15

FINAL

GEOLOGICAL REPORT

on

"GRAVEL RIVER AND EAST FORK OF LITTLE BEAR RIVER
KAY MOUNTAINS AND SUMMIT ANTICLINE"

N.W.T. (Canada)

IMPERIAL OIL LTD., CANOL PROJECT

Assignment Nos. 2, 2A, 30, 37.

By:- Lt. R. M. Hart — Party Chief
Lt. V. B. Monnett — Assistant
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John Stewart — "
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Date submitted: January 26, 1944.

Read and accepted by:- Herb A Link

Date:- Jan. 27th. '44.

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FINAL GEOLOGICAL REPORT

on

GRAVEL RIVER AND EAST FORK OF LITTLE BEAR RIVER
KAY MOUNTAINS AND SUMMIT ANTICLINE

N.W.T.(Canada)

A B S T R A C T

A Tertiary basin, much larger in extent than previously thought, covers the greater part of this area. The sands, gravels, and shales earlier thought to be Cretacecus are now assigned to the Tertiary.

Two anticlinal mountain ranges are present in the area. One range is the foothills of the Mackenzie Mountains, and the other a continuation or a branch of the Discovery Range forming the Kay Mountains. On these mountains the possible producing horizons are brought to the surface.

A small anticline was found along the East Fork River where the East Fork shales are the oldest rocks exposed. This structure is the only worthwhile feature found, and has a good possibility of producing oil if southwest dip can be determined by geophysical methods.

The stratigraphic column in this area ranges from Silurian (Mt. Ronning) through Devonian, Cretaceous, Tertiary and Quaternary.

INDEX MAP OF
NORTH WESTERN CANADA SHOWING
GRAVEL RIVER AND EAST FORK LITTLE BEAR RIVER AND KAY MOUNTAINS

INTRODUCTION

Party 61 was assigned (Assignment Nos. 2, 2A, 30 and 37) the general area throughout the entire field season, therefore a compilation of the various trips will be covered in this final report.

Generally speaking, the area lies within longitudes 124° 50'-126° 10', latitudes 64°10' - 64°50', covering approximately 1800 square miles. It is bounded on the north and west by the Little Bear River, the east by the Mackenzie River, and on the south by the Gravel River. The northern boundary is approximately 10 miles southwest of Fort Norman, Northwest Territories.

The entire area is covered with muskeg and stunted spruce with the exception of the mountainous areas and along the stream beds. In the regions of lower elevations outcrops can be seen only along the stream and river banks.

The first two trips covered the East Fork of Little Bear River and Kay Mountains. The party consisted of Lt. R. M. Hart, Geologist, Lt. V. B. Monnett, Assistant Geologist, and John Nichols, Helper. The lower half of the East Fork River was reached and surveyed by trekking a canoe up Little Bear River from the Mackenzie and packing into the areas inaccessible by canoe. The Upper part of the East Fork and the Kay Mountains were worked from a base camp established on the south side of the Mountains. The party and equipment were flown in by plane, landing on one of the lakes and packing into the more distant points.

For the third trip, the party was made up of Lt. R. M. Hart-Geologist, P. H. Blanchet, Assistant Geologist, John Stewart, Helper. The party was landed on Tate Lake by plane, and all geology was done

within a radius of 12 miles of this lake, proceeding from this camp through Stewart Lake to the Gravel River via. Tertiary Creek. This Creek was then surveyed for a distance of 15 miles. The lower part of the Gravel River was descended to the Mackenzie and then down this river to Ft. Norman, observing what few outcrops that are exposed along the river banks.

The fourth trip covered the southwestern part of the area and the upper part of the Gravel River. This party consisted of the writer, P. H. Blanchet, Assistant Geologist, and Roman Sluzar, Helper. Equipment was flown into Summit Lake where pack trips were made into the Summit Anticline, tying in this work with that of Lt. Monnett on the upper part of Little Bear River.

Only a small portion of the area mapped was found favorable for the accumulation of petroleum. The East Fork Anticline is the most likely structure to produce oil. It lies approximately 5 miles southeast of the mouth of East Fork River. The accessibility to this structure for geophysical work is similar to the area along Little Bear River. It is rather heavily timbered, somewhat rolling terrain, and a few muskeg lakes.

The base map was compiled mostly from aerial photos, but that part not covered by this method was mapped with the plane table.

Looking northeast up the East Fork River Valley toward the Kay Mountains showing the topography and heavy growth of timber. Picture was taken from The East Fork Anticline.

Chapter II.

