# DETAILED GEOCHEMICAL INVESTIGATIONS FOR URANIUM AND BASE METAL EXPLORATION IN THE NONACHO LAKE AREA, DISTRICT OF MACKENZIE

Project 760043: Uranium Reconnaissance Program

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## Introduction

The work described in this report was carried out in the summer of 1976 under the auspices of the Federal-Provincial Uranium Reconnaissance Program and consists in the follow-up of anomalous geochemical results obtained from a reconnaissance lake sediment survey undertaken in the Nonacho Lake area in 1975. During this survey, close to 2700 samples were collected at a density of one in five square miles thus covering all of 1: 250 000 NTS map sheets 75C, F and K. The analytical data for twelve elements (U, Zn, Cu, Pb, Ni, Co, Ag, Mn, As, Mo, Fe, Hg) and loss on ignition to estimate the organic carbon content, were released as Geological Survey Open Files 324, 325 and 326 earlier this year.

The objectives of the 1976 work were: 1) to determine the usefulness of reconnaissance geochemical surveying as a guide to mineral exploration in the Nonacho Lake area, 2) to establish a useful follow-up procedure that may be employed in future exploration programs in the area, and 3) to collect data that may help assess the mineral (particularly the uranium) potential of the area surveyed.

Uranium mineralization occurs at several localities south of the East Arm of Great Slave Lake and is particularly abundant within and around the Nonacho sedimentary basin. It is most interesting to note the wide variety of geological settings in which the radioactive minerals occur; host rocks include arkosic conglomerates, arkoses, greywackes and other clastic sediments, dolomites, basic intrusives, granites and granitic pegmatites, granodiorites and a variety of gneisses and schists. The radioactive minerals are often found in structurally controlled veins and lenses emplaced in fractures or shear zones, but in many cases, they are disseminated in the host rocks. In several of the showings, small quantities of sulphides, most frequently chalcopyrite and molybdenite, are associated with the radioactive minerals.

A few base metal showings (mainly copper) are known in the area and these occur mainly along the shores of the East Arm of Great Slave Lake.

During the first two weeks of field work, several showings were visited and sampled by the writer for mineralogical and chemical determinations. This work will, it is hoped, permit the identification of potential pathfinders that may later assist in the interpretation of the regional reconnaissance as well as the follow-up data. In addition, visiting the showings allowed the field crew to become familiar with the different types of mineral occurrences that may be encountered during the field operations.

## Field Procedures

The 1975 reconnaissance lake sediment survey outlined several areas of anomalous metal concentrations. Several of these were found to be related to existing showings, but most do not appear to be associated with any known mineralization. The strongest anomalies were found in undifferentiated basement rocks, generally within ten miles of the unconformity that underlies the Nonacho sediments. Although the Nonacho basin itself is characterized by lower background concentrations and weaker anomalies than the surrounding Archean basement, anomalies that occur within the sedimentary basin were considered particularly interesting because of the presence of radioactive minerals in this geological unit.

Several uranium and base metal anomalies were outlined north of the McDonald Fault within the Slave Province. A moderately strong uranium anomaly was also outlined within the Great Slave Supergroup and appears to be related to a granodiorite laccolith (Hoffman, 1968), the same type of rock which hosts uranium mineralization at the Ridley Mines, about 20 miles to the southwest.

Seventeen anomalous areas, ten in NTS map-area 75K and seven in NTS map-area 75F, representing a total surface area of approximately 550 square miles were selected for follow-up work (*see* Figs. 49.1 and 49.2). Three of these are strictly base metal anomalies and the rest are uranium anomalies that, except for two that occur in the Nonacho basin, are combined with one or more base metals.

In each of these areas, detailed sampling of centre-lake sediments and waters was carried out with the support of a Hughes 500-C turbo-helicopter. An attempt was made to sample every lake shown on the 1: 50 000 topographical maps resulting in a density averaging 2.1 sites per square mile. Water samples were collected by hand in 500 ml polyethylene bottles from the lake surface. An improved version of the Hornbrook sediment sampler allowed a sampling rate averaging 21 per hour.

