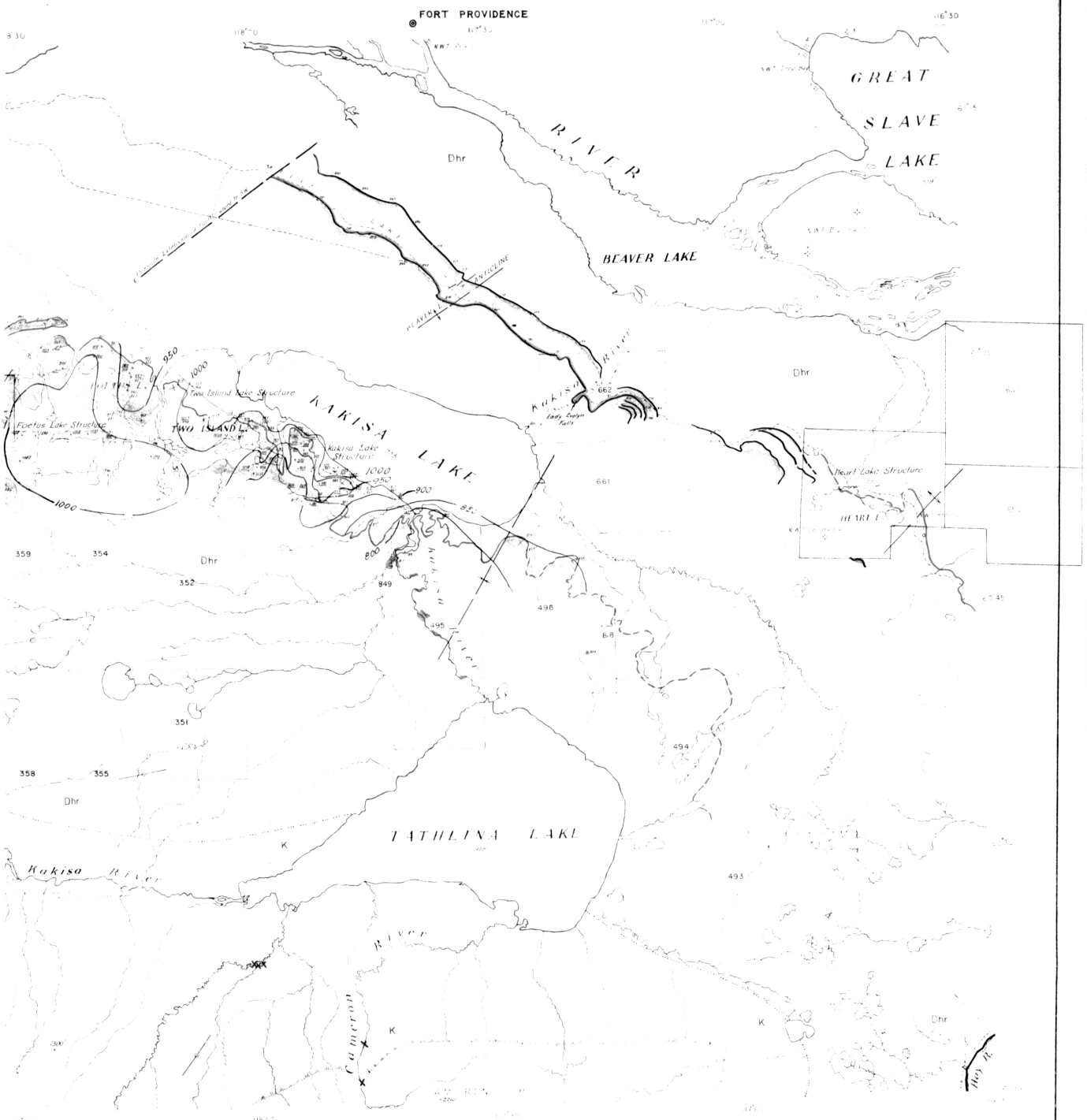

GEOLOGICAL LEGEND

- Formation Contact
- Anticlinal Axis
- Synclinal Axis
- Fault
- Strike and Dip
- Glacial Gouging
- Jointing
- x1052' Altimeter Elevation
- Abandoned Dry Hole
- K — Cretaceous Outcrop
- Dhr — Devonian Hay River Formation Outcrop or near-outcrop
- Reef Development
- Escarpment - Kakisa Limestone Member
- Escarpment - Lady Evelyn Falls Limestone Member
- Escarpment - Heart Lake Limestone Member
- Escarpment - Locally Mappable Limestone Member
- Locally Mappable Sandstone Member
- Contours on Kakisa Reef Horizon

GEOLOGICAL MAP

D. TODD BRIGGS PROJECT

TROUT LAKE - HAY RIVER AREA, N.W.T.

EAST OF 118°30'

Contours on Kakisa Reef Horizon

Interval 50 ft. Datum Sea Level

Note: This map, which is a portion of a larger map covering the D. Todd Briggs Project.

508-1-4-7

GEOLOGICAL REPORT

on

P. & N. G. PERMITS NOS. 661 AND 662

NORTHWEST TERRITORIES

J. C. SPROULE & ASSOCIATES
GEOLOGICAL & EXPLORATION CONSULTANTS

901 EIGHTH AVENUE WEST
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GEOLOGICAL REPORT

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P. & N. G. PERMITS NOS. 661 AND 662

NORTHWEST TERRITORIES

INTRODUCTION

The surface geology of P. & N. G. Permits Nos. 661 and 662 was studied in connection with a field geological study of all the P. & N. G. Permits comprising the D. Todd Briggs Project, N.W.T., conducted by J.C. Sproule & Associates during the summer of 1954.

