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NORCEN ENERGY RESOURCES LIMITED

MINING EXPLORATION DEPARTMENT

YEAREND REPORT
QUARTZ MINERAL EXPLORATION PROJECT
NORTHEASTERN ALBERTA

LAKE ATHABASCA AND ATHABASCA RIVER AREAS

[redacted]
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November, 1976

Don Sawyer

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J. Sciarra
20-April-06

A. SUMMARY

Great Plains Development Company of Canada, Ltd., a wholly owned subsidiary of Norcen Energy Resources Limited, acquired six Quartz Mineral Exploration Permits from the Alberta Government along the western margin of the Athabasca Sandstone Basin in January, 1976. An exploration program was designed to search for basement unconformity supergene uranium deposits of the type found along the margin of the Athabasca Sandstone Basin at Rabbit and Key Lakes, Saskatchewan. During the 1976 field season which spanned from May 14 to August 26, a 7 to 10 man helicopter supported team carried out an exploration program which included a study of the surficial deposits, ground prospecting with scintillometers and a lake bottom geochemical survey. This approach was designed to locate boulder trains from any uranium deposit which has been subjected to glaciation and to detect changes in the bedrock below the glacial cover.

The study of the surficial deposits began with a detailed photo interpretation of 1 inch to 1/2 mile air photos by L. Bayrock followed by a 5 day field examination by L. Bayrock and assistant G. Bhile of Bayrock and Reimchen Surficial Geology Limited. This study revealed that much of the surficial cover in northeastern Alberta was carried within the ice and therefore not representative of the underlying bedrock. Ground moraines, which represent scoured material overriden by the ice and, therefore, of local origin are not common in the area. Where present, these areas were examined in detail. Close examination of these areas indicate that at least locally the Athabasca Formation extends further west than indicated on the Alberta Government Geological maps.

A total of 320 man days were spent on ground traverses prospecting with hand held scintillometers. Ground traverses were conducted over all the large boulder fields, ground moraines, eskers and in the areas surrounding lake sediment uranium anomalies. A single radioactive pebble conglomerate boulder was found seven miles east of Archer Lake in a crevasse filling. Three fluorimetric assays from this boulder ranged from 5.2 to 6.2 ppm U308 and .031 to .042% Th02. Radioactive granite boulders were found in clusters in the end moraine ridges and hills east of the Keane fire tower and in crevasse filling complexes south of Helen Lake. Scintillometer counts over large granite boulders (4 to 5 feet in diameter) in these areas produced equivalent uranium and thorium values up to 50 ppm U308 and 200 ppm Th02. A corresponding fluorimetric assay from one of these boulders was 42 ppm U308 and 100 ppm Th02. These granite boulders and the previously mentioned pebble conglomerate boulder occur with material that has been carried within the ice and not of local origin. Since these boulders are found in a down ice direction from the Carswell Dome, it is believed that this is the most likely source area.

A total of 719 lake sediment samples were collected during the field season using a "Hornbrook" sampler. Uranium content of the lake sediments ranged from nil to 18.8 ppm, with a mean of 1.6 ppm, 90 percentile of 3.6 ppm and 94 percentile of 5 ppm U308. The largest anomaly was associated with radioactive granite boulders east of the Keane fire tower. Contoured maps of the lake sediment data indicates that changes in background uranium values appear to reflect changes in the surficial deposits rather than changes in the underlying bedrock.

The pervasive cover of glacial deposits in northeastern Alberta has produced a greater barrier than anticipated. Exploration in this area requires more than the conventional lake sediment survey, boulder tracing technique which has proven successful in other areas. Results from the surveys conducted during the 1976 field season do not isolate specific uraniferous target areas. Future work in this area will require tools which penetrate this cover and allow one to better define the underlying geology. Information of this type augmented with the information gathered this year will provide a more complete evaluation of the permit areas.

RECOMMENDATIONS

A thick and pervasive cover of glacial deposits make surficial evaluations of the permits difficult and in parts of the permits impossible. All information collected during the 1976 field season indicates that the western boundary of the Athabasca Formation is much further west than previously thought. In light of this information large sections of the Great Plains quartz mineral exploration permits should be surrendered to the Crown.

Application for new quartz mineral exploration permits south of Richardson Lake where we now believe the western boundary of the Athabasca Formation to be, should be made at the earliest possible date. Since this area is covered by sand and gravel outwash, an overburden drilling program designed to delineate the contact should be carried out prior to the spring breakup in 1977. This program should consist of at least ten holes to bedrock, and where the bedrock is Athabasca Formation, drilling should continue to determine the thickness of the Athabasca Formation. If these holes continue through the Athabasca Formation to greater than 500 feet, they should be discontinued. This initial program would consist of acquiring four permits at a cost of $2,500.00. Estimated drilling costs of $18.00 per foot for ten holes drilled to an average depth of 400 feet would cost $72,000.00. The total cost of the program would be less than $80,000.00.

ACKNOWLEDGEMENTS

The writers, G. McWilliams and D. Sawyer, wish to acknowledge the people who played a role in the uranium exploration program in northern Alberta this past year. The summer program was conducted with the help of assistants: Dr. Asplund - student, University of Alberta; D. Blackadar - Norcen Energy Resources Limited; B. Bushfield - cook; G. Ferguson - student, University of Alberta; M. Hutchison - graduate student, University of Toronto; D. Jarvis - student, Northern Alberta Insititute of Technology; J. Keating - student, University of Alberta; H. Paterson - Norcen Energy Resources Limited. L. Bayrock and G. Bihl of Bayrock and Reimchen Surficial Geology Ltd. provided expertise on the evaluation of surficial deposits of the area. P. Bradshaw of Barringer Research Limited, helped set up the lake bottom geochemical sampling program. Loring Laboratories, Calgary, conducted geochemical assays of the samples collected. T. Kamiaho and L. Davidson of Shirley Helicopters, safely piloted the Bell 206 helicopter serviced by T. Fofanof. Mobilization and demobilization was carried out with a LaRonge Aviation Services twin otter. Weekly cessna supply flights were provided by Contact Airways of Fort McMurray.

HISTORY

The uranium discoveries of Gulf's Rabbit Lake deposits, Amok's Cluff Lake deposits and the Uranerz, Inexco, Saskatchewan Mining Development Corporation's deposits at Key Lake have focused much attention upon the search for low temperature supergene uranium deposits occurring near the unconformity between the Athabasca Formation and the underlying crystalline basement rocks. Most of the near surface unconformity in northeastern Alberta south of Lake Athabasca was open ground. Since the uranium potential on the Alberta side for similar supergene orebodies is good, 256,000 acres along the projected Athabasca Formation - basement unconformity were acquired by Great Plains in six quartz mineral exploration permits.

OWNERSHIP

Great Plains Development Company of Canada Ltd., a wholly owned subsidiary of Norcen Energy Resources Limited holds 100 percent interest in six (6) quartz mineral exploration permits as described below:

------------ See Appendix 1 -------------

Applications for quartz mineral exploration permits were made at the Alberta Mining Recorder's Office in Edmonton on September 10th, 1975 by the author. A minimum of six weeks was expected in order to process these applications. Permits are granted after approval by the Alberta Mining Recorder and The Alberta Special Land Use Branch. Actual permits were granted on January 28th, 1976. For more details on permit applications and regulations see Appendix 2.

OBJECTIVES

This project was conceived in order to search for low temperature supergene uranium deposits along the Athabasca Sandstone - basement unconformity similar to the existing orebodies at Rabbit Lake, the deposits at Cluff Lake and Key Lake, all in Saskatchewan. Description of these deposits are found in Appendix 3.

Although the permits are situated in a highly favourable location for supergene uranium deposits, this area has been neglected in the past due to the presence of extensive glacial deposits which make exploration more difficult. Our objective was to carry out an extensive ground traverses which would intersect boulder trains eminating from glacial scouring of any ore deposits occurring at surface. Similar ground surveys have played key rolls in the discoveries at Rabbit, Cluff and Key Lakes. A lake bottom geochemical survey was designed to locate uranium anomalies associated with acid phases in the underlying bedrock and mineralization either in place or in boulders. Scintillometer traverses, in addition to follow up for the lake sediment survey, included areas covered by locally derived glacial deposits and all of the boulder fields of the permits.

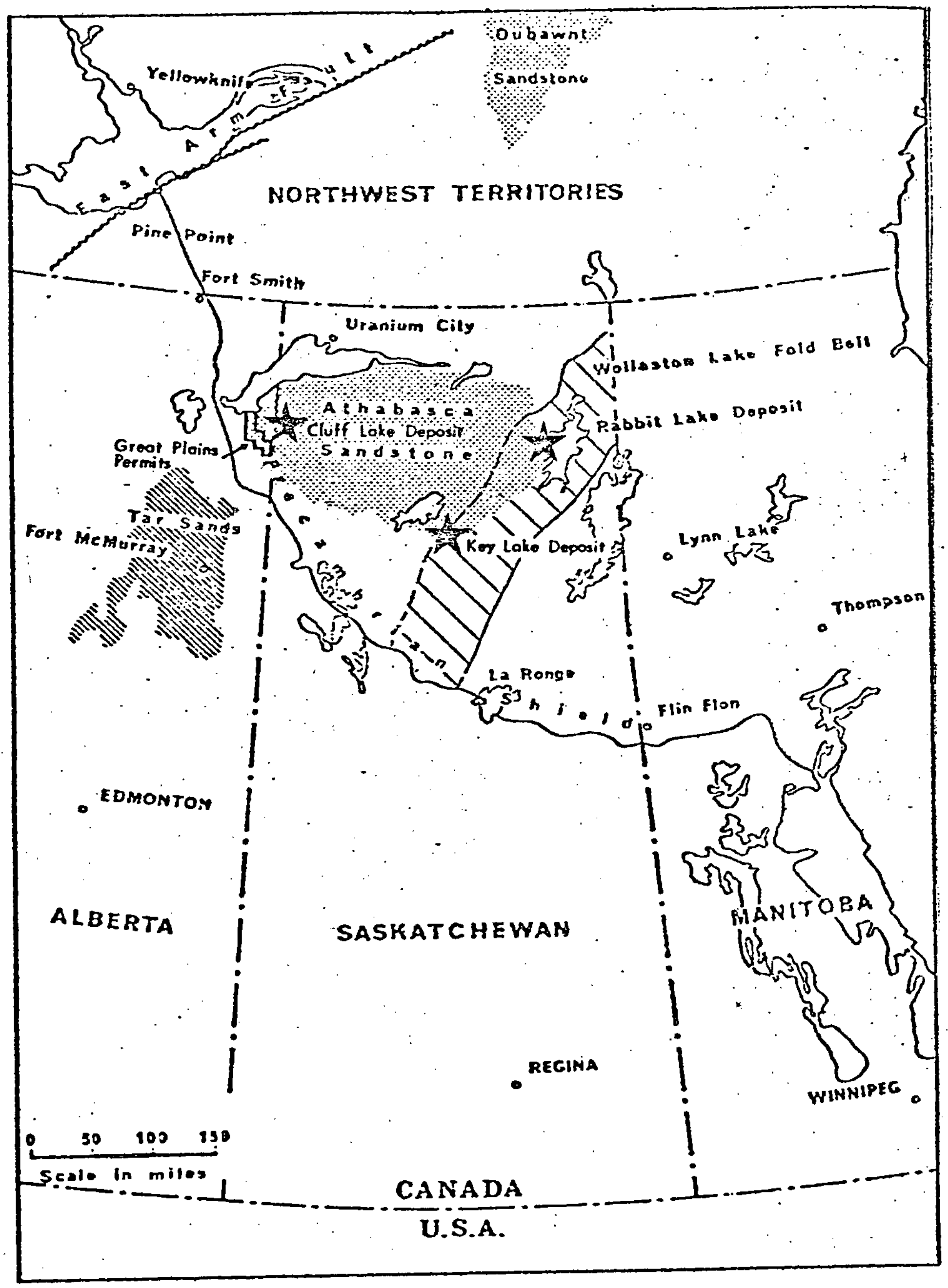

fig. 1

Location of Athabasca Sandstone Type Uranium Deposits

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LOCATION

The six permits lie south of Lake Athabasca within Alberta, in N.T.S. 74-E, L. The centre of the permit areas is 40 miles southeast of Fort Chipewyan, 110 miles northeast of Fort McMurray, 110 miles south-west of Uranium City and 40 miles west southwest of Cluff Lake (Amok's uranium deposits) in Saskatchewan.

The permit areas are located on the Lake Athabasca Area and Athabasca River Area quartz mineral land maps.

The centre of the permits is at 58 degrees 15 minutes north; 110 degrees 30 minutes west.

ECONOMIC CONSIDERATIONS

Fixed wing aircraft and supplies for exploration crews are available at Fort McMurray, Alberta and Uranium City, Saskatchewan both 110 air miles from the centre of the permit areas.

The Northern Transportation Company Ltd. barges up and down the Athabasca River between Fort McMurray and points on Lake Athabasca including Fort Chipewyan from May to October.

Three road routes have been proposed to link Fort McMurray and Fort Chipewyan by road. The centre of the Project area would be 40 miles from any of these proposed roads. No government decision has been announced regarding an all weather road into Fort Chipewyan nor is such an announcement anticipated within the short term.

PREVIOUS EXPLORATION

Great Plains has not previously explored in the northeastern Alberta area south of Lake Athabasca.

Most of the past exploration in the area was performed in 1969 by others as a result of massive land positions that were taken by various companies stemming from the December 1968 Rabbit Lake uranium discovery announcement by Gulf Minerals Ltd.

The following is a summary of recent past exploration in the general permit area. It is emphasized that almost all of this exploration consisted of airborne radiometric surveys with very limited follow-up.

PREVIOUS QUARTZ MINERAL EXPLORATION
(Athabasca Sandstone Area N.E. Alberta)

*	Current Permits
A.S.S.	Airborne Spectrometric Survey
A.E.M.	Airborne Electromagnetic Survey
A.R.S.	Airborne Radiometric Survey
A. Mag	Airborne Magnetic Survey

PERMIT #	COMPANY	DATE ISSUED & REMARKS
69	R. H. King	1969 Geo - August, 1969. A.R.S., A. Mag. Geol. report by W.B. Gallup - only Athabasca Formation detritus.
* 73	Pacific Silver Mines and Oil Ltd.,	1969 August 25 to 30, 1969 prospecting and geological reconnaissance, 2 outcrops located in Athabasca Sandstone. 1970 MacKenzie, Angus followed up his 1969 work and a scintillometer survey - some "highs" present. 1971 Ground scintillometer and magnetometer recommends 4 hole drill program 4 x 400 feet.
74	Ft. Reliance Ltd., +Ensign Oils Ltd.,	1969 Geo - September, 1969 A.R.S. Geological report by P.E. Hirst - less than 200 feet relief, swamp, sand, one outcrop spotted by helicopter reconnaissance.
82, 83 84, 85	National Nickel	Memorandum report on Photogeologic interpretation of the old Fort River Area, Alberta prepared by V. Zay Smith. - May, 1969 optioned 50% to Bow Valley Industries - Bow Valley Industries had Geo X Survey do A.S.S. - December, 1969 - Bow Valley Industries dropped option. - February, 1970 - Pioneer Exploration of Calgary was assigned a 50% interest.

PERMIT #	COMPANY	DATE ISSUED & REMARKS
	Geo X	- survey September, 1969 - 4 channel spectrometer - N-S flight lines - no interpretation - survey of little value.
	Velocity Surveys	- report on Aeromagnetic interpretation by R. G. Agarwal - little value.
	Meyers & Paulson	- report - June 25, 1970. - ground check - scintillometer and prospecting - Bloom test - geochemistry - only I outcrop - see map - red massive coarse grained micaceous sandstone. - 2 - 2 man parties.
87, 88	McIntyre Mines	1969 - Geo - Flew A. Mag and A.R.S.
89	Canada Southern Petroleum	1959 - A.S.S. - October 8, 1968 - hand held Precision Model 117 B scintillometer - 325 line miles N-S. - ¼ mile lines. - no outcrops or boulders. - also photogeological mapping report by Geophoto - July, 1969. - Muskeg, glacial outwash, recessional ridges, moraines.
93 to 102	Anco Exploration Ltd.,	1968 A.E.M., Airborne Mag and gamma ray spectrometer survey by Canadian Aero report by R. W. Stemp. - ¼ mile flight lines - 2796.5 line miles - Survey dated September 15 to 18, 1969 - very doubtful EM conductors - weak uranium anomalies 1½ x B.G. - Stemp recommended follow-up to airborne uranium anomalies. - NW-SE flight lines.
103	North Canadian Oils Ltd.,	1969 A.R.S. - 750 feet E-W - Helicopter borne.
109, 110	Ledo Mines	1969 - report by Abcon Engineering and W. J. Blackstock.

PERMIT #	COMPANY	DATE ISSUED & REMARKS
		- preliminary appraisal of uranium potential of permits 109, 110. - negative report.
117, 118	Radex Minerals Ltd.,	1969 Proposal by Trigg - February, 1969 for the Marguerite River Area. Archaean sediments and intrusives. - September to October, 1969 Seigel Associates Ltd., A.S.S. - 1,230 miles - nine anomalies - N-S at 660 feet spacing. - interpretation report of above by Norman Paterson - he mentions zones 1 and 2 as the most interest.
120	R. H. King	1969 - letter by Gallup - says little.
*185, 186, 187	Eldorado Nuclear Ltd.,	1974 - prospecting, airborne radiometric survey (rumoured).

TOPOGRAPHY AND DRAINAGE

Relief in the area is variable, generally low with ridges and hills of moraine locally providing up to 300 feet of relief. Regional drainage is north and west with rivers draining into either the Athabasca River or Lake Athabasca. In the south, lakes are plentiful and shallow, 10 to 15 feet maximum depth. Swamps commonly found bordering lakes in the southern permits are grass covered and generally dry by late summer. This southern area is poorly drained with a high water table. In the northern permits the few lakes are 20 to 45 feet deep filling kettle holes in the overburden. The steep high banks of the Keane Creek indicate that the water table is 20 to 40 feet below the ground surface.

REGIONAL GEOLOGY

The northeast corner of Alberta is occupied by 6,000 square miles of the Canadian Shield, consisting of a complex of igneous, metamorphic and sedimentary rocks ranging in age from 1.7 to 2.3 billion years and forming part of the Churchill Structural Province.

South of Lake Athabasca lie rocks of the Athabasca Formation within the Athabasca intracratonic basin. This Formation covers an area of 40,000 square miles mainly in Saskatchewan and reaches a thickness of 6,000 feet. However, approximately 1,200 square miles of this Athabasca Sandstone occurs in Alberta and appears on islands in Lake Athabasca as well as small peninsula's located as Shelter Point and Fidler Point on the north shore of Lake Athabasca.

The Athabasca Formation is considered to belong to the Paleohelikian Era (1.3 - 1.7 billion years).

LOCAL GEOLOGY

The pervasive cover of glacial overburden masks the bedrock geology of the western margin of the Athabasca basin. No bedrock outcroppings were found in the permit areas. Prior to examination of the area in the field it was thought that gross changes in the style of the unconsolidated glacial debris, evident in air photographs, reflected a change in the underlying bedrock. The contact between the Athabasca Formation and the granitic plutonic rocks to the west was interpreted to underlie the Norcen permits. Information gathered in the field indicates that this model is too simple and the margin of the Athabasca Formation is less regular than originally thought.

Granitic Plutonic Rocks

Granitic plutonic rocks in northeastern Alberta can be divided into two types, highly deformed granitic gneiss containing metasedimentary xenoliths and massive leucocratic equigranular to porphyroblastic granite to granodiorite. Schistosity and foliation are well developed in most units indicating a north-northwest structural trend. These rocks are thought to be of Archean age and have undergone metamorphism and deformation during the Hudsonian Orogeny.

Athabasca Formation

The Formation consists of sandstone with some interbeds of conglomerate, and very minor shale and siltstone beds generally less than one foot thick. Grit and conglomerate beds total about two percent of the formation; shale and siltstone amount to less than one percent of the total section, cored at Rumple Lake, Saskatchewan in the centre of the Athabasca Basin.

