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Date ____________

SURFACE GEOLOGY
EASTERN RICHARDSON MOUNTAINS, YUKON
& N.W.T. FORT McPHERSON AREA

DECEMBER, 1969
C. H. RIDDELL, P. GEOL.

Amoco

GR - FXB - 100

Surface Geology
of the
Eastern Richardson Mountains and
Fort McPherson Area
Yukon and Northwest Territories

prepared for

Amoco Canada Petroleum Company Limited

by

C. H. Riddell

OIL & GAS OPERATIONS UNIT
Oil and Mineral Division
APR 14 1970
OTTAWA, CANADA
Dept. of Indian Affairs & Northern Development

December, 1969

Respectfully submitted

C. H. Riddell, P. Geol.

TABLE OF CONTENTS

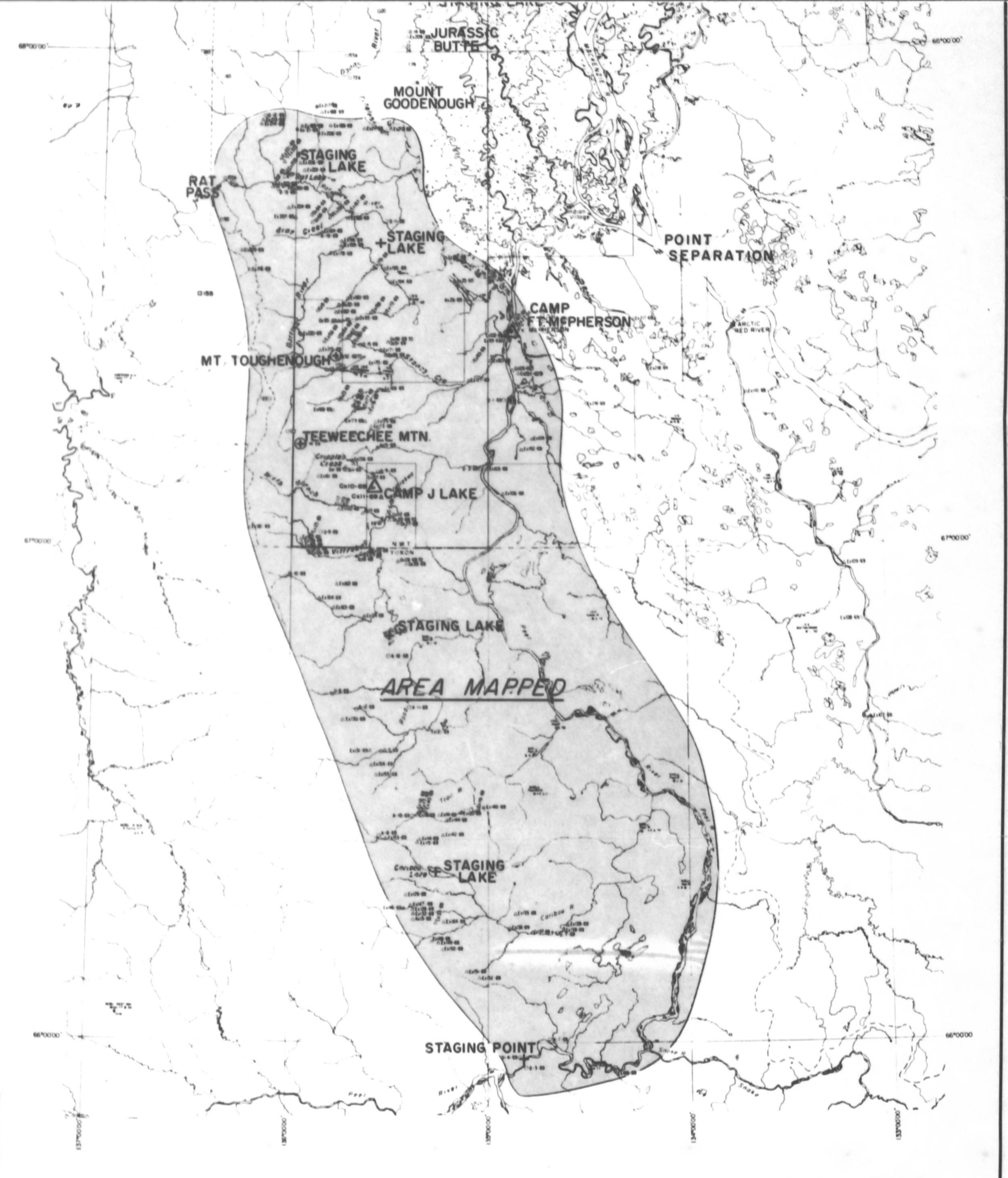
LIST OF PLATES (in pocket)

INTRODUCTION

During the period June 17, 1969 to August 26, 1969 surface geologic studies were carried out on and adjacent to Federal Exploratory Permits No. 5231 to 6250 inclusive and No. 6295 inclusive located on the east flank of the Richardson Mountains near Fort McPherson. The work was performed by a field party under the direction of the writer for Amoco Canada Petroleum Company Ltd. who operate these permits for themselves and Union Oil Company.

Field work was hampered by a series of misadventures and inclement weather. The helicopter was conscripted (to fight forest fires near Fort Good Hope) on June 19th for 6 days, following which it was unserviceable for 5 days; thus the field party was without helicopter support until July 1. During this period, use was made of the GNA Found CF RXK fixed wing both for reconnaissance and placing crews along the Peel River for section measuring. The first three weeks of July saw a tremendous number of forest fires in the area and visibility was often very limited by smoke. About the third week in July the weather turned very bad and it rained or snowed almost every day thereafter. Snow which fell during the first week of August never melted and continued to pile up during August making work above 2500' difficult to impossible (See Fig. 1).

However, all the objectives of the field party were completed and this report outlines this work. It should be noted that this report is being written prior to obtaining most of the microfossil identifications which could alter some maps or interpretations made herein.



LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

☐ PUBLISHED G.S.C. SECTIONS

AMOCO CANADA
PETROLEUM COMPANY LTD.

FORT McPHERSON AREA, N.W.T

LOCATION MAP

G.R. XB - IOC	Compiled By: J.H. FIDDELL
Figure No. 2	Date: OCTOBER 1985
Scale: 1" = 64,000'	

Figure 2

2 of 2

Location and Topography

The area covered by this report lies between latitudes 66°00' and 68°00' and from longitude 136°30' east to the Peel River (See Fig. 2) although reconnaissance flights were taken outside this area and reference is made to them. The area comprises the east flank of the Richardson Mountains extending south and east to the Peel River and north to the Rat River (See Fig. 2).

The Permits east of the Peel River are lightly wooded with spruce, poplar and birch and have abundant lakes and muskeg. Heavier timber is present along the Peel and Arctic Red Rivers. Helicopter landing spots are rare and seismic work would have to be confined to winter months. West of the Peel River the land rises gently to the edge of the Richardson Mountains where, abruptly the land rises to form mountains over 5,000' high. The plateau is mainly barren of trees except along the deeply insized streams which cut canyons through the plateau which is covered by muskeg and "nigger heads". The area has been glaciated and a morraine of varying thickness covers most of the area and glacial erratics and glacial topographic features are common.

Transportation across the western permits to the edge of the mountains would present no problem in winter and could possibly be traversed by tracked vehicle in summer but continual summer use would cause melting of the permafrost and a trail would soon become impassable. In this regard it is interesting to note how the old seismic lines in the area have caused melting of the permafrost and now are ditches and in some cases carry small tributary streams. Winter transportation would present no problem in this area except crossing the stream valleys which are deeply insized and should be avoided as much as possible when laying out any work program. The mountain area in the western portion of the permit area would be more difficult to traverse with land vehicles but selected lines could be shot through the mountains.

The plateau is ideal for helicopter work as the lack of trees and relatively large gravel bars in the streams allow the helicopter to land close to almost any outcrop. Outcrop is almost entirely restricted to the stream valleys and it is necessary to interpolate the geology between the stream cuts.

Previous Work

In 1914, T. O. Bosworth, an officer of the Geological Survey of Canada, reported oil seeps in the Normal Wells area which began the search for oil in the north and led to the discovery of the Norman Wells oil field in 1920. This was followed by a few years of geologic studies by the Geological Survey of Canada including work by E. M. Kindle, M. Y. Williams, G. S. Hume, T. O. Bosworth and D. B. Dowling. Interest subsided until 1940 when the Governments of the United States and Canada undertook an extensive exploration, development and pipelining operation to provide a safe supply of oil during the war with Japan. Geologic work during this period was widespread and included work along the Peel River, adjacent to the project area.

Between 1945 and 1950, Imperial Oil drilled several unsuccessful wildcat wells in the Mackenzie River valley. After 1950 most of the major oil companies began sending surface geologic parties into the project area; followed by seismic crews and drilling rigs. Notable contributions to the understanding of the geology of the area were made should be avoided as much as possible when laying out any work program. The mountain area in the western portion of the permit area would be more difficult to traverse with land vehicles but selected lines could be shot through the mountains.

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Personnel

C. H. Riddell	Party Chief
T. Boleantu	Senior Geologist
M. Renolds	Senior Geologist
G. Streeton	Junior Geologist
R. Smith	Junior Geologist
W. Johnston	Helicopter Pilot
M. Brown	Helicopter Engineer
M. Woods	Found Pilot
W. Bailey	Beaver Pilot
W. Townsend	Cook
I. Duff	Camp Helper

C. H. Riddell, consulting geologist, was retained by Amoco to supervise a surface geologic party and to complete a report on the project area.

Tom Boleantu and Mike Renolds are permanent employees of Amoco and acted as senior geologists on the field party.

Grant Streeton and Ron Smith were temporary employees of Amoco and returned to the University of Saskatchewan and the University of New Brunswick, respectively, to complete their studies following the field season.

Bill Johnston and Mel Brown were pilot and engineer, respectively, on a G3B1 model helicopter which was contracted from Alpine Helicopters.

Milt Woods was the pilot on the Found airplane supplied by Great Northern Airways until the unfortunate crash on July 27. Bill Bailey flew the Great Northern Airways Beaver which replaced the Found for the remainder of the season.

Bill Townsend and Ian Duff were employed by Canfield Caterers who were engaged to cater for the field party.

Objectives of the Field Program

1. Map in detail all the structures on the McPherson Block Permits, in particular the Toughenough, Stony and Vittrekwa anticlines.
2. Check and measure in detail at least four (4) sections of Prongs Creek shale to determine its age and to delineate the carbonate-shale facies strike relative to joint Amoco-Union acreage.
3. Examine and measure Permo-Carboniferous sections between Caribou Lake and the McPherson Block Permits to determine if any significant sand developments extend over the joint acreage.
4. Obtain more control of possible major unconformities at the top of the Paleozoic carbonates.
5. Investigate and compile any information relating to the shale-carbonate facies-boundary from Ordovician to Middle Devonian.
6. In the course of investigations note any good Cretaceous-Jurassic sections.

Method of Operation

Field personnel were moved into "J" Lake (not named on topographic sheets (See Fig. 2) located at latitude 67°07' and longitude 135°35'W on June 17, 1969 where a permanent field camp was set up. The camp was moved to the Anglican Hostel in Ft. McPherson on August 6 from where field work was completed.

From June 18th until August 26th a total of 70 days; 45 days were spent mapping and measuring sections while 25 days were lost due to bad weather or lack of a helicopter. The helicopter flew a total of 220 hours from July 1 to August 26.

Several lakes in the area were used to stage daily operation including Caribou Lake (latitude 66°20', longitude 135°15'), Road Lake (lat. 66°50' long. 135°30'), Rat Lake (lat. 67°45', long. 136°03') and unnamed lakes at lat. 67°40', long. 135°50' and lat. 67°08', long 135°15'. On these days the helicopter and fixed wing aircraft were used to transport gas and personnel to the staging lake in the morning from where the helicopter would put out the section and/or traversing crews. Both aircraft would be used to return personnel to base camps in the evening.

The field personnel were divided into two-man parties which, during the first half of the season measured and sampled the exposed geologic section and during the latter portion of the field season ran structure traverses on and near the permit areas. After the crews were out each day the party chief did aerial geologic mapping, located sections and made spot structural and stratigraphic observations.

Each geologist was assigned a letter to identify his sections (thus the A-?-69 secions were described by Boleantu; the B-?-69 sections by Streeton; C-?-69 by Smith; D-?-69 by Renolds and the E- -69 by Riddell. The subscript 'x' following the identification letter (i.e., Ex-?-69) indicates a stop was made at this point and structural or stratigraphic notes were made and generally a sample was taken. Appendix I is a list of all measured sections and geologic locations.

Samples were taken through all sections measured. Each sample is clearly labelled with section number, sample number as recorded on the plotted section, the footage at which each sample was taken and the purpose for which they were taken (e.g., lithology, porosity, fossil, microfossil, etc.). The samples have been catalogued and filed by Canadian Rock Surgery.

In addition to material accompanying this report a photo library was prepared and supplied to Amoco and Union Oil as well as a complete set of files on each measured section and structural location. Symbols used in the plotting of these sections are outlined in Appendix II of this report.

Acknowledgements

The writer was ably assisted in the field by Mr. T. Boleantu and Mr. M. Renolds of Amoco and Mr. G. Streeton and Mr. R. Smith from the University of Saskätchewan and the University of New Brusnwick, respectively. The cooperation and skill of the Alpine Helicopter crew, Bill Johnston and Mel Brown aided in creating a smooth running operation. Milt Woods aided the operation greatly especially during the period the party was without a helicopter and the July 27 crash was extremely unfortunate.

During the stay at Ft. McPherson the crew was aided by several residents including Mr. Fred Firth, Anglican hostel custodian, and Mr. Frank Dunn of the R.C.M.P.

STRATIGRAPHY

During the 1969 field season Paleozoic sections were measured and sampled in several localities between the Peel River. North of the Vittrekwa River, Paleozoic sections are not well exposed and the data are limited to isolated outcrops which were visited.

Only very few Jurassic and Cretaceous sections were measured as this part of the geologic section was studied by a Geophoto field party during the 1968 season. However, to adequately map the permit areas it was necessary to become familiar with the Jura-Cretaceous stratigraphy and using this data and published data, the Jurassic and Cretaceous is discussed briefly herein.

PALEOZOIC

Pre-Cambrian

Pre-Cambrian rocks outcrop over a few square miles of area near the east flank of the Richardson Mountains five miles south of Caribou Lake. The rocXs were studied on only one traverse (A x 13-69) and the stratigraphic sequence is not known. An estimated 2000-3000 feet of sediments are exposed here but accurate estimates are impossible due to poor exposure and complicated structure.

The main lithology is calcareous dolomite grading to dolomitic limestone; highly fractures and brecciated, greenish grey to pinkish with occasional greenish grey chert lenses. Ripple marks were identified.

Light green chloritic material often slickensided is common along fractures. Bedding is blocky occasionally but mainly thin bedded.

Another common lithology which is often interbedded and gradational with the dolomite is light green, chloritic, calcareous argillite or phyllite. It is schistose, usually parallel to the bedding and it exhibits wavy to highly contorted folding with a few inches wave length. Pyrite and specularite are common and often very abundant.

The above two lithologies make up the bulk of the unit but white, hard, dense quartzite and hard, brown, dense, banded dolomite were also seen.

The age of these rocks is unknown as no fossils were found. They are the oldest rocks exposed in the Richardson Mountains and underlie several thousand feet of sediments which are Cambrian or older and therefore these rocks are assigned to the Pre-Cambrian.

The contact with the overlying Basal Cambrian? limestone unit was not seen but the strike of the beds below the limestone is considerably different from the attitude of the limestone where the contact was crossed and for this reason the contact is believed to be an angular unconformity.

Basal Cambrian Limestone

Immediately overlying the Pre-Cambrian beds is a white weathering, massive, highly fractured limestone formation which is not named or described in the published material. It is very light grey weathering, light brownish grey, cryptocrystalline to microcrystalline lime mud (no original texture can be seen). Faint hints of oolites and possible fossil ghosts were noted but these are uncertain. The unit has the physical appearance of an algal reef.

Outcrops of the limestone rim the Pre-Cambrian outcrops south of Caribou Lake except along the east side where its absence is probably due to faulting. The unit was not measured but is estimated to vary in thickness from 100 to 600 feet; the thickest sections being at the southeast limit of the exposure.

This is the only known occurrence of the limestone unit but it may be correlative with part or all of the Cambrian limestone exposed in the Rat Lake high, which are highly altered, fractured, argillaceous, thin to massive bedded, white to yellowish grey weathering, with some beds being composed of spar cemented oolites (oosparrite or grapestone). No fossils were found in the carbonate but Gabrielse (1957) reports trilobites from the limestones in this area. Trilobites collected at Ex 218-69 are approximately 500 to 1000 feet above the limestone unit. These trilobites, were recently identified as Middle to Upper Cambrian forms.

The contact with the overlying Cambrian shales was not seen either south of Caribou Lake or in the Rat Lake high, but at the former locality, slaty siltstones of possible Cambrian age overlie the limestone band with no angularity and no apparent unconformity.

The unit was not examined in any detail at either locality but no reservoir beds were noted. However, this carbonate unit would be an excellent reservoir bed especially if there are areas where the oolite facies is not completely cemented. The unit would be very deeply buried beneath the subject lands.

Cambrian Shale

The core of the Richardson Mountains is composed of a thick, unnamed sequence of recessive weathering sediments which are referred to in this report as the "Cambrian shale." It is equivalent to the lower portion of Map Unit 3 of Norris et al, GSC Map 10-1963, and is a distinct mappable unit, and should be named and given formation status. Detailed study may make further subdivision possible and the sequence may ultimately be divided into several formations.

This unit is not studied in detail and was measured only on the Trail River where about 3400 feet of the unit is exposed. The total thickness of the formation is unknown but is probably in excess of 5000 feet. It appears to thin south of Caribou Lake where only about 1500 feet of the formation appears to be present but the contact may be faulted in this locality.

The Cambrian shale unit consists of interbedded limestone, dolomite, shale and claystone. It is recessive compared to the overlying and underlying Cambrian carbonate units. The limestone and dolomite grade into each other and are argillaceous, slabby to blocky bedded, silty, dark brownish grey with concretions and occasional cross bedding. The shales and claystones also grade into each other and are gradational into the argillaceous carbonates. They are calcareous, very dark grey, slabby bedded, silty, grey to rusty grey weathering grading from soft to hard and siliceous. They are mainly well bedded with numerous pyritic concretions. Cross bedding, graded bedding and cusps were notes. Gypsum plates are common along bedding planes. Occasional argillaceous, ferruginous siltstone interbeds occur, especially towards the base of the unit.

The contact between the Basal Cambrian limestone and the Cambrian shales was not exposed but was crossed on traverse A x 13-69 where no angularity was apparent. The contact with the overlying Cambrian carbonate was studied on the Trail River where it appeared to be gradational over a few hundred feet.

The age of the Cambrian shale is unknown as no diagnostic fossils were collected and none have been reported to date in the literature. Sponge specules were noted in the formation in several localities which may indicate it is not Pre-Cambrian. It is over 3000 feet below the Lower Ordovician and it is thus assigned to the Cambrian. It is not known how this unit correlates with the black, calcareous, platy shales containing Middle to Upper Cambrian trilobites which were examined north of Rat Lake but they could be correlative.

No reservoir beds were seen in the series and the lithology seemed relatively unattractive unless a major facies change occurs in the subsurface.

Cambrian Carbonate

Between the relatively recessive Cambrian shales and Road River shales, a thick resistant carbonate series was mapped and is referred to in this report as the Cambrian carbonate unit. It is a distinct mappable unit and will undoubtedly be named and given formation status at a future date.

The unit outcrops extensively but was studied only along the Trail and Road Rivers and at a few isolated localities elsewhere. Three thousand feet were measured along the Trail River but the top contact is faulted and the true thickness is probably somewhat greater, perhaps over 5000 feet. Faulting along the flank of the Richardson Mountains made it impossible to measure an accurate thickness.

COLOR CODL

- ▨ DOLOMITE.
- ▨ POSSIBLE REEF
- ▨ CHERT.
- ▨ ŁIMESTONE.

LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

☐ PUBLISHED G.S.C. SECTIONS

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ROAD RIVER – RONNING
LITHOFACIES

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Figure No.: 8	Date: OCTOBER 1969
Scale: 1" = 64,000'	

Figure 6

2 of 2

of

The Cambrian carbonate is composed almost entirely of limestone, very dark grey, light to medium grey weathering, sometimes banded, argillaceous, sometimes slightly dolomitic. The unit is very resistant, flaggy to slabby to occasionally blocky bedded. Thin chert bands and nodules sometimes occupy up to 10 per cent of the interval. Fracturing and brecciation (probably tectonic breccia) are extreme in places. Very poorly preserved fossil fragments occur along some bedding planes.

