REPORT ON THE GEOLOGY

PERMIT 1127

NORTHWEST TERRITORIES

By:

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Geological Report

Permit 1427

Northwest Territories

1. Summary and Conclusions

Permit 1427 is situated in the Peel Plateau, 14 miles southeast of Fort McPherson, Northwest Territories. The western boundary is three miles from the Peel River on which shallow-draft river boats make regular trips to Fort McPherson during the summer months. Thus the transportation of heavy equipment would be comparatively simple. The greater part of the permit is underlain by sediments of the Imperial formation of Upper Devonian age. The contact between the Imperial formation and the overlying Cretaceous sandstones and conglomerates projects across the southwest corner of the permit. Thus it is to be expected that comparatively shallow holes, ranging in depth from 2,000 to 5,000 feet, will test all of the most likely oil and gas horizons.

It is not possible to work out details of structure because of the lack of outcrops on this permit. However, it seems probable from a study of the outcrops along the Peel River and those a short distance southwest of the permit, that the strata have a gentle dip to the west or southwest.

The structure of the Norman Wells field is a monoclinal dip upon which is superimposed a limestone reef having a maximum thickness of 500 feet. It is conceivable that a similar reef may be found in this part of the country.

The fact that the reef at Norman Wells gives rise to good seismic reflections gives hope that geophysical methods will lead to the discovery of other reef fields.

It is recommended that a seismic survey be conducted as the next step in the exploration for oil and gas.

2. Location

Permit 1427 is situated 14 miles southeast of Fort McPherson and three miles east of the Peel River in the Northwest Territories. The northeast corner of the permit is at the intersection of 67° 15' north and 134° 30' west.

3. Ownership

The permit consists of 24,832 acres. Mr. David McNair, 404, 510 West Hastings Street, Vancouver, B. C. is the owner.

4. Accessibility

Canadian Pacific Airlines operates scheduled flights to Fort McPherson using a DC-3 as far as Norman Wells and an Otter from there north. During the summer months, there are many extra flights to take care of additional freight and passengers.

Much of the heavy freight is shipped from Edmonton by train to Waterways, Alberta, and thence by barge down the Athabaska River, Athabaska Lake, Slave River, Great Slave Lake, Mackenzie River and Peel River

to Fort McPherson. 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.

Local transportation is usually by light aircraft using floats in the summer and skis in the winter. The transportation of heavy equipment from the Peel River to the permit should be done during the winter when the lakes and muskegs are frozen. Winter roads are comparatively easy to build and maintain.

5. Climate and Vegetation

The permit is situated nearly fifty miles north of the Arctic Circle with the result that there is almost continuous day ight and warm summer weather during May, June, and July. During the mid-winter months, the sun is below the horizon the greater part of the day. The winter may be severe with temperatures as low as 50 or 60 degrees below zero for short periods.

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

The area is close to the northern limit of tree growth. Most of the trees are small and scrubby, but in a few sheltered places along the banks of streams, they may grow to a height of 40 feet. They consist of spruce, poplar,

birch, and larch. Willow and alder may grow in thick masses along the banks of streams. The greater part of the area is covered by the various types of moss and grass that are common to the Arctic tundra.

6. Physiography

The permit is situated on the large Peel River Plateau near where it merges into the Mackenzie River delta on the north and into the Richardson Mountains on the west. A part of the area is covered by small lakes and most of the remaining part is covered by muskeg. It is drained by large rivers such as the Peel and Arctic Red, which flow into the Mackenzie, and by numerous small streams which meander across the flat plain. The larger rivers flow between banks that may be up to 100 or 150 feet high but the smaller streams are usually confined by low banks that are covered by muskeg and Arctic vegetation, and as a general rule do not expose bedrock. Ox-bow lakes are common near the smaller streams.