About half the particles in the sandstones are coarse and very coarse sand. Interbedding of finer and coarser grained sand occurs throughout. Granules and pebbles are rare in the upper part but occur in considerable amounts in the lower part. Cobbles and boulders are lacking except locally in the basal few feet. Shale chip fragments are common throughout the basin and are mainly cream coloured but some are maroon. Locally they form an almost continuous pavement.

The most common colours are light buff, grey, white, cream and various combinations and mixtures of these. Light to dark purplish and pink, red and maroon are also common. Most reddish colours result from hematite staining and much of which cuts across primary stratification. Much of the hematite stain has been removed as a result of selective reduction.

Potash feldspar is present in negligible amounts and the sandstones are composed almost entirely of quartz with a little chert. The quartz is strongly undulose and strained quartz of metamorphic origin is more abundant than unstrained igneous quartz. Heavy minerals occur in very small amounts, and tourmaline and zircon are the only non-opaques occurring in significant amounts. Both are well rounded and the tourmaline grains typically exhibit clear authigenic overgrowths.

The pebbles, most of which are less than 2 cm. long, the largest being 6 to 7 cm., are composed mostly of quartz and chert, but some feldspar, granite, gneiss, quartzite and greenstone were identified in the basal part where cobbles and boulders occur.

Cross-bedding is the most prominent sedimentary structure and ripple marks are common. Many pebbles have a preferred orientation parallel with the direction of sediment transport shown by cross-bedding azimuths.

The Athabasca sedimentary rocks possess many features typical of fluviatile deposits such as: consistent and widespread cross-bedding; overturned cross-bedding; rain-prints; dessication cracks; shale chip fragments; poor sorting and strong textural lamination. The sediment, which was derived from the east and southeast with a minor contribution from the northeast, was probably deposited on a coastal plain onto which rivers converged towards the sea.

In the Black Lake area, the Athabasca sandstones are folded and faulted. Post-depositional basement adjustment tilted the strata and created dips as high as 25 degrees in parts of the basin. Diabase dykes cut the sandstone at a number of localities.

The Athabasca Formation rests with major unconformity on older rocks. At some points, probably depending on the composition of the Archaean rocks and local relief, a regolith is developed. Locally the Athabasca rests on intensely weathered gneiss, and at other localities it rests on Tazin quartzite, where a basal breccia of anular quartzite boulders occur while at other places only fine conglomerate and sandstone are found.

Fahrig (1961) concluded that because of the high degree of mineralogical maturity of the light and heavy mineral fractions, high degree of roundness, and presence of chert, that the Athabasca was a multicycle sediment derived from a largely sedimentary terrain.

Surficial Geology

All of the Norcen permits and most of the surrounding areas are covered by unconsolidated glacial, fluvial and lacustrine deposits ranging from a few to several hundred feet thick. Pleistocene glacial, glaciofluvial and glaciolacustrine deposts are, in part, overlain by recent aeolian and alluvial deposits. The glacial overburden was deposited from glaciers which moved into Alberta from the Northwest Territories (Keewatin Centre). The direction of ice movement associated with earlier glaciations are poorly preserved, there is evidence of a westerly advance north of Lake Athabasca (personal communication with J. D. Godfrey), but the South 30 degrees West orientation of the last glaciation is clearly preserved by drumlin and fluting directions. Although it is generally recognized that Alberta has been glaciated more than once, no buried soils or other evidence of a long period between glacial deposits have been found, consequently there has been little agreement among the various participating geologists on the age and correlation of the glacial deposits (Gravenor and Bayrock 1956).

The nature of the retreat was apparently one of large scale downwasting leading to stagnation, followed by rejuventation which resulted in small lobes or fingers being sent out from the main ice mass. From analysis of the fan shaped nature of the ice-movement directions in southern and central Alberta, in conjunction with the distribution of transverse elements, it can be suggested that the cycle of stagnation-rejuventation must have occurred many times during general retreat. Certain of the rejuvenations were of considerable magnitude and it is possible that these may correlate with known readvances in the Great Lakes region during the retreat of the classical Wisconsin ice (Gravenor, et al 1960).

Surficial geology maps on a scale 1:250,000 by L. A. Bayrock 1969, 1970 (formerly with the Research Council of Alberta) are available for the Norcen permit areas (N.T.S. 74 E-L). Since tills in the permit areas are both residual and transported, which of course has significant consequence during "boulder train" follow-up, L. Bayrock of Bayrock and Reimchen Surficial Geology Ltd. carried out a detailed (1:31,680) photo interpretation of the permit area (see enclosed maps). This study was followed up by a five-day field inspection by L. Bayrock and assistant G. Bihl in which tills and eskers of the permit areas were examined for criteria indicating their transport history. From this field examination, Lu Bayrock concluded, "It is indeed unfortunate that most of the Norcen permits in Alberta are underlain by thick and of distant origin outwash plains and end moraines. These effectively obscure the underlying topography and make the study of tracing of erratics to their source very difficult".

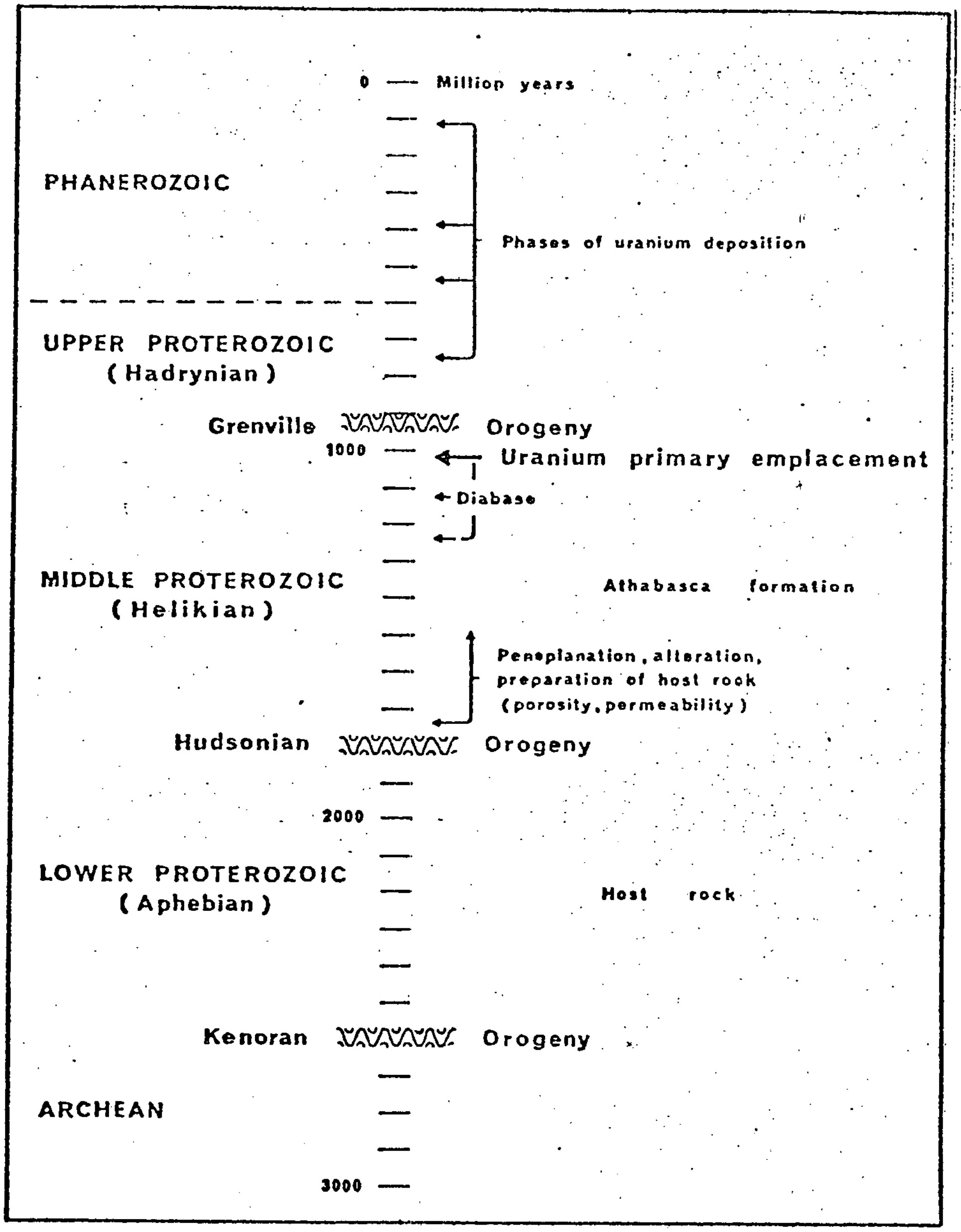

FIG. 2. Geological time frame for uranium emplacement at Rabbit Lake.

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STRUCTURAL GEOLOGY

The Athabasca Sandstone lies within a Paleohelikian intracratonic basin. Generally bedding dips very gently 3 degrees to 5 degrees towards the centre of the basin.

North of Lake Athabasca, rocks of the Tazin Group have been extensively and intensely folded, faulted and fractured.

South of Lake Athabasca structural trends become more obscure due to the extensive surficial cover. However a regional ERTS reconnaissance lineament analysis by Geophoto Services Ltd. (Scale 1:1,000,000) indicates two dominant lineament trends in the Athabasca Sandstone being northeast and northwest. A major lineament is discernible near the edge of the Athabasca Sandstone just south of Richardson Lake and trending northeast. This lineament is believed by some to be an extension of the Black Bay Fault in the Uranium City area. Aeromagnetic maps do not clearly indicate the extension of the Black Bay Fault to the south shore of Lake Athabasca.

Hobson and MacAulay interpret sharp changes in the direction of seismic refraction contours for the pre-Athabasca surface to be a series of lineaments reflecting a system of northeast trending grabens and horsts.

ORE CONTROLS

Both supergene and hypogene models of emplacement of the Rabbit, Cluff and Key Lakes uranium deposits are currently in vogue. Knipping (1974), Langford (1974) and other conclude that the supergene model is more probable although fluid inclusion studies of gangue minerals at Rabbit Lake indicating temperatures in the order of 200 degrees centigrate (Little 1974) suggest a hypogene source.

The authors believe that the supergene model is more likely, however the exploration target is the same for both models. This is to say the origin and direction of the solutions is of little importance, the salient point of both models is that uranium minerals are concentrated in the regolith immediately overlying the basement rocks or in permeable structure close to the unconformity.

Hypogene Model

1. Hydrothermal solutions containing uranium generated at great depths.
2. These solutions migrated upward until trapped beneath the Athabasca Formation.
3. Massive and colloform pitchblend deposited.
4. Supergene processes brought about deposition of sooty pitchblend.

Supergene Model

1. Uranium derived from granitic and/or metasedimentary source rocks on the perimeter of the Athabasca Sandstone Basin.

2. Uranium enters the ground water during an extended period of weathering of these source rocks.

3. The ground water enters the basin, percolates along channels in the unconformity between the porous Athabasca Formation and the underlying basement rocks.

4. Uranium is precipitated by reductants in suitable areas of ground preparation.

The Beaverlodge-Uranium City vein type deposits may occur south of Lake Athabasca and within the permit areas but the authors believe that the likelihood for this holding true is very remote and exploration for such deposits will be of secondary importance.

EXPLORATION

1. Research

N.W. Reynolds, former Great Plains mineral exploration manager, and D. Sawyer decided to acquire acreage in Alberta along the edge of the Athabasca Sandstone shortly before taking part in a C.I.M.M. sponsored field trip of the Rabbit Lake, Uranium City and Cluff Lake uranium deposits in September 1975.

A search of the Athabasca Sandstone edge in Saskatchewan revealed that almost all of this ground was under disposition as was the case in Alberta north of Lake Athabasca. South of Lake Athabasca practically all of the Sandstone edge was open ground. Only Eldorado Nuclear Ltd., occupied Quartz Mineral Permits 183, 184, 185 which covered a small portion of the edge.

Previous assessment work for the south Lake Athabasca area was examined by the author in Edmonton at the Research Council of Alberta. Results of this examination revealed the area was flown with various airborne radiometric systems in 1969-1970 but almost no ground follow-up was done (see previous work).

Six mineral permits were filed for on September 10th, 1975. The permit areas were selected to coincide with the Athabasca Sandstone - undivided plutonic rock contact and some selected airborne radiometric anomalies determined from previous surveys.

2. Determination of Athabasca Sandstone Edge

Due to the lack of outcrop owing to the extensive nature of the surficial deposits, the contact between the undivided plutonic rocks and the Athabasca Sandstone as shown on Research Council of Alberta "Bedrock Geology of Northern Alberta, 1970" is inferred and not defined.

(a) Aeromagnetic Data

The edge of the Athabasca Sandstone is not readily discernible on the basis of the standard aeromagnetic maps.

(b) Seismic Survey Data

A seismic reconnaissance survey was performed over the Athabasca Sandstone in 1963 and 1968. (see A Seismic Reconnaissance Survey of the Athabasca Formation, Alberta and Saskatchewan, (Part of 74) by Hobson and MacAulay, 1969, G.S.C. Paper 69-18). This seismic survey resulted in four calculations for the thickness of the Athabasca Formation at four localities in Alberta as follows:

1.	Old Fort Bay Twp. 111, Rge. 3, W4	171 feet
2.	Old Fort Bay Twp. 106, Rge. 3, W4	770 feet
3.	Old Fort Bay Twp. 106, Rge. 1, W4	108 feet
4.	Old Fort Bay Twp. 104, Rge. 1, W4	118 feet

3. Scintillometer Survey and Prospecting Method

A combined prospecting and scintillometer survey was conducted over selected areas of the permit. Selected areas included areas of high uranium background responses from the lake sediment geochemistry, areas of near travelled glacial cover and all major boulder fields within the permit. The method of survey could best be described as prospecting using hand held (McPhar TV-l) scintillometer to point out areas and boulders which emit above background levels of gama radiation. The McPhar TV-l scintillometer is a light (3 pounds) three channel integral type scintillometer with a linear visual meter and an audio buzzer. For further information, see Appendix #5. These scintillometers proved to be sufficiently sensitive to locate both surface and near surface granite boulders and other gamma ray emitting sources such as a buried thorium bearing conglomerate boulder and soils with a high clay contact.

In addition to using the scintillometer to detect sources of gamma radiation, the geologist would identify and make notes on any unusual boulders encountered on the traverse. The traverse areas were first circled at a minimum height and speed with the helicopter to outline glacial features and boulder trains to be checked out on the ground. On the ground air photos at a scale of l to 37,000 provided enough detail to navigate and outline tographical and surficial features. The area covered per day was variable depending on the type of glacial cover, the variability in composition of the boulders and the number of boulders. In an area of sand and outwash a two-man team could cover several square miles per day, while an area of ground moraine, eskers or crevasse fillings would limit two geologists to less than a square mile in a day's work. A total in excess of 320 man days were spent on ground traverses, with the bulk of the time spent on the southern permits where boulder fields and near travelled overburden provide a good indication of the underlying bedrock. In the north large areas of thick sand and gravel glacial outwash do not lend themselves to this type of prospecting.

Results

In general the composition of the moraines, tills, outwash, eskers and crevasse fillings were dominantly composed of various sizes and colours of Athabasca Sandstone fragments. Pebbles, cobbles and boulders of other than sandstone were rare except for terminal moraines and esker crevasse filling complexes which contain far travelled material. In these areas, several percent erratic pebbles, cobbles and boulders were encountered; they include, in order of decreasing abundance, felsic granitic, intermediate granitic, mafic volcanics, diabase, dolomite, mylonite, regolith, conglomerate and felsic volcanics. In most areas these erratic boulders constitute one or two percent of the boulder population. Northwest of the Keane Tower, several ridges of terminal moraine contain pockets of granite boulders of similar composition up to 8 feet in diameter.

These granites are pink to buff, hypidiomorphic, porphyritic containing 5 to 10 percent biotite and up to 30 percent K-Spar phenocrysts. Scintillometer readings over these boulders were recorded as high as T1 = 35,000 c.p.m., T2 = 1,500 c.p.m., T3 = 350 c.p.m., which according to the McPhar Quantitive Evaluation (see appendix 5) is equivalent to 50 p.p.m. U308 and 200 p.p.m. Th02. Fluorimetric analysis from a chip sample of one of these boulders yielded 42 p.p.m. U308 and 100 p.p.m. Th02 (see appendix 4). Pebble counts in this area similarly contain 10 to 30 percent granitic clasts. These granite pebbles and boulders occur on the hummocky ridges of a terminal moraine with local relief up to 200 feet. Glacial deposits of this type travel within and on top of the ice and are therefore not of local origin. Ice directions indicated by drumlin orientations to the south indicate that these granite are located directly down ice from the Carswell Dome located 25 miles to the northeast.

Several subtle scintillometer anomalies of 1 1/4 to 2 times background were encountered in areas of sand outwash. Digging down into the sand often did not indicate the source of the anomaly nor did the scintillometer count increase with depth, however in some instances a fine clay within the sand appeared to be the source of this type of anomaly.

A radioactive conglomerate boulder was found with a scintillometer approximately 50 feet north of a small unnamed lake (latitude 59 degrees, 0.5 minutes North and longitude 110 degrees, 9 minutes West) seven miles west of Archer Lake on permit 208. This 18 inch diameter hematite stained pebble conglomerate was found 6 inches below the surface along a ridge formed by a crevasse filling. Scintillometer readings over the conglomerate boulder after it had been uncovered were T1 = 25,000 c.p.m., T2 = 1,000 c.p.m., T3 = 350 c.p.m. Three assays of the boulder range from 5.2 to 6.2 p.p.m. U308, .031% to .042% Th02 12 p.p.m. Cu, 30 to 32 p.p.m. Ni, 2 p.p.m. Mo.

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In a detailed search of the surrounding area, no other conglomerate boulders were found. The surrounding boulders were mainly Athabasca Sandstone types with an estimated 1 percent erratic types including in order of abundance, massive granite, gneissic granite, diabase and mylonite.

Sandstone clasts in the overburden were found to have a very monotonous similarity; generally grey to buff, massive, medium grained and featureless. Cross-bedding, graded bedding, colour banding and colour variations were observed but these cobbles and boulders were subordinate to the grey massive sandstone. Boulders on the western margin of the permit in the Archer Lake area differed from the norm in that most of the boulders were dark red to maroon in colour.

A unique feature found in large boulders along the eastern boundary of the permit was a dark oil stain which appeared to mark channel ways where solutions had percolated through the porous sandstone. This bituminous material in Athabasca Sandstone boulders indicates that the heavy oils from the Tar Sands extended further north and overlapped onto the Precambrian Shield.

Geochemical Survey - Method

Lake bottom samples were collected from lake centres using a "Hornbrook" sampler. This torpedo shaped sampler has a simple ball valve which traps the silty or jelly like ooze allowing it to be pulled up to the surface for retrieval. Success rate was high with problems developing in lakes with a sand gravel or grass bottom. In these lakes the sampler bounced off the bottom with insuffícent penetration to retrieve a sample. Initially samples were collected at an average density of one per square mile with a higher distribution in the south where there is an abundance of lakes. The paucity of lakes and the pervasive sand cover in the northern permits provided less than adequate coverage by this method or any other type of geochemical survey.

A "Bell Jet Ranger" helicopter equipped with floats was used for sample collection. The removal of the back door and a platform on the float facilitated rapid retrieval of the samples by the collector seated in the rear of the helicopter. The navigator in the front spotted locations labeled the sample bags and recorded data at the sample site. At each site the following parameters were recorded on 5" x 7" data cards; (1) location, (2) water colour, (3) sample colour, (4) depth of lake at sample site, (5) pH, (6) unusual features (sample odour, texture, organic content, etc. The rate of sampling averaged 12 to 20 samples per hour with the slower rate occurring in the northern areas where lakes were few and sample recovery was poor.

