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MP 164

FINAL

GEOLOGICAL REPORT

on

"THE CARCAJOU RIDGE - EAST MOUNTAIN AREA"

N.W.T. (Canada)

IMPERIAL OIL LTD., CANOL PROJECT

Assignment No. 6

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FINAL GEOLOGICAL REPORT

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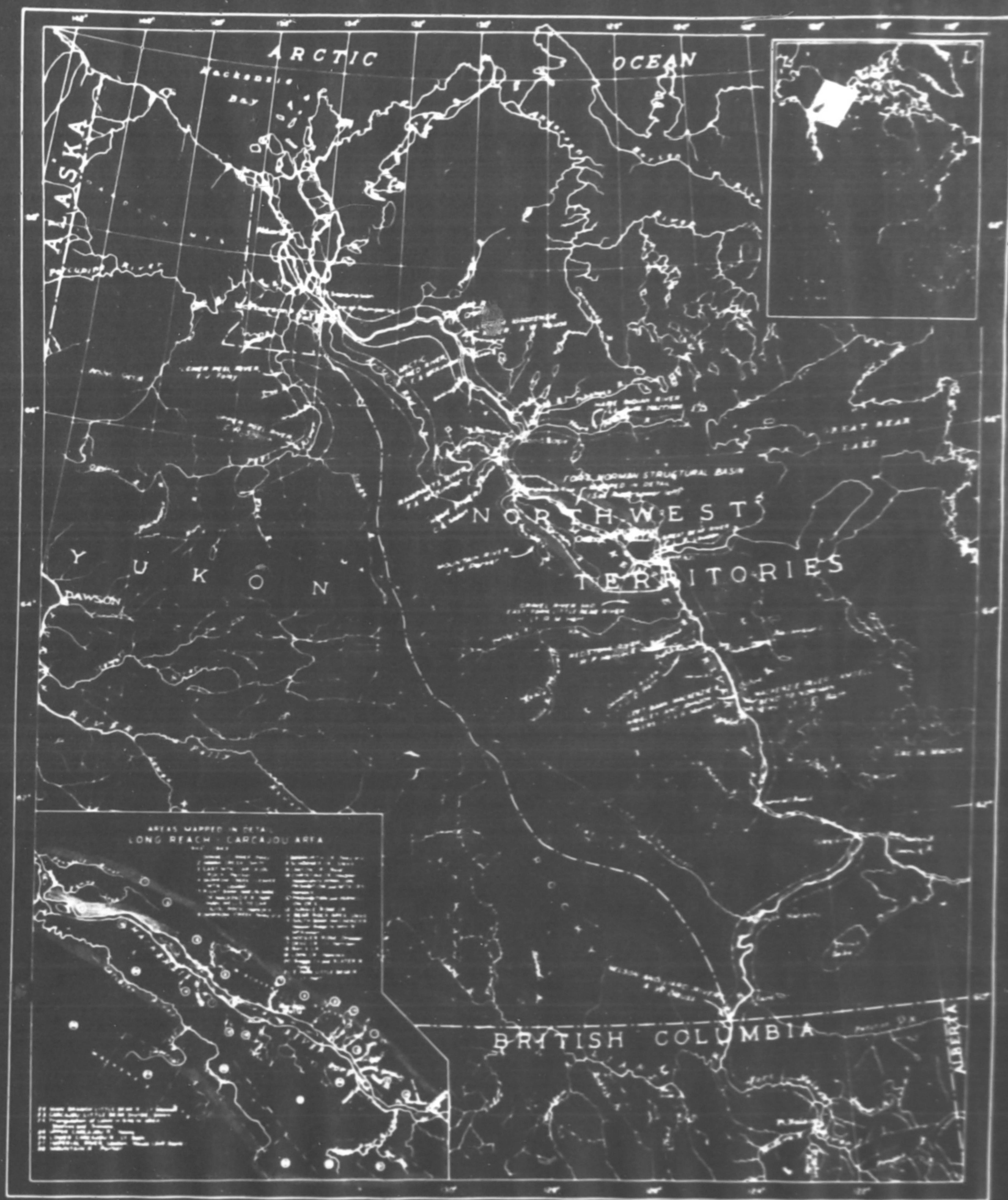
"THE CARCAJOU RIDGE - EAST MOUNTAIN AREA"

N.W.T. (Canada)

A B S T R A C T

Approximately 3800 feet of strata were measured and described and nineteen fossil suites were collected in the "Carcajou Ridge-East Mountain Area". The rocks are of Middle and Upper Devonian and Lower Cretaceous age. Good source beds (bituminous black shales), reservoir beds (coralline reef limestones), and cap rocks are present.

Carcajou Ridge and East Mountain are anticlinal mountains with Devonian beds exposed at the surface. These mountains are flanked by structural basins with Cretaceous beds at the surface. The basin to the south of Carcajou Ridge and East Mountain is believed to be good oil prospecting territory, where stratigraphic traps of the reef limestone type occur. Therefore anticlinal structures may not be necessary for commercial oil accumulations in that basin. An anticline with Cretaceous beds exposed at the surface is present on the west side of the Sans Sault Rapids. It is recommended that a wildcat be drilled on this anticline if seismograph work confirms the presence of closure.



INDEX MAP OF
LOCATION OF EAST MOUNTAIN-CARCAJOU RIDGE AREA

50 0 50 100 150

Scale: 1 in. = 100 mi.

Chapter I

INTRODUCTION

Carcajou Ridge and East Mountain are prominent anticlinal uplifts that have long been well-known landmarks on the northeast bank of the Mackenzie River. The area covered in this report lies between north latitudes $65^{\circ} 35'$ and $65^{\circ} 45'$, and west longitudes $128^{\circ} 00'$ and $129^{\circ} 00'$ (see index map). It includes both sides of the Mackenzie River from "Clam Shell Island" upstream to the mouth of the Mountain River and the northeast side of the river from the Mountain River to the east end of Carcajou Ridge.

Carcajou Ridge is known variously as Roche Carcajou, Wolverine Anticline, Carcajou Mountain, and Carcajou Rock, and received its name from the Indians, who believe a pinnacle of rock by the river bank resembles a wolverine or carcajou (see photograph No. 1). East Mountain and West Mountain are so named because of their position on the east and west sides of the river.

Because of the ease with which this area can be reached, and because of the numerous outcrops in the river banks and vicinity, several geologists have reported on it.

The earliest geological notes on the Mackenzie River Valley are found in the following reference: Dawson, G.M., Collection of Geological notes on the Mackenzie River Valley; Geological Survey of Canada, Annual Report, 1886, Part R. The first actual report was by McConnell (1), who canoed down the Mackenzie in 1888, making notes on the Roche Carcajou and East Mountain. Bosworth (2), in 1914, made sketches of the Wolverine Anticline and East Mountain while he was travelling down the Mackenzie in a steamboat. Link (3), in 1919, made a reconnaissance survey of the

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area adjacent to the Mackenzie, collected fossils, and outlined the general stratigraphy and structure. Kindle and Bosworth (4), in 1920, visited the area, measured a few sections and collected fossils. Link's report helped especially to give the writer a good idea of the nature of the area.

In the spring of 1943, party "D" of the Imperial Oil Limited-Canol Project geological staff was assigned to this area (Assignment No. 6) with instructions to explore for possible oil-containing structures in the low-lying areas between the major anticlinal uplifts. They were to make a geologic map of the area and to measure as many sections as seemed practical. Party "D" consisted of J.A. Simons, assistant geologist, M.M. Hanna, helper, and the writer.

All of the country surrounding this area was mapped by Canol Project geologists in the summer of 1943. McKinnon (5) surveyed the southwest bank of the Mackenzie River down to the mouth of the Mountain River; Smith (6) worked the Hanna River basin to the north and east of this area; Foley (7) explored the area directly to the north of this one; the writer was assigned to the Mackenzie River downstream from this area (8) and the Mountain River (9); Hancock (10) worked the northeast bank of the Mackenzie upstream from this area.

An aerial reconnaissance in the Norseman airplane was made the day before leaving for the field. This flight helped immensely in planning overland routes of travel in the area so that the best exposures might be studied.

Party "D" left Norman Wells in the motor launch Mackenzie, on May 29, with one 18-foot canoe and four weeks' supplies. A cache was made at the mouth of the Mountain River after which they returned up-

stream to the bend in the Mackenzie at the east end of Carcajou Ridge where the party left the MacLiski.

Field Procedure

A base map of the area (scale, one inch equals one mile) had been prepared by Mr. Alec Frame from the Canadian government Mackenzie River traverse and C.P.A. vertical photographs. Approximately half of the area was not covered by photographs. Where the photographs provided coverage, field stations were marked directly on them (C.P.A. Set No. 1) by stereoscopic inspection in the field. Where there were no photographs, field stations were located on the base map by telescopic alidade stadia or Brunton Pace traverses or by Brunton compass triangulation from known points. Nineteen fossil suites were collected. An areal geologic map, scale ~~one~~ one inch equals one mile, accompanies this report (plate I).

Numerous trips inland were made while working down the Mackenzie along Carcajou Ridge, including two overnight pack trips to the Hanna River. Above the Sans Sault Rapids, the party crossed to the cache at the mouth of Mountain River, then went through the Sans Sault Rapids, keeping close to the left bank. The Mackenzie was re-crossed below the rapids, and they then canoed up the "Hanna River" for thirty miles. There are no bad rapids on the Hanna River, and the canoe was lined up those chutes and riffles that were too swift to paddle. One portage was necessary to pass a log jam. The men then paddled back down the Hanna River, stopping to work along the north side of East Mountain. After reaching the Mackenzie, they paddled to the foot of the Sans Sault Rapids, portaged their dunnage, and lined the empty canoe to the head

of the rapids. There they crossed to the mouth of the Mountain River, and were picked up by the motor launch, Gold Nugget on June 26, to return to Norman Wells. A preliminary report (report No. 18, file No. G.C. 43-17) on the area was written in July, 1943.

Accessibility

The central part of the area is about fifty-five miles northwest of Norman Wells. The Mackenzie River is navigable by river steam-boats (large boats have difficulty going through the Sans Sault Rapids at a low water stage) and there are several lakes in the area that are suitable for pontoon plane landing. The Hanna River is navigable only by canoe. Overland travel in the summer is difficult because of the heavy bush, muskeg, and numerous lakes. Winter travel by muskeg schooner, dog team, or snowshoes would present no more than the usual difficulties.

Chapter II

TOPOGRAPHY

The Mackenzie River valley, the two structural limestone mountains, and the surrounding flat muskeg country are the main topographic units. All of this country was glaciated. Pre-glacial relief was probably similar to present relief.

Muskeg is the local name for all flat, lake-dotted, semi-swampy areas in this region, although these muskegs are not like the northern temperate zone muskegs in that there are no deep quaking bogs or swamps (see photograph No. 4). A heavy growth of sphagnum and other mosses is present everywhere in this region, and the vegetation is a typical sub-arctic black spruce climax forest. Aspen, poplar, birch, alder and willow are the main accessory trees.

The Mackenzie River has no recent floodplain, and its present width varies from 3200 to 19,000 feet. The gradient of the Mackenzie ranges from less than one-half foot per mile, to about three feet per mile in the Sans Sault Rapids. These rapids are caused by gently dipping sandstone beds that are underlain and overlain by softer shales. The main current flow of the Mackenzie was estimated to vary between three and five miles per hour. The maximum depth of the Mackenzie is probably about 76 feet, which is the depth recorded by a government sounding near the west end of Carcajou Ridge where the river has its minimum width.

The gross form of the two mountains is due to their structure. Glacial action since orogeny has modified them by major trenching parallel to the anticlinal axes. Minor glacial features on the mountains are distinctive large grooves, glacial lakes, (photographs 5 & 6)

and *roche moutonnée*. The large grooves may be continuous for over 2000 feet and have a width of several hundred feet and a depth of as much as thirty feet. One esker in the center of Carcajou Ridge and located on the areal map looks precisely like a limestone ridge when viewed from the air or on aerial photographs, and even appears to conform with the outcrop trend and dip of the surrounding rocks. The highest point of East Mountain is about 1500 feet above the Mackenzie, and the crest of Carcajou Ridge is about 900 feet above the river. Glacial erratics of igneous and metamorphic rocks were found on the tops of both mountains.

The flat muskeg and lake country is from two to four hundred feet above the Mackenzie and constitutes both a structural and topographic basin. Fluvio-glacial sands, silts and clays cover the muskeg country with a probable maximum thickness of 150 feet. There are small, elongate, indistinct sand bar deposits with a maximum relief of 30 feet in this flat area. The Hanna River, which drains this basin area, is a small meandering stream that flows in a single channel two to ten feet deep and 20 to 70 feet wide. The meanders are well developed, in some cases cut off and abandoned, and are incised to a maximum depth of about one hundred feet. The banks are characterized by large and small mud flows and slumps, which in two places have almost dammed the stream. The large flows are caused by a combination of the following features: 1. Underlying soft argillaceous Cretaceous shales. 2. A surface cover of gummy silts and clays residual from the shales or deposited by glacial streams and lakes. 3. A water lubricated slippage zone near the shale-soil contact and the presence of the permanent frost line near this zone.

