01	3	6	1	4	1	60	30	73	34	8	26	65	42368	621	.20	3.5
52F13	752013	15	446800	5520200	IMVC	01	5	2	0	4	0	55	30	70	13	13	26	94	41579	589	.50	3.9
52F13	752015	15	445400	5520300	IMVC	01	5	2	1	4	0	55	25	70	29	14	24	92	29600	421	.58	3.3
52F13	752016	15	443800	5520700	IMVC	01	5	2	1	4	0	50	35	77	18	13	24	34	43947	813	.29	3.3
52F13	752017	15	441700	5520700	IMVC	01	5	2	0	4	0	45	30	72	47	13	35	77	61316	1100	.50	4.0
52F13	752018	15	439700	5521000	GRDR	01	0	7	1	0	0	65	35	37	6	26	2	5	9509	184	2.00	2.6
52F13	752019	15	439200	5521900	IMVC	01	5	2	0	4	0	60	30	95	24	13	32	100	48112	912	.88	3.1
52F13	752020	15	439200	5521900	GRPG	01	0	7	1	0	0	150	30	10	7	56	1	3	3200	69	1.30	2.1
52F13	752022	15	438200	5521600	IMVC	01	5	3	1	4	0	45	10	73	58	14	33	100	48392	735	.68	3.6
52F13	752023	15	436800	5521300	MMVC	01	4	3	1	0	0	60	20	83	61	11	48	126	73566	1338	.12	4.0
52F13	752024	15	434600	5521500	GRNT	01	9	8	2	0	0	250	10	16	4	47	1	2	4444	67	11.50	2.1
52F13	752025	15	434500	5521500	MMVC	01	5	3	1	4	0	65	10	75	90	12	31	59	47832	715	1.80	6.2
52F13	752026	15	433300	5520900	GRNT	01	1	4	1	0	0	60	15	38	11	19	4	6	10264	181	1.70	2.3
52F13	752027	15	431500	5520100	GRNT	01	9	4	1	0	0	65	10	35	7	23	3	4	8755	165	3.20	3.1
52F13	752028	15	428900	5519300	MMVC	01	5	3	1	4	0	55	6	69	25	11	23	37	39600	764	.69	3.1
52F13	752029	15	433200	5522100	MMVC	01	4	2	1	4	0	35	20	85	77	7	47	92	72448	1700	.05	3.4
52F13	752030	15	428300	5517700	MMVC	01	3	2	1	4	0	60	5	72	54	11	23	44	41399	677	.67	3.9
52F13	752032	15	428300	5518500	GRNT	01	9	8	2	0	0	350	20	13	3	54	2	2	5689	127	44.50	1.9
52F13	752033	15	428300	5518600	MMVC	01	4	2	1	4	0	55	5	107	24	9	35	128	47832	1110	.29	3.5
52F13	752034	15	433200	5522100	MMVC	01	3	4	1	4	0	40	3	126	49	4	51	20	128485	2269	.05	4.2
52F13	752035	15	443600	5521000	IMVC	01	3	4	1	4	0	35	10	109	40	7	47	191	78601	2212	.26	4.7
52F13	752036	15	446300	5526000	GRNS	01	8	6	1	5	0	55	15	24	10	21	6	6	9962	168	.57	3.1
52F13	752038	15	444700	5524900	GRNS	01	8	6	1	5	0	80	10	57	13	23	14	33	26000	588	1.20	2.3
52F13	752039	15	443800	5524100	GRNT	01	1	5	1	0	0	75	3	32	5	32	2	4	9660	159	2.30	2.4
52F13	752040	15	443800	5523600	MSDM	01	3	4	1	4	0	45	5	90	45	14	24	127	31800	550	.73	3.2
52F13	752042	15	444300	5523600	MMVC	01	4	3	1	4	0	35	10	99	51	4	46	116	91250	1445	.05	4.1
52F13	752043	15	444500	5523500	GRPG	01	0	9	3	0	0	200	15	14	3	56	2	1	4444	619	150.00	2.7
52F13	752044	15	444200	5522700	GBBR	01	4	3	1	0	0	30	5	71	67	4	66	305	73566	1280	.29	2.1
Lower detection limits														2	2	2	2	2	20	10	0.10	0.2
Value recorded for the lower detection limit is equal to one-half the actual lower detection limit														1	1	1	1	1	10	5	0.05	0.1

[1] Bedrock type: GBBR – gabbro; GRDR – granodiorite; GRNS – granitic gneiss; GRNT – granite; GRPG – granite pegmatite; IMVC – intermediate metavolcanics; MMVC – mafic metavolcanics; MSDM – metasediments

[2] Precambrian undivided.

