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STRATIGRAPHIC SECTIONS

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-4	East Mountain	in pocket
-6	Imperial River	in pocket
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SURFACE GEOLOGY OF THE NORMAN WELLS AREA

INTRODUCTION

Present Study

Description of Area - The Norman Wells area (Fig. 1) extends from Latitude $64^{\circ}30'$ near Fort Norman to Latitude $66^{\circ}30'$ near Fort Good Hope and includes all the Franklin Mountains, the Mackenzie Plain and the eastern edge of the Mackenzie Mountains between Longitude $125^{\circ}00'$ and Longitude $130^{\circ}00'$. This area comprises some 13,000 square miles.

Method of Study - Imperial Oil Party P.R. 2-59 was given a six-week assignment to conduct a brief structural investigation of the Company's acreage holdings in the Norman Wells area and to perform a stratigraphic study of the Middle Devonian. The seven-man geological crew, based at Norman Wells and equipped with a Bell G-2 helicopter, devoted the period from June 2nd to July 12th, 1959, to field work. The operations are summarized under the following headings:

Weather - Exceptionally good weather conditions greatly facilitated field work. The long daylight hours allowed time to be made up for any time lost due to showers and low clouds. The main limiting factor in operations was pilot-fatigue. Two days off were taken for this reason and part of another day was lost when the machine was commandeered for forest fire fighting services.

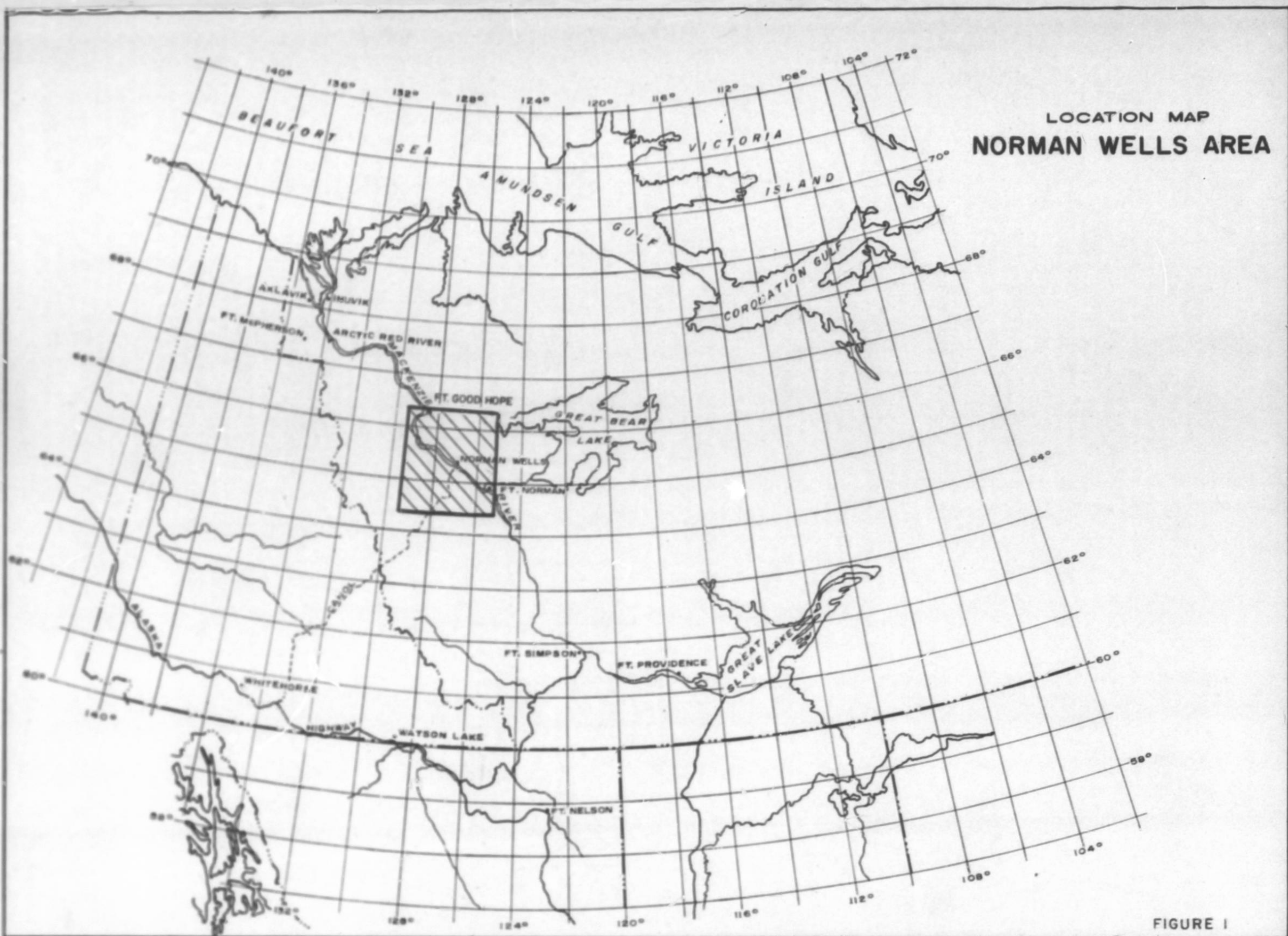


FIGURE 1

Transportation - The field party was moved from Dawson Creek to Norman Wells in two trips with a Company DC-3. All geological field and office equipment and food supplies for fly camps were also transported at this time.

Base Camp - The crew was housed and fed in the Imperial Oil quarters at Norman Wells. A combination of a ready gas supply, good communications and comfortable living quarters made this an ideal base for operations. Arrangements for accommodations should be made well in advance of arrival at Norman Wells.

Communications - Communications with the Dawson Creek office were maintained through the Department of Transport telegraph service from Norman Wells. This service was entirely satisfactory.

A 60-watt Kaar radio was used as the base camp radio and small 10-watt sets were available for the fly camps. All these radios, as well as the helicopter set, were equipped with the Company's frequency of 5435 Kc.

Radio communications was unsatisfactory due to malfunctioning of the base radio.

Crew - The geological crew consisted of the following personnel:

R. A. Meneley	Party Chief
M. Mazurkewich	Assistant Party Chief
B. J. G. Patsch	Senior Assistant
H. R. Balkwill	Senior Assistant
G. A. Caklos	Junior Assistant
D. A. Coulombe	"
D. Cowling	"

A Bell G-2 helicopter was supplied by Okanagan
Helicopters Ltd. of Vancouver:

E. Phillips	Pilot
A. Johnson	Engineer

The geological crew was divided into three sub-crews of two men each who were engaged solely with measuring stratigraphic sections, while observations on structure and stratigraphy at traverse stations were made by the Party Chief.

Fly camps were used on all stratigraphic sections. The general practice of operation was to rotate the sub-crews so that two fly camps were out at all times with the third sub-crew in base camp where they compiled the field data from the sections which they had measured. This system worked well during the long period of exceptionally good weather. The only limiting factor was the stamina of the pilot (184 hours were flown in the six-week period, averaging 4.6 hours per day).

Measurement and Sampling - A variety of measuring techniques were used, the choice depending on the type of outcrop exposure which existing. Pogo-stick, tape and brunton, and plane-table surveying were each used.

A light rubber dingy was a valuable asset in measuring sections along streams. Both the Mountain River and the Imperial River were traversed in this manner. Automatically inflating life jackets were worn on such occasions.

The exposure of sections in this area was quite variable. Excellent sections were found along the Mackenzie Mountains while further to the east less ideal conditions prevailed.

A consistent sample interval of 10 feet was maintained. Ideally, one rock chip was taken from each five foot interval. Lithologic breaks within the 10 foot interval were noted in the field descriptions. In pre-Devonian sections the sample interval was increased to 50 feet.

Accessibility - Norman Wells can be reached by air throughout the year, and in the summer months, June to October, by water as well. The Department of Transport maintains a gravelled airstrip which is long enough for four-engine propeller driven planes. Pacific Western Airlines operate a bi-weekly scheduled flight from Edmonton.

The Mackenzie River forms the chief artery of transportation by which the bulk of the yearly supplies reach

Norman Wells and other communities along the river, and by which products of the Norman Wells refinery are distributed to the consumers. Freight reaches the Mackenzie water system from Edmonton by Northern Alberta Railways at its terminal at Waterways. From there it is carried by barges via Athabasca River, Lake Athabasca and Slave River to Ft. Fitzgerald, Alberta, where a 16 mile portage by road is necessary to by-pass rapids. At Ft. Smith, N.W.T., the northern end of the portage, the freight is put onto shallow draught diesel-powered barges to continue its descent of the Slave River to Great Slave Lake and thence the Mackenzie River which is navigable to the Arctic Ocean.

Since 1948, much freight reached the Mackenzie water system through Hay River on Great Slave Lake, which is the terminus of the all-weather Mackenzie Highway. Goods can be shipped more quickly by this route.

Previous Investigations

Pre-Canol Surveys - Oil was discovered at Norman Wells in 1920. As a result of the interest in the Mackenzie River area which this discovery aroused, the Federal Government was requested for geological and geographic information about this hitherto virtually unknown part of the country. The response was the publication of the Geological Survey Memoir 108, the Mackenzie River Basin, by Cammell and Malcolm. The Memoir

summarizes information as then known. It gives an account of the early explorations, most of which were geographic in nature but also make some references to geology. Some accurate mapping, mostly of the principal waterways, was done.

Geological work was done by Kindle, Bosworth, Williams, Dowling and Hume in the years 1920 - 1927 and data which was collected is published in the Geological Survey Summary Reports for these years.

It was not until the outbreak of World War II that interest in the region was renewed. Very quickly the hitherto unmapped areas were photographed by the Royal Canadian and United States Air Forces and good maps were produced both for use in air navigation and also for the revived interest in the region's oil possibilities.

Canol Project - The Norman Wells oil field assumed strategic importance as the result of the war. In 1942, the wartime Canol Project was initiated for the development of the oil field, the building of a 600-mile pipeline to Whitehorse and the construction of a refinery at Whitehorse. Also, as part of the Canol Agreement, extensive geological investigations were carried out under the direction of Dr. T. A. Link and with the co-operation of Imperial Oil and the Canadian and United States Governments. This geological work was undertaken under great transportation difficulties and mostly took the form of traverses up the major tributaries of the Mackenzie River. Hume (1954) lists the various Canol reports dealing with the project area.

Post-Canol Surveys - Since the end of the war, and especially in recent years, geological surface crews of many oil companies have undertaken studies in the Norman Wells and adjacent areas. Among these were parties from Imperial Oil, British American, Mobil, Texaco, California Standard, Shell and Sproule, and no doubt, others.

STRATIGRAPHY

General Remarks - Sediments ranging in age from Precambrian to Quaternary make up the estimated 15,000 feet of sedimentary section which is found in the Norman Wells area. The stratigraphic column is by no means complete, erosion and non-deposition have created great gaps in the stratigraphic succession.

Table I gives a summary of the stratigraphic terminology as used in this area.

The accompanying surface geological map shows where the various formations appear in outcrop. Since much of the surface mapping was done from the air, certain similar appearing formations were grouped, e.g., the upper, bedded part of the Bear Rock formation differs little from the thick-bedded limestone of the overlying Hume formation and hence the two were combined as the Bhbr map unit. Also, the clastics of the Imperial formation are included with those of the Cretaceous in the KDu map unit.

