

GEOLOGY OF THE BOND LAKE AREA,
NORTHWEST TERRITORIES.

BY

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WESTERN DECATIA PETROLEUM LIMITED

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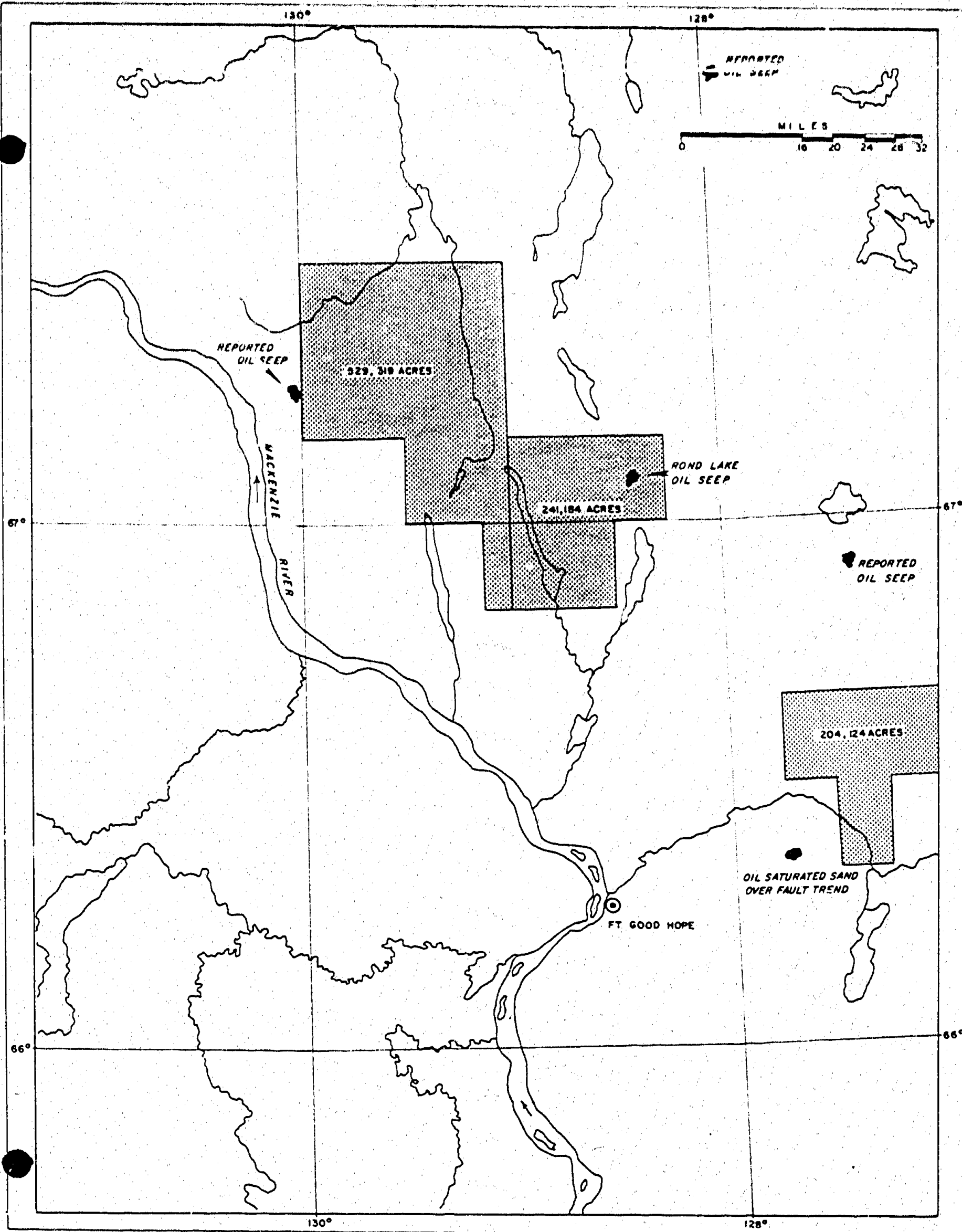
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INTRODUCTION

The project covered in this report consists of a field geological study of Permits Nos. 1483, 1484, 1515, 1516, 1517 and the adjoining permits shown on the index map.

Members of the party left Calgary on August 20 and returned on September 9.

The base camp was established on the east side of Pond Lake. Supplies of fuel and food were obtained from Fort Good Hope, 58 miles to the south. The fuel had previously been ordered from Norman Wells and was barged to Fort Good Hope.