Chapter III

STRATIGRAPHY

General

Middle and Upper Devonian, Lower Cretaceous, and Quaternary sediments are present in this area. Differentiation into these groups is based on paleontologic evidence. All fossil determinations were made by Mr. C. R. Stelck at Norman Wells, July, 1943. At the east end of Carcajou Ridge, Cretaceous sediments lie on Devonian beds stratigraphically 1600 feet higher than the Devonian beds at the west end. Because of this large interval removed by erosion, and because of differences in the stratigraphy as a whole, the Carcajou Ridge and East Mountain sections are tabulated separately under each formation heading in the detailed discussion of stratigraphy. Summaries of the stratigraphic sections follow.

(see table on following page)

Carcassou Ridge

<u>Formation or Member</u>	<u>Map Symbol</u>	<u>Thickness in feet</u>
Quaternary unconsolidated sands, silts and clays		0 - 150
---Unconformity---		
<u>Lower Cretaceous</u>		
Sans Sault Sandstone & Shale	Kss	630 incomplete
---Unconformity---		
<u>Upper Devonian</u>		
Norman Sandstone and Shale	Dn	650
Upper Fort Creek Shale	Dfc	975
Reef Limestone		6 - 70
---Unconformity---		
Lower Fort Creek Shale	Dbt	0 - 21
<u>Middle Devonian</u>		
Beavertail Limestone		10
Upper Ramparts Limestone		50
Middle Ramparts Shales	Dr	745
Lower Ramparts Limestone		96 incomplete

East Mountain

<u>Formation or Member</u>	<u>Map Symbol</u>	<u>Thickness in feet</u>
Quaternary unconsolidated sands, silts and clays		0 - 150
---Unconformity---		
<u>Lower Cretaceous</u>		
Sans Sault Sandstone & Shale	Kss	1411
---Unconformity---		
<u>Upper Devonian</u>		
Reef Limestone		200 <u>+</u>
Beavertail Limestone	Dbt	125 <u>+</u>
Upper Ramparts Limestone		60
Middle Ramparts Shale	Dr	565
Lower Ramparts Limestone		200
Bear Rock Dolomite	Dbr	135 Incomplete

In making a geological map of this area, it is impractical to map the lower limit of the Fort Creek Reef Limestone, the top or base of the lower Fort Creek shale, or the top of the Beavertail. For this reason, the Reef Limestone, the Lower Fort Creek Shale, and the Beavertail are all mapped and shown on the cross sections as one unit, identified by the symbol for the Beavertail Formation (Bbt). Plate II is a composite columnar section of the Carcajou Ridge area and Plate III is a composite columnar section of the East Mountain Area.

Detailed Description of Formations

Middle Devonian (?)

Bear Rock Formation

This formation was defined by Link (3), and the type locality is at Bear Rock. Bear Rock beds are exposed in this area only in the cut out center of the East Mountain anticline. These beds are classified as fair source beds for oil. No fossils were found in the Bear Rock formation and it could be Silurian in age.

East Mountain Section - base not exposed.

Dolomite (?) grey, sandy, banded, crystalline in lower part, dark grey and even grained in the upper 30 feet. All highly fractured, petroliferous, contains numerous stylolites and calcite veinlets -----

138 feet

Totals 138 feet

Middle DevonianLong Reach Group (new name)

This name is used to describe the Ramparts and Beavertail formations, which together form a distinct lithologic and paleontologic group of coralline limestones and shales that outcrop extensively in the Long Reach area of the Mackenzie River.

Ramparts Formation

This formation is defined as including all beds below the massive non-shaly coralline Beavertail limestone and above the Bear Rock dolomite. The top of the formation is just above the Stringocephalus zone. The name Ramparts was first used for a formation by Bosworth (2), and the type locality is The Ramparts of the Mackenzie River. The writer worked in The Ramparts after finishing this assignment. In some localities the Beavertail-Ramparts contact is gradational; the upper Ramparts limestones are not shaly, and are just as massive as the overlying Beavertail limestones. The formation is divisible into three natural lithologic members throughout most of the Long Reach area. The following names are used to designate these members: Lower Ramparts Limestone, Middle Ramparts Shale, and Upper Ramparts Limestone. The top beds of the Lower Ramparts Limestone member form prominent dip slopes in the central parts of both mountains. The Middle Ramparts strata are ordinarily not well exposed and the Upper Ramparts limestones form the base of the Beavertail-Reef scarp on the flanks of the anticline.

The Lower Ramparts limestones are frequently very petroliferous, and on Carcassou Ridge contain small grains of bitumen. This member is referred to as a source bed, but cannot be considered as an oil reservoir because the limestone is dense; or if it is coralline and

porous, it usually contains shaly fillings thus eliminating good permeability. The Middle Ramparts limy shales are thought to be the equivalent of Link's (3) Hare Indian River Shale formation. The type locality of that formation is the mouth of the Hare Indian River. They would make an excellent cap rock. The Upper Ramparts limestones are similar to the Lower Ramparts except that they are not as petroliferous, therefore they are classified neither as source nor reservoir beds.

Lower Ramparts Limestone Member (new name)

East Mountain Section

Limestone - dark grey, irregularly bedded to shaly, often a coralline rubble, fine to medium grained, contains many Stromatoporoids ----- 200 feet

Total: 200 feet

Carcassou Ridge section - top to bottom, base not exposed.

Limestone - grey, weathers grey, dense, hard, massive, coarse to fine grained, fossiliferous, petroliferous, contains fine fragments of bitumen, gastropods common, scarp forming ----- 28 feet

Limestone - grey to dark grey, irregular and nodular to massive and platy, bituminous, petroliferous. The nodular beds have an earthy, limy, and shaly matrix. Corals abundant, trilobites fairly common ----- 68 feet

Total: 96 feet

The following suites were collected from the Lower Ramparts
Limestone member on Carcajou Ridge:

Suite 8506

<u>Cladopora roemerii</u>	<u>Proetus sp.</u>
<u>Atrypa spinosa</u>	<u>Acervularia sp.</u>
<u>Camarateochia sp.</u>	<u>Pleurotomaria sp.</u>

Suite 8507

<u>Bellerophon sp.</u>	<u>Proetus sp.</u>
<u>Atrypa (new species)</u>	<u>Martinia sp.</u>
<u>Atrypa independencis</u> (new variety)	<u>Euomphalus sp.</u>
<u>Atrypa spinosa</u>	<u>Actinoceras sp.</u>
<u>Spirifer delthyris</u>	<u>Zaphrentis sp.</u>

Suite 8514

<u>Euomphalus sp.</u>	<u>Cyathophyllum sp.</u>
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Middle Rapparts Shale Member (new name)East Mountain Section - top to bottom

<u>Covered interval</u>	-----	300 (?) feet
<u>Limestone and Shale</u> - alternating 0.2 feet to 2.0 feet beds of thin, platy, limestone, shaly limestone, and limy shale. The beds are ripple marked, and cracked, and contain abundant fucoids, the limestone is dark grey, medium to fine grained. All of these beds weather buff. <u>Atrypa reticularis</u> is common	-----	200 feet
<u>Covered interval</u>	-----	65 (?) feet
		<u>Total: 565 (?) feet</u>

Carcajou Ridge Section - top to bottom

Limestone and Shale - grey hard limestone in 0.3 to 1.0 ft. irregular beds separated by buff sandy earthy limy shale beds 0.7 foot thick. Fossil suites 8508 and 8518 were collected from these beds.

Suite 8508

<u>Paracyclas</u> sp.	<u>Orthoceras</u> (?)
<u>Productella</u> sp.	<u>Gomphoceras</u> (?)
<u>Gyroceras</u> (?)	

Suite 8518

<u>Schizophoria macfarlani</u>	<u>Zaphrentis</u> sp.
<u>Martinia</u> sp.	<u>Paracyclas</u> sp.
<u>Pheladostrophia</u> sp. or <u>Lentostrophia</u> sp.	

Covered interval - similar to above unit but probably more shaly ----- 45 feet

Limestone - rubbly and nodular with grey shale around the nodules, the limestone is dark grey, medium to fine grained, petrolierous and contains many large colonies of Cyathophyllum and Acervularia. Suite 8519 was collected from these beds

Suite 8519

<u>Cyathophyllum</u> sp.	<u>Cladopora</u> sp.
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<u>Pleurotomaria</u> sp.	<u>Martinia</u> sp.
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20 feet

Covered interval	15 feet
------------------	---------

Limestone - coquincid, very thin plates of limestone interbedded with limy shale. Corularia and brachiopods abundant

5 feet

Covered interval	10 feet
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Total: 745 feet

Upper Remparts Limestone Member (new name)East Mountain Section

Limestone - dark grey, brecciated and rubbly, coralline with shaly partings and fillings. Upper 20 feet more massive.

60 feet

Total: 60 feet

Carcajou Ridge Section

Limestone - dark grey, shaly and soft, to massive and non-shaly. The basal beds contain laminae composed of coral fragments. Stringocephalus is abundant. The following suites were collected from this member:

Suite 8509

<u>Stringocephalus</u> sp.	<u>Paracyclas</u> sp.
<u>Douvallina</u> sp.	<u>Pteria</u> (?)

Suite 8510

<u>Frengu</u> sp.	<u>Cyathophyllum</u> sp.
<u>Martinia</u> sp.	<u>Atrypa reticularis</u>
<u>Cladopora</u> sp.	<u>Atrypa devoniana</u>
<u>Pleurotomaria</u> sp.	<u>Atrypa</u> (new species)
<u>Orthoceras</u> sp.	

Suite 8515

Acervularia sp.
Zaphrentis sp.
Atrypa devoniana

Suite 8516

Atrypa devoniana

Maclurea sp.

20 feet

Total: 50 feet

Middle DevonianLong Reach GroupBeavertail Formation

This formation was named by Bosworth (2); the type locality is Beavertail Point on the Mackenzie River. The formation was originally defined in a vague manner, and various geologists have ascribed different lithologic units to it. The original Beavertail probably consisted of the following units, defined in this report: Upper Ramparts Limestone, Beavertail Limestone, Lower Fort Creek Shale, and a Reef limestone, which in this area may rest directly on the Beavertail Limestone. All of these units may vary considerably in thickness and composition, and for this reason the term Beavertail has caused confusion. At the type locality, there are only thirty feet of beds exposed and they comprise a reef limestone, which in that area rests directly on the Beavertail as herein defined. This writer restricts the use of the name Beavertail to beds that are below a bituminous shaly sedimentary phase that is characterized by the brachiopod Hypothyridina castanea, and lie above massive limestones or non-massive shaly limestones containing the black, earthy, limy, and fossiliferous partings typical of the Upper Ramparts limestones. The Beavertail may be composed of either reef or non-reef limestones. The Stringocephalus horizon, in The Ramparts of the Mackenzie River, in the Gibson Range and the Bath Hills, and at Carcassou Ridge, coincides approximately with the top of the Upper Ramparts member. These four localities and Great Slave Lake are the only places in the Northwest Territories where Stringocephalus has been collected to date.

The Beavertail Limestone is believed to be an excellent oil reservoir bed where it is composed of coral fragments.

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Carcajou Ridge Section

Limestone - grey-buff, weathers white to light grey or buff, contains abundant Cladopora (½ inch diameter), some of the beds are composed almost entirely of Cladopora fragments 10 feet

Total: 10 feet

East Mountain Section - The Beavertail formation was not delineated from the reef limestone, which overlies it on East Mountain. Both the Beavertail beds and the overlying reef beds are described in the discussion of the Fort Creek Shale formation.

Upper DevonianCarcajou Group (new name)

The Carcajou Group includes the Fort Creek and Norman formations, which are well exposed on Carcajou Ridge and the Carcajou River.

Fort Creek Formation

This formation was first defined by Link (3), who called it the Hope Shale formation after Old Fort Good Hope, which was located near his type section on Fort Creek. Fort Creek (Thunder River), is a small stream that enters the Mackenzie from the east about 120 miles downstream from the present Fort Good Hope. Bosworth and Kindle (4) called the same formation the Fort Creek Shale, and this name is the one now used. The top of this formation is an arbitrary line placed at a change from a shale to a sandstone depositional phase. The base is placed at the top of the Beavertail formation. In this area, the formation may be divided into three members, the Lower Fort Creek Shale, a Reef limestone, and the Upper Fort Creek Shale. The reef limestone in this region is believed to be an approximate stratigraphic equivalent of the Kee Scarp

reef limestone at Norman Wells. There is an erosional unconformity separating the reef limestone from the Lower Fort Creek Shale member in the Carcajou Ridge area. Ten feet of relief were observed on this old erosion surface. On East Mountain and at the east end of Carcajou Ridge, the reef limestone rests directly on the Beavertail. It is not known whether there was an erosion interval separating the reef deposition from Beavertail deposition where the Lower Fort Creek Shale is absent. Stelck (11) and McKinnon (12) concur with the writer in the hypothesis that this erosional unconformity represents the same erosion period during which older Devonian sediments in the Arctic Red and Upper Peel River areas were removed. In those areas, Fort Creek shales lie unconformably on various parts of the Ramparts formation.

