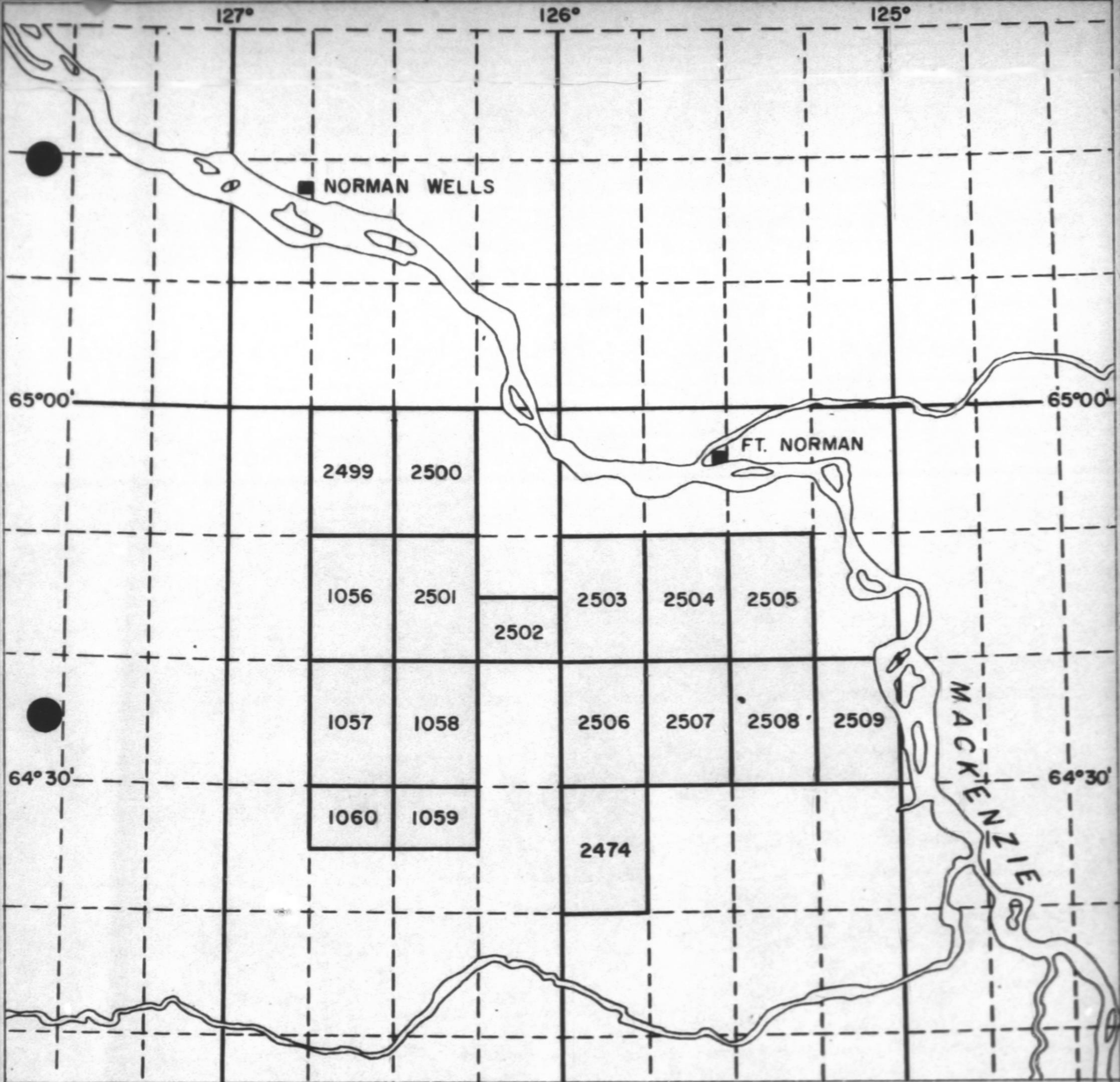


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Maps Submitted:

1. Station Location & Elevation.
2. Observer Bouguer Gravity.



MOBIL OIL OF CANADA, LTD.

FORT NORMAN AREA, N. W. T.

LOCATION PLAT

PERMIT No. : 1056-1060, 2499-2509 & 2474

SCALE: 1" = 12 MILES

REPORT ON GRAVITY SURVEY

N.W.T. PERMITS 1056 - 1060 INCL.,

2499 - 2509 INCL., AND 2474.

June 6, 1959 - October 2, 1959.

by Mobil Oil of Canada, Ltd.

During the period June 6, 1959, to October 2, 1959, a gravity survey was conducted in the above permits by Geophysical Associates of Canada, Ltd. for Mobil Oil of Canada, Ltd.

The area surveyed is described as the Fort Norman area, District of Mackenzie, Northwest Territories and comprises 225 square miles, bounded by Latitudes $64^{\circ} 30' N.$, $64^{\circ} 50' N.$, and Longitude $126^{\circ} 00' W.$, $126^{\circ} 45' W.$

Gravity measurements were taken at a total of 475 stations with the La Coste-Romberg No. 69 and Worden No. 365 meters. These stations were located at one quarter mile intervals on six east-west lines spaced approximately two miles apart and on four north-south lines spaced about six miles apart.

A topographic survey was established by transit, and it was found necessary to clear all survey lines due to the heavy growth of vegetation.

Field conditions necessitated the use of a helicopter to transport personnel and equipment between base camp and the field each day. For this purpose, landing areas of 80 by 100 feet were cleared near the scene of daily operations. Weather conditions were often a deciding factor in this type of operation, and 21 work days were lost on this account.

Personnel employed comprised 5 technicians, 6 labourers and the helicopter pilot.

Interpretation

Observed field data were reduced employing an elevation factor of 0.065 milligal/ft. Interpretation of these data was performed by the Gravity Meter Exploration Company, Houston.

The observed contours form a broad, northerly trending, area of minimal embayment in the central portion of the survey. To the east, positive reversal is evident in conjunction with a sharp elongated minimal nosing. A southward decrease in gravity is noted with approach to exposed Paleozoic beds, while a uniform increase in gravity is evident to the northwest.

Several narrow, localized anomalies of 0.5 to 1.5 milligal relief transect the area as shown by sharp and continuous nosings in the observed contours. These are related to local density variations in the shallow section, especially in the vicinity of sharply incised canyons in the present drainage system.

Copies of the following maps are submitted with this report:

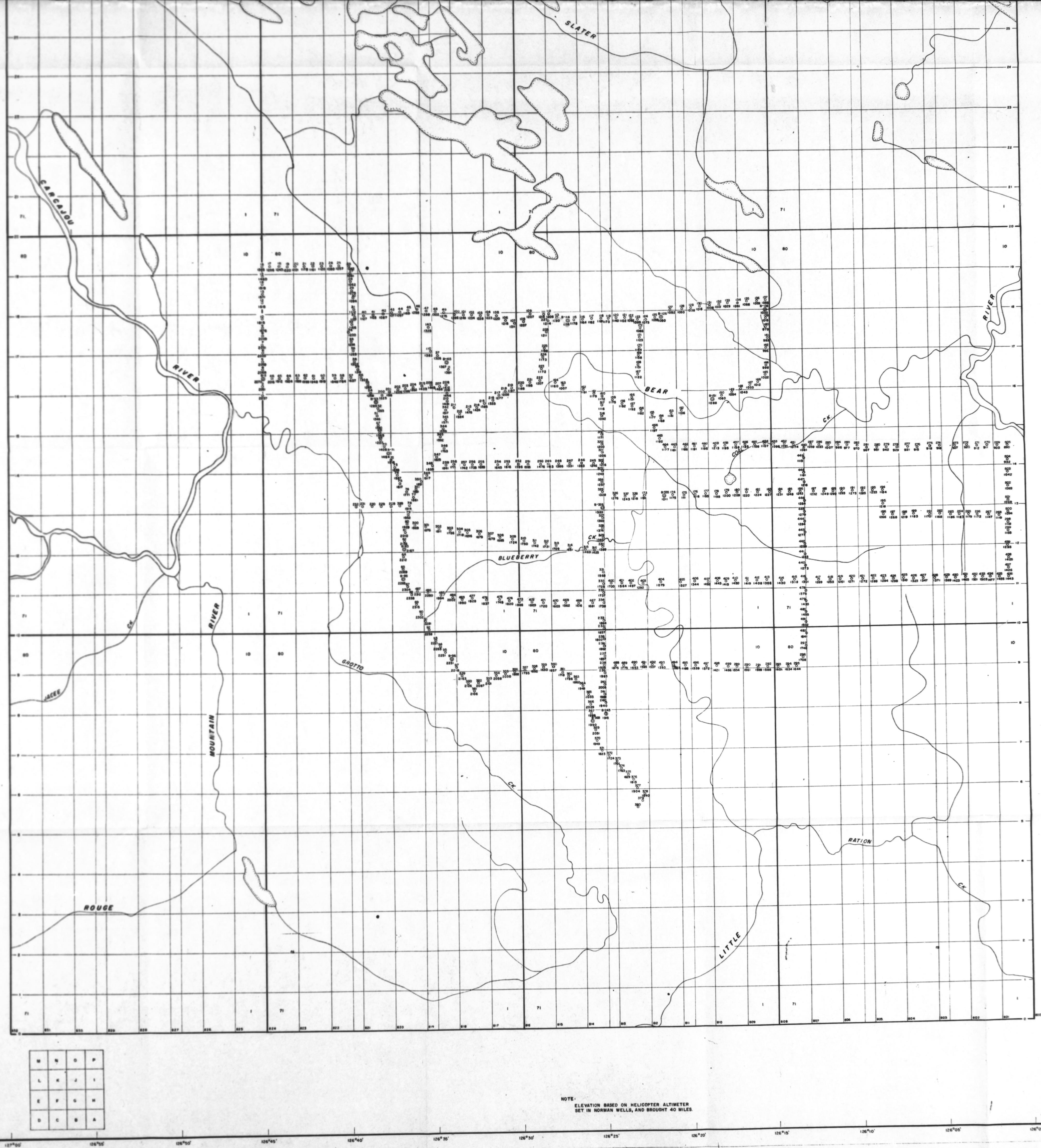
1. Station location and elevation map, scale 1 in. = 1 mile.
2. Observed Bouguer gravity, contour interval 0.5 milligal, - *Removed*
scale 1 in. = 1 mile.