T O P O G R A P H Y

The topography of the region is young. The hilly parts are dissected by numerous small streams with steep sharp valleys, which often have a gradient of 50 feet per mile or more. The larger streams, to a certain extent, seem to typify the geology. When their course is through the harder rocks the channel is usually narrow. In passing through shales the valley broadens out and large meanders are developed.

The eastern part of the area is a broad flat upland, gently sloping toward the Mackenzie River. It has some large muskeg lakes, and in general is covered with a thick growth of moss and stunted spruce.

In the north central part are the Kay Mountains rising abruptly 1600 feet above the surrounding terrain. These mountains form a hogback approximately 15 miles in length and have a steep east facing scarp. The general strike is North 50° West. Both the north and south ends of these mountains are abrupt.

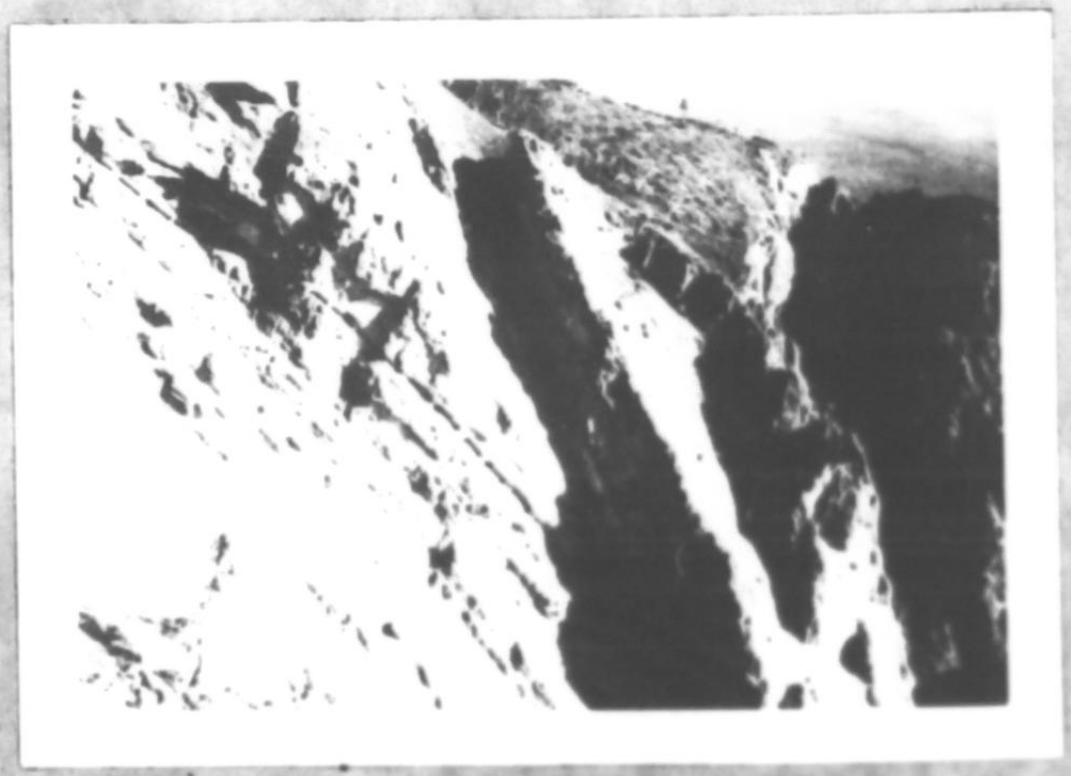
Gravel hills, with rolling topography continue toward the south where they are broken off by the Gravel River Valley. Toward the north the country is flat between these mountains and Bear Rock.

Southwest of the above mountains is a high plateau area with dissected slopes, consisting of somewhat rounded almost treeless hills formed by the coarser Tertiary gravels held in place by thick lignite and massive well cemented conglomerate beds.

The foothills of the Mackenzie Mountains form the western boundary of the area mapped, and here the topography is very rugged.

(See Plate II for above described areas).

Exposure of the Ronning dolomite in the Kay Mountains.



Bear Rock Mount Ronning contact on the back side of the Kay Mountains.

Chapter III.

S T R A T I G R A P H Y

Mount Ronning.

The oldest rocks examined along the Gravel River, East Fork, Kay Mountains and Summit Anticline are the Mount Ronning Series of Silurian age. This formation has a thickness in excess of 600 feet and consists of thin to medium, well-imbedded, grey, dense dolomites, weathering to buff color, and are very brittle. No indications of porosity were found and very little chance for production of oil from these beds can be expected.

