GEOLOGICAL REPORT ON NORTHWEST

TERRITORIES PERMITS

1056, 1057, 1058, 1059 and 1060.

By:-

W. I. Wright,

&

J. Harrison.

Calgary, Alberta.
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ILLUSTRATIONS

INTRODUCTION

During the last few days of the 1956 field season in the Fort Norman region, a reconnaissance survey revealed the presence of geological conditions that warranted further detailed investigation and land acquisition. Accordingly plans were made to carry out this work early in the 1957 field season and the permits covered by this report were applied for and issued on December 3, 1956. The lands included in the permits, as indicated on the attached geological map, are as follows:-

Permit No. 1056 - All of Grid Area bounded by 64° 40' to 64° 50' N. Lat., and 126° 30' to 126° 45' W. Long.

54,664 acres.

Permit No. 1057 - All of Grid Area bounded by 64° 30' to 64° 40' N. Lat., and 126° 30' to 126° 45' W. Long.

55,000 acres.

Permit No. 1058 - All of Grid Area bounded by 64° 30' to 64° 40' N. Lat., and 126° 15' to 126° 30' W. Long.

55,000 acres.

Permit No. 1059 - N ½ of Grid Area bounded by 64° 20' N. Lat., - 64° 30' N. Lat., and 126° 15' - 126° 30' W. Long.

27,626 acres.

Permit No. 1060 - N ½ of Grid Area bounded by 64° 20' N. Lat., - 64° 30' N. Lat. and 126° 30' - 126° 45' W. Long.

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The field work started on June 2, 1957, with the base camp at Fort Norman and work was continued until June 17. The party consisted of eight men - five geologists, a cook, a helicopter pilot and a mechanic.

Before going into the field a base map was drawn up on a 1" to 4 miles scale on which were plotted the flight runs and photo centres of the Royal Canadian Air Force vertical serial photographs. From an examination of the photographs the various structural trends of the area were worked out and recorded on the base map. From this map the work in the field was planned. Reconnaissance flights being undertaken first to find out the most suitable sections to measure. This was followed by a two man party examining the various outcrops. The locations of the sections and samples were recorded on the appropriate serial photographs in the field and later transferred to the base map so that each outcrop examined was placed on the map in its correct geographical position.

T O P O G R A P H Y

The general area in which the subject permits are located forms a large embayment in the mountains with the Mackenzie Mountains to the west and the Gambill Mountains, a spur of the Mackenzie Mountains, to the south and east. A plateau-like area, thickly wooded and deeply dissected by Grotto Creek and Little Beaver River and their tributaries, occupies the centre of this embayment. The plateau slopes gently northward to an area where lakes and muskeg begin. The general elevation of this plateau is about 1500 feet above sea level.

Two streams drain this permit area, they are Grotto Creek and Little Beaver River, both being small and navigable only by canoes. The Little Beaver River is swift flowing and has an abraided stream channel while Grotto Creek is sluggish with many meanders.

A C C E S S I B I L I T Y

The area is 57 miles due south of Norman Wells and 38 miles southwest of Fort Norman. During the construction of the Canol Road from Norman Wells to Whitehorse in 1943 several routes were tried until the one through the Macdougal Canyon was decided upon. One of these trial routes leads into

the permit areas, as indicated on the attached geological map.

On this map the road is shown as running from Twenty-five Mile Lake southeast for 16 miles where it stops and a cut trail continues southward through the subject permit areas and terminates at Little Bear River. The road for the first 16 miles is gravelled and two lanes wide while the remainder of the route through the permit areas and to Little Bear River is a track 20 to 30 feet wide cut in the bush with no road construction done; although tracked vehicles have traversed this part of the route.

The part of this road from Twenty-five Mile Lake, northwestward to the main Canol road although observed, has not been shown on the enclosed map because its exact position is not known due to the lack of appropriate aerial photographs over this part of the area.

