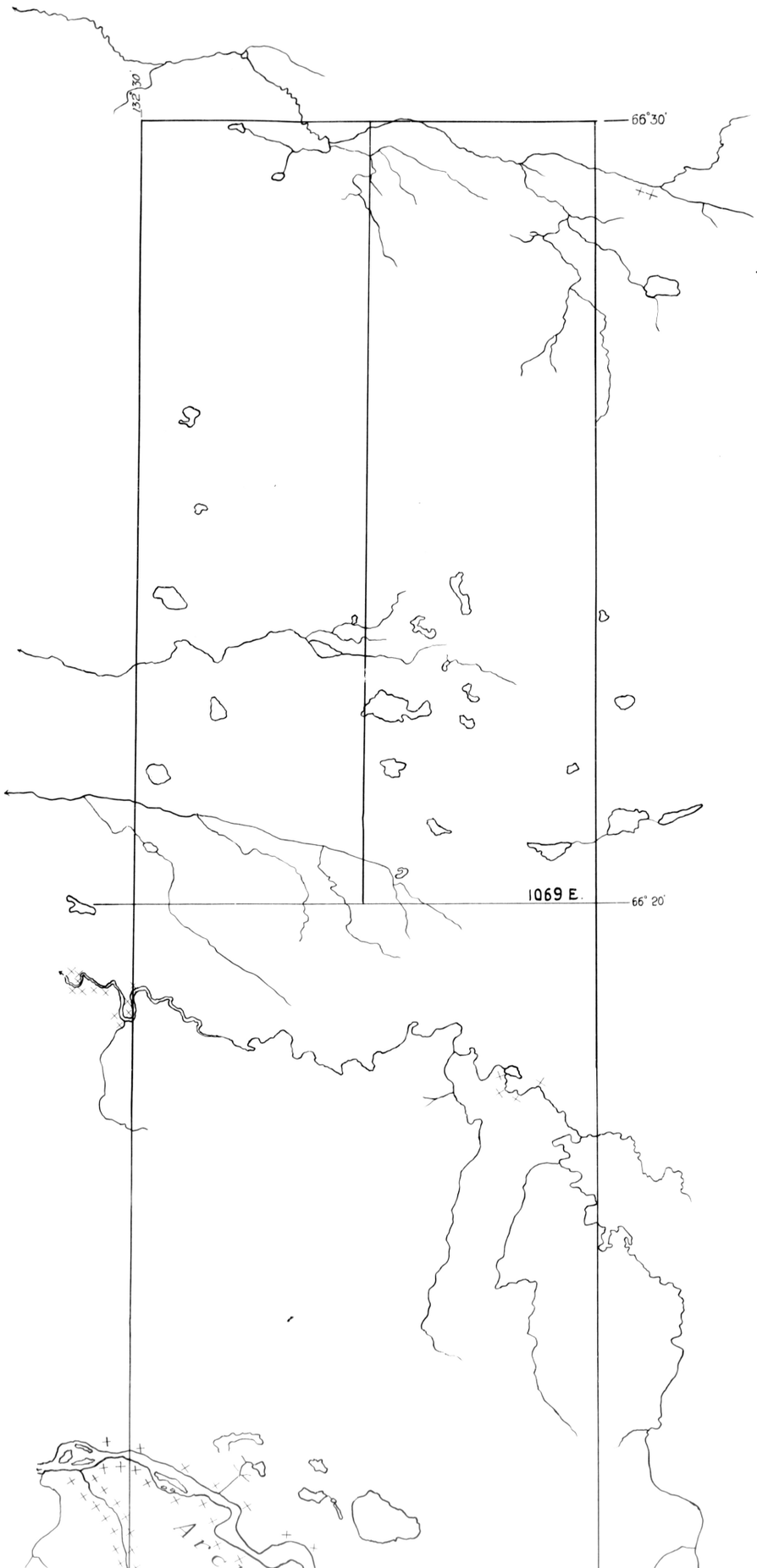


GEOLOGY

PERMIT No. 1067

SCALE: 1 INCH = 1 MILE. OCTOBER 1957.

