No 19

FINAL

GEOLOGICAL REPORT

on

"THE ARCTIC RED RIVER AREA"

N.W.T. (Canada)

IMPERIAL OIL LTD., CANOL PROJECT

Assignment No.22.

By: - F. A. McKinnon Party Chief
K. F. Huff Assistant
I. D. Crawford Helper

Date submitted:- January 20,1944

Read and accepted by:- Herb. Link

Date:- Jan. 22 - 44

CONFIDENTIAL

TABLE OF CONTENTS

Abstract

		Page
CHAPTER I	INTRODUCTION	1
CHAPTER II	TOPOGRAPHY	3
CHAPTER III	STRATIGRAPHY	5
CHAPTER IV	STRUCTURE	14
CHAPTER V	HISTORICAL GEOLOGY	16
CHAPTER VI	RECOMMENDATIONS & CONCLUSIONS	18
BIBLIOGRAPHY		i
PHOTOGRAPHIC ILLUSTRATIONS		ii.
PALEONTOLOGY		Appendix

LIST OF PLATES AND ILLUSTRATIONS

Plate I.	Index Map of Northwestern Canada showing Location of Arctic Red River Area	ff. p. 2
Plate II.	Areal Geologic Map of Arctic Red River Area.	in pocket
Plate III.	Geologic Structure Section - Upper Part of Arctic Red River Area.	in pocket
Plate IV.	Stratigraphic Columnar Section - Arctic Red River Area.	in pocket
	Photographic Illustrations	ff. p. ii.

LIST OF PLATES AND ILLUSTRATIONS

Plate I.	Index Map of Northwestern Canada showing Location of Arctic Red River Area	ff. p. 2
Plate II.	Areal Geologic Map of Arctic Red River Area.	in pocket
Plate III.	Geologic Structure Section - Upper Part of Arctic Red River Area.	in pocket
Plate IV.	Stratigraphic Columnar Section - Arctic Red River Area.	in pocket
Photographic Illustrations		ff. p. ii.

FINAL GEOLOGICAL REPORT ON THE

ARCTIC RED RIVER

N.W.T.

A B S T R A C T

A survey of Arctic Red River was carried out by the writer and two assistants during the last two weeks of August and the first three weeks of September 1943, to determine the possible presence of favorable petroleum prospects in this area. The survey of Arctic Red River reveals the presence of a low broad positive structural feature in Cretaceous sediments, lying in a wide synclinal area between the Mackenzie mountains and Mackenzie river. It is suggested that this feature is continuous with similar structural trends previously mapped on Ramparts river, Hume river and Mountain river. Because of the inaccessibility of the Arctic Red river area, no further work on the structure in this area is recommended until the more accessible parts in the Mountain river area have been tested.

Chapter I.

I N T R O D U C T I O N

In accordance with instructions received from Dr. T. A. Link, a party consisting of K.F. Huff, I. D. Crawford and the writer left Norman Wells by plane on August 18, 1943, to begin work on Assignment No. 22 - a survey of Arctic Red river. The purpose of the survey was to determine and report the possible presence in the area of any conditions favorable to the accumulation of oil or gas. This assignment was completed in 35 days and the party arrived at Arctic Red River Post on September 22nd. The results of this work, together with maps and sections, are presented in the following report, which is the first geological report written on Arctic Red river.

The maps and sections prepared to accompany this report are as follows:

Plate I. - Index Map of Northwestern Canada, showing location of Arctic Red River Area, Scale 1" - 100 miles.

Plate II. - Areal Geologic Map of Arctic Red River Area. Scale 1" - 4 miles.

Plate III.- Geologic Structure Section - Upper part of Arctic Red River. Horizontal Scale 1" - 1 mile, Vertical scale 1" - $\frac{1}{2}$ mile.

Plate IV. - Stratigraphic Columnar Section - Arctic Red River Area. Scale 1" - 100 feet.

Arctic Red river has its source in the Mackenzie mountains about 140 miles northwest of Norman Wells. The river drains an area on the west side of the Mackenzie basin between Ramparts river and the Peel drainage basin, and flows in a northwesterly direction to enter the Mackenzie river at Arctic Red River Post, near N. Lat. 67° 31', about 100 miles upstream from Aklavik. (See index map, Plate I).

The party was landed on Lake Edith, ½ mile west of the river just outside the mountains (Fig.1). The survey was begun about 10 miles upstream from the point where the river leaves the mountains, and was continued downstream to the river's mouth. Tributaries of Arctic Red river were traversed wherever additional information could thus be obtained.

U.S.A.A.F. vertical and oblique aerial photographs (Roll 305LVR - 126 to 173 and roll 324LVR - 1 to 72) were used in mapping the river and locating outcrops. Several plane table traverses were run, mainly for photo scale and orientation control, and in one case to map a section of the river which had been covered by clouds when the photographs were taken.

For the most part, Arctic Red river is easily traversed by canoe. However, in the upper parts of the river, swift water and numerous rapids necessitate much lining and occasional portages. Sand bars and shallows in the lower part prohibit navigation to any craft larger than light canoes.

In summer the area drained by Arctic Red river is inaccessible except by air. Winter roads could be constructed after freeze-up, and the area could then be reached by tractor train.

Chapter II.

T O P O G R A P H Y

In the Mackenzie mountains, Arctic Red river occupies a broad open valley bordered on both sides by wooded and grassy slopes above which the barren limestone peaks rise almost 3000 feet. The river is swift and deep and is braided into many channels over a boulder-strewn plain which, at the mountain front, is about a mile wide.

Houston river comes out of the mountains through a deep narrow gorge about five miles west of Arctic Red river (Fig.2), then turns eastward and flows through a wide gravel-covered valley to join the Arctic Red about two miles downstream from the front of the mountains.

After leaving the Mackenzie mountains the Arctic Red flows northward for several miles in a meandering valley deeply incised in a fairly high plateau (Fig.3). A well-developed dendritic system of tributary streams drains the area on either side. Lakes in this area are relatively few. The country is sparsely wooded except in the river valley, the sides of which are generally thickly overgrown with spruce, willow and poplar. The average river gradient is about 25 to 30 feet per mile. The current is swift and the river winds through its valley around a complex pattern of gravel bars, cutting down through massive gently-dipping sandstone and forming rapids and swells which make canoe work hazardous. (Fig. 4)

About forty miles downstream from the mountains the plateau country drops off northward in a high, receding, north-facing erosional escarpment trending east and west (Fig. 5). The river here makes a wide bend to the west, and continues northwestward across a flat, poorly-drained lake and muskeg country, through a valley cut down into flat-lying shales (Fig. 6). The current is still fairly swift and the stream

meandering in the valley undercuts the shales on the bends, forming high vertical banks on alternate sides.

In the lower reaches the valley walls become more receding and are thickly covered with spruce and poplar. As the river gradient lessens the current slows and the river begins to deposit silt, forming bars and shallows. Muskeg lakes cover the valley floor inside the river bends. Near the Mackenzie the country through which the Arctic Red flows is very flat and poorly-drained and dotted with many large and small lakes.

