REPORT ON SURFACE GEOLOGY

BIRCH RIVER AREA

Conducted By

D.G. Martin and N.G. Koch

During the period July 3 to September 5, 1957

and June 10 to July 30, 1958

on

NORTHWEST TERRITORIES PERMITS

No. 1409
No. 1410
No. 1411
No. 1412
No. 1413
No. 1414

Prepared By

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(Surface Geologist)

February 16, 1959

Surface Geological Maps and Section
Location Maps in Separate Folder

TABLE OF CONTENTS

ENCLOSURES

#1	Surface Geological Map (1957)	1" - 8 miles	In Separate Folder ?
#2	Section Location Map (1957)	1" -12 miles	" " "
#3	Surface Geological Map (1958)	1" - 4 miles	" " " ?
#4	Section Location Map (1958)	1" - 4 miles	" " "

GEOLOGICAL REPORTS FXD-30 and FXD-40

INTRODUCTION

During the summer of 1957, surface geological investigations were carried out by a Pan American geological party in the Mackenzie River Area. This work was continued during the summer of 1958 to the north and west into the Peel Plateau Area. Stratigraphic work was emphasized and carried on in the north and eastern ranges of the Mackenzie Mountains and the northern Franklin Mountains. Structural mapping was done on the Peel Plateau where favourable structure for the accumulation of hydrocarbons was located.

The 1957 field party consisted of seven geologists with D. Q. Martin acting as party chief. Sub-party chiefs were N.C. Koch, Y. Kawase, W. J. Fulop and W.O. Richmond. Assistance was given in the field by N. White and D. McLean. The following summer the field party consisted of six geologists with D. Q. Martin co-ordinating and N.C. Koch acting as party chief. K.E. Peterson was sub-party chief and able assistance was given in the field by H. Stevens, P. Smoor and B. Natsen. During both summers, supplies and foodstuffs were flown by Canadian Pacific Airlines from Edmonton to Norman Wells where Pan American's float-equipped Otter or Beaver was available to relay goods to our base camps. (Shown on Enclosures #2 and #4.) Canada Catering Company of Edmonton supplied the foodstuffs, cooks and kitchen equipment. A Bell model G-2 helicopter was contracted for both summers from Spartan Air Services of Ottawa, Ontario. Contact with commercial communication systems at Norman Wells was maintained by means of a 50-watt two-way radio. Where fly camping was found necessary in cases of excessive distances from base camp, contact with the fly camps to base camp was made by means of 2½-watt model B Chisholm radios.

Fossils collected in the field were identified by Dr. P.S. Warren and Dr. C.R. Stelck of the University of Alberta Geological Department.

OUTCROPS AND TERRAIN

The area worked lies in mountainous country west of the Mackenzie River Plain and south of the Peel Plateau. Relief up to 5000 feet was encountered in the area. Most of the ridges were devoid of vegetation and offered good landing spots for a helicopter. Sections measured were fair to good and many measured from 4000 feet to 5000 feet in thickness. Forty-nine sections were located and studied and a total of 240,940 feet of section were measured.

NATURE OF WORK

The prime purpose of the work was to obtain as much knowledge as possible of the stratigraphy and structure in the mountains to the south of Pan American's Hume River acreage. An attempt to project such stratigraphy to the north towards the acreage and a study of the relation of the mountain structure to that of the Mackenzie Plain and Peel Plateau was made. Aerial reconnaissance for determining the position of base camps, locating measurable sections and noting structure present was carried out by Otter, Beaver and helicopter. Base maps and mosaics obtained from the Department of Mines and Technical Surveys were used for plotting. Sections were measured with a one hundred foot tape or five-foot staff. Detailed sampling (approximately one sample for 25 feet) of the sections for stratigraphic purposes was carried out. Dips and strikes were taken in the field by means of Brunton Compasses, and where more detail warranted, elevations were carried out along marker beds by means of Paulin Altimeters.

STRATIGRAPHY

During the two field seasons, rocks ranging from Cambrian to Cretaceous were examined. Emphasis was placed on beds of Middle Devonian, Silurian, and Ordovician age. Other beds were mapped in a reconnaissance manner.

