76-2-5-6 Photogeologic Evaluation of the Mackenzie Plain Area part

Part 1

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PHOTOGEOLOGIC EVALUATION of the MACKENZIE PLAIN AREA, NORTHWEST TERRITORIES & YUKON.

PART I

PHOTOGEOLOGIC EVALUATION

OF THE

MACKENZIE PLAIN AREA,

NORTHWEST TERRITORIES AND YUKON

PART I

GEOPHOTO SERVICES, LTD.

Prepared by

GEOPHOTO SERVICES, LTD.

Calgary, Alberta.

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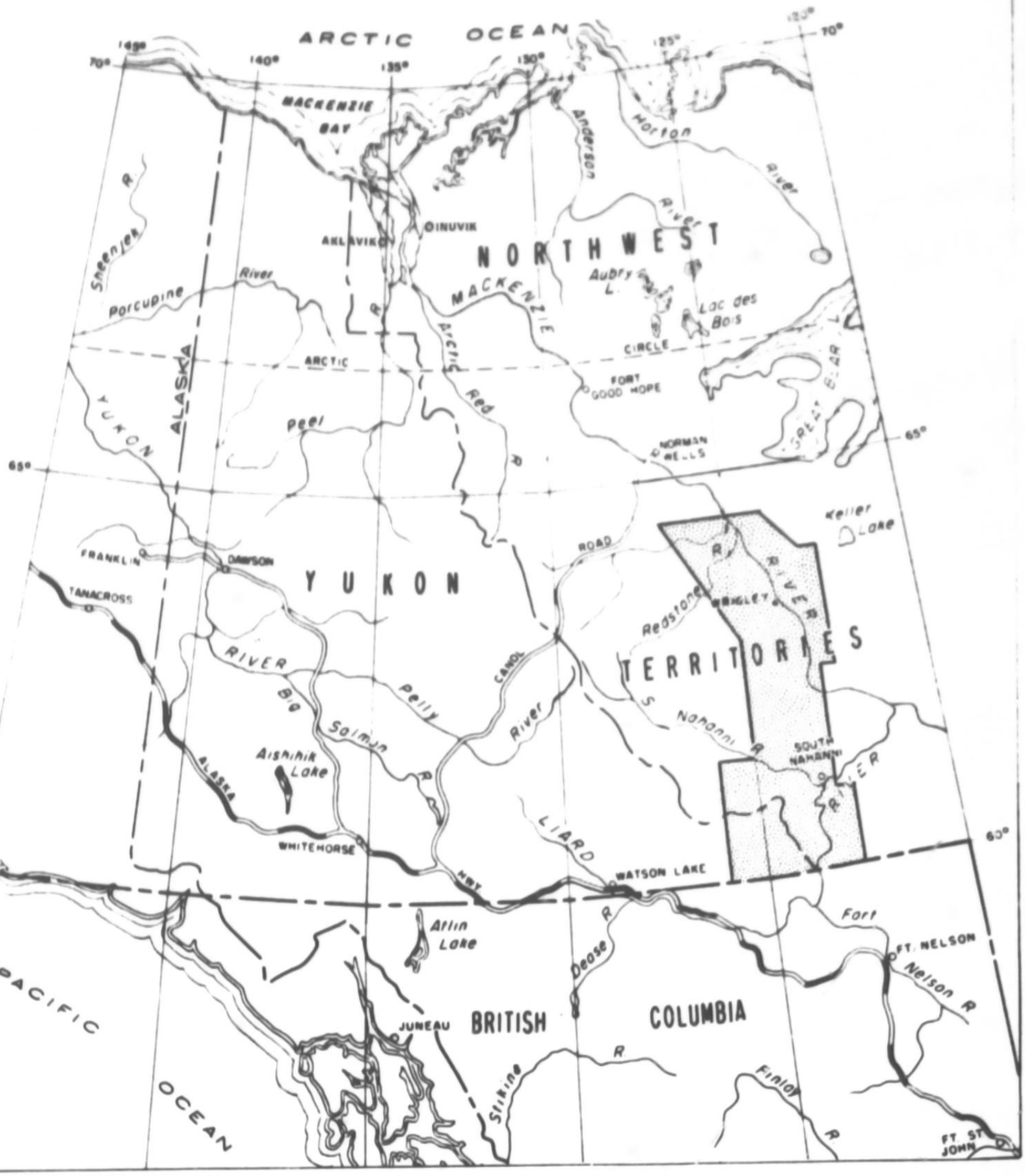


Plate 1

REGIONAL LOCATION MAP

GEOPHOTO SERVICES LTD.

SCALE: 1 inch = 135 miles approx.

MACKENZIE PLAIN AREA

3/12/65

INTRODUCTION

The series of maps and illustrations which accompany this report represent the results of a photogeologic evaluation of an area 29, 300 square miles, located along the eastern front of the Canadian Cordillera in the southwestern part of the Northwest Territories, and including a small part of the southern Yukon. The regional location of the project area, and its relation to political boundaries, towns and major streams is shown on Plate 1. This photogeologic study was undertaken by Geophoto in order to present a coordinated and uniform series of maps of this highly prospective area. The evaluation is one of a series of such studies which will ultimately cover a large part of the sedimentary basin of Western Canada.

This evaluation is based on a study of air photographs, available geologic literature, and reflects Geophoto's ten years of photogeologic and field experience in northern Canada. Geologic control in the form of published literature is fairly abundant in this area, and dates back thirty years or more. All available pertinent geologic literature was consulted during this evaluation and interpreted in terms of the more recent formational terminology. A selected bibliography is appended to this report; all references to the bibliography are by author and date.

TOPOGRAPHY AND ACCESSIBILITY

Plates 2a and 2b are World Aeronautical Charts at a scale of 1:1,000,000, on which the project area is outlined. A pronounced change in the physiography of the Canadian Cordillera occurs at approximately the 60th parallel. South of this parallel, the familiar terrain of the Canadian Rockies and their Foothills may be traced southwards for a distance of almost 1,000 miles to the U.S. border. At the 60th parallel, the Rocky Mountains and their Foothills disappear as a topographic unit, and are replaced in a right-hand en echelon manner by the Mackenzie Mountains, and associated foreland ranges which are collectively known as the Franklin Mountains. The low lying areas occurring between the eastern front of the Mackenzie Mountains and the Franklin Mountains are known as the Mackenzie Plain. The southern boundary of the project area is the 60th parallel, and the project area includes the eastern front of the Mackenzie Mountains, a large portion of the Mackenzie Plains, and a large portion of the Franklin Mountains. The Franklin Mountains form an elongate arcuate belt merging with the Mackenzie Mountains to the south at approximately the 60th parallel, and merging with them again some distance to the north, north of the project boundary. In the intervening area, the maximum separation between the Mackenzie front and the outermost range of the Franklin Mountains is approximately 80 miles. To the south, where the Mackenzie and Franklin merge, the definition between the two mountain systems is not clear and the region has been termed the Liard Plateau. In this area, for the purposes of this report, the

Liard Range is considered to be part of the Franklin Mountains System, whereas the Labiche Range is considered to mark the easternmost range of the Mackenzie Mountains System.

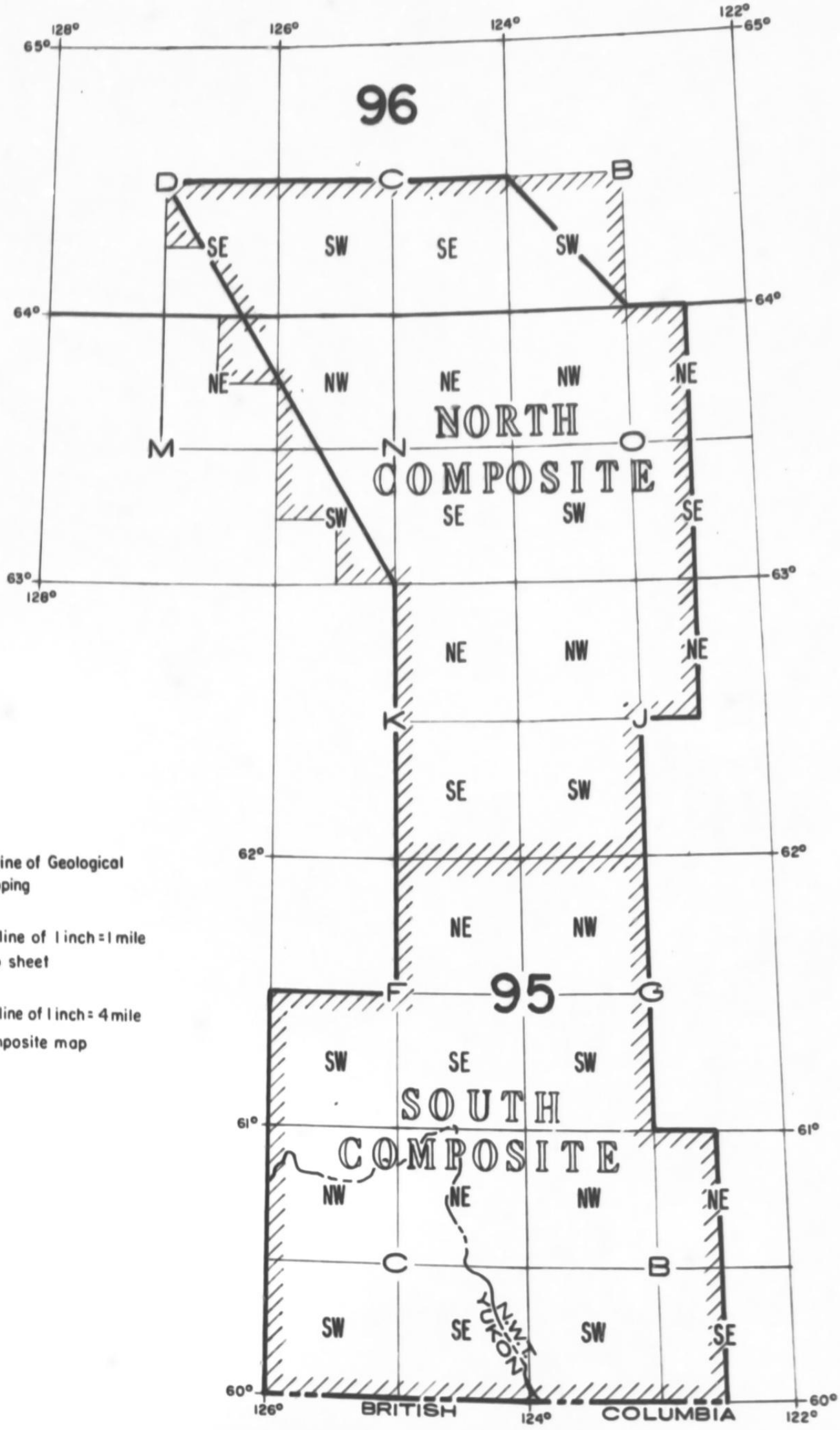
Bostock (1949) divided the Mackenzie Mountains into two parts: an easternmost portion which he termed the Canyon Ranges, and a westerly portion which he termed the Backbone Ranges. The project area includes a small part of the Canyon Ranges.

Within the project area maximum elevation is attained in the southern part of the Mackenzie Mountains (Liard Plateau), where in the vicinity of the Nahanni River elevations of 6, 200 feet are reported. The Franklin Mountains are somewhat lower with average elevations of approximately 3, 000 feet, attaining a maximum elevation of 5, 200 feet in the Nahanni Range. The intervening Mackenzie Plain lies at an average elevation of less than 2, 000 feet, and at some places descends to less than 1, 000 feet elevation. In general, the mountainous areas are relatively free of vegetation, and form bold rocky terrain. The lowlands are poorly drained, and support numerous lakes and extensive m uskeg deposits. In general, the lowlands are densely covered with small trees and bush which seriously impede ground travel.

The Mackenzie River area is served by Pacific Western Air Lines with regular scheduled service to Fort Simpson (east of the project area) and Wrigley (north of the project area). During the summer months a considerable amount of freight is moved by barge down the Liard and Mackenzie Rivers.

Winter tractor roads can easily be constructed through most of the low lying areas of the project, and many such roads have been built to service seismic and drilling operations.

Geologic field operations in this region are usually conducted with the aid of helicopters during the short summer field season. Field parties usually operate out of base camps established with float equipped aircraft on the larger lakes and rivers.



Outline of Geological mapping

SW — Outline of 1 inch = 1 mile map sheet

Outline of 1 inch = 4 mile composite map

Plate 3

DETAILED AREA OUTLINE AND INDEX TO EVALUATION MAPS

PHOTOGRAPHY AND MAP COMPILATION

The air photography used for this photogeologic evaluation was obtained from the Royal Canadian Air Force, and is at a scale ranging from 1:35,000 to 1:40,000. This photography was flown during the period 1949 to 1954 with a camera equipped with a six-inch focal length lens. This photography is not of high quality, but, in general, is suitable for a regional evaluation of this type.

A set of evaluation maps covering this area consists of 31 individual map sheets prepared at a scale of 1 mile to 1 inch; these maps are identified by number and letter according to the Canadian National Topographic System. Each of the map sheets covers an area of 30 minutes of latitude by 1 degree of longitude, and forms one quadrant of a National Topographic System letter designated area. The locations of these 31 map sheets are shown on Plate 3, Detailed Area Cutline and Index to Evaluation Maps.

Geologic detail was annotated directly on alternate air photos by geologists while viewing the photographs stereoscopically. The geologic detail was then transferred from the air photos to a Permascale planimetric base by means of a Map-O-Graph, a projection-type instrument providing a method of making rapid scale changes, thereby accomodating air photographs of different scales. The base maps were constructed by inking a polyconic projection at the designated scale of 1:63,360 on Permascale film. Streams and cultural features were inked to these bases from planimetric maps issued by the Map Distribution Office, Dept. of Mines and Technical Surveys, Ottawa, Ontario.

All topographic, cultural and hydrographic details were compared with the air photographs and corrected where necessary.

Two composite geologic maps at a scale of 4 miles to 1 inch were produced by photographically reducing the 31 evaluation maps, splicing together the film negatives, and making blue line prints directly from the negatives. The north composite map includes the area north of 62°00' north latitude, and the south composite map includes the area south of 62°00' north latitude.

Many structural features shown on the accompanying maps are arbitrarily named by Geophoto to facilitate the following discussion. Such arbitrary names are enclosed in quotation marks on the maps and in the following report.

132° 130° 128° 126° 124° 122° 120° 118°

66° 65° 64° 63° 62° 61° 60° 59° 58°

ONTARAT
ARCTIC RED R.
PEEL BASIN
HARE INDIAN RIVER
FORT GOOD HOPE
FRANKLIN
MACKENZIE
NORMAN WELLS
FT. NORMAN
MACKENZIE MOUNTAINS
SELWYN TRENCH
SELWYN MOUNTAINS
TINTINA TRENCH
MACKENZIE RIVER
PROJECT BOUNDARY
MOUNTAINS
PLAIN
BASIN
UPLIFT
(LIARD PLATEAU)
LIARD RIVER
ALASKA
YUKON B.C.
HIGHWAY
ROCKY MTN. TRENCH
ROCKY MTNS UPLIFT
FOOTHILLS BELT
FOLD
BLACKWATER LAKE
KELLER LAKE
GREAT BEAR LAKE
HOTTAH LAKE
PRECAMBRIAN SHIELD
LAC LA MARTRE
GREAT BEAR
WILLOW LAKE RIVER
HOMOCLINE
RIVER
FT SIMPSON
LINE
TROUT LAKE
FORT LIARD
NELSON FORKS
FORT NELSON RIVER
PETITOT RIVER
N.W.T. ALTA
ALBERTA BASIN

Plate 4

REGIONAL STRUCTURE

Plutonic Rocks

GEOPHOTO SERVICES LTD.

SCALE 1 INCH TO 60 MILES

REGIONAL GEOLOGY

The eastern edge of the Canadian Cordillera extends northwestward from the U.S. border to approximately the 60th parallel, a distance of almost 1,000 miles, without major changes in terrain, geologic structure, or trend. At about the 60th parallel the Rocky Mountain System dies out, and is replaced in a right-hand en echelon manner by the Mackenzie Mountain System. North of the 60th parallel the eastern margin of the Cordillera swings northwesterly in a broad arc. The project area lies along the eastern edge of the Cordillera, and includes a part of the above described broad arc. Plate 4 shows the project area and its relation to regional features, which are described in the following paragraphs.

Rocky Mountain System

South of the 60th parallel the marginal deformation of the Cordillera is represented by the Rocky Mountains and their Foothills. Parallel features are: the Rocky Mountain Trench, which is a large fault zone; and the Alberta Basin, a structural feature expressed in Cretaceous strata. It is generally believed that the deformation in the Rocky Mountain Foothills is largely surficial, and that the relatively undeformed crystalline basement is separated from surface structure by one or more basal shearing planes. The boundary between the Foothills and the Alberta Basin is fairly sharp, and no foreland ranges are present. The Rocky Mountain Trench, the Rocky Mountains, the Foothills, and the Alberta Basin all terminate northward against a linear element herein

termed the Liard Line.

Liard Line

The Liard Line is not based on direct surface evidence, but rather on contrasting terrain, structure, and stratigraphic section. Parts of the Liard Line are distinct lineaments, and one such lineament is indicated on the accompanying photogeologic map 95B/SW.

The existence of the inferred Liard Line is based on the following evidence:

a) Topographic - A prominent topographic division and lateral offset occurs between the Rocky Mountains and Mackenzie Mountains.

b) Structural - The structural forms found in the Mackenzie Mountain System are vastly different from those found in the Rocky Mountains and Foothills. It is emphasized that the structural change is transitional over some 25 miles, and there are no prominent northeasterly trending surface faults. Several regional structural units terminate northward against the Liard Line.

c) Stratigraphic - In the northern part of the Alberta Basin, Middle Devonian strata rest on a thin to absent Cambrian section which in turn rests on the Precambrian. In the northern part of the Rocky Mountains Uplift, a thin Silurian section rests on the Precambrian. In the Mackenzie Mountains an extremely thick Ordovician and Silurian section is present, which contains formational units not

recognized south of the Liard Line. A relatively thin Cambrian and Ordovician section, overlain by Devonian rock, is present in the Great Bear Homocline. The Devonian section is thicker and more varied north of the Liard Line. Some 5,000 feet of arenaceous Permo-Carboniferous strata are present north of the line, while equivalent strata are virtually absent to the south.

The Liard Line is believed to mark a prominent transverse zone, along which there has been differential movement during geologic time. The movements had a marked influence on the depositional and structural history of the region. The Liard Line probably marks a zone of basement faults.

Mackenzie Mountains Uplift and Selwyn Mountains

The internal structure of the Mackenzie Mountains Uplift conforms to the general arcuate pattern of the uplift, and exposes a section of folded and faulted Paleozoic rocks. The faults trend parallel to the general structural trend, and, within the project area, are high angle reverse faults which dip either westerly or easterly. In general, these faults occur on the flanks of elongate and sinuous anticlines and dip toward the uplifted areas. An exception occurs at about 61°45', where a large, almost dome-like uplift is present.

The Mackenzie Mountains structure is very different from that of the Rocky Mountains and Foothills, and the stratigraphic section is thicker and more varied. It is suggested that the Liard Line marks the southern edge of a mobile block, which subsided during the early Paleozoic, allowing an eastern

transgression of the early Paleozoic seas on the craton. During time of uplift this mobile block responded to a greater degree than areas to the south, and several marked unconformities are present in the upper Paleozoic and Mesozoic section. It is postulated that vertical movement in this mobile block was accomplished by movement along high angle faults. Deformation in the Mackenzie Mountains was distributed over a wider area than in the Rocky Mountain System, and was less severe. In contrast, in the Rocky Mountain System, the marginal deformation of the Cordillera was limited on the east by the relatively stable and unfractured basement underlying the Alberta Basin.

West of the area of Plate 4, the Mackenzie Mountains narrow and trend nearly due west. The early Paleozoic section exposed in this portion of the Mackenzie is relatively thin, compared to that in the northwesterly trending portion. It is suggested that the linear northern front of the northern part of the Mackenzie Mountains may mark a tectonic line, complementary to the Liard Line.

Information regarding the geologic provinces west of the Mackenzie Mountains is sparse. The Tintina Trench appears to be a continuation of the Rocky Mountain Trench. The Selwyn Mountains expose Paleozoic rock and are in part separated from the Mackenzie Mountains by the Selwyn Trench (Haites, 1960). The Selwyn Mountains contain large masses of plutonic rock, while the Mackenzie and Rocky Mountains do not. All trenchs are believed to be large fault zones.

Franklin Mountains Uplift

The Franklin Mountains Uplift is a series of arcuate foreland fault blocks, separated from the Mackenzie Mountain front by the Mackenzie Plain Basin. Strata ranging from Precambrian to Upper Devonian are exposed in the fault blocks. The Franklin Mountains merge with the Mackenzie Mountains both to the north and south, and only occur opposite the great arc of the Mackenzies. The individual ranges of the Franklin Mountains are bounded, on one or the other side, by high angle reverse faults which dip toward the uplift. These are "upthrust"faults, as the term is defined by de Sitter (1956), and may involve basement rock. Martin (1963) believes these faults are splays from a basal shearing plane at the Archeozoic-Proterozoic boundary. The anomalous Bovie Range, south of the Liard Line, is structurally similar to the Franklin Mount - ains.

The fronts of the Mackenzie and Franklin Mountains form arcs, which may represent the intersection of southwesterly dipping planes with the earth's surface. The radius of curvature of these arcs indicate dip at 5 - 6 degrees. The significance of these planes is unknown; if there is a deep-seated detach-ment at the Archeozoic-Proterozoic boundary, the planes could represent the dip of the detachment surface.

Mackenzie Plain Basin

The several intermontane structural basins which form the Mackenzie Plain Basin are relatively undeformed in comparison to the adjoining uplifted

areas. The Mackenzie Plain Basin exposes mainly Upper Devonian rock within the project area, but to the north exposes mainly Cretaceous strata.

Great Bear Homocline

East of the project area a relatively thin section of Paleozoic strata dips gently southwest away from the Canadian Shield. Regional dip in this area is reported as less than 25 feet per mile. Rocks present above the Precambrian include about 1, 500 feet of Cambrian and Ordovician, and about 1, 200 feet of Middle Devonian. Variable thicknesses of Upper Devonian and Cretaceous are present.

Peel Basin

To the northwest of the project area a Cretaceous structural basin is present off the north front of the northern part of the Mackenzie Mountains. This basin is very asymmetric, with its axial portion lying close to the Mac-Kenzie Mountain front. In a gross sense the Franklin Mountains Uplift may be thought of as a broad salient, separating the Alberta Basin from the Peel Basin.

Tectonic History

The stratigraphic record in the project area gives evidence of periods of tectonic disturbances throughout geologic history. Sufficient data are not available to accurately map the limits of these disturbances, but there is some evidence for charting the times of the major disturbances.

Late Cretaceous and Early Tertiary - the last major structural dis-turbance occurred during this period. Relatively undisturbed nonmarine

Tertiary strata of Eocene age are found in the project area. This period corresponds to the widespread Laramide Orogeny, and has been termed the Rocky Mountain Orogeny by White (1959).

Jurassic and Early Cretaceous - within the project area a stratigraphic hiatus exists between the Triassic and upper Lower Cretaceous. The Lower Cretaceous strata transgress older rock in a northerly direction. This major period of deformation is widely known as the Nevadan Orogeny, and has been termed the Coast Range Orogeny by White (1959).

Late Permian and Early Triassic - in northwestern British Columbia the Triassic section transgresses older strata in an easterly direction. The evidence for this unconformity has been obscured in the area of the present project by the sub - Cretaceous unconformity, but it is very probable that the area was subject to deformation at the close of the Paleozoic. White (1959) terms this deformation the Cassiar Orogeny.

Late Pennsylvanian and Early Permian - a marked sub-Permian(?) angular unconformity is present in the southwestern part of the mapped area.

Late Silurian and Early Devonian - the Lower(?) Devonian strata transgress older strata in an easterly direction in the project area. In northeastern British Columbia there is evidence of a major change in basin configuration at this time. In the Great Bear Homocline, Devonian strata overlie Ordovician strata. Baadsgaard et. al. (1960) postulate a widespread "Caledonian" orogenic episode at about this time.

Early and Middle Ordovician - in the southwestern part of the mapped area, Cambrian and Lower Ordovician rock are absent. The oldest Paleozoic strata present in this area are dated as Middle Ordovician. In other parts of the project area Ordovician rocks rest disconformably on Cambrian strata. White (1959) postulates a Middle to Late Ordovician "Cariboo" Orogeny at this time.

Late Precambrian - the Precambrian is separated from the Paleozoic by a pronounced angular unconformity.

MAP UNITS

Age	Formation	Unit
QUATERNARY	Surficial deposits	Q
UPPER CRETACEOUS	Kotaneelee — D — Dunvegan	Ku
LOWER CRETACEOUS	Sully; Sikanni; Lepine — SC — Scatter — GA — Garbutt — CB — Basal conglomerate (Ft St John Group)	Kfj
TRIASSIC (?)	Grayling(?)	Tr
PERMO - CARBONIFEROUS	Fantasque — F — Mattson	PMm
MISSISSIPPIAN	Flett	Mf
UPPER DEVONIAN	Shale; Undivided shale, sandstone & limestone — FS — Ft Simpson — HR —	MDu; Du
MIDDLE DEVONIAN	Horn River; Nahanni — N — Headless	Dm; Dml
LOWER(?) DEVONIAN	Landry — FLT — Funeral; Manetoe — ARr — Arnica	Dm-O; Dm-Os
SILURIAN	Sombre — Cs — Camsell — C — Delorme	S; SO
SILURIAN - ORDOVICIAN	Whittaker	SOw
ORDOVICIAN	Sunblood	Os
ORDOVICIAN - CAMBRIAN	Conglomerate	O€cg
PRECAMBRIAN	Metasediments	p€

MACKENZIE PLAIN

Age	Lithology	Unit
TERTIARY	Sandstone & conglomerate	Tu
LOWER CRETACEOUS	Shale & sandstone	Kl (KDu)
UPPER DEVONIAN	Shale & sandstone	Du (KDu)

IGNEOUS ROCK | I | Trachyte and syenite plugs of probable Cretaceous age

FRANKLIN MOUNTAINS

Age	Formation	Unit
MIDDLE DEVONIAN	Horn River	
	Nahanni — N —	Dn (Dnbr)
LOWER(?) DEVONIAN	Bear Rock	Dbr (Dnbr)
SILURIAN-ORDOVICIAN(?)	Mt Kindle — MK —	SOr (Ronning Group)
ORDOVICIAN	Franklin Mtn	
CAMBRIAN	Saline River — SR — Mt Cap	€smc
	Mt Clark	€mc
PRECAMBRIAN	Unnamed	p€

KEY HORIZONS

- — D — Top of Dunvegan
- — SC — Top of Scatter
- — GA — Top of Garbutt
- — CB — Top of basal Cretaceous conglomerate
- — F — Base of Fantasque
- Contact of middle and upper Mattson
- Contact of lower and middle Mattson
- Base of *Athyris angelicoides* zone
- — LT — Top of *Leiorhynchus* zone
- — L — Base of *Leiorhynchus* zone
- — R — Top of reef limestone
- — HR — Top of Horn River
- — N — Base of Nahanni
- — FLT — Top of Funeral
- — ARr — Top of Arnica
- — CT — Top of Camsell
- — C — Base of Camsell
- — MK — Base of Mt Kindle
- — SR — Base of Saline River

Plate 5

STRATIGRAPHY

The rocks exposed in the project area range in age from Precambrian to Recent, with all of the geologic systems represented except the Jurassic. The pre-Upper Devonian sedimentary section outcrops, for the most part, in the mountainous areas and is fairly well exposed. Formational boundaries in this part of the geologic column are fairly well expressed on the air photographs. The Upper Devonian and later section outcrops mainly in the valley areas and is masked by Quaternary deposits and vegetation. Formational boundaries are not readily apparent on the air photographs in this part of the geologic section, and in many cases must be inferred on the basis of indirect evidence. In some cases it is necessary to group two or more formational units into one map unit. Plate 5 of this report is reproduced from the legend of the accompany photo-geologic maps and shows the map units used in the photogeologic evaluation. This plate is herein included for ready reference during the following discussion of the stratigraphic column.

Paleozoic sedimentary rocks in the project area were deposited on the eastern margin of the Cordilleran geosyncline and were influenced in their distribution and composition by tectonic movements of both orogenic and epeirogenic magnitudes. In the following pages the evidence of the sedimentary column is presented in a systematic manner. Several illustrations are presented to graphically display the stratigraphic relationships discussed in this report. Regional cross-sections included with the report illustrate gross thicknesses and dis-

Plate 7 (from Douglas, Norris, Thorsteinsson and Tozer, 1963)

PERIOD AND STAGE			INTERIOR PLAINS (Southern)				LIARD PLATEAU		MACKENZIE MOUNTAINS				FRANKLIN MOUNTAINS			MACKENZIE MTNS	INTERIOR PLAINS (Northern	
			SLAVE R. 1	GREAT SLAVE L. 2	LAMARTRE-HORN R'e 3	TROUT L. 4	EASTERN 5	SOUTH-WESTERN 6	SUNBLOOD RANGE 7	FUNERAL RANGE 8	NAHANNI PLATEAU 9	WHITTAKER-REDSTONE RANGES 10	NAHANNI-CAMBELL RANGES 11	McCONNELL RANGE 12	NORMAN WELLS 13	CARCAJOU-MOUNTAIN RIVERS 14	LOWER MACKENZIE R. 15	ANDERSON-HORNADAY R'e 16 17
Overlying					Cretaceous	Mississippian	Mississippian	Carboniferous			Mississippian		Mississippian ?		Cretaceous	Cretaceous	Cretaceous	Cretaceous
DEVONIAN	Upper	Famennian				KOTCHO	Shale (may include representatives of Middle Devonian to Mississippian formations)	Shale (may include representatives of Middle Devonian to Mississippian formations)			Shale / Sandstone	Shale Siltstone Limestone / Sandstone	Shale Sandstone / Shale Limestone / Sandstone / Sandstone Shale Limestone					
						TETCHO												
						TROUT R.												
		Frasnian		KAKISA		KAKISA												
				REDKNIFE		REDKNIFE / JEAN-MARIE						Sandstone						
				TATHLINA		FORT SIMPSON			?		FORT SIMPSON	FORT SIMPSON	FORT SIMPSON		IMPERIAL	IMPERIAL	IMPERIAL	
				TWIN FALLS / ALEXANDRA / ESCARPMENT	FORT SIMPSON				Shale	? Shale				?	CANOL / KEE SCARP / CANOL		?	
				HAY RIVER														
	Middle	Givetian	SLAVE PT	SLAVE PT	Le	SLAVE PT					HORN RIVER	HORN RIVER	HORN RIVER		HARE INDIAN	HARE INDIAN	Shale	Shale
			NYARLING / SULPHUR PT / PRESQU'ILE PT	WATT MTN.	HORN RIVER	WATT MTN. / SULPHUR POINT												
			LITTLE BUFFALO FALLS	PINE POINT	LONELY BAY	PINE POINT	NAHANNI / HEADLEE	?	HEADLEE	NAHANNI / HEADLEE	NAHANNI / HEADLEE	NAHANNI / HEADLEE	NAHANNI / HEADLEE	NAHANNI	HUME	HUME	HUME	Shale Limestone
		Eifelian	CHINCHAGA	CHINCHAGA	CHINCHAGA	CHINCHAGA	MANETOE / ARNICA	MANETOE / ? ARNICA	MANETOE / ARNICA	FUNERAL / ARNICA	MANETOE / FUNERAL / ARNICA	LANDRY / ARNICA	MANETOE / LANDRY / ARNICA	BEAR ROCK	BEAR ROCK	BEAR ROCK	Limestone / Dolomite	Limestone / BEAR ROCK
			Salt	Salt														
DEVONIAN OR SILURIAN											BOMBE	BOMBE						
SILURIAN								Limestone Shale Conglomerate ?	Limestone Shale	Limestone Shale Sandstone ?	Dolomite ?	CAMBELL / DELORME	Dolomite ?			RONNING	Dolomite	Dolomite
ORDOVICIAN					CHEDA / BUCTO				Shale Dolomite Limestone			WHITTAKER	Dolomite	MT KINDLE / FRANKLIN MTN	MT KINDLE / FRANKLIN MTN			
— ? —					LAMARTRE													
CAMBRIAN				MIRAGE POINT	MAZENOD / OLD PORT I.				SUNBLOOD / Sandstone Dolomite Shale	SUNBLOOD		SUNBLOOD / Dolomite Sandstone	? Dolomite Sandstone ?	SALINE R / MT CAP / MT CLARK / LONE LAND / Shale Sandstone Dolomite	SALINE R / MT CAP	Mac DOUGAL / KATHERINE		Shale Gypsum Sandstone
PRECAMBRIAN			Igneous and metamorphic rocks	Sedimentary igneous and metamorphic rocks	Igneous and metamorphic rocks	Sedimentary igneous and metamorphic rocks		Argillite										

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CORRELATION OF DEVONIAN AND OLDER PALAEOZOIC ROCKS OF DISTRICT OF MACKENZIE

Plate 8 (from Douglas, Norris, Thorsteinsson and Tozer, 1963)

Period		CAMPBELL UPLIFT 32	RICHARDSON MTNS. TRAIL RIVER 33	RICHARDSON MTNS. NORTHERN 34	WEST KEELE AND OLD CROW RGES. 35	OGILVIE MTNS PORCUPINE R. 36	OGILVIE MTNS BLACKSTONE R. 37	WERNECKE MTNS. WIND RIVER 38	NORTHERN MACKENZIE MOUNTAINS KNORR RANGE 39	NORTHERN MACKENZIE MOUNTAINS SNAKE RIVER 40	NORTHERN MACKENZIE MOUNTAINS CRANSWICK R. 41
Overlying			Carboniferous	Penn.		Mississippian	Mississippian	Tertiary		Mississippian	Lower Cretaceous
DEVONIAN	Upper		IMPERIAL				IMPERIAL	IMPERIAL		IMPERIAL	IMPERIAL
	Middle	Limestone Dolomite	Shale	Limestone		Limestone	Shale Limestone	Shale	Shale	Shale Limestone Dolomite	Shale Limestone Limestone
	Lower						Shale				
SILURIAN		Dolomite	ROAD RIVER Shale	Limestone	Limestone	Dolomite	ROAD RIVER	ROAD RIVER	Shale Limestone	Dolomite Limestone	Dolomite
ORDOVICIAN			Limestone	Limestone Dolomite		Dolomite	Dolomite	Limestone Dolomite	Limestone Dolomite	Dolomite	Dolomite
CAMBRIAN		Dolomite Siltstone	Siltstone Limestone	Dolomite Mudstone		MACDOUGAL Qtz. Silts.	MACDOUGAL	MACDOUGAL		Conglomerate Hematite MACDOUGAL KATHERINE	MACDOUGAL KATHERINE
PRECAMBRIAN			Phyllite		TINDIR	TINDIR	Phyllite	Phyllite	Slate	Phyllite	Phyllite

GEOPHOTO SERVICES LTD.