Chapter III.

STRATIGRAPHY

The following table shows the relationships and thicknesses of the various formations encountered on the survey of Arctic Red River.

TABLE OF FORMATIONS
ARCTIC RED RIVER AREA

ERA	SYSTEM	SERIES	FORMATION	DESCRIPTION	THICKNESS IN FEET
MESOZOIC	CRETACEOUS	UPPER(?) CRETACEOUS	"C" unit	Sandstones, massive, fine-grained, gray-brown, alternating with gray sandy shales.	900
		LOWER CRETACEOUS	"B" unit	Shales, dark gray, fissile, nodular in part, with thin sandstone and ironstone bands.	1500
			"A" unit	Sandstones, massive, gray to greenish, with alternating shales and sandy shales.	600
				UNCONFORMITY	
PALAEOZOIC	DEVONIAN	UPPER DEVONIAN	Bosworth	Sandstones, massive to thin bedded greenish, micaceous, with coaly remains of primitive plants.	1000±
			Fort Creek	Shales, dark gray to black, platey, bituminous near base.	400
				PROBABLE UNCONFORMITY	
		MIDDLE DEVONIAN	Ramparts	Limestone, thin bedded, dark gray, fetid, fossiliferous.	10
				Limestone, rubbly, dark gray, 6"-10" bedded, with thin black shale breaks. Very fossiliferous.	135
				Limestone, light gray to buff, 8" - 12" bedded, with gray limey shale breaks.	65
				Limestone, dark gray, 6" - 12" bedded, with 3" shaley breaks.	65
	?	LOWER DEVONIAN OR SILURIAN		*UNCONFORMITY*	
			Bear Rock ?	Limestone and dolomite, massive, light gray, dense.	500+
	?			*POSSIBLE UNCONFORMITY*	
	SILURIAN		Mt. Ronning	Limestone and dolomite, massive to thin bedded, fossiliferous in part.	500+
				UNCONFORMITY	
				Limestone and dolomite, cherty, massive, dense.	500+
				MAJOR UNCONFORMITY	
	CAMBRIAN		MacDougal	Covered interval--may represent gypsiferous shales.	150
				Limestone, probably dolomitic.	250
				Sandstone, quartzitic, variegated, red brown to grey green white.	1+

CAMBRIAN

MacDougal Formation

Rocks thought to be Cambrian in age were found on the north side of the first range of the Mackenzie mountains near Arctic Red River. The base of the exposed section consists of 15 feet of quartzitic sandstone, variegated red brown tan, grey, green and white in color. Overlying the sandstone is a 250-foot series of rocks which were not examined in detail but which appear to be mainly massive limestone. Quarts crystals were found at the base of the limestone series.

A covered interval above this limestone series is thought to represent the gypsiferous shales and anhydrite series reported elsewhere by Laudon, Nauss and Stelck. (1, 2, 3) *

No fossils were found in any of these beds, but on the basis of their lithologic characteristics and their stratigraphic position they are assigned to the MacDougal series.

SILURIAN

Mount Ronning Formation

The first range of the Mackenzie mountains in the vicinity of Arctic Red river is composed almost entirely of rocks of Silurian age, belonging to the Mount Ronning formation.

In this area the Mount Ronning consists of at least 1100 feet of massive dolomite and limestone beds which often contain variable amounts of chert. The section may be divided into two units, separated by an unconformity marked by a brecciated zone bearing re-worked chert, which occurs about 400 feet from the base.

Lithologically the lower unit differs from the upper unit in that it is relatively more dolomitic and contains more chert. The dolomite is

---

* Numbers in parenthesis refer to bibliography.

saccharoidal, steel grey to dark grey, sometimes siliceous and usually very hard.

The upper unit contains fossils of Silurian age, including Orthoceras, Syringopora, Halysites, Favosites and Zygospira (?). (6570, 6571)* Neither the base nor the top of the Mount Ronning was exposed.

SILURIAN OR DEVONIAN

Bear Rock Formation?

Rocks occupying a stratigraphic position equivalent to that of the Bear Rock formation were found on Houston river west of the Arctic Red (Fig. 7).

The section consists of at least 500 feet of dolomite and dolomitic limestone which is light gray, dense and finely crystalline. Lithologically these rocks differ from the rocks of the Mt. Ronning formation in the mountains nearby and also from those of the Ramparts formation to which they are subjacent. None of the breccia typical of the Bear Rock in other areas was found in the section on Houston River. The base of the section was not exposed.

The contact of the Bear Rock with the overlying Ramparts formation is marked by a sharp stratigraphic break accompanied by a sudden change in lithology, but no sign of discordant dips above and below was observed.

No fossils were found in these beds, and correlation with the Bear Rock is based entirely on their stratigraphic position below the Ramparts formation, and above the Mount Ronning formation.

---

* Fossil suite numbers - See Appendix, also Columnar Section (Plate IV)

DEVONIAN

Ramparts Formation

The Ramparts formation in this area consists of a series of limestones which fall naturally into four units. The series is well exposed on Houston river, where the measured section was found to be 275 feet thick.

The lowest unit is 65 feet thick and is made up of 6-inch to 12-inch bedded limestone bands separated by 3-inch bands of shale. The limestone is dark grey, fine grained and rather dense, and apparently contains no fossils. The basal disconformity is marked by a sudden change in lithology at the top of the dolomites of the Bear Rock formation.

The second unit consists of 65 feet of buff-weathering light grey limestone in beds 8 inches to 12 inches thick, separated by thin bands of grey limey shales, and containing few fossils (6583).

The third unit is a series of 135 feet of rubbly limestone, which is dark grey, fine grained and very fossiliferous, and which occurs in beds 6 inches to 10 inches thick, separated by black platey shale bands less than 3 inches in thickness. This series is very fossiliferous (6578, 6578, 6579, 6580, 6581, 6582).

The fourth and uppermost member is 10 feet thick. It is composed of dark grey limestone, fine grained, fetid, irregularly thin-bedded and very fossiliferous but with no shale breaks. The faunal assemblage contains many forms which are also found in the 135-foot interval underlying this unit (6573, 6574, 6575).

The upper limit of the formation is apparently at the top of the 10-foot limestone band, since the beds above this consist of black platey shales which are correlative with the Fort Creek, The Beavertail limestone,

which normally overlies the Ramparts, is not present in the Arctic Red river area.

Fort Creek Formation

Above the topmost member of the Ramparts formation is a 90 foot series of platey black shales representing the lower part of the Fort Creek formation. The lower ten feet of this shale series contains several four-inch to six-inch bands of dark grey limestone, and the shales between the limestone bands carry Tentaculites (6577) in great abundance.