Respectfully Submitted,

COPY(^{Original}_{Signed}) H. J. Kidder

H. J. Kidder,
Chief Geophysicist.

NR/rg.
Attachs.



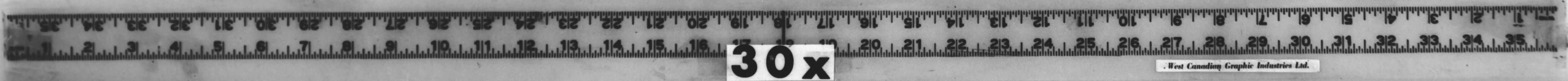
1:50,000
1 Section
Approx
600,000 Acres

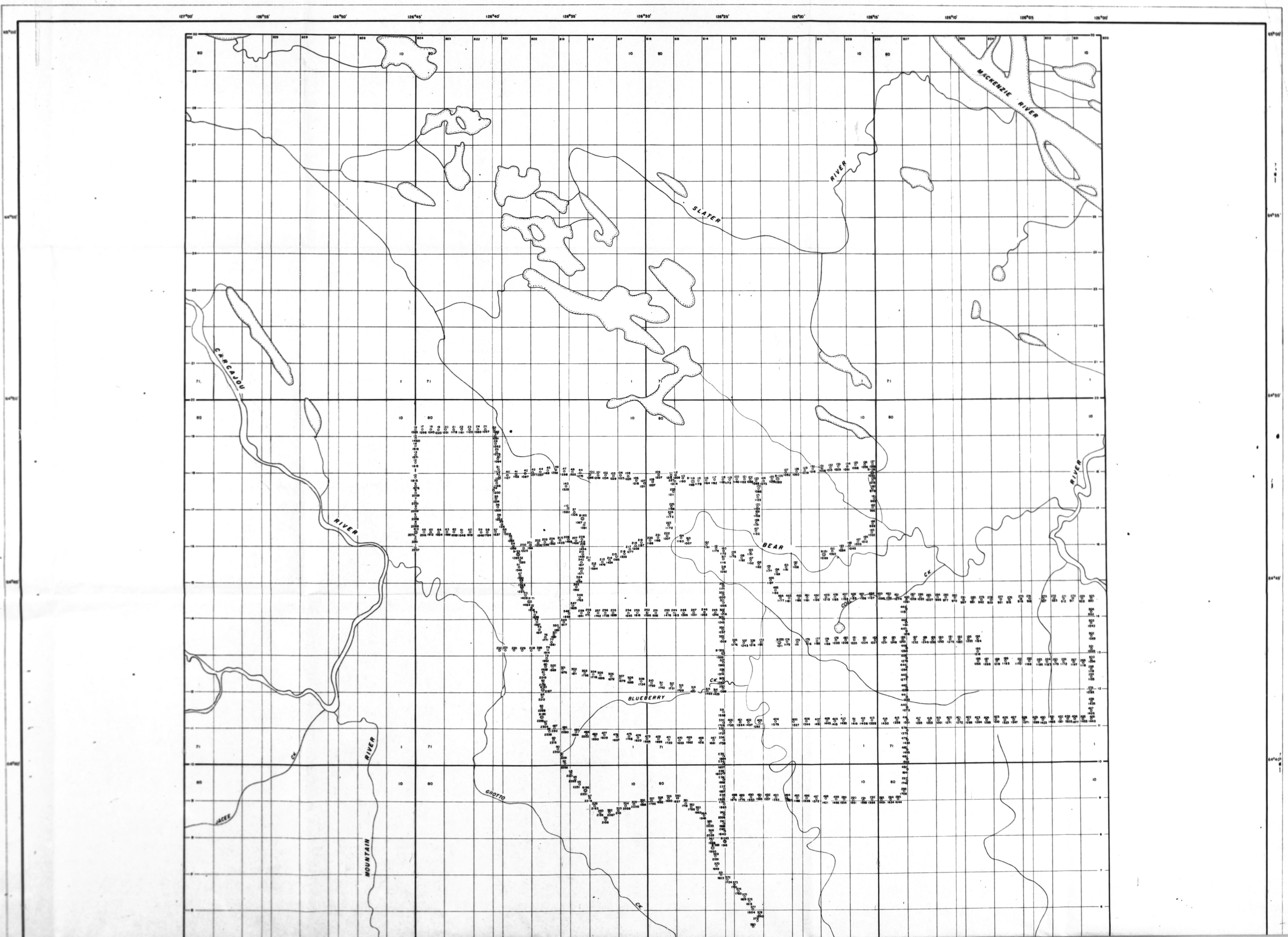
M	N	O	P
L	K	J	I
E	F	G	H
D	C	B	A

NOTE:
ELEVATION BASED ON HELICOPTER ALTIMETER
SET IN NORMAN WELLS, AND BROUGHT 40 MILES



GSR
MOBIL OIL OF CANADA, LTD.
CALGARY (B.C. District - N.W.T.) ALBERTA
GRAVITY METER SURVEY
FORT NORMAN AREA
N.W.T. (CARCAJOU RIVER) SHEET
ELEVATION MAP
52-8-5-22
SCALE 1 IN = 1 MI
GEOPHYSICAL ASSOCIATES OF CANADA LTD.
27 NOV 1959





GEOLOGY OF MOBIL OIL PERMITS

1056-1060, 2499-2509 and 2474

LITTLE BEAR RIVER AREA

NORTHWEST TERRITORIES

BY

D.H. Magnusson

January, 1960
Dawson Creek, British Columbia

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ILLUSTRATIONS

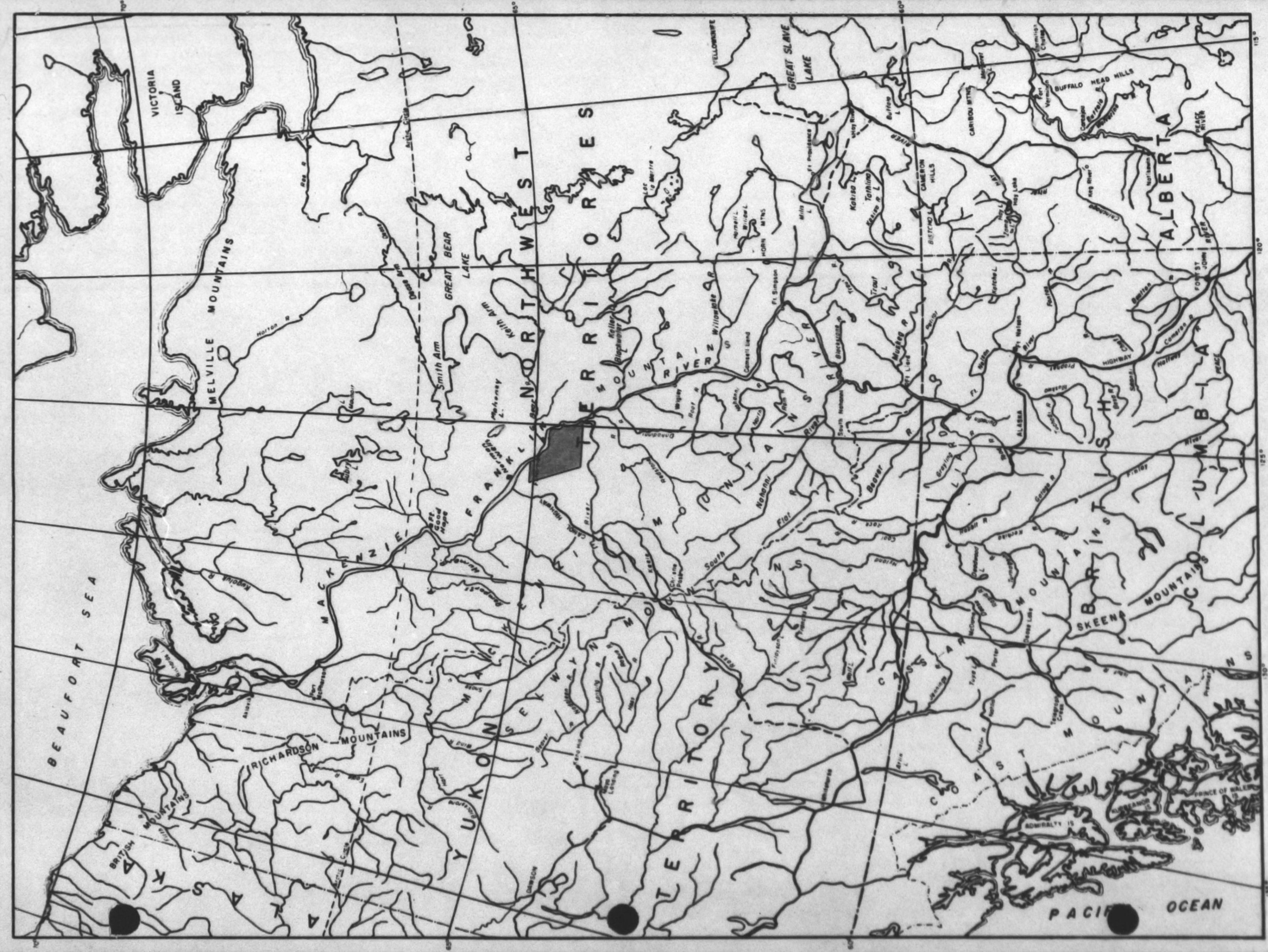
Figure 1. Northwestern Canada showing Area Worked