CORRELATION OF DEVONIAN AND OLDER PALAEOZOIC ROCKS OF NORTHERN YUKON

Plate 9 (from Douglas, Norris, Thorsteinsson and Tozer, 1963)

PERIOD		PETITOT RIVER 42	LIARD PLATEAU 43	PEEL CANYON 44	OGILVIE MTNS 45	NORTHERN RICHARDSON MTNS 46	BRITISH MTNS 47	NORTHEAST MELVILLE ISLAND 48	49	GRINNELL PENINSULA 50	ELLESMERE I BLIND FIORD 51	AXEL HEIBERG I WHITSUNDAY BAY 52	ELLESMERE ISLAND NORTH OF CANYON FIORD 53	54	BLAA MTN 55	NORTHERN AXEL HEIBERG I 56
Overlying		L. Cretaceous	L. Cretaceous	L. Cretaceous	Triassic	Jurassic	Pre-Jurassic Sandstone	Triassic	Triassic		Triassic	Triassic	Triassic	Triassic	Triassic	Triassic
PERMIAN	Upper	FANTASQUE	FANTASQUE		TAHKANDIT			ASSISTANCE	ASSISTANCE	ASSISTANCE	Chert Shale Siltstone	?	ASSISTANCE	ASSIS-TANCE	Siltstone Shale	Red sandstone; Chert Basalt
	Lower		Upper	Sandstone	Calcarenite Shale	Siltstone Sandstone Limestone	?		SABINE BAY	BELCHER CHANNEL	BELCHER CHANNEL	Siltstone Shale Sandstone	SABINE BAY	SABINE BAY	Siltstone Shale Limestone	Limestone
PENNSYLVANIAN	Upper								BELCHER CHANNEL				Siltstone Sandstone	BELCHER CHANNEL		
	Middle		MATTSON Middle	Calcarenite	Calcarenite			CANYON FIORD	CANYON FIORD		Limestone Siltstone		Anhydrite			
	Lower				? Limestone Shale ? Shale		Shale						Limestone	Limestone		
MISSISSIPPIAN	Upper	MATTSON	Lower	Limestone Shale	Limestone Shale							Anhydrite Gypsum		CANYON FIORD	Reef Limestone	
	Middle	FLETT	FLETT				? Lisburne limestone ?								Anhydrite Gypsum	Anhydrite Gypsum
	Lower	'BANFF'	CLAUBEN													Sandstone Coal
			YOHIN				Kyak shale									
		EXSHAW	? Upper Devonian													
Underlying		KOTCHO		IMPERIAL	IMPERIAL ?	IMPERIAL	Precambrian NERUOKPUK	L and M Palaeozoic	L and M Palaeozoic	CORNWALLIS				Lower Palaeozoic		

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CORRELATION OF CARBONIFEROUS AND PERMIAN ROCKS OF NORTHERN CANADA

tribution of rock units in the project area. Several illustrations are presented to illustrate more local conditions. Reference is occasionally made to section localities shown on the panel diagram, Plate 6. The stratigraphic thicknesses shown on Plate 6 are derived from published information and well records and, in some cases, from the air photographs.

Plates 7, 8, and 9 are correlation charts reproduced from Douglas et. al. (1963). These charts are regional in scope, and show the relation of the stratigraphic units of the project area to other stratigraphic units in Western Canada.

In the following pages the essential data relevant to each formation or map unit are presented in a series of "Formational Data Sheets". Many of the data are derived from published literature, and in all cases the bibliographic reference is given. Of particular value are the series of four papers prepared by R. J. W. Douglas and D. K. Norris, and published by the Geological Survey of Canada in 1959, 1960(b), 1961, and 1963. These four papers cover map areas 95B, C, F, G, J, K, N, and O, and present a considerable amount of basic stratigraphic information. These four papers must be studied as a unit, as the latest papers describe and name formational units which were recognized but not named in the first published papers. The frequent reference to Douglas and Norris in the following pages refer to the above mentioned four papers.

Many of the type localities and measured sections reported by Douglas and Norris are a few miles west of the area of photogeologic mapping. A

description of these localities is included in the following pages, however, as the data are relevant to an evaluation of the Mackenzie Plain.

PROTEROZOIC ROCKS

Mapping Methods

All Proterozoic strata cropping out within the project area are mapped with the symbol pC.

Distribution

Relatively small outcrops of Proterozoic strata are mapped at three localities in the McConnell Range, and at one locality in the Beaver River area in the southwestern part of the project area. It is presumed that Proterozoic strata underlie the entire area. Several exploratory tests in the southeastern part of the mapped area penetrated the Proterozoic.

Lithology and Thickness

Douglas and Norris recognize a four-fold division of the Proterozoic in the Mt. Cap area (map areas 95O/SW and 95O/SE) as follows:

Lone Land Formation	965 ft.	Shale, siltstone, and mudstone; with a basal section of 200 ft. of fine-grained white sandstone.

Angular Unconformity

Unnamed Unit	1510 ft.	Interbedded shale, siltstone, and sandstone.
Unnamed Unit	1585 ft.	Red shale, with minor siltstone and sandstone.
Unnamed Unit	1700 ft.	Interbedded dolomite, sandstone, siltstone, and shale.

At the Beaver River locality Douglas and Norris report massive t~ thin-bedded greenish-gray argillite.

At some of the exploratory tests drilled in the southeastern part of the mapped area the Proterozoic is reported as "quartzite", "sandstone", or "chert". In the Shell Liard No. 2 well, igneous rock (syenite) was encountered which could be Archeozoic, but it is more likely a later intrusion. In the Beaver River area syenite plugs intrude Cretaceous strata.

Age

These rocks are overlain with angular unconformity by Cambrian strata, and are presumed to be Proterozoic on the basis of lithology and stratigraphic position.

Contacts

The lower contact of the Proterozoic map unit is not exposed; the upper contact is a distinct angular unconformity.

Correlation

These strata are probably part of the Belt Series of western North America. To the north they are correlative with the Katherine Group.

LOWER CAMBRIAN MT. CLARK FORMATION

Type Locality

Mt. Clark in map area 96C/SE (Williams, 1923).

Mapping Methods

The Mt. Clark Formation forms resistant topography, and is a distinct photogeologic unit which is mapped with the symbol Ємc.

Distribution

The Mt. Clark crops out at several localities in the McConnell Range. It is presumably widespread in the Mackenzie Plain, and truncated southwestward in the Mackenzie Mountains.

Lithology

Sandstone, fine-grained, white with purplish red laminae and bands, massive to thin bedded, partly cross-bedded, weathers reddish (Douglas and Norris); includes conglomerate and shale (Williams, 1963).

Thickness

1000 feet in northern part of area at Mt. Paisley in map area 96C/SE (Bell, 1957), 736 feet on east side of Mt. Cap in map area 95O/SW (Bell, 1957), 450 feet at Mt. Cap (Douglas and Norris), and absent in Beaver River area in map area 95C/SE.

These data indicate a pronounced southwesterly thinning through the project area.

Age

Early Cambrian trilobites in intercalated shale in upper part of formation (Williams, 1923).

Contacts

The Mt. Clark rests on the underlying Proterozoic strata with distinct angular unconformity. The upper contact is apparently sharp, with no angular discordance.

Correlation

The Mt. Clark is probably correlative with basal Cambrian sandstones reported in some exploratory tests in the southeastern part of the project area, and with the basal part of the Macdougal Formation which occurs north of the project area.

Remarks

In the upper reaches of the Beaver River, in map area 95C/SW, Proterozoic strata crop out, but equivalents of the Mt. Clark are absent. The Proterozoic is overlain with angular unconformity by a conglomerate composed of boulders of white quartzite which may have been derived from the Mt. Clark Formation. The position of the southwestern erosional wedge-edge of the Mt. Clark is unknown. Douglas et. al. (1963) refer to this area as the "Beaver High".

LOWER AND MIDDLE CAMBRIAN MT. CAP FORMATION

Type Locality

West slope of Cap Mountain in map area 95O/SW (Williams, 1922).

Mapping Methods

The Mt. Cap and the overlying Saline River Formations form recessive topography and, at most places, cannot be separated on the air photographs. The two formations comprise a single map unit identified with a symbol Csrmc. At a few localities the base of the Saline River is identified as a key horizon labeled SR.

Distribution

The Mt. Cap Formation crops out in the McConnell Range of the Franklin Mountain System, and in the Mackenzie Mountains in the extreme northwestern part of the project area. It is presumed that the Mt. Cap is present in the subsurface throughout much of the project area, with the exception of the extreme southwestern portion in the Beaver River region.

Lithology and Thickness

Douglas and Norris report that only a few feet of Mt. Cap shale is exposed at the type locality at Cap Mountain. These shales are white, olive green, soft and fissile, and weather light-green to light orange-red and yellowish-orange. The thickness of the formation at this locality is not known, but was estimated by Williams (1922) to be about 200 feet.

Age

Williams (1922, 1963) assigns the Mt. Cap Formation to the Middle Cambrian Series on the basis of trilobite fauna. Douglas and Norris report Early Cambrian trilobites in the basal part of the formation.

Contacts

The contact of the Mt. Cap Formation with the underlying Early Cambrian Mt. Clark Formation is believed to be conformable. No data are available concerning the contact of the Mt. Cap Formation with the overlying Saline River Formation, but there is no reason to believe that the contact is not conformable.

Correlation

The Mt. Cap Formation is probably a lateral equivalent of some part of the Macdougal Formation, which occurs north of the project area.

MIDDLE CAMBRIAN SALINE RIVER FORMATION

Type Locality

On the banks of the Saline River in map area 96C/SE (Williams, 1922).

Mapping Methods

The Saline River Formation and the underlying Mt. Cap Formation outcrop in a recessive interval, and cannot be separated on the air photos at all places. The Saline River Formation and the underlying Mt. Cap Formation form a single map unit, which is designated on the accompanying maps with the symbol €srmc. At some places the contact between the two formations is visible for short distances, and is identified as a key horizon labeled SR.

Distribution

The Saline River Formation is presumed to be present over much of the project area with the exception of the extreme southwestern part.

Lithology and Thickness

The Saline River Formation is poorly exposed at most localities, and there are conflicting reports regarding its thickness and lithology. In general, it appears to range from about 300 to 500 feet thick, and consists of variegated gypsiferous shales and evaporites.

Age

The age of the Saline River Formation is somewhat uncertain because of lack of conclusive faunal evidence. At one time or another dates ranging from Middle Cambrian to Silurian have been attributed to the Saline River Formation. Williams (1963) places the Saline River Formation in the upper part of the Middle Cambrian Series.

Contacts

The contact of the Saline River Formation with the underlying Mt. Cap Formation is covered at most localities, but is presumed to be conformable. The upper contact of the Saline River Formation is poorly exposed but is presumed to be a disconformity.

Correlation

The Saline River Formation is correlative with some part of the Macdougal Formation exposed north of the project area. Some of the exploratory tests drilled in the southeastern portion of the mapped area encountered evaporite beds, which are doubtless lateral equivalents of the Saline River Formation.

CAMBRIAN OR ORDOVICIAN CONGLOMERATE

Mapping Methods

In the Beaver River region (map area 95C/SW) a conglomerate unit is mapped with the symbol O€cg.

Distribution

This conglomerate has been observed only in the Beaver River area, and is presumed to have a fairly local distribution.

Lithology

Massive boulder conglomerate, with boulders up to a foot in diameter, composed of white and gray quartzite, banded gray quartzite, and gray chert. The matrix is sparse and composed of similar coarse-grained material (Douglas and Norris).

Thickness

Douglas and Norris observed the conglomerate to be in excess of 10 feet thick. The air photos indicate the unit may be as much as 100 feet thick.

Age

The conglomerate rests on Proterozoic strata and is overlain by Ordovician carbonate rock. A Cambrian or Ordovician age is indicated. The Early Cambrian Mt. Clark Formation is absent at the Beaver River locality, and the conglomerate could have derived from erosion of the Mt. Clark. White (1959) notes evidence of a mid-Ordovician orogeny in central British Columbia. The rocks overlying the conglomerate are tentatively dated as Middle Ordovician. These observations suggest the conglomerate may be of Ordovician age.

Contacts

The lower contact of the conglomerate unit is a distinct angular unconformity. The upper contact appears sharp on the air photos, and there is no observable angular unconformity.

MIDDLE ORDOVICIAN SUNBLOOD FORMATION

Type Locality

Sunblood Mountain, map area 95F/NW (Kingston, 1951; Douglas and Norris).

Mapping Methods

Through much of the mapped area the Sunblood can be recognized on the air photos, and is mapped with the symbol Os. In the extreme southwest the lower Paleozoic formational contacts are not clear on the air photos, and the Sunblood is included in a broad map unit labeled Dm-Os.

Distribution

The Sunblood Formation is probably present in the Mackenzie Mountains through the greater part of the project area, but is not present in the Franklin Mountains.

Lithology and Thickness

Thickness data on the Sunblood are sparse, as the base of the unit is exposed in the project area only in the vicinity of the Beaver River, and in this region the unit is poorly developed and cannot be separated on the air photos from overlying strata. At the type locality Douglas and Norris report the following section.

2810 ft. Limestone, dark gray, weathers various shades of orange and brown, capped by brilliant orange colored limestone

330 ft. Covered

350 ft. Limestone, dark gray, dark gray weathering

3490 ft. Base not exposed

Farther north, in the Whittaker and Delorme Ranges, Douglas and Norris measured partial Sunblood sections consisting of about 1600 feet of orange weathering limestone, dolomite, siltstone, and sandstone.

The Sunblood probably has a maximum development of about 3600 feet in the west-central part of the mapped area, and thins to the north and south.

Age

Fossils collected from the Sunblood by Douglas and Norris have been assigned a Middle Ordovician age.

Contacts

The lower contact of the Sunblood has been observed only in the Beaver River area, where the formation appears to rest conformably on the underlying conglomerate. The Sunblood is overlain conformably by the Ordovician and Silurian Whittaker Formation.

Correlation

As a rock unit, the Sunblood appears to be a lateral very thick equivalent of the lower carbonate member of the Franklin Mountain Formation (as described by Douglas and Norris) of the Ronning Group. As a time unit perhaps only the upper part of the Sunblood correlates with the lower carbonate unit of the Franklin Mountain Formation, evolving from an eastward transgressing sea in Middle Ordovician time (Plate 10).

ORDOVICIAN OR SILURIAN FRANKLIN MOUNTAIN FORMATION

Type Locality

Eastern flank of Mt. Kindle in map area 95O/SE (Williams, 1922).

Mapping Methods

The Mt. Kindle and the Franklin Mountain Formations together form the Ronning Group, which is shown on the accompanying maps with the symbol SOr. At some localities the contact between the two formations is visible on the air photographs, and is mapped as a key horizon labeled MK (base of Mt. Kindle).

Distribution

The Franklin Mountain Formation crops out throughout the Franklin Mountains in the eastern part of the mapped area, and in the Mackenzie Mountains in the extreme northwestern part of the area.

Lithology and Thickness

Douglas and Norris examined the type locality of the Franklin Mountain Formation and recognized 1265 feet of the formation as follows:

745 ft.	Dolomite, fine-grained, light gray, thin bedded.
260 ft.	Shale, yellowish brown, green, and red; with minor quartzose sandstone.
155 ft.	Dolomite, grey, fine-grained, thin bedded.
105 ft.	Limestone and calcareous shale.
1265 ft.	Total thickness

Williams re-published a description of his type locality in 1963, and assigned the Franklin Mountain Formation a thickness of only about 500 feet. The photogeologic study indicates a thickness of about 1250 ft.

Age

Douglas and Norris imply that the formation has a Late Ordovician age. Williams (1963) assigns the formation to the Lower Silurian Series.

ORDOVICIAN OR SILURIAN FRANKLIN MOUNTAIN FORMATION

Type Locality

Eastern flank of Mt. Kindle in map area 95O/SE (Williams, 1922).

Mapping Methods

The Mt. Kindle and the Franklin Mountain Formations together form the Ronning Group, which is shown on the accompanying maps with the symbol SOr. At some localities the contact between the two formations is visible on the air photographs, and is mapped as a key horizon labeled MK (base of Mt. Kindle).

Distribution

The Franklin Mountain Formation crops out throughout the Franklin Mountains in the eastern part of the mapped area, and in the Mackenzie Mountains in the extreme northwestern part of the area.

Lithology and Thickness

Douglas and Norris examined the type locality of the Franklin Mountain Formation and recognized 1265 feet of the formation as follows:

745 ft.	Dolomite, fine-grained, light gray, thin bedded.
260 ft.	Shale, yellowish brown, green, and red; with minor quartzose sandstone.
155 ft.	Dolomite, grey, fine-grained, thin bedded.
105 ft.	Limestone and calcareous shale.
1265 ft.	Total thickness

Williams re-published a description of his type locality in 1963, and assigned the Franklin Mountain Formation a thickness of only about 500 feet. The photogeologic study indicates a thickness of about 1250 ft.

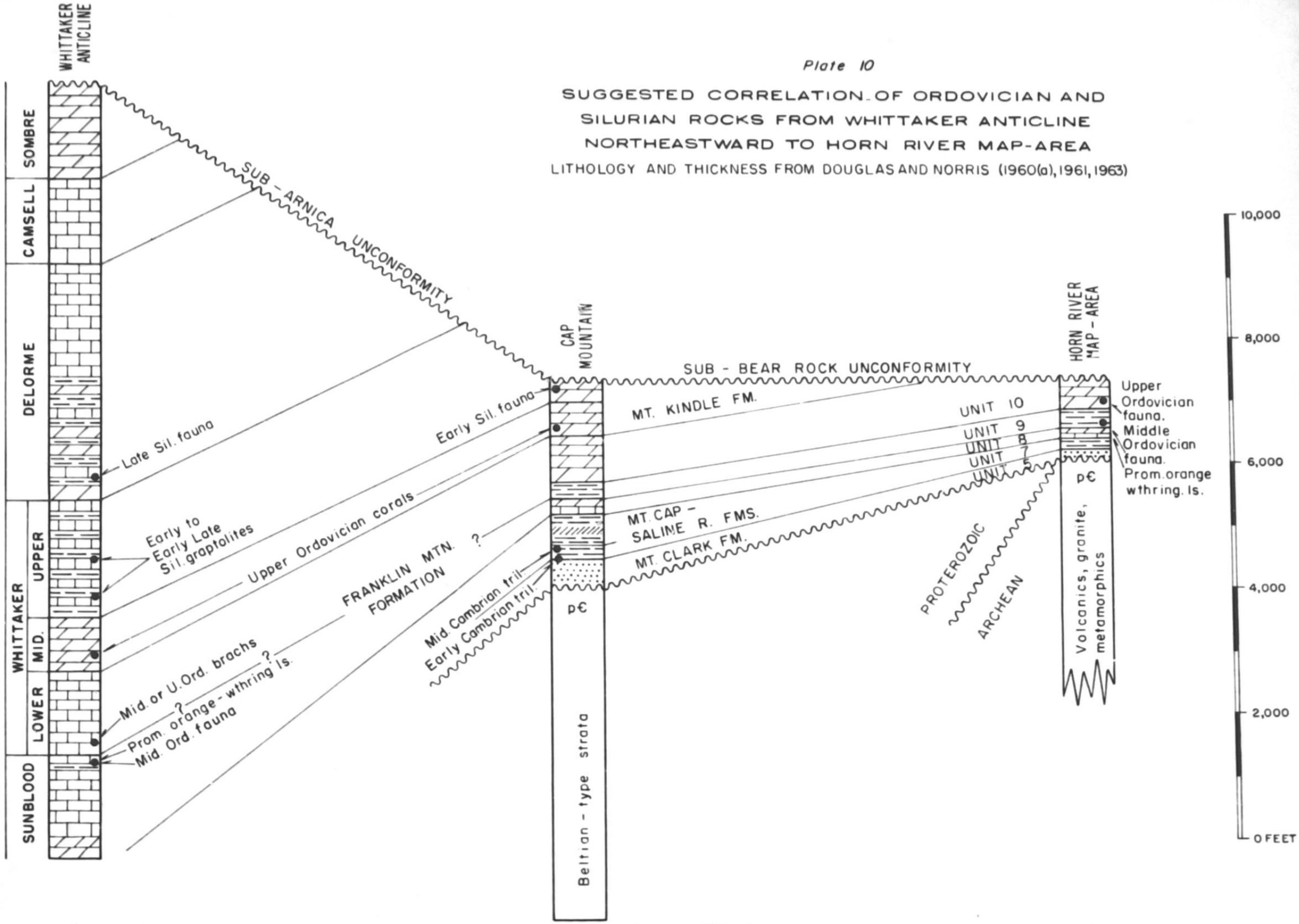
Age

Douglas and Norris imply that the formation has a Late Ordovician age. Williams (1963) assigns the formation to the Lower Silurian Series.

Plate 10

SUGGESTED CORRELATION OF ORDOVICIAN AND SILURIAN ROCKS FROM WHITTAKER ANTICLINE NORTHEASTWARD TO HORN RIVER MAP-AREA

LITHOLOGY AND THICKNESS FROM DOUGLAS AND NORRIS (1960(a), 1961, 1963)



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Contacts

The contact of the Franklin Mountain with the underlying Saline River Formation is covered at most localities, and there is no published description of the contact. There is no photo-evidence to suggest an angular discordance between the formations, but a time hiatus is present. The contact between the Franklin Mountains and the overlying Mt. Kindle Formation is apparently conformable.

Correlation

The Franklin Mountain Formation is believed to be more-or-less a lateral equivalent of the Sunblood Formation and the lower unit of the Whittaker Formation (Plate 10).

ORDOVICIAN AND SILURIAN WHITTAKER FORMATION

Type Locality

East flank of the Whittaker Range in map area 95K/NE (Douglas and Norris).

Mapping Methods

In the vicinity of the type locality the Whittaker Formation is a readily identifiable photogeologic map unit and is mapped with the symbol SOw. At other localities the Whittaker cannot be separated from the overlying and underlying strata, and is included in a map unit with a broad age range (see Plate 5).

Distribution

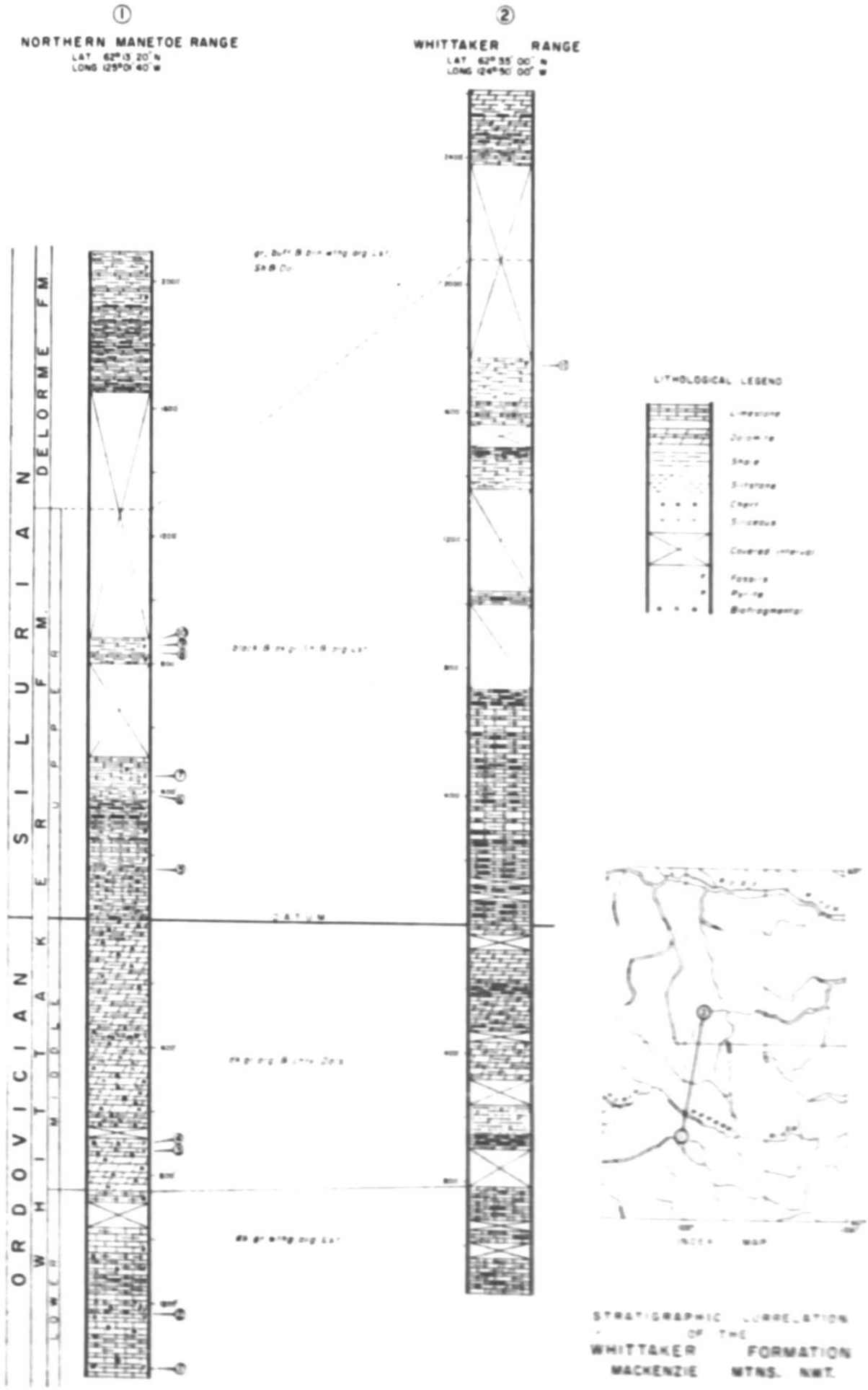
The Whittaker or equivalent strata are present in the Mackenzie Mountains throughout the greater part of the project area.

Lithology and Thickness

At the type locality the Whittaker Formation is 4,070 feet thick; the following section is reported by Douglas and Norris:

Upper Part	1890 ft.	Argillaceous limestone, dark gray to grayish-black, fine-grained, platy to thinly bedded; with alternating thin beds of black and dark gray siltstone.
Middle Part	860 ft.	Dolomite, mainly fine-grained, dark gray, medium- to thick-bedded, sparsely cherty, commonly fossiliferous.
Lower Part	1320 ft.	Limestone, dark gray to gray, fine-to medium-grained, thinly bedded.
	4070 ft.	Total Thickness

Twenty-four miles to the northwest on the west flank of the Delorme syncline, west of the project boundary, the following section is reported by Douglas and Norris:



Stratigraphic correlation of the Whittaker formation, Mackenzie Mtns., N.W.T.

Plate II

Upper Part	980 ft.	
Middle Part	580 ft.	
Lower Part	1330 ft.	
	2890 ft.	Total Thickness

This section is considerably thinner than at the type locality, but the lithology of the three units are essentially similar to the lithology at the type locality.

Two additional sections of the Whittaker Formation are reported by O'Bertos and Jackson (1963). These two sections are in the same general vicinity as the type locality. Plate 11, reproduced from O'Bertos and Jackson, illustrates the lithology and thickness of these two sections and includes an index map which locates them.

Farther south, in the vicinity of Sunblood Mountain and Virginia Falls, in map area 95F/NW, a section of 2,530 feet of limestone, shale, siltstone, and sandstone, with minor dolomite beds, is reported by Douglas and Norris. Although this section is not specifically identified as the Whittaker Formation, the age and stratigraphic position of this section suggests that it is a Whittaker equivalent.

North of the type locality, in the vicinity of Blue Lake (map area 95N/SW) a Whittaker section is reported as follows:

Upper Part	680 ft.	Dolomite, fine- to medium-grained, gray to dark gray, massive to thin bedded.
Middle Part	2060 ft.	Dolomite, light gray, medium-grained, partly porous and vuggy, cherty, fossiliferous.
Lower Part	620 ft.	Dolomite and limestone.
	3360 ft.	Total Thickness

Age

At the type locality the lower and middle part of the Whittaker are dated as Late Ordovician, whereas the upper part is dated as Early Silurian. O'Bertos and Jackson extend the age range of the Whittaker Formation from Middle? Ordovician to Late Silurian.

Contacts

The Sunblood-Whittaker contact is apparently conformable. The contact between the Whittaker and the overlying strata of the Delorme Formation is conformable.

Correlation

The lower part of the Whittaker Formation is believed to be the lateral equivalent of the upper carbonate unit of the Franklin Mountain Formation, while the middle part of the Whittaker correlates with most of the Mt. Kindle Formation (Plate 10).

ORDOVICIAN AND SILURIAN MT. KINDLE FORMATION

Type Locality

At Mt. Kindle in map area 95O SE (Williams, 1922, 1963).

Mapping Methods

The Mt. Kindle and Franklin Mountain Formations together form the Ronning Group, which is shown on the accompanying maps with the symbol SOr. At some localities the contact between the two formations is visible on the air photographs, and is mapped as a key horizon labeled MK (base of Mt. Kindle).

Distribution

The Mt. Kindle Formation crops out throughout the Franklin Mountains in the eastern part of the project area, and in the Mackenzie Mountains in the extreme northwestern part of the area.

Lithology and Thickness

At the type locality Williams (1922, 1963) describes the Mt. Kindle as 560 feet of gray magnesium limestone. Douglas and Norris report a 900 foot composite section in the same general area, consisting of a lower 500 to 600 feet of massive to thick-bedded, medium gray reefy dolomite, and an upper 300 to 400 feet of medium-bedded light gray to brownish gray dolomite, with silty zones near the top.

Age

Williams, in 1963, reasserted his belief in the Middle Silurian age of the Mt. Kindle. Douglas and Norris report Late Ordovician fauna in the lower part, and Silurian fauna in the upper part.

Contacts

The contact of the Mt. Kindle with the underlying Franklin Mountains Formation is apparently conformable. The upper contact of the Mt. Kindle is covered at most places, but there is no evidence of angular discordance.

Correlation

The Mt. Kindle is believed to be approximately a lateral equivalent of the middle unit of the Whittaker Formation of the Mackenzie Mountains.

SILURIAN DELORME FORMATION

Type Locality

In the Delorme Range at the headwaters of Pastel Creek, in map area 95K/NW (Douglas and Norris).

Mapping Methods

The Delorme Formation does not form a good photogeologic map unit, and at most places is included with other Silurian rocks in a map unit labeled S. At some places the contact between the Delorme and the overlying Camsell Formation can be recognized on the air photos and is mapped as a key horizon labeled C, signifying the base of the Camsell Formation. At other localities, particularly in the southwestern part of the project area, the Delorme is included in broader mapping units which include Ordovician, Silurian, and Devonian strata.

Distribution

The Delorme Formation is not present in the eastern part of the Franklin Mountains, but outcrops in the Mackenzie Mountains throughout the central and northern part of the project area.

Lithology and Thickness

At the type locality the following section of the Delorme is reported:

750 ft.	Mainly concealed, partly composed of crypto-crystalline limestone, dark gray, and thin-bedded.
700 ft.	Dolomite, fine-grained, silty, medium-bedded.
1300 ft.	Dolomite, fine-grained, light gray, in part massive and resistant, ranging to whitish gray and brown.
500 ft.	Interbedded dark gray shale and black argillaceous limestone and dolomite.
3250 ft.	Total Thickness (Douglas and Norris)

A few miles farther south, on the east flank of the Whittaker Range, the Delorme Formation is 3,800 feet thick and displays a lithology much

like that of the type section (Douglas and Norris). Farther north, in the Rouge Range, the Delorme Formation is reported as being 2,100 feet thick (Douglas and Norris).

Age

At the type locality in the Delorme Range, Douglas and Norris collected fossils from the Delorme Formation which indicate a Silurian age, possibly ranging upward into the Devonian. In general, however, considering the stratigraphic position of the Delorme Formation, it is probably restricted to the Silurian System.

Contacts

The contact between the Delorme Formation and the underlying Whittaker Formation appears to be conformable. In the Mackenzie Mountains the contact of the Delorme with the overlying Camsell Formation appears to be conformable. To the east, the Delorme is probably truncated below the pre-Arnica unconformity.

SILURIAN (?) CAMSELL FORMATION

Type Locality

Not specifically stated, apparently in the Whittaker or Delorme Ranges.

Mapping Methods

Throughout much of the project area the Camsell Formation does not form a distinct photogeologic unit and is included in a broader map unit designated as S. At some localities the lower and upper contacts of the Camsell Formation can be seen on the air photographs and are indicated respectively as key horizons labeled C and CT. At other localities the Camsell Formation is included within even broader map units which include parts of the Ordovician, Silurian and Devonian Systems. The several methods of mapping the Camsell Formation are indicated on Plate 5.

Distribution

The distribution of the Camsell Formation appears to follow closely that of the underlying Delorme Formation. The Camsell wedges-out south of the 62nd parallel, and is not present in the McConnell Range.