The contact with the underlying Cambrian shale is gradational where it was studied on the Trail River. The contact with the overlying Road River formation is well exposed along the Road River (D-5-69) where it is gradational over about 50 feet with shales gradually increasing upward. The first graptolite appears about 75 feet above the massive limestones.

The age of this resistant carbonate is unknown as there are no published fossil identifications and the 1969 fossils have not been identified to date. Poorly preserved sponge spicules and fragments of brachiopods, trilobites and bryozoa were collected but preservation may be too poor for identification. The unit occurs directly below Didymograptus and thus it is assigned to the Cambrian. Very recent identification of Cambrian phyllocarids confirm this age dating.

No porosity was noted except for fracture porosity due to tectonics and this facies does not appear to be an attractive potential reservoir.

Road River Shale

The Road River Formation was proposed by D. E. Jackson and A. C. Lenz (AAPG Vol. 46 No. 1-1962) for the Siluro-Ordovician graptolitic shales and carbonates in the Richardson Mountains. The type locality is on the north branch of the Road River. This section was studied by the 1969 field crew

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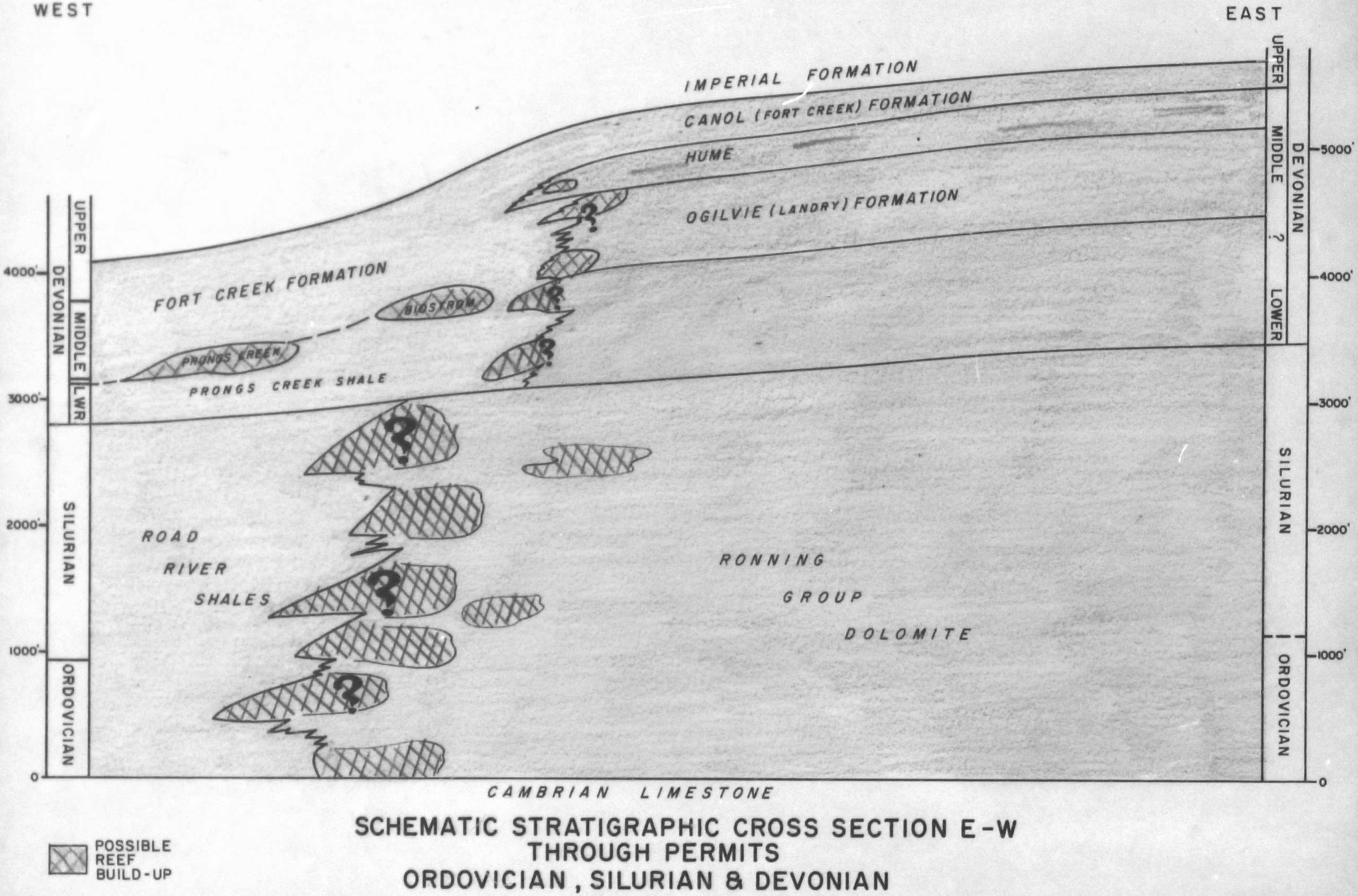
Road River Shale

The Road River Formation was proposed by D. E. Jackson and A. C. Lenz (AAPG Vol. 46 No. 1-1962) for the Siluro-Ordovician graptolitic shales and carbonates in the Richardson Mountains. The type locality is on the north branch of the Road River. This section was studied by the 1969 field crew along with several other sections and it is felt that the section on the main Road River is far better but it may be inaccessible much of the time due to high water. This section (D-5-69) was measured during 1969 at very low water and numerous collections should provide excellent faunal and lithologic control in this formation.

The type section of Road River is a little over 3000 feet thick but several faults are present and actual thickness is doubtful. On the Road River proper about 3200 feet of the formation was measured and this is probably about the true thickness of the unit in this area. To the east this unit passes into the Ronning group carbonates and no nearby wells penetrated a complete section of this group but it is probably 3000 to 3500 feet thick.

The Road River formation consists mainly of hard, black to dark grey to occasionally orange weathering chert or siliceous shale which is platy to flaggy, calcareous and pyritic with interbedded dark grey to black, calcareous shale grading from fissile to mudstone texture; and interbedded black, argillaceous, aphinitic, flaggy limestone which commonly contain crinoid oscicles. Occasional beds of limestone conglomerate (turbidites?) up to 10 feet thick occur. These bands contain subangular fragments of micritic limestone and fossilferous limestone containing corals, bryozoa, brachiopods, crinoid stems and algae in a matrix of dark grey to black calcareous shale. Thin beds, less than one foot thick, of bryozoa limestone occur frequently towards the top of the formation.

Detailed collections of graptolites and shelly fauna were made in several localities, the best being throughout D-5-69. These have not been identified to date but will probably indicate that all stages of the Ordovician and Silurian are represented in the section. The collections,



SCHEMATIC STRATIGRAPHIC CROSS SECTION E-W THROUGH PERMITS ORDOVICIAN, SILURIAN & DEVONIAN

VERTICAL SCALE: 1" = 1000'

FIGURE 9.

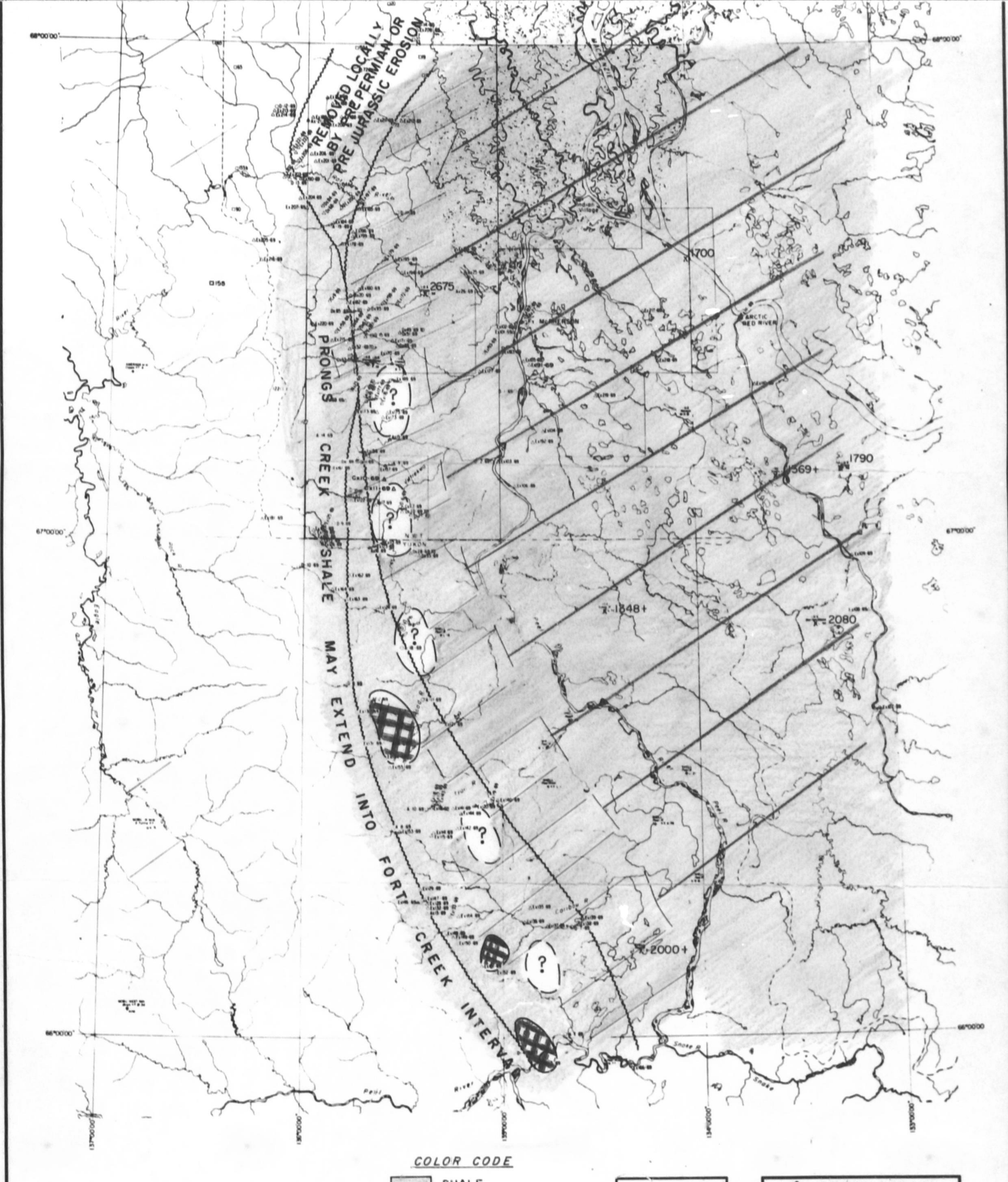
when identified, should be valuable for correlation especially if diagnostic shell fauna can be identified and dated precisely with the aid of the graptolites. Preliminary identifications would indicate that the lower third of the Road River Formation is Ordovician while the upper two thirds is Silurian.

The upper and lower contacts of this formation have been described elsewhere in this report. Both are conformable and gradational. Lenz and Jackson placed all the graptolitic shales in the Ordovician and Silurian but it is generally recognized now that the top few hundred feet contain graptolites of Lower Devonian age (_Monograptus yukonensis_) and these shales have been included in the Prongs Creek Formation in this report. There is no lithologic break at the upper contact and it can only be determined by the faunal identifications and it was therefore not mapped in the field.

No reservoir beds were seen in this formation but this interval is one of the main objectives beneath the subject permits as the shale facies of the Richardson Mountains passes to a carbonate facies to the east and it is postulated that reefing occurs at or near the facies boundary.

Prongs Creek Formation

The Prongs Creek Formation was proposed by A. W. Norris, Paper 67-53, for the Devonian shales overlying the Road River Formation and underlying the Canol (Fort Creek) and Imperial Formation. The type section is on Royal Creek, 65 miles south of the Peel River. The same report correlates the Fort Creek Formation of this report with the Prongs Creek Formation.



COLOR CODE

- ▨ SHALE
- ▨ LIMESTONE
- ▨ LIMESTONE REEF
- ▨ DOLOMITIC

LEGEND

- ○ SECTIONS
- △ STRUCTURAL LOCATIONS
- □ PUBLISHED G.S.C. SECTIONS

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PRONGS CREEK LITHOFACIES

GR 7X8 - 100
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Figure No. 10
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Scale: 1" = 64000'

Figure 10

2 of 2

It is felt that the Prongs Creek Formation extends somewhat below the Fort Creek at least to the lowest occurrence of Monograptus yukonensis and probably at least the upper portion of the siliceous shales referred to the Fort Creek Formation are Frasnian and not equivalent to the Prongs Creek but the lower part Fort Creek siliceous shales may be Prongs Creek equivalent.

The Prongs Creek interval which spans all the Lower and Middle Devonian is represented in the Peel River area by up to 2675 feet of "shelf type" limestone and dolomite which has been referred to various formations by different workers. (Formation names used by various workers include Hume, Nahanni, Headless, Landry, Bear Rock, Arnica, Sombre, Lone Mountain, Gossage, Ogilvie, Cranswich and Michelle Formations which indicates the diversity of opinion as to age and correlation of these carbonates).

Adjacent to the Richardson Mountains only 100-600 feet of shale occurs between the Road River shales and the Fort Creek siliceous shales. This thickness discrepancy has led workers to the search for the unconformity which has caused the thickness discrepancy and has resulted in the reporting of an unconformity at three localities.

Lenz and Jackson (1962 AAPG Vol.46, No.1) described an erosional unconformity at the base of the Fort Creek shales on the north branch of the Road River. This section was studied in Section D-8-69 and no significant unconformity was noted.

A. W. Norris (Paper 67-53) describes an erosional and angular unconformity on the Trail River (See Figure 14). This was studied and beds appear to truncate against the contact both above and below and it is felt this is a fault contact.

D. Wilson (personal communication) noted a slight angularity (1-2°) near the base of the Fort Creek shales on the Road River and feels this may be the major unconformity. This was not noted by the 1969 field party but it is suggested this type of minor angularity can be seen within any sequence.

The writer feels that there was no unconformity during this period in the Richardson Mountains and that the Richardson shale basin remained negative throughout the Lower and Middle Devonian and the relatively thin shale sequence is due to basin starving. The following reasons are given for this conclusion:

1. The contact was studied at several localities and no unconformity was noted. The contact appears sharp but conformable.
2. No evidence of erosion was seen and no erosional detritus was seen or reported. This would be a major uplift and erosion over a relatively short time span and some evidence should be present if it occurred. If the area was positive during this entire period some near shore deposits should be evident.
3. It seems unlikely that an area which had been basinal for the entire Lower Paleozoic would become positive for part or all the Lower and Middle Devonian and then become basinal again for the deposition of the Fort Creek shales.
4. The top zones of the Silurian are nowhere missing (except locally due to faulting) and it would seem extremely fortuitous that only the Devonian and never the Silurian was eroded during the hypothetical uplift.

5. If the lower portion of the Fort Creek is actually Middle Devonian, the thickness discrepancy is not great (See Figure 9). Much or all of the thickness difference could be caused by differential compaction.
6. Throughout the northern cordillera the same phenomena has been noted of a thick Devonian carbonate and a thin shale equivalent. Each time workers have hypothesized an unconformity but no good evidence has been reported. It would be unusual for an uplift to follow this pattern along the carbonate edge and never erode the Silurian.

It would seem that the evidence is overwhelmingly in favor of a starved basin concept compared to an uplift and erosion or nondeposition along the Richardson trough. The Silurian shale is comparable in thickness to the carbonate and the basin apparently became starved during the Devonian possibly due to the increase in carbonate reef growth surrounding the basin.

The Prongs Creek shale is a dark grey, calcareous, often sooty appearing, fissile, platy shale. Thin coquinoid pyritic limestone beds occur which could be turbidity current deposits off the reefs to the east. The lower contact is gradational and was picked in the field at the lowest occurrence of Monograptus yukonensis. The Prongs Creek biostrom and the lower Fort Creek shale, described later, are probably part of this time unit.

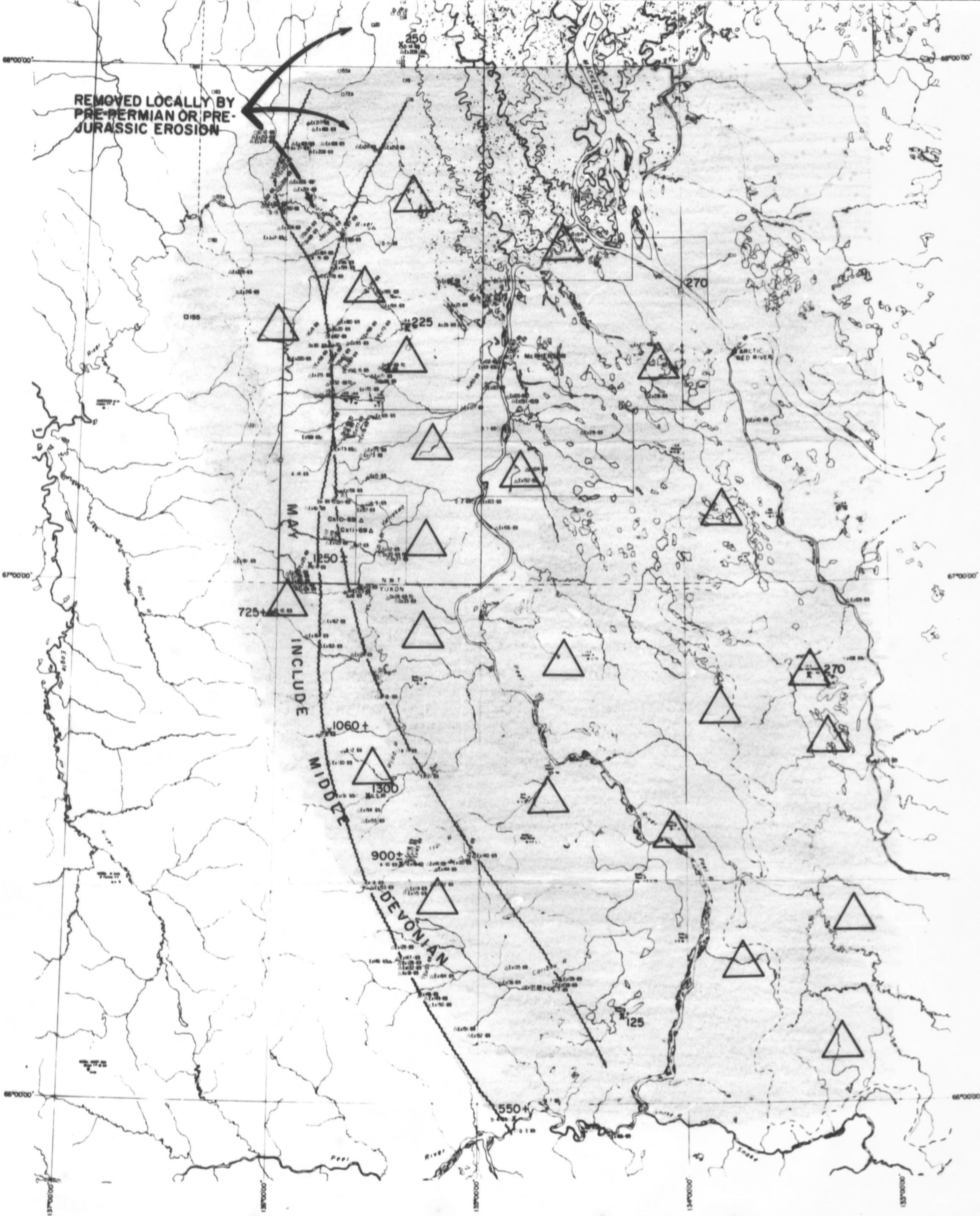
The Prongs Creek yielded many Monograptus yukonensis and other Monograptus of Lower Devonian age. The Prongs Creek biostrom which overlies the Prongs Creek shale in places is Upper Emsian to Eifelian indicating that the Lower Fort Creek shales probably are Givetian and are thin equivalents of the thick Givetian carbonates to the east.

The Prongs Creek shales, of course, are not prospective reservoir beds. However, it is anticipated that there will be reef development between the shelf carbonates to the east and Prongs Creek shale equivalent (See Figure 9) and these reefs are probably the prime objective within the subject permits.

Prongs Creek Biostrom

In several localities a limestone varying in thickness up to 300 feet is present between the Fort Creek shales and the Prongs Creek shales. This unit is unnamed and is referred to as the Prongs Creek biostrom in this report.

The unit occurs intermittently along the Richardson Mountains from the Peel River to the Road River. Exposures allow only a two dimensional view as dips are steep. The lenses of limestone are up to 300 feet thick and up to ten miles long. The contact between the Fort Creek and the Prongs Creek biostrom was examined in many localities and is generally abrupt with interbedding of limestone and shale over only a few inches to a few feet but there is no evidence of an unconformity. The lower contact is interbedded and lensing over several feet (See Figure 12). It is interesting to note that the shale interbeds are siliceous Fort Creek type shales lending support to the hypothesis that the lower part of the Fort Creek shales are Middle Devonian. There is no evidence of a disconformity at this contact. It is felt that this unit is a series of elongate reefoid or biostromal mounds and its distribution is depositional rather than erosional.