Proterozoic - No Proterozoic rocks were encountered in the report area, however, slaty shale, phyllite, quartzite and dolomite have been reported in the Backbone Ranges of the Mackenzie Mountains, and Bell (1959) measured over 1600 feet of variegated Precambrian shales on Cap Mountain in the McConnell Range of the Franklin Mountains.

TABLE I

TABLE OF FORMATIONS

	System	Formation or Group		Lithology
Cenozoic	Quaternary			soil, till, alluvium
	Tertiary	Erosional Unconformity 1600'-3000'		poorly consolidated sediments and lignite
		Angular Unconformity		
Mesozoic	Cretaceous	East Fork 850'		Grey shale
		Little Bear 780'		sandy series, sandstone, sandy shale with coal
		Slater River 2150'		black, friable shale, thin beds of bentonite
		Sans Sault -3850'		marine sandstone and shale
		Erosional Unconformity		
Paleozoic	Upper Devonian	Imperial -2000'		Greenish fine grained sandstone, siltstone and silty shale
	Middle Devonian	Fort Creek Group	Canol	dark grey bituminous shale
			Kee Scarp	reef limestone, coral, stromatoporoid, many bryozoan fragments
			Hare Indian	grey, slightly calcareous shale
			Hume 400'	upper massive limestone, middle interbedded limestone and shale, lower limestone
	Lower Devonian	Bear Rock 400'-1200'		brecciated dolomite, some limestone gypsum and anhydrite
	Ordovician and Silurian	Erosional Unconformity		
		Ronning Group 2200'		dolomite, grey, fine crystalline silicified fossil zones
	Middle Cambrian	Erosional Unconformity		
		MacDougal Group	Saline River	gypsiferous shale
			Mount Cap	dark petroliferous shale
			Dodo Mountain	nodular red limestone
			Katherine Group	
Lower Cambrian	Mount Clark +1000		orthoquartzite	
Proterozoic	Pre-Cambrian	Erosional Unconformity		
				variable, sandstone, shale, dolomite, metamorphosed

Cambrian - Cambrian strata were measured at the Mountain River and Imperial River sections. The enclosed graphic logs contain thicknesses and lithologic descriptions. Other Cambrian outcrops were described by Canol geologists from the Mackenzie Mountain front and by Bell (1959) from the Franklin Mountains south of the report area.

A generalized breakdown for the Cambrian of the area is given in the Table of Formations.

The lowermost Cambrian rocks to underly the report area are orthoquartzites of the Mt. Clark formation. The thickness of this formation in the Mackenzie Plains area is about 1000 feet.

Middle Cambrian rocks are predominantly red and green shales in the outcrop area. The greatest thickness, in excess of 3000', occurs in the subsurface of the Mackenzie Plains mainly due to the thick salt section of the Saline River formation, which is thin or absent in the outcrops.

During the Upper Cambrian uplift and erosion, Cambrian rocks were removed from the Peel River area and parts of the Middle Cambrian section were stripped from the western Mackenzie Mountains.

Ordovician and Silurian - Both Ordovician and Silurian fossil zones have been found in a thick dolomite sequence which is known as the Ronning group. Deposition of this sequence must have been continuous as there is no break at the Ordovician-Silurian boundary. Rocks of the

Ronning Group outcrop in Franklin and Mackenzie Mountains. They consist of massive, well-bedded, cliff-forming grey dolomite, grey and buff weathering, fine to microcrystalline with some quartz silt, and some silicified fossil zones. An abrupt morphological break occurs at the base of the Ronning. The upper surface of the Ronning is the pre-Devonian erosion surface.

DEVONIAN

Miscorrelation of the Devonian stratigraphic units by early workers in the Norman Wells area gave rise to a great deal of confusion which especially concerned the terms Ramparts and Beavertail formations. For this reason, Bassett (1960) proposed the dropping of the above two names and the use of the following terminology:

<u>Upper Devonian</u>		<u>Imperial Formation</u>
Middle Devonian	Fort	Canol Formation
	Creek	Kee Scarp Formation
	Group	Hare Indian Formation
		Hume Formation
<u>Lower Devonian</u>		<u>Bear Rock Formation</u>
<u>Silurian</u>		

Bear Rock Formation - Bear Rock formation is the name which was given to a brecciated and unbedded dolomite sequence which outcrops at the type-section at Bear Rock, just north of Fort Norman. The Bear Rock formation was deposited on the eroded surface of the Ronning Group. The contact is sharp and channeling is evident in some sections.

Outcrops of the Bear Rock formation form a characteristic recessive topography marked by hoodoo weathering and sink holes. Lithologically the Bear Rock consists of a brown and grey, very fine crystalline, brecciated dolomite.

The fragments range from gravel size to angular blocks several feet across which are surrounded by a matrix of similar appearing dolomite with abundant calcite cement. The breccia often has considerable vuggy porosity, the vugs at times reaching cavernous size. Minor amounts of gypsum and anhydrite have been reported from some outcrops in the Franklin Mountains. In places there is considerable bituminous material in the vugs and the rocks often emit a strong petroliferous odour.

In subsurface, as reported from wells drilled as part of the Cazol project, the Bear Rock formation consists to a large extent of evaporites which are mostly grey, massive, anhydrite with interbeds of dolomite.

The upper part of the Bear Rock is more often a dolomitic limestone with vague to fair bedding. As the Bear Rock is overlain by well-bedded limestones of the Hume formation, the contact between the two is rarely well-defined.

The Bear Rock underlies the entire report area. The eastern extent of the formation in the Interior Plains area is not known. Along the Mackenzie River to the south, the characteristic brecciated facies has been recognized in the Franklin Mountains as far south as Willowlake River.

The Bear Rock formation is now considered to be no older than Lower Devonian although in the past some writers have considered it to be Silurian in age. Bassett (1960) reported

that the basal 2,000 feet of a 6,500 foot Devonian section on the upper Redstone River contained a Lower Devonian fauna and he implied that this was an age equivalent of the Bear Rock. On the basis of the implied Lower Devonian age, the unconformable Ronning-Bear Rock contact, and the gradational contact with the overlying Hume formation of definite Middle Devonian age, we may now consider that the Bear Rock is no older than Lower Devonian.

Some Carol geologists considered the Bear Rock formation as a primary breccia (Laudon (1943) described it as a fanglomerate) and Stelek (1943) lists the following criteria as proof for its primary nature: (1) the uppermost beds of the Ronning are of a composition similar to boulders in the Bear Rock; (2) relief on the upper surface of the Ronning, and (3) rapid variations in the Bear Rock thickness. Laudon (1943) considered the formation to be a fanglomerate. The concept of a primary breccia has, however, become discredited. It is rather thought that the Bear Rock formation was deposited as an evaporitic sequence and that subsequent leaching of the evaporites caused the collapse and brecciation of interbedded dolomite strata. In Carcajou Canyon, some brecciation has been reported in the overlying Hume limestone which laterally grades into well bedded limestone (Hume, 1954). This had at one time been misinterpreted as an unconformity between the Hume and Bear Rock formation. Newly interpreted, however, it shows that

Bear Rock brecciation must have taken place after the deposition of the Hume formation and the brecciation extended into the Hume by a process of stoping.

The Bear Rock formation forms potential reservoir beds in the Norman Wells area. Leached porosity, often of cavernous size, has been seen and is reported from most sections. This, together with the frequent occurrence of bitumen, oil staining, petroliferous odour, and its covering by shaly Hume limestone make this a formation to be watched in drilling operations.

Hume Formation - The Hume formation, as defined by Bassett (1960) is an easily correlated unit which overlies the Bear Rock formation and underlies the shales of the Hare Indian formation. In outcrop sections, the Hume has a distinctive morphologic breakdown. The upper unit is a very massive and resistant ridge forming limestone. The lower part consists of interbedded argillaceous limestone and shale, less resistant and more recessive weathering. In certain sections the base is again thick bedded and grades into the bedded upper part of the Bear Rock. Variations in thickness of the Hume formation are very gradual.

Hare Indian Formation - The Hare Indian formation is defined as the shale sequence above the Hume formation and below the Kee Scarp where it is present. Where the Kee Scarp is absent the Hare Indian and the Canol formations combine to form the Fort Creek group. The lower contact is abrupt but

conformable, while the upper contact is gradational through a sequence of interbedded bituminous limestone and calcareous shale below the Kee Scarp. Over most of the area the formation consists of shale, dark grey, platy to fissile, slightly silty in part, bituminous in part and slightly calcareous in part. In the northern part of the area the shale grades to an argillaceous limestone. Thickness of the Hare Indian increases from around 200 feet at Little Bear River to over 700 feet at East Mountain.

Kee Scarp - Economically, the Kee Scarp is the most interesting formation in the report area, since the Norman Wells oil production comes from it. The formation gets its name from the Kee Scarp where it outcrops a few miles east of Norman Wells in the Discovery Range.

Lithologically, the formation is a reef limestone, brown grey weathering, massive bedded, consisting of bioclastic fragments derived from corals and stromatoporoids with a fine argillaceous limestone matrix which often is oil stained and in part becomes solid bitumen. Varying porosity was observed in outcrop sections, ranging from mostly tight to poor matrix porosity to coarse vuggy porosity.

The Kee Scarp has been eroded and partially eroded in many outcrop sections, so that observed thicknesses vary considerably. Hume (1954) lists and summarizes thicknesses and descriptions of many of the outcrop and some well sections studied by Canol geologists.

Canol Formation - Bassett (1960) defined the Canol formation as the bituminous shale unit which overlies the Kee Scarp. Here the contact is sharp and conformable. In areas where the Kee Scarp is not present, the Canol formation overlies the Hare Indian shale with which the contact is more or less gradational, and often it is difficult to pick the contact. The Canol shale is dark grey, bituminous, blocky and resistant and contains some large calcareous concretions. This formation is of widespread extent, and Bassett (1960) mentions that it can be recognized as far south as the Nahanni area. The thickness varies between sections but is in the order of two hundred feet.

The bituminous nature of the Canol, and of part of the Hare Indian, which two completely enclose the Kee Scarp reef, make this triplet of Middle Devonian formations an economically important combination of source rock and possible reservoir.

Imperial Formation - The Imperial formation of Upper Devonian age has its type section on the northern flank of the Imperial Mountain range on the Imperial River, 10 miles southwest of its junction with the Carcajou River. The formation is a clastic sequence consisting of sandstone, siltstone and shale, with an increasing gradation of grain size from the bottom up. Only the lower parts of the formation

were studied. Canol geologists reported thicknesses up to nearly 2,000 feet. The rocks usually show a greenish coloration in the sands and silts and medium grey shales. Both marine fossils and carbonaceous plant material have been found in this formation.

CRETACEOUS

A period of folding and erosion existed between the deposition of the Imperial formation and the overlying Cretaceous which was deposited during a major marine transgression. In places, e.g., the MacKay Mountains in the south and the Ramparts in the north, the entire Imperial formation and parts of the Fort Creek Group have been removed. Bell (1959) also refers to great variations in thickness in the Imperial.

With the exception of a few traverse observations, no Cretaceous beds were examined in the field.

The Cretaceous has been subdivided by Stewart (1945) and his terminology has now been adopted.