HISTOGRAM OF LAKE SEDIMENT URANIUM VALUES IN NORCEN QUARTZ MINERAL PERMITS

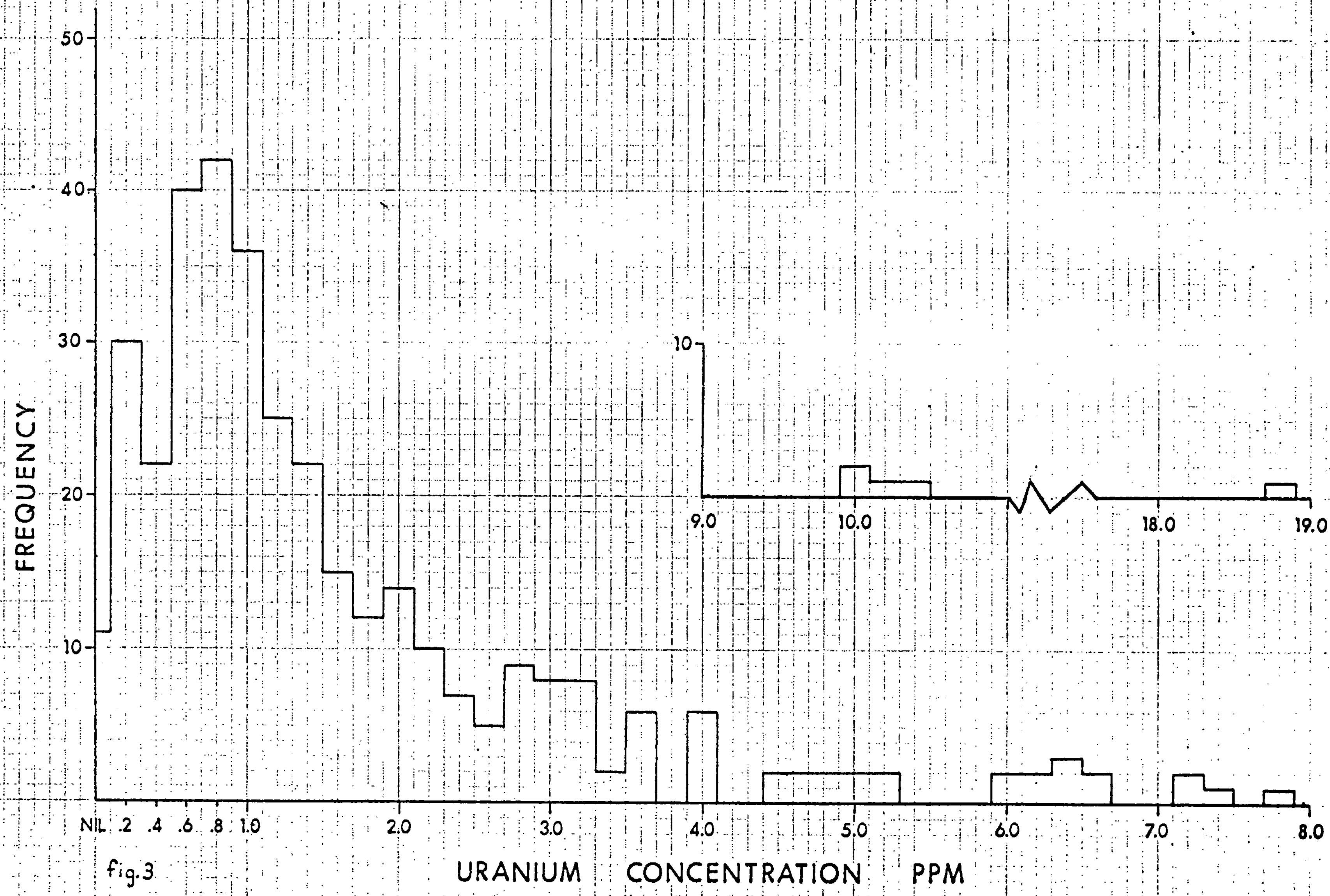

fig.3

19760008

CUMULATIVE FREQUENCY DISTRIBUTION OF LAKE SEDIMENT URANIUM SAMPLES NORTHEASTERN ALBERTA

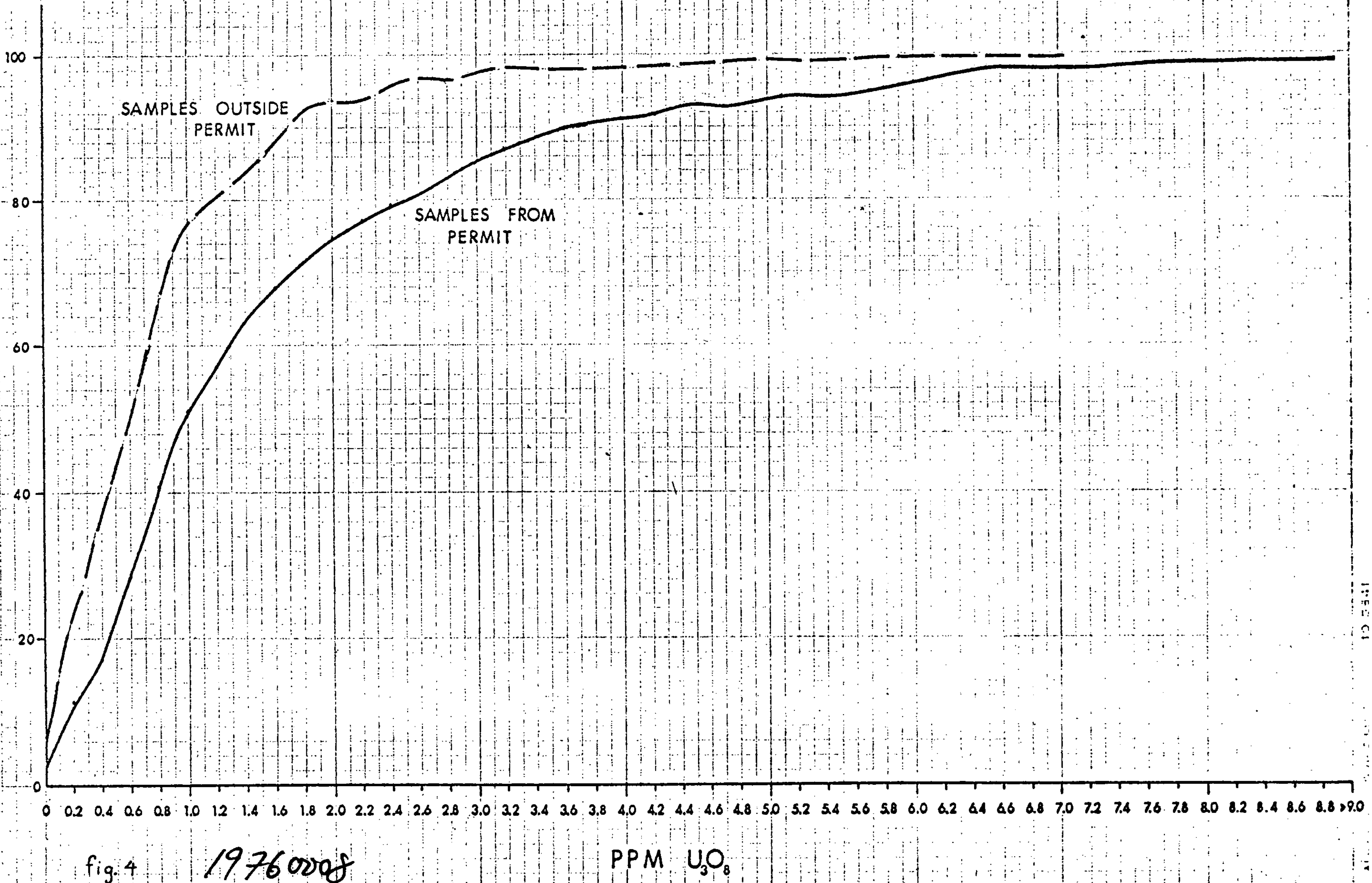

fig. 4 1976008

19c.

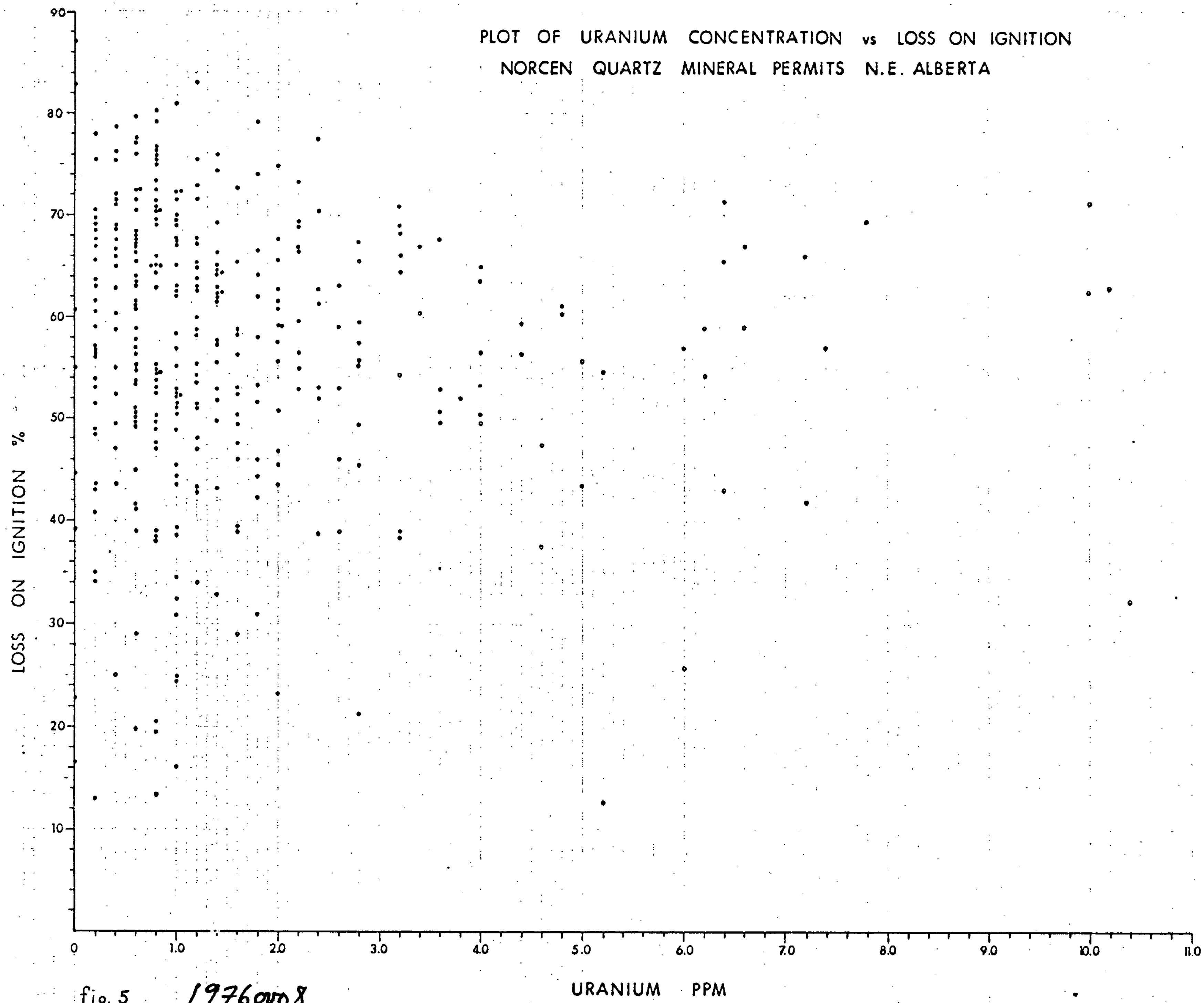

fig. 5 19760008

Samples were collected in plastic bags then split and transferred to "Kraft" paper bags, then hung to dry. One sample was sent to Loring Laboratories in Calgary for analysis and the other kept for reference. At the laboratory the samples were dried out further and sieved to minus 80 mesh for analysis. Uranium concentrations were determined by fluorimetry and organic content calculated on loss on ignition. The total lapse time from sampling to receiving analytical results ranged from two weeks to a month.

Results of the initial survey indicated several weak to moderate anomalies with most of the anomalous values occurring in two large areas. Geochemical follow-up of anomalous areas included taking several samples from the anomalous lake and saturation coverage of the surrounding lakes and marshes. Where the "Hornbrook" sampler was unable to collect a sample from the marshes, a hand auger was used to penetrate the organic mat on the bottom of the swamp and collect a sample from the underlying silt. In addition to the geochemical follow-up of anomalous lakes, the areas surrounding these lakes were checked out on the ground with ground scintillometer. The amount of time spent on ground scintillometer follow-up varied with the type of overburden. Those areas covered with thick sand outwash receiving less time than areas of near travelled ground moraine.

In general, the method of sampling was quite successful. The only change in the method for future considerations would include some type of oven for faster drying of the samples in the field. A drying oven would cut down turn around time for the results by as much as a week.

Results

In general the lake sediment uranium values indicate the area surveyed has a low background with moderate to weak anomalies (arithmetic mean 1.6 ppm, geometric mean 1.0 ppm, 90 percentile less than 3.6 ppm, 94 percentile less than 5.0 ppm., range nil to 18.8 ppm. It is thought that these weak anomalies (values greater than 5 ppm) probably reflect local changes in the bedrock and/or the surrounding overburden. An attempt to correlate uranium concentration to organic content Fig. 5) indicates that in this area organic matter does not act as a scavenger. There also does not appear to be any direct correlation between uranium concentration and sample colour, or depth of lake at sample site or pH. The large anomalous area west of the Keane fire tower occurs in an area of thick terminal moraine with local relief in excess of 150 feet. Here large granite boulders, probably originating from the Carswell Dome to the east, are locally abundant and presumably are the source of the anomaly. In other areas ground prospecting with a scintillometer in the area surrounding anomalous lakes did not indicate the source of the uranium. When anomalous lakes and the surrounding lakes were resampled, the uranium values were the same as the original or slightly lower.

In a similar reconnaissance Geochemical Survey conducted by C. E. Dunn of the Saskatchewan Geological Survey in an area surrounding the Gulf Minerals Rabbit Lake Deposit, geochemical anomalies in the vicinity of the mine were in excess of 1,000 p.p.m. uranium. Background values of 1 to 2 p.p.m. were characterisitic of lakes on the Athabasca Formation and 3 to 4 p.p.m. uranium for lakes on the crystalline basement. In the lake sediment survey of the Great Plains permits, local changes in background appear to reflect local changes in the surficial deposits rather than a change in the underlying formations.

Since the permit is assumed to straddle the sandstone granite basement contact, one would expect that the lakes on the western edge of the permit to have higher uranium values than those to the east. No such correlation was found. Thus one must conclude either that the permit boundary is further to the west or that the overburden is sufficiently thick to mask any bedrock lithological variations.

CONCLUSIONS

Most of the Great Plains quartz mineral exploration permits in northeastern Alberta are underlain by thick and distant origin outwash plains and moraines. These effectively obscure the underlying topography and make the study of tracing of erratics to their source very difficult. In several locations along the western boundary of the permit, large angular boulders, which appear to have travelled a short distance, less than a mile, indicate that the Athabasca Formation extends further to the west than originally assumed.

One large boulder field located 5 miles west of Archer Lake contained large angular Athabasca Sandstone boulders within ground moraine. These boulders appear to have been overriden by the glacier and therefore represent near source material. Thus at this location, the western extent of the Athabasca Formation is at least 5 miles west of where we originally assumed the contact to be.

The radioactive response of the Athabasca Sandstone boulders examined while prospecting with scintillometers was uniformly low, variations noted seldom exceeded one-fifth of the background value. It would appear from this that these sandstone boulders are sufficiently above the Athabasca Formation - basement unconformity to have been affected by postulated aqueous solutions moving along the unconformity.

The geochemical survey did not pick up any anomalies which could be related to a uranium deposit. Geochemical highs occur in areas of end moraine, crevasse filling or outwash from end moraines. These weak anomalies reflect the presence of far travelled felsic rocks in the overburden rather than mineralization in the underlying bedrock.

There is no increase in background from east to west across the margin of the basin as one should expect when moving from an area of sandstone bedrock to felsic intrusive rocks. This may indicate that the glacial cover is too thick for the geochemistry to reflect changes in the underlying rock.

In October, while in Edmonton checking assessment files, I was talking with John Godfrey of the Research Council of Alberta. He mentioned that the Athabasca Sandstone can be found forming shallow reefs in Lake Athabasca just south of Fort Chipewyan. The presence of these sandstones, at least 10 miles west of the assumed western boundary of the Athabasca Formation, indicates that this boundary is much further west than previously thought.

It would appear from the information gathered during this past field season that future exploration should be extended to the west of the present Great Plains permits. I feel that the area south of Richardson Lake and along the Richardson River has the greatest potential.

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APPENDIX 1

QUARTZ MINERAL PERMIT DESCRIPTIONS

BRS.

SCHEDULE
to Quartz Mineral Exploration Permit No. 208

IN TOWNSHIP ONE HUNDRED AND THREE (103), RANGE ONE (1), WEST OF THE FOURTH (4) MERIDIAN:

Sections Twenty-five (25) and Twenty-six (26) and Sections Thirty-three (33) to Thirty-six (36) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND FOUR (104), RANGE ONE (1), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1) to Twenty-four (24) inclusive and Sections Twenty-six (26) to Thirty-four (34) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND FIVE (105), RANGE ONE (1), WEST OF THE FOURTH (4) MERIDIAN:

Sections Four (4) to Nine (9) inclusive and Sections Sixteen (16), Seventeen (17) and Eighteen (18);

AND

IN TOWNSHIP ONE HUNDRED AND FOUR (104), RANGE TWO (2), WEST OF THE FOURTH (4) MERIDIAN:

Sections Eleven (11) to Fifteen (15) inclusive, Sections Twenty (20) to Twenty-nine (29) inclusive and Sections Thirty-two (32) to Thirty-six (36) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND FIVE (105), RANGE TWO (2), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1) to Five (5) inclusive and Sections Eight (8) to Twelve (12) inclusive;

containing an area of Forty-nine Thousand, Nine Hundred and Twenty (49,920) acres, more or less.

[redacted]

File No. 175972

SCHEDULE
to Quartz Mineral Exploration Permit No. 209

IN TOWNSHIP ONE HUNDRED AND FIVE (105), RANGE ONE (1), WEST OF THE FOURTH (4) MERIDIAN:

Sections Nineteen (19) to Twenty-three (23) inclusive and Sections Twenty-six (26) to Thirty-four (34) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND SIX (106), RANGE ONE (1), WEST OF THE FOURTH (4) MERIDIAN:

Sections Three (3) and Four (4);

AND

IN TOWNSHIP ONE HUNDRED AND FIVE ('05), RANGE TWO (2), WEST OF THE FOURTH (4) MERIDIAN:

Sections Thirteen (13) to Thirty-six (36) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND FIVE (105), RANGE THREE (3), WEST OF THE FOURTH (4) MERIDIAN:

Sections Twenty-four (24), Twenty-five (25), Twenty-six (26), Thirty-four (34), Thirty-five (35) and Thirty-six (36);

containing an area of Twenty-nine Thousand, Four Hundred and Forty (29,440) acres, more or less.

[redacted]

File No. 173973

BBr.

SCHEDULE
to Quartz Mineral Exploration Permit No. 210

IN TOWNSHIP ONE HUNDRED AND SEVEN (107), RANGE ONE (1), WEST OF THE FOURTH (4) MERIDIAN:

Sections Six (6), Seven (7) and Eighteen (18);

AND

IN TOWNSHIP ONE HUNDRED AND SIX (106), RANGE TWO (2), WEST OF THE FOURTH (4) MERIDIAN:

Sections Seven (7) and Eighteen (18) and Sections Thirty (30) to Thirty-four (34) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND SEVEN (107), RANGE TWO (2), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1) to Eighteen (18) inclusive, Sections Twenty (20) to Twenty-four (24) inclusive, Sections Twenty-six (26) to Twenty-nine (29) inclusive and Sections Thirty-three (33), Thirty-four (34) and Thirty-five (35);

AND

IN TOWNSHIP ONE HUNDRED AND SIX (106), RANGE THREE (3), WEST OF THE FOURTH (4) MERIDIAN:

Sections Two (2) and Three (3), Sections Ten (10) to Sixteen (16) inclusive and Sections Twenty (20) to Thirty-six (36) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND SEVEN (107), RANGE THREE (3), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1) to Four (4) inclusive and Sections Nine (9) to Fifteen (15) inclusive;

AND

BBS.