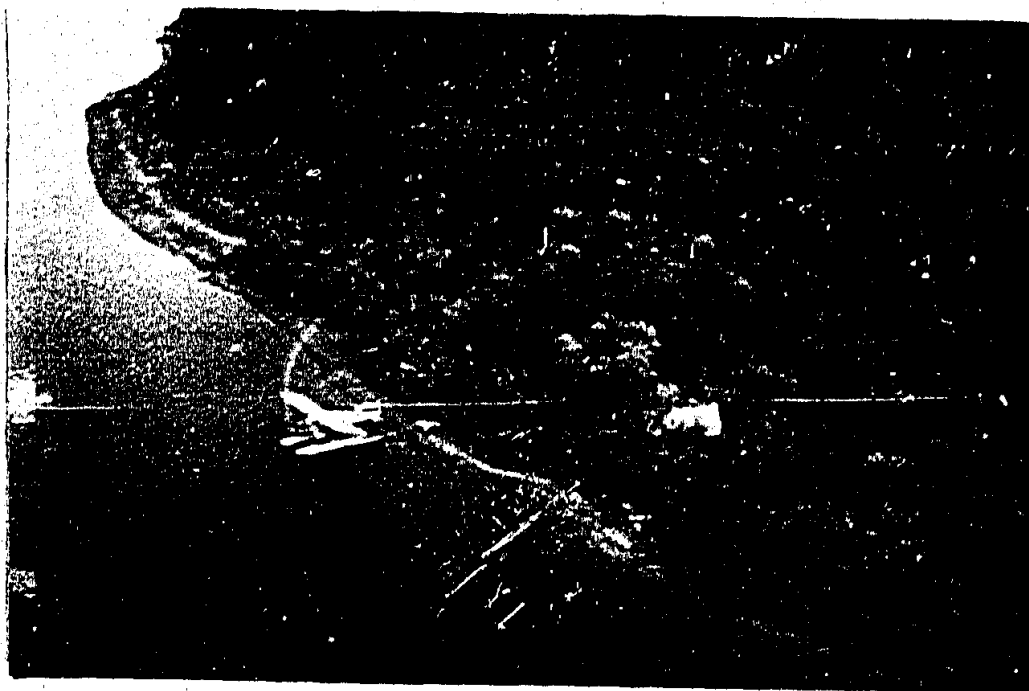


Plate I. View of Base Camp from helicopter.

A Norseman Mark 4, float-equipped, aircraft - leased from Pacific Western Airlines - served the camp and was used for geological reconnaissance.

A Bell C-2 Helicopter on skis - leased from Associated Helicopters - was used in the geological work.

All the work was accomplished from the base camp by daily flights in the Norseman and Helicopter. Many outcrops proved inaccessible to the helicopter due to bush cover but the more important of these were visited on foot from the nearest safe landing spot.

The work with the Norseman was accomplished by landing on lakes and by foot traverses from these lakes to the various outcrop areas.

Accessibility.

The area covered by this report is mainly muskeg terrain, gently rolling with little more than 300 feet of local relief. The area is dotted by numerous large and small lakes. The bush cover is relatively light, there being few trees greater than 8" in diameter at the base. None of the rivers in the report area would be satisfactory for large boat travel. The southeast part of the area is drained to the south through Rond and Forey Lakes and the Bluefish River. The area to the northwest is drained by the north-flowing Iroquois River.

The nearest scheduled transport is the Canadian Pacific Airlines run to Norman Wells and Aklavik. This is a daily freight service and a tri-weekly passenger service. Intermediate points, such as Fort Good Hope, have a weekly service by either float or ski equipped aircraft from Norman Wells. The area covered by the report is accessible mainly to aircraft, float equipped in summer and ski in winter. Large wheel equipped freighter aircraft could work off any of the larger lakes during the winter. Skid mounted helicopters are quite satisfactory in summer work.

The nearest settlement, Fort Good Hope on the banks of the Mackenzie River, consists of about two dozen white people and a varying Indian population.



Plate II. Fort Good Hope from the air. (Note tug and barge on the Mackenzie River).

At Fort Good Hope there are a nursing station, a R.C.M.P. detachment, a Northwest Communication Signals Station, a R.C. mission, a Hudson's Bay store and a free traders' store. Good food supplies are obtainable and a twenty-four hour telegraph service is maintained. Unskilled Indian labor is also available. Heavy equipment can be moved down the Mackenzie watershed from either the rail head of Waterways, or the highway termination at Hay River. Traffic, of course, also runs up the river from the Arctic Ocean at Aklavik. Heavy material can be landed at practically any spot along the river.

Two companies - Northern Transportation Limited, and Yellowknife Transportation Limited - operate tug and barge services along the river. Their barges distribute manufactured goods from the south and also distribute Norman Wells' refined products to Aklavik, Port Radium, all the Western D.E.W. line sites and, of course, the intermediate points.

Previous work:

The only previous published work abutting on this area is that of Memoir No. 273 by G.S. Hume, a compilation of the work accomplished during the Canol project. An unpublished report by J.C. Sproule & Associates was made for Glacier Explorers Ltd., the original holder of these permits. This report touches on the current area only in a reconnaissance manner.

