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MATTAGAMI LAKE MINES LTD.

GEOLOGICAL, GEOPHYSICAL AND GEOCHEMICAL REPORT

AGAR LAKE PERMIT

ATHABASCA AREA, ALBERTA

PERMIT NO. 224

TWP 106 R1, R2 W4M

NTS 74L

DECEMBER 1976

W. MERCER, Ph.D.

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FIGURES

CHAPTER ONE

INTRODUCTION

The Agar Lake Permit area was obtained as an option for one year from C. and E. Explorations of Calgary. The area had been identified as a potential host of uranium deposits by Demex of Denver, Colorado. Application of density slicing of LANDSAT satellite images had suggested a concentration of zones posessing similar reflectance to the Cluff Lake area. On the basis of this work, C. and E. Explorations obtained permits covering these zones.

The area is underlain by Athabasca sandstone, which has proven to be the host to rich uranium deposits in the Cluff Lake area. Mattagami Lake Mines Limited optioned the property in 1976 with the purpose of conducting investigations to determine whether uranium existed below the Athabasca sandstone, and whether this uranium could be located with existing exploration techniques.

The area is of great challenge to geological exploration, as there appears to be promise of very rich uranium deposits, but beneath seemingly impenetrable thicknesses of sandstone. Blind drilling would be futile in such a large area.

For bush work in June 1976, a camp of eight geologists was established on Moose Point in Old Fort Bay by Twin Otter of Wardair of Yellowknife. Crews were ferried to the work area by Bell B2 helicopter of Shirley Helicopters of Edmonton piloted by Rod Wood. The enthusiastic co-operation of Mr. Wood is gratefully acknowledged.

A second camp of four geologists was established for a short period on Agar Lake in July 1976, supported by Hiller 12E helicopter. Thanks are due to pilot Ken Waines for his consideration of our requirements. This helicopter proved particularly suitable for work in confined spaces.

The credit for the Quaternary section is due wholly to G. Castles. Partial credit for the text and for setting up the programme must go to J. Helsen for the Track Etch survey and M. Kreczmer for the geochemical surveys of uranium in waters and lake sediments.

The conclusions are solely the responsibility of this writer.

Location and Access (Figure 1)

The permit area, of some 30,000 acres, lies 40 air miles due east of Fort Chipewyan, Alberta, and 100 air miles south-west of Uranium City, Saskatchewan, at 58° 10' N, 110° 15' W. The centre of the area is 20 miles south of Old Fort Bay, Lake Athabasca.

At present the main part of the area is accessible only by helicopter, except for Agar and Bowen Lakes in the north, which permit landing of float planes. The shore of Lake Athabasca is more than 30 miles from the permit area, but although the lake is shallow it permits movement of large barges. There

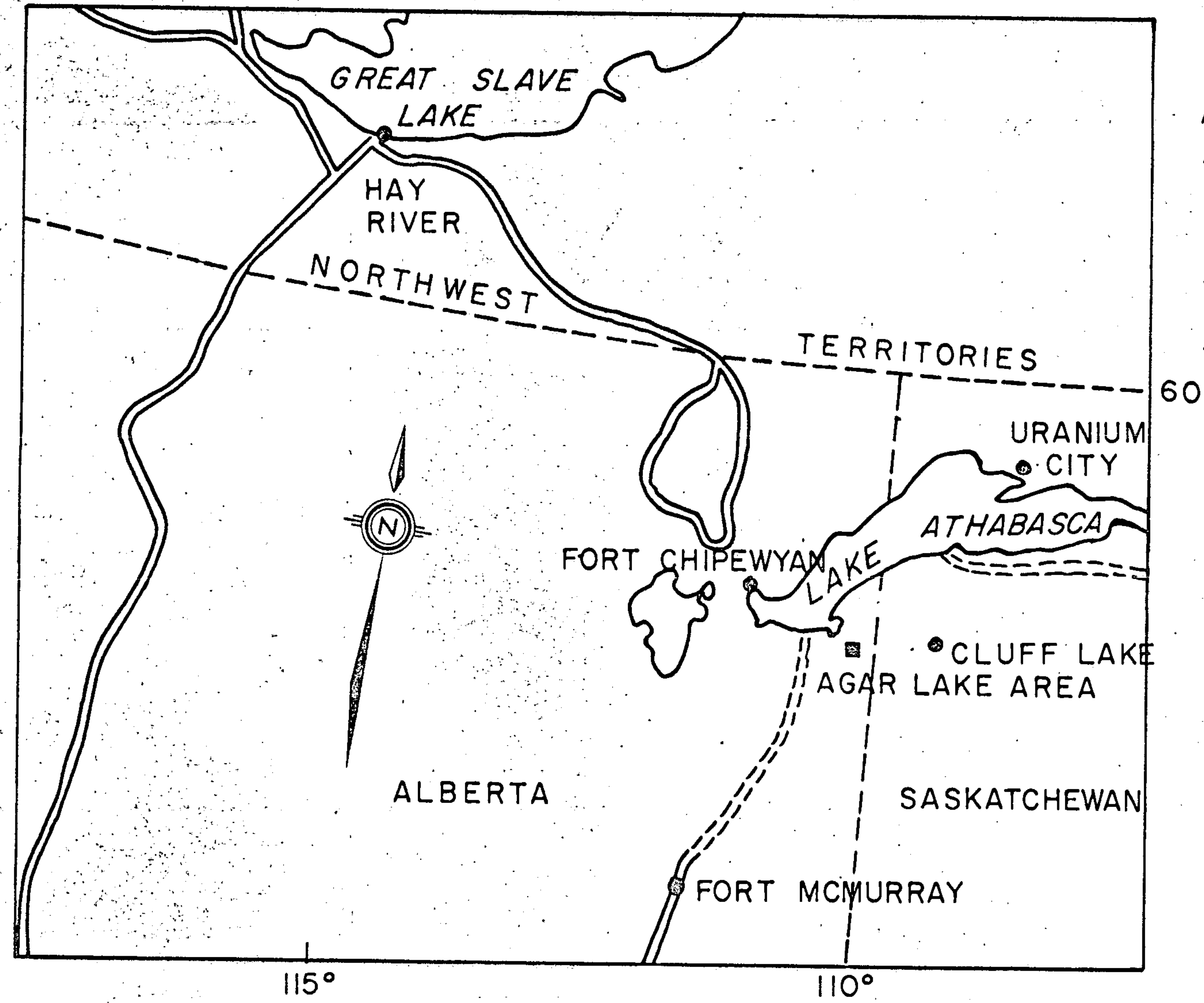

FIGURE 1.
LOCATION AND ACCESS
AGAR LAKE AREA
ALBERTA

SCALE: 1:4,000,000

LEGEND
═══ ROAD
==== DISUSED WINTER ROAD

are two disused winter roads within NTS 74L and M, one ending 20 miles southwest on the shore of Lake Athabasca, the other some 50 miles away northeast in Saskatchewan.

Physiography and Vegetation

The physiography of the area is dominated by glacial deposits (see Chapter below). The area consists of alternating dry glacial ridges and low-lying and swampy areas.

The climate has a tendency towards dryness compared to other parts of the north of Alberta. Consequently, this fact, combined with the well-drained nature of the ground, leads to a general predominance of pine (generally Jack Pine) over Black Spruce. White Birch is common.

Lakes are generally fairly deep within the area.

CHAPTER TWO

QUATERNARY GEOLOGY

The Quaternary geology of the area is reviewed as no rock outcrop is present. Consequently any exploration technique must take into account the various surficial and glacial deposits and landforms. This applies in the sense that it is difficult to measure parameters related to bedrock through 100 feet of glacial deposits. Also, any geochemical survey of the surface material relates, not to the underlying bedrock, but to the area from which the surface material was derived. Thus, scintillometer readings off boulders are only significant if one knows where the latter are derived from. Also, exploration on surface material is unproductive if it has all been transported for some miles from outside the exploration permit area.

The surficial deposits and landforms resulting from geological processes associated with Pleistocene glaciation are assumed to unconformably overly the late Precambrian Athabasca Formation within the study area. Ice-contact glaciofluvial materials is the main Quaternary surficial deposit observed. Landforms associated with these deposits include eskers, crevasse fillings and kame moraines. Adjacent to the southwestern boundary of the study area, a region of fluted and drumlinized terrain is encountered. Outwash sands and gravels overridden by a more recent glacial advance are observed here.

The ice-contact glaciofluvial deposits consist of very coarse sand and gravel, although a number of large boulders are also present. The dominant clast in these deposits is orthoquartzite, which would imply that the late Precambrian Athabasca Formation served as the primary source. While the direction of glacial transport is approximately northeast to southwest, the distances travelled by the various materials comprising the ice-contact glaciofluvial deposits is much less well documented. Poor to moderate sorting and sphericities (subangular - subrounded) appear to indicate a comparatively short distance of transport, thus implying a rather localized northeasterly source area. Geophysical work (Chapter Five, this report) indicates that average sediment thicknesses vary from roughly 60 feet (20 metres), on the southeast shore of Agar Lake, to 30 feet (10 metres) in the west central portion of the study area.

As previously mentioned, numerous distinct landforms consisting of ice-contact glaciofluvial material are present within and adjacent to the area. A large kame moraine complex (representing a continuation of the Cree Lake moraine of NW Saskatchewan) is situated approximately 5 miles north of the study area. It likely formed during a temporary stillstand of the classical Wisconsin Laurentide Ice Sheet. Constituent materials include very coarse sand and gravel, coarse boulder gravel, and large boulders. The kame moraine complex essentially comprises a series of northwesterly trending semi-continuous ridges with attributable topographic relief varying between 150-500 feet (50-165 metres).

Numerous crevasse fillings are present in the area overlain by the ice-contact glaciofluvial deposits. Generally, these morphological features, averaging 20-45 feet (6-15 metres) in height, are located to the south of the kame moraine complex and consist primarily of orthoquartzitic boulders. Some very coarse sand and gravel may also be prevalent where these crevasse fillings are found in conjunction with eskers. The majority of the crevasse fillings formed perpendicular to the direction of ice flow. In a few localities, however, these features appear to have been deposited parallel to the ice-flow direction. The orthoquartzitic boulders (some crystalline rocks have also been observed) were likely deposited in crevasses within the glacial ice by rapidly flowing superglacial streams or as a consequence of slumping associated with ablation during ice stagnation. The late Precambrian Athabasca Formation undoubtedly served as the regional source for the orthoquartzitic boulders as the southwest advances of the Laurentide Ice Sheet inundated the area. The crystalline boulders were also initially transported into the area from a source lying to the northeast. Thus, it appears likely that the distance of overall transport with regard to those boulders comprising the crevasse fillings is of the order of several tens of miles.

The fluted and drumlinized terrain located adjacent to the southwestern boundary of the Agar Lake area covers a rather expansive tract of land. Individual drumlins may exceed 1000 ft. in length although the average value tends to approximate 500 ft. (165 metres). The vast majority of these landforms trend in a southwest direction. This implies formation parallel to ice-flow direction. The drumlins and flutings consist of fine to medium grained sands and gravels which were molded into their characteristic streamlined forms as a consequence of erosional and/or depositional processes acting at the base of the Laurentide Ice Sheet.

Accumulations of organic material, commonly referred to as muskeg, mantle the Quaternary surficial deposits in numerous localities throughout the study area. These deposits formed during Holocene time. Their thickness is extremely variable between 1 and 15 feet (0.3 to 5 metres) although these values can only be classed as unqualified estimates.

CHAPTER THREE

TRACK ETCH SURVEY

Theory (Figure 3)

Track Etch method is claimed to utilize small alpha-particle-track detectors to measure the radon gas emitted by uranium ore bodies. It is expected to detect uranium mineralization buried at depths too great to be measured with surface or airborne scintillometer techniques.

Uranium is a radioactive element that decays via a number of daughter products to radioactive lead. One of the intermediates is radon, a radioactive inert gas. Due to its inert nature but that it is soluble in water radon can migrate easily in the surficial environment. Hence the basis for the Track Etch method.

