GEOLOGICAL RECONNAISSANCE REPORT

P. & N. G. PERMITS NOS. 3002 TO 3005, INCLUSIVE

CAEN LAKE AREA, NORTHWEST TERRITORIES

Prepared For

Glacier Explorers Limited

March, 1961

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To accompany Geological Report to Glacier Explorers Limited, March 1961

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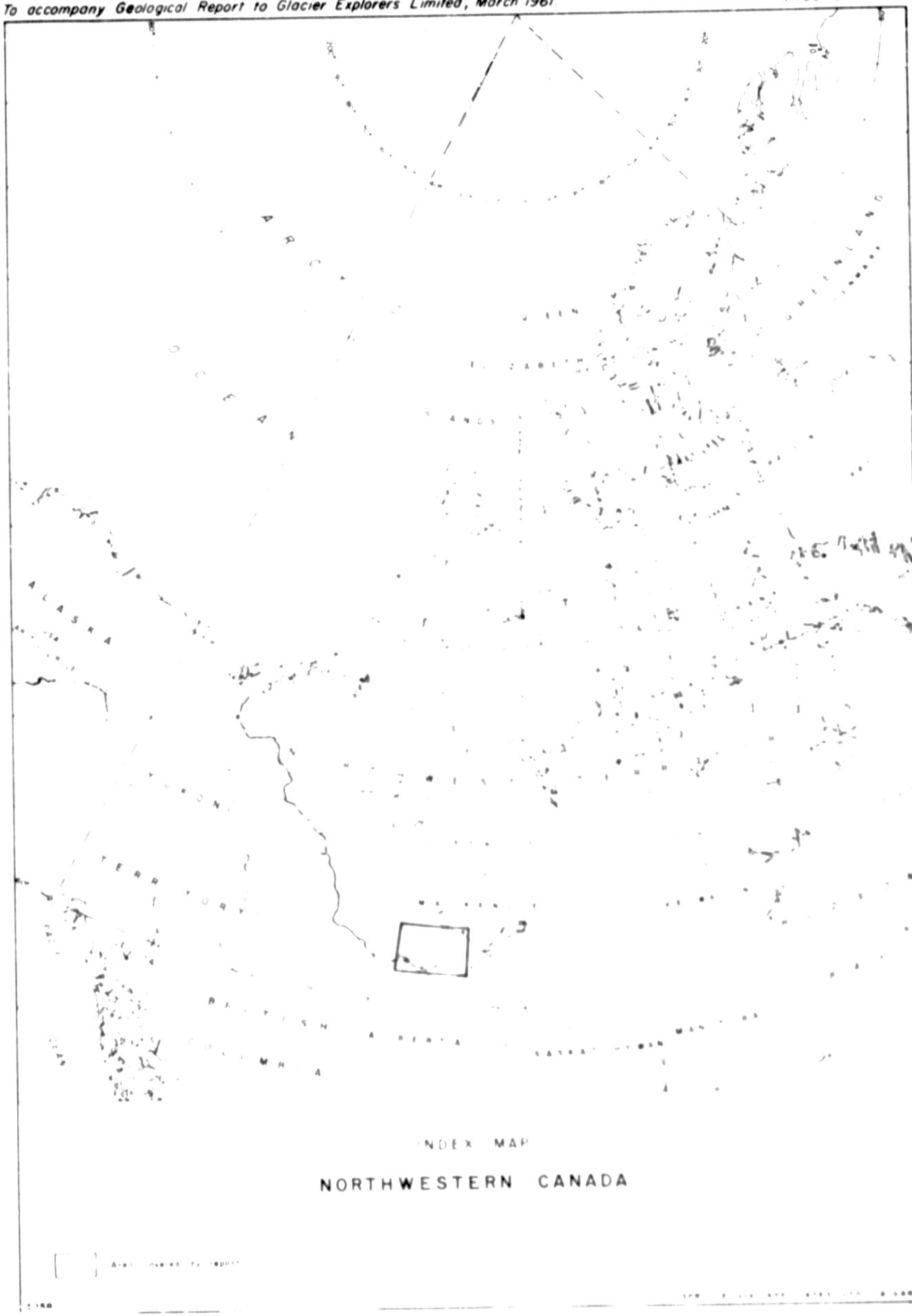

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INTRODUCTION

Description of Project

This report presents the results and conclusions of a combined geological and photogeological survey of P. & N. G. Permits Nos. 3002 to 3005, inclusive, in the Caen Lake area, Northwest Territories, conducted by J. C. Sproule and Associates Ltd. during the summer of 1960 at the request of Mr. R. Brodie Hicks, General Manager of Glacier Explorers Limited, hereinafter referred to as the "Company." The objective of the field study was to evaluate the petroleum and natural gas prospects of the Company Permits by detailed mapping and subsurface studies of the stratigraphy and structure found within the limits of the Permits and in the general vicinity. Supplementary to this work, extensive studies of the airphotographs and photomosaics were made prior to, during, and subsequent to, the field work. This photogeological work proved to be one of the most important aspects of the study, primarily because it is a type of investigation which can be done, not only in the office, but also in the field as a necessary supplement to examination of the rocks at the outcrop.

Petroleum and Natural Gas Permits Nos. 3002 to 3005, inclusive, held by the Company, are situated approximately between 61° 40' and 61° 30' North Latitude and between 116° 15' and 117° 15' West Longitude. The Permit area is more or less bounded on the southwest by Caen Lake and on the southeast by Dieppe Lake. The southern boundary on the Yellowknife Highway is located approximately 30 miles northeast of Fort Providence, Northwest Territories.

Due to the general inaccessibility of the study area, transportation to outcrops within it was accomplished by air. For transport in the field, a Bell Model G-1 helicopter (Plate 1-A) owned by J. C. Sproule and Associates Ltd. was used. The move into the area and fuel deliveries were accomplished by a light truck.

The field work was conducted under the supervision of G. V. Lloyd, who was assisted in the field by senior geologist N. N. Peterson. The helicopter crew consisted of J. D. Durkie, pilot, and H. Carmichael, engineer. The source

of fuel for the aircraft was Hay River, Northwest Territories. Accommodation was obtained near Fort Providence, N.W.T. at a construction camp operated by McNamara Construction Company Ltd.

In addition to an examination of the Permit area, the field study was expanded to include a study of those outcrops which occur to the southeast in the vicinity of Falaise Lake and along the northwest shore of Great Slave Lake. The additional area provides an extension of the control necessary to predict the subsurface section. It was also found necessary, in order to make the studies as complete as possible, to include subsurface studies of the region. The regional discussion of the broad area, outlined on Figure III, adjacent to the Permits is based on information derived from the available geological literature.

Through an exchange arrangement which the Company effected with Imperial Oil Limited, well data were obtained for the following three wells:

Imperial Triad Davidson Creek P-2
Lat. 62° 11' 11" N. and Long. 118° 15' 11" W.

Imperial Windflower G-77
Lat. 62° 56' 26" N. and Long. 118° 59' 02" W.

Imperial Triad Harris River F-71
Lat. 62° 20' 21" N. and Long. 120° 14' 30" W.

These three wells give geological control in the area to the northwest of the Company holdings. The data from these three wells, together with the data from wells to the south and southwest, permit the construction of subsurface maps which are an important supplement to the outcrop data. Because the outcrops are scattered, with no single outcrop exposing a thick stratigraphic section, it is only by means of well control that a reasonably accurate picture of formation thicknesses and the areal changes in thickness and rock character can be ascertained.

The field work involved traverses by helicopter along not only the major creeks and ridges in the area but also a grid coverage of the entire Permit block. In addition, as mentioned previously, trips were made beyond the Permit boundaries. An attempt was made to examine all outcrops visible near the Permits and, where practical, these sections were measured, described, and sampled in detail so that the geological section and structure could be mapped with as much confidence as possible. Most of the outcrops, however, were found to expose only thin sections, such as that shown on Plates 3-A and 4-A. Fossil collections were made wherever possible and searches were conducted for direct evidence of oil or gas, such as oil-stained outcrops (Plate 5-A) and oil or natural gas seeps (Plate 5-A).

The field party arrived in Hay River on Thursday, September 8th, and departed from there for Calgary on Wednesday, September 21st. The base camp was

established near Fort Providence, about 30 miles southwest of the Permit area. The geologists were transported by helicopter each morning from the base camp to the outcrops where they were working and were flown back to camp in the evening. Due to the small size of the outcrops, however, the helicopter was mostly used by a single geologist conducting traverses along a systematic pattern throughout the Permits and adjacent regions. Establishment of gas caches by truck along the Yellowknife Highway near Caen Lake enabled the helicopter to refuel during these traverses without returning to camp.

The report presented herein describes the details of the geological features of the Caen Lake area gathered during the course of this field study. The report is illustrated by an index map, a detailed geological map, and two photomosaics, a generalized geological map and cross-section, and subsurface isopach and structural maps. Colour photographs which show methods of operation and aspects of culture, geology and terrain are also presented in this report.

Previous Work

Due to the remote location of the Permit block relative to native settlements and transportation routes, there has been little detailed previous geological investigation in this region. The early explorers, beginning in 1789 with Alexander Mackenzie who descended the Mackenzie River, confined their traverses to main water routes.

A fairly large amount of geological information pertinent to the Mackenzie River drainage area and the northwest Great Slave Lake area is now available in maps and reports. Much of this material is listed alphabetically in the bibliography, which also includes references to some of the previous studies and results of drilling in the Great Slave Lake area.

Acknowledgments

Acknowledgment should be made first to the members of the Department of Transport at the airport at Hay River for the use of their facilities when required. Our appreciation is also extended to McNamara Construction Company Ltd., who allowed us to utilize their camp and radio facilities. Messages and supplies were expedited to the field party by Mrs. P. D'Aoust and family at Hay River, to whom acknowledgment for this service must be mentioned.

PHYSIOGRAPHY AND ACCESSIBILITY

Physiography

The Company Permit block lies northwest of Great Slave Lake, in the southern part of the Northwest Territories, about 30 miles northeast of Fort Providence, N.W.T. and about 80 miles southwest of Yellowknife, N.W.T. The town of Hay River, which is on the south shore of Great Slave Lake, lies about 60 miles to the southeast. The Permit block is poorly drained, and lies approximately across the drainage divide that separates the Horn River drainage system

from east-flowing creeks which drain toward Great Slave Lake. The rivers and creeks which drain the area are not prominent and most are small and not of extensive length.

Throughout much of the Permit area the elevation of the terrain is in the order of 700 feet above sea level. The height of Caen Lake is about 660 feet, which is about 150 feet above the elevation of Great Slave Lake. The Permit block is characterized by gently rolling topography with numerous small, linear, shallow lakes, and relatively little muskeg area. Ice flow features in the form of drumlins and fluting are common. Strand line features or indistinct beach ridges in the higher areas are also present nearby.