The water samples were selectively analyzed in the field for uranium and total heavy metals, depending on whether uranium and/or base metals were initially enriched in the reconnaissance samples. A Jarrell-Ash fluorimeter using AC power supplied by a Honda, 1000 watts generator, was used for uranium determinations. These analyses were performed using the method described by Smith and Lynch (1969). Heavy metal concentrations were determined using a colorimetric technique. Specific conductivity and pH measurements on all water samples and alkalinity ($HCO_3^-$) determinations on uranium-rich waters were also performed in

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Geol. Surv. Can., Paper 76-1C (1976).

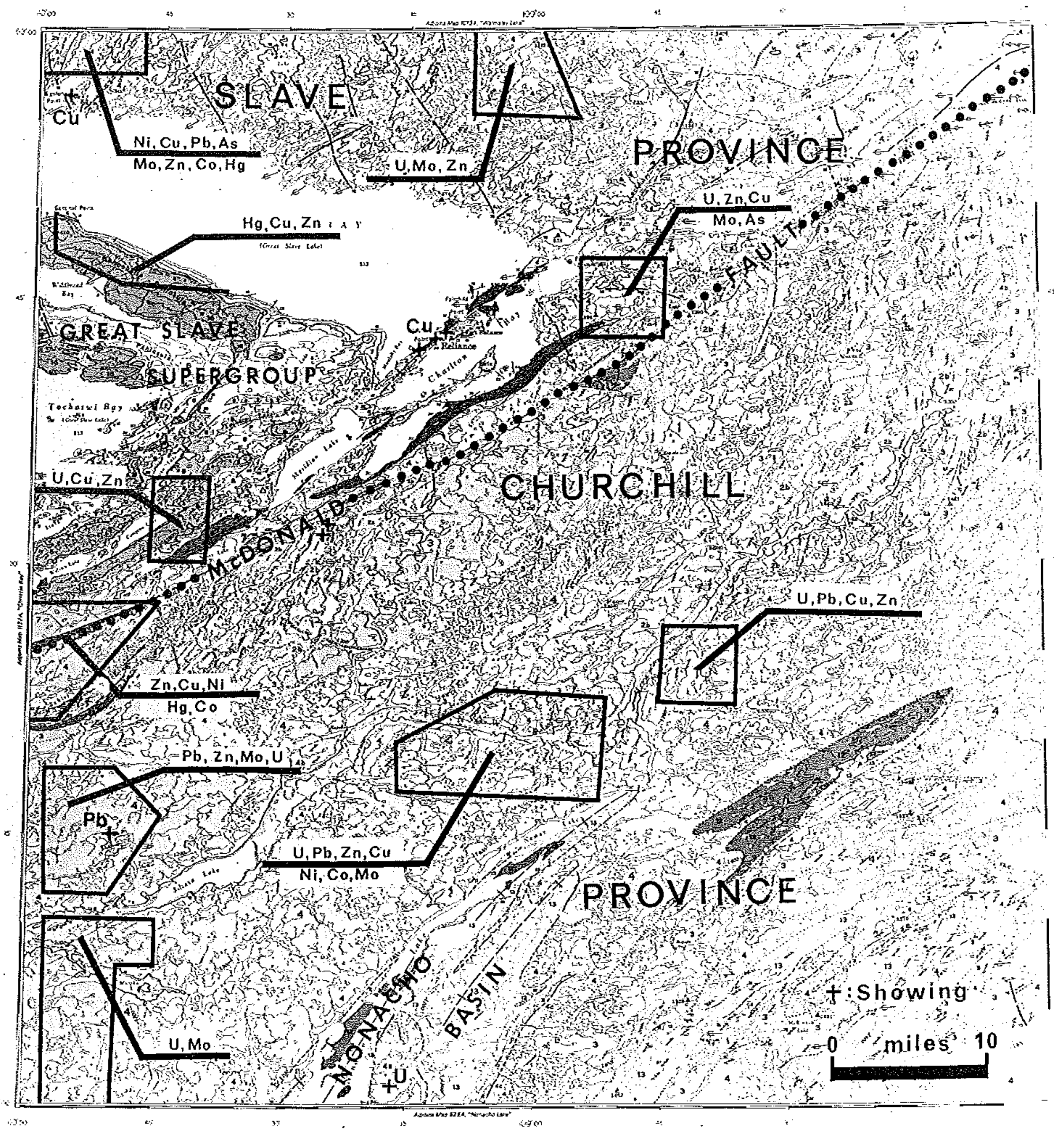


Figure 49. 1. Location of study areas and elements enriched in lake sediments in NTS map 75K. (Geol. Surv. Can. Map 1123A, 1968)

the field laboratory. The sediments were dried in the field and sent to Ottawa to be analyzed at a later date.