This reef limestone varies tremendously in thickness. Only six feet of it are present at the west end of Carcajou Ridge, while in the central part of the south side of Carcajou Ridge, there are about 70 feet. At the east end of East Mountain, there is a 325 foot section of limestone that probably includes both the Beavertail and the reef limestone, both being developed to a much greater thickness there than anywhere else in this area.

The basal portion of the Upper Fort Creek member is well exposed in the river bank at the west end of Carcajou Ridge, and the upper beds are well exposed in the river bank at the east end of Carcajou Ridge.

The upper part of the reef is very bituminous and petrolierous and is classed as a good source bed. The composition of the reef varies laterally, and some of the beds in it are quite dense and impervious. In general, however, it is classed as a fair to good reservoir bed.

The Lower Fort Creek shales are present to a very limited extent in the area. However, where present, they are classed as fair source beds. The Upper Fort Creek shales are good source beds as they are very bituminous in the lower part. They also constitute an excellent oil reservoir cap rock.

Upper DevonianCarcajou GroupFort Creek FormationLower Fort Creek Shale Member

East Mountain Section - It is believed that there is no Lower Fort Creek on East Mountain; either it was not deposited or it was removed by erosion prior to the deposition of the reef limestone.

Carcajou Ridge Section

Limestone and Shale - alternating beds of chocolate-colored limestones 0.6 to 1.5 feet thick, and chocolate to black shales 0.1 to 0.6 foot thick. These beds are very fossiliferous and most of the specimens are perfectly preserved. The detailed columnar section on Plate VA shows the relationship of these beds to the strata above and below. Suite 8517 was collected from these beds -----

21 feet

Total: 21 feet

Suite 8517

Reticularia franklini
Hypothyridina castanea
Leiorhynchus sp.
Pugnoides sp.
Martinia sp.
Douvallina sp.

Atryna reticularis
Cyrtina sp.
Schizophoria macfarlani
Productella sp.
Crinoid stems

Reef Limestone Member

East Mountain Section - This section includes both the Beavertail and the overlying reef which are not separable in this area. The thickness of this unit varies, 325 feet is approximately the thickness at the east end of the mountain. At the west end it is probably thinner.

Limestone - dark grey, weathers grey to brown, medium to fine grained, petrolierous, mostly massive. Cladopora and Stromatoporoids abundant. The upper 20 feet are very bituminous and petrolierous, and frequently these upper limestones are almost completely composed of 1/8 inch diameter Cladopora fragments in a bituminous matrix. Black shale partings are common throughout this unit. Some of the beds are banded and have a sandy texture ----- 325/- feet

Total: 325/- feet

Carcassou Ridge Section

Limestone - grey buff, weathers white to light grey-buff, medium to coarse grained, massive to nodular and frequently has a bracciated appearance. Usually very coralline, especially the upper few feet. Cladopora with a 1/8 inch diameter is the most abundant form. The Cladopora in the Beavertail commonly have a diameter of 1/4". This difference in diameter is a useful criterion for distinguishing the reef from the Beavertail. Suite 8513 was collected from the reef and Suite 8505 was collected from the reef and the underlying Beavertail.

Suite 8513

Hypothyridina sp. Atrypa spinosa
Atrypa reticularis Martinia sp.

Suite 8505

<u>Cyrtina</u> sp. two varieties	<u>Cladopora dentata</u>
<u>Atrypa devoniana</u>	<u>Cladopora roemeri</u>
<u>Atrypa spinosa</u>	<u>Schizophoria</u> sp.
<u>Martinia</u> sp.	<u>Alveolites</u> sp.

----- 6 to 70 feet

Total: 6 to 70 feet

Upper Fort Creek Shale Member

East Mountain Section - a thin remnant of the Upper Fort Creek Shale is shown on the east end of East Mountain on the areal geologic map (Plate I). This locality was not visited, and it is not known whether there is actually any Fort Creek present there. The formation is shown on the map because it appears reasonable that pre-Cretaceous erosion did not cut as low as the top of the reef in that area.

Carcajou Ridge Section - section from top to bottom.

Shale - black to dark grey, contains a few very thin, grey-brown, micaceous, very fine grained sandstone laminæ. Also contains many dark grey to black concretions with a maximum diameter of 0.2 foot ----- 200 feet

Covered interval ----- 735 (?) feet

Shale - alternating beds of hard, blocky, limy, slaty, black shales, and soft, papery, black shales. Abundant sulphur staining and coating. The blocky layers often break with a conchoidal fracture and sometimes contain large concretions. The blocky layers vary from six feet to 0.1 foot in thickness, and often lens rapidly. The thin papery shale beds are more regular, usually they are 0.3 foot thick. ----- 40 feet

Total: 975 (?) feet

Upper DevonianCarcajou GroupNorman Formation

This formation was originally known as the Bosworth formation and was named by Bosworth (2) at the type locality of Bosworth (Oil) Creek. Link (3) redefined the formation and called it the Norman, which is the name now used. There are partial exposures of this formation at both ends of Carcajou Ridge. It is not present in the East Mountain area, having been removed by pre-Cretaceous erosion. The various sandstones in this formation are believed to be lensing units, and because of this and the incomplete exposures, no differentiation into members is made. Some of the sandstones in this formation could be classed as fair oil reservoir rocks.

Carcajou Ridge Section - top to bottom

Sandstone and sandy shale - the sandstone is grey to brown, weathers brown, is flaggy, fine grained, and well cemented. The sandy shale is grey to brown, mottled and streaked. Devonian corals, brachiopods, and crinoid fragments are present in the sandstone. The interval is partly covered. ----- 200 (?) feet

Shale - dark grey to black, interval partly covered ----- 150 (?) feet

<u>Sandstone</u> - grey brown, weathers buff, bedding planes are 0.1 to 0.4 foot apart. The upper beds are slightly conglomeratic and contain pebbles with a maximum diameter of 1/4 inch. This unit contains many fucoids and also numerous large grey limy concretions that weather red-brown. There is some interbedded shale in these sandstones	30 feet
<u>Sandstone</u> and <u>sandy shale</u> - interval mostly covered -	210 (?) feet
<u>Sandstone</u> - grey to brown, thin bedded, micaceous, contains many fucoids and algae (?)	20 feet
<u>Sandstone</u> , <u>shale</u> and <u>shaly sandstone</u> - the sandstone is similar to that described in the above unit. Mud cracks are present in some of the shaly beds,	40 feet
Total:	650 (?) feet

Lower Cretaceous

Sans Sault Formation (new name)

This formation is defined to include all beds from the base of the Lower Cretaceous upward to the base of a non-sandy, thick shale section. The formation may be subdivided into three natural sedimentary phases, a basal sand, a middle shaly unit, and an upper sand. These units are not given member status as their lensing nature and lack of exposures makes correlation difficult.

The type exposure of these beds is on the west end of East Mountain and both sides of the Mackenzie River at the Sans Sault Rapids. The rapids are caused by the upper sandstones. The basal sandstone is classed as a good reservoir bed, and the middle shales are a good oil reservoir cap rock. No angular discordance was observed between the Cretaceous strata and the underlying Devonian beds.

East Mountain and Sans Sault Section - top to bottom

Sandstone - grey, weathers brown, often shaly, may be mottled or banded, some of the beds are ripple marked, fucoids are common. Contains 0.7- $\frac{1}{2}$ foot thick, grey limestone concretionary beds that weather red brown. The following fossils were collected from these beds:

Suite 8521

<u>Gastropites</u> (?)	<u>Lima</u> sp.
<u>Pleuroxyta</u> sp.	<u>Fucoids</u> (?) very large clams
<u>Bivalanticeras</u> sp.	
<u>Inoceramus</u> sp.	

Suite 8528

<u>Hoplites</u> sp.	<u>Fusula</u> sp.	
		114 feet

Covered interval - probably sandstone and shale similar to the beds above and below ----- 245 (?) feet

Shale - grey green to dark grey, sandy, nodular and irregularly bedded, weathers soft and crumbly, micaceous, contains numerous limonite crystal growths and stains ----- 35 feet

Shaly Sandstone - grey-green, fine grained, micaceous. There is a 0.1 foot- $\frac{1}{2}$ conglomeratic and concretionary zone at the top of this unit ----- 6 feet

Sandstone - light grey-green, fine grained, laminated, contains small stringers of coarser grains. The basal beds are pock-marked and ripple marked. ----- 11 feet

Covered interval - probably shale and sandy shale ----- 950 feet (?)

Sandstone - dark brown to purple, weathers red to grey, fine grained, thin bedded, weathers slabby, limonite stained. ----- 10 feet

Covered interval - probably shaly sandstone and sandstone. ----- 40 feet (?)

Totals: 1411 (?) feet

Caronou Ridge Section - top to bottom, top of formation not exposed.

Shale - grey to black, soft, blocky, contains large septarian ironstone concretions. Interval mostly covered. 400+ feet

Shale - grey to black, interval contains a few 0.5 foot thick beds of grey fine grained sandstone. Interval mostly covered. 200 feet

Sandstone - grey to brown, conglomeratic at base, only exposed at low water and then only poorly exposed. 30 feet

Totals: 630 (?) feet

Caronou Ridge - Hanna River Section. (The following section is exposed in the Hanna River as shown on the areal map (Plate I). Section from top to bottom, top of formation not exposed.

Shale - grey, contains many ironstone concretions and some sandy laminae. 20 feet

Shaly Sandstone 5 feet

Covered interval 50 (?) feet

Sandstone - light grey brown, fine grained, massive to platy, beds are lensing, one shale parting in the unit. 10 feet

Covered interval 120 (?) feet

Sandstone - grey-brown, weathers white to grey brown, fine grained, massive, lower two feet very limy and well cemented. 8 feet

Sandstone - shaly and limy with fine 0.1 foot harder laminae. 4 feet

Sandstone - grey-brown, conglomeratic, pebbles have a maximum diameter of 0.1 foot, medium grained, massive. 3 feet

Total: 220 (?) feet

The following fossils were collected from these beds:

Suite 8511

Beudanticeras sp.

Gastropolites sp.

Pseudoceratite (Hoplite ?) cephalopod

Quaternary

Unconsolidated sands, silts and clays of fluvio-glacial origin cover the flat sections in this area. Some of the sands contain a few igneous, sedimentary and metamorphic boulders. Small fragments (maximum diameter 0.2 inch) of lignite are present in some of the sands. These deposits frequently show stratification. The estimated maximum thickness of these deposits is 150 feet.

Correlation

The Cretaceous strata exposed on the south flank of East Mountain are included in the composite columnar section of East Mountain (Plate III). They are shown to be about 1000 feet above the base of the Cretaceous, however, their exact stratigraphic position is not known. The Cretaceous strata exposed in the cliffs on both sides of the Sault Rapids are believed to be approximately the same series of beds. If this is true, there is no uniform dip in the strata underlying the rapids. The beds there undulate gently and the same horizons are seen on both sides of the river.

Plate VIII illustrates correlations with the surrounding areas. H.T.U. Smith's generalized columnar section of the upper Hanna River Area (6) was reinterpreted. No lithologic unit thicknesses were changed but his formation boundaries were. The other sections shown in Plate VIII were copied without change.

Origin of sediments

The following tabulation is generalized and the origins suggested are based only on field observations.

<u>Formation or Member</u>	<u>Origin</u>
<u>Lower Cretaceous</u> Sans Sault Sandstone and Shale.	Marine deposits, shallow near shore environment. The upper sands show cyclical repetition of types of beds. (Sandstone to shaly sandstones to limestone concretionary band and repeat).
<u>Upper Devonian</u> Norman Sandstone and Shale.	Marine deposits, shallow channelled and irregular ocean bottom giving rise to lensing units. Some cyclical deposition.
Upper Fort Creek Shale	Marine. The lower platy shales are very bituminous. This suggests a partially closed lagoonal environment.
Reef Limestone	Marine, original coral reef deposits and coral clastics, in shallow shoaling seas with probable non-contemporaneous reworking of some of the beds.
Lower Fort Creek Shales	Marine, similar to upper Fort Creek but water probably cleaner and better aerated.
<u>Middle Devonian</u> Beavertail Limestone	Marine, original coral reef deposits, and reef clastics.
Upper Ramparts Limestone	Marine, coral and Stromatoporoid deposits with some shale and lime deposition of chemical origin. The seas were alternately riley and clean and closer to shore than in the above bioclastic deposits.
Middle Ramparts Shale	Marine, cyclical, shallow and slightly turbid water deposits.
Lower Ramparts Limestone	Marine, similar to upper Ramparts Limestone.
Bear Rock Dolomite	Marine, chemical precipitates in a shallow sea.

Dust Mountain and Sans Sault Section - top to bottom

Sandstone - grey, weathers brown, often shaly, may be mottled or banded, some of the beds are ripple marked, facoids are common. Contains 0.7+ foot thick, grey limestones concretionary beds that weather red brown. The following fossils were collected from these beds:

Suite 8521

Gastropilites (?) Lima sp.
Fluviostria sp. Festen (?) very large classes
Bendaticeras sp.
Inoceramus sp.

Suite 8528

Hoplites sp. Pinda sp.