The following is summarized from Hume (1954):

Sans Sault Formation - The Sans Sault formation rests disconformably on Devonian strata and includes the sequence of marine shales and sandstones up to the first bentonitic bed. The greatest thickness measured, 3,850 feet, occurs in the Imperial Range where the Mountain River crosses the range.

Slater River Formation - The Slater River formation overlies the Sans Sault formation and consists of thin bedded, black, friable, shale with some sulphur and alum and characteristically thin beds of bentonite. Bell (1959) measured a 100-foot thick section of this formation.

Little Bear Formation - The Little Bear formation refers to a sandy series lying above the shales of the Slater River formation. At the type section on Little Bear River, 780 feet of sandstone, minor conglomerate, sandy shale and coal exist. Marine, brackish and fresh water fossils have been found.

East Fork Formation - The East Fork formation consists at its type section on the east fork of Little Bear River of a series of about 850 feet of well bedded, grey, conchoidal and plastic marine shales with minor sands at the base. The formation is not known to occur north of the Little Bear River.

TERTIARY

Tertiary beds are found in the Fort Norman area. They consist of thick sands and gravels interbedded with soft clays and shale and lignite seams. The Tertiary covers Cretaceous beds with an angular unconformity. Bell (1959) reports estimated thicknesses up to 3,000 feet.

QUATERNARY

Recent sediments are found in many places on the Mackenzie Plains area. They occur as rock pediments along fault scarps and steep folds of the various mountain fronts, as alluvial fans where rivers issue from the mountains and as valley alluvium along the braided streams on the plains. Many of the islands in the Mackenzie River also consist of recent sands and silts.

STRUCTURAL GEOLOGY

Traversing the Norman Wells area from east to west, one crosses the three structural provinces which make up the area. The Franklin Mountains, here represented by the Discovery Range, form the first mountain chain to rise above the Interior Plains. Next comes the low lying Mackenzie Plain, a long broad valley, from which the Canyon Ranges of the Mackenzie Mountains abruptly rise.

The Mackenzie Plain is an elongate structural basin, about 30 miles wide, morphologically it is an area of relatively low elevation and relief. Several anticlines are superimposed on this synclinal basin; the largest of these anticlines forms the Imperial Mountains where erosion has exposed some older Palaeozoic rocks. The remainder of the plain is underlain by Cretaceous and some Quaternary sediments as well as some Tertiary in the Fort Norman area. To the south, the basin is closed by the Gambill and MacKay Mountains while to the north it broadens and joins the Interior Plains area.

To the west, the gently folded strata of the broad Mackenzie Plains basin abruptly curve upward as the MacDougall anticline to form the mountain front of the Canyon Ranges of the Mackenzie Mountains. Folding rather than faulting characterises the Mackenzie Mountains. In the very broad folds

and resulting high plateau areas of the Canyon Ranges early Palaeozoic rocks are well exposed in several deeply incised river canyons.

In contrast, the rising Palaeozoic rocks on the eastern side of the Mackenzie Plains syncline form a number of fault scarp ridges facing northeast. These faults are due to the overthrusting of anticlines. The direction of overthrusting is not constant along strike and may change from one flank of the structure to the other as it does in the west dipping thrust on Discovery Range which laterally passes through an anticline to an east dipping thrust on Cleaver Mountain.

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LITHOPERCENTAGE LOG
OF OUTCROP SECTION

STATION NO. P.B. 15-58-7
GRANT CREEK

LOCATION: L.S.D. SEC. TWP. RSE. W. M.
UNIT ZONE N.T.S.
SEC. LAT. N. LONG. W. LONG. 47°

Description of location: Grant Creek, near mouth of
Grant Creek.

ELEVATION MEASURED METHOD Tape and Brunton

FORMATIONS

TO ACCOMPANY REPORT

Surface Geology of the Norman Wells Area

BY: R. A. MURPHY

DATE: 1960

DESCRIBED

BY: R. A. Rudkin

DATE: August 1958

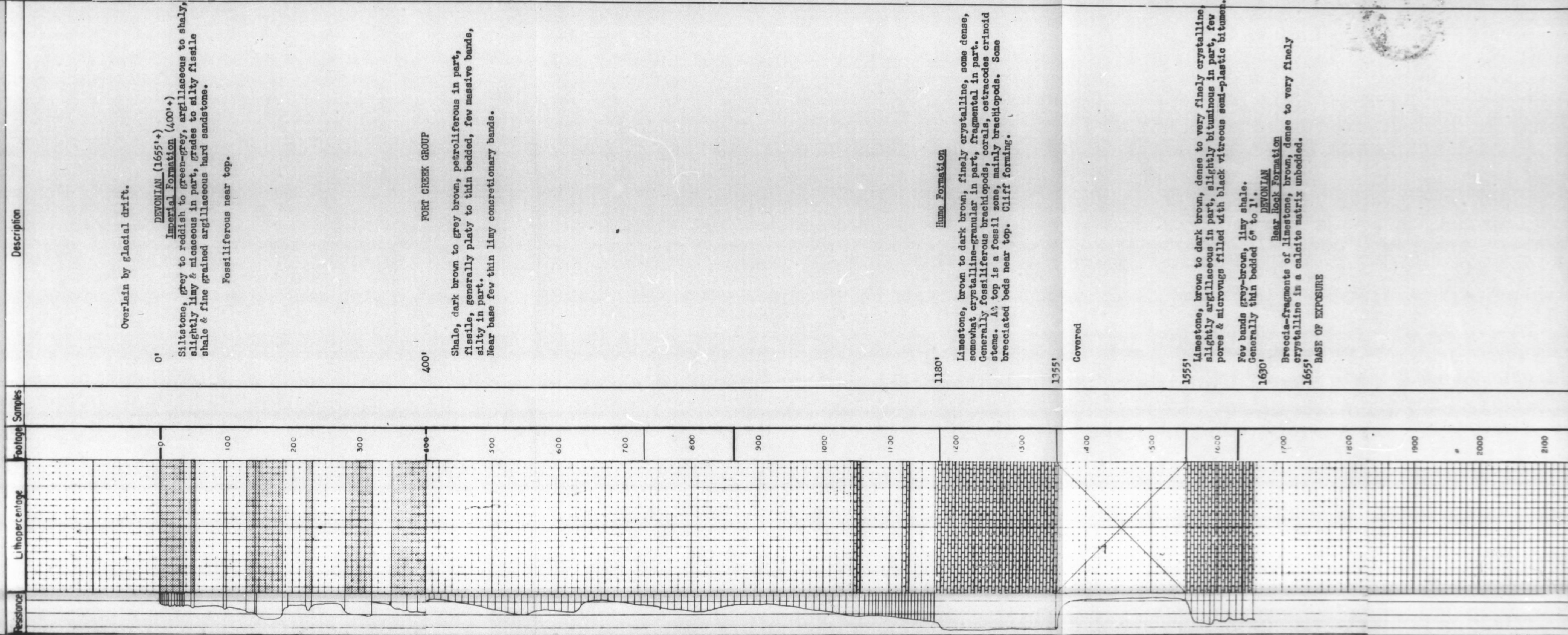
LEGEND

- Coal
- Salt
- Anhydrite
- Dolomite
- Limestone
- Massive Chert
- Conglomerate
- Sandstone
- Siltstone
- Shale

IMPERIAL OIL LIMITED

EXPLORATION DEPARTMENT

PEACE RIVER DISTRICT



LITHOPERCENTAGE LOG
OF OUTCROP SECTION

STATION NO. P.R. 2-59-2 & 3
GATSA RIVER

LOCATION: L.S.D. SEC. TWP. RGE. UNIT ZONE N.T.S. LONG. LAT. 66° 30' 129° 00'

Description of location: Measured near the junction of the Gaysa and the Mountain Rivers.

ELEVATION MEASURED METHOD



TO ACCOMPANY REPORT

Surface Geology of the Norman Wells Area

BY: R. A. MEHELEY

DATE: 1960

BY: M. Masurkovich

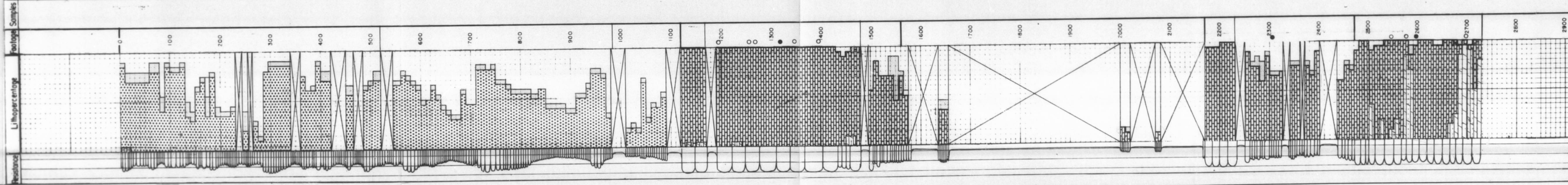
DATE: June 1959

DESCRIBED

LEGEND

Coal Salt Anhydrite Dolomite Limestone Massive Chert Conglomerate Sandstone Siltstone Shale

IMPERIAL OIL LIMITED EXPLORATION DEPARTMENT PEACE RIVER DISTRICT



Feet	Lithopercantage	Feet	Description
0		0	Sand Member Imperial Formation (1120'±) Sandstone interbedded with and grading to very sandy shale, protoquartzite, gray green, weathering grey buff, flaggy to platy, grades to siltstone in part.
520		520	Interval between 545' and 1120' was measured and sparsely sampled and briefly examined, very similar to section above, resistant sandstones with low weathering shales inbetween.
985		985	Shale Member Shale, greenish grey, trace calcareous, grading to very fine grained silty sandstone in part.
1120		1120	FORT CREEK GROUP
1170		1170	Inaccessible P.R. 2-59-2
1480		1480	Limestone, skeletal to skeletal micritic, argillaceous and silty in part, shale partings, abundant corals and coral debris, 20% pyrobitumen, diagnostic earthy appearance, thin to thick bedded.
1600		1600	Shale, interbedded with micritic limestone, silty with scattered very fine sand grains.
1700		1700	Concealed, probably shale as below
2000		2000	Shale, grey green, calcareous, trace silty, soft, fissile to platy.
2100		2100	Concealed.
2170		2170	Hume Formation (300') Limestone micritic skeletal, skeletal in part fossiliferous massive.
2230		2230	Limestone, mostly skeletal to skeletal micritic, argillaceous with shale partings, the limestone is nodular and the nodules are surrounded by shale, very rubbly weathering, very fossiliferous.
2470		2470	Beaver Rock Formation (265'±) Limestone, pelletal to micritic, very fine to coarse pellets, well rounded, some calcite cement, massive.
2600		2600	Dolomite, microcrystalline, sugary on fresh surface, slightly calcareous, massive, porous.
2700		2700	Limestone, mostly pelletal, massive.
2730		2730	Dolomite, microcrystalline to coarse crystalline in part, slightly calcareous, massive.
2800		2800	END SECTION
2900		2900	

LITHOPERCENTAGE LOG
OF OUTCROP SECTION

STATION NO. P.R. 15-58-7
GROTTA CREEK

LOCATION: LSD. SEC. TWP. RGE. W. M.
UNIT ZONE N.T.S.
SEC. LAT. N. LONG. N. 126° 47'

Description of location: Carajou River near mouth of
Grotto Creek.