From the water results, a limited number of ground traverses were carried out to examine the drainage basins of anomalous lakes. The purpose of this work was primarily to gather geological and secondary environmental information that will help in the interpretation of the lake geochemical data. Portable radiometric equipment was carried at all times during these traverses, to record radioactivity directly from exposed bedrock and boulders.

## Results and Discussion

The uranium results obtained by analyzing lake waters in the field were generally satisfactory, and with the exception of those areas that occur within the Nonacho sedimentary basins, the uranium anomalies, as outlined by the reconnaissance lake sediment survey, are confirmed anomalous by the water data. With respect to the total heavy metals, the water data indicates less contrast between background and anomalous concentrations than for uranium. Nevertheless, a few

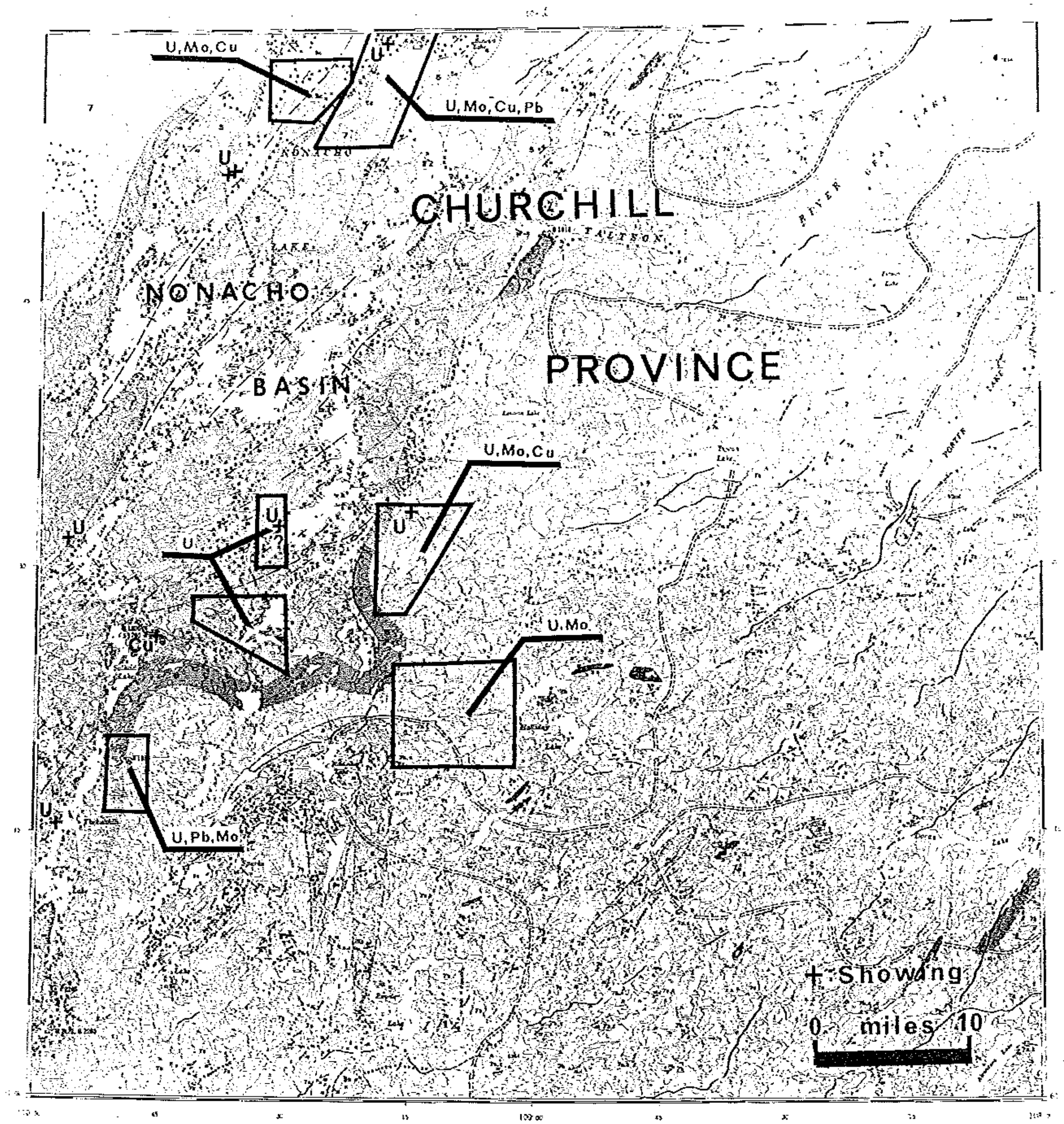


Figure 49. 2. Location of study areas and elements enriched in lake sediments in NTS map 75F. (Geol. Surv. Can. Map 1281A, 1971).