These Permits are located at the easterly end of Kakisa Lake, as illustrated on the accompanying map, Figure I. The more northerly Permit No. 662 includes much of that portion of the Kakisa River (locally known as the Beaver River) which drains Kakisa Lake into that part of the Mackenzie River known as Beaver Lake.

Geological field studies in this area were accomplished in large part with the assistance of a Model "D" Bell helicopter, which operated from a base camp on the south side of Kakisa Lake. With the helicopter it was possible to locate and study bedrock outcrops inaccessible by other means. Full use was made of the stereoscopic photo coverage obtained from the R.C.A.F. at Ottawa, and photogeological studies supplemented all field work.

This general summary has been prepared for the most part by S. R. L. Harding.

PHYSIOGRAPHY AND CULTURE

A series of northwest-southeast trending limestone escarpments are present in Permit No. 662 and a similar escarpment lies south of Permit No. 661. This latter Permit is a poorly drained, swampy area in which no outcrops were observed. The chief streams are an unnamed sluggish creek flowing northwestward through swampy ground into the eastern end of Kakisa Lake and the portion of the Kakisa River which drains northeast from Kakisa Lake to the Mackenzie River. The most outstanding single physiographic feature of the area is Lady Evelyn Falls, formed where the Kakisa River drops 47 feet over the most prominent of the limestone escarpments in the subject Permit area. Total relief in the Permit area is approximately 350 feet, with elevations ranging from about 550 to 900 feet above sea-level.

Access to the area is by means of the Mills Lake Road, a winter trail which follows limestone escarpments and sandy beach ridges from the Mackenzie Highway past Escarpment Lake to Lady Evelyn Falls, a distance of some 50 miles, and beyond this to the Mackenzie River below Mills Lake, approximately another 50 miles. Except for a few low spots this road is usable in summer as well as winter.

GENERAL GEOLOGY AND STRATIGRAPHY

All rock exposures in Permits Nos. 661 and 662 are Upper Devonian beds of the Hay River formation, although some Upper Devonian rocks exposed south of Permit 662 may be higher in the stratigraphic section than any exposed further east on the Hay River and hence higher than the Hay River formation. The best rock section in the subject area is exposed along the valley of the Kakisa River. The description of this section from Kakisa Lake to the Mackenzie River follows:

Thickness	Description
	Kakisa River Section Below Kakisa Lake
1'6"	Limestone - brownish grey, very fine crystalline, thin bedded ½" to 1".
?	Under cover.
1'6"	Limestone - light brownish grey to medium grey, fragmental, in part very fine crystalline.
?	Under cover.
0'6"	Limestone at water level with a few green shale partings.
?	Under cover.
0'6"	Limestone - dark brownish grey with greenish tinge, soft.
3'6"	Limestone - light brown, very fine grained, fossiliferous, in part fragmental.
16'	Fragmental limestone, outcrops discontinuous.
4'	Limestone - light brownish grey, fine crystalline, fragmental, very fossiliferous.
2'	Limestone - medium grey, coarse fragmental, fine crystalline matrix, considerable pyrite in cubes and little nodules. Thin bedded lime with brown shale partings makes upper contact; this varies laterally to limestone, light brownish grey, fragmental, pseudo-oolitic especially at top. Stylolites form break at base.

Thickness	Description
3'	Limestone - light grey, medium granular, hackly vertical fracture, no apparent bedding. This bed only 8" thick 100 yards northwards.
5'	Limestone - medium brown, coarse crystalline, trace of fragmental material, slightly oolitic giving mottled appearance; dark brown bituminous? material in wavy bedding partings; rough bedding with pronounced but irregular jointing.
12'	Limestone - light brown, very fine crystalline to fine granular, completely organic, but of uniform thickness.
23'	Limestone - brownish grey, very fine crystalline with trace of fragmental texture, slightly silty and especially in some zones, massive bedding; a few poorly preserved brachiopod fragments and some disseminated pyrite.
5'6"	Siltstone - very limy, interbedded with silty limestone; numerous green shale partings; thinner bedded at top.
4'	Dolomitic siltstone - coarse, massive, brown, weathering reddish; a few thin argillaceous partings.
2'	Interbedded limy siltstone, and silty limestone. Siltstone - green, soft, argillaceous, fissile. Limestone - greenish grey, occasional fossil fragment and disseminated pyrite.
	Lady Evelyn Falls
44'	Limestone - forming an overhang, dull olive grey crypto-crystalline, argillaceous, becoming more so toward bottom, interbedded with thin shaly layers, leaving beds of limestone 1" to 1' in thickness.
0'6"	Shale - dark greenish grey, limy, blocky to slightly fissile, very rich in fossils, mainly brachiopods, some corals and crinoids.
3'	Limestone - dull olive grey, crypto-crystalline, to slightly fragmental with calcite veinlets, very hard, argillaceous, frequent brachiopods.
3'	Shale - dark greenish grey, limy blocky, homogenous, weathers earthy brown, undercut by stream.
	Base of Lady Evelyn Falls
2'	Limestone - brownish grey to olive green, crypto-crystalline, argillaceous in part. Trace of fragmental material, highly fossiliferous.