The Permit block is heavily wooded, chiefly by spruce. Poplar and birch also occur in the better drained places, especially along ridges.

Not only the Permits but also a large part of the surrounding area is covered by a mantle of glacial drift derived from Laurentide glaciation which greatly complicates the work of determining the stratigraphy and structure of the consolidated bedrock of the region. In contrast, the presence of large areas of outcrop to the east and south, especially near Faleise Lake and along the shoreline of Great Slave Lake, clarifies our interpretation of the geology exposed there.

In general, the Permit block lies within the Interior Plains, near the northwest shore of Great Slave Lake, in a forested area of fairly low relief and elevation that is locally modified by gentle hills which show glacial fluting and strand line features formed as a result of the effects of Laurentide glaciation. The down-cutting of the Mackenzie River through a dam of glacial material in the vicinity of Trout River greatly reduced the size of Great Slave Lake from its ancestral form and left strand lines far inland from the present lake.

Accessibility

The Permit area is accessible during either winter or summer by the Yellowknife Highway which leads westward from Hay River near the south shore of Great Slave Lake to Fort Providence, where the Mackenzie River is crossed by means of a ferry. From the ferry landing the road heads northeasterly to Yellowknife and it is along this route, near Caen Lake, that the highway crosses the Permit block. The Mackenzie Highway extends south of Hay River to Grimshaw, Alberta, where it joins the Alberta Provincial highways system.

There is a small airstrip at Fort Providence, and airports serviced by schedule flights are located at both Yellowknife and Hay River. It was noted during the past summer that small wheel-equipped airplanes were using the highway as a landing strip in the vicinity of Caen Lake.

From our studies in the area of the Permits, it seems apparent that tracked vehicles could operate here throughout the year except, perhaps, for a short time during the spring thaw.

The accessibility of the Permits is determined primarily by its climate and secondarily by its remote location. The change-over from summer to winter conditions occurs in October and the converse takes place in May. Planes operate on skis between November and May, and float-planes operate between June and September. Planes on wheels can operate throughout the year from Hay River. The cross-country freighting takes place ordinarily on the frozen ground during the winter, although freighting by truck is now conducted throughout the year.

Climate

Climate forms a rather important part of the background necessary to the planning of an oil exploration program in the vicinity of the Permits. Several interesting features are presented herein, along with some general observations made by our field personnel during the past 11 years in the general vicinity of the Upper Mackenzie Valley.

The range of temperatures can be expected to be about 140° near the Permits, varying between the mean annual minimum of -55° F. and the mean annual maximum of 85° F. The climate is sub-arctic, that is, it is characterized by a season of long winters and cool, short summers of approximately three months with a mean temperature above 50° F. The mean annual frost-free period is about 80 days, with a growing season of some 130 days. The mean growing season precipitation is about 5 inches. The annual precipitation is 11 inches, with a 25 percent variability factor. The mean annual total snowfall is approximately 40 inches.

Although the summers are short, the hours of daylight are long, due to the northern latitude. The daylight is, for example, more or less continuous here during June, July and early August. In contrast to the many hours of daylight during the summertime, the winter has very few hours of daylight. The sun is low on the horizon in late November and December. There is, however, still enough light for normal activities during the wintertime day.

Winter begins usually in early October, with its first signs being the freezing of lake shores, swamps and smaller creeks. This is followed by the freezing of the larger rivers and lakes. The Mackenzie River, for example, usually freezes in early November, following a transition period which lasts through October. The river ice breaks up earlier than that on the lakes or sea. The lake ice is usually melted by mid-June, although small cakes of ice may remain on some of the larger lakes until as late as July. By November, depending on area and local weather of course, the ice on most lakes will be thick enough to support aircraft on skis.

The Permits lie near the limits of the permafrost zone. Permafrost or perennially frozen ground may be defined, on the basis of temperature, to exist where the ground temperature is always at or below 32° F. This definition implies that permafrost can exist without ice where moisture is lacking, such as in bedrock or in loose gravel. The depth to which the permafrost extends near the Permit is not known.

REGIONAL GEOLOGICAL SETTING

The lands held under P. & N. G. Permit by Glacier Explorers Limited in the Caen Lake area, which are the subject of this geological reconnaissance report, may be considered geologically to lie within the Upper Mackenzie Basin. The eastern side of the basin is formed by the Precambrian Shield. To the west lie the Mahanni Mountains. The southern extent is arbitrarily placed at the northern Alberta border, south of which lies the "Peace River Basin." The Franklin Mountains form the northwest boundary of the Upper Mackenzie Basin. The strata exposed along the borders vary in age from Precambrian to Pleistocene and, in addition to bore-hole data, provide considerable information concerning the beds expected to occur in the subsurface of the basin. Outcrops of consolidated bedrock are not present within the Permit block.

Deposition of sediments in the Upper Mackenzie Basin was initiated in Precambrian time and has continued, with numerous interruptions, until the present. Upwarps of the basin into the environment of erosion during certain geological periods have resulted in the destruction of the sedimentary record in many places. In the Permit blocks, Silurian, Late Devonian, late Paleozoic, Mesozoic and Tertiary strata are missing, although some are present nearby and in large regions of the western Northwest Territories and Yukon. The absence of formations of these ages indicates that an important hiatus exists between Devonian strata and the overlying Quaternary glacial deposits, and that pre-Devonian breaks in sedimentation are also present.

Rock outcrops near the Permit area vary in age from Cambro-Ordovician to Middle Devonian and Pleistocene. The Paleozoic beds occur in scattered outcrops along the shoreline of Great Slave Lake and in some small escarpments found inland, especially in the area east of Falaise Lake. Upper Devonian beds are found south of Mackenzie River along the banks of the Lakisa River and adjacent areas. In the Horn Plateau, which lies west of the Permits, Cretaceous sediments are present.

The formations of the Permit block form part of a homocline that dips gently to the southwest. The dip of the lower formations of Paleozoic age has been estimated to be in the order of 20 to 30 feet per mile southwest. There is strong evidence to suggest that the homocline has been locally faulted and also that the Precambrian surface upon which the overlying sediments were deposited was one of considerable relief.

STRATIGRAPHY

The stratigraphic section which is present in the general area of the Company holdings is summarized in the following table:

Table of Formations

Age	Group or Formation	Lithology	Estimated Thickness Feet (1)
CENOZOIC Quaternary Pleistocene and Recent	Unnamed	Unsorted and unwashed glacial till of uncemented coarse sand, gravel and igneous boulders in a clay matrix. Overlain in part by deposits of washed gravels representing eskers or strand lines.	100+
		- UNCONFORMITY -	
MESOZOIC Cretaceous	Unnamed	Sands and shales.	Present only to the west of the Permits.
		- UNCONFORMITY -	
PALEOZOIC Upper Devonian	Alexandra	Limestones with basal sand.	Present only on south side Great Slave Lake.
	Hay River	Olive grey and grey-green shales with siltstones and minor limestones.	0-100
Middle Devonian	Horn River	Dark grey, soft, rubby, shale with rusty staining and sulphur encrustations. Probably equivalent to Slave Point limestone.	0-200+
	Slave Point	Limestone - light grey, fine-grained, granular, in part stromatoporoidal. Dolomite - medium grey-brown, granular, minor. Probably equivalent to Horn River shales.	0-200+

(1) Thickness in the vicinity of Company holdings.

Table of Formations - Continued

Age	Group or Formation	Lithology	Estimated Thickness Feet
	Fine Point-Presqu'ile	Limestone - brown cryptograined to fine-grained, well bedded, in part dolomite, fossiliferous, argillaceous and petroliferous with coarsely crystalline porous dolomite reef developed locally near top.	700
	Fitzgerald	Massive, fine granular limestone and dolomite with interbedded anhydrite and gypsum; locally brecciated.	300
Cambro-Ordovician	Unnamed	Thinly interbedded silty shales, argillaceous dolomites and gypsum, marked by brick-red colours in part with red weathering basal sand.	400-700
PRECAMBRIAN Proterozoic and Archaeozoic	Unnamed	Granitic and basic intrusives interbedded with conglomerate, arkose and dolomite and unconformably overlain by interbedded sandstone, quartzite, argillites, limestones and dolomites.	- -

Description of Formations

Precambrian Basement Complex

Not only is it useful to know the depth to the "basement" rocks but so something about them in order to evaluate the character of the erosional surface formed on them prior to deposition of the overlying beds and to note also the presence or absence of regional fault zones or zones with weakness. There are no Precambrian outcrops near the Permits. Several wells in the general area have, however, been drilled into the Precambrian and abundant outcrops of Precambrian rocks are present along the North Arm of Great Slave Lake. The discussion of these rocks which follows summarizes the work of Douglas

(1959, p. 10). Further information is also available in the studies of Douglas and Norris (1959) concerning the Horn River map-area.

The oldest Precambrian rocks consist of the Point Lake-Wilson Island group in the general vicinity of the delta of Slave River. Sedimentary gneiss and schist are found in the Point Lake beds, and the Wilson Island group consists of acidic lava flows interlayered with conglomerate and arkose, some quartzite with dolomite and schist, and phyllite and schist. The granitic rocks are formed of granite, granodiorite, quartz diorite, garnetiferous sedimentary gneiss and chloritic granite. These are known to be in part younger than the Point Lake-Wilson Island group.

Unconformably overlying these rocks is a group consisting of sandstone, quartzite, conglomerate, argillites, oolitic iron-bearing limestones and volcanic rocks that are followed upward by limestones and dolomites with algal structures. These, in turn, are locally overlain by varicoloured dolomite, shale, limestone and breccia overlain by shale and sandstone and capped by lava flows. This entire sequence of rocks comprises the Great Slave group.

The contact between rocks of Archean age and those of Proterozoic age is placed by Douglas (1959, p. 9) at the unconformity which exists between the sedimentary and volcanics of the Great Slave group and the underlying granitic rocks.

The Great Slave group and the older rocks are intruded by a series of sills, dykes and stocks of dioritic rocks.

A conglomerate unconformably overlies these and the older groups. This conglomerate forms a unit that is known as the Et-then series and consists of up to several thousand feet of beds. It is overlain by sandstone and quartzites.

Both the Proterozoic and Archean rocks are cut by large faults, according to Douglas (1959, p. 11), who also notes that the Et-then series is disrupted by diabase sills and dykes which are later in age than the faults.

From a survey of the literature of the Yellowknife area, it seems apparent that a close parallel exists between regional trends in the Archean sediments and those of the Paleozoic sediments, which indicates that the fundamental tectonic framework of this region is a very ancient feature. This subject is discussed more fully in the chapter dealing with Structural Geology.

A well which was drilled along the strike of rocks of the Permit block, Northwest Territories Windy Point No. 1, encountered granite at a driller's depth of 1,705 feet, or 1,225 feet below sea level.