Bear Rock

Overlying the Mount Ronning series is the Bear Rock formation, having a thickness of 300 - 350 feet, consisting of dolomites and limestones, brecciated with small to large pieces of angular dolomite. The upper 50 - 75 feet in Kay Mountains is porous and on a fresh break has a good petroliferous odor. It is reported that in the number two well drilled at Hoosier Ridge a heavy flow of saltwater was encountered at a depth of 2817 feet, this being 148 feet below the top of the Bear Rock. The fluid rose to within 1000 feet of the top of the hole and could not be lowered by bailing on a 14 hour test. In the well drilled at Bluefish, near Fort Norman it is reported to have had a flow of sulphur water from this formation thus showing the wide distribution of porosity over the Norman Wells Basin, and, if found structurally favorable should form an excellent reservoir rock for petroleum.

Some controversy has arisen out of the past summer's field work regarding the age of the Bear Rock. No conclusive fossil evidence has been found to identify it, and for all practical purposes, in this report, it will be considered lower Middle Devonian.

Small anticline on the back side of the Kay Mountains showing warping of Ramparts limestone in foreground and Beavertail limestone in right background.

On fresh exposure it is grey but weathers to a buff color and into distinct pinnacles. The lack of bedding, the presence of fossils and the type of weathering makes this an easily recognizable formation in the field.

Ramparts

The Ramparts limestone lies conformably on the Bear Rock. It has a thickness of approximately 400 feet and consists of thin to medium beds of limestone separated by varying thicknesses of highly calcareous fossiliferous shales. The limestone beds are dense to crystalline, non-porous, hard, and weather grey. The shales are softer, often eroding into small valleys and weathering buff color.

Beavertail

The Beavertail limestone should probably be grouped as the upper member of the Ramparts instead of a separate formation. It is massive bedded, dense, fossiliferous and weathers grey to buff. The upper few feet, both in the Kay Mountains and Summit Anticline, have a strong petroliferous odor on fresh break, but the lack of porosity in this area prevents it from being classified as a reservoir rock. The thickness of this massive group of beds is approximately 100 feet.

Fort Creek Shales

These shales have a thickness of over 850 feet and are conformable with the underlying limestones. The bottom few feet is a gradational zone consisting of thin beds of black shale with interbedded thin limestones. In some localities rounded limestone concretions are found above the transitional zone.

The lower 200 - 400 feet of these shales weather black, hard, and into thin slate-like beds, often highly jointed with the joints filled with bituminous material, and a strong petroliferous odor is

present throughout this section.

The upper 300 - 500 feet of the shales are thinner bedded, softer, more plastic, micaceous and weather a greenish color. The producing horizon of the Norman Wells field is a large coral reef or bioherm in the bituminous zone. This depositional feature could not be found in the area covered by this report, but is always a possible reservoir rock when present, and is merely pointed out here for that reason.

Norman Series

The only exposures seen of this formation were in the vicinity of Summit Anticline, and here it has an estimated thickness of 700 feet. Due to the numerous mud slides in the softer plastic shales and the muskeg covering, very few good outcrops were found.

The base is apparently a shale having a thickness of 50 - 100 feet. It is a grey soft plastic shale grading into the underlying shales of the Fort Creek.

A sandstone member overlies the above shale having a thickness of approximately 50 feet. The texture varies from fine tight silty to medium coarse and porous. The color is grey, brown to greenish, and is easily recognizable by its abundance of spirifers and other fossil content. This sandstone is petroliferous in other areas and is considered a good reservoir rock when found on structure.

Above this sandstone is 500 - 600 feet of soft, plastic, thin-bedded, grey marine shale. Near the top of this shale is a thin-bedded sandstone member forming the higher ridges on the west side of Summit Creek valley. Nowhere could the sandstone be found in place, although float was present in the stream valleys.

Exposure of Slater River Shales in high cut bank 6 miles above mouth of the Gravel River.

Thick Cretaceous sandstone member of the Little Bear Formation on Little Bear River.

Cretaceous

The Cretaceous formations consist mainly of shales and sandstones with an occasional coal seam. These beds were laid down during a period of crustal unstability as shown by their relation to the underlying formations. In some areas the contact is disconformable, in others there is an angular unconformity, and the overlapping of older beds and formations is common.

Lower Cretaceous shales were reported to have been found by McKinnon along the Ramparts and Arctic Red Rivers, by Parker on the Mountain River and Stelck on the Peel River. Stelck also identified fossils from cores out of the Bluefish well as Lower Cretaceous.

Beds of Lower Cretaceous age were not seen or recognised in the area covered in this report but it is not impossible for them to be present in this large Tertiary basin.

Slater River Shales

The base of the Slater River shales was not exposed, and at no place was the contact with the overlying Little Bear Series found. Four hundred feet of section was seen along the lower part of Gravel River, and here it is a grey, conchoidal, marine shale, very plastic and well bedded. These shales are sparsely fossiliferous and contain only an occasional ammonite.