Thickness	Description
?	Thin hard limestone, not well exposed.
?	Under cover.
2'	Limestone - two thin resistant beds, medium grey, crypto-crystalline, argillaceous, numerous calcite veinlets, fossil fragments. Underlying rock not exposed, but rubble along stream indicates it to be a greenish grey, soft, limy shale.
?	Under cover.
2'	Limestone - resistant bed, greenish grey, argillaceous. Over and under lying rock not exposed.
?	Under cover.
12'	Limestone - resistant bed of 2 feet, brownish grey, crypto-crystalline, hard, numerous calcite veinlets. Underlain and overlain by a greenish grey shaly limestone and limy shale. Zone under limestone bed fossiliferous.
?	Under cover.
2'	Limestone - fragmental, brownish grey with greenish cast, very fine crystals, rich in fossil fragments, in part argillaceous, weathering to a rubbly surface.
0'6"	Limestone - greenish grey, argillaceous, very fossiliferous, and some hard, crypto-crystalline limestone, weathers dull grey, leaving a clay residue.
20'	Limestone - light brownish grey, crypto-crystalline, hard with irregularly distributed patches of brown, fine granular limestone, numerous veinlets and occasional small vugs filled with calcite, weathering chalky, with a very uneven surface, traces of fossils: corals, gastropods - poorly preserved. Rough, uneven rubbly bedding planes about 2" apart give banded appearance. Vertical jointing in evidence.
	Below Mills Lake Trail Crossing
?	No bedrock exposed downstream to the Mackenzie River from location where Mills Lake Trail crosses the Kakisa River. Banks are composed of clay. River bed is mainly cobbles and boulders of dark iron stained igneous rock with some angular limestone boulders.
175'	

As indicated on the accompanying geological map, it was possible to trace for some distance northwest and southeast the Lady Evelyn limestone member which forms the falls. Other scarp-forming members were also traced.

No well-developed reef facies were present within the subject Permits, but reefs were observed to the east and south.

STRUCTURAL GEOLOGY

By carrying elevations along the scarp-forming limestone members in the area, it was possible to gain some knowledge of the structure. In general a regional northeast-southwest syncline appears to be present at the east end of Kakisa Lake. This is best demonstrated in Permit No. 662 where the Kakisa River crosses the limestone escarpments at points along a structural low. The possibility of local structural "highs" is present, but the distribution of outcrop is insufficient to indicate them.

All elevations were taken by means of a Wallace and Tierman Model No. F.A. 181 altimeter used on helicopter traverses. By this means of transportation relatively short times elapsed between outcrop stops and traverses could be frequently closed and balanced. In this way inaccuracies were minimized.

OIL AND GAS PROSPECTS

A.E. Cameron states that "the presence of asphaltum and oil-bearing rocks in the Mackenzie Basin and on the shores of Great Slave Lake has been known ever since the earliest explorers visited that part of the Northwest Territories." One of the best known oil seepages is the one on Windy (Nintsi) Point on the north shore of Great Slave Lake, of which G.S. Hume says, "At Windy Point a number of oil seepages occur from the Presqu'ile formation of Middle Devonian age. The Presqu'ile formation is a porous dolomite containing caverns lined with dolomite crystals and partly filled with a thick heavy oil. Where fractures have occurred in the rock or where other factors have tended to concentrate the oil, small pools occur on the surface, and where such seepages occur under the lake the surface of the water is almost constantly covered by a thin film of oil. A black viscous substance derived from the oil stains the face of the rock, and on a warm day dark streaks of an oily mixture ooze out of the rock and slowly run down over the edges of the exposures. There is no doubt that this horison contains oil in quantity."

Recent drilling by N.W.T. Petroleums Limited in the Deep Bay area, west of Windy Point, has produced additional evidence of oil in both the Territories-Slave Point and Presqu'ile formations. Good oil saturation and bleeding cores were reported from several wells. Failure to recover oil on tests appeared to result from insufficient permeability and low formation pressures. Farther west at N.W.T. No. 1, near Fort Providence, gas, which flowed on drill stem test at the rate of 40 Mcf/day, was discovered in the Slave Point and/or Presqu'ile formations.

Evidence of oil and gas is also present on the south side of Great Slave Lake. Neil Campbell, who supervised the C. M. & S. Company test program in the exploration for lead and zinc in the Pine Point area, stated "pyrobitumen and small traces of oil are found in increasing abundance toward the west in the Slave Point and Presqu'ile formations." Oil saturated reef cores were taken from Frobisher test holes at Mile 12 south of Hay River and gas was encountered in tests at several horisons. Inflammable gas is still escaping under slight pressure from a test drilled at this location in 1947. Live oil was also present in reef cores at C. M. & S. No. G-2 at Mile 16. The C. M. & S. No. G-3 test at Escarpment Lake was not drilled deep enough to test the Presqu'ile formation. This year N.W.T. Petroleums drilled a well at Escarpment Lake and were sufficiently encouraged by a show of live light oil (33 A.P.I.) in the Territories-Slave Point formations to drill a second test. Unfortunately, porosities and permeabilities were poor and there was poor oil and water separation.

In his paper of 1920, Hume stated further, "The possibilities of finding oil at some distance inland from Windy Point are unknown ..... If favorable structures can be located in this region with a cover of ..... shale the possibilities of finding oil would seem to be very good."

The authors of this report consider that the possibilities of finding gas and/or oil in commercial quantities in the D. Todd Briggs area southwest of Great Slave Lake are very good indeed. In this area reef-type reservoirs which can provide their own structural closure can be expected to occur in known oil and gas-bearing formations under suitable cover and at depths adequate for the preservation of gas and/or oil of commercial quality. Formation pressures should also be higher than in the shallower tests to the northeast.

The principal prospective oil and gas zones in the subject area are limestone or dolomite reef developments in the Territories-Slave Point and Presqu'ile formations. The stratigraphic relationships of these formations in the general region are still not fully understood, but the drilling already conducted in the Great Slave area has shown at least that the known reef developments tend to be localised. Various factors, such as depth and character of water and temperature, determine the locations of reef growth. Depth of water is, of course, related to topographic relief on the sea floor, which in turn is commonly related to structural trends. It is a well-known fact that the world's great oil fields are located along lines of structural weakness that are subject to rapid structural and sedimentary change.