The method consists of emplacing plastic cups, the size of a 6 oz. drinking cup, face downwards in a hole 3 feet deep. The cup has a piece of plastic film on its bottom that is sensitive to alpha particles. Radon migrates through the soil and collects with soil gas in the cup. The number of alpha tracks left in the plastic film is proportional to the radon of the soil. The alpha tracks consist of damage to the molecular structure of the plastic where the alpha particle has travelled through. When the film is placed in a corrosive chemical, the alpha tracks are preferentially etched out and can then be counted under the microscope. In practice, about

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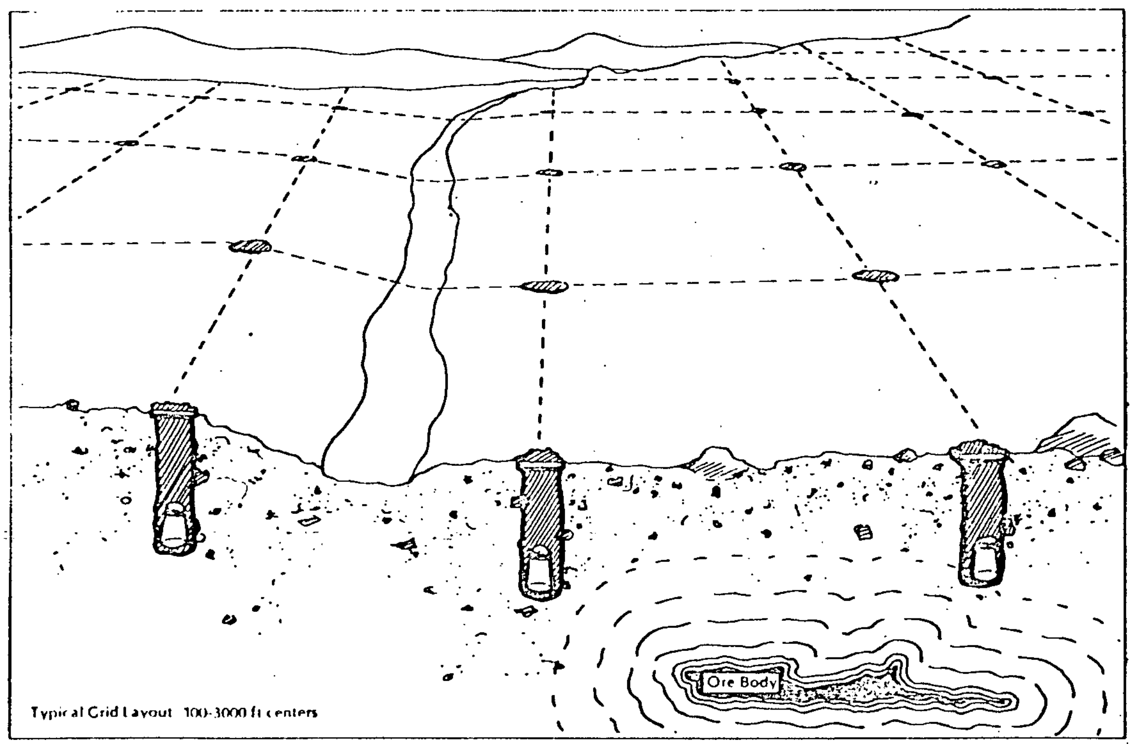
Figure 3. TRACK ETCH FIELD PROCEDURE

Sampling Cup with
Track Etch Detector



Typical Field Sampling Arrangement

three weeks is required for the cups to accumulate enough tracks whilst in the ground.

There is some controversy between proponents of radon emanometers and the Track Etch technique and the relative merits of the two exploration methods.

Field Procedure

Starting on June 3rd 1976, Track Etch cups were placed in the area. An attempt was made to use a grid pattern. It was soon realized that picking up these cups would involve several problems, including difficulties in finding them in dense forest, despite very obvious markings of the locations. Using a grid pattern also implies putting cups in swamps and other unsuitable terrains. For these reasons the grid pattern was abandoned. Instead, subsequent traverses were run following more obvious topographic features on the air photographs. For example, in several cases the boundary between high ground (moraines, dunes, drumlins, eskers, etc.) and low ground (swamps, river basins, etc.) was followed and track etch cups were placed in more easily recognizable spots.

The track etch cups were placed whenever possible at a depth of about 3 feet. In several cases, however, cups were placed at shallower levels because of presence of groundwater and/or boulders. The hole for the cup was made using a 4-inch diameter post-hole auger. Under most circumstances except for bouldery ground, this was sufficient. The location was marked with flagging tape, and recorded on air photograph overlays.

The placing of the cups was started with a team of four, but later on this team was divided into two teams of two in order to speed up the work as much as possible.

Placement of cups was terminated June 19th, a total of about 100 having been emplaced. Pickup of the cups was completed between July 7th and 18th, thus most cups were left in the ground for periods between 3 to 5 weeks.

In addition to the regional surveys, 50 cups were emplaced on 2 detail grids in areas where high radon emanometer results were obtained. These cups were to serve as a check on Track Etch itself and to compare Track Etch and radon emanometer surveys. These grid cups were left in the ground about 10 days.

Various difficulties were encountered when retrieving cups. The first one was finding them. This is partly due to the fact that much flagging tape had been removed by animals. A second problem was that many cup holes had been uncovered, either by animals or by rain or wind. This could possibly be avoided by use of very large plastic sheets for hole covers. Finally, a small number of cups were removed from the holes and smashed, presumably by bears.

Out of 100 cups, 40 had the plastic cover removed from the hole but were covered with up to one foot (0.3 metres) of sand. Three cups were smashed.

Results (Figure 4)

The results of the regional Track Etch survey, as summarized by Terradex of California*, are below:

"The Track Etch detector readings are reported in units of tracks per square millimeter (T/sq.mm) and they are normalized to equivalent 30 day exposures. The data have been tabulated in two different ways for easy use; firstly by ascending film serial numbers and secondly by ascending Track Etch readings. The Track Etch radon contour maps were computer generated using a 6 point weighted average computer smoothing routine and were drawn with a 2 T/sq.mm contour interval. With this mapping technique some higher contour intervals may be found between the actual data points but this is normal since the computer attempts to interpolate intermediate values based on the general average values measured in the area. Short incomplete contour lines may also appear on the maps without identifying numbers but their values can usually be determined from adjacent contour values. The contour maps show small +'s at the locations where the field samples were located. Where the +'s do not appear the Track Etch films were either lost or the readings were not used.

On this project 93 Track Etch cups were used and the readings ranged from 2.1 to 21.5 T/sq.mm with the mean of the background distribution at 8.7 T/sq.mm and the standard deviation of the mean at 4.2 T/sq.mm or 49%.

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*Letter from H. Ward Alter, President of Terradex, September 3rd, 1976.

The high ranking points are shown below:

Range of Z	No. of Points	Range of T/sq.mm	Range of Ratio to Background
2 - 3	5	17.4 - 21.1	2.0 - 2.4
3 - 4	1	21.5	2.5
4 - 5	0	-	-

There is only 1 point with a Z value greater than 3 representing 1.1% of the total number of points. In our experience, this is a very low percentage of high values and a poor indication of uranium mineralization unless good clustering of high points is apparent on the map.

The Track Etch contour map (Figure 4, in pocket) shows weak structure, if any as expected."

The two grid track etch surveys are summarized by Alter as below:-

In the GA area ... "41 cups were used and the readings ranged from 5.8 - 31.9 T/sq.mm with the mean of the background distribution at 20 T/sq.mm and the standard deviation of the mean at 6 T/sq.mm or 30%. Statistics are pure background although it should be noted that the mean is twice that of the reconnaissance survey. There were no points even higher than 2 standard deviations above the mean. It should be noted, however, that of the highest 14 points, 8 are on the northern line between 85233 and 85222. Nevertheless the low values of all points are not promising for uranium mineralization."

In the LA area ... "20 cups in this survey had readings from 5.2 to 31.3 T/sq.mm. Although detailed statistics are meaningless for such a small sample, the median of the data is about 14 T/sq.mm. No clustering of high points is shown along the line of cups and we would not view the area as promising in our experience."

The GA area coincides with the values of 31 counts/ 3 minutes and 25 counts/3 minutes in the west part of Figure 6 and LA with the 21 counts/3 minutes and 13 counts/3 minutes, just to the north of the GA area.

Although Terradex stress the background-type nature of the values, the means of these results are higher than the reconnaissance survey. The difference in mean values between the reconnaissance and grid surveys are not statistically significant.

The conclusion is that the Track Etch results confirm the radon emanometer findings that some areas are marginally higher in radon in soil gas. However, these higher areas are not due to anomalous uranium in the underlying ground. The broad diffuse nature of these areas suggests to the writer that they may represent areas in which granitic basement occurs closer to the surface than in the rest of the permit.

CHAPTER FOUR

RADON EMANOMETER SURVEYS

Theory

Radon emanometry (radon "sniffing" or radon counting) consists of counting radioactivity due to radon in soil gas or dissolved in water. This discussion is solely concerned with radon in soil gas, a method most suited to detailed studies of areas covered by overburden.

Radon is found naturally as three radioactive isotopes: Rn^{219}, Rn^{220} and Rn^{222}. They are daughter products of uranium and thorium, as shown below:

Parent atom	U^{235}	Th^{232}	U^{238}
Daughter atom	Rn^{219}	Rn^{220}	Rn^{222}
1/2 life of daughter	3.9 secs	54.5 secs	3.82 days

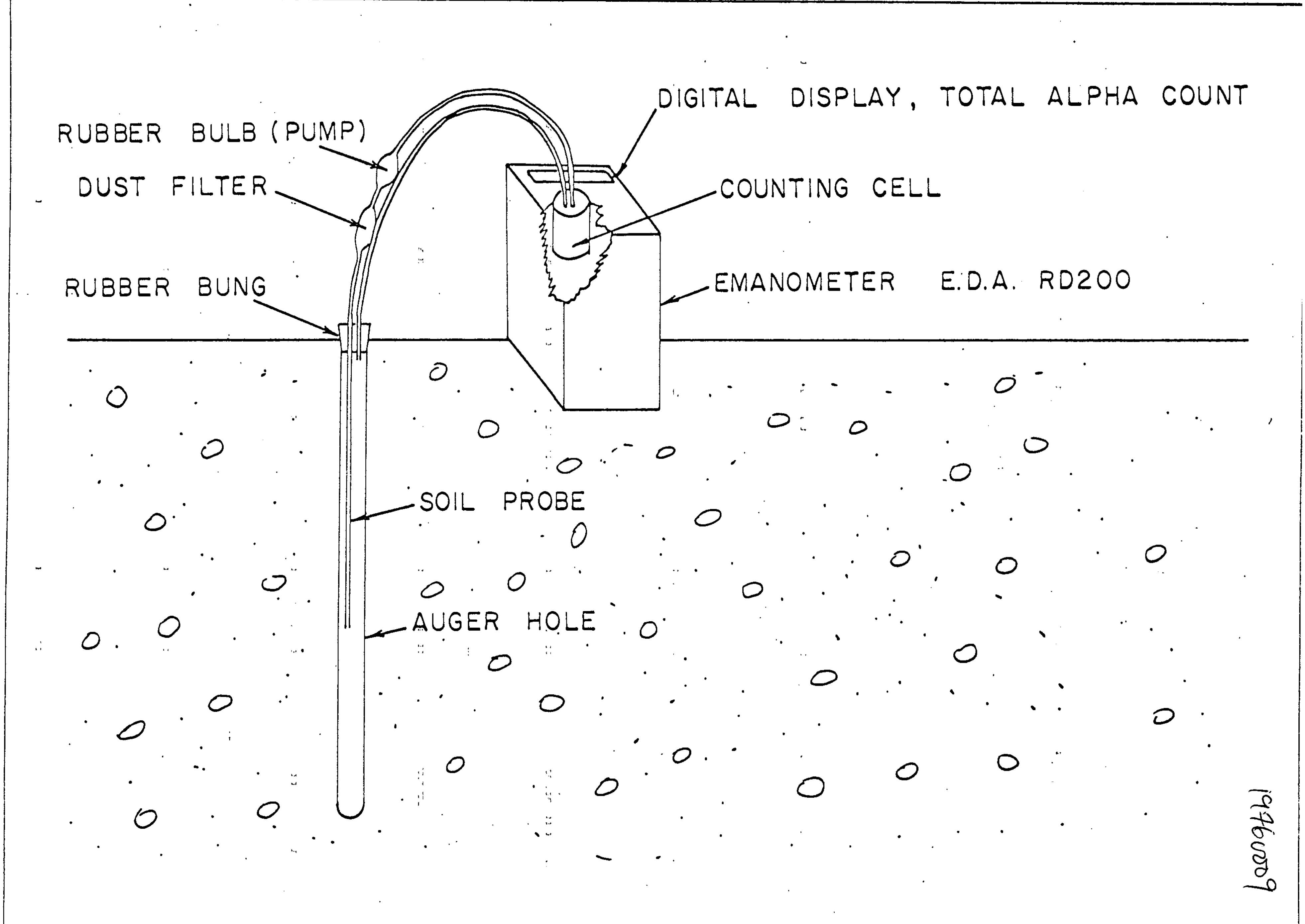
The basic difference between the apparatus for radon emanometry and a field scintillometer is that the former is for measuring alpha activity of gases and the latter for measurement of gamma activity of solids. However, both methods are indirect with respect to uranium, that is they measure activity due to daughter products of uranium. The radon emanometer measures all radon activity and the scintillometer measures Bi^{214} activity.