Lithology and Thickness

The Camsell Formation exhibits a southerly and easterly thinning through the project area, with the following thicknesses reported by Douglas and Norris:

1850 ft. In Rouge Range in map area 95N/SW

1700 ft. In the Redstone Range where crossed over by the Redstone River, in map area 95N/NW

1750 ft. In the Delorme Range in map area 95K/NW

1400 ft. In the Whittaker Range in map area 95K/SE

South of the 62nd parallel, the Camsell Formation is present as a thin wedge between the Sombre and Whittaker, and ultimately wedges-out.

The Camsell Formation in the Mackenzie Mountains is composed mainly of limestone and dolomite that is commonly brecciated and massive to thickly bedded. It weathers light gray with interbeds of soft yellow and orange. Breccias are common with fragments ranging up to 10 feet or more in diameter. At a few localities, salt casts are present on bedding surfaces.

Age

No fossils have been reported in the Camsell Formation, but it is generally assumed to be of Silurian age.

Contacts

Contact of the Camsell with the underlying Delorme Formation appears to be conformable. The upper contact of the Camsell Formation is an erosional unconformity, and the Camsell is overlain by either the Sombre or Arnica Formations.

SILURIAN(?) SOMBRE FORMATION

Type Locality

At Tundra Ridge in map area 95F/NE (Douglas and Norris).

Mapping Methods

Sombre Formation is not a consistently good photogeologic map unit, and on the accompanying maps is included within the map unit designated as Silurian with the symbol S. At some localities the base of the Sombre is designated as key horizon labeled C_T. The upper contact of the Sombre Formation is the upper contact of the Silurian map unit. At a few localities, where the Silurian map unit cannot be recognized, equivalent strata are included in map units with broader age range (see Plate 5).

Distribution

The Sombre is present in the eastern part of the mapped area in the Mackenzie Mountain System. It is truncated northward and eastward by the overlying Arnica Formation, and is not present in the Franklin Mountains.

Lithology and Thickness

The following details concerning the lithology and thickness of the Sombre are from Douglas and Norris.

Northern Redstone Range, map area 95N/NW, nearly absent.

Dusky Range, map area 95N/SW, 360 feet of dolomite and dolomitic limestone, with a basal 55 feet sandy zone.

Southern Rouge Range, map area 95N/SW, as follows:

Upper Part	820 ft.	Dolomite, medium gray, medium-grained.
Middle Part	250 ft.	Partly covered, mainly dolomite, dary gray, fine-grained, partly brecciated, dark weathering.
Lower Part	550 ft.	Limestone and dolomite, grey, fine-grained.
	1250 ft.	Dolomite, gray to dark gray, fine-grained.
	2870 ft.	Total Thickness

Delorme Range, map area 95K/NW, 1600 feet dolomite, light gray, fine-grained, laminated, partly silty, interbedded with minor fine-grained limestone, weathers to dark and light gray bands.

Tundra Ridge, map area 95F/NE, as follows:

Upper Part	2370 ft.	Dolomite, mainly fine-grained, dark gray to black, medium to thick bedded.
Middle Part	570 ft.	Dolomite, dark gray, fine-grained, weathers dark.
Lower Part	1160 ft.	Dolomite, dark gray to black, fine-grained, weathers in alternating dark and light gray bands.
	4100 ft.	Total Thickness.

First Canyon of the South Nahanni, map area 95F/SE, 650 feet of dolomite, dark to medium gray, crypto-grained, weathers banded.

Age

No fossil collections are reported from the Sombre Formation; it is presumed to be of Silurian age.

Contacts

The Sombre unconformably overlies the Camsell Formation, and overlaps the Camsell southward. The Arnica (and facies equivalents) overlies the Sombre with angular discordance, and truncates the Sombre northward and eastward.

LOWER(?) DEVONIAN FUNERAL FORMATION

Type Locality

The Northern Nahanni Plateau, map area 95F/NE (Douglas and Norris).

Mapping Methods

The Funeral Formation is included as part of the Lower(?) and Middle Devonian map unit, designated with the map symbol Dml. At a few localities the upper contact of the Funeral Formation was noted on the air photographs and is indicated on the accompanying photogeologic maps as a key horizon labeled FL_T.

Distribution

The Funeral Formation is a facies equivalent of several other recog - nized formations, and appears to have a rather limited lateral develop- ment. The Funeral Formation probably does not occur south of the 61st parallel. North of the 61st parallel, the Funeral is not present in the Nahanni Range, but is present in the Nahanni Plateau a few miles farther west. The Funeral Formation can be traced northerly through the Nahanni Plateau and into the Dahadinni and Dusky Ranges as far north as approximately 63°45'N. Northwest of this last mentioned locality, the lower part of the Funeral Formation grades laterally into the Arnica Formation, and the upper part grades into the Landry For - mation. To the east, throughout the greater part of the Franklin Moun- tain System, the Funeral is replaced by the dolomites of the Arnica and Manetoe Formations.

Lithology and Thickness

The following descriptions of the lithology and thickness of the Funeral Formation are taken from the several papers of Douglas and Norris. At the type locality, in the northern Nahanni Plateau, in map area 95F/NE, a published section of the Funeral Formation is as follows:

Upper Part	670 ft.	Calcareous shale and blocky mudstone, black, platy to fissile, alternating with thin lenticular beds of black bioclastic limestone, and thick to massive bedded black hard argillaceous limestone.
Middle Part	225 ft.	Limestone, black, silty argillaceous, thinly bedded, bioclastic, with black shale partings, cliff former.

Lower Part	1655 ft.	Calcareous mudstone and calcareous shale, black, platy, interbedded with black silty to argillaceous limestone.
	2550 ft.	Total Thickness

The lithology of the Funeral Formation at its type locality is fairly representative of the formation throughout the project area. Near the facies boundary of the Funeral with equivalent formations, the Funeral becomes less argillaceous. Other reported thicknesses of the Funeral are as follows:

Southern Iverson Range, map area 95K/SE	900 ft.
Whittaker Range, map area 95K/NE	1300 ft.
Mount Haywood, in the Dahadinni Range, map area 95N/NW	550 ft.

Age

Fossils collected from the Funeral Formation by Douglas and Norris have been assigned to the Middle Devonian. Other workers believe that equivalent strata (Bear Rock Formation) are of Early Devonian age. In this evaluation, the Funeral Formation is tentatively considered to be of Early Devonian age.

Contacts

At some places the Funeral overlies the Sombre with angular discordance. At other localities the Funeral Formation is transitional downward into the underlying dolomites of the Arnica Formation. Where the Funeral is overlain by the limestones of the Landry Formation, the contact is presumed to be transitional. At other localities the Funeral is overlain by the Middle Devonian strata of either the Headless or Nahanni Formations, and at these localities the upper contact is presumed to be a disconformity between Lower and Middle Devonian strata.

Correlation

The Funeral Formation is a relatively local argillaceous facies development, and has a complex lateral relationship to several other formational units. To the south and east, the Funeral grades into the coarsely crystalline dolomites of the Manetoe Formation. To the north and west,

the lower part of the Funeral grades into the Arnica Formation and the upper part into the Landry Formation. To the east, the Bear Rock Formation may be equivalent to some part of the Funeral.

LOWER(?) DEVONIAN ARNICA FORMATION

Type Locality

First Canyon of the South Nahanni River in map area 95F/SE (Douglas and Norris).

Mapping Methods

On the accompanying photogeologic maps the Arnica Formation is included within a Lower(?) and Middle Devonian map unit designated as Dml. At some places the top of the Arnica Formation is visible on the air photographs and is indicated as a key horizon labeled ART. At other localities the Arnica and equivalents are included in map units with the broader age range.

Distribution

The Arnica Formation crops out in the Mackenzie Mountains System throughout most of the project area from about the 61st parallel north to the project boundary. Some of the 61st parallel Arnica equivalents may be present but have not been identified. Eastward, in the Franklin Mountains System, the Arnica Formation grades laterally into the equivalent Bear Rock Formation.

Lithology and Thickness

The following summary of the lithology and thickness of the Arnica Formation is taken from several publications of Douglas and Norris. At the type locality, in the First Canyon of the South Nahanni River, in map area 95F/SE, the Arnica Formation consists of 1,650 feet of dolomite, described as follows: "fine-grained, granular, massive to thick-bedded, and dark grey to black -- interbedded with dolomite which is silty, very fine grained, black to brown, and massive-bedded, and with light brownish grey, thinly bedded dolomites, and with vuggy and porous dolomites. These rocks alternate in thick units that weather grey and dark grey, giving rise to a distinctive banded appearance." This lithologic description of the Arnica Formation applies to most outcrops within the project area. The reported thicknesses are as follows:

Cathedral Mountain, in map area 95F/NW	2,630 ft.
Little Doctor Lake, in the Nahanni Range, map area 95G/NW	2,430 ft.
Tundra Ridge, in map area 95F/NE	495 ft.

Pastell Creek, in the Delorme Range, map area 95K/NW	2,100 ft.
Iverson Range, map area 95K/NW	1,700 ft.
Camsell Range, map area 95O/SW	1,340 ft.
Rouge Range, map area 95N/NW	2,420 ft.
Redstone Range, map area 95N/NW	1,775 ft.
Dusky Range, map area 95N/NW	1,480 ft.
Mount Haywood, map area 95N/NW	435 ft.

The upper beds of the Arnica Formation are replaced at some localities by the argillaceous limestone of the overlying Funeral Formation, and the formation intertongues eastward with the breccias of the Bear Rock Formation. The extreme thickness range of the Arnica Formation is the result of these lateral and vertical facies changes.

Age

The Arnica Formation is apparently relatively unfossiliferous and there are no reported age determinations based on fossils collected from the Arnica Formation. The Funeral Formation, a lateral equivalent of the Arnica, contains fossils which Douglas and Norris assign to the Middle Devonian Series. Other investigators (Bassett, 1960) feel that these strata are more likely of Early Devonian age. In this evaluation the Arnica is considered to have an Early Devonian age.

Contacts

The lower contact of the Arnica Formation is an angular unconformity, and the Arnica transgresses on progressively older strata in a northerly and easterly direction. The contact of the Arnica Formation with overlying facies equivalents (Landry and Funeral) is transitional. Where the Arnica is overlain by the Middle Devonian Headless or Nahanni, the contact is probably disconformable.

LOWER(?) DEVONIAN LANDRY FORMATION

Type Locality

In the Delorme Range, map area 95K/NW, and in the Whittaker Range, map area 95K/SE (Douglas and Norris).

Mapping Methods

Where the Landry Formation is present it is included within the Dml map unit, which is comprised of Lower(?) and Middle Devonian strata.

Distribution

Within the project area the Landry Formation crops out in the Redstone, Dusky, and Whittaker Ranges.

Lithology and Thickness

On the Whittaker Range the Landry Formation is 400 feet thick, and is composed of medium-gray to black crypto- to medium-grained lime - stone, which is medium to thick bedded, and weathers light gray. In the Delorme Range the formation is 300 feet thick, and is composed of crypto-grained dark gray to black limestone, which is thick bedded, gray weathering, and partly silty and argillaceous towards the top. Farther to the northwest, in the Dusky, Redstone, and Rouge Ranges, Douglas and Norris report thicknesses of 410, 570 and 730 feet re- spectively.

Age

Douglas and Norris found no fossils in the Landry Formation; the age of its lateral equivalent, the Funeral Formation, has been discussed.

Contacts

The contact of the Landry Formation with the underlying Arnica Forma- tion is sharp and conformable. Where the Landry is underlain by the Funeral Formation the contact is transitional. The Landry is separated from the overlying Middle Devonian strata by a disconformity.

Correlation

To the southeast, the Landry grades into the argillaceous strata of the

Funeral Formation. To the east, the Arnica Formation is probably a partial equivalent of the Landry.

LOWER(?) DEVONIAN MANETOE FORMATION

Type Locality

The First Canyon of the South Nahanni River in map area 95F/SE (Douglas and Norris).

Mapping Methods

The Manetoe Formation is a relatively poor photogeologic mapping unit, and at all localities is included within the Lower(?) and Middle Devonian map unit designated Dml.

Distribution

The Manetoe Formation is a dolomitized coarsely crystalline facies that has a limited distribution. To the south, it is present in the Nahanni Range as far south as approximately 61°35' of latitude (map area 95G/NW). South of this area, the Manetoe grades into an undolomitized equivalent. Farther west, in the Nahanni Plateau, in map area 95F/SE, the Manetoe outcrops as far south as about 61°10'N. Northward, in the Mackenzie Mountains System, Manetoe facies outcrop as far north as 62°25'N latitude in map area 95K/SE. In the Mackenzie Mountains System the Manetoe facies range farther north, outcropping in the Camsell Range at about latitude 63°10'N (map area 95O/SW). In the Mackenzie Plain, Manetoe facies were encountered in the subsurface as far south as the Imperial Redstone No. 1 well located in map area 96C/SE. The Manetoe Formation has also been reported at the BA-HB Trail Creek No. 1 exploratory test in map area 95J/SE.

Lithology and Thickness

The Manetoe Formation is a coarsely crystalline and porous dolomite, which at some places includes minor interbeds of limestone and shale. The formation is typically brecciated, and cut by numerous white calcite and dolomite veins. Reported thicknesses of the Manetoe are as follows:

At Nahanni Butte, map area 95G/SW	350 ft.
First Canyon of the South Nahanni River (type locality), map area 95F/SE	375 ft.
Blue Fish Lake, map area 95G/SW	540 ft.

Little Doctor Lake, map area 95G/NW	310 ft.
Camsell Range, map area 95J/SW	150 ft.
Northern Camsell Range, map area 95O/SW	135 ft.
Imperial Redstone No. 1 test, map area 96C/SE	30 ft.

(All thicknesses from Douglas and Norris.)

Age

Douglas and Norris assigned the Manetoe Formation to the Middle Devonian Series. Other workers, however, (Bassett, 1960) assigned a lateral equivalent of the Manetoe Formation (Bear Rock Formation) to the Lower Devonian Series. In this evaluation the Manetoe Formation is tentatively considered as having an Early Devonian age.

Contacts

The nature of the contacts of the Manetoe Formation with the underlying Arnica Formation is not clearly established. Available reports indicate that the contact is fairly sharp and distinct; however, there is some evidence that the contact is diachronous. The Manetoe is overlain either by the calcareous shale of the Funeral Formation or limestone of the Landry Formation. The Funeral and the Landry are time equivalents and grade laterally into each other. The contact of the Manetoe with either one of these overlying formations is presumed to be transitional and diachronous.

Correlation

The Manetoe grades northward into the argillaceous limestone of the Funeral Formation. Southward, it grades into an undolomitized limestone, which in this report is considered as the upper part of the Arnica Formation. Eastward, the formation is probably represented by the uppermost beds of the Bear Rock Formation.

LOWER(?) DEVONIAN BEAR ROCK FORMATION

Type Locality

The type locality of the Bear Rock Formation is at Bear Rock, near Fort Norman, north of the project area (Williams, 1923).

Mapping Methods

At some localities the Bear Rock forms a distinct photogeologic map unit, and is mapped with the symbol Dbr. At other localities the Bear Rock and the overlying Nahanni Formation are mapped together with the symbol Dnbr. Where the compound map unit is used, the base of the Nahanni is locally mapped as key horizon N. To the southeast the Bear Rock grades into the Arnica, and at some localities may be included in the map units used for the Arnica Formation.

Distribution

Within the project area, the Bear Rock crops out in the McConnell Range, and in the Mackenzie Mountains in the extreme northwest. To the southwest, the Bear Rock grades into the Arnica and other equivalent strata. The Bear Rock crops out extensively to the north of the project area.

Lithology and Thickness

The Bear Rock is typically a massive breccia composed of fine-grained slightly silty and argillaceous pale brown to dark gray limestone. At Mt. Haywood, in map area 95N/NW, the Bear Rock is 1,000 feet thick, and 1,070 feet at Smith Ridge in the McConnell Range (Douglas and Norris). Test wells in the eastern part of the project area encountered dolomite and anhydrite in the Bear Rock interval (see Plate 6).

Age

The age of the Bear Rock has long been disputed. Bassett assigns the formation to the Lower Devonian Series.

Contacts

Where the Bear Rock overlies the Mt. Kindle, the contact is an unconformity. Farther west, tongues of the Bear Rock are underlain by the Arnica, and this contact is conformable. The upper contact of the Bear Rock is believed to be disconformable.

Correlation

The Bear Rock is a stratigraphic equivalent of the Arnica, and its lateral equivalents, the Funeral, Manetoe, and Landry.

MIDDLE DEVONIAN HEADLESS AND NAHANNI FORMATIONS

Type Locality

The term Nahanni Formation was proposed by Hage (1945) for 450 feet of limestone of Middle Devonian age in the upper part of the south facing cliff at Nahanni Butte (map area 95G/SW). Subsequently Douglas and Norris reported that the Nahanni Formation grades easterly into an argillaceous facies for which they proposed the name Headless Formation. Type locality of the Headless Formation is presumably somewhere in the Headless Range (map area 95F/SE).

Mapping Methods

The Headless and Nahanni Formations are shown on the accompanying photogeologic maps as a single map unit designated as Middle Devonian (Dm). At some localities the contact between the Headless Formation and the overlying Nahanni Formation can be observed on the air photos, and is indicated as a key horizon labeled N, denoting the base of the Nahanni Formation. At some places the formational contacts are not visible on the air photographs, and the Headless and Nahanni Formations are mapped as part of a map unit with a broad age range.

Distribution

The Nahanni and Headless are facies equivalents; the Nahanni being a carbonate section while the Headless is a shale section. In the eastern part of the project area this interval is entirely represented by limestone of the Nahanni Formation. Just west of the project area, near Virginia Falls (map area 95F/NW), the entire interval is represented by argillaceous beds of the Headless. At intervening areas both facies are present, with the Nahanni overlying the Headless. The rocks of this sequence were deposited throughout the project area, and are present except where they have been removed by recent erosion.

Lithology and Thickness

The following data concerning the thickness and lithology of the Headless and Nahanni Formations are taken from Douglas and Norris.

Headless Range, map area 95F/SE

Nahanni Formation	295 ft.	Massive cliff-forming limestone
Headless Formation	560 ft.	Dark gray calcareous shale, with interbedded limestone in the upper 150 feet.

Near Cathedral Mountain, map area 95F/NW

Nahanni Formation	absent	
Headless Formation	980 ft.	Of interbedded calcareous shale and limestone.

Nahanni Butte, map area 95G/SW

Nahanni Formation	350 ft.	Dark gray limestone
Headless Formation	130 ft.	Of argillaceous limestone

Blue Fish Lake, map area 95G/SW

Nahanni Formation	310 ft.
Headless Formation	85 ft.

Little Doctor Lake, map area 95G/NW

Nahanni Formation	410 ft.
Headless Formation	145 ft.

First Canyon of South Nahanni River, map area 95F/SE

Nahanni Formation	475 ft.
Headless Formation	130 ft.

Delorme Range, map area 95K/NW

Nahanni Formation	830 ft.
Headless Formation	not measured

Whittaker Range, map area 95K/NE

Nahanni Formation	800 ft.
Headless Formation	not measured

Iverson Range at the Root River, map area 95K/NW

Nahanni Formation	600 ft.
Headless Formation	not measured

South Iverson Range, map area 95K/SW

Nahanni Formation	965 ft.
Headless Formation	not measured

Camsell Range, map area 95O/SW

Nahanni Formation	360 ft.
Headless Formation	130 ft.

Rouge and Dusky Ranges, map area 95N/SW

Nahanni Formation	750 ft.
Headless Formation	100 to 125 ft.

Redstone Range at the Redstone River, map area 95N/NW

Nahanni Formation	380 ft.
Headless Formation	300 ft.

Mt. Haywood, map area 95N/NW

Nahanni Formation	410 ft.
Headless Formation	140 ft.

Age

Both the Headless and Nahanni Formations are fossiliferous, and their Middle Devonian age is well established.

Contacts

The Headless-Nahanni interval is believed to be separated from the underlying Lower(?) Devonian strata by a disconformity. The contact of the Nahanni with the overlying shale unit is sharp, with no evidence of angular discordance. It is quite possible, however, that this contact is a disconformity.

Correlation

The Nahanni Formation appears to be a stratigraphic equivalent of the Middle Devonian Hume Formation of the Norman Wells area. In the subsurface of the Interior Plains, the Nahanni interval is represented by some part of the Pine Point - Presqu'ile interval.

MIDDLE DEVONIAN HORN RIVER FORMATION

Type Locality

East of the project area, in the Horn River map area (Whittaker, 1922).

Mapping Methods

The Horn River Formation is recessive on outcrop and good exposures are rare. The formation is overlain by the relatively recessive Fort Simpson Formation, and the contact between the formations can be seen at only a very few localities. The Horn River Formation, the overlying Fort Simpson Formation, and other overlying recessive rocks, are shown on the accompanying photogeologic maps with either the symbol Du or MDu. The Horn River Formation is of definite Middle Devonian age, but is included in these Devonian map units for convenience. At a very few localities the top of the Horn River is mapped as a key horizon labeled HR.

Distribution

Because of very poor exposures in this part of the sedimentary section there is little information available concerning the distribution of the Horn River Formation within the confines of the project area. Douglas and Norris report a few outcrops of the Horn River in map areas 95O and 95N. In general, it is believed that the Horn River or equivalent strata are present at the base of the Upper Devonian shale sequence throughout the greater part of the project area (see Plate 12).

Lithology and Thickness

Douglas and Norris observed the following section of the Horn River Formation on a tributary of the Redstone River in map area 95N/NW:

Upper Part	230 ft.	Interbedded silty shale and fine-grained, thinly bedded, platy siltstone and sandstone, rusty brown weathering.
Lower Part	595 ft.	Shale, blocky to fissile, dark gray to black, interbedded in the upper 200 feet with hard, black, non-calcareous mudstone. The lower 160 feet is calcareous and interbedded in the basal 25 feet with argillaceous and arenaceous limestone.
	825 ft.	Total Thickness

Age

To the east of the project area, in the Horn River map area, similar strata contain Middle Devonian fossils (Douglas and Norris, 1960(a)).

Contacts

The contact of the Horn River Formation with the underlying Middle Devonian carbonate rock is sharp and possibly unconformable, although there is no evidence of angular discordance. There are little data available concerning the upper contact of the Horn River Formation; it appears that this contact may be transitional.

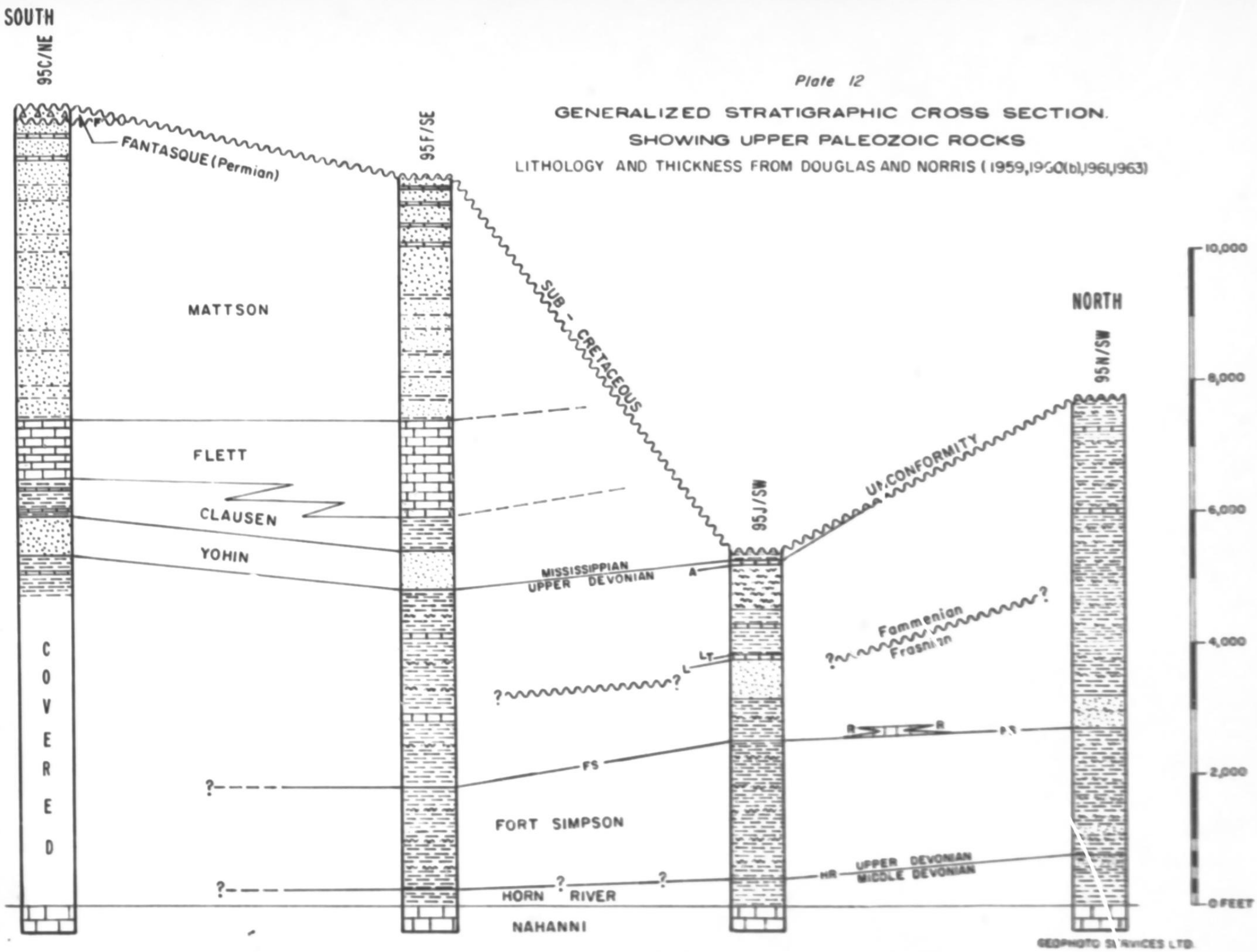
Correlation

The Horn River Formation is probably a correlative of the lower part of the Besa River Formation of northeastern British Columbia, and a direct correlative of the Canol and Hare Indian Formations of the Norman Wells area.

Plate 12

GENERALIZED STRATIGRAPHIC CROSS SECTION SHOWING UPPER PALEOZOIC ROCKS

LITHOLOGY AND THICKNESS FROM DOUGLAS AND NORRIS (1959, 1960(b), 1961, 1963)



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UPPER DEVONIAN FORT SIMPSON FORMATION

Type Locality

The term "Simpson" was originally proposed by Cameron in 1918. In 1961 Douglas and Norris proposed that the name be changed to the "Fort Simpson" Formation, as the term Simpson was pre-empted. Exact location of the type locality is unknown, but it is presumably somewhere in the vicinity of Fort Simpson.

Mapping Methods

The Fort Simpson Formation is included in a thick section of recessive shale and sandstone, which is indicated on the accompanying photogeologic maps with either the symbol Du or MDu. At a few localities the upper contact of the Fort Simpson can be observed on the air photographs, and is shown on the accompanying maps as a key horizon labeled FS.

Distribution

The Fort Simpson Formation was apparently widely distributed throughout the project area, and is present wherever it has not been removed by relatively recent erosion.

Lithology and Thickness

Douglas and Norris report that a nearly complete section of the Fort Simpson Formation is present along the Ram River in map area 95F/NE. The basal 220 feet is reported to consist of black fissile shale and sandy mudstone. It appears probable that this basal unit is actually the Horn River Formation (see Plate 12). The succeeding 1580 feet of strata probably represent a nearly complete section of the Fort Simpson Formation, and consist mainly of non-calcareous dark gray shale with interbedded argillaceous sandstone. Farther north, on the west flank of the Camsell Range (map area 95J/NW), the Fort Simpson is about 2500 feet thick, and consists of shale and mudstone with interbedded argillaceous limestone, calcareous siltstone, and sandstone. Still farther north, in map area 95N/NW, the Fort Simpson Formation is 1, 950 feet thick and consists of soft gray to black shale, interbedded with siltstone and some sandstone.

Age

The Fort Simpson Formation has long been considered to be of Late

Devonian age. Douglas and Norris report no fossil occurrences in the sections of the Fort Simpson that they examined within the project area.

Contacts

There is little available evidence concerning the nature of the contacts of the Fort Simpson Formation. It is presumed that both the upper and lower contacts are conformable and perhaps transitional.

Correlation

The Fort Simpson Formation is correlative with some part of the Besa River Formation of northeastern British Columbia, and with part of the Imperial Formation of the Norman Wells area.

UPPER DEVONIAN AND MISSISSIPPIAN STRATA

A considerable portion of the project area exposes a sequence of sandstone, shale, and siltstone, which is mapped either as Mississippian and Upper Devonian, or Upper Devonian (MDu or Du). The lower part of this sequence includes the Horn River and Fort Simpson Formations, which have already been described. The upper portion of this sequence includes a section of poorly exposed and relatively unknown shale, siltstone, and sandstone, with minor limestone beds. At different times several geologists have investigated this sequence of rock and applied informal and formal stratigraphic names, but, in general, this terminology has not proven to be widely useable. In 1922 Hume published a map showing outcrop distribution of several Upper Devonian zones which carry distinctive fossils. One of these zones, the Leiorhynochus zone, forms fairly prominent topography and can be mapped for short distances on the air photos. On the accompanying maps the base of the Leiorhynochus zone is shown as key horizon labeled L, while the top of the zone is a key horizon labeled L_T. Hume also mapped the Athyris angelica zone, which is higher in the section than the Leiorhynochus zone, and less widely distributed. At a very few places in the project area the base of the Athyris angelica zone is mapped as a key horizon labeled A. The top of a thin reef limestone, which locally occurs just above the top of the Fort Simpson, is delineated as key horizon R.

The series of relatively recent papers by Douglas and Norris include somewhat sketchy descriptions of the lithology and thickness of this part of the stratigraphic section. Plate 12 is a compilation of the material presented by Douglas and Norris, and is a small scale north-south stratigraphic cross-section showing the upper Paleozoic strata in the project area. It will be noted on Plate 12 that Douglas and Norris did not recognize the Horn River and Fort Simpson Formations in the southern part of the project area; but they are probably present.

Two map units recognized by Douglas and Norris have been given formational names by Harker (1961, 1963). These formations, the Yohin and Clausen Formations, have a more or less local distribution in the south-central part of the project area, and the names have not been widely accepted by the petroleum industry. In map area 95G/NW the Clausen and Yohin Formations can be recognized on the air photographs, and are indicated on the accompanying maps as key horizons with an appropriate note.

It will be noted on Plate 9 that in the south-central part of the project area the Clausen Formation is overlain by the Mississippian Flett Formation, a limestone unit which is shown as a separate map unit on the accompanying

maps. The Flett grades to shale in the southwestern part of the project area, and the equivalent shale section is mapped as part of the MDu map unit. At this locality, the MDu map unit is directly overlain by the Permo-Carboniferous Mattson Formation. Northward, the upper part of the MDu map unit has been removed by pre-Cretaceous erosion (see Plate 8), and in this area the remaining part of the section is mapped as Upper Devonian (Du).

The MDu map unit is a direct lateral equivalent of the Besa River Formation of northeastern British Columbia. To the north, the Du map unit grades into the Canol and Imperial Formations of the Norman Wells region.

MISSISSIPPIAN FLETT FORMATION

Type Locality

In the vicinity of Flett Creek in map area 95B/NW (Harker, 1963).

Mapping Methods

The Flett Formation is a prominent morphologic unit and is readily visible on the air photographs. On the accompanying photogeologic maps the Flett is shown as a separate unit identified with the symbol Mf.

Distribution

In outcrop the Flett is relatively restricted, not being mapped within the project area north of 61°30', or west of 124°30'. The western termination of the Flett is marked by a facies change, where the Flett grades laterally into shale. To the north, the Flett has been removed by pre-Cretaceous erosion. To the southeast, the Flett is probably widely present in the subsurface of the Interior Plains.

Lithology and Thickness

The Flett Formation is characteristically composed of medium to thick bedded, medium to coarse crystalline, gray crinoidal fossiliferous limestone, with interbeds of calcareous shale, calcareous sandstone, and dolomite. The relative proportions of the several rock types are extremely variable and near the western facies boundary of the formation a considerable amount of argillaceous material is present.

Thicknesses reported by Douglas and Norris are as follows:

Jackfish Gap, map area 95G/SW	1,430 ft.
North face of the Tlogotsho Plateau, map area 95F/SE	660 ft.
Mattson Creek, map area 95G/NW	1,920 ft.

Age

Harker (1963) reports that the Flett Formation contains a sequence of Mississippian faunas of Kinderhook-Osage and Chester age.

Contacts

Harker (1963) reports that the contact of the Flett with the underlying black shales is fairly distinct; however, it is presumed that this contact must be transitional and diachronous. The contact of the Flett with the overlying Mattson Formation is sharp (Harker, 1963).

Correlation

The Flett Formation appears to be a lithologic correlative of the Prophet Formation of northeastern British Columbia, and the Debolt Formation of the northern part of the Alberta Basin. To the west and southwest the Flett grades laterally into shales of the upper part of the Besa River Formation.

PERMO-CARBONIFEROUS MATTSON FORMATION

Type Locality

The term "Mattson Formation" was first proposed by Patton (1958) for exposures at Jackfish Gap in map area 95G/SW. In 1959, after extensive field work, Douglas and Norris redefined the stratigraphic limits of the Mattson Formation, as the entire section is not exposed at the type locality.

Mapping Methods

The Mattson Formation and the overlying thin Fantasque Formation form a distinct photogeologic map unit and are shown on the accompanying maps with the symbol PMm. At some places the base of the Fantasque is delineated as key horizon "F". At many localities the Mattson is divisible into three parts, and key horizons have been mapped at the contacts between these three parts. The method of representing these horizons on the photogeologic maps is indicated on Plate 5.

Distribution

The maximum development of the Mattson Formation is in the south-central part of the project area. South of this area the Mattson extends for a short distance into northeastern British Columbia. The Mattson extends northward in the project area as far as the Tlogotsho Plateau at approximately 61° 10'N. To the southeast, in the Interior Plains, test wells have penetrated thin sections of the Mattson Formation.

Lithology and Thickness

In most places the Mattson is divisible into three parts as follows:

Upper Part	Thin bedded sandstone and shale, with minor thin beds of sandy limestone and dolomite.
Middle Part	Massive sandstone, with minor shaly interbeds.
Lower Part	Thin bedded sandstone and shale, with minor coal seams.