ELEVATION MEASURED METHOD Tape and Brunton

FORMATIONS

TO ACCOMPANY REPORT

Surface Geology of the Norman Wells Area

BY: R. A. MEYER

DATE: 1960

DESCRIBED

BY: R. A. Rudkin

DATE: August 1958

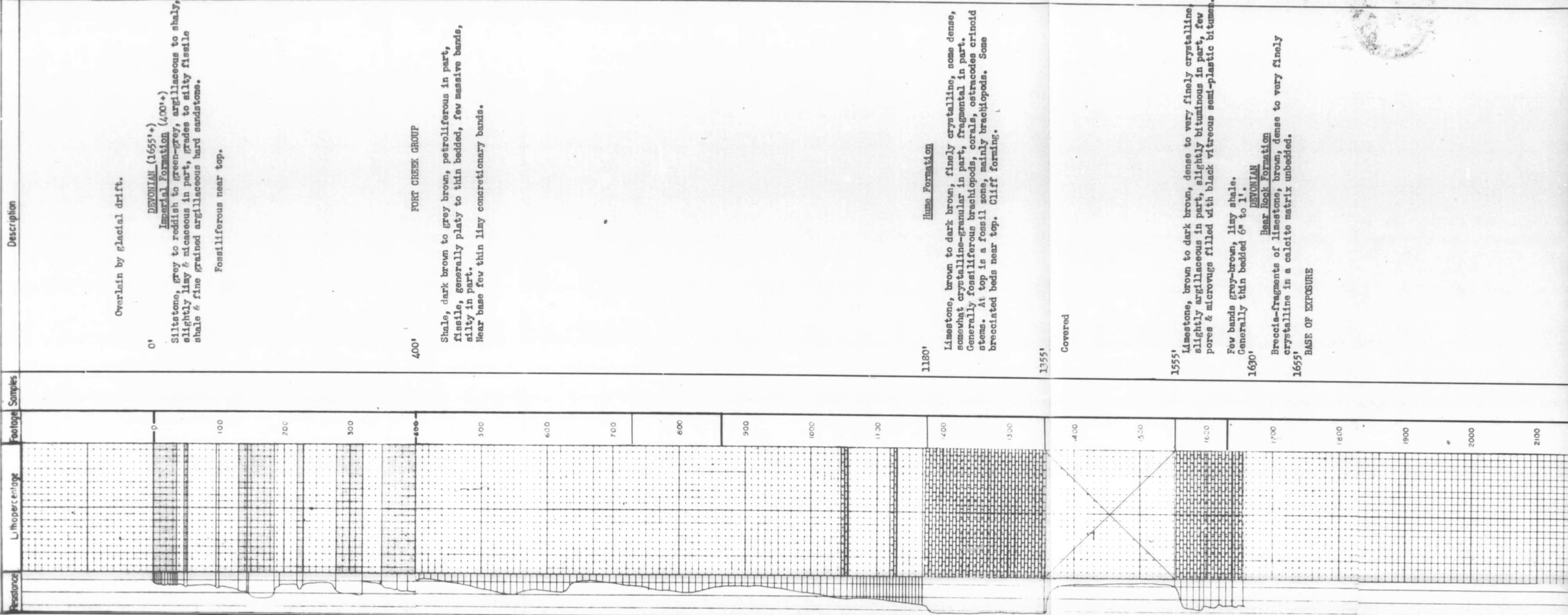
LEGEND

Coal Salt Anhydrite Dolomite Limestone Massive Chert Conglomerate Sandstone Siltstone Shale

IMPERIAL OIL LIMITED

EXPLORATION DEPARTMENT

PEACE RIVER DISTRICT



LITHOPERCENTAGE LOG
OF OUTCROP SECTION

STATION NO. P.R. 2-59-6

IMPERIAL RIVER

FORMATIONS

LOCATION: L.S.D. SEC. TWP. RGE. W. M.
UNIT ZONE T. S. LONG. 127° 43'
N. 1/4 SEC. 37. LAT. 36° 10' N. LONG. 127° 43'

Description of location: Measured on the north bank of the Imperial River at the front range of the Mackenzie Mountains.

ELEVATION MEASURED METHOD

TO ACCOMPANY REPORT

Surface Geology of the Hornum Wells Area

BY: R. A. MOSELEY

DATE: 1960

DESCRIBED

BY: M. Masarikovich DATE: June, 1959

LEGEND

Limestone Massive Chert Conglomerate Sandstone Siltstone Shale

Imperial Oil Limited Exploration Department Peace River District

Imperial River

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LITHOPERCENTAGE LOG
OF OUTCROP SECTION

STATION NO. P.R. 2-59-4
EAST MOUNTAIN

LOCATION: LSD. SEC. TWP. RGE. W. M.
UNIT ZONE N.T.S.
S.E. 1/4 SEC. 62 LAT. 65° 50' LONG. 128° 30'

Description of location: East Mountain

ELEVATION MEASURED METHOD

FORMATIONS

TO ACCOMPANY REPORT

Surface Geology of the Norman Wells Area

BY: R. A. MENELEY

DATE: 1960

DESCRIBED

BY: M. Mazurkewich

DATE: June, 1959

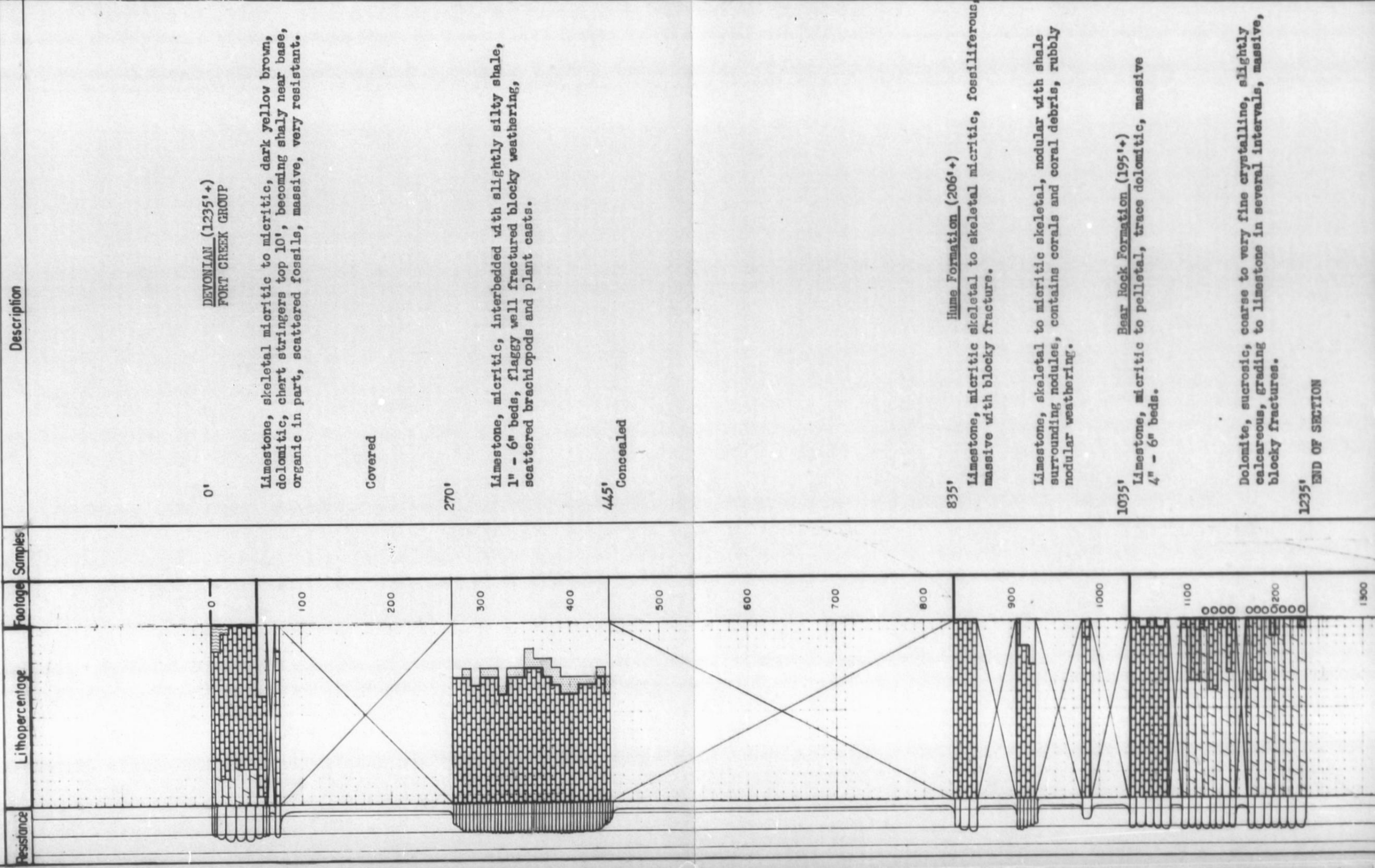
LEGEND

Coal Salt Anhydrite Dolomite Limestone Massive Chert Conglomerate Sandstone Shale

IMPERIAL OIL LIMITED

EXPLORATION DEPARTMENT

PEACE RIVER DISTRICT



LITHOPERCENTAGE LOG
OF OUTCROP SECTION

STATION NO. P.R. 2-59-101 &
102
PROHIBITION CREEK

LOCATION: LSD. SEC. TWP. RGE. W. M.
UNIT ZONE N.T.S.
S.W. 1/4 SEC. 62 LAT. 65° 20' LONG. 126° 00'

Description of location: Measured along Prohibition Creek on the western slope of the Norman Range.

