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BRITISH EMPIRE OIL COMPANY LTD.

GEOLOGY OF THE WILLOW LAKE PERMITS, N.W.T.

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INTRODUCTION

This report is done at the request of Mr. J. H. Bevel for British Empire Oil Company Ltd. on the Company's permits in the Willow Lake River Basin, Northwest Territories, Canada. It is intended as a compilation of regional geologic information and a general statement of prospects as they appear prior to preliminary exploration.

TERRAIN AND ACCESSIBILITY

The permits of British Empire Oil Company Ltd. are located in the northern part of the Willow Lake River basin, north and east of the Mackenzie River, approximately 200 miles northwest of the Town of Hay River, Northwest Territories.

The Mackenzie River constitutes the main traffic artery of the North country, most freight movement being by barge in the four months of summer. Tractor trains also move large quantities of freight over winter trails. A winter tractor road connecting Fort Simpson with Fort Norman passes directly across the British Empire Oil Company Ltd. permits. However, due to the permits being located in the "bush" country away from the Mackenzie River they will be found to be inaccessible in summertime excepting by aircraft fitted with floats for water landings.

Fort Simpson, the nearest settlement which may be considered a supply base, is served by a large airfield and may be expected to furnish gasoline and other basic supplies for an exploration party. A radio station and R. C. M. P. station are also located at the town.

The Willow Lake River basin lies east of the Franklin Mountains. The Willow Lake River is probably an antecedent stream

flowing through the mountains to reach the Mackenzie. The upper portions of the basin around Willow Lake are largely flat-lying muskeg. The western portions of the permits are in more undulating country which will probably be found to be better drained. All of the country is, in fact, relatively poorly drained and has been scoured and moulded by Pleistocene glaciers. Eskers, drumlins, glacial chatter marks, moraines and Pleistocene river channels obscure many of the differential erosion features which would normally be present. In many places glacial structures constitute the only features of the low-lying sub-arctic plain. To the southeast the Horn Mountains composed of flat-lying Devonian and Cretaceous strata can be seen to rise above the flat plain.

Probably the most feasible method of exploration for British Empire Oil Company Ltd. will be a winter operation from tractor trains. Some summer reconnaissance with light equipment may, however, be made by landing on the Willow Lake or the small lakes which lie in many places over the permit areas.

STRATIGRAPHY

Devonian

Upper Devonian limestones and shales are believed to outcrop over the entire area covered by British Empire Oil Company Ltd. permits. West of the permits the Franklin Mountains are believed to be faulted above the plain and are known to expose Silurian, Ordovician and Cambrian strata. To the east a greatly thinned section of Devonian and lower Paleozoic rocks outcrops as it rises on the Canadian Shield.

The permit area beneath the glacial drift is believed to be mainly underlain by a bedrock of upper Devonian shales and limestones correlative to the Hay River limestones and Hay River shales as exposed on the banks of the lower portions of the Liard River. The Hay River beds have been reported to contain occasional minor bioherms but in general are composed of calcareous grey and green shales and thinly bedded dense limestones. The thickness of these beds on the British Empire Oil Company Ltd. permits is not known but should vary from nothing in the northeast where they have probably been eroded away to several hundred feet in the southwest.

Underlying the Hay River shales is the light green Simpson shale. This formation is approximately correlative to the Ireton shales of the Leduc area and the Fort Creek shale at Norman Wells.

Good outcrops are not found wherever this formation occurs due to its softness; and for that reason it may comprise the bedrock in the swampy northeasterly parts of the permits. Subsurface studies in the vicinity of the west end of Great Slave Lake and the Fort Providence region indicate that there is good possibility of reef development in the Simpson shale.

Early geologists surveying the Great Slave Lake and Fort Simpson area examined the outcrops on the shores of the Lake. They estimated the columnar thickness between the middle Devonian limestone, which they called the Slave Point limestone, and the Hay River shales. From this information they deduced a thickness of 250 feet for the Simpson shale in that locality. Subsequent drilling in the vicinity of Fort Providence has indicated that this shale formation is at least 1200 and possibly 1800 feet thick in the absence of reef development. This shale body may, in fact, transcend the upper Devonian-middle Devonian time line. It is my opinion that the early investigators in examining and describing the Presqu'ile dolomite and the Slave Point limestone in the vicinity of Slave Point on Great Slave Lake, N. W. T., were dealing with a local condition, a reef and its dense limestone cap. If this is the case, such reefs can and do occur erratically within the large shale body of which the top member is the Simpson green shale. There is

no indication how thick the Simpson shale or underlying shales may be in the Fort Simpson area although there may well be 2000 feet of barren shale overlying the middle Devonian and Silurian limestones and dolomites. It is not known whether the Ramparts reef limestone as exposed in many places along the Mackenzie basin between Fort Simpson and Fort Norman is of equivalent age to the lower portions of the shale body found at Fort Providence or whether this reef formation is of older age and will be found underlying the thick shale section at a point intermediate to Providence and the Franklin Mountains. Only drilling will tell. In any case the middle Devonian Ramparts limestone is an important prospect for oil in the Willow Lake River basin.

Silurian

In the Franklin Mountains west of the British Empire Oil Company Ltd. permits prominent reef limestones and dolomites of Silurian age occur. These reefs should be ideal as source and reservoir rocks. There is good possibility but no assurance that Silurian reef material will be found in the Willow Lake River basin area. In this case, again, drilling will be necessary to determine the existence of a prospect.