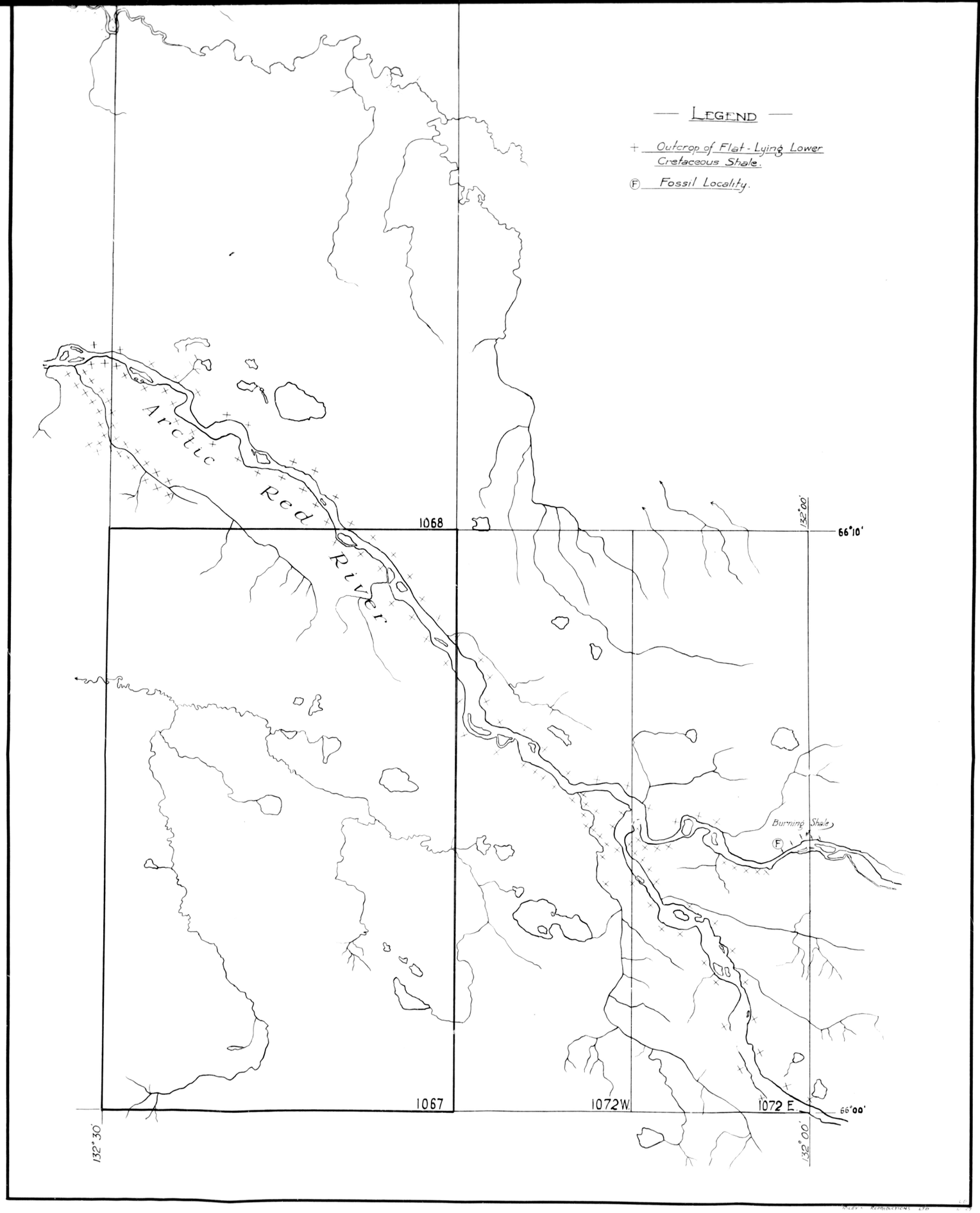
PENTLAND AND ALLEN PETROLEUM CONSULTANTS LTD.