On the whole the shale series appears slightly bituminous and contains considerable sulphur which in places forms a vivid yellow bloom on the face of the outcrop. Some of the shale has been oxidized to a brick reddish color. (Fig. 8)

Absence of outcrop over a considerable distance along Houston river prevents any accurate determination of thickness and lithology of the remainder of the Fort Creek formation, but it is estimated to be less than 400 feet. At Station 26, on Houston river, a very good exposure occurs. Here a 30-foot series of black platey shales underlies a series of brown flaggy sandstones. The shale is nodular and contains sulphur. No fossils were found, but it is thought to be the top of the shale series of the Fort Creek formation, and the brown flaggy sandstones considered to be the base of the Bosworth.

Bosworth Formation

The sandstone series overlying the 30 foot shale series at Station 26 on Houston river is fine grained, dark grey to brownish, micaceous, well indurated, somewhat flaggy, and contains no fossils. The contact with the underlying shale is very well defined.

At Station 25 on Houston river a higher zone in the section is composed of light grey to greenish micaceous sandy shales with thin sand-

stone stringers. No fossils were found in these beds.

No further outcrops were observed below the Cretaceous near the head of Arctic Red river. The top of the Upper Devonian was not observed, and in view of the extent of the covered interval no accurate estimate of its thickness can be made, although it is thought to be in the neighbourhood of 1000 feet. Beds considered to be equivalent to the Bosworth formation were found in the lower 50 miles of Arctic Red river. These beds consist mainly of sandstones, with lesser amounts of shales and sandy shales. The sandstones are generally grey to brown in color, evenly fine grained, well indurated and micaceous, and contain variable amounts of soft coaly remains and impressions of primitive plant forms (6596, 6597, 6599). Fragments of brachiopods and crinoid columns were found in limey sandstones at two horizons near the base of the section (6594, 6595).

The contact with the overlying Cretaceous occurs at Station 99 at a 6-inch conglomerate zone composed of grey, green brown and black quartzite, chert and argillite pebbles in a matrix of greenish grey fine grained sandstone.

Outcrops are not plentiful, and over most of the area underlain by these sediments no measurable dips were found. Four miles above the mouth of the river southward dips of two degrees were encountered.

The part of the formation exposed on Arctic Red river is estimated to be about 1000 feet thick.

CRETACEOUS

By far the greater part of the area between the Mackenzie mountains and the mouth of Arctic Red river is underlain by sediments of Cretaceous age, which also form most of the outcrops. They are described here in the order in which they are encountered while travelling downstream.

stone stringers. No fossils were found in these beds.

No further outcrops were observed below the Cretaceous near the head of Arctic Red river. The top of the Upper Devonian was not observed, and in view of the extent of the covered interval no accurate estimate of its thickness can be made, although it is thought to be in the neighbourhood of 1000 feet. Beds considered to be equivalent to the Bosworth formation were found in the lower 50 miles of Arctic Red river. These beds consist mainly of sandstones, with lesser amounts of shales and sandy shales. The sandstones are generally grey to brown in color, evenly fine grained, well indurated and micaceous, and contain variable amounts of soft coaly remains and impressions of primitive plant forms (6596, 6597, 6599). Fragments of brachiopods and crinoid columns were found in limey sandstones at two horizons near the base of the section (6594, 6595).

The contact with the overlying Cretaceous occurs at Station 99 at a 6-inch conglomerate zone composed of grey, green brown and black quartzite, chert and argillite pebbles in a matrix of greenish grey fine grained sandstone.

Outcrops are not plentiful, and over most of the area underlain by these sediments no measurable dips were found. Four miles above the mouth of the river southward dips of two degrees were encountered.

The part of the formation exposed on Arctic Red river is estimated to be about 1000 feet thick.

CRETACEOUS

By far the greater part of the area between the Mackenzie mountains and the mouth of Arctic Red river is underlain by sediments of Cretaceous age, which also form most of the outcrops. They are described here in the order in which they are encountered while travelling downstream.

The base of the Cretaceous series is not exposed in the upper part of the river. The outcrop at Station 35 is mainly sandstone which is somewhat conglomeratic in part, and which probably is not far above the Devonian - Cretaceous contact. From this point downstream for about 10 miles, as far as the synclinal axis near Station 51, exposures are fairly continuous. The section is made up of three parts as follows: "A" unit, a lower sandstone series; "B" unit, and intermediate shale series; and "C" unit, an upper sandstone series. The total thickness of the Cretaceous in these parts is about 2900 feet.

"A" unit, the lower sandstone series, consists of alternating sandstones and shales, the sandstones being generally massive, fine grained, light grey to buff well indurated, with few fossils. A thin seam of coal was found near the base. This unit is about 500 feet thick.

"B" unit overlies the lower sandstone at Station 40. It consists of dark grey fissile shales which weather brownish and which contain much sulphur. At intervals they are ribboned with 1/2-inch to 3/4-inch sandstones and occasional ironstone bands. Over most of the shale interval the beds are considerably folded. The thickening, due to this folding, is impossible to determine, but the stratigraphic interval between the upper and lower sandstone series is about 1500 feet.

Stratigraphically above the shale series is "C" unit, a succession of heavy sandstone beds alternating with sandy shales. The highest Cretaceous beds occur at the synclinal axis near Station 51, and below this they outcrop in the river bed, forming a series of rapids and waterfalls which extend along the river for a mile and a half. A large Inoceramus was collected from these beds. The upper sandstone series is approximately 900 feet thick.

Downstream from the synclinal axis the whole Cretaceous section is repeated, but is considerably thinner. A composite section from Station 51 to Station 99 shows a thickness of about 1800 feet. On the whole, this section contains relatively more shale and less sandstone than the section found farther up the river, although the same three formational units are distinguishable.

The upper sandstone series comprising "C" unit, is about 700 feet thick. Since it is exposed near the synclinal axis it resembles closely the equivalent part of the up-river section. The basal member of this unit is a forty-foot bed of massive sandstone which is exposed for several miles along the river bank, becoming progressively more shaly until around Station 80 it has practically lost its identity in a section which is almost entirely shale. This is an example of basinward facies change from sandstone to shale.

"B" unit, the intermediate shale series, is estimated to be 1000 feet thick. The shales are dark grey to black, fissile, with minor thin sandstone and ironstone bands, and contain variable amounts of sulphur and gypsum. In some localities they are burned and weathered to a reddish color, probably as a result of heat generated by natural chemical reactions. The lower 150 feet of this series is nodular and contains ammonites (6590, 6591, 6592, 6593).

"A" unit, the lower sandy part of the Cretaceous section, is only about 70 feet thick in the lower part of the river. It is composed mainly of sandstone which is grey to greenish, fine-grained, thin-bedded, massive and sometimes glauconitic.

The contact between the Cretaceous and the subjacent Lower Devonian sandstone is marked by a conglomerate found at Station 99.

The presence of Beudanticeras dates the intermediate shale series as late Lower Cretaceous. At the present writing the fossils collected from the upper sandstone series have not been definitely identified. However, the writer is of the opinion that these fossils are indicative of Upper Cretaceous age, and the boundary between Lower and Upper Cretaceous is tentatively drawn at the top of the intermediate shale series, between "B" unit and "C" unit.