Ordovician - Cambrian

Thick sections of Ordovician and Cambrian limestones and

shales are found in the Franklin Mountains and to the south in the Nahanni Mountains. Some porous members are definitely present in those areas but seem to be of minor consequence in comparison to the massive reef formations of the Devonian and Silurian. The Ordovician and Cambrian are largely replaced with red beds at Great Slave Lake and in the better known Alberta oil country to the southeast. For these reasons prospects in Ordovician and Cambrian strata in the Willow Lake basin region do not appear to merit the attention which the younger strata of proved oil potential deserve.

General

Limestone and dolomite reefs are the principal prospect for oil or gas in the Willow Lake River basin area. Various stratigraphic studies on all sides of this area indicate the likelihood of the occurrence of reefs of upper and middle Devonian and Silurian ages. The prospective horizons in which these reefs may occur are all believed to be buried in the Willow Lake River basin under the Simpson shale and consequently offer attractive prospects for exploration drilling.

Strict interpolation of the Great Slave Lake section and the Franklin Mountain section indicates that the Silurian could be tested with a 2000 foot well in the middle of the British Empire Oil Company Ltd. permits. There is a possibility, however, that this estimate might have to be increased 50% or even 100%. Such a well would have prospect for reef development from the surface to total depth.

COMPOSITE STRATIGRAPHIC SECTION

IN THE VICINITY OF WRIGLEY AND THE FRANKLIN MOUNTAINS, N. W. T.

AGE	THICKNESS	FORMATION	DESCRIPTION
UPPER DEVONIAN	100'	Upper Shale Zone	Dark fissile shale
	200'	Athyris Angelica Zone	Yellow limestone with some interstratified grey shales.
	500'	Middle Shale Zone	Red shales and red massive limestones.
	500'		Interbedded grey shale and thin bedded dense grey limestone
	800'	Leiorynchus Zone	Interbedded limestones and shales mainly thin bedded and dense Coral reefs.
MIDDLE DEVONIAN	1000'	Lower Shale Zone	Dark brown to black bituminous, locally calcareous or arenaceous in places concretionary.
	1500'	Middle Devonian Undiff.	Dark grey crystalline to dense limestone veined with calcite and selenite and containing numerous bivalves, gastropods and corals.
Bear Mt. Formation			Cavernous reef dolomite
SILURIAN	500'	Mt. Kindle Forma- tion	Coral reef material, largely grey magnesian limestone.
	500'	Franklin Shale	Red and pea-green shales

COMPOSITE STRATIGRAPHIC SECTION

IN THE VICINITY OF WRIGLEY AND THE FRANKLIN MOUNTAINS, N. W. T.

[Continued]

AGE	THICKNESS	FORMATION	DESCRIPTION
LOWER SILURIAN- ORDOVICIAN UNDIFF.	2000'	Lower Silurian- Ordovician Undiff.	Soft red and green shales
CAMBRIAN	1000'	Cambrian Undiff.	Red quartzitic sandstone, red shale, hematite and drab grey shales.

COMPOSITE STRATIGRAPHIC SECTION
IN THE VICINITY OF GREAT SLAVE LAKE, N. W. T.

AGE	THICKNESS	FORMATION	DESCRIPTION
UPPER DEVONIAN	300'	Hay River Limestone	Hard dolomitic limestones sometimes shaly
	400'	Hay River Shale	Shales with local limestone and sandstone beds, some ironstone.
	250'	Simpson Shale	Greenish-grey clay shales, fissile and soft-weathering
MIDDLE DEVONIAN	200'	Slave Point Limestone	Grey shaly limestones.
	375'	Presqu'ile Dolomite	Crystalline reef dolomite with traces limestone
	595'	Pine Point Limestone	Soft grey shaly blue to black hard thinly-bedded limestones.
SILURIAN	275'	Fitzgerald Dolomite	Grey dolomitic limestone with gypsum and anhydrite
PALEOZOIC UNDIFF.	595'	Red Beds	Red calcareous shale, red gypsum, salt and red arenaceous shale.
PRE- CAMBRIAN		pre-Cambrian	Hard red sandstone and granite.

STRUCTURE

The Paleozoic sediments thicken westward and south-westward as they dip gently away from the pre-Cambrian Shield. To the west the isocline comes abruptly to an end against the fault escarpment of the Franklin Mountains, where the entire stratigraphic section has been raised and exposed to view and the upper beds have been eroded away. Due to the inaccessibility of the Willow Lake River basin little investigation has been made in this area and prospects for structure are not known.

It is probable that in spite of glacial effects on the topography of the country aerial photographs would show the presence of any large structure where Hay River limestone and shale beds were at the surface. A detailed exploration program on the British Empire Oil Company Ltd. permits could be decided upon after such an aerial photographic survey.

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C E R T I F I C A T E

I, Charles Warren Hunt, of 111 Petroleum Building,
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THAT I graduated as a geologist from the California
Institute of Technology with the degree of Bachelor of Science
in the field of Geology in the year 1949; I am a member of the
American Association of Petroleum Geologists.

THAT the above report is based on information obtained
from study of published reports on the area, studies of well
samples and cores from wells in the Northwest Territories,
from regional airplane reconnaissance of nearby areas, and
from regional knowledge of the petroleum geology of Canada.


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