GEOLOGY

General Geology:

The area of this report is underlain by essentially homoclinal beds, dipping gently to the southwest. A few interruptions of this gentle southwest dip were noted and are discussed under Structure.

Cambrian, Ordovician and Silurian beds underlie the area; Middle Devonian, Upper Devonian and Cretaceous beds outcrop. The total thickness of sediments in the Rond Lake area is estimated to be 3,500 feet.

The surface geology of the permits shows erosional remnants of the Basal Cretaceous sands lying on progressively older Devonian beds to the east. In the northwestern area the Basal Cretaceous lies on Upper Fort Creek shales. As you progress east and south Lower Fort Creek is exposed until Rorey, Rond and Carcajou Lakes are approached where the



Plate III. View southwest from Base Camp. Ridges on horizon are formed by Upper Ramparts limestone.

Upper Ramparts limestone is exposed. North of Rond Lake this limestone changes to shale and has no surface expression. East of these lakes shales of the Hare Indian (Middle Ramparts) are assumed to underlie the Basal Cretaceous remnants. There is a possibility that these shales belong to the Fort Creek formation and a fault occurs along the trend of these lakes. This possibility is discussed under the heading of Structure.

STRATIGRAPHYCambrian.

Cambrian rocks are known to outcrop in the mountains to the west and south, and they are presumed to underlie the report area. These rocks comprise mainly quartzites and shales and some limestone. The possibilities of oil production in these rocks cannot be discounted, although at the present time the lack of knowledge regarding their character under the report area prohibits considering them as one of the main prospective horizons. The probable thickness of Cambrian rocks underlying the Pond Lake area would be in the order of 500 or 600 feet.

Ordovician.

Ordovician rocks like the Cambrian are exposed to the west and south. At the exposures the Ordovician rocks are mainly shales and argillites with minor limestone bands. These shales are frequently petroliferous and undoubtedly would be a good source rock for petroleum. Whether or not any satisfactory porosity is developed in the Ordovician under the report area is not known. The thickness of Ordovician sediments in this area can only be guessed and is assumed to be about 500 feet thick.

Silurian.

Silurian rocks are exposed to the west and south and also exposed to the east against the Shield. The Silurian sequence consists mainly of hard locally waxy and cherty dolomite. These rocks frequently exhibit biostromal characteristics and some bituminous residues have been noted in the

outcrop. The Silurian is undoubtedly one of the more prospective horizons under the report area. About 1,000 feet or less of Silurian rocks are anticipated under the report area.

Silurian or Devonian.

The Bear Rock formation which lies between the known Silurian and known Middle Devonian rocks consists mainly of dolomite, limestone, gypsum and anhydrite and is characterized in most outcrop occurrences by a brecciated nature, very frequently exhibiting excellent porosity and in many occurrences bituminous residues in the porous bands. One well, drilled



Plate IV. Bear Rock on Belot Ridge. (Note brecciated appearance).

during the Canol project, encountered the Bear Rock in a porous development and this well flowed 24,000 barrels a day of salt water. This is the most prospective horizon in the report area.

Middle Devonian.

The Middle Devonian Ramparts formation is exposed on the west side of Rond Lake and lies in the subsurface under our northwestern permits. If there is a fault along the Horey-Rond-Carcajou Lakes trend the complete Ramparts will lie in the subsurface in the Rond Lake area and in the permits just east. The Ramparts consist of limestone and shale and can usually be