Cambro-Ordovician

The oldest Paleozoic beds, unconformably overlying the Precambrian

basement complex and associated clastics, appear to have been deposited in a large evaporitic basin. Bright red interbedded shales, dolomite and anhydrite as well as some thick sections of salt are common in many wells and several outcrops. These have been referred to in several reports as the "Red Beds." Similar beds are present throughout much of the Upper and Lower Mackenzie Basins. Lithologically correlative strata from nearby area have previously been described as both Cambrian and Ordovician in age. As some doubt exists concerning their exact age and because we do not possess detailed fossil data, they are referred to collectively as of Cambro-Ordovician age in this report.

Approximately 100 miles northwest of the report area, near Mount Cap in the Franklin Mountains, Williams (Hume, 1954) described an estimated 1,300 feet of beds which consisted of 500 feet of red and green shales with salt and gypsum underlain by approximately 800 feet of pink and red quartzites, sandstones and conglomerates. These beds contained Lingulella, Bathyuriscus, Ptychoparia and Saratogia indicative of a Middle Cambrian age. Hume suggests that these beds are correlative with beds of similar lithology which have been mapped by him as the Cambrian Macdougal group in the Lower Mackenzie Basin.

Several deep tests in northern Alberta have encountered a very thin zone of red beds overlying the basal sands or Granite Wash. These beds may be correlative with the red shales, dolomites and evaporites exposed in the report area, at least in stratigraphic position if not in age.

During the course of the past field season a thin series of beds was examined at Gypsum Point (Plate 3-A and B) on the west side of the North Arm of Great Slave Lake. At this location the beds consisted of a dolomite which is shaly, and probably slightly silty, very fine crystalline to dense, thinly laminated and ripple marked to irregularly medium bedded. The dolomite is interbedded with white and pink finely crystalline gypsum in beds up to two inches thick. The outcroppings weather to a dull brick red (Plate 3-A and B). These beds were examined by Douglas (1959), who states they are lithologically similar to parts of a thicker sequence of strata which is well exposed north of Gypsum Point. Ordovician fossils were collected from these outcrops and on the basis of these Douglas places the red beds of this locality in the Ordovician. The beds exposed at Gypsum Point dip towards the southwest and may be expected to underlie the Company Permit area.

The red beds were penetrated in several of the wells that were studied in connection with the construction of the subsurface geological maps which accompany this report. The thickness of the red bed zone varies considerably and may, in fact, be absent from several wells which penetrated to the basement complex. The Windy Point No. 1 well penetrated 708 feet of thinly interbedded red shale, gypsum and salt marked by a thin red basal sandstone (Cross-section A-A'). Westward from this well the red bed sequence apparently thins. Forty miles west of Fort Providence, for example, in the Northwest Territories No. 2 well, which was drilled to the Precambrian basement complex, only 50 feet of brick red dolomite and anhydrite are present above the granite. South and west of Great Slave Lake the red bed interval was recognized in only one well of those

studied for this report. This well, Northwest Territories Desmarais Lake No. 1, is situated approximately 30 miles south of Deep Bay on the south side of Great Slave Lake. The section consisted of 210 feet of interbedded anhydrite and red shale with minor dolomite and sandstone. The reason for the absence of this unit in some wells is not clearly understood at this time, but may be related to topographic relief on the Precambrian erosional surface.

The red bed interval is present in two of the wells studied, northwest of the Company Permits. Imperial Triad Davidson Creek P-2, which is located on the eastern edge of the Horn Plateau, drilled through 533 feet of interbedded dolomite, shale, anhydrite and salt. The salt section is prominent in this well, one salt bed attaining a thickness of 235 feet. To the north of the above location, at Imperial Windflower G-77, 465 feet of interbedded sandstone, shale, dolomite and anhydrite were drilled which may comprise part of the red bed sequence. Salt was not reported from this well.

From the foregoing well and surface data, it appears that the red beds were deposited unconformably on the Precambrian basement complex and in places may be associated with a basal clastic unit, which is indistinguishable from the red beds. The irregular thickness of the unit suggests the existence of basement "highs" over which there was either non-deposition or erosional thinning previous to deposition of younger sediments. These red beds would tend to fill in topographically low areas and mask the erosional topography of the underlying basement complex.

The red bed unit appears to represent an evaporitic sequence which is lithologically correlatable over a large part of the Mackenzie Basin; however, as was previously mentioned, fossils collected from this unit vary in age from Cambrian to Ordovician. It seems possible that the red beds may represent a diachronous unit which was deposited in the deeper parts of the basin during Cambrian time but which did not transgress to the Great Slave Lake area until Ordovician time. Such an eastward transgression would explain the occurrence of Ordovician fossils near where the granite outcrops on Great Slave Lake and the Cambrian fossils found by Williams in the Cap Mountain area; however, this explanation is only offered tentatively, as additional stratigraphic and paleontological studies are required in order to arrive at a definite conclusion.

The red beds are expected to occur in the subsurface of the Permit area; their thickness can, however, only be roughly estimated. It should not exceed the 708 feet of beds found in the nearby Windy Point No. 1 well.

Lower or Middle Devonian

Fitzgerald Formation

Cameron (1922), was one of the early geologists to examine the Great Slave Lake area, and mapped a series of poorly exposed strata in the vicinity of Little Buffalo and Slave Rivers to which he applied the name "Fitzgerald" formation. The beds described by Cameron consist of grey dolomitic limestones

with interbedded gypsum and anhydrite which unconformably overlie red beds and are overlain by carbonates from which Devonian fossils have been collected. Strata, similar in lithology to the beds which Cameron placed in his Fitzgerald formation, had previously been described by Kindle (1917) from outcrops exposed along the Peace River to the south. Kindle reported Silurian fossils from these beds and stated that they were separated from carbonates of the Middle Devonian by an unconformity. In accordance with this earlier work Cameron placed the Fitzgerald formation in the Silurian mainly on the basis of the occurrence of gypsum in both sections. In order to arrive at a Silurian age for these beds it was necessary for Cameron to disregard the Devonian forms which he collected and which were mentioned briefly in his text.

More recent information indicates that these massive carbonates and anhydrites are, in fact, Devonian in age and not Silurian as believed by Kindle and Cameron. Douglas (1959) reports that fossils collected from near the base of the series have been provisionally established as Middle Devonian in age. He also confirms that the contact with the underlying red beds is unconformable and that the upper contact is conformable with the overlying Middle Devonian beds.

At Bell Rock on Slave River, Douglas reports a massive breccia of pale brown cryptograined limestone, dark brown laminated limestone and light buff dolomitic limestone in fault contact with a gypsum-limestone-shale sequence. No fossils were reported from the brecciated unit; however, it may be equivalent in age to the massive carbonates and interbedded anhydrites of the Fitzgerald formation.

Northwest of the Company Permits, in the Central Mackenzie Basin, a thick unit occupies a stratigraphic position similar to that of the Fitzgerald formation and may be correlative with it. The Middle Devonian carbonates of this area are in gradational contact with an underlying unit of massive limestone, dolomite and anhydrite known as the Bear Rock formation. In this area the Bear Rock formation overlies massive dolomites of Ordovician-Silurian age with angular unconformity. The Bear Rock formation is massively brecciated at many exposures, in which case the gypsum and anhydrite are normally absent. No significant fossils have been reported from the Bear Rock formation; its age is, however, fairly well established as either Lower or Middle Devonian. Without fossil evidence or additional subsurface data a definite correlation of the Bear Rock and Fitzgerald formations cannot be made at this time, on a basis, however, of similar lithologies and stratigraphic position, this correlation seems most probable.

No outcrops of the Fitzgerald formation were observed in the report area during the past field season. North of the Company Permits a large area has been mapped as this formation on the basis of photogeology and on the distinctive topography which consists of many slumped areas, shallow, small sinter lakes and sink-holes.

The Fitzgerald formation appears to dip southwestward beneath the Company Permits; however, in several of the wells studied in preparation of the accompanying subsurface maps, the formation was either absent or not

recognizable as a unit. This is especially so in wells where the total interval from the top of the Middle Devonian to the top of the Cambro-Ordovician beds is thin. The thin section present in some of the wells may indicate proximity to a basement high during deposition, which could account for the change of character of the sediments, rendering the formation lithologically unrecognizable, although still present as a time-equivalent. Cross-section A-A' (Figure VII) shows not only the wells in which the formation was recognized but also the thinning of the unit into the present structural low at Northwest Territories No. 1 well. This area, as revealed by the isopach map, was apparently a topographic or structural high during early Paleozoic deposition.

The thickness of the Fitzgerald formation underlying the Company Permits is unknown. Approximately 300 feet were drilled in the nearby Windy Point No. 1 well and this figure probably represents a maximum, as the formation appears to thin westward at least as far as the Northwest Territories No. 2 well, west of Fort Providence.

Middle Devonian

Pine Point-Presqu'ile Formations

Cameron (1922) divided what was then considered to be the Middle Devonian section in the Great Slave Lake area into three formations which he named, in ascending order, Pine Point, Presqu'ile and Slave Point. The exposures mapped by Cameron occurred along the lake shore and were all small and scattered across a wide area. On the basis of more recent surface and subsurface information it now appears that some of the divisions he applied are no longer applicable. It is for this reason that the Pine Point and Presqu'ile formations are grouped together in this report.

The Pine Point formation was described originally by Cameron at Pine Point on the south shore of Great Slave Lake. Several small exposures were measured by him which consisted of soft grey, shaly limestones, blue to black, thin-bedded, hard limestones and grey to brown shaly limestones. The limestones contained Middle Devonian fossils.

The Middle Devonian in the central Mackenzie River area is represented by a carbonate and shale sequence which conformably overlies massive dolomitic limestones and breccias of the Bear Rock formation. It is possible to approximately correlate the total Middle Devonian section of the central Mackenzie River area with the combined Pine Point, Presqu'ile and Slave Point formations of the Great Slave Lake area; there does not seem to be, however, a direct correlation of the Pine Point with any particular unit of the Middle Devonian section of the Mackenzie River area.

The Pine Point was examined during the past field season at several small outcrops on the northwest shore of Great Slave Lake as well as on South Cranberry Island. The beds consist of a light brown-grey limestone that is cryptocrystalline to sublithographic in texture with abundant small fragments of calcite and fossil debris. The bedding is thin and irregular and the unit

weathers to light grey cobbles. Several small crystals of galena in the limestone were noticed, none of which were obviously associated with fractures.

Cameron (1922) mapped several small exposures on Presqu'ile Point which he called the Presqu'ile formation. He described these beds as hard crystalline dolomites and dolomitic limestones with thin beds of shaly grey limestone. The type section at Presqu'ile Point contains only a few feet of beds exposed at water level but is abundantly fossiliferous, containing, among other Middle Devonian forms, the brachiopod Stringocephalus burtini. This brachiopod is regarded by Cameron and Kindle as being characteristic of the Presqu'ile formation.