The presence of Beudanticeras dates the intermediate shale series as late Lower Cretaceous. At the present writing the fossils collected from the upper sandstone series have not been definitely identified. However, the writer is of the opinion that these fossils are indicative of Upper Cretaceous age, and the boundary between Lower and Upper Cretaceous is tentatively drawn at the top of the intermediate shale series, between "B" unit and "C" unit.

Chapter IV.

S T R U C T U R E

In the area immediately adjacent to the Mackenzie mountains a zone of faulting occurs and structural conditions in this locality do not favor the accumulation of oil or gas.

Downstream from the mountains the river flows across a wide shallow synclinal basin, the axis of which lies between Station 51 and Station 52, about twelve miles from the front of the mountains.

Information regarding the structure immediately below the faulted zone at the mountain front was obtained in the canyon of Houston river, west of the Arctic Red. Here beds of the Bear Rock, Ramparts and Fort Creek formations were found, dipping uniformly northward at about 20 degrees. Over a covered interval of almost two miles at right angles to the strike no outcrops were seen, but it is assumed that the dip gradually flattens out, since Cretaceous beds at Station 35 on Arctic Red river are almost flat.

From Station 35 on downstream over the next three miles the dip steepens again, and at Station 39 a massive sandstone dips 20 degrees north. Immediately overlying this sandstone is a shale series, which between Station 40 and Station 46, is intricately folded in sharp crenulations. At Station 45 another sandstone member, stratigraphically above the shale series, dips northward at 35 degrees. The complex folding in the shales between gently dipping sandstones suggests drag folding caused by differential movement of competent and incompetent beds during regional deformation.

Downstream from Station 45 the beds continue to dip regularly northward until the synclinal axis is reached, between Station 51 and Station 52.

Below this, southward dips up to four degrees were encountered over a distance of about 6 miles, as far as Station 60. At Station 60 and Station 61 the beds are apparently flat. At Station 62 an excellent exposure of shales in a high vertical bank shows northward dips of two degrees. This slight reversal is similar to that mapped by the writer on Ramparts river, (4) and from oblique aerial photographs the two features appear continuous.

In the flat-lying shales immediately above Station 62, two low-angle, south-dipping thrust faults of very small displacement were observed. (Fig. 9). At this point the shale banks are about 250 feet high and are capped by a 40-foot bed of massive sandstone. The faults, which in the shales have a maximum throw of 50 feet, do not displace the sandstone. This faulting may have arisen from stresses set up by the same type of movement to which the drag folding at Station 40 was attributed. However, in view of the relatively flat dips in the beds on this side of the syncline it appears more probable that these faults are a result of simple thrusting over the crest of a low broad anticlinal fold.

At Station 63, a short distance below Station 62, the beds are again flat-lying. Below this for about 8 miles, southward dips up to four degrees were recorded.

From Station 77 downstream almost to the river's mouth, no measurable dips were found. However, on the basis of information obtained from occasional outcrops along the river, a regional dip of 20 feet per mile southward was assigned to the beds over this wide area.

Four miles above the mouth of Arctic Red river, Upper Devonian beds were encountered, dipping southwestward at two degrees. Similar beds lying in the same attitude occur on the Mackenzie river near Arctic Red River Post.

Chapter V.

HISTORICAL GEOLOGY

The history of sedimentation in the Arctic Red River area is essentially the same as that previously worked out for the Fort Norman area farther south. (5)

PALEOZOIC ERA

During Paleozoic time most of the material deposited in this region was in the form of limestone, a good part of which was altered to dolomite by processes which were almost contemporaneous with deposition.

Pre-Silurian Time

Unconformities of various magnitudes at several horizons throughout the Paleozoic section mark breaks in deposition. The most profound of these breaks lies above the MacDougal formation where the sedimentary record of the long interval between Cambrian and Silurian time is completely lacking. No definite conclusions were reached regarding the nature of this hiatus, but there is no evidence that any major regional diastrophism took place during this time.

Silurian Time

Throughout most of Lower and Middle Silurian time the region was covered by relatively deep quiet seas, and it is possible that similar conditions also prevailed in Upper Silurian time. Information pertaining to the interval between Middle Silurian and Middle Devonian time was not obtained by the writer during the short stay in the mountain region. However, it seems probable that the general sequence of events is similar to that already established in the Fort Norman area.

Devonian Time

The Middle Devonian sea was evidently warm and relatively shallow, and must have supported a great abundance of many varieties of animal life.

Upper Devonian time was a period of shallower, more turbulent seas which slowly retreated as the shale series of the Fort Creek and the sandstone series of the Bosworth were laid down.

At the close of Upper Devonian time deposition was interrupted by crustal movements which uplifted the region and caused the final retreat of the Paleozoic sea, leaving the land high and dry until Lower Cretaceous time.

It is unlikely that the long interval during late Paleozoic and early Mesozoic time was a period of intense erosion, and so far as can be determined, no great crustal movements occurred.

MESOZOIC ERA

Cretaceous Time

In Lower Cretaceous time the region was once more covered by a shallow fluctuating sea which caused considerable lateral and vertical variation in the sandstones and shales which were deposited.

CENOZOIC ERA

Tertiary Time

Toward the close of Cretaceous time the mountain-building Laramide Revolution began, accompanied by a withdrawal of the sea, and followed by a subsequent period of erosion which has continued, except for glaciation during the ice age, to the present time.

Quaternary Time

In glacial time the whole area, with the possible exception of the higher parts of the Mackenzie mountains, was covered by the ice sheet, and during this period active erosion probably ceased. With the disappearance of the ice, erosion again set in, and subsequent isostatic adjustment due to the removal of the ice load uplifted the region, rejuvenating the main streams and resulting in the present deeply incised valleys.

Chapter VI.

C O N C L U S I O N S A N D R E C O M M E N D A T I O N S

The structural possibilities suggested by the presence of reverse dips at Station 62 on Arctic Red river are interesting, since similar conditions were mapped by the writer on Ramparts river (4), and by Moon on Hume river (6). According to Parker (7) the small structure on Hume river lines up with a larger fold on Mountain river. The implication is that this feature is continuous across the area drained by the four rivers.

Thus the regional picture presented is that of a fairly well-defined continuous low broad anticlinal structure paralleling the front of the Mackenzie mountains, with axial extent from Mountain river at least as far as Arctic Red river.

Information from available data indicates that this feature is structurally more favorable in the more accessible area around Mountain river. In view of its inaccessibility, no further development is recommended in the Arctic Red River area at the present time, or at least until testing in the Mountain river area has been carried out.

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

1. Loudon, L. R. - "The Imperial River Area", Assignment No. 16, Report No. 22, Imperial Oil Limited, Canol Project, August 1943.

2. Mauss, A. W. - "The Upper Carcajou - Imperial River Area", Assignment Nos. 10 and 16A, Final Report, Imperial Oil Ltd. - Canol Project, January 1944.

3. Stelck, C.R. - "Carcajou River - Little Bear River Divide Area", Assignment No. 2B, Final Report, Imperial Oil Ltd. - Canol Project, January 1944.