COLOR CODE

△ SILICEOUS SHALE

LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

☐ PUBLISHED GSC SECTIONS

AMOCO CANADA
PETROLEUM COMPANY LTD

FORT McPHERSON AREA, N.W.T.

FORT CREEK FM.

GR.FXB-100
Figure No: 15
Scale 1" = 64,000'
Compiled By C.M. RIDDELL
Date OCTOBER, 1969

2 of 2

Figure 15

The biostrom is composed of limestone which is light grey weathering with a fresh surface varying from dark grey to medium grey. It varies from fossiliferous micrite to limestone breccia or penecontemporaneous conglomerate composed of algal balls, stromatoporoids and other fossil debris including rugose corals, crinoids, tabulate corals, brachiopods and shale fragments up to two inches across. The matrix is micrite and occasionally spar. The unit resembles a reef slope type deposit on the Peel River where it is coarse conglomeratic, while near the Road River the limestone is composed of finer fossil fragments in a sparry cement.

Numerous fossil collections were made from this unit including species of coral, trilobite, brachiopod, crinoid, bryozoa, stromatoporoids and algal balls. The distinctive fossil is the crinoid oscicle with the double axial canal and some were seen with four axial canals or crossed axial canals. The two-holed echinoderm oscicle is apparently confined to the Upper Emsian to Eifelian stage of the Middle Devonian. When fossil collections are identified, they will probably confirm the age.

The biohermal or biostromal nature of this unit makes it very interesting for oil and gas exploration although only poor porosity was noted on the Peel River and no porosity was noted in other outcrops. Bitumen fills the vugs in the formation on the Peel River.

Fort Creek Formation

The Fort Creek Formation was named by T. A. Link for the black, siliceous shales of Upper Devonian age occurring along Fort Creek near the Thunder River (unpublished Canol Report). This formation is referred to as the Prongs Creek Formation by A. W. Norris (GSC Paper 67-53) and, in fact, may be the time equivalent of the type Prongs Creek Formation in part.

The Fort Creek shales are hard, resistant siliceous, silty and noncalcareous. They are very black and weather steel blue to black to occasionally red (burnt). Rivers and streams running through the formation cut narrow, steep sided canyons which are often untraversible. The distinctive shales are so hard and siliceous they are often described as chert. Pyrite nodules are common. Peculiar large concretions occur at several zones in the formations and have been referred to as "boudinage structure" in the description. On the Road River about 200' of calcareous, dark grey sooty mudstone occurs above the Prongs Creek biostrom within the Fort Creek interval. Similar lithology was noted within the Fort Creek in Section A-14-69.

The contact between the Fort Creek and Prongs Creek (or Prongs Creek biostrom) was studied at several localities and is sharp but apparently conformable (see Prongs Creek for a complete discussion of this contact). The contact between the Imperial Formation and the Fort Creek contact). The contact between the Imperial Formation and the Fort Creek Formation is gradational.

The Fort Creek Formation is 1000 to 1500 feet thick on the east flank of the Richardson Mountains but thins rapidly eastward where it is equivalent to the Canol Formation which is 150 to 400 feet thick in the wells east of the shale carbonate edge. The Fort Creek shales may have filled the Prongs Creek starved basin or the lower portion of the Fort Creek may be Prongs Creek equivalent.

The Upper Devonian and Mississippian clastics shale out southward and have been included in this map unit on the 1"=8000' maps. These shales are silty but less siliceous and platy than the typical Fort Creek shales.

Tentaculites was collected from the Fort Creek Formation in section D-5-69, D-10-69, A-10-69 and A-12-69, but they have not been identified to date. Gastropod operculum impressions were collected from less siliceous shales at the top of the Fort Creek in Section A-10-69. Numerous large samples were taken for conodonts and these are currently being processed. It is felt that the lower portion of the Fort Creek Formation is probably Givetian and is equivalent entirely or in part to the Hume-Landry carbonate sequence to the east. The upper portion is probably Frasnian in age and equivalent to the Canol Formation.

No reservoir beds are present within the project area. In the Norman Wells area carbonate reefs (Kee Scarp-Ramparts) occur at the base of this unit but these were not seen in this area.

Imperial Formation

Rocks assigned to the Imperial Formation are widespread throughout the project area. The Imperial Formation was defined by Kindle and Bosworth (Geol.Surv.Canada, Sum.Report 1920) on the Imperial River.

The thickness of the Imperial Formation changes rapidly varying from 0 to over 14,000 feet (estimated). The thickness distribution is difficult to map as there are few complete sections exposed and the thickness has also been altered radically by pre Permo-Carboniferous, pre-Jurassic and pre-Cretaceous erosion.

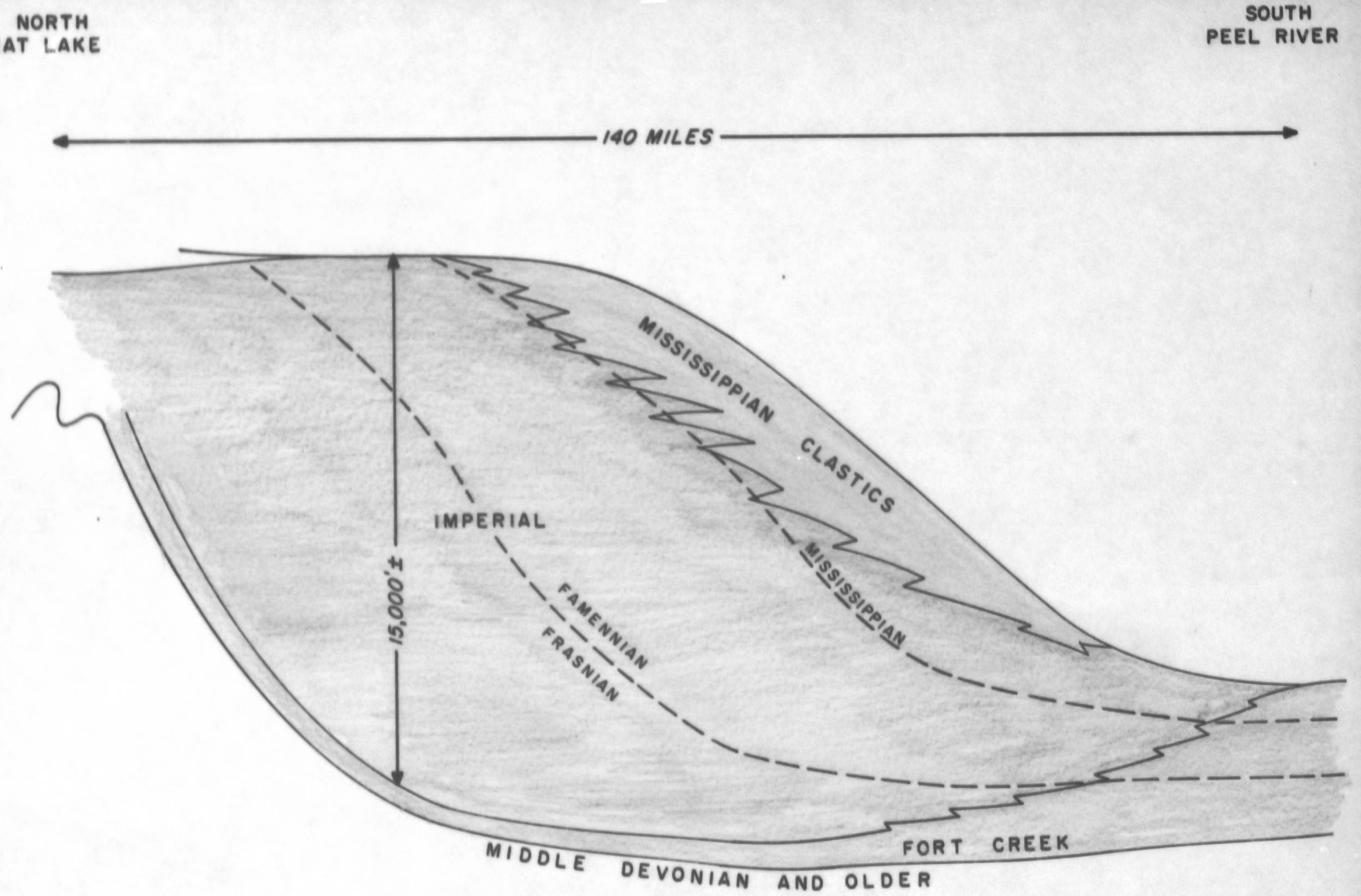


Figure No.: SCHEMATIC DIAGRAM ILLUSTRATING UPPER DEVONIAN - MISSISSIPPIAN DELTAIC DEPOSITION

FORT McPHERSON AREA, N.W.T.

G.R. FXB-100 Compiled By: C.H. RIDDELL

Figure No.: 19 Date: OCTOBER, 1969.

On the west side of the major strike slip fault (and Rat Lake fault) the zero edge of the Imperial Formation lies just south of Latitude 68° 00' and the formation rapidly thickens southward to at least 14,000 feet at Teeweechee Mountain which is the thickest known section of the formation. However, even here, the formation is truncated at an angle of 15-20° by the overlying Jurassic beds indicating the the depositional thickness was greater than the preserved thickness. From Teeweechee Mountain south along the east side of the Richardson Mountains, the formation thins gradually to 6200 feet on the Road River and 6000 feet on the Trail River.

East of the major strike slip fault the thickness distribution is not known accurately as no complete sections are exposed. The formation was completely penetrated by a few wells with the thickest section being 6080 feet at the IOE Stony I-50 well. Areas of much thicker Imperial are probably present and could be mapped seismically. The rapid change in thickness is due in part to pre-Cretaceous erosion and in part to depositional thinning (to the north as the strand line is approached, and to the south as the deeper part of the basin is approached.

Between the Rat Lake fault and the Treeless Creek fault, no Imperial Formation was recognized and the Permo-Carboniferous lies directly on pre-Imperial rocks at several localities. Immediately west of the Rat Lake fault, thick sections of Imperial occur north to D-12-69 at Latitude 67°53'. Paleozoic rocks are not exposed east of the Treeless Creek fault and it is not known how thick they are in this area. The thickness variation across the Rat Lake fault is almost certainly controlled by the fault. Two explanations are possible: (1) substantial strike slip movement or, (2) post Imperial pre-Permian uplift and erosion west of the fault.

The Imperial Formation throughout the main part of the area consists of interbedded sandstone, siltstone, and shale. It typically weathers brownish grey and is usually lithologically distinguishable from the Mesozoic units. The sandstones are generally poorly sorted, argillaceous, non-calcareous and flaggy to slabby bedded. Grains are mainly chert with some quartz grains and rock fragments. To the north the sandstone becomes coarser, sometimes approaching fine conglomerate and to the northeast near Arctic Red River, the sands are greenish grey and glauconitic. The shales are silty, non calcareous, brownish grey with a mudstone texture. Siltstones are argillaceous, non-calcareous, poorly sorted and flaggy to slabby bedded. Flute casts and load casts are diagnostic and carbonaceous marking and plant remains are common. The unit is very noticeably more shaly in the lower half to two-thirds with numerous bands of ironstone concretions, white sandstones and siltstone occupy 30-50 per cent of the interval in the upper part. The sandstones and siltstones become more prevalent to the north.

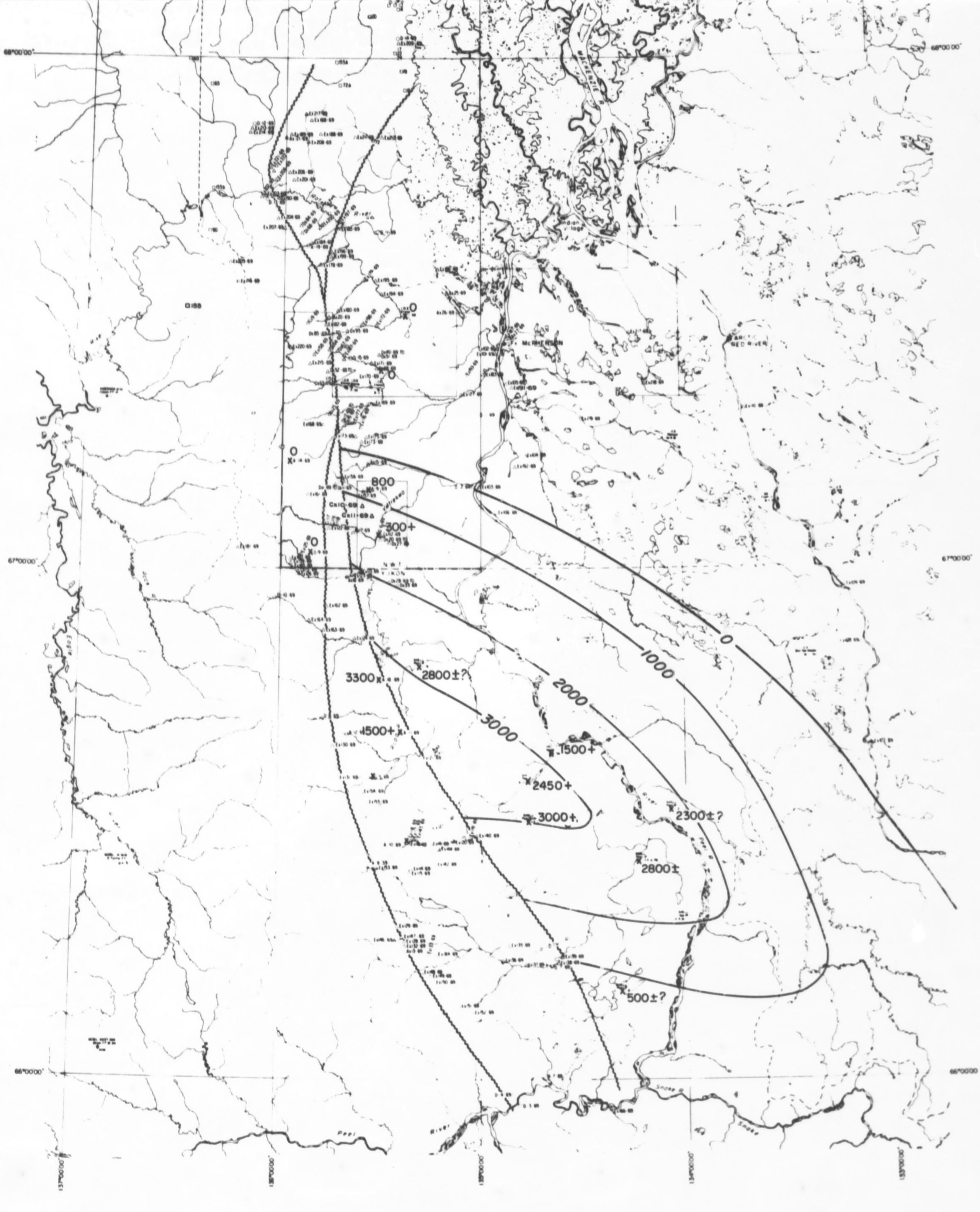
The sourve of the Imperial clastics was to the north and probably not too far north of the project area. A considerable orogeny would have been required to produce this volume of sediments. Igneous activity of the approximate age has been reported in the British Mountains. The deposit appears deltaic with the strand line generally retreating southward (See Figure 19).

The contact between the Imperial Formation and the Fort Creek Formation was studied in a few places in the Road River-Trail River area and was found to be gradational with siliceous shale gradually changing to soft brown-grey, poorly bedded shale. The exact contact between the Imperial and the Mississippian was not located but the contact is assumed to be conformable as early Mississippian beds have been dated from microfossil work on the Caribou River. Further palynology or microfossil work on samples collected will probably indicate the contact is conformable.

North of Latitude 67° 00' the Imperial Formation is overlain by Mesozoic rocks and the contact is an angular unconformity. Although angularity apparently decreases eastward, angularity up to 90° was noted but it generally is 5-20°. (See Figure 37).

There are no microfossils in the Imperial and age determination must be on the basis of palynology and or microfossil work, the results of which are not available at this writing. The unit almost certainly encompasses much of the Frasnian and probably all of the Famennian except where the top has undergone erosion. Norris (GSC Paper 67-53) published several palynological identifications along the Trail River which substantiate this time span.

No very porous sands were seen in the Imperial Formation the lack of porosity being due to argillaceous material and poor sorting. Poor porosity was noted in the slightly glauconitic sands near the Arctic Red River but this would not make too good a potential reservoir. However, it is an extremely thick clastic unit and almost certainly some porosity will exist somewhere but from present knowledge, porous sand areas cannot be outlined.



LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

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FORT McPHERSON AREA, N.W.T.

MISSISSIPPIAN
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Figure No. 22	Date OCTOBER, 1969
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2 of 2

Figure 22

Mississippian Clastics

The clastic unit overlying the Imperial Formation and underlying the various Mesozoic units is referred to as the "Mississippian clastic unit" in this report. The exact age and correlation is unknown. It was referred to as Upper Devonian by the Geologic Survey of Canada (Paper 67-53) on the Trail River and some workers (personal communication) have dated it as young as Pennsylvanian. It is as yet unnamed.

The unit is generally poorly exposed and almost all exposures are steeply dipping and structurally complex. It is probably 60-70 per cent shale and siltstone as exposures are poor, but the characteristic lithology is coarse grit to conglomerate. It weathers brownish grey to orange-grey and the fresh surface is salt and pepper. Grains are subangular to rounded with fair sorting. Porosity is reduced by silica cement. White grains of tripolitic chert are particularly characteristic and green and grey chert are common grains. Bedding is slabby to massive with abundant shale interbeds. Minor coal beds occur in more northerly exposures. Unless the coarse sands or conglomerates are exposed these sediments are difficult to differentiate from the Imperial and Mesozoic sediments. Occasional conglomerate beds are friable with a bluish-green shale matrix.

The distribution of the Mississippian is outlined on Figure 22. The maximum thickness is in the Shell Peel River YT L-1 well where over 3000 feet of Mississippian was penetrated. The unit thins rapidly to the north and east due to non deposition and/or pre-Cretaceous erosion.

The Imperial-Mississippian clastic contact is conformable and gradational. The Cretaceous-Missippian contact is an angular unconformity. The contact is well exposed on the Trial River (See Figure 21) and in the "J" Lake area.

The Mississippian sequence appears to be mainly a continental or marginal sequence and no marine fauna were collected. Carboniferous plants including Lepidodendron, Sigillaria and Calamites (field identifications) were found in several localties indicating a Carboniferous age. The lack of an unconformity between the Upper Devonian and this unit perhaps indicates a Mississippian age. Only one microfossil sample has been identified to date, that being a Kinderhookian identification from the Caribou River section. Further work on microfossils and spores probably will indicate a more accurate time span.

Poor to occasionally fair porosity was noted in the unit, probably not exceeding 15 per cent. The porosity is reduced due to poor sorting and silica cement but some beds were friable and porous enough to make a good reservoir. The large grain size would result in good permeabilities even with mediocre porosity. Several wells have been drilled south of Latitude 67° 00' and northwest of the Peel River with this unit as the apparent objective, but no shows were encountered.

At Ex136-69 on the Caribou River (Latitude 66° 00'N, Longitude 134° 54'W) there is a very bituminous shale or oil shale with a tar-like substance oozing over the surface. The shale contained Calamites and apparently belongs to this sequence. A bulk sample was taken at this locality. Red weathering (burnt?) shales along the Peel River may be equivalent to this unit (See Figure 20).

Permo Carboniferous

Permo Carboniferous rocks outcrop extensively in the Rat Lake area but little has been published and the sequence has not been named to date. The unit was studied at only a few localities during the 1969 field season as these rocks do not appear to underlie the subject permits.

Three different facies of this sequence were encountered but it is not known whether they are exact age equivalents or not.

In the general area west of Mount Toughenough a thin limestone occurs beneath the Bug Creek sandstone and above the Imperial Formation. (See Figure 25). Fossils were collected from the limestone but they have not been identified to date and the precise age is unknown. The limestone, varying from 0 to 35 feet thick; is light grey weathering, dark grey to dark brownish grey fresh surface, massive bedded, resistant lime mud with many poorly preserved fossil fragments including crinoids and brachiopods. It is argillaceous and generally highly fractured and no porosity was observed.

In the area west of Rat Lake the Permian consists of 3000 feet or more of interbedded sandy limestone, calcareous sandstone, calcareous siltstone and shale. The unit is generally resistant and blocky to massive bedded, weathering yellow to light brown. Lithology is gradtional from limestone with floating sand and silt grains to calcareous sandstone and siltstone. Fresh surface is dirty grey to brown grey. No good porosity was noted in the formation. Spirophyton whorls are the most common fossil and were used to differentiate this unit from other clastics while brachiopods including Productids and worm trails also occur.