In the central Mackenzie River area the upper part of the Middle Devonian carbonates is represented by a massive, often reefoid, limestone known as the Upper Ramparts member. This upper limestone is marked by the occurrence of several Middle Devonian corals and brachiopods including Stringocephalus burtini. From a faunal point of view it would seem probable, as suggested by Kindle (1917), that the two units are correlative; however, other factors must also be considered.

During the past field season several small exposures were mapped northeast of the Company Permits, in Sulphur Bay, which were recognized as part of the Presqu'ile formation as mapped by Cameron. These strata consisted of light brown, coarsely crystalline dolomite. The rocks were massive, unbedded and contained abundant vuggy porosity but no permeability. Sulphur springs flowed from several fractures and live oil flowed from several freshly fractured vugs. The exposure had the appearance of a reef in which fossil evidence had been destroyed by the process of dolomitization.

Westward from these surface exposures the Presqu'ile formation dips into the subsurface, where it loses its identity. It is possible, as suggested by Douglas (1959), that the Presqu'ile is correlative with part of the overlying Slave Point limestone. In his report on the Great Slave and Trout River map-areas Douglas regards the Presqu'ile as a reef phase of the overlying Slave Point formation and, as such, not everywhere present. The occurrence of Stringocephalus burtini in the uppermost limestone member of the Middle Devonian in the Mackenzie Basin and the occurrence of this same fossil in the Presqu'ile does suggest a closer association with the overlying Slave Point formation than with the underlying Pine Point formation. The Pine Point formation is recognizable in the small surface outcrops surrounding Great Slave Lake in positions that appear to be stratigraphically lower than the Presqu'ile dolomite. In the subsurface sections to the south and west, however, rocks with Pine Point lithology are sometimes present above the Presqu'ile, or the Presqu'ile may be absent. On the basis of subsurface studies, we have mapped the Presqu'ile as a reefoid member of the underlying Pine Point formation and it is shown as such on the accompanying maps, photomosaics, and cross-section.

Regardless of whether the Presqu'ile is a reefoid development of either the Pine Point formation or Slave Point formation, it does lose its identity in the subsurface to the west of Windy Point No. 1 well and to the west of

the surface exposures on Great Slave Lake. This is especially so where the early Paleozoic section is thin over areas which were topographically and possibly structurally high during Middle Devonian deposition, such as in the Northwest Territories Nos. 1 and 2 wells (Cross-section A-A', Figure VII). In the subsurface of the Glacier Explorers holdings, the Presqu'ile may be present as a dolomitized reef. It is expected, however, to occur at a very shallow depth. Douglas (1959) assigns a thickness of 0 to 150 feet to the Presqu'ile reef development and the latter thickness might be assumed to occur beneath the Company Permits.

Slave Point and Horn River Formations

The Slave Point and Horn River formations have lithologies which are distinct from one another and the formations were named from widely separated areas. More recent studies, however, especially in the Mackenzie Mountains, have indicated that these beds may be correlatable and they are discussed herein under the same heading.

Near Sulphur Bay and around Slave Point on Great Slave Lake, Cameron (1922) described grey shaly limestones overlying the Presqu'ile dolomites which he called the Slave Point formation. Cameron assigned a thickness of 200 feet to these limestones, although near Slave Point, which is apparently his type section, less than a total of 10 feet are exposed, most of which is a wave-washed rubble. Cameron collected Middle Devonian fossils from one small outcrop on the hills near Sulphur Bay which he considered to be Slave Point formation.

Correlation of the Slave Point formation with beds in the subsurface to the west of the Permits and with the Mackenzie Basin sediments is not definite. In many early wells the first limestone beneath the Upper Devonian shales have been referred to as the Slave Point formation, often without any conclusive evidence. On the basis of more recent information it now seems probable that the Slave Point formation is not always a carbonate and that the top of the Middle Devonian need not be represented by a limestone.

In the Lower Mackenzie Basin the upper limits of the Middle Devonian carbonates is represented by the uppermost limestone of the Upper Ramparts member. These limestones are overlain by black shales of the Fort Creek formation. Where the Ramparts section is complete this limestone overlies that part of the Upper Ramparts member which contains the Stringocephalus burtini fauna. As the Slave Point formation overlies the Presqu'ile dolomite, which also contains S. burtini, the most likely correlation of the Slave Point is with the upper limestones of the Upper Ramparts. Subsurface control, especially in the Norman Wells area of the Mackenzie Basin, shows that the Upper Ramparts member thins and thickens radically and, further, that where the Upper Ramparts limestones are thick, the overlying black shales of the Fort Creek formation are thin, and correspondingly where the limestones are thin the black shales are thickest. The contact between the limestone and overlying black shales is unconformable near Fort Good Hope, but at other localities it appears conformable. Where the contact is conformable the thinning of the limestone can be

explained as a facies change to black shale, and in the Mackenzie Basin the Fort Creek shales and Upper Ramparts limestones are considered to be probable time-equivalents of each other. In the Great Slave Lake area a somewhat similar correlation may be made involving the Slave Point limestone and the shales of the Horn River formation.

Whittaker (1922) applied the name "Horn River shales" to several small exposures on the Horn River upstream from Fawn Lake. Approximately 60 feet of these shales were reported in which no fossils were found but which were believed to be Middle Devonian on the basis of an overlying limestone which Whittaker mapped as Pine Point formation. Later work by Douglas (1959) has shown this limestone to be younger than Pine Point and possibly younger than Slave Point. The limestone is undoubtedly thin and probably represents only a local occurrence in a primarily black shale section. In a nearby well, Imperial Triad Davidson Creek P-2, the dark brown to black shales are overlain by green shales and no limestones are reported. The shales overlie limestones which are considered to belong to the Pine Point-Presqu'ile formation. From this more recent information it appears that Whittaker's Horn River formation, which he considered to be equivalent to the Cambro-Ordovician red beds, is in fact late Middle or early Upper Devonian. On a basis of lithology and stratigraphic position these shales are probably equivalent to the Fort Creek shales of the Norman Wells area. It is further suggested that these shales may have the same facies relationship with the underlying Slave Point as do the Fort Creek and Upper Ramparts formations.

Cross-section A-A' (Figure VII) shows that in the Deep Bay No. 1 well 215 feet of Slave Point limestone were penetrated below a green shale of Upper Devonian age. To the west, in the Northwest Territories Providence No. 1 well, the Slave Point is not recognisable as a formation; however, a brownish black bituminous shale is present underlying the Upper Devonian green shales and overlying the Middle Devonian limestones. From the above, and as a result of the apparent lithological correlation with the Norman Wells section, it is proposed that the Horn River brownish black bituminous shales are a facies change from the carbonates of the Slave Point formation.

In the subsurface of the Company Permits, it is expected that both black shale and limestone will be present. The Slave Point limestone may be thinner than the 215 feet found in the Deep Bay No. 1 well. On the basis of the photogeological interpretation of the glacial features it is considered, however, that the Slave Point, which is present immediately below the drift in the Permit area, will be composed essentially of limestones.

Upper Devonian

Hay River Formation

The Hay River formation is named from rock exposures along the lower portions of the valley of Hay River which flows northward into the south side of Great Slave Lake at the town of Hay River. These rocks were originally called the Hay River shales by Cameron (1922). The Hay River formation as now applied

includes all Upper Devonian beds above Middle Devonian beds and beneath the sand bed at the base of Alexandra Falls at Mile 35 on Hay River.

The Hay River formation comprises olive grey and grey-green shales with siltstones and minor limestone beds in the upper part.

The Hay River beds are expected to occur only in the southwest part of the Permit area, west of Caen Lake, where they will probably not exceed 100 feet in thickness.

Alexandra Formation

The Alexandra formation is a carbonate unit approximately 120 feet thick marked by a sand at the base. The type section is in the canyon below Alexandra Falls on Hay River at Mile 35 on the Mackenzie Highway, south of the town of Hay River.

This formation is local in extent and changes to a shale facies to the west. No evidence of this formation is known west of the 116th Meridian in the vicinity of Mills Lake. It does not occur in the Permit areas due to post-Devonian erosion and is included here only because it is shown on the geological maps accompanying this report.

Quaternary

Pleistocene and Recent

A mantle of glacial drift covers almost all of the study area. On the basis of well information, the drift thickens northwesterly from the shore of Great Slave Lake. Near Deep Bay, for example, less than 100 feet of unconsolidated buff to varicoloured, coarse to very coarse sand, gravel and boulders (mainly derived from such igneous rock types as granite) are present above the consolidated rocks. At the Davidson Creek well, about 400 feet of drift are present. Many of the smaller lake shores in this area, in addition to that of Great Slave Lake, as well as the beds of streams such as Hare River and the Mackenzie, are full of boulders of igneous rocks as large as 48 inches in diameter washed out of glacial boulder clay.

The surface area of the Company's Permits is dominated by ice flow features in the form of drumlins and flutings. The ice flow features near Caen Lake occur down to an elevation of about 600 feet and the direction of the movement of the glaciers indicated by these is southwesterly. These features are clearly visible on the photomosaics accompanying this report. Outwash esker, or wave-washed sand lines, consisting mainly of cobble and boulder gravels, are also present in the Permits. A good example of one of these is present on the north side of Caen Lake (Plate 3-A).

Bottom deposits and strand line features of the ancient proglacial lake that occupied the Great Slave Lake-Mackenzie River basin are also present

in the general area of the Permits. It has been stated by Craig and Fyles (1960, p. 8) that the highest beaches of this ancient lake are now slightly more than 900 feet above sea level and about 400 feet above the present level of the lakes. Indistinct beach ridges have been noted on some of the higher hills up to 800 feet above sea level by Douglas (1955, p. 6). It is also noted by Douglas that below about 800 feet it is difficult to differentiate drumlins from beach ridges without detailed ground examination.

Ice-crack moraine is a glacial feature common to parts of the Permit area, particularly in the southwest where it is believed the shales of the Hay River formation probably became mixed into the glacial ice. Ice-crack moraine is a feature associated with the disintegration pattern of the stagnating ice of a continental glacier. The accumulation of debris in the crevasses and fractures during times of melting ultimately leaves the pattern of the ice-cracks in slight relief on the land surface after the glacier disappears.

STRUCTURAL GEOLOGY

Structurally, the Permit block lies within the Upper Mackenzie Basin, an area which is part of the Interior Plains. The basin is limited on the west by the Mahanni Mountain Range and eastwards by the Precambrian Shield. Northwestern and southern boundaries of the Upper Mackenzie Basin are somewhat arbitrarily placed in the vicinity of the Franklin Mountains and at the southern boundary of the Northwest Territories.