2. Table of Formations

**3. Composite Stratigraphic Section for Mobil Oil Permits
Little Bear River Area, N.W.T.**

Map

**Surface Geological Map of Mobil Oil Permits - Little
Bear River Area, N.W.T.**



NORTHWESTERN CANADA

Scale: 1" = 115 miles (approx)

FIG. 1

INTRODUCTION

Purpose of Work

The purpose of the field project was to conduct a detailed surface geological investigation of Mobil Oil permits in the Little Bear River area.

Location and Access

The Mobil Oil permits consist of 849,564 acres around Little Bear River immediately south and west of the settlement of Fort Norman (Lat 64°54'N, Long 125°35'W) Northwest Territories. There are two blocks joined by a narrow corridor comprising a total of seventeen permits. The mapped area lies within a tract bounded on the east and northeast by the MacKenzie River to Latitude 65°03', west to Longitude 127°, south to Latitude 64°20'.

The area is within comparatively easy access of the MacKenzie River. Five permits are situated less than four miles from it. Barges ply the MacKenzie from early June on into September. Nearby Fort Norman contains a small Department of Transport radio communications centre as well as a commercial outlet catering mainly to the needs of the local inhabitants.

The northernmost permits are twenty miles south of Norman Wells. The unpaved air strip at Norman Wells can accommodate aircraft up to the specifications of a "C-46" or equivalent, but is often unserviceable for a day or two after periods of heavy rainfall. The airport is managed by the Department of Transport and is a major radio communications center for the region. It is served by a commercial airline and small aircraft are sometimes available for charter. Norman Wells is also an important fuel supply center.

A number of lakes are suitable for small float or ski-equipped aircraft in the northwestern part of the permit area. This is, of course, in addition to MacKenzie River itself.

A spur of the old Canol Road from Norman Wells trends southward along a low escarpment into three of our westernmost permits. It has been partially covered by growth since its construction; however, no great difficulty would be encountered reconstructing it at least as a winter road for wheeled vehicles.

Previous Work

The first geological work known to have been carried out in the project area was the traverse of T.A. Link who ascended Little Bear River as far as Blueberry Creek in 1920. In 1922 Hume investigated Carcajou Canyon.

Parts of the permit area were examined in some detail under the auspices of the Canol Project. During the summer of 1943 seven parties were engaged in this work. C. R. Stelck examined parts of MacKay Creek and lower Little Bear River as well as the MacKenzie Mountain front in the Little Bear-Carcajou divide area. E. J. Foley traversed much of Slater River and Boggs Creek while R. M. Hart similarly examined East Fork River, MacKay Mountains and Summit Creek area. V. B. Monnett studied Gambil Mountains and Little Bear River from Ration Creek to beyond the "big bend" area of the river. Finally, A. W. Nauss investigated the Carcajou Canyon-Mirror Lake area.

During the summers of 1954 and 1955 a Shell Oil field party worked in the map area.

In 1956, a Mobil Oil party under J. Harrison mapped the area as part of a reconnaissance project of the regions between Camsell Bend and Fort Norman. Early in the field season of 1957 Harrison examined permits 1056 to 1060 in more detail.

Present Work

Previous to the commencement of field operations the writer studied aerial photographs and became acquainted in a general way with pertinent literature dealing with the area. The first base camp was situated in the settlement of Fort Norman. Foot traverses and stratigraphic work commenced after a number of reconnaissance flights. It was found that the airphoto mosaics obtained this year were extremely useful in all phases of the project, particularly in the field. Helicopter traverses were conducted where feasible, including the extensive outcrop on Little Bear River below Ration Creek. Stratigraphic work involved outcrop description and measuring of sections. In all, 18,500 feet were measured of which over 10,000 feet were described. The party moved from Fort Norman to Mirror Lake on July 3. Toward the middle of July three field crews were in operation. The project area was vacated on August 11 and 12, 1959. During this project, nine days were lost owing to unfavorable weather. In all approximately 285 helicopter hours were flown in the Northwest Territories operation.

Acknowledgments

The writer wishes to thank R. White, M. Helpern, T. MacPhee, and R. Platt, who was senior assistant. All were very able and co-operative both in the field and at camp.

G. Pieters served capably as cook.

The writer benefited from the presence of J. Harrison who was with the party until June 11.

G. Hansen, pilot, and M. MacArther, mechanic, of Associated Helicopters were most obliging in their capable service to the field operation.

The writer gratefully acknowledges the generous hospitality and services of the administrative and business people of the settlement of Fort Norman.

The courtesies extended to us while at Mirror Lake by J. Kommonoski and Geophysical Associates is appreciated.

R. Graves, Geologist-in-charge Dawson Creek, assisted in many ways while in the field and in the preparation and editing of this report. M. Moorhouse also assisted in editing.

Miss A. Smith capably typed the report and in similar manner R. Key drafted the illustrations.

PHYSICAL FEATURES

Topography and Drainage

There are two main physiographic divisions apparent in the permit area. These have been termed the "MacKenzie Mountains," and the "MacKenzie Plain." A maximum relief of over 2,500 feet is present over the area.

The mountain area comprises the MacKenzie Mountain front, Gambil Mountains, Summit Mountains and MacKay Mountains. Only the eastern edge of the MacKenzie Mountain Canyon Ranges are present in the mapped area. The transition from plains to mountains in this area is gradual and the boundary is somewhat arbitrary; however, the edge of the Ramparts limestone may be considered as the mountain front. Along much of the front the rise is gradual toward the west and southwest. The main relief is effected by streams which have cut narrow, rugged canyons in which waterfalls and natural bridges are common. The Carcajou River provides major drainage and near Mirror Lake has incised a canyon over one thousand feet deep.

The Gambil Mountains form a narrow north northeast strike ridge which joins the main mass of MacKenzie Mountains south of permit 1059. The Gambils stand about 700 feet above the plains and are bounded along most of their length by a steep east facing escarpment, which contrasts with the gentle rise from the west. Though nearly flat-topped, they show considerable relief at their southern end, and are abruptly terminated on the north.

The Summit Mountains are a small northwest trending range which rise 1500 feet above the plains level.

The MacKay Mountains are by far the most rugged of the mountainous areas mapped. They form a narrow, sinuous range 16 miles long and up to two miles broad. They rise abruptly to a height of 1500 feet above the surrounding plain and have steep flanks, particularly on the east where near vertical cliffs are present along much of their length.

The MacKenzie Plain can be divided into a plateau, a sloping plain, and a dissected area of high relief. Much of the area between MacKenzie and Gambil Mountains and northward is a plateau upheld by Devonian and Cretaceous sandstones. The plateau gently slopes northward, and eastward away from the mountain front, resulting in a gradual north northeast gradient toward MacKenzie River. This plateau has been deeply dissected by the entrenched meandering course of Little Bear River and its tributaries and by the smaller Slater River, which is similar in nature. The broad, but steep valley of Grotto Creek drains the southwest part of this plateau area. The northwestern part of the plateau is more poorly developed. Here the ground level is more uneven and drainage is poor with numerous lakes in evidence.

The area east of MacKay Mountains is a sloping plain. This slope is gradual toward the east and relief is generally very low. MacKay Creek drains much of this plain but has not deeply incised it.

Much of the plains area flanked by MacKay, Gambil and Summit Mountains is composed of a mass of highly dissected, soft sedimentary rocks. From the 3,000 foot summit of this mass, which is just to the east of permit 2474, streams radiate in all directions. They all have

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a well developed dendritic drainage pattern which imparts a rugged relief to the area.

Glacial Geology

The entire area has been glaciated, but comparatively few of the more striking features resulting from glaciation were found. Glacial erratics have been found in the region at elevations of 5,000 feet. In the bed of Slater and Little Bear Rivers many large granitic and gneissic boulders were seen and small glacial grooves were observed on Gambil and MacKay Mountains. Sandy boulder clays were evident in cut-banks of the larger streams. In the main, glacial processes were working from a southeast to northwesterly direction.

Stelck reported the presence of post-glacial lake clays in MacKay Creek. It is considered that the glacial drift is thick in this area probably ranging from 200 feet to 400 feet. Similarly, the drift is believed to be thick in the area north and northwest of the "big bend" of Little Bear River. In this area, numerous lakes with poor drainage and short low ridges, which resemble eskers, are set in a generally hummocky terrain.