7. Purpose of Investigation

The geological investigation of this area was undertaken in order to map the outcrops of rock and to determine their age and attitude. It was hoped that this information would furnish a sound basis upon which to recommend further work aimed at the finding of oil and 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 area 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 permit, 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 a river or lake, the party separated and pace and compass surveys were 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. History of Geological Investigation

Early geological investigations in the Mackenzie River basin were carried out by McConnell (1),Camsell (2), and other geologists. The Northwest Company, a subsidiary of Imperial Oil Limited, began exploration and drilling in the Mackenzie River area in 1919. This work led to the discovery of the Norman Wells field in 1920. The Geological Survey of Canada sent parties into the field with the result that Hume, Kindle, Cameron, Whittaker, and Williams published reports during the years 1921 to 1924.

The work received a great impetus during World War II when oil was considered to be of strategic importance. In the early summer of 1942 geological work was conducted over a wide area by several geologists.

Widespread interest has developed during the past year with the result that many parties were in the field during the summer of 1957.

10. Stratigraphy

There are no outcrops on the permit. Therefore it is necessary to study sections that have been mapped in other parts of the country in order to predict the types of sediments that may be encountered below the surface.

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	Imperial	Green, fine-grained sandstone and shale
	Fort Creek	Upper grey shales, thin sandstones, bituminous 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

Cambrian

The oldest rocks known in the area are quartzites and black platy shales of the Katherine Group. No fossils have been found and therefore the exact age is not known. However, they underlie rocks of the Macdougal group, which have been assigned to the Middle or Upper Cambrian on the basis of fossil evidence, and are assumed to be Cambrian or older in age.

Cambrian rocks are well exposed along the banks of the Upper Peel River. Here they range from fairly massive, grey to black argillite and limy argillite to almost paper-thin shale interbedded with limy and a few arenaceous strata. Hume (3,p.13) states that Stelck observed 6,500 feet of slates and shales overlain by 500 feet of argillites with chert, at the head of the lower canyon of Peel River and on Mountain River. The only fossils found were Tetractinellid remains.

Steeply dipping blue and grey mottled limestones found north of the Rat River in the Richardson Mountains have been classed as Cambrian by fossil evidence. Gabrielse (5) mapped rocks of similar appearance but without fossils in a dome-shaped outcrop north of Summit Lake at the headwaters of Rat River.

Ordovician

Ordovician strata appear to be absent from the greater part of the Mackenzie River basin but Stelck found 1,500 feet of shales and argillites in the lower canyon of the Peel River. Two zones in the middle part of the section

contain graptolites of which Tetragraptus is sufficient to indicate an Ordovician age. Therefore, it seems probable that beds of this age underlie the permit.

Silurian

Silurian rocks are known to outcrop over a widespread area. They have been found from Great Slave Lake through Norman Wells and northward into the Mackenzie Mountains. Hume suggests that they be divided into two groups, a lower Ronning group and an upper Bear Rock formation which overlies the Ronning with a marked erosional disconformity. The Ronning group consists of limestone with chert and contains a Niagaran fauna in places. The age of the Bear Rock formation is somewhat in doubt because fossils are scarce in it. It may be Silurian or Devonian. It consists of brecciated dolomites and limestones, gypsum and anhydrite. The high porosity of the brecciated dolomites and limestones make them a favorable reservoir rock where they occur without anhydrite and gypsum. In places they are highly bituminous.

On the upper Peel River, the base of the Silurian is a limestone conglomerate. This is overlain by a thick series of shales and argillites followed by limestones, which are hard and dense and finely crystalline.

On Margery Creek, the upper part of the Silurian is composed of massive reefal dolomites. They are coarsely crystalline and exhibit excellent reservoir characteristics.

Middle Devonian

The Ramparts formation of Middle Devonian age is divided into upper and lower limestone members separated by a middle shale member in the type locality.

Stelck reports that no Middle Ramparts shales were seen on the Upper Peel River. A conglomerate carrying Ramparts fossils is overlain by Fort Creek shales and underlain by Silurian strata. On Margery 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.

Upper Devonian

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.