For exploration work that requires heavy equipment access to the area would be from Norman Wells southwest along the Canol road to approximately the Carcajou River. From this point the gravel road and the cut track described above could be used. Freight could be moved only during the frozen winter period and the roads would require the use of a bulldozer before attempting to travel.

STRATIGRAPHY

All the sedimentary rocks observed in situ were of sedimentary origin and range in age from Cambrian to Tertiary. A composite stratigraphic section showing all formations found in the area on a scale of one inch to three hundred feet has been prepared to accompany this report (Figure 2).

CAMBRIAN

Saline River Formation

The Saline River is the oldest exposed formation in the area of this report. It has a wide distribution and appears along the high peaks of the Mackenzie Mountains on the western part of the map sheet. This formation, where exposed, consists of about 500 feet of bright red sandstones, siltstones, argillites and salmon pink and green gypsiferous shales. The characteristic bright red colour makes the outcrops very easy to see and has given the names to topographic features such as Rouge Mountain.

No fossils were found in the Saline River formation, but Williams[1] obtained faunal evidence which indicated Middle Cambrian age.

The contact of the Saline River formation with the overlying Ronning Group is sharp and distinct with no difference in

[1] Williams, M. Y. - Exploration East of the Mackenzie Mountains between Simpson and Wrigley. Geol. Surv. Can. Summary Report, 1921, Part B.

the dip or strike. However, this contact does represent a hiatus in the geological sequence.

SILURIAN

Ronning Group

The Ronning Group occupies extensive areas in the deeply eroded folds of the mountains to the west and south of the permit areas and to the east along the Gambill Mountain fault. These beds attain a thickness of 1400 feet in the canyon along the Carcajou River. They consist of light grey, micro to finely crystalline, thinly to thickly bedded, jointed, cliff-forming calcareous dolomites. Slightly silty dolomite is common towards the base and a prominent zone of chert pebbles occurs near the base in most localities. Above the chert zone there is a coralline band, some 200 feet thick, which is often very porous. No fossils were found in this formation.

The beds of the Ronning Group directly underlying the Lone Mountain formation consist of a breccia of dark grey dolomite pebbles cemented by secondary white dolomite. The contact, therefore, is believed to be an erosional disconformity.

Lone Mountain (Bear Rock) Formation

This formation has a similar outcrop area to that of the Ronning Group so it has not been shown separately on the

attached geological map.

This formation has a thickness of about 400-500 feet. It consists of poorly bedded dolomites with distinctive light and dark colour bands in the upper part. Below this there is a breccia of brown dolomite blocks in a coarsely crystalline matrix of white calcite. Porosity is sometimes observed in the breccia and also in the bedded dolomite. No fossils were found in this formation.

The contact of the Lone Mountain formation with the overlying Middle Devonian Ramparts is parallel, but because of the brecciated nature of the topmost beds of the Lone Mountain formation it is considered that a period of erosion took place at the end of Silurian time. The contact is, therefore, an erosional disconformity.

DEVONIAN

Middle Devonian

Ramparts Formation

The Ramparts formation appears as a narrow continuous belt on the east side of the Mackenzie Mountain and on the west side of Gambill Mountain. It also occurs on the flanks of the anticline to west of Summit Creek. Within the map area the Ramparts formation is 500 feet thick. The top 100 feet consists of massive cliff-forming limestones while the lower part is made up of interbedded argillaceous limestone and highly calcareous shale.

Fossils are very abundant throughout particularly in the upper beds. Corals, brachiopods, crinoids, trilobites gastropods and stromatorporoids were found.

In general the Ramparts formation is dense although there are traces of pin-point porosity near the top and minor oil staining was noted in one locality.

The contact of the Ramparts formation with the overlying Upper Devonian Fort Creek formation is sharp, distinct and conformable. Correlation with beds of similar lithology and age from elsewhere in the Mackenzie River region is good; although the Ramparts formation could not be broken down into the three members as is possible farther to the south.