114 feet

Covered interval - probably sandstone and shale similar to the beds above and below -----

245 (?) feet

Shale - grey green to dark grey, sandy, nodular and irregularly bedded, weathers soft and crumbly, micaceous, contains numerous limonite crystal growths and stains -----

35 feet

Shaly Sandstone - grey-green, fine grained, micaceous. There is a 0.1 foot+ conglomeratic and concretionary zone at the top of this unit -----

6 feet

Sandstone - light grey-green, fine grained, laminated, contains small stringers of coarser grains. The basal beds are pock-marked and ripple marked. -----

11 feet

Covered interval - probably shale and sandy shale -----

950 feet (?)

Sandstone - dark brown to purple, weathers red to grey, fine grained, thin bedded, weathers slabby, limonite stained. -----

10 feet

Covered interval - probably shaly sandstone and sandstone -----

40 feet (?)

Total: 1411 (?) feet

A zone of faulting and flowage is postulated in the basement complex, (the present depth to the basement is believed to be twelve to fifteen thousand feet) and movements within this deep zone could find relief by nearly vertical branch faults toward the surface of the earth. The surface structures are believed to represent different stages of development, all caused by varying amounts of similar forces. These stages are: a low relief anticline, a high relief sharply asymmetric overturned anticline, and a reverse fault with great displacement. At the surface, the stage reached depends on the activity of the branch fault. The beginning stage would be caused by a fault which extended only a short distance up from the deep zone. The relative movement in the basement zone would determine the angle at which the branch fault joins the main fault zone, and thus the direction of dip of the fault (or overturn) at the surface.

Detailed Discussion of Structures.

Carsonou Ridge (see Plate J and Photographs 12 and 13)

This structure is an asymmetrical anticline with the steeply dipping side facing south. It is about twenty miles long and three miles wide but only the western twelve miles form a prominent topographic feature. The axis trend is east-west and the axis itself is well exposed along the whole length of the anticline except for a short distance in the central part of the western half of the structure. The axis of the structure dips obliquely against Pine Mountain which is an antecedent mountain. According to this it is a normal fault on the end of Carsonou Ridge or faulting and folding in the basement. A major fault.

eighty two degrees and on the north side from five to twenty degrees. The west end flattens out and plunges in a westward direction under the Mackenzie River at about ten degrees. The axis of the anticline is relatively straight. Where the Mackenzie River flows along the south flank minor sinuosity in the axis are indicated almost perfectly by a corresponding change in direction of the slope line.

Small faults parallel to the general strike, with only a dip-slip displacement at a low angle to the bedding and with only a few feet of displacement, were observed on the north limb of the anticline.

The Miller deposit of 1970 is the fourth veinlet system
belt on the south-west side of Garryville which contains a number of
parallel to the strike in the bedrock with thicknesses ranging from
feet up to several hundred.

work the Buffalo for a temporary suspended sentence but he denied this at the trial and, the court rejected this as an admission. The sentence (between six and eleven years) was an effort to satisfy demands. The trial committee twice called him and he twice refused. The sentence was suspended and he was not sentenced at the trial and will probably be the subject of the next trial. The trial of the case in the court and of course, will necessarily coincide with the trial of the case of the Buffalo.

faulting is well exposed in the tightly compressed axial region in the central part of the mountain. The axis is not exposed in the overturned part of the structure and its position is only suggested. It is possible that reverse faulting of some magnitude occurred on the north flank of the overturned portion but there are no outcrops there which would make it possible to determine if such faulting took place.

East Sans Fault Structures (east side of the Mackenzie River, see Plates I and VI).

A complex group of branching normal and reverse faults is present in the Cretaceous strata lying on the north side of the west end of East Mountain. These faults are steeply dipping and it is believed that all of them have relatively minor displacement. They are believed to have been caused by the same forces which formed East Mountain. Downstream from these faults there is a reversal in dip (a dip toward East Mountain). This reversal was only seen in one rather poor sandstone outcrop, and downstream from this reverse dip the next dip recorded is a north dip (away from East Mountain). The reverse dip may have been caused by a large slump block, by a fault which is not exposed and which rotated these beds from their original inclination, or by an anticlinal structure.

West Sans Fault Structures (west side of the Mackenzie River, see Plates I and VII).

West and north of East Mountain the dip flattens and the strata form a gently rolling terrace. The beds probably have a general dip down to the northwest somewhere beyond the west bank of the Mackenzie. Two small anticlines are present in the Cretaceous strata on the west side of the Mackenzie opposite the Sans Fault Rapids. The dip of the rocks upstream and downstream from these anticlines show that they are minor wrinkles on the top of a larger anticlinal structure. The axis of this

larger structure is not exposed.

From the top of East Mountain, two indistinct elongate knolls 1800 feet west of the west bank of the Mackenzie are visible in the area where the two small anticlines are located. These small topographic highs, which are in line with each other, suggest an anticlinal axis of the larger structure that trends N 25° E. This trend is at right angles to the axial trend of the two small anticlines. As far as could be determined from the field work there is approximately eighty feet of closure in the minor arches in a line parallel to the river and a minimum of 140 feet of closure along the same trend in the whole uplift. Strikes and dips measured opposite the upstream tip of Glam Shell Island indicate some closure to the east and west at the north end of the major arch.

A wildcat location (see Plate I and Chapter VII) is recommended to test this structure. Because of the incomplete knowledge of the structure, both as to its size and position, a wildcat should not be drilled unless seismograph work confirms the presence of closure and possibly gives a better outline of the anticline.

Incompetancy of the Cretaceous strata is indicated by the small faults which relieve the low angle flexures on these arches. Because of this incompetency, the surface structure is probably not an accurate reflection of the underlying structure in the Devonian rocks.

Chapter V.

HISTORICAL GEOLOGY.

The discussion of geologic history is not limited to the Carcassou Ridge-East Mountain area, but will include the adjacent areas in which the writer worked, namely: The Imperial and Mountain River areas, the Bosworth and Oscar (Morrow) Creek areas, and The Rampsarts area on the Mackenzie River. General references will be made to these and other areas without specific acknowledgement as the ideas set forth in this chapter are the result of numerous discussions on the subject with all of the Canol geologists during the 1943 field season. Discussion of the sedimentary record will not include any beds older than the Bear Rock formation. It must be kept in mind that little detail is known about the areas surrounding the country explored by the Canol geologists, and therefore the following statements are based on incomplete evidence.

Deposition of the Bear Rock formation followed an erosional unconformity which may have been of considerable duration in some localities. The lower Bear Rock strata includes dolomites, limestones, and salt and gypsum beds. The evaporites are best developed in the area between the Upper Hanna River area and the Oscar (Morrow) Creek basin. No evaporites are found in the Bear Rock strata on the Mackenzie Mountain front. The relationship of the salt and gypsum beds to the dolomites is not clear, as the correlations made so far are based on rather meager data. The evaporites may have been deposited only in low areas on the old Silurian land surface. This deposition was followed by further erosion, which was followed by general submergence and flooding.

The following sequence of events is suggested as the origin of

the Bear Rock limestones and dolomites: Chemical precipitates of calcium carbonate were subsequently partially changed to dolomite by the action of magnesium carbonate which was deposited later than the calcium carbonate. Post-depositional deformation and brecciation of the Bear Rock deposits occurred some time after lithification and before the end of the most recent orogeny. In the areas where there are evaporites, this deformation had two causes; first, volume expansion, caused by the change of the underlying and in some cases interbedded anhydrite into gypsum; and second, incompetancy of these beds during regional deformation. In the areas where there are no evaporites the deformed zones in the Bear Rock are thought to be intra-bed movement breccias formed during regional folding. This intra bed brecciation was intensified because of slight original wrinkling due to dolomitization.

A possible alternative to the above theory of the origin of the Bear Rock breccia is: Changing sea levels left large areas of the newly deposited beds exposed to the air. Previous to, or during this exposure, partial lithification took place. Before resubmergence the beds were broken up. It is conceivable that any or all of the following forces caused the brecciation: 1. differential leaching followed by collapse, 2. shrinkage and cracking, 3. wave action, 4. crustal movements such as earthquakes. This theory would account for the occurrence of brecciated beds between lithologically similar regularly bedded strata. Given three similar units of beds it is hard to conceive that one would react incompetantly during regional deformation and beds above and below it would react competantly.

Deposition of the Rasparts formation followed Bear Rock time without any decided break in sedimentation. The initial Rasparts beds are dark

bituminous limestones, and the upper Bear Rock beds are usually dark bituminous non-fossiliferous and often sandy dolomites. Sea conditions became favorable for organisms, and the lower Ramparts limestones grade upwards into coralline and Stromatoporoidal limestones. This was followed by a change in sea level and source materials and the deposition of the Middle Ramparts limy shales and limestones with their abundant content of brachiopods, corals, gastropods, trilobites, crinoids and cephalopods. This shaly phase attained its maximum development west of a line drawn between the Imperial River and the west end of Paige Mountain, and away from the Mackenzie Mountain front. This shaly phase grades upwards into another coral and Stromatoporoidal limestone series that is terminated in most localities by Cladopora reef beds, (Beavertail age). Southeast of Carcajou Ridge, this reef development was followed by a new phase of shale deposition (lower Fort Creek), while to the northwest, limestone deposition continued, although it contained a higher bitumen and organic matter content than the earlier reef beds.

While lower Fort Creek shales were being deposited to the south and east of Carcajou Ridge and reef limestones were being deposited to the north and west, erosion was taking place in the Carcajou Ridge area and in some areas to the north and west. This erosion cut the lowest in an area connecting the Upper Peel and Arctic Red River areas with the Fort Creek (Thunder River) area on the Mackenzie River. In these places, upper Fort Creek shales rest on middle and lower Ramparts strata. A widespread sea invasion followed with both reef limestone and shale deposition either being initiated or continued over all of the lower Mackenzie basin area (Kee Scarp and upper Fort Creek time). In the areas where reefs were being deposited, a sudden break occurred and

shale deposition began. Fort Creek time ended everywhere with shale deposition. This shale series changed gradually to a sandstone phase, and Norman time began. Norman deposition was interrupted by a short erosion period as evidenced by the intra-formational breccias and conglomerates found in the lower Norman limy sandstones in the Imperial and Mountain River areas and on Carcassou Ridge. The upper Norman beds contain varying amounts of sandstone, shale and limy sandstone and then suddenly change to a relatively pure shale phase, which shales are the latest Devonian beds so far as is known in this region.

A lengthy and extensive hiatus occurs after the deposition of the Norman sandstones and shales, as the next highest beds are Lower Cretaceous in age. It is probable that upper Devonian sediments, the Fort Creek and Norman formations, were not developed to anywhere near the same thicknesses in different parts of the region, but as Cretaceous beds are found resting on strata as low as the Upper Rangely limestones in parts of this region, it is not possible to determine the extent and thicknesses of Upper Devonian deposition.

No angular discordance between Devonian and Cretaceous strata was observed anywhere in the area. Cretaceous deposition began with a conglomeratic sandstone. On the south side of the Imperial Range the base of the Cretaceous is marked by a pebble conglomerate. A lower Cretaceous fauna is not recognized east of the Imperial River area, and it may be that this area is the eastern limit of Lower Cretaceous deposition. The lower Cretaceous beds consist of a thick series of lensing sandstones and shales, the Sams Sault formation. This is followed in the Imperial and Mountain River area by a thick series of non-fossiliferous dark gray to black shales which contain thin ironstone concretionary beds, the Sperry shales. The type exposure of these beds

is in the Sperry Creek area on the Mountain River. The Sperry shales may be the equivalent of the Slater River shales found in the Little Bear River area. The Slater River shales are the basal Cretaceous shales found in that area.

The Sperry shales are overlain by coarse grained sandstones and grey shales in the Mountain and Imperial River area. This series of beds is called the Link formation, and the type locality is Link's Bend of the Imperial River. The Link formation possibly correlates with the Little Bear formation in the Little Bear River area. Similar appearing huge Inoceramus forms are found in both the Link formation and the Little Bear formation. These coarse-grained sandstones are overlain by grey shales in both the Mountain River and Little Bear River areas and these shales are the highest Cretaceous beds known in the region.

The major mountain-building in this region occurred in late Cretaceous time. This orogeny was followed by deposition of continental Tertiary coarse sands, gravels and lignites over parts of the region. The Tertiary-Cretaceous unconformity is angular.

During Pleistocene time, a large continental glacier moved across the region from the southeast to the northwest. The movement of the ice roughly paralleled the front of the Mackenzie Mountains, and the ice covered all of the land except the tops of the peaks in the Mackenzie Range. Glacial erosion did not modify the major topographic form of the region.

During the retreat of the glacier, succeeding outwash streams reworked the Tertiary deposits and built terraces on the flanks of the Discovery Range and in the major stream valleys in the Mackenzie Mountains. Outwash deposits of sand, silts, and clays now cover all of the lower

levels of flat country in the area. Some changes in the drainage pattern were effected during the Pleistocene and Quaternary periods.

A recent rejuvenation of the whole region is indicated by the general topographic form and drainage characteristics. Many of the smaller streams have deeply incised meanders.

Chapter VI

OIL AND GAS MANIFESTATIONS AND MINERAL DEPOSITS

Several questionable oil seepages were observed in the area and they are all shown on the areal map (Plate I). These seeps (?) were all similar in nature and consisted of small puddles of oil on the Mackenzie River beach. Gas bubbles in connection with these seeps were only observed in the river at the farthest seepage upstream at the edge of Carcajou Ridge. It is possible that these oil puddles are river and ice deposits and that the oils' source was a leaking pipe line at the Norman Wells oil field.