Table of Formations

Age	Formation or Group	Lithology	Thickness	Remarks
Tertiary		Poorly consolidated clays, ss. and cgl. with lignite.	0-1050'	
Cretaceous	Upper Unit	Fine/med.grn. ss. with interbeds of siltst. and sh.	4400'±	Scarp-forming sands
	Lower Unit	Dk.gry. sh. with some silt. Some glauconite and bentonite bands. Ss. member with coal fragments at the base.	4600'±	Surface fm. over most of the area.
Upper Devonian	Imperial	Marine ss., siltst., and sh.	1000'±	
	Ft.Creek Fm.	Black shales, in places bitum., pyritic, siliceous, cherty.	1000-1400'	
Middle Devonian	Upper Ramparts	Reefoid and bioclastic ls. with some bioherms. "Off-reef" limy sh. facies.	0-700'	Kee Scarp equivalent?
	Middle Ramparts	Dense shaly ls., limy sh., and marl.	500-700'	Hare Indian sh. equiv.
	Lower Ramparts	Dense dk. gry. in places argill. and slightly bituminous ls.	0-1000'	
Lower Devonian	Bear Rock	Cavernous wea., dol. and ls. breccia.	200-600'	Conformable with overlying Ramparts.
	Un-named unit	Fine-coarse, xln. ls. and dol. in places bituminous.	0-900'	
Silurian-Ordovician	Ronning Group	Litho. to coarse xln., lt. gry. dol.	2000-3000'	Silurian and Ordovician may only be separated on paleontological evidence.
Ordovician		Siliceous Sandstone and argillites	600'	
Cambrian		Qtzite., ls., gypsum red green	base not seen.	

CAMBRIAN:

Beds consisting of quartzites, gypsum, red and green shales, and some carbonates compose the Cambrian in this area. Having no effective porosity these beds were not considered economic and only occasional reconnaissance mapping of Cambrian beds was carried out.

ORDOVICIAN-SILURIAN:

Ordovician-Silurian sediments are for the most part indivisible except on fossil evidence. In the west and south-west the lowermost unit consists of siliceous sandstone and argillites, which represents a deeper area of deposition than the carbonates to the east and north. The carbonate unit has been placed in the Ronning Group and consists mainly of dolomites with or without chert and some limestones. Porous Ordovician and Silurian dolomites are believed to underlie the central portion of the map area becoming dense to the east and changing facies to the west to a more argillaceous unit and into a graptolitic facies.

The carbonate beds appear to be a shelf-type with an open sea basin to the west. Contact with the overlying Lower Devonian is thought to be unconformable in the east, with continuous sedimentation from Silurian into Lower Devonian in the west. The Silurian-Ordovician carbonates are considered a favourable reservoir under the Hume River acreage and all wells drilled should penetrate the total section.

LOWER DEVONIAN (?):

At the end of Silurian time the sea withdrew only from the east and north of the map area. Hence from the Arctic Red River to the west sedimentation was changed only slightly and from zero to 1500 feet of Lower Devonian

(?) carbonates were deposited. Good vuggy and intercrystalline porosity occurs in the lower part of the section.

Towards the end of the Lower Devonian the subsidence of the southern part of the shelf area allowed the sea to advance over a Karst type surface in rocks of Silurian age. Hence, from somewhere between the Arctic Red and Hume Rivers the sediments change from a fine crystalline limestone and dolomite to a dolomite breccia (Bear Rock formation) with a limestone and dolomite matrix. The Bear Rock breccia is thus considered a facies of the lower part of what is usually termed the "Lower Ramparts". Fossil evidence now suggests that the Bear Rock is a mappable unit which lies disconformably on beds of Silurian age. East of the map area the Bear Rock beds are often a very gypsiferrous dolomite. Abundant limestone sink-holes where the Bear Rock is the surface formation, and good water flow in Imperial Discovery #3 at Norman Wells indicates that both good porosity and permeability are developed in this formation in at least some areas in the general Hume River area.

MIDDLE DEVONIAN:

The deposition of the Lower Ramparts formation continued into Middle Devonian time. On the Anderson River (personal communication C.R. Stelck) north-east of the map area, and also in the Ogilvie Mountains, the base of the Middle Devonian is marked by an Ostracod horizon in which the Ostracods are up to three-quarters of an inch in diameter. However, the oldest recognizable Middle Devonian fauna in the map area is the Radiastrea arachne fauna.