Alfred R. Allen. A.G. Pentland

— LEGEND —

+ Outcrop of Flat-Lying Lower Cretaceous Shale.

Ⓕ Fossil Locality.


LEGEND
+ Outcrop of Flat-Lying Lower Cretaceous Shale.
Ⓕ Fossil Locality.
Arctic Red River
1068
1067
1072W
1072 E.
132°30'
132°00'
66°10'
66°00'
Burning Shale
Ⓕ

GEOLOGICAL REPORT

PERMIT 1067

NORTHWEST TERRITORIES

REPORT ON THE GEOLOGY

PERMIT 1067

NORTHWEST TERRITORIES

By:

A.S. Pentland
and
A.R. Allen,
Vancouver, B. C.
November, 1957.

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1. Introduction

The development of petroleum on an economic basis in the Mackenzie River basin is dependent upon finding sufficiently large reserves to warrant the construction of a large pipe line to the coast. Only through large scale production can the cost of transportation be reduced to the point where the products can compete on the world market.

The construction of a pipe line would not create problems that cannot be overcome. This has been proved by the completion of both oil and gas lines from Northern British Columbia and Alberta to the Pacific Coast. The Canol pipeline, which was constructed from Norman Wells to Whitehorse during World War II is a 4-inch line and is capable of carrying up to 4,000 barrels per day. It is 600 miles long. This is not a prohibitive distance providing the reserve of oil is sufficiently large.

There is every reason to believe that large oil reserves will be discovered in this area. The Athabaska bituminous sand has been known for many years and is considered to contain a very large potential reserve of oil. The discovery well at Norman Wells was drilled in 1920. The Canol project was started in 1942, and during 1944, 1,229,310 barrels of oil were produced from this field. By the end of

1945, 64 producing wells had been completed. Although wildcat drilling has failed to extend the field or to discover new fields so far, most of it has been confined to a very small area in the neighborhood of Norman Wells.

Oil seepages have been known in the Mackenzie River area for many years and more are being found as exploration continues. There are many thousands of square miles that are underlain by sediments of Cretaceous and Paleozoic age in this basin. Exploration for oil has just begun. It does not seem unreasonable to consider that this area is in the stage of development that Alberta was before the discovery of the Leduc field, and that future development may disclose oil and gas fields of great potential.

2. Location

The northeast corner of the permit is situated at 66°10' north and 132°15' west. It is on the Arctic Red River 100 miles southeast of the Village of Arctic Red River, which is at the junction of the Mackenzie and Arctic Red Rivers, and 160 miles northwest of Norman Wells, Northwest Territories. It adjoins the southeast corner of the Peel Plateau Reservation.

3. Ownership

Permit 1067 is owned by Atlas Investments Ltd., Mr. A. Brossard, 569 Howe Street, Vancouver, B. C., is the representative.

The permit consists of 51,966 acres.

4. Accessibility

Canadian Pacific Airlines operates two scheduled flights per week from Edmonton to Norman Wells, using a DC-3, and three scheduled flights per week from Norman Wells to Aklavik, using an otter. During the summer there are usually many extra flights to take care of additional freight and passengers.

Much of the heavy freight is shipped into the country by train and barge during the summer months. Freight is shipped from Edmonton to Waterways by train, a distance of 300 miles, and thence by barge down the Athabaska River, Athabaska Lake, Slave River, Great Slave Lake, and Mackenzie River. The only interruption to navigation on this route is the 16-mile portage from Fitzgerald at the northern boundary of Alberta to Fort Smith in the Northwest Territories because of rapids in the Slave River.

The Arctic Red River cuts across the northeast corner of Permit 1067 making it possible to transport equipment by means of shallow-draft riverboats from the village of Arctic Red River to the permit. This should be undertaken in the spring when the water is high in order to avoid sandbars.

The transportation of heavy equipment by cat-train over a winter road is feasible. In fact, the moving of equipment from one part of the area to the other would have to be done during the winter months when the muskeg and lakes are frozen.