Gamma scintillometry, in that it measures a solid product of uranium decay, is limited effectively to the top few inches of rock or soil, due to the strong shielding of gamma rays by these materials, especially if damp. However, radon emanometry measures the alpha radiation due to an inert gas which has 20 days before its radioactivity is reduced by a hundred-fold. Radon may migrate up to 23 feet (7 metres), during the twenty days, to collect in the upper soil layers (Miller and Ostle, 1973). It should be noted that radium, which has a longer half-life (1620 years) may also migrate in dissolved form and enhance radon values at the surface, effectively increasing the depth of penetration of the method. This has been suggested in the context of success with Track Etch cups to depths of 300 feet, under favourable circumstances.

Field Procedure

The radon emanometer used (E.D.A., Ottawa, Model RD200) consists of an alpha-detector (scintillometer) and a counting cell lined with zinc sulphide. The latter chemical produces scintillations (flashes of light) when bombarded by alpha particles. The emanometer counts these scintillations. The counting cell is the size of a cup and can be replaced in five minutes. Soil gas is pumped into the cell by means of a rubber bulb. There are inlet and outlet tubes inserted through a rubber bung, one being attached to a 1.5-foot (0.5 metres), metal probe, the other flush with the bung. The field procedure (Figure 5) is to make a hole 2 to 3 feet (0.6 to 0.9

FIGURE 5 RADON EMANOMETRY SKETCH OF FIELD TECHNIQUE FOR SOIL GAS



metres) deep and 0.75 inches (1.9 centimeters) in radius with a soil auger. The gas tube is immediately inserted into the hole, rubber bung being flush with the hole entrance. Soil gas is pumped into the counting cell and counting begins.

A crew of 2 can expect to perform between 30 and 80 determinations per day depending on conditions. The instrument operates for 3 to 5 days on 1 set of 8 alkaline C-cell batteries.

Factors Affecting Results

There are a great number of variables involved in controlling the radon content of soil. Among these are soil variables (e.g.: water, clay, organic and sand proportions), climatic variables (e.g.: relative amounts and frequency of rain during survey, effects of high ground winds and varying atmospheric pressure), and variables due to depth and mineralogical host of parent uranium atoms. Consequently, radon soil values should not be used in any quantitative context or to relate differing areas in terms of uranium potential.

As has been mentioned above, radon is also produced by decay of thorium. However, Rn^{220} from thorium has a half-life of only 54.5 seconds. Consequently, Rn^{220} cannot migrate any distance through soil and any anomaly due to it suggests thorium-rich material in the immediate vicinity of the hole. Thorium-derived radon can be distinguished from that derived from uranium by three successive one-minute counts. The activity due to thoron (Rn^{220}) will decay by half for each successive count. Thus the first-minute count would be about 2.5

times the third-minute count for activity due to thoron. Rn^{219} is not of significance due to its short (3.9 seconds) half-life.

<u>Results</u> (Figure 6)

The results of the radon emanometer survey in the Agar Lake area show a mean count rate of 3.6 cpm with a standard deviation of 3.2 cpm (over three minutes 10.8 count mean with 9.7 count standard deviation). Values exceeding one standard deviation (Z) are tabulated below (compare with Track Etch results):

Range of Z	No. of Points
Mean +1Z to Mean +2Z	23
Mean +2Z to Mean +3Z	5
Mean +3Z to Mean +4Z	2

Hence, two results exceed three standard deviations from the mean. However, these two high results - of 41 counts and 44 counts - show no geographical clustering and represent only 1.1% of the total number of data. In addition, the high radon and high Track Etch results do not coincide in detail.

The minimum error in radioactivity measurements is N where N is the number of counts. That is, a reading of 5 counts per minute is in fact $5 \pm \sqrt{5}$ or 5 ± 2.3 counts per minute. Thus, there is no real difference between a measurement of 2.7 counts per minute and 7.3 counts per minute (or 8.1 counts and 21.9 counts in three minutes, respectively). As most of the radon emanometer results (i.e. within the range

0 to 10 counts per minute, the error statistics and the lack of clustering of high values imply that the values are purely from the background.

The nature of the background radon values may be indicated by the detailed Track Etch surveys. The Athabasca Formation contains little or no uranium or radon, while the Archean basement probably has moderate levels - possibly 5 ppm. Consequently most of the radon where present in the soil is contributed by the granitic basement. Slightly higher radon in soil values suggest granitic basement close to surface rather than mineralization.

CHAPTER FIVE

HAMMER SEISMIC SURVEY

Theory

Following the suggestion of Hobson and MacAulay (1969) hammer seismic technique was attempted on the Agar Lake area. The instrument used was a HUNTEC FS-3 facsimile seismograph rented from Kenting of Calgary. A consultant geophysicist, Mr. Brian Henry, was hired from Kenting for 5 days to help set up the methodology.

The HUNTEC FS-3 seismograph can be used in the refraction or reflection mode and is equipped with a variable gate correlator that enables elimination of refractions from the record. Refraction technique can be used with the hammer to determine interfaces of depths of about 300 feet. Reflection, on the other hand, theoretically enables depths of the order of 1000 feet to be determined with the hammer seismograph.

Test runs with the technique were first made to determine overburden thicknesses by refraction near Moose Point. Reflection mode analysis was unsuccessful in locating the Athabasca sandstone-basement contact in this locality. The GSC survey (Hobson and MacAulay, 1969) suggests depths of 500 to 2000 feet for this interface. The reason for the lack of success of reflection technique is partly due to the great depth present in the area, and partly that the FS-3 supplied by Kenting was possibly not working properly in reflection mode.

However, the confidence of Hobson and MacAulay in hammer seismic work to depths of 1000 feet does not seem justified in the light of this work and their lack of good evidence for success.

Results

Attempts at reflection seismology being unsuccessful, work in the Agar Lake Permit concentrated on refraction geophysics. It is unfortunate that this precluded the possibility of continuous profiling.

In general, the Athabasca-basement contact was identified at depths of 130 to 300 feet. This necessitated hammer points in excess of 1000 feet from geophones. At this distance the energy radiated to the geophones is very low and communication between operator and hammerman becomes difficult.

Overburden thicknesses suggested range between 6 and 100 feet, but average out generally at 50 to 80 feet. There is a weak trend of decreasing overburden thickness from east to west.

Depth to basement varies between 130 to 300 feet including overburden thickness, but no general trends are apparent. It is of interest that relatively high Track Etch and radon emanometer results were obtained near Shot #13 where the basement is apparently only 130 feet from the surface.

The scope of the HUNTEC FS-3 would be considerably extended by the use of seismocaps. An explosives expert, costing $100 per day, would then be required. A survey using a 12-channel portable seismograph would be superior. This would enable detailed mapping of the Athabasca sandstone/basement contact.

Should geochemical anomalies be found, a seismic survey would be an invaluable aid to locating drill targets.

Summary of Seismic Shots (Figure 8)

Shot No.	Date	Thickness in Feet Overburden	Thickness in Feet Athabasca	Depth to Basement
1	June 5	70 - 100	180 - 190	250 - 290
5,6,7	June 5	No good record		
10	June 9	40 - 80	98 - 105	140 - 180
11	June 10	12 - 100	80 - 140	90 - 240
12	June 10	No good record		
13	June 10	6 - 13	100 - 110	110 - 120
15	June 14	60	220	280

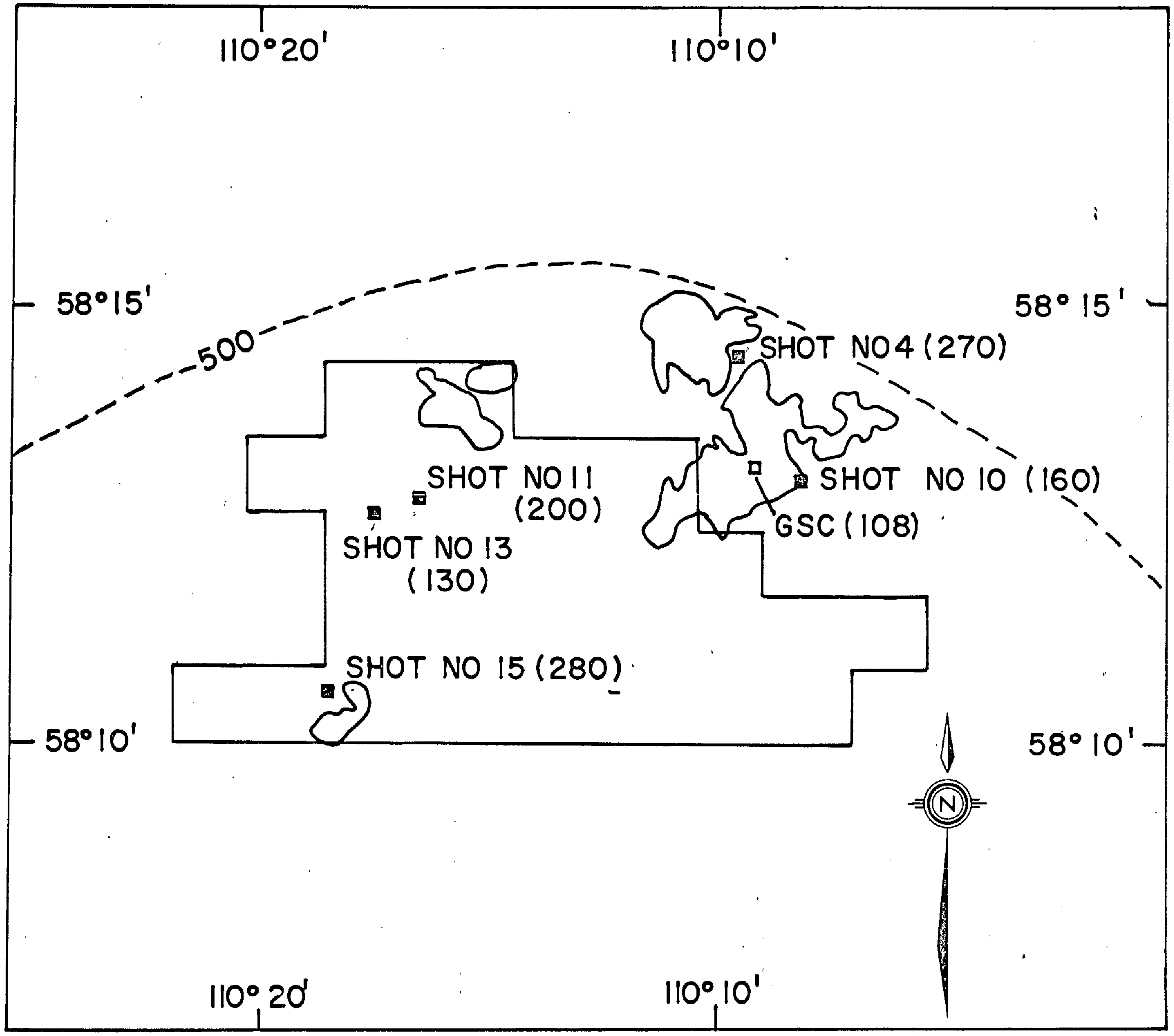


FIGURE 8.
HAMMER SEISMIC SHOT LOCATIONS
AGAR LAKE AREA
JUNE 1976

LEGEND

SHOT NO 10 (160)	SHOT NUMBER AND LOCATION (DEPTH IN FEET)
--500--	GSC DEPTH TO BASEMENT CONTOUR APPROXIMATE IN FEET
GSC (108)	GSC DEPTH TO BASEMENT (MINIMUM DEPTH IN FEET)

SCALE

M 1 0 5 M

KM 1 0 5 KM

[redacted]

CHAPTER SIX

GEOCHEMICAL SURVEYS

Theory

The secondary environment media (lake, pond, stream water and sediments) commonly show extensive geochemical anomalies over uranium mineralization. The choice between water and sediment sampling is still a matter of heated debate among geochemists. In general, it depends upon the geochemical regime of the area concerned and therefore different terrains may require water and/or sediment sampling. In oxygenated environments (e.g. rivers), water has been shown to outline the anomalies better than sediments.

Uranium, being a very mobile element in the secondary environment, should always be considered with other lower solubility elements commonly associated with uranium mineralization, to delineate the anomaly. In Key Lake, Mo, Cu and Ni are commonly associated with uranium (Parslow, 1976). In the case of sediments, the knowledge of the amount of Fe, Mn and organic matter is critical as it is possible that they tend to "scavenge" uranium, resulting in false anomalies especially in oxygenated waters, where Fe and Mn are insoluble.

The solubility of uranium in water is strongly dependent upon pH, the knowledge of which can clearly validate the resulting analyses. For this reason water samples should be acified to prevent uranium precipitation on the walls of the container or on organic matter present.

Field Procedure

The geochemical survey for uranium on the Agar Lake permit area was undertaken during the first 3 weeks of June. A half-mile sampling grid was established over the permit area, on the 1:126,720 (1" = 2 miles) map. The survey extended to cover 300 sq. miles. As of June 15, samples were collected giving the average density of 1 sample/1.3 miles. At most sites both water and sediment samples were collected. Flying time averaged 1 water and sediment sample/6 minutes.