Little Bear Series

The most complete exposures of this formation were seen along the lower part of the Little Bear River, and a detailed description can be found in Dr. T. A. Link's 1921 Report of the Norman Area. Only the essential characteristics will be taken up here.

This formation consists of a series of massive sandstones and shales with a few thin coal seams and an abundance of carbon-

aceous material scattered throughout. There is considerable variation in the texture of the sandstone members. They range from fine, tight, silty, to porous, coarse grained, thin to massive bedded, some cross bedding, interbedded shales, and conglomerates. A color variation from white, light grey, salt and pepper to brown. The shales are black, grey, to olive drab. The thick sandstones grade laterally into sandy shale and shale in a relatively short distance. If found favorable structurally, the porous sandstones would make good reservoir rocks, and their lenticular nature makes them excellent possibilities for stratigraphic traps.

East Fork Series

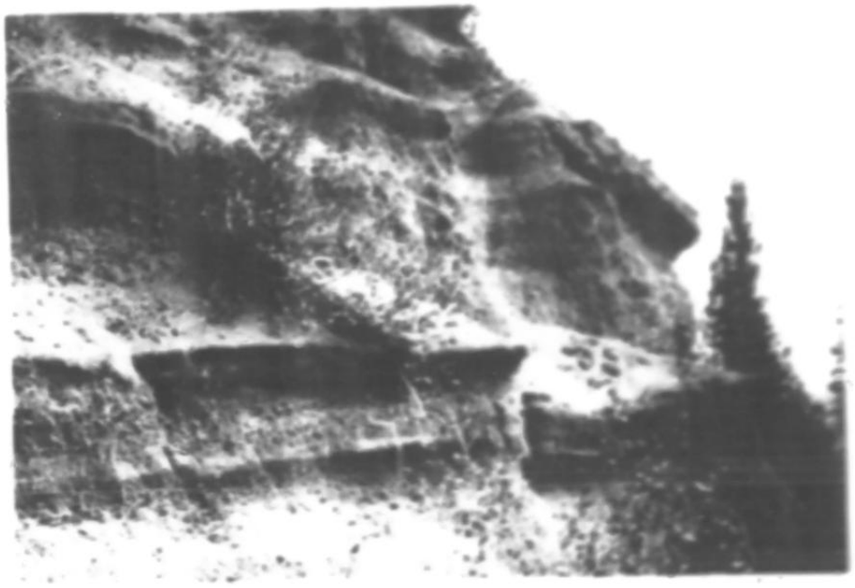
Above the sandstone series of the Little Bear Formation is a grey, conchoidal, plastic, well-bedded marine shale. It has a thickness of approximately 850 feet. Near the base are some thin calcareous sandstone members. A coal seam 12-14 inches in thickness, containing fossil resin was seen along one of the small tributaries. Due to the plasticity of the shales, mudslides of considerable size are common along the higher outbanks. These shales are very similar in lithology to the Slater River group.

Outcrops of this formation were seen below the mouth of East Fork along the Little Bear River, also for several miles up the East Fork River.

A tentative correlation of the Cretaceous shale and sands of the Little Bear River area extending north to the Peel River is as follows:

The East Fork shales are not recognized north of the Little Bear River.

The Little Bear series of Little Bear River is probably correlative with the Link Formation of Mountain River and the "C"



Close up view of Tertiary sands and gravels along lower East Fork River.

Tertiary sands and gravels on the lower part of the East Fork River.

zone of the Ramparts and Arctic Red Rivers.

The Slater River shales are thought to be the same age as the Sperry Shale of Mountain River and the "B" zone of the Ramparts River and the K2 zone of the Peel River.

This correlation is on lithology. The paleontological evidence was not worked out when this report was written.

Tertiary

The Tertiary sediments represent a rapid rate of deposition in a brackish sea. They are at least 1600 feet thick and consist of soft coarse carbonaceous sands, gravels, conglomerates, shales and lignites.

The Cretaceous shales above the mouth of East Fork River are covered with conglomerates and interbedded sands. The dips on these beds are probably exaggerated but they are thought to conform in direction both in dip and strike to the underlying shales.

The coarse grey gravels at the headwaters of the East Fork River, and Tertiary Creek, are assorted, well rounded, and have some massive ferrunginous conglomerates and lignite beds 8 - 10 feet thick. These gravels form the high plateau area southwest of Kay Mountains and have a thickness of approximately 400 feet.

From the mouth of Tertiary Creek toward the headwaters for a distance of 18 miles the high hills on both sides of the creek valley are made up of sands, gravels, conglomerates, lignites and shales having a measured thickness of over 1200 feet.