The sediments of the area near the Permits form a homocline that dips gently southwestward at about 20 to 30 feet per mile, as indicated by the accompanying structure maps. Local variations in the amount and direction of regional dip may be expected and could have their origin in paleotopographic relief on the Precambrian erosional surface brought about by differential erosion on the Precambrian basement complex, or by faults, or a combination of both, or by solution or hydration of the evaporitic sequence known to underlie this area at a relatively shallow depth.

Northeast-trending faults have been mapped south of the Permits near Kakisa Lake, and to the southeast in the Pine Point area, on the south shore of Great Slave Lake. Several of these, including the prominent Providence fault near the Rabbit Lake No. 1 discovery well, are shown on Figure III. Douglas (1959), in addition to showing these on the map, presents a discussion of the Precambrian rocks and structure found on the east side of Great Slave Lake. It is from this discussion and from our own knowledge that the following observations are made.

The Precambrian strata are broken by northeasterly-trending faults that are mainly linear or arranged en echelon. Minor splays are noted. Their displacement is normal and apparently very large in places. Topographic relief up to 1,000 feet is recorded along the fault scarps in the East Arm region of

Great Slave Lake. Douglas writes that the faults form potential lines of weakness on which some Paleozoic or post-Paleozoic displacement may have taken place. Steep dips and minor folds, for example, are mapped at Fort Resolution and Dawson Landing, in Middle Devonian sediments.

These faults which are undoubtedly numerous under the glacial cover are important because of their contribution to the formation of potential oil traps and also because the relief which they caused on the sea floors of past periods, even though slight, affected the character of the overlying sediments. For example, numerous core holes in the Pine Point area show that Middle Devonian reef developments were localized along the fault zones.

OIL AND GAS POSSIBILITIES

A discussion of the oil and gas possibilities of this area can be separated into three parts: the direct or visible indications of oil and gas, such as seeps, the potentialities of prospective oil and gas reservoirs and source beds as revealed by geological studies, and the presence or absence of favourable structures within, or trending toward, the area under consideration. The following discussion attempts to summarize our opinions, in the light of present knowledge, about the oil and gas possibilities of the Company's holdings in the Caen Lake area.

Oil and Gas Indications

The oil potential of the Great Slave Lake area has long been recognized. The presence of oil seeps around the western shores of Great Slave Lake has been known since the earliest explorers visited this part of the Northwest Territories. Many claims, for example, were staked in 1914-15 for oil and gas in the vicinity of Windy Point on the basis of the oil seeps there. These seepages occur on bare outcrops of Presqu'ile dolomite which are exposed along the shoreline near Windy Point and Sulphur Bay. The dolomites are porous and oil stained; however, the oil seepages seemingly occur mainly along fractures and bedding planes in the dolomite (Plate 5-A).

Oil seepages from the Presqu'ile dolomite also occur in the vicinity of Presqu'ile Point, which is on the south shore of Great Slave Lake about 40 miles east of Hay River.

The number of oil-stained sections obtained in cores of the Middle Devonian beds in the general area around the west and southwest end of Great Slave Lake is impressive. In many places these intervals are oil saturated, and oil-bleeding cores have been recovered from several wells.

The core description of the Middle Devonian carbonate section in the Imperial Triad Davidson Creek well reports bleeding oil from vugs in an essentially tight limestone. Other wells which reported oil-bleeding cores from

the Middle Devonian carbonates are Northwest Territories Deep Bay No. 1, Briggs Northeast Tathlina Lake No. 2, and Briggs Rabbit Lake No. 1 and No. 2. Gas has been encountered in several wells and gas in large volume has been obtained from Middle Devonian rocks in the Briggs Rabbit Lake wells. At Escarpment Lake near the junction of the Yellowknife Highway with the Mackenzie Highway, south of Hay River town, free light gravity oil was obtained from the Slave Point formation, but the formation lacked sufficient permeability to make the well commercially productive.

Cold sulphur springs are of fairly common occurrence along the northwestern and southern shores of Great Slave Lake, and are especially notable near Sulphur Bay. An analysis of precipitates from near one of these springs reported by Cameron (1921, p. 398) indicated that abundant sulphates and carbonates of calcium with appreciable amounts of magnesium are present.

Prospective Formations

Faults or tectonic features that could involve the Precambrian rocks and overlying sediments are known to trend toward the general area of the Permit block. Secondary reservoirs may have been formed along these faults from fault breccias, in addition to the primary prospective reservoir beds outlined below. Contemporaneous sedimentation and movement along the fault may also have influenced the sedimentary environment during deposition, which could have led to the deposition of localized porous detrital beds. These could form oil and gas reservoirs where they are in association with source beds. In a similar manner to the faults, Precambrian or "basement" highs that existed during Paleozoic time may have played a part in the deposition of reservoir beds. It is also possible that erosion of these high areas during sedimentation could have supplied clastic sediments that laterally interfinger off the structure with source beds to form stratigraphic reservoirs flanking the Precambrian high.

"Granite Wash" or "Basement" Detritus

The evidence is fairly clear that the rocks of Precambrian age will be found at relatively shallow depths in the Permit area. It is also evident that the Precambrian surface was one of considerable relief prior to deposition of the overlying sediments. The basement highs probably projected upward into the zone of cleaning or "washing" above the effective wave base which existed during deposition of the sediments. Much additional study is needed to fully evaluate this possibility. All wells should be drilled below their main objectives to the Precambrian in an attempt to determine the oil prospects in the "basement" detritus.

Fitzgerald Formation

Where the dolomites or limestones of the Fitzgerald formation are brecciated, or porous for other reasons, a suitable reservoir for hydrocarbons may be developed.

Pine Point-Presqu'ile Formations

The carbonates of the Pine Point-Presqu'ile formations are bituminous and interbedded with shaly beds. They are also locally porous in dolomite beds and in massive dolomite reef facies. Oil seeps and staining from these porous dolomites seem to be the rule rather than the exception in this area. There is insufficient subsurface data currently available to be certain of the distribution of the Presqu'ile reef, but these rocks are probably present as subcrop beneath the drift in the northeastern part of the Company Permits. Farther west, where they are under more cover, reefs are less likely to be developed because of an overall thinning of Lower Paleozoic beds in this direction.

It may well be that the porous dolomite beds and reefs of the undivided Pine Point-Presqu'ile are either associated with basement highs due to paleotopographic relief, or with trends of escarpments caused by faults. Such local structures as these may provide a lateral separation at depth between the surface outcrops of Presqu'ile reefs and those which may occur in the area of the Permit block. The presence of such a lateral separation is considered essential to oil prospects here in the Presqu'ile, for without this these beds will probably be saturated with fresh water from their exposures at Great Slave Lake.

Slave Point Formation

The Slave Point formation is a prospective oil reservoir in the area to the south of the Permits. However, present information indicates that the eroded surface of this unit will be found in the subsurface of the Permits due mainly to pre-Quaternary erosion. There is also evidence to suggest that the Slave Point limestones preserved in the Permit area below this erosional surface may be more argillaceous than elsewhere.

Prospective Structures

The Company's Permit block overlies part of a large, gently southwest-dipping homocline. Faults are known to disrupt this structure in the Great Slave Lake area. These faults are apparently of the normal type. Similar faults may be revealed in the Permit area by structure test drilling. It is also likely that the Precambrian surface has considerable relief due to pre-Paleozoic differential weathering of its component rock types. This relief may have affected the structure of the overlying sediments due to compaction and differential sedimentation of these strata over the high.

CONCLUSIONS AND RECOMMENDATIONS

The Glacier Explorers Limited P. & N. G. Permits Nos. 3002 to 3005, inclusive, are located in the Upper Mackenzie Basin, about 30 miles northeast of Fort Providence, N.W.T. The Permits are easily accessible at all times by an all-weather road that is an extension of the Mackenzie Highway to Yellowknife. It should be possible to construct roads in the Permits during the summertime

but road construction is less costly during the winter, when ground and lakes, as well as the muskeg or marsh areas, are frozen. No accessibility difficulties should be encountered during drilling along the highway at any time.

Bedrock is not exposed within the Permits; a short distance to the east and southeast, however, bedrock forms outcrops across a considerable area, especially along the shore of Great Slave Lake. These exposures consist mainly of Middle Devonian limestones and dolomites. Older Paleozoic sediments outcrop along the shore near Gypsum Point, about 50 miles northeast of the Permit block.

The regional structural position occupied by the Permit block is on a large, gently southwest-dipping homocline with dips estimated to be in the order of 20 to 30 feet per mile. The presence of areas of high topographic relief on the Precambrian erosional surface, as well as the possible presence of steeply faulted zones, would, of course, locally modify this structure.

The abundance of oil seeps in the area adjacent to the Permits indicates that a potentially productive area is present. Further support for this is indicated by oil and gas shows obtained in several wells situated in this general area.

The total stratigraphic section near the Permits is approximately 1,000 feet thick, exclusive of the Cambro-Ordovician red beds.

The principal prospective oil and gas zones within the Company Permits include the Presqu'ile dolomite reefs of Middle Devonian age, porous limestones within the Middle Devonian Slave Point formation and porous clastics, or "detritus," above the Precambrian. Of these, the possible porous reefs under cover in the western part of the Permit area and discontinuous with the surface outcrops would provide the main prospective zones.

Local structures formed as the result of the reef growths, normal faults, and buried areas of relief on the Precambrian erosional surface may be expected to be present in the general area of the Permits. The presence of these features may provide reversal of the regional southwest dip at depth, which would serve to isolate the exposed oil-stained beds found near Great Slave Lake from equivalent strata of the subsurface in the area northwest of the lake.

With regard to a continuing program of oil and gas exploration in the area, it is suggested that, due to the relatively small area encompassed by the Permits and in consideration of the facts that there is no readily apparent structural trend into the area, that the main prospective porous zone, the Presqu'ile reef, is expected to be exposed beneath the drift in part of the Permits, and that good caprocks are not present over the reef beds in the balance of the Permits, the Company discontinue their program of oil and gas exploration on these Permits.

If this step is not followed, the Company should consider participating with owners of the surrounding acreage in a structure test program. The purpose

of this structure test program would be to confirm and delineate structural highs and would give a valuable supplement to our surface geological studies.

Due to the relatively thin stratigraphic section present and the current high cost of seismic exploration compared to the low cost and positive information obtained by structure tests, there seems little reason to pursue seismic or other geophysical work in this area at this time.

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March 14, 1961.