ELEVATION MEASURED METHOD

TO ACCOMPANY REPORT
Surface Geology of the Norman Wells Area

BY: R. A. MENELEY
DATE: 1960

BY: B. Patsch
DATE: June, 1959

FORMATIONS

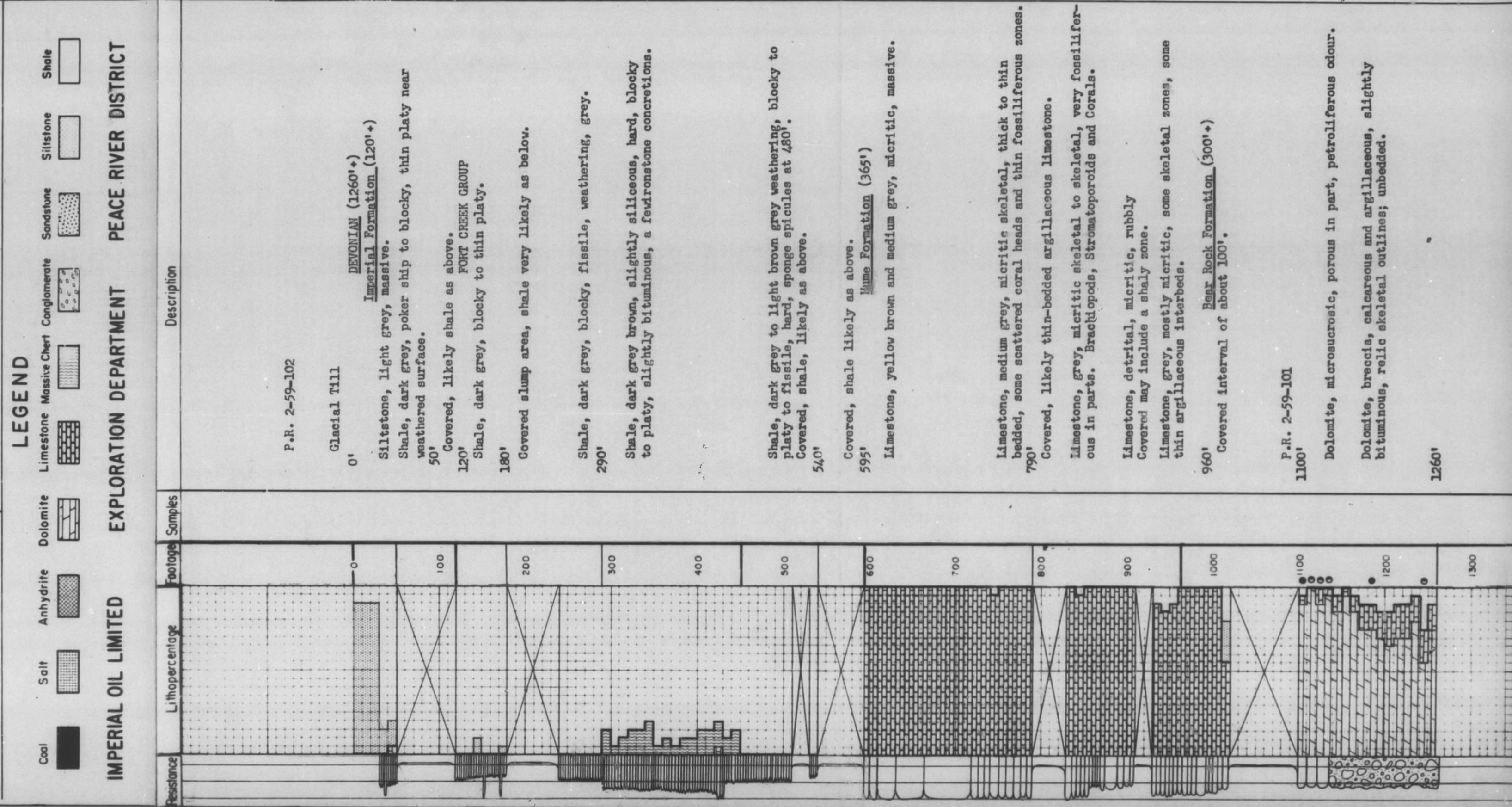
IMPERIAL OIL LIMITED
EXPLORATION DEPARTMENT
PEACE RIVER DISTRICT

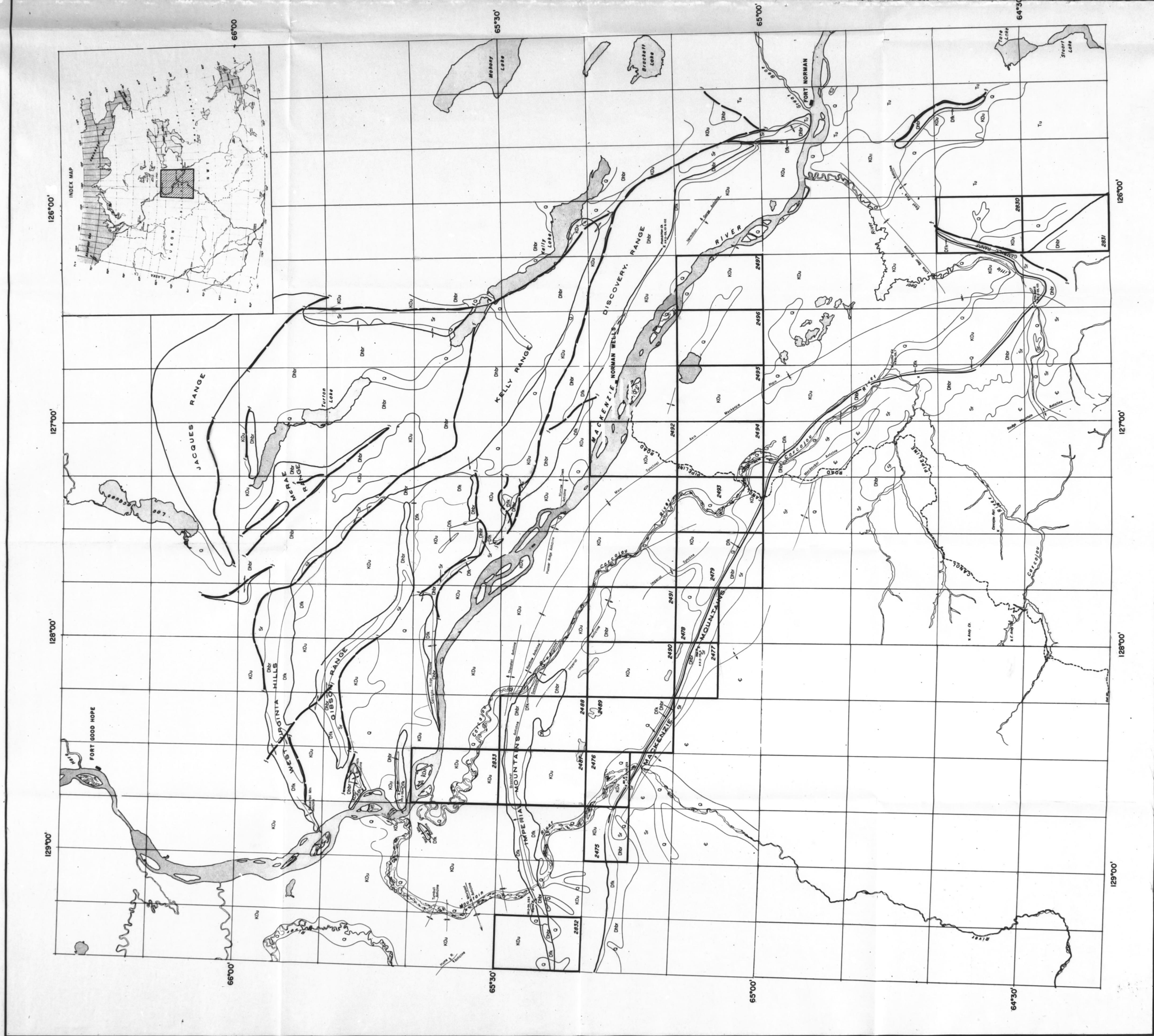
MEASURED METHOD

TO ACCOMPANY REPORT
Surface Geology of the Norman Wells Area

BY: R. A. MENELEY
DATE: 1960

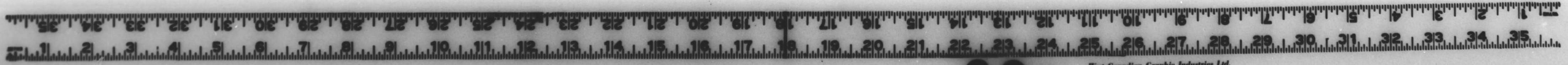
BY: B. Patsch
DATE: June, 1959



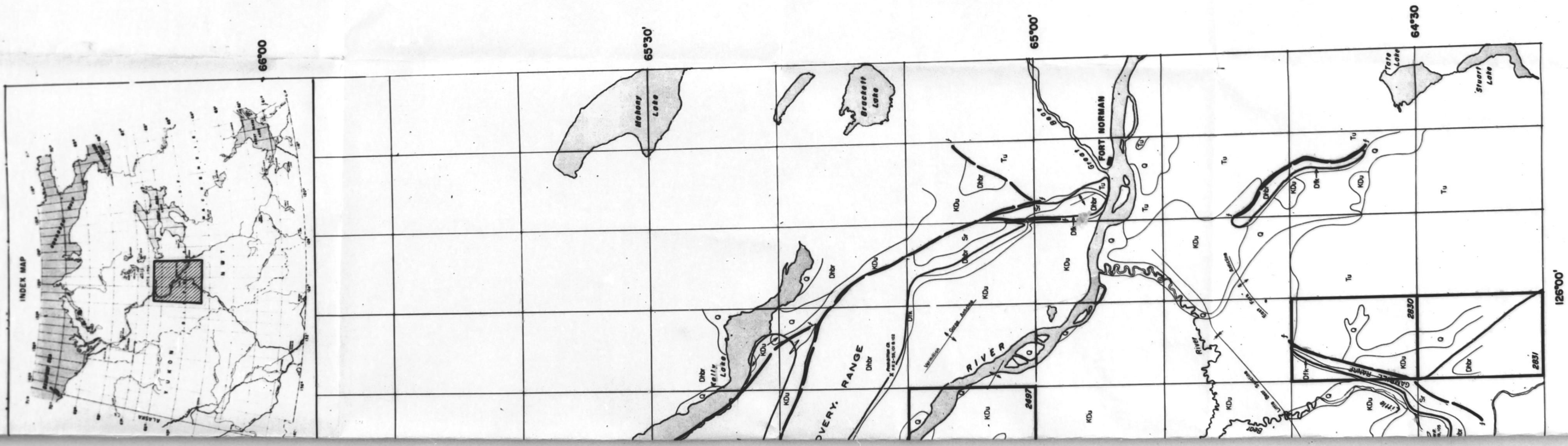


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IMPERIAL OIL LIMITED
EXPLORATION DEPARTMENT PEACE RIVER DISTRICT



CENOZOIC	QUATERNARY
	TERTIARY
MESOZOIC	CRETACEOUS
	DEVONIAN
PALEOZOIC	ORDOVICIAN & SILURIAN
	CAMBRIAN
	PRE-CAMBRIAN

East Park
Lithic River
Sandy River
Dark Shale

Imperial
Fort Good Hope
Horse
Bear River

Norman River
Norman Lake