[3] Colour:
0 – white, <20% dark minerals
1 – white and black, 20-40%
2 – white equals black, 40-60%
3 – black and white, 60-80%
4 – black, >80%
5 – grey
6 – green
7 – buff
8 – orange or yellow
9 – red or purple

[4] Grain size:
0 – <0.004 mm, clay, glassy
1 – 0.004 - 0.025 mm, silt, aphanitic
2 – 0.025 - 0.125 mm, very fine sand, aphanitic
3 – 0.125 - 0.125 mm, fine sand, very fine grained
4 – 0.250 - .050 mm, medium coarse sand, very fine grained
5 – 0.50 - 1.00 mm, coarse sand, fine grained
6 – 1.00 - 2.00 mm, very coarse sand, medium grained
7 – 2.00 - 5.00 mm, granules, medium grained
8 – 5.00 - 20.00 mm, pebbles, coarse grained
9 – 20.00 mm -σ, cobbles, etc., very coarse grained

[5] Texture:
0 – uniform grain size
1 – variable grain
2 – megacrystic
3 – pegmatitic
4 – miarolitic
5 – pyroclastic
6 – cataclastic
7 – bioclastic
8 – oolitic
9 – other

[6] Banding or bedding:
0 – massive
1 – bedded
2 – crossbedded
3 – slump structures
4 – schistose or foliated
5 – gneissic banding
6 – migmatitic
7 – oriented megacrysts
8 – trachytic groundmass
9 – other

[7] Alteration:
0 – fresh
1 – weathered
2 – weathered, gossanous
3 – hydrothermal bleached white
4 – hydrothermal stained red or rusty

[8] Radioactivity (counts per second): Average cps obtained over the length of the outcrop sampled. Measurements were made with an Exploranium GRS-101 scintillometer held on the outcrop surface.

GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM , MACNICOL,TUSTIN,BRIDGES AND DOCKER TOWNSHIPS , KENORA DISTRICT (52/F/13) , ONTARIO , 1975
BEDROCK (COMPOSITE CHIP SAMPLES)
THE DATA LISTED BELOW (SR TO Y) WERE ESTIMATED BY EMISSION SPECTROMETRY