Lower Ramparts type sedimentation ended with the deposition of a black, bituminous, fissile shale which is characterized by the fossil, Leiorhynchus castanea. The sea soon became limy and a very limy shale and marl was next laid down. This deposit constitutes the Middle Ramparts formation, and varies from 500 to 700 feet in thickness throughout the southern part of the map area. It quite probably thins to the north.

The Upper Ramparts formation is a reefoid and bioclastic limestone which remains approximately 700 feet thick along the Mackenzie Mountain front. This unit is considered equivalent to the Kee Scarp reef present at Norman Wells and thus is considered favourable for hydrocarbon entrapment such as is found in the Norman Wells field.

UPPER DEVONIAN:

Although the exact age and correlation of the Upper Ramparts, Kee Scarp, and Lower Fort Creek formations are still controversial, it is a definite fact that any Middle or Upper Devonian reef or reefoid reservoir rock underlying the map area will have an effective cap rock of Fort Creek shale.

The following table is the correlation of Devonian used in this report and believed to be correct from the field evidence collected in the area.

This Report	Norman Wells Area	Age
Fort Creek Shales	Upper Fort Creek Shale Bituminous Zone	Upper Devonian
Upper Ramparts Ls.	Reef Ls.	
Shaly base with L.castanea var.	Lower Fort Creek	Middle Devonian
Middle Ramparts Mar.&Sh. (L. castanea)	Shales (L. castanea)	
Lower Ramparts Ls.	Ramparts Ls.	Lower Devonian
Bear Rock Formation	Bear Rock Formation	

The Fort Creek formation consists of black shales, and in some areas cherty and siliceous shales. In the western part of the map area sandy lenses are not uncommon. In places some shale members were so bituminous

that they have been burnt brick-red by fires. Within the map area the shales vary in thickness from approximately 1000 feet in the east to 1400 feet in the west and northwest.

The Imperial formation lies, with a gradational contact, immediately over the Fort Creek shales in the area east of the Hume River. To the west, the contact is difficult to determine. The Imperial formation is a succession of marine sands, silts and shales approximately 1000 feet thick to the east. As you go west the beds decrease first then increase in thickness and become increasingly less marine and more continental in nature. Little or no porosity was found in any of the sections measured.

CRETACEOUS:

For the convenience of mapping the Cretaceous sediments were divided into two units; an upper sandy unit, and a lower shaly unit. The upper unit, actually 5 or 6 sandstone members with interbedded shaly members, has a calculated thickness of 4400 feet. Because it is the plateau-forming sand and therefore was found to be breached on all of the structures where it was present, very little time was spent in mapping this unit.

The lower shaly unit has, at least in the Hume River-Sans Sault area, a basal sandstone member which rests unconformably on Upper Devonian strata. In this area the thickness of the lower unit was calculated (from air photographs) to be 4600 feet thick. It forms the surface formations in most of the remaining area away from the mountain front.

STRUCTURAL GEOLOGY

The area worked may be divided into three structural provinces; the Peel Plateau to the north, the Mackenzie Mountains to the south and west and the Mackenzie foreland to the east. The Peel Plateau is structurally one

large syncline running east-west, with smaller folds developed on either limb of the syncline. South of the Peel Plateau and west of the Mackenzie foreland large open folds make up the Mackenzie Mountains. Large scale faulting typical of the Rocky Mountains was not observed. The Mackenzie Mountains have no foothills comparable with the Rockies. However in the east there is a foreland area in which narrow mountain ridges are separated by wide flat area for the most part covered by muskeg. The Franklin Mountains are one example of such a mountain ridge on the Mackenzie Plain. Some folding of the sediments has taken place between these mountain ridges and may be an indirect result of basement faulting whereas folding on the Peel Plateau was a direct result of the mountain building to the south and west, giving relatively simple and large folds with minor drag and cross folds.

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Respectfully submitted,

PAN AMERICAN PETROLEUM CORPORATION

By: G.F. Stansberry

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(Surface Geologist)

GFS:trc

February 16, 1959
Edmonton, Alberta

APPENDIX

List of fossils collected - Mackenzie River - Peel Plateau Area.