General Character of Mobil Oil Permits

Much of the permit area is covered by a moderate to light spruce forest, and is comparatively dry with low to moderate relief. Steep stream valley walls, particularly those facing the west or southwest, contain a heavy growth of tall spruce trees. This terrain is especially evident along Grotto Creek and some of its tributaries in permits 1057 and 1058. Numerous small patches of open, spengy muskeg

occur in permits 2499, 2500, and 2501, and are often associated with the many lakes which occur in this area. The western parts of permits 1056 and 1057 contain flat or gently sloping open patches which support little vegetation save for small scattered spruce and alder. Tracts of a similar nature occur east of MacKay Mountains, although there is also some burn and associated windfall in this area. Comparatively low lying land near MacKenzie River supports a heavy growth of tall spruce, poplar and birch trees. A considerable portion of permit 2506 and lesser patches within permits 2474 and 2507 contain barrens with extremely high relief caused by a deeply incised dendritic drainage pattern. MacKay Mountains straddle three permits namely: 2503, 2504 and 2507. Other areas classified as having mountainous terrain occur within permits 1059 and 1060. This terrain is characterized by high relief, considerable rock exposure, and is comparatively free of significant vegetation.

Climate and Weather

The permit area lies in the north interior climatic zone, and is influenced by continental arctic air masses in winter and maritime arctic air masses in summer.

The mean annual precipitation at Fort Norman is 11.8 inches. Over 60 per cent of this is in the form of rain, falling mainly during June, July and August. The mean temperature is below 32°F for 6½ months of the year. The coldest month is January when the mean temperature is -15°F, and the warmest is July at 60°F. Permafrost is believed to be confined to small sheltered tracts near the mountains.

STRATIGRAPHY

The strata in the permit area are lower and middle Paleozoic, late Cretaceous and Tertiary in age. In general exposures of Paleozoic rocks are confined to large structural uplifts, while Cretaceous and Tertiary strata occur in the intermontane plains.

Paleozoic strata were studied in some detail. Only one well exposed and nearly complete section was found. A description of these beds as they occur on upper Little Bear River is found in an appendix to this report. A composite stratigraphic columnar section (Figure 3) has been enclosed to illustrate in one continuous column the general lithology and thickness of all sediments found in the area.

Saline River Formation:

This is the lowest rock unit of the stratigraphic sequence exposed in the mapped area. The base of the formation was not observed. The contact with the overlying Hanning group is sharp and distinct. It is unconformable although there is no apparent difference in attitude where the contact is exposed. The best exposures of Saline River strata occur along the upper reaches of Little Bear River. A few outcrops were noted near the south end of Goshute Mountains, in the core of Summit Arch (Mountains), and at several localities on the eastern side of Hocking Mountains.

The Saline River formation consists of pink to bright red gypsiferous shale, banded gypsum, and contorted green and red variegated shale with nodules and lenses of gypsum. On upper Little Bear River overlying the gypsiferous beds are minor thicknesses of dark grey

Figure 2

TABLE OF FORMATIONS				
ERA	PERIOD OR EPOCH	FORMATION OR GROUP	LITHOLOGY	THICKNESS (FEET)
CENOZOIC	EOCENE	EOCENE BEDS	CONTINENTAL SANDSTONE, CONGLOMERATE, SHALE, COAL.	1400' to 2000' +
	UNCONFORMITY			
MESOZOIC	UPPER CRETACEOUS	EAST FORK	MARINE GREY SHALE	750'
		LITTLE BEAR	CONTINENTAL SANDSTONE, SILTSTONE SHALE	810'
		SLATER RIVER	MARINE GREY SHALE	1035'
UNCONFORMITY				
PALAEOZOIC	UPPER DEVONIAN	IMPERIAL	MARINE GREY SHALE, SILTSTONE, SANDSTONE	0' to 1459'
		FORT CREEK	MARINE GREY SHALE	1350' to 1450'
	MIDDLE DEVONIAN	RAMPARTS	MARINE LIMESTONE	405' to 515'
	UNCONFORMITY(?)			
	SILURIAN (?)	BEAR ROCK	MARINE BRECCIATED DOLOMITE	400' to 946'
	UNCONFORMITY			
	ORDOVICIAN	RONNING	MARINE DOLOMITE	1400' to 1864'
	UNCONFORMITY			
	CAMBRIAN	SALINE RIVER	MARINE SHALE, GYPSUM	—

argillaceous limestone, and black platy shale. Less than 200 feet of this formation is exposed at any one locality within the area mapped.

This rock unit is Middle Cambrian and may include some Upper Cambrian. It can be correlated in a general way without difficulty throughout the region.

Ronning Group

Strata of the Ronning group outcrop extensively on mountain uplifts in the report area. Steep massive cliffs are exposed in Carcajou Canyon and outcrops of gently dipping Ronning fringe the western and south edges of the area. Considerable thicknesses are also exposed on upper Little Bear River, on the east side of Gambel Mountains and on Summit and MacKay Mountains. The relationship of this unit with the overlying Bear Rock formation is unconformable. From a distance, the contact of the massive bedded Ronning with the brecciated Bear Rock is quite distinct as it is exposed in the western part of the area; however, upon closer examination, the contact is more subtle with no evidence of erosion. One section studied on Gambel Mountains exhibits some fine quartzose sandstone at the base of the Bear Rock.

The Ronning group consists essentially of bedded dolomite. In the report area, it may be divided into three units, the uppermost of which consists of over 400 feet of massive bedded, brown to grey weathering, varishaded grey dolomite. This coralline unit is medium to finely crystalline. The middle unit, which is of variable thickness, consists of light grey to cream finely crystalline dolomite which is cherty toward the top. The lower unit is composed of massive to thin bedded, light grey

to buff very fine, dense dolomite with a number of dark grey recessive argillaceous beds toward the base. Sections examined in a number of localities contain a thin conglomeratic zone which is composed of rounded poorly sorted quartz pebbles, which are as yet non-correlative. A total of 1864 feet of Ronning beds are present on upper Little Bear River. This is considered to be the maximum thickness for the area. Over 1600 feet were measured in Dodo Canyon. This rock unit thins eastwardly across the area and the upper unit is not present on MacKay Mountains.

The Ronning group is now considered to be of latest Ordovician age. The upper portion of the group is the probable correlative of the Mount Kindle formation described south of the area.

Bear Rock Formation

This formation can be traced from near Mirror Lake around the eastern flank of MacKenzie Mountains and northward up the left centre of Gambil Mountains. The Bear Rock is also well exposed on the steeply dipping eastern limit of Summit anticline, and a considerable portion of MacKay Mountains consists of this formation. The contact with the overlying Ramparts is probably unconformable. It is placed at the plane of demarcation between the dark Ramparts limestone and the brown crystalline dolomite of the Bear Rock.

The Bear Rock is composed of an upper bedded dolomite grading down the section into a massive, chaotic, dolomite breccia. The upper unit consists of greyish brown, laminated, finely crystalline, slightly argillaceous dolomite. The bedded dolomite is highly calcareous in a number of sections studied. It has a wide distribution and is 68 feet

thick on upper Little Bear River which is average for the area. The dolomite breccia is generally over 400 feet thick. It is massive, rubbly to blocky weathering, hoodoo-forming, with a rusty brown weathering color. The fragments range in size from less than one inch to over six feet. Some large blocks of well bedded dolomite grade laterally to a fine breccia within a few feet. The matrix is very similar in lithology to the fragments, and consists of medium to dark brownish grey, partly laminated, generally finely crystalline to microcrystalline dolomite. On Little Bear River, the lower part of the formation shows less acute brecciation with large blocks of undeformed massive to medium bedded, hard, dense dolomite. The breccia is more or less calcareous with some fragments which can be classified as limestone.

The formation varies greatly in thickness. Measurements of 946 feet and 590 feet were obtained on Little Bear River and Carcajou Canyon respectively. Complete thicknesses such as the above are not available from other sections studied in the area. The Bear Rock formation is believed to thin from a maximum of 946 feet in the western part of the area to less than 500 feet in the eastern permit areas.

Mobil Oil parties working in the lower MacKenzie River area have commonly regarded the Bear Rock formation of tentative Silurian age. Some other workers consider this controversial formation to be Lower Devonian. Until such time as more definite palaeontological evidence is available the formation will continue to be considered Silurian.

Ramparts Formation

The Ramparts formation is easily traced around the edge of MacKenzie Mountains in the mapped area. Ramparts is exposed on Summit Mountains, and the western flanks of Gambil and MacKay Mountains. One isolated dip slope exposure occurs on the eastern side of MacKay Mountains near their northern terminous. The Ramparts formation underlies Fort Creek formation conformably. There are numerous exposures of a distinct contact within the report area.

The Ramparts formation can be divided into three units, an upper limestone, a middle shale and limestone and a lower limestone. The upper unit is from 97 to 127 feet thick, and is composed of limestone which is buff to light grey weathering, massive bedded, highly fractured, dark grey to black and cryptocrystalline. It is generally fossiliferous throughout. The middle unit is composed of massive to thin bedded, dark grey, crypto-microcrystalline limestone, interbedded with dark grey to green calcareous shale. Beds of 100 per cent shale are present up to 8 feet in thickness. The middle Ramparts is highly fossiliferous and carries a prolific brachiopod fauna. The lower Ramparts consists of up to 90 feet of rusty brown to buff weathering, massive bedded, dense, argillaceous limestone. A total Ramparts thickness of 515 feet was measured on upper Little Bear River, and 425 feet near Mirror Lake. A total of 430 feet occur in Imperial Loon Creek #2.