Non-marine sandstones and shales of the Imperial formation have been mapped along the Peel River about three

miles west of the permit and along the Mackenzie and Arctic Red Rivers to the north, east, and southeast. The section along the Peel River consists of 50 feet of grey sandstones overlain by 10 feet of sandstone made up of subangular fragments of feldspar, ferromagnesium minerals, and a little quartz. Both of these sandstones contain tiny transported fragments of asphaltites. They are overlain by 100 feet of grey shales with hard, dark grey sandstones.

A section along the Mackenzie River from ten miles above Tree River to Point Separation is as follows (3,p.44):

Smooth, grey, crumbly, homogeneous shale; some thin, fine-grained sandstone beds	350 feet
Interbedded, fine- and medium-grained; greenish grey, blocky and flaggy sandstone and grey, silty shale	500
Grey silty shale and argillaceous siltstone; some thin sandstone beds. Base not seen.	150

11. Local Geology

No outcrops were found on this permit. The banks of a U-shaped lake situated about one mile west of the permit expose the contact between the Cretaceous and the underlying Imperial formation.

At the eastern end of the lake, talus slopes are covered with grey to rusty-colored shale. A few sandstone beds, up to one foot in thickness, are interbedded with the shale. Ripple marks were observed in the sandstone.

About 500 feet west, the top of the bank exposes massive buff-colored sandstone and fine-grained conglomerate

with pebbles up to one half inch in diameter. West from here, the conglomerate outcrops at lower and lower elevations, forming the shore of the lake at the western end. Here the sandstone and conglomerate is at least 200 feet thick. The gradual decrease in elevation of the sandstone and conglomerate indicates a dip of about five degrees to the west or southwest.

No fossils were found in this outcrop. The lithology indicates that the sandstone and conglomerate are of Lower Cretaceous age and the shale with interbedded sandstones of Imperial or Upper Devonian age.

Outcrops of Lower Cretaceous age were examined along the Peel River about seven miles south of the permit. Here the bank of the river is composed of interbedded sandstone and conglomerate having a gentle dip to the south. Fossil wood and shell fragments are common. Glauconite is present and in places gives the sandstone a greenish color. The pebbles in the conglomerate are generally small but a few were found up to two inches in diameter.

The conglomerate beds are overlain by a dark grey, carbonaceous shale with interbedded sandstones up totwo feet in thickness. Worm borings, plant remains, and ripple marks are common. A petrified log was observed.

The following fossils were collected and sent to C.R. Stelck of the University of Alberta. He identified them as follows:

Tancredia two species

Pleuromya

Astarte cf. natosini Lower Cretaceous

The projection of the contact between the Lower Cretaceous and the underlying Imperial formation from the Peel River through the U-shaped lake to the Arctic Red River crosses the southwest corner of Permit 1427. Therefore it seems evident that the greater part of the permit is underlain by Imperial formation, and that the southwest corner has a thin covering of Lower Cretaceous beds.

A. G. Pentland

Alfred E. Allen

Vancouver, B. C.
December, 1957.

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4. Wheeler, J.O.: A Geological Reconnaissance of the Northern Selwyn Mountains Region, Yukon and Northwest Territories; Geol. Surv., Canada, Paper 53-7, 1954.