The known structural trends in the area strike northeast-southwest, and in line with the above it is believed that the tendency will be for such trends to be repetitive from one geological period to the next. The recognition of Devonian facies changes along a northeast-southwest trend (reef and back-reef facies changes in the Middle Devonian, and shale and limestone facies changes in the Upper Devonian) is further evidence that paleotopographic influences were operative along this strike at that time.

CONCLUSIONS AND RECOMMENDATIONS

P. & N. G. Permits Nos. 661 and 662 occur at the eastern end of Kakisa Lake and include much of the area through which the Kakisa River flows to drain Kakisa Lake. Bedrock exposures of the Upper Devonian Hay River formation are chiefly along the Kakisa River and along escarpments which can be traced northwest and southeast roughly at right angles to the Kakisa River.

Elevations taken along these limestone escarpments indicate that the Kakisa River flows through a southwestward plunging syncline which is the most prominent structural feature of the area.

Prospective oil and gas reservoirs in the area are the limestone or dolomite reef developments of the Territories-Slave Point and Presqu'ile formations, which are essentially Middle Devonian in age.

J.C. Sproule,
P.Eng., Alberta.

901 - 8th Ave. West,
Calgary, Alberta,
August 12, 1955.

GEOLOGICAL RECONNAISSANCE
&
INDEX MAP
GREAT SLAVE LAKE - LIARD RIVER AREA, N.W.T.

(SHOWING RECONNAISSANCE GEOLOGY
COMPILATION AND PERMITS HELD BY KELCAM OILS)
REGIONAL GEOLOGICAL INFORMATION AS OF FEBRUARY 1954.

SCALE
0 8 16 24 32 MILES
0 1 2 3 4 INCHES

GENERAL LEGEND

- P 166 — RESERVATION BOUNDARY
- GEOLOGICAL BOUNDARY
- FAULT
- ANTICLINAL AXIS
- SYNCLINAL AXIS
- TRAIL
- Location or Drilling Well
- Abandoned Well
- Gas Cache
- Photo Mosaic

FORT LIARD AREA

MESOZOIC

CRETACEOUS

UPPER CRETACEOUS
- K
- KK — KOTANEELEE
- Kfn — FORT NELSON

LOWER CRETACEOUS
- Kfsj — FORT ST JOHN

PALEOZOIC

CARBONIFEROUS
- PM — PENNSYLVANIAN &/or MISSISSIPPIAN
- M — MISSISSIPPIAN

DEVONIAN
- D — UPPER DEVONIAN

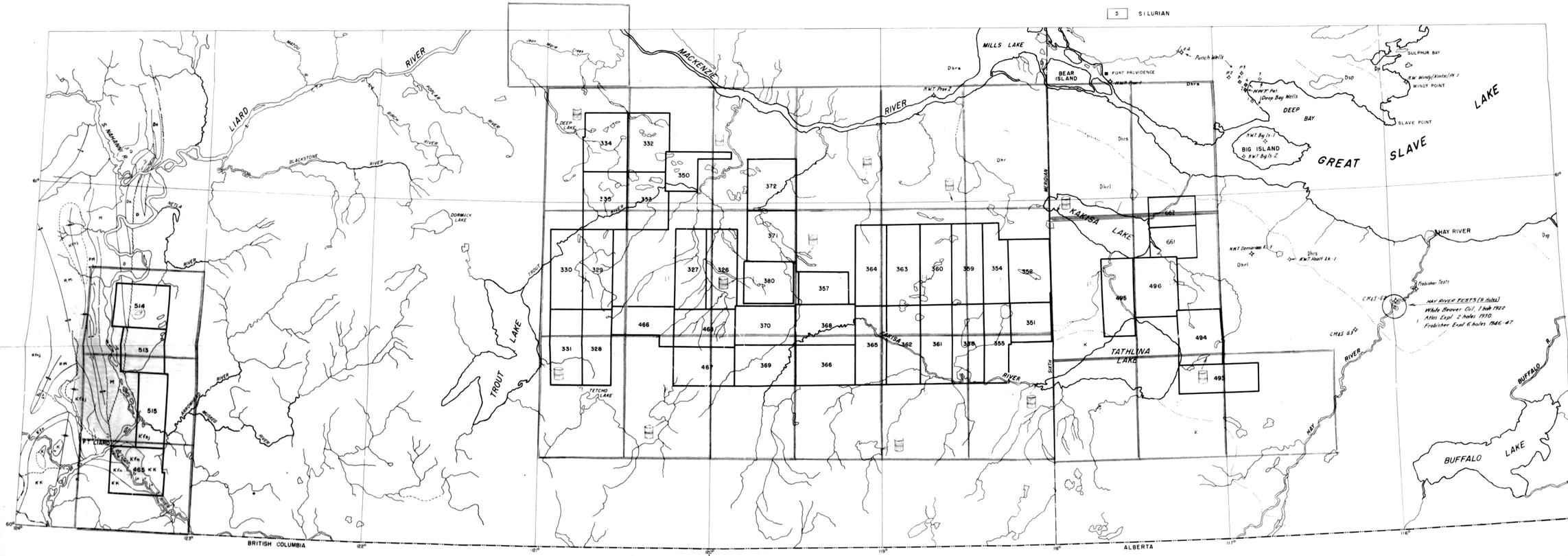
MIDDLE DEVONIAN
- Dn — NAHANNI
- S — SILURIAN

GREAT SLAVE LAKE AREA

- K — CRETACEOUS

UPPER DEVONIAN
- Dhrl — HAY RIVER Ls
- Dhrs — HAY RIVER Sh
- Dsp — SLAVE POINT Ls

MIDDLE DEVONIAN
- Dp — PRESQU'ILE DOLOMITE
- Dpp — PINE POINT Ls



Compiled from published maps of the Geological Survey of Canada

J.C. SPROULE & ASSOCIATES
901-8th Ave. W. Calgary, Alta.