The third facies is widespread in the vicinity of, and east of Rat Lake. It is a chert pebble conglomerate varying in thickness from 0 to 3000 feet (Section D-13-69). The unit weathers a distinctive maroon color and contains interbeds of sandstone and shale. The fragments are mainly angular, black chert in a sandy shale matrix. Sandstones are poorly sorted and exhibit only poor porosity. The conglomerate appears to be derived locally with fragments being Devonian or older siliceous shale. Plant fragments including Calamites were collected and Spirophyton whorls were noted.

The contact between the Permian and the Imperial or older beds is unconformable with a major post Imperial-pre-Permo Carboniferous unconformity indicated. Angularity up to 10 degrees was noted and in the Rat Lake area the Permian rests on Fort Creek or older beds with the Imperial entirely removed. The contact between the Permo Carboniferous and Jurassic was not studied and is difficult to pick as the Permo Carboniferous becomes very similar to the Jurassic near the contact. The contact is certainly regionally unconformable and in places there is probably a marked angular unconformity. (This may be the case just east of Rat Lake but poor exposures make it impossible to be certain).

The age relationship between the three facies is uncertain as fossils have not been identified to date. It is felt from field identification that both Pennsylvanian and Permian rocks are present but it is not known whether the sequence is continuous or not.

No good reservoir rocks were seen within the Permo Carboniferous but it was not studied in enough localities to determine its worth as a potential reservoir. Certainly areas of porous sandstone or conglomerate could be present or porous reefs or shell banks may exist in the limestone unit.

MESOZOIC

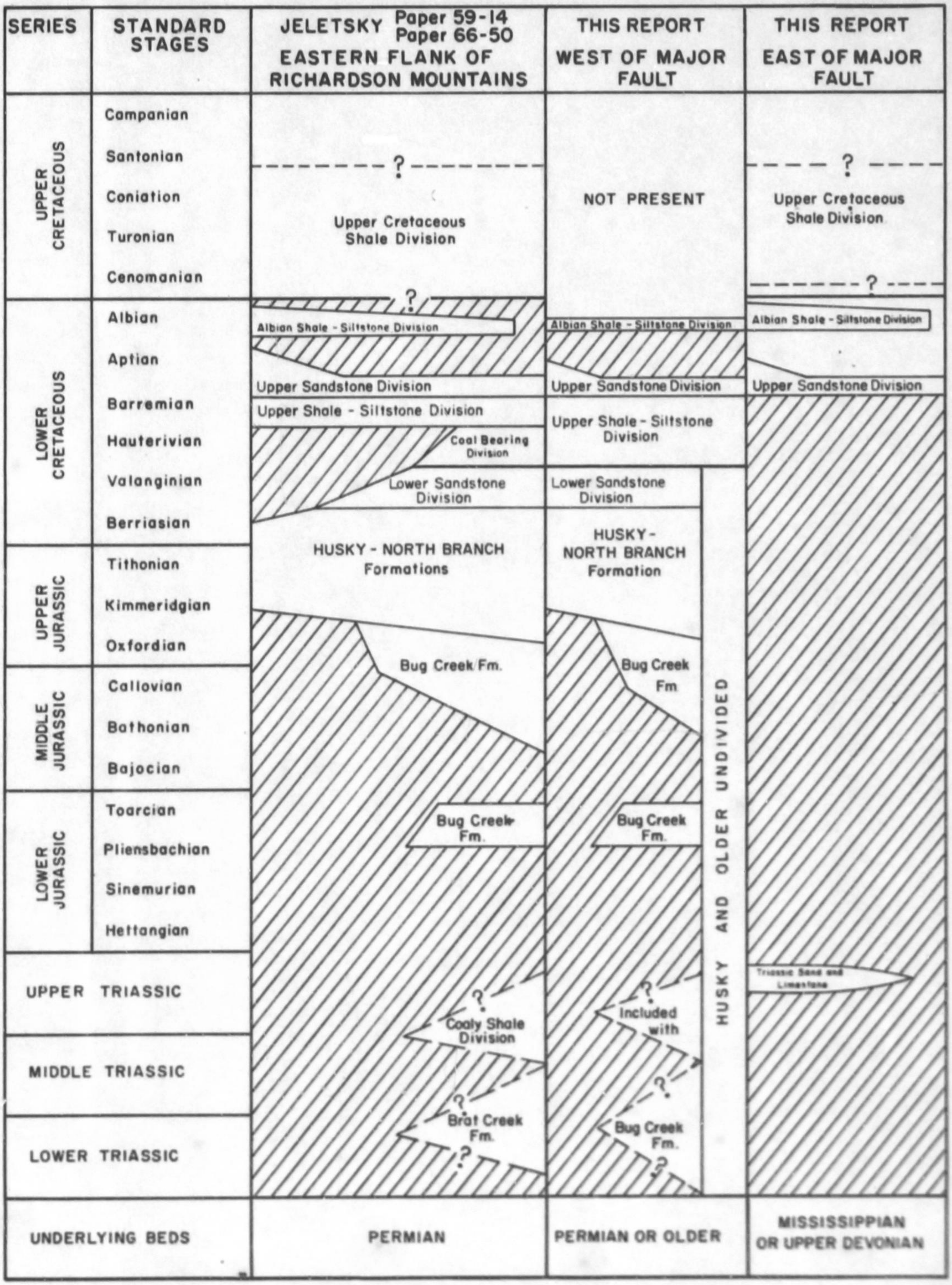
The 1969 field party was assigned to study the Paleozoic section and map the permit area. As a result, only a few short sections of Mesozoic rocks were measured but it was necessary to become familiar with the Mesozoic section to be able to complete the structural mapping of the project area. The units were observed in many localities, on traverses and at spot stops made with the helicopter, and even from the air certain observations could be made.

To make this report complete, the Mesozoic stratigraphy is discussed but for a more thorough discussion the reader is referred to the various publications of Jeletsky, who is undoubtedly the Mesozoic authority on the area. The observation of the 1969 field party offered herein are from areas less well known to Jeletsky and are meant to be used in conjunction with his work. A complete study of the Mesozoic would take much longer than the 1969 field party had to devote to it.

Triassic

The only confirmed Triassic beds which are present within the project area occur on mesas south of Caribou Lake. Here flat lying Triassic calcareous sandstone grading to sandy limestone, cap several hills. Less than 20 feet of strata is exposed and neither the upper nor the lower contact is exposed and the thickness of the unit is unknown.

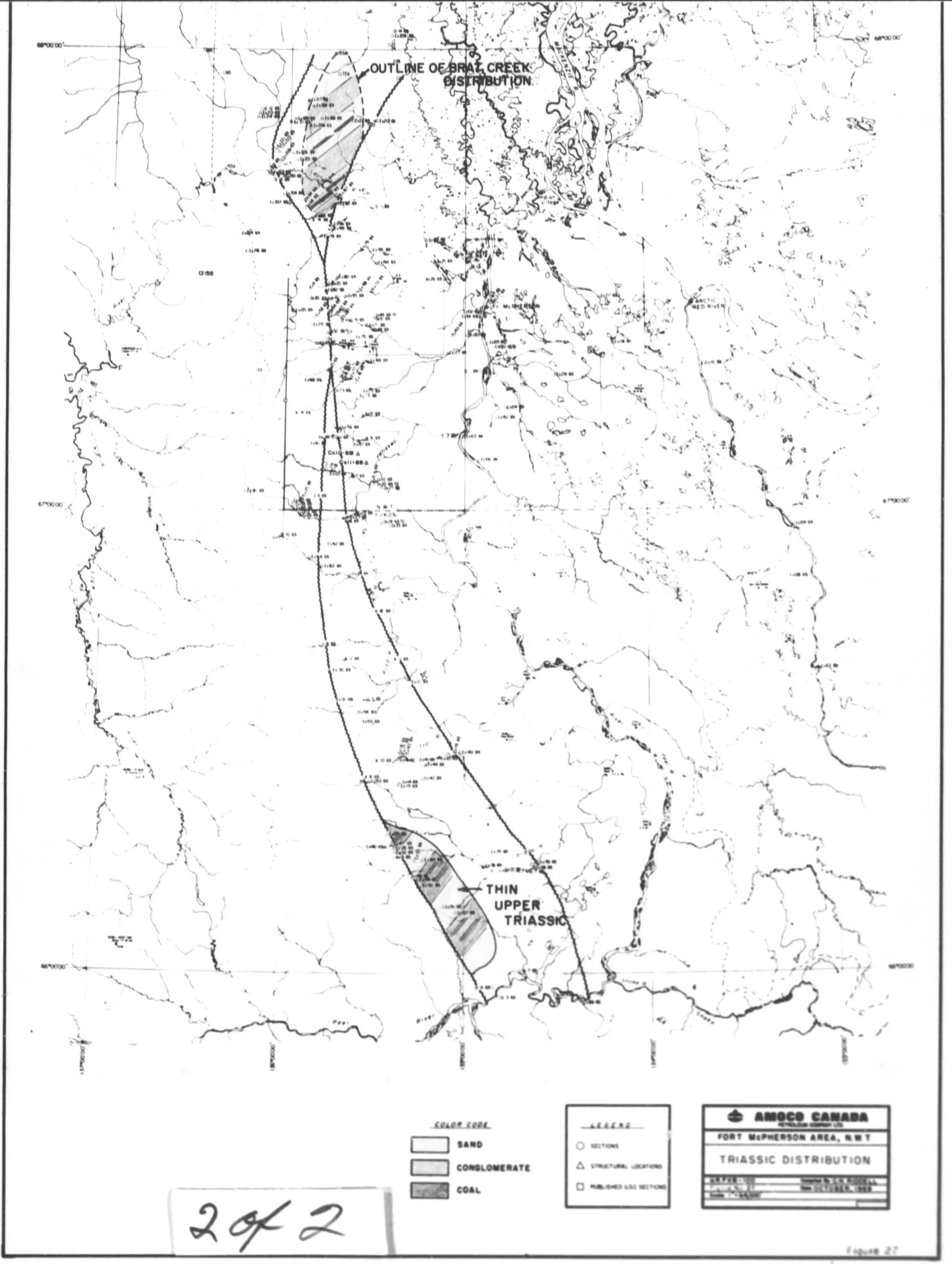
The sandstone is light brown, flaggy bedded, argillaceous, grading from fine to coarse grit to slightly conglomeratic with poor to fair intergranular porosity.



MESOZOIC CORRELATION CHART

G.R. FXB-100 Compiled By: C.H.RIDDELL

Figure No: 26 Date: OCTOBER, 1969.



2 of 2

Figure 27

Pentacrinus oscicles are abundant in the sandstones and other fragments of fossils (brachiopods or pelecypods) are rare. Jeletsky (GSC Paper 66-50) refers to these limestones as Upper Triassic.

The aerial extent of this unit is probably very limited but if it was found in subsurface beneath the Albian shales to the east it would be a potential reservoir. They have a fetid (petroliferous?) odor.

Jeletsky introduced two other possibly Triassic formations on Brat Creek; the Brat Creek formation and the Coaly shale division. The Brat Creek formation is about 500 feet thick at its type section on Brat Creek near its junction with the Rat River and is composed of light grey weathering friable, pebbly conglomerate with pebbles up to 3" in diameter but mainly finer. A poor sandstone matrix and little cement leave good intergranular porosity. Interbeds of sandstone and coal are present. On the southwest limit of the syncline passing through Brat Creek the formation charges facies to interbedded greenish glauconite sandstone and siltstone with abundant pelecypods.

The distribution of the Brat Creek formation is not known as it appears to change facies rapidly and is difficult to map. It was included with the Bug Creek formation on the geologic maps accompanying this report.

Jeletsky (Paper 66-50) discusses at length the age of this formation which could be as old as Permo-Pennsylvanian or as young as Jurassic. Fauna collected in A-19-69 have not been identified to date and these may offer further evidence as to its age. It is not impossible that these conglomerates belong to the North Branch formation.

The fine conglomerates are very porous and would make an extremely good reservoir bed but the distribution of the unit is unknown.

re but from present knowledge, porous sand areas can-

The Coaly shale-division disconformably overlies the Brat Creek formation in the Rat River-Brat Creek area. The black coaly shales were not studied by the 1969 field party.

Both the Brat Creek Formation and Coaly Shale divisions were included with the Bug Creek Formation on the geologic maps accompanying this report.

Bug Creek Formation

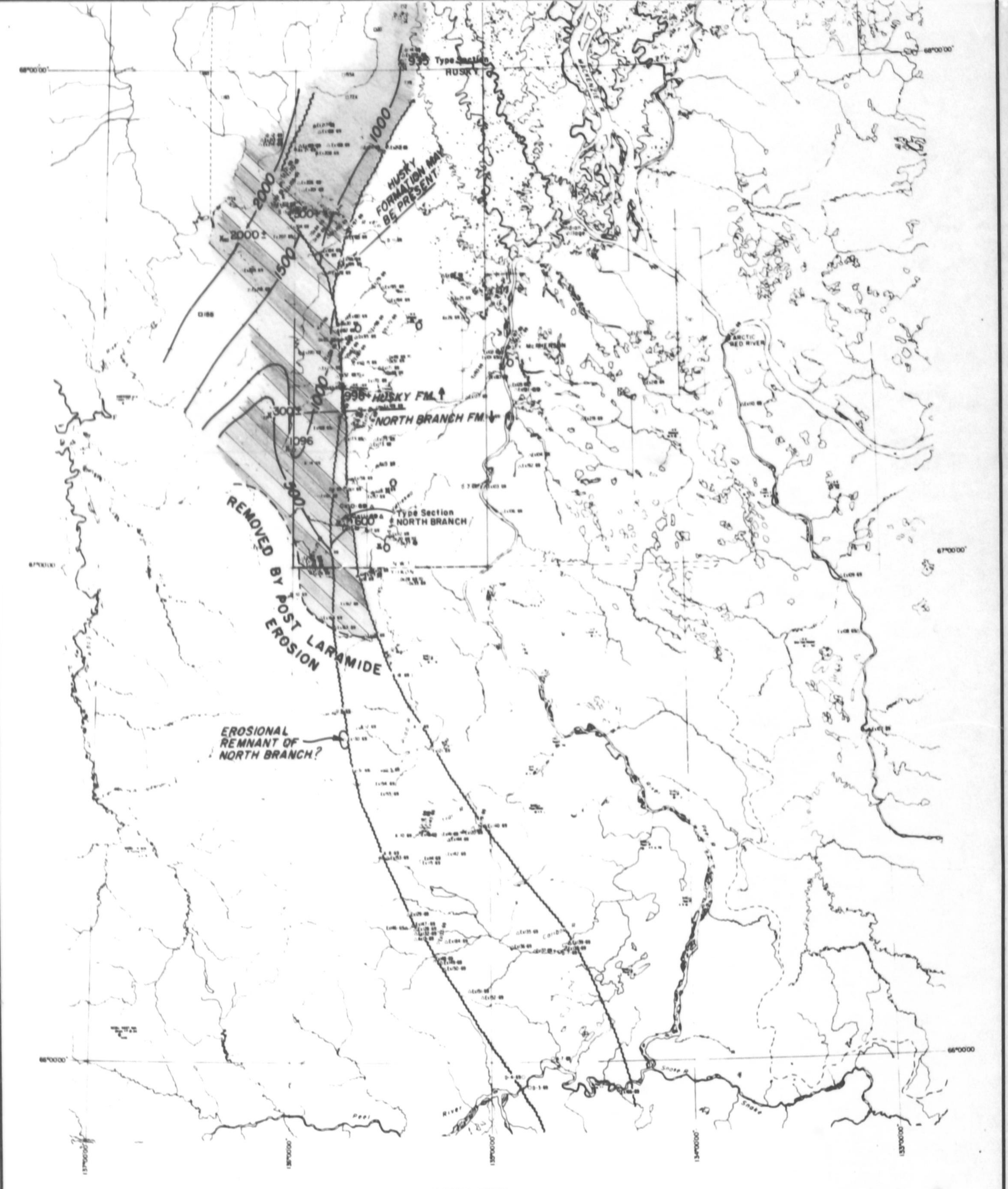
The Bug Creek Formation was proposed by Jeletsky (Paper 66-60) for the 100 to 2,000 feet of Jurassic clastics underlying the North Branch - Husky formation. These rocks were referred to as "Older Jurassic" in previous reports by Jeletsky. The type section was designated as the southern wall of the canyon on Bug Creek 1-1/2 miles west of Bug Lake (Latitude 68°04'00"N; Longitude 135°25'00"W). No sections of Bug Creek were measured by the 1969 field party and observations are made from isolated outcrops and traverses.

The Bug Creek Formation outcrops extensively west of the major strike slip fault north of Latitude 67°00'. No outcrops of this formation were recognized east of this fault and this is probably the approximate strand line of the Bug Creek at least in the south portion of the project area, where the formation is relatively thin and contains chert and quartzite cobble conglomerate in a silicified sandstone matrix. A similar conglomerate which may be Bug Creek Formation is present immediately overlying the Paleozoic on the west flank of the Richardson Mountains near Latitude 67°00' also. The Bug Creek thickens rapidly northward to about 2,000 feet in the Rat Pass area.

The thinner eastern sections are composed almost entirely of light grey, fine grained, siliceous, hard sandstone or quartzite. The sands weather buff but are mainly covered with black and green lichen; the bedding is blocky to massive and the unit is very resistant. The sands are quartzose with some chert grains, well sorted and fairly clean. As the formation thickens westward, shale and siltstone interbeds develop until at the Rat Pass the formation is approaching 50% shale. The shales are dark grey to dark brownish grey, silty, non calcareous with banks of clay ironstone nodules. The shales are usually recessive weathering and covered with sandstone talus creating the illusion that the formation is almost entirely sandstone.

No good exposure of the Bug Creek/Husky-North Branch Formation contact were studied but no evidence of an unconformity were seen. The North Branch Formation apparently overlaps the Bug Creek south and east and it is probable that there is a minor hiatus in this area. The contact between the Bug Creek and the Brat Creek Formation or Coaly shale division is not exposed. In the Aklavik Range the Bug Creek formation lies unconformably on the Permo-Carboniferous conglomerates with evidence of truncation and erosion of the underlying beds. In the Teeweechee Mountain area the contact Bug Creek overlies the Imperial Formation with angular unconformity ranging up to 20 degrees but generally in the order of 10 degrees.

The 1969 field party did not collect any fossils from this formation. Jeletsky (Paper 66-50) identifies many species from the formation including pelecypods, ammonities and belemnites which indicate the age ranges from lower to upper Jurassic in different parts of the area with perhaps one or more hiatus within the formation.



COLOR CODE

▭	SAND
▨	CONGLOMERATE
▨	SHALE
▨	SILTSTONE

LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

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FORT McPHERSON AREA, N.W.T.

NORTH BRANCH – HUSKY FM.

G.R. FXB-100	Compiled By C.H. RIDDELL
Figure No. 29	Date OCTOBER, 1969
Scale 1" = 64,000'	C.I. 500'

2 of 2

Figure 29

The Bug Creek sandstone would make an excellent reservoir if it were not for the siliceous cement which infills most of the porosity. The sandstone is clean and well sorted and primary porosity would have been excellent. Some friable sands are noted in northern exposures reported on by Jeletsky. If the silicification is a result of tectonism porosity may be present in areas of less severe tectonism, perhaps beneath the western Mackenzie Delta or the northern Eagle Plains. It was impossible to make a complete study of this unit but it could form an important objective if there are areas where the primary porosity is preserved.

Husky Formation - North Branch Formation

The name Husky Formation was introduced by Jeletsky (Paper 66-50) for the shales and siltstones previously referred to as the Lower Shale - Siltstone Division (Paper 59-14). The type section is along the north slope of Husky Creek at a point 3-1/2 miles west of the Husky Channel and one mile south east of the Jurassic Butte.

The North Branch Formation was introduced by Jeletsky (Paper 66-50) for the sandstones and conglomerates of Jurassic age on the north branch of the Vittrekwa River and is the lateral equivalent to the Husky Formation southwards. The type section is on the northern wall in the First Gorge about 6 miles up the north branch from its confluence with the Vittrekwa River proper (See Fig. 30).

The Husky and North Branch Formations are widespread throughout the project area west of the major strike-slip fault, but beds of this age were not recognized east of this fault. Many excellent sections are exposed but none were measured by the 1969 field party.

The North Branch Formation is composed primarily of fine to coarse grained, calcareous to non calcareous, glauconitic, sandstone which weathers light brown grey but is mainly covered with black and green lichen. Occasional coaly fragments were seen and large tree trunks up to 6 inches in diameter were seen. The sandstones vary from hard to friable with beds 1/2" to 3 feet thick. Grains are quartz and chert mainly and grain size varies from very fine to cobble conglomerate with chert boulders up to 6 inches in diameter in a sandy matrix. The formation forms a prominent resistant ridge in this area.