4. McKinnon, F.A.- "A Survey of Ramparts River", Assignment No. 16, Final Report, Imperial Oil Ltd. - Canol Project, January 1944.

5. Link, T.A. - "Geological Report on the Fort Norman Area", Imperial Oil Ltd., Report, Chapter VI, page 88, (1921).

6. Moon, C.G. - "The Hume River Area", Assignment No. 15, Report No. 23, Imperial Oil Ltd. - Canol Project, August 1943.

7. Parker, J.M. - "Geological Report on the Mountain River Area" Assignment No. 17, Final Report, Imperial Oil Ltd. - Canol Project, January 1944.

. . . . . .

Figure 1.

Looking westward across Lake Edith along the first range of the Mackenzie Mountains.

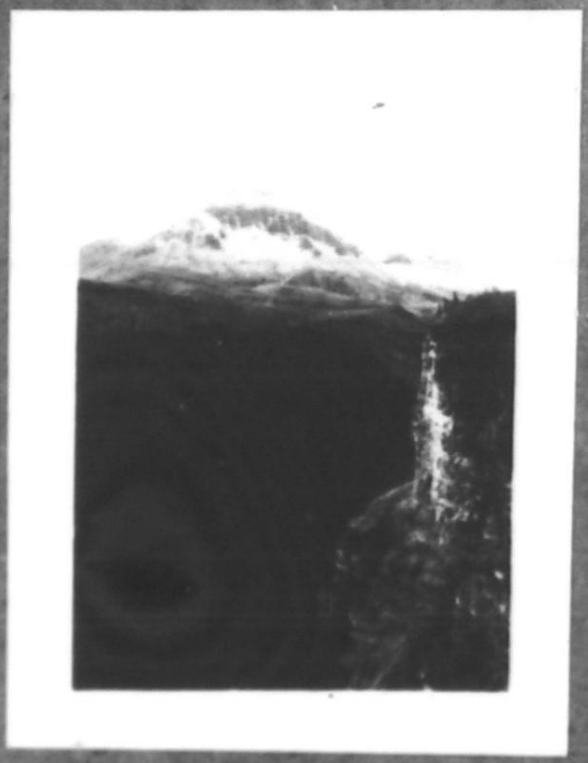


Figure 2.

Looking southward toward the Mackenzie mountains, through the gorge of Houston River.

Figure 3.

Looking northward from a point in the vicinity of Station 71, showing the valley of Arctic Red River deeply incised in gently southward-dipping Cretaceous shales.

Figure 4.

Looking upstream from a point near Station 55, showing rapids and waterfalls formed where the river flows over south-dipping Cretaceous sandstones.

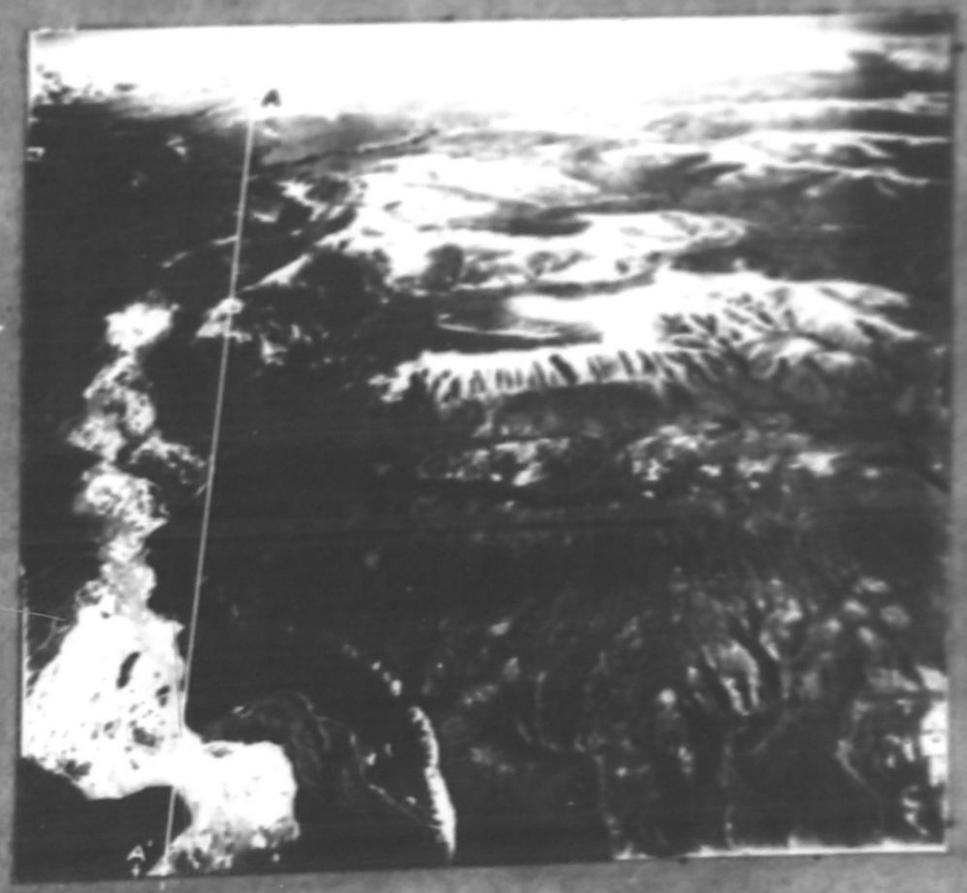


Figure 5.

Aerial view from a point above Station 80A, looking southward up Arctic Red River toward the Mackenzie Mountains which are about 40 miles distant. White areas are snow-covered. A-A' shows location of line of cross-section (Plate III).

Figure 6.

View looking northwestward from top of scarp at Station 80, showing gravel bars in the river, and also the flat topography of the country in the central part of the Mackenzie basin.

Figure 7.

Canyon of Houston River, showing massive limestones of the Bear Rock (?) formation.

Figure 8.

Fort Creek shales exposed at Station 27 on Houston River, west of Arctic Red River.

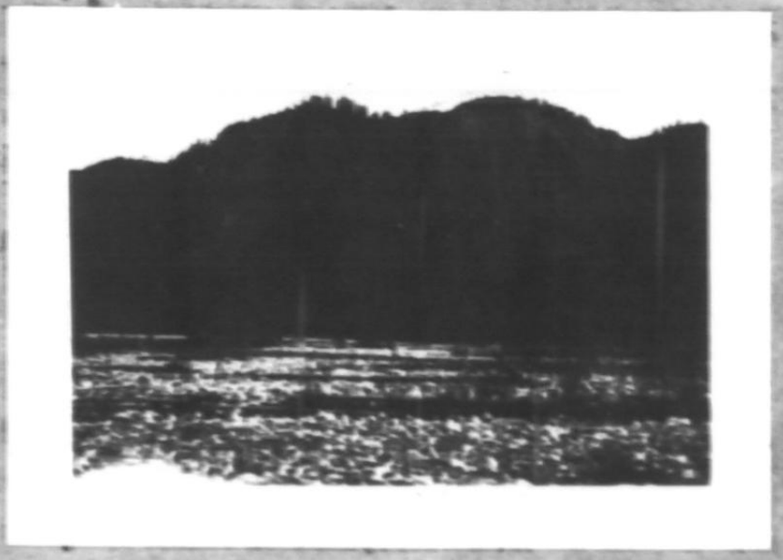


Figure 9.