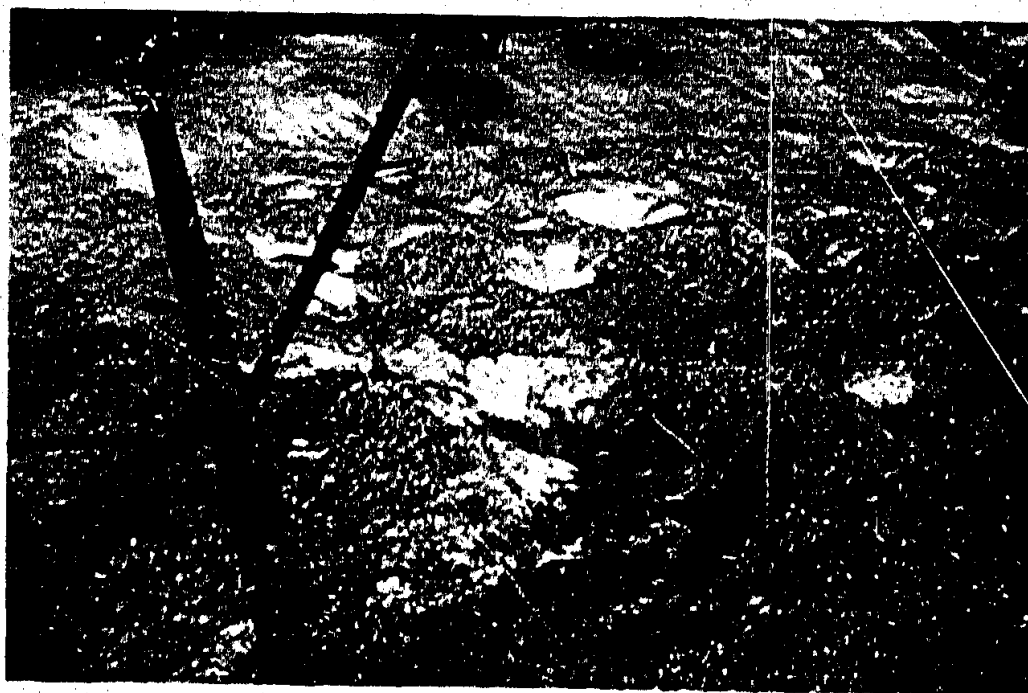


Plate V. Sink Holes in Bear Rock, West of Belot Lake.

divided into three units; a lower limestone unit that may in places be reefoid, a middle shale unit, and an upper limestone unit that in the Rond Lake area is quite reefal. To the north and in the northwestern part

of our permits this upper unit grades into shale, 700 to 800 feet of



Plate VI. Ramparts ridge west of Pond Lake.

Ramparts are anticipated in the subsurface under our permits.

Upper Devonian - Fort Creek Formation.

Overlying the Ramparts there is a shale series known as the Fort Creek formation. The basal part of the shale is very petroliferous - Hard and black, frequently with limy bands. This lower part is exceedingly

petroleumiferous and has in some localities actually dripped oil.

Marcasite nodules are very common and disseminated marcasite occurs



Plate VII. Ramparts reef, west of Manuel Lake.

throughout the formation. This lower member is the off-reef facies of the Harman Wells producing reef and undoubtedly is the source of the great part of the oil in that reef. In the report area the Fort Creek is exposed in the northwestern area where a sufficient thickness is anticipated to cover any reefs occurring in this area. The Fort Creek may be exposed to the south of Rond Lake on the Bluefish River.

Cretaceous.

Overlying the Paleozoic rocks in the report area is the Basal Cretaceous Sand Fault formation. This formation consists of 100 feet or more of soft, friable, clean quartz-sand. The grains are well-rounded, frequently frosted and fairly well sorted. Cross-bedding is common and



Plate VIII. Fort Creek on tributary of Iroquois River.

towards the base particularly carbonaceous material is very frequent. This Basal Cretaceous sand occurs usually as erosional remnants lying on top of the post-Paleozoic erosion surface. In three localities known to

the writers, the Basal Cretaceous is oil stained. One locality is to the south, near our T-shaped block of permits, where there are anomalous dips in the Basal Cretaceous and where light oil staining occurs.



Plate IX. Conglomerate at base of Cretaceous at Belot Ridge.

Another locality is east of our permits along the Belot Ridge uplift, where there is an excellent outcrop of oil stained Basal Sand.

The third occurrence of oil stained Basal Cretaceous sand is about one half mile south of the oil seep at Rond Lake. Here the Basal Cretaceous sand is quite heavily oil stained and appears to have an anomalous dip to the northeast. Elsewhere on our permits and in this area in general the Basal Cretaceous sand is not oil stained, it is a clean, white sand.

STRUCTURE.

Structural relief suitable for oil accumulation is found in the general report area. To the south the Mackenzie Mountains are from a north-south to an east-west trend and to the west the Richardson Mountains strike north-south but eventually as one goes northward they swing to the west and become the British Range. To the east of our permits Belot Ridge, a sharp uplift involving Bear Rock and Basal Cretaceous sand at the surface, strikes north-south but bifurcates at the north end of Belot Lake where one arm plunges rapidly to the north and the other swings westward and then north again where it dips from view. The writers suspect another similar uplift farther to the east.

In the report area the beds dip gently to the southwest and only two anomalous dips were observed - one in the Bluefish River, where Devonian shales dip between two and four degrees to the south and strike about east-west.



Plate XI. Basal Sandstone at Belot Ridge.

This is apparently a local undulation but could be quite significant in view of the underlying reef possibilities. The other anomalous dip is in the Basal Cretaceous outcrop about one mile straight south of the Pond Lake scarp. Here the Basal Cretaceous has an apparent dip of thirty degrees to the east and a strike about straight north. This anomalous dip could be due to either cross-bedding or slumping and one must be careful not to attach too much credence to it.

The alignment of Rorey, Pond and Carcajou Lakes is suggestive of a fault trend. The Upper Rampart limestone forms a scarp along the southern part of this trend at an elevation in the neighbourhood of 1,000 feet. On Bluefish River to the east Devonian shales outcrop at an elevation of 350'. These shales have all the lithological characteristics of the lower Fort Creek but may however be from the Hare Indian or Middle Ramparts shale. Until all our fossil material has been identified no certain correlations can be made. If this shale is Fort Creek then it is reasonable to assume a fault



Plate XII. Devonian shales on Bluefish River.

trend along the alignment of Rorey, Bond and Carcajou Lakes. This would be a normal fault with the down-thrown side to the east. For the present the maps and cross-sections are drawn assuming there is no fault.