Upper Devonian

Fort Creek and Imperial Formations

Outcrops of these formations have a similar distribution to the Ramparts formation, that is, on the east side of the Mackenzie Mountains, on the west side of Gambill Mountains and on the flanks of the anticline west of Summit Creek. A total of 2600 feet of Upper Devonian were measured in this general area. For the mapping in this report the Fort Creek and Imperial formations are included as undivided Upper Devonian.

The Fort Creek formation is 1100 feet thick. It is made up of two parts, namely, a basal member consisting of

420 feet of black, thickly bedded, hard bituminous shale and an upper 600 feet of dark grey to greenish fissile platy micaceous shale in which ironstone concretions are common. The best sections of the bituminous shale member were found on Little Bear River. Here the strata consists of a dull black, rusty to yellow weathering, brittle, thinly bedded, jointed and fractured shale. It is hard and cliff-forming near the base but softer towards the top. Selenite, pyrite and native sulphur occur along the bedding planes and iron staining is common throughout. The shale is so highly bituminous that it actually has burnt in several places leaving a bright pink shale.

The bituminous shale member grades upward into the overlying non-bituminous shale through a transition zone in which there is considerable interfingering of the two shales.

The non-bituminous member of the Fort Creek formation is soft and weathers readily to give a thick soil cover favourable for a rich growth of vegetation. It outcrops mainly along the stream banks and consists of uniform dark grey to greenish, dark grey weathering, fissile, well-laminated shale which is soft and weathers into thin flakes. Slightly harder silty bands occur in places and layers of ironstone concretions are common throughout. Although the shale itself is non-calcareous, thin calcite veins traverse the beds while selenite flakes and pyrite

also occur. The shale contains considerable quantities of bentonite and this has been partly responsible for numerous landslides seen in the rolling hills composed of this formation.

The contact of the non-bituminous member of the Fort Creek formation with the overlying Imperial formation is often gradational, but in a few localities in the Mackenzie region it was seen to be sharp, distinct and conformable.

The Imperial formation is the youngest unit and hardest of the Upper Devonian sequence. There are at least 1500 feet of beds of this age in the Little Bear River section. This formation consists of intervedd of silty limestone and shale with thin bands of fine sandstone near the top. The limestone beds vary from one inch to two feet thick and are light grey to cream weathering, microcrystalline, jointed, argillaceous, silty and dense. Fossils are very abundant in the limestones; the assemblage being mainly brachiopods, but corals and crinoid stems were also found.

The shales are light grey-green, light grey weathering finely laminated, platy, calcareous and weather readily to thin slabs. Some bands have a reddish tinge and, containing iron oxide, are slightly harder. The silt in the shale increases upwards in the section until fine sandstone phases appear at the top of the formation.

The actual contact of the Imperial formation with the overlying Upper Cretaceous Slater River formation was not observed, but from outcrops of both formations in close proximity to one another it is clear that no angular discordance exists. Because of the non-deposition of earlier Mesozoic sediments, the contact is considered to be that of an erosional disconformity.

CRETACEOUS

Upper Cretaceous

Strata of Upper Cretaceous age occupy the central part of the map area and continue to the northern boundary. Although the Cretaceous in this area can be broken down into three formations it has been shown on the geological map as undivided. These three formations, from bottom up, are as follows:- Slater River, Little Bear and East Fork.

Slater River Formation

The Slater River formation consists of about 900 feet of dark grey to black, light grey weathering, thinly bedded, brittle, micaceous silty shale with very fine bands of siltstone. Seams of alum and sulphur are common and incrustations of these materials occur in every outcrop. Bentonite in bands up to one inch thick are found throughout the formation. No discordance was observed between the Slater River formation and the overlying Little Bear formation.

Little Bear Formation

The Little Bear formation, being mainly arenaceous sediments, is harder and gives better outcrops than the other Cretaceous formations. Although good outcrops are present, no complete section has been observed or measured and a thickness of 750 feet has been estimated.