Small low-angle, south-dipping thrust fault in flat-lying Cretaceous shales near Station 62 on Arctic Red River.

APPENDIX

January 5,1944

MEMORANDUM:

TO: Dr. T. A. Link.

RE: Fossil Identification

Attached is a tentative identification of fossils collected by Mr. E. J. Foley on Assignment No. 3 - Boggs' Creek - Slater River.

C. E. Stelck

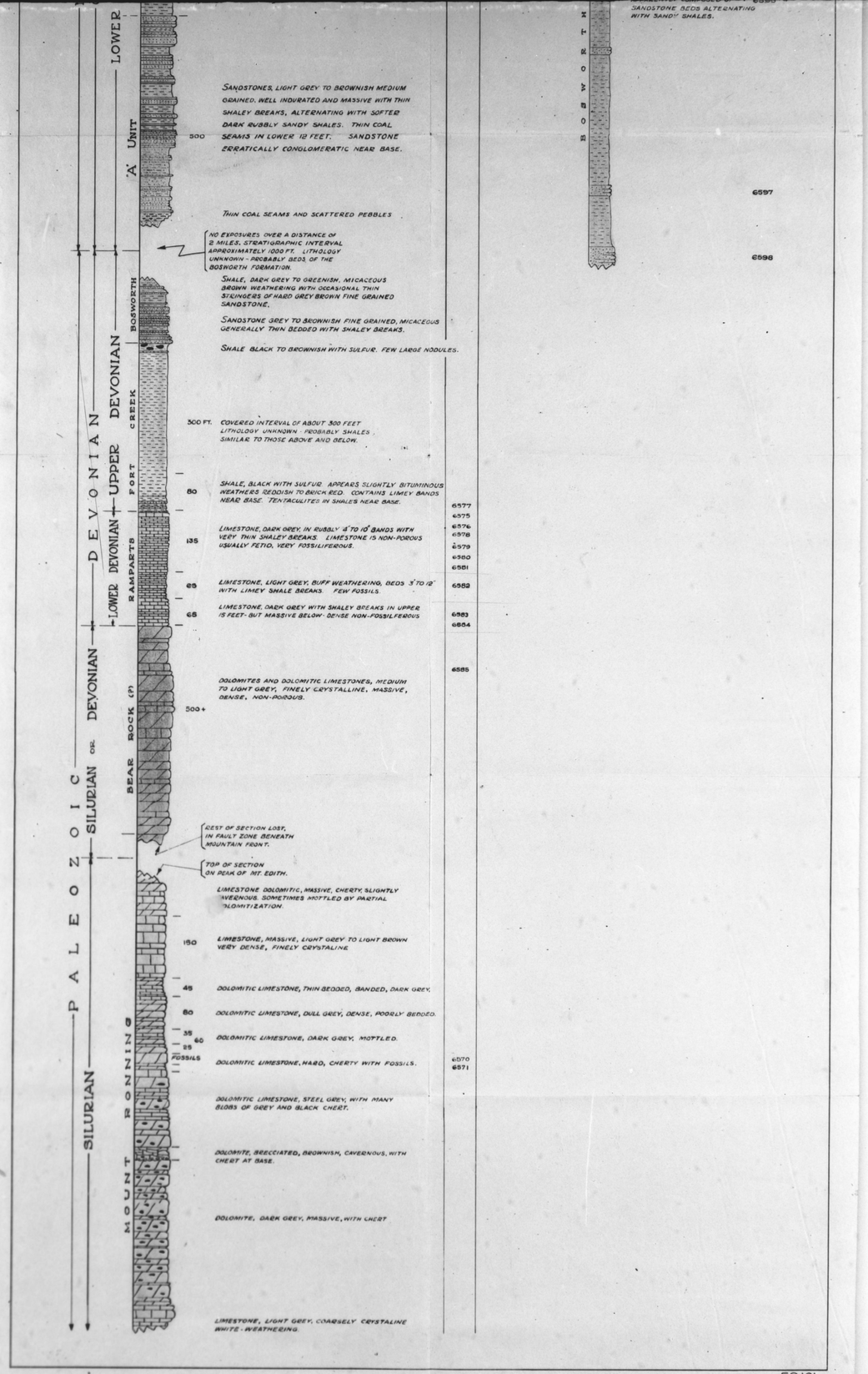
KE/en

FOSSIL IDENTIFICATION - ARCTIC RED RIVER

F. A. McKinnon

Suite No.	Date	Location	Fossil	Accession No.	Age
6590	Sept.10	Sta.91.Photo 324V-5 Arctic Red River.	Gastroplites	43737	Cretaceous
6591	Sept.10	Sta.88 Arctic Red Rvr.	Beudanticeras	43738	Cretaceous
6592	Sept.16	Sta.90 Arctic Red Rvr.	Beudanticeras	43739	Cretaceous
"	"	"	Hoplite	43740	"
6597	Sept.21	Sta.105 Photo 324V-70 Arctic Red River.	Plant Remains	43741	Cretaceous —
6596	Sept.21	Sta.105 Arctic Red Rvr.	Plant remains	43742	Cretaceous —
6598	Sept.21	Sta.106 Arctic Red Rvr.	Plant remains	43743	Cretaceous
6597	Sept.21	Sta.105 Arctic Red Rvr.	Plant remains	43744	Cretaceous —
"	"	"	Plant remains	43745	" —
6572	Aug. 28	Sta.25 Houston Rvr. W Arctic Red River	?	43746	Cretaceous or Devonian
6577	Aug. 28	Sta.29 Houston Rivr.	Tentaculites	43747	U.Devonian
6571	Aug. 26	Sta.21 Mt.Edith. Head of Arctic Red River	Coral	43748	Silurian
6574	Aug. 28	Sta.28 Houston River	Blastoid ?	43749	Ramparts.
"	"	"	Small Coral	43750	"
"	"	"	Orthoceras ?	43751	"
6573	Aug. 28	Sta.27 Houston River	Chonetes	43752	Ramparts
"	"	"	Fenestella	43753	"
"	"	"	Coral	43754	"
6570	Aug. 26	Sta. 21 Mt. Edith	Orthoceras	43755	Silurian
"	"	"	Brachiopod	43756	"
"	"	"	Coral	43757	"
6595	Sept.20	Sta.103 Arctic Red R.	Sandstone with Brachiopod fragments and parts of Crinoid stems	43758	Cretaceous or U.Devonian
6576	Aug. 28	Sta.30 Houston Rvr.	Pugnax	43759	Ramparts.
"	"	"	Atrypa reticularis	43760	"
"	"	"	Cyathophyllum	43761	"
"	"	"	Atrypa spinosa	43762	"
"	"	"	Martinia	43763	"
"	"	"	Miscellaneous Brachiopods	43764	"
6587	Sept. 5	Sta.50 Photo 305V-133 Arctic Red River.	Inoceramus	43765	Cretaceous
6597	Sept.21	Sta.105 Arctic Red R.	Pelecypod	43766	Cretaceous or Devonian.
6593	Sept.17	Sta.92 Arctic Red R.	Inoceramus	43767	Cretaceous
6584 (Loose)	Sept. 2	Sta.30 Houston Rvr.	Schuchertella	43768	Ramparts
6575	Aug.28	Sta.30 Houston Rvr.	Proetus	43769	Ramparts.
"	"	"	Crinoid ?	43770	"
"	"	"	Coral	43771	"
"	"	"	Ostracods	43772	"
6594	Sept.18	Sta.99 Arctic Red R.	Sandstone with Crinoid fragments	43773	Cretaceous or Devonian -
6570	Aug.26	Sta.21 Mt. Edith	Syringopora	43774	Silurian
"	"	"	Cup Coral	43775	"
"	"	"	Halysites	43776	"
6571	Aug.26	Sta.21 Mt. Edith	Favosites	43777	Silurian
6585	Aug.28	Sta.31 Houston Rvr.	Ostracod	43778	Ramparts.