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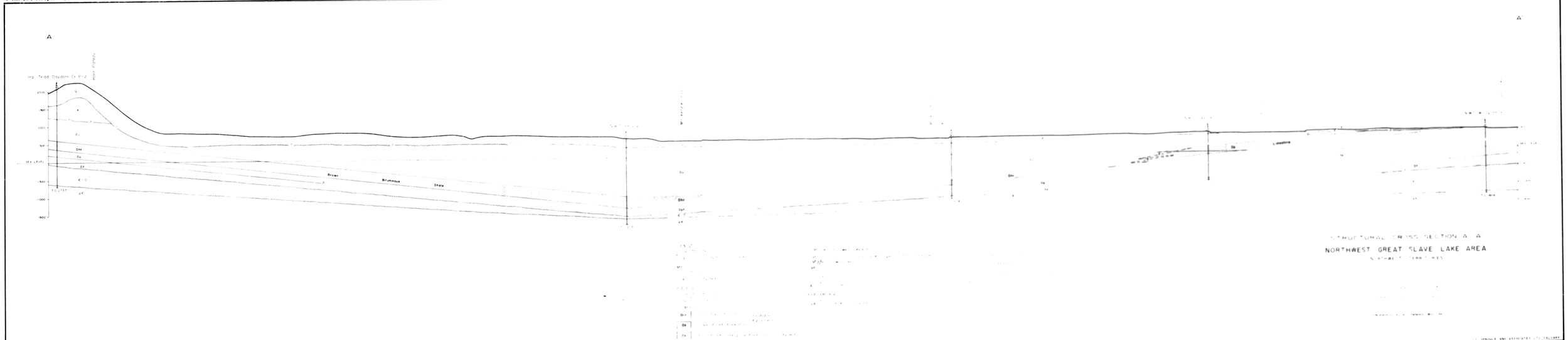
To accompany Geological Report to Glacier Explorers Limited, March 1961.