Douglas and Norris report the following thicknesses of the Mattson Formation:

Jackfish Gap, map area 95G/SW		3,160 ft.
Mattson Gap, map area 95B/NW		3,700 ft.
Tika Creek, map area 95C/NE		4,582 ft.
Beaver River, map area 95C/SW	(estimated)	2,000 ft.
Bovie Anticline, map area 95B/SE		A few hundred feet

It will be noted from the above figures that the Mattson Formation thins both to the east and west. The cause of the westerly thinning is not known. It may represent an original depositional pattern. The easterly thinning is the result of truncation by the pre-Fantasque and pre-Cretaceous unconformities. It can be demonstrated that at the thin eastern section localities only the lower parts of the Mattson Formation are present. To the north recent erosion has removed the Mattson Formation, and the position of the pre-Cretaceous erosional edge is not known.

Age

Harker (1963) reports that the lower part of the Mattson is of Mississippian (Chester) age, and that the middle and upper parts are mainly Pennsylvanian age. At the thicker sections, such as Tika Creek, some beds of Permian age occur.

Contacts

The contact of the Mattson with the underlying Mississippian shale appears to be transitional. The contact of the Mattson with the overlying strata, either Fantasque or Cretaceous, is a regional unconformity.

Correlation

On the basis of lithology and stratigraphic position, the Mattson appears to be correlative with the Stoddart Formation of northeastern British Columbia.

PERMIAN FANTASQUE FORMATION

Type Locality

North side of Beaver River on the southwestern edge of Mt. Merrill in map area 95C/SE (Harker, 1963).

Mapping Methods

The Fantasque Formation, where present in the project area, is included within the Mattson map unit, which is identified with the symbol PMm . At some places the contact between the Mattson and Fantasque is visible on the air photographs and is indicated as key horizon labeled F.

Distribution

The Fantasque Formation occurs only in the extreme southwestern part of the project area. North and east it is truncated by the sub-Cretaceous unconformity. The Fantasque Formation extends south of the project area into northeastern British Columbia.

Lithology and Thickness

At its type locality the Fantasque Formation is composed of 150 feet of gray chert overlain by approximately 30 feet of fine-grained, gray sandstone and mudstone. The above figures very likely represent the maximum development of the Fantasque within the project area, as the formation is truncated by the sub-Cretaceous unconformity in a northeasterly direction.

Age

Inconclusive faunal evidence from the sandstones overlying the chert suggest a Permian age (Harker, 1963).

Contacts

Both the upper and lower contact of the Fantasque Formation is an erosional unconformity.

Correlation

South of the project area, in northeastern British Columbia, a chert

unit of probable Permian age is found in the Rocky Mountain Foothills. This unit is very likely a direct lateral equivalent of the Fantasque. In the subsurface of the Peace River area of northeastern British Columbia equivalent strata are known as the Belloy Formation.

LOWER TRIASSIC GRAYLING (?) FORMATION

In the extreme southern part of the project area a thin unit of soft shale is present above the Paleozoic strata and below the basal rocks of the Cretaceous Fort St. John Group. These shales are progressively truncated northward by the overlying Cretaceous strata, and are not present in the project area north of about 60°40' of latitude. These shales are believed to represent a northern wedge-edge of the Lower Triassic Grayling Formation of northeastern British Columbia. This unit forms a fairly distinct photogeologic map unit and at most places is indicated on the accompanying photogeologic maps with the symbol **R**. At a few localities, particularly on the flanks of the Beaver River Basin (map area 95C/SW), Triassic strata are believed to be present but cannot be mapped on the air photographs and are included with the overlying Cretaceous map unit.

It is estimated that not more than 200 to 300 feet of Triassic strata are present within the project area at the point of maximum development along the 60th parallel. From this position the Triassic thins rapidly northward by Cretaceous truncation.

LOWER CRETACEOUS FORT ST. JOHN GROUP

Type Locality

The Fort St. John Group was defined originally in the Peace River region of northeastern British Columbia. The group is composed of a sequence of sandstone and shale; the sandstones being lenticular and diachronous and appearing in different parts of the section at different places. As a result a great number of formational names have been applied to different parts of the Fort St. John Group, and the correlation of these many formational units is a formidable task. In 1960 Stott published the results of his investigation of the Fort St. John Group in the southern part of the project area, and Stott's terminology will be used in the following discussion.

Mapping Methods

Fort St. John Group is a readily recognizable photogeologic map unit and is shown on the maps with the symbol Kfj. At certain localities formational boundaries are recognized on the air photographs in the Fort St. John Group, and are shown on the accompanying photogeologic maps as key horizons with appropriate labels. These key horizons are graphically shown on Plate 5.

Distribution

The Fort St. John Group is present throughout northeastern British Columbia and extends a short distance into the southern part of the project area. Rocks of the Fort St. John Group are not mapped on the accompanying maps north of the 61st parallel. North of this area, in the Mackenzie Plain, Lower Cretaceous strata are present but appear to be more closely related to the Lower Cretaceous section of the Norman Wells region of the Northwest Territories.

Lithology and Thickness

The following data is taken from Stott (1960):

Sully Formation	1,000-1,500 ft.	Concretionary and gypsiferous shale.
Sikanni Formation	300- 400 ft.	Fine-grained, glauconitic sandstone and siltstone.

Chischa River (Stelck, *et al.*)	Liard River (Kindle)	Kotaneelee River
Fort Nelson formation		
Sikanni shale	Lépine	Sully
Sikanni sandstone		Sikanni
Lépine		
Scatter	Scatter	Buckinghorse
Garbutt	Garbutt	

Diagram showing relationships of rock units in Northwest Territories and northeastern British Columbia

FROM STOTT, 1960

Buckinghorse Formation	2, 500-3, 000 ft.
Upper Member	Concretionary shale with some siltstone and sandstone.
Middle Member	Argillaceous siltstone with fine-grained sandstone.
Lower Member	Concretionary shale with bentonite beds, and with a coarse-grained basal unit of sandstone and conglomerate.

The division of the Buckinghorse Formation into three parts consisting of a lower shale member, middle sandstone member, and an upper shale member, has been recognized in northeastern British Columbia and has been given formational status as the Garbutt Formation, Scatter Formation, and the Lepine Formation. It appears that this formational terminology can be used within the project area, and is so shown on the legend of the accompanying maps. Plate 13 is reproduced from Stott (1960) and shows the relation of the section studied by Stott in the vicinity of the Kotaneelee River to more southerly sections of the Fort St. John Group farther south.

Age

Stott reports that in the vicinity of the Kotaneelee River the Fort St. John Group ranges in age from early to late Albian.

Contacts

The base of the Fort St. John Group is an erosional unconformity. The uppermost part of the Fort St. John Group is transitional with the overlying Upper Cretaceous strata.

Remarks

The basal conglomerate unit of the Fort St. John Group in this region has a very local distribution, and has not been reported at localities in northeastern British Columbia. The air photo study indicates that the thickest development of this basal conglomerate is in the vicinity of Pointed Mountain, in map area 95B/SW. Stott reports that the basal conglomerate consists predominantly of chert with some limestone and sandstone pebbles. The northern erosional wedge-edge of the underlying Permian Fantasque Formation is present a few miles north of

Pointed Mountain, and it is suggested that the basal Cretaceous conglomerate was derived from erosion of the Fantasque. The rather limited distribution of the basal conglomerate of the Cretaceous system in this area probably has a direct spatial relationship to the erosional wedge-edge of the underlying Fantasque.

LOWER CRETACEOUS STRATA OF THE MACKENZIE PLAIN AREA

In the northern and eastern part of the project area large areas of Lower Cretaceous rock are present. In general, these rocks are recessive and very little information regarding their lithology or thickness can be derived from the study of the air photos. An exception occurs in the general area of 64° north latitude, 125° 15' west longitude, where a considerable thickness of Lower Cretaceous strata is exposed on the moderately dipping flanks of a syncline. In this area a photo estimated 1, 600 feet of Lower Cretaceous strata is exposed. Some of the beds in this sequence are resistant ridge formers, and key horizons are mapped.

Much of the Lower Cretaceous outcrop described in this section of the report is shown on the accompanying maps as an undivided map unit labeled Kl. At a few localities a combined Upper Devonian and Lower Cretaceous map unit, designated as KDu, is used. The exact age and correlation of the strata included in the Kl map unit is not known. Regional consideration suggested these rocks are probably all of Early Cretaceous age, and may be correlative with the Slater River Formation of the Norman Wells region. It is possible, however, that this unit could include some Upper Cretaceous rock, particularly in the thicker sections near the northern boundary of the project. The base of the Kl map unit is a regional unconformity and at some localities these strata may be observed to transgress on older rocks. One example is in the extreme northeastern part of the project area, where Lower Cretaceous strata apparently rest on the Cambrian Saline River Formation. In the extreme northern part of the project the Lower Cretaceous map unit is overlain unconformably by non-marine Tertiary strata.

UPPER CRETACEOUS DUNVEGAN(FORT NELSON)FORMATION

Type Locality

The term "Dunvegan Formation" was first applied in the Peace River district of northeastern British Columbia. Subsequently, the term was widely used in northeastern British Columbia for the basal sandstone unit of the Upper Cretaceous Series. In 1944 Kindle mapped beds of conglomeratic sandstone exposed on cliffs along the river in the vicinity of Fort Nelson as the "Fort Nelson Formation". The Fort Nelson and the Dunvegan Formation appear to be direct stratigraphic equivalents, and the term Dunvegan has been used in this evaluation.

Mapping Methods

The Dunvegan Formation and the overlying soft shales of the Kotaneelee Formation are mapped as one unit in this photogeologic evaluation, and are indicated on the accompanying maps by the symbol Ku. At some localities the top of the Dunvegan is mapped as key horizon D.

Distribution

In the extreme southern part of the project area two relatively small areas of Upper Cretaceous strata are present.

Lithology and Thickness

Stott (1960) reports that the Dunvegan (Fort Nelson) Formation in this area consists of 500 to 600 feet of coarse-grained sandstone, conglomerate, coal and carbonaceous mudstone.

Age

The Dunvegan Formation is of early Late Cretaceous age (Cenomanian).

Contacts

The contact of the Dunvegan Formation with the underlying rocks of the Fort St. John Group is transitional. The contact of the Dunvegan Formation with the overlying strata of the Kotaneelee Formation is believed to be a disconformity.

UPPER CRETACEOUS KOTANEELEE FORMATION

Type Locality

The type locality is located along the Kotaneelee River, just south of the project area, (Hage, 1945).

Mapping Methods

The Upper Cretaceous Dunvegan and Kotaneelee Formations are shown on the accompanying photogeologic maps with the symbol Ku. At some localities the contact between these two formations is visible on the air photographs and is mapped as a key horizon designated with a capital D, indicating the top of the Dunvegan Formation.

Distribution

The Kotaneelee Formation has a limited distribution in the extreme southern part of the project area.

Lithology and Thickness

Stott (1963) reports that in this general area the Kotaneelee Formation consists of 500 to 1000 feet of concretionary shale with some sandstone and pebbly mudstone.

Age

Fauna collected from the Kotaneelee Formation by Stott (1960) are dated as Late Cretaceous (early Santonian).

Contacts

Because of the time hiatus between the Dunvegan and Kotaneelee Formations, the contact between these two formations is presumed to be a disconformity. The upper contact of the Kotaneelee Formation is not exposed within the project area.

Correlation

Stott suggests that the Kotaneelee Formation is probably stratigraphically equivalent to the East Fork Formation of the Norman Wells region.

TERTIARY ROCKS

In the northern part of the project a moderately large area of Tertiary strata is mapped resting unconformably on Lower Cretaceous strata. Tertiary rocks extend north of the project and crop out over a moderately large area in the vicinity of Fort Norman. These rocks were first described by Hart (1944) who, in an area north of the present project, described 1, 200 feet of sand, gravel, conglomerate, lignite and shale, overlain by approximately 400 feet of ferruginous conglomerate and lignite. These strata have no formational name and are shown on the accompanying photogeologic maps with the symbol Tu. Hume (1954) reports Eocene fossil plants from these strata in the vicinity of Fort Nelson.

These Tertiary rocks rest unconformably on older strata of several ages, and north of the project area transgress the Middle Devonian.

IGNEOUS ROCKS

In the extreme southwestern part of the project area, in the vicinity of the Beaver River, several small plugs of intrusive rock are mapped with the symbol I. The largest plug intrudes Proterozoic rock exposed in the Beaver River fault block. Four much smaller plugs are present, one intruding the Upper Devonian-Mississippian shale unit, and three intruding the Lower Cretaceous Fort St. John Group.

Douglas and Norris report that these plugs consist of trachyte and syenite.

Three of these plugs apparently intrude Cretaceous strata, and would normally be expected to be of Cretaceous or later age. Baadsgaard et. al. (1960) report a potassium-argon age of 240 (320?) million years for the plug intruding the Proterozoic rocks, which places it in the mid- to late-Paleozoic. Two ages of igneous rock may be present, the Cretaceous strata may have been deposited around a volcanic "tower", or the geochronology may be wrong. In any event, the plugs appear to have a spatial relation to the "Beaver High" outlined in the Cambrian isopachs (Douglas et al. 1963).

PHOTOGEOLOGIC EVALUATION

OF THE

MACKENZIE PLAIN AREA,

NORTHWEST TERRITORIES AND YUKON

PART II

Prepared by

GEOPHOTO SERVICES, LTD.

Calgary, Alberta.

1964

LIST OF ILLUSTRATIONS

PART I

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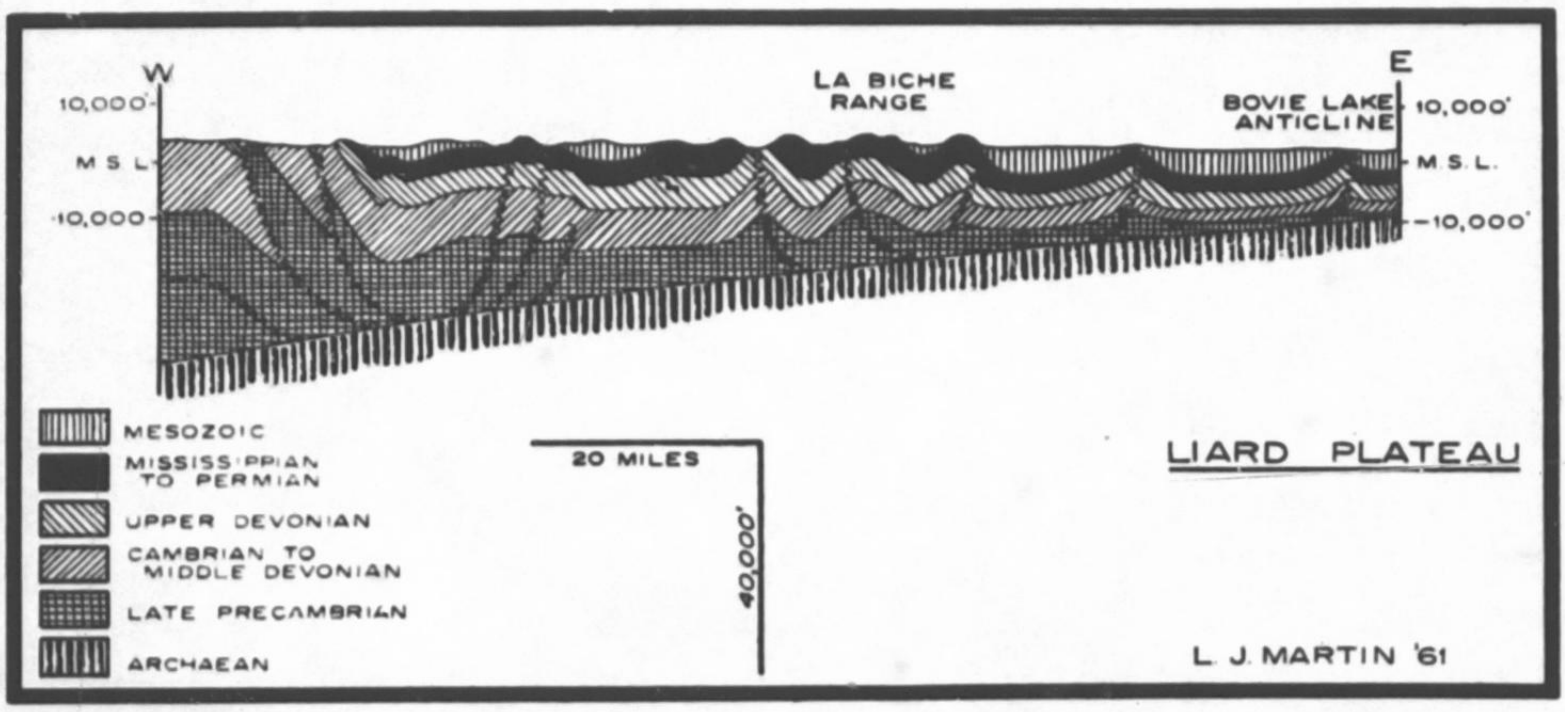
PART I

STRUCTURAL GEOLOGY

The mapped area includes parts of several major structural provinces. The gross features of these structural provinces and their relations to adjoining structural provinces are described in a preceding part of this report under the heading of "Regional Geology". In the following pages the more local structural conditions are described.

General Structural Style

It has been emphasized (see Regional Geology) that the structure of the project area represents a fairly abrupt departure from the more familiar structure of the Rocky Mountains and their Foothills. The structural change is transitional over a distance of about 25 miles, and is accompanied by equally profound changes in the stratigraphic section and topography. The generalized line separating these areas of contrasting structure, stratigraphy, and topography is herein named the "Liard Line". It is suggested that the structure north of the Liard Line can best be explained as the result of near vertical movement of basement fault blocks. This thesis was advanced in 1951 by A. J. Goodman, and has been followed in constructing the geologic cross-sections which accompany this report. More recently Martin (1963) suggested that the faults which bound many of the uplifts in this area are splays from a master zone of separation at the Archeozoic-Proterozoic boundary. Plate 14, reproduced from Martin, illustrates this concept. It is suggested that Goodman's theories are more acceptable, as the stratigraphic column in this region gives evidence of a history of high



Cross section through southern end of Franklin Mountains and Liard Plateau.

Plate 14

From Martin, 1963

mobility, with extremes of subsidence and elevation. A basement surface segmented into a series of fault blocks could be expected to display such mobility in response to regional stress.

Zones of Deformation

The overall structural pattern of the project area is dominated by faults, and many of the anticlinal folds appear to be related to faults. The mapped area may be divided into four zones in which the type and degree of deformation appears to be similar. These zones partly conform to the regional structural provinces shown on Plate 4, but in part transgress the boundaries of these provinces. Zones are identified from east to west as Zones I, II, III, and IV.

Zone I

Zone I includes the relatively undeformed area lying to the east of the easternmost uplifted ranges of the Franklin Mountains Uplift. This region coincides with parts of the Great Bear Homocline and the Alberta Basin, as indicated on Plate 4. The zone is crossed by the Liard Line which separates the Great Bear Homocline from the Alberta Basin. In the Great Bear Homocline there is very little surface evidence of geologic structure, the surface being mantled by glacial debris. Geomorphic studies indicate a system of northeasterly and northwesterly trending fractures, and there is some evidence of a broad syncline a few miles east of the eastern front of the Franklin Mountains Uplift. It is believed that this region is relatively undeformed, except in the areas immediately adjacent to the uplifted ranges of the Franklin Mountains.

It is noted that Willow Ridge, which projects into the Great Bear Homocline in a northeasterly direction, is considered as part of the Franklin Mountains Uplift.

There is no direct surface evidence for the existence of the northeasterly trending Liard Line in Zone I, but there is indirect evidence for this feature. The Shell Liard No. 2 test, located a few miles east of the project area in map area 95G/SE, lies directly on the inferred Liard Line and encountered the Precambrian basement at the shallow depth of 1,885 feet. The rocks encountered at this depth are igneous rocks and are presumed to be Archeozoic. It is noted, however, that Baadsgaard, et. al. (1960) believe these igneous rocks are part of a mid-Paleozoic intrusion. In any event, the presence of the igneous rocks indicate anomalous conditions. Igneous dikes have been reported on the surface near the Shell Liard No. 2 test, again indicating deep-seated fractures.

South of the Liard Line a small part of the Alberta Basin is mapped within the confines of the project area. Here again there is little evidence of surface structure, and the exposed Cretaceous strata have a regional dip to the southeast. There is some geomorphic indication of gentle folds and northeasterly and northwesterly trending fractures. The rather anomalous Bovie anticline occurs in this region, but it appears that this feature should be more properly classed as an outlying part of the Franklin Mountains Uplift. The series of wells drilled in the vicinity of the Celibeta gas field, near the extreme southeastern part of the project area, indicate a large broad pre-Cretaceous structure (see Plate 16).

In summary, it is believed that the rocks underlying Zone I are relatively undeformed, except in the vicinity of the Liard Line. There is, however, some evidence of pre-Cretaceous structure which is not reflected in the surface structure.

Zone II

Zone II comprises the upthrust ranges which form the broad arcuate belt of the Franklin Mountains Uplift. The individual ranges which comprise this zone include, from south to north, the Liard Range, the Nahanni Range, the Camsell Range, Willow Ridge, and the McConnell Range. These ranges form a more or less continuous zone of upthrust blocks with moderate to severe deformation. Most of these fault blocks are anticlinal or, as in the case of the Nahanni Range, may represent one flank of a faulted anticline. The faults which bound these ranges occur on both flanks of the uplift, although they more commonly occur on the east flank. In almost all cases the faults dip toward the uplifted block. In general, the individual fault planes are believed to descend to the basement rock at a rather steep angle, although locally the sinuous trace of the surface outcrop of the fault plane is suggestive of a rather low dip. It is suggested that the fault planes may locally have a low dip near the surface, but a steeper dip in the subsurface. These concepts were incorporated in the geologic cross-sections. At some localities, such as at Cap Mountain, prominent faults trend transverse to the overall structural grain of the uplift. These faults are also believed to be primarily high-angle reverse faults.

Throughout most of Zone II the youngest exposed rock are Middle Devonian. In the southern part of the Franklin Mountains Uplift, however, the exposed rocks range up to include Mississippian and Permo-Carboniferous strata. It is believed that at most localities these upper Paleozoic rocks are separated from the lower Paleozoic carbonate strata by one or more zones of separation in the intervening Upper Devonian and Mississippian shale section. Thus, the structure of the upper Paleozoic rock may differ markedly from that of the lower Paleozoic rock. In the southern part of the Zone II, where upper Paleozoic rock is exposed, many relatively minor folds are present, and some of the outcropping faults may root in a zone of separation in the Upper Devonian and Mississippian shale. It is believed, that the structure of the buried lower Paleozoic rocks in this region is similar to that of the lower Paleozoic rocks exposed in the northern part of the Franklin Mountains Uplift. It is possible that the major basement faults, which are believed to be the direct cause of the Franklin Mountains Uplift, may disappear upwards in the incompetent Upper Devonian and Mississippian shale section, and not outcrop in the southern part of the Franklin Mountains Uplift.

Zone III

Zone III is a belt of relatively gentle folds lying to the west of the main portion of the Franklin Mountains Uplift and to the east of the eastern front of the Mackenzie Mountains. With reference to Figure 4 of this report, Zone III includes all of the Mackenzie Plain Basin, plus a southerly extension into the Liard

Plateau. The limits of Zone III are well defined in the northern part of the project area by the limits of the Mackenzie Plain Basin. In this area a few upthrust foreland ranges, such as the Dahadinni Range, disrupt the continuity of the Mackenzie Plain Basin. These semi-isolated foreland ranges are similar to the Franklin Mountains Uplift and the preceding remarks on Zone II apply to these upthrust ranges. To the south, in the Liard Plateau, the limits of Zone III are not as distinct as they are farther north. It will be noted in the Liard Plateau that there is a belt of relatively broad essentially unfaulted folds extending from the Ram Plateau and Nahanni Plateau southward to include the Kotaneelee, La Biche, and Beavercrow anticlines. West of this area the strongly faulted Tundra Range, Funeral Range, and Caribou Range exhibit obviously different structure. The limits of Zone III in the southern part of the project area cannot be precisely defined, nevertheless, this broad central area of moderate folding is obvious. The exposures of Middle Devonian strata in the Ram Plateau mark the structurally highest part of Zone III. From this region Zone III plunges both to the north and to the south. The southerly plunge is pronounced, and extends southward to the project boundary. The northerly plunge into the Mackenzie Plain Basin is fairly well defined, and progressively younger rock is exposed. In the extreme northern part of the project area, Tertiary rock occurs in the Mackenzie Plain Basin. This Tertiary strata transgresses older rocks on the flanks of the basin, and it is possible that the Tertiary rock may mantle a structural high in Paleozoic rock.

The folds expressed in the Upper Devonian and Cretaceous strata within the Mackenzie Plain portion of Zone III are relatively broad and moderately to gently folded. It is presumed that the major surface structures in this region fairly accurately reflect the structure of the underlying lower Paleozoic carbonate rock, although unquestionably there are many small scale structures within this shale unit which may not persist with depth. Farther south, in the Ram Plateau area, the lower Paleozoic carbonates are exposed in a very broad, almost dome-like, anticlinal upwarp. Another prominent feature of Zone III is the bowl-like synclinal area centered on the Tlogotscho Plateau. Farther south, broad elongate folds, such as Kotaneelee anticline, La Biche anticline, and Pointed Mountain anticline are present in Zone III. These last three mentioned anticlines are expressed mainly in surface exposures of the Permo-Carboniferous Mattson Formation, and it is presumed that surface structure in this region may be markedly different from the structure in the underlying lower Paleozoic carbonate section. The Upper Devonian and Mississippian shale section which intervenes between the lower Paleozoic carbonates and the upper Paleozoic Mattson Formation marks a potential zone of detachment, and the rocks above this zone may be more severely deformed than those underlying this zone. This relationship is demonstrated by test wells drilled in the vicinity of Kotaneelee anticline, and is discussed more fully in the Structure Data Sheet section of this report. In general, it is presumed that tectonic stresses have attenuated the Upper Devonian and Mississippian shale section on the flanks of the surface structures, and

thickened the same section on the crests of these structures.

Zone IV

Zone IV includes that small portion of the main part of the Mackenzie Mountains which is included within the project area. To the south this highly deformed zone is represented by the block-faulted Funeral and Caribou Ranges and other unnamed ranges. In this area the anticlinal structures appear to be associated with prominent fault zones and are separated by relatively wide and less deformed synclinal areas. The faults in this region are believed to be high-angle reverse faults which dip both to the east and to the west, but in most cases toward areas of local uplift. Farther north Zone IV includes the Whittaker anticline, a major anticlinal feature. Whittaker anticline is unique in that it is relatively unfaulted and may persist to some depth as a simple concentric fold. Still farther north Zone IV is represented by the Redstone Range, an abrupt upwarp along the eastern margin of the Mackenzie Mountains. The east flank of this upwarp is not continuously faulted at the surface, but it probably overlies a fault involving basement rock.

Geologic Cross-Sections

Geologic cross-sections constructed at the scale of one inch to one mile are included as Plates 15 through 19 of this report. The lines of geologic cross-section are shown on the individual one inch to one mile scale map sheets. In addition, the geologic cross-sections are photographically reduced to the scale of one inch equals four miles, and are shown on the margins of the composite

maps of the same scale.

Structure Data Sheets

The remaining part of this discussion on structural geology is presented as a series of Structure Data Sheets, each one of which discusses the salient features of an individual anticline. Only those anticlines which are judged to have some possible economic significance are described by means of the Structure Data Sheets. In order to facilitate the reading of the Structure Data Sheets each Structure Data Sheet is numbered, and the corresponding structure is numbered and named on Plate 20, Generalized Geologic Map and Index to Structure Data Sheets. Plate 20 is a compilation of all the individual one inch to one mile sheets, and shows the generalized distribution of gross rock units, and the major geologic structure. A certain amount of interpretation is involved in the material presented on Plate 20; many minor structural features are not shown and connections are postulated between major structural features. Plate 20 also shows the lines of geologic cross-section.

The anticlinal structures described on the following data sheets are believed to have economic potential. This does not imply, however, that non-anticlinal traps do not exist. There is abundant evidence suggesting conditions favorable for non-structural hydrocarbon accumulation.

STRUCTURE DATA SHEET 1

NAME: "North Bovie" Anticline

TYPE: Elongate, moderately to steeply folded, faulted, southerly plunging anticline.

TREND: Northerly

AXIS MAPPED: FROM: 60°00'N., 122°57'W. (project boundary)
TO: 60°15'N., 123°01'W.

APPROXIMATE LENGTH: 17 Miles.

MAP SHEETS: 95B/SE
95B/SW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Mississippian
Flett Formation

SURFACE CLOSURE: None apparent

REMARKS

"North Bovie" anticline is the northern segment of an anticlinal trend that extends for a considerable distance south of the 60th parallel. Within the project area, the anticline is steeply folded, asymmetric with the steep side to the east. The anticline is parallel to and bounded on the eastern flank by the high-angle Bovie fault.

The surface trace of the "North Bovie" anticline is truncated by the Bovie fault approximately 6 miles north of a point where the axis intersects the Petitot River. In the vicinity of Lake Bovie, the fault appears to cut up-section and the apparent stratigraphic separation is progressively reduced towards the north. Also in this locality, the Paleozoic strata appear to converge towards the fault indicating the probable existence of structural plunge towards the northwest; the inferred presence of northerly structural plunge suggests that the "North Bovie" anticline is structurally high immediately to the south of Lake Bovie.

A dry and abandoned test, the Texaco N.F.A. Bovie Lake No. 1, was drilled approximately half a mile west of the crest line of "North Bovie" anticline. This well spudded in the Permian chert unit and was abandoned at 1,400 feet in the sandstones of the Mattson Formation.

STRUCTURE DATA SHEET 2

NAME: "Tricorner" Anticline

TYPE: Broad, gently folded, southeasterly plunging anticline

TREND: Southeasterly

AXIS MAPPED: FROM: 60°07'N., 124°06'W.
TO: 60°00'N., 123°58'W. (project boundary)

APPROXIMATE LENGTH: 10 Miles. MAP SHEETS: 95B/SW
95C/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower Cretaceous
Garbutt Formation

SURFACE CLOSURE: Possible fault closure

REMARKS

The broad "Tricorner" anticline plunges southeasterly from the flank of the Liard Uplift in the Yukon Territory, and then trends more southerly as it extends into the Northwest Territories.

The "Tricorner" anticline is truncated and terminated to the north by the "Pointed Mountain" fault. This high-angle, westerly dipping, reverse fault may provide fault closure on reservoir beds at depth.

The Canada Southern et. al. North Beaver River Y.T. I-27, located on the eastern flank of this broad anticlinal feature, is currently testing the northern terminus of this anticline. Current reports indicate that the top of the Middle Devonian Nahanni carbonates were encountered at 12,160 feet below sea level. The well is presently undergoing formational testing and all data remain confidential.

STRUCTURE DATA SHEET 3

NAME: "Pointed Mountain" Anticline

TYPE: Elongate, moderately folded, faulted, closed anticline

TREND: Northeasterly

AXIS MAPPED: FROM: 60° 16'N., 123° 59'W.
TO: 60° 31'N., 123° 49'W.

APPROXIMATE LENGTH: 18 Miles. MAP SHEETS: 95B/SW
95B/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Carboniferous and Permian
Mattson Formation

SURFACE CLOSURE: Northern Area - moderately well defined independent closure
Southern Area - possible fault closure

APPROXIMATE POSITION OF APEX: 60° 26'N., 123° 52'W.

REMARKS

"Pointed Mountain" anticline is a moderately folded, relatively symmetrical structure exhibiting well defined plunge both to the south and north. Throughout the entire length of the fold, the anticline is bounded on the east by the high-angle, up-on-the-west, reverse Pointed Mountain fault. Towards the south the surface trace of the anticline is truncated by this fault.

West of Fisherman Lake, the crest line of the "Pointed Mountain" anticline is truncated and offset by a zone of transverse faults. This zone of transverse faulting is interpreted to be relatively minor and to be restricted to the Mattson and underlying Upper Devonian Mississippian Shale Unit.

The "Pointed Mountain" anticline exhibits a well defined area of independent structural closure when the entire anticline is considered as one structural unit and the minor faulting is discounted. The precise location of the apex is not possible, and the position as indicated on the photogeologic maps is only approximate.

The success of the Pan American Beaver River test well on Kotaneelee anticline would suggest that the "Pointed Mountain" structure is also a favorable prospect.

As mentioned in the remarks section of the data sheet on Kotaneelee anticline (Data Sheet No. 4), drilling revealed the presence of an apparent structural discordance between the surface strata and the Middle Devonian at depth.

Due to the similarity and proximity of the "Pointed Mountain" anticline to the Kotaneelee anticline, it is anticipated that similar subsurface structural conditions will be encountered in the testing of the "Pointed Mountain" anticline.

STRUCTURE DATA SHEET 4

NAME: Kotaneelee Anticline

TYPE: Elongate, moderately to steeply folded, faulted, sinuous, closed anticline.

TREND: Northerly

AXIS MAPPED: FROM: 60°00'N., 124°17'W. (project boundary)
TO: 60°47'N., 124°17'W.

APPROXIMATE LENGTH: 57 Miles. MAP SHEETS: 95C/SE
95C/NE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE:
North - poorly defined
Central - moderately well defined
South Central - poorly defined
South - moderately well defined

APPROXIMATE POSITION OF APICES:
North - 60°45'N., 124°18'W.
Central - 60°30'N., 124°12'W.
South Central - 60°17'N., 124°10'W.
South - 60°10'N., 124°08'W.

REMARKS

The Kotaneelee line of folding is one of the most pronounced structural features in the southern area, exhibiting a variety of geologic structure along trend. Generally speaking, it is asymmetric with the steep flank on the west. Throughout part of its mapped extent, this steep flank is associated with a zone of high-angle, up-on-the-east, reverse faults.

Within the project area the Kotaneelee anticline possesses two principal and two minor areas of closure.

