FINAL GEOLOGICAL REPORT

on

THE LOWER CARCAJOU RIVER AREA.

N.W.T.(Canada)

IMPERIAL OIL LIMITED - CANOL PROJECT.

Assignment No. 9

By: Lt. G. D. Bath Party Chief
S. S. Cosburn Assistant
J. E. Baugh Helper.

Date submitted: February 22,1944.

Read and accepted by: [signature]

Date: 3/3/'44

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FINAL GEOLOGICAL REPORT

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THE LOWER CARCAJOU RIVER AREA

N.W.T. (Canada)

A B S T R A C T

A geological survey was made of the Lower Carcajou River and adjacent area from the mouth of the Imperial to the Mackenzie River. Two structural zones, Imperial and Sammons-Rainbow Arch anticlinoria were mapped where the older resistant beds outcrop. The folded and faulted structural zones plunge to the eastward, and the detail of their continuation may be followed with geophysical aids, and possibly by more inaccessible rock outcrops. The area to the west and to the southeast of Hoosier Ridge should be explored with the seismograph. No closed structures involving possible productive horizons were found. Imperial Anticline lacks closure to the northwest. Favorable reservoir beds were found in the Cretaceous sandstones, Norman Sandstone Series, Kee Scarp limestones, and Bear Rock dolomites. The upper Sandstone lenses of the Norman Series form an excellent horizon for the accumulation of oil in stratigraphic traps.

Acknowledgment - The Carcajou River had previously been traversed in 1922 by Dr. T. A. Link and by Dr. G. S. Hume. The author is indebted to Dr. Link for his helpful suggestions, his participation in the aerial reconnaissance, and his discussion after making a second trip on the Carcajou River this past year. Dr. Hume shows the general geology, together with strikes and dips on an accompanying map in the Summary Report, 1922, Part B, of the Canadian Geological Survey.

Appreciation is extended to John M. Parker, and Dr. A. W. Nauss for their suggestions and for the further information acquired when they descended the river in the late summer when the water was low, thus exposing outcrops previously covered with water.

Chapter II.

T O P O G R A P H Y

At the mouth of the Imperial River, the start of the traverse, the Carcajou River flows along the eroded crest of Imperial Anticline for four miles to where the river cuts through the strike of the north limb and roughly parallels the anticline to near the vicinity of Rainbow Arch. Imperial Anticline is the most northward member of the Imperial Anticlinorium; the anticlinorium being a moderate expression of a positive area between the flat topography adjacent to the foothills of the Mackenzie Mountains and the flat topography of the Mackenzie River Basin.

In the vicinity of Rainbow Arch a series of irregular hills and low mountains have been formed by the east-west trending Rainbow Arch, Sammons, Shavetail, and other anticlines. This trend is represented to the west by over sixteen miles of mountainous area to a point near the Mountain River. To the east the trend gradually dies out, but again becomes prominent at Hoosier Ridge. From Rainbow Arch to the Mackenzie River the topography is relatively flat.

Chapter III.

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

General - Outcrops observed in the Lower Carcajou River area are of Devonian and Cretaceous age. Devonian outcrops consist of the Bear Rock, Ramparts, Beavertail, Fort Creek, and Norman Series formations. Cretaceous outcrops consist of the Slater River formation. Only occasional fossil suites were collected in Devonian beds as these sediments had previously been correlated by Dr. T. A. Link (1) and Dr. G. S. Hume (2). In the Cretaceous shales several samples were taken to be worked for microfossil content and correlation. The work with microfossils is not included in this report. The following is an abridged stratigraphic table of formations found in this area.

Age	Formation	Thickness (feet)	General Description
CRETACEOUS	Slater River	350 ±	Soft dark shales overlying resistant sandstones.
DEVONIAN	Norman Series	1075	Alternating shales and sandstones. Limey beds near base.
	Fort Creek	800	Soft light grey to black resistant shales, inter-bedded limestones near base.
	Beavertail	80	Massive limestones.
	Ramparts	175	Alternating shales and limestones.
	Bear Rock	500 ±	Brecciated dolomite and anhydrite beds.

DEVONIAN

Bear Rock Formation - Dolomite and anhydrite beds underlying the Ramparts formation are found at Rainbow Arch and along Sammons Creek. There is a striking similarity between these outcrops and the corresponding horizons as seen in samples and cores from Hossler Ridge Wildcat No. 1.

The top of the Bear Rock formation was taken at the first appearance of a brown crystalline dolomite. This dolomite is quite homogeneous throughout fifty feet of thickness, and underlies shales and interbedded grey dolomitic limestones. The brown crystalline dolomite is a true dolomite (insoluble in cold acid but completely soluble in hot acid) that is characteristically banded with black bituminous material. The dolomite is porous, containing small openings sometimes unnoticeable to the unaided eye, and upon fracture emits a strong odor of hydrogen sulphite.

Interbedded grey dolomite and anhydrite beds underlie the brown dolomite. The anhydrite beds reach a maximum thickness of five feet and are light colored, unconsolidated beds with occasional iron stains.

Underlying fifty feet of interbedded dolomite and anhydrite horizon are over 150 feet of resistant, grey, brecciated dolomites and limestones. The beds are cavernous and show evidence of continual solution and redeposition of calcite and anhydrite by underground waters. A portion of Sammons Creek is routed along an underground channel for several miles in the fractures and other openings of the Bear Rock and adjacent formations.