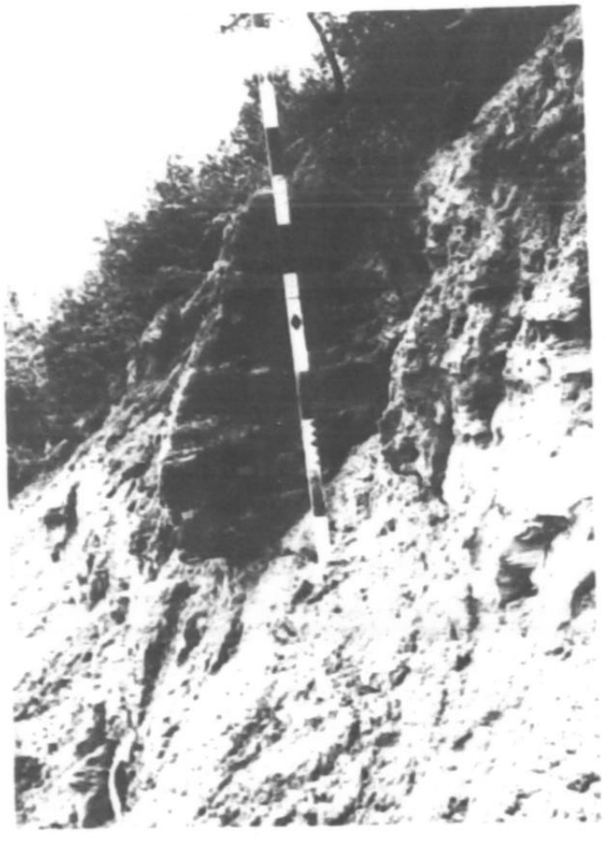
At the south end of Kay Mountains the lignites and shales have been burned a brick red color, and are dipping 50 degrees toward the northeast. From a plane it gives a first impression of the older Paleozoic rocks forming the east limb of the anticline. Along the Mackenzie River at Old Fort Point these same beds are exposed dipping

Tertiary sands and gravels exposed on Tertiary Creek.

Unconformity between Tertiary beds (note angle of dip) and Quaternary glacial till. Near the headwaters of the East Fork River.

Between pages 9-10

toward the southwest. (See Plate III Columnar Section).



Thick Tertiary lignite bed on the upper part of Tertiary Creek.

B. Tertiary pages 10-11

Chapter IV.

S T R U C T U R A L G E O L O G Y

General

When the Mackenzie Mountains were formed during late Cretaceous time the more competent beds were moved laterally toward the east until sufficient resistance was built up to cause these beds to buckle up and form steeply folded anticlines with basins in between. Two such folded zones are in the area covered in this report, Kay Mountains and Summit Anticline. Minor wrinkles were probably formed at the same time which are the more favorable conditions for the accumulation of petroleum.

Kay Mountains

This is the west limb of a highly folded, thrust faulted, asymmetrical anticline, rising several hundred feet above the surrounding terrain. The east limb has been eroded away leaving a perpendicular east-facing scarp. The oldest rocks examined along the scarp face were the Mount Ronning series of Silurian age. Dips in the older rocks are as steep as 80 degrees toward the southwest while only a short distance in the same direction the dips in the younger beds flatten out to almost horizontal. It is here however, that the Cretaceous beds overlap the older formations.

The Kay Mountains probably connected at one time with Bear Rock, or at least the same thrust movements are synonymous and the Mackenzie River has cut out the connecting evidence leaving a gap of several miles where only younger sediments are exposed and do not reflect the diastrophic results.

South of the present mountains either erosion has removed

East Fork Shales showing 10 degree southeast dip on the East Fork Anticline.

the older formations and they have been overlapped by the Tertiary gravels, or the thrust movement was somewhat dissipated in this immediate area, or it may be a combination of both, because the mountains end abruptly and very little if any movement is reflected in the younger beds in this direction.

A small faulted anticline is present on the southwest side toward the north end of the mountains (Plate V). It is very narrow and only beds of Beavertail and older are exposed, but in these beds minor folds are developed which extend basinward, and if this same condition is present where the older beds are covered with Cretaceous sediments, and closure can be established this would be a good prospect for drilling. (See Plate IV).

East Fork Anticline.

The East Fork Anticline is the most promising structure for the production of oil in the area mapped. It is located approximately two miles west of the north end of Kay Mountains with the axis in a northeast southwest direction. A strike fault paralleling the Kay Mountains probably extends northwestward into the basin, giving closure on the northeast end of this structure. Beds of Cretaceous age (East Fork Series) along the East Fork River dip toward the northwest into the Little Bear syncline, while a few miles further up the river a reversal was found in the same shale series dipping 10 degrees toward the southeast.