Gas bubbles were observed in the water at the upstream mouth of the Carcajou River but no oil scum or stainings were seen there.

Iron films are common on the muskeg area ponds and streams. The muskeg streams all have a characteristic "strong tea" color due to their high humic acid content, but, neither the iron films nor the brown colored water have any connection with oil.

Nearly all of the limestones in the area are petroliferous and the upper beds in the Fort Creek reef limestones have a high bitumen content. The basal portion of the upper Fort Creek shales are very bituminous.

Several sulphur springs are present in the area and their locations are marked on the areal map. The sulphur spring in the central part of the overturned portion of East Mountain issues from a limestone cavern. The Beavertail and the overlying reef beds, and the Bear Rock dolomites, are believed to be the source of the sulphur water.

Chapter VII.

CONCLUSIONS AND RECOMMENDATIONS.

Conclusions

Carcajou Ridge and East Mountain are on the north side of a structural basin which is believed to be a good potential oil producing area. The stratigraphic features observed in the area studied which show the possibilities of the basin are:

1. The presence of good source beds, the highly bituminous Fort Creek shales. It is also possible that the reef limestones, and the Beavertail, Rasparts, and Bear Rock formations could be source beds.
2. The presence of good reservoir beds below and above the source beds, namely the reef limestones and the basal Cretaceous sandstones.
3. The presence of two erosional unconformities, a minor one (in this area), at the base of the Fort Creek reef limestone, and a major unconformity separating the Cretaceous from the Devonian. About 1600 feet of sediments under the basal Cretaceous beds have been removed between the east end of Carcajou Ridge and the west end of East Mountain.
4. The presence of good oil reservoir cap rocks; the upper part of the upper Fort Creek shales, and the shales in the middle of the Sans Sault formation.

Closed anticlinal structures are not a necessary pre-requisite for an oil trap in this basin. A stratigraphic trap could be formed by the pinching out of porous reef beds under a cap rock and above a non-porous limestone or shale. It is also possible that the buried Cretaceous-Devonian erosional unconformity could truncate a sequence of beds in the

Recommendations - Wildcat Location

It is recommended that a wildcat be drilled on the west bank of the Mackenzie River opposite the Sans Sault Rapids, at the location shown on the areal map (Plate I). This location is at the edge of the above mentioned basin area and is located on a surface anticline (see Plate VII), where the upper beds in the Sans Sault formation are exposed. Across the river from this location, on East Mountain, the reef limestones which underlie the basal Cretaceous sandstone are very bituminous.

It is not known whether the structure at the proposed location is a closed anticline. Field work in the area suggests closure to the north, south and east with a minimum vertical relief of about 100 feet. As the structure is on the southeast flank of a synclinal basin closure to the west is probable. The possible producing horizons at this location would be the basal Cretaceous sandstone and the underlying reef limestone. The location is placed on the northernmost of the two small anticlines because it is believed that there is a better chance of eastward closure being present there. The calculated depth to the top of the reef limestone at the proposed location is 1380 feet. This figure is an estimate obtained from cross sections on which there is incomplete strike and dip control.

Before a well is drilled at this location, it is recommended that a seismograph survey be made of the location to confirm the presence of closure. The area surveyed should include the west bank of the Mackenzie River between the mouth of the Mountain River and P.M.O. 6. If feasible, seismograph records should be obtained on Clam Shell Island. If a well

is drilled at this location, and the Cretaceous sandstones, the reef limestone, and the underlying beavertail limestone prove barren, it is recommended that drilling be continued down through the Bear Rock formation. In adjacent areas where the Bear Rock beds are exposed, it is believed that they have sufficient porosity and permeability to act as reservoir beds, and the Bear Rock everywhere has a considerable bitumen content. This wildcat location is classified as a fair prospect. A proposed road location to the proposed well site is shown on the areal map (Plate I). The river adjacent to the location is too shallow for large boats and there is a sixty-foot cliff at the river's edge.

Recommendations - General.

Because it is more accessible and the surrounding areas have been more thoroughly explored, the basin to the south of the Carcajou Ridge-East Mountain area is at present a better prospecting area than the basins to the north of the report area.

As outcrops are very scarce in the basin areas, and as surface structure does not reveal the presence of buried reef limestones, seismograph prospecting should precede exploratory drilling in the basin areas. Preparation of paleo-geographic maps would help to delineate the best prospecting areas.

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

1. McConnell, R.C. Report of an exploration in the Yukon and Mackenzie Basins, N.W.T., 1887-1888; Geological Survey of Canada, Annual Report 1888-1889, Volume IV pp. 5-163.
2. Dawson, T.O. Geological Report on the Mackenzie River Basin, 1914; privately distributed.
3. Link, T.A. Geological Report on the Lower Mackenzie River Basin, N.W.T., 1919; Imperial Oil Limited; privately distributed.
4. Kindle, E.M. and Dawson, T.O. Oil Bearing Rocks of the Lower Mackenzie River Valley; Geological Survey of Canada, Summary Report, 1920, part B, p.37.
5. Holliston, F.A. Report on the South Bank of the Mackenzie River from Hoosier Ridge to the Mountain River, N.W.T., Canada, 1944. Final Geological Report, Imperial Oil Ltd., Canol Project, assignment No. 7; privately distributed.
6. Smith, H.T.H. Report on the Hanna River Area, N.W.T., Canada, 1943. Final Geological Report, Imperial Oil Ltd., Canol Project, assignment No. 25; privately distributed.
7. Foley, F.J. Report on the Donnelly River Area, N.W.T., Canada, 1944. Final Geological Report, Imperial Oil Ltd., Canol Project, assignment No. 26; privately distributed.
8. Parker, J.H. Report on the Mackenzie River Area between the Sans Sault Rapids and The Ramparts, N.W.T., Canada, 1944. Final Geological Report, Imperial Oil Ltd., Canol Project, assignment No. 31; privately distributed.
9. Parker, J.H. Report on the Mountain River Area, N.W.T., Canada, 1944. Final Geological Report, Imperial Oil Limited, Canol Project, assignment No. 19; privately distributed.

Bibliography cont'd

10. Hancock, W.P.

Report on the North Bank and Islands of the Mackenzie River, Norman Wells to Carcajou Rock, N.W.T. Canada, 1944. Final Geological Report, Imperial Oil Limited, Canol Project, assignment No. 39: privately distributed.

11. Stelck, G.R.

Report on the Upper Peel River Area, Yukon, Canada, 1944. Final Geological Report, Imperial Oil Limited, Canol Project, assignment No. 23: privately distributed.

12. McKinnon, F.A.

Report on the Arctic Red River, N.W.T. Canada, 1944. Final Geological Report Imperial Oil Limited, Canol Project, assignment No. 22: privately distributed.

Photograph No. 1
Taken by E. J. Foley, 1943.

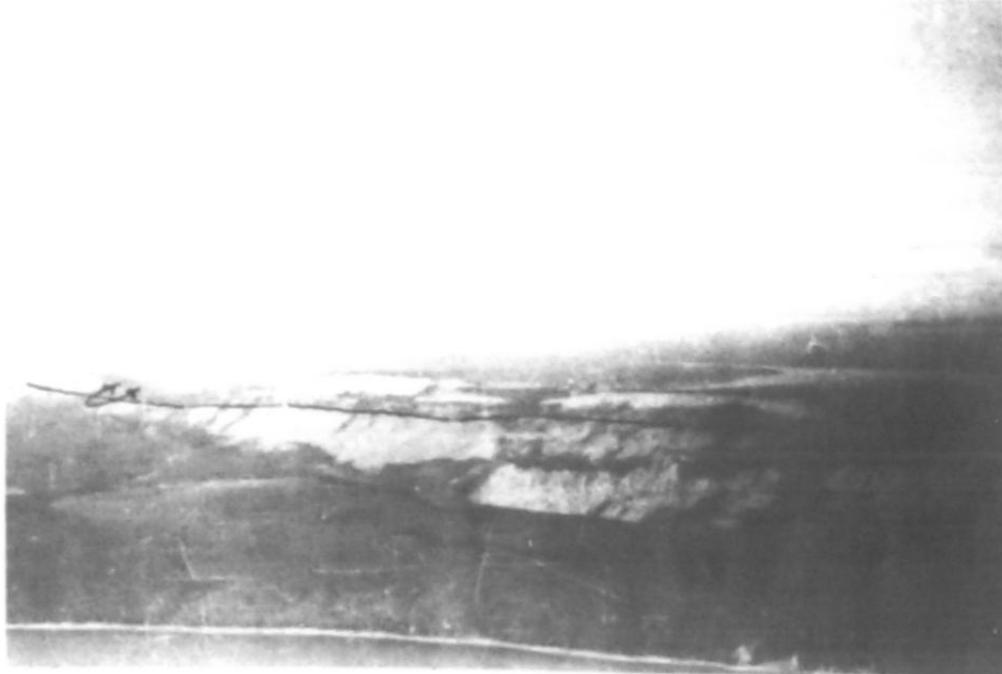


WEST

EAST

View of the cliff at the Mackenzie River's edge on the south side of Carcajou Ridge. The strike is parallel to the edge of the river and the dip is about seventy degrees toward the river. From left to right the following beds can be seen in the picture: the massive, rough weathering and pinnacle forming Reef limestones, thin bedded lower Fort Creek siltstones, and the Beavertail limestones. The pinnacle in the upper central part of the picture is the original Carcajou Rock. The Indians believe that this rock resembles a wolverine or Carcajou.

Photograph No. 2
7-5-43, 8:15 p.m., 1/100, f.8, inf., filter



EAST

WEST

Aerial view of East Mountain looking to the southeast. The Mackenzie River shows at the bottom edge and in the background of the picture. The glacially effected erosion of the north side of the mountain shows clearly in this picture. The south side of the structure is a dip slope.

Photograph No. 3
6-7-43, 9:50 p.m., 1/50, f.16, inf.

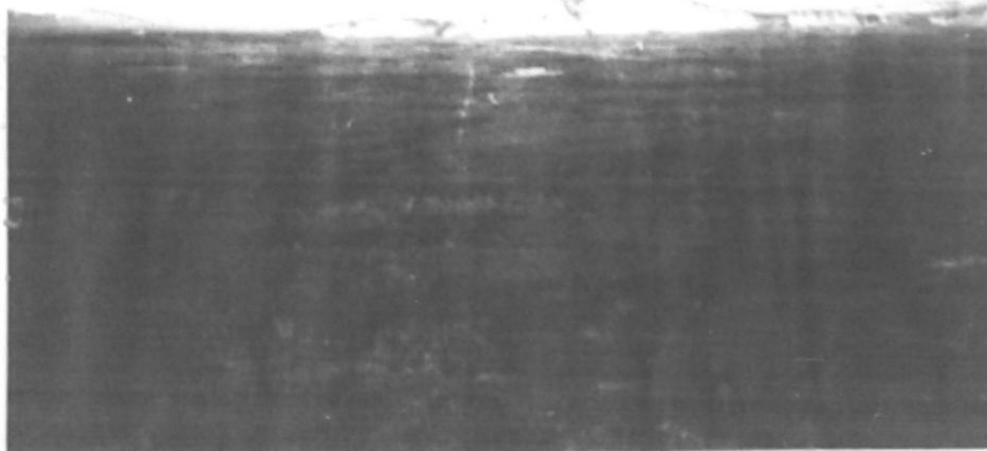


NORTH

SOUTH

View of the south side of Carcassou Ridge looking east and up the Mackenzie River, from a point opposite Maida Creek.

Photograph No. 4
6-23-43, 5:00 p.m., 1/50, f.16, inf., filter



WEST

EAST

View to the north-northeast from the central part of East Mountain. The flat muskeg country is the Hanna Basin. The closest mountain in the background is Mount Dellis, and the range at the horizon is the West Virginia Hills - Battle Axe Range.

Photograph No. 5
6-21-43, 8:00 p.m., 1/25, f.16, inf.



SOUTH

NORTH

View looking to the west at Joe's Lake in the center of the eastern part of East Mountain. West Mountain is visible in the background across the Mackenzie River.