<u>Ramparts Formation</u> - The Ramparts formation consists of 175 feet of interbedded shales and limestones. The following Ramparts section was measured in the Rainbow Arch area:

20 feet	Resistant dark grey dense limestone. Very fossiliferous. Base contains 2-3 inch persistent coral horizons.
90 feet	Nonresistant shale and thin beds of interbedded dark grey dolomitic limestone. Fossiliferous.
20 feet	Massive dark grey dolomitic limestone. Ostracoda.
25 feet	Less resistant more thinly bedded dark grey dolomitic limestone and interbedded shale.

Beavertail Formation - The Beavertail formation consists of 80 feet of massive dark grey limestone. The limestone is identified by the fossiliferous horizon (abundant Hypothyridina castanea) just above the top of the limestone at the contact with the Fort Creek Shales. The limestone is quite homogenous but in places the limestones have been recrystallized and are fossiliferous with corals predominating.

Fort Creek Formation - The Fort Creek formation was found to be 800 feet thick and is separated into the Upper and the Lower Fort Creek Shales by five feet of Kee Scarp limestone.

The Upper Fort Creek shales are 625 feet thick and consist of two separate lithological horizons, the upper horizon (360 feet) and the lower horizon (265 feet). The upper horizon is made up of soft steel grey shales with numerous ironstone lenses and occasional concretions of cone-in-cone structure. The lower horizon consists of more resistant dark grey to black carbonaceous shales and ironstone lenses which weather to brilliant colors of red, yellow and orange.

The Kee Scarp formation is represented by five feet of dark grey crystalline limestone with numerous fossil fragments and calcite crystals. The Lower Fort Creek shales are 170 feet thick and consist of shales with interbedded limestones as follows:

70 feet	Blue-grey to black soft shale
50 feet	Interbedded dark grey to black resistant shale and dark grey shaley limestone. Shale beds vary from a few inches to 8 feet, limestone beds from 1 to 18 inches.
50 feet	Soft blue-grey to a more resistant black carbonaceous shale.

Norman Series Formation - The Norman Series was found to be 1075 feet thick. The top of the Series was placed at the base of a sandstone member underlying the Slater River Shales of Cretaceous age. The base of the Series was placed at the bottom of the first resistant sandstone overlying the soft Fort Creek shales.

Detailed descriptions and an attempt to correlate the lower 300 feet of the Series appear on the accompanying geologic column. It will be noticed that correlation of the resistant sandstone beds is possible only over a short distance, as the beds are continually lensing out and reappearing at a different horizon. The two thin limestone beds at the base of the Series were the most persistant beds noticed.

The Norman Series changes from an interbedded fine grained sandstone in the lower beds, to a medium grained more porous sandstone in the upper beds. The lower beds are quite often non-porous, the pores being filled with a calcareous cement.

CRETACEOUS SEDIMENTS

Several hundred feet of soft, dark grey, Slater River shales outcrop in the low "basin" area. These shales overlie 50 feet of light grey medium grained sandstone. Further description and correlation of these sediments await the completion of work with the microfossil samples.

Chapter IV

S T R U C T U R E

General - The two major trends occurring in the Lower Carcajou Area are the Imperial and Sammons-Rainbow Arch anticlinoria. These trends are composed of a series of related folds and faults; the former being exposed at the Imperial River and adjacent areas, and the latter at the Rainbow Arch Area.

Imperial Anticline - Imperial Anticline is the only structure in the Imperial Anticlinorium that has been mapped. It is apparent from section D-D' that folding or faulting occur to the south of Imperial Anticline.

The reversal noted on the Carcajou River, three miles downstream from the mouth of the Imperial River, defines the Imperial Anticline. The Anticline can be traced from the air and from outcrops on the ground for over ten miles. No definite evidence of closure was noted. The structure plunges to the southeast, decreasing approximately 1000 feet in elevation in the seven miles between Walker Creek (section C-C') and the reversal on the Carcajou River (section D-D'). At Walker Creek the anticline has been eroded through the Beavertail formation. The structure at Sammons Creek thought to be the extension of Imperial Anticline to the northwest has been eroded several hundred feet into the Bear Rock formation.

A small fold is found on the northeast flank of Imperial Anticline at Walker Creek (section C-C' - "Walker Fold"). This fold is a minor structure that parallels Imperial Anticline and exposes rocks that are near the base of the Fort Creek formation.

Sammons-Rainbow Arch Anticlinorium - The Sammons-Rainbow Arch anticlinorium is composed of several folds and faults that trend in a generally east-west direction. These structures plunge under the topographic low "basin" area to the east where the outcrops have been removed by erosion and covered with Pleistocene or Recent sediments. It is believed that possibly Hoosier Ridge, 14 miles to the east, is the continuation and a positive expression of one of the structures of this anticlinorium.

The folds of this area are surprisingly similar; being tightly folded, asymmetrical anticlines (section B-B' and A-A'). "Shavetail" anticline, the most northward member of the group, is characterized by its steep north flank and its contrast with the adjacent low topography. This anticline has been eroded into the Bear Rock formation to the west and plunges rather steeply to the east.