Cambrian

No fossils collected.

Ordovician

Paleophyllum halysitoides
Bighornia sp.
Catenipora acquavalis
Oxopcecia
Strophomenids
Endoceratid
Plasmapora
Paleofavosites asfer.
Catenipora cf. acquavalis
Macleurites type
Manipora - regularis
Paleophyllum halistoides
Streptelasma trilobatum
Catenipora gracilis
Halystoid coral
Actinoceras
Cycloceras
Heleolites
Parastrophia

Silurian

Halysites magnituba
Diplophyllum verneialian
Paleophylum
Halysites catenularia
Favosites favosus
Lyellia cf. americana
Labechia
Camarotoechia cf. indianensis
Stromatoporoids
Synaptophyllum sp.
Zaphrentis
Pasceolus
Parastrophia
Homospira
Favosites niagarensis
Favosites cf. tyrrelli
Plectambonites
Conchidium
Paleophyllum halysitoides

Lower Devonian

Favosites limitaris
Favosites cf. alpenensis
Trematopora
Martinia cf. occidentalis
Martinia richardsoni
Martinia n. sp.
Hypothyridina n.sp.
Tentaculites

Middle Devonian

Hemicosmites sp.
Cryptophyllum rectum
Proetus sp.
Proetus cf. haldemani
Productella
Favosites
Favosites limitaris
Anoplophyllum
Camarotoechia
Schizophoria cf. mcfarleni
Tentaculites
Martinia cf. franklini
Martinia kirki var.
McCoya
Pugnoides cf. sandersoni
Martinia aff. occidentalis
Atrypa cf. andersonensis
Productella
Ballerophon
Martinia cf. richardsoni
Atrypa aff. clarkei
Cladopora
Hexagonaria aff. flexuosa
Cosmites
Pugnoides sp.
Stromatoporoids
Diaphyllum
Dendropora
Alveolites
Atrypa andersonensis var.
Amplexus invaginatus
Leiorhynchus castanea var.
Leiorhynchus castanea
Martinia richardsoni
Siphonophrentis gigantea
Cystiphyllum sp.
Favosites alpenensis
Hexagonaria
Amphipora

Atrypa cf. borealis
Actinostroma
Hederella
Atrypa cf. arctica
Actinoptera
Schuchertella nevadensis
Paracyclas elliptica
Cyathophyllum
Schizophoria
Ambocoelia meristoides
Combophyllum
Hexagonaria arctica
Atrypa pechiensis
Favosites alponensis
Billingsastrea nevadense
Radiastraea arachne
Favosites alpenensis valorum
Phillipsastrea verrilli
Prismatophyllum fisherae Stumm
Hexagonaria cf. kirki.
Proetus cf. mundulus
Disphyllum coespitosum
Alveolites vellorum
Cystiphyllum americanam
Schuchertella nevadensis Merriam
Atrypa arctica Warren
Alveolites avalorum Meek
Prismatophyllum arctica
Martinia sublineata
Atrypa cf. breverensis
Syringopora
Elytha undifera (Roemer)
Lyathophyllum cf. lonense Stumm
Atrypa cf masula
Papilcophyllum elegantulum Stumm
Aulophyllum sp.
Ractiastrea arachne
Microplasma sp.
Leptodema sp.
Doevillina

Upper Devonian

Camarotoechia cf. contracta
Cyrtospirifer whitneyi
Theodossia (Vandergrachtella)
Stropheodonta
Chonetes
Productella sp.
Nudirostra sp.
Nudirostra cf. seversoni
Proetus
Buchelia

Tentaculites
Coenites
Atrypa sp.
Melrosophyllum sp.