Runways could be prepared and kept open during the winter on some of the larger lakes, thus giving access to the area by means of large aircraft equipped either with wheels or skis.

Landing can be made on some of the larger lakes and on the river with small aircraft equipped with floats.

5. Climate and Vegetation

The rivers and creeks generally open during the latter part of May, but ice may remain on some of the larger lakes until the first or second week in June. Freeze-up comes in September or early October, but occasionally the large rivers remain open until well into November.

During May, June, and July there is almost continuous daylight with warm summer weather. During November, December, and January the sun is below the horizon the greater part of the day. The result is that the length of day varies rapidly during the intervening months. The winter may be severe with temperatures as low as 50 or 60 degrees below zero.

Trees are absent or are stunted over most of the muskeg area. They consist of white spruce, poplar, birch, and tamarack. In a few sheltered places, such as the banks of streams, trees may reach a height of 30 or 40 feet and a diameter of 12 to 18 inches. Here, too, willows and alders grow in thick masses.

The greater part of the area is covered with the various types of moss that are common to the Arctic muskeg.

6. Physiography

The permit is situated on the Peel Plateau. This consists of hundreds of square miles of ground that is nearly flat and is covered with lakes and muskeg. The lakes range in size from mere potholes to ten or 20 miles in length. The parts that are not covered with water are covered with muskeg, making travel on the ground all but impossible during the summer months.

Small, meandering streams cross the area, and are confined by low banks that expose bedrock in only a few places except where the streams approach the main rivers. Here they have cut deep V-shaped valleys. The larger rivers, such as the Arctic Red River, flow between banks that range in height from 20 to 150 feet.

The land to the south rises gently for the first few miles into the foothills and thereafter more abruptly into the Mackenzie Mountains. The plateau is bounded on the west by the Richardson Mountains.

7. Reasons for the Investigation

Geological mapping was undertaken as the first step in a comprehensive program of exploration. It was considered that a study of the formations, with particular attention to their ages, attitudes, and type of rock, was essential and would form a sound basis upon which to outline further work that might culminate in the discovery of oil or gas.

8. Methods of Investigation

The party consisted of A.R. Allen and A.G. Pentland. A Cessna aircraft, model 170B equipped with floats was used for transportation. Full camping equipment was carried. The method used was to fly over the permit at low elevation and at reduced cruising speed in order to observe the general topography and to spot outcrops. Flight lines were along the borders of the permit first and then several passes were made across the central part. In addition, all rivers and streams on the permit or within a radius of several miles of the permit were flown in order to locate all outcrops that might have a bearing on the structure of the area.

Control of flight lines was by means of maps and aerial photographs. The 8 miles to 1 inch map from the National Topographic Series, which is published by the Department of Mines and Technical Surveys, was found to be accurate and useful for the purpose of determining the limits of the permits and for locating outcrops.

The second step was to make traverses on foot to examine all outcrops, collect fossils, and determine attitudes. Generally, a landing was made on the river or a lake, the party separated, each going in opposite direction, and a pace and compass survey was made or the outcrops were located by means of maps and aerial photographs.

A photographic mosaic was made to the scale of 1 inch to 1 mile on which outcrops were accurately located and the whole was traced in order to make a map from which additional copies could be taken.

9. Stratigraphy

Beds of Lower Cretaceous age form the only outcrops on this permit. Rocks of older age are exposed in the Upper Peel River area to the west, and in the Mackenzie Mountains to the south and east. The Imperial formation is exposed along the Arctic Red River starting about 46 miles north of the north end of the permit. It is necessary to review the various sections in order to come to an understanding of the strata that underlie the Cretaceous shales.

Cambrian rocks have been mapped on the upper part of the Arctic Red River (60 miles south) and also on Mountain River (116 miles southeast) and Imperial River (135 miles southeast). The section consists of quartzites, shales, sandstones, and limestones. Stelck (1, p.13) observed 6,500 feet of slates and shales overlain by 500 feet of argillites and chert in the Upper Peel River area 80 miles to the west. These beds are not considered to be of importance for the accumulation of oil.