Rainbow Arch anticline, at the point where the Carcajou River cuts through the structure, plunges both to the east under the "basin" area, and to the west in the more mountainous area. The structure has been eroded into the dolomite and anhydrite beds of the Bear Rock formation.

Sammons Anticline plunges to the east exposing Bear Rock dolomite along its crest on Sammons Creek and exposing Upper Fort Creek shale at the point where the Carcajou River cuts through the structure.

Trail Rapids Structure- Outcrops of lower Cretaceous shales and sandstones at Trail Rapids suggest a terrace or a possible east-west anticline. Section A-A' shows the gently dipping south flank of a possible structure. Cretaceous beds to the west are stratigraphically higher in the section and are approximately the same elevation as the outcrops at Trail Rapids.

No field evidence of reversal of the beds toward the north is found. This is probably due to the non-resistant nature and the slight dips of the lower Cretaceous sediments involved.

NOTE: Aerial observation by Dr. T. A. Link and geology of the Mountain River by John M. Parker indicates that Sammons-Rainbow

Arch and Imperial Anticlinoria are not separate structural zones, but that Sammons-Rainbow Arch anticlinorium represents one of the series of structural trends of Imperial Anticlinorium.

This break-down is not made in this report as the information was not evident while in the field and none but a preliminary aerial reconnaissance was made of the area by the undersigned.

Chapter V

H I S T O R I C A L   G E O L O G Y

On the north flank of Imperial Anticline Cretaceous beds were found to be lying conformably upon the older Devonian beds. Although the actual contact between the two formations was not seen, the strike and dip of the Cretaceous sandstones was found to be essentially the same as the underlying Devonian shales and sandstones. This indicates a widespread regional uplift prior to Cretaceous time. The mountain building forming the Imperial and Sammons-Rainbow Arch anticlinoria is post-Cretaceous.

Chapter VI.

OIL AND GAS MANIFESTATIONS

No gas or oil seeps were found in the Lower Carcajou Area. Black iron sediments, several inches thick that resembled petroliferous material, was found under melting ice on Rankin Creek where it had collected from months of filter action of water flowing over and through ice and snow.

The most favorable producing horizon encountered was the Bear Rock formation. The dolomites and limestones of this formation are porous to the extent of being cavernous, and proof of permeability is apparent in the underground channel of Sammons Creek. Bitumen is found in the dolomites, the upper section of which emits a strong odor of hydrogen sulphide.

The upper porous sandstone section of the Norman Series formation contains potential reservoir beds. Bitumen was found in these beds. The lensing out of the sandstones indicate favorable conditions for the accumulation of oil in stratigraphic traps on the flanks of the folds of Imperial and Sammons-Rainbow Arch anticlinoria.

The fifty foot Cretaceous sandstone bed underlying the Slater River shales is another potential reservoir bed.

Source beds include the Slater River Shales, Norman Series shales, Lower Fort Creek bituminous shales, and the Kee Scarp limestone horizon.

Chapter VII

CONCLUSIONS AND RECOMMENDATIONS

<u>Imperial Anticline</u> – Considerable field information was collected concerning Imperial Anticline, and while no definite evidence of closure could be found, the structure does warrant further consideration. The plunge of the axis of the anticline to the southeast gives closure in that direction. To the northeast the axis of the anticline gradually rises to where beds older than the Beaverhill formation are exposed beyond Walker Creek. The presence of small faults and the gradual slope of the axis (the slope averages less than 3% between Walker Creek and the point of reversal on the Coronjou River) indicates conditions favoring the formation of a small oil field. It seems evident that at best only a small field could be found at the Imperial Anticline structure.

It is recommended that an accurate geologic survey be made of Imperial Anticline. All ridges should be walked and a plane table survey should be made of the slope of the axis of the anticline. Relatively accurate elevations should be carried.

<u>Extension of Semmons-Rainbow Arch Anticlinorium</u> – The area to the east of Rainbow Arch in the low "basin" area towards Hoosier Ridge is of primary importance. It is known that the folds of the Semmons-Rainbow Arch anticlinorium that plunge to the east do not completely die out but extend beyond Hoosier Ridge. In this area the Ace Quarry limestones may be found [illegible] the Cretaceous sandstones, the [illegible] sandstones, and the Bear Rock dolomites as possible producing horizons.

It is recommended that further seismic work be done to the west and to the northeast of Hoosier Ridge in an attempt to trace the folds and faults of this anticlinorium. Should a structure be traced to a point to the southeast of Hoosier Ridge, it would become an excellent wildcat prospect.

Trail Rapids Structure - Further geological and geophysical work should be done to the north of Trail Rapids. Careful aerial reconnaissance may show rock outcrops in this area. Seismic exploration may be the only effective method that can be used, but efforts should be made to obtain as much additional surface geology in the Basin area as possible.

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BIBLIOGRAPHY

1. Link, T.A. "Fort Norman Area", N.W.T. 1921.

2. Hume, G.S. Norman Oil Area- Mackenzie District, N.W.T.; Summary Report, 1922, Part B, Canada Geological Survey

APPENDIX

Edmonton, Alberta,
February 7, 1944.