The North Branch Formation gradually becomes less conglomeratic and contains more siltstone and shale interbeds northward and passes into its lateral equivalent, the Husky Formation. The boundary has been placed arbitrarily just south of Mount Toughenough. Near Mount Toughenough the Husky formation is composed of mainly flaggy to blocky bedded, fine to occasionally coarse grained, siliceous, hard sandstone occasionally grading to quartzite with brownish grey silty shale interbeds. Some conglomerate is still present at Mount Toughenough and the formation is still a ridge forming unit and remains so north to the Rat River. The lithology remains about the same except the sandstone becomes softer and slightly more porous.

North of the Rat River the Husky Formation is a black marine shale with occasional siltstone beds and nodular clay ironstone concretionary bands.

In the northwest part of the project area the formation thickens rapidly to over 2,000 feet of black marine shale with numerous hard, fine to occasionally coarse grained, resistant, blocky bedded sandstone or quartzite.

The 1969 field party collected only a few pelecypods and wood fragments from this formation. Buchia mosquensis and Buchia okensis are the guide fossils for this formation but several other species of Buchia as well as other pelecypods are described by Jeletsky in detail in Paper 66-50. The formation spans the time interval from middle Jurassic to lowermost Cretaceous (Upper Oxfordian-Berriasian).

The contacts of the North Branch-Husky Formation were not studied in detail but no discordance was noted at either the upper or lower contacts and no apparent age gap exists. In a few localities the Husky lies directly on the Imperial Formation (or possible Mississippian clastics) and a definite truncation of these underlying beds was observed in the headwaters of the Vittrekwa River.

The sandstones of the North Branch and Husky Formations are generally hard siliceous and non porous but probably had excellent primary porosity and would make a good prospective reservoir if areas could be found where there was not extensive silicification. Some porosity was noted within the North Branch Formation on the Vittrekwa River and fair porosity is developed in some sand beds in the Husky Formation south of the Rat River. However, the formation outcrops widely and probably any trapped hydrocarbons have escaped. The Husky formation may be present beneath the Mackenzie delta north of the Rat River and could be prospective in this area. The lack of porosity may be a function of the tectonism which the Richardson Mountains have undergone and if the North Branch facies is preserved beneath the western portion of the delta it could make an attractive reservoir.

Lower Sandstone Division

The Lower Sandstone Division is the name given by Jeletsky (Paper 58-2) to the sandstone unit separating the Husky Formation (Lower Shale Siltstone Division) and the Upper Shale Siltstone Division (or coal bearing Division where present).

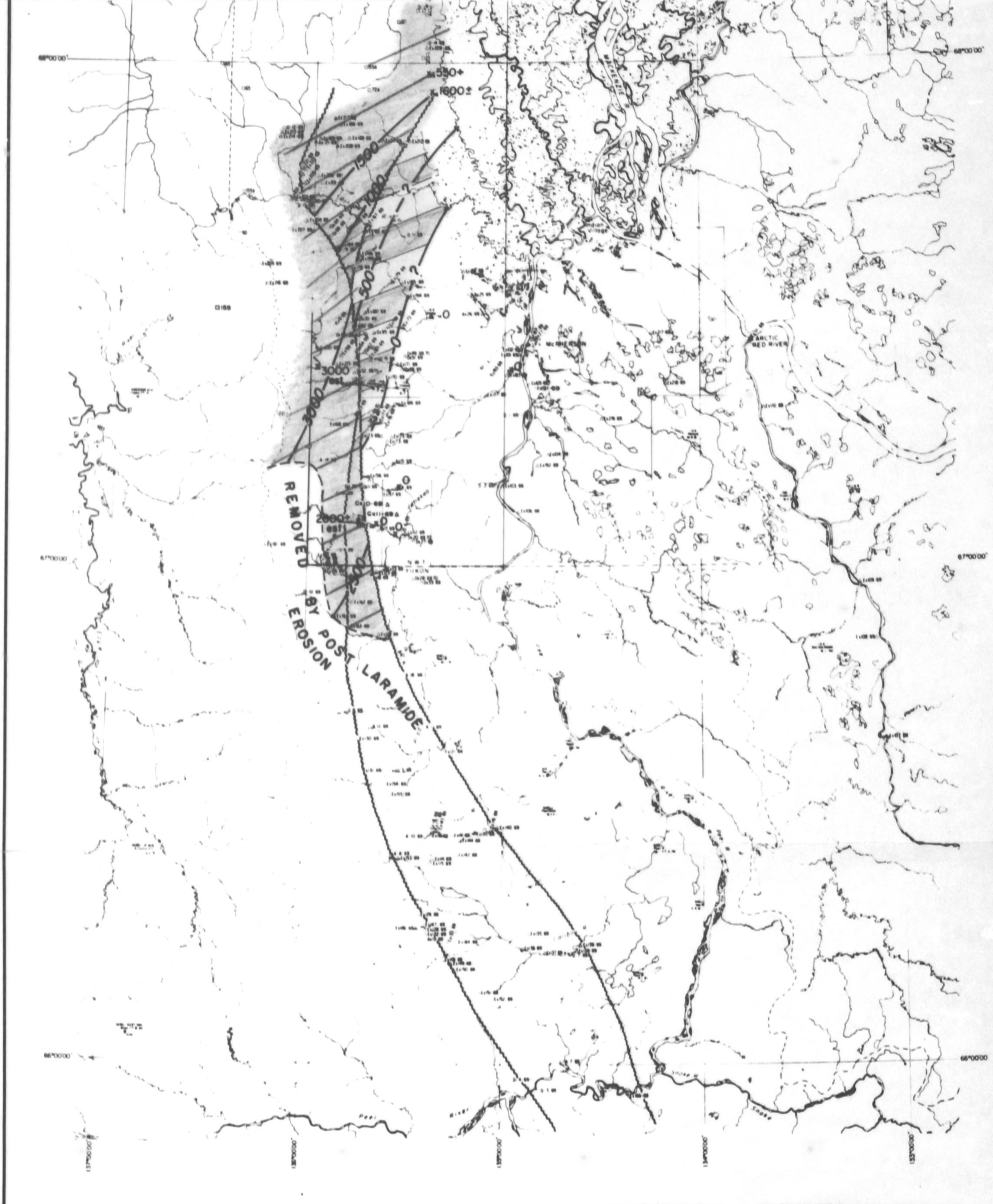
This unit is very difficult to map and has only been mapped near the headwaters of Stony Creek. Even here the unit may not correlate exactly with the Lower Sandstone Division of Jeletsky although Jeletsky reports fossil verification of the age in the Stony Creek area. In other parts of the project area the Lower Sandstone Division has been included in the Husky or North Branch formations.

The Lower Sandstone Division at the headwaters of Stony Creek includes a prominent hard sandstone bed at the base of the Upper Shale Siltstone Division. The sandstone is fine grained, siliceous, non porous, non calcareous and is covered with black and green lichen. The bedding is massive and it forms resistant cliffs.

The contact with the overlying or underlying beds was not observed but Jeletsky describes the lower contact as conformable and the upper contact erosionally unconformable.

Jeletsky's Paper 59-14 describes fauna collected from the Lower Sandstone Division and dates them as lower Valanginian. The 1969 field party did not collect any fossils from this unit.

No reservoir rocks were noted in outcrops of this unit although the sands are well sorted and clean and had excellent primary porosity. The porosity in the sands has been nearly obliterated by silica cement.



COLOR CODE

▨ SHALE

☐ SANDSTONE

▨ SILTSTONE

LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

☐ PUBLISHED GSC SECTIONS

AMOCO CANADA
PETROLEUM COMPANY LTD

FORT McPHERSON AREA, N.W.T.

UPPER SHALE
SILTSTONE DIVISION

GR FXB-100	Compiled By C H RIDDELL
Figure No 31	Date OCTOBER, 1969
Scale 1" = 64,000'	C.I. 500'

2 of 2

Figure 31

Coal-Bearing Division

The Coal-Bearing Division is a unit described by Jeletsky (Paper 59-14) for coaly shales underlying the Upper Shale Siltstone Division in the Aklavik Range.

This unit was not identified south of the Aklavik Range and was probably included in the Upper Shale Siltstone Division or the Husky formation.

Upper Shale - Siltstone Division

The Upper Shale-Siltstone Division is the name introduced by Jeletsky (GSC Paper 58-2) for the Lower Cretaceous black shales separating the Lower and Upper Sandstone Divisions. It is a distinct mappable unit and should be named and given formation status. No sections of this formation were measured by the 1969 field party but the formation was examined along traverses in many localities.

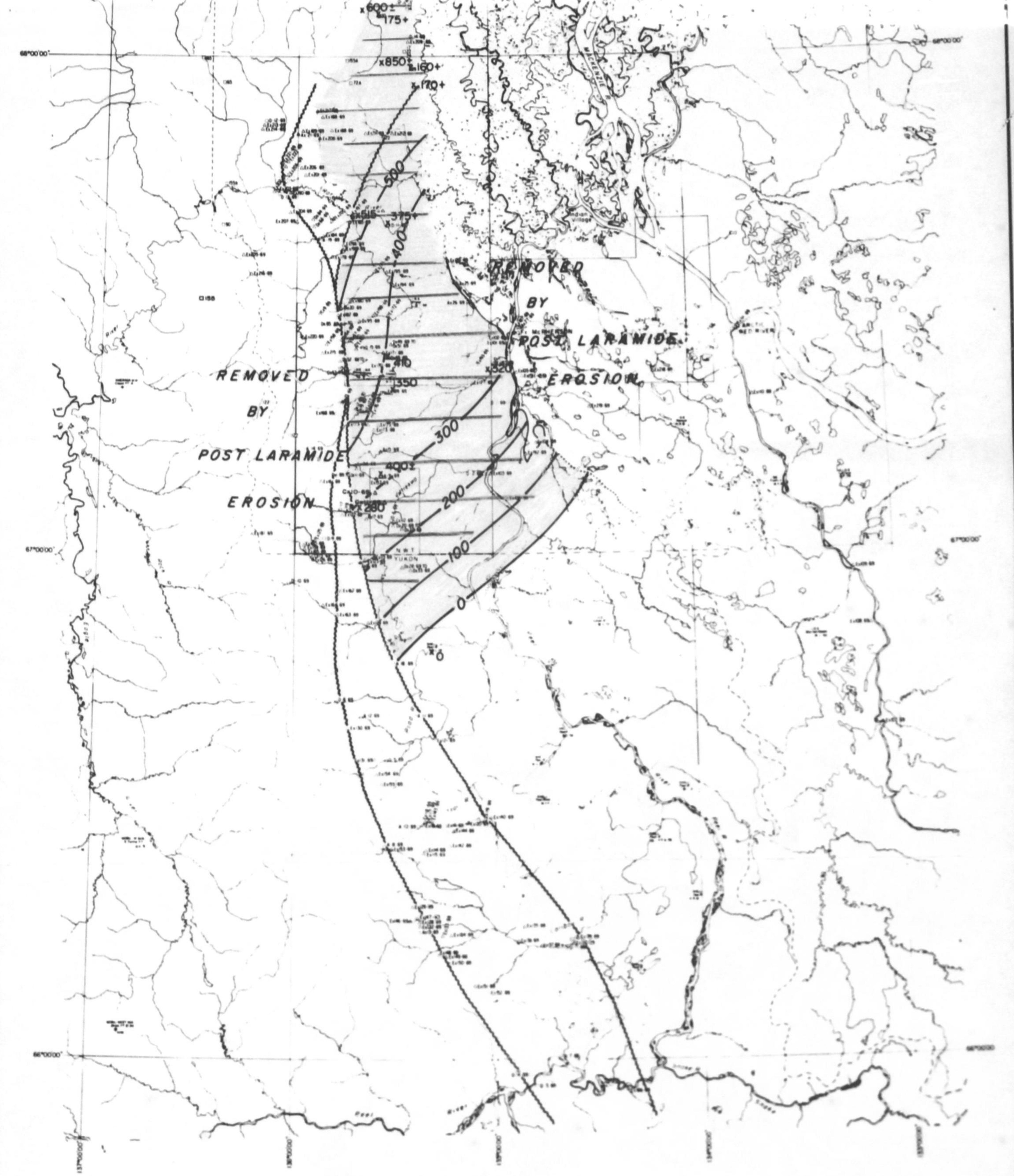
The Upper Shale-Siltstone Division was only identified with confidence west of the major strike slip fault. The southernmost exposure is at the south branch of the Vittrekwa River and the formation outcrops northward intermittently from there to the Donna River. Between the Vittrekwa River and Rat River the formation can be divided into two parts:

(a) The Lower 300 to 700 feet is composed of interbedded sandstone, siltstone and shale. The dominant lithology is black marine shale which is poorly fissile, silty and non calcareous. Siltstone and sandstone usually form less than 30% of the unit. The sandstones are very fine to fine grained, flaggy to slabby, hard and tight with only an occasional pelecypod mould. The siltstones are argillaceous, non calcareous, brownish grey and thin bedded. The unit is more resistant than the overlying shales but less resistant than the underlying North Branch Formation and weathers a distinctive brownish grey color.

(b) The upper 2,000 to 3,000 feet is composed of very dark grey to black, non calcareous poorly fissile to mudstone textured marine shale with intermittent rusty weathering clay ironstone bands. It weathers black and is industinguishable from the Albian Shale-Siltstone Division but is usually easily differentiated from the brown weathering Imperial Formation.

There are several good sections of Upper Shale-Siltstone Division in the Aklavik Range. Jeletsky divided it into a lower unit 1000 to 1200 feet thick composed of dark to blackish grey shale with numerous clay-ironstone concretionary bands and an upper unit 500 to 550 feet thick composed of interbedded hard fine grained sandstone, siltstone and shale.

The distribution of the Upper Shale Siltstone Division is apparently affected by the major strike-slip fault. West of the fault the thick sections are common but no rocks of this division have been definitely identified east of the fault. However, in the Stony Creek area east of the strike-slip fault 300 to 600 feet of interbedded sandstone, siltstone, shale and minor conglomerate is poorly exposed. No fauna was found in the rocks and microfossil studies have not been completed to date, but the rocks may be a shoreline facies of the Upper Shale-Siltstone Division. (They were included with the Upper Sandstone Division on the geologic map but they could be as old as Imperial Formation (Ex 177-69; Dx 12-69 to Dx 19-69; Ax 23-69). The sandstone is hard, fine to occasionally coarse grained, poorly sorted, siliceous, argillaceous flaggy to blocky bedded, tight sandstone with numerous bedding plane grooves and markings and some plant markings. The shale is dark grey, non calcareous, poorly bedded approaching a mudstone texture. The siltstone is flaggy bedded, argillaceous and non calcareous



2 of 2

COLOR CODE

- ☐ SANDSTONE
- ☐ SHALE

LEGEND

- ○ SECTIONS
- △ STRUCTURAL LOCATIONS
- ☐ PUBLISHED G.S.C. SECTIONS

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FORT McPHERSON AREA, N.W.T.

UPPER SANDSTONE DIVISION

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Date OCTOBER, 1969
C.I. 100

Figure 33

with occasional plant markings. Microfossil work may aid in the identification of these rocks. The area of exposure is very complicated structurally adding to the identification problem.

Jeletsky maps Upper Shale-Siltstone Division in the core of an anticline east of the major slip fault on the Rat River. These outcrops were not visited but Upper Shale-Siltstone Division could certainly be present on the east side of the fault at this location.

The contact between the Upper Sandstone Division and the Upper Shale-Siltstone Division is not exposed south of the Aklavik Range. In the Aklavik range Jeletsky describes this contact as mostly gradational with no indication of an erosional contact. The lower contact is well exposed on the north branch of the Vittrekwa River where it appears gradational with the North Branch Formation. However, it may be regionally unconformable as Jeletsky suggests. In the Aklavik Range Jeletsky describes a basal conglomerate which rests with a sharp uneven contact on the older rocks.

Only a few fossils (Peleypods) were found in this formation and these have not been identified to date. Jeletsky (Paper 59-14) discusses the fauna of this group in some detail. The fauna indicates the formation spans the time interval from late Hauterivian to late Barremian.

The unit contains no good reservoir beds although it is probably a good source rock. The shoreline facies probably contains coarser clastics which could be prospective.

Upper Sandstone Division

The Upper Sandstone Division is the name introduced by Jeletsky (Paper 58-2), for the mid-Lower Cretaceous sandstone overlying the Upper Shale-Siltstone Division. The division forms a mappable unit and as such should have formation status but it has not been named to date, nor has a type section been designated. Outcrops of the Upper Sandstone Division are widespread throughout the project area north of Latitude 67°00'. Many excellent sections are exposed although only a few were measured.

Between the Vittrekwa River and the Rat River the Upper Sandstone Division thickens from 300 feet to 500 feet (See Fig. 33). In this area the division can be subdivided into three distinct lithologic units:

(a) The lowermost 100 to 200 feet is mainly massive bedded, cross bedded, soft, friable, light tan, non calcareous, well sorted, fine grained, porous, quartz sandstone with occasional black, non calcareous shale beds 5 to 50 feet thick. Pelecypod remains are rare in this sand but some <u>Belemnites</u> were collected from the shale interbeds (Ex 169-67 and Ex 127-69). Vertical worm burrows are occasionally numerous in the soft sand which is probably a near shore marine deposit. (See Fig. 39). Locally south of "J" Lake a coarse, current cross bedded, pebble conglomerate is developed in the lower part of this unit. The light colored sands of this lower unit form the distinctive white cliffs which are seen along the banks of the Vittrekwa River, Stony Creek and the Rat River. This lower sand is locally absent in small areas near the Vittrekwa River.

(b) The middle 100 to 200 feet is generally poorly exposed. It is over 50% shale which is slightly calcareous to non calcareous, very dark grey and poorly fissile. Fine grained, brown to brownish-green, cross bedded, occasionally glauconitic, slabby to blockly interbeds of sandstone are 1" to 5 feet thick. These sands are harder and less porous than the underlying unit.

(c) The uppermost 50 to 100 feet is mainly fine grained, calcareous, cross bedded, flaggy to slabby bedded, greenish grey, glauconitic sandstone, usually carrying large quantities of pelecypods. Porosity in the sands in this unit is reduced by partial cementation with calcite.

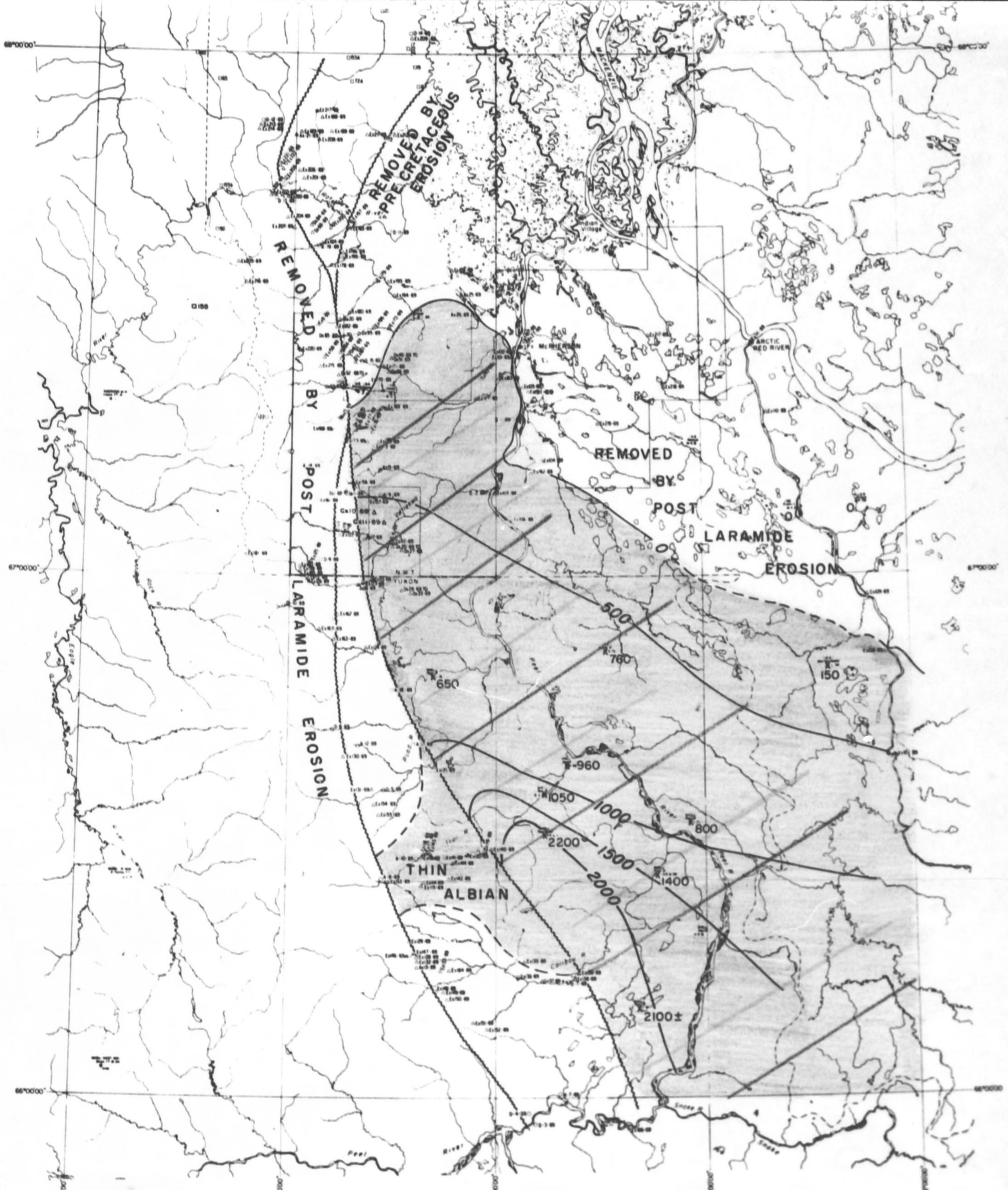
The southern limit of the Upper Sandstone Division cannot be defined exactly due to poor exposures south of the Vittrekwa River. It is 300 feet thick near "J" Lake but begins thinning noticeably in the southernmost exposures on the Vittrekwa River. Large tree trunks were collected from the formation at this locality. (Fig. 35). The Upper Sandstone Division was not identified on the Road River or on the Trail River, although the only good exposure of the Cretaceous-Mississippian contact is on the Trail River at Ex 143-69 where the unit was absent. The division was not recognized in the Shell Peel River YT L-19 well drilled between the Vittrekwa and Road Rivers.