In the Gambill Mountains on the upper part of Little Bear River, Lt. Monnett reports a fault extending along the face of the scarp, swinging possibly toward the east paralleling the Little Bear Syncline. This fault may pass into a fold forming the axis of the

above anticline. No definite closure toward the southwest could be found due to the lack of outcrops. If southwest dip could be established by seismic work this would be an excellent structure to test the sands of the Little Bear Series, also the Bear Rock which is petroliferous a few miles to the east.

Summit Anticline

In the western part of the area covered by this report is a large anticline in the foothills of the Mackenzie Mountains, the axis striking approximately north 30 degrees west.

The north end of the structure was mapped in detail with plane table, but due to an unfortunate occurrence in which all equipment was lost in a flood, including the maps which contained the detailed sections and various formational contacts, it will be impossible to show the features in their exact locations. On the accompanying map (Plate II) the Paleozoic formations were grouped and labelled undifferentiated.

The beds that could be classified as reservoirs for petroleum are exposed on the surface, dissipating any hydrocarbons that might have accumulated in the past ages.

A large down faulted block of almost flat lying beds of the Norman Series forms a graben between Summit Anticline and the Gambill Mountains. The work done in this area was near the close of the field season and time did not permit the necessary work to cover this graben area in detail.

OIL AND GAS MANIFESTATIONS

The lower Fort Creek Shale, where exposed, has a good petroliferous odor on fresh break. In places, where a thick section has been observed, and fracturing has taken place, the joints are often filled with solidified hydrocarbons. The discovery well at Norman Wells first produced oil from this horizon.

Underlying the Fort Creek Shales is the Beavertail limestone which, over a large area, is variable in character. In some places the upper part consists of corraline limestone, while at other places the limestone is hard, tight, and dense. This formation being in contact with the highly petroliferous Fort Creek Shales has absorbed, under pressure, some of the petroleum and gas released by the above shales. Due to its lack of porosity and permeability it should not be classified as a reservoir rock.

The Bear Rock formation contains both porosity and a good petroliferous odor in the Kay Mountains. The petroleum odors are not always present where exposures are found, but this formation should always be considered a possible producing horizon.

Coal and Lignite

Thin coal seams up to 12- 18 inches in thickness were seen along the Little Bear River in the Little Bear formation. One seam of approximately 12 inches in thickness was seen 3½ miles above the mouth of the East Fork River in a small tributary. This coal was in the East Fork Shales. The quality of the coal appeared good, but the thinness of the seams would make mining uneconomical.

Some lignite beds 8-10 feet thick were seen in the Tertiary. The quality was evidently poor because when thrown on a fire it would not burn very well.

Chapter VI.

CONCLUSIONS AND RECOMMENDATIONS

One structural feature in the area is worthy of further exploratory work, namely, the East Fork Anticline. It has a breadth of at least 3 miles along the East Fork River. The length could not be approximated because of lack of outcrops, but probably extends for several miles toward the southwest. If critical closure in this direction could be established by seismic methods this would make an excellent prospect for testing the Cretaceous and older formations.

A test well could be drilled on this structure to a depth of 4000 feet for approximately $100,000.00. This would test all possible producing horizons through the Bear Rock Formation. The above cost includes Transportation of Equipment, Supervision, Road Building to the original location, drilling, testing, coring and depreciation on the equipment.

A seismic survey covering the area approximately 10 miles long and two miles wide, shooting the holes one mile apart will cost approximately $30,000.00 and will take two months to complete the survey.

It is here recommended that a well be drilled on this anticline after a suitable location has been made from seismic information.

B I B L I O G R A P H Y

Joseph Keele	"A Reconnaissance across the Mackenzie Mountains on the Pelly, Ross and Gravel Rivers - 1910".
G.S. Hume	"Canadian Geological Survey Summary Report 1923, Part B. Mackenzie River Area, District of Mackenzie N.W.T."
T. A. Link	"Report on Fort Norman Area, 1921".
Lt. V.B.Monnett	"Upper Part of the Little Bear River" 1944, Imperial Oil Ltd. - Canol Report.
C. R. Stelck	"Upper Carcajou River and Little Bear Divide" Imperial Oil Ltd.- Canol Report, 1944.
C. R. Stelck	"Bear Rock Bluefish Area". 1943 Imperial Oil Ltd. Canol Report.