Where possible, the water and sediment samples were collected simultaneously. Water was hand-pumped into 100 m. hard plastic bottles. The lake sediments were collected into plastic bags, using the tube sampler designed by the GSC, attached to 70 feet of calibrated rope. This technique was inadequate when sampling lakes with a depth of 10 feet or less. On shallow lakes a jaw sampler should be used. Each of the samples collected were described to aid the interpretation of the results. The following parameters were noted: lake surface (indicating water movement); type of vegetation; type of lake; relief around the lake; colour of water; amount of suspended organic matter in water; depth at which sediment samples were collected. Finally, any possible contamination was noted. To make the results more meaningful, care was taken to sample small lakes in the middle and large lakes in the bays.

The pH of selected samples was measured in camp using a Corning pH meter. Water samples were acidified with 0.5 ml. of 10% HNO_3. Both water and sediment samples were shipped to

Bondar-Clegg and Co. in Vancouver for analysis for U, Mo, Cu, Ni, and Mn contents and "loss-on-ignition" for sediments. "Loss-on-ignition" gives an estimate of the organic content of the sample.

It should be noted that sample localities in the middle part of the area are only approximate. At present time, the lakes are overgrown and have changed their shape.

<u>Results - Water</u>

The low content of uranium in the waters of the Agar Lake permit area is emphasized by the fact that uranium was below the detection limit of 0.1 ppb in every sample.

<u>Results - Sediments</u> (Figure 9)

The uranium content of 103 sediment samples is uniformly low with a mean of 0.41 ppm. There are no clusters of high values, though there are two isolated values that exceed three standard deviations from the mean, being of 5 ppm and 4 ppm. No other elements were anomalous in these samples, and this fact coupled with the lack of clustering do not suggest mineralization. Both samples are from lakes some distance outside the permit area.

It is apparent from the data (Appendix 1) that there is no relationship between any of the variables (metals and "loss-on-ignition") measured. It is sometimes suggested that manganese hydroxides or organic matter ("loss-on-ignition") can absorb or adsorb elements such as uranium or copper causing spurious anomalies. The absence of any correlations in the data presented implies the absence of any such processes. This is presumably due to the extremely low levels of metals, such as uranium or copper, in the surface waters, as evidenced by the water geochemistry survey.

CHAPTER SEVEN

ASSESSMENT OF ANOMALIES FROM SATELLITE IMAGES

Introduction

The initial exploration area was defined on the basis of processing of LANDSAT images. The general area of the Cluff Lake uranium deposits of Mokta Ltd. was processed by density slicer to obtain a "ground truth" by Demex Corp. (For a general discussion of LANDSAT imagery and the density slicer see Inter-office Memorandum from W. Mercer to J.D. Harvey, November 4, 1975, page 4). The density slicer utilizes a black and white image and the operator can assign certain colours to certain reflectance levels. This is purely a technique for visual enhancement of certain features of a LANDSAT image. The density slicer was set in this investigation by Demex Corp. such that the area of interest - Cluff Lake region - shows a bright white colour.

The image of the area of exploration is then processed by density slicer at exactly the same settings, such that the areas of identical reflectance as the ground truth (Cluff Lake uranium deposits) show the same bright white colour (Figure 11).

The Agar Lake area was found to contain a particular concentration of areas of similar reflectivity to the vicinity of Cluff Lake.

LANDSAT Image Interpretation - Current Status

LANDSAT imagery and its application in mineral exploration has attracted considerable attention in recent years in the United States of America. Advances in the utilization of this advanced technology have been swift. In Canada, however, satellite imagery has not gained acceptance for a number of reasons, including: -

i) most of the country has been photographed from the air already;

ii) many areas where orebodies could be detected at the surface have already been explored by surface prospecting;

iii) Canada has few regions where abundant outcrop is coupled with lack of vegetation (as is found in the desert regions of the world) - in applying sophisticated techniques to LANDSAT images to distinguish areas of different bedrock types, even a cm-thick layer of lichen can obscure differences in reflectance.

In the USA, research by the Geological Survey has been directed towards the relationship between anomalous concentrations of metals in soil and bedrock ("mineralization") and health, or lack thereof, of vegetation. This has been done with a view to distinguishing healthy and sick vegetation on satellite images. The infrared part of the satellite image is particularly suited for this.

Sick plants are very distinctive in the infrared portion of the spectrum because of changes in the chlorophyll content, which has a marked effect on the absorbance of infrared light by plants. Unfortunately, attempts to use these factors in mineral exploration have so far been rather unsuccessful. This is largely due to different types of vegetation reacting differently to various metals and their contents in soil and rock. In most areas more than one species of tree, for example, is present and effects on individual species tend to canel one another out.

LANDSAT Image Anomalies - Evaluation for Agar Lake Area

In considering the Demex work discussed above we must focus attention on the following: -

i) what do the anomalies in the Cluff Lake area correspond to on the ground;

ii) what do the anomalies in the Agar Lake area correspond to on the ground;

iii) does it seem likely that the anomalies represent areas of high uranium content in soil or rocks, and if not, why not.

In the original report submitted by C. and E. Explorations Ltd. to Mattagami Lake Mines the density slicing data of the Cluff Lake area are presented. If one obtains map showing the position of the Cluff Lake known uranium orebodies it is apparent that the anomalies indicated by Demex do not correspond to the position of the orebodies. Consequently, no simple explanation exists for the "anomalies" in relation to uranium, if they are related to it at all. This casts doubt on the validity of the Demex density slicing settings as used in the Agar Lake area.

Figures 10 and 11 show prints of the colour composite LANDSAT image and the density sliced image respectively for the Agar Lake area. A side-by-side comparison of the two images reveals some interesting features. Firstly, the "anomalous" areas on Figure 11 correspond to clearly visible yellow-to-salmon-pink areas on Figure 10. Secondly, the "anomalies" seem to correspond, not to a subtle change in vegetation due to anomalous uranium contents in the soil, but actually to abrupt, conspicuous changes in the vegetation. Inspection of black and white air photographs of the area reveal that the "anomalies" overlie damp low ground with muskeg and/or black spruce.

There seems to be no doubt that the Agar Lake area is underlain by at least 100 feet and possibly 300 feet of Athabasca Sandstone (see Chapter Five, this study). Uranium orebodies are expected to lie close to the Athabasca Sandstone - Archean basement contact and hence at least a hundred feet below the present topographic surface. It seems unlikely that uranium orebodies at such depths could have any effect on surface vegetation. Anomalous uranium in surface rock, soils, lake sediments or lake waters have not been found in the Agar Lake permit area by any of the exploration techniques used. Consequently, it is concluded that the "anomalies" cannot be due to anomalous uranium contents in the ground- or surface-water or soils.

Demex has implied the presence of lineaments in the Agar Lake area that can be distinguished on the density-sliced image. Inspection of black and white air photographs shows that lineations in this area are not due to any underlying structure but firstly the action of present creeks and secondarily the direction of Pleistocene glacial movement. The "anomalous", topographically low spots are in fact largely between glacial ridges and such their shapes are controlled mainly by the ridges.

Conclusions

1. The LANDSAT "anomalies" of Demex in the Cluff Lake area do not correspond to the location of known uranium orebodies.

2. LANDSAT "anomalies" of Demex in the Agar Lake area do not correspond to anomalous uranium in surface bedrock, soils, surface waters or lake sediments, according to the geochemical investigations conducted in this study.

3. The above-mentioned "anomalies" of Demex appear to relate to muskeg with or without black spruce.

4. Apparent lineations in the anomalies are in fact due to the combined actions firstly of creeks (northwest) and secondarily, flow of the Pleistocene ice sheet (northeast). The low ground lies between sand dunes or glacially deposited ridges.

5. It is unfortunate indeed, if unscientific studies of satellite images combined with lack of knowledge of the nature of "ground truths" used and the geology and vegetation of the area under investigation, combine to place LANDSAT imagery in disrepute among exploration geologists. This author believes that satellite data will be of great use to mineral exploration provided that the investigation of its possible applications is done in scientific manner.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

1. The Agar Lake permit area is difficult for mineral exploration due to absence of outcrop, depth of overburden and thickness of Athabasca Formation. No ideal reconnaissance techniques are available for this type of terrain.

2. Quaternary geology studies indicate that glacial sediments in the permit area are not of local origin.

3. Track Etch surveys are not ideally suited for reconnaissance exploration. However, no indication of anomalous values was found, to quote; "The Track Etch contour map shows weak structure if any."

4. Radon emanometer survey was performed on a restricted scale but results are anyway all low. Emanometer results are so low that little significance can be attached to individual results.

5. Hammer seismic surveys confirm the results of the GSC survey (Hobson and MacAulay, 1969) that the basement is at least 100 feet and maybe 300 feet below the surface. Any uranium deposits present are expected to be either in the basement or close to the basement-Athabasca Formation unconformity.

6. Geochemical surveys for uranium in water indicates very low values. Comparison with geochemical surveys near Key Lake and Rabbit Lake result in the conclusion that there is no suggestion of uranium mineralization.

7. Geochemical surveys for uranium in lake sediments within the permit area have uniformly low results and none suggest the presence of uranium mineralization.

8. The "anomalies" indicated by Demex to be in the permit area in fact appear to correlate with topographically low, muskeg areas. There is no indication of stressed vegetation resulting from high uranium contents in bedrock or soil.

9. None of the exploration techniques applied indicate the presence of economic uranium mineralization in the Agar Lake area.

10. It is concluded that the density slicing techniques of Demex do not distinguish areas of high uranium in the ground and consequently that present knowledge does not allow LANDSAT images to be used for detecting mineralization in vegetated terrains. This is confirmed by Canney et al. (1975).

11. Owing to the absence of any further possible exploration techniques short of blind drilling, it is recommended that Mattagami Lake Mines Ltd. should not retain the Agar Lake option.

REFERENCES

Canney, F.C. and G.L. Raines (1975) LANDSAT and Other Remote Sensing Techniques Applied to the Investigation of Vegetated Geochemical Anomalies. Unpublished paper of 1st Annual William T. Pecora Memorial Symposium. American Mining Congress, Oct. 28-31, Sioux Falls.

Denver Mineral Exploration Corp. (1975) LANDSAT Search for Uranium in Northeastern Alberta. Unpublished report, 16 pages.

Hobson, G.D. and H.A. MacAulay (1969) A Seismic Reconnaissance Survey of the Athabasca Formation, Alberta and Saskatchewan. GSC Paper 69-18, 23 pages.

Miller, J.M. and D. Ostle (1973) Radon Measurement in Uranium Prospecting in Uranium Exploration Methods, IAEA, Vienna, p. 237-248.

Parslow, G.R. (1976) Exploration for Uranium, Key Lake Area. Unpublished paper presented in Regina, November 9th, 1976 in Saskatchewan Geological Survey Meeting.

Respectfully submitted,

[redacted]

William Mercer

Ph.D., M.G.A.C., M.C.I.M.M.

APPENDIX ONE

LAKE SEDIMENT RESULTS,
AGAR LAKE PERMIT AREA

SAMPLE NUMBER	Cu ppm	Mo ppm	Mn ppm	U ppm	LOI %
S 81 - 1	9	2	75	1	64.4
81 - 2	11	3	80	1	58.9
82	8	ND	165	0.4	48.7
90	7	2	6050	0.4	31.7
91	33	4	80	2	51.4
92	10	2	800	0.8	38.4
93	5	ND	290	0.8	28.6
94	10	1	50	1	44.9
95	12	1	110	1	67.7
96	4	1	340	0.4	38.0
97	14	1	150	0.6	39.0
98	12	3	125	2	63.2
99	8	ND	60	0.8	53.6
101	9	ND	135	0.8	67.2
102	10	1	120	1	67.3
S 103	4	ND	155	0.4	65.6
104	7	ND	275	1	58.1
106	11	5	95	2	62.0
107	14	4	55	3	58.3
108	10	3	30	2	54.1
109	10	1	50	0.8	51.6
110	17	2	135	2	57.5
111	7	1	105	0.6	74.5
113	10	2	80	0.6	20.3
114	8	1	65	ND	69.0
115	6	1	220	0.4	67.0
116	22	2	165	2	64.4
117	9	ND	70	2	55.1
118	8	3	45	2	55.2
119	9	2	770	1	51.9
120	14	4	145	2	68.1

122	6	ND	160	0.8	77.0			
124	8	1	120	1	67.0			
125 A	7	2	105	1	54.5			
125B	10	2	90	0.6	72.4			
128	10	3	590	2	46.6			
130	9	ND	250	0.8	56.7			