Cretaceous

Mytilus
Inoceramus aff. endottensis
Inoceramus cxgr. rutherfordi
Ammonite

PAN AMERICAN PETROLEUM CORPORATION
NORTH CANADIAN DISTRICT

N.W.T.-Y.T. CANADA

AREA: FORT LIARD - NORMAN WELLS

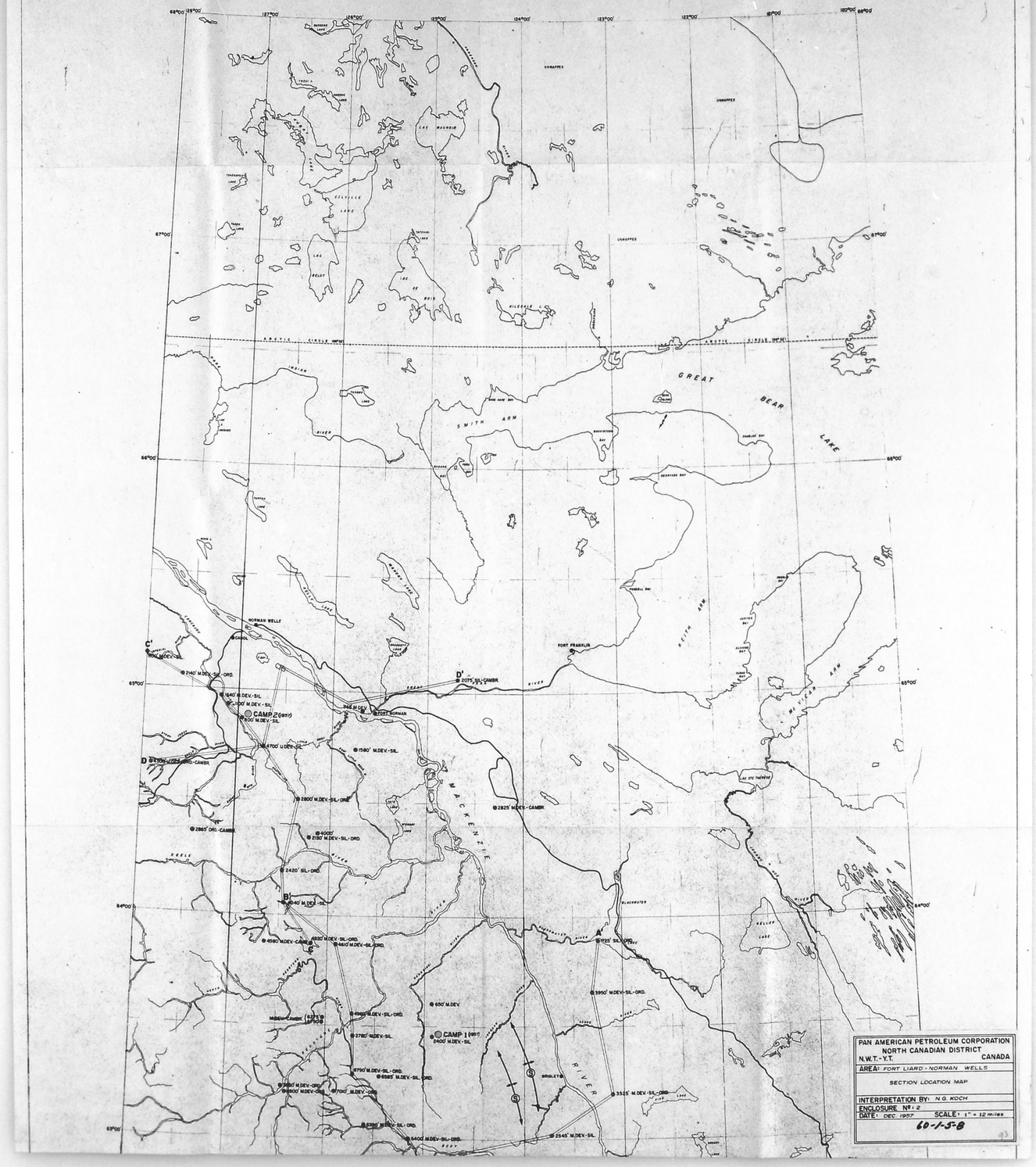
SURFACE GEOLOGIC MAP (1957)