Ordovician shales and argillites have been mapped in the Upper Peel River area but no sediments of this age have been positively identified in sections to the south and east. It is probable that Ordovician rocks are lacking, or if present, are comparatively thin in the area occupied by these permits.

Silurian strata are widely distributed throughout the Mackenzie River basin. McKinnon (1, p. 18) mapped 1,100 feet of limestone on the Arctic Red River. The lower unit contains 400 feet of chert in dolomite and the upper

Table of Formations

Eocene		Imperfectly consolidated sands, clays, and conglomerates with lignite. Contain leaf and plant fragments.
		Erosional Unconformity
Cretaceous	East Fork	Grey shales
	Little Bear	Sandstones and shale with coal
	Slater River	Dark grey to black shales, some siltstones and sandstones
	Sans Sault	Fine-grained sandstone with glauconite; grey sandy shales. Sandstone and conglomerate at or near base.
		Erosional Unconformity
Upper Devonian		Green, fine-grained sandstone and shale.
	Imperial	Upper grey shales, thin sandstones, bituminous
	Fort Creek	shales, coral reef and limestones; lower dark platy shales
	Ramparts	Heavy massive limestone at top with or without coralline beds, limestone interbedded with shales in middle part; limestone in lower part.
Silurian or Devonian	Bear rock	Brecciated dolomites and limestones, gypsum and anhydrite.
		Erosional Disconformity
Silurian	Ronning group	Limestone with chert
Ordovician		Argillites and shales
Cambrian	Macdougal group	Limestone; greenish, grey, and black shales; sandstones, gypsum, etc.
Cambrian and/or earlier	Katherine group	Interbedded quartzite and black platy shales.

part 700 feet of limestone carrying a Niagaran fauna. The upper Niagaran coral zone is reported to be quite porous in places and capable of serving as a reservoir.

The name Bear Rock formation is used by Canol geologists to describe the brecciated and non-bedded dolomites and limestones lying below Middle Devonian strata and above a sharp disconformity with well-bedded Silurian limestones below. The Bear Rock formation is reported to be more than 200 feet thick in the Mountain River area where it consists of brecciated limestones and dolomites. In places the beds are gypsum-bearing. The Bear Rock dolomites are generally the most porous rocks in the area except where their position is occupied by gypsum and anhydrite beds. They may be highly bituminous.

The Middle Devonian section on Mountain River has been divided into three parts, the Lower Ramparts limestone, (180 feet), the Middle Ramparts shale (700 feet), and the Upper Ramparts limestone (445 feet). However, it seems probable that the Ramparts formation is much thinner in the area covered by the permits. On Margary Creek a section 225 feet thick contains lenses and discontinuous bands of fossil detritus. Several small coral aggregates have been noted and the upper contact is marked by a thick limestone conglomerate. Scattered accumulations of solid tar or bitumen are present and a fresh surface of limestone emits a strong odor of sulphur and gas. Stelck found a conglomerate on the Peel River carrying Ramparts fossils. It is overlain by Fort Creek shales and underlain by Silurian limestone.

The Upper Devonian is usually divided into two groups, the Fort Creek and Imperial. The Fort Creek formation is exposed along the Peel River from the Lower Canyon to several miles below its junction with Snake River. The base is composed of a limestone conglomerate and this is overlain by black shales and limestones. Near the top the shales contain fewer limestones and are very bituminous. In the proven field at Norman Wells a reef in the Fort Creek formation forms the oil-bearing reservoir and is the source of production in that field. The Imperial formation is composed essentially of fine-grained sandstones and shales. It outcrops extensively along the Arctic Red River starting about 46 miles north of the permit. Also, it has been mapped in the upper parts of the Arctic Red River and the Peel River.