508-1-4-1

LETTER REPORT

OUTLINE OF PROPOSED EXPLORATORY

AND

FOLLOW-UP DRILLING PROGRAM

N.W.T. PROJECT

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LETTER REPORT

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(Bingo?)

Calgary, Alberta,
May 12, 1954.

Mr. A. M. Lloyd,
White & Loyd,
402 First National Bank Bldg.,
Dallas, Texas.

Re: Outline of Proposed Exploratory and Follow-up Drilling Program, N.W.T.

Dear Mr. Lloyd:

The recommended program of exploration that follows is supplementary to that presented to you on March 8, 1954, as covering the surface geological program that we are prepared to carry out on a contract basis during the coming field season for a total of $82,000.

Since our original presentation of this program and the authorization that followed, we have taken the following action to get the program under way.

1. The helicopter fuel caches have been flown to the area by Associated Airways, to the points indicated on the attached reference map. For later identification the plane crew marked on photographs supplied by us the exact locations of the caches and subsequently a toboggan sled ground crew moved the gas drums off the lakes to safe positions on shores of the landing lakes and arranged for additional identification.

2. A minimum three-month contract has been signed with Canadian Helicopters.

3. Our field equipment, camp supplies, etc. have all been purchased and are ready for the field.

4. All mosaics, as indicated on the attached reference map, have been completed and are being subjected to regional geological study for guidance in further study of indicated points in the field. Such mosaics are also being studied in relation to the geophysical results shown on aeromagnetic maps purchased from Aeromagnetic Surveys Limited. Copies of all mosaics have been made for field use. It has also been found desirable to obtain a second complete set of alternate photographs for stereoscopic use in the field,

in consideration of the fact that the base mosaics should be left as they are in the interests of the time element. If this were not done the mosaics would all have to be torn down and rebuilt, a difficult feat for a firmly cemented network of photographs.

5. A geological report by C. O. Hage on the Liard River-Trout Lake Area, originally agreed for separate purchase, is being completed. It should be available within a week or two.

After a preliminary perusal of this report I believe it will save us a certain amount of effort in our Liard River studies and think, therefore, that this should be included as an expense chargeable to us. We are, therefore, with your permission, assuming this obligation as part of our $83,000 program. Incidentally, since Mr. Hage is an authority on the Liard River area along the British Columbia-Northwest Territories boundary, I made an effort to have him take charge of our field party on that Liard project, but he believes he will be involved in other foothills field work during most of the summer season. We already have a well qualified man with many years experience for that work, but had we been able to employ Mr. Hage, we would have used the other geologist, Professor Best, on other work.

6. The field parties have been organized and for your information the organization is as follows:

District Field Supervisors - J. C. Sproule & S. R. L. Harding

Liard Project: Party Chief - Prof. R. V. Best (University of Western Ontario).

Assistant - Keith Lyle (Graduate in Geology University of Alberta).

Mr. Best's party will also require a river houseboat and a crew because of the dangerous character of the Liard River, which passes through the length of the area and from which all lateral traverses must be run. We have been in contact with transportation firms on the Liard River and are making arrangements for a houseboat and a crew from which to operate our base camps.

Trout Lake-Hay River Area:

1. Party No. 1 - Party Chief - S.R.L. Harding

   Assistant Geologist - D.L. Campbell (Graduate geologist University of Alberta)

   Cook - C. C. Jackson

   Canoeman - (Local)

2. Party No. 2 - Party Chief - Keith Williams (Graduate geologist University of Alberta)

   Assistant Geologist - David Sellers (Student)

In a sense it is of interest to note that the relative strength of the field staff will be improved by arrangements made to fly supplies to the main camps from Hay River. We are also arranging for a field radio in order to improve the efficiency of the service.

In addition to the routine exploration planned for the area, as described in previous correspondence, we may say that we plan to spend some time in an examination of the lower part of the geological section at the outcrops at the west end of Great Slave Lake, in particular Devonian reefoid facies, in order to confirm or deny the present conception of the widespread relationship that exists between Precambrian topographic and structural trends, and reefal trends. Although this outcrop area is some distance from the field area, the conclusions to be drawn are very definitely of considerable interest. It is anticipated that the above program will outline local structural features and point to regional structural features that should be checked more closely either by geophysical structure test or slim hole methods. Until the surface geological work is complete, however, it would not make sense to spell out too rigidly the program that should be followed. The follow-up methods described below may be regarded as probable procedures, except possibly for the first mentioned, which should depend on an early evaluation of it, which we believe can be made.

We would avoid at this time describing too closely the relative importance that should be placed on the methods that follow, as we believe that that should be decided as the program proceeds. The follow-up work that we now anticipate may be recommended as a result of our field geological program may be summarized as follows:

1. Study of Access Routes
2. Airborne Magnetometer Work
3. Structure Test Work
4. Seismic Work
5. Deep Test Work

1. Study of Access Routes

Supplementary to the various exploration methods referred to below, a detailed study should be made of all access routes to, and within, the project area.