In the Aklavik Range the Upper Sandstone Division is 600 to 900 feet thick. The 1969 field party did not examine any sections in this area but many are described by Jeletsky in his various publications.

The contact between the Upper Sandstone Division and the Albian shale was seen in many places. It is sharp but even and no evidence of angularity or erosion was noted. (Elevations were taken at this contact in many places over the permits in order to construct a structure contour map (See Plate IX). Jeletsky says this contact is everywhere sharp and uneven and a pebble conglomerate of varying thickness fills the depressions in the surface of the division. This relationship was not observed by the 1969 field party.

Jeletsky suggests there is a regional unconformity between the Upper Sandstone Division and the Albian Shale-Siltstone Division with perhaps the lower Albian time being unrepresented. This may very well be accurate as the Upper Sandstone Division strand line was near latitude 67°00' and the area was undoubtedly emergent at times prior to the advance of the Albian seas.

The contact between the Upper Sandstone Division and the underlying beds was examined at many localities and in the area south of Stony Creek it is everywhere sharply unconformable with angularity ranging from a few degrees to vertical. Little relief was seen on the unconformity indicating peneplanation may have been near complete prior to deposition of the Upper Sandstone Division. The contact is often marked by a layer of large round sandstone boulders up to 12" in diameter where the underlying beds are Mississippian clastics.(Fig. 37). Further north, where Upper Sandstone Division lies on the Imperial Formation these boulders are not present. North of the Rat River the Upper Sandstone Division lies on the Upper Shale-Siltstone Division. This contact was not studied but Jeletsky describes it as gradational with no indication of erosion. (NOTE: In paper 59-14 Jeletsky describes an angular unconformity within the Upper Sandstone Division in the Stony Creek-Vittrekwa River Area. This is presumably the same unconformity described above. Several samples were taken from the rocks immediately underlying this contact to verify a Paleozoic age and at one locality (DX 20-69 to DX 27-69) Carboniferous plants were collected and identified. It is felt that when further microfossil identifications are made it will be substantiated that the sediments underlying the unconformity are Paleozoic).



COLOR CODE

▨ SHALE

▨ SILTSTONE

▨ SANDSTONE

LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

☐ PUBLISHED G.S.C. SECTIONS

AMOCO CANADA
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FORT McPHERSON AREA, N.W.T.

ALBIAN SHALE
SILTSTONE DIVISION

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Figure No. 40	Date [illegible]
Scale 1" = 64,000	[illegible]

2 of 2

Several fossil collections were made from the Upper Sandstone Division but these have not been identified to date. Thin shelled, chalky pelecypods are the dominant fossil type. Jeletsky's publications give a detailed discussion of the fauna which indicates the division spans the time interval from latest Barremian to late Upper Aptian.

The Upper Sandstone Division would make an excellent reservoir with porosity estimated at 15 to 25% with very good permeability. Unfortunately this unit outcrops very extensively throughout the area and any hydrocarbons have probably escaped.

At Ex 169-69 on Stony Creek (latitude 67°19'N, longitude 153°33'W) six feet of the fine grained, well sorted sandstone of the lower member of this unit had a brown oil stain and a strong petroliferous odor. Several samples of this were collected.

Albian Shale-Siltstone Division

The Albian Shale-Siltstone Division was introduced by Jeletsky (Paper 59-14) for the Late Lower Cretaceous shales covering the south eastern portion of the project area. This unit is a distinct mappable unit and should be named and have formation status. The unit is approximately equivalent to the Sans Sault Group of the Mackenzie basin area and could be referred to that group.

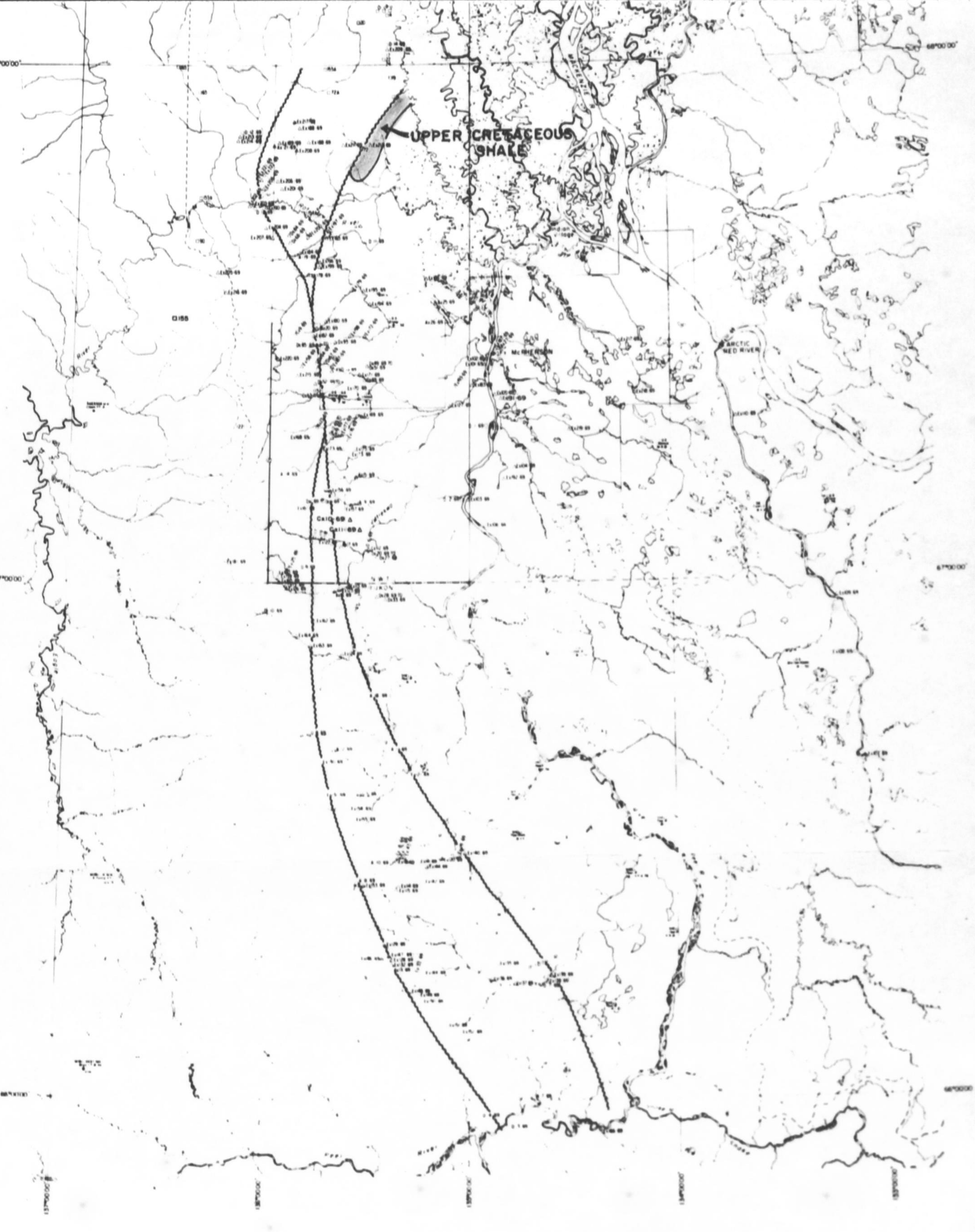
No sections of the Albian Shale-Siltstone Division measured by the 1969 field party but the formation was examined in a few locations on traverses and spot landings.

The Albian Shale-Siltstone Division is a monotonous sequence of dark grey, poorly fissile grading to mudstone textured, silty shales with numerous bands of clay ironstone concretions. Siltstone beds occupy less than 20 percent of the entire interval and argillaceous silty sandstone occurs often near the base of the unit. The sands are thin bedded, cross bedded and often exhibit numerous plant markings and fragments.

A thick glauconitic sandstone has been reported at the base of this interval near the Peel-Snake River junction. The basal Albian is not well exposed through the area. The contact was studied on the Trail River where no thick sandstone was present and it was observed in many places from the Vittrekwa River northward and no significant development of basal Albian sandstone was noted. Near the mouth of the Vittrekwa River there is at least 20 feet of conglomerate composed of angular fragments of sandstone and chert up to 12 inches. This has been referred to as Devonian by Jeletsky but it could be basal Albian (or Upper Sandstone Division). A 50 foot thick coarse grained green, porous, glauconitic sandstone with occasional belemnites occurs on the Vittrekwa River at latitude 66°59'; longitude 135°36' (Ax 16-69). This sand, which would make an excellent reservoir could be either basal Albian Shale-Siltstone Division or Upper Sandstone Division equivalent.

The Albian Shale-Siltstone Division disappears north of Stony Creek either due to pre Cretaceous erosion or non deposition. The formation gradually thickens southward to over 2,000 feet thick.

The upper contact between the Upper Cretaceous and Albian was not observed and probably does not exist in the project area. It is evidently regionally unconformable resulting in the absence of Albian Shale-Siltstone Division north of the Rat River. The contact between the Upper Sandstone



2 of 2

LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

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AMOCO CANADA
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FORT McPHERSON AREA, N.W.T.

UPPER CRETACEOUS SHALE

G.W.F.X.B.-100	Compiled By C.H.RIDDELL
Figure No. 41	Date OCTOBER, 1969
Scale 1"=64,000'	

Figure 41

Division and the Upper Shale-Siltstone Division was discussed previously. The contact between the Albian and the Mississippian clastics was only observed at one locality, Ex 143-69, on the Trail River. Here there was a strong angular unconformity with the underlying beds being truncated at a 30 degree angle (See Fig. 21). Only 2 - 5 feet of basal sand was observed at this location.

Jeletsky has identified several species of ammonite from the division which indicate the base of the division is late lower or early middle Albian and higher beds are assumed to include younger Albian zones. The division evidently does not include any Upper Cretaceous rocks.

The only potential reservoir beds found within this Division are the 50 feet of porous glauconite sandstone which occur on the Vittrekwa River. This had excellent porosity and permeability and if it was found in trap position possibly in the southeastern portion of the project area it could produce accumulations similar to the Basal Quartz and Glauconite of southern Alberta. It is not known how widespread the sand is or what is controlling its distribution.

Upper Cretaceous

The youngest beds present within the project area are unnamed Upper Cretaceous shales which outcrop east of the Treeless Creek fault north of the Rat River. The shales were only studied at one locality on Treeless Creek where they consisted of light to medium grey, soft, muddy shale often appearing bluish grey from aerial observation. Jeletsky (59-14) provides a detailed discussion of the unit.

The contact between the Upper Cretaceous and the Upper Sandstone

Division was not observed but Jelestsky describes an eight foot glauconitic basal pebble conglomerate which rests with an uneven and sharp boundary on the Upper Sandstone Division on Treeless Creek.

The exact age of the Upper Cretaceous is unknown due to a poor faunal assemblage but the lowest beds are probably earliest Upper Cretaceous and they may include beds as late as Coniatian.

TECTONIC HISTORY

The project area is at the north end of the Cordilleran geosyncline and has at times been affected by the events and trends of the Franklinian geosyncline to the north.

Precambrian exposures are only known at one locality but there is probably a considerable thickness of sediments before crystaline basement is reached. The Precambrian probably closed with a major orogeny.

Exposures of the Cambrian are too fragmental to determine any facies trends. From late Cambrian through Silurian time the Richardson Mountains were the axis of a shale basin with the shelf type carbonates being deposited on either side. The carbonate shelf deposits were probably deposited in shallow water while the deeper Richardson trough may have been fringed by a reef front at the carbonate edge. Sedimentation in the trough apparently kept pace with sedimentation on the shelf during the Ordovician and Silurian. However, during the Devonian the shale section appears to be thinner than the corresponding shelf carbonate section and it is suggested the Richardson trough was starved during this period. (Note - this is in sharp contrast to the hypothesis of other workers who have postulated a Middle Devonian high in the area. There is no evidence of a major unconformity at this contact anywhere in the area). Reefoid Middle Devonian carbonates extended farther westward into the shale basin (Prongs Creek biostrom).

The end of the Middle Devonian was marked by a period of subsidence and deeper water deposition over the entire area during which the siliceous Fort Creek shales were deposited in the Richardson trough and over the shelf areas as well.

During Frasnian time a major orogeny occurred along the north coast of Canada probably extending from Alaska to Ellesmere Island. A major mountain chain was built which shed a thick clastic wedge, several thousand feet thick, southward. Large deltas were probably built and the project area must have undergone rapid subsidence. The sequence becomes finer and more marine southward. The delta or clastic wedge prograded southward through Devonian time until by the beginning of Mississippian time the shoreline was at about latitude 67°00'. Thus during Mississippian time the north half of the project area was emergent, while the south half was receiving clastic, continental to marginal, deposition.

During the Permo-Pennsylvanian the southern portion of the area may have been emergent. An orogeny occurred over the north half of the permits during the Carboniferous prior to the deposition of the Permo-Pennsylvanian clastics and limestones. The southeast shoreline during the Permo-Pennsylvanian was just southeast of the Rat Lake.

The geologic history during the Triassic and Lower Jurassic is unclear as the only deposits known are the thin limy sands of Upper Triassic age south of Caribou Lake and the possible Triassic clastics on Brat Creek. It is possible that the area was mainly emergent during this time. Sometime during the Lower Mesozoic a major orogeny occurred over the entire project area at least as far south as the Trail River and a considerable amount of erosion occurred.

During Middle Jurassic the north portion of the project area began subsiding and subsidence continued into Aptian time. The southern shoreline fluctuated during the time but usually remained north of 67°00'. During this period a thick clastic succession of Jurassic and Lower Cretaceous was deposited, thickening to the northwest.

In late Aptian time, the area became emergent briefly before the Albian Shale-Siltstone Division began being deposited over the south portion of the area. The Albian shoreline was at about latitude 67°30'. The pre-Albian emergence was probably epeirogenic rather than orogenic.

The portion of the project area south of the Rat River has no Upper Cretaceous and Upper Cretaceous may have been confined to the northeast corner of the project area.

STRUCTURE

Pre Laramide Structure

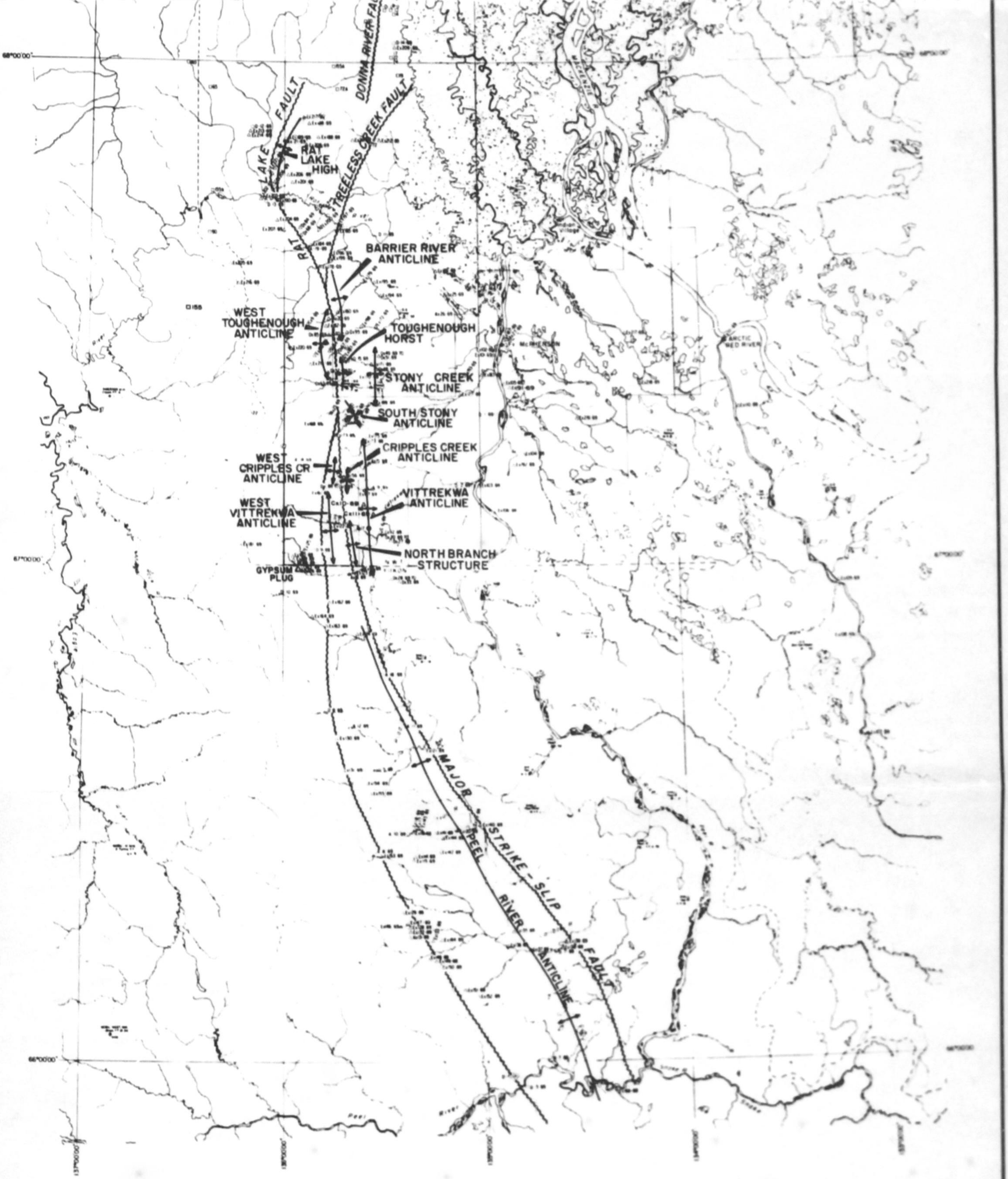
The East Flank of the Richdson Mountains has undergone several major and minor orogenies during geologic time. Major orogenies occurred prior to the deposition of the Cambrian beds as well as pre Permian and pre Middle Jurassic while minor unconformities are present in the upper lower Cretaceous (pre Albian) and between the Upper and Lower Cretaceous.

The pre Permian and pre Middle Jurassic unconformities are not pronounced south of the subject permits but this is probably a function of the exposures as this contact is not exposed very often. The contact is exposed on the Trail River at (latitude 66°28', longitude 135°21') where the angularity is about 30 degrees degrees with the apparent truncation westward. The contact was not seen on the Caribou River but the angularity there would probably be slight. It is interesting to note that the Cretaceous beds south of the permits are all nearly flat, as are the Triassic beds south of Caribou Lake which could indicate that some of the structure seen on the east flank of the Richardson Mountains is pre Mesozoic structure.

North of latitude 67°00'N the angularity between the Upper Devonian, Imperial Formation (and/or the Mississippian clastics) and the overlying beds varies up to 90 degrees. Faulting and drag folding has been seen which obviously occurred during a pre Cretaceous orogeny. (See Fig. 36). The strike of the old structure is difficult to determine precisely as the beds have been re-oriented by later folding but the strike probably averages 060°.