BOND LAKE SEEP.

The seep at Bond Lake occurs on the side of a west-facing hill, about one mile from the east shore of the lake. The seep covers an area of about one acre and occurs as four separate seeps, two small ones to the northeast and two large ones to the southwest. The oil comes to the surface in small springs and runs down the hillside forming



Plate XIII. Devonian shales on Bluefish River.

a residuum of organic matter, clay and residual oil. This residuum is soft and sticky. In the early days Indians collected this material and

carried it to Fort Good Hope where it was sold to the Hudson's Bay Company as caulking. Small animals and birds are frequently caught in the seep.



Plate XIV. Helicopter on Seep.

During this project samples of the oil were taken and the seep was investigated by trenching and by augering with a power auger. Numerous small holes, about one foot in diameter and one foot deep were dug on the seep. These holes filled with oil and fresh water overnight. The fresh water is apparently a product of the melting perma-frost. The trenches and auger holes also acquired a filling of oil and water and the sides of the trench rapidly became coated with light brown crude oil. The material encountered in the trench and auger holes was glacial clay completely saturated with oil, forming a material about the consistency

of warm plasticene. The deepest hole at the seep was augered to 15 feet where permea-front was encountered and no further digging could be accomplished.

The gravity of the seeping oil has been determined as 17.7° A.P.I. The writers interpret the seep as being leakage from a subsurface accumulation - possibly from the Lower Ramparts or Ronning, but more probably from the Bear Rock formation.

Petroleum Possibilities.

The writers regard this area as having outstanding possibilities for the production of petroleum. Petroleum source rocks occur in beds of Cambrian, Ordovician, Silurian, Middle Devonian and Upper Devonian. In the immediate report area good porosity is anticipated in the reefs of the Silurian, the breccias of the Bear Rock lying between the Silurian and Middle Devonian. The reef, or reef horizons in the lower part and upper part of the Middle Devonian and reef horizons in the Upper Devonian. These factors, coupled with the favourable structural conditions and the presence of the Rond Lake oil seep, present a prospect of most unusual merit.



Plate XV. Augering on Seep.

ECONOMICS OF OIL PRODUCTION IN THIS AREA.

The following factors must be borne in mind when assessing the economics of possible production:

1) Government Regulations.

The Government regulations covering the exploration of oil and gas in the Northwest Territories are designed to encourage the exploration of large spreads of land in an orderly fashion. Large blocks of land as Permits may be obtained. Rental for these permits is on the following scale: 5 cents an acre for the first eighteen months; 25 cents an acre for the next eighteen months; 30 cents an acre during the fourth year; 40 cents an acre during the fifth year; 50 cents an acre during the sixth year. All rentals are refundable for work performed in the area.

Over-expenditures above commitments of one period are applicable on subsequent periods. Fifty percent of a permit may be taken in lease. Lease rentals are 50 cents for the first year and \$1.00 an acre subsequent years. Over-expenditures incurred during the permit stage are applicable against 50 percent of the lease rentals until wells start producing. Exploratory costs during the lease stage are applicable against 50 percent of lease rentals. Lease rentals on producing properties are reduced to 25 cents per acre until such time as an adequate market for production is obtained. Royalty during the first three years of commercial production is six and one-quarter percent. After the first three years, the royalty may range up to a maximum of twelve and one-half percent. The royalty may be reduced if conditions warrant. All regulations are subject to the discretion of the Minister and if good cause is shown, extensions may be obtained at any stage of exploration.

2) The Mackenzie Water Route.

The Mackenzie River is the "main street" of this section of Canada's Northland. Practically all civilized facilities are located along this river or its tributaries as are most of the airports and mining centres. This has been the natural outcome of easy and cheap transportation. The Mackenzie River averages two to three miles in breadth and can accommodate large barge traffic.

As mentioned above two companies, Northern Transportation and Yellowknife Transportation are operating large barges on the Mackenzie system. These barges are operating from Waterways in Alberta to Aklavik. Fuel barges are being used to distribute Edmonton and Norman Wells refined products. The present capacity of these barges ranges from 100,000 to 150,000 gallons (4,300 barrels). Between six and eleven barges are pushed by one tug (25,000 to 47,000 barrels). These barges and tugs draw up to 8 feet of water when loaded and can easily make the run from Fort Good Hope down the river past Aklavik to Port Brabant which is a satisfactory deep sea port. Of interest is the fact that a successful trip from Vancouver around Alaska to the Canadian Arctic coast was made this year by a subsidiary of Yellowknife Transportation. The Canadian Navy is servicing many D.E.W. line installations in this manner. The navigation season for this operation would run from June 1st to October 15th (4½ months). There is also, of course, the water route to the south to Hay River, the present road terminus, Yellowknife, the mining and air transportation centre, and Waterways, the present rail terminus.