Norman Shale
Norman Sandstone
Norman Clay

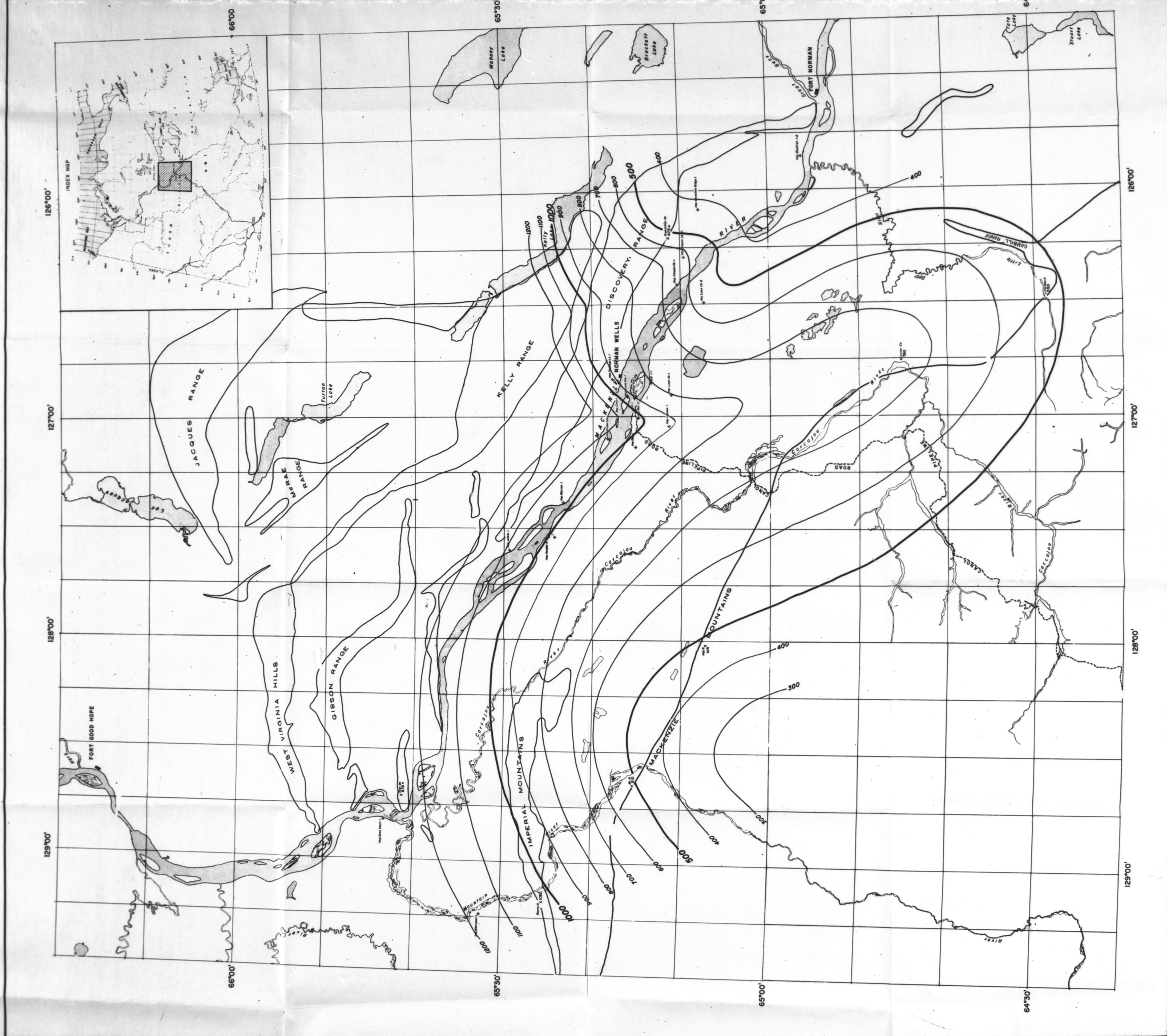
Norman River
Norman Lake
Norman Shale
Norman Sandstone
Norman Clay

Norman River
Norman Lake
Norman Shale
Norman Sandstone
Norman Clay

SURFACE GEOLOGIC MAP
OF
NORMAN WELLS AREA

SCALE: 1" = 4 MILES
TO ACCOMPANY REPORT:
Surface Geology of the Norman Wells area
by A.E. Manning and B. Pugh.

APRIL 1960

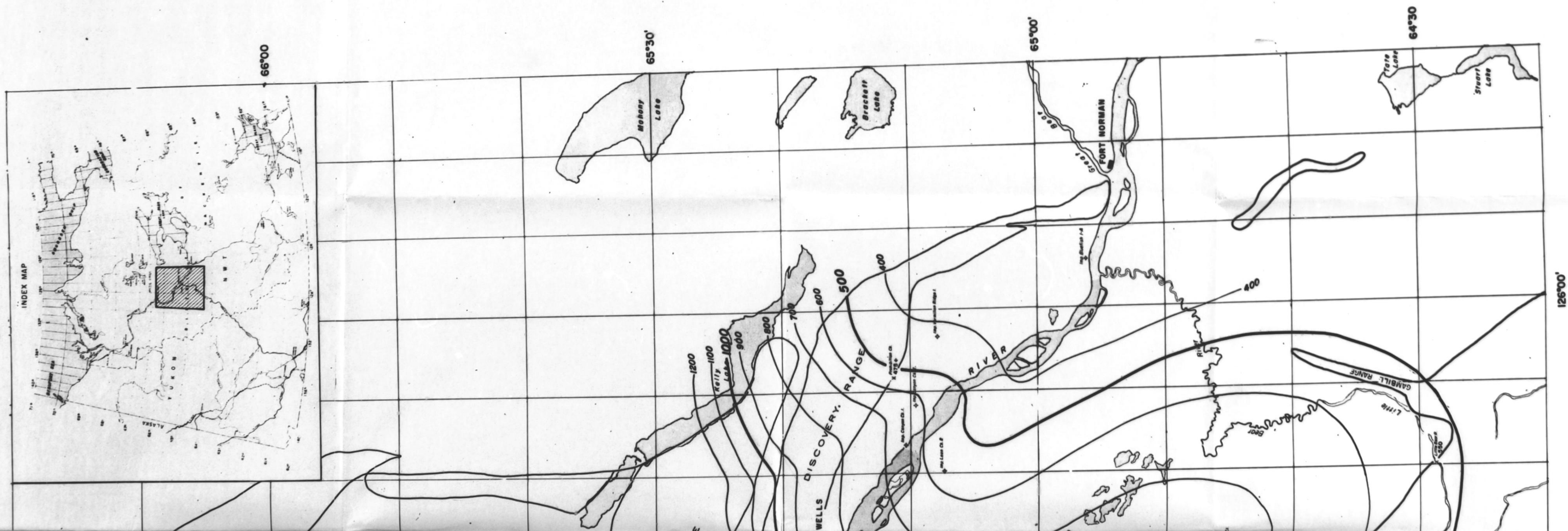


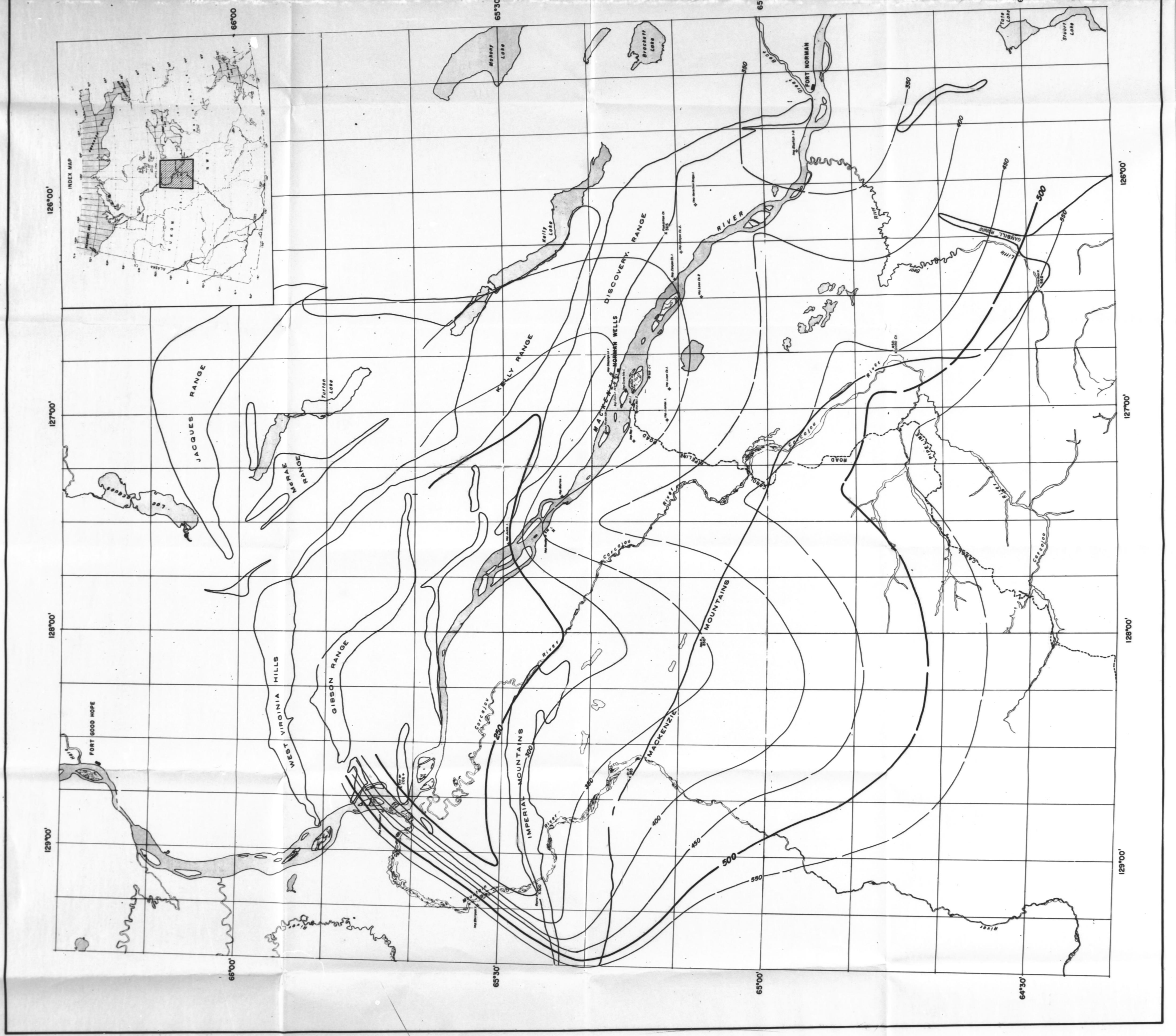
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FIGURE 3
ISOPACH
FORT CREEK GROUP
CONTOUR INTERVAL 100 FT.

- 16 MILES
- LEGEND**
- LOCATION
 - DRILLING
 - OIL PRODUCER
 - GAS PRODUCER
 - ✕ OUTCROP SECTION
 - ABANDONED LOCATION
 - ◆ ABANDONED DRY HOLE
 - ABANDONED OIL PRODUCER
 - ABANDONED GAS PRODUCER
 - ABANDONED WELL WITH OIL & GAS
 - SUSPENDED
 - SECTION WELL
 - ABANDONED WELL WITH OIL
 - ABANDONED WELL WITH GAS