On the east side of the major strike-slip fault the beds beneath the Cretaceous all are truncated northward. No reversals were noted in the windows where beds below the unconformity are exposed but control is very loose. The Vittrekwa anticline may form a trap at the north plunge-out as a result of the pre Laramide structure if structure continues of depth. The carbonate section would be rising to the north but reversal may be caused by the plunge-out of the Laramide structure. At any rate, the carbonate section should be rising to the north across the permits east of the strike-slip fault and the trend of any pre Laramide structures should be about 060°. North of the Barrier River the Upper Devonian has been entirely removed by pre Jurassic erosion or non deposition and the Jurassic rests on Fort Creek and Prongs Creek. In the Horn Lake high the pre Jurassic structures appear to strike about 060° and it is difficult to determine the strike of the pre Permo-Pennsylvania structures. West of the major strike-slip fault the Imperial is truncated southward through the permit area with angularity ranging from 2 degrees to 20 degrees; thus the truncation is opposite to that on the other side of the fault. The pre-Jurassic attitudes have been mapped in this area but the Laramide structure is the dominant structure.

In any interpretation of the structure or in the selection of a drilling location, the pre Laramide structure must be considered. These structural trends could provide several unmapped closures especially where crossing Laramide features or reef edges. A major orogeny must have occurred north of the Rat Pass immediately prior to or during the Upper Devonian causing highlands from which the Imperial Formation was derived. The trend of these mountains was north east. While no orogeny could be identified at this time over the permits or to the south, the trend of this deformation is similar to that of the pre Jurassic deformation. It is not known if the Rat Lake area underwent this deformation.



LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

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FORT McPHERSON AREA, N.W.T.

MAJOR STRUCTURAL FEATURES

Figure No. 42

2 of 2

Figure 42

Laramide Structure

The Richardson Mountains are formed by a large north plunging anticlinorium over 100 miles long and 40 miles wide. The oldest rocks exposed in the core are apparently Pre Cambrian and the youngest beds along the flanks are Upper Cretaceous. The main portion of the core of the anticlinorium is composed of Cambrian rocks which are not mapped in detail but large symmetrical folds and some steep dipping faults were noted in the mountain core.

The orientation of the mountains was undoubtedly influenced by the lower Paleozoic stratigraphy. The mountains formed along the shale trough between the thick carbonate sections which occur along the flank of the mountains.

The report is mainly concerned with thestructure of the east flank of the Richardson Mountains.

The east flank of the Richardson Mountains between the Peel River and the subject permits is characterized by steeply dipping beds ranging in age from Cambrian to Mississippian. Major faults are present with steep fault planes that can be either normal or reverse. The upthrown block is mainly the west block. The beds are highly contorted in the vicinity of the fault and small tight folding and some bedding plane faulting is seen throughout this area. This type of structure persists east to about the first Cretaceous beds and possibly a fault exists along the top of the vertical dipping Mississippian clastic beds which form a prominent ridge across the country. Some faulting almost certainly occurs here as the Mississippian is vertical while a few hundred yards east the Cretaceous is near horizontal.

East of this Mississippian ridge the structure becomes much less complex, and is gently rolling as far east as the major strike slip fault. The mammoth Peel River structure extending from the Peel River to the Vittrekwa River is present in this belt. This structure was not mapped in detail but several culminations could occur along it.

Contorted beds in the Albian shales were seen where the major strike-slip fault crossed the Trail and Caribou Rivers. East of this fault the dips rarely exceed 3 degrees and are generally flat.

The permits are located on the east flank of the Richardson Mountains at a point where the Paleozoic rocks are plunging rapidly northward. The permit areas west of the major strike-slip fault are structurally very complex with many major faults and minor faults. The structural trend is approximately north-south. Several closed structures have been mapped in this area and these are dealt with separately in the following pages. The structural habit similar to that of the Rat Lake area in that the structures are mainly domes, closing in all directions, with steep, and often faulted flanks. The difference is that these structures are mainly oriented in a north south direction. The permit areas immediately east of the strike-slip fault contain several attractive closed structures which are discussed later. The structures are usually faulted on one limb but are not as complex as the structures west of the fault. The limbs of the anticlines rarely exceed 30 degrees. East of these structures Cretaceous beds dip gently south east. See Plate X, Structure Contours (over the eastern portion of the permits) on top of the Upper Sandstone Division.

North of the permits and west of the Treeless Creek fault, domal structures predominate, often faulted on the flanks or through the core.

The faults appear to be all steeply dipping. The structures have varying trends and their orientation almost appears random. Evaporite tectonics may be the mechanism by which these structures were formed.

South east of the Treeless Creek fault the structure is much less complex. Some structural highs are present adjacent to the fault and the area to the east is generally flat to gently dipping.

One of the dominant structural features of the project areas is the abundant long steeply dipping faults which have been referred to before. The most important of these is the fault running from the Peel River to Treeless Creek and from there probably north along the edge of the Delta. The fault plane was seen in several places and usually dipped about 60° west. The age relationship from one side of the fault to the other changes from normal to reverse along the fault. The stratigraphy changes markedly across the fault in several places. For this reason it is believed to be a strike slip fault with possibly several miles displacement. Along the Vittrekwa River a particularly noticeable change in stratigraphy occurs. On the west side of the fault the Imperial Formation is overlain by about 600 feet of Jurassic North Branch Formation which in turn is overlain by about 3,000 feet of Upper Shale-Siltstone Division. On the east side of the fault Upper Sandstone Division lies on Mississippian clastics. The Mississippian clastics are thin to absent on the west side of the fault while the North Branch Formation and Upper Shale-Siltstone Division are absent on the east side of the fault. This condition can be observed in several creek cuts west of "J" Lake and the changes appear to be much too rapid to be depositional changes.

Another major change across this fault in the Permit area is that on the west side the Imperial clastics are truncated southward while on the east side the Imperial clastics are truncated northward both over distances exceeding 10 miles.

The fault trace is well defined through the permit areas but is difficult to follow to the south and to the north. To the south the fault appears to join the Trevor Mountains faults but it could join one of the major faults further west. Exposure makes it difficult to trace the fault. Similarly to the north the fault plane is difficult to trace although it can be followed to the southmost drainage of Barrier River. Here the fault appears to split into two major faults; the Rat Lake fault and the Treeless Creek fault (NOTE: The Donna River fault on Jeletsky's map (Paper 59-14) is not a major strike-slip fault and the major fault appears to be the Treeless Creek fault. There appears to be no important strike-slip movement along the Donna River fault and indeed the fault cannot be seen to cross Treeless Creek where Jeletsky has indicated it should cross (See Fig. 32). It is believed that the Donna River fault is a steeply dipping normal fault with little or no strike-slip movement).

There are important changes in stratigraphy across the Rat Lake fault also. Five miles south of Rat Lake, Jurassic beds overly Prongs Creek shale with possibly a little Permo-Pennsylvanian between. On the west side of the fault Jurassic Bug Creek Formation overlies an estimated 3,000 feet of Permian and 4,000 feet of Upper Devonian.

Other explanations can be advanced to explain the distribution of rock units on either side of these faults. One hypothesis could be a "bouncing" block theory and a complicated series of erosion and non deposition and tilting wedges but it becomes difficult to believe. Another hypothesis might be that the units deposition were controlled by the fault but surely 3,000' of shale (Upper Shale-Siltstone Division) would not be present on one side and absent on the other without any evidence of shoreline facies.

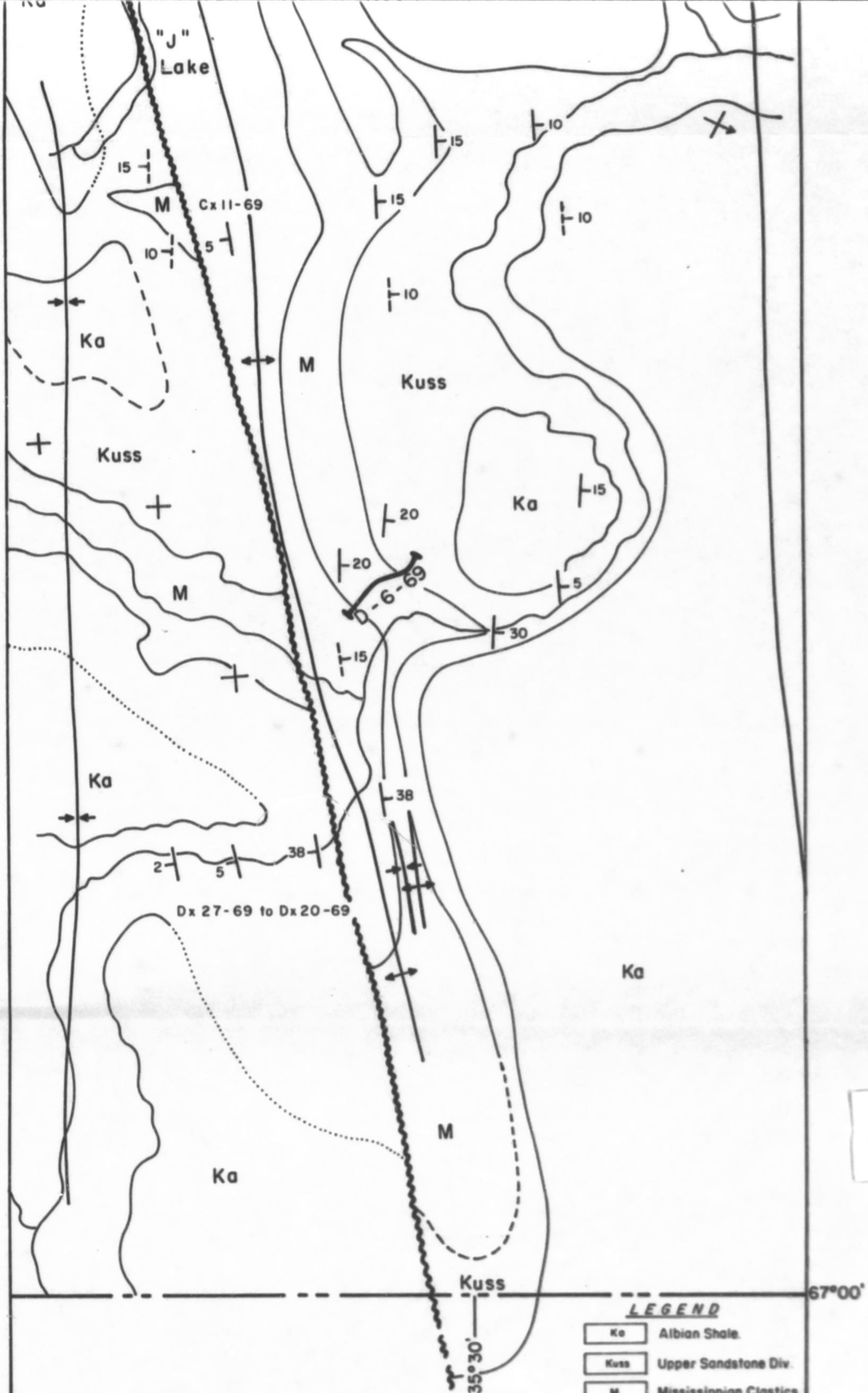
Other workers have postulated strike-slip faults in this area but all are of the opinion that the movement was right lateral. The distribution of formations would indicate that the movement is probably left lateral (the west block moves south relative to the east block). There is no published data indicating why other workers believe the movement to be right lateral. The Jurassic and Lower Cretaceous formations thicken to the north and the southern limit is much farther south on the west side of the fault. The Mississippian clastic unit thickens to the south of the northern limit of Mississippian appears to be much farther north of the east side of the fault. The Permo Pennsylvanian unit thickens northward and it appears to extend much farther south on the west side of the fault. The distribution of Imperial clastics appears to be somewhat contradictory in that they extend much farther north on the west side of the fault. This could indicate that the Treeless Creek fault is the major strike-slip fault and the absence of Upper Devonian in the Rat Lake high occurs on the west side of the fault. However, an explanation is still required for the presence of Imperial Formation to the west of the Rat Lake fault.

The evidence appears to point fairly strongly to the fact that the fault is a major strike-slip fault with left lateral movement. The amount of offset is unknown but could easily exceed 30 miles.

Several other long steeply dipping faultsexist to the west of this fault; some apparently have no lateral movement but it is very probable that some have a considerable amount of strike-slip movement. One of these crosses the Trail River faulting Cambrian limestone against Road River or Prongs Creek shale (Fig. 44). The fault is steeply dipping and has a fault zone of contorted beds on either side of the fault. Another major fault runs north-south on the east side of Teeweechee Mountain and is accompanied by severe contortion on the east fault block.

Major steeply dipping faults occur on the west flank of the Richardson Mountains as well. These were only observed briefly and there is not known whether there is any lateral movement.

It is possible that the carbonate edge may coincide with the major strike-slip fault, being a zone of weakness although the fault may be controlled by something much deeper. If seismic indicates that the carbonate edge coincides with the strike-slip fault it may be worthwhile tracing the fault north of the project area on the assumption that it defines the reef edge. This would be a very economical way to select acreage for farmin or purchase.



3 of 3

AMOCO CANADA
PETROLEUM COMPANY LTD.

FT. McPHERSON AREA, SURFACE GEOLOGY
VITTREKWA ANTICLINE
G.R.FXB-100 Compiled By: C.H.RIDDELL
Figure No: 48 Date: OCTOBER, 1969
Scale: 1" = 4000'

Evaluation of Closed Structures On and Near the McPherson Permits

The Western portion of the permit areas and areas to the north of this are characterized by elongate structures which plunge steeply in both directions. Few areas offer the number of closed structures found in this area. The reason for the existance of these structures is unknown but the possibility of salt (or other evaporites) tectonics is suggested as a possibility. The presence of known gypsum intrusions perhaps lends support to this theory. (See section on gypsum intrusions following).

The following pages present a summary of the closed structuresmapped on and near the permit areas. It should be stressed that these are Laramide structures and when the deeper horizons is being evaluated, consideration must be given to the pre Laramide structure as well. It is not known if the shape of these structures persists to depth.

Vittrekwa Anticline

The Vittrekwa anticline is one of the best defined structures within the area of interest. It is a doubly plunging faulted anticline with Imperial Formation exposed in the core and Albian Shale-Siltstone Division exposed on the flanks.

The east limb of the anticline dips 10-30 degrees over about a mile before the beds become essentially horizontal. The west limb is a steeply dipping fault with about 500 to 1,000 feet of throw. The south plunge is quite well established but poor exposures make the north plunge difficult to map.

The structure is 20 miles long and about one mile wide with vertical closure of about 1,000 feet and aerial closure of about 10,000 acres. Exposures in the area are good and the structural configuration is quite certain.

West Vittrekwa Anticline

The subject structure lies at latitude 67°05', longitude 135°45' east of "J" Lake. It is a structurally complex, north-south trending, faulted anticline with Imperial in the core.

The east limb is steeply dipping with beds as young as Upper Shale-Siltstone Division exposed on the flank. The west side of the structure is a steeply dipping to vertical fault with Imperial on the east and Jurassic rocks on the west. North plunge is well established as Jura-Cretaceous rocks wrap around against the fault to the north. It is not known how much south closure there is but there is apparently at least a slight reversal before the structure continues rising southward.

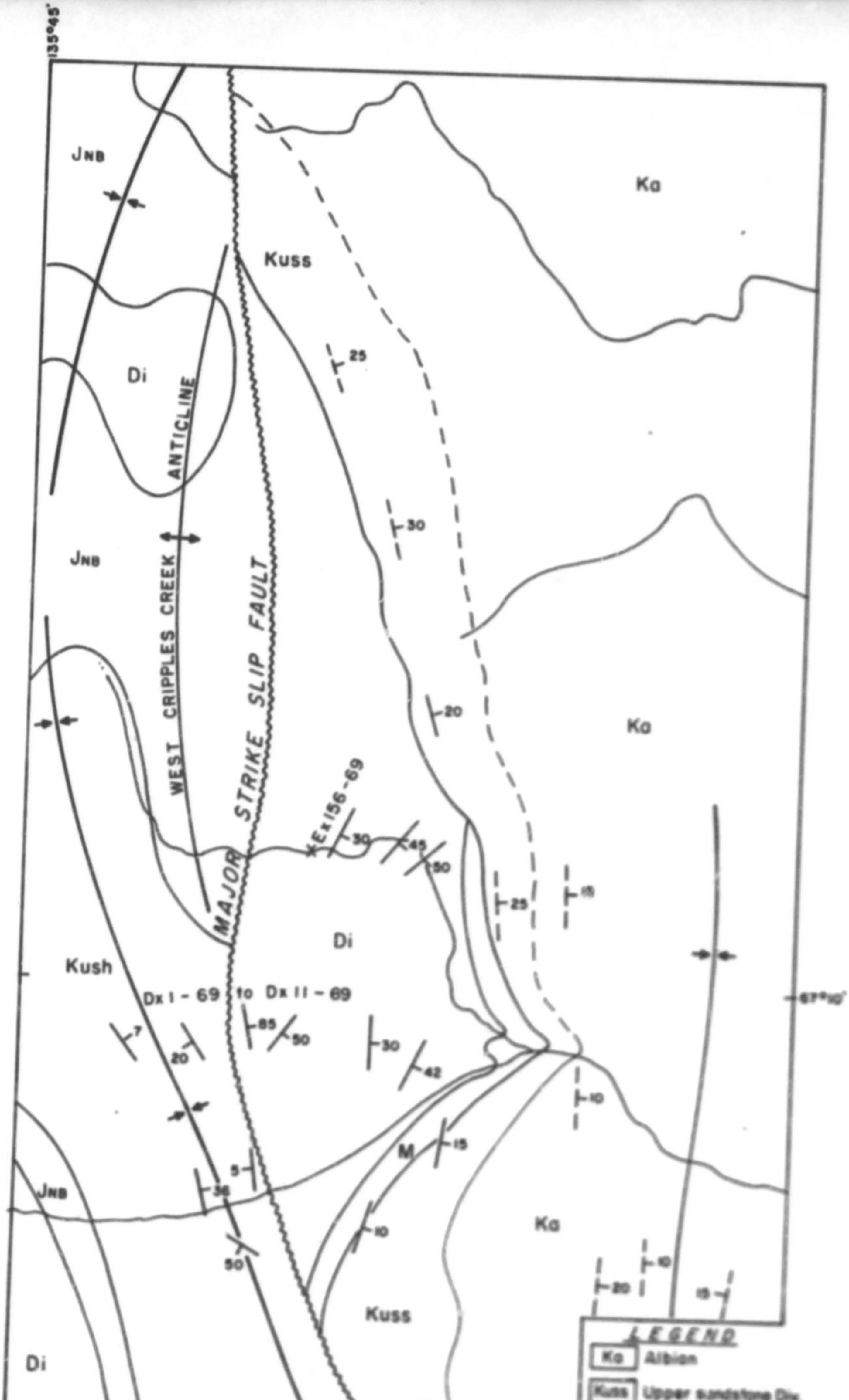
The West Vittrekwa structure is 6 - 8 miles long and one-half to one mile wide and vertical closure of perhaps 300 - 500 feet. The aerial closure is probably about 3000-4000 acres. The highly complex structure and the doubtful south closure may make this structure less prospective than others initially.

North Branch Structure

The North Branch anticline located at latitude 67°00' and longitude 135°40' is similar to the Cripple Creek structure which lies just north of the structure but exposures in this area are poor.

West closure is supplied by the major strike-slip fault while east closure is supplied by 5-20° east dip for over a mile. Exposures are poor at the north and south ends but closure almost certainly exists.

The subject structure is about eight miles long and one mile wide and vertical closure of probably 400-500 feet. Aerial closure is about 5000 acres.