The Cretaceous overlies the older beds unconformably in the Norman Wells area, and the erosion interval is very marked. In places both the Imperial and Fort Creek formations have been eroded and the Cretaceous strata are in contact with Middle Devonian limestone. Hume divides the Cretaceous into four parts, the Sans Sault group, Slater River formation, Little Bear formation, and East Fork formation. The Sans Sault group is defined as being composed essentially of shales and sandstones of marine origin and includes all Lower Cretaceous strata from the base up to the first or lowest bentonite beds. The Slater River formation overlies the Sans Sault and is composed of thin-

bedded, black, friable shales with numerous ironstone concretions. Typically, it contains many thin bands of bentonite 1/8 to 1 inch thick. The Little Bear formation consists of sandstone, some conglomerate, sandy shales, and coal seams. The East Fork formation directly overlies the sandstone series and consists of well-bedded, grey, conchoidal and plastic marine shale. It has not been recognized north of Norman Wells.

10. Local Stratigraphy

The whole of the area covered by the permit is underlain by thin-bedded, dark grey to black, friable shales. They form fairly continuous outcrops along the banks of the Arctic Red River, and along the smaller V-shaped valleys formed where small streams plunge down from the general level of the muskeg to that of the main river.

The shales have been assigned to the Lower Cretaceous on the basis of fossils that were collected from the banks of the Arctic Red River about six miles east of the permit. They were sent to C.R. Stelck, University of Alberta, who identified them as fish bones and Gastroplites liardense.

The shales commonly contain ironstone concretions which stand out in the banks or accumulate at the base of the outcrops as the shale is removed by erosion. The concretions may contain fragments of fossils. A few ironstone bands or sandy layers are interbedded with the shales.

There is a sufficiently high concentration of sulphur in the shales to give a strong odor when the sun beats down on an outcrop. A few crystals of gypsum were observed on the surface.

Sloughing is common along the river banks where large blocks of shale, up to 1,000 feet in length and 200 to 300 feet wide, have slid down from above. The beds are generally tilted and in some places broken and crumpled.

A feature of considerable interest was observed on the north bank of the main river about six miles east of the permit. Here the shale is apparently on fire, throwing up a large column of smoke that can be seen from a considerable distance from an aircraft. It is not known what is being consumed. No coal seams were observed in any of the outcrops and it seems doubtful that a sufficient concentration of carbonaceous material is present in the shale to burn. It seems more probable that a concentration of a petroleum product or sulphur is being burned. A strong odor of sulphur dioxide is present but this could be due to the small amount of sulphur that is present in most of the outcrops.

This type of fire appears to have been fairly common along the banks of the river. A number of places were observed where the shale had been burned to a red color or various shades of grey. Nothing was observed that would give a definite clue to the type of material that was burned in these places.

11. Structure

The shales are monotonously flat throughout all

of the exposures on the permit. Nowhere was a dip observed with sufficient magnitude to be measurable. The permit lies near the centre of a Cretaceous basin with outcrops of the older Imperial formation along the Arctic Red River 46 miles to the northwest and about an equal distance to the southeast. An outcrop of rock that appears to be Imperial formation was found on the headwaters of Tree River, 45 miles due north of the permit. Fossils found here are of indeterminate age. They were identified by C.R. Stelck, of the University of Alberta, as siphuncle tubes ? and Mya ?

The exact thickness of Cretaceous strata underlying the permit cannot be determined by surface methods but it may be as much as two to three thousand feet.

12. Economic Possibilities

Although no structure that could serve as a trap for oil or gas was observed at the surface on the permit, there is a possibility that such structures are present in the older formations which underlie the Cretaceous. A marked erosional unconformity is present between the Cretaceous and the Devonian. This break is of sufficient magnitude that it could completely mask an underlying structure.

The Cretaceous shales are underlain by Devonian and Silurian strata. A study of these beds in other parts of the country has shown that some may have sufficient porosity to allow them to act as reservoirs and that reef structures may be present. It has been shown that several of the beds carry petroleum products in surface outcrops

and seepages of oil and gas have been reported from various localities. Therefore, the area warrants further investigation.

The next step should be a seismic survey. This method has been proved to be successful in locating buried reef structures in many parts of Western Canada. It offers the best chance of getting definite information regarding subsurface structures.