Near the Yukon Territory-British Columbia border a structural saddle indicates a reversal in the pronounced southwesterly plunge of the structure.

This reversal provides an additional area of independent structural closure known to exist on the Kotaneelee anticline immediately to the south of the

project boundary. This southernmost closure, which is the structurally lowest area of closure along the entire anticlinal trend, has been tested by two exploratory tests. The first of these wells, the Pan Am Beaver River b-63-K, was abandoned in December, 1960, after having been suspended in May of the same year. The original rig was destroyed by fire and the well is reported to have discovered substantial quantities of gas, but to have been abandoned because of mechanical trouble. The follow-up well, the Pan Am Beaver River b-73-K, was completed in December, 1961, as a gas well. Production at the last locality is reportedly from equivalents of the Middle Devonian Presqu'ile Formation.

The second area of closure occurs in the vicinity of the La Biche River. In this region the anticline is steeply folded and slightly asymmetrical, with the steeper flank to the west. This segment of the Kotaneelee anticline exhibits well defined southerly axial plunge. In contrast, the north axial plunge is poorly defined and is expressed solely by slight convergence of strike. The anticline is breached by the La Biche River with low Mattson rocks comprising the oldest rocks exposed, although it is possible Upper Mississippian shales may be present.

The La Biche River area of closure on the Kotaneelee anticline is currently being evaluated by the Pan Am Home Signal CSP A-1 Kotaneelee Y.T. J-50 well. This test, initially spudded in April, 1962, experienced considerable difficulty in attempting to reach and test the Middle Devonian carbonates. The carbonates were eventually topped at 12,917 feet below sea level.

Farther north, in the vicinity of 60° 15'N., a small area of closure is inferred to be present. In this region, south axial plunge is relatively well expressed, whereas north axial plunge is poorly defined and may be more apparent than real. The questionable north plunge is apparently terminated by a relatively minor high-angle up-on-the-west reverse fault. Immediately north of this point south structural plunge is again well developed.

The structurally highest point at the surface on the entire Kotaneelee line of folding occurs in the vicinity of 60°30'N. latitude. In this area the crest line of the fold is truncated by the Kotaneelee fault. This fault appears to be a high-angle, up-on-the-east, reverse fault with the Upper Devonian and Mississippian Shale Unit in the hanging wall thrust westward over the Upper Devonian Mississippian Shale Unit and the Carboniferous and Permian Mattson Formation. Farther south, the fault cuts rapidly up section and apparently dies out.

Towards the north, the surface trace of the Kotaneelee anticline is closely bounded on the western flank by the Kotaneelee fault. The fault also serves to separate the vertical to overturned and complex structure of the western flank from the relatively uncomplicated axial region and the uniformly and moderately dipping eastern flank.

The northernmost area of closure, approximately 5 miles in length, is inferred on questionable evidence. As the strike of the defining beds in this region is essentially parallel to the axis of the structure, it is possible that structural plunge indicated on the evaluation map is topographic and not structural.

In addition to the two previously mentioned test wells along the surface axis of Kotaneelee anticline, another test is currently being drilled 2 miles east of the surface axis. This well, the Canada Southern et. al. North Beaver River Y. T. I-27, is located approximately 4 miles southeast from the Pan American-Home Signal Kotaneelee well previously discussed.

Based on the subsurface information obtained from the drilling of these three wells, the following structural inferences and deductions can be made.

Evaluation of the subsurface data indicates that there is apparently a structural discordance between the subsurface Middle Devonian carbonates and the surface resistant units of the Mattson Formation.

In the original discovery Beaver River well, the Nahanni carbonates were topped at 9, 543 feet below sea level. Northward, along trend, in a structurally much higher area, the Pan American-Home Signal Kotaneelee well was spudded in approximately 3, 000 feet stratigraphically lower than the Beaver River well. Based on the previous considerations, the Middle Devonian carbonates should have been topped at a depth of approximately 6, 000 feet below sea level. After considerable drilling difficulty and after passing through a greatly thickened Upper Devonian and Mississippian Shale Unit, the Middle Devonian carbonates were eventually topped at 12, 917 feet below sea level. As can be seen, the Middle Devonian carbonates in the structurally highest area were encountered 3, 400 feet deeper than reported in the structurally lower area to the south, and approximately 7, 000 feet lower than originally anticipated.

It is apparent that a structural discordance may be expected where the incompetent Upper Devonian and Mississippian Shale Unit separates the competent Mattson and Middle Devonian carbonates. As such, prominent surface features may not be concordant with or extend to target horizons in the Middle Devonian strata. In addition, considerable tectonic thickening of the Upper Devonian and Mississippian Shale Unit can be expected as a result of fault repetition and plastic flow of strata from the flanks due to compression.

STRUCTURE DATA SHEET 5

NAME: "Mount Merrill" Anticline

TYPE: Elongate, steeply folded, faulted, southerly plunging anticline

TREND: Southerly

AXIS MAPPED: FROM: 60°07'N., 124°41'W.
TO: 60°00'N., 124°40'W. (project boundary)

APPROXIMATE LENGTH: 9 Miles. MAP SHEET: 94C/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Carboniferous and Permian Mattson Formation

SURFACE CLOSURE: None

REMARKS

"Mount Merrill" anticline is a southerly trending, elongate, faulted anticline on the southeast flank of the La Biche line of folding. "Mount Merrill" anticline is strongly asymmetrical with the steep flank to the west. The anticline is bounded on the west flank by a relatively minor east-dipping high-angle reverse fault. This fault, involving small stratigraphic separation, appears to merge towards the surface trace of the anticline towards the north.

The strong asymmetry of the anticline is interpreted as primarily a surface feature and due to rotation of strata along the previously mentioned fault.

Photogeologic studies indicate that the "Mount Merrill" anticline continues in a southerly to southeasterly plunge, and apparently dies out within the Cretaceous rocks of the Liard Basin.

No exploratory tests have been drilled on or near the "Mount Merrill" anticline.

STRUCTURE DATA SHEET 6

NAME: "South" La Biche Anticline

TYPE: Elongate, moderately to steeply folded, faulted, sinuous, closed anticline.

TREND: Northeasterly

AXIS MAPPED: FROM: 60°00'N., 124°51'W. (project boundary)
TO: 60°14'N., 124°37'W.

APPROXIMATE LENGTH: 19 Miles. MAP SHEET: 95C/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Moderately well defined

APPROXIMATE POSITION OF APEX: 60°11'N., 124°40'W.

REMARKS

"South" La Biche anticline is the southernmost closed portion of a 50 mile long anticlinal trend. The more northerly independent areas of closure are termed the "Central" and "North" La Biche anticlines, and are individually discussed in Data Sheets 6A and 6B respectively.

"South" La Biche anticline is moderately asymmetrical to the west. The western and steeper flank is closely associated with a high-angle up-on-the-east reverse fault. Rotation of the strata on the hanging wall side of the fault has greatly increased the apparent asymmetry on the anticline.

North and south plunge are well defined. The exact location of the apex is not possible due to the lack of structural information in the Upper Devonian and Mississippian Shale Unit. Northward, the anticline plunges into a faulted and folded area and assumes a right-hand en echelon arrangement with the "Central" La Biche anticline.

Photogeologic mapping south of 60°00'N., indicates that the "South" La Biche anticline continues its southerly plunge for an additional 15 miles before terminating in an area of complex folds and faults.

STRUCTURE DATA SHEET 6A

NAME: "Central" La Biche Anticline

TYPE: Elongate, moderately folded, faulted, closed anticline

TREND: Northeasterly

AXIS MAPPED: FROM: 60° 14'N., 124° 33'W.
TO: 60° 28'N., 124° 26'W.

APPROXIMATE LENGTH: 18 Miles. MAP SHEET: 95C/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Moderately well defined

APPROXIMATE POSITION OF APEX: 60° 21'N., 124° 28'W.

REMARKS

"Central" La Biche anticline exhibits a right-hand en echelon relationship with the "South" La Biche anticline discussed in the Data Sheet No. 6. The anticline is asymmetrical with the steep flank to the west. The crest line of the structure is coincident with an up-on-the-east, high-angle, reverse fault with relatively little stratigraphic separation.

South structural plunge is well defined in the resistant units of the Mattson Formation, but north structural plunge is poorly defined and complicated by a zone of faulting and folding. The precise location of the apical area is not known due to the lack of structural detail observable in the Upper Devonian and Mississippian Shale Unit.

The area of closure appears to be well defined by the resistant rim-forming units of the lower Mattson Formation. It should be emphasized that north structural plunge is not well defined and that the shale unit exposed in the window may be more the result of topography than structural plunge.

STRUCTURE DATA SHEET 6B

NAME: "North" La Biche Anticline

TYPE: Elongate, moderately folded, faulted, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 60° 28'N., 124° 26'W.
TO: 60° 41'N., 124° 33'W.

APPROXIMATE LENGTH: 16 Miles. MAP SHEET: 95C/SE
95C/NE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Well defined

APPROXIMATE POSITION OF APEX: Indeterminate

REMARKS

"North" La Biche anticline represents the structurally highest part of the La Biche line of folding. North and south structural plunge is relatively well defined by the prominent and resistant Mattson units. In addition, the structural closure is emphasized by the resistant rim of Mattson strata overlying the core of relatively soft and incompetent Upper Devonian and Mississippian Shale Unit. The location of the apex is indeterminate as the structural attitude of the shale unit cannot be determined.

A minor, up-on-the-west, northwesterly trending, reverse fault intersects the surface trace of the anticline on the south plunge. Towards the north, the anticline plunges into an area of minor folds and faults with an indicated left en echelon continuation of the axis for an additional seven miles further north.

The southwestern flank of the "North" La Biche anticline is cut by a high-angle northwesterly trending and westerly dipping reverse fault. This fault generally parallels the surface trace of the anticlinal axis and towards the south the fault is truncated or overridden by an easterly dipping reverse fault.

STRUCTURE DATA SHEET 7

NAME: "Beavercrow" Anticline

TYPE: Elongate, moderately folded, faulted, asymmetric, closed anticline

TREND: Northeasterly to northerly

AXIS MAPPED: FROM: 60°00'N., 125°04'W. (project boundary)
TO: 60°13'N., 124°57'W.

APPROXIMATE LENGTH: 16 Miles. MAP SHEETS: 94C/SW
94C/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Well defined

APPROXIMATE POSITION OF APEX: 60°07'N., 124°57'W.

REMARKS

"Beavercrow" anticline exhibits well defined structural plunge both to the south and north. The anticline is moderately asymmetrical with the steep flank to the west. Photogeologic mapping, south of the project boundary, indicates that the anticline is sharply asymmetric with a steep and probably faulted west flank. In this area, the structure also displays pronounced southerly axial plunge.

Towards the north, in the vicinity of Beaver River, the crest line of the anticline is intersected by a northeasterly trending high-angle southeasterly dipping reverse fault. The fault characteristics further suggest transcurrent or left lateral motion.

The point at which the fault intersects the axial trace of the anticline also marks the approximate location of the apical region.

As a result of well defined north structural plunge immediately north of the Beaver River, the appearance of the relatively soft Cretaceous Fort St. John strata effectively masks the northward extension of the axis. Photogeologic mapping indicates that the anticline passes northward into a northerly trending high-angle westerly dipping reverse fault.

The SOBC Shell Beavercrow YT K-2 dry and abandoned test was located down-plunge and on the more gently dipping east flank of the anticline. To date, all well data remain confidential, but it is reported that the well reached a total depth of 13,045 feet.

It should be noted that the apparent down-plunge and off-structure location of this well suggests the existence of a structural discordance between surface structure and structure at target horizon. This condition is similar to the Kotaneelee anticlinal area previously discussed in Data Sheet No. 4.

STRUCTURE DATA SHEET 8

NAME: Unnamed Anticline

TYPE: Elongate, moderately folded, faulted, northerly plunging anticline

TREND: Northerly

AXIS MAPPED: FROM: 60°03'N., 125°20'W.
TO: 60°12'N., 125°20'W.

APPROXIMATE LENGTH: 10 Miles. MAP SHEET: 95C/SW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Carboniferous and Permian Mattson Formation

SURFACE CLOSURE: Possible fault closure

REMARKS

This moderately folded unnamed anticlinal feature is expressed primarily in strata of the Carboniferous and Permian Mattson Formation. North structural plunge is moderately well defined, and the structure is asymmetrical with the steep flank to the west. A high-angle northerly trending and eastward dipping reverse fault cuts the western flank and parallels the surface trace of the axis. Towards the south, the fault appears to truncate the crest line.

STRUCTURE DATA SHEET 9

NAME: Unnamed Anticline

TYPE: Elongate, moderately folded, faulted, closed anticline

TREND: Northeasterly

AXIS MAPPED: FROM: 60°32'N., 125°42'W.
TO: 60°44'N., 125°35'W.

APPROXIMATE LENGTH: 16 Miles. MAP SHEET: 95C/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Poorly defined

APPROXIMATE POSITION OF APEX: 60°39'N., 125°35'W.

REMARKS

This unnamed feature exhibits poorly defined structural plunge both north and south. A slight convergence of strike, on strata that is forested and extremely glaciated, suggests the presence of structural closure. Towards the south, a relatively broad structural saddle separates the inferred structurally closed area on the north from the steeply folded and faulted southwesterly continuation of the anticline.

The northward extension of the anticlinal axis is questionable and, in the vicinity of Whitefish River, the fold appears to be truncated by a high-angle westerly dipping reverse fault. This fault, termed the "Pine" fault, cuts the western flank of the anticline and thrusts the Upper Devonian and Mississippian Shale Unit in the hanging wall eastward over the Permian Carboniferous Mattson Formation in the footwall. Towards the south, this fault appears to be truncated and overridden by the arcuate and easterly to southerly dipping Beaver River reverse fault.

No exploratory tests have been drilled on or near the crest line of this anticlinal feature.

STRUCTURE DATA SHEET 10

NAME: "Whitefish" Anticline

TYPE: Elongate, moderately folded, faulted, southerly plunging anticline

TREND: Northerly

AXIS MAPPED: FROM: 60°23'N., 125°07'W.
TO: 60°44'N., 125°06'W.

APPROXIMATE LENGTH: 26 Miles. MAP SHEETS: 95C/SW
95C/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Carboniferous and Permian
Mattson Formation

SURFACE CLOSURE: Possible fault closure

REMARKS

"Whitefish" anticline is a moderately folded structure that exhibits relatively well defined south structural plunge. Towards the south the anticline appears to pass into a zone of folding and faulting which appears to be in a left-hand en echelon relationship with the "Beavercrow" line of folding.

The northernmost segment of the structure, from Whitefish River northward, is defined primarily by indeterminate and geomorphic dips. The anticline is truncated to the north by an eastward dipping reverse fault. The surface trace of this fault appears to be anticlinal in nature and towards the north the fault either passes into or is truncated by the Funeral fault.

STRUCTURE DATA SHEET 11

NAME: Unnamed Anticline

TYPE: Elongate, steeply folded, asymmetric, faulted, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 60°23'N., 125°02'W.
TO: 60°48'N., 124°59'W.

APPROXIMATE LENGTH: 28 Miles.

MAP SHEETS: 95C/SW
95C/SE
95C/NE
95C/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Poorly defi ned

APPROXIMATE POSITION OF APEX: Indeterminate

REMARKS

This strongly asymmetrical anticline, with the steep flank on the west, is paralleled and bounded on both flanks by faults. The "Whitefish" fault on the western flank is a high-angle westerly dipping reverse fault with an apparent small stratigraphic separation. Towards the north this fault appears to pass into or is truncated by an easterly dipping reverse fault.

The eastern flank of this unnamed anticline is bounded by the "Dendale" fault, a relatively major reverse fault which thrusts Upper Devonian and Mississippian Shale Unit in the hanging wall westward over Carboniferous and Permian Mattson Formation in the footwall. This fault converges with and is truncated by the "Whitefish" fault near the southern limits of the fold.

This unnamed anticlinal feature is interpreted to represent a northward continuation of the "Beavercrow" line of folding previously discussed in Data Sheet No. 7. Structural closure on this fold is poorly defined, and questionable. South structural plunge is suggested both on regional relationships and the stratigraphic distribution. North structural plunge is extremely tenuous and based primarily on an apparent slight convergence of strike.

STRUCTURE DATA SHEET 12

NAME: "Spruce" Anticline

TYPE: Elongate, moderately folded, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 60°43'N., 125°19'W.
TO: 60°56'N., 125°25'W.

APPROXIMATE LENGTH: 15 Miles. MAP SHEET: 95C/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Poorly defined

APPROXIMATE POSITION OF APEX: 60°53'N., 125°25'W.

REMARKS

"Spruce" anticline is primarily defined by dips in the extensively forested and glaciated strata of the Upper Devonian and Mississippian Shale Unit. South structural plunge is poorly defined and extension of the axis in this direction is inferred on the basis of tenuous control. North structural plunge is extremely questionable and is based on geomorphic land forms interpreted to be possible dip slopes.

STRUCTURE DATA SHEET 13

NAME: Unnamed Anticline

TYPE: Elongate, moderately to steeply folded, asymmetric, faulted, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 60°48'N., 124°57'W.
TO: 61°02'N., 125°04'W.

APPROXIMATELY LENGTH: 18 Miles.

MAP SHEETS: 95C/NE
95C/NW
95F/SW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Moderately well defined

APPROXIMATE POSITION OF APEX: 60°53'N., 124°59'W.

REMARKS

This unnamed asymmetric anticline is bounded on the steep west flank by the easterly dipping high-angle reverse Funeral fault. This fault parallels the crest line and appears to truncate the fold towards the north. Southward, the fault converges towards the crest line and may intersect and truncate the crest line in this direction.

Steep southerly plunge is well defined by the Carboniferous and Permian Mattson Formation. North structural plunge is moderately well defined by resistant beds in the Upper Devonian and Mississippian Shale Unit.

The northernmost part of the fold is bounded on the eastern flank by minor folds and faults. It is possible that the convergence of strike indicating northerly structural plunge may be the result of unrecognized faults not indicated on the photogeologic evaluation maps.

STRUCTURE DATA SHEET 14

NAME: "Entanda" Dome

TYPE: Moderately folded, faulted, closed, dome-like structure

TREND: Northwesterly to northeasterly

AXIS MAPPED: FROM: 60°45'N., 124°20'W.
TO: 60°57'N., 124°35'W.

APPROXIMATE LENGTH: 17 Miles. MAP SHEET: 95C/NE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Well defined

APPROXIMATE POSITION OF APEX: 60°52'N., 124°25'W.

REMARKS

"Entanda" Dome is a dome-like structure that bounds the essentially synclinal Tlogotscho Plateau to the north.

The "Entanda" Dome has the appearance of a triangular or tri-cornered structure with elongate, gently to steeply folded, longitudinal anticlinal extens ions emphasizing the tri-cornered nature of the structure.

The moderately folded dome-like structure also exhibits an overall northwesterly trending main axis.

The southeasterly plunging anticlinal extension is strongly asymmetrical, with the steep flank on the west, and is terminated by an up-on-the-east, high-angle, reverse fault in the vicinity of Entanda Lakes. This strong asymmetry is probably due to fault rotation of the strata.

A northeasterly trending anticlinal extension radiates outward from the apex of "Entanda" Dome. This anticlinal extension is truncated in the apical region by an up-on-the-west, high-angle, reverse fault which may be structurally related to the previously mentioned fault bounding the southeasterly plunging anticlinal extension.

The northwesterly trending anticlinal extension is the largest and best defined anticlinal axis radiating from the apex. Towards the northwest the crest line of the fold is truncated by an up-on-the-west reverse fault.

The faulted apical region is relatively well defined by the rim of the resistant Mattson strata overlying the easily eroded core of the Upper Devonian and Mississippian Shale Unit.

To date no exploratory tests have been drilled on or near the apical region of the "Entanda" Dome.

STRUCTURE DATA SHEET 15

NAME: "South" Mattson Anticline

TYPE: Elongate, steeply folded, faulted, closed anticline

TREND: Northerly to northwesterly

AXIS MAPPED: FROM: 60°20'N., 123°46'W.
TO: 60°42'N., 123°52'W.

APPROXIMATE LENGTH: 12 Miles. MAP SHEET: 95B/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Moderately well defined

APPROXIMATE POSITION OF APEX: 60°40'N., 123°47'W.

REMARKS

"South" Mattson anticline is a relatively symmetrical fold bounded on the west flank by the "Mattson" fault, an up-on-the-west, reverse fault. The "Mattson" fault, overrides and truncates the crest line of the anticline both to the south and to the north. The largest stratigraphic separation along the fault involves Mississippian Flett Formation thrust eastward over Cretaceous Fort St. John strata.

Northwesterly structural plunge is well defined and strongly emphasized by the stratigraphic contrast between the resistant carbonates of the Mississippian Flett Formation overlying the nonresistant Upper Devonian and Mississippian Shale Unit. South structural plunge is not as well defined. Stratigraphic distribution, coupled with an apparent slight convergence of strike, indicate that south structural plunge is probably present.

No exploratory tests have been drilled on or near the crest of "South" Mattson anticline.

STRUCTURE DATA SHEET 16

NAME: Liard Anticline

TYPE: Elongate, moderately folded, faulted, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 60° 16'N., 123° 29'W.
TO: 60° 38'N., 123° 42'W.

APPROXIMATE LENGTH: 26 Miles. MAP SHEETS: 95B/SW
95B/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Moderately well defined

APPROXIMATE POSITION OF APEX: 60° 31'N., 123° 37'W.

REMARKS

The Liard anticline is flanked on the east by the major, high-angle, reverse Liard fault. The greatest stratigraphic separation on the Liard fault occurs in the vicinity of the Liard River where Permian-Carboniferous Mattson strata in the hanging wall have been thrust eastward over the Cretaceous Fort St. John strata of the footwall.

South structural plunge on the Liard anticline is well defined and the crest line is truncated by the Liard fault immediately to the north of the Liard River. The northern part of the Liard anticline is in a fault offset, left-hand, en echelon relationship with the main Liard fold to the south. This northern segment possesses well defined north plunge and is breached to the Upper Devonian and Mississippian Shale Unit. The apical region occurs in an area of numerous minor folds and faults, and is not readily apparent due to fault offset of the axis.

The location of the Liard anticline is an area of shelf deposition indicates that this structure is a favorable prospect.

STRUCTURE DATA SHEET 17

NAME: "North" Mattson Anticline

TYPE: Elongate, moderately to steeply folded, faulted, closed anticline

TREND: Northeasterly to northwesterly

AXIS MAPPED: FROM: 60°52'N., 124°02'W.
TO: 61°08'N., 123°50'W.

APPROXIMATE LENGTH: 21 Miles.

MAP SHEETS: 95C/NE
95B/NW
95G/SW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Well defined

APPROXIMATE POSITION OF APEX: Indeterminate

REMARKS

"North" Mattson anticline possesses a large amount of well defined structural closure. The core of this anticline is breached to the recessive outcrops of the Upper Devonian and Mississippian Shale Unit.

The anticline is slightly asymmetric with the steep flank to the west. The "Mattson" fault, previously described on the west flank of the "South" Mattson anticline, extends northerly and flanks the southerly part of the west flank of the "North" Mattson anticline. A similar fault is noted on the west flank of the northern part of the "North" Mattson anticline. It is possible that these two faults are genetically related, but structural definition in the recessive outcrops of the Upper Devonian and Mississippian Shale Unit does not permit delineation of structural details.

Locally, the "Mattson" fault is folded over the crest of the "North" Mattson anticline. Folding of the thrust plane further emphasizes the fact that structure in this area is probably the result of both basement control and bedding plane slippage. Consequently, as discussed in Data Sheet No. 4, it is possible that a pronounced structural discordance exists between the Permian-Carboniferous Mattson Formation and the subsurface Devonian carbonates.

A dry and abandoned test, the Pan American Mattson A-1, was drilled to a total depth of 10,890 feet in July, 1961. This well topped the Nahanni carbonates at 260 feet below sea level, and after drilling through the Lone Mountain and Ronning Formations, bottomed in questionable Cambrian Ordovician strata.

STRUCTURE DATA SHEET 18

NAME: "Nahanni Butte" Anticline

TYPE: Moderately folded, faulted, asymmetric, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 61°03'N., 123°23'W.
TO: 61°07'N., 123°23'W.

APPROXIMATE LENGTH: 4 Miles. MAP SHEET: 95G/SW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower and Middle Devonian Undivided

SURFACE CLOSURE: Well defined

APPROXIMATE POSITION OF APEX: 61°05'N., 123°23'W.

REMARKS

"Nahanni Butte" anticline is a fault associated fold bounded on the east by both the "Nahanni Butte" and the "South" Nahanni faults.

The core of this fold is breached to the Lower and Middle Devonian strata and is of little significance as an above plate test. Due to the apparently low-angle and folded nature of the "South" Nahanni fault in the vicinity of Nahanni Butte, it is possible that the below plate terrane may be structurally favorable.

STRUCTURE DATA SHEET 19

NAME: "South Nahanni" Anticline

TYPE: Elongate, gently folded, sinuous, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 61°09'N., 124°13'W.
TO: 61°35'N., 124°14'W.

APPROXIMATE LENGTH: 31 Miles. MAP SHEETS: 95F/SE
95F/NE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Silurian undivided

SURFACE CLOSURE: Well defined

APPROXIMATE POSITION OF APEX: 61°23'N., 124°19'W.

REMARKS

The "South Nahanni" anticline is a large gently folded anticlinal feature exhibiting well defined north and south plunge. As the anticline is interpreted to be breached to the Silurian, the economic significance of this relatively large and broad feature is extremely questionable.

STRUCTURE DATA SHEET 20

NAME: "Meilleur" Anticline

TYPE: Elongate, moderately folded, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 60°54'N., 125°37'W.
TO: 61°23'N., 125°33'W.

APPROXIMA TE LENGTH: 35 Miles. MAP SHEETS: 95C/NW
95F/SW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian and Mississippian Shale Unit

SURFACE CLOSURE: Poorly defined

APPROXIMATE POSITION OF APEX: Indeterminate

REMARKS

This elongate and relatively broad anticlinal feature is expressed entirely in the extensively forested and mantled strata of the Upper Devonian and Mississippian Shale Unit. South structural plunge is poorly defined and is based primarily on inconclusive evidence.

North structural plunge appears to be moderately well defined by an apparent strike convergence in the vicinity of Mary River.

The presence of distinctive alignments intersecting the crest line of this anticline suggests that the "Meilleur" anticline is probably more faulted than indicated on the photogeologic maps.

The economic potential of this anticline is questionable as the prospective reservoir horizons are exposed in the areas immediately to the east.

STRUCTURE DATA SHEET 21

NAME: "South Ram" Anticline

TYPE: Elongate, gently to moderately folded, faulted, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 61°34'N., 123°48'W.
TO: 62°10'N., 124°28'W.

APPROXIMATE LENGTH: 48 Miles.

MAP SHEETS: 95F/NE
95G/NW
95K/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower and Middle Devonian undivided

SURFACE CLOSURE: Northern Area - moderately well defined
Southern Area - well defined

APPROXIMATE POSITION OF APEX: Northern Area - 62°05'N., 124°25'W.
Southern Area - 61°45'N., 124°00'W.

REMARKS

The southern area of closure on the "South Ram" anticline is well defined by northwesterly and southeasterly structural plunge. The position of the apical area cannot be accurately determined, but it is interpreted to occur where the crest line of the anticline is intersected by the southern terminus of the "Ram" fault. In the vicinity of the fault, beds are locally rotated to a high-angle of dip.

The core of this southern area of closure is breached to the Lower Devonian. Exposures of Lower Devonian strata considerably reduce the economic potential of the fold.

STRUCTURE DATA SHEET 22

NAME: "West Ram" Anticline

TYPE: Elongate, gently to moderately folded, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 61°45'N., 124°32'W.
TO: 62°02'N., 124°43'W.

APPROXIMATE LENGTH: 23 Miles. MAP SHEETS: 95F/NE
95K/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower and Middle Devonian undivided

SURFACE CLOSURE: Poorly defined

APPROXIMATE POSITION OF APEX: 62°01'N., 124°41'W.

REMARKS

This relatively broad fold is slightly asymmetric with the steeper flank on the west. South structural plunge is well defined and a structural saddle is present immediately to the north of the junction of Ram River and Corridor Creek.

A poorly defined area of closure is mapped on the extreme northerly segment of this anticlinal trend. This area of closure is based primarily on a slight convergence of strike and may be more apparent than real.

The questionable presence of closure coupled with the exposure of Lower and Middle Devonian strata considerably reduces the economic potential of this structure.

STRUCTURE DATA SHEET 23

NAME: Ram Anticline

TYPE: Elongate, gently to moderately folded, sinuous, folded, faulted, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 62°00'N., 123°52'W.
TO: 62°42'N., 123°58'W.

APPROXIMATE LENGTH: 50 Miles. MAP SHEETS: 95J/SW
95J/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower and Middle Devonian undivided

SURFACE CLOSURE: Northern Area - moderately well defined
Central Area - poorly defined
Southern Area - well defined

APPROXIMATE POSITION OF APICES: Northern Area - 62°32'N., 123°56'W.
Central Area - 62°14'N., 123°46'W.
Southern Area - 62°10'N., 123°46'W.

REMARKS

The well defined southern area of closure exhibits good southwesterly structural plunge. The axial trace of the anticline appears to terminate at approximately 62° latitude where it passes from the competent Lower and Middle Devonian carbonates to the nonresistant Upper Devonian clastics. It is probable that the anticline extends further southwest in this area, but is not reflected in the incompetent Upper Devonian clastic units. North structural plunge is moderately well defined and a small structural saddle is mapped immediately to the north of Battlement Creek.

The central area of closure is poorly defined and is based primarily on an apparent reversal in the predominantly northerly structural plunge. It is possible that this poorly defined south plunge does not exist and the structure maintains an uninterrupted northerly structural plunge.

Throughout the central and southern extension of the Ram anticline, the fold is bounded on the east flank by the Ram fault. This fault is a high-angle up-

on-the-west reverse fault, which generally parallels the fold and appears to truncate the crest line in the vicinity of the North Nahanni River. From the point of truncation, the fault extends an additional 7 miles to Carlson Lake, at which point the fault evidently terminates and the Ram anticline continues northward. The greatest stratigraphic separation along the fault involves Middle Devonian Nahanni strata thrust eastward over Upper Devonian clastics. Strata associated with the fault are locally folded into minor folds and rotated to a much higher angle of dip.

The northernmost area of closure exhibits moderately well defined north a nd south structural plunge with the entire fold being expressed solely in the Upper Devonian strata. The fold exhibits a slight asymmetry with the steep f lank on the west. The precise location of the apex is not possible due to the gently mantled and incompetent nature of the Upper Devonian strata.

The economic attractiveness of the Ram anticline is considerably diminished by the presence of Lower and Middle Devonian strata along the core and eastern flanks of the structure.

It should be emphasized that the sinuous n ature of the Camsell fault, a major bounding thrust to the east, is suggestive of relatively low dip with possible warping of the fault plane at depth. If such is the case, the sub-plate terrane below the Ram anticline may offer economic potential.

STRUCTURE DATA SHEET 24

NAME: English Chief Anticline

TYPE: Elongate, moderately folded, broad, closed anticline

TREND:: Northwesterly

AXIS MAPPED: FROM: 62°09'N., 124°10'W.
TO: 62°42'N., 124°32'W.

APPROXIMATE LENGTH: 43 Miles. MAP SHEETS: 95K/NE
95K/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower(?) Devonian
Arnica Formation

SURFACE CLOSURE: Well defined

APPROXIMATE POSITION OF APEX: 62°15'N., 124°09'W.

REMARKS

The English Chief anticline exhibits well defined northerly and southerly structural plunge. In the apical region, the crest line is extremely arcuate and the western flank of the fold is disturbed by minor folding.

Northward from the North Nahanni River, the English Chief anticline is mapped as possessing only northerly structural plunge without any apparent structural saddles or reversals. It is possible, though not indicated on the accompanying photogeologic maps, that a structural saddle may be present immediately south of the English Chief River, thus affording structural closure on the northern segment of the English Chief anticline. If southerly structural plunge is present in this region, the apical region would like somewhere north of the English Chief River.

STRUCTURE DATA SHEET 25

NAME: Root River Anticline

TYPE: Elongate, moderately folded, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 62° 26'N., 123° 25'W.
TO: 62° 43'N., 123° 24'W.

APPROXIMATE LENGTH: 21 Miles. MAP SHEETS: 95J/NW
95J/SW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian
Fort Simpson Formation

SURFACE CLOSURE: Poorly defined

APPROXIMATE POSITION OF APEX: 62° 39'N., 123° 24'W.

REMARKS

Structural closure on the Root River anticline is relatively poorly defined due to the lack of structural detail in the forested and glaciated Upper Devonian strata. The presence of resistant beds in the Upper Devonian on the west flank permits greater structural detail and definition than on the mantled strata of the east flank.

North structural plunge is relatively well defined by the presence of a resistant reef limestone. South structural plunge is based primarily on the apparent convergence of strike on strata of the previously mentioned reef zone immediately south of the apical region. South structural plunge is also further suggested by the presence of published field observed dips in the vicinity of Root River.

Extension of the anticline approximately 6 miles south of the Root River is questionable, and is based solely on widely spaced dip control and geomorphic data. The F. P. C. - Tenneco Root River I-60 well was drilled near the crest line and immediately north of the apical region. This dry and abandoned test was drilled to a total depth of 8,571 feet, but detailed well information is still classified. The B. A. -H. B. Root River No. 1 dry and abandoned test is located approximately 6 miles east of the southern termination of the anticline. This well was completed in 1953 at a total depth of 2,778 feet.

STRUCTURE DATA SHEET 26

NAME: Willow Ridge Anticline

TYPE: Elongate, steeply folded, narrow, asymmetric, closed anticline

TREND: Northeasterly

AXIS MAPPED: FROM: 62°43'N., 122°55'W.
TO: 63°08'N., 122°43'W.