The Ramparts formation in this area is essentially of Middle Devonian age. Some writers place the contact between the Middle and Upper Devonian within the upper limestone member of the Ramparts.

Fort Creek Formation

The Fort Creek formation outcrops in a narrow belt trending along the MacKenzie Mountain front and up the west side of Gambel Mountains. The best exposures of the formation in the permit area are found at the head of Carcajou Canyon and near the headwaters of Little Bear River. Fort Creek shales are overlain conformably by Imperial siltstones and shales with a gradational contact.

The Fort Creek formation can be divided into a lower bituminous shale and an upper shale member. The bituminous shale is 436 feet thick on upper Little Bear River where it is composed of black to rusty weathering, black, fissile to platy, shale containing a few nodular ironstone beds.

A number of black, cryptocrystalline, argillaceous limestone beds less than six inches thick occur in this member. The upper shale is dark grey, micromicaceous, and weathers from grey to a purplish rust color. The shale is slightly silty toward the top and contains grey siltstone stringers. A total section of 1,455 feet of Fort Creek was measured near the head of Carcajou Canyon. However, this is considered to be an unusually thick section. Thicknesses of 1386 and 1370 feet are present in Dodo Canyon and the Loon Creek #2 well respectively. The Fort Creek thins due to pre-Cretaceous erosion beyond the limit of the overlying Imperial formation. An estimated 1100 feet is present near MacKay Mountains from where the formation thins to the east and southeast.

Imperial Formation

This formation underlies a tract which trends southwesterly from Mirror Lake then curving to the west side of Gambil Mountains. It also crops out on the flanks of the Summit anticline. The contact with the overlying Cretaceous Slater River formation is unconformable. In view of the lengthy hiatus involved between late Devonian and late Cretaceous, during which it is probable there were epirogenic uplifts and some depositional tilting, there is doubtless some angular discordance between Upper Devonian and Upper Cretaceous strata.

The Imperial formation consists of shale, silstone, and sandstone in order of abundance. In general, the flaggy sandstone and silstone beds are confined to the lower half of the formation. The sandstones are grey to green, fine to very fine grained, and commonly micaceous, and found in beds up to 50 feet in thickness. Thin horizons are highly fossiliferous and calcareous. The silstone beds are greenish grey and maroon, micaceous, and often laminated. Shales, which are interbedded with the sand and silstone also occur as a thick unit at the top of the formation. The shales are grey with minor variegated red and purple beds, and are commonly micaceous and often silty.

A measurement of 1459 feet was obtained near the head of Carcajou Canyon. This figure is probably the maximum section present in the permit area. The Imperial thins rapidly to the east and south. No Imperial is present near MacKay Mountains, and a greatly reduced thickness is apparent on the flanks of Summit anticline.

The Imperial formation is marine in this area and contains a prolific Upper Devonian fauna.

Slater River Formation

Most exposures of this formation are confined to the type area on Slater River. The formation is inferred to be present near the western base of MacKay Mountains and, in part, on the eastern base. It underlies a roughly triangular tract north of the Summit structure. The Slater River formation underlies an area which follows the strike of the west side of Gambil Mountains and east of MacKenzie Mountains. Although poor in outcrop habit, the formation can often be traced by its characteristic landslide topography. The contact with the overlying Little Bear formation is conformable and gradational.

The Slater River formation consists essentially of dark grey marine shale. The shale is grey to rusty grey weathering, soft, plastic and contains numerous seams of bentonite. Ironstone concretions up to four feet in maximum intercept are common as nodular zones or as scattered nodules. Several small outcrops of sandstone occur at the base of the formation on a ridge east of Mirror Lake. The sandstone is grey white, fine grained, conglomeratic, and quartzose. The Slater River formation generally is about 1035 feet in thickness. It is of Upper Cretaceous age.

Little Bear Formation

This formation is widespread throughout the project area. It outcrops near the edge of MacKay Mountains and as a belt extending east of Gambil Mountains southward along the trend of Summit Creek. The formation underlies much of the intermontane area between Gambil and MacKenzie Mountains from where it trends northwesterly over a broad area. The rock

unit outcrops most extensively along Little Bear River. The contact which is exposed in several cutbanks on Little Bear River, is gradational with the overlying East Fork.

The Little Bear formation is composed dominantly (60 per cent) of fine and very fine grained, quartz-chert sandstones, are generally soft, brown to grey weathering, light grey to brownish grey, massive bedded toward the base becoming thinner bedded higher in the section. Many of the sandstones are carbonaceous and plant fossils are common. The massive sandstone beds are lensing in character and are difficult to correlate even between two nearly adjacent outcrops. Medium to fine conglomerates are associated with Little Bear sandstones at scattered localities. Thin grit and pebble lenses are common. Grey micaceous shale and carbonaceous siltstone occur interbedded with the sandstones and make up about 40 per cent of the formation along with sporadic lignitic coal seams up to 18 inches thick. In the Summit Creek area, the sandstones have been altered to a soft reddish brown color and some of the siltstones to a deep maroon shade. This phenomena is believed to be the result of burnt coal seams and forest fires. A maximum thickness of 810 feet has been ascribed to this Upper Cretaceous formation.

East Fork Formation

Outcrops of the East Fork Formation are confined to a relatively small tract lying west of MacKay Mountains, outcropping mainly on Little Bear and East Fork Rivers. One outcrop was found immediately east of Gambil Mountains near their south end. The contact with the overlying Tertiary is nowhere exposed; however, there is evidence that it is an angular unconformity of some magnitude.

The formation consists of dark grey to very dark grey marine shale. The shales are soft and plastic and generally resemble the Slater River shales. Mud flows are common on cutbank exposures of the formation. East Fork outcrops exhibit a greyish white alum encrustation. Some thin silty and sandy beds occur near the base of the formation. The rock unit is calculated to be 750 feet thick although no more than 280 feet are exposed at any one outcrop. The East Fork is of Upper Cretaceous age and is of very limited regional extent.

Eocene Beds

Eocene beds underly a broad tract in the eastern part of the permit area. They underly the gently rising plain from MacKenzie River westward to near MacKay Mountains. A tongue of Eocene beds occupies highlands west of MacKay Mountains. The sediments are most frequently exposed in the high barrens near the headwaters of East Fork River and Ration Creek. A profound, angular unconformity separates this unit from all underlying formations.

The Eocene beds consist of a poorly consolidated mass of continental clastic sediments. Exposures show evidence of a high initial dip and rapid deposition. The sediments consist of conglomerate sandstone, and shale. Conglomerate beds contain phenoclasts ranging from cobble to pebble size and often exhibit torrential cross bedding toward the east. Their matrix contains particles ranging in size from clay to coarse sand. Scour and fill structures are common. Sandstones are brownish with poorly sorted grains set in a clayey matrix and are frequently cross-bedded and lensing. The shales are brown to grey, silty,

and very clayey in appearance and many of the finer clastics are carbonaceous. The finer sediments contain numerous plant fossils including silicified tree stumps over a foot in diameter. Lensing lignite seams over three feet thick occur at different horizons. It is difficult to trace a bed in the Eocene sequence due to rapid lateral facies changes. In a general way, the Eocene sediments are gradually coarser grained toward the top of the unit and are finer grained toward the east away from the MacKenzie Mountains. They are over 2000 feet thick near the headwaters of East Fork River.

As their designation implies, these beds are of lower Eocene age. They represent a post orogenic "molasse" type of deposit as a result of "Laramide" uplift of MacKenzie and related mountain systems.

STRUCTURAL GEOLOGY

Sierrita Mountain Front

Only the fringe of the mountain front is represented in the map area. A series of gentle folds exposing Cambrian are present in the extreme southwest part. These are subsidiary to a regional anticline to the east, whose outermost flank forms the mountain front near Gracie Lake and Snake Mountain River. Paleozoic carbonates exposed along this belt form a structural terrace. Some minor folding and also faulting is evident in these strata. This is especially evident in the incompetent middle Sandstone. Farther east, the fine clastics of the Fort Union and Imperial dip more steeply and become somewhat undulous but never actually reversing.

The strata west of Mirror Lake form a portion of the eastern limb of another major structure known as the McDougal anticline.

Sierrita Mountains

These mountains form a north northeast trending spur of MacDougal Mountains. They join the main mountain mass south of permit 1059. The uplift is bounded on the east southeast by a major fault, which at one locality, thrusts Cambrian Saline River beds over those of the Cretaceous Fort Park formation. In general, however, Bonning overlies little lower in the area mapped. Farther south, the throw of the fault decreases so that Cambrian overlies Upper Devonian. This major fault is west dipping and is closer in nature to an up-thrust rather than a true thrust fault. It is interesting to note that the Cretaceous beds in juxtaposition with the fault are also west dipping. The minor flexure toward the south end of the Sierrita is probably caused by the buttress

effect of Summit anticline. Thus the major fault is warped causing a flexure to form on the strata of the hanging wall. The Palaeozoic beds on the upthrown side of the fault are homoclinal in structure. Their gradients are steeper toward the north and where dips range from 40° to a maximum recording of 68° . Dips averaging from 10° to 30° occur in permit 1059. The westerly dips decrease considerably westward of the Paleozoic exposures.