2. Airborne Magnetometer Work

The known existence of Precambrian trends in this general area that have an effect on reef development places a premium on giving airborne magnetometer work a fair trial. In our opinion, giving this method a fair trial involves careful study of the maps already prepared by Aeromagnetic Surveys Limited in relation to what knowledge of geological structure may arise from our forthcoming field study. If strong geological features are recognized on the ground, a fair evaluation of the aeromagnetic method will be possible, in part at least. If no geological features are recognized the aeromagnetic method will not have been evaluated. If that should turn out to be the case, however, we would then include in our seismic, structure test, or slim hole program a partial evaluation of one or two key aeromagnetic anomalies, before coming to any conclusion as to the value of this method. Meanwhile, we

believe the results at hand cover a sufficiently wide area to provide a fair test of this method, and that no further aeromagnetic work should be done until evaluation of the present data warrants it.

The fact that the semi-detailed exploratory work within the project area is being supplemented by regional reconnaissance work outside the reservations, will aid in our evaluation of aeromagnetic work.

Aeromagnetic work could be done during either the winter or the summer months in this area.

3. Structure Test Work

The project area is one that involves small scattered outcrops over a relatively flat terrain, with fair-sized areas of muskeg and thinly covered lowland. At this stage we do not know whether or not the geological control will be sufficiently closely spaced to provide adequate structure control for all the regional and the larger local structures. We believe it to be certain, however, that between outcrops structure control will be desired, of the type that can be done most efficiently and economically by use of shallow core drills.

In summary of its value, this tool should be available for establishment of wide-spaced structure control in broad muskeg areas, for checking of indicated local structures outlined by ground and photogeological methods, aeromagnetic anomalies and seismic work.

The widespread muskeg areas dictate the use of the structure drill in the early stages of the program only during the winter months.

4. Seismic Work

Seismic work is the type of work that in this area should be expected to refine structural features to the point where the most suitable locations for deep tests can be made. Because of its relatively high coverage cost it is desirable to restrict such coverage to local areas of structural interest by early use of surface geological methods, possibly checked by the others referred to above. These other methods in this area are expected to evaluate and refine local and regional structure to the point where blind coverage of structurally unknown terrain by the relatively expensive seismic method will be unnecessary.

Seismic work of the type that will be done here should be done initially only during the winter months.

5. Deep Test Work

The present project may or may not be ready for deep drilling during the coming winter season. The initiation of a deep test will depend on how thoroughly we can outline a drillable structure during the coming summer. Our objective should be to find such a structure in order that it can be further tested, if necessary, early in the winter, for drilling also during the coming winter. The desirability of an early stratigraphic test of this

large unknown area is obvious, particularly when we take into consideration the results of the currently drilling Imperial Indian Island well, south of Trout Lake. This well recently penetrated upwards of 500 feet of Mississippian before entering the Devonian group. It is (today, May 12th) drilling at 6,808 feet in the Devonian. On a regional structure basis this well should have not over about 5,000 feet of stratigraphic section, which means that a local steepening of the "regional" somewhere within your project lands is indicated. This, of course, adds considerably to the interest in the area and places an additional premium on early knowledge of the stratigraphic section.

In the hope that this brief summary of our views is what you have asked for, we remain,

Yours very truly,

J. C. Sproule

JCS:BI
Encls.

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GEOLOGICAL REPORT

D. TODD BRIGGS PROJECT, N. W. T.

Summary of
Geological Report
D. Todd Briggs Project N.W.T.
with March 1953

J. C. SPROULE & ASSOCIATES LTD.
GEOLOGICAL & EXPLORATION CONSULTANTS

901 EIGHTH AVENUE WEST
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LEGEND

[Dhr] Hay River Formation

[Dhr] Limestone at or near surface

x 1055 Altimeter Elevation above sea level

Fault

Stratigraphic Strike and Dip

RABBIT LAKE STRUCTURE

HAY RIVER - TROUT LAKE AREA

NORTHWEST TERRITORIES

1 0 1 2 MILES

SCALE APPROXIMATE

J.C. SPROULE & ASSOCIATES LTD
901 8th Ave W. Calgary Alberta

GEOLOGICAL REPORT

D. TODD BRIGGS PROJECT, N. W. T.

INTRODUCTION

At the request of White & Lloyd and Lehman Brothers interests a field and photogeological survey of their respective Petroleum and Natural Gas Permits in the Northwest Territories was undertaken during the summer of 1954. These Permits, which are outlined in Figures II, III and IV accompanying this report, have been grouped as the "D. Todd Briggs Project" and are readily divided into two blocks, an eastern block which has been called the Trout Lake-Hay River area (Figures II and III), and a western block which has been called the Liard River area (Figure IV). Total lands held under permit by the above groups at the time the study was commenced amounted to some 3,646,543 acres, of which approximately 3,173,933 acres were in the Trout Lake-Hay River area and 472,610 acres in the Liard River area. Boundaries of the eastern area are approximately 116°45' and 121°30' West Longitude and 60°25' and 61°20' North Latitude. Boundaries of the western area are approximately 123° and 123°45' West Longitude and 60° and 61° 40' North Latitude.

Detailed photogeological maps of the project, which have been prepared to accompany this report, cover approximately 9½ million acres. These maps are 35 in number, Nos. 1 to 26 inclusive and Nos. 33, 34 and 35 cover the eastern block and Nos. 27 to 32 inclusive cover the western block. They have been reduced from the original scale of approximately 1.65 inches to the mile to a scale approximately one inch to the mile. The more essential geological data on these mosaics have in turn been placed on the 4 miles to the inch maps, Figures II and IV, with structural interpretations added.

Some studies were also conducted beyond the limits of the areas mapped on photo-mosaics where pertinent information was desirable and available. A broader regional study has been considered essential to a full understanding of the project area. The map-area chosen for regional review (Figure I) includes that area lying between 114° and 124° West Longitude and 59° and 62° North Latitude and comprises the northern parts of Alberta and British Columbia as well as a large area in the Northwest Territories.