MAP SHEET	SAMPLE NUMBER	SR PPM	BA PPM	MN PPM	TI PPM	AL %	CA %	MG %	FE %	K %	PB PPM	ZN PPM	AG PPM	V PPM	MO PPM	CR PPM	CU PPM	CO PPM	NI PPM	BE PPM	LA PPM	Y PPM
52F13	752002	382	827	131	1125	7.6	1.6	0.3	1.7	3.9	17	38	0.2	36	1.6	42	14	4	17	1.3	36	5
52F13	752004	332	839	50	338	7.5	1.2	0.1	0.4	3.6	8	12	0.2	23	0.5	6	5	1	6	0.5	50	5
52F13	752005	505	715	172	1387	7.5	1.9	0.2	1.7	2.4	7	60	0.2	39	1.4	9	17	1	5	0.5	38	5
52F13	752006	302	700	50	932	6.9	1.5	0.1	1.4	4.1	20	66	0.2	18	1.3	15	71	1	18	0.5	63	5
52F13	752007	262	1319	50	944	6.2	0.9	0.1	1.8	4.1	1	41	0.2	48	0.5	14	3	1	3	0.5	194	5
52F13	752008	398	959	50	1355	8.0	1.5	0.1	2.0	3.8	8	39	0.2	41	0.5	11	10	1	5	0.5	68	5
52F13	752009	417	1046	50	1414	6.0	2.0	0.2	2.0	2.9	5	70	0.2	55	1.0	23	11	2	10	0.5	95	5
52F13	752010	161	501	50	440	7.1	0.6	0.1	0.7	5.1	76	55	0.2	5	1.5	3	18	1	4	2.4	43	5
52F13	752011	27	39	50	363	5.6	0.6	0.1	0.3	2.4	37	34	0.2	5	0.5	3	6	1	2	2.7	27	16
52F13	752012	343	386	651	3932	6.9	3.7	2.0	5.1	2.2	12	48	0.2	178	3.1	141	36	28	54	1.1	21	15
52F13	752013	477	888	702	3908	6.1	3.8	2.1	5.4	1.9	18	61	0.2	186	3.9	150	25	32	125	1.1	71	17
52F13	752015	440	676	391	2701	6.5	3.6	1.4	4.4	2.8	16	52	0.2	136	1.9	150	42	30	125	1.6	37	14
52F13	752016	643	1010	1011	4384	7.7	4.3	1.7	5.7	2.7	10	46	0.2	177	3.0	50	18	28	32	1.6	46	19
52F13	752017	632	544	582	4296	6.3	5.8	1.2	7.2	1.8	6	31	0.2	301	3.1	150	45	35	63	0.5	5	30
52F13	752018	562	840	100	1107	6.3	1.8	0.1	1.3	2.5	16	39	0.2	31	1.2	8	4	1	5	2.1	36	5
52F13	752019	297	342	975	3866	6.0	3.4	3.0	5.3	1.5	22	119	0.2	166	4.1	150	27	35	125	1.7	38	16
52F13	752020	95	174	50	207	6.6	0.9	0.1	0.3	2.9	60	46	0.2	5	1.5	3	10	1	3	2.9	17	5
52F13	752022	481	550	1186	4484	7.2	3.8	1.8	5.8	1.3	15	75	0.2	159	4.2	150	68	32	125	1.2	40	15
52F13	752023	129	81	1538	5194	7.0	5.1	3.2	7.8	0.8	11	103	0.2	229	5.6	150	64	50	125	0.5	15	23
52F13	752024	89	56	50	237	6.7	0.6	0.1	0.6	3.2	57	51	0.2	11	1.7	3	4	1	3	3.6	18	5
52F13	752025	1300	820	649	4475	6.2	4.0	2.0	5.7	1.9	14	58	0.2	179	4.0	92	91	31	125	1.8	112	21
52F13	752026	683	1023	111	1249	5.9	1.6	0.2	1.3	1.8	14	72	0.2	28	1.4	9	12	2	6	2.1	30	5
52F13	752027	574	1046	50	1234	6.0	1.5	0.1	1.0	1.8	16	78	0.2	22	1.1	6	6	1	3	1.5	40	5
52F13	752028	553	631	829	3797	6.8	4.2	1.7	5.2	2.0	11	47	0.2	164	3.2	91	20	22	34	1.5	49	17
52F13	752029	144	158	1621	4583	6.5	5.6	3.5	8.8	0.6	12	65	0.2	279	5.5	150	83	58	125	0.5	5	19
52F13	752030	379	577	781	4837	6.9	3.3	1.8	5.1	1.6	10	74	0.2	174	3.7	113	48	20	36	0.7	37	21
52F13	752032	119	47	58	338	7.0	1.1	0.1	0.8	1.7	52	52	0.2	11	0.5	4	2	1	2	1.6	16	5
52F13	752033	362	551	1150	4006	6.9	4.3	3.3	5.7	1.4	13	83	0.2	205	3.7	150	24	41	125	1.3	43	18
52F13	752034	117	94	1800	6500	6.0	4.2	2.0	14.0	0.5	7	94	0.2	400	6.3	6	48	66	26	0.5	20	50
52F13	752035	399	244	1800	4593	7.9	5.5	3.0	7.8	0.8	9	136	0.2	215	5.4	150	30	44	125	0.5	41	27
52F13	752036	383	1500	50	1151	6.4	1.3	0.1	1.2	3.2	13	51	0.2	43	0.5	9	8	1	5	1.4	26	5
52F13	752038	284	604	798	2752	6.6	2.7	1.1	3.6	2.2	23	67	0.2	101	2.9	57	12	14	29	1.8	28	19
52F13	752039	490	1556	127	1159	6.9	1.3	0.1	1.2	3.1	25	68	0.2	19	1.6	8	8	1	6	1.5	40	12
52F13	752040	505	511	733	4159	7.1	3.2	2.0	4.1	1.6	13	124	0.2	127	3.6	152	43	28	125	0.5	37	13
52F13	752042	178	47	1800	5328	8.4	5.2	4.7	8.4	0.4	7	113	0.2	245	6.8	150	49	44	86	1.4	12	21
52F13	752043	11	7	650	100	6.0	0.3	0.1	0.5	3.3	43	46	0.2	5	0.5	3	3	1	2	2.1	24	34
52F13	752044	116	49	1181	2878	6.1	5.3	5.5	8.1	0.2	13	55	0.2	193	4.7	150	70	79	125	0.5	11	12
Lower detection limits		2	2	100	200	0.5	0.2	0.2	0.2	0.2	2	25	0.5	10	1.0	2	2	2	2	1.0	10	10
		1	1	50	100	0.2	0.1	0.1	0.1	0.1	1	13	0.2	5	0.5	1	1	1	1	0.5	5	5
(Value recorded for the lower detection limit is equal to approximately one-half the actual lower detection limit)																						
Upper detection limits		1300	2100	1800	6500	10.0	8.0	8.0	15.0	9.0	100	1000	10.0	400	20.0	150	200	150	125	25.0	300	450