TO: Dr. T. A. Link

RE: Fossil Identification

The attached list is a tentative identification of fossils collected by Lt. Bath on Assignment No. 9, Lower Carcajou River (Rainbow Trail).

C. R. Stelck

KH/tm

FOSSIL IDENTIFICATION - LOWER CARCAJOU RIVER (Rainbow Trail).

Suite No.	Location	Fossil	Accession No.	Age
100 B	Bed X on Sammons Creek, Lower Carcajou	Ostracods	42988	Ramparts?
		Stromatoporoid ?	42989	
---	Lower Carcajou	Schuchertella	42990	Ramparts
---	Outcrop No. 1 Zone X	Atrypa devoniana	42991	Ramparts
		Terebratula	42992	"
		Cyathophyllum	42993	"
		Productella	42994	"
---	23, Lower Carcajou	Cladopora	42995	Ramparts - Beavertail
100 C	Contact Fort Creek - Beavertail Sammons Creek. Lower Carcajou	Cladopora	42996	Beavertail
Float	Loco Ridge, Lower Carcajou	Atrypa reticularis	42997	--- ?
		Syringopora	42998	"
		Cladopora	42999	"
---	Lower Carcajou	Atrypa	41000	--- ?
---	Lower Carcajou	Paracyclas	41001	--- ?
(8)	Lower Carcajou	Rock ls.	41002	--- ?
Float	Lower Carcajou	Atrypa reticularis	41003	Bosworth
		Prismatophyllum	41004	"
Photo 1067A	About 3 mi. above Walker Cr. Lower Carcajou	Cyrtospirifer	41005	Norman
100 A	Beds just below Bt. at large fold on Sammons Cr. L. Car.	Ostracods	41006	Ramparts
No. washed out	Lower Carcajou	Atrypa reticularis	41007	Ramparts
		Atrypa	41008	"
		Paracyclas	41009	"
		Cystiphyllum	41010	"
Float	Lower Carcajou	Cystiphyllum	41011	Bosworth
		Atrypa reticularis	41012	"
		Martinia	41013	"
		Atrypa spinosa	41014	"
		Stropheodonta	41015	"
		Pugnax	41016	"
		Gastropod	41017	"

Fossil Identification

Suite No.	Location	Fossil	Accession No.	Age
24	Imperial River, Lower Carcajou	Atrypa reticularis	41018	Ramparts
---	Outcrop No. 1 Zone X	Productella	41019	Fort Creek
		Hypothyridina	41020	Ditto
		Atrypa spinosa	41021	"
		Paracyclas	41022	"
		Martinia	41023	"
No. 5	P.T. Sta. 46 L. Carcajou	Cyrtospirifer	41024	--- ?
---	Outcrop No. 1 Lower Carcajou	Martinia (Ambocoelus)	41025	Fort Cr. sh.
		Conularia	41026	Ditto
---	Lower Carcajou	Atrypa reticularis	41027	Ramparts
		Proetus	41028	
Photo 1056-C	Lower Carcajou	Atrypa	41029	--- ?
Photo 1054-B	Sammons Cr. Lower Carcajou	Hypothyridina	41030	Fort Creek
		Paracylas	41031	Ditto
		Leiorhynchus	41032	"
		Brachiopod ?	41033	"
		Atrypa spinosa	41034	"
36	Imperial River Lower Carcajou	Cladopora & Productella	41035	Kee Scarp Horizon
		Martinia	41036	Ditto
		Schizophoria ?	41037	"
Photo 1067A	About 3 mi. above Walker Cr. L. Carcajou	Cyrtospirifer	41038	Norman
---	Lower Carcajou	Inoceramus	41039	Cretaceous
22	Imperial River Lower Carcajou	Actinopteria	41040	Ramparts?
Photo 1061 A	Near mouth Walker Cr. Lower Carcajou	Productid ?	41041	Norman
	Ditto	Chonetes	41042	"
Photo 1054-2	F9 in shale member Sammons Cr. Lower Carcajou	Leda ?	41043	--- ?
114-3	P.T. Sheet 8 Lower Carcajou	Hypothyridina	41044	Fort Creek
	Ditto	Productella	41045	Ditto

Fossil Identification

Suite No.	Location	Fossil	Accession No.	Age
---	Ridge ls. Lower Carcajou	Hypothyridina cuboides	41046	Bosworth
		Stromatoporoid?	41047	"
		Atrypa reticularis	41048	"
		Gastropod	41049	"
13	Lower Carcajou	Syringopora	41050	--- ?
(12)	Lower Carcajou	Proetus	41051	M.Devonian
27	Imperial River	Proetus	41052	Ramparts
		Pelecypod	41053	"
		Orthoceras	41054	"
		Syringopora	41055	"
		Martinia	41056	"
P.T.21	Sheet 1 below Rankin Creek 12001 Imperial River	Crinoidal ls.	41057	--- ?
---	Lower Carcajou	Reticularia	41058	--- ?
		Atrypa	41059	"
Photo 1054-2	Lower Carcajou	Alveolites	41060	Beavertail - Ft. Creek contact
		Stromatoporoid?	41061	
		Hypothyridina	41062	
B 1	Lower Carcajou	Hypothyridina	41063	Fort Creek
---	Lower Carcajou	Schuchertella	41064	M. Ramparts
		Proetus	41065	"
		Productella	41066	"
P.T.20	Sheet 1 Mouth Rankin Creek, Imperial River, Lower Carcajou	Acervularia	41067	Ramparts
		Atrypa	41068	"
B1	Lower Carcajou	Favosites	41069	Ramparts
		Cystiphyllum	41070	"
		Stromatoporoid?	41071	"
PT25	Imperial River	Atrypa spinosa	41072	Ramparts
		Paracyclas	41073	"
PT26	Imperial River	Productella	41074	--- ?
PT46	Lower Carcajou	Cyrtospirifer	41075	--- ?
Loose, not in bags	1 mi. up Walker Cr. Lower Carcajou	Cyrtospirifer	41076	Norman