The Little Bear formation is comprised of thick beds of sandstone, very thin conglomerate bands, coal seams and small amounts of shale. The sandstone is the "salt and pepper" type, buff weathering, fine to medium grained, well sorted, sub-angular to sub-rounded grains, massive to thickly cross bedded and cliff forming. The grains are mainly quartz and chert cemented with argillaceous material and iron oxide. Occassional thin lenses of pea conglomerate within the sandstone beds and carbonaceous flecks are scattered throughout. In the Little Bear River section there are coal seams about one foot thick near the base of the formation.

The shales within the Little Bear formation are very dark grey, light grey weathering, poorly bedded and silty. They are soft and break off in lumps. Much iron staining and gypsum incrustations occur on the surface of the shale.

East Fork Formation

This formation consists almost entirely of soft plastic-like shale and, as a result, does not form good

outcrops. From dip evidence the thickness of the East Fork formation has been calculated at 750 feet, although only 280 feet of the beds were measured at the junction of Little Bear and East Fork Rivers.

The East Fork formation is made up of dark grey, light grey weathering, very soft, plastic, marine shale. Towards the base there are a few thin sandy beds. A few ironstone concretionary beds are present and iron staining and gypsum incrustations were observed on the surface of the outcrop. Bentonite probably is present in the shale as, when wet, it is plastic and slumping and landslides are common. No fossils were found in these beds.

The East Fork formation and the overlying Tertiary beds were not seen in contact. However, since the Cretaceous shales have appreciable dips while the Tertiary strata are flat lying, it is evident that an angular unconformity exists at the contact.

TERTIARY

Eocene

Within the map area the Tertiary strata occupy an area along the east side of Gambill Mountains and Summit Creek. These beds are essentially flat lying and are found from the divide of Tertiary Creek and East Little Bear River, at an altitude of 3,000 feet above sea level, right down to the

Mackenzie River at Fort Norman. For this reason a thickness of in excess of 2,500 feet has been calculated for the Tertiary in this area.

The Tertiary strata consists of conglomerate, sandstone, shale and lignite seams, all poorly consolidated except for some of the conglomerate beds which have been cemented by iron oxides. Pebbles and boulders in the conglomerate range in diameter from one-half inch to one foot and all show rounding to some extent. Limestone, dolomite, quartzite and chert boulders are present and pea gravels of Upper Devonian bituminous shale are very abundant. It was noted that, in contrast to the gravels of glacial origin, no igneous boulders were seen in the Tertiary conglomerates.

The sandstones are very poorly sorted. They are strongly cross-bedded, fine to coarse grained, sub-angular and in some places very calcareous and iron stained. The shales are grey brown, well bedded soft and iron stained. Lignite seams up to three feet thick occur at frequent intervals and carbonaceous material and plant remains are common throughout the entire unit. Baked shales are often seen above the lignite seams which were at one time on fire. These shales are bright brick red and often contain beautifully preserved leaves and twigs which have been identified as Lower Eocene.

Apart from the deposits of Pleistocene glacial drift and recent river sands and gravels, the laying down of the Eocene conglomerates, sands, shales and lignites completed the sedimentary history of the area.

STRUCTURE

The map area may be divided into three structural provinces, namely, the Mackenzie Mountains, Gambill Mountain fault and the Plains.

Mackenzie Mountains

The Mackenzie Mountains form the largest structural province of the area. They occupy the western part of the map and extend beyond the northern and southern boundaries. These mountains are characterized by long parallel folds which, though locally sinuous, have a fairly constant strike to the north-northwest. In this part of the Mackenzie Mountains folding is dominant over faulting, at the surface; although faulting at depth is suspected. In comparison to the folds the south of the map area, these folds have very gentle dips on their flanks; in general less than 25 degrees. Since the anticlines of the Mackenzie Mountains expose Cambrian in their cores, they are not considered favourable for oil or gas exploration.