201	6	1	235	1	70.4			
203	6	1	115	1	38.3			
204	8	1	80	1	46.4			
206	5	ND	200	0.8	81.8			
207	10	1	115	2	58.6			
208	5	1	190	0.8	84.4			
209	6	ND	300	0.6	61.7			
210	4	ND	70	0.8	16.0			
212	8	ND	270	0.6	46.2			
214	11	2	55	2	56.9			
215	17	ND	510	0.4	49.0			
216	6	ND	195	0.4	63.0			
217	20	5	220	2	68.6			
219	5	ND	80	0.2	11.0			
220	14	2	340	1	40.9			
221	7	ND	185	0.4	26.0			
223	7	ND	135	1	73.8			
225	15	2	225	2	63.0			
226	10	3	80	5	62.7			
227	12	4	65	3	63.7			
231	9	2	65	1	51.9			
232	16	1	125	3	81.3			
233	24	1	120	2	61.8			
234	29	3	85	3	60.9			
236	10	1	90	1	68.5			
237	10	3	75	0.8	65.9			

238	5	ND	195	1	88.0			
239	14	5	95	2	68.1			
240	10	1	85	0.6	67.8			
241	12	2	230	1	60.7			
242	11	1	50	1	63.9			
243	7	ND	170	0.4	65.0			
244	8	1	85	0.4	65.4			
245	14	1	330	0.8	48.2			
246	9	2	35	2	44.4			
248	4	ND	110	1	83.4			
249	7	ND	85	0.8	64.6			
251A	9	ND	75	1	64.3			
251B	5	ND	190	3	71.6			

252	6	ND	75	1	15.4			
253	5	ND	230	1	85.3			
255	10	4	135	2	52.2			
262	9	3	100	1	57.1			
263	18	2	215	2	70.0			
264	6	1	60	0.8	70.7			
265	2	ND	4	ND	7.8			
270	5	ND	240	0.8	68.1			
274	5	ND	215	0.8	80.1			
276	13	ND	140	ND	58.1			
277	8	3	135	2	66.5			
279	5	ND	130	0.8	69.0			
280	15	2	440	2	74.2			
281	20	3	545	4	52.2			
282	12	1	490	2	59.5			
284	15	1	25	2	41.1			
285	12	2	290	2	50.7			
286	12	ND	275	1	52.2			42.
287	8	1	4600	0.4	56.5			

288	13	2	185	2	76.6			
289	13	ND	130	0.8	76.8			
290	22	3	110	2	74.3			
291	14	ND	100	0.6	66.2			
292	14	2	115	1	64.5			Card C...
293	11	1	90	1	59.2			
294	10	2	110	1	67.4			
295	7	ND	115	0.8	47.3			
296	8	ND	105	0.8	45.0			

APPENDIX TWO

TRACK ETCH DATA,
AGAR LAKE PERMIT AREA

MATTAGAMI TRACK DENSITY (1/SQ. MM.)	SOUTHERN FILM SERIAL NUMBER	FIELD NOTES AND DATA			
	85086.		06	11001NOT RET	0.9
	~~85094.~~		~~06~~	~~11001NOT RET~~	~~0.9~~
2.087	85165.	002	01	11003	MO.9
2.087	85133.	U03	06	11001	0.9
~~2.115~~	~~85091.~~	~~U01~~	~~03~~	~~21001~~	~~0.6~~
2.268	85141.	U05	14	11001	0.9
2.609	85105.	U02	05	11001	0.9
~~2.820~~	~~85089.~~	~~U00T~~	~~01~~	~~13002~~	~~0.6~~
2.898	85120.	U06	02	31001	0.8
3.130	85129.	U03	02	31001	0.3
~~3.162~~	~~85118.~~	~~000~~	~~07~~	~~21001~~	~~0.6~~
3.162	85115.	U005	04	21001	0.6
3.432	85088.	U00T	10	31001	0.3
~~3.432~~	~~85087.~~	~~001~~	~~09~~	~~21001~~	~~0.6~~
3.623	85098.	S BR	10	21001	0.8
3.864	85122.	010 W	04	13003	0.3
~~4.076~~	~~85113.~~	~~U03~~	~~02~~	~~11001~~	~~0.9~~
4.174	85163.	U002	03	31001	MO.3
4.174	85137.	U12	10	11001	0.9
~~4.207~~	~~85102.~~	~~007 W~~	~~02~~	~~23003~~	~~0.3~~
4.348	85097.	006	09	11001	0.9
4.537	85143.	001	16	31001	0.9
~~4.831~~	~~85154.~~	~~U07~~	~~07~~	~~11001~~	~~KO.9~~
4.831	85126.	U00T	08	33003	0.6
4.891	85112.	U02	01	13003	0.5
~~4.891~~	~~85114.~~		~~03~~	~~21001~~	~~0.6~~
5.217	85177.	000	09	12003	MO.6
5.217	85135.	002	08	11001	0.9
~~5.797~~	~~85127.~~	~~U005~~	~~09~~	~~33003~~	~~0.3~~
6.260	85132.	001	05	13003	0.9
6.260	85166.	001	02	31001	BO.3
~~6.260~~	~~85178.~~	~~U04~~	~~08~~	~~12003~~	~~MO.6~~
6.324	85116.	005	05	11001	0.9
6.521	85119.	U09	01	31001	0.9
~~6.521~~	~~85082.~~	~~U05~~	~~02~~	~~11001~~	~~0.9~~
6.805	85140.	U01	13	11001	0.9
6.805	85146.	U07	19	31001	0.6
~~7.023~~	~~85158.~~	~~002~~	~~03~~	~~11001~~	~~KO.9~~
7.246	85081.	U07	01	11001	0.9
7.304	85176.	003	10	21001	MO.9
~~7.304~~	~~85136.~~	~~000~~	~~09~~	~~11001~~	~~0.9~~
7.304	85179.	002	07	11001	MO.9
7.453	85152.	001	04	11001	BO.9

MATTAGAMI TRACK DENSITY (T/SQ. MM.)	SOUTHERN FILM SERIAL NUMBER	FIELD NOTES AND DATA			
7.453	85170.	001	06	11001	BO.9
7.573	85111.	000T	12	11001	0.9
~~7.573~~	~~85106.~~	~~U01~~	~~07~~	~~11001~~	~~0.9~~
7.608	85161.	005	05	31001	MO.3
7.729	85125.	U12	07	21001	0.9
~~7.729~~	~~85124.~~	~~U07~~	~~06~~	~~31001~~	~~0.9~~
7.826	85093.	U03	05	11001	0.9
7.939	85142.	U03	15	11001	0.9
~~7.939~~	~~85138.~~	~~U16~~	~~11~~	~~31001~~	~~0.8~~
7.970	85083.	001	03	11001	0.9
8.347	85167.	002	01	11001	BO.9
~~8.415~~	~~85108.~~	~~001~~	~~09~~	~~11001~~	~~0.9~~
8.415	85104.	U06	04	21001	0.8
8.460	85096.	U01	08	31001	0.5
~~8.695~~	~~85123.~~	~~U10~~	~~05~~	~~11001~~	~~0.9~~
8.695	85099.	U05	11	11001	0.9
8.695	85121.	002	03	31001	0.5
~~8.695~~	~~85150.~~	~~001~~	~~09~~	~~21001~~	~~BO.6~~
9.165	85090.	001	02	11001	0.9
9.391	85180.	002	06	31001	MO.6
~~10.097~~	~~85101.~~	~~000~~	~~01~~	~~21001~~	~~0.3~~
10.144	85100.	001	12	11001	0.9
10.434	85131.	002	04	21001	0.5
~~10.434~~	~~85130.~~	~~002~~	~~03~~	~~11001~~	~~0.9~~
10.939	85109.	U05	10	11001	0.9
11.066	85117.	U03	06	21001	0.9
~~11.086~~	~~85092.~~	~~U04~~	~~04~~	~~11001~~	~~0.9~~
11.179	85168.	U04	08	11001	BO.9
11.179	85162.	001	04	13003	MO.9
~~11.280~~	~~85095.~~	~~001~~	~~07~~	~~11001~~	~~0.9~~
11.280	85085.	U03	05	11001	0.9
12.039	85159.	001	02	21001	KO.9
~~12.039~~	~~85160.~~	~~001~~	~~01~~	~~21001~~	~~KO.9~~
12.421	85148.	001	11	11001	BO.9
12.521	85134.	001	07	11001	0.9
~~12.622~~	~~85107.~~	~~U05~~	~~08~~	~~11001~~	~~0.9~~
12.622	85110.	001	11	11001	0.9
13.526	85157.	002	04	31001	KO.9
~~14.046~~	~~85156.~~	~~001~~	~~05~~	~~21001~~	~~KO.6~~
14.492	85147.	000		11001	MO.9
14.492	85155.	U04	06	21001	KO.9
~~14.608~~	~~85164.~~	~~U02~~	~~02~~	~~21001~~	~~MO.8~~
14.906	85153.	002	03	13002	BO.9
15.788	85084.	U02	04	11001	0.9
~~15.878~~	~~85144.~~	~~U06~~	~~17~~	~~31001~~	~~0.6~~
15.983	85103.	U04	03	11001	0.9
17.390	85169.	002	07	21001	BO.6
~~17.390~~	~~85151.~~	~~001~~	~~05~~	~~11001~~	~~BO.9~~
19.280	85145.	U06	18	31001	0.9
19.825	85128.	001	01	13003	0.6

MATTAGAMI TRACK DENSITY (T/SQ. MM.)	SOUTHERN FILM SERIAL NUMBER	FIELD NOTES AND DATA		
21.116	85149.	001	10 11001	BO.6
21.548	85139.	U03	12 11001	0.9

MATTAGAMI LAKE MINES LIMITED

(NO PERSONAL LIABILITY)

EXPLORATION DIVISION
WESTERN FIELD OFFICE

SUITE 502
8215 - 112 STREET
COLLEGE PLAZA OFFICE TOWER
EDMONTON, ALBERTA
T6G 2C8

TELEPHONE 403-433-1488

January 9, 1977

Mr. G. Fulford
Manager - Earth Sciences
Alberta Energy and Natural Resources
Petroleum Plaza
9915 - 108 Street
Edmonton, Alberta

