GEOCHEMICAL FOLLOW-UP STUDIES, NORTHWESTERN MANITOBA

Project 760044: Uranium Reconnaissance Program

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Introduction

As part of the Federal-Provincial Uranium Reconnaissance Program (Darnley *et al.*, 1975) regional geochemical and airborne radiometric surveys were carried out in northwestern Manitoba during the summer of 1975.

The geochemical surveys covered map-sheets 64J, K, N and O and consisted of the collection of lake sediments at a density of one sample per five square miles. The lake sediment samples were analyzed for Zn, Cu, Pb, Ni, Co, Ag, Mn, As, Mo, Fe, Hg, U and L.O.I. (loss on ignition) and these data released as Open Files 320, 321, and 323 in the spring of 1976 (Hornbrook *et al.*, 1976a, b, c, d).

The airborne gamma-ray spectrometry, flown at five kilometer line spacings, covered map-sheets 64F, J, K, N and O. These data were presented as (1) contour maps of the integral count, the potassium, equivalent uranium and equivalent thorium concentrations, and the eU/eTh, eU/K and eTh/K ratios; and (2) stacked profiles of the seven radiometric parameters plotted for each flight line from each of the five map-sheets. These data were released as Open Files 315, 316, 317, 318 and 319 in the spring of 1976 (Resource Geophysics and Geochemistry Division, 1976a, b, c, d, e).

Thirteen areas, anomalous in uranium or having a known uranium occurrence, were selected for a geochemically oriented follow-up study on the basis of the regional geochemical and geophysical data (Fig. 50.1, areas 1 to 13; Table 50.1). The areas were chosen to cover as many of the different geological environments present in the area as possible. The geochemical data were also used to give an indication of any anomalous concentrations of other elements, associated with anomalous uranium values, in the selected areas. A complementary geophysically oriented follow-up program was carried out from the same base camp under the supervision of B.W. Charbonneau, Radiation Methods Section.

A further six areas anomalous in one or more of Cu, Ni, Zn, Ag and/or Mo were selected for follow-up investigations on the basis of the regional geochemical data (Fig. 50.1, areas 14 to 19; Table 50.2).

Objectives of Follow-up Program

The overall objective of the follow-up studies is to provide information which will maximize the usefulness of the regional reconnaissance surveys produced by the Uranium Reconnaissance Program by:

1. investigating the causes of anomaly patterns and selected individual anomalies in order to assemble examples and hence guidelines for the general interpretation of reconnaissance data.
2. by establishing effective follow-up procedures that can be employed by the mineral exploration industry.
3. identifying features in the reconnaissance data which in themselves or in conjunction with other geoscience data are most diagnostic of mineralization.

Northwestern Manitoba (64J, K, N, O)

General Geology

The earliest mapping in the area was carried out by the Geological Survey (Currie, 1961; Davison, 1962, 1963; Fraser, 1962).

Recently the government of Manitoba has carried out further geological mapping in the area, 64N and the north half of 64K (Weber *et al.*, 1975). The Manitoba Department of Mines, Resources and Environmental Management is currently continuing the mapping of the area in sheets 64J, 64O, and the south half of 64K.

Bedrock exposures in the area average one to two per cent and seldom exceed five per cent. The bedrock is Precambrian and forms part of the Churchill structural province. Weber *et al.* (1975) divided the bedrock into three main groups; Archean rocks, Aphebian rocks of mainly sedimentary origin, and Hudsonian igneous and metamorphic rocks.

The Archean rocks consist of foliated granitoid bodies, ranging in composition from quartz diorite to alaskite granite (Weber *et al.*, 1975). The Aphebian rocks in the northern part of the area are felt to be continuous with the Hurwitz Group sediments in the southern part of the District of Keewatin. The remainder of the Aphebian rocks lie in the extension of the Wollaston fold belt, as defined by Money (1968), in Saskatchewan. The igneous and metamorphic rocks produced during the Hudsonian orogeny include migmatite, plugs and stocks of anatexite, and syn- and late-orogenic batholiths. Most are massive and many truncate Hudsonian trends.

Although no mineral occurrences of economic significance have yet been found in the area there are a number of showings, base metal, uranium and radiometric, present in the area. These are described in detail by Weber *et al.* (1975).

One inch to four mile aeromagnetic maps 7146G, 7147G, 7150G and 7175G cover the project area.

Surficial Geology

As no surficial geology maps were available for the area R.W. Klassen, Terrain Sciences Division, prepared such maps from airphoto interpretation for 64N.

From: Report of Activities, Part C;
Geol. Surv. Can., Paper 76-1C (1976).