Suite No.	Date	Location	Fossil	Accession No.	Age
6576	Aug. 28	Sta. 30 Houston Rvr.	Favosites	43779	Ramparts
6582	Aug. 28	Sta. 30 Houston Rvr.	Ancryopyge	43780	Ramparts.
"	"	"	Favosites	43781	"
"	"	"	Nautiloid	43782	"
"	"	"	Atrypa (sp.?)	43783	"
"	"	"	Trilobite	43784	"
"	"	"	Fenestella	43785	"
"	"	"	Pleurotomaria	43786	"
"	"	"	Cystiphyllum	43787	"
6576	Aug.28	Sta.30 Houston Rvr.	Cladopora	43788	Ramparts
"	"	"	Hederella	43789	"
"	"	"	Prismatophyllum	43790	"
"	"	"	Atrypa spinosa	43791	"
"	"	"	Proetus	43792	"
"	"	"	Cyathophyllum	43793	"
"	"	"	Gastropod	43794	"
"	"	"	Pelecypod	43795	"
"	"	"	Cup coral	43796	"
"	"	"	Miscellaneous	43797	"
6570	Aug.26	Sta.21 Mt. Edith	Halysites c.f.43776	43798	Silurian
"	"	"	Cystiphyllum	43799	"
"	"	"	Favosites	43800	"
"	"	"	Brachiopod	43801	"
6579	Aug.28	Sta.30 Houston Rvr.	Crinoid stem	43802	Ramparts.
"	"	"	Atrypa reticularis	43803	"
"	"	"	Pleurotomaria	43804	"
6582	Aug.26	Sta. 30 Houston Rvr.	Trilobite fragments (Proetus)	43805	Ramparts.
"	"	"	Cladopora	43806	"
"	"	"	Phillipsastrea	43807	"
"	"	"	Atrypa spinosa	43808	"
"	"	"	Gastropod	43809	"
"	"	"	Prismatophyllum	43810	"
"	"	"	Spirifer	43811	"
6580	Aug.26	Sta.30 Houston Rvr.	Eucmphalus	43812	Ramparts
"	"	"	Atrypa spinosa	43813	"
"	"	"	Coral	43814	"
6576	Aug.26	Sta.30 Houston Rvr.	Cystiphyllidae	43815	Ramparts
"	"	"	Atrypa	43816	"
"	"	"	Eucmphalus	43817	"
"	"	"	Cyathophyllum	43818	"
"	"	"	Favosites	43819	"
"	"	"	Actinoceras	43820	"
"	"	"	Martinia	43821	"
"	"	"	Cladopora	43822	"
6583	Aug. 26	Sta.30 Houston Rvr.	Pleurotomaria ?	43823	Ramparts ?
"	"	"	Pleurotomaria ?	43824	"
"	"	"	Cladopora	43825	"
"	"	"	Small Brachiopods	43826	"
6581	Aug.26	Sta. 30 Houston Rvr.	Atrypa	43827	Ramparts
6592	Sept.27	Sta.90 Arctic Red R.	Beaudanticeras	43828	Cretaceous
----	Aug. 26	Mt. Edith	Zygospira ?	43829	Silurian


PALEOZOIC
DEVONIAN OR SILURIAN
SILURIAN
DEVONIAN
LOWER DEVONIAN
UPPER DEVONIAN
LOWER
MOUNT RONNING
BEAR ROCK (?)
RAMPARTS
FORT CREEK
BOSWORTH
'A' UNIT
BOSWORTH
Sandstones, light grey to brownish medium grained, well indurated and massive with thin shaley breaks, alternating with softer dark rubbly sandy shales. Thin coal seams in lower 12 feet. Sandstone erratically conglomeratic near base.
300
Thin coal seams and scattered pebbles
No exposures over a distance of 2 miles, stratigraphic interval approximately 1000 ft. Lithology unknown - probably beds of the Bosworth formation.
Shale, dark grey to greenish, micaceous brown weathering with occasional thin steingers of hard grey brown fine grained sandstone.
Sandstone grey to brownish fine grained, micaceous generally thin bedded with shaley breaks.
Shale black to brownish with sulfur. Few large nodules.
300 ft.
Covered interval of about 300 feet. Lithology unknown - probably shales similar to those above and below.
80
Shale, black with sulfur appears slightly bituminous weathers reddish to brick red. Contains limey bands near base. Tentaculites in shales near base.
6577
6575
6576
6578
6579
6580
6581
135
Limestone, dark grey, in rubbly 4" to 10" bands with very thin shaley breaks. Limestone is non-porous usually fetid, very fossiliferous.
25
Limestone, light grey, buff weathering, beds 3' to 12' with limey shale breaks. Few fossils.
6582
65
Limestone, dark grey with shaley breaks in upper 15 feet- but massive below- dense non-fossiliferous
6583
6584
6585
Dolomites and dolomitic limestones, medium to light grey, finely crystalline, massive, dense, non-porous.
500+
Rest of section lost, in fault zone beneath mountain front.
Top of section on peak of Mt. Edith.
Limestone dolomitic, massive, cherty, slightly cavernous. Sometimes mottled by partial dolomitization.
150
Limestone, massive, light grey to light brown very dense, finely crystaline
45
Dolomitic limestone, thin bedded, banded, dark grey.
60
Dolomitic limestone, dull grey, dense, poorly bedded.
35
40
25
Dolomitic limestone, dark grey, mottled.
FOSSILS
Dolomitic limestone, hard, cherty with fossils.
6570
6571
Dolomitic limestone, steel grey, with many blobs of grey and black chert.
Dolomite, brecciated, brownish, cavernous, with chert at base.
Dolomite, dark grey, massive, with chert
Limestone, light grey, coarsely crystaline white-weathering.
BOSWORTH
Sandstone beds alternating with sandy shales.
6597
6596

F 2161


30x
West Canadian Graphic Industries Ltd.