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PEEL RIVER

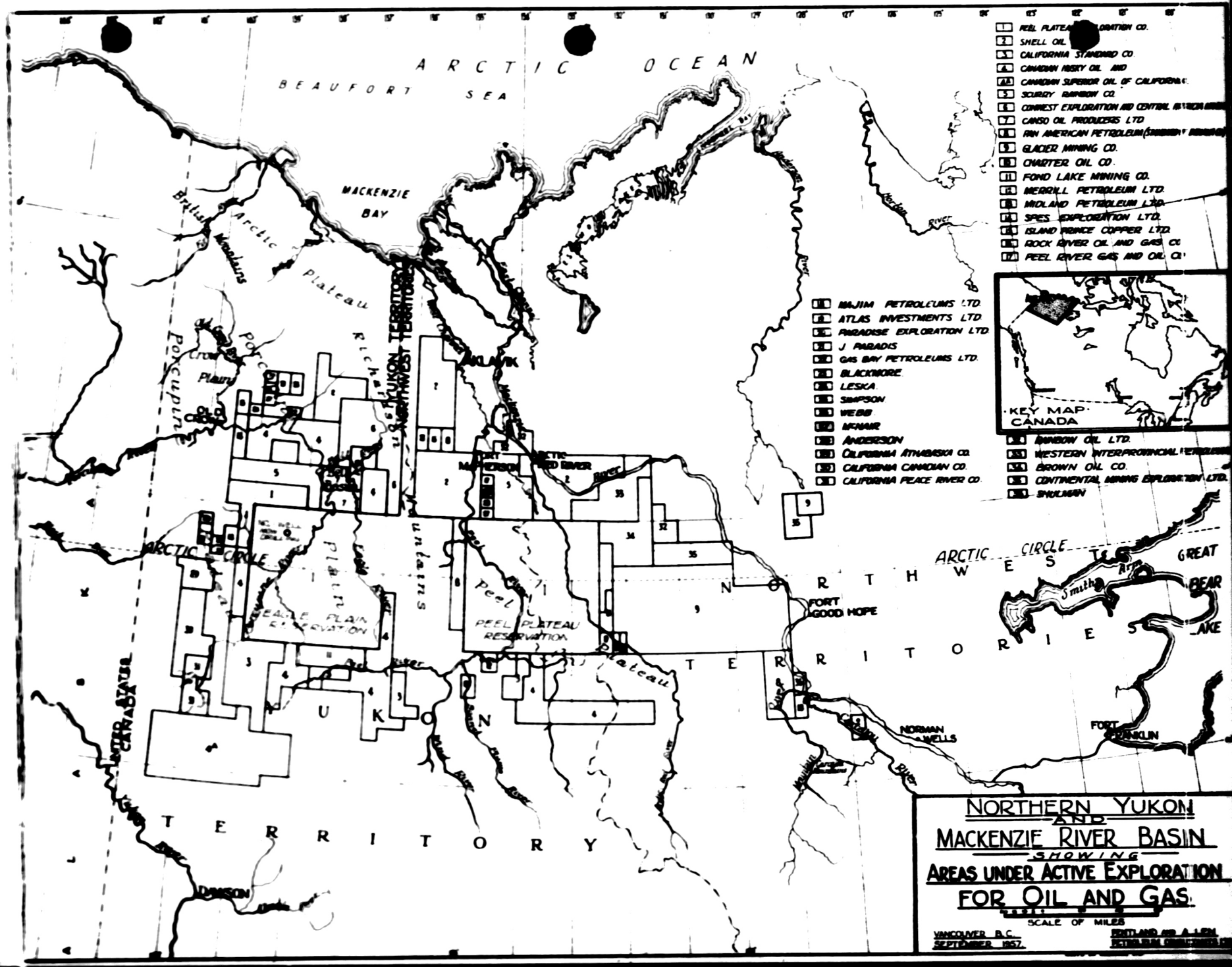
About 30 miles south of Ft. McPherson.

Flat lying grey sandstone and shale near the base of the Lower Cretaceous.

PEEL RIVER

About 30 miles south of Fort McPherson.

Glauconitic sandstone and conglomerate
at the base of the Lower Cretaceous.



NORTHERN YUKON AND MACKENZIE RIVER BASIN

SHOWING

AREAS UNDER ACTIVE EXPLORATION FOR OIL AND GAS

SCALE OF MILES

VANCOUVER B.C.
SEPTEMBER 1957.