Gambill Fault

This fault has formed the Gambill Mountains, a spur of the main Mackenzie Mountains. It extends from the Keele River, south of the map area, in a northwesterly direction to the southern part of the subject permits. From this point the strike of the fault changes abruptly to the northeast. It continues in this direction to approximately six miles north

of Ration Creek where it disappears.

Cambrian Saline River formation has been brought into contact with Upper Devonian Fort Creek shale in the south and with Upper Cretaceous Little Bear formation in the Ration Creek area where there is a displacement is in the order of 6,000 feet. Where Ration Creek cuts through Gambill Mountain a complete section of all sediments from Middle Cambrian to Upper Cretaceous is exposed.

The Gambill fault block forms the eastern limb of the broad syncline expressed in Cretaceous sediments which traverses the Permit area and which cuts this syncline off to south.

Plains Area

The Plains structural province is found in the east and northeast part of the map area. Here beds of Cretaceous and Tertiary ages form the surface bed rock. The outcrops are confined mainly to the main stream channels and, as a result, little is known of the structure. The areas of muskeg and lakes are lacking in outcrops. There may be small buried structures below the glacial drift, also structures may occur under the flat lying Tertiary beds.

SUMMARY AND CONCLUSIONS

This report presents the results of a semi-detailed geological survey of Permit areas 1056 to 1060 and adjacent areas of interest. A total of about 9,500 feet of sediments were examined varying in age from Cambrian to Tertiary. In general the Cambrian, the oldest Palaeozoic rocks, are clastics. A thick carbonate series was laid down during Silurian and Middle Devonian. This was followed by shale and silt and fine sandstone in the Upper Devonian and finally in Upper Cretaceous and Tertiary clastic sediments again predominate.

The Silurian Ronning group contains the best porosity of any rock unit studied in the area with the lowest few hundred feet containing vuggy to cavernous calcareous dolomite. The Silurian Lone Mountain formation is generally dense except for the topmost beds which usually show some vuggy and inter-crystalline porosity due to brecciation and recrystallization. Traces of pin-point porosity were observed in bands in the Middle Devonian Ramparts formation but in general the unit is dense.

Nowhere in the Upper Devonian series was porosity observed, although the abundant fractures in the bituminous shale would permit the movement of fluids through the rock. The only porosity observed in the Cretaceous was in the sand-stone of the Little Bear formation. Tertiary sandstones, though loosely compacted, show very little porosity due to poor sorting and secondary calcite filling.

There are, therefore, by direct observation four possible reservoir rocks, viz:- the Silurian Ronning group, the Silurian Lone Mountain formation, the Middle Devonian Ramparts formation and the Upper Cretaceous Little Bear formation. By inference there is a fifth possible reservoir rock, namely the reef limestone within the Upper Devonian Fort Creek shale similar to that found at the Norman Wells oil field.

From the point of view of structure the Mackenzie Mountains area are the least attractive because all possible producing zones are exposed on the flanks of the range and thus any oil or gas which they might have contained would have been dissipated. Due to scarcity of outcrops on the Plains areas little can be said of the oil and gas possibilities. There may be small ~~burned~~ buried structures below the glacial drift and the possibility of Upper Devonian corraline reefs. Small structures may also occur under the flat lying Tertiary sediments in which case the sandstones of the Little Bear formation would be prospective.