APPENDIX 8

Overburden
Field Observations and Analytical Data

GEOCHEMICAL ORIENTATION SURVEY FOR URANIUM , MACNICOL,TUSTIN,BRIDGES AND DOCKER TOWNSHIPS , KENORA DISTRICT (52/F/13) , ONTARIO , 1975
OVERBURDEN
U BY FLUORIMETRY ; ZN,CU,PB,CO,NI,FE,MN, AND MO BY ATOMIC ABSORPTION TECHNIQUES

MAP SHEET	SAMPLE NUMBER	UTM COORDINATES ZONE	EAST	NORTH	UNDERLYING ROCK TYPE[1]	SLOPE[2]	REL[3]	DOM VEG[4]	VEG INT[5]	SOIL TYPE[6]	DEP CM[7]	THK CM[8]	HOR[9]	COL[10]	TEX[11]	CNST[12]	MST[13]	DRNG[14]	ZN PPM	CU PPM	PB PPM	CO PPM	NI PPM	FE PPM	MN PPM	U PPM	MO PPM
52F13	751002	15	463600	5518300	GRNS	S10	1	1S	3	51	5	5	6	6	1	61	3	2	92	24	28	5	14	34000	266	1.0	4.8
52F13	751004	15	462200	5517900	GRPG	SW05	1	1S	3	62	15	5	6	6	0	33	1	2	71	32	17	15	46	36000	528	1.0	0.8
52F13	751005	15	460500	5519300	GROR	SE05	1	3A	2	51	10	5	6	6	3	61	3	2	38	10	10	8	15	16762	334	0.8	0.1
52F13	751006	15	459400	5520000	GRNT	N10	1	1S	3	34	20	5	6	6	2	53	2	2	61	19	17	9	21	35600	334	0.9	1.2
52F13	751007	15	458200	5520000	GRNT	S10	1	1S	3	35	15	5	6	5	2	53	2	2	54	12	17	11	33	27429	334	1.9	0.6
52F13	751008	15	455000	5519400	GROR	N05	1	1S	3	35	10	5	6	5	2	53	2	2	70	15	24	12	30	30857	331	0.9	1.0
52F13	751009	15	453100	5520100	GRNT	S20	1	1S	3	35	5	5	6	5	4	52	2	2	96	34	21	13	28	32000	545	1.6	2.3
52F13	751010	15	451200	5520400	GRPG	SE10	1	3S	3	35	10	5	6	5	4	52	2	2	177	34	21	18	40	43200	572	1.2	0.4
52F13	751011	15	448800	5520200	GRPG	S05	1	3S	3	35	15	5	6	5	2	53	2	2	52	16	18	10	21	27429	269	15.0	1.3
52F13	751012	15	447900	5520300	IMVC	S20	1	1N	3	35	10	5	6	6	2	53	2	2	36	14	18	13	47	24331	366	1.4	1.5
52F13	751013	15	446800	5520200	IMVC	SW10	1	1N	3	35	15	5	6	6	2	53	2	2	30	6	14	9	32	23619	331	0.7	0.4
52F13	751015	15	445400	5520300	IMVC	NE05	1	3A	3	35	10	5	6	5	2	53	2	2	35	11	21	16	44	27429	359	0.6	0.9
52F13	751016	15	443800	5520700	IMVC	S10	1	2B	3	35	15	5	6	5	2	53	2	2	53	18	17	12	32	28571	391	0.4	0.1
52F13	751017	15	441700	5520700	IMVC	E10	1	3A	3	35	15	5	6	5	2	53	2	2	68	45	15	22	46	46800	617	0.9	1.7
52F13	751018	15	439700	5521900	GROR	N05	1	3A	3	35	10	5	6	6	2	53	2	2	35	9	15	10	27	22476	344	0.6	0.4
52F13	751019	15	439200	5521900	IMVC	N05	1	3N	3	35	5	5	6	5	2	53	2	2	45	24	24	13	30	27810	431	13.0	1.1
52F13	751020	15	439200	5521900	GRPG	N05	1	3N	3	51	10	5	6	6	2	53	2	2	76	48	17	18	47	40000	438	8.8	1.9
52F13	751022	15	438200	5521600	IMVC	S05	1	2B	2	35	20	10	6	6	1	61	3	2	64	14	15	15	42	42800	521	0.5	0.6