SCHEDULE (continued)
to Quartz Mineral Exploration Permit No. 210

IN TOWNSHIP ONE HUNDRED AND SIX (106), RANGE FOUR (4), WEST OF THE FOURTH (4) MERIDIAN:

Section Thirty-six (36);

containing an area of Forty-nine Thousand, Nine Hundred and Twenty (49,920) acres, more or less.

[redacted]

SCHEDULE
to Quartz Mineral Exploration Permit No. 211

IN TOWNSHIP ONE HUNDRED AND SEVEN (107), RANGE THREE (3), WEST OF THE FOURTH (4) MERIDIAN:

Sections Five (5) to Eight (8) inclusive and Sections Sixteen (16) to Twenty (20) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND SEVEN (107), RANGE FOUR (4), WEST OF THE FOURTH (4) MERIDIAN:

Section One (1), Sections Ten (10) to Fifteen (15) inclusive and Sections Nineteen (19) to Thirty-six (36) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND EIGHT (108), RANGE FOUR (4), WEST OF THE FOURTH (4) MERIDIAN:

Sections Two (2) to Ten (10) inclusive and Sections Fifteen (15) to Twenty-two (22) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND SEVEN (107), RANGE FIVE (5), WEST OF THE FOURTH (4) MERIDIAN:

Sections Twenty-three (23) to Twenty-six (26) inclusive and Sections Thirty-four (34), Thirty-five (35) and Thirty-six (36);

AND

IN TOWNSHIP ONE HUNDRED AND EIGHT (108), RANGE FIVE (5), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1), Two (2) and Three (3), Sections Nine (9) to Sixteen (16) inclusive, Sections Twenty (20) to Twenty-four (24) inclusive and Sections Twenty-seven (27) to Thirty (30) inclusive;

containing an area of Forty-nine Thousand, Nine Hundred and Twenty (49,920) acres, more or less.

[redacted]

SCHEDULE
to Quartz Mineral Exploration Permit No. 212

IN TOWNSHIP ONE HUNDRED AND NINE (109), RANGE THREE (3), WEST OF THE FOURTH (4) MERIDIAN:

Sections Five (5) to Eight (8) inclusive,
Sections Seventeen (17) to Twenty (20)
inclusive and Section Thirty (30);

AND

IN TOWNSHIP ONE HUNDRED AND EIGHT (108), RANGE FOUR (4), WEST OF THE FOURTH (4) MERIDIAN:

Sections Twenty-six (26) to Thirty-five (35)
inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND NINE (109), RANGE FOUR (4), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1) to Thirty-three (33) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND EIGHT (108), RANGE FIVE (5), WEST OF THE FOURTH (4) MERIDIAN:

Sections Twenty-five (25) and Twenty-six (26)
and Sections Thirty-one (31) to Thirty-six
(36) inclusive;

AND

IN TOWNSHIP ONE HUNDRED AND NINE (109), RANGE FIVE (5), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1) to Seventeen (17) inclusive and
the South half and North East quarter of Section
Eighteen (18) and that portion of the North West
quarter of Section Eighteen (18) lying outside
Indian Reserve No. 201;

containing an area of Forty-nine Thousand, Nine Hundred and Eighteen (49,918) acres, more or less.

[redacted]

File No. 173976

BB.

SCHEDULE
to Quartz Mineral Exploration Permit No. 213

IN TOWNSHIP ONE HUNDRED AND NINE (109), RANGE FIVE (5), WEST OF THE FOURTH (4) MERIDIAN:

The South half and North East quarter of Section Twenty (20), Sections Twenty-one (21) to Twenty-eight (28) inclusive, the East half of Section Twenty-nine (29), the South East quarter of Section Thirty-two (32), the South half and North East quarter of Section Thirty-three (33) and Sections Thirty-four (34), Thirty-five (35) and Thirty-six (36) and those portions of the South half and North East quarter of Section Nineteen (19), the North West quarter of Section Twenty (20), the West half of Section Twenty-nine (29), the North East quarter and the South West quarter of Section Thirty-two (32) and the North West quarter of Section Thirty-three (33) lying to the South and East of the right bank of the Athabasca River;

AND

IN TOWNSHIP ONE HUNDRED AND TEN (110), RANGE FIVE (5), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1), Two (2) and Three (3), Sections Ten (10) to Fifteen (15) inclusive, Sections Twenty-two (22) to Twenty-seven (27) inclusive, the North half and South East quarter of Section Thirty-three (33) and Sections Thirty-four (34), Thirty-five (35) and Thirty-six (36) and those portions of Section Four (4), the East halves of Sections Nine (9) and Sixteen (16), Section Twenty-one (21), the North half and South East quarter of Section Twenty-eight (28), the North East quarter of Section Thirty-two (32) and the South West quarter of Section Thirty-three (33) lying to the East of the right bank of the Athabasca River; Excepting out of the South West quarter of Section Thirty-three (33), Indian Reserve No. 201-B;

AND

SCHEDULE (continued)
to Quartz Mineral Exploration Permit No. 213

IN TOWNSHIP ONE HUNDRED AND ELEVEN (111), RANGE FIVE (5), WEST OF THE FOURTH (4) MERIDIAN:

Sections One (1), Two (2) and Three (3), the East half of Section Four (4), the South East quarter of Section Nine (9), Section Ten (10), the South half and North West quarter of Section Eleven (11) and the South half of Section Twelve (12), those portions of the West half of Section Four (4) and the North East quarter of Section Five (5) lying to the East of the right bank of the Athabasca River and those portions of the South East quarter of Section Eight (8) and the North half and South West quarter of Section Nine (9) not covered by Lake Athabasca;

containing an area of Twenty-six Thousand, Nine Hundred and Fifty-four (26,954) acres, more or less.

[redacted]

APPENDIX 2

PERMIT REGULATIONS SUMMARY

PERMIT REGULATIONS SUMMARY

The following is a brief summary of the more salient features regarding quartz mineral permits. For a complete list of the regulations the reader is referred to Quartz Mining Regulations under The Mines and Mineral Act, 1962, Alberta Regulations 377/67 (as amended by Alberta Regulation 397/68).

1. Each application for a permit must include
   (a) a fee of $125.00
   (b) a deposit of $1,000.00
   for each ten thousand acres or portion thereof.

2. A permit cannot exceed 50,000 acres.

3. Length cannot exceed three times average width.

4. Lands applied for must be described by section, township, range and meridian.

5. A plan detailing the nature of the examination of the intended permit must be sent to the Mining Recorder within twenty (20) days from the date of application.

6. Permits are granted for one year terms from the date of the permit, renewable for a second term of one year upon payment of 10 cents per acre and renewable for a third term of one year upon payment of 15 cents an acre.

7. The permittee may surrender at any time or from time to time any part of the location.

8. The deposit will be refunded upon the termination of the permit if the permittee has complied with the terms and conditions thereof.

9. When the permit terminates, the permittee must submit to the Mining Recorder a report including maps showing the factual data obtained in the examination.

A permit cannot be held for more than three years. Prior to the termination of a permit, the permittee has the right to apply for a lease of quartz minerals. The term of a lease is twenty-one (21) years renewable for further 21 year terms if quartz minerals are being produced. Where a lease is acquired out of a permit the annual rental of the lease payable yearly in advance is:

(a) twenty-five (25) cents per acre for the first five years.
(b) one dollar an acre for the balance of the term and any renewal thereof.

APPENDIX 3

DESCRIPTIONS OF BEAVERLODGE DISTRICT, RABBIT LAKE, CLUFF LAKE AND KEY LAKE.

URANIUM DEPOSITS

DESCRIPTIONS OF BEAVERLODGE DISTRICT, RABBIT LAKE, CLUFF LAKE AND KEY LAKE

Brief descriptions of the Beaverlodge district, Rabbit Lake orebody, and the Cluff Lake and Key Lake deposits are mentioned.

Beaverlodge District

Located on the north side of Lake Athabasca this area is underlain by highly metamorphosed sedimentary and volcanic rocks of the Archean or Aphebian Tazin Group, granitic gneiss and granite, and the Paleohelikian Martin and Athabasca Formations, Uranium deposits are controlled by regional and local structures and by lithology. Pitchblende deposits lie along northeasterly trending faults. Most deposits are mineralogically simple but some are more complex.

Production from Eldorado Nuclear Ltd's Ace-Verna mine began in 1953 The mill can handle 2,200 tons per day and ore usually averages 3 to 4 pounds U3O8 per ton. Orebodies are in Tazin rocks along the St. Louis Fault. The Ace ore is in brecciated feldspathic rock cemented by pitchblende, quartz, calcite and chlorite.

The Verna ores are in groups of veins in argillite 350 feet from the fault.

Ore reserves are presently expected to last for 10 to 14 years. Much mill feed is presently being mined from small open pit uranium deposits.

The Ace-Verna ores are probably of a deep seated hypogene origin which have undergone various remobilizations. Some however maintain these ores are supergene in origin.

Rabbit Lake

Gulf Minerals Canada Ltd., announced the Rabbit Lake discovery in December 1968. Ground checking of airborne radiometric anomalies resulted in the discovery of uraniferous boulders which were later traced to source. Uranium occurs in rocks of the Wollaston Lake Fold Belt immediately below the Athabasca Formation. Pitchblende occurs in a brecciated meta dolomite along a northeast trending synform. Minor amounts of pyrite and marcasite are present.

Feasibility studies were originally calculated on the basis of 25,000 tons of U3O8. However the author understands that this figure can be tripled to 75,000 tons. Two other deposits are rumoured in the immediate area and this 75,000 ton figure probably includes these two additional deposits. Initial grades were reported to be 14 pounds U3O8 per ton, but the latest figures estimate grade at 8 pounds per ton.

A supergene origin is currently in vogue for the Rabbit Lake ore.

Rabbit Lake is presently on stream.

Cluff Lake

Amok Ltd., formerly Mokta (Canada) Ltd., discovered uraniferous boulders in 1968 as a result of following up an airborne radiometric survey which led to the discovery of three ore bodies within the Carswell Dome structure within the Athabasca basin.

The Carswell Dome consists of a circular core of Aphebian and Archean age metamorphic rocks 12 miles in diameter surrounded by Athabasca Formation an annular ring of dolomites (Carswell Formation) and siltstones, sandstones (Douglas Formation).

The three ore bodies located to date are called "D" "N" and Claude and contain a combined figure of 24,000 tons of U3O8. Production is scheduled for 1978.

"D" Orebody

These Cluff Lake orebodies are thought to basically entail a supergene origin with probable latter remobilization.

Uraninite, pitchblende, claustalite, coffinite occurs in graphitic pelites along with minor selenium, cobalt, bismuth, sphalerite, chalcopyrite, pyrite, galena and antive gold. This ore body occurs along the basement - Athabasca Formation unconformity.

The orebody is 450 feet x 60 feet x 150 feet with approximate grades of 10% to 13% U3O8. Gold has been reported to average better than 1 oz/ton throughout much of the orebody. About 5,000 tons of U3O8 have been calculated.

"N" Orebody

Pitchblende and coffinite occur along shear zones within pelitic gneisses, quartz-feldspathic granulite and amphibolite gneiss. Accessory minerals include pyrite, marcasite, chalcopyrite and galena.

The orebody measures 3,500 feet x 450 feet x 300 feet and grades 0.5% to 1% U3O8. This orebody is credited with an airborne radiometric anomaly. A significant anomaly occurs just south of the pit.

Claude Orebody

Uraninite and coffinite occur in shear zones within the basement quartzite gneisses. Graphite, pyrite, marcasite, chalcopyrite, galena and molybdenite have been observed.

This orebody is 1,800 feet x 600 feet x 200 feet and the grade is lower than either "D" or "N" orebodies.

Key Lake

These deposits were announced by Uranerz, Inexco and the SMDC (Saskatchewan Mining Development Corporation) in August, 1975. Particulars are meagre to date but the uranium appears to occur within calc-silicate rocks of the Wollaston Lake Fold Belt close to the Athabasca Formation.

Unaniferous boulders bearing pitchblende were traced to sources.

As in the case of Rabbit Lake and Cluff Lake, a supergene genesis is suggested for this deposit.

Although at least two deposits have been found to date, most of the work has been concentrated on outlining Gaertner ore deposit.

The Key Lake deposits are covered by 50 to 80 feet of glacial overburden. They are located along the boundary between the Athabasca Sandstone and the crystalline basement.

Gaertner Orebody

This orebody, as outlined by surface drilling, is 4,140 feet long, 45 to 135 feet wide and ranges from 15 to 90 feet thick. A preliminary estimate of ore reserves by D. S. Robertson and Aossicates is reported as 500,000 metric tons containing 19.60 million kg (43.22 million pounds) and 16.34 million kg nickel (36.0 million pounds). The ore is reported to have an average grade of 3.9 percent U308.

Deilman Orebody

Initial drilling of the Deilman deposit indicates a length of at least 870 feet, width of 54 to 195 feet and a depth range of 16 to 99 feet. Indications are that the grade will be similar to that found on the Deilman Orebody.

APPENDIX 4

GEOCHEMICAL ASSAY CERTIFICATES

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
algary, Alberta T2P 2X7

ATTN: Norm Reynolds

File No. 11494
Date June 9, 1976
Samples Lake Sediments
PO # C3141
AFE 01 62401-340-017-014

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 1

SAMPLE No.	% L.O.I.	PPM U308
L-1-1	45.90	2.6
L-1-2	38.82	2.6
L-1-3	52.88	1.4
L-1-4	54.36	3.2
L-1-5	43.60	2.0
L-1-6	55.30	3.0
L-1-7	64.94	0.4
L-1-8	24.72	1.0
L-1-9	51.24	1.2
L-1-10	43.46	1.0
L-1-11	44.54	1.0
L-1-12	74.60	1.4
L-1-13	55.68	2.8
L-1-14	51.14	0.6
L-1-16	56.78	0.6
L-1-17	64.52	3.2
L-1-18	57.90	0.6
L-1-19	80.10	0.8
L-1-20	61.60	1.4
L-1-21	43.42	1.2
L-1-22	44.32	1.8
L-1-23	75.70	0.4
L-1-24	68.54	0.4
L-1-25	56.48	0.2
L-1-26	55.18	0.4
L-1-27	67.60	0.2
L-1-28	65.12	0.8
L-1-29	13.56	0.8
L-1-30	67.88	0.6
L-1-32	76.14	0.4
L-1-33	69.78	0.2

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

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Page # 2

SAMPLE No.	% L.O.I.	PPM U3O8
L-1-34	55.06	NIL
L-1-35	60.50	0.2
L-1-36	78.98	0.4
L-1-37	75.92	0.6
L-1-38	65.76	0.2
L-1-39	56.00	0.2
L-1-40	77.98	0.2
L-1-41	60.40	0.4
L-1-42	61.48	0.6
L-1-43	50.82	0.6
L-1-44	59.32	0.6
L-1-46	73.64	0.8
L-1-47	54.90	0.8
L-1-43	62.16	1.4
L-1-49	75.62	0.8
L-1-50	68.84	0.4
L-1-51	57.50	1.4
L-1-52	58.04	1.8
L-1-53	59.44	2.6
L-1-54	16.04	1.0
L-1-55	71.80	0.6
L-1-56	39.62	1.6
L-1-57	56.20	0.6
L-1-58	46.96	0.8
L-1-59	65.74	1.6
L-1-60	72.34	0.6
L-1-61	71.14	3.2
L-1-62	59.78	2.2
L-1-63	52.08	3.8
L-1-64	49.66	2.8
L-1-65	38.26	3.2

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Pulps Retained one month
nless specific arrangements
made in advance.

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LORING LABORATORIES LTD.

Page # 3

SAMPLE No.	% L.O.I.	PPM U308
L-1-66	52.52	1.6
L-1-67	57.78	2.0
L-1-68	53.94	0.8
L-1-69	55.38	0.8
L-1-70	65.20	0.8
L-1-71	67.20	1.0
L-1-72	76.14	0.8
L-1-73	48.96	1.4
L-1-74	54.52	1.2
L-1-75	69.20	1.0
L-1-76	72.90	0.8
L-1-77	52.60	1.0
L-1-78	56.32	1.6
L-1-79	61.90	1.4
L-1-80	51.12	1.0
L-1-81	79.36	0.8
L-1-82	32.16	1.0
L-1-83	54.94	0.6
L-1-84	43.34	1.4
L-1-85	51.18	1.2
L-1-86	77.84	2.4
L-1-87	74.74	2.0
L-1-88	73.30	2.2
L-1-89	70.22	0.8
L-1-90	49.14	0.2
L-1-91	63.96	4.0
L-1-92	58.88	1.6
L-1-93	63.08	0.4
L-1-94	69.44	1.4
L-1-95	53.44	0.2
L-1-96	48.68	0.2

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Licensed Assayer of British Columbia

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Calgary, Alberta T2P 2X7

ATTN: Norm Reynolds

File No. 11494
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PO # C3141
AFE 01 62401-340-017-014

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	% L.O.I.	PPM U308
L-1-97	68.16	0.6
L-1-98	68.22	3.2
L-1-99	56.20	0.2
L-1-100	77.42	0.6
L-1-101	79.38	1.8
L-1-102	57.32	0.2
L-1-103	54.50	0.8
L-1-104	61.46	0.6
L-1-105	47.70	1.6
L-1-106	19.78	0.8
L-1-107	63.94	1.2
L-1-108	70.38	0.8
L-1-109	45.00	0.6
L-1-110	58.48	1.6
L-1-111	41.86	0.6
L-1-112	75.14	0.8
L-1-113	53.26	1.6
L-1-114	71.02	0.4
L-1-115	58.72	0.4
L-1-116	66.40	2.2
L-1-117	72.40	0.6
L-1-118	71.46	0.4
L-1-119	66.44	0.6
L-1-120	62.24	1.4
L-1-121	65.52	0.6
L-1-122	37.38	4.6
L-1-123	49.66	1.6
L-1-124	71.42	0.8
L-1-125	43.94	0.2
L-1-126	70.00	1.0
L-1-127	61.32	0.6

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Licensed Assayer of British Columbia

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LORING LABORATORIES LTD.

SAMPLE No.	% L.O.I.	PPM U308
L-1-128	47.68	4.6
L-1-129	82.72	NIL
L-1-130	22.80	NIL
L-1-131	61.22	4.8
L-1-132	75.40	0.2
L-1-133	67.70	0.4
L-1-134	51.78	1.8
L-1-135	62.68	1.0
L-1-136	57.16	7.4
L-1-137	65.14	1.0
L-1-138	72.06	1.0
L-1-139	67.98	0.6
L-1-140	71.74	1.2
L-1-141	32.30	10.4
L-1-142	70.60	0.8
L-1-143	60.52	2.0
L-1-144	41.28	0.2
L-1-145	63.72	0.2
L-1-146	47.56	0.4
L-1-147	66.68	1.8
L-1-148	69.32	0.2
L-1-149	66.72	0.4
L-1-150	68.60	0.2
L-1-151	48.54	0.2
L-1-152	60.64	NIL
L-1-153	44.74	NIL
L-1-154	64.44	1.4
L-1-155	79.76	0.6
L-1-156	65.94	0.4
L-1-157	33.96	1.2
L-1-158	70.14	0.2

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Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
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Calgary, Alberta T2P 2X7

ATTN: Norm Reynolds

File No. 11494
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Samples Lake Sediments
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LTD.