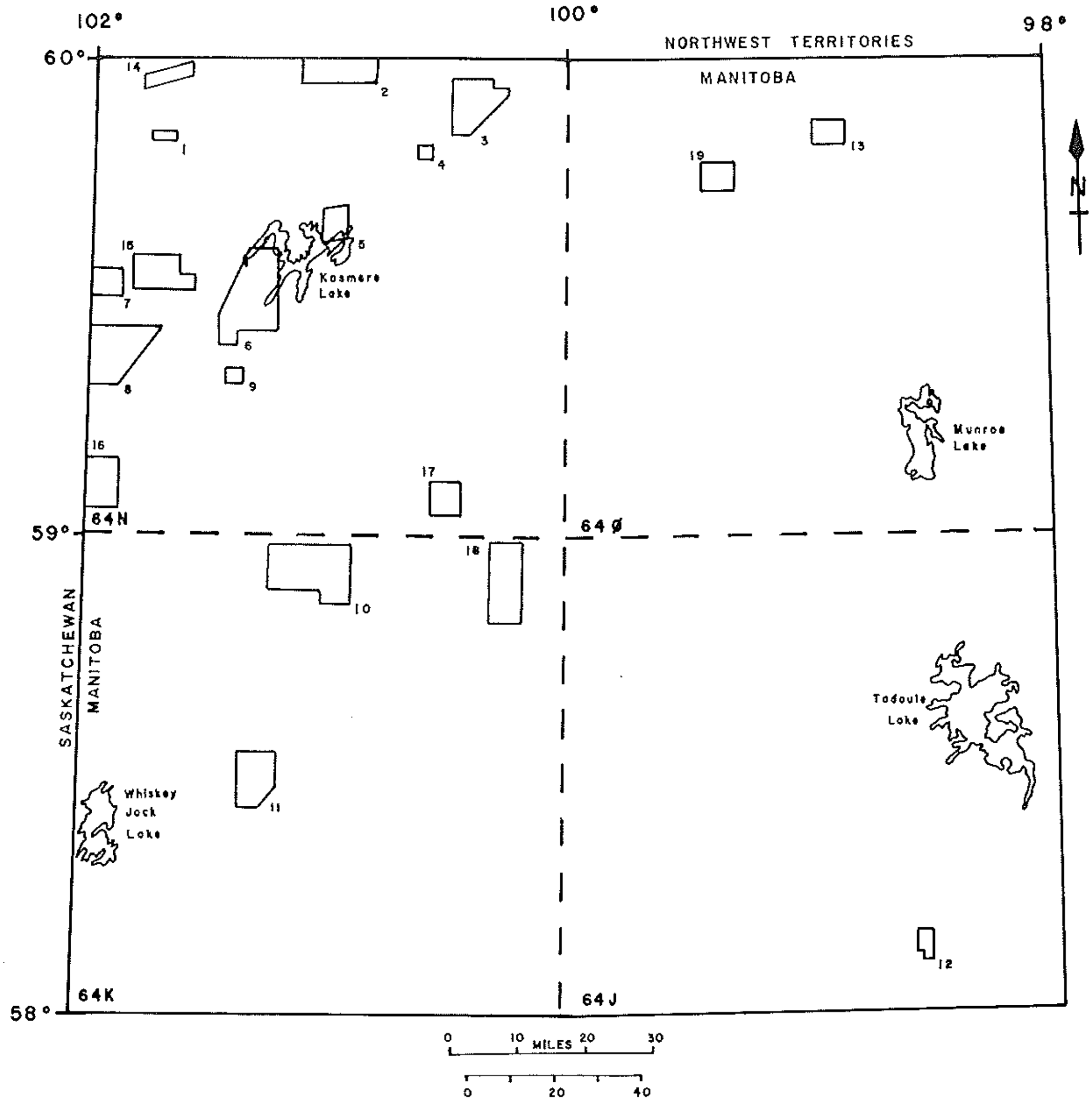

Figure 50.1. Areas of follow-up work, northwestern Manitoba.

Five main types of moraine units, two main types of glaciofluvial units and a till veneered bedrock unit were identified. Glacial features and landscapes in the form of drumlins, moraine ridges, hummocky moraine and esker complexes were noted over most of the map area (64N) and were felt to indicate an almost continuous blanket of drift (mostly till).

Follow-up Program

1. Detailed Regional Surveys

Detailed Lake Sampling

The first facet of the follow-up program involved the detailed sampling of lakes in the areas selected as anomalous in U and/or Cu, Ni, Zn, Ag and/or Mo (Fig. 50.1). The purpose of this work was to:

1. Verify the anomalous dispersion patterns outlined by the reconnaissance surveys, and;
2. Define more precisely the dimension and amplitude of the local anomalies thereby focusing on the cores of the reconnaissance anomalies and narrowing down the area requiring ground work.