Plate XVI. Oil Stained Basal Sandstone, south of Seep.

Shipping on the Mackenzie drainage system is quite cheap, for example we can move a large 230 ton drilling rig from Hay River to Fort Good Hope for \$9,000. A small drilling rig, currently working for the Government at Aklavik, can be moved with the camp and all other necessary equipment to Fort Good Hope for \$1,200. The fuel costs at Norman Wells are roughly equivalent to those at Calgary.

3) Government Road Building Program.

Perhaps the most significant thing regarding the Government road building program is that it does not closely parallel existing water routes. In other words, the building of these roads will open up new country and undoubtedly a number of mineral discoveries will be the direct outcome of this program. At present roads are being built from Hay River via Fort Providence to Yellowknife and north eventually to Great Bear Lake. The other road is being built from Dawson City to Aklavik.

4) Expanding Local Market.

There is an ever-expanding local market; whereas Norman Wells a few years ago supplied points as far south as Hay River, Yellowknife and Fort Simpson with their refined products. The Norman Wells refinery, now running at full capacity, can supply only Fort Radium, Aklavik and the D.E.W. line sites. Fort Simpson, Yellowknife and Hay River are now using Edmonton refined products.

5) Terrain on our Permits.

On our existing permits and in other interesting areas the tree cover is light and there is a lack of steep relief - this will be of considerable aid to exploration.