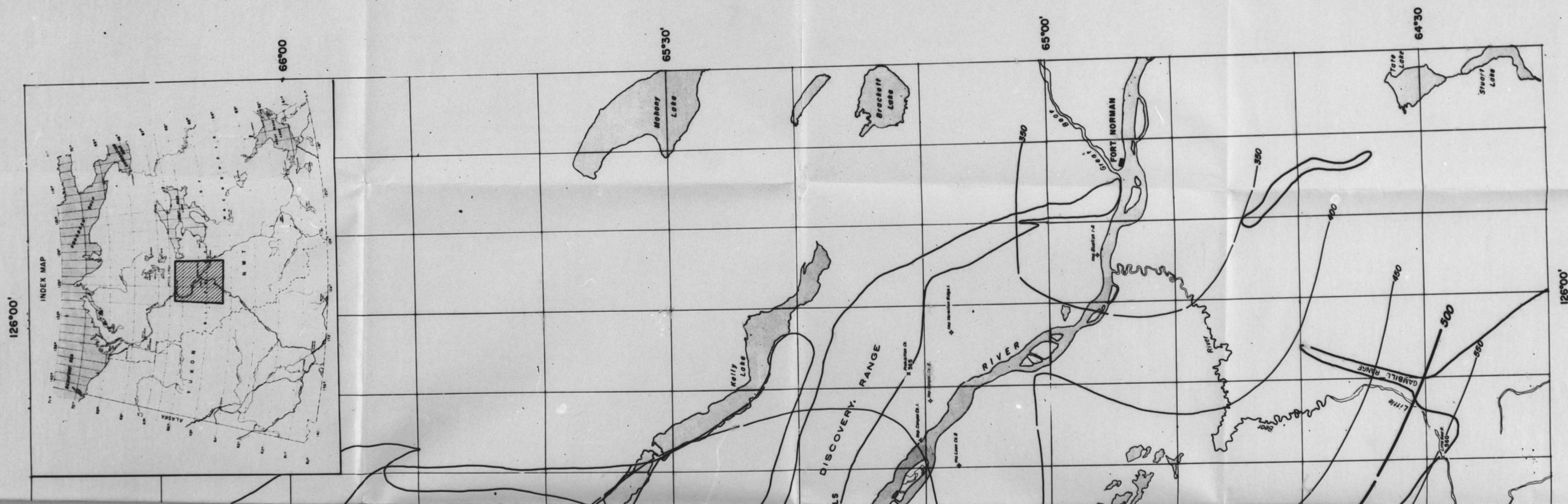
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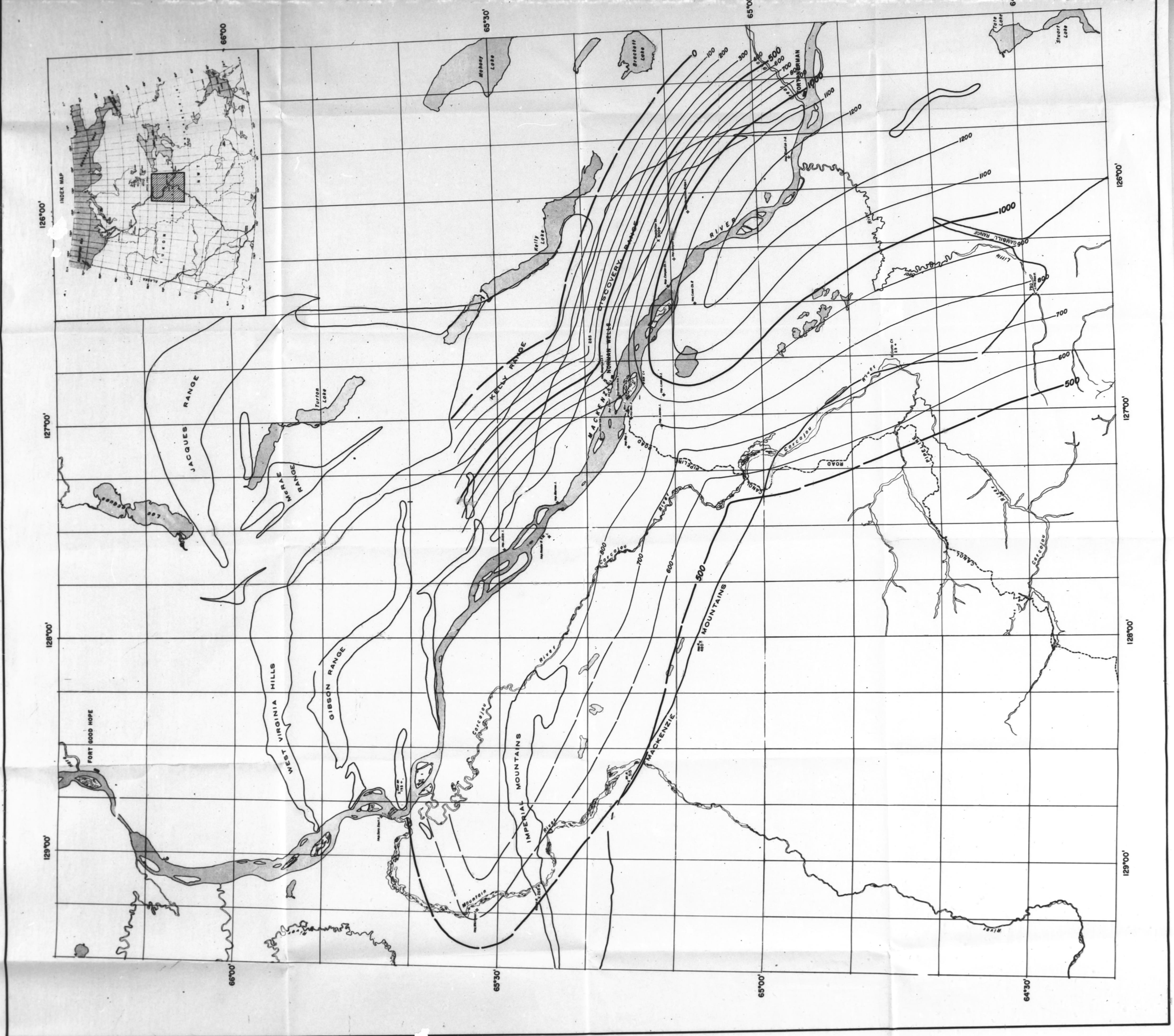
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FIGURE 4
ISOPACH
HUME FM.
CONTOUR INTERVAL 50 FT.

1:6 MILES

- LEGEND
- LOCATION
 - DRILLING
 - OIL PRODUCER
 - ⊙ GAS PRODUCER
 - ✕ OUTCROP SECTION
 - ABANDONED LOCATION
 - ◇ ABANDONED OIL HOLE
 - ABANDONED OIL PRODUCER
 - ⊙ ABANDONED GAS PRODUCER
 - ABANDONED WELL WITH OIL
 - ⊙ ABANDONED WELL WITH GAS
 - ✕ ABANDONED WELL WITH OIL & GAS





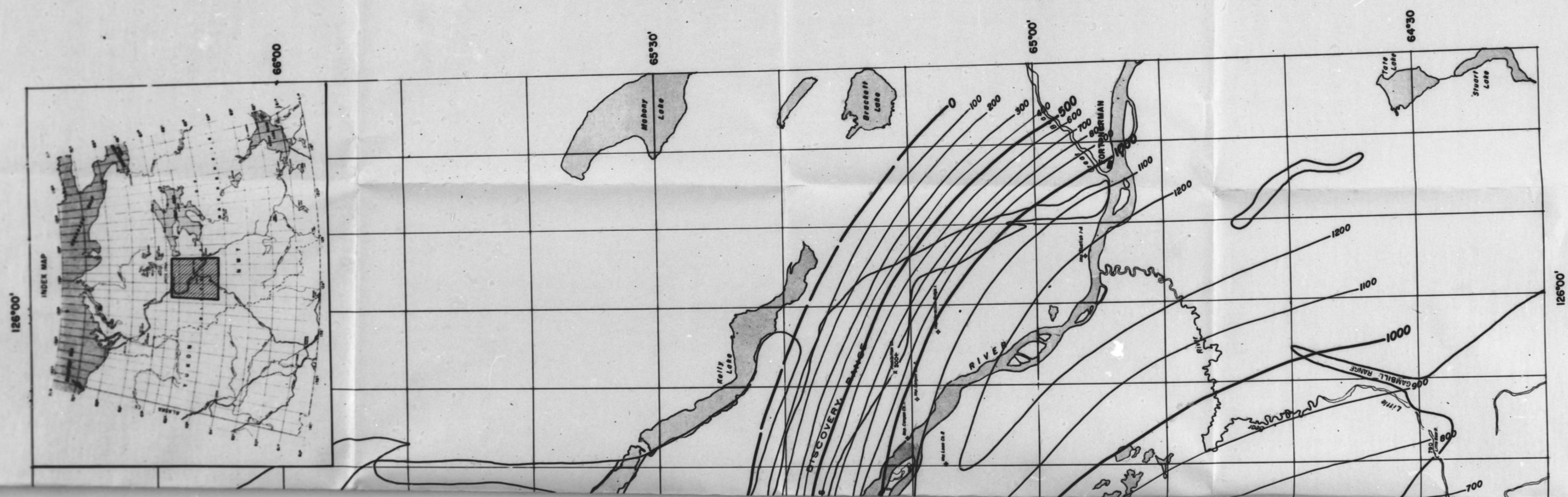
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FIGURE 5
ISOPACH
BEAR ROCK FM.
CONTOUR INTERVAL 100 FT.

1/8 MILES

- LEGEND
- LOCATION
 - WELL
 - OIL PRODUCER
 - GAS PRODUCER
 - OUTCROP SECTION
 - ABANDONED LOCATION
 - ABANDONED DRY HOLE
 - ABANDONED GAS PRODUCER
 - ABANDONED OIL PRODUCER
 - ABANDONED WELL WITH OIL
 - ABANDONED WELL WITH GAS
 - SUSPENDED
 - INJECTION WELL