Surface water and bottom sediments were collected from lakes at a density of approximately one sample site per km^2. Surface water pH, conductivity, temperature and dissolved oxygen levels were measured using a Martek Mark V Water Quality Analyzer. A Hughes 500-C helicopter was employed for this work.

Table 50.1

Follow-up Surveys - Uranium, northwestern Manitoba

Area No. (Fig. 50.1)	Name	N.T.S.	Anomaly type	Type of work performed*
1	Parsons L.	64 N 13	Known mineralization (U)	1, 2b, 3, 5
2	Schell – Lamontague L.	64 N 14/15	U, Cu	1
3	Leathwood L.	64 N 16	U, Mo	1, 2a, 3, 4, 5, 6
4	Saar L.	64 N 15	Known mineralization (U)	1, 2a, 3, 5
5	Northeast Arm Kasmere L.	64 N 10/11	U	1, 2a
6	Kasmere Falls	64 N 6/11	U	1, 2a, 2b, 3, 4, 5
7	Sharman L.	64 N 12	U	1, 3, 6
8	Grevstad L.	64 N 5	U, Cu	1, 2a, 3, 4, 5
9	Thanout L.	64 N 11	Known mineralization (U)	1, 2a, 2b, 3, 5
10	McGill L.	64 K 15/16	Radiometric	1, 3, 6
11	Sandy Hill L.	64 K 6/11	U, Mo	1, 3, 6
12	Gimby L.	64 J 2	U (?)	1
13	Blevins L.	64 O 15	U	1, 3, 4, 5

*1. Detailed lake sampling
2a. Airborne gamma-ray spectrometry, Skyvan
b. Airborne gamma-ray spectrometry, helicopter
3. Ground scintillometer and/or gamma-ray spectrometer measurements
4. Overburden sampling
5. Bedrock sampling, routine
6. Bedrock sampling, bedrock study

Lake sediments were collected, using a modified Hornbrook sampler, placed in waterproof kraft paper bags, field dried and shipped to Ottawa for later preparation and analyses.

Lake waters were collected in 500-ml polyethylene bottles. On the day of collection half of each sample was transferred to a second, 250-ml, bottle acidified and subsequently shipped to Ottawa for later check and additional element analyses. The remainder of the water samples were utilized, depending on the anomaly type, to determine the U content (by fluorimetry), the F content (by selective ion electrode), and the Cu, Zn and Ni contents (by colorimetry). The lake water analyses were performed in the field by G.E.M. Aslin and A.I. MacLaurin.

Detailed Airborne Gamma-Ray Spectrometry Surveys

Employing the G.S.C. Skyvan, airborne measurements were made using a four window spectrometer (U, Th, K and total counts), with twelve 22.86 cm x 10.16 cm NaI (Tl) detectors, flown at a mean terrain clearance of 122 m and 190 km/hr. North-south flight lines were at 1-km line spacings and map-sheets 64N-5, 6, 10, 11, 15 and 16 were covered.

In addition, a helicopter-mounted McPhar airborne gamma-ray spectrometer was used for the detailed work on selected areas. The McPhar spectrometer utilizes a single 22.86 cm x 10.16 cm NaI crystal, contains a 1024 channel analog to digital converter, and a read only memory decodes 4 spectral windows corresponding to U, Th, K and total counts. North-south flight lines were at 0.5 km line spacings flown at a mean terrain clearance of 45 m and 60 km/hr. This work was supervised by J. Parker.

The purpose of this work was essentially similar, while being confirmative, to the detailed lake sampling.

2. Ground Investigations

Utilizing the data from the detailed lake water and gamma-ray spectrometer surveys the core areas of the regional uranium anomalies were identified and ground work carried out over these areas to:

1. Verify on the ground and define more concisely the dimensions and amplitude of the local anomalies and relate these to the detailed and reconnaissance regional anomaly patterns.
2. Relate the results, obtained from the reconnaissance and detailed lake sediment and water surveys, to:
   (a) mineralization, unknown or known (if known and mineralization did not give an anomalous response, establish why).
   (b) surficial and/or bedrock composition.
   (c) known geology.