Fossil Identification

Suite No.	Location	Fossil	Accession No.	Age
Loose, not in bags	1 mi. up Walker Cr. Lower Carcajou	Cyrtospirifer	41077	Norman
		Cladopora	41078	"
	Ditto	Hypothyridina	41079	Ft. Creek
"	"	Productella?	41080	"
"	"	Leiorhynchus	41081	"
"	"	Disphyllum	41082	Beavertail
"	"	Prismatophyllum	41083	"


MACKENZIE RIVER
CRETACEOUS SHALE
(undifferentiated)
CARCAJOU RIVER
SCALE: 2 INS. TO 1 MI. OR 1:31680
MILES

30x

PLATE II

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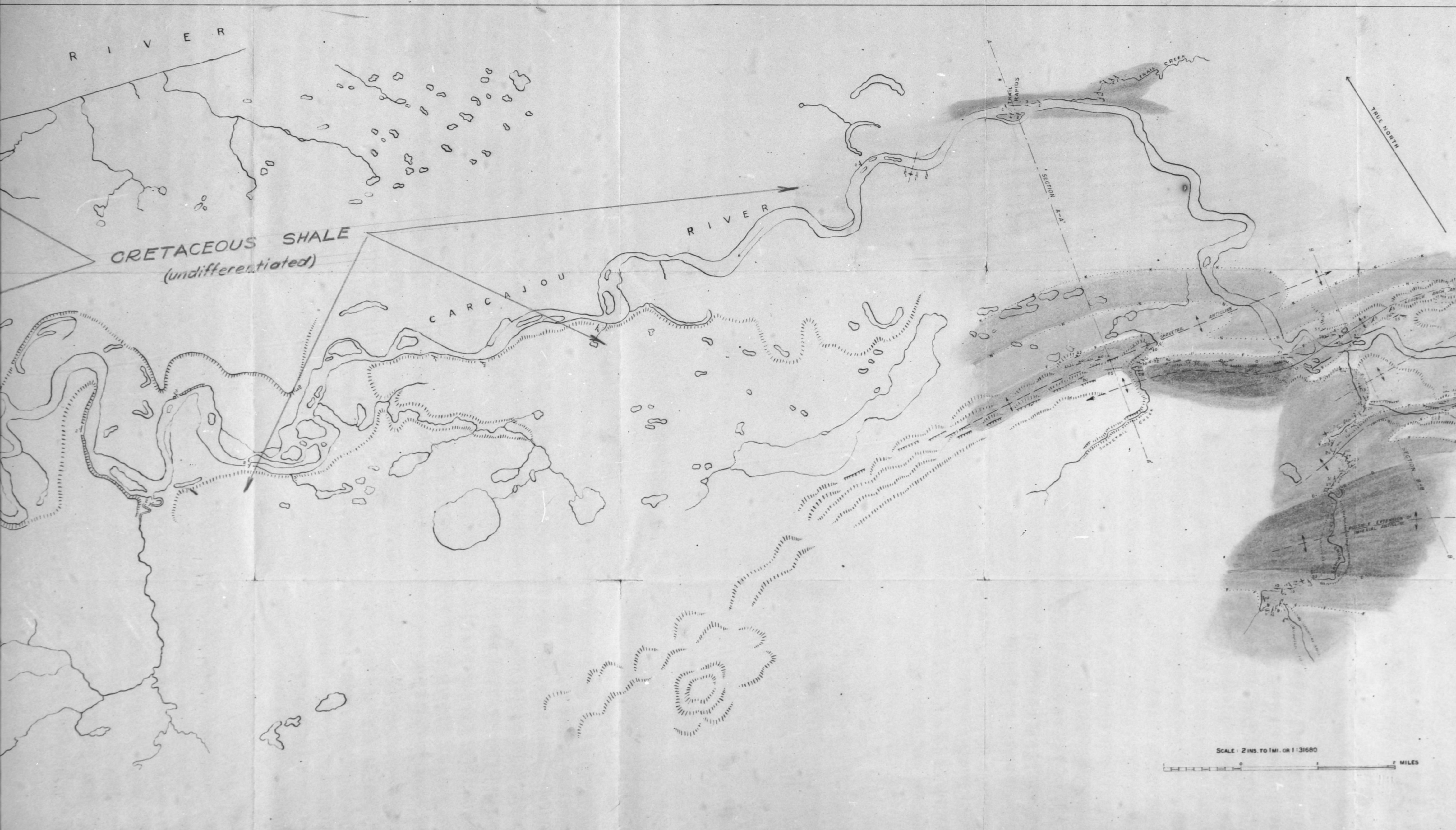

AREAL GEOLOGY

LOWER CARCAJOU RIVER

- Base of Cretaceous.
- Base of Norman Series.
- Top of Beavertail Limestone.
- Top of Bear Rock Dolomite.