FIGURE III

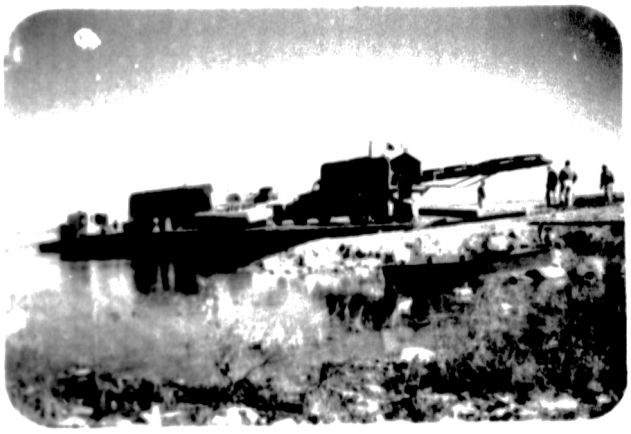


STRUCTURAL CROSS SECTION A - A

NORTHWEST GREAT SLAVE LAKE AREA

NORTHWEST TERRITORIES

SPROULE AND ASSOCIATES LTD. CALGARY



A. Tug and barge used on Mackenzie River as ferry at Fort Providence, N.W.T.

B. Northeast view of Yellowknife Highway in Permits near Caen Lake.

Photos by G. V. Lloyd

A. Field transportation was provided by Bell Model G-1 helicopter, shown on Quaternary gravel deposit in Permit block.

B. Glacial fluting in north-central part of Permit block.

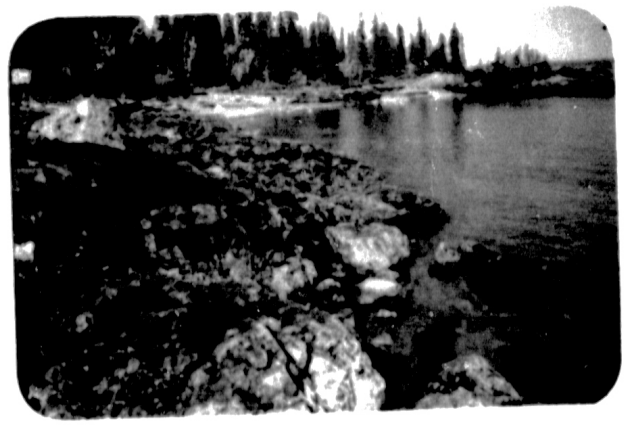
Photos by G. V. Lloyd

A. Typical exposures of Cambro-Ordovician red beds at Gypsum Point.

B. Detail of interbedded gypsum and sandy dolomite at Gypsum Point.

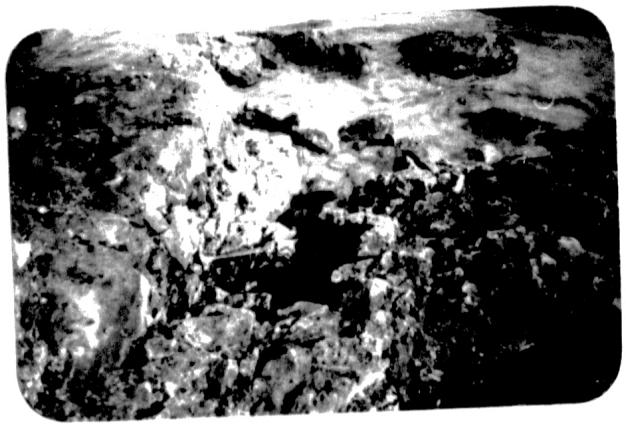
Photos by G. V. Lloyd

A. Typical outcrop of Pine Point formation, near Great Slave Lake.



B. Outcrop of Presqu'ile reef, near Windy Point.

Photos by G. V. Lloyd

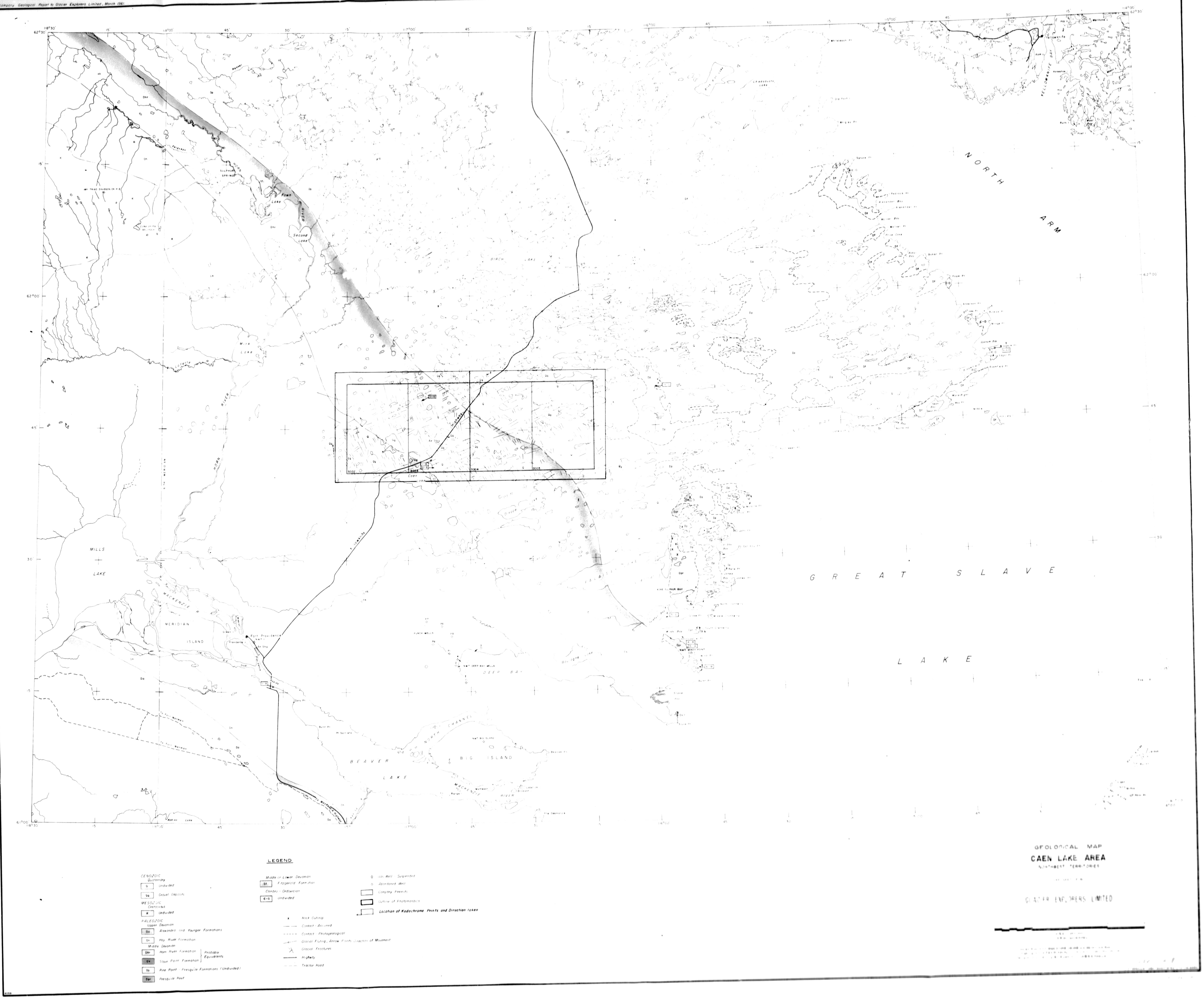


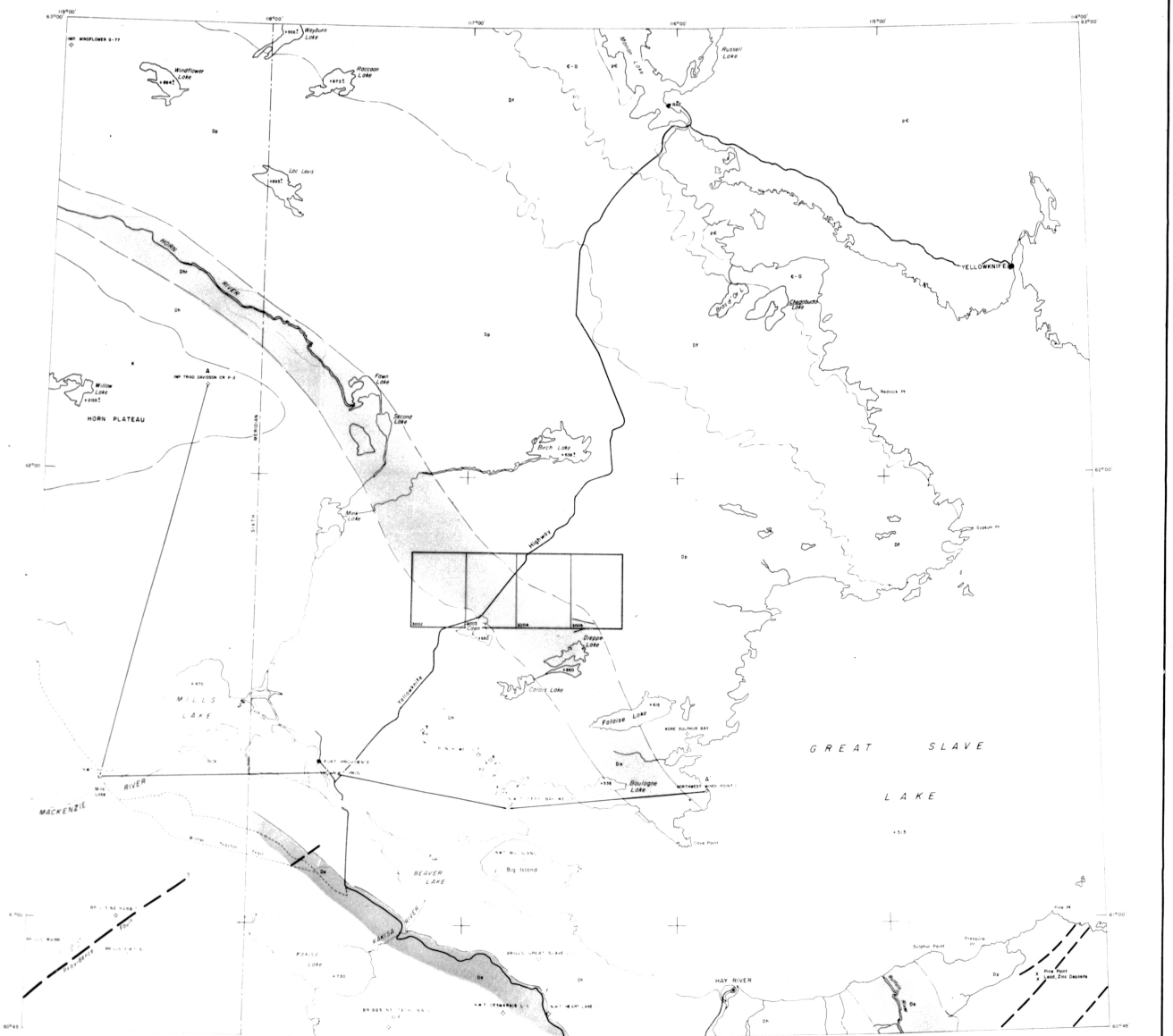
A Oil seep (near hammer) in fractured Presqu'ile reef dolomite, near Windy Point.

B. Detail of vuggy porosity on weathered surface of Presqu'ile reef dolomite.

Photos by G. V. Lloyd and N. N. Peterson

To accompany Geological Report to Glacier Explorers Limited, March 1961.





LEGEND

MESOZOIC
Cretaceous
K Undivided

PALEOZOIC
Upper Devonian
Dh Alexandra and Younger Formations
Dh Hay River Formation
Middle Devonian
Dhr Hare River Formation
Ds Slave Point Formation
Dp Pine Point - Presqu'ile Formations (Undivided)

Probable Equivalents

Middle or Lower Devonian
Df Fitzgerald Formation
Cambro - Ordovician
€-O Undivided
PRE CAMBRIAN
Proterozoic - Archaeozoic
pE Basement Complex

Gas Well - Suspended
Abandoned Well
Line of Cross Section A - A'
Company Permits
Fault, Defined
Formation Contact, Approximate

REGIONAL GEOLOGICAL MAP
NORTHWEST GREAT SLAVE LAKE AREA
NORTHWEST TERRITORIES

PREPARED FOR

GLACIER EXPLORERS LIMITED

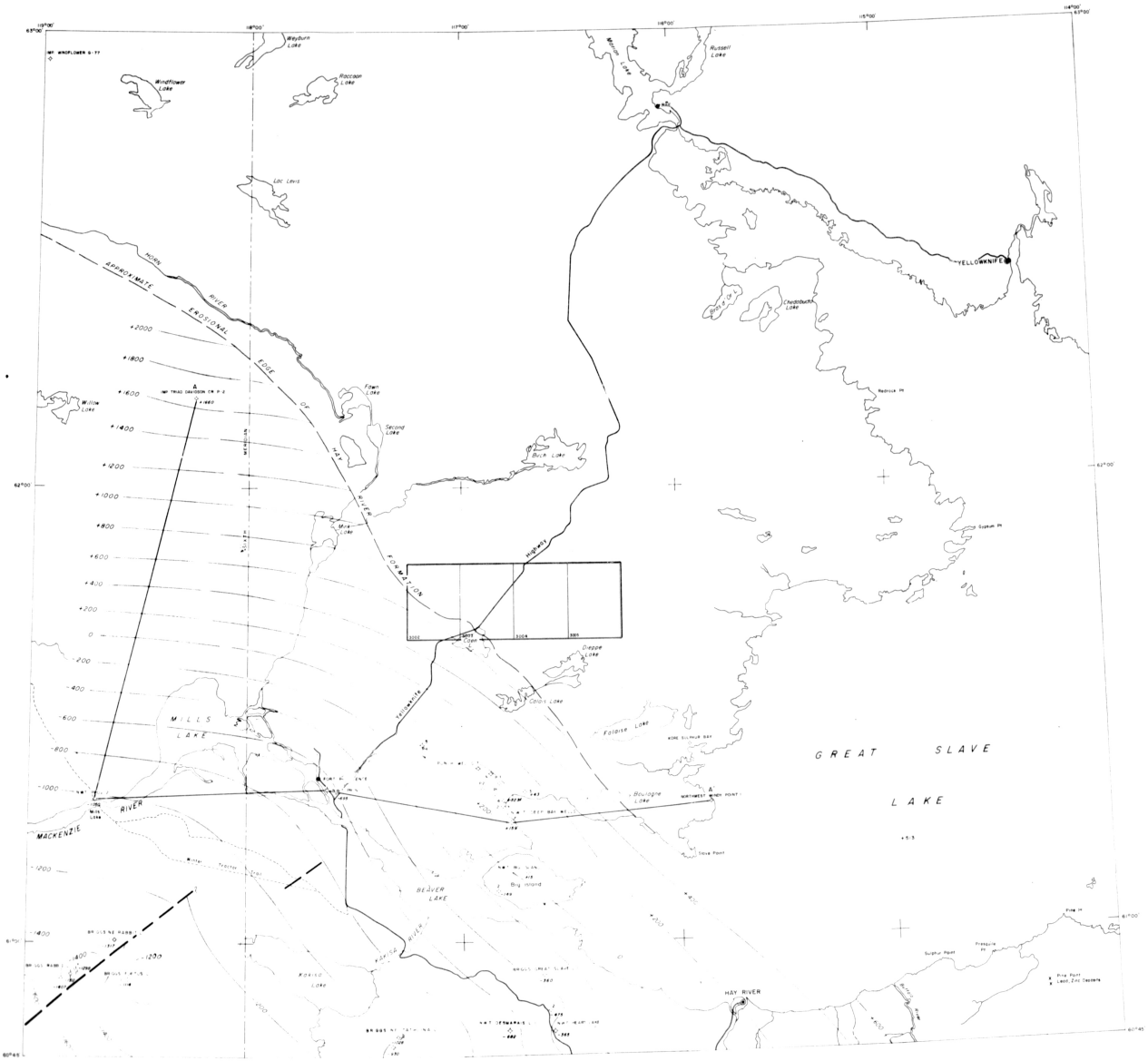
SCALE 1" = 8 Miles

Compiled from G.S.C. Maps 2-1958, 28-1958 and 48-1959 and from Photogeological and Field Studies by J.C. Sproule and Associates Ltd., 1960
Geologists S.R.L. Harding, W.H. Mupnch, G.V. Lloyd & N.N. Peterson

Maps Revised to Feb. 28, 1961

J.C. SPROULE AND ASSOCIATES LTD., CALGARY

SGC-1-41-5



STRUCTURE MAP

NORTHWEST GREAT SLAVE LAKE AREA

NORTHWEST TERRITORIES

Base of Hay River Formation

Contour Interval 200 Ft. Datum Sea Level

SCALE 1" = 8 Miles

Interpretation by S.R.L. Harding, March 1961

Gas Well - Suspended

Abandoned Well

Elevation on Base of Hay River Formation

Line of Cross Section

Company Permits

Fault, Defined

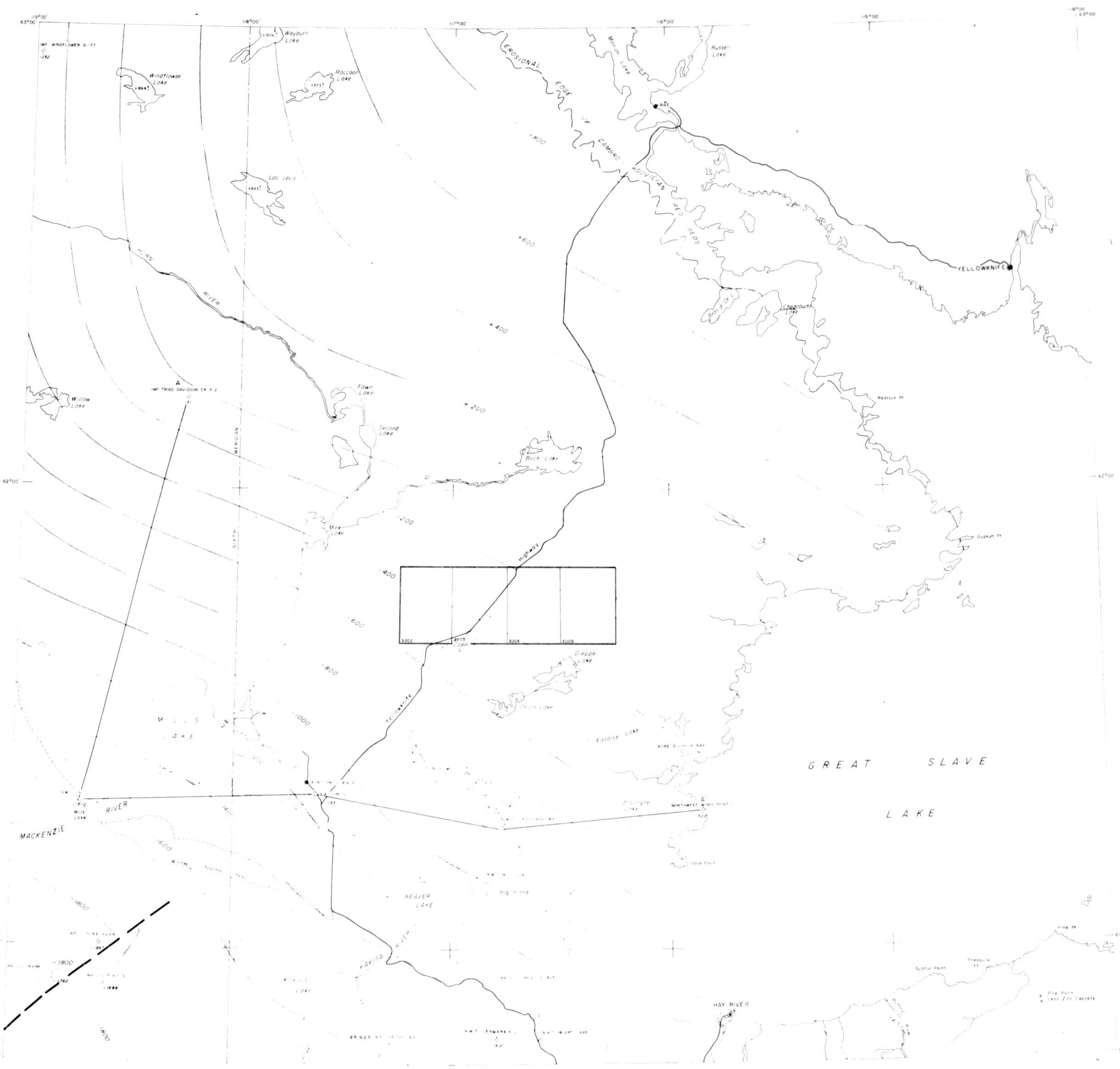
Work Revised to Feb. 28, 1961

J.C. SPROULE AND ASSOCIATES LTD. CALGARY

320-1-4-9

To accompany Geological Report to Glacier Explorers Limited, March 1961.