CRETACEOUS	Little Bear Series	750'	Massive to Thin-bedded Sandstones, Varying From Fine, Silty, to Coarse, Porous, Salt and Pepper; Some Well-bedded Sandstone, Some Conglomeratic, Some Cross-bedded Sandstone. Some Fossils in Upper Portion, Carbonaceous Plant Remains Found Throughout the Entire Section. Grey Shale Beds, Sandy to Plastic, and Varying From 1' to 25' in Thickness, Separate the Sandstone Members. Some Thin Coal Seams, 6" to 1' Thick, are Present.
	Slate River Series	400'±	Shale, Grey, Conchoidal, Same Description as Above Shale.
	Norman Series	700'±	Dark Grey Shales with Lenticular Sands in the Upper and Lower Part of the Section.
DEVONIAN	Fort Creek Shale	850'±	Dark Grey Shales; Weathers to Thin, Flaky, Micaceous Weathers Greenish Shale, Dark Grey, Weathers Black, Hard, Slaty-Like, Thin-Bedded, Petroliferous. Tentaculitet Zone at Base.
	Pinebluff	100'±	Massive Bedded, Dense, Grey Limestone Top is Petroliferous, Non-Porous.
	Pumpkin Series	400'±	Thin-Bedded, Grey Limestone, Dense; More Fossiliferous Than Above Massive Beds Some Granular to Fine, Crystalline Limestone in Middle Section Beds Become More Massive Toward the Base Some Shale Beds.
	Bear Rock	300'	Dolomite and Limestones, Brecciated with Limestone and Dolomite Rock and Boulders; Some Few Pieces of Black Chert. Weathers Buff Color, into Distinct Pinnacle Shapes Very Petroliferous for First 80'. Upper Part has Some Porosity, Bedded Toward the Base, and Lies Conformable on the Silurian.
SILURIAN	Mount Running Series	600'±	Thin-Bedded, Light Grey Dolomites; Weather to Buff Color Very Brittle.

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PLATE III

GENERALIZED COLUMNAR SECTION OF GRAVEL RIVER AND EAST FORK OF LITTLE BEAR RIVER AND KAY MOUNTAINS

SCALE : 0.6" = 100 FT.

PARTY E

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Lt. V.B. Monnett
P. N. Blanchet
John Nichols
John Stewart
R.D. Sluzar
AUGUST, 1943.

AGE	Fm.	COLUMN	THICKNESS	DESCRIPTION
TERTIARY			400'±	Well Assorted Grey Gravels; Some Thick Beds of Lignite, A Massive, Ferruginous Conglomerate Near the Base.
			1200'	Sands are Cross-bedded Conglomeratic, and Carbonaceous. Shales are Olive Drab, Fine Textured. Some Thick Lignite Beds.
				UNCONFORMITY
CRETACEOUS	East Fork Series		750'±	Gray, Carbonaceous Shale with Thin Ironstone Streaks and Thin, Salt and Pepper Sandstone Beds Which Vary in Hardness From Soft to Hard, and are Usually Coarse-Grained and Porous. Some Thin, 6" to 8" Coal Seams.
	Little Bear Series		750'	Massive to Thin-bedded Sandstones, Varying From Fine, Silty, to Coarse, Porous, Salt and Pepper; Some Well-bedded Sandstone, Some Conglomeratic, Some Cross-bedded Sandstone. Some Fossils in Upper Portion, Carbonaceous Plant Remains Found Throughout the Entire Section. Grey Shale Beds, Sandy to Plastic, and Varying From 1' to 25' in Thickness, Separate the Sandstone Members. Some Thin Coal Seams, 6" to 1' Thick, are Present.

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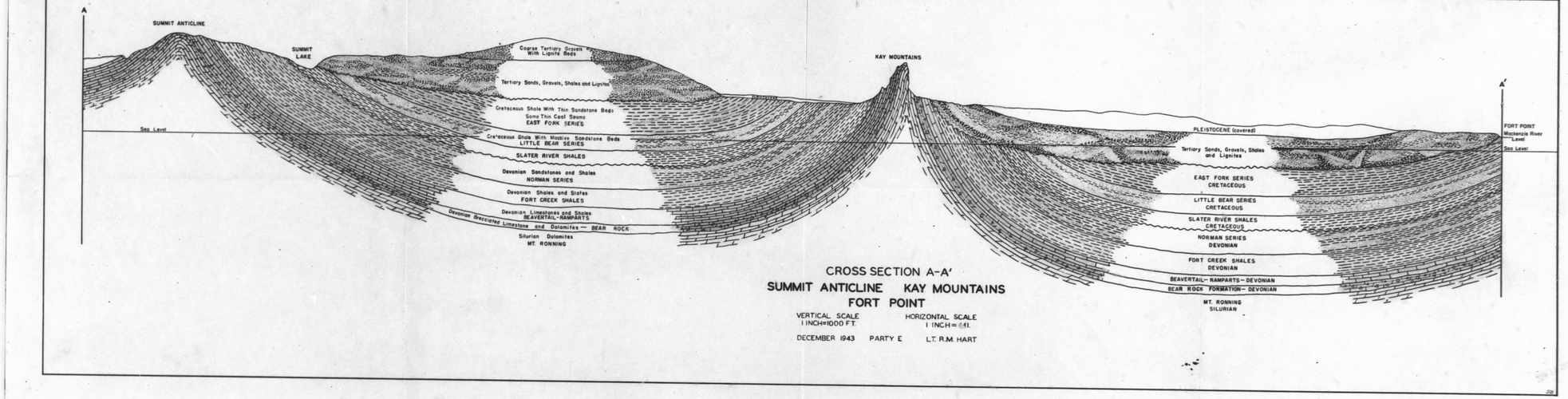
PLATE IV