Photograph No. 6
6-1-43, 2:30 p.m., 1/75, f.11, inf., filter

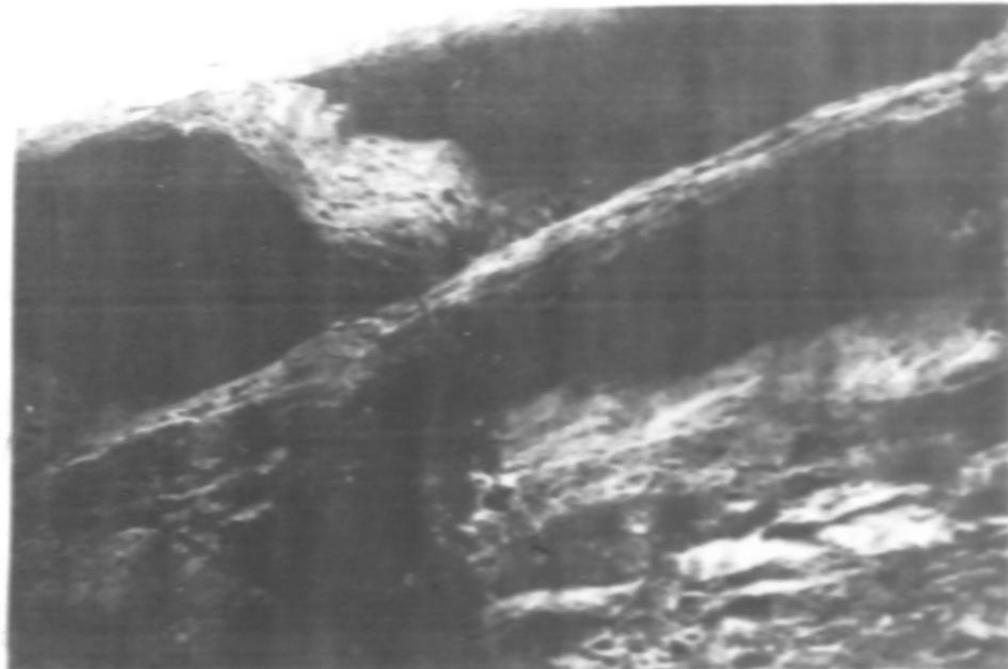


SOUTH

NORTH

Lake Jan in the central trench in Carcajou Ridge. The Fort Creek Reef limestone lies at the top of the scarp on the right side of the lake, and the upper beds of the Lower Ramparts Limestone Member form the dip slope seen in the left background.

Photograph No. 7
6-1-43, 9:40 p.m., 1/50, f.8, 40 feet.



Coralline reef limestone (Beavertail and the overlying Reef) in the cliff on the north side of Lake Jan. An eagles nest is just above the top of the spruce tree.

Photograph No. 8
6-21-43, 7:35 p.m., 1/25, f.16, inf.



NORTH

SOUTH

View looking east up the Hanna River basin. The high limestone scarp in the foreground is the north side of the east end of East Mountain.

Photograph No. 9
6-23-43, 7:30 p.m., 1/50, f.16, inf.

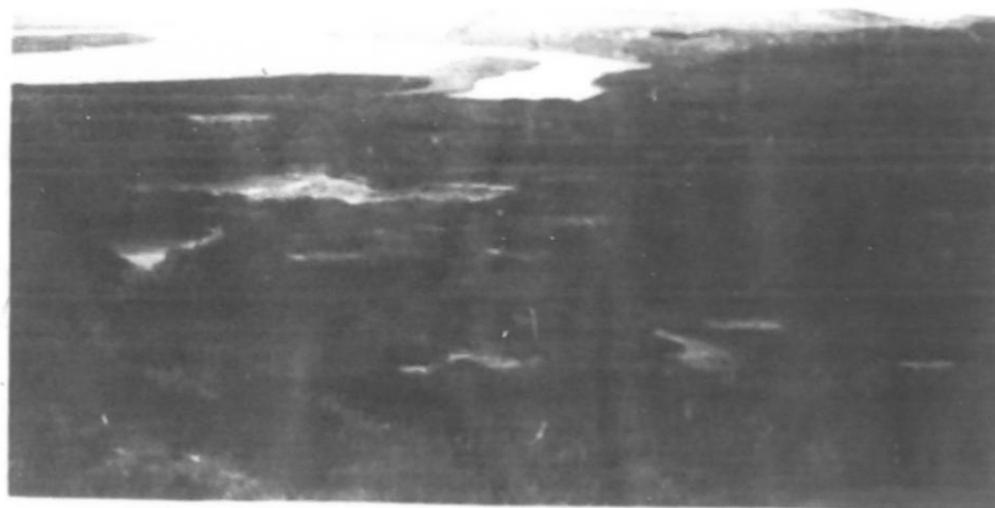


NORTH

SOUTH

View looking east along the top of Fast Mountain. This picture was taken near the central portion (cross section B-B') of the mountain. The dip slope on the south side of the mountain is well shown in this picture. The Gibson Range is in the background.

Photograph No. 10
6-23-43, 5:00 p.m., 1/50, f.16, inf., filter



WEST

EAST

View looking northwest at the Mackenzie River from the top of the central part of East Mountain. The Bath Hills and Beavertail Mountain are visible in the right background.

Photograph No. 11
6-23-43, 7:30 p.m., 1/50, f.16, inf., filter



EAST

WEST

View of the structural and topographic basin south of East Mountain. The horizon is formed by the Mackenzie Mountains and the range in front of the Mackenzies is the Imperial Range. In the right central part of the picture, and behind the second island in the Mackenzie River, the mouth of the Carcajou River is visible.

Photograph No. 12
Taken by F. J. Foley, 1943



WEST

EAST

Aerial view looking northeast at Carcajou Ridge and the Mackenzie River. The closest range in the background is the Gibson Range.

Photograph No. 13
Taken by E. J. Foley, 1943.

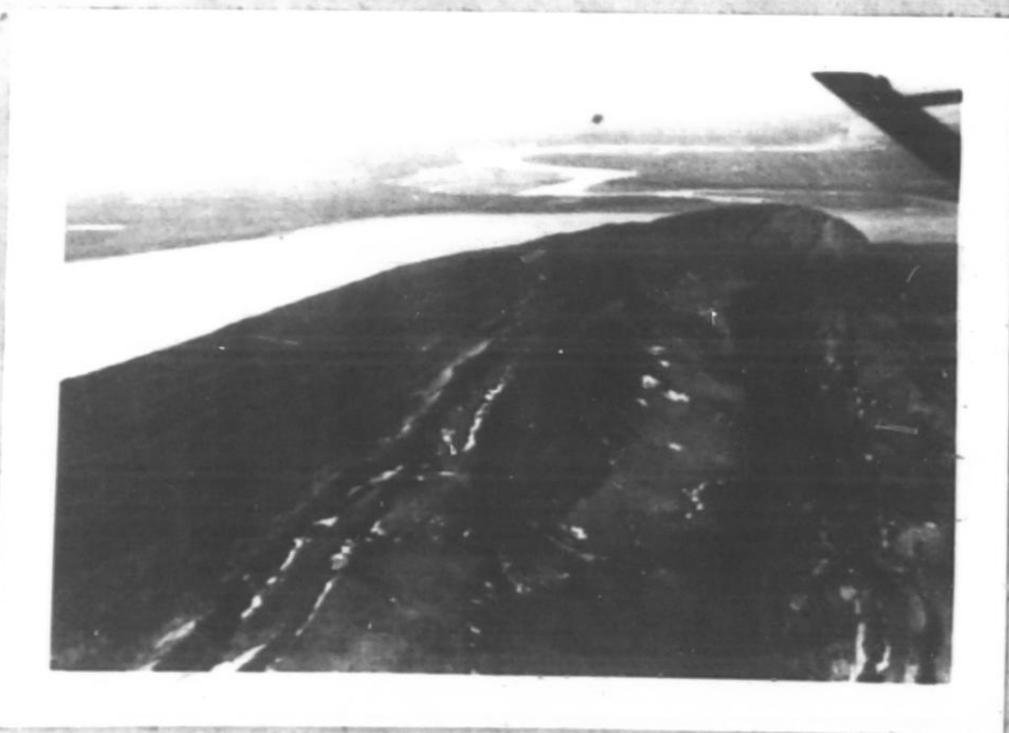


WEST

EAST

View from the Mackenzie River looking northwest at Carcajou Ridge. The beds close to the right margin are middle Ramparts limy shales. To the left of these beds and farther from the camera the axis of the anticline can be seen, with an arching dip slope of lower Ramparts limestones exposed below the axis. The rocks near the left margin and close to the river, are nearly vertical beds of the Beavertail and Reef limestones.

Photograph No. 14
Taken by Dr. T. A. Link, 1943



SOUTH

NORTH

Aerial view of the western part of East Mountain. The anticlinal axis goes through the highest part of the arch at the end of the mountain, and can also be seen in the picture for a short distance close to the right margin. The Mountain River and its junction with the Mackenzie River can be seen in the background.

APPENDIX

January 12, 1944.

MEMORANDUM:

TO: Dr. T. A. Link.

RE: Fossil Identification

Attached is a tentative identification of fossils
collected by Mr. John M. Parker on Assignment No. 6 -
Carcajou Rock - East Mtns.

C. R. Stelek.

KH/cm

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FOSSIL IDENTIFICATION
CARCAJOU ROCK - EAST MIN. - By J. M. Parker.

<u>Suite No.</u>	<u>Date</u>	<u>Location</u>	<u>Fossil</u>	<u>Accession No.</u>	<u>Age.</u>
8505	May 31	East end Carcajou Ridge	Alveolites	42136	Beavertail
"	"	"	Cladopora	42137	"
"	"	"	Hederella	42138	"
"	"	"	Cyathophyllum	42139	"
"	"	"	Atrypa	42140	"
"	"	"	Cyrtina	42141	"
"	"	"	Martinia	42142	"
8506	June 1	East end Carcajou Ridge	Atrypa spinosa	42132	L. Ramparts
"	"	"	Proetus	42133	"
"	"	"	Pachyphyllum	42134	"
"	"	"	Cladopora	42135	"
8507	June 1	East end Carcajou Ridge	Atrypa	42143	L. Ramparts
"	"	"	Euomphalus	42144	"
"	"	"	Trilobite	42145	"
"	"	"	Spirifer	42146	"
"	"	"	Zaphrentis	42147	"
8508	June 1	East end Carcajou Ridge	Paracyclas	42148	M. Ramparts
"	"	"	Gyroceras	42149	"
"	"	"	Orthoceras	42150	"
"	"	"	Atrypa	42151	"
8509	June 1	East end Carcajou Ridge	Stringocephalus	42152	U. Ramparts
"	"	"	Paracyclas	42153	"
"	"	"	Pteria	42154	"
"	"	"	Productella	42155	"
8510	May 31	East end Carcajou Ridge	Atrypa	42156	M. Ramparts
"	"	"	Pleurotomaria	42157	"
"	"	"	Cladopora	42158	"
"	"	"	Orthoceras	42159	"
"	"	"	Proetus	42160	"
8511	June 3	Hannah Cr. N. Carcajou Ridge	Hoplites	42161	Cretaceous
"	"	"	Beudanticeras	42162	"
8512	June 4	East end Carcajou Ridge	Amphicoelus	42163	M. Ramparts.
"	"	"	Paracyclas	42164	"
"	"	"	Productella	42165	"
"	"	"	Fucoids	42166	"
8513	June 6	Central Part Carcajou Ridge	Hypothyridina	42167	Ft. Creek
"	"	"	Atrypa	42168	"
8514	June 6	Central Part Carcajou Ridge	Euomphalus	42169	L. Ramparts.
"	"	"	Cyathophyllum	42170	"
8515	June 6	Central Part Carcajou Ridge.	Zaphrentis	42171	U. Ramparts.
"	"	"	Acervularia	42172	"
"	"	"	Atrypa	42173	"
8516	June 6	Central Part Carcajou Ridge	Macularea	42174	U. Ramparts.
"	"	"	Atrypa	42175	"
8517	June 6	Central part Carcajou Ridge	Hypothyridina	42176	Ft. Creek

<u>Suite No.</u>	<u>Date</u>	<u>Location</u>	<u>Fossil</u>	<u>Accession No.</u>	<u>Age</u>
8517	June 6	Central Part Carcajou Ridge	Reticularia	42177	Ft. Creek
"	"	"	Leiorhynchus	42178	"
"	"	"	Atrypa	42179	"
"	"	"	Cyrtina	42180	"
"	"	"	Productella	42181	"
"	"	"	Martinia	42182	"
8518	June 6	Central Part Carcajou Ridge	Cystiphyllum	42183	M. Ramparts.
"	"	"	Paracyclas	42184	"
"	"	"	Schizophoria	42185	"
"	"	"	Martinia	42186	"
8519	June 8	Central Part Carcajou Ridge	Cyathophyllum	42187	L. Ramparts.
"	"	"	Martinia	42188	"
8520	June 8	Central Part Carcajou Ridge	Bellerophon	42189	M. Ramparts.
"	"	"	Hypothyridina	42190	"
"	"	"	Cystiphyllum	42191	"
"	"	"	Amphicoelus	42192	"
8521	June 15	Upstream end of Big Island below Sans Sault Rapids	Pleuromya	42193	Cretaceous
8522	June 23	East Mountain	Acervularia	42194	Ramparts
"	"	"	Orthoceras	42195	"
"	"	"	Atrypa	42196	"
"	"	"	Pleurotomaria	42197	"
8523	June 23	East Mountain	Atrypa	42198	Ramparts
8508	June 1	East end Carcajou Ridge	Gyroceras	42199	M. Ramparts
8521	June 15	Upstream end Big Island below Sans Sault Rapids	Hoplites	42200	Cretaceous
"	"	"	Beudanticeras	42201	"
"	"	"	Pecten	42202	"
8512	June 4	East end Carcajou Ridge	Gyroceras	42203	M. Ramparts