52F13	751023	15	436800	5521300	MMVC	00	1	2B	2	35	5	10	6	5	1	61	3	2	76	28	17	18	50	37600	469	0.8	0.1
52F13	751024	15	434600	5521500	GRNT	S05	1	2B	2	35	5	10	6	5	1	61	3	2	54	24	15	13	38	31238	448	16.8	1.2
52F13	751025	15	434500	5521500	MMVC	S05	1	2B	2	35	10	10	6	6	2	61	3	2	45	19	21	17	40	28190	479	22.0	0.1
52F13	751026	15	433300	5520900	GRNT	S05	1	3B	2	35	15	5	6	5	1	61	3	2	45	11	18	11	25	27810	366	1.1	1.0
52F13	751027	15	431500	5520100	GRNT	00	1	1S	2	35	15	5	6	5	1	61	3	2	36	7	17	11	29	23619	322	0.8	0.7
52F13	751028	15	428900	5519300	MMVC	00	1	2B	2	35	10	5	6	5	1	61	3	2	102	37	28	12	25	35600	414	6.0	8.4
52F13	751029	15	433200	5522100	MMVC	N05	1	1S	2	35	15	5	6	5	1	61	3	2	81	81	19	17	41	45600	445	1.2	4.5
52F13	751030	15	428300	5517700	MMVC	S05	1	1N	2	51	10	5	6	7	1	61	3	2	160	41	21	22	53	57778	1074	0.5	2.5
52F13	751032	15	428300	5518500	GRNT	00	1	1N	3	51	10	5	6	6	1	61	3	2	63	57	10	19	40	59111	490	5.2	8.7
52F13	751033	15	428300	5518600	MMVC	00	1	1N	2	51	5	5	6	6	2	61	3	2	83	33	17	27	77	44800	818	10.8	1.5
52F13	751034	15	433200	5522100	MMVC	N05	1	3B	3	51	15	5	6	6	2	61	3	2	90	35	36	41	71	33600	1191	1.3	1.6
52F13	751035	15	443600	5521000	IMVC	N05	1	1N	2	35	15	5	6	5	1	61	3	2	86	28	8	32	115	59556	1029	0.2	2.9
52F13	751036	15	446300	5526800	GRNS	N05	1	3B	3	35	15	5	6	6	1	61	3	2	188	24	21	14	29	40800	431	0.9	1.6
52F13	751038	15	444700	5524900	GRNS	00	1	2A	2	35	20	5	6	5	1	61	3	2	45	13	21	10	19	38000	366	3.0	2.0
52F13	751039	15	443800	5524100	GRNT	S05	1	2B	3	35	15	5	6	6	1	61	3	2	68	11	19	12	23	36000	466	1.6	1.4
52F13	751040	15	443800	5523600	MSDM	00	1	3B	2	35	10	5	6	6	1	61	3	2	63	18	10	13	38	44800	579	0.5	1.1
52F13	751042	15	444300	5523600	MMVC	00	1	2B	2	35	15	5	6	6	1	61	3	2	56	16	15	13	34	32800	424	0.9	0.7
52F13	751043	15	444500	5523500	GRPG	S05	1	2B	3	35	20	10	6	6	1	61	3	2	43	17	13	13	25	27429	306	84.0	0.6
52F13	751044	15	444200	5522700	GBBR	00	1	3S	3	35	15	10	6	5	1	61	3	2	77	12	13	12	39	30857	397	1.2	0.3
Lower detection limits																			2	2	2	2	2	20	10	0.4	0.2
Value recorded for the lower detection limit is equal to one-half the actual lower detection limit																			1	1	1	1	1	10	5	0.2	0.1

[1] Underlying bedrock type: See explanation Appendix 7

[2] The slope of the ground at the sample site is recorded in two parts: direction of slope, towards the direction, i.e. N slopes away to north, SW slopes away to the southwest; magnitude of slope, to the nearest 5 degrees, i.e. 05–5°, 25–25°.