CROSS SECTION A-A'

SUMMIT ANTICLINE KAY MOUNTAINS

FORT POINT

VERTICAL SCALE 1 INCH=1000 FT.

HORIZONTAL SCALE 1 INCH = 4 MI.

DECEMBER 1943 PARTY E LT. R.M. HART

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PLATE V

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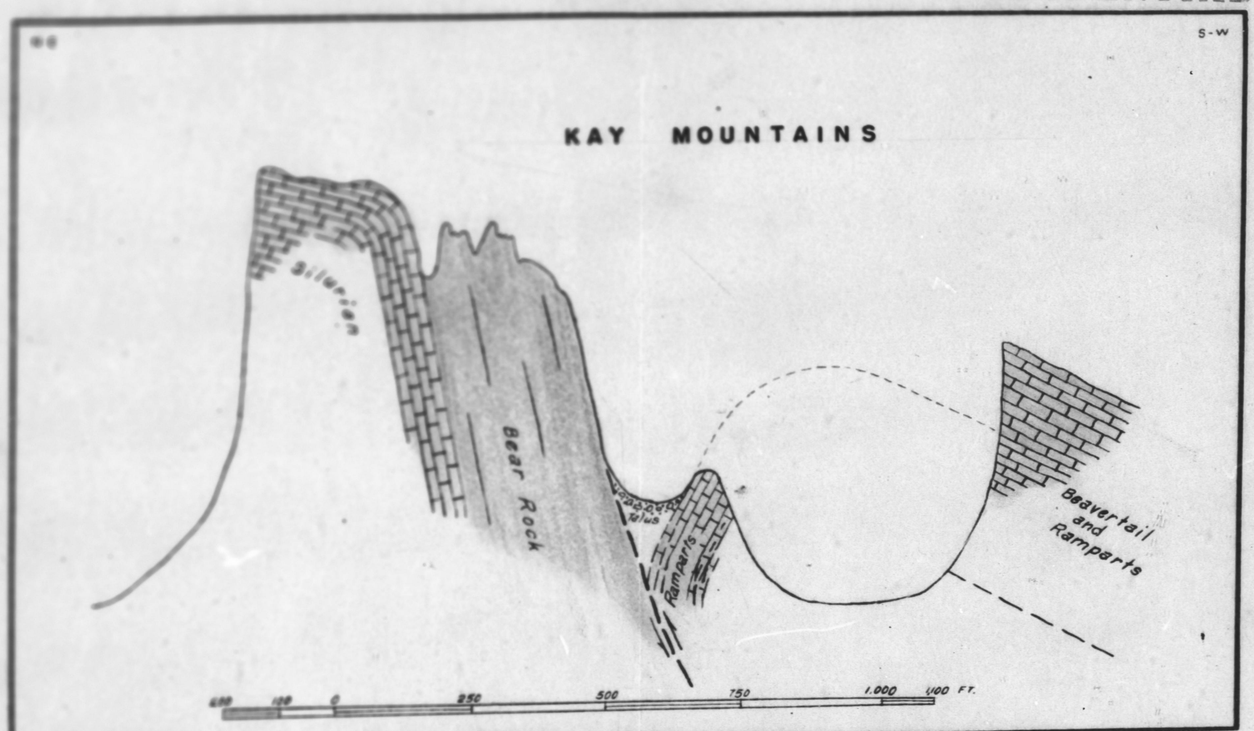

GENERALIZED CROSS SECTION OF
NORTH-CENTRAL PORTION OF KAY MOUNTAINS
SCALE: 0.4" = 100 FEET
PARTY E
LT. R. M. HART, LT. V. B. MONNETT, AND JOHN NICHOLS
JANUARY, 1944

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