ASSIGNMENT NO·9

LEGEND

- Cretaceous (Undifferentiated) Trail Sandstone
- Norman Series
- Fort Creek Shale
- Beavertail-Ramparts
- Bear Rock

T-2.39-81


Sheet 2
AREAL GEOLOGY
LOWER CARCAJOU RIVER
JULY 1943.
Base of Cretaceous
Base of Norman Series
Top of Beavertail Limestone
Assigment No. 9
Scale 2 inches to 1 mile or 1:31,680
Miles
Miles
LEGEND
Cretaceous (Undifferentiated)
Norman Series
Fort Creek Shale
Beavertail - Ramparts
RIVER
PERRY ISLAND
JUDITH I.
OGILVIE I.
Hoosier Ridge Anticline
HOOSIER RIDGE
Possible extension of SHAVETAIL ANTICLINE
RAINBOW ARCH ANTICLINE
SAMMONS ANTICLINE
RETE LAKE
CARCAJOU RIVER
Section C-C'
East Fork Walker Creek
WALKER CREEK
Walker Fold
IMPERIAL ANTICLINE
LAKE MAJEL
Section D-D'
RANKIN CREEK
T-2-41-83


PLATE II
CONFIDENTIAL
MACKENZIE
RIVER
WILLARD I.
STANLEY I.
PERRY ISLAND
JUDITH I.
OGILVIE I.
Hoosier Ridge Anticline
HOOSIER RIDGE
Hoosier No 2
Hoosier No 1
SHEET 2
AREAL GEOLOGY
LOWER CARCAJOU RIVER
JULY 1943.
BASE OF CRETACEOUS
BASE OF NORMAN SERIES
TOP OF BEAVERTAIL LIMESTONE
ASSIGMENT NO. 9
Miles
Miles
LEGEND
Cretaceous (Undifferentiated)
Norman Series
Fort Creek Shale
Beavertail - Ramparts

Series	Formation	Thickness	Description
Upper Devonian	Upper Fort Creek 625'*	400'	(Lower part of Norman Series is given on Plate No. IV in detail.) Interbedded grey fine grained Ss. and soft grey shale. Occasional massive grey Ls. in lower section.
		200'	Soft steel grey shale, crumbled and badly fractioned. Flakes of Muscovite abundant. Thin beds of persistent ferruginous concretions. Occasional (3") layers of calcareous cone-in-cone-structure concretions. In places shale characterized by smooth, well-rounded outcrops.
		50'	No outcrops seen.
		10'	Limonite stained, steel grey soft shale coated with white limey precipitate.
		5'	1"-36" concretion horizon in dark carbonaceous shale.
		32'	Dark carbonaceous shale containing numerous ironstone concretions.
		115'	Black carbonaceous shale that weathers locally to yellow (iron stain) and white (calcareous precipitate). Strong sulphur odor and presence of free sulphur.
		18'	Harder slate-like carbonaceous shale. Thin ironstone beds and lenses.
		70'	No outcrops seen.
		75'	Black hard shale to softer carbonaceous shale. Shale weathers locally to brilliant reds and oranges, and also to yellow rust color. Occasional thin ironstone bed. Appearance of 2-3 foot beds of hard massive grey shaley limestone.
		50'	(Estimated thickness)
		5'	Dark grey crystalline limestone with numerous fossil fragments and calcite crystals. Somewhat porous and hetrogenous.
	Lower Fort Creek 175'*	70'	Blue-grey to black soft shale. Thin bedded and friable in places.
		50'	Interbedded dark grey to black resistant thin bedded shale and dark grey massive shaley limestone. Shale beds vary from a few inches to 8 feet; limestone varies from a few inches to 1½ feet.
		50'	Varies from soft blue-grey thin bedded shale to a more resistant black shale.
Middle Devonian	Beavertail Ls.	55'	Fossiliferous Zone. Massive dark grey dense to semi-crystalline limestone. Tends to form a pattern of a series of 5' beds. Limestone has been recrystallized in places.
		25'	Nodular appearing dark grey limestone interbedded thin grey shale beds.
	Ramparts	20'	Non resistant shales with interbedded limestones
		20'	Resistant dark grey dense limestone. Fossiliferous. Base contains 2"-3" persistant coral horizons.
		90'	Non resistant shale and thin beds of interbedded dark grey dolomitic limestone. Fossiliferous.
		20'	Massive dark grey dolomitic limestone. Ostracods.
		25'	Less resistant more thinly bedded dark grey dolomitic limestone and shale.
	Bear Rock Dolomite	50'	Brown crystalline Bear Rock Dolomite. In places dolomite is banded and quite porous with H_2S odor.
		100'*	Brown to grey crystalline Dolomite with interbedded soft anhydrite beds. More resistant light grey dolomite badly brecciated with deposition of calcite and anhydrite along the fractures.

* Upper 625' shales outcrop near mouth of Imperial River.
Lower 175' shales and limestones outcrop near Rainbow Arch.