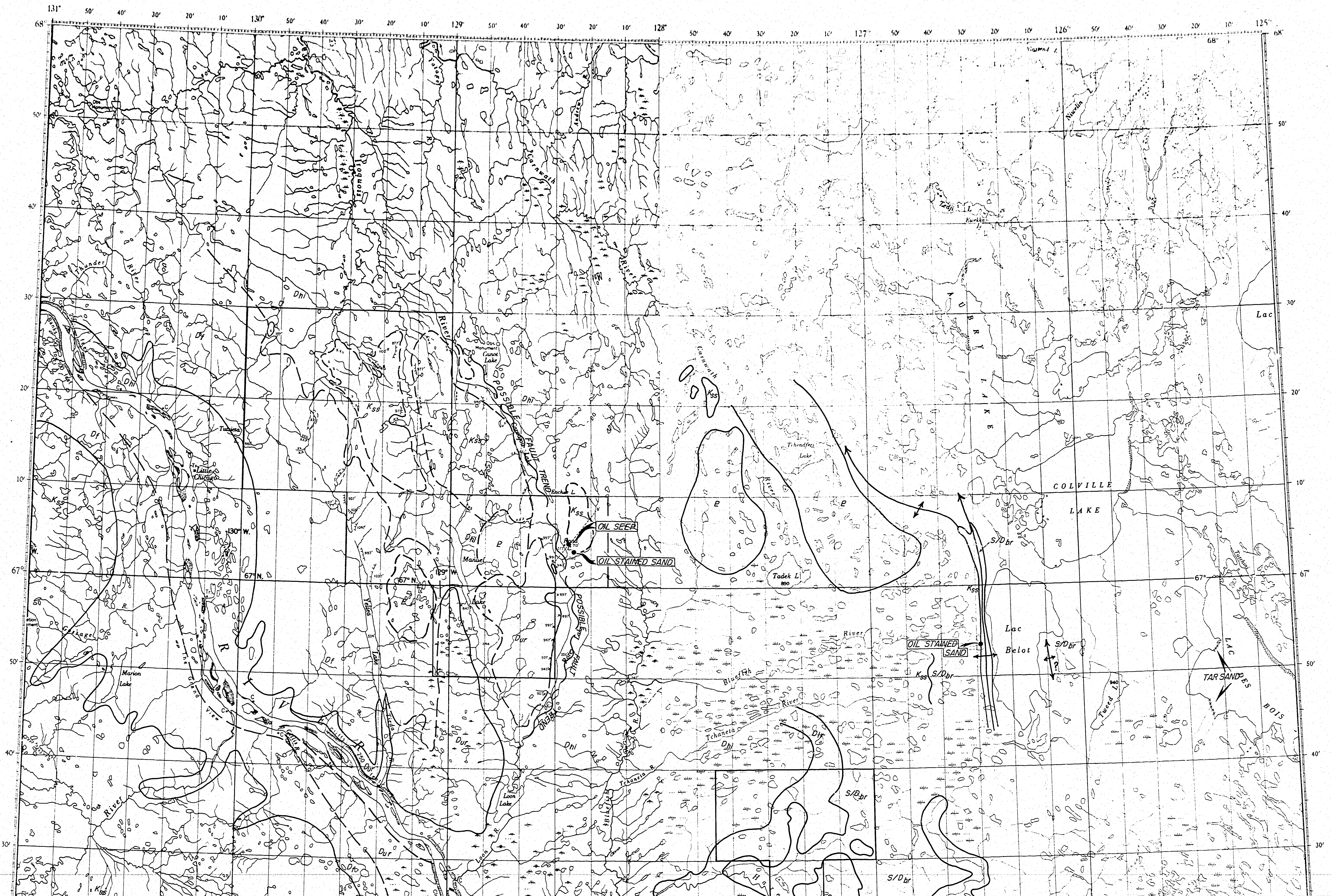


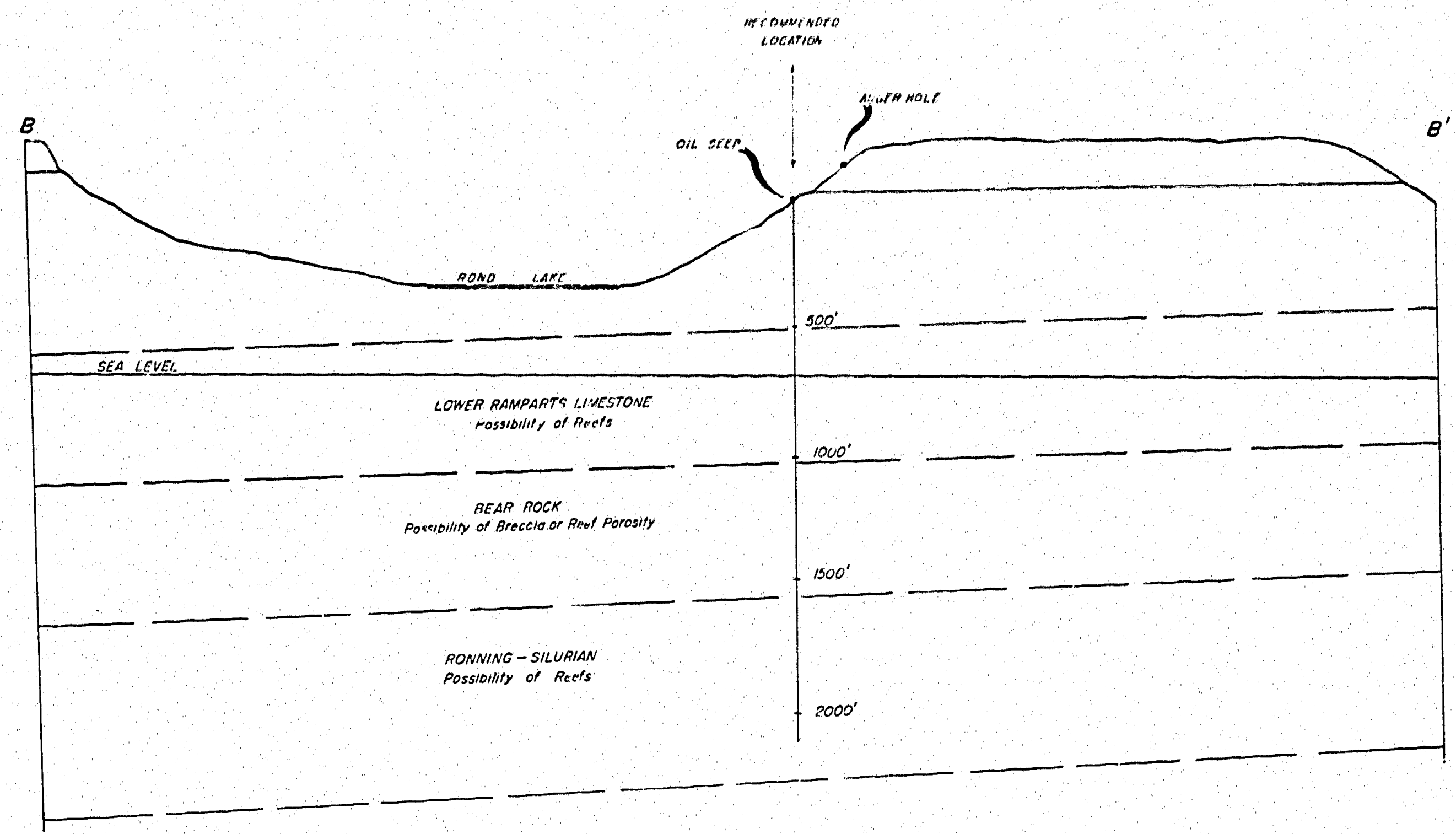
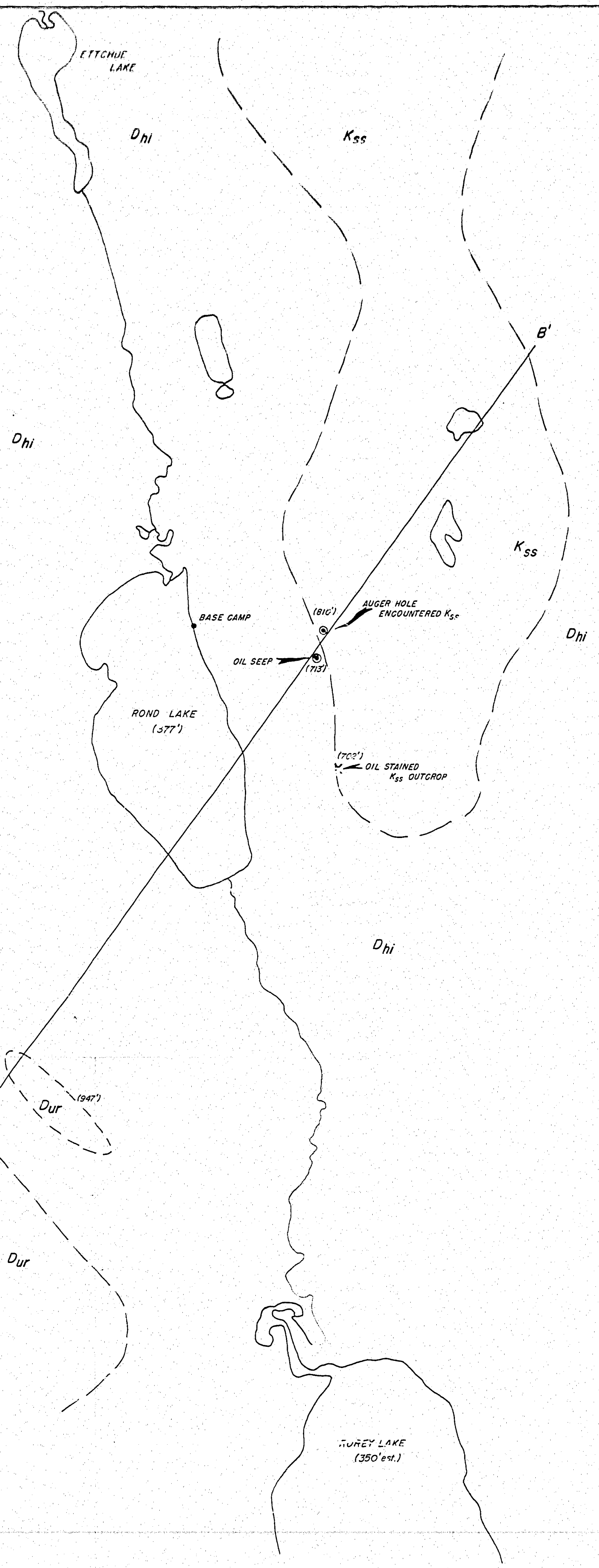
Pate XVII. Ramparts of the Mackenzie River,
just north of Fort Good Hope.