To establish the extent to which the anomaly patterns, both geochemical and radiometric, reflect

Table 50.2

Follow-up Surveys - Cu, Zn, Ni, Ag and/or Mo, northwestern Manitoba

Area No. (Fig. 50.1)	Name	N.T.S.	Anomaly type	Type of work performed*
14	Buckels L.	64 N 13	Cu, Ni	1
15	Brophy L.	64 N 12	Cu	1, 5
16	Quasso-Wolfe L.	64 N 4	Known mineralization (Zn)	1, 5
17	Barthelette L.	64 N 1/2	Mo	1, 5, 6
18	Magas L.	64 K 16	Ag	1, 4, 5
19	Macksimchuk L.	64 O 11/14	Zn, Ag	1

*1. Detailed lake sampling
4. Overburden sampling, dispersion study
5. Bedrock sampling, routine
6. Bedrock sampling, bedrock study

either surficial overburden, bedrock and/or mineralization systematic ground traversing was carried out over the core areas of the anomalies. This involved the taking of *in situ* radiometric measurements and the collection of overburden, bedrock and mineralized material for later analyses and laboratory identification and confirmation of the source of radioactivity. This phase of the work was carried out jointly with B.W. Charbonneau, who as well investigated some sharp spot radiometric anomalies in both Manitoba and Saskatchewan.

Within northwestern Manitoba several of the large granitoid bodies exhibit anomalous radiometric and/or geochemical characteristics. To establish to what extent these characteristics are a reflection of bedrock composition, paired bedrock samples were collected from a number of sites within these bodies. *In situ* radiometric measurements were also taken at the sample sites. The granitoid bodies sampled include (Fig. 50.1):

3. Leathwood Lake; biotite-quartz monzonite
7. Sharman Lake; fluorite-quartz monzonite
10. McGill Lake; alaskite
11. Sandy Hill Lake; granite to quartz monzonite
17. Barthelette Lake; and surrounding bedrock unit of same composition; biotite-quartz monzonite (little radiometric or geochemical response for uranium-chosen as a background unit).

A study of the bedrock samples from these granitoid bodies will be undertaken, to examine their mineralogy, petrology, and geochemistry in order to determine the nature and form of the uranium present. This will involve chemical analyses, including leaching studies, and electron microprobe examination.

Only a minor amount of ground traversing, primarily involving the collection of bedrock samples, was carried out over the areas anomalous in one or more of Cu, Zn, Ni and/or Mo (Table 50.2). The colorimetric tests for Cu, Zn and Ni in waters proved of little use in the field, the detection limits being generally higher than the levels encountered in most waters in the area. Solvent extraction – atomic absorption techniques are currently being applied to determine the Cu, Zn and Ni contents of the acidified surface lake water samples that were returned to Ottawa.

The Magas Lake Ag anomaly (Table 50.2) was examined in detail, with L. Dredge, and both bedrock and surficial overburden samples were collected systematically from the area. Both geochemical and glacial dispersion studies will be carried out on this area, employing chemical and microscopic examination of the overburden samples, in order to assess the significance of the Ag anomaly.

Discussion

The results of the follow-up work are not yet available. However, some general comments regarding the findings in northwestern Manitoba can be made.

The field fluorimetric analysis of uranium in surface lake waters confirmed the uranium anomalies as outlined by the 1975 reconnaissance lake sediment survey. Within the anomalous areas patterns and trends of uranium concentrations were depicted and the core areas within the anomalies were clearly discernible by grouped anomalous samples.

Similarly, the detailed airborne gamma-ray spectrometer surveys verified the 1975 reconnaissance results, defining the anomalous areas in considerably more detail.

The detailed geochemistry and radiometrics produced analogous results enabling the areas requiring ground examination to be considerably lessened with regard to the original anomalous areas as outlined by the regional reconnaissance lake sediment and radiometric surveys.

The general lack of response of the field colorimetric tests for Cu, Zn and Ni in the lake waters of northwestern Manitoba illustrates the need to collect lake sediments as well as waters. The collection and analysis of lake sediments is necessary not only for outlining anomalous concentrations of Cu, Zn, Ni, etc. but also to show the association of other elements with uranium. It is the association of other elements with uranium which may possibly be used to identify different types of uranium anomalies, a necessary step in assessing the economic potential of each anomaly.

The only analyzed element, other than uranium, detectable in the surface lake waters was fluorine. A close association was found to exist between uranium and fluorine in the surface waters of lakes located within most of the large granitoid bodies sampled. The uranium and fluorine results in the surface lake waters defined quite precisely the extent of these granitoid bodies even illustrating zoning within them. Further work will be done on this feature to examine how the associations and patterns for these elements in the surface lake waters and sediments relate to the bedrock itself.

It is the association of the other elements with uranium in the surface lake waters and, more significantly, in the lake sediments that can possibly be used to discriminate between large regional uranium anomalies related to elevated uranium levels in bedrock and point concentrations of possible economic significance. However, the possibility of a large-tonnage low-grade deposit must not be overlooked. But, perhaps in choosing an exploration target lake sediment anomalies that can be identified as related to elevated uranium levels in bedrock, on the basis of the other elements (F, Cu, Mo ?) associated with uranium, should be assigned a lower exploration priority.

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