The topographic expression of Gambil Mountains fades rapidly near their northern terminus. The structure may curve and trend northeastward to an area near East Fork River.

Summit Anticline

Summit anticline was mapped mainly by reconnaissance procedures. It is a doubly plunging anticline which is asymmetrical toward the east. Dips on the east limb are variable along, as well as across strike. For the most part, dips of 30° to 40° are evident; however, some overturned strata were observed in the Ramparts and Fort Creek. This overturning may be in part due to local contortion and faulting. Ronning dolomite forms the core of the structure, with the exception of some small outcrops of Cambrian Saline River formation near the apex of the fold.

Summit anticline is diverted from its main trend by the fault on the east side of Gambil Mountains; thus it trends north from its general northwest strike and plunges out near Ration Creek, just east of the Gambil uplift. An alternate hypothesis is that an area east of Gambil Mountains was warped into an anticline as a result of the Gambil fault.

MacKay Mountains

MacKay Mountains are formed by a narrow, sinuous anticlinal uplift exposing rocks as old as Cambrian. The structure is faulted along the crest. The trend of the fold can be easily traced along the western limb by a low ridge formed by upper Ramparts limestone. Dips of these beds vary greatly as suggested by the irregular width of Ramparts outcrop. The strata on the west limb dip from 32° to 56° , but the dip flattens considerably on the outermost flank where Cretaceous sediments are very poorly exposed. Most of the east limb is unexposed owing to faulting; however, near the northeast end of the fold east dipping, nearly vertical poorly bedded Bear Rock can be seen east of flat lying Ronning. A small remnant of Ramparts in the form of a dip slope overlies Bear Rock in a part of this area. Elsewhere on the east side, strata ranging in age from Cambrian to Silurian have been thrust over Cretaceous. A small fault wedge of Cambrian occurs near the culmination of the structure. Elsewhere, Cambrian beds are well exposed along the east side of the structure at the south end. There is an abbreviated Ronning section exposed on the uplift. This may be due in part to a faulted Cambro-Ordovician contact in which part of the Ronning is faulted out. Small cross faults near the south end have tilted a small segment of the west limb.

Plains Areas

A structural basin, which is closed on three sides, is formed in the area between MacKenzie and Gambel Mountains. It is in the form of a large, slightly asymmetrical syncline, which for part of its length,

is steeply north plunging. Beds of the Little Bear formation illustrate these features. On the west side of the axis these strata dip east at an average of 20° while on the east side the average dip is 25° .

A synclinorium is apparent in the northwest part of the permit area. There is little outcrop in the project area to illustrate this feature; however, the broad area underlain by Cretaceous with Palaeozoic strata dipping under the former from both MacKenzie and Franklin Mountains would indicate the presence of a synclinorium with a northwest trending axis.

Eocene beds tend to mask any structural features that may be present beneath them. They have been slightly affected by the latest tectonic movements. In the mapped area, these movements have been in the form of gentle warping. One synclinal warp is evident between Gambil and MacKay Mountains while another may be present between the MacKays and the MacKenzie River.

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APPENDIX

Outcrop Description of Ramparts, Bear Rock, and Ronning Formations, Upper
Little Bear River (Lat 64°26'N, Long 126°26'W)

Ramparts Formation: Overlying beds consist of black bituminous Fort
Creek shales.

- 25' Ls. v/dk. gy. to blk., cryptox. w/occas. scat. f. x'tals.
Wea. lt. brn.-gy. as large lenses w/numerous large bun-
shaped corals, few thin shaley zones 1" thk.
spaced 4' to 6'.
- 57' Ls. mass., fract., dk. gy., cryptox. occas. brachs. & corals..
Numerous buff. wea. wht. calc. veinlets mostly par. to bed.
- 45' Ls. buff wea., mass. in 10' bds, v/dk. gy. cryptox., occas.
crinoid plates, brachs. & gastropods.
- 4' Ls. buff wea. recess. wea. thin bed. from 1" to 4" thk.,
v/dk. gy. cryptox. w/shale partings.
- 39' Ls. buff. wea., v/mass., sl. arg., highly frac., dk. gy.,
cryptox. to microx.
- 18.3' Ls. gy.-brn. wea., med. to thin bed. w/shaley ptings., sl.
nod. app., v/dk. gy. cryptox. to microx. fossiliferous.
- 4.6' Ls. brn. buff. wea. mass. in beds up to 18" thk., blk. wea.,
v/dk. gy. cryptox.
- 21.5' Ls. med. to dk. brn. wea. rubbly wea. recessive dk. gy. cryptox.
w/scat. f. x'tals., arg., sl. foss.
- 9' Ls. dk. gy. to brn. wea., w/dk. gy. thin bed, nodular wea.,
foss. frag.
- 5' Covered Possibly dk. gy. sh.
- 8' Ls. gy. to brn. wea. thin bed. each ½" thk., v/dk. gy. cryptox.,
sl. conchoidal frac., highly foss. mostly brachs.
- 19.3' Covered
- 13.5' Ls. dk. gy. to brn. wea., v/dk. gy., thin bed., nod. wea.
foss. frag.
- 1.3' Ls. mass., dk. brn.-gy. wea., hd., cryptox.-microx.

- 14.2' Covered, essentially, but for 3' Ls. gy. to brn. wea., dk. gy., hd., rubbly wea., in 6" beds.
- 8.2' Ls. buff-gy., mass., highly frac., v/dk. gy., microx., sl. foss.
- 11.5' Ls. buff-gy., wea., thin bed., nodular wea., gy., microx., w/wavey dk. shaley ptings., coralline.
- 22.4' Ls. brn.-gy. wea., mass., med. gy., v/fx-fx
- 5.7' Ls. thin bed. w/numerous shaley ptings, lt. gy., cryptox.
- 7.9' Sh. gy. calc.
- 1.4' Ls. dk. brn.-gy. wea., hd., resistant, dk. gy., microx.-fx.
- 32' Ls. med. to lt. gy., thin bed. in beds up to 2" tkns., w/interbed. highly foss., dk. sh.
- 20.5' Ls. brn. wea., thin bed., dk. gy., cryptox., v/foss. w/interbed. soft, grn., flakey. sh. in beds up to 8" thk.
- 10.7' Ls. lt. brn. wea., mass. to med. bed., gy., microx.-fx., sl. foss., interbed w/sh (10%) as ptings.
- 21.3' Sh. grn.-gy., platey in beds up to 2' thk., interbed. w/thin bed., v/dk. gy., microx., Ls. foss. frag.
- 14.4' Ls. blk., cryptox., mass. bed. in pt. w/interbed gy. shaley Ls. and platey calc. sh.
- 35' Ls. brn.-buff. wea., mass., gy., cryptox.-microx., arg. in pt., knobby wea. in pt. w/occas. thin bed of Ls., dk. gy., crypto., arg.
- 1' Ls. lt. to med. gy., highly frac., slty., w/thin shale bands near base
- 5.5' Sh. lt. to med. gy., highly calc.
- 4.8' Ls. grn.-gy., shaley, cryptox.
- 5' Ls. thin bed., shaley, recessive wea., microx., blk.
- 5.5' Ls. brn. wea., splintery, shaley grn.-gy., cryptox.
- 3' Ls. rusty wea., slabby, grn.-gy. to dk. gy. cryptox., minor cx. toward base.

- 12' Ls., rusty buff wea., mass. to thin bed., recessive toward base, dk. gy. microx. dense., laminated.
- 3.3' Ls., gy. wea., mass. blk. microx., base of Ramparts formation - no evidence of erosion.

Bear Rock Formation:

- 5.6' Dol. lt. gy., microx., w/dk. calc. x'tals, scat. throughout, lam., highly frac., 6" hackly bed of sl. brecciated dol. gy., microx. recessive.
- 67.9' Dol. dk. brn. wea., dk. gy.-brn., microx. to f. x., sl. slty and lam. app. Sl. lighter color toward base w/white. dol. veining down section to brecciation in pt.
- 36.5' Dol. as above, brecciated for most part w/some remaining semblence of bedding.
- 620' Dol., mass., rubbly to hackly wea., hoodoo forming, rusty brn. wea. completely brecciated. med. to dk. brn.-gy., laminated in part microx. to f. x. in frags. varying from less than 1" up to 10' or more in maximum intercept w/white. alum encrustation in lower 200' of unit. Some blocks showing up to 6" strat. thns. grading within few feet into fine breccia. Matrix is of similar lithology to most frags.
- 170' Dol. brecciated aa w/cons. more bedding w/large blocks of undeformed mass. to med. bedded hd. dense.

Ronning Group:

- 46' Covered
- 24.2' Dol. blu.-gy. wea., mass., well bedded, gy. to dk. gy., cryptox., minor microx., hd., dense.
- 12.7' Dol. lt. gy. wea., mass. bed., microx. med. bed., hd., dnse.
- 21.8' Dol. lt. gy. to gy., microx-f.x., dk. gy. wea.,
- 12.5' Covered, essentially w/one exp. of thin bed. dol.
- 30' Dol. mass., brn.-gy. wea., microx.-m.x., lt. to med. pink-gy.
- 77' Dol. buff.-wht., sil., foss.
- 40' Dol. buff dense
- 26' Dol. lt. gy. wea. w/buff & blk. patches, mass., gy. f. x.