RECOMMENDATIONS

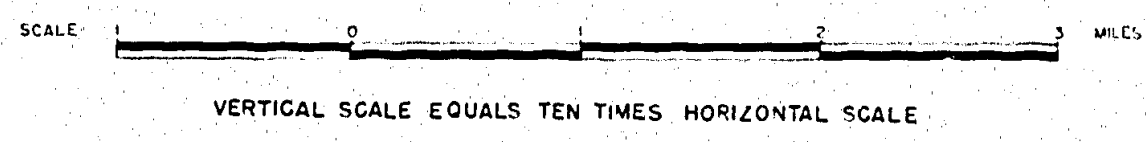
Further surface work on these permits will accomplish little and geophysical surveys will at the moment be very expensive. In view of these facts we recommend that the next stage in the exploration of our present permits be the drilling of a series of wells at and near the Fond Lake seep and on the permits to the northwest. These tests should be drilled to a total depth of 1,500 feet in order to test the most prospective horizons in the area, they should be drilled as "slim holes" providing, of course, that adequate testing, coring and logging can still be carried on. A study is currently being made to determine the cheapest method of transporting the necessary drilling equipment to the area.

The equipment can be transported to Fort Good Hope by barge and then hauled by winter tractor road to the drill sites, or it can be flown to Fond Lake by freight aircraft. Which method will prove to be the most economical will depend on the equipment used and the timing of the drilling.





- K_{ss}* BASAL CRETACEOUS SANDSTONE
- D_{ur}* UPPER RAMPARTS REEF LIMESTONE
- D_{hi}* MIDDLE RAMPARTS SHALE
- (947') ELEVATIONS



19-1-6-1

WESTERN DECALTA PET. LTD.

ROND LAKE AREA, N.W.T.

DETAIL MAP

DATE: SEPT 1958
 CROSS SECTION: B-B'

SCALE: AS SHOWN