A. G. Pentland

Alfred W. Allen

Vancouver, B. C.
November, 1957.

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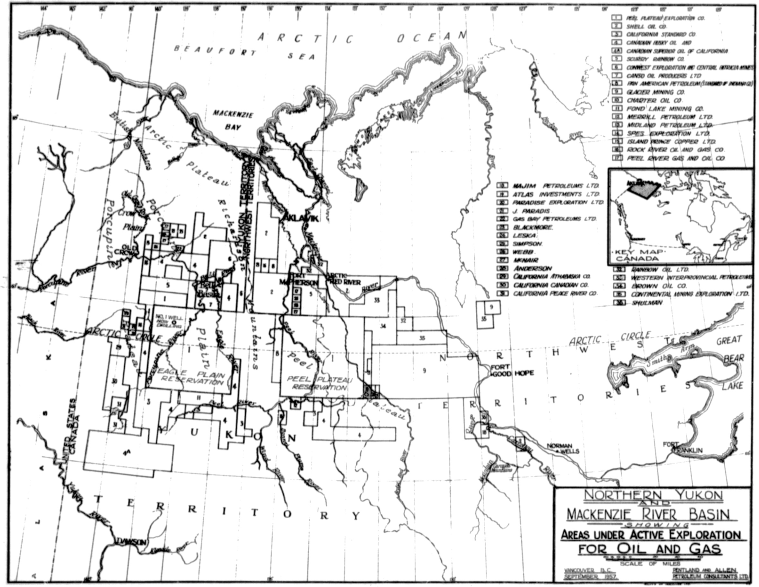
ARCTIC OCEAN
BEAUFORT SEA
MACKENZIE BAY
British Mountains
Arctic Plateau
Porcupine
Crow Plain
OLD CROW
Porcupine River
Richardson Mountains
YUKON TERRITORY
NORTHWEST TERRITORIES
AKLAVIK
FORT McPHERSON
ARCTIC RED RIVER
Bell Basin
NO. 1 WELL NOW DRILLING
ARCTIC CIRCLE
Eagle Plain
EAGLE PLAIN RESERVATION
Peel Plateau
PEEL PLATEAU RESERVATION
Peel River
FORT GOOD HOPE
NORTHWEST TERRITORIES
GREAT BEAR LAKE
Smith Arm
NORMAN WELLS
FORT FRANKLIN
YUKON TERRITORY
ALASKA
UNITED STATES
CANADA
DAWSON
Klondike River
Yukon River
1 PEEL PLATEAU EXPLORATION CO.
2 SHELL OIL CO.
3 CALIFORNIA STANDARD CO.
4 CANADIAN HUSKY OIL AND
4A CANADIAN SUPERIOR OIL OF CALIFORNIA
5 SCURRY RAINBOW CO.
6 CONWEST EXPLORATION AND CENTRAL PATRICIA MINES
7 CANSO OIL PRODUCERS LTD
8 PAN AMERICAN PETROLEUM (STANDARD OF INDIANA CO)
9 GLACIER MINING CO.
10 CHARTER OIL CO
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34 BROWN OIL CO.
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36 SHULMAN
KEY MAP CANADA
NORTHERN YUKON AND MACKENZIE RIVER BASIN SHOWING AREAS UNDER ACTIVE EXPLORATION FOR OIL AND GAS
SCALE OF MILES
VANCOUVER B.C.
SEPTEMBER 1957.
PENTLAND AND ALLEN PETROLEUM CONSULTANTS LTD.

ARCTIC RED RIVER

Flat Lying Black Lower
Cretaceous Shale.

ARCTIC RED RIVER

Flat lying black lower
Cretaceous shale.

ARCTIC RED RIVER

BURNING SHALE

Flat lying Black
Lower Cretaceous Shale

Note smoke from burning shale
to the right of the Spruce tree.

ARCTIC RED RIVER

BURNING SHALE

Flat lying Black
Lower Cretaceous Shale

Note smoke from burning shale
to the right of the Spruce tree.