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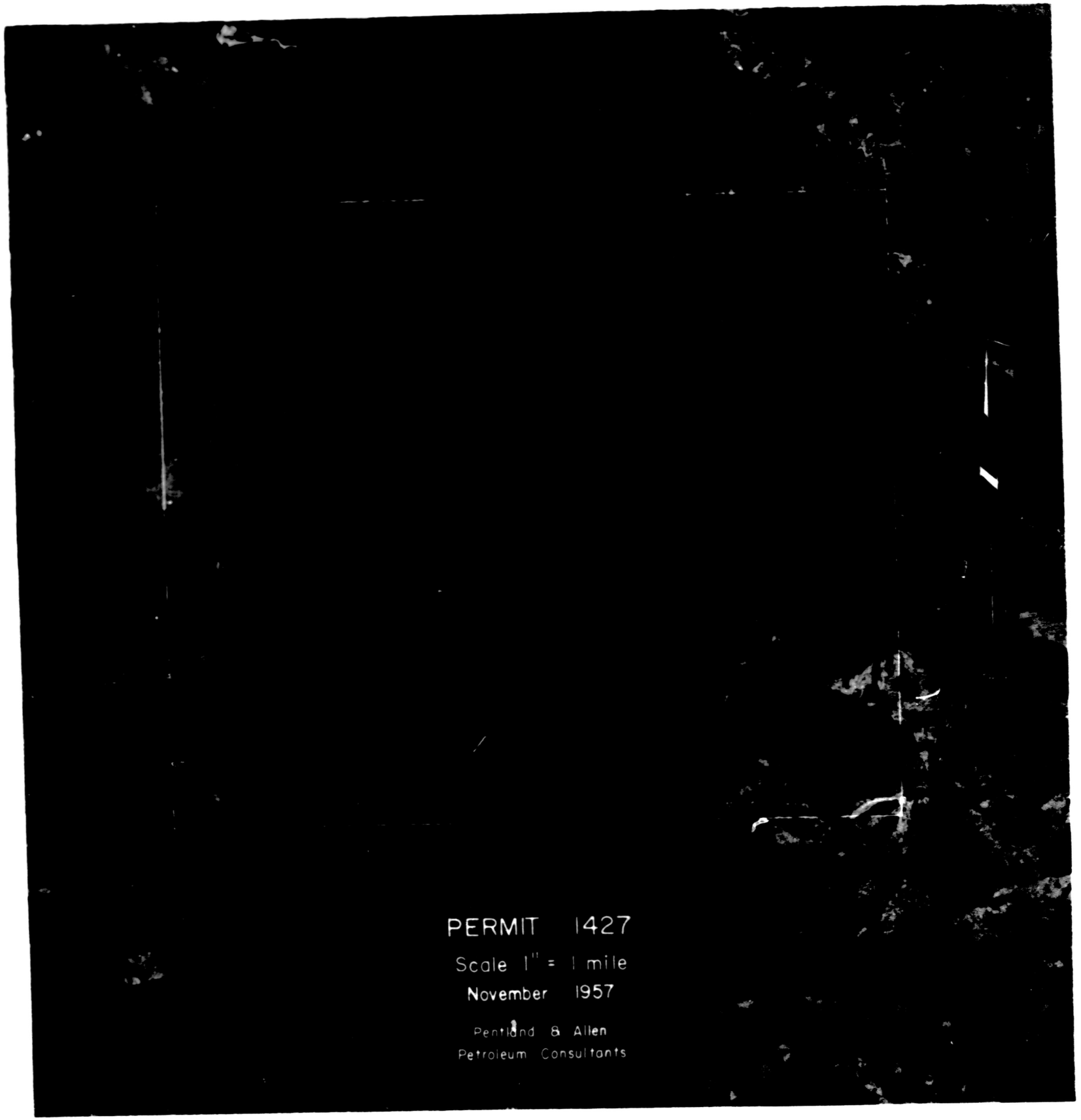
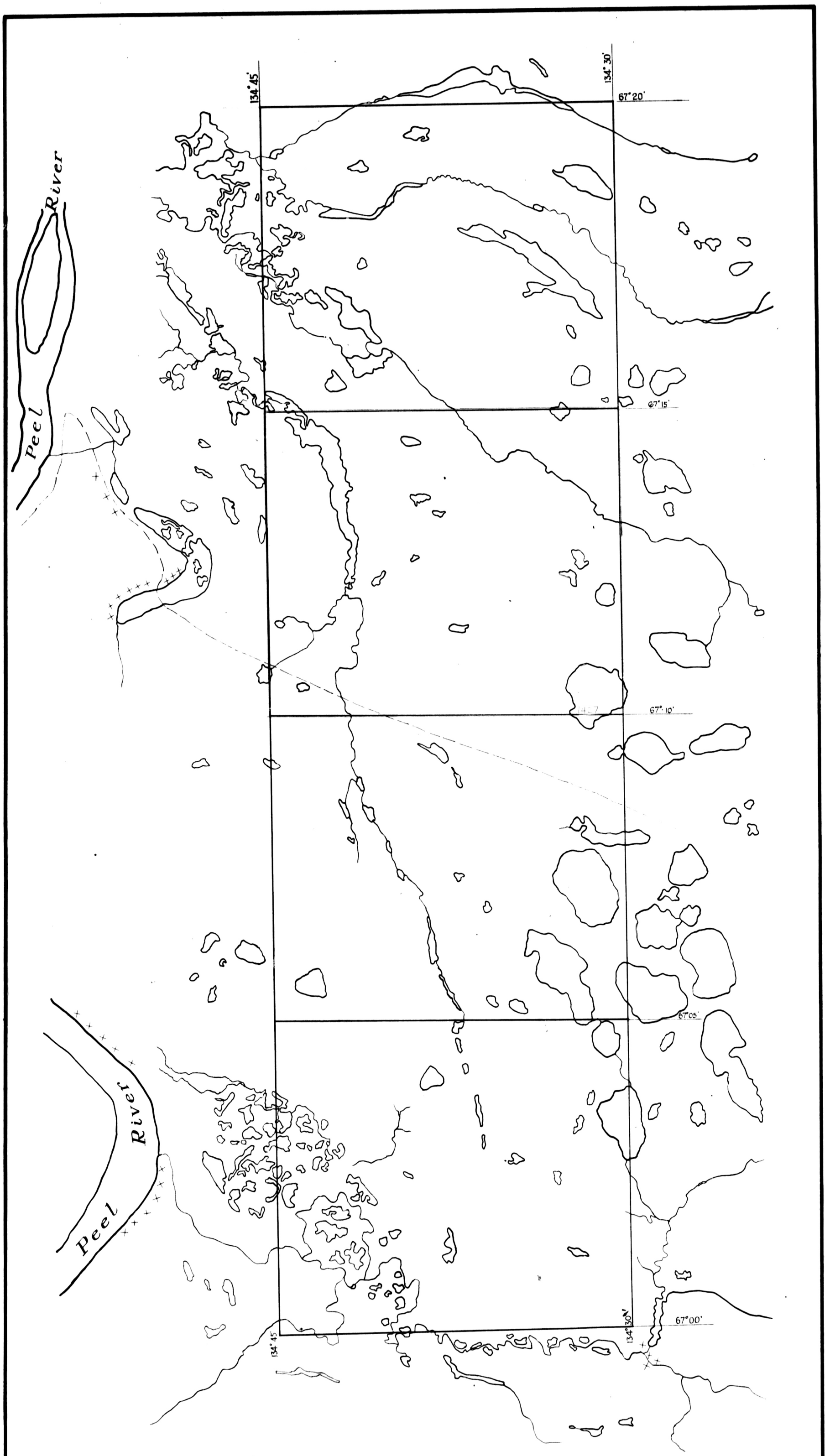

PERMIT 1427
Scale 1" = 1 mile
November 1957
Pentland & Allen
Petroleum Consultants



LEGEND

+ Outcrop, Attitude Flat.
Geological Contact.
Cretaceous.
Devonian.

SCALE: 1 INCH = 1 MILE.
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