PLATE NO. 4.

CONFIDENTIAL

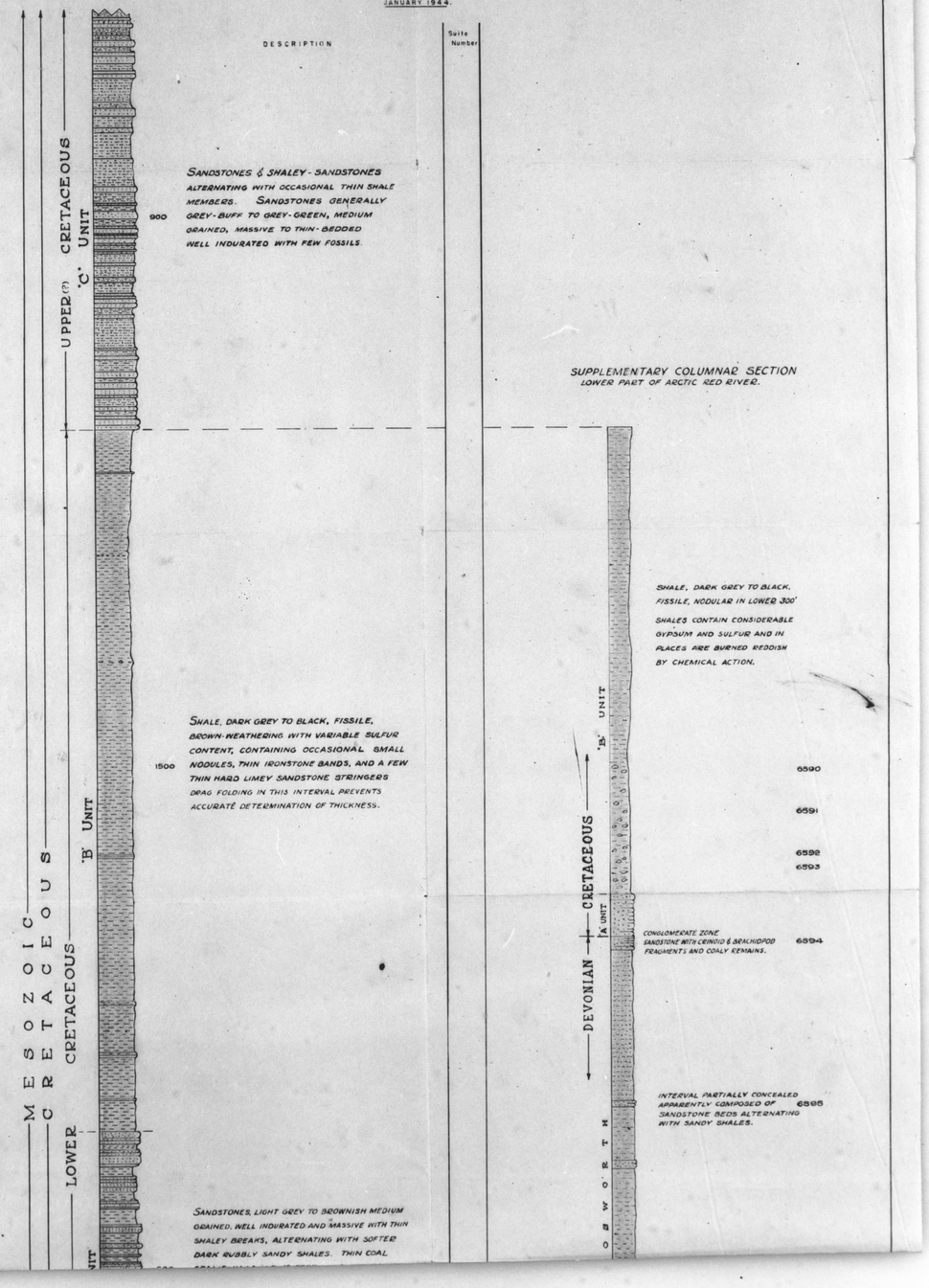
COMPOSITE COLUMNAR SECTION

ARCTIC RED RIVER AREA

SCALE 1 INCH 100 FEET

ASSIGNMENT NO. 22. PARTY, A.

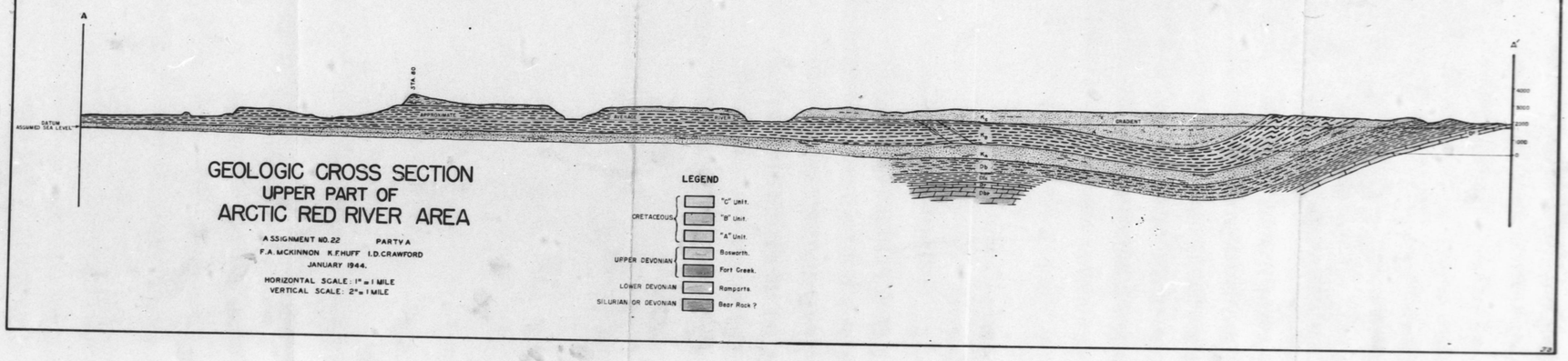
F. A. MCKINNON.
K. F. HUFF.
I. D. CRAWFORD.
JANUARY 1944.



30x

West Canadian Graphic Industries Ltd.

CONFIDENTIAL PLATE No 3



GEOLOGIC CROSS SECTION UPPER PART OF ARCTIC RED RIVER AREA

ASSIGNMENT NO. 22 PARTY A

F.A. McKINNON K.F.HUFF I.D.CRAWFORD

JANUARY 1944.

HORIZONTAL SCALE: 1" = 1 MILE
VERTICAL SCALE: 2" = 1 MILE

LEGEND

CRETACEOUS	"C" Unit.	Kc
	"B" Unit.	Kb
	"A" Unit.	Ka
UPPER DEVONIAN	Bosworth.	Db
	Fort Creek.	Dc
LOWER DEVONIAN	Ramparts.	Dr
SILURIAN OR DEVONIAN	Bear Rock ?	Dbr

F-2.223