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	% L.O.I.	PPM U308
L-1-159	71.48	1.0
L-1-160	46.80	1.2
L-1-161	69.88	0.8
L-1-162	52.78	0.8
L-1-163	55.04	1.0
L-1-164	45.58	1.0
L-1-166	57.52	2.8
L-1-167	55.78	2.0
L-1-168	46.00	1.8
L-1-169	63.08	0.6
L-1-170	69.66	1.0
L-1-171	65.90	3.2
L-1-175	62.02	1.8
L-1-178	66.04	0.8
L-1-179	55.74	1.4
L-1-180	65.24	0.8
L-1-181	50.32	1.6
L-1-182	49.14	3.0
L-1-183	58.82	1.2
L-1-184	69.26	0.4
L-1-185	66.08	1.4
L-1-186	70.42	2.4
L-1-187	76.68	0.8
L-1-188	64.54	1.4
L-1-189	60.02	1.2
L-1-190	56.62	2.2
L-1-191	19.94	0.6
L-1-192	47.78	0.8
L-1-193	65.90	7.2
L-1-194	69.16	2.2
L-1-195	64.22	1.4

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SAMPLE No.	% L.O.I.	PPM U3O8
L-1-196	29.42	0.6
L-1-197	64.24	0.8
L-1-198	51.50	0.6
L-1-199	49.80	0.4
L-1-200	70.52	0.6
L-1-201	24.58	0.4
L-1-202	81.10	1.0
L-1-203	43.86	5.0
L-1-204	64.60	1.2
L-1-205	71.96	0.4
L-1-206	54.92	0.6
L-1-207	77.52	0.6
L-1-208	54.06	0.2
L-1-209	51.80	0.2
L-8-1	59.34	2.0
L-8-2	52.90	0.8
L-8-3	63.00	0.2
L-8-4	65.16	0.8
L-8-5	31.18	1.0
L-8-7	65.58	2.8
L-8-10	62.86	1.4
L-8-11	74.02	1.8
L-8-12	59.18	0.2
L-8-13	53.98	0.6
L-8-14	66.94	3.4
L-8-15	76.06	1.4
L-8-16	67.90	1.0
L-8-17	73.38	1.2
L-8-18	55.16	2.8
L-8-19	75.84	1.2
L-8-20	66.78	2.2

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Certificate of ASSAY
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Page # 8

SAMPLE No.	% L.O.I.	PPM U3O8
L-8-21	49.14	1.0
L-8-22	39.62	NIL
L-8-23	60.98	1.4
L-8-24	64.12	1.8
L-8-25	72.10	1.0
L-8-26	41.62	0.6
L-8-27	13.16	0.2
L-8-28	58.94	6.6
L-8-29	67.02	6.0
L-8-30	69.64	7.8
L-8-31	53.02	2.4
L-8-32	67.12	2.8
L-8-33	65.54	6.4
L-8-34	54.14	6.2
L-8-35	63.88	18.8
L-8-36	53.32	2.2
L-8-37	70.80	10.0
L-8-38	54.44	5.2
L-8-39	64.70	4.0
L-8-40	59.62	2.2
L-8-41	12.40	5.2
L-8-42	69.12	3.2
L-8-43	62.90	2.6
L-8-44	55.16	2.2
L-8-45	51.32	1.0
L-8-46	62.68	10.2
L-8-47	62.88	2.4
L-8-48	83.14	1.2
L-8-49	52.62	1.0
L-8-50	18.36	3.0
L-8-51	35.26	0.2

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Page # 9

SAMPLE No.	% L.O.I.	PPM U308
L-8-52	65.34	1.4
L-8-53	63.48	0.6
L-8-54	16.54	NIL
L-8-55	62.30	1.0
L-8-56	62.68	1.2
L-8-57	65.50	1.2
L-8-58	53.68	1.8
L-8-59	67.42	1.0
L-8-60	65.94	2.0
L-8-61	58.20	1.0
L-8-62	34.76	1.0
L-8-63	34.22	1.0
L-8-64	61.14	2.0
L-8-65	38.88	1.0
L-8-66	43.96	0.4
L-8-67	49.34	0.6
L-8-172	64.04	0.6
L-8-173	75.70	0.8
L-8-174	69.32	2.2
L-8-176	57.86	1.4
L-8-177	67.16	1.2
L-2-1	62.90	0.8
L-2-2	67.12	0.6
L-2-3	39.22	1.6
L-2-4	62.76	1.0
L-10-1	28.90	1.6
L-10-2	33.10	1.4
2	48.06	1.2
3	67.82	1.2
4	50.48	2.0
L-7-1	23.44	2.0

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L-7-2	52.66	2.6
L-7-3	38.60	2.4
L-7-4	60.32	4.8
L-7-5	67.34	6.6
L-7-6	62.10	10.0
L-7-7	57.64	4.0
L-7-8	60.28	3.0
L-7-9	50.82	1.0
L-7-10	69.26	0.8
L-7-11	45.94	2.8
L-7-13	25.96	6.0
L-7-14	43.14	6.4
L-7-15	71.10	6.4
L-7-17	59.74	4.4
L-7-18	58.78	6.2
L-7-19	45.48	2.0
L-7-20	56.74	1.0
L-7-21	54.40	0.8
L-7-22	50.50	0.8
L-7-23	67.86	3.6
L-7-24	52.76	3.6
L-7-25	32.02	3.0
L-7-26	59.56	2.8
L-7-27	55.98	5.0
L-7-28	60.30	3.4
L-7-29	39.00	3.2
L-7-30	50.72	3.6
L-7-31	46.94	2.0
L-7-32	56.18	4.4
L-7-33	72.62	1.6
L-7-34	67.80	2.0

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L-7-35	58.46	1.6
L-7-36	51.92	1.4
L-7-37	62.76	2.0
L-7-38	50.24	4.0
L-7-39	21.54	2.8
L-7-40	36.24	3.6
L-7-41	53.66	0.6
L-7-42	49.88	3.6
L-7-43	52.84	3.0
L-7-44	60.10	3.0
L-7-45	38.52	0.8
L-7-46	42.24	1.8
L-7-47	58.36	1.2
L-7-48	53.72	1.2
L-7-49	53.74	4.0
L-7-50	65.24	0.8
L-7-51	38.00	0.8
L-7-52	46.12	1.6
L-7-53	49.00	0.8
L-7-54	52.24	0.4
L-7-55	.40	NIL
L-7-56	52.02	2.4
L-7-57	50.28	0.6
L-7-58	53.28	1.0
L-7-59	87.20	NIL
L-7-60	39.56	0.6
L-7-61	20.58	0.8
L-7-62	4.12	NIL
L-7-63	3.24	NIL
E-16-1	43.74	0.2
E-16-5	55.46	1.2

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Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
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Calgary, Alberta T2P 2X7

ATTN: Norm Reynolds

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Date June 9, 1976
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PO # C3141
AFE 01 62401-340-017-014

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 12

SAMPLE No.	% L.O.I.	PPM U3O8
E-16-6	67.34	0.6
E-16-7	52.52	1.0
E-16-8	61.54	2.4
E-16-9	61.78	0.2
E-16-11	42.04	7.2
E-16-12	49.80	4.0
E-16-13	67.10	0.2
E-16-14	49.90	0.6
E-16-15	62.62	1.2
E-16-16	47.56	3.0
E-16-17	34.04	0.2
E-16-18	38.70	0.8
E-16-19	39.70	1.0
E-16-20	42.46	1.2
E-16-21	49.98	0.8
E-16-22	31.20	1.8

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[redacted]
Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
algary, Alberta T2P 2X7

ATTN: Norm Reynolds
cc: Glen McWilliams

LTD.

File No. 11537
Date June 21, 1976
Samples Lake Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	% L.O.I.	PPM U308	PPM Cu	PPM Ni	PPM Mo
A-L-1-33	51.84	0.2	5	4	1
B-L-1-33	57.46	0.2	5	4	1
C-L-1-33	2.98	NIL	1	1	NIL
D-L-1-33	3.60	0.2	1	1	NIL
E-L-1-33	1.84	NIL	1	1	NIL
F-L-1-33	3.90	NIL	1	1	NIL
L-1-301	89.52	0.2	5	4	1
L-1-302	74.16	0.2	4	4	1
L-1-303	69.02	0.2	13	11	1
L-1-304	75.30	0.4	5	4	1
L-1-305	92.08	0.2	5	5	1
L-1-306	68.86	0.4	8	7	1
L-1-307	63.02	2.4	14	12	6
L-1-308	46.56	1.2	10	24	3
L-1-309	69.92	0.4	10	8	2
L-1-310	69.06	0.2	11	10	1
L-1-311	81.40	0.6	11	10	1
L-1-312	52.48	1.4	12	20	2
L-1-313	51.64	0.4	7	21	2
L-1-314	38.74	0.6	8	26	2
L-1-315	54.82	1.2	8	11	1
L-1-316	72.94	1.6	14	17	2
L-1-317	69.08	0.2	9	8	2
L-1-318	54.08	0.8	8	10	1
L-1-319	68.22	0.6	5	15	1
L-1-320	50.40	2.0	10	21	1
L-1-321	66.26	0.6	11	17	1

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
algary, Alberta T2P 2X7

ATTN: Norm Reynolds
cc: Glen McWilliams

File No. 11537
Date June 21, 1976
Samples Rock Chips

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 2

SAMPLE No.	PPM Cu	PPM Ni	PPM Mo	PPM U308
"Rock Chips" *				
13-6-A	12	32	2	5.6
13-6-B	12	30	2	5.2
13-6-C	12	32	2	6.2
17-6-J	8	21	2	42.2

* Pebbles removed from matrix as instructed.

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

M E Atla

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
algary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11645
Date July 12, 1976
Samples Pulps
(OLD FILE 11537)

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	% ThO_2
"Chip Samples"	
13-6-A	.033
13-6-B	.042
13-6-C	.031
17-6-J	.010

Pebbles removed from sample.

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

ME Atta.

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
algary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11660
Date July 14, 1976
Samples Lake Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 1

SAMPLE No.	PPM U308	% L.O.I.
L-8-100 A	4.8	2.97
L-8-100 B	4.6	
L-8-101 A	2.8	57.46
L-8-101 B	3.2	
L-8-102 A	9.6	55.22
L-8-102 B	10.0	
L-8-103 A	8.8	58.39
L-8-103 B	8.8	
L-8-104 A	5.6	46.47
L-8-104 B	4.4	
L-8-105 A	4.2	46.34
L-8-105 B	4.0	
L-8-106 A	1.4	62.17
L-8-106 B	1.4	
L-8-107 A	1.2	48.76
L-8-107 B	1.2	
L-8-108 A	0.8	63.89
L-8-108 B	0.8	
L-8-109 A	2.4	64.18
L-8-109 B	2.6	
L-8-110 A	8.8	66.72
L-8-110 B	9.0	
L-8-111 A	4.8	64.24
L-8-111 B	4.0	
L-8-112 A	1.2	47.51
L-8-112 B	2.2	
L-8-113 A	0.4	54.44
L-8-113 B	0.4	
L-8-114 A	5.0	60.08
L-8-114 B	7.4	

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2p 2X7

ATTN: Don Sawyer

File No. 11660
Date July 14, 1976
Samples Lake Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	PPM U308	% L.O.I.
L-8-115 A	9.0	68.67
L-8-115 B	8.6	
L-1-350 A	0.8	65.83
L-1-350 B	0.6	
L-1-351 A	1.0	53.26
L-1-351 B	1.4	
L-1-352 A	0.6	77.36
L-1-352 B	0.4	
L-1-353 A	1.0	67.17
L-1-353 B	0.8	
L-1-354 A	0.6	41.43
L-1-354 B	0.6	
L-1-355 A	1.0	61.24
L-1-355 B	1.4	
L-1-356 A	1.4	60.43
L-1-356 B	1.4	
L-1-357 A	1.6	67.81
L-1-357 B	2.0	
L-1-358 A	1.8	64.40
L-1-358 B	1.6	
L-1-359 A	1.8	73.85
L-1-359 B	2.4	
L-1-360 A	0.2	74.32
L-1-360 B	0.8	
L-1-361 A	0.6	72.56
L-1-361 B	0.6	
L-1-362 A	2.4	69.72
L-1-362 B	2.6	
L-1-363 A	2.8	54.29
L-1-363 B	3.0	

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
algary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11660
Date July 14, 1976
Samples Lake Sediments

LTD.

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 3

SAMPLE No.	PPM U308	% L.O.I.
L-1-364 A	1.4	66.02
L-1-364 B	1.6	
L-1-365 A	2.0	70.86
L-1-365 B	1.8	
L-1-366 A	1.0	56.31
L-1-366 B	0.6	
L-1-367 A	4.6	63.16
L-1-367 B	5.0	
L-1-368 A	2.2	67.74
L-1-368 B	2.2	
L-1-369 A	1.0	64.07
L-1-369 B	0.8	
L-1-370 A	1.0	71.34
L-1-370 B	1.4	
L-1-374 A	1.6	63.65
L-1-374 B	0.8	
L-1-375 A	0.6	60.78
L-1-375 B	0.6	

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
algary, Alberta T2P 2X7

ATTN: Glen McWilliams

File No. 11747
Date July 29, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 1

SAMPLE No.	% L.O.I.	PPM U308
E-16-100	57.64	0.8
E-16-101	48.82	1.4
E-16-102	50.76	1.8
E-16-103	40.02	0.8
E-16-104	37.46	1.0
E-16-105	47.56	2.2
E-16-106	71.84	0.4
L-1-376	67.52	1.8
L-1-377	55.42	4.2
L-1-378	69.80	0.8
L-1-379	71.82	1.0
L-1-380	43.92	0.6
L-1-381	71.60	0.6
L-1-382	61.74	0.2
L-1-383	69.80	0.4
L-1-384	61.74	1.8
L-1-385	75.14	0.4
L-1-386	63.76	0.4
L-1-387	9.54	0.8
L-1-388	54.84	0.6
L-1-389	61.00	0.6
L-1-390	39.02	0.2
L-1-391	66.06	3.2
L-1-392	64.44	1.4
L-1-393	56.12	3.4
L-1-394	49.56	1.0
L-1-395	72.48	0.2
L-1-396	69.34	0.8
L-1-397	67.80	0.8
L-1-398	26.54	1.6
L-1-399	62.72	1.0

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Glen McWilliams

File No. 11747
Date July 29, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 2

SAMPLE No.	% L.O.I.	PPM U308
L-1-400	47.66	3.0
L-1-401	46.27	2.4
L-1-402	70.10	0.2
L-1-403	68.38	0.6
L-1-404	47.88	0.2
L-1-405	77.94	0.2
L-1-407	77.66	0.2
L-1-408	74.32	0.4
L-1-409	45.94	0.4
L-1-410	46.82	0.6
L-1-411	71.02	0.4
L-1-412	63.00	0.4
L-1-413	66.74	0.8
L-1-414	67.56	0.2
L-1-415	49.30	NIL
L-7-75	39.42	4.4
L-7-76	66.32	0.4
L-7-77	75.70	2.6
L-7-78	50.49	0.8
L-7-79	36.70	2.2
L-7-80	61.36	1.2
L-7-81	43.22	1.4
L-7-82	3.82	1.4
L-7-83	53.20	1.6
L-7-84	75.94	0.4
L-7-85	53.14	0.8
L-7-86	32.60	3.2
L-7-87	63.58	1.0
L-7-88	44.82	0.4
L-7-89	51.98	0.8
L-7-90	65.34	2.8

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Glen McWilliams

File No. 11747
Date July 29, 1976
Samples Lake Bottom Sediments

LTD.

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 3

SAMPLE No.	% L.O.I.	PPM U308
L-7-91	54.94	3.6
L-7-92	51.70	3.0
L-7-93	60.46	1.4
L-7-94	41.56	0.8
L-7-95	50.12	0.8
L-7-96	54.24	1.6
L-7-97	59.52	1.4
L-7-98	72.06	2.8
L-7-99	70.36	2.4
L-7-100	58.00	1.8
L-7-101	49.42	1.6
L-7-102	60.62	1.8
L-7-103	59.96	2.4
L-7-104	54.64	0.8

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Ave. S.W.,
algary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11791
Date August 6, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 1

SAMPLE No.	% L.O.I.	% U308
"Lake Bottom Sediments"		
0-1	64.38	1.6
0-2	55.62	1.0
0-3	60.24	0.8
0-4	60.88	0.8
0-5	45.14	2.4
0-6	54.52	7.3
0-7	46.70	3.0
0-8	55.80	1.2
0-9	53.38	0.8
0-10	59.78	1.0
0-11	52.60	1.6
0-12	63.10	0.8
0-13	44.50	0.2
0-14	63.02	0.2
0-15	63.70	0.4
0-16	77.36	4.2
0-17	58.32	3.2
0-18	43.92	0.8
0-19	69.98	0.2
0-20	64.66	8.5
0-21	55.10	1.2
0-22	50.80	1.4
0-23	61.50	1.0
0-24	56.54	0.6
0-25	58.52	0.8
0-26	63.40	1.6
0-27	62.22	0.6

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Ave. S.W.,
Calgary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11791
Date August 6, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 2

SAMPLE No.	% L.O.I.	% U308
0-28	49.74	0.8
0-29	37.26	0.8
0-30	77.40	0.6
0-31	71.26	0.4
0-32	55.18	1.2
0-34	72.10	0.8
0-36	64.72	0.8
0-37	70.36	1.0
0-38	3.78	0.2
0-39	73.26	0.2
0-40	64.12	NIL
0-41	48.48	0.4
0-42	61.40	1.0
0-43	74.24	0.6
0-44	78.76	1.0
0-45	72.30	0.8
0-46	77.96	0.6
0-47	74.58	0.8
0-48	58.22	0.8
0-49	53.10	1.8
0-50	52.12	1.0
0-51	71.50	1.0
0-52	49.90	1.0
0-53	61.58	1.0
0-54	70.76	0.6
0-55	66.52	1.0
0-56	51.22	1.0
0-57	63.96	0.8
0-58	52.12	1.0
0-59	76.16	0.2
0-60	70.20	0.8

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Ave. S.W.,
Calgary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11791
Date August 6, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 3

SAMPLE No.	% L.O.I.	% U308
0-61	68.38	0.8
0-62	63.76	0.2
0-63	66.56	0.8
0-64	76.54	0.4
0-65	68.24	0.6
0-66	68.02	0.8
0-67	72.52	0.6
0-68	51.76	1.6
0-69	40.48	0.6
0-70	72.14	0.6
0-71	63.14	0.8
0-72	62.96	0.4
0-73	82.74	0.2
0-74	66.06	0.6
0-75	65.80	0.4
0-76	72.86	0.6
0-77	66.26	0.2
0-78	63.10	0.6
0-79	64.68	1.0
0-80	72.76	0.6
0-81	68.38	0.6
0-82	67.42	0.2
0-83	78.38	0.4
0-84	53.72	0.2
0-85	75.34	0.2
0-86	48.38	NIL
0-87	46.92	NIL
0-88	66.60	0.2
0-89	72.50	0.6
0-90	49.46	NIL
0-91	62.52	1.2

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

25

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Ave. S.W.,
Calgary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11791
Date August 6, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 4

SAMPLE No.	% L.O.I.	% U308
0-92	73.24	5.0
0-93	52.06	0.4
0-94	76.18	0.8

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

N.E. Alta.