30

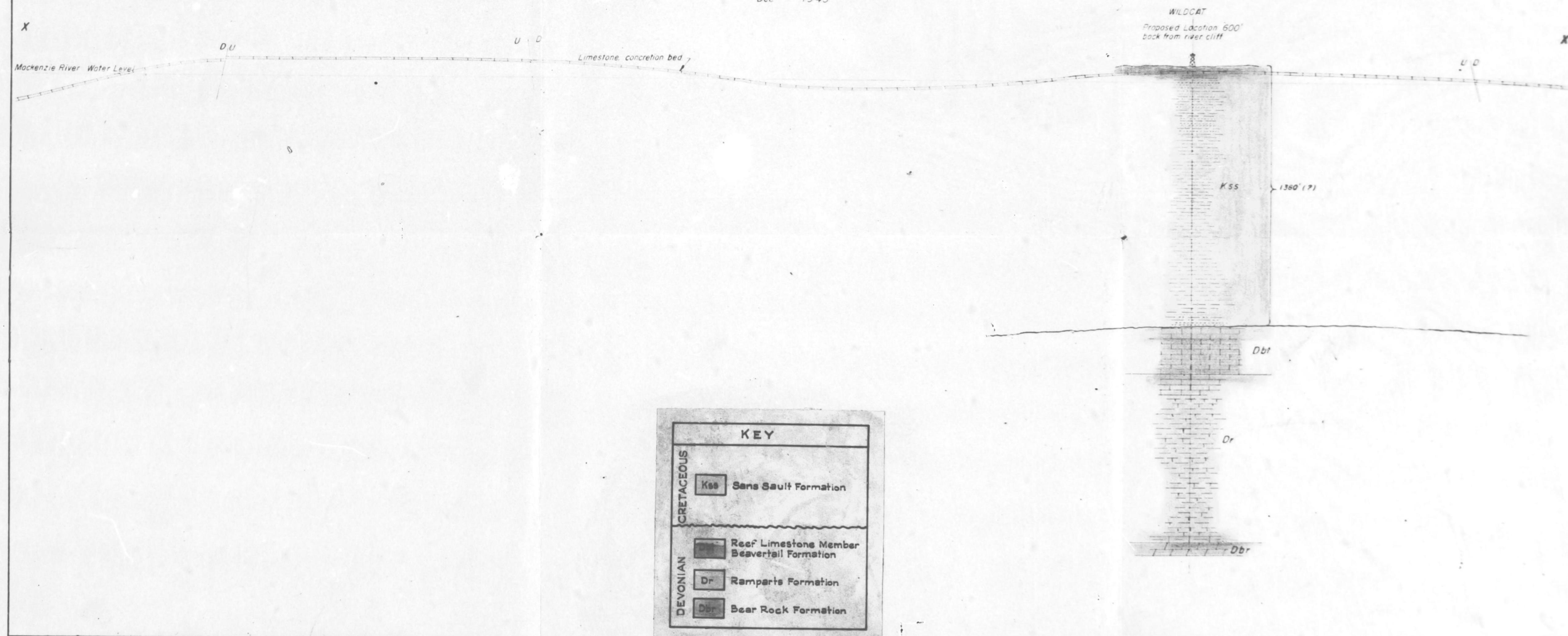
CONFIDENTIAL PLATE - VII

CROSS SECTION X-X'
West Bank of Mackenzie River
at
SANS SAULT RAPIDS, N.W.T., Canada

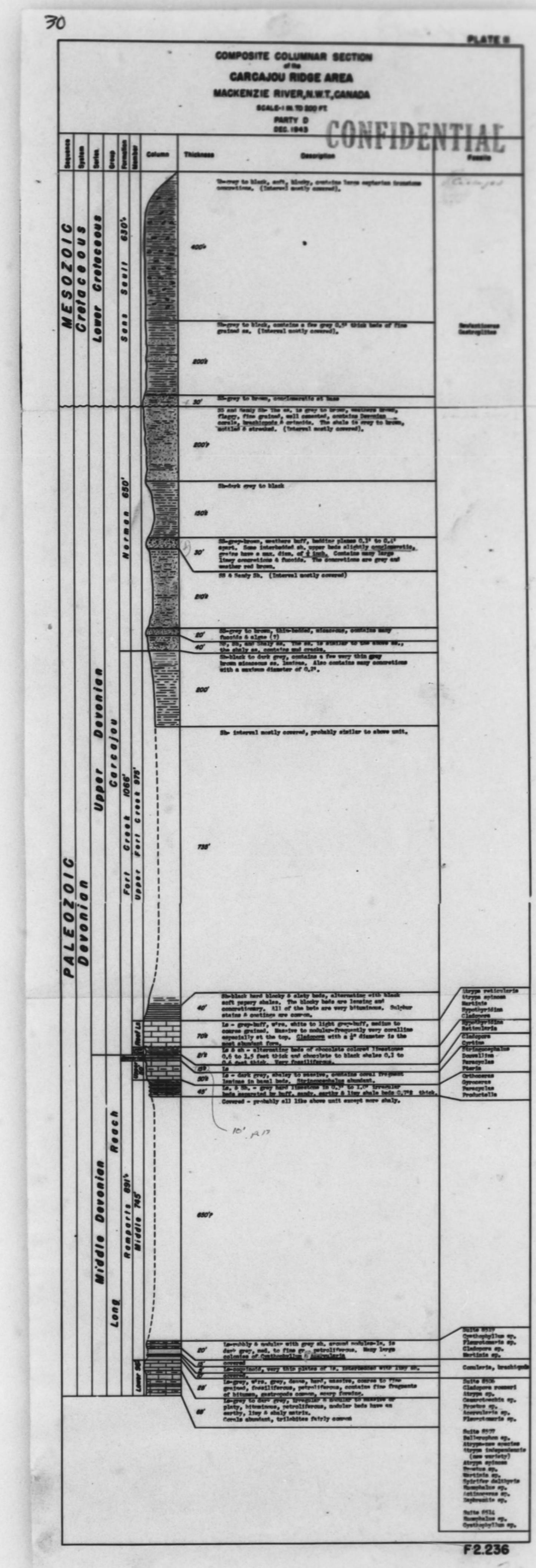
Vertical and Horizontal Scale

0 500 1000
SCALE - 16 IN : 1 MILE
The section was projected from a plan table map of the area.

PARTY - D
Dec - 1943

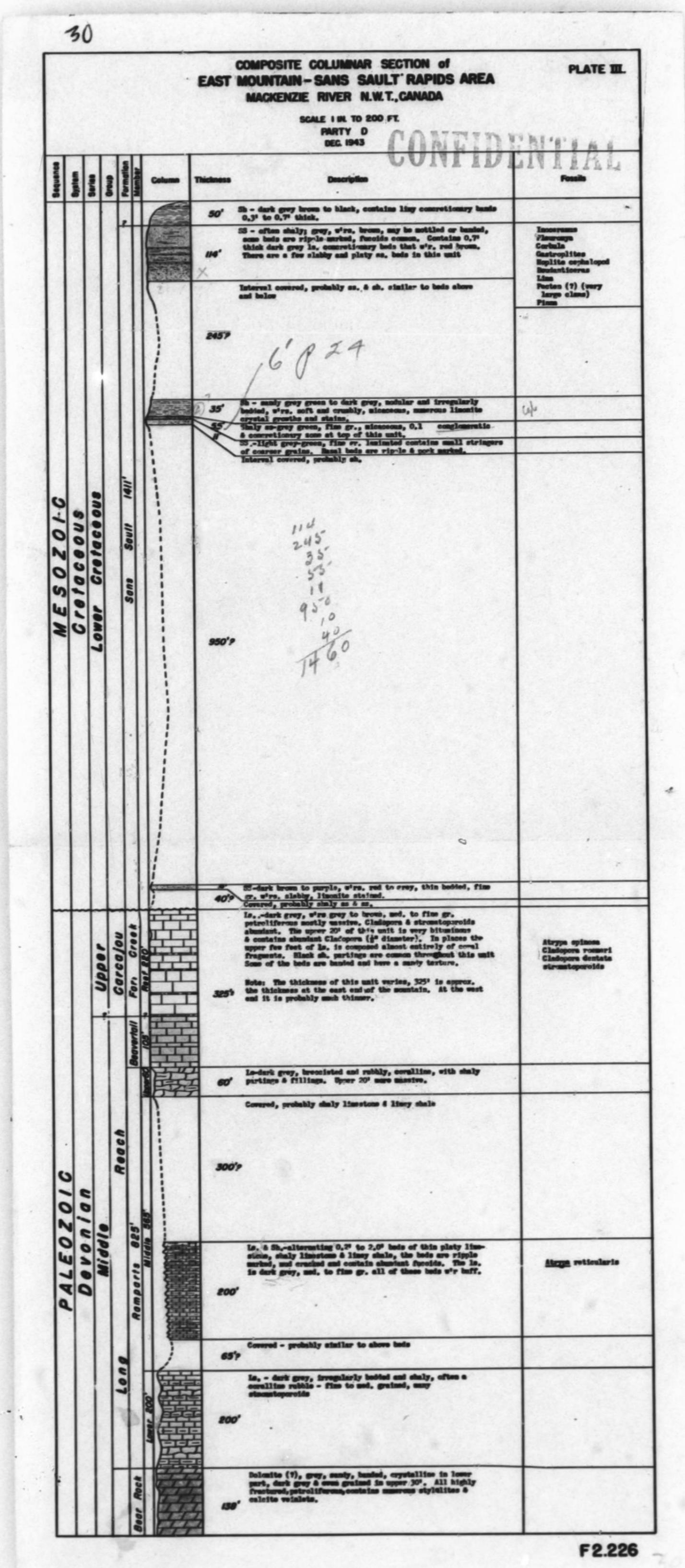


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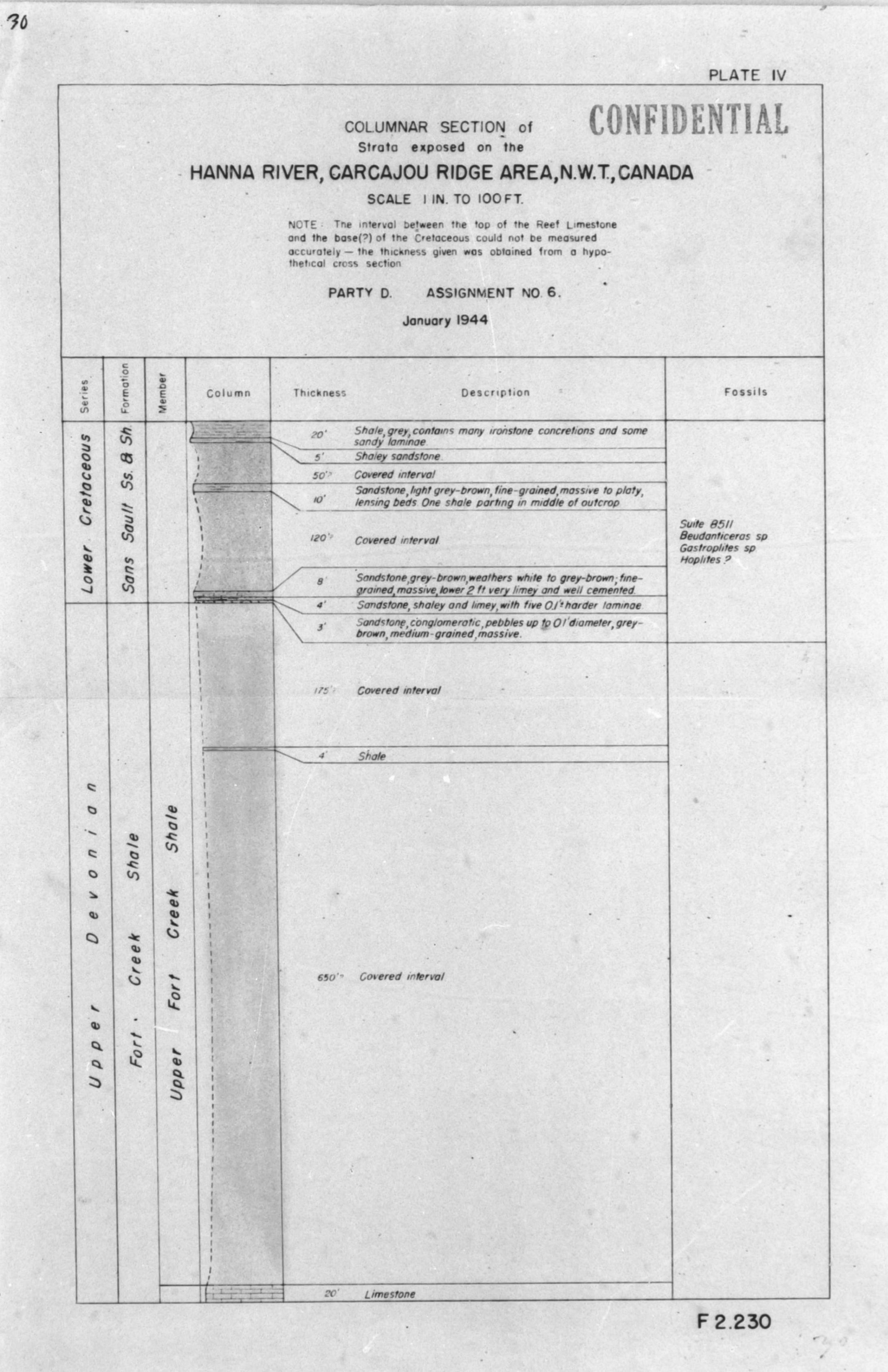
F223





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CONFIDENTIAL

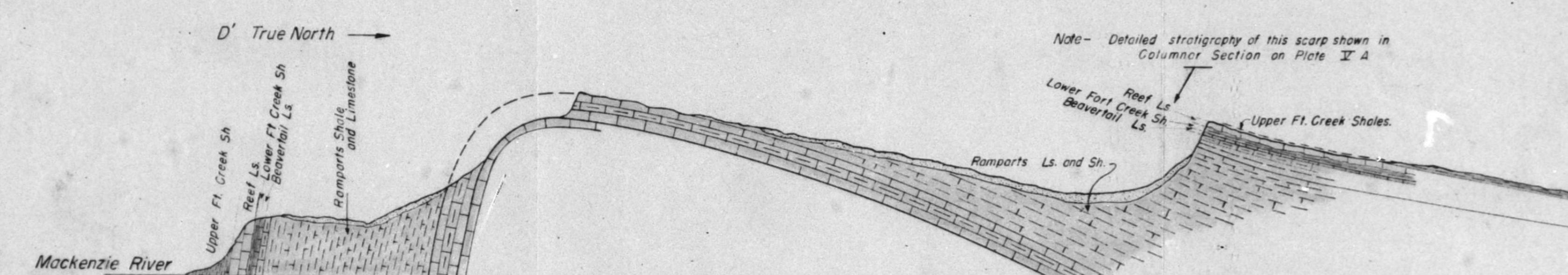
Cross Section D'-D
Through the Central Part of

CARCAJOU RIDGE, MACKENZIE RIVER,
N.W.T. Canada.