APPROXIMATE LENGTH: 31 Miles. MAP SHEETS: 95J/NE
95O/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower(?) Devonian
Bear Rock Formation

SURFACE CLOSURE: Major closure - well defined
Six subordinate areas of closure moderately well defined

APPROXIMATE POSITION OF APEX: Major - 62°47'N., 122°52'W.
Minor - see remarks

REMARKS

The Willow Ridge anticline, asymmetric eastward, possesses well defined and strong southerly structural plunge. North structural plunge is more gentle and the fold apparently dies out a short distance south of Fish Lake.

The southern and major apical region is relatively well defined by closely spaced control, and the apex as indicated on the photogeologic maps is expected to be within acceptable limits of accuracy. On the basis of geomorphic criteria, the Willow Ridge structure is extended an additional 6 miles to the south.

Northward, the Willow Ridge anticline appears to pass into a series of right and left-hand en echelon minor anticlines, each of which exhibits a minor individual area of closure. In spite of the minor anticlines the broad overall structure is still interpreted to possess north structural plunge. These minor areas of closure probably reflect right lateral motion on oblique trending minor faults.

STRUCTURE DATA SHEET 27

NAME: Wrigley Anticline

TYPE: Elongate, moderately folded, sinuous, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 63°03'N., 123°56'W.
TO: 63°33'N., 124°11'W.

APPROXIMATE LENGTH: 38 Miles.

MAP SHEETS: 95O/SW
95O/SE
95N/NE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian
Fort Simpson Formation

SURFACE CLOSURE: Northern Area - poorly defined
Central Area - poorly defined
Southern Area - moderately well defined

APPROXIMATE POSITION OF APICES: Northern Area - 63°28'N., 124°06'W.
Central Area - 63°18'N., 124°02'W.
Southern Area - 63°13'N., 123°54'W.

REMARKS

The Wrigley anticline is mapped as possessing three areas of independent closure. The northern and central areas of closure are based on questionable s tructural control and both the presence of individual closure and the location of apical regions is extremely conjectural.

South structural plunge on the southern area of closure is defined by an apparent convergence of published dip and strike control, coupled with photo-geologic and geomorphic dip control. A structural saddle is mapped as 63°17'N.; delineation and definition of this structural saddle is based on extremely tenuous photogeologic evidence, and it is possible that no reversal in the northwesterly structural plunge is present. If this is the case, the location of the apical region in the southern area of closure is indeterminate, and the central area of closure does not exist.

A second and better defined structural saddle occurs at 63°24'N.. This structural saddle, indicating a reversal in the north to northwesterly structural

plunge, is based on relatively reliable geologic data defining southerly structural plunge. North structural plunge on this segment of the Wrigley anticline is less well defined and based primarily on geomorphic data and the slight convergence of strike on widely spaced dip control.

The Wrigley anticline appears to be right-hand en echelon elliptically linked to the Wrigley syncline.

STRUCTURE DATA SHEET 28

NAME: "West Wrigley" Anticline

TYPE: Elongate, moderately folded, sinuous, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 62°50'N., 123°56'W.
TO: 63°25'N., 124°27'W.

APPROXIMATE LENGTH: 45 Miles.

MAP SHEETS: 95N/SE
95J/NW
95K/NE

OLDEST ROCK EXPOSED ON CREST OF FOLD: Upper Devonian
Fort Simpson Formation

SURFACE CLOSURE: Moderately well defined

APPROXIMATE POSITION OF APEX: 63°10'N., 124°11'W.

REMARKS

The southern part of the "West Wrigley" anticline is bounded by the folded and faulted Lower and Middle Devonian strata of the Camsell Range. The anticline possesses good northwesterly structural plunge from the Camsell Range area to the Wrigley River region where a structural saddle is mapped. Northward, for approximately 10 miles, the "West Wrigley" anticline possesses relatively well defined southerly plunge.

The precise location of the apex is not possible due to the lack of closely spaced structural control in the forested and mantled strata of the Upper Devonian. Northwesterly structural plunge is not as well defined as the southerly plunge, but geomorphic data, coupled with regional considerations, indicate the probable existence of northwesterly plunge.

STRUCTURE DATA SHEET 29

NAME: "North" English Chief Anticline

TYPE: Elongate, moderately to steeply folded, faulted, closed anticline

TREND: Northerly

AXIS MAPPED: FROM: 62°48'N., 124°38'W.
TO: 63°27'N., 124°53'W.

APPROXIMATE LENGTH: 47 Miles. MAP SHEETS: 95N/SE
95K/NE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Middle Devonian
Arnica Formation

SURFACE CLOSURE: One area poorly defined independent closure with alternate areas of fault closure.

APPROXIMATE POSITION OF APEX: Indeterminate

REMARKS

The "North" English Chief anticline is a compound fold structure that appears to be genetically related to the English Chief anticline line of folding further south. This inferred northern continuation of English Chief anticline is linked left-hand en echelon and is bounded and cut by both major and minor faults.

In the southern area, south structural plunge is well defined by closely spaced dip control in the resistant Nahanni carbonates. As a result of the steep southerly plunge, younger stratigraphic units progressively appear in this direction. As these units are reflected in the generally mantled and forested Upper Devonian sequence, extension and positioning of the anticlinal axis towards the south becomes increasingly more difficult.

Northward, the crest line of the "North" English Chief anticline is cut and offset by a minor up-on-the-east fault. In this region the eastern flank is cut by two large high-angle reverse westward dipping faults. The more westerly of the faults is termed the Lyall fault. The Lyall fault closely parallels the crest line and locally has rotated associated strata to a high-angle of dip. Towards the north, the fault truncates the crest line and the surface trace of the fault becomes anticlinal in nature passing northward into an anticlinal complex of minor folds and faults.

The more easterly bounding fault is termed the South Dahadinni fault, and is also a high-angle reverse westward dipping thrust. This fault closely bounds the anticline to the east and parallels the crest line northward to the vicinity of Slim Lake. At this point motion on the fault is evidently linked en echelon westward to the North Dahadinni fault which lies on the west flank of the structure.

STRUCTURE DATA SHEET 30

NAME: Crescent Ridge Johnson Anticline

TYPE: Elongate, moderately folded, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 63°39'N., 124°03'W.
TO: 64°08'N., 125°03'W.

APPROXIMATE LENGTH: 46 Miles.

MAP SHEETS: 96C/SW
96C/SE
95N/NE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Upper Devonian Shale Unit

SURFACE CLOSURE: Poorly defined

APPROXIMATE POSITION OF APEX: Indeterminate

REMARKS

The Crescent Ridge-Johnson anticlinal trend is defined by widely spaced and indeterminate structural control.

Extension of the fold towards the southeast and southeasterly structural plunge is based primarily on published dip control in the Johnson River area.

The crest line is positioned by widely spaced and sparse structural control and generally reflects an uncontrolled axial projection.

In the vicinity of the Dahadinni River, the surface trace of the fold is intersected by an arcuate up-on-the-east minor fault. North of the Dahadinni River geomorphic and published data are used to position and extend the anticline in this direction. North structural plunge is extremely conjectural and is defined primarily on regional considerations and generalized stratigraphic distribution.

STRUCTURE DATA SHEET 31

NAME: Silvan-"West" Silvan Anticline

TYPE: Elongate, moderately folded, faulted, asymmetric, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 63°31'N., 124°59'W.
TO: 63°59'N., 125°38'W.

APPROXIMATE LENGTH: 41 Miles. MAP SHEETS: 95N/NE
95N/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower(?) Devonian
Bear Rock Formation

SURFACE CLOSURE: Northern Area - well defined
Southern Area - poorly defined

APPROXIMATE POSITION OF APEX: Northern Area - 63°52'N., 125°32'W.
Southern Area - Indeterminate

REMARKS

The Silvan-"West" Silvan anticline is a compound fold structure that is linked elliptically left-hand en echelon in the southern area and right-hand en echelon in the northern area.

The southern area of closure is poorly defined and may not be present. North structural plunge is truncated by a triangular fault pattern involving up-on-the-west reverse faults. In this area the north structural plunge is linked elliptically right-hand en echelon to the northwesterly trending and southeasterly plunging northward fold continuation.

The southern part of the "West" Silvan anticline is linked elliptically, left-hand, en echelon to a moderately folded steeply asymmetric eastward anticlinal extension. This southeasterly extension persists for an additional 9 miles at which point the crest line passes into a reverse up-on-the-west fault. The presence of closure on the southern portion of the Silvan line of folding is extremely tenuous as a result of poorly defined south structural plunge.

The northern area of closure, in the vicinity of the Redstone River, is

relatively well defined. The precise location of the apex is not possible due to the lack of structural detail observable in the forested Upper Devonian Shale Unit. North structural plunge is moderately well defined in resistant units overlying the Fort Simpson Formation.

Both the northern and southern terminal areas of the Silvan anticlinal line of folding appear to be linked elliptically right hand en echelon to the Silvan syncline.

STRUCTURE DATA SHEET 32

NAME: Moose Prairie Anticline

TYPE: Elongate, moderately folded, faulted, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 63°38'N., 125°29'W.
TO: 64°13'N., 126°03'W.

APPROXIMATE LENGTH: 54 Miles.

MAP SHEETS: 96D/SE
96C/SW
95N/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower and Middle Cambrian
Mt. Capp-Saline River Formations

SURFACE CLOSURE: Moderately well defined

APPROXIMATELY POSITION OF APEX: 63°41'N., 125°33'W.

REMARKS

The Moose Prairie anticline is the most western fold of a series of folds in the Mackenzie Plain area, which are generally linked into a system of right-hand en echelon folds.

The Moose Prairie anticline, to the south is linked right hand en echelon to the large faulted anticline of the Dusky Range.

In the vicinity of the Redstone River, the Moose Prairie anticline possesses moderately well defined structural closure with well developed and well defined northwesterly structural plunge. Southeasterly structural plunge is not as well developed or defined, but stratigraphic distribution and slight convergence of strike indicate plunge in this direction. The core of the fold, in this area of closure, is breached to the Lower(?) Devonian Funeral Formation.

At approximately 63°53'N., a broad structural saddle is mapped separating the pronounced northwesterly structural plunge of the southern segment from the more dominant, steeper folded, southeasterly plunging northern segment of the fold.

In the northern portion of the Moose Prairie anticline, the crest line is

truncated and offset by a series of oblique, up-on-the-northwest faults. In addition to apparent dip separation, these faults probably reflect some transcurrent left lateral motion.

The northern portion of the Moose Prairie anticline is also bounded on the east by the Gambill fault. This fault exhibits a sinuous surface trace suggesting that the fault plane may be warped to some degree.

The possibility that the Gambill fault may be warped is further evidenced by the arcuate nature of the surface trace of the thrust where it flanks, broadly outlines and appears to be concordant with the underlying "Summit" anticlinal area.

STRUCTURE DATA SHEET 33

NAME: "Red Dog" Anticline

TYPE: Elongate, moderately folded, faulted, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 63°59'N., 125°24'W.
TO: 64°20'N., 125°55'W.

APPROXIMATE LENGTH: 32 Miles. MAP SHEETS: 96C/SW
95N/NW

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower and Middle Devonian undivided

SURFACE CLOSURE: Moderately well defined

APPROXIMATE POSITION OF APEX: 64°04'N., 125°30'W.

REMARKS

The core of the "Red Dog" anticline is breached to the Lower and Middle Devonian strata. The crest line is truncated on the south by the high-angle reverse up-on-the-west Silvan fault. This fault is anticlinal in nature and continues southeasterly to where it intersects and is truncated by the northerly trending high-angle reverse North Dahadinni fault.

In the area of structural closure both north and south structural plunge is relatively well defined. In the vicinity of Keele River, the crest line of the anticline is truncated and offset by an up-on-the-east reverse fault. North of this point, the anticline appears to become asymmetric to the west, but structural detail in the Upper Devonian units is inconclusive.

STRUCTURE DATA SHEET 34

NAME: Big Bend Anticline

TYPE: Minor, gently folded, closed anticline

TREND: Northwesterly

AXIS MAPPED: FROM: 64° 11'N., 124° 37'W.
TO: 64° 13'N., 124° 40'W.

APPROXIMATE LENGTH: 2 Miles. MAP SHEET: 96C/SE

OLDEST ROCKS EXPOSED ON CREST OF FOLD: Lower Cretaceous

SURFACE CLOSURE: Poorly defined

APPROXIMATE POSITION OF APEX: 64° 12'N., 124° 39'W.

REMARKS

Big Bend anticline is a minor structural feature expressed solely in the Lower Cretaceous strata. The area is extensively forested and mantled by Quaternary deposits with structural control restricted to the deep river cuts. Configuration and lateral extent of the anticline is defined solely on the basis of published structural control.

A dry and abandoned test, the Imperial Redstone No. 1, was drilled to a total depth of 4,874 feet in 1946. This well spudded in Cretaceous strata and after drilling through Imperial, Canol, Hare Indian, Hume, and Bear Rock strata, topped the Ronning at a drilling depth of 4,500 feet.

PETROLEUM

Production

In 1961 the Pan American Petroleum Corporation completed the Beaver River b-73-K test well as a gas producer. This gas well is located on the Kotaneelee anticline, about one mile south of the 60th parallel. The greater part of the Kotaneelee anticline is located north of the 60th parallel, in the area of the present project. Two tests are currently drilling on the structure, and have apparently encountered favorable gas shows. The producing zone at the Beaver River well is in the Lower(?) and Middle Devonian carbonate section, and the reported shows at the two current tests are in the same part of the section.

The Imperial Sun Netla F-7 well was completed as a Middle Devonian (Slave Point?) gas producer in 1961. This well is located in the southeastern part of the mapped area, in the extreme northern tip of the Alberta Basin (Plate 4). There is no obvious structural anomaly in the Cretaceous strata at this location, and the accumulation is controlled by pre-Cretaceous structure or by stratigraphic conditions. A few miles farther south the Celibeta Gas Field is located on a large pre-Cretaceous structure. This field produces from the Middle Devonian Slave Point Formation.

About 50 miles north of the project area is the Norman Wells Oil Field, located in the northern part of the Mackenzie Plain Basin in a homoclinal structure on the southwest flank of the Norman Range. Production is obtained from the Middle Devonian Kee Scarp reefoid limestone at a depth of 1,400 to 1,700 feet.

The porous upper part of the lime stone member shales-out up-dip thereby providing the necessary trap for the accumulation of oil. The lower non-petroliferous part of the Kee Scarp crops out on the flank of the Norman Range. Within the Norman Wells field the oil saturated part of the reef ranges up to 400 feet thick. Current production (1963) from the Norman Wells field is over 700,000 barrels a year. The field was originally located by drilling on seepages.

Exploratory Drilling

Four dry and abandoned tests are located in the Alberta Basin portion of the project area. One of these tests was drilled on the large Bovie anticline which exposes Mississippian strata. The other three are located in apparently undeformed Cretaceous rock. Other tests have been drilled in this general area a short distance east of the project area.

To the northwest, in the Liard Range, the dry and abandoned Pan American Mattson Creek No. 1 tested the large Mattson anticline.

Farther north, in the main part of the Mackenzie Plain Basin, only two widely separated tests have been drilled. These are the Imperial Redstone No. 1, which was abandoned at a total depth of 4,874 feet, and the F. P. C. -Tenneco Root River I-60, which was abandoned at a total depth of 8,571 feet. One currently drilling test is located east of the McConnell Range in the Great Bear Homocline. Other current tests are located in this general area, just outside of the project boundary.

Reservoir and Traps

The gas shows at Kotaneelee anticline emphasize the reservoir possibilities of the Lower(?) and Middle Devonian carbonate section. Of particular interest in this section are the coarsely-crystalline dolomites of the Manetoe Formation. It is possible that the complex facies relationship between Bear Rock, Arnica, Landry, Funeral, and Manetoe Formations may provide ideal conditions for the entrapment of hydrocarbons under the Mackenzie Basin.

A prominent angular unconformity is present in the stratigraphic section at the base of the Arnica Formation, and several thousand feet of underlying strata are truncated below this unconformity in an easterly direction across the Mackenzie Plain Basin. These conditions provide an ideal environment for the entrapment of hydrocarbons, and many of the great oil fields of the world are found in similar stratigraphic situations.

Untested closed anticlines are present in the Liard Plateau and in the Mackenzie Plain Basin. In the eastern portion of the mapped area, east of the Franklin Mountains, the Cretaceous rocks exposed at the surface may possibly conceal pre-Cretaceous structure in the underlying Paleozoic strata.

In summary, the Mackenzie Plain Basin and adjoining areas have a high petroleum potential. Stratigraphic and/or structural traps may exist under the Mackenzie Plain Basin and Great Bear Homocline, and some of the large anticlines in the vicinity of Kotaneelee anticline warrant testing. The Netla discovery indicates the potential of the extreme northern part of the Alberta Basin.

SUMMARY AND CONCLUSIONS

This report presents the results of a photogeologic evaluation of a 29, 300 square mile area of northern Canada, which includes a large part of the Mackenzie Plain Basin and parts of adjacent areas. Accompanying this report are 31 photogeological map sheets at a scale of 1 inch equals 1 mile. In addition, the photogeological mapping is presented at the reduced scale of 1 inch equals 4 miles on two composite maps. The report incorporates all pertinent published and unpublished information available to Geophoto, and is illustrated by a series of stratigraphic and structural diagrams.

The project area includes parts of five major provinces which are:

The Mackenzie Mountains Uplift

The Mackenzie Plain Basin

The Franklin Mountains Uplift

The Great Bear Homocline

The Alberta Basin

The southwestern part of the mapped area includes a part of the Mackenzie Mountain System, where Paleozoic rocks are exposed in a series of northerly trending folds and fault blocks. These rocks are moderately deformed, and many large anticlinal structures are present. The Mackenzie Plain Basin is a low lying area of Upper Devonian, Mississippian, Cretaceous, and Tertiary clastic rock, bounded on the west by the Mackenzie Mountains and on the east by the Franklin Mountains. The rocks in the Mackenzie Plain Basin are gently

deformed into a series of broadly arched anticlines and wide synclines. The Franklin Mountains are formed by a series of upthrust fault blocks which trace a broad arc through the eastern part of the mapped area and expose lower Paleozoic rocks. East of the Franklin Mountains is the Great Bear Homocline where relatively undeformed Cretaceous strata outcrop. The extreme southeastern part of the mapped area include a small part of the Alberta Basin. The structural provinces of the project area are separated from the structural provinces of northeastern British Columbia by a postulated tectonic line, termed the Liard Line.

The post-Cambrian sedimentary section present in the project area ranges in thickness from a minimum of about 4,000 feet in the east to a maximum of over 20,000 feet in the west. Much of this easterly thinning is due to truncation below the sub-Devonian unconformity, but some is the result of depositional thinning. Some westerly shaling of carbonate units occurs, particularly in the Middle Devonian.

Oil production of approximately 700,000 barrels a year is obtained from a Middle Devonian reef at Norman Wells, some 50 miles north of the northern project boundary. In the extreme southern part of the mapped area natural gas has been found in a Middle Devonian reservoir located on a major anticline in the Mackenzie Mountains, and in Middle Devonian Slave Point reefs in the Alberta Basin. It is believed that additional hydrocarbon potential exists in the project area, particularly in the Mackenzie Plain Basin and in the southern part of the

Mackenzie Mountains (Liard Plateau).

The sub-Devonian angular unconformity truncates several thousand feet of strata across the Mackenzie Plain Basin, creating an ideal environment for the accumulation of hydrocarbons, with or without the additional control of folded structures. In this same area the complex facies relationships in the Middle Devonian may provide stratigraphic trap-type hydrocarbon accumulation. Widespread porous zones, such as the Lower(?) Devonian Bear Rock Formation, may contain hydrocarbon accumulations in favorable structural situations. There are many large untested anticlines in the Liard Plateau portion of the Mackenzie Plateau, some of which obviously warrent testing in view of the success at Kotaneelee anticline.

Thirty-four anticlinal structures of possible economic importance are detailed on Structure Data Sheets. The more favorable structures appear to be Liard anticline, Pointed Mountain anticline, Mount Merrill anticline, La Biche anticline, Wrigley anticline, and West Wrigley anticline.

Respectfully submitted,

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APPENDIX

Sources of Information Used in the Panel Diagram, Plate 6 .

Canada Southern Cornwath River No. 1	Well Information Services Ltd.
R.O.C. Point Separation No. 1	Well Information Services Ltd.
Vittrekwa River	Field Reconnaissance
R.O.C. Grandview Hills No. 1	Well Information Services Ltd.
Atlantic Circle River No. 1	Well Information Services Ltd.
Atlantic SW Airport Creek No. 1	Well Information Services Ltd.
Hare Indian River	Harrison, J.W., 1943, Canol Rpt. No. 14
Margery Creek	Field Reconnaissance
Prong Creek	Field Reconnaissance
Imperial Ridge	Photogrammetric measurement and field reconnaissance
Snake River	Photogrammetric measurement and field reconnaissance
Lemming Anticline	Photogrammetric measurement and field reconnaissance
East Cranswick River	Photogrammetric measurement and field reconnaissance
Arctic Red River	McKinnon, F.A., 1944, Canol Rpt. No. 22
Hume River	Moon, C.G., 1943, Canol Rpt. No. 25
Imperials Sans Sault No. 1	Schedule of Wells, N.W.T. and Yukon
Donnelly River	Foley, E.J., 1944, Canol Rpt. No. 7
Imperial Anticline on Mountain River	Parker, J.M., 1944, Canol Rpt. No. 29
Moon Lake	Photogrammetric measurement and field reconnaissance
Imperial Judile No. 1	Schedule of Wells, N.W.T. and Yukon
Imperial Morrow Creek No. 1	Schedule of Wells, N.W.T. and Yukon
Imperial River	Laudon, L.R., 1943, Canol Rpt. No. 18
Imperial Loonex No. 1	Schedule of Wells, N.W.T. and Yukon
Imperial Loon Creek No. 2	Schedule of Wells, N.W.T. and Yukon
Dodo Creek	Nauss, A.W., 1944, Canol Rpt. No. 27
Imperial Vermilion Ridge No. 1	Schedule of Wells, N.W.T. and Yukon
Bear Rock	Stelck, C.R., 1944, Canol Rpt. No. 36
North McConnell Range	Dept. Northern Affairs & Nat. Res. release, Ft. Norman-Kelly Lake
Range Mountain	Stelck, C.R., 1944, Canol Rpt. No. 37
Gambill Range	Monnet, V.B., 1944, Canol Rpt. No. 23
Kay Range	Hart, R.M., 1944, Canol Rpt. No. 15
McConnell Range	Dept. Northern Affairs & Nat. Res. release, Ft. Norman-Kelly Lake

Illustrations to Accompany
Geophoto Registered Report No. F 273

Photogeologic Evaluation of the Peel Basin Area, Northwest Territories & Yukon.

SECTION: IMPERIAL RIDGE

LOCATION: 65° 34' N, 133° 50' W
Map area, 106 F/NW

SCALE: 1 INCH = 200 FEET

METHOD: Photogrammetric measurement and field reconnaissance.

SYSTEM OR SERIES	MAP SYMBOL	FORMATION	THICKNESS (FEET)	LITHOLOGY
LOWER CRET.	KI	A & B UNITS	140+	Covered, probably shale
				ANGULAR UNCONFORMITY
UPPER DEVONIAN AND MISSISSIPPIAN	MDi	"UPPER" IMPERIAL	2060	SANDSTONE and SHALE Sandstone, two distinct types: uppermost sandstone is light-gray, weathers gray to buff, quartzose, "clean", well sorted and rounded, fine-grained, resistant, 1' to 3' beds; lowermost sandstone is medium-gray, weathers buff, silty, fine-grained, carbonaceous, ripple-marked, cross-bedded, "dirty", worm tracks, plant impressions, recessive 1' to 2' beds. Shale, dark-gray, fissile, silty to sandy, carbonaceous. (130)
				Covered, minor exposures of sandstone, as above. (460)
				SANDSTONE, minor SHALE Sandstone, alternation of two types as described above. (305)
				Covered (140)
				SHALE, medium- to dark-gray, weathers dark-gray, silty, fissile to blocky, minor iron stain. (75)
				SANDSTONE, minor SHALE Sandstone, 50% "clean", and 50% "dirty", as described above. (260)
				Covered (110)
				SANDSTONE, minor SHALE Sandstone, 70% "clean" and 30% "dirty", as described above. (170)
				Covered (260)
				SANDSTONE, 70% "dirty" and 30% "clean", as described above, small brachiopods. (150)
UPPER DEVONIAN	Dc	"LOWER" IMPERIAL	180+	SHALE, dark-gray, iron-stained, weathers buff, silty to argillaceous, fissile to platy. Underlying section covered

SECTION: SNAKE RIVER

LOCATION: 65° 30' N., 133° 22' W.
Map Area 106 F/SW

SCALE: 1 INCH = 200 FEET

METHOD: Photogrammetric measurement and field reconnaissance

SYSTEM OR SERIES	MAP SYMBOL	FORMATION	THICKNESS (FEET)	LITHOLOGY
UPPER DEVONIAN	MDi	IMPERIAL	100 +	Interbedded SILTSTONE and SANDSTONE. Siltstone, dark-gray, weathers rusty-brown, sandy, ferruginous, platy. Sandstone, brownish-gray, weathers gray to brown, very fine-grained, silty, sub-angular quartz grains, hard, siliceous, platy.
MIDDLE DEVONIAN	Dc	CANOL	500	SHALE, black, weathers black with rusty-brown stain, fissile to platy.
	Dmc	UNNAMED LIMESTONE	600	LIMESTONE, brownish-gray, weathers buff, bioclastic and reefoid, 6" to 2' beds, resistant, argillaceous; minor interbeds of SHALE, gray to buff, very calcareous. Abundant colonial and solitary corals, brachiopods, crinoid stems.
	Dhi	HARE INDIAN	1400	SHALE, partly covered, dark-gray, weathers dark-gray, argillaceous and calcareous, fissile to blocky, rare brachiopods.
		HUME	350	LIMESTONE, dark-gray to black, weathers medium- to light-gray, micro-crystalline, crinoidal.
LOWER (?) DEVONIAN	Dml	UNNAMED	550	Interbedded DOLOMITE and LIMESTONE, about 50% of each, light- to medium-gray, weathers gray, micro- to medium-crystalline, beds 1' - 4', brachiopods, large ostracods.
			850	
			300	DOLOMITE, light-gray to tan, weathers to very prominent yellowish-buff zone, slightly calcareous, very fine-grained, partly argillaceous to silty, rare chert, 3" to 3' beds; interbedded with 20% SHALE, dark-gray, platy to flaggy.
SILURIAN		"UPPER RONNING"	2650	DOLOMITE, light- to medium grain to tan, rarely dark-gray, weathers medium-gray with a few tan zones, fine- to medium-crystalline, 2' to 6' beds, rare chert, abundant colonial corals near base.

1 of 1

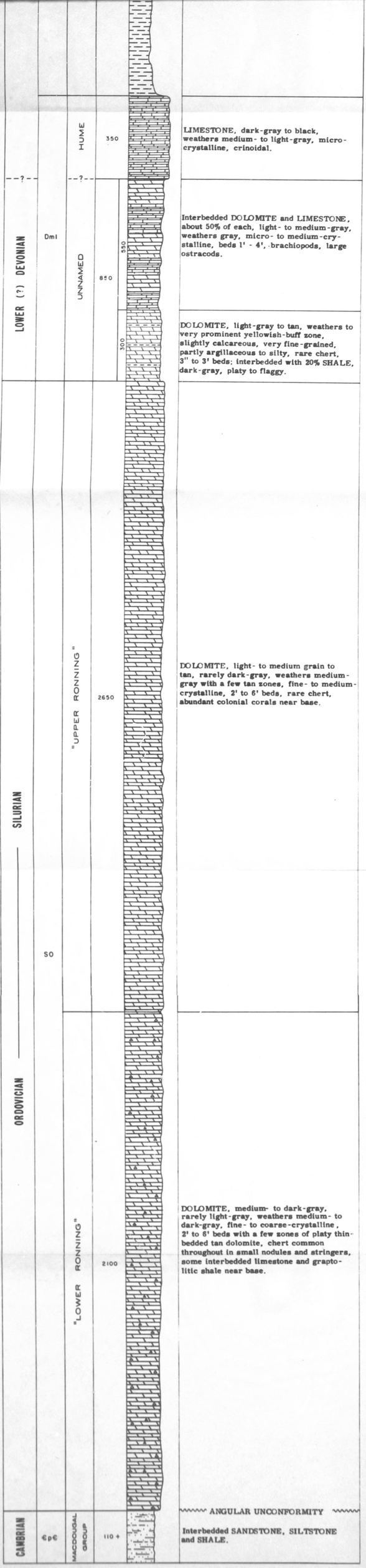
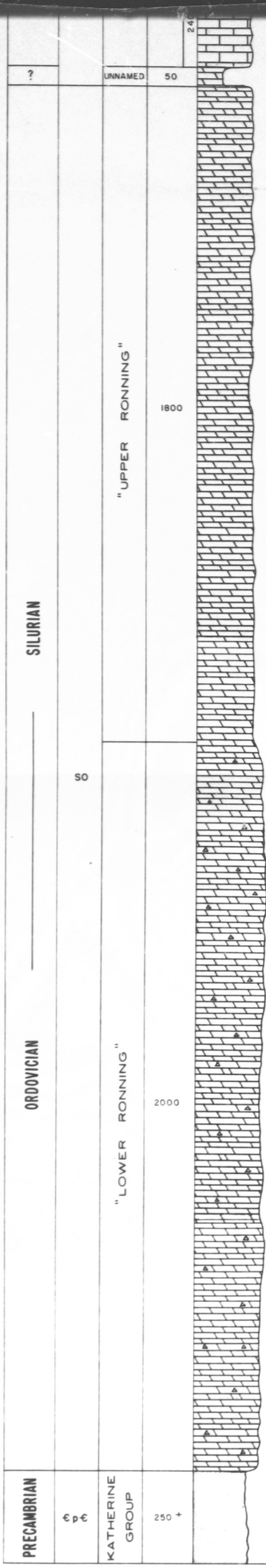


Plate 15

2 of 2



			24	medium-gray, fine- to intercrystalline, sublithographic, 1' - 4' beds, dolomitic in lower part.
?		UNNAMED	50	Partly covered, few poor exposures of DOLOMITE, tan, argillaceous to silty, micro- to fine-crystalline, 1" to 6" beds, abundant pyrite nodules, weathers bright orange. This recessive interval is a prominent marker zone on north flank of Mackenzie Mountains.
SILURIAN		"UPPER RONNING"	1800	DOLOMITE, light- to medium-gray to tan, rarely dark-gray, weathers medium-gray with a few tan zones, fine- to medium-crystalline, 2' to 6' beds, rare chert, abundant colonial corals in lower 100'.
ORDOVICIAN	SO	"LOWER RONNING"	2000	DOLOMITE, medium- to dark-gray, rarely light-gray, weathers medium- to dark-gray, fine-to coarse-crystalline, 2' to 6' beds with a few zones of platy thin-bedded tan dolomite, chert common throughout in small nodules and stringers, essentially unfossiliferous.
PRECAMBRIAN	€p€	KATHERINE GROUP	250 +	ANGULAR UNCONFORMITY SANDSTONE, light-gray, weathers rusty-brown, quartzose, ripple marks, cross-bedding, 1" to 10" flaggy beds, upper few feet is intensely iron-stained. Underlying beds not examined.

SECTION: LEMMING ANTICLINE

LOCATION: 65° 30' N., 132° 37' W.
Map Areas 106 F/NE & SE

SCALE: 1 INCH = 200 FEET

METHOD: Photogrammetric measurement and field reconnaissance.

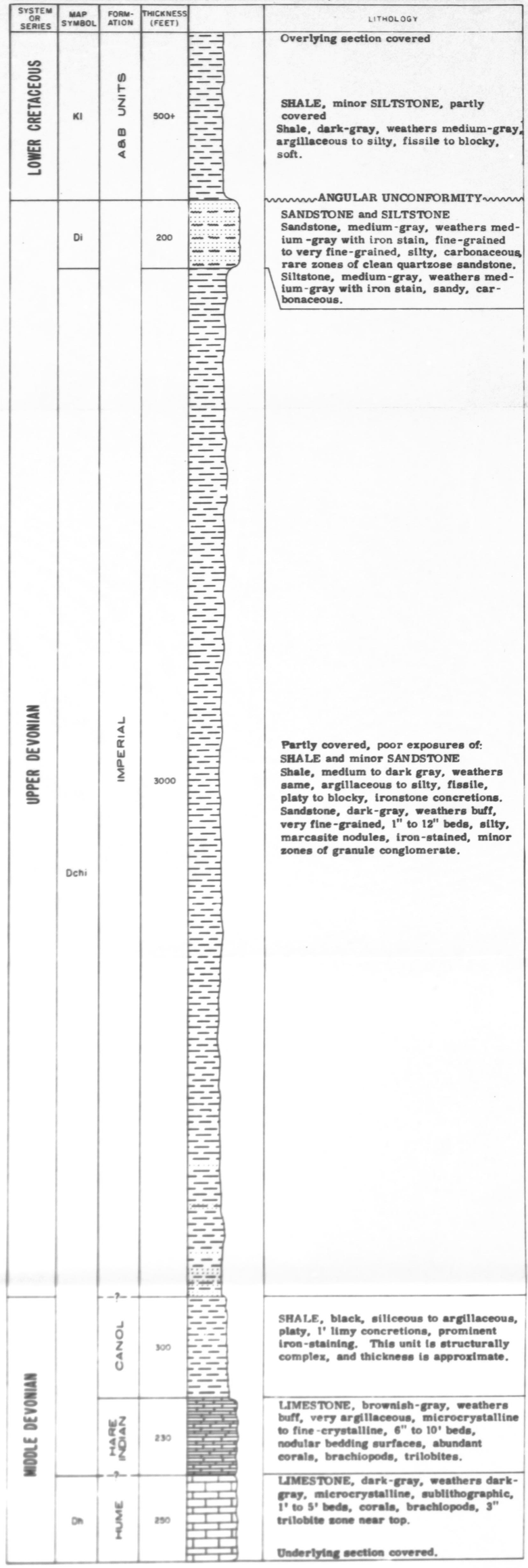
SYSTEM OR SERIES	MAP SYMBOL	FORMATION	THICKNESS (FEET)	LITHOLOGY
MIDDLE DEVONIAN	Dhi	HARE INDIAN	500 +	**Overlying section covered, very near top of Hare Indian.** **SHALE and LIMESTONE, interbedded. Shale, tan to pale greenish gray, very calcareous, soft, fissile to blocky. Limestone, light-gray, weathers buff, microcrystalline, 1" to 1' crinkly nodular beds, argillaceous. Abundant brachiopods, colonial and solitary corals.**
	Dh	HUME	900	LIMESTONE, light- to dark-gray, weathers medium-gray, microcrystalline, sublithographic, 2' to 10' beds, rare colonial corals in upper part.
LOWER(?) DEVONIAN	Dl	UNNAMED	280	LIMESTONE, dark- to light-gray, weathers in very prominent dark and light-gray zones about 30' thick, fine- to microcrystalline, 2' to 4' beds, rare colonial corals.
			240	LIMESTONE, dark-gray, weathers medium-gray, medium- to coarse-grained, massive, much calcite spar, massive, colonial corals, crinoid stems.
			240	LIMESTONE, dark-gray, weathers dark-gray, microcrystalline, 1/2" platy beds, argillaceous, common small brachiopods.
			240	LIMESTONE, dark-gray, weathers medium-gray, fine- to microcrystalline, sublithographic, 1' - 4' beds, dolomitic in lower part.
?		UNNAMED	50	Partly covered, few poor exposures of DOLOMITE, tan, argillaceous to silty, micro- to fine-crystalline, 1" to 6" beds, abundant pyrite nodules, weathers bright orange. This recessive interval is a prominent marker zone on north flank of Mackenzie Mountains.
AN		"UPPER RONNING"	1800	DOLOMITE, light- to medium-gray to tan, rarely dark-gray, weathers medium-gray with a few tan zones, fine- to medium-crystalline, 2' to 6' beds, rare chert, abundant colonial corals in lower 100'.