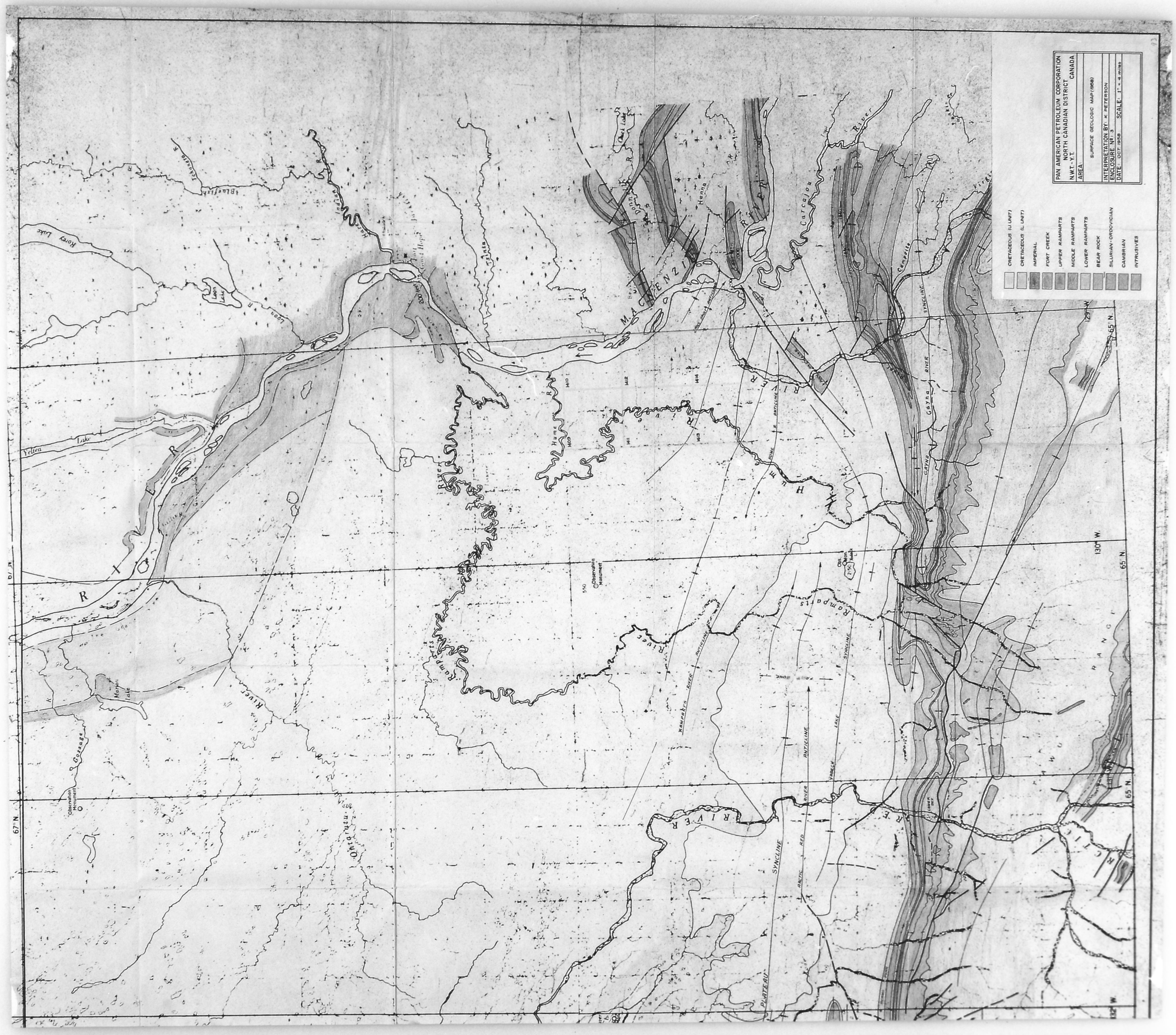
INTERPRETATION BY: S. ANTONIUK - D. MARTIN

ENCLOSURE Nº: 1

DATE: SCALE: 1" = 8 miles

60-1-5-8





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West Canadian Graphic Industries Ltd.

PAN AMERICAN PETROLEUM CORPORATION
NORTH CANADIAN DISTRICT
N.W.T. - Y.T. CANADA
AREA: *HUME RIVER*

SECTION LOCATION MAP

INTERPRETATION BY: K. PETERSON
ENCLOSURE NO: 4
DATE: OCT. 1958 SCALE: 1" = 4 miles

60-1-55-B