Geological studies over this large area have been conducted at irregular intervals by geologists of both the Geological Survey of Canada and private interests. For the most part the studies of previous survey parties have been restricted to canoe and boat traverses along the main streams and much inter-stream geology of interest has in this way been unobserved. One of the earliest geological surveys of the area was conducted by R.G. McConnell for the G.S.C. in 1888. Because of its oil possibilities the area has subsequently received considerable attention from other G.S.C. geologists, such as A.E. Cameron, G.S. Hume, E.J. Whittaker and C.O. Hage. Oil was discovered by Imperial Oil Limited in 1920 north of Fort Norman on the Mackenzie River and the first drilling in the Great Slave Lake area was undertaken by Imperial Oil Limited in 1922 at Windy Point on the north shore of Great Slave Lake. Since then additional drilling has been undertaken from time to time, for the most part adjacent to major water courses, but no drilling has been conducted in the project area. Commercial oil has not yet been found in the immediate area but the numerous shows found are encouraging.

The widespread development of Devonian reefs on outcrops on Great Slave Lake and at numerous localities west of Great Slave Lake, in and in the vicinity of the map-area, combined with the numerous shows of oil on outcrops at Pine and Slave Points on Great Slave Lake and in most of the wells drilled throughout the area, adds considerable interest to the petroleum and natural gas prospects.

Geological field work for this study was accomplished by the use of canoes, river boat and helicopter. The project was under the general supervision of J.C. Sproule and S.R.L. Harding who were assisted by geologists G.K. Williams, D.L. Campbell, R.V. Best and K. Lyle.

Best and Lyle with B. Jobin, a boatman-cook, worked as a semi-independent party in the Liard River area. Williams, with D. Sellers as canoeman, conducted most of the stream traverses in the Trout Lake-Hay River, or eastern area. The foot traverses in this more eastern area were handled in large part by Campbell and his assistant, H. Martel, who were transported to specific areas by helicopter. Except for two visits to the Liard party the Model "D" Bell helicopter operated from the movable base camp which was situated in the eastern area. In addition to those previously named, camp cook C.C. Jackson and the Canadian Helicopters Limited crew of Pilot J. Foster and Engineer H. Wilson completed the survey personnel.

The helicopter was invaluable in accomplishing the geological mapping of the area. Not only was it possible to do many seasons' work in one summer but it is safe to say the project could not have been accomplished without the helicopter, because so much of the exposed rock would have been inaccessible by any other means. As it turned out, the more interesting geological structures observed in the eastern block are in an inter-stream area far from normal access routes.

As a supplement to this report, a report entitled "Regional Geological Study of the Southern Portion of the Northwest Territories, Northeastern British Columbia and Northwestern Alberta for J.C. Sproule and Associates" by C.O. Hage, dated June 1, 1954, has already been submitted.

What we still do not know about the results of this magnetometer work is whether or not the magnetometer highs are due to topographically high dolomitic limestone areas as contrasted with the relatively non-magnetic glacial drift and shale surrounding them. For example, the Rabbit Lake structural high is also a topographically high limestone outcrop area, as is also the west side of the Providence Fault within that area indicated as being a high anomaly on the magnetometer map. Once we pass away from the outcrop of limestone any indication of a fault also disappears on the magnetometer map, which is very suggestive of the interpretation that it is not a really deep-seated fault that shows on this magnetometer map, but rather the near-surface terrain results.

Further steps should be taken to evaluate the magnetic results in this area, in addition to those efforts that are being made through currently drilling structure test wells.

CONCLUSIONS AND RECOMMENDATIONS

The project area is located in the southern portion of the Mackenzie River Basin within that broad area that extends from the Precambrian on the east to the Nahanni and Liard Mountains on the west. That portion of the D. Todd Briggs project under study involves approximately 3,646,543 acres within this area, approximately 3,173,933 acres of which lie on the plains of the Hay River-Trout Lake area and 472,610 acres in and adjacent to the mountains and foothills of the Liard area. The gross acreage surveyed, and for which photo-mosaics were prepared, amounted to 9,500,000 acres.

From the standpoint of accessibility, the Liard River passes through the Fort Liard project block and the Mackenzie River passes through and provides a traffic artery in the northern portion of the Hay River-Trout Lake project area. The Mackenzie Highway, linking Edmonton and Hay River, passes close to the southeast corner of the map-area and a potential all-weather road, by way of the Mills Lake tractor trail, might easily be built into the eastern and northern parts of the Hay River-Trout Lake area, where Devonian rocks are close to the surface over a large area. The area of outcrop and near-outcrop would appear to be subject to access during the summer months with a minimum of road-building effort. Most of the rest of the area is heavily wooded and muskeg-covered and could, therefore, only be reached during the winter months. Several winter trails enter the area from the Mackenzie River Highway on the south and from the Mackenzie River on the north but are of little use other than during the winter months.

Relief in the Hay River-Trout Lake area varies from a minimum of 375 feet above sea-level on the Mackenzie River to a maximum of 2,740 feet on the Cameron Hills, whereas relief in the Liard River area varies from less than 700 feet on the Liard River to 5,200 feet in the Nahanni Mountains.

Glaciation has modified all of the area except possibly parts of the mountains themselves. Glacial deposits are a serious obstruction to an under-

standing of the structure over most of the area, which, therefore, places a high premium on the value of geophysical and structure test operations.

The geology of the project area has not been well known prior to the present operation, having been covered only by a few rapid reconnaissance surveys, mainly by the Geological Survey of Canada. These surveys yielded only a general picture of the stratigraphic section and have given little information on the structure, either regional or local.