SECTION: EAST CRANSWICK RIVER

LOCATION: 65°27'N, 132°03'W
Map area, 106 F/SE

SCALE: 1 INCH = 200 FEET

METHOD: Photogrammetric measurement and field reconnaissance.



SECTION: MOON LAKE

LOCATION: 127°25' W, 65°40' N
Map area, 96 E/NW

SCALE: 1 INCH = 200 FEET

METHOD: Photogrammetric measurement
lithologies by photo-interpretation

SYSTEM OR SERIES	MAP SYMBOL	FORMATION	THICKNESS (FEET)		INTERPRETIVE LITHOLOGY
DEVONIAN	Dc	CANOL	45		**SHALE, recessive, overlying section covered.**
	Dks	KEE SCARP	17	62	**LIMESTONE, coralline, well-expressed bedding, resistant, forms distinctive double-ridged low-lying scarp.**
			45		
	Dhi	HARE INDIAN	222	413	**SHALE, recessive, indistinct banding.**
			33		**LIMESTONE, shaly, weakly resistant.**
			158		SHALE, recessive, banding suggests presence of thin, weakly resistant limestone or siltstone stringers.
MIDDLE	Dh	HUME	225	303	**LIMESTONE, bedding well-expressed, resistant, with argillaceous interbeds.**
			78		
LOWER (?) DEVONIAN	Dbr	BEAR ROCK	107	280+	**LIMESTONE, massive, very resistant, forms massive cliff.**
			173		**LIMESTONE, gypsiferous, brecciated, poorly bedded, hummocky, irregular weathering with sinkholes. Moderately resistant. Base of section at anticlinal axis.**

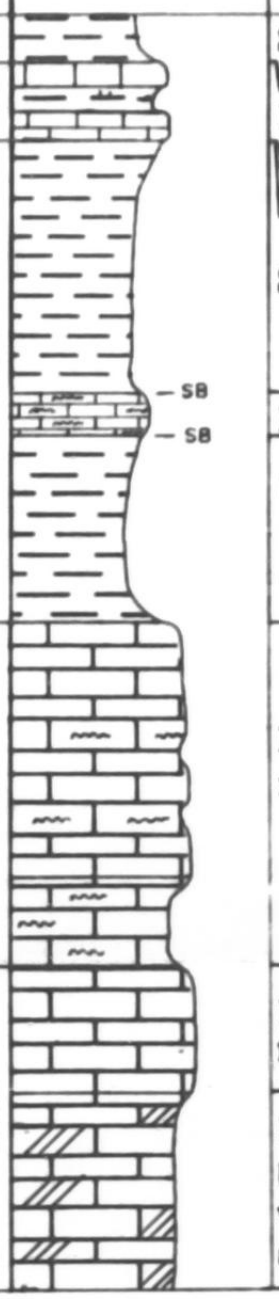
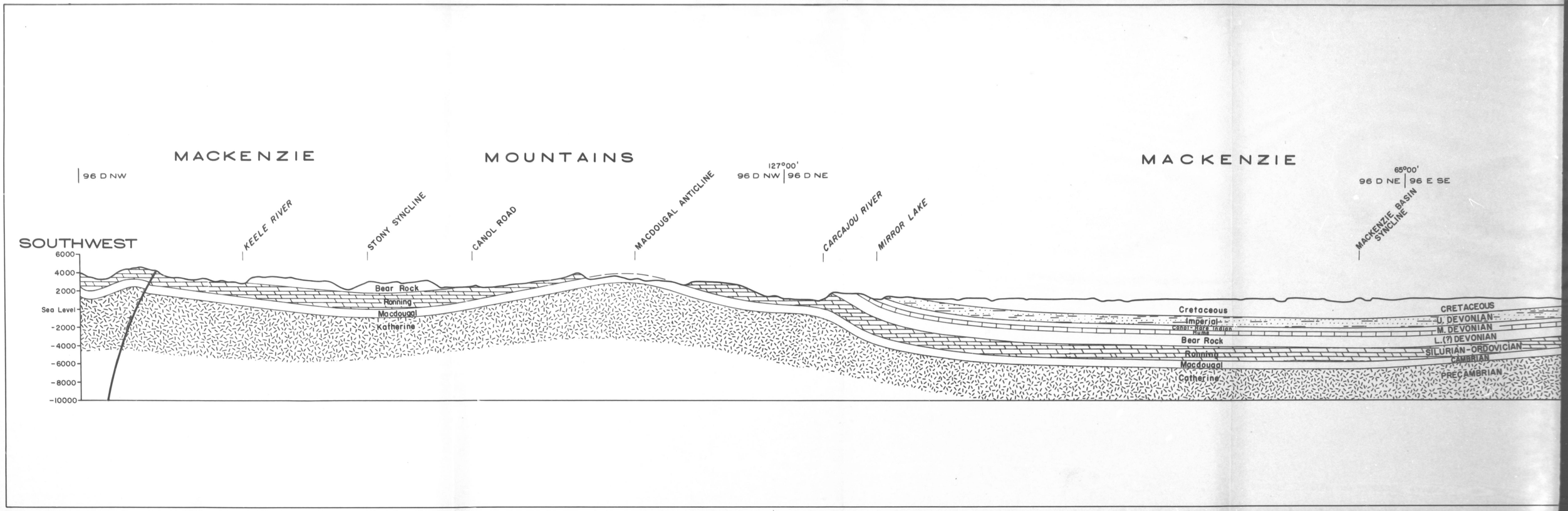
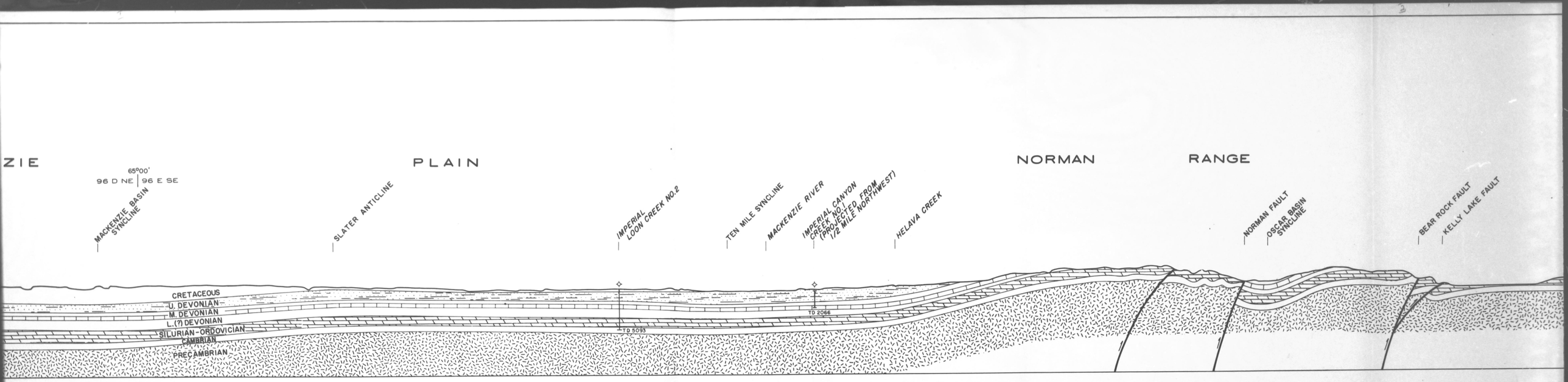


Plate 12

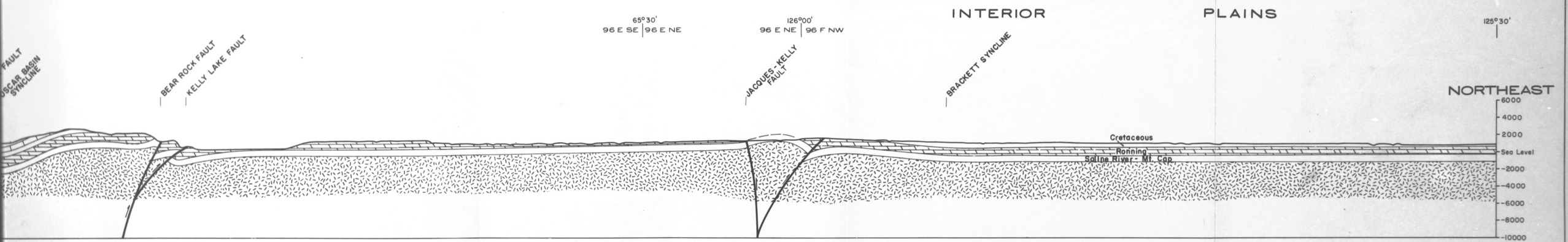

MACKENZIE MOUNTAINS
MACKENZIE
96 D NW
127°00'
96 D NW | 96 D NE
65°00'
96 D NE | 96 E SE
SOUTHWEST
KEELE RIVER
STONY SYNCLINE
CANOL ROAD
MACDOUGAL ANTICLINE
CARCAJOU RIVER
MIRROR LAKE
MACKENZIE BASIN SYNCLINE
6000
4000
2000
Sea Level
-2000
-4000
-6000
-8000
-10000
Bear Rock
Ronning
Macdougal
Katherine
Cretaceous
Imperial
Canol-Hare Indian
Hume
Bear Rock
Ronning
Macdougal
Cathering
CRETACEOUS
U. DEVONIAN
M. DEVONIAN
L.(?) DEVONIAN
SILURIAN-ORDOVICIAN
CAMBRIAN
PRECAMBRIAN

2 of



GEOLOGIC CROSS SECTION NO. 1

3 of 3



GEOLOGIC CROSS SECTION NO. 1

Plate 20

MACKENZIE MOUNTAINS

65°15'
106 G SE

65°30'
106 G SE | 106 G NE

PEEL

SOUTH

6000
4000
2000
Sea Level
-2000
-4000
-6000
-8000
-10000

IMPERIAL SYNCLINE
HUME FAULT
WHIRLPOOL SYNCLINE
ARCTIC RED ANTICLINE
BALD HILL SYNCLINE
OFFSET IN SECTION

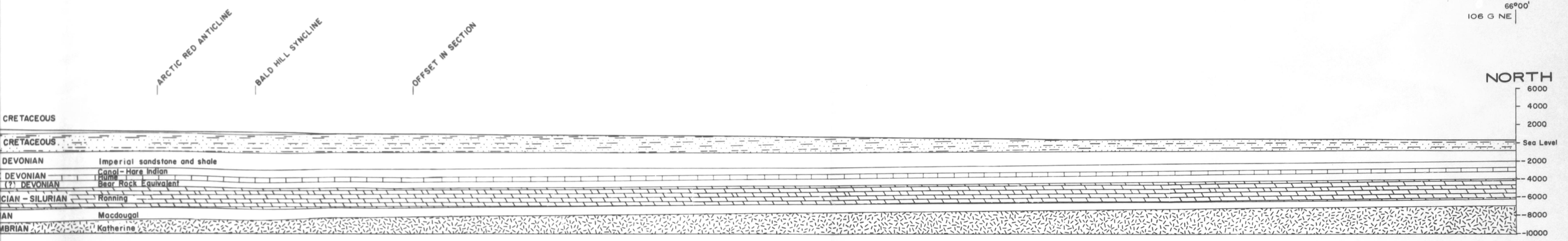
UPPER CRETACEOUS
LOWER CRETACEOUS
UPPER DEVONIAN — Imperial sandstone and shale
MIDDLE DEVONIAN — Canol - Hare Indian
LOWER (?) DEVONIAN — Hume Bear Rock Equivalent
ORDOVICIAN - SILURIAN — Ronning
CAMBRIAN — Macdougal
PRECAMBRIAN — Katherine

GEOLOGIC CROSS SECTION NO

PEEL PLATEAU

66°00'
106 G NE

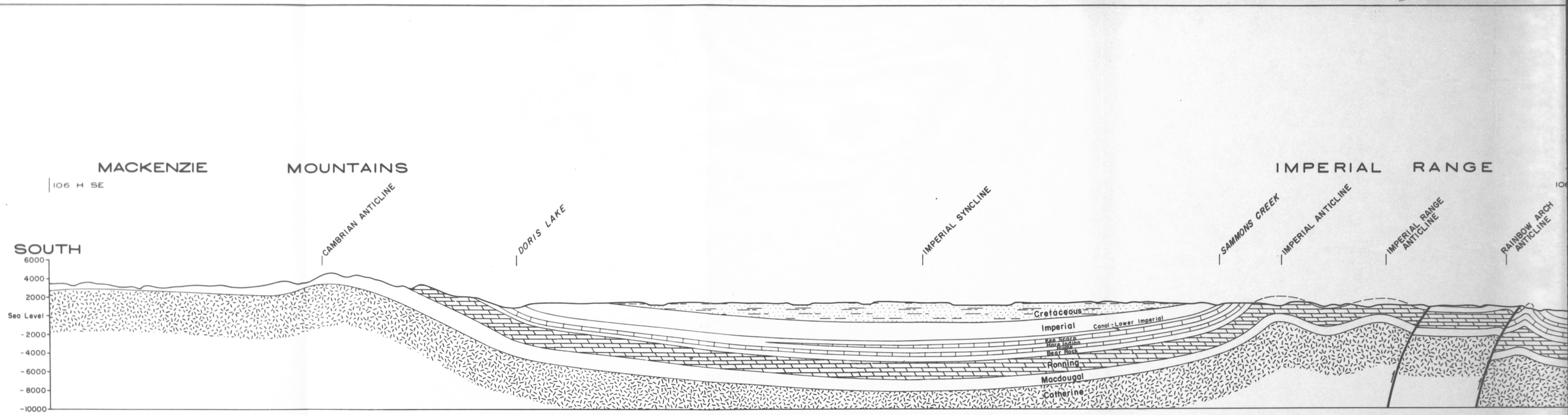
NORTH



GEOLOGIC CROSS SECTION NO. 3A

GEOLOGIC CROSS SECTION NO. 3A

Plate 22


MACKENZIE MOUNTAINS
IMPERIAL RANGE
106 H SE
SOUTH
CAMBRIAN ANTICLINE
DORIS LAKE
IMPERIAL SYNCLINE
SAMMONS CREEK
IMPERIAL ANTICLINE
IMPERIAL RANGE ANTICLINE
RAINBOW ARCH ANTICLINE
6000
4000
2000
Sea Level
-2000
-4000
-6000
-8000
-10000
Cretaceous
Imperial
Canol - Lower Imperial
Kee Scarp
Hare Indian
Ramparts
Bear Rock
Ronning
Macdougal
Catherine

2 of

IMPERIAL RANGE

65°30'

106 H SE | 106 H NE

CARCAJOU RIDGE

GIBSON RANGE

MONS CREEK

IMPERIAL ANTICLINE

IMPERIAL RANGE ANTICLINE

RAINBOW ARCH ANTICLINE

CARCAJOU RIVER

WHIRLPOOL SYNCLINE

MACKENZIE RIVER

CARCAJOU RIDGE ANTICLINE

HANNA RIVER

GIBSON FAULT

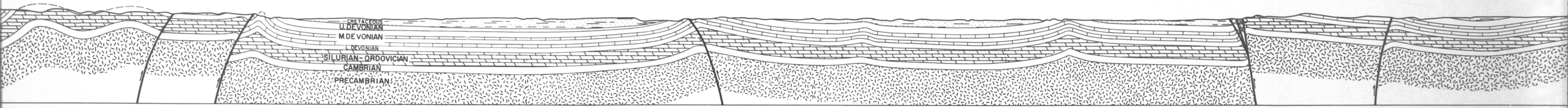
GRUMBLE FAULT

VICTORY RIDGE

DOMNELLY RIVER

SLIMY CREEK

CHICK LAKE SYNCLINE



GEOLOGIC CROSS SECTION NO. 2

GIBSON RANGE

INTERIOR PLAINS

66°00'
106 H NE | 106 I SE

66°15'
106 I SE

GIBSON FAULT

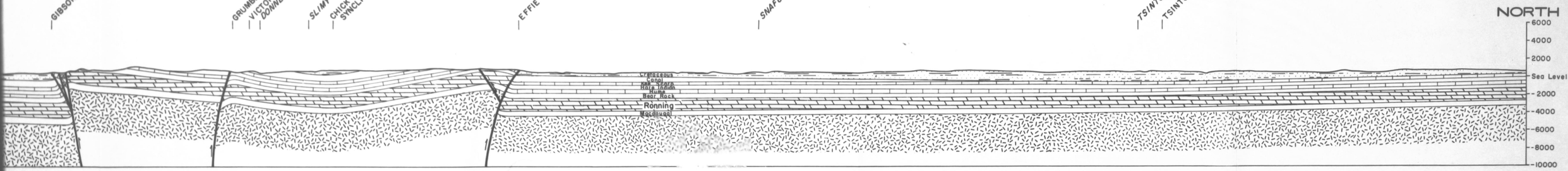
GRUMBLE FAULT
VICTORY RIDGE
DONNELLY RIVER

SLIMY CREEK
CHICK LAKE SYNCLINE

EFFIE FAULT

SNAFU CREEK

TSINTU RIVER
TSINTU SYNCLINE



 F 273

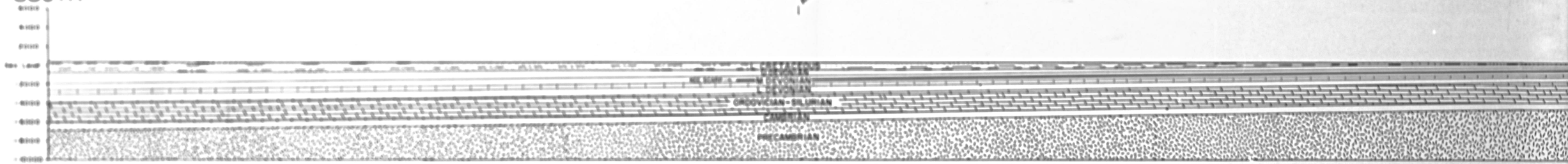
GEOLOGIC CROSS SECTION NO. 2

Plate 21

PEEL PLATEAU

SOUTH

RAMPART'S RIVER



GEO

PLATEAU

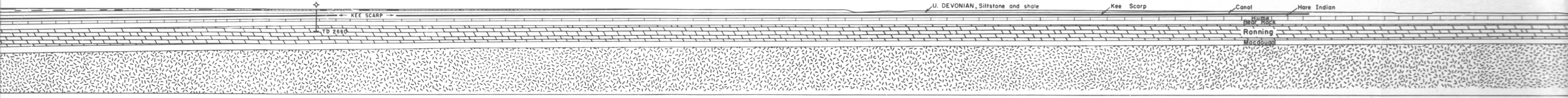
66°30'

106 J SE | 106 J NE

Atlantic Circle River No.1

INTERSECTION GEOLOGIC CROSS SECTION No. 5

ONTARATUE RIVER



GEOLOGIC CROSS SECTION NO. 3B

3 of 3

INTERSECTION GEOLOGIC CROSS SECTION No. 5

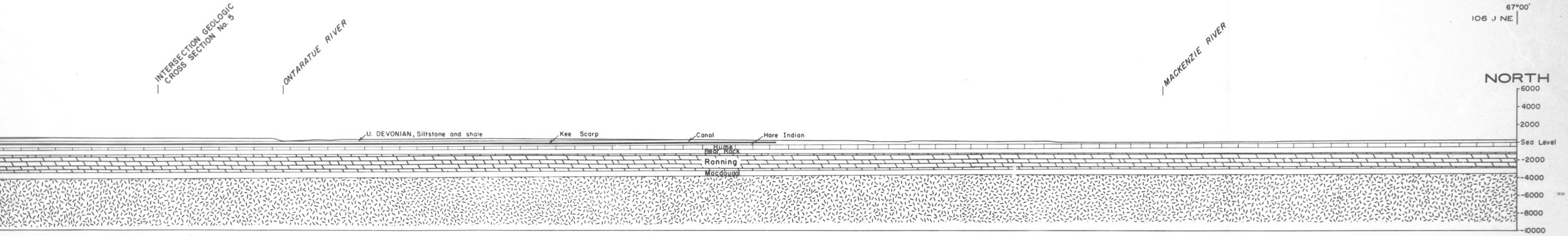
ONTARATUE RIVER

MACKENZIE RIVER

67°00'

106 J NE

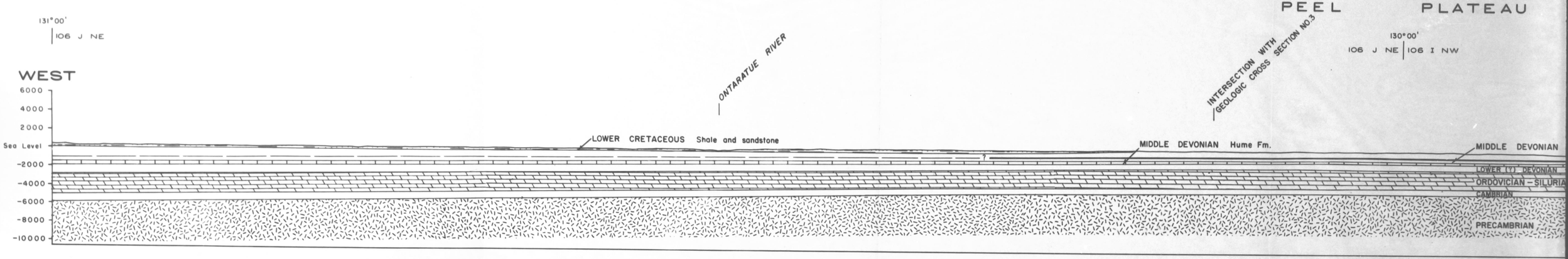
NORTH



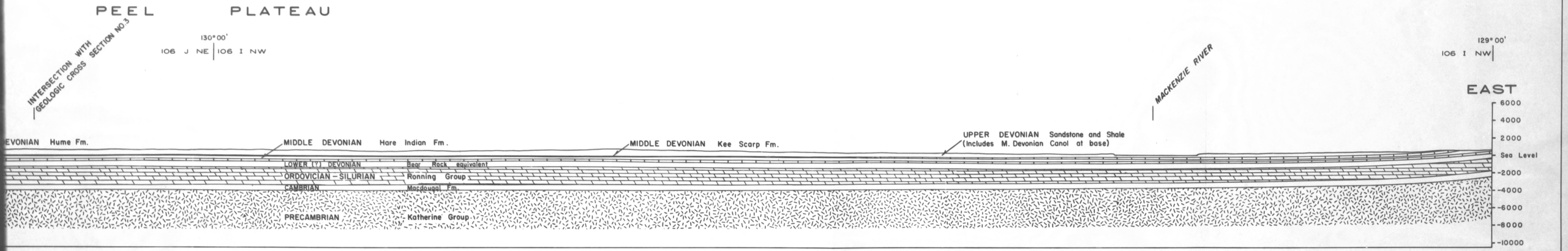
ON NO. 3B

GEOLOGIC CROSS SECTION NO. 3B

Plate 23



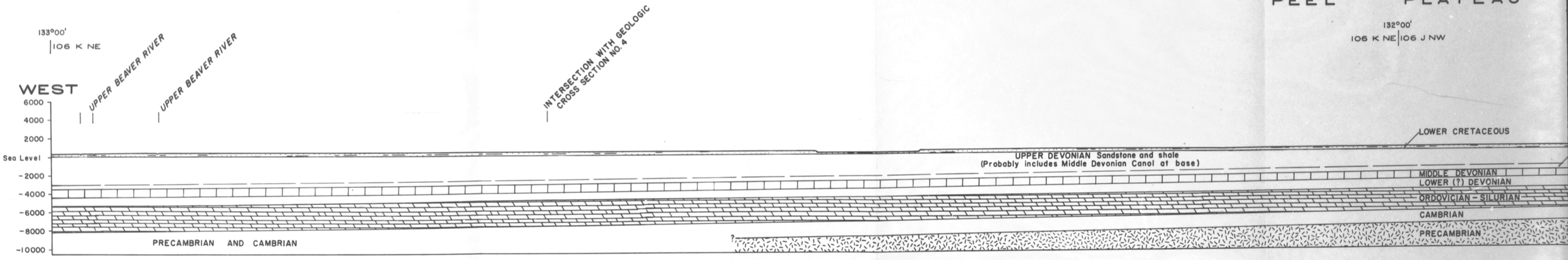
GEOLOGIC CROSS SECTION



OLOGIC CROSS SECTION NO. 5 C

GEOLOGIC CROSS SECTION NO. 5C

Plate 28



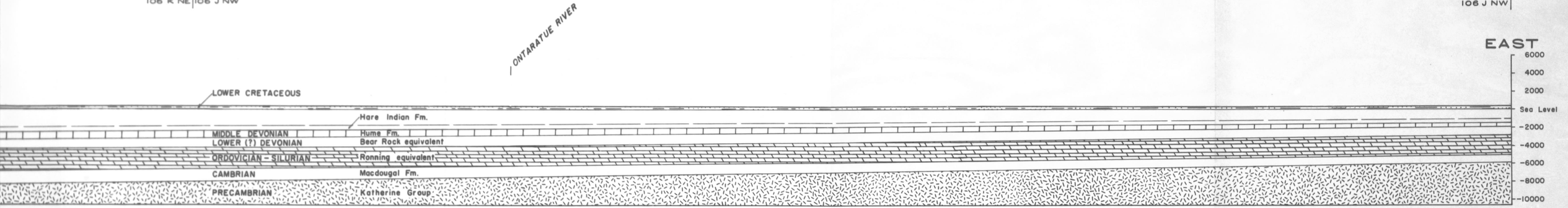
GEOLOGIC CROSS SECTION N

PEEL PLATEAU

132°00'
106 K NE | 106 J NW

ONTARATUE RIVER

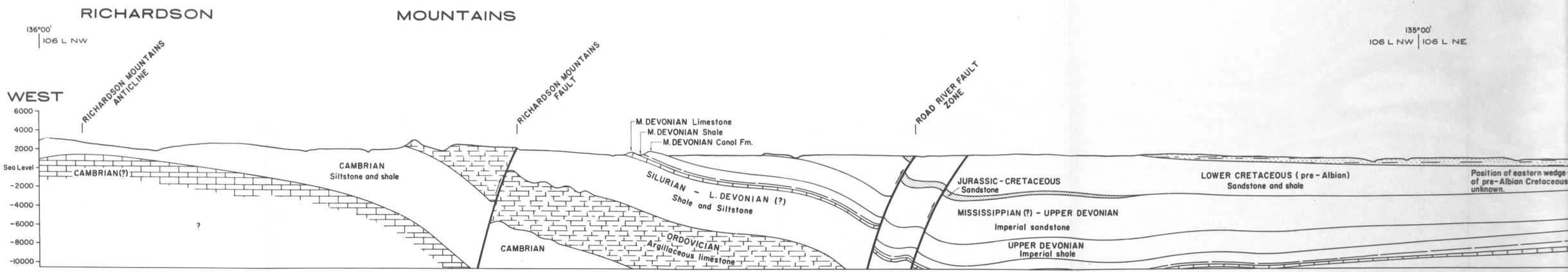
131°00'
106 J NW



LOGIC CROSS SECTION NO. 5B

GEOLOGIC CROSS SECTION NO. 5B

Plate 27


RICHARDSON
MOUNTAINS
136°00'
106 L NW
135°00'
106 L NW | 106 L NE
WEST
RICHARDSON MOUNTAINS ANTICLINE
RICHARDSON MOUNTAINS FAULT
ROAD RIVER FAULT ZONE
6000
4000
2000
Sea Level
-2000
-4000
-6000
-8000
-10000
CAMBRIAN(?)
CAMBRIAN
Siltstone and shale
?
CAMBRIAN
M. DEVONIAN Limestone
M. DEVONIAN Shale
M. DEVONIAN Canol Fm.
SILURIAN - L. DEVONIAN (?)
Shale and Siltstone
ORDOVICIAN
Argillaceous limestone
JURASSIC - CRETACEOUS
Sandstone
MISSISSIPPIAN (?) - UPPER DEVONIAN
Imperial sandstone
UPPER DEVONIAN
Imperial shale
LOWER CRETACEOUS (pre - Albian)
Sandstone and shale
Position of eastern wedge of pre-Albian Cretaceous unknown.