T-2.55-99

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PLATE III

COMPOSITE COLUMNAR SECTION

LOWER CARCAJOU AREA

SCALE: 1 IN. TO 50 FT.

ASSIGNMENT NO. 9

LT. G. D. BATH
S. S. COSBURN
J. E. BAUGH

FEBRUARY 1944.

System	Series	Formation	Member	Column	Thickness	Description
CRETACEOUS	Lower Cretaceous				50'	Dark grey to black fissile shale. Free sulphur deposit on shale
					25'	Light grey medium grained Ss. Badly brecciated.
					15'	Soft grey shale
					25'	Light grey medium grained Ss. Limonite stain. Ironstone lenses. Some bituminous matter.
		Norman			150'	Occasional outcrop dark grey shale. Most of interval covered
					5'	Dark grey resistant shale, weathers red and yellow.
					10'	Interbedded dark grey shale and grey fine grained Ss
					10'	Dark grey to black shale – weathers dull red and yellow.
					20'	Dark grey to black shale
					2'	Massive light grey medium grained Ss.
					5'	Sandy grey shale.
					2'	Medium grained grey Ss.– porous
					3'	Thin bedded shaley grey Ss.
					4'	Grey shale. Yellow alteration 2"–10" Iron Concretionary beds.
					3'	Massive light grey medium grained Ss.
					5'	Grey shale
					455'?	(Estimated thickness) Only occasional scattered outcrops. Interbedded medium grained brown to grey Ss. and grey shale. Occasional Ironstone concretionary beds. Thin beds of brown crystalline limestone containing numerous fossils. 10' Spirifer horizon in thin layers calcareous matrix in dark brown Ss. Medium grained Ss. frequently cross bedded and contains carbonaceous material and pebble beds (mostly quartzite) up to 1' thick. Ss. usually porous.
					400'	(Lower part of Norman Series is given on Plate No. IV in detail.) Interbedded grey fine grained Ss. and soft grey shale. Occasional massive grey Ls. in lower section.

Graphic Scale

0 100 200 300 400 FEET

30x

CORRELATION CHART OF LOWER PART OF NORMAN SERIES in the LOWER CARCAJOU AREA

SCALE : 1 IN. TO 10 FT.

Correlation is made on Key Bed A-A' (2½' massive Grey Limestone) 50' to 100' above contact of the Norman Series and Upper Fort Creek Shale.