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11819
Date August 10, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 1

SAMPLE No.	% L.O.I.	PPM U308
Lake Bottom Sediments		
L-8-116	69.46	3.0
L-8-117	65.12	3.8
L-8-118	70.76	10.5
L-8-119	50.88	11.3
L-8-120	61.84	1.6
L-8-121	91.78	0.4
L-8-122	57.12	2.6
L-8-123	78.76	0.6
L-8-124	62.26	16.7
L-8-125	91.96	0.6
L-8-126	51.44	2.6
L-8-127	15.20	3.8
L-8-128	69.72	2.8
L-8-129	91.42	0.4
L-8-130	62.80	8.8
L-8-131	45.50	10.9
L-8-132	31.22	4.7
L-8-133	60.52	4.3
L-8-134	74.46	4.7
L-8-135	67.74	14.8
L-8-136	50.72	6.8
L-8-137	61.44	5.8
L-8-138	85.00	2.4
L-8-139	88.06	2.8
L-8-140	90.50	0.4
L-8-141	77.32	1.4
L-8-142	90.96	0.2

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11819
Date August 10, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 2

SAMPLE No.	% L.O.I.	PPM U308
L-8-143	91.70	0.2
L-8-144	82.70	4.0
L-8-145	67.42	3.0
L-8-146	51.88	6.8
L-8-147	50.04	8.0
L-8-148	57.70	6.6
L-8-149	65.30	2.6
L-8-150	77.90	0.8
L-8-151	93.98	0.2
L-8-152	93.80	0.2
L-8-153	55.54	6.0
L-8-154	89.42	0.4
L-8-155	73.70	1.4
L-8-156	66.02	8.2
L-8-157	93.52	0.6
L-8-158	67.46	0.6

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

[redacted]

Licensed Assayer of British Columbia

NE Alta Field File.

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11861
Date August 17, 1976
Samples Chip

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	Chemical % U308
"Chip Samples"	
DA-1-DM	.020
DA-2-DM	.250
DA-3-DM	2.130
DA-4-DM	.036
DA-5-DM	.077
DA-6-DM	.101

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Glen McWilliams

File No. 11953
Date September 1, 1976
Samples Chips

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 4

SAMPLE No.	% Cu	% Ni	PPM U308	% ThO2
"Chip Samples"				
8751	.01	Trace	14.0	.042
8752	.04	Trace	16.5	.032
8753	.26	.005	10.5	Trace

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

30

ME Alberta Field File

To: NORCEN ENERGY RESOURCES LIMITED,
15 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Glen McWilliams

File No. 11953
Date September 1, 1976
Samples Lake Bottom Sediments

MINERALS
RECEIVED
SEP 14 1976
DEPARTMENT

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 1

SAMPLE No.	% L.O.I.	PPM U308
"Lake Bottom Sediments"		
GM-3	50.68	0.7
GM-4	32.84	1.6
GM-5	62.76	0.9
GM-6	57.94	1.8
GM-7	33.62	2.0
GM-8	3.08	0.4
GM-9	48.96	2.7
GM-10	61.04	0.2
GM-11	56.22	0.4
GM-12	67.40	0.4
GM-13	68.92	0.4
GM-14	2.66	0.2
GM-15	0.40	NIL
GM-16	60.94	0.2
GM-17	64.50	0.4
GM-18	46.76	0.4
GM-19	41.52	0.4
GM-20	2.30	0.2
GM-21	63.96	0.4
GM-22	68.72	2.5
GM-23 A	19.40	0.2
GM-23 B	21.44	0.2
GM-24	39.04	0.2
GM-25	67.52	0.2
GM-26	70.06	0.4
GM-27	70.14	0.2
GM-28	68.58	0.4

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
15 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Glen McWilliams

File No. 11953
Date September 1, 1976
Samples Lake Bottom Sediments

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 2

SAMPLE No.	% L.O.I.	PPM U308
GM-29	66.88	0.7
GM-30	60.72	2.4
GM-31	76.40	0.2
GM-32	67.96	0.9
GM-33	56.54	0.9
GM-34	75.40	0.2
GM-35	56.42	0.4
GM-36	49.36	0.7
GM-37	62.30	0.4
GM-38	61.86	0.2
GM-39	17.00	NIL
GM-40	9.34	0.2
GM-41	27.36	0.4
GM-42	49.50	0.4
GM-43	66.38	0.4
GM-44	48.18	0.2
GM-45	42.90	0.2
GM-46	65.10	2.0
GM-47	36.42	1.4
GM-48	62.72	1.3
GM-49	64.02	2.5
GM-50	73.78	0.9
GM-51	63.16	0.7
GM-52	60.78	1.3
GM-53	94.68	0.4
GM-54	56.66	1.4
GM-55	64.20	1.8
GM-56	47.38	0.9
GM-57	56.62	1.8
GM-58	68.28	1.1
GM-59	55.22	0.5

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Glen McWilliams

File No. 11953
Date September 1, 1976
Samples Lake Bottom Sediemts

Certificate of ASSAY
LORING LABORATORIES LTD.

Page # 3

SAMPLE No.	% L.O.I.	PPM U308
GM-60	43.12	0.7
GM-61	45.96	0.4
GM-62	66.20	1.8
GM-63	19.86	0.7

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

To Glen McW.

To: NORCEN ENERGY RESOURCES LIMITED,
715 - 5th Avenue S.W.,
Calgary, Alberta T2P 2X7

ATTN: Don Sawyer

File No. 11983
Date September 24, 1976
Samples Chips

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	% ThO2
"Chip Samples"	
A-24-2	Trace
A-24-3	.003

M. METALS
RECEIVED
SEP 27 1976
DEPARTMENT

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

[redacted]
Licensed Assayer of British Columbia

APPENDIX 5

McPHAR MODEL TV-1 SCINTILLOMETER

SECTION 1

INTRODUCTION

Model TV-1 is a three threshold scintillometer. Measurements are based on the spectral characteristics or energy levels of gamma radiation from radioactive elements. Selection of the operating threshold is made by means of the threshold selector switch.

The instrument is designed primarily for reconnaissance. The selective thresholds however provide the capability to differentiate between gamma radiations emanating from uranium and thorium and to provide quantitative information relating to each.

The meter is calibrated to display zero to 100 counts per minute. A four position scale multiplier switch provides four full scale ranges of 100, 1000, 10,000 and 100,000 counts per minute. A fifth position on this switch is employed to test the condition of the batteries.

The variable time constants are tied in with the threshold selector switch. In the wide open (maximum sensitivity) operation, a fast or slow time constant may be selected. In the upper thresholds (lower net count), the long time constant only is in effect.

The detecting element is a 1-1/4 by 1 inch sodium iodide crystal coupled to a photomultiplier tube. These are hermetically sealed, magnetically shielded and mounted in the forward end of the scintillometer housing.

A speaker provides a variable pitch output with changing radiation levels. A speaker control, mounted on the top of the instrument, can be used to adjust the pitch for any given level of radiation.

SECTION 2

SPECIFICATIONS

2 - 1 THRESHOLD POSITIONS

T_1 at 0.2 Mev. - measures the total count across the entire gamma energy spectrum for maximum sensitivity.

T_2 at 1.6 Mev. - measures characteristic uranium and thorium radiations.

T_3 at 2.5 Mev. - measures diagnostic thorium radiations only.

2 - 2 MEASUREMENT RANGES

Range Switch Position	Full Scale Counts
x 1	100
x 10	1,000
x 100	10,000
x 1000	100,000

2 - 3 TIME CONSTANTS

T_1 F (Fast) - 1 second

T_1 S (Slow) - 10 seconds

T_2 - 10 seconds

T_3 - 10 seconds

2 - 4 SPEAKER

A speaker is mounted in a top compartment of the instrument.

The variable pitch output of the speaker is governed by the intensity of radiation and can also be adjusted by a speaker pitch control.

2 - 5 BATTERY SUPPLY

The instrument operates from two "c" size flashlight type cells, located in the handle. Ordinary zinc carbon cells may be used. From the standpoint of longer life and low temperature operation, the alkaline type should be employed wherever available.

Both the high and low voltages, generated internally to operate the instrument, are regulated to a high degree of stability. The batteries can be allowed to drop to one half of their initial voltage without any effect on the operation of the instrument.

2 - 6 SENSITIVITY

The instrument, on threshold 2, registers approximately 50 counts per minute on an in-situ measurement, (2π geometry) over homogeneous material containing 5 parts per million uranium or thorium

2 - 7 TEMPERATURE RANGE

The instrument has been designed to operate over the temperature range of -35 to +55 degrees centigrade. Low temperatures require the use of alkaline type batteries.

2 - 8 DETECTOR CRYSTAL

The sodium iodide crystal is 1 inch in diameter and 1-1/4 inches thick. The crystal is coupled to the photomultiplier in a permanent hermetically sealed housing.

2 - 9 WEIGHT

The total weight of the instrument is 3 pounds.

2 - 10 DIMENSIONS

The length including rubber end guards is 13 inches. The maximum height is 8 inches.

2 - 11 ACCESSORIES

The scintillometer is supplied with a leather belt holster, a thorium calibrating source, spare batteries and an instruction manual.

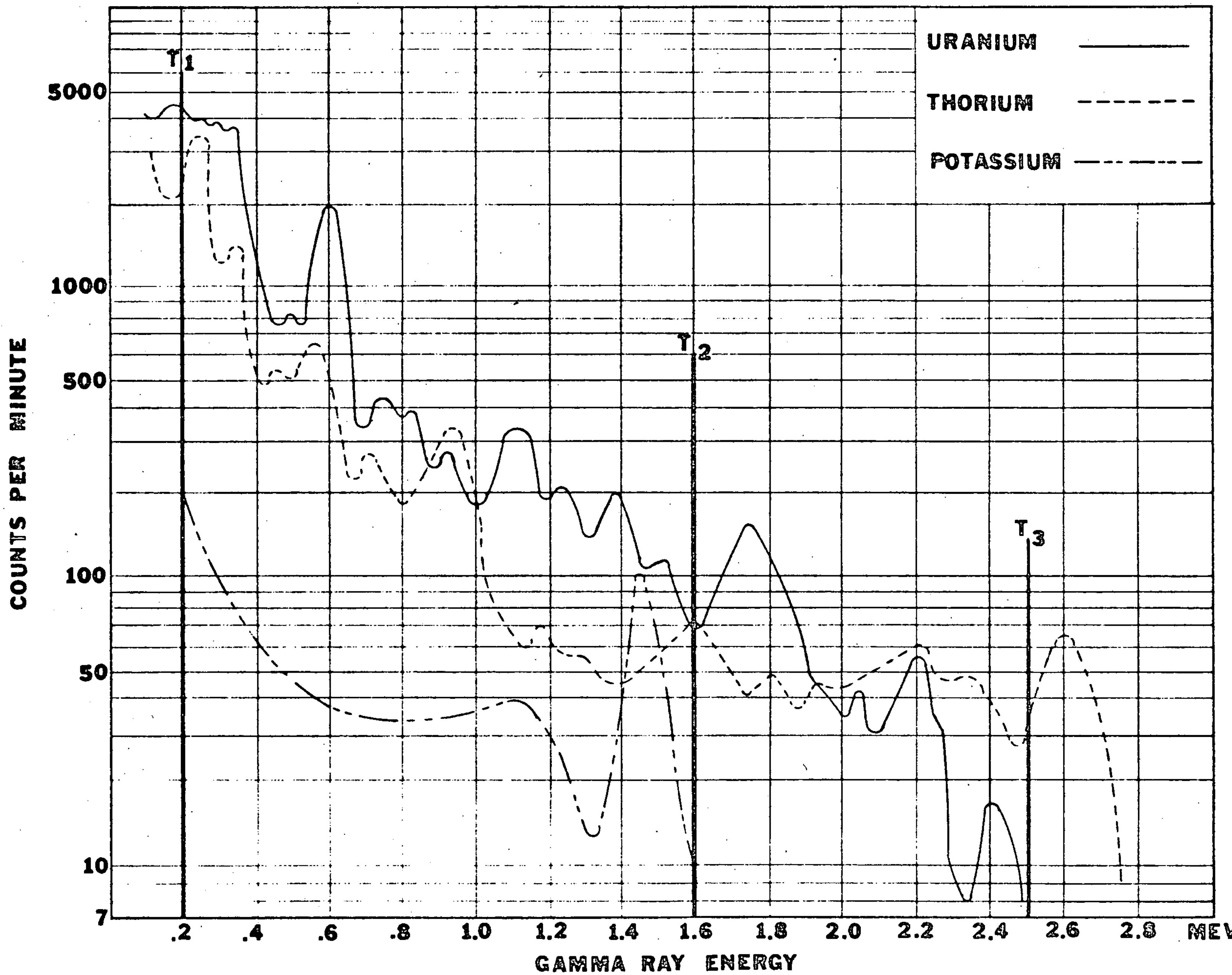


FIG-1 A

GAMMA RAY SPECTRA FROM NATURAL ORES OR THEIR CONSTITUENTS

1976006.

SECTION 3

GENERAL DESCRIPTION AND APPLICATIONS.

The gamma ray detecting principle lies in the sodium iodide crystal. Gamma rays entering the crystal, interact with the crystal atoms, resulting in free electrons and light emission. The optically coupled photomultiplier converts the light emission to electrical pulses. The magnitudes of the electrical pulses bear a realtionship to the energy levels the intercepted gamma rays.

Various radioactive elements have characteristic gamma energy spectrums. The nature of the spectrum for a given element can be used to advantage in indentifying it in the presence of other radioactive elements. Figure 1 shows spectral curves for the three main elements of interest in radioactive surveys; potassium, uranium and thorium.

Thorium emits gamma rays with energy levels exceeding 2.5 Mev. The highest energy radiation from potassium is about 1.6 Mev. The three vertical lines marked T_1, T_2, and T_3 show the location of the threshold settings of the TV-1 scintillometer after the instrument has been calibrated. Threshold T_3 at 2.5 Mev. allows only those electrical pulses to be registered whose amplitudes correspond to gamma rays with energy levels above 2.5 Mev. T_2 similarly responds to gamma energy levels above 1.6 Mev. When both thorium and uranium are present during a measurement, then the reading at T_2 contains counts resulting from both elements whereas T_3 contains counts from thorium only.

It is possible then, to subtract the count due to thorium in the T_2 reading, leaving the count from uranium only. The count representing thorium in the T_2 reading is a fixed multiple of the T3 reading. In the TV-1 scintillometer, this multiple is 3.5. That is, the count in T_2 due to uranium is $T_2 - 3.5\ T_3$. A thorium calibrating source and calibration procedure, provided with the instrument, ensures that this is always the case.

Once the count in T_2 has been resolved into net count for uranium, it is possible to arrive at a quantitative estimate of the material grade. This requires reference to certain conditions described in section 6-3.

SECTION 6

DETERMINATION FOR URANIUM, THORIUM

6-1 EXPLANATION OF T_1, T_2 AND T_3 READINGS

Following a calibration procedure, the three thresholds are established on the gamma energy spectrum, in the positions shown in Figure 1. T_3 is set at 2.5 Mev. and from the curves of the three elements displayed, it is noted that only thorium contains gamma radiation with energy levels above 2.5 Mev. The use of T_3 then forms the basis of a diagnostic test for thorium. The number of counts, measured under controlled conditions, can also form the basis of a quantitative evaluation for thorium.

T_2 is at 1.6 Mev. and from the curves, it is apparent that this threshold provides a diagnostic test for the presence of both uranium and thorium. The number of counts due to uranium in a sample containing both is readily established by subtracting 3.5 times the T_3 counts. The difference represents the counts relating to uranium. The subtraction of 3.5 times the T_3 count is valid since this is the basis of the calibration procedure with the thorium source. The count remaining after the subtraction can further be related to the quantity of uranium (in equilibrium) that is present.

T_1 is at 0.2 Mev. and measurements with this threshold will include gamma counts from all three elements of potassium, uranium and thorium. This is the most sensitive threshold position since it includes practically the entire energy spectrum. It is common therefore to employ threshold one for general reconnaissance.

6-2 BACKGROUND MEASUREMENTS

So far, the influence of natural background radiation has not been introduced. It is recognized however, that measurements on any sample material include count contributions from background radiation. When the count yield from a sample or in-situ measurement is low, it is necessary to subtract the background count prior to any attempt at qualitative or quantitative evaluation.

For survey work, the background count on all thresholds should be recorded at an area away from any known source of radioactivity. For sample work, the background should be taken at the location of the measurement site but with radioactive samples removed to such a distance that random position changes of the samples do not influence the general background level. In all cases, no radioactive articles, personal or otherwise, should be in the vicinity of the instrument.

Background count levels are generally low and difficult to establish to any high degree of accuracy, particularly in the upper threshold settings. Extra care should be taken to measure the background. Fortunately the background does not have to be measured frequently so a longer time can be taken to arrive at a more accurate measurement.

The background is recorded and subtracted from future readings. The background should be rechecked from time to time but the frequency of rechecking depends on the nature of the work.

6-3 ISOLATING URANIUM

From a sample or outcrop containing both uranium and thorium, the net count due to uranium is obtained as follows.

1. Measured background counts at $T_3 = C_{3B}$
   and background counts at $T_2 = C_{2B}$

2. Measured counts on sample at $T_3 = C_3$
   and counts on sample at $T_2 = C_2$

3. Counts at T_3 due to thorium $= C_3 - C_{3B} = C_{3Th}$
   Counts at T_2 due to thorium and uranium $= C_2 - C_{2B} = C_{2(U+Th)}$

4. Counts at T_2 due to uranium only

$$= C_{2U} = C_{2\,(U+Th)} - 3.5\,C_{3Th}$$

C_{2U} = Net counts per minute in threshold 2 due to uranium after the subtraction of all background and thorium counts. C_{2U} can then be applied toward a quantitative estimate of grade as per Section 6-4.

C_{3Th} = Net counts per minute in threshold 3 due to thorium after the subtraction of the background counts.

6-4 QUANTITATIVE EVALUATION

The relationship between the counts per minute obtained from radioactive material and the assay grade of the material is subject to many variables.

Among these are; geometry of the material, distribution of the radioactive elements in the material, volume, density, distance of probe to source, background changes, and equilibrium state. The most dependable method of quantitative evaluation includes the control of as many of the variables as possible by establishing fixed procedures. The measurements on test samples are then related to accurately assayed samples of preferably the same or near the same grade as the grade of the test samples.

In-situ measurements are more difficult to relate because of lack of control on the source. However, several considerations can be applied to minimize the variables.

To enhance the usefulness of the instrument on initial applications, an approximate relationship between counts per minute and grade is tabulated below. The operator is cautioned to use these as approximations only until verification with assayed samples can be obtained. Assumption is made that the uranium is in equilibrium.

TEST CONDITIONS

5 lb. Sample: The diameter of the container containing 5 lbs. of crushed material was 4-1/2 inches.

The probe was brought into contact with material through the top of the container.

In-Situ: The readings shown in the in-situ column were extrapolated from the approximate emperical relationship between hand samples and the same material of homogeneous consistency in-situ, as follows:

5 lb. Sample (probe in contact with sample material	2π Geometry (probe in contact with flat outcrop of the same material)	4π Geometry (probe recessed in ground so crystal is considered completely covered)
1 c.p.m.	10 c.p.m.	20 c.p.m.

GRADE LEVELS (Parts per million)

Uranium p.p.m.	T_2 c.p.m. 5 lb. sample	T_2 c.p.m. 2π Geometry	Thorium p.p.m.	T_3 c.p.m. 5 lb. sample	T_3 c.p.m. 2π Geometry
10	5	50	10	-	15
100	50	500	100	15	150
1,000	500	5,000	1,000	150	1,500

T_2 = net counts for uranium = C_{2U} (Section 6-3)

T_3 = net counts for thorium = C_{3Th} (Section 6-3)

APPENDIX 6

REPORT ON SURFICIAL GEOLOGY - L. Bayrock

BAYROCK AND REIMCHEN SURFICIAL GEOLOGY LTD.
SUITE 201 - 1429 DOMINION STREET
NORTH VANCOUVER, B.C.
CANADA
V7J 1B3

TELEPHONE: (604) 980-0215

August 18, 1976

Mr. D. A. Sawyer,
c/o Contact Airways,
Box 5175,
Fort McMurray, Alberta
T9H 3G2

Dear Don:

This letter is a preliminary report on the results obtained during the short field visit by myself and Dr. Gerhard Bihl to your camp at Archer Lake, Alberta. We arrived at the camp on July 27 and departed on July 31, 1976.

Besides the discussions, we held on the genesis of surficial deposits of the area, I, in the company of yourself and Mr. Bruce McWilliams, examined eleven locations on the ground. At these locations short traverses were conducted, surficial materials described and sampled, and pebble or boulder counts performed.