The principal prospects within the area are reef horizons in the Devonian. The project area covers one of the widest spreads of potential Devonian reef prospects in western Canada. Devonian reefs of the type that can be expected to reservoir oil are known at the surface or at depth from the vicinity of Hay River to the vicinity of the Liard Mountains, over a distance of nearly 250 miles. Naturally the entire intervening area would not involve reef, but it is believed that connecting reef belts are present.

In addition to the Devonian prospects, the Mississippian and to a lesser extent the Silurian and the basal sand of the Paleozoic group have some possibilities, but they appear to be of secondary interest.

The Devonian prospects referred to above are believed to be related primarily to reefs that are caused directly or indirectly by paleotopographic highs and by fault scarps in the Precambrian that are reflected with sufficient strength in the overlying stratigraphic section to have provided ideal conditions for reef development. This idea, which has dominated much of our thinking in the field operations to date, has had strong support in what drilling results have been obtained, particularly in the drilling of Heart Lake No. 1 and Heart Lake No. 2 wells. These wells are located on strong reefs at the surface and they found excessive reef development at depth. On the other hand, the nearby Desmarais Lake and Escarpment Lake wells were located on non-reefal limestone facies of the same Heart Lake reefoid horizon and showed no unusual reefoid development at depth.

Another significant conclusion worth recording is that the Pine Point fault line shows an excessive development of reefoid reservoirs. These reservoirs contain residual bitumen as well as the lead-zinc deposits of the Pine Point mining operation, indicating that some re-juvenation of the fault line responsible for the original scarp, and the original reef conditions must have taken place. The Pine Point fault trend is only one of a number in the area that appear to be basement features and which probably are associated with reefoid development.

The oil seepages reported at Windy Point and Pine Point in the Presqu'ile and Slave Point formations are very significant to the general prospects in the area, particularly when combined with the evidence provided by the numerous oil shows found in the wells drilled.

What is even more significant with respect to the Presqu'ile and Slave Point formations on Great Slave Lake is the presence of this reefoid horizon outcropping in the Nahanni Mountains, 250 miles to the west. The conclusion seems reasonable that there is a reefoid belt connecting the two that should cross a fair proportion of the map-area.

A regional facies change of particular interest is the manner in which the lower limestones of the Hay River formation of the eastern portion of the map-area blend westward into the shale and sand facies from the vicinity of Kakisa Lake westward to the Liard River area.

There have been very few deep tests drilled in the region, considering its size. Of those drilled, most have been grouped locally and have not properly tested any significant structural features. None of these holes have been drilled in the project area.

The most significant data obtained from the holes drilled has been:

1. A very thick section totalling over 8,000 feet was penetrated in the Imperial Island River well. Part of the section was Mississippian, which may place the Mississippian pinchout within the project area.

2. The depth to the Precambrian in the above well means that a very strong terrace probably exists between the relatively shallow holes of the Providence-Heart Lake area and the Trout Lake portion of the project area.

3. Most of the wells drilled are in the area immediately to the east of the project block and almost all of them had significant shows of oil.

4. The Heart Lake wells proved the presence of excessive reefoid conditions at depth beneath reefs at the surface.

The principal structural features of interest in the Liard area are:

1. Bovie Lake Fault, which merges northward into an anticline.

2. Subsidiary folds in the Petitot River Syncline.

3. The fold that represents the southern extension of the Liard Range Fault.

4. A large oblique northeast-trending fault (?) that may have exerted an influence over a wide area and another fault (?) and a fold in the Blackstone River area. These features may indicate a cross-trend that will turn out to be of value to some of the Permit acreage.

The principal structural features of interest in the Hay River-Trout Lake area are the several strong features mapped on surface evidence. One of them is the Providence Fault. The remainder, some of which at least are closed, are low "rolls" with apparently associated excessive reefoid developments. These features look promising for similar reefoid conditions at depth and are currently being checked by structure testing. One or two deep tests are being drilled on the two most prominent of these structures, the Rabbit Lake and the Foetus Lake Structures.

In consideration of the above, our recommendations, some of which are at the time of writing already being carried out, are:

1. Seismic work should be conducted in the Hay River-Trout Lake area, with special consideration being given to structural trends indicated by the surface geological work and the airborne magnetometer work.

2. Structure test holes should be drilled to test the value of some of the surface observations and to obtain additional information where surface observations are lacking.

3. Drill at least one deep test on the Rabbit Lake Structure, since it is already known to be a closed surface feature. It should, however, be understood that this hole will be in part a purely stratigraphic test since the high part of the structure is not known for sure, and since the Permit boundaries will not permit a location on what is already known to be structurally higher point.

4. Further special consideration should be given to a full evaluation of the aeromagnetic results, because of the possible regional as well as local significance of some of the basement features that are probably involved in those results.

5. If any significant encouragement is obtained from the first deep test (or tests) drilled, an all-weather road into the area should be seriously considered. In view of the value of such a road to the development of the Northwest Territories, with particular reference to the Mackenzie Highway as a traffic artery, it is suggested that this access route be brought to the attention of the Northwest Territories Administration for their attention and possible action.

6. In consideration of the fact that some at least of the "reef build-ups" in the Kakisa area are closed, we have every reason to believe that the Heart Lake reef "build-up" is also closed. Since the latter is known to be strongly reefoid at depth, it is suggested that the D. Todd Briggs group seriously consider taking an interest in the New Superior Oils of Canada spread of acreage, involving the Heart Lake and other similar features.

7. Abandon Liard Permit No. 438.

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March 4, 1955.