FIGURE - V



Gas Well - Suspended

Abandoned Well

Elevation on Top of Cambro - Ordovician Red Beds (-1648)

Line of Cross Section

Company Permits

Fault, Defined

STRUCTURE MAP

NORTHWEST GREAT SLAVE LAKE AREA

NORTHWEST TERRITORIES

Top of Cambro - Ordovician Red Beds

Contour Interval 200 Ft. Datum Sea Level

8 0 8 16 24

SCALE 1" = 8 Miles

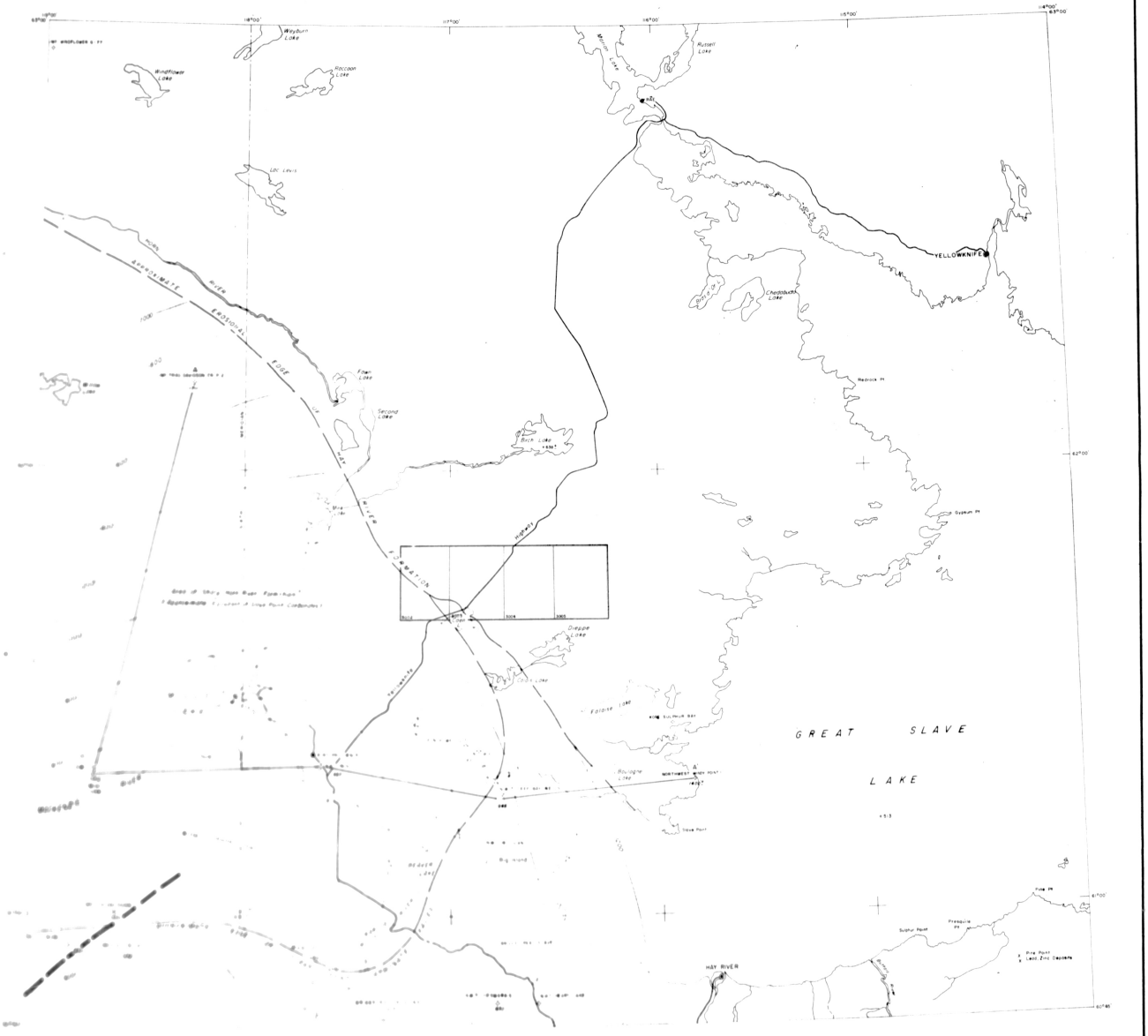
Interpretation by S.R.L. Harding, March 1961

530-1-4-9

Wells Revised to Feb. 28, 1961

J.C. SPROULE AND ASSOCIATES LTD., CALGARY

FIGURE - V



ISOPACH MAP

NORTHWEST GREAT SLAVE LAKE AREA

NORTHWEST TERRITORIES

Base of Hay River Formation to
Top of Cambro - Ordovician Red Beds

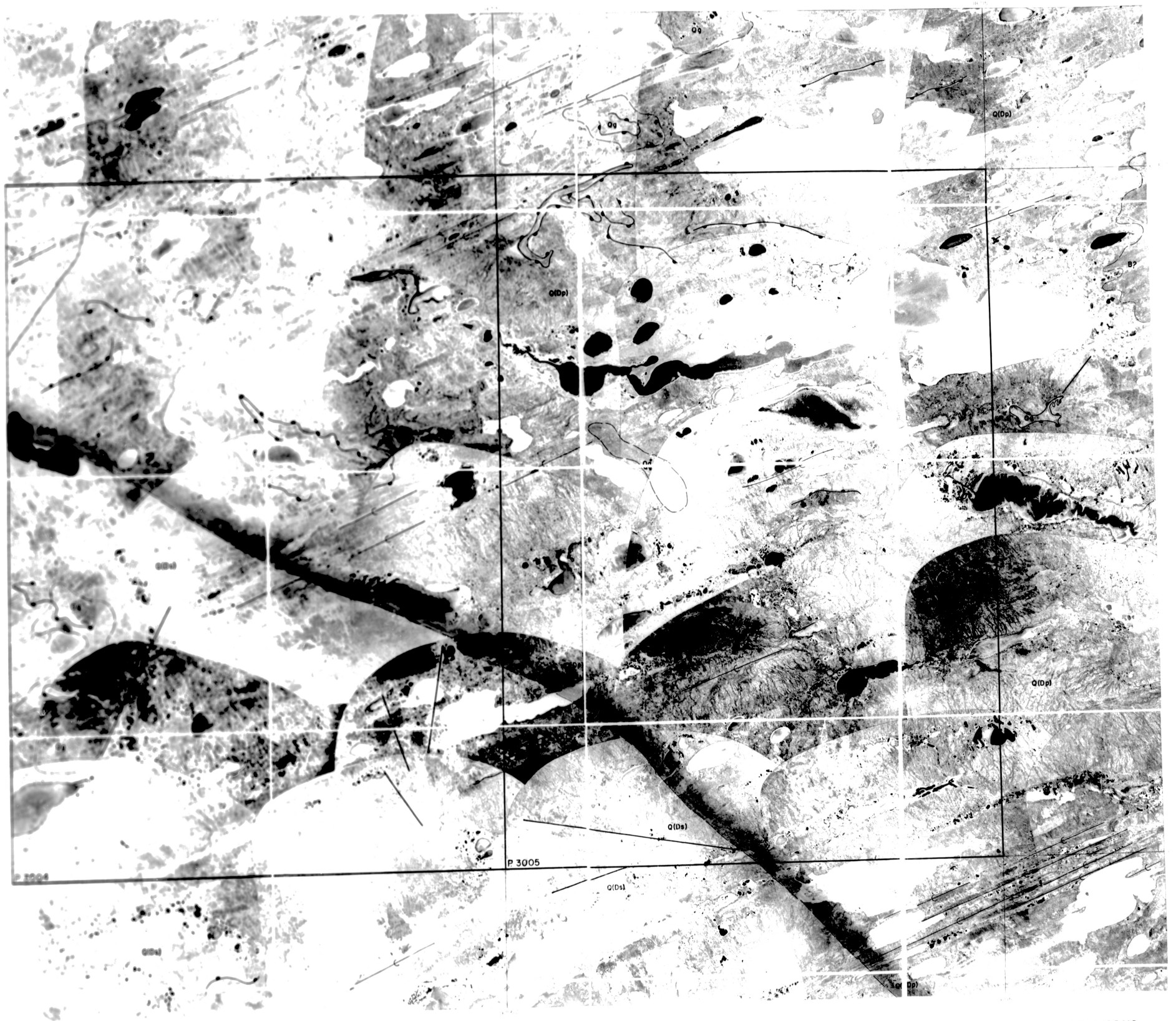
Isopach Interval 200 Ft

SCALE 1" = 8 Miles

Interpretation by S.R. Harding, March 1961

Maps Revised to Feb. 28, 1961

J.C. SPROULE AND ASSOCIATES LTD. CALGARY



LEGEND

TOPOGRAPHICAL

GEOLOGICAL

Q(Dp)

MISCELLANEOUS

PHOTOGEOLOGICAL MOSAIC

CAEN LAKE AREA

NORTHWEST TERRITORIES

SHEET N°

30x

West Canadian Graphic Industries Ltd.

117°45'

117°00'

116°45'

61°50'

Q(Dp)

Q(Ds)

Qg

Q(Dh)

Air strip

Construction camp

P 3002

P 3003

CAEN LAKE

INDEX MAP

LEGEND

TOPOGRAPHICAL

GEOLOGICAL

MISCELLANEOUS

PHOTOGEOLOGICAL MOSAIC

CAEN LAKE AREA

NORTHWEST TERRITORIES