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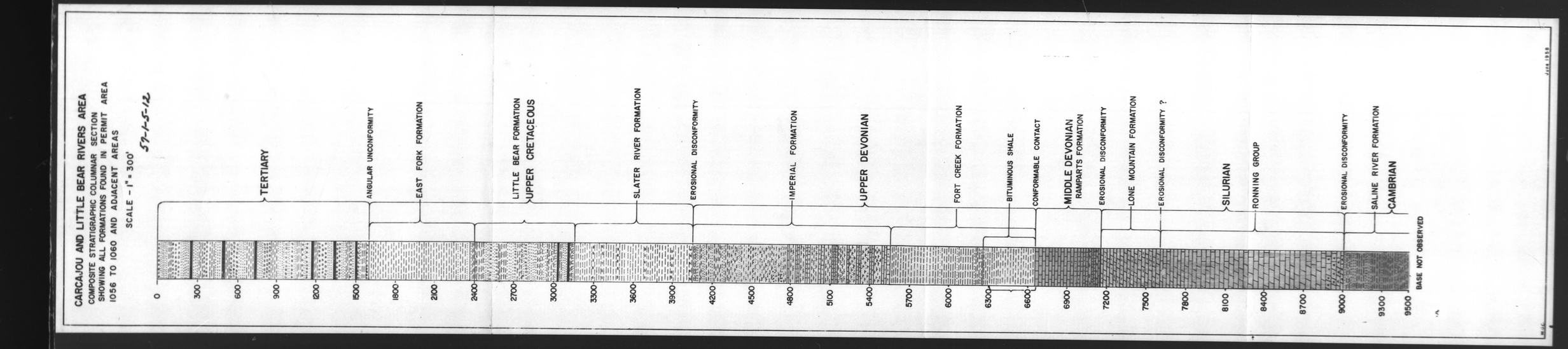

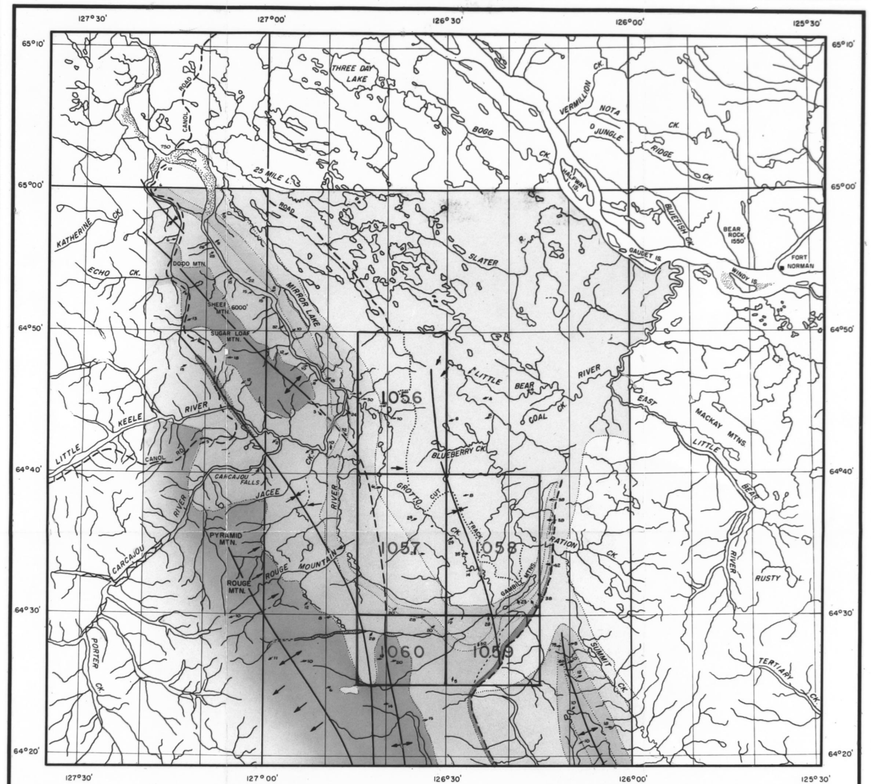

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GEOLOGICAL MAP OF

PERMIT AREAS 1056 - 1060 INCLUSIVE AND ADJACENT AREAS

SCALE: 1 INCH = 4 MILES

LEGEND

- TERTIARY
- CRETACEOUS
- UPPER DEVONIAN
- MIDDLE DEVONIAN
- SILURIAN
- CAMBRIAN

SYMBOLS

- GEOLOGICAL BOUNDARY
- ANTICLINAL AXIS
- SYNCLINAL AXIS
- FAULT
- DIP (Recorded on ground) 10
- DIP DIRECTION (from aerial photographs)
- ROAD
- CUT TRACK