Re: Quartz Mineral Exploration Permits 224 and 225

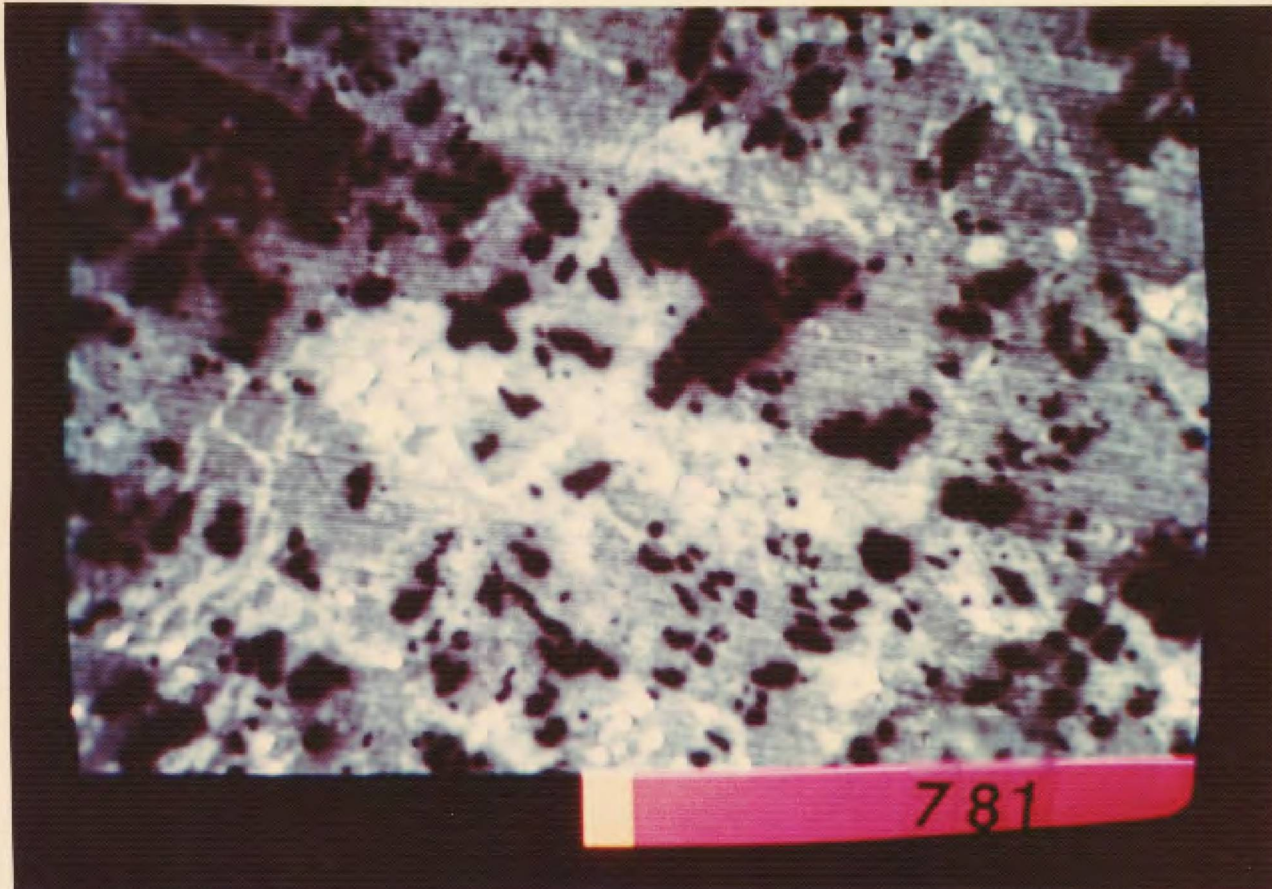
Dear Mr. Fulford,

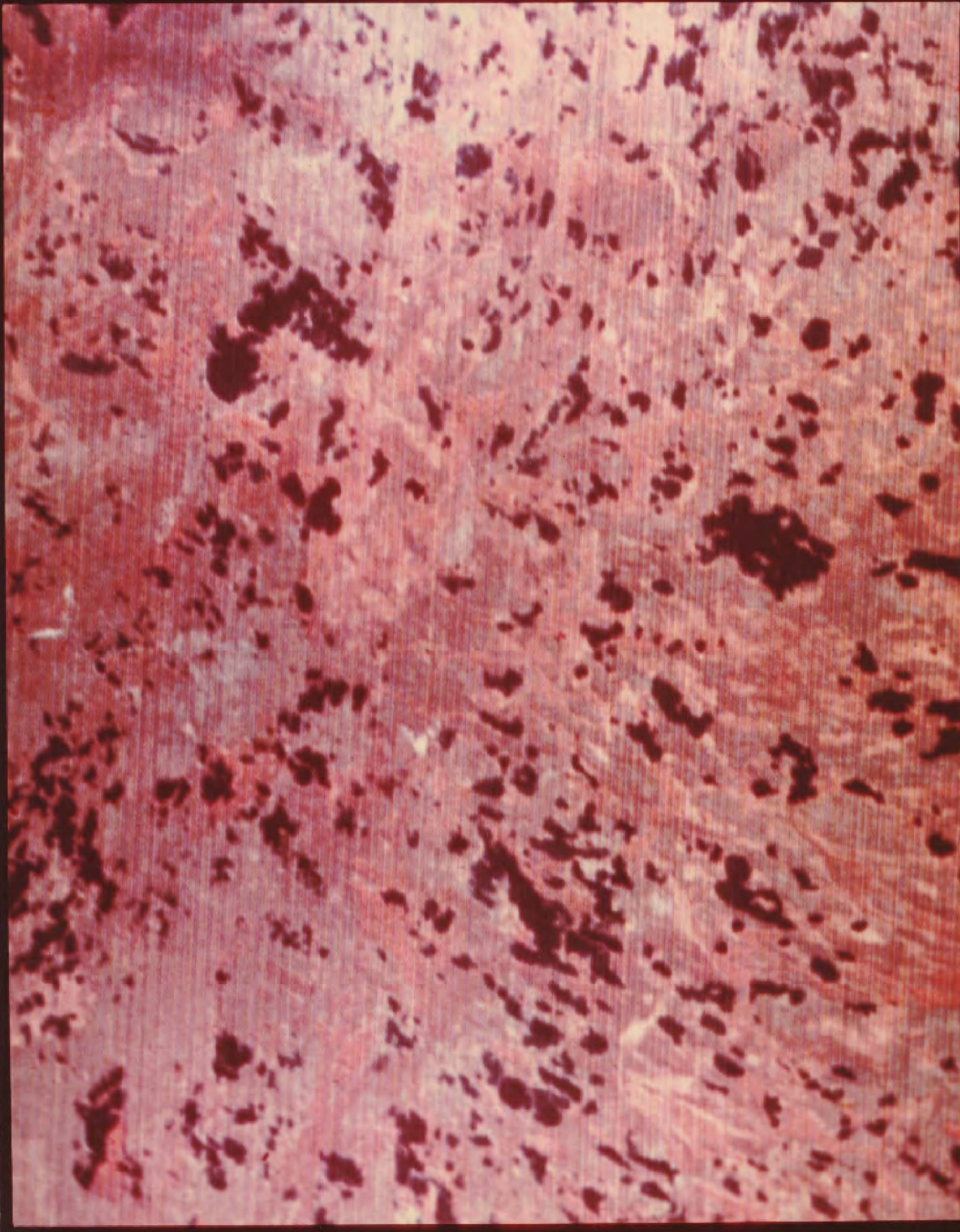
Please find enclosed end of year reports for above Exploration Permits. Mattagami Lake Mines Ltd will not be retaining these from Mr. Les Card of Calgary for a second year, so they should revert back to him.

Yours sincerely,

[redacted]

W. Mercer, Ph.D.
District Geologist


781



RESEARCH COUNCIL OF ALBERTA

LEGEND

RECENT

EROSIONAL FEATURES

- 17 — Slump: *mixed glacial and bedrock materials; unstable slope*
- 16 — Gully, creek valley: *thin colluvial cover on valley slopes; thin alluvial materials along streams*

ALLUVIAL DEPOSITS

- 15 — Alluvial fan: *bedded silt, sand and clay; variable thickness, overlying glacial deposits*
- 14 — Stream alluvium: *mainly sand along Athabasca River; sand and silty sand along other streams*
- 13 — Athabasca River delta: *alluvial sand, silt and clay, calcareous*
- 12 — Peace River delta: *alluvial silt, sand and clay, calcareous*
- 11 — Small stream delta: *sand, silt and clay*
- 10 — Early Athabasca River sediments and terraces: *medium- to coarse-grained sand, overlying thin gravel and lag gravel*

AEOLIAN DEPOSITS

- 9 — Aeolian sand, dunes: *medium-grained quartzitic sand in sheet and dune form; thick in dunes, 2 to 10 feet in sheet sand*

PLEISTOCENE

GLACIOLACUSTRINE DEPOSITS

- 8 — Sand: *thin, over glacial outwash sand and gravel*
- 7 — Sand: *thick, medium- to fine-grained sand with scattered silt and clay beds*

GLACIOFLUVIAL DEPOSITS

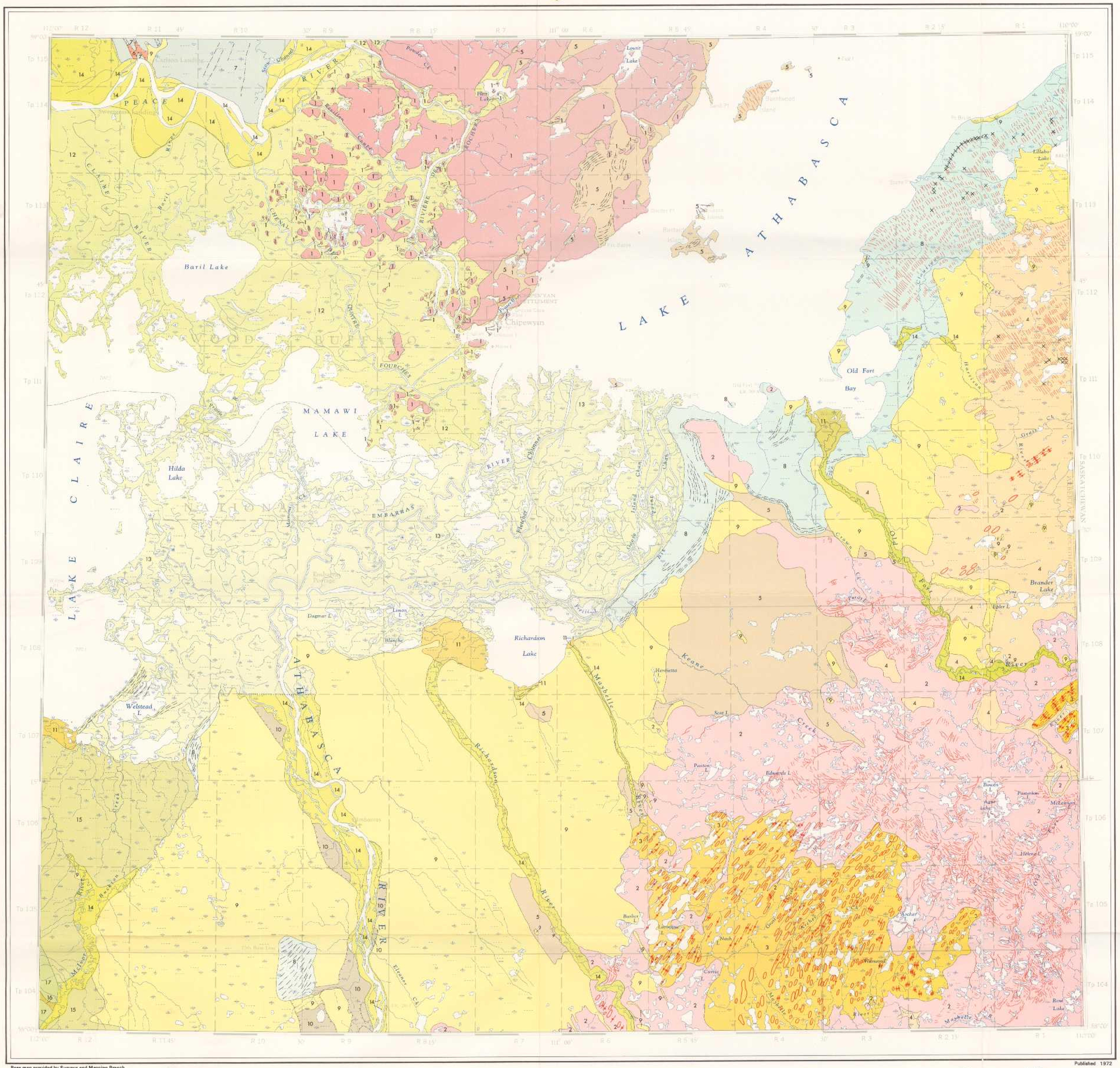
- 6 — Meltwater channel sediment: *medium- to coarse-grained sand, overlying thin gravel and lag gravel*
- 5 — Outwash sand: *medium- to coarse-grained sand with pebbles and small gravel lenses; surface level to gently undulating*
- 4 — Outwash sand and gravel: *medium- to coarse-grained sand and gravel, with many large boulders; generally thin with some outcrops of Athabasca sandstone; topography undulating to rolling*
- 3 — Outwash sand and gravel overriden by glacier: *fluted and drumlinized outwash of sand and gravel to gravel, with many large boulders; generally thick to very thick; topography undulating to rolling*
- 2 — Ice-contact deposits: *sand and gravel to gravel, numerous very large boulders; rolling topography, individual hills reach heights of several hundred feet; includes kame moraine, eskers, moulin kames, crevasse fillings, and other related ice-contact glaciofluvial deposits; form end moraines of glacier advances*

PRECAMBRIAN

- 1 — Granite, gneiss and metasedimentary rocks: *outcrops form hills and knolls; generally bare, locally covered with thin drift*

Geological boundary; defined, approximate, assumed
Abandoned beach
Channel scarp (ticks indicate downslope side)
Athabasca sandstone outcrop
Crevasse filling
Drumlin (outline to scale)
Glacial fluting

Geology by L. A. Bayrock, 1969, 1970



Base map provided by Surveys and Mapping Branch, Department of Energy, Mines and Resources: modified by Surveys Branch, Alberta Department of Highways and Transport

Cartographic editing by J. D. Root

Drawn by F. L. Copeland

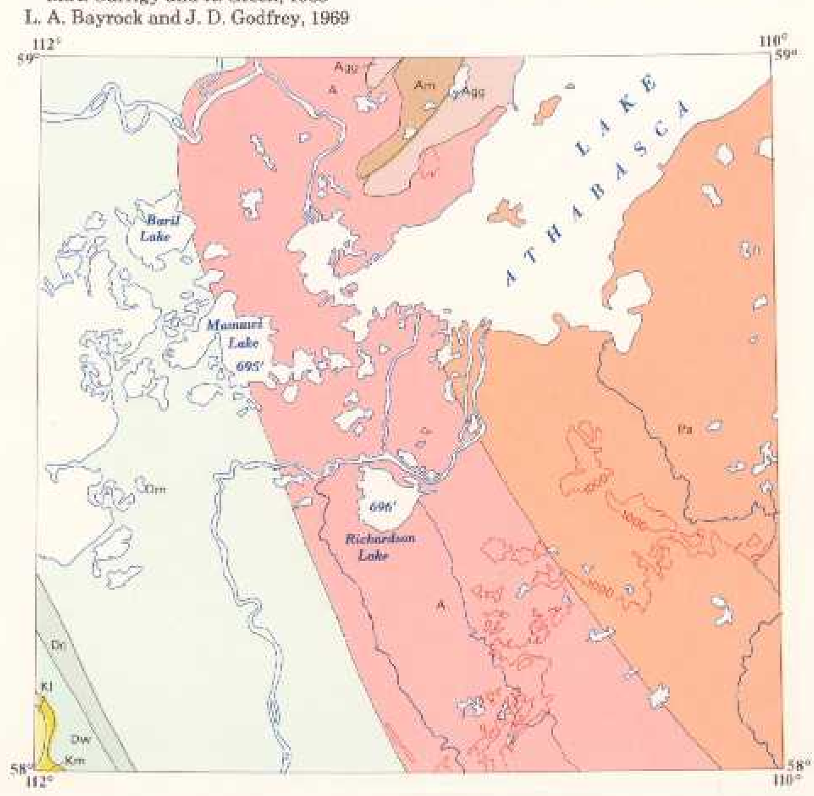
SCALE 1:250,000
1 Inch to 4 Miles Approximately