- 16' Dol. buff wea., lt. gy to cream, microx.-v/fx., hd., sl. sil. rare irreg. 2" nods of wht. ch.
- 40' Dol. lt. gy. wea., mass. to thin bed., lt. gy., f. x.
- 88' Dol. lt. gy. wea., mostly mass. bed., gy., v/f.-f.x., foss. w/sil. corals w/few ch. wht. irreg. nods. and lenses. sl. brecciated in pt.
- 16' Dol. gy. wea., mass., gy., v.f.-f.x., occas. corals w/large irreg. lenses of cream, microx.-v/f.x. dol.
- 110' Dol. dk. gy. wea., mass. gy. f.x. foss.
- 33' Dol. gy. w/buff patches wea., gy., mass., f.x., large irreg. nods and lenses of ch. lt. gy.
- 82' Dol. lt. gy. to cream wea., gy.-buff, f.-v.f.x. pinkish toward base.
- 183' Dol. gy.-buff wea., m.s., gy., mass., styolitic sl. algal. in pt., band of wht. ch. near base.
- 10' Dol. as above microx. neat top, patchy irreg. lenses of ch.
- 48' Dol. lt. gy. wea., mass. bed., gy. w/vugs., filled w/wht. dol., f.x.
- 80' Covered
- 57' Dol. gy.-buff. wea., gy., m.-c.x. saccaroidal, hd., dense
- 3' Dol. buff wea., cream, m.x., banded w/algal app.
- 44' Dol. buff wea., recess., flaggy., gy., v.f.-f.x.
- 6' Dol. orange-buff wea., buff, c.x.
- 33' Dol. buff wea., lt. gy. to cream w/streaks of med. gy., f.x. w/bands of microx., sl. algal app.
- 23' Dol. buff wea., lt. gy.-cream. v/f.x., sl. arg., dense.
- 11' Dol. buff. wea., thin bed, recess, shaley, lt. gy., v/f.x.
- 123' Dol., lt. gy. buff wea., banded, mass. to thin bed., buff, v/f.x. arg. bands, hd, dnse, w/aporadic wht. calc. veinlets
- 91' Dol. buff. wea., cream to wht., f.x., mass. bed. at top to thinner bed. toward base, arg. bands toward base.
- 40' Dol. as above, med. to thin bed.

35' Del. buff wea., finely banded, med. bed. mostly, cream, v/f.x.,
hd. oolitic band 9" thk. 4' above base.

433' Covered

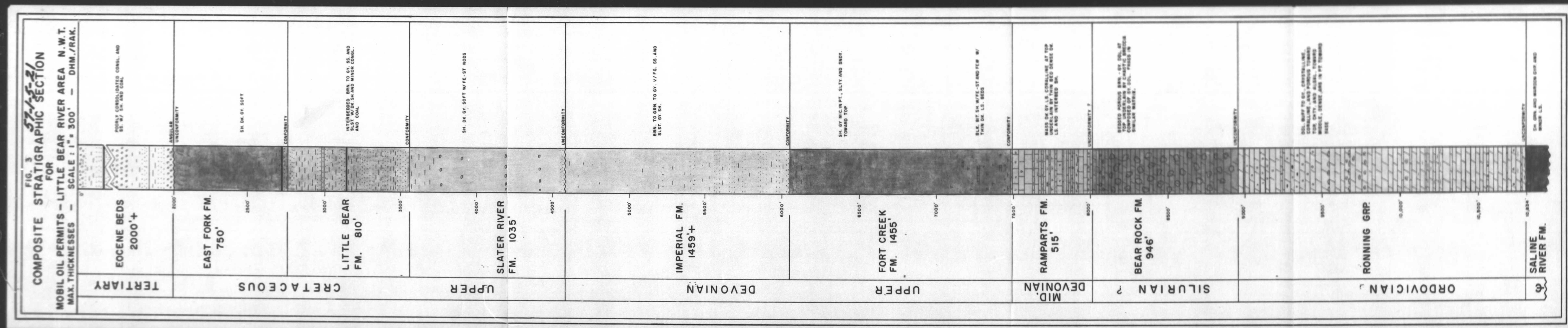
Gypsum, white. & blk. banded. Saline River Formation (Cambrian)

These mountains form a north northeast trending spur of MacKenzie Mountains. They join the main mountain mass south of permit 101. The uplift is bounded on the east southeast by a major fault, which at one locality, thrusts Cambrian Saline River beds over those of the Cretaceous East Fork formation. In general, however, Ronning overlies Little Bear in the area mapped. Farther south, the throw of the fault decreases so that Cambrian overlies Upper Devonian. This major fault west dipping and is closer in nature to an up-thrust rather than a true thrust fault. It is interesting to note that the Cretaceous beds in juxtaposition with the fault are also west dipping. The minor flexure toward the south end of the Gambels is probably caused by the buttress

Summit anticline is diverted from its main trend by the fault on the east side of Gambel Mountains; thus it trends north from its general northwest strike and plunges out near Nation Creek, just east of the Gambel uplift. An alternate hypothesis is that an area east of Gambel Mountains was warped into an anticline as a result of the Gambel fault.

Flaine Area

A structural basin, which is closed on three sides, is formed in the area between MacKenzie and Gribil Mountains. It is in the form of a large, slightly asymmetrical syncline, which for part of its length