Aerial photo interpretations of surficial deposits of the area to a scale of 1:25,000 with a legend has been submitted to you in the camp.

SURFICIAL DEPOSITS AND THEIR ORIGIN

The field checking of surficial deposits of the Norcen mineral lease confirmed to a large extent the initial aerial photo interpretations.

...2

Most of the surficial deposits underlying the surface of the lease area are end moraine, outwash and muskeg. Deposits underlying relatively small areas are crevasse fillings, eskers, ground moraine and aeolian sand.

Till

Till is unsorted material deposited directly from a glacier. It is composed of different proportions of materials over which the glacier flowed.

Till may be deposited during the active stage of a glacier as lodgement till or later, during the retreat, as basal or ablation till.

Ground moraine till is made of materials having been present close to the base of the glacier. Ablation till is till composed of materials positioned relatively higher in the glacier.

End moraine is made of till and glaciofluvial materials deposited during a time when the glacier front was more or less stationary. Generally, end moraines represent relatively thick accumulation of glacial debris of relatively distant origin. Ground moraine is a relatively thin deposit of till containing a significant proportion of local materials.

Outwash is made of sand and gravel present in the glacier. Outwash present in part of an end moraine is composed thus of materials worked out from the end moraine.

...3

Crevasse fillings and kames in end moraine are made of outwash or till of the same origin as the end moraine.

Eskers may on occassion erode bedrock underlying its course thus incorporating some material of relatively local origin.

Surficial deposits underlying most of the lease area are either end moraine with the associated crevasse fillings and kames or outwash plains derived from the end moraines. Both of these groups of deposits are thick; end moraines 100 to 300 feet and outwash plains 50 to 200 feet.

Ground moraine in the lease area is generally drumlinized and forms only a very small proportion of the total surface. In thickness the ground moraine is estimated to be from 10 to 50 feet.

On the accompanying maps are shown areas of ground moraine and eskers. These were prepared on your request to aid prospecting during this year.

Pebble Counts

Pebble count results obtained during the field visit to your camp and supplemented from my 1969 fieldwork, are shown on a separate map included here. The map is a xerox reproduction of a portion of the Research Council of Alberta Geology Map of Northern Alberta.

The map shows a line of 95 per cent Athabasca sandstone. Athabasca Formation edge should be present to the northeast of this line.

...4

Aerial photo interpretation was performed on landforms which may indicate Athabasca sandstone boundary. The new interpretation is based on the fact that well developed drumlins are present on the sandstone but not on the crystalline basement complex. The aerial interpretation boundary is shown also on the Pebble Count map. This boundary is positioned a significant distance to the northeast of the 95 per cent Athabasca sandstone pebble line.

It is highly probable that the actual boundary is present northeast of the aerial interpretation border. The distance may be anywhere up to 5 miles to the northeast. It is thought that a distance of 10 miles would be excessive.

RESULTS

Pebble counts show a difference between Athabasca sandstone domain and the crystalline basement complex to be at about 95 per cent Athabasca sandstone content. This amount is significant but difficult to use as a ready key in the field. In order to have meaningful results numerous pebble and cobble determinations will have to be conducted. If the 95 per cent Athabasca sandstone pebble concentration border could be better defined, it would show more accurately northeast of where the border is positioned.

It would be desireable to extend the pebble counts to the areas of ground moraine as shown on the accompanying maps. If significant amounts of crystalline rocks will be found, then, it could be stated that the Athabasca sandstone border is positioned to the northeast of there. Unfortunately, the converse is not necessarily true. If no increase in crystalline rocks will be found there, it may still be possible to have crystalline rocks underlying the area. In

...5

this case, they would not have been eroded by the glacier.

It is indeed unfortunate that most of the Norcen lease area in Alberta is underlain by thick and of distant origin outwash plains and end moraines. These effectively obscure the underlying topography and make the study of tracing of erratics to their source very difficult.

The final report on this study will be submitted to you at a later date.

Sincerely,

[redacted]

L. A. Bayrock, Ph.D.

LAB/mp
Encls:

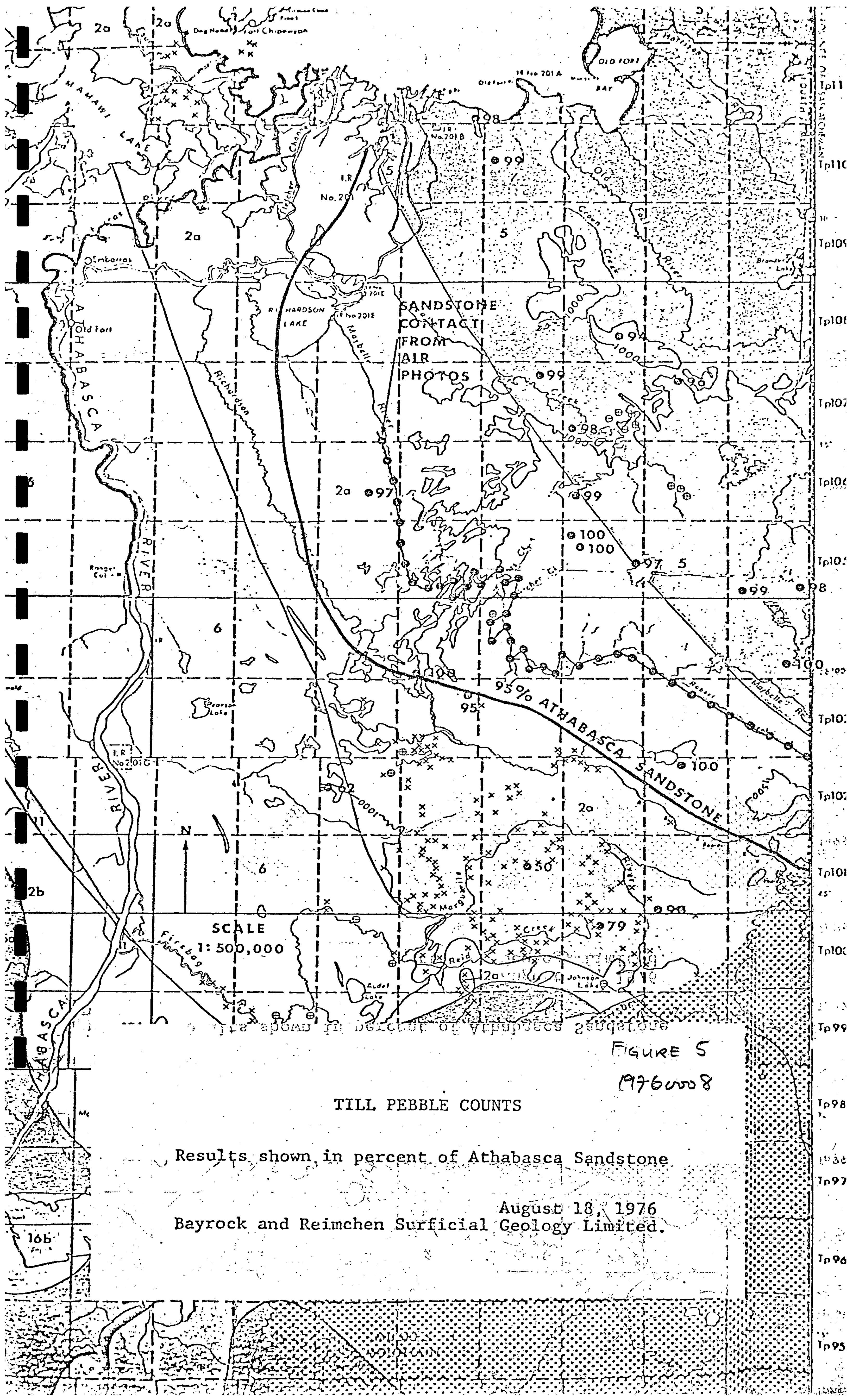


FIGURE 5

1976008

TILL PEBBLE COUNTS

Results shown in percent of Athabasca Sandstone

August 18, 1976

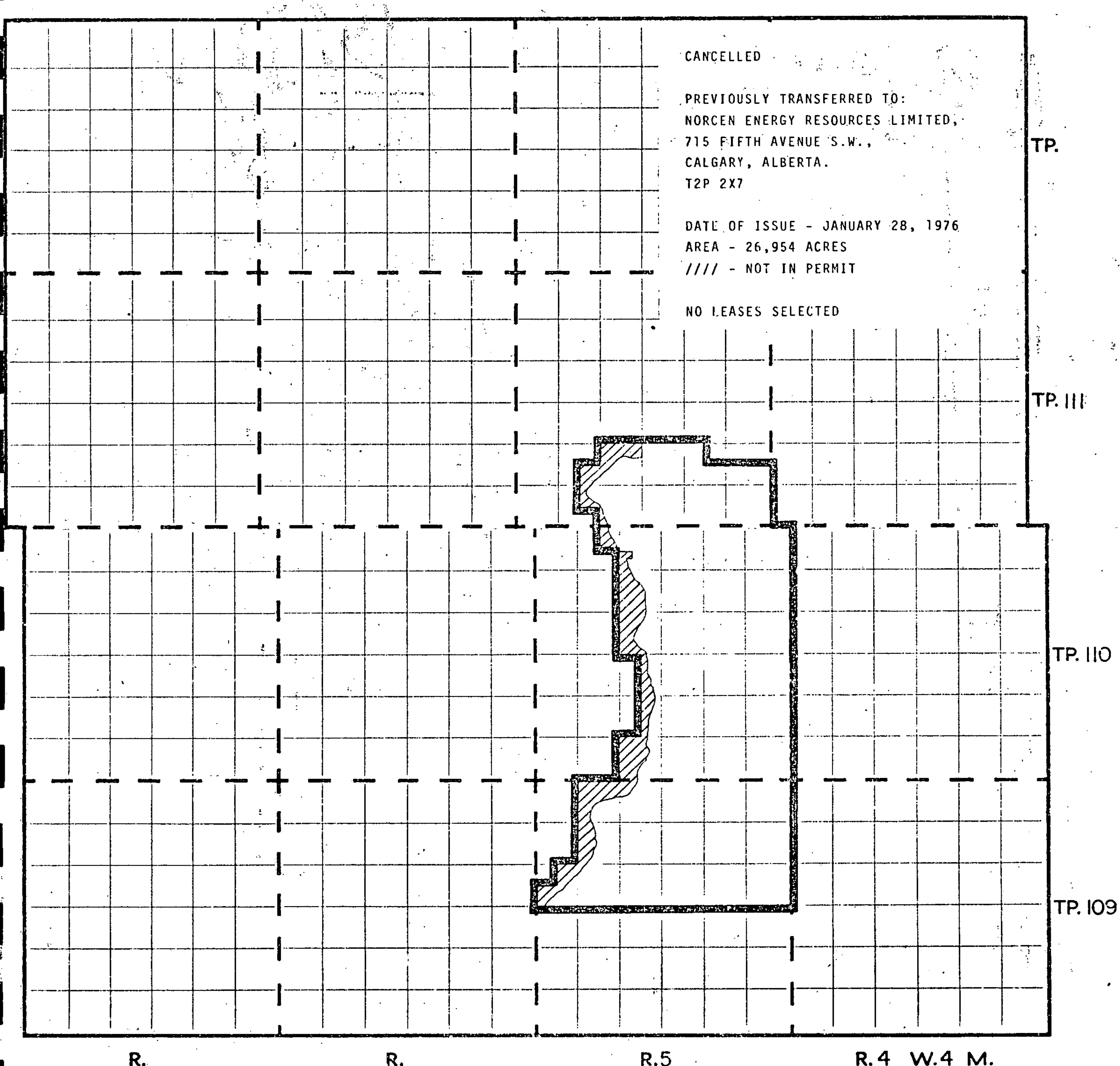
Bayrock and Reimchen Surficial Geology Limited.

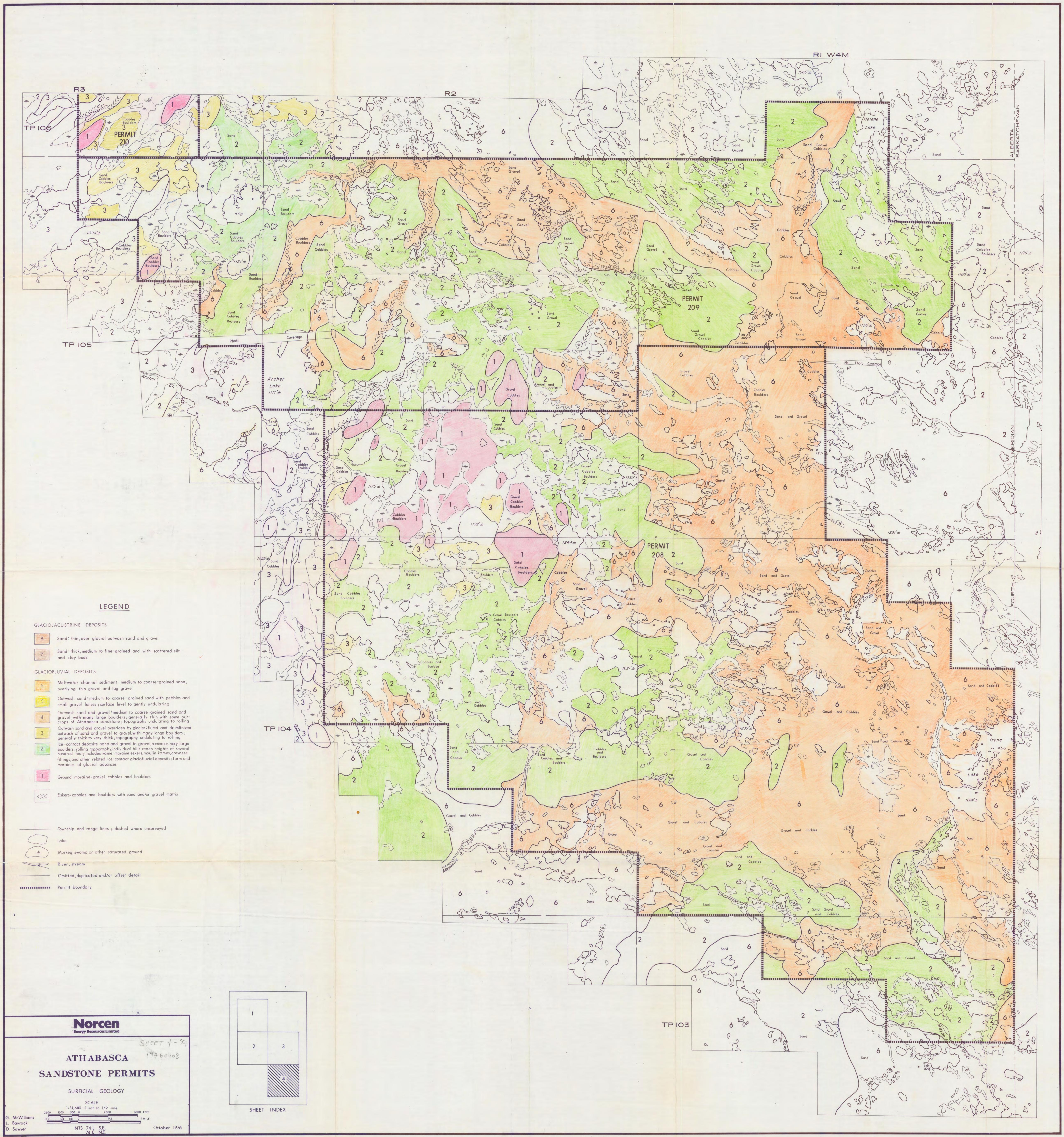
PROVINCE	PROJECT	AFE NO.
ALBERTA	NORTHEASTERN ALBERTA	01-62401 01-62401-1

DESCRIPTION	AMOUNT	OVERHEAD 10%	OVERHEAD 5%	TOTAL
Contractor & Consulting Fees				
Base maps and Lineament Study G.S.I.	$ 6,287.50		$ 314.38	
Geochemical Consulting - Barringer	$ 955.87		$ 47.79	
Surficial Geology Consulting - [redacted]	$ 6,154.40		$ 307.72	$ 14,067.66
Equipment Rentals and Chemical Analysis				
Geochemical Analysis - Loring Lab	$ 4,757.00		$ 239.95	
Scintillometer Rentals - McPhar Exploranium	$ 6,636.95		$ 331.85	
Telephone rental & toll charges - A.G.T.	$ 950.50	$ 95.05		
Truck Rentals	$ 690.23	$ 69.02		$ 13,770.55
Helicopter & Fixed Wing				
Helicopter - Shirley	$55,620.93		$ 2,781.05	
Fixed Wing Service Flights - Contact Air	$ 2,804.60		$ 140.23	
Camp Mob & Demob - LaRonge	$10,438.49		$ 521.92	
Helicopter Fuel	$ 5,822.19	$ 582.21		$ 78,711.62
Salaries				
732 days @$55/day	$41,097.75	$ 4,109.76		
39 days @$125/day	$ 4,875.00	$ 487.50		$ 50,570.01
Transportation				
Equipment and Fuel	$ 1,681.84		$ 84.09	
Personal	$ 1,678.15		$ 83.91	
Accommodation - Personal	$ 785.85	$ 78.59		$ 4,392.43
Camp Costs				
Equipment	$ 9,319.98	$ 932.00		
Food	$ 5,369.31	$ 536.93		
Other	$ 1.219.92	$ 121.99		$175,001.13
TOTALS	$167,146.46	$ 7,013.05	$ 4,852.89	$179.012.40