Miles 5 0 5 10 15 20

Kilometres 5 0 5 10 15 20 25 30

BEDROCK GEOLOGY

M.A. Carrigy and R. Green, 1965
L. A. Bayrock and J. D. Godfrey, 1969



LEGEND

CRETACEOUS

- Kl — Loon River Formation: *dark grey shale*
- Km — McMurray Formation: *oil-impregnated quartz sand*

DEVONIAN

- Dw — Waterways Formation: *grey shale, argillaceous limestone*
- Dc — Slave Point Formation: *limestone and dolomitic limestone, minor shale and gypsum*
- Dm — Middle Devonian (undivided): *dolomite, gypsum, anhydrite*

PRECAMBRIAN

- Ps — Athabasca Formation: *quartzose sandstone, minor conglomerate and shale*
- Am — Metasedimentary rocks: *quartzite, schist, phyllite*
- Agg — Granite gneiss
- A — Granitic plutonic rocks

Geological boundary
Surface contour (contour interval 500 feet)

LEGEND

River or stream
Intermittent river or stream
Lake
Marsh or swamp
Township boundary; surveyed, unsurveyed
National Park boundary, Indian Reserve boundary

SURFICIAL GEOLOGY
FORT CHIPEWYAN
NTS74L

DESCRIPTIVE NOTES

BEDROCK GEOLOGY

Precambrian rocks underlie the eastern two thirds of the area, although exposures in the heavily drift-covered terrain south of Lake Athabasca are few. The oldest rocks are crystalline Shield rocks which outcrop extensively in the Peace-Athabasca delta region and north of Lake Athabasca. They are divisible into three general types: granitic plutonic rocks, granite gneiss of various types, and metasedimentary quartzite, schist, and amphibolite. These rocks are overlain unconformably by nearly flat-lying quartzose sandstone and minor conglomerate of the Late Precambrian Athabasca Formation, which apparently extends under Lake Athabasca and the drift-covered area to the southeast.

Strata of Middle to Late Devonian ages are inferred to underlie the marshy lowlands along the western part of the region, although no outcrops were observed within the map area boundaries. From observations in nearby areas, the strata are assumed to comprise a succession of interbedded carbonate and evaporite deposits divisible into the three units described in the accompanying legend. They are overlain in the southwest corner of the area by Lower Cretaceous sandstone and shale exposed along the lower slopes of Birch Mountains.

SURFICIAL DEPOSITS AND LANDFORMS

Glaciofluvial Deposits

Ice-contact deposits form the surficial sediments in the southeast part of the map area, comprising a complex of kame moraines, eskers, moulin kames, and crevasse fillings. Kame deposits, with local relief ranging between 100 and 600 feet, are composed of sand and gravel to coarse boulder gravel, forming a series of northwest-trending end moraines in continuation with the Cree Lake Moraine of northwestern Saskatchewan. Crevasse fillings associated with kame moraines are relatively high and sinuous, grading into small eskers. Most are composed of gravel.

Centered in this complex of ice-contact deposits is a large area underlain by *fluted and drumlinized outwash sand and gravel*, containing materials overridden by a local advance of the glacier from the northeast. The drumlins, which trend northeast-southwest, are well shaped and mantled by a layer of large boulders. Flutings also are well developed and grade in places into drumlins; they extend together with small drumlins onto the flat outwash plain south of Lake Athabasca. There, the outwash deposits cover an older drumlinized and fluted terrain, not entirely obscured by the younger sediments.

Outwash plains with nearly flat to gently undulating surfaces are widely exposed in the area south of Lake Athabasca, extending to the southeast under a cover of aeolian sand, adjacent to the Athabasca River delta. The outwash plain east of Old Fort River and extending to the Saskatchewan border is composed in places of large boulders of Athabasca Formation sandstone (quartzite) with few Shield erratics. It has little interstitial material and presumably overlies bedrock at shallow depths, in view of the frequency of bedrock outcrops in this area. Relatively short, straight crevasse fillings associated with the northern part of the outwash plain also are composed of large boulders of Athabasca Formation sandstone, among which bedrock outcrops of the same material are found. The outwash plain west of Old Fort River contains mainly medium- to coarse-grained sand derived from the Athabasca Formation. These deposits are thicker than those to the northeast: approximately 65 feet of outwash sand is exposed on the Athabasca River near Embarras airport, and similar thicknesses were observed on the Richardson and Maybelle Rivers to the east. Smaller bodies of outwash sand cover low areas in the Canadian Shield northeast of Fort Chipewyan as well as Bustard and Burntwood Islands in Lake Athabasca.

The high terraces along the Athabasca River and related channels adjacent to them, and small channels near Carlson Landing on the Peace River are interpreted here as *meltwater channel* landforms, although some of the associated sediments may have been deposited by nonglacial streams. The deposits are similar in that they contain a gravel layer at the base (thin or absent in places) overlain by variable thicknesses of fluvial sand. The channels are bounded by erosional scarps transected in places by the valleys of younger, postglacial streams.

Glaciolacustrine Deposits

Thin deposits of *glaciolacustrine sand* cover a wide expanse of flat ground along the south shore of Lake Athabasca, and flanking the east margin of the Athabasca River delta. Smaller areas of lacustrine sand are found west of the Athabasca River southeast of Lake Claire, and north of the Peace River in the vicinity of Carlson Landing. The deposits range from 2 to 5 feet thick and are associated in places with sandy beach ridges from 5 to 10 feet thick. The sediments were formed by reworking of older glacial deposits (mainly outwash) when Lake Athabasca covered a much larger area than at present, reaching elevations approximately 300 feet above the current lake level.

Aeolian Deposits

Aeolian sheet and dune sands derived from nearby outwash deposits cover a large area south of Lake Athabasca and the adjacent delta complex, extending from the Saskatchewan border in the northeast to the margin of the Birch Mountains in the southwest. Dunes are well developed in many parts of the area, although most are now stabilized by vegetation. Some dunes attain heights of more than 100 feet, and trend in a northwest-southeast direction. Two large active dunes are located in the vicinity of Richardson and Maybelle Rivers, and smaller active dunes are found along the shore of Lake Athabasca. Blowouts also are present on the crests of some of the larger stabilized dunes. In general, most of the dune sand is fine to medium grained, although coarse sand is present in the dunes in township 105, range 6.

Alluvial Deposits

Deltaic sediments deposited by the Peace and Athabasca Rivers cover much of the lowlands adjacent to Lakes Athabasca and Claire in the west-central part of the map area. The deltas have converged, forming a continuous complex of sand, silt, clay, and organic deposits covered by a series of shallow lakes and swamps. Most of the Athabasca River bedload, composed mainly of silty sand, is deposited along the delta front near the distributary mouths. The silt and clay are deposited in the subaqueous part of the delta, although some material is carried to the Slave River through the Rivière des Rochers. In contrast, the Peace River delta contains much more silt and clay, for most of the bedload is carried downstream into the Slave River. Locally, the delta surficial deposits vary widely in sand, silt, and clay contents: generally the levees contain more sand than the interlevee areas, many of which contain shallow lakes and swamps.

Recent stream sediments occupy the valleys of the Peace, Athabasca, and smaller rivers. The floodplain sediments of the two larger rivers are predominantly silt and sand with a small amount of clay, whereas those of the smaller rivers (Richardson, Maybelle, and Old Fort Rivers) are mainly sand. An exception is the floodplain of the McIvor River, which contains abundant silt and clay derived from the Birch Mountains to the southwest.

Alluvial fan sediments cover an area of approximately 100 square miles in the southwest corner of the area, skirting the flank of the Birch Mountains. They range in thickness from a few to more than 20 feet, thickening towards the Birch Mountains escarpment. Locally, the deposits are highly variable in texture, consisting of interbedded sand, silt, and clay derived from Cretaceous shales and sandstones underlying the upland to the southwest.

Erosional Features

Large-scale erosional features *(slump, colluvium)* are confined to the slopes of the Birch Mountains in the extreme southwest corner of the area.

Organic Deposits

Postglacial accumulations of organic materials, commonly called *muskeg*, mantle most of the surficial deposits described above. In general, these deposits are thin, although locally they may attain a thickness of 20 feet or more.

FIGURE 2
19760009

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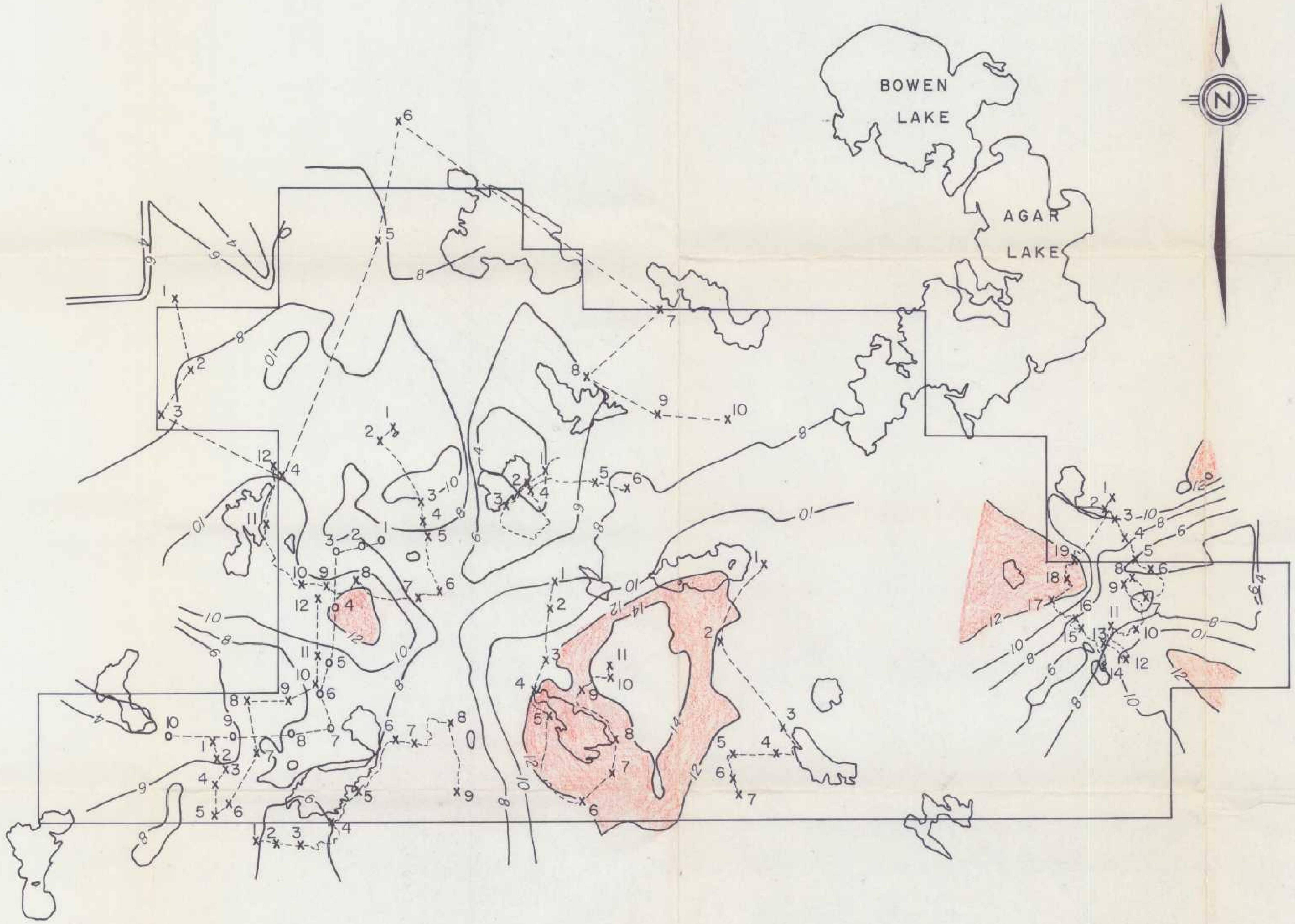

LEGEND

x,o TRACK ETCH CUP LOCATION

-x1--x2 EMPLACEMENT TRAVERSE

—8— TRACK ETCH CONTOUR (for 8 tracks / mm^2)