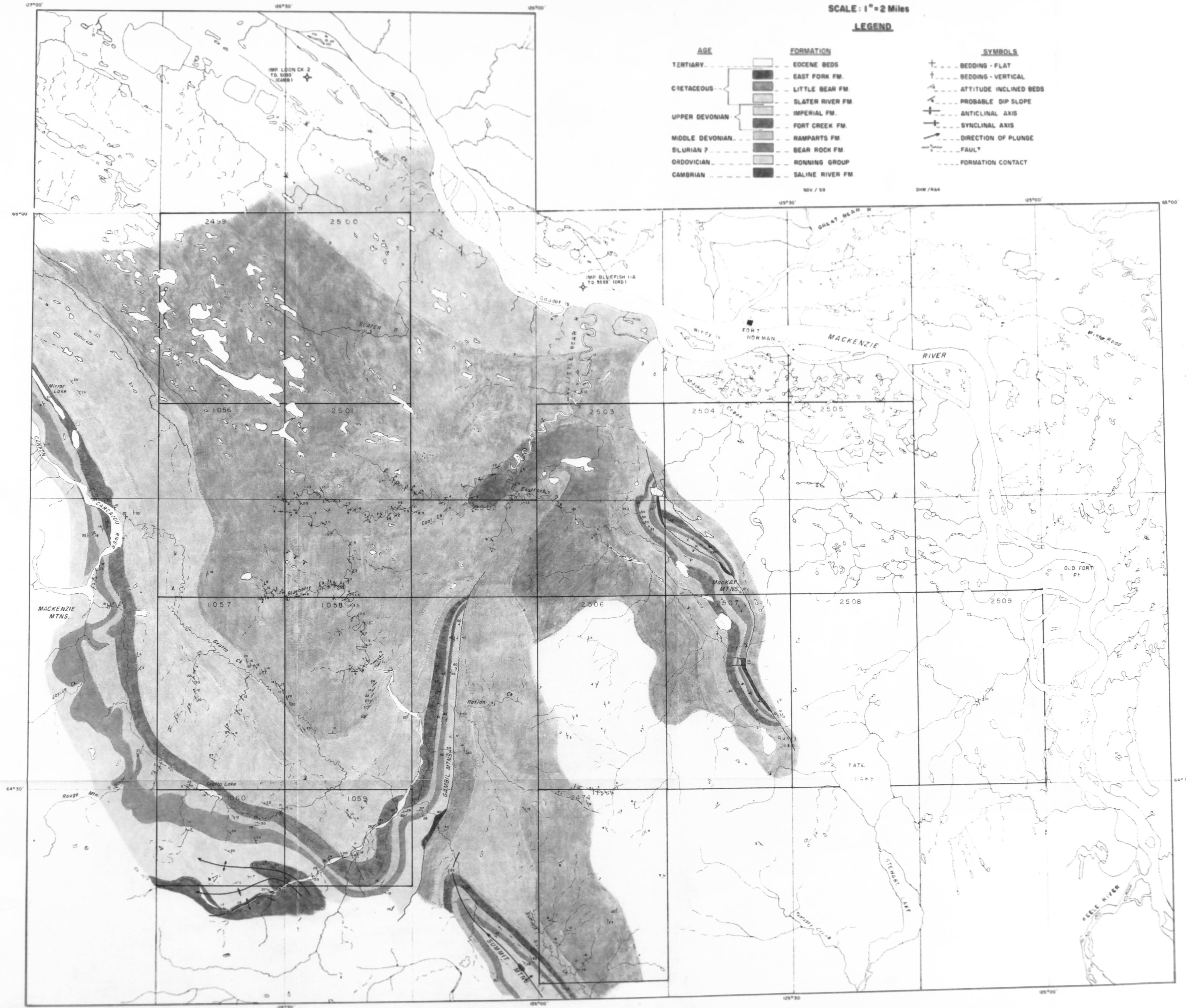


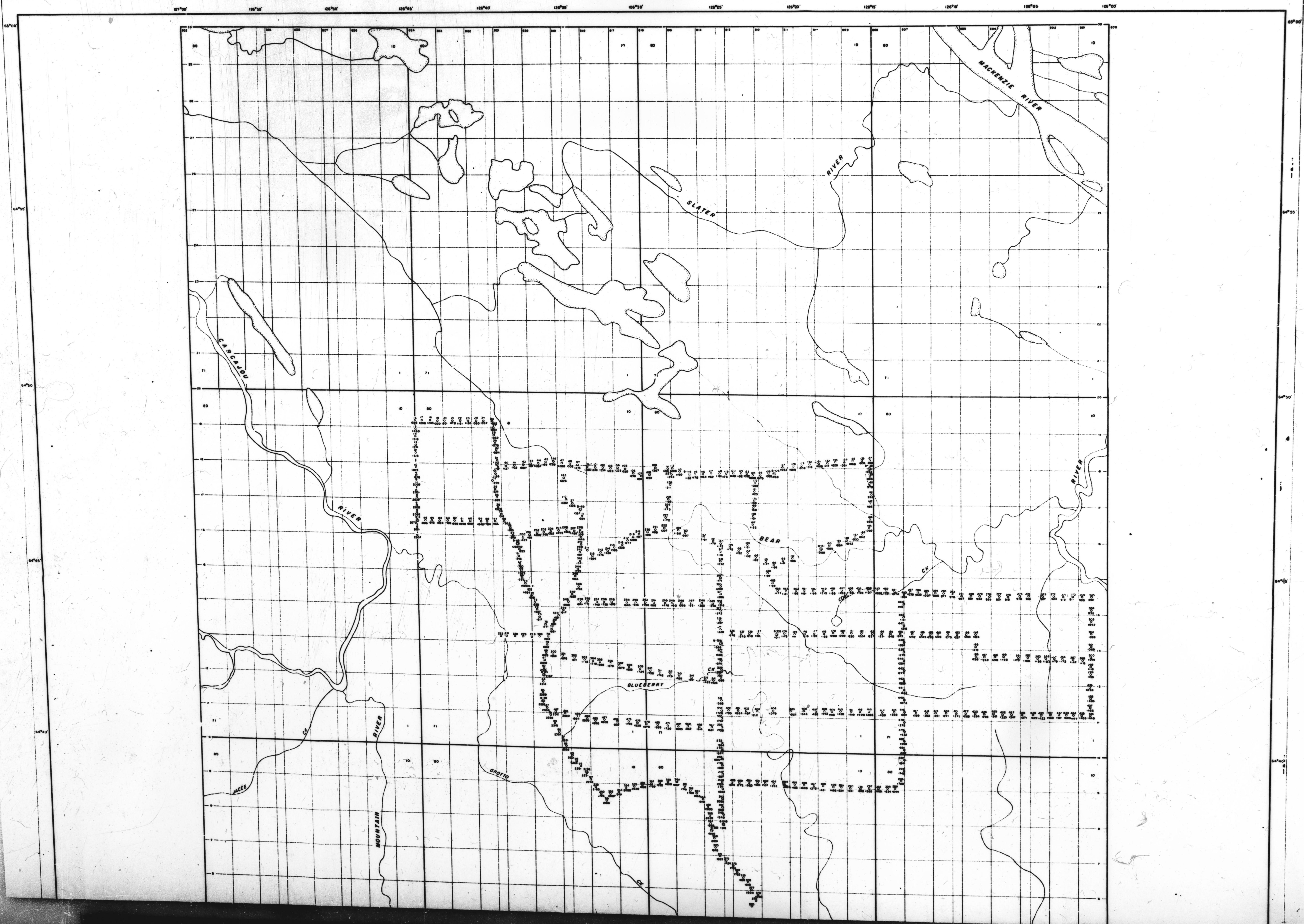
MAP 1 57-1-5-21
SURFACE GEOLOGICAL MAP
 OF
MOBIL OIL PERMITS-LITTLE BEAR RIVER AREA, N.W.T.

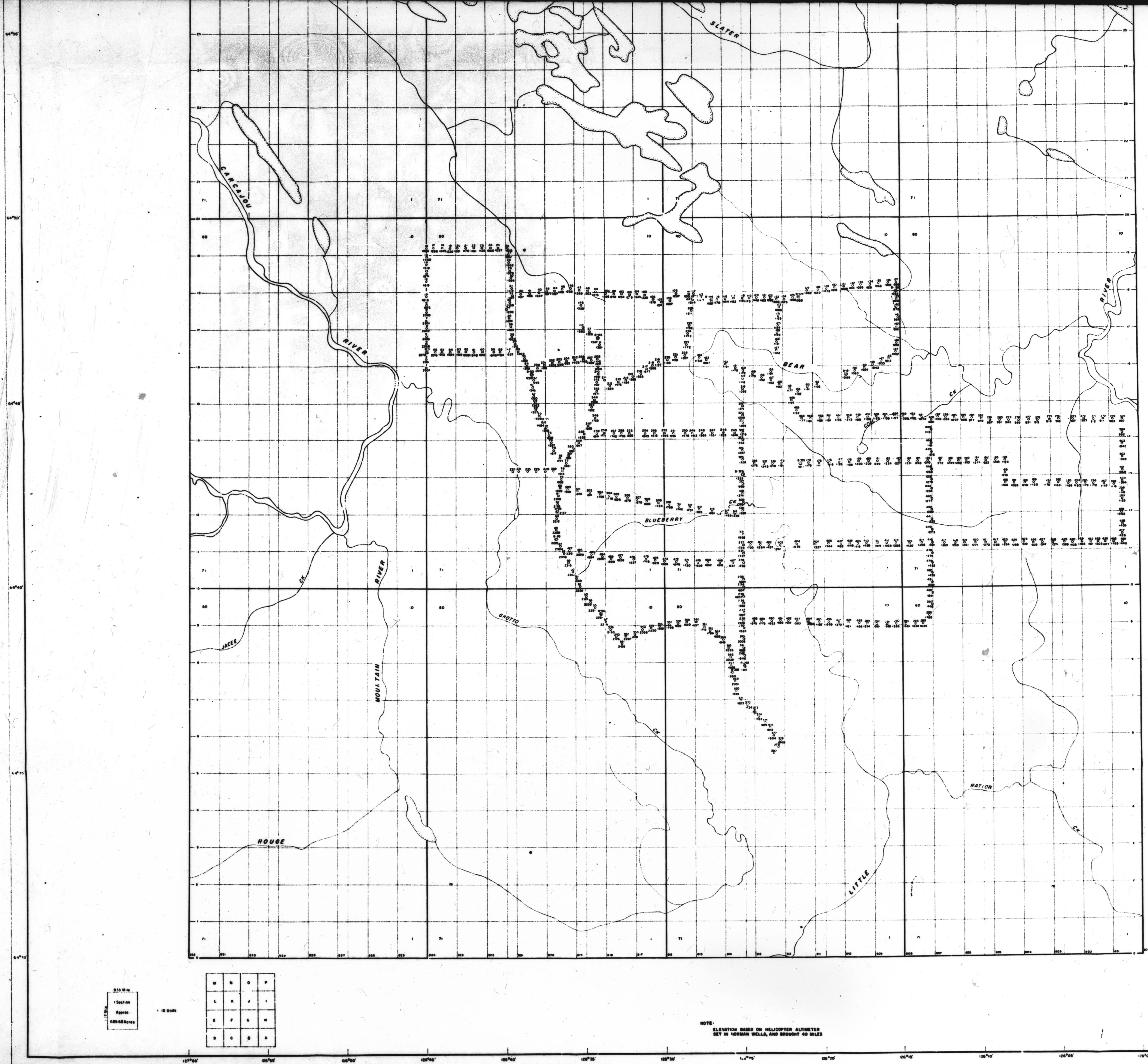
SCALE: 1" = 2 Miles

LEGEND

AGE	FORMATION	SYMBOLS
TERTIARY	EOCENE BEDS	— BEDDING - FLAT
	EAST FORK FM.	— BEDDING - VERTICAL
CRETACEOUS	LITTLE BEAR FM.	— ATTITUDE INCLINED BEDS
	SLATER RIVER FM.	— PROBABLE DIP SLOPE
	IMPERIAL FM.	— ANTICLINAL AXIS
UPPER DEVONIAN	FORT CREEK FM.	— SYNCLINAL AXIS
MIDDLE DEVONIAN	RAMPARTS FM.	— DIRECTION OF PLUNGE
SLURIAN ?	BEAR ROCK FM.	— FAULT
ORDOVICIAN	RONNING GROUP	— FORMATION CONTACT
CAMBRIAN	SALINE RIVER FM.	







250 Miles
 1 Section
 Approx.
 6400 Acres

M	N	O	P
L	K	J	I
E	F	G	H
D	C	B	A

NOTE:
 ELEVATION BASED ON HELICOPTER ALTIMETER
 SET IN 'ORMAN WELLS, AND BROUGHT 40 MILES



MOBIL OIL OF CANADA, LTD.
 CALGARY (B.C. District - N.W.T.) ALBERTA
 GRAVITY METER SURVEY
 FORT NORMAN AREA
 N.W.T. (CARCAJOU RIVER) SHEET
 ELEVATION MAP
 57-8-5-22
 SCALE 1 IN = 1 MI
 GEOPHYSICAL ASSOCIATES OF CANADA LTD.
 27 NOV 1959