—SCALE—
1000 500 0 1000 1500 2000 FEET
Vertical and Horizontal Scale 12 in = 1 mi.

Profile elevations determined from parallax measurements on
C.P.A. Photographs.

Party D. Dec 1943
Assignment No 6

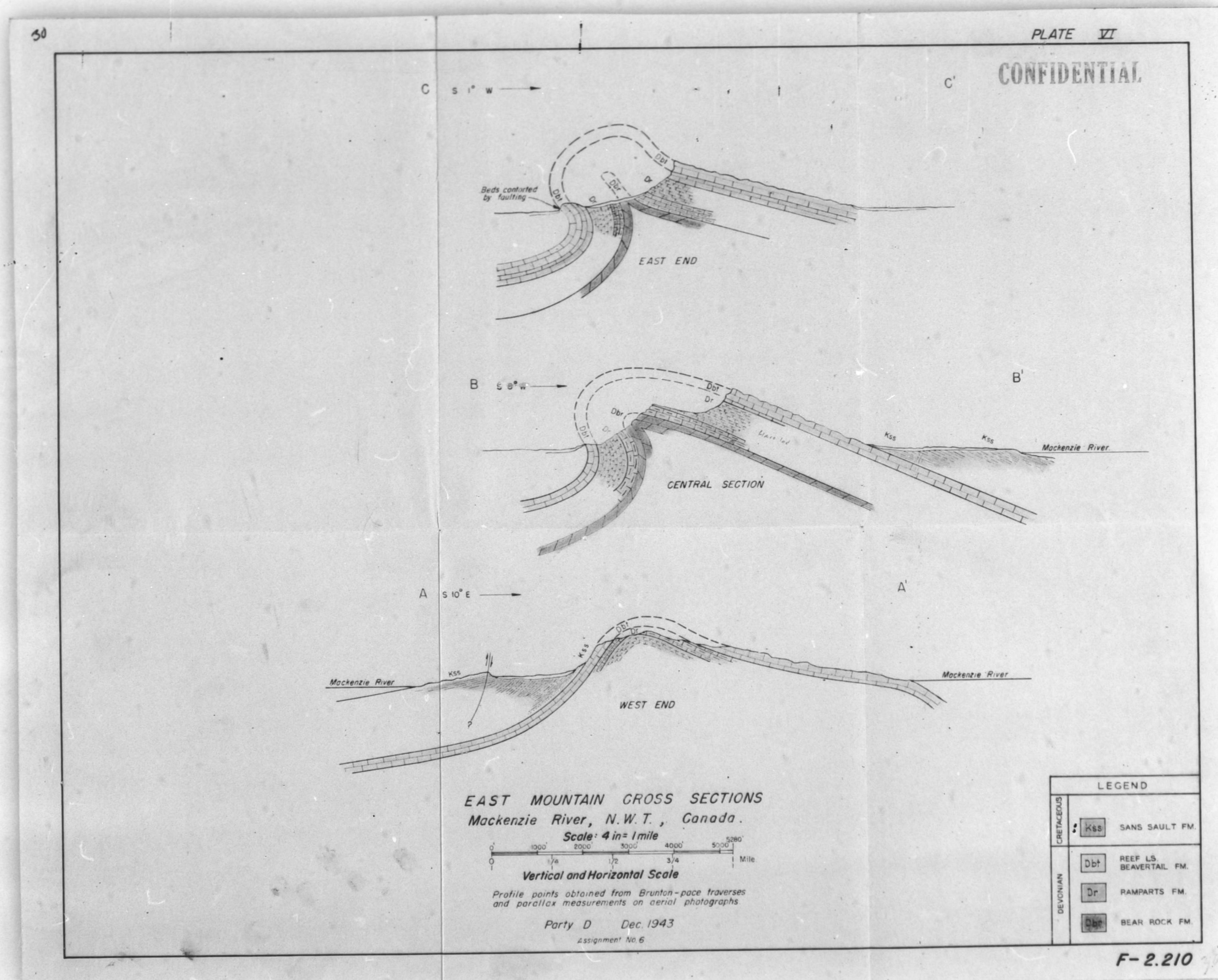


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24x

West Canadian Graphic Industries Ltd.





50

ASSIGNMENT N°6 PARTY

Jan - 1941

PLATE V A

CONFIDENTIAL

AL PLATE V A

1/10 COLUMNAR SECTION
to accompany
CROSS SECTION - D-D

CROSS SECTION

Off. See Sec. D-D' Plate N

COLUMNAR SECTION

to accompany
CROSS SECTION- D-D'

Scale: 1 in = 10 ft.

See Sec. D-D' Plate N

FORMATION	MEMBER	COLUMN	THICKNESS	DESCRIPTION	FOSSILS
	Upper Ft. Creek Shale		1	Shale, black	- SUITE 851
			20'	Limestone, breccia, highly fractured, may weather to smooth or very rough surface. Contains limestone fragments up to two feet diam. Upper three to four feet contains many corals (1/8 inch diam. <i>Cladopora</i>) and Stromatoporoids that weather out in relief when exposed.	<i>Hypothyridina</i> <i>Atrypa reticularis</i> <i>Atrypa spinosa</i> <i>Martinia</i> sp.
	FORT CREEK SHALE		21.3'	Disconformity - 10 feet relief observed on old erosion surface. Limestone and shale, the limestones are chocolate colored, in beds 0.6' to 1.5' thick. Shales are chocolate colored to black, 0.1' to 0.6' thick. Very fossiliferous.	- SUITE 851-7 <i>Reticularia franklini</i> <i>Hypothyridina costata</i> <i>Leiorhynchus</i> sp. <i>Pugnoides</i> sp. <i>Martinia</i> sp. <i>Douvallina</i> sp. <i>Atrypa reticularis</i> <i>Cyrtina</i> sp. <i>Schizophoria maculata</i> <i>Productella</i> sp. Crinoid stems
	BEAVERTAIL		.01'	Shale, black, fossiliferous.	
			5.2'	Limestone beds 0.1' to 1.0' thick, coralline; alternating coral clastics and non-clastics.	
			4.5'	Limestone, massive; irregular shale parting 1.5' from top.	
			2.0'	Interval covered.	
			11'	Limestone, massive and hard, especially lower eight feet.	
			14'		
			22'	Limestone and limey shale (interval mostly covered). Lower four feet is sandy and limey shale, above which is eight feet of alternating 1' limestone beds and shale.	- SUITE 851 <i>Atrypa devonianus</i> <i>Maculinea</i> sp.
			8.5'		
			4.8'	Limestone, hard, massive, stained yellow; black shale parting at base.	
			1.8' ^{7.0} _{0.2}	Limestone, nodular to shaly.	
			4.4' ^{9.0} _{0.0}	Limestone, massive, but not so massive as bed below.	
			3.4' ^{10.4} _{0.0}	Limestone, massive.	
			2.8' ^{10.2} _{0.2}	Limestone, nodular to shaly at top.	
			4' ^{10.2} _{0.2}	Limestone, massive.	
			11'	Limestone, grey, hard, nodular, irregularly bedded, with buff, sandy, earthy, limey streaks and laminae. Many of the nodules coated white. Massive, 1.5 foot coral bearing beds at base.	- SUITE- 851-5 <i>Acerularia</i> sp. <i>Zaphrentis</i> sp. <i>Atrypa devonianus</i>
			11.82'		
	RAM PARTS		37'	Limestone and shale. Grey, hard limestone in 0.3' to 1.0' irregular beds separated by buff, sandy, earthy and limey shale beds 0.7' thick.	- SUITE 851-6 <i>Schizophoria maculata</i> <i>Martinia</i> sp. <i>Paracyclas</i> sp. <i>Pholidostrophia</i> sp. <i>Leptostrophia</i> sp. <i>Zaphrentis</i> sp.
			154.2'		
	MIDDLE RAM PARTS SHALE				

COLUMNAR SECTION
of

Strata Exposed in Cliff on North Side of Lake Jan.
Scale: 1 in = 10 ft.

1071

COLUMNAR SECTION
of
Strata Exposed in Cliff on North Side of Lake Jan. •
Scale: 1 in = 10 ft.

FORMATION	MEMBER	COLUMN	THICKNESS	DESCRIPTION	FOSSILS
			3'	Limestone, grey-buff, weathers white to light grey-buff; platy, coralline, diam. of corals $1/8$ " (<i>Cladopora</i>)	-SUITE 8505-
			12'	Limestone, ditto above, but massive.	
			7'	Limestone, coralline, with very little matrix, otherwise ditto above.	
			5'	Limestone, blocky to nodular to massive, similar to above limestone.	
			2'	Limestone grey buff, weathers white to light grey buff, coarse grained, many <i>Cladopora</i> $3/8$ " diam. Consists of two distinct beds with prominent parting in middle.	
			4'	Ls. composed of <i>Cladopora</i> , consists of alternating 0.4' beds of corals in a limey matrix, and 0.4'-0.6' beds of corals with almost no matrix. Most of fossils collected come from this horizon	
			4'	Ls. grey, medium grained, nodular to massive. Contains many corals.	
			1.5'	Limestone, dark grey, medium grained, hard, brittle.	
			2.0'	Shale, dark grey, earthy, sandy and limey, fossiliferous.	-SUITE 8509-
BEAVERTAIL	REEF LIMESTONE		29'	Limestone, dark grey, hard, brittle, medium to fine-grained, bedding planes 1.0' to 1.5' apart. Regularly and intensely fractured at right angles to bedding. Lower three feet contains abundant <i>Stringocephalus</i> .	<i>Stringocephalus</i> sp. <i>Douvallina</i> sp. <i>Paracyclas</i> sp. <i>Pteria</i> (?)
	UPPER RAMPARTS LIMESTONE		6'	Limestone, dark grey, impure, many sandy and shaly, partings, unit may appear massive, and shows rapid lateral variation. Contains many Stromatoporoids and several coral fragment laminae. The parting between this and the above limestone is often filled with crystalline calcite.	-SUITE 8510- See below †
			16'	Limestone and limey shale, alternating beds. Limestone beds are 0.3' to 1.0' thick, dark blue grey, very hard, dense, fine-grained, brittle, breaks with sharp angular edges. The inter bedded shale is buff, soft, with a sandy feel. Bedding planes have an irregular surface.	-SUITE 8508- <i>Paracyclas</i> sp. <i>Productella</i> sp. <i>Gyroceras</i> (?) <i>Orthoceras</i> (?) <i>Gomphoceras</i> (?)
RAMPARTS	MIDDLE RAMPARTS SHALE		30'	Limestone and limey shale, gradational from above unit. The shale becomes more sandy and the limestone becomes light grey to buff, medium grained, sometimes laminated. Beds vary from 0.3' to 1.0' in thickness.	
					-SUITE 8510- For above †
					<i>Proetus</i> sp. <i>Martinia</i> sp. <i>Cladopora</i> sp. <i>Pleurotomaria</i> sp. <i>Orthoceras</i> sp. <i>Gyathophyllum</i> sp. <i>Atrypa reticularis</i> <i>Atrypa devoniana</i> <i>Atrypa</i> (new species)
• This section is 3.5 miles east of the other section shown on this sheet.					

• This section is 3.5 miles east of the other section shown on this sheet.

F-2.209




CORRELATION CHART
TO ACCOMPANY
CARCAJOU RIDGE-EAST MOUNTAIN AREA REPORT

ASSIGNMENT No. 6

JANUARY, 1944.

SCALE: 1" = 200'



F-2,231

24x