[3] Relief: 0 – flat
1 – low, 0 - 50 feet
2 – gentle, 50 - 200 feet
3 – moderate, 200 - 1000 feet
4 – high, > 1000 feet

[4] Dominant vegetation:

0 –	no trees	C –	Cedar
1 –	conifers	T –	Tamarak
2 –	deciduous	P –	Poplar
3 –	mixed conifers and deciduous	H –	Hemlok
		M –	Maple
M –	moss	B –	Birch
G –	grass	O –	Oak
L –	Labrador tea	A –	Alder
S –	Spruce	W –	Willow
N –	Pine		

[5] Vegetation Intensity: 0 – open
1 – sparse
2 – moderate, parkland
3 – well-wooded, forest

[6] Soil Type:

Chernozem	10 –	undifferentiated
	11 –	brown
	12 –	dark brown
	13 –	black
	14 –	dark grey
Solonetyic	20 –	undifferentiated
	21 –	solonety
	22 –	Solod
Podzolic	30 –	undifferentiated
	31 –	grey brown
	32 –	dark grey wooded
	33 –	grey wooded
	34 –	humic Podzol
	35 –	Podzol
Bremisolic	40 –	undifferentiated
	41 –	brown forest
	42 –	brown wooded
	43 –	acid brown wooded
	44 –	acid brown forest
	45 –	concretionary brown
	46 –	alpine brown
Regosolic	50 –	undifferentiated
	51 –	Regosol
	52 –	Podzol-Regosol

[6] Soil Type: (continued)

Gleysolic	60 –	undifferentiated
	61 –	humic Gleysol
	62 –	Gleysol
	63 –	eluviated Gleysol
Organic	70 –	undifferentiated
	71 –	Fibrisol
	72 –	Mesisol
	73 –	Humisol
Glacial	80 –	undifferentiated
	81 –	local till
	82 –	transported till
	83 –	glacial-lacustrine sediment
	84 –	esker sediment

[7] Depth to the top of the sample in centimetres.

[8] Sample thickness in centimetres.

[9] Soil horizon:

	United States	Canada
0 –	A_{00}	L or L-H
1 –	A_0	F
2 –	A_1	H or A_n
3 –	A_2	Ae
4 –	A_3	AB
5 –	B_1	BA
6 –	B_2	N_f or B_t
7 –	B_3	BC
8 –	C	C

[10] Colour: 0 – white
1 – buff
2 – yellow
3 – orange
4 – pink
5 – red
6 – brown
7 – dark brown
8 – black
9 – grey

[11] Texture: 0 – <0.004 mm, fine silt and clay, clayey soil
1 – 0.004 - 0.125 mm, silt, clayey loam
2 – 0.125 - 05 mm, fine sand, loam
3 – 0.5 - 1.0 mm, medium sand, sandy loam
4 – 1.0 - 2.0 mm, coarse sand, sandy soil
5 – >2.0 mm, granules etc.

[12] Consistence: The consistence of the sample is used to describe the aggregate nature of the sample and is dependent on the moisture content of the sample. See moisture.

When sample is wet, moisture = 1

11 – non sticky - non plastic
12 – slightly plastic
13 – plastic
14 – very plastic

This is extended to slightly sticky, sticky and very sticky material.

	non plastic	slightly plastic
non sticky	11	12
slightly sticky	21	22
sticky	31	32
very sticky	41	42

	plastic	very plastic
non sticky	13	14
slightly sticky	23	24
sticky	33	34
very sticky	43	44

When sample is moist, moisture = 2

51 – non coherent
52 – very friable
53 – friable
54 – firm
55 – very firm

When sample is dry, moisture = 3

61 – loose
62 – soft
63 – slightly hard
64 – hard
65 – very hard
66 – extremely hard
71 – weakly cemented
72 – strongly cemented
73 – indurated

[13] Moisture: 1 – wet
2 – moist
3 – dry

[14] Drainage: 1 – rapidly drained
2 – well drained
3 – moderately well drained