ground traverses were carried out in anomalous drainage basins, but more useful information concerning base metal distribution in the area is expected from the sediment data.

The uranium in lake water results generated a large numbers of individual anomalies that preliminary ground observations show to be related to one or a combination of three factors:

1. Concentrated uranium mineralization that occurs in relatively small areas,
2. Large areas of certain rock types that contain above average uranium concentrations, and,
3. Secondary environmental conditions that cause appreciable enhancement of uranium in lake waters.

In order to conduct the most efficient follow-up work on as many lake water anomalies as possible, it is important to identify the nature of these anomalies and exercise some form of discrimination. No doubt that multielement analysis of sediment and bedrock samples (including data from representative mineral occurrences in the area) will provide valuable information to that effect, but on the basis of water results only, the problem is somewhat more difficult.

Anomalies that are caused by more or less concentrated uranium mineralization (factor 1 above) are small, generally involving no more than a single basin and sometimes, a single lake. Their intensities seem to depend on the size and location of the radioactive rocks in relation to the drainage pattern on the size of the lakes within the basin. This last point is particularly important as showings located near the shores of large bodies of water, such as Nonacho Lake, failed to generate lake water anomalies. On the other hand, uranium mineralization located in proximity to smaller lakes generally showed intense water anomalies (from 2 to 5 ppb U). It is hoped that sediments collected in small inlets of large lakes will be more revealing than the waters as they may not be diluted to the same extent.

Anomalies related to factor 2 are generally of low intensity, often extending into several drainage basins. This results in a high background effect with no distinct peaks and concentrations rarely exceeding 1.5 ppb U (the regional background is of the order of 0.1 ppb U). Rock units that have been found to generate this type of anomaly include granites in the Archean basement of the Churchill Province to the east of the Nonacho basin and in southern Slave Province, and porphyries in the Churchill Province, just north of the Nonacho basin. The porphyries are particularly interesting in that they also generated a few sharp and intense uranium-in-lake-water peaks that protrude over a generally uniform and high background generated by the porphyries. These peaks were found to be related to localized zones of previously unreported concentrations of uranium minerals within the porphyries. Their presence at the surface is revealed by large patches of yellow stains and moderately high radiation (from 700 to 1200 total counts/second (cps) over a background of less than 500 cps for unmineralized porphyry and less than 100 cps in country rock). At the time of writing, (September 1976) samples of biotite-rich material that occurs as narrow bands within the porphyritic bodies. They are moderately to strongly radioactive (up to 3200 cps) and may represent undigested inclusions of metasedimentary country rock that have been impregnated with mineralization fluids. Fluorite was found to be a common joint filling material in the porphyries and sulphide mineralization (pyrite and pyrrhotite) was observed in thick lenses within the metasediments, generally in close proximity to the contacts with the porphyries.

Anomalies that are related to secondary environmental conditions (factor 3) are those that are found in waters containing heavy organic suspensions or high levels of dissolved bicarbonate. Both these conditions are known to enhance the uranium content of lake waters (Meyer, 1969; Maurice, in press), and further studies are presently underway to estimate the best corrections to apply.

In addition to the geochemical surveying described so far, limited airborne gamma-ray spectrometry, using a McPhar, Spectra 1, 4 channel spectrometer, equipped with a 9 x 4 in. crystal, was also carried out in areas of geochemical anomalies. The instrument was installed in the same helicopter that had been used for geochemical surveying and a total of 260 line miles were flown at 100-foot ground clearance along several grids having 1500-foot line spacing. In general, the results obtained are in agreement with the geochemical pattern, particularly in areas of flat relief and good rock exposure. These radiometric data proved particularly helpful in assessing lake water anomalies of doubtful origin.

## References

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