SCALE

Miles 1 0 1 2 3 Miles

Kilometres 1 0 1 2 3 4 Kilometres

MATTAGAMI LAKE MINES LIMITED	
TRACK ETCH SURVEY CARD OPTIONS	
AGAR LAKE AREA, ALBERTA	
TERRADEX CORP	DWN BY: R.M.S.
SCALE: AS SHOWN	DATE: OCTOBER 1976

FIGURE 4
19760009

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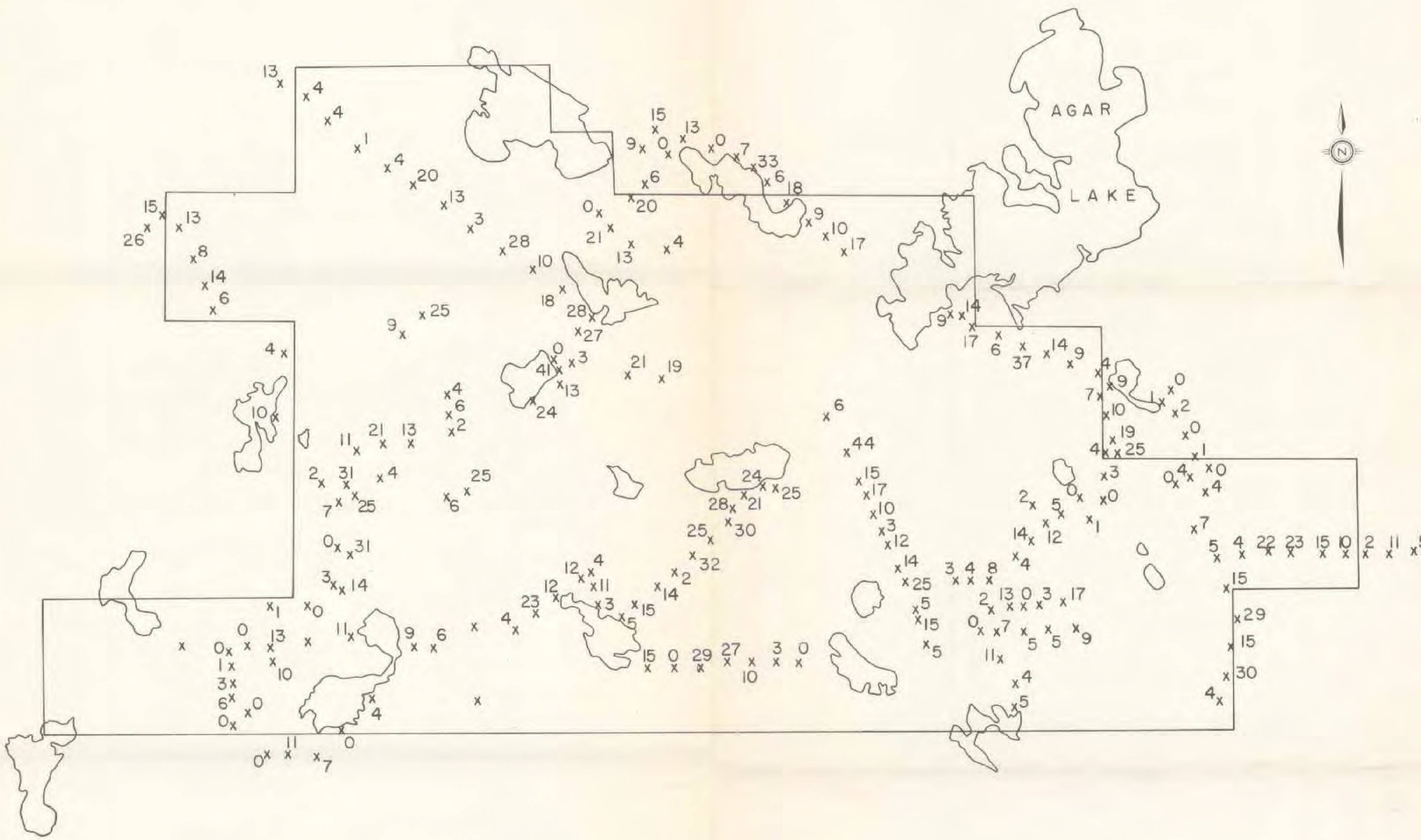


LEGEND

x 4 RADON EMANOMETER COUNT OVER 3 MINUTES

1 Mile

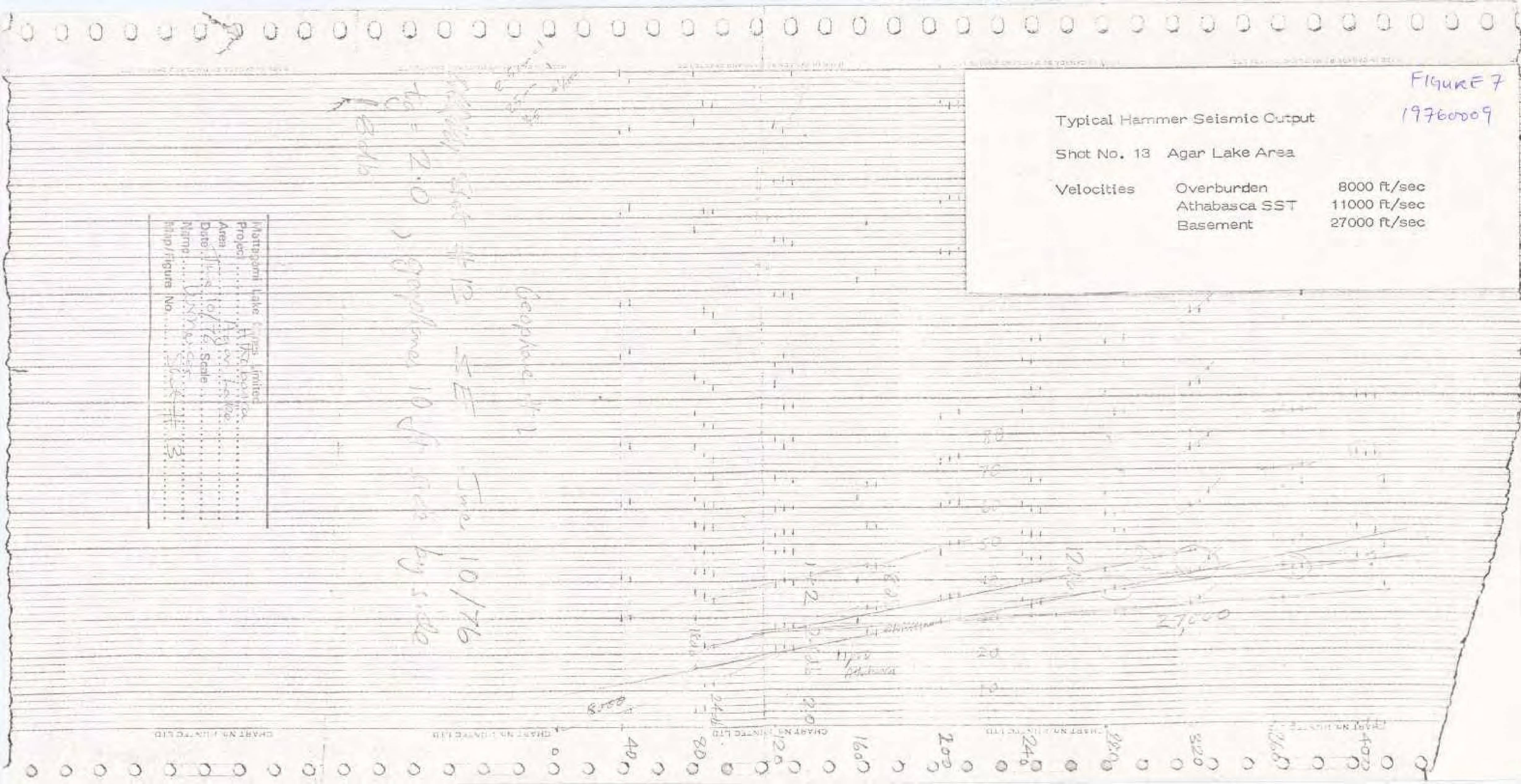
MATTAGAMI LAKE MINES LIMITED	
SURVEY FOR RADON IN SOIL GAS ALBERTA	
AREA AGAR LAKE	SHEET
SCALE 1:40,000	DATE JULY 1976
W. MERCER AND PARTY	RMS

FIGURE 6

19760009

FIGURE 7

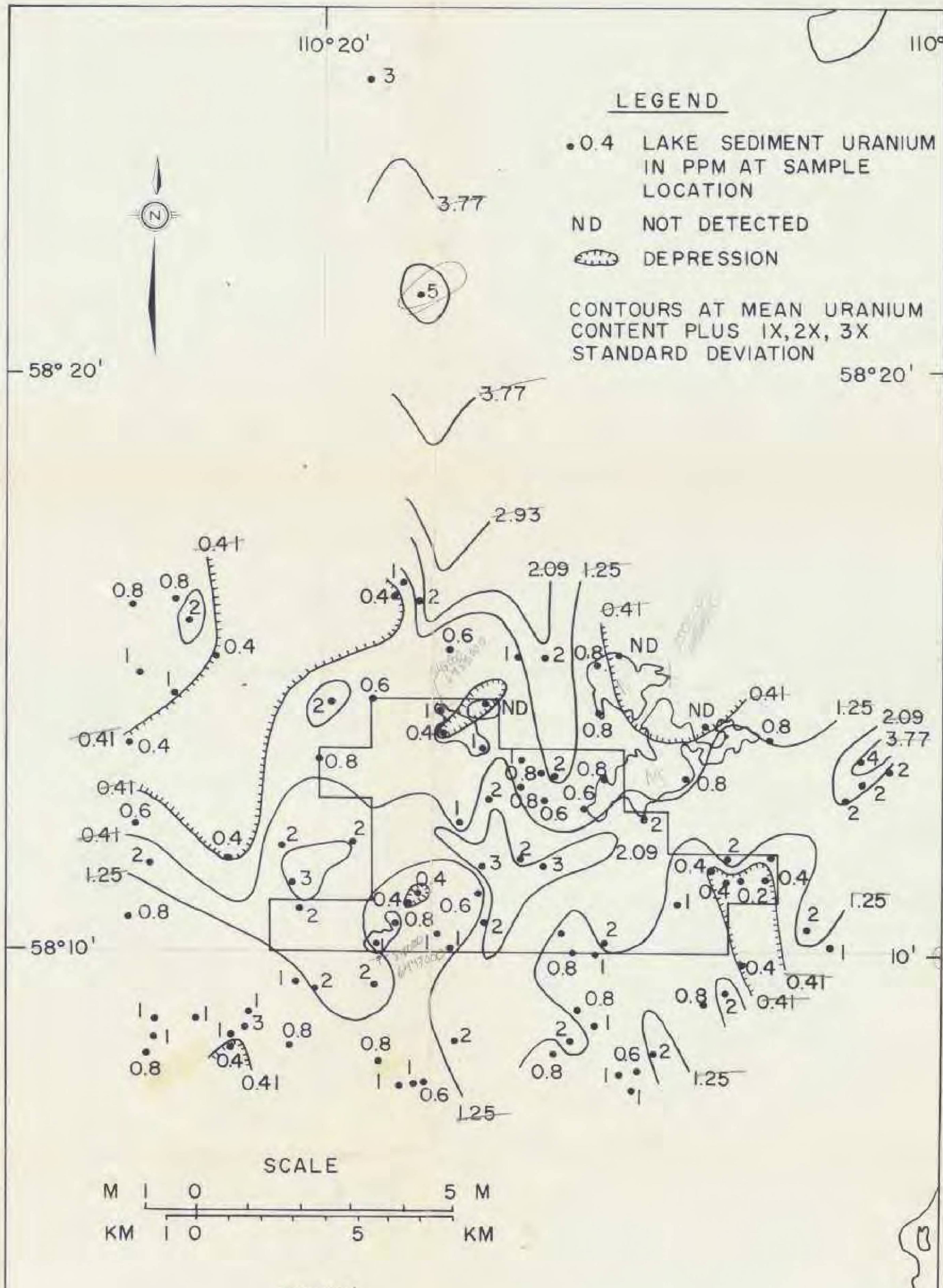
19760009



Typical Hammer Seismic Output

Shot No. 13 Agar Lake Area

Velocities	Overburden	8000 ft/sec
	Athabasca SST	11000 ft/sec
	Basement	27000 ft/sec



MATTAGAMI LAKE MINES LIMITED	
URANIUM IN LAKE SEDIMENTS AGAR LAKE PERMIT AREA	
NORTH EAST ALBERTA	
AREA: 74L S.E.	SHEET: FIGURE 9
SCALE: 1 to 126,720	DATE: SEPTEMBER 1976

FIGURE 9
19760009

QUARTZ MINERAL EXPLORATION PERMIT No. 224