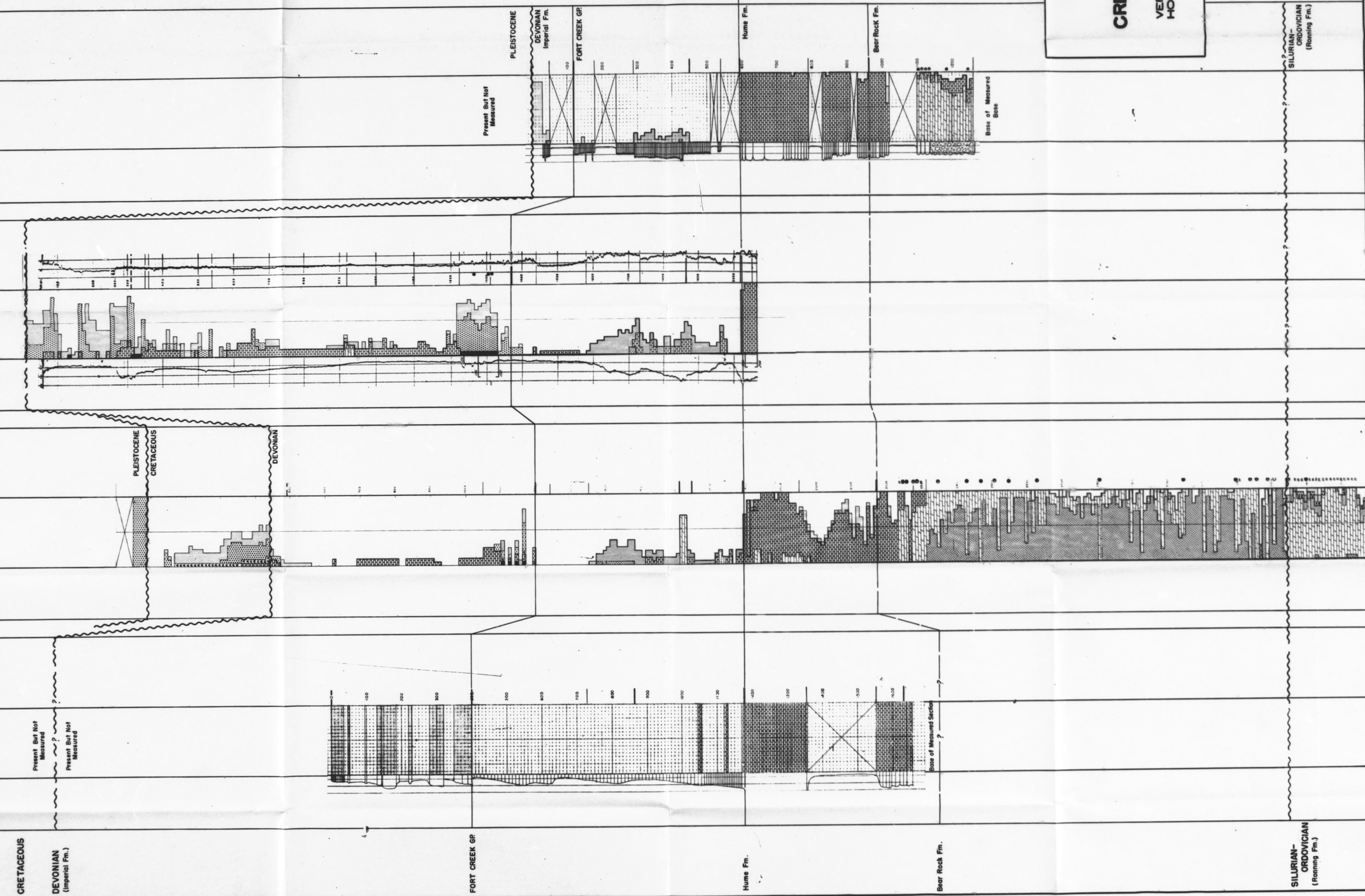


PROHIBITION CREEK (PR-2-59-101 & 102)
SW 1/4-62 65°20'N-128°00'W

IMPERIAL CANYON 1
65°10'N 128°24'W
S.S. 310

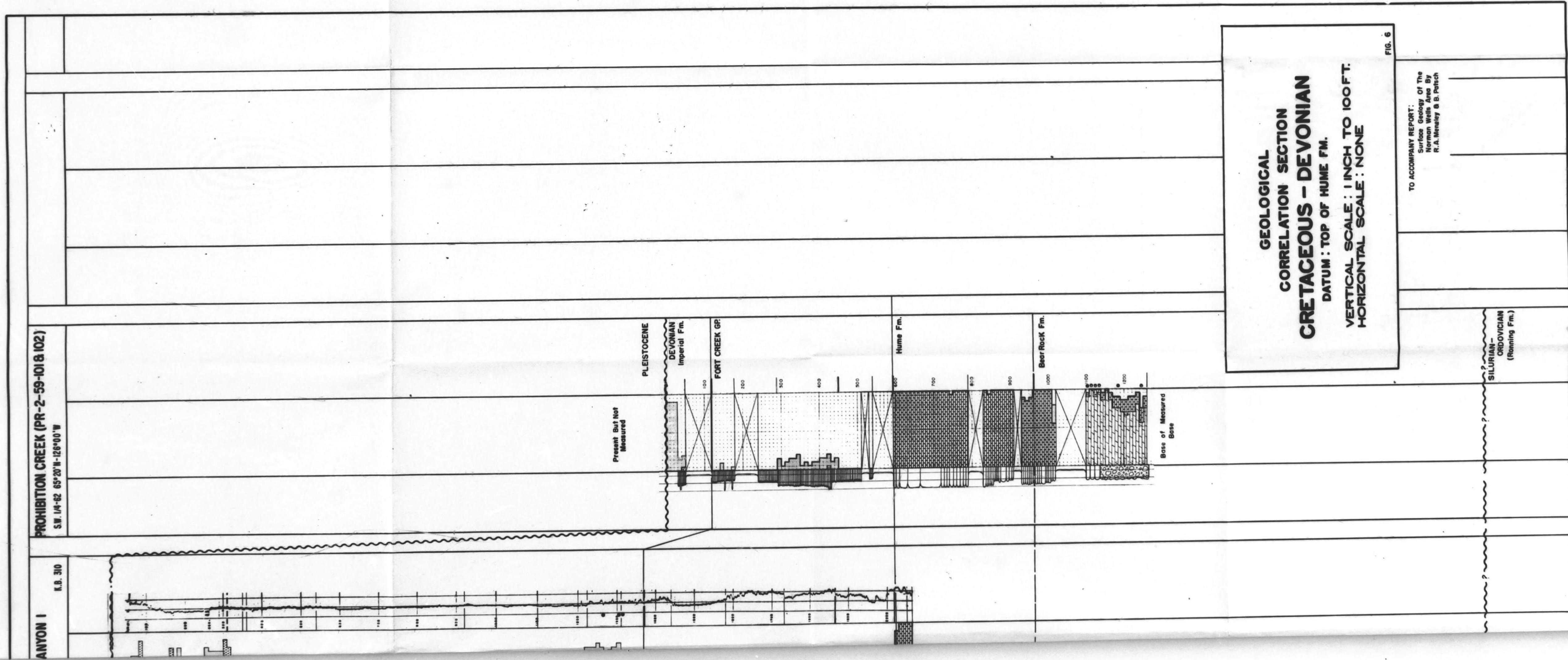
IMPERIAL LOON CREEK 2
65°07'N 128°28'W
S.S. 433

GROTTO CREEK (PR-15-58-7)
64°45'N 128°



GEOLOGICAL
CORRELATION SECTION
CRETACEOUS - DEVON
DATUM : TOP OF HUME FM.
VERTICAL SCALE : 1 INCH TO
HORIZONTAL SCALE : NONE

TO ACCOMPANY REPORT
Submitted to
Norman Wells
R.A. Ministry



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GAYNA RIVER (PR-2-59-283)
SW 1/4 S8, 65°30'N - 129°00'W

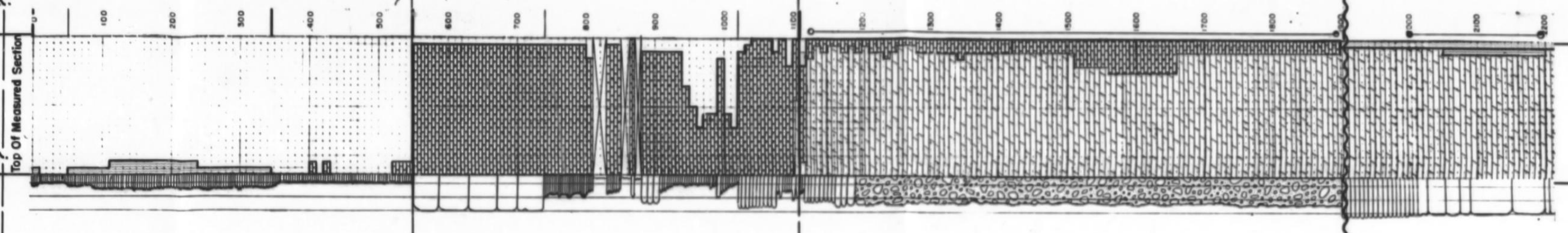
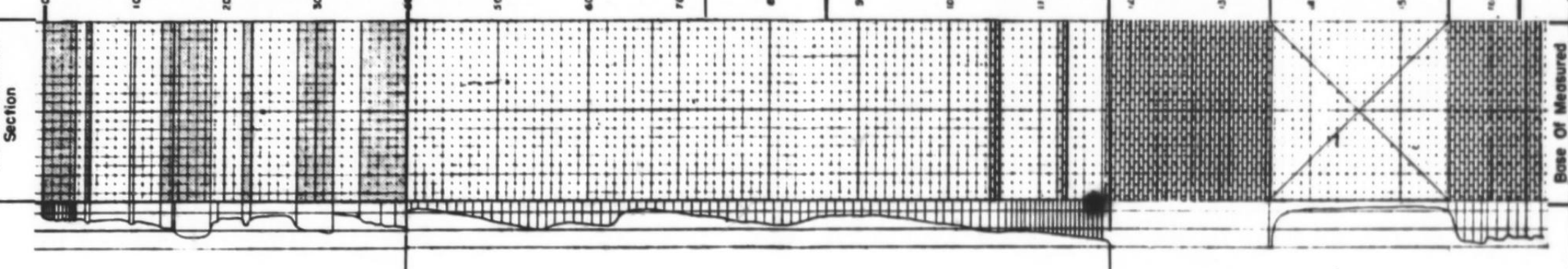
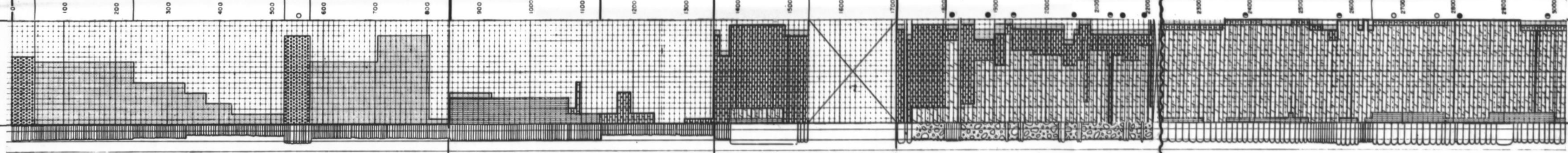
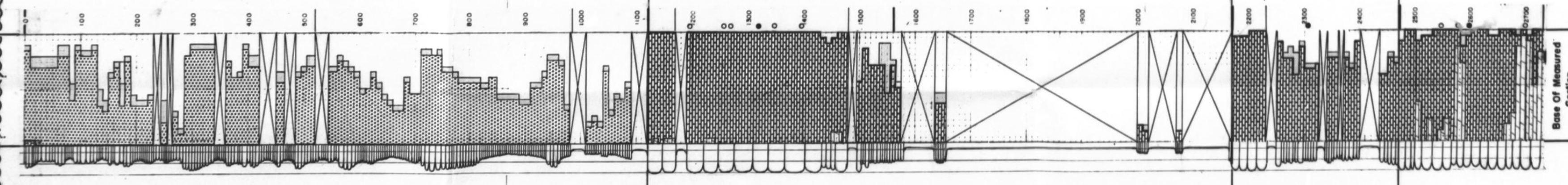
CRETACEOUS
DEVONIAN
(Imperial Fm.)

MOUNTAIN RIVER (PR-2-59-203)
SW 1/4 46, 65°20'N - 120°30'W

IMPERIAL RIVER (PR-2-59-6)
NW 1/4 37, 65°10'N - 121°45'W

GROTTO CREEK (PR-15-58-7)
64°45'N 128°47'W

LITTLE BEAR RIVER (PR-2-59-105)
NW 1/4 79 64°30'N - 128°15'W



FORT CREEK GP

Hume Fm.

Bear Rock Fm.

SILURIAN-
ORDOVICIAN
(Rommel Fm.)

GEOLOGIC
CORRELATION
DEVONIAN
DATUM : TOP OF H
VERTICAL SCALE :
HORIZONTAL SCALE :



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GROTTO CREEK (PR-15-58-7)

64°45'N 128°47'W

Present But Not Measured

LITTLE BEAR RIVER (PR-2-59-105)

NW 1/4 - T9 64°30'N - 128°15'W

Present But Not Measured

DEVONIAN
(Imperial Fm.)

GEOLOGICAL
CORRELATION SECTION
DEVONIAN

DATUM : TOP OF HUME FM.
VERTICAL SCALE : 1 INCH TO 100 FT.
HORIZONTAL SCALE : NONE

FIG. 7

TO ACCOMPANY REPORT:
Surface Geology Of The
Devonian Section
R.N. Murray & S. Finch