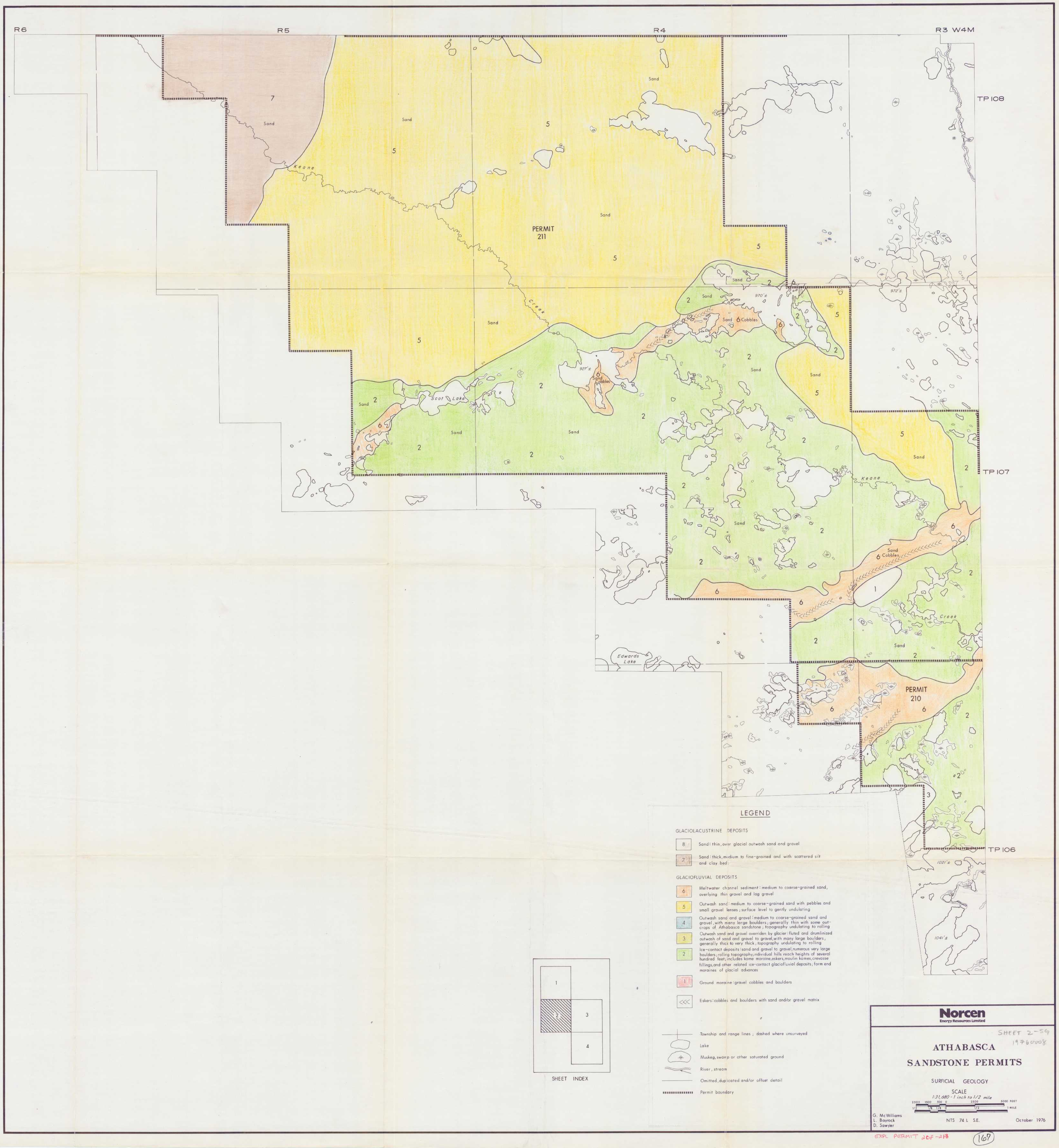
19760008

QUARTZ MINERAL EXPLORATION PERMIT No. 213





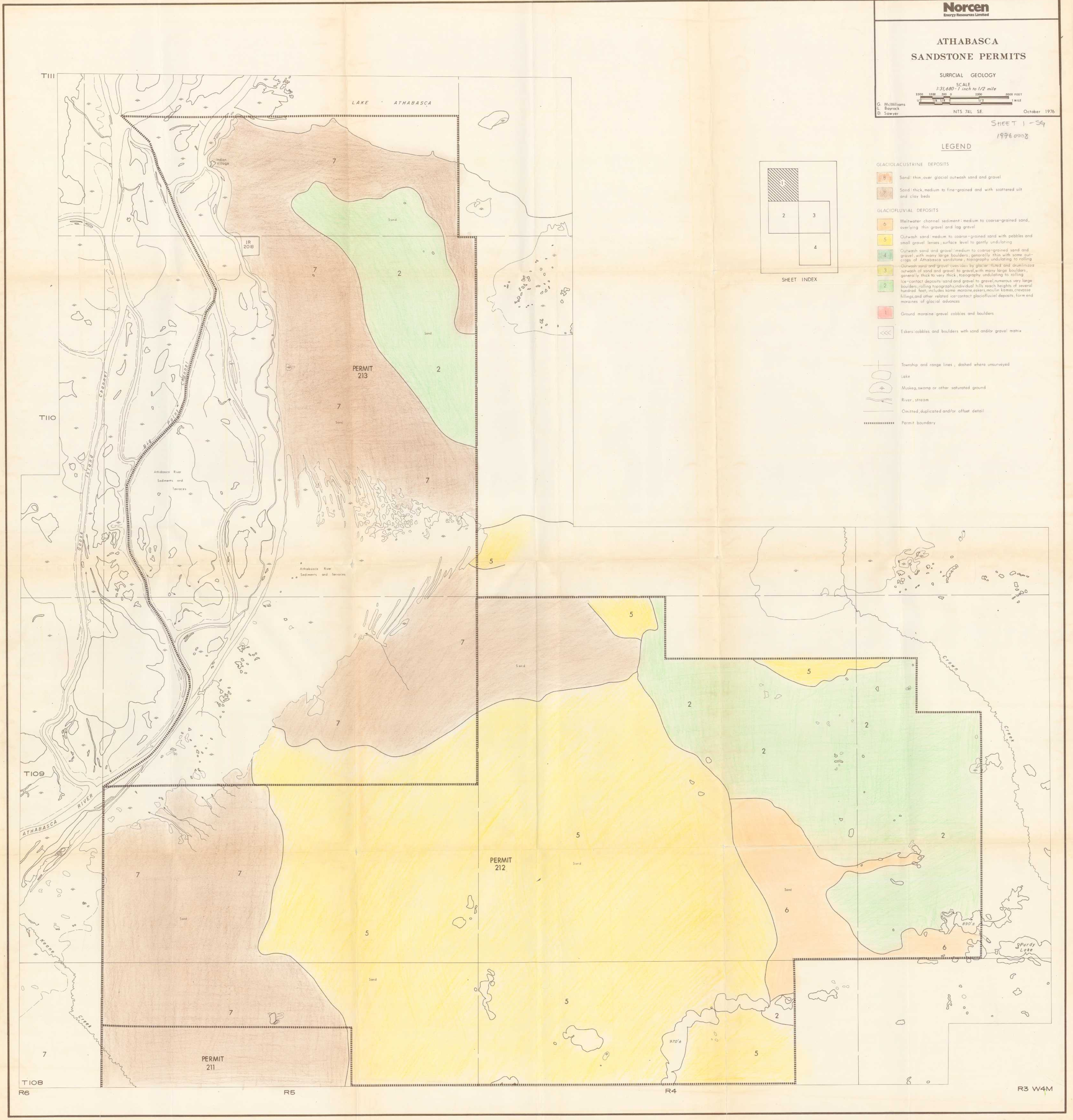
R3
R2
R1 W4M
TP 106
TP 105
TP 104
TP 103
PERMIT 210
PERMIT 209
PERMIT 208
ALBERTA
SASKATCHEWAN
FOURTH MERIDIAN
Archer Lake
Helene Lake
Irene Lake
Maybelle R.
No Photo Coverage
SHEET INDEX
LEGEND
GLACIOLACUSTRINE DEPOSITS
8 Sand: thin, over glacial outwash sand and gravel
7 Sand: thick, medium to fine-grained and 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 glacial advances
1 Ground moraine: gravel cobbles and boulders
<<< Eskers: cobbles and boulders with sand and/or gravel matrix
Township and range lines; dashed where unsurveyed
Lake
Muskeg, swamp or other saturated ground
River, stream
Omitted, duplicated and/or offset detail
Permit boundary
Norcen
Energy Resources Limited
SHEET 4-SG
19760008
ATHABASCA
SANDSTONE PERMITS
SURFICIAL GEOLOGY
SCALE
1:31,680 - 1 inch to 1/2 mile
2500 1500 500 0 2500 5000 FEET
1/2 1/4 1/8 0 1/2 1 MILE
G. McWilliams
L. Bayrock
D. Sawyer
NTS 74 L S.E.
74 E N.E.
October 1976
165
EXPL PERMIT 208-213

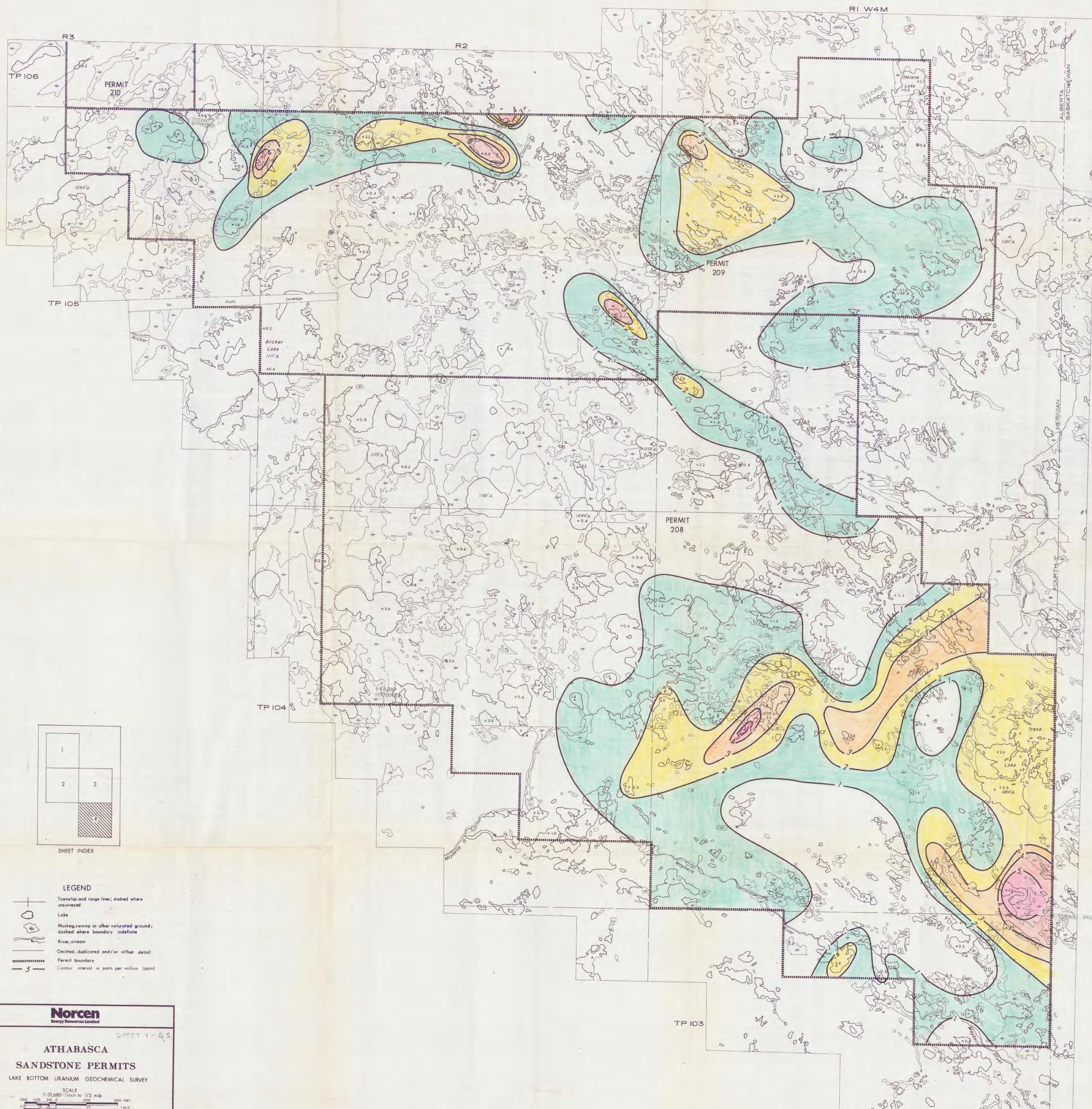


EXPL PERMIT 208-213

EXPL PERMIT 208-213

166





LEGEND

- Township and range lines; dashed where unsurveyed
- Lake
- Muskeg, swamp or other saturated ground; dashed where boundary indefinite
- River, stream
- Omitted, duplicated and/or offset detail
- Permit boundary
- — 5 — Contour interval in parts per million (ppm)

Norcen
Energy Resources Limited

SHEET 4 - G.S.

ATHABASCA SANDSTONE PERMITS

LAKE BOTTOM URANIUM GEOCHEMICAL SURVEY

SCALE
1:31,680 - 1 inch to 1/2 mile

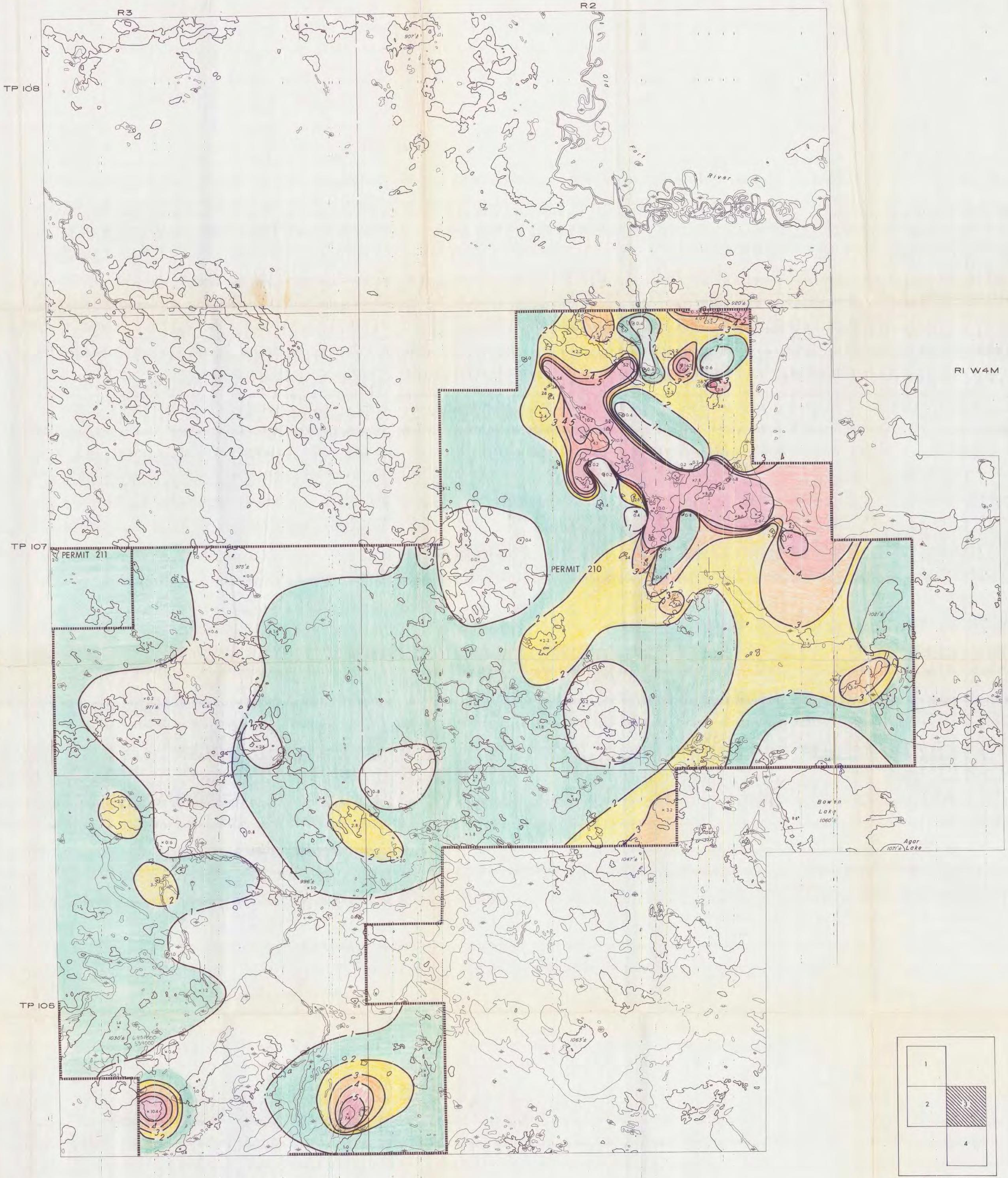
G. McWilliams
D. Sawyers

NTS 74 L S.E.
74 E N.E.

October 1976

(170) EXPL PERMIT 208-213

EXPL PERMIT 208-213



SHEET INDEX

LEGEND

- Township and range lines; dashed where unsurveyed
- Lake
- Muskeg, swamp or other saturated ground; dashed where boundary indefinite
- River, stream
- Omitted, duplicated and/or offset detail
- Permit boundary
- —5— Contour interval in parts per million (ppm)

Norcen
Energy Resources Limited

SHEET 3 - G3

ATHABASCA SANDSTONE PERMITS

LAKE BOTTOM URANIUM GEOCHEMICAL SURVEY

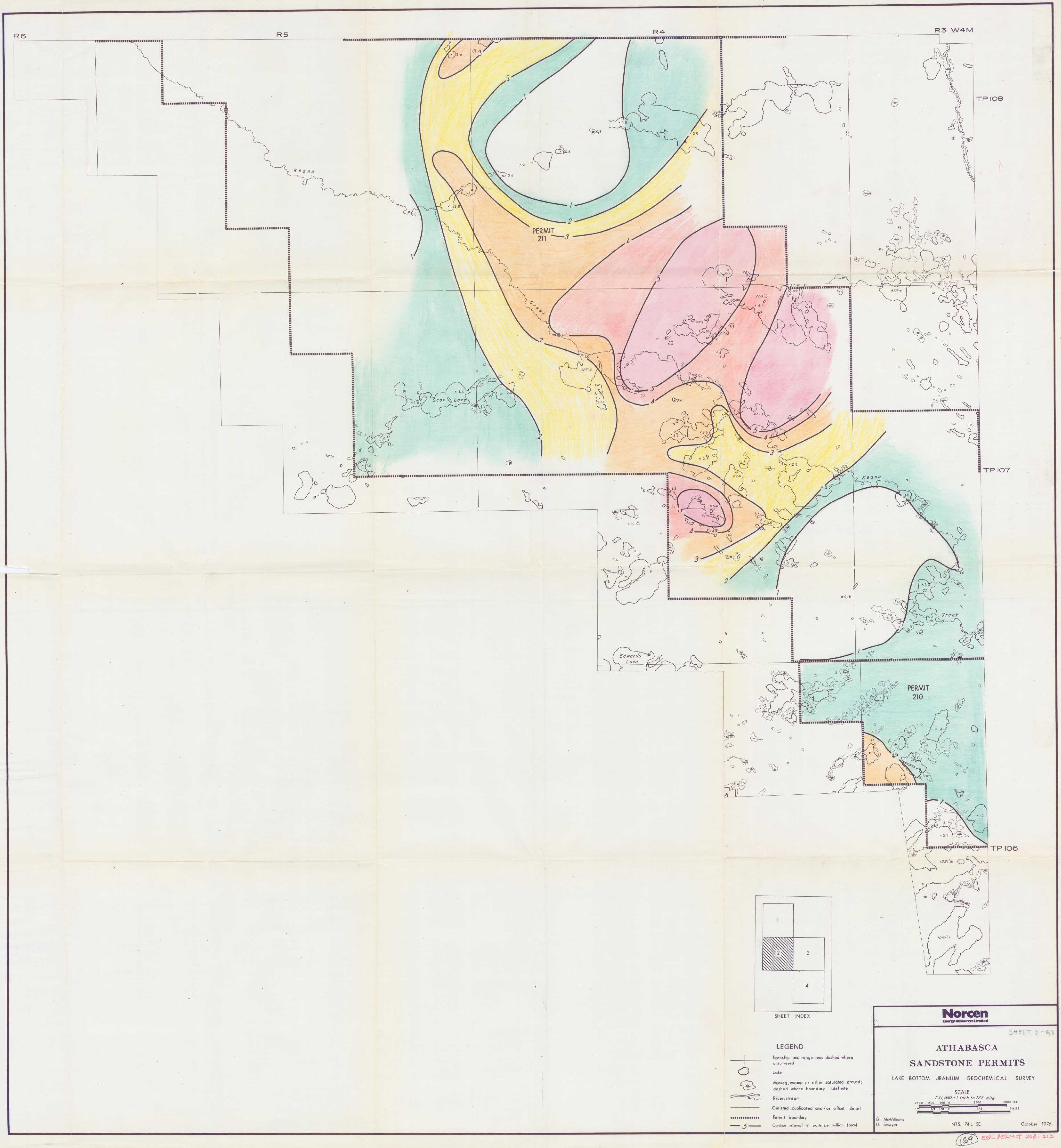
SCALE
1:31,680 - 1 inch to 1/2 mile

2500 1500 500 0 2500 5000 FEET
1/2 1/4 1/8 0 1/2 1 MILE

G. McWilliams
D. Sawyer

NTS 74 L SE

October 1976



LEGEND

Township and range lines; dashed where unsurveyed

Lake

Muskeg, swamp or other saturated ground; dashed where boundary indefinite

River, stream

Omitted, duplicated and/or offset detail

Permit boundary

Contour interval in parts per million (ppm)

Norcen
Energy Resources Limited

SHEET 2 - GS

ATHABASCA SANDSTONE PERMITS

LAKE BOTTOM URANIUM GEOCHEMICAL SURVEY

SCALE
1:31,680 - 1 inch to 1/2 mile

G. McWilliams
D. Sawyer

NTS. 74 L SE.

October 1976

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EXPL PERMIT 208-213 (171)