ASSIGNMENT NO. 9

LT. G.D. BATH
S.S. COSBURN
J.E. BAUGH

FEBRUARY 1944

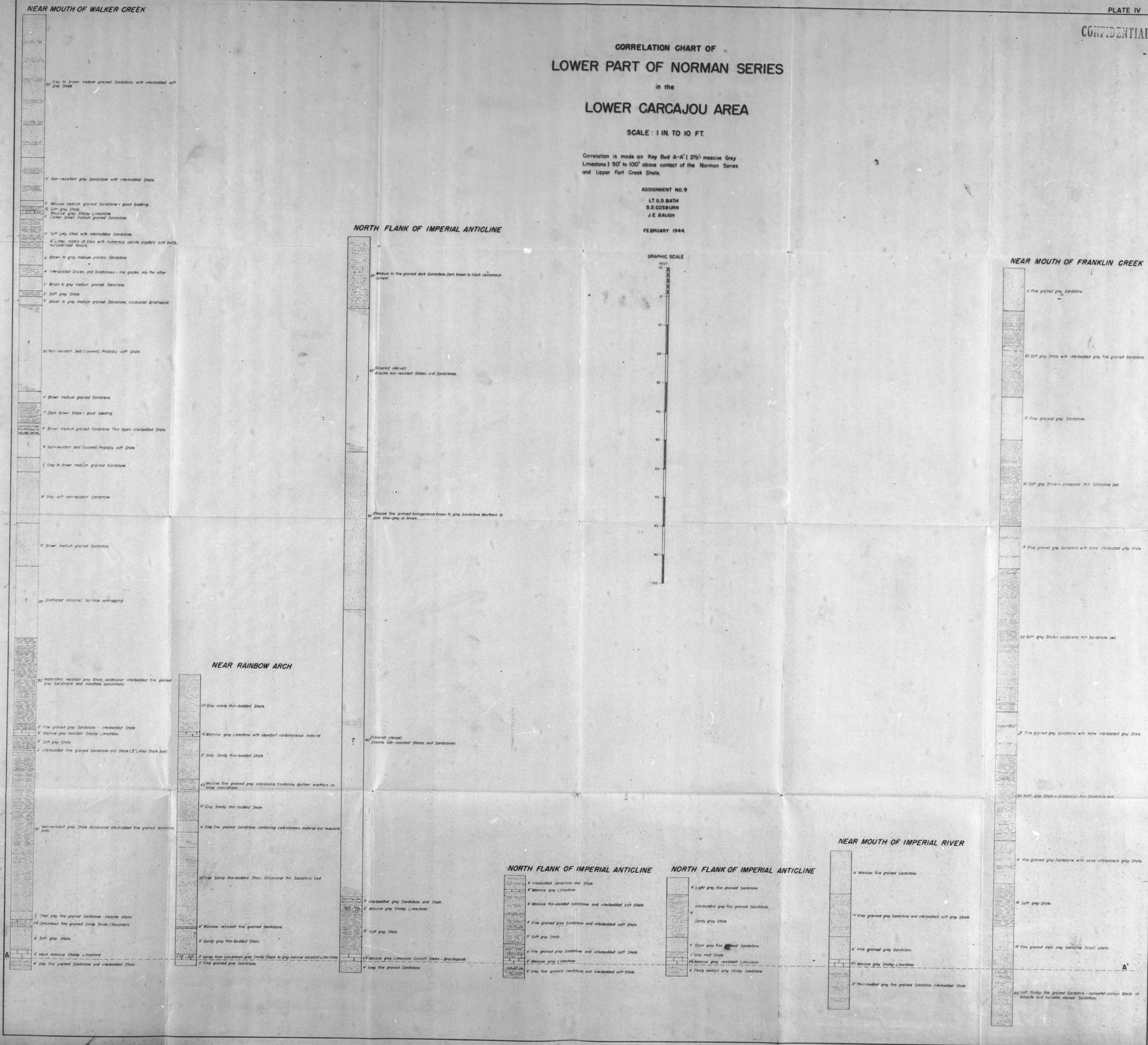

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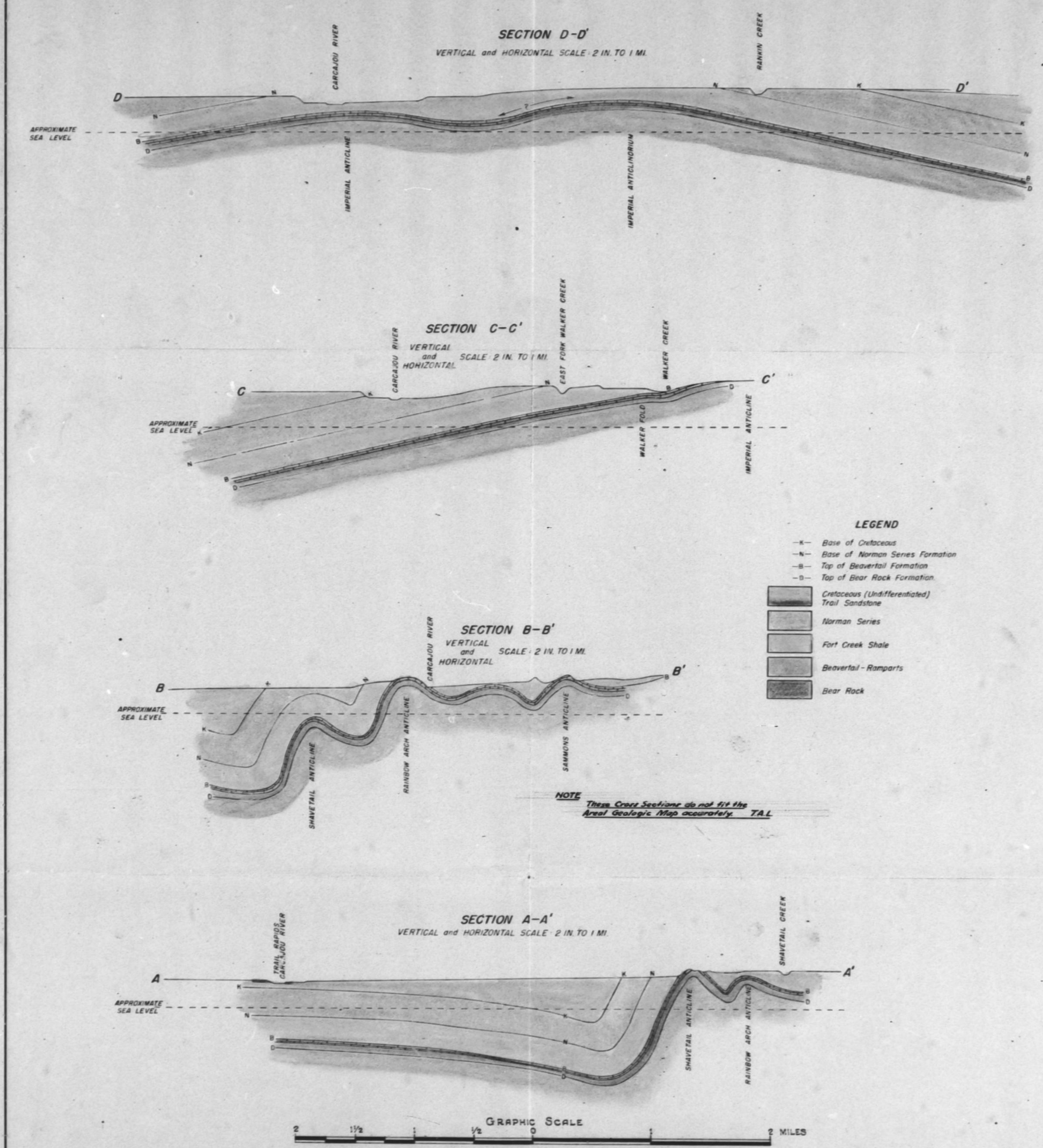
PLATE V



CROSS SECTIONS of

LOWER CARCAJOU RIVER

PARTY J

ASSIGNMENT NO. 9

JUNE 1943

F 2.246