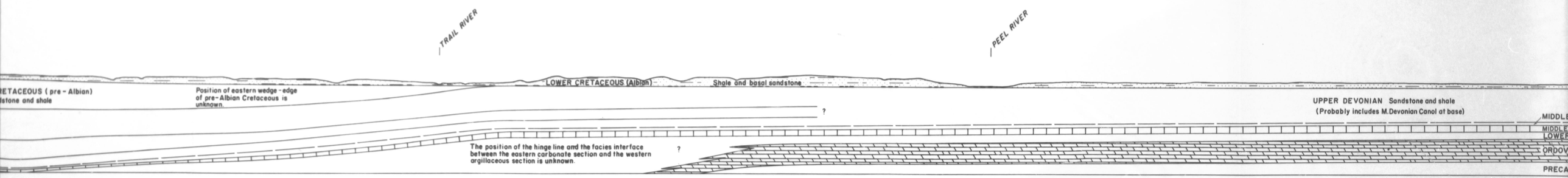
PEEL PLATEAU

135°00'
106 L NW | 106 L NE

134°00'
106 L NE | 106 K NW

TRAIL RIVER

PEEL RIVER



GEOLOGIC CROSS SECTION NO. 5A

134°00'
106 L NE | 106 K NW

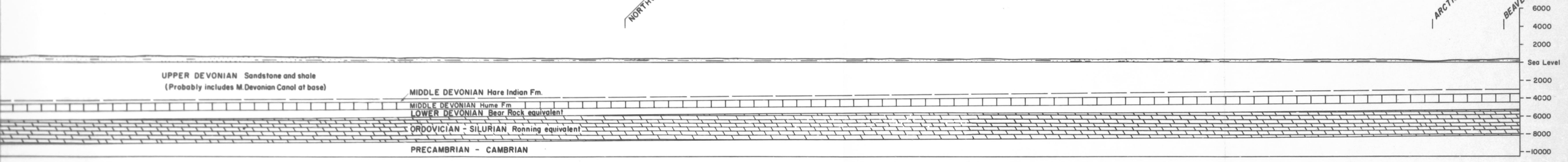
YUKON
NORTHWEST TERRITORIES

133°00'
106 K NW

EAST

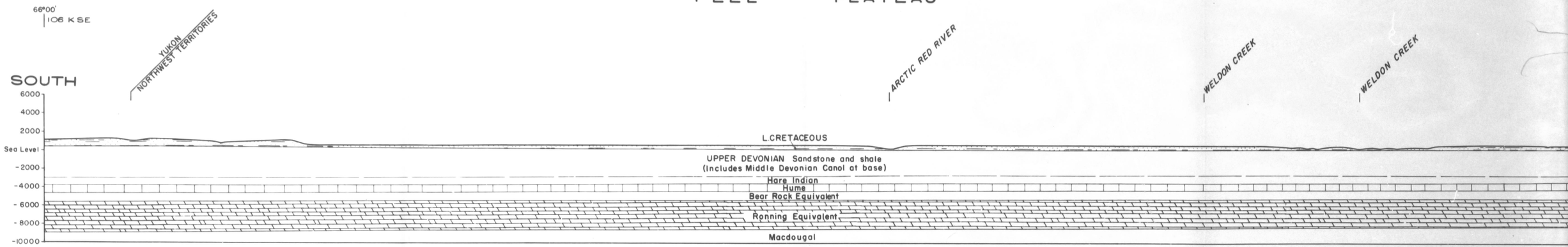
ARCTIC RED RIVER

BEAVER RIVER



GEOLOGIC CROSS SECTION NO. 5A

Plate 26


PEEL PLATEAU
66°00'
106 K SE
YUKON
NORTHWEST TERRITORIES
ARCTIC RED RIVER
WELDON CREEK
WELDON CREEK
SOUTH
6000
4000
2000
Sea Level
-2000
-4000
-6000
-8000
-10000
L. CRETACEOUS
UPPER DEVONIAN Sandstone and shale
(Includes Middle Devonian Canol at base)
Hare Indian
Hume
Bear Rock Equivalent
Ronning Equivalent
Macdougal

2 of

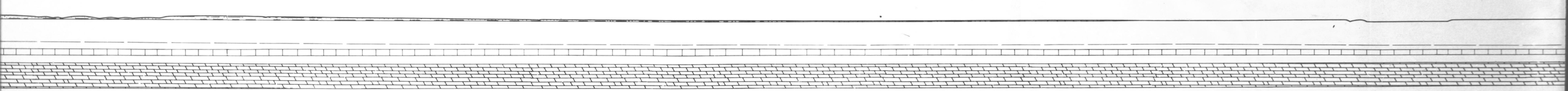
66°30'
106 K SE | 106 K NE

WELDON CREEK

UPPER BEAVER RIVER

INTERSECTION GEOLOGIC CROSS SECTION NO. 5

LOWER BEAVER RIVER



GEOLOGIC CROSS SECTION NO. 4B

67°00'
106 K NE | 106 N SE

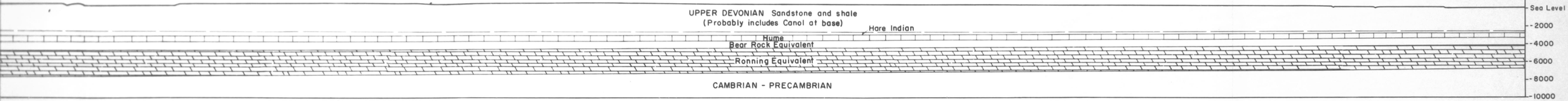
67°15'
106 N SE

LOWER BEAVER RIVER

TREE RIVER

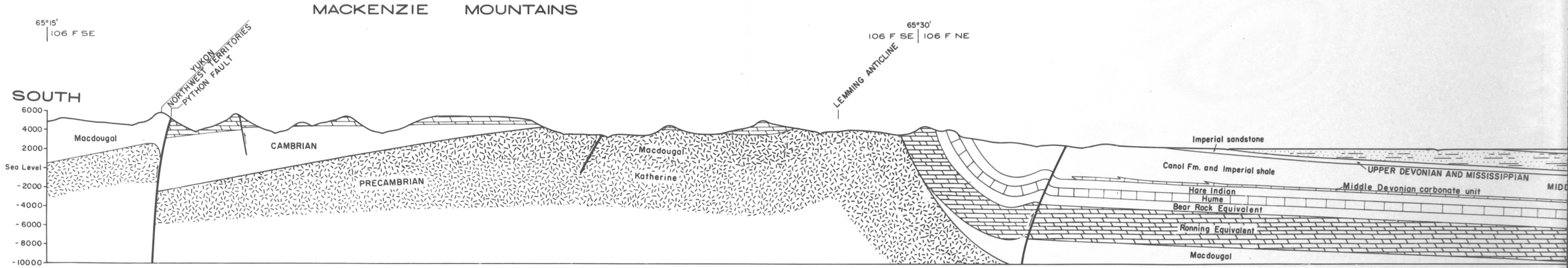
MACKENZIE RIVER

NORTH



GEOLOGIC CROSS SECTION NO. 4B

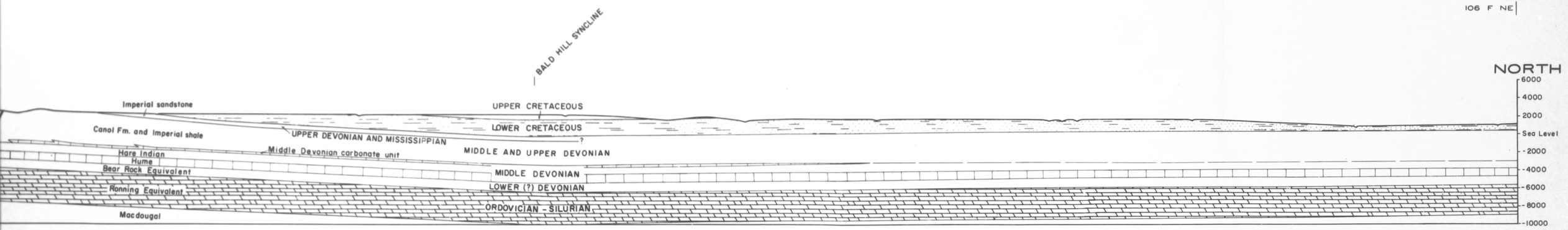
Plate 25



GEOLOGIC CROSS SECTION N

PEEL PLATEAU

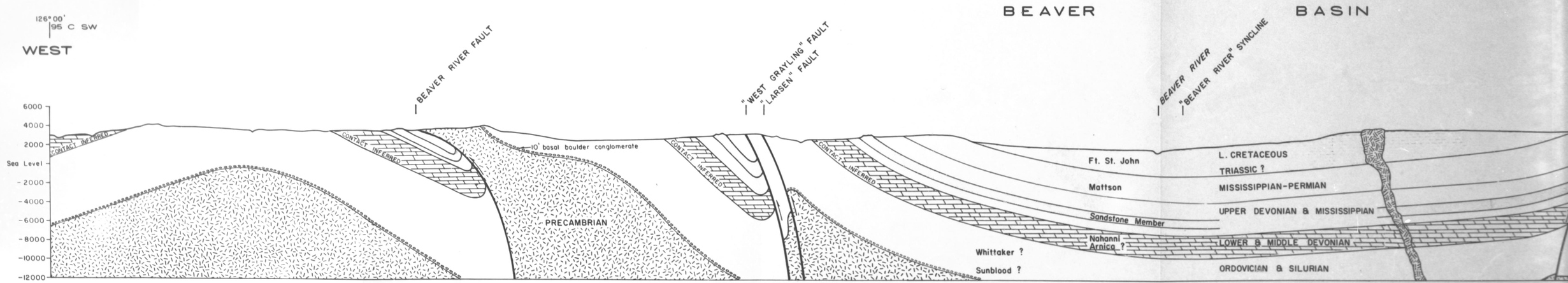
66°00'
106 F NE



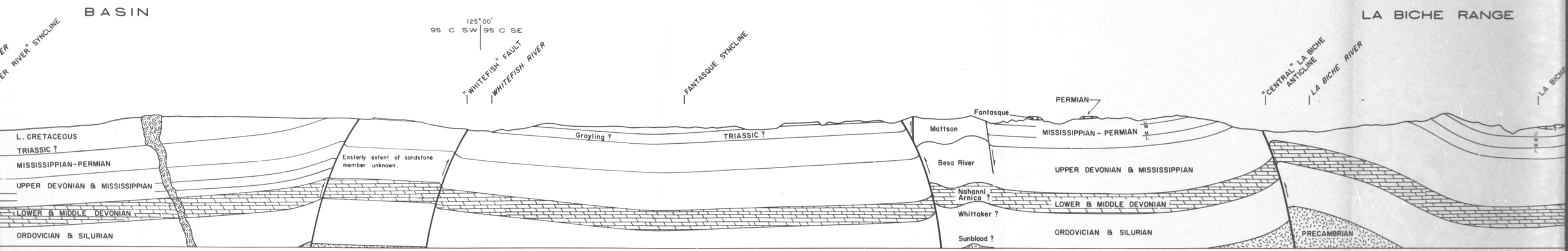
GEOLOGIC CROSS SECTION NO. 4 A

GEOLOGIC CROSS SECTION NO.4A

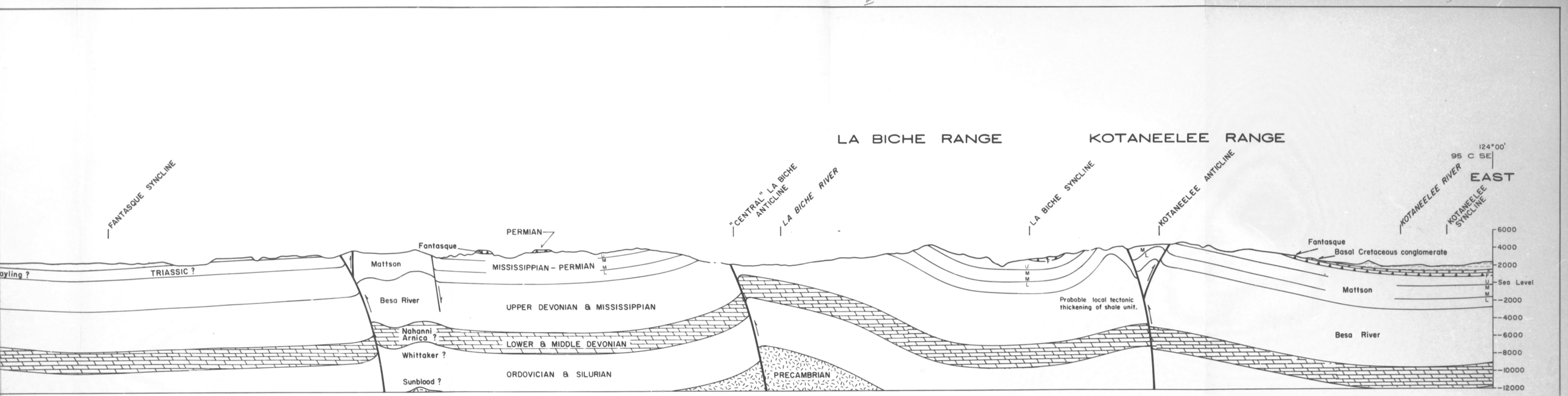
Plate 24


126°00'
95 C SW
WEST
BEAVER
BASIN
BEAVER RIVER FAULT
"WEST GRAYLING" FAULT
"LARSEN" FAULT
BEAVER RIVER
"BEAVER RIVER" SYNCLINE
6000
4000
2000
Sea Level
-2000
-4000
-6000
-8000
-10000
-12000
CONTACT INFERRED
CONTACT INFERRED
10' basal boulder conglomerate
PRECAMBRIAN
CONTACT INFERRED
CONTACT INFERRED
Ft. St. John
Mattson
Sandstone Member
Nahanni
Arnica ?
Whittaker ?
Sunblood ?
L. CRETACEOUS
TRIASSIC ?
MISSISSIPPIAN-PERMIAN
UPPER DEVONIAN & MISSISSIPPIAN
LOWER & MIDDLE DEVONIAN
ORDOVICIAN & SILURIAN

GEOLOGIC CR

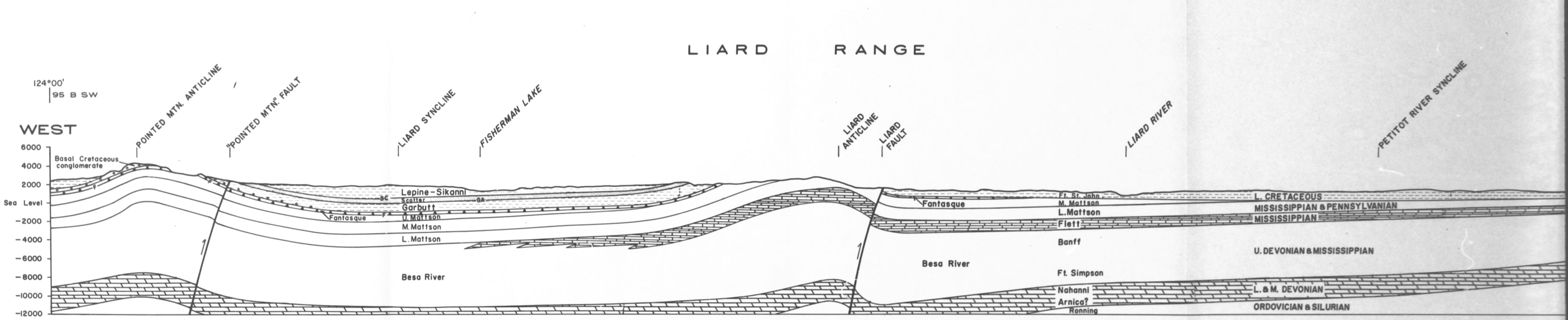


GEOLOGIC CROSS SECTION NO. 1A

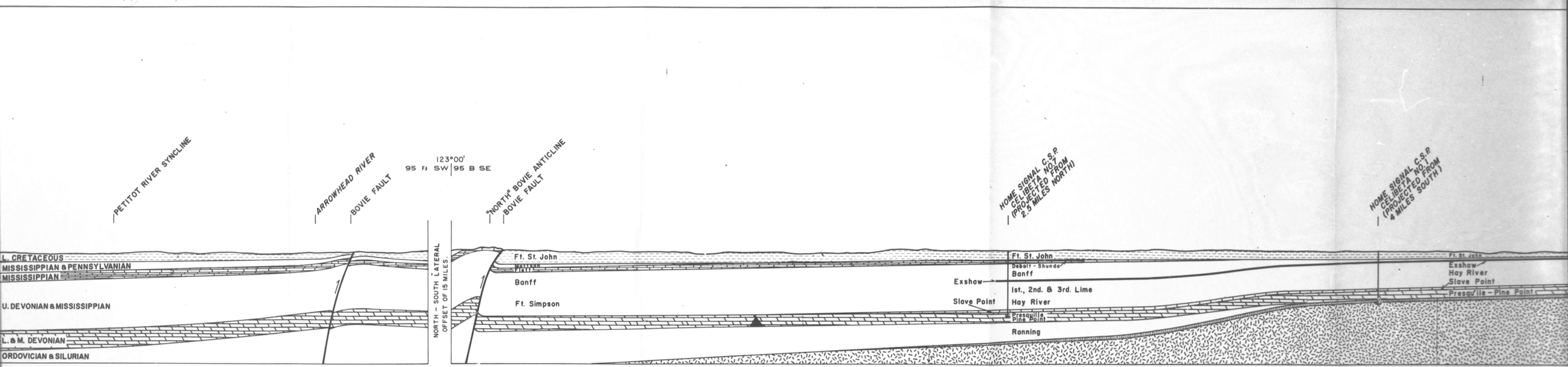


GEOLOGIC CROSS SECTION NO. 1A

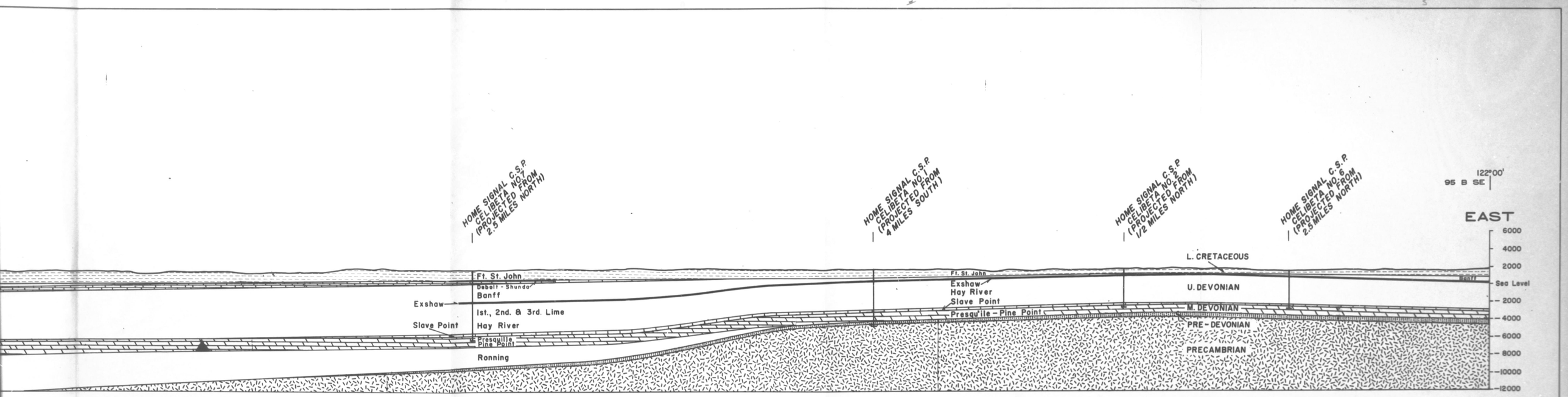
Plate 15


LIARD RANGE
124°00'
95 B SW
WEST
POINTED MTN. ANTICLINE
"POINTED MTN" FAULT
LIARD SYNCLINE
FISHERMAN LAKE
LIARD ANTICLINE
LIARD FAULT
LIARD RIVER
PETITOT RIVER SYNCLINE
6000
4000
2000
Sea Level
-2000
-4000
-6000
-8000
-10000
-12000
Basal Cretaceous conglomerate
Fantasque
Lepine-Sikanni
Scatter
Garbutt
U. Mattson
M. Mattson
L. Mattson
Besa River
Fantasque
Ft. St. John
M. Mattson
L. Mattson
Flett
Banff
Ft. Simpson
Nahanni
Arnica?
Ronning
Besa River
L. CRETACEOUS
MISSISSIPPIAN & PENNSYLVANIAN
MISSISSIPPIAN
U. DEVONIAN & MISSISSIPPIAN
L. & M. DEVONIAN
ORDOVICIAN & SILURIAN

GEOLOGIC CR

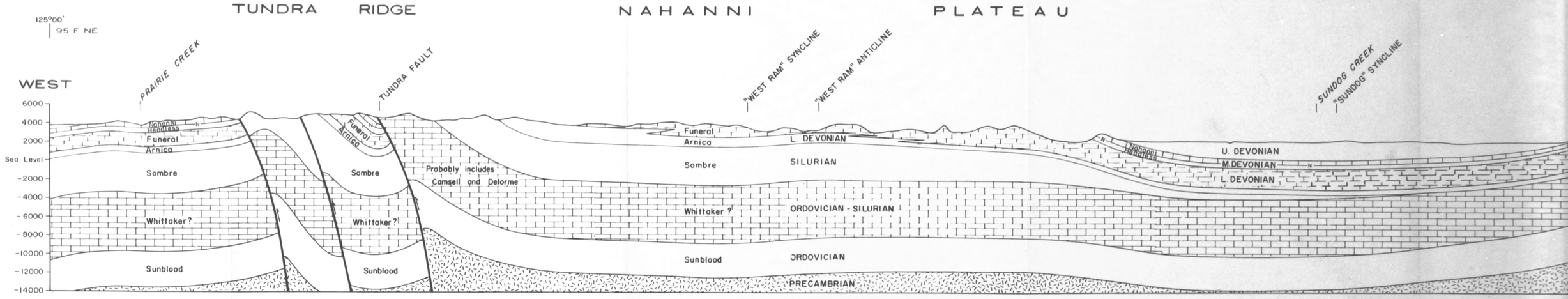


GEOLOGIC CROSS SECTION NO. 1B

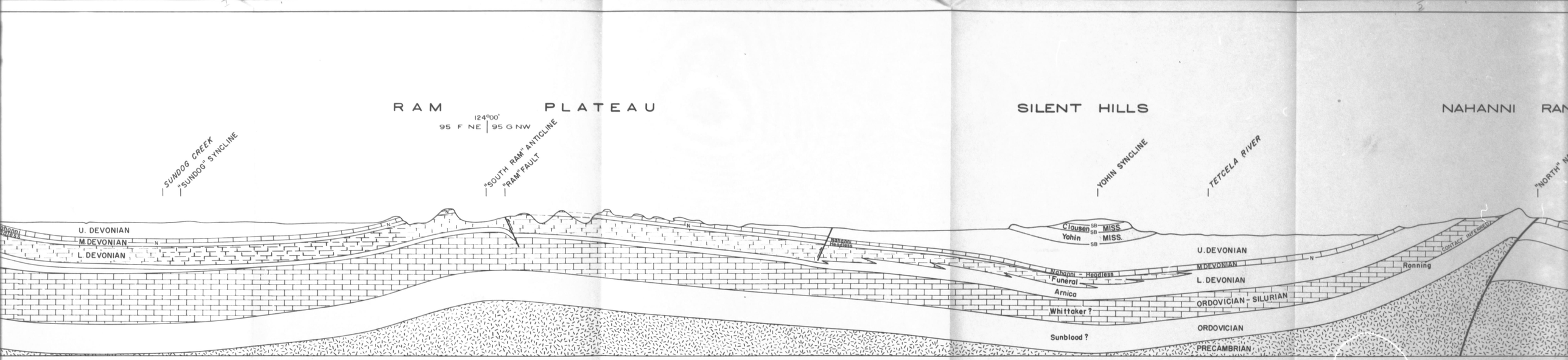


GEOLOGIC CROSS SECTION NO. 1B

Plate 16



GEOLOGIC CROSS



GEOLOGIC CROSS SECTION NO. 2

PLATEAU

SILENT HILLS

NAHANNI RANGE

INTERIOR PLAINS

123°00'

95 G NW

NTICLINE

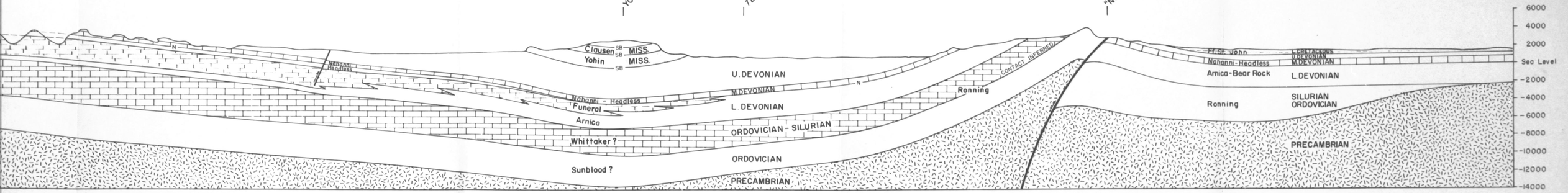
ULT

YOHIN SYNCLINE

TETCELA RIVER

"NORTH" NAHANNI FAULT

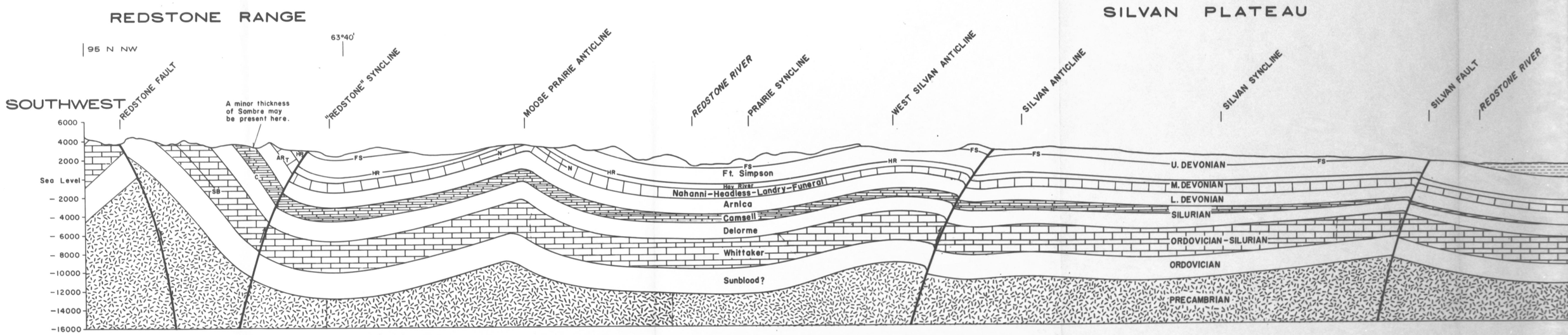
EAST



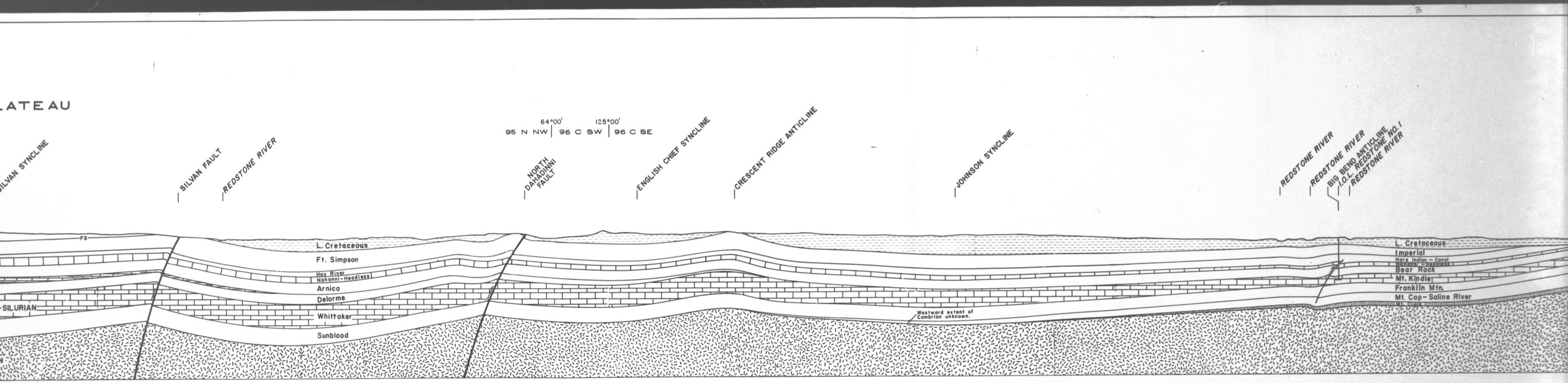
NO. 2

GEOLOGIC CROSS SECTION NO. 2

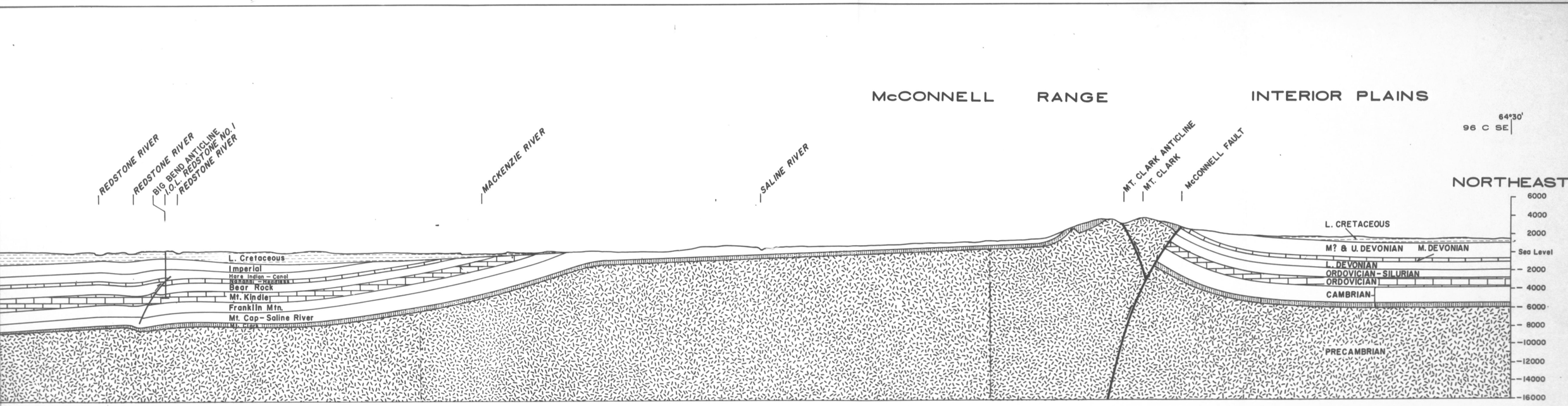
Plate 17


REDSTONE RANGE
SILVAN PLATEAU
95 N NW
63°40'
SOUTHWEST
REDSTONE FAULT
A minor thickness of Sombre may be present here.
"REDSTONE" SYNCLINE
MOOSE PRAIRIE ANTICLINE
REDSTONE RIVER
PRAIRIE SYNCLINE
WEST SILVAN ANTICLINE
SILVAN ANTICLINE
SILVAN SYNCLINE
SILVAN FAULT
REDSTONE RIVER
6000
4000
2000
Sea Level
- 2000
- 4000
- 6000
- 8000
-10000
-12000
-14000
-16000
SB
AR
HR
FS
N
Ft. Simpson
Hay River
Nahanni-Headless-Landry-Funeral
Arnica
Camsell
Delorme
Whittaker
Sunblood?
U. DEVONIAN
M. DEVONIAN
L. DEVONIAN
SILURIAN
ORDOVICIAN-SILURIAN
ORDOVICIAN
PRECAMBRIAN

2 of

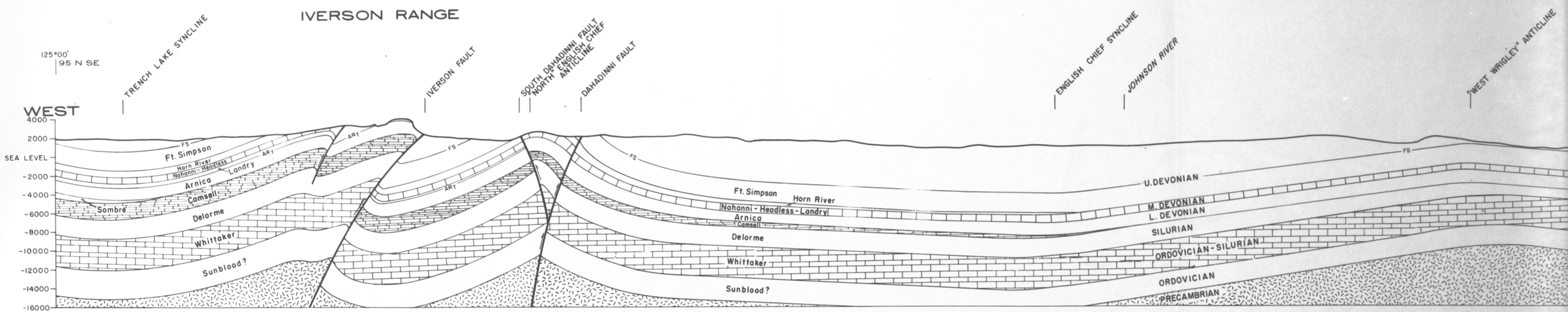


GEOLOGIC CROSS SECTION NO. 4



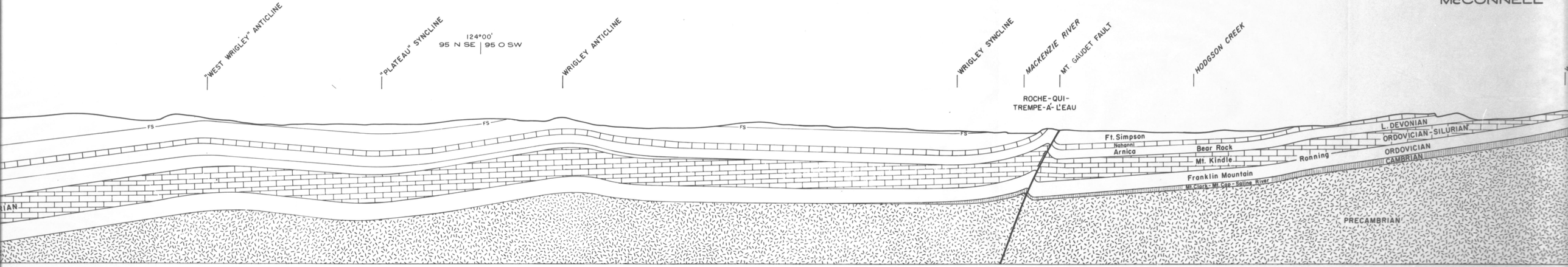
GEOLOGIC CROSS SECTION NO. 4

Plate 19

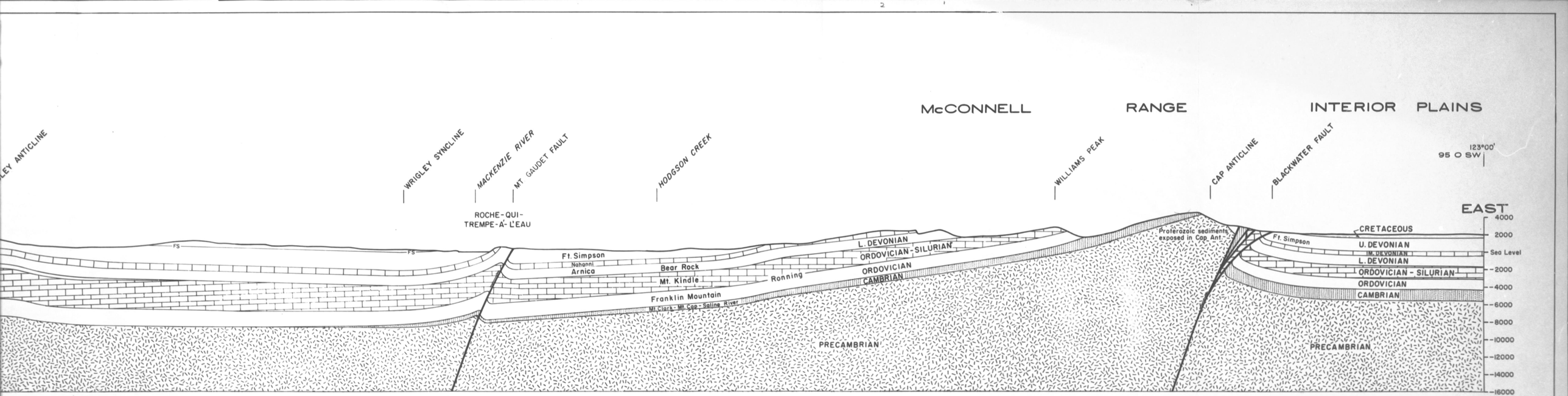

IVERSON RANGE
125°00'
95 N SE
WEST
TRENCH LAKE SYNCLINE
IVERSON FAULT
SOUTH DAHADINNI FAULT
NORTH ENGLISH CHIEF ANTICLINE
DAHADINNI FAULT
ENGLISH CHIEF SYNCLINE
JOHNSON RIVER
"WEST WRIGLEY" ANTICLINE
4000
2000
SEA LEVEL
-2000
-4000
-6000
-8000
-10000
-12000
-14000
-16000
FS
ART
Ft. Simpson
Horn River
Nahanni - Headless
Landry
Arnica
Comsell
Sombre
Delorme
Whittaker
Sunblood?
U.DEVONIAN
M. DEVONIAN
L. DEVONIAN
SILURIAN
ORDOVICIAN - SILURIAN
ORDOVICIAN
PRECAMBRIAN

GEOLOGIC C

McCONNELL



GEOLOGIC CROSS SECTION NO. 3



GEOLOGIC CROSS SECTION NO. 3

Plate 18