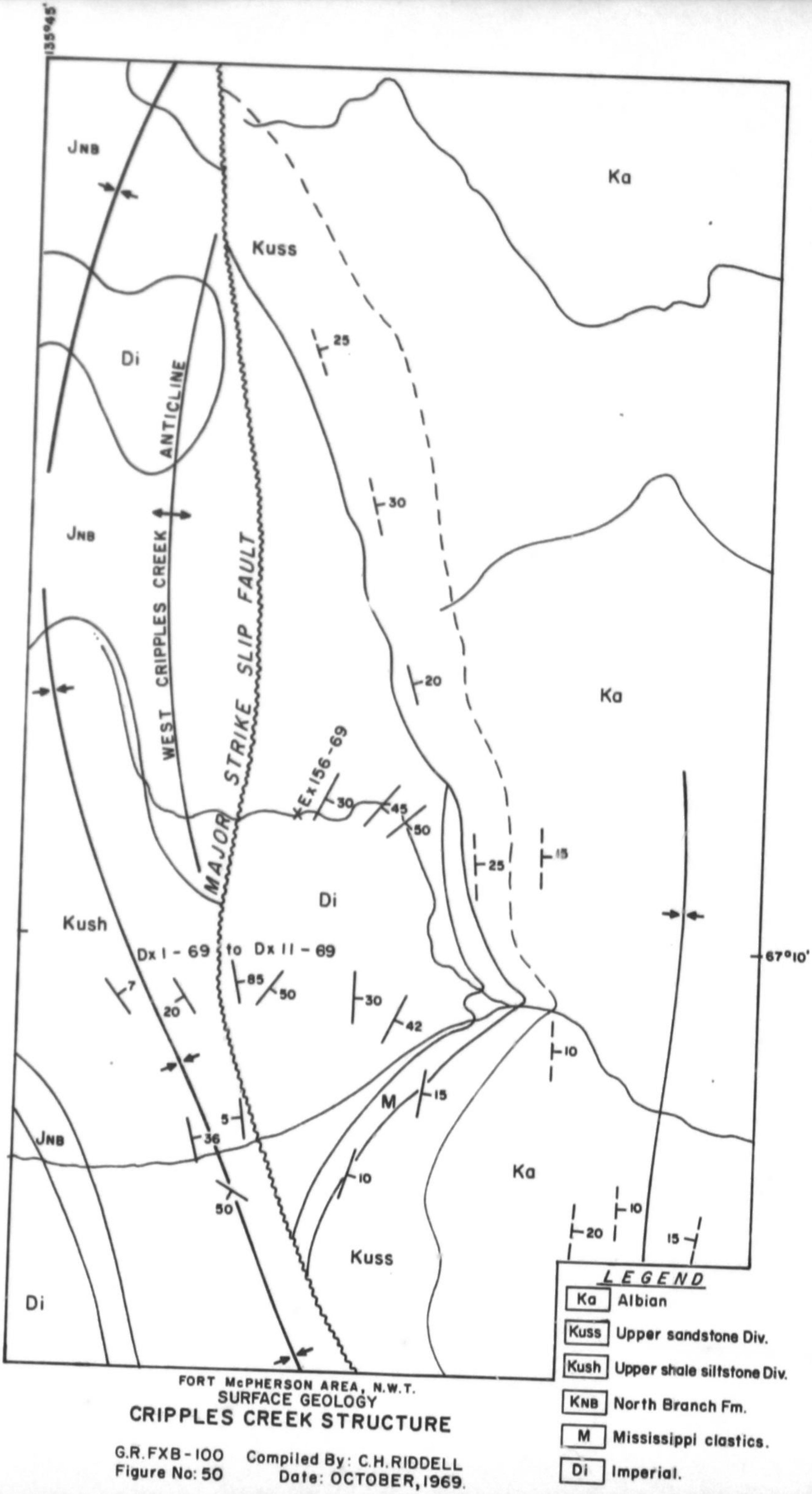
FORT McPHERSON AREA, N.W.T.
SURFACE GEOLOGY
CRIPPLES CREEK STRUCTURE

G.R.FXB-100
Figure No: 50

Compiled By: C.H.RIDDELL
Date: OCTOBER, 1969

LEGEND

Ka	Albian
Kuss	Upper sandstone Div.
Kush	Upper shale siltstone Div.
KNB	North Branch Fm.
M	Mississippi clastics.
Di	Imperial.

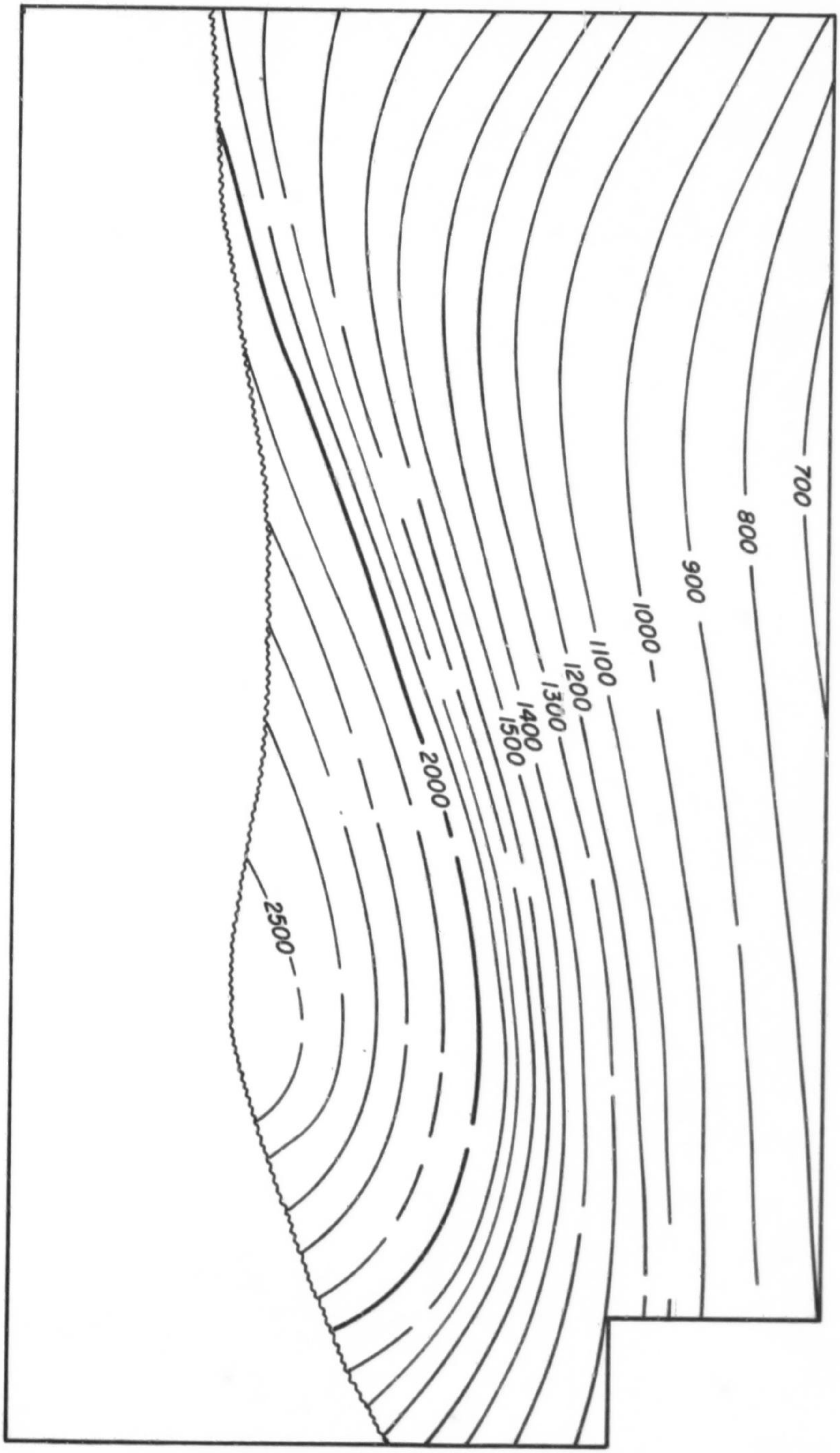


LEGEND

Ka	Albian
Kuss	Upper sandstone Div.
Kush	Upper shale siltstone Div.
KNB	North Branch Fm.
M	Mississippi clastics.
Di	Imperial.

FORT McPHERSON AREA, N.W.T.
SURFACE GEOLOGY
CRIPPLES CREEK STRUCTURE

G.R.FXB-100 Compiled By: C.H.RIDDELL
Figure No: 50 Date: OCTOBER, 1969.



TOP OF UPPER SANDSTONE DIVISION

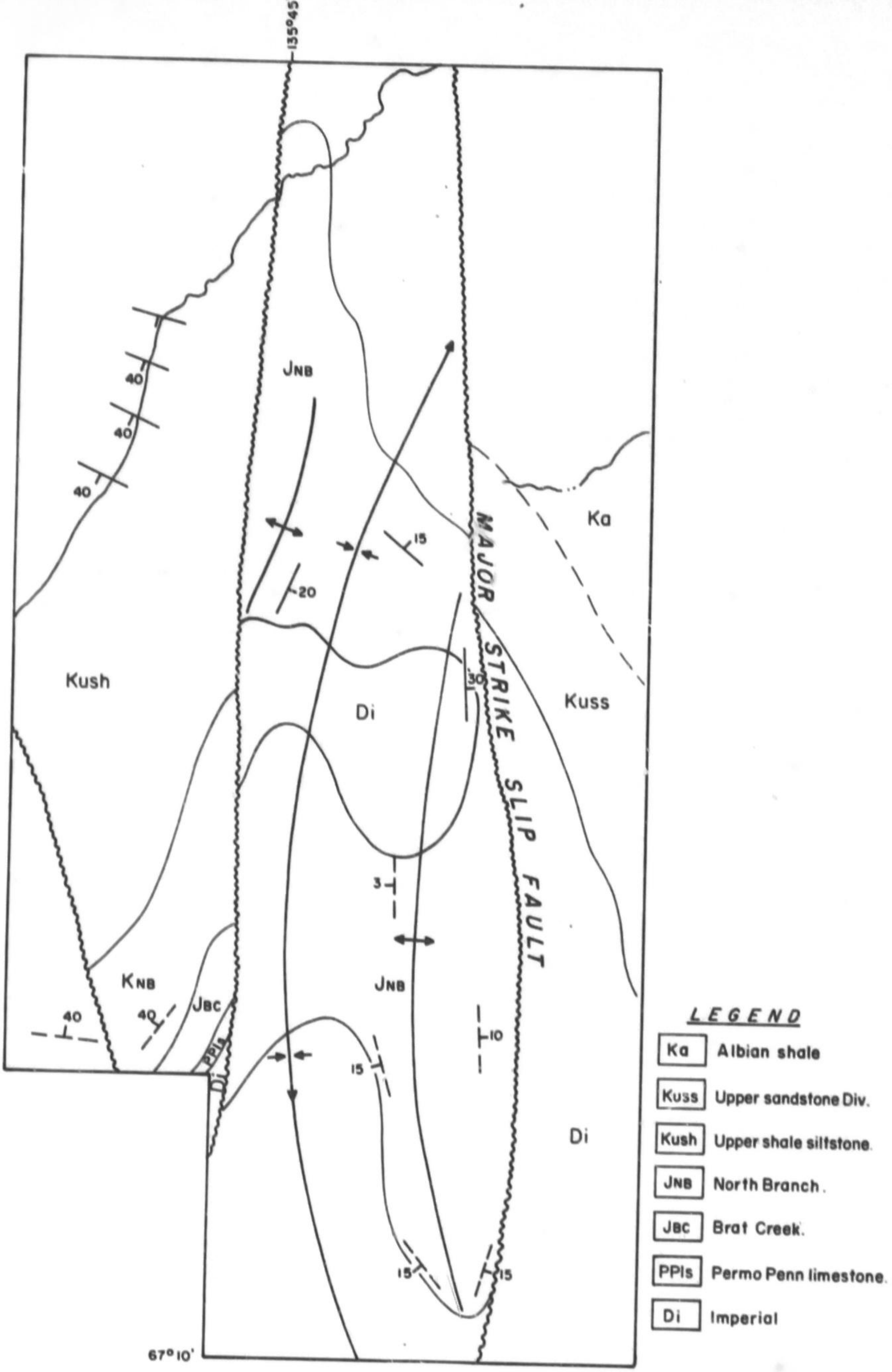
C.I.: 100'

Cripples Creek Structure

The Cripples Creek structure is the name given to the triangular shaped high on the east side of the major strike slip fault two miles north of "J" Lake. The exposures are good and the structure is quite well defined.

West closure is supplied by the major strike slip fault while east closure is supplied by east dip for about one mile at 10-25°. The core of the structure is highly contorted Imperial with Albian shale on the flanks of the structure. Albian shales wrap around against the major strike-slip fault north and south of the structure, indicating the extent of closure in these directions.

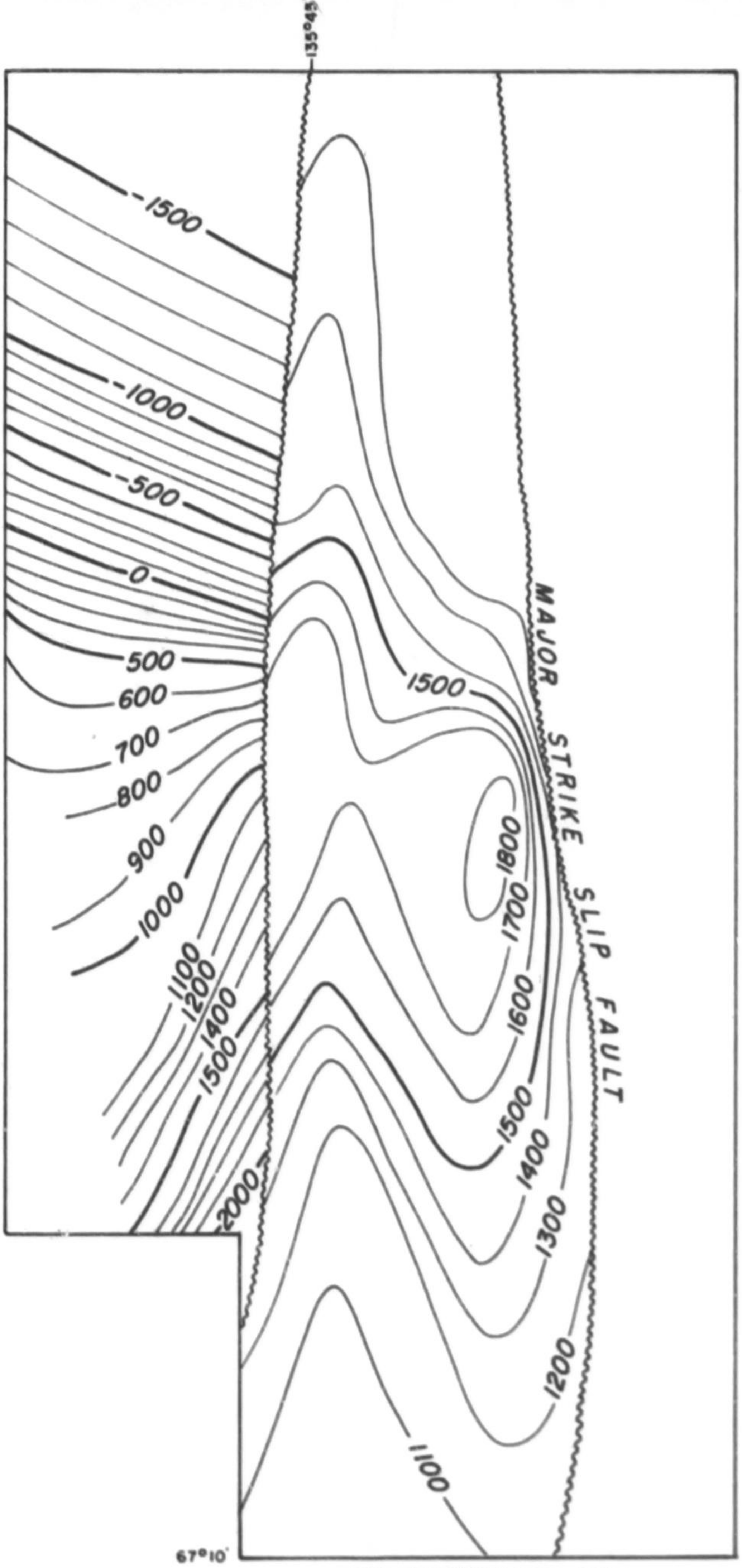
The structure is about six miles long and one mile wide. Vertical closure is about 600-800 feet while aerial closure is about 2000 acres.



FORT McPHERSON AREA, N.W.T.
WEST CRIPPLES CREEK STRUCTURE
SURFACE GEOLOGY

G.R. FXB-100
Figure No: 52
C.I.: 100'

Compiled By: C.H. RIDDELL
Date: OCTOBER, 1969.
Scale: 1" = 4000'



FORT McPHERSON AREA, N.W.T.

WEST CRIPPLES CREEK ANTICLINE

BASE OF JURASSIC S.C.M.

G.R. FXB-100
Figure No: 51
C.I.: 100'

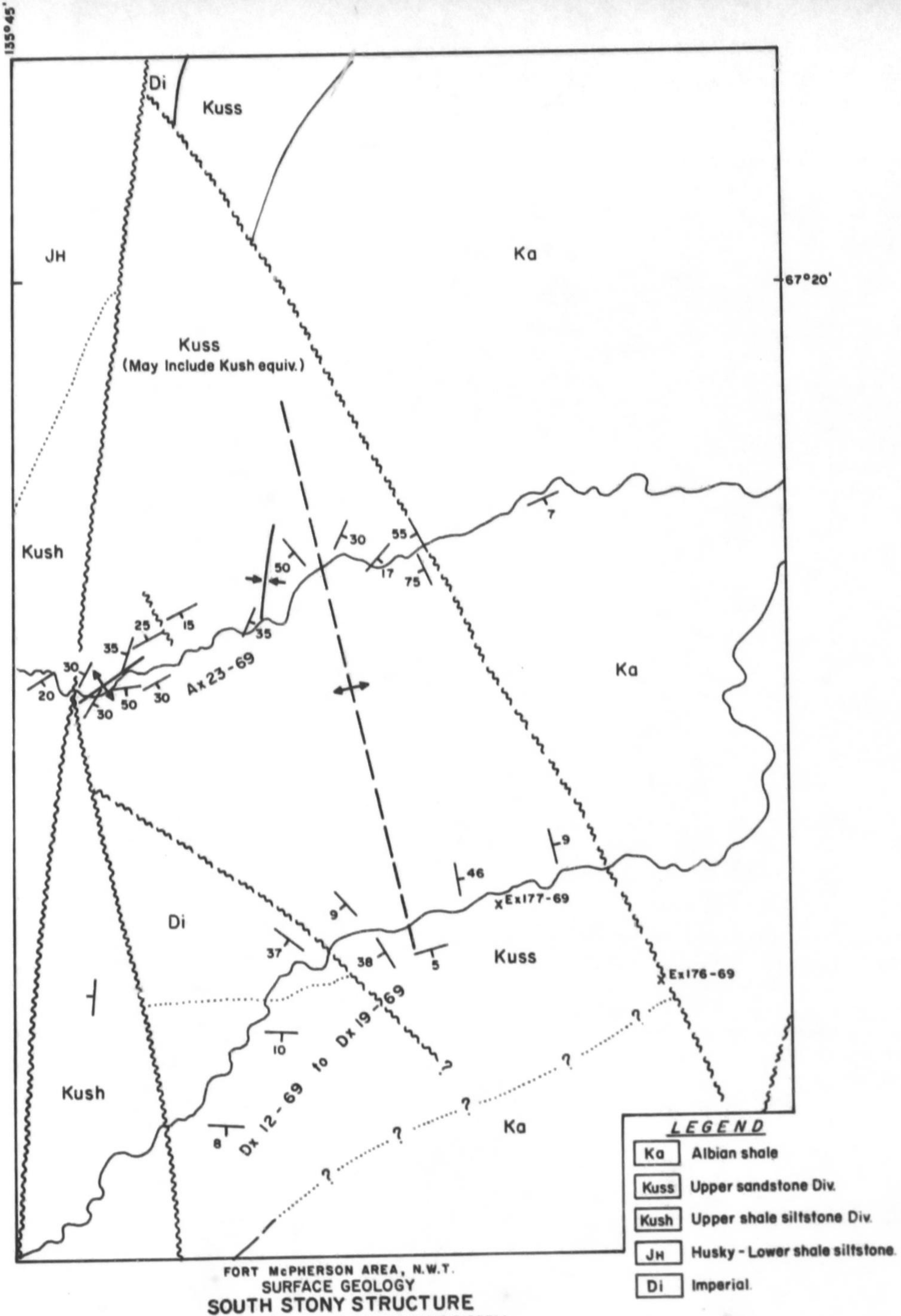
Compiled By : C.H. RIDDELL
Date: OCTOBER, 1969.
Scale: 1" = 4000'

West Cripples Creek Anticline

The subject structure lies on the west side of the major strike-slip fault immediately west of the Cripples Creek structure. Exposure is good and control on the structure is quite good.

The structure is a doubly plunging anticline with faults on the east and west supplying additional closure. A topographic expression of the structure is supplied by the North Branch Formation which is at surface over most of the area (See Fig. 53), Imperial is exposed in the creek cut running through the culmination of the structure.

The structure is six miles long and one mile wide and has vertical closure of about 700 feet. Aerial closure is about 3000 acres.



FORT McPHERSON AREA, N.W.T.

SURFACE GEOLOGY

SOUTH STONY STRUCTURE

G.R. FXB - 100　　Compiled By: C.H. RIDDELL

Figure No.: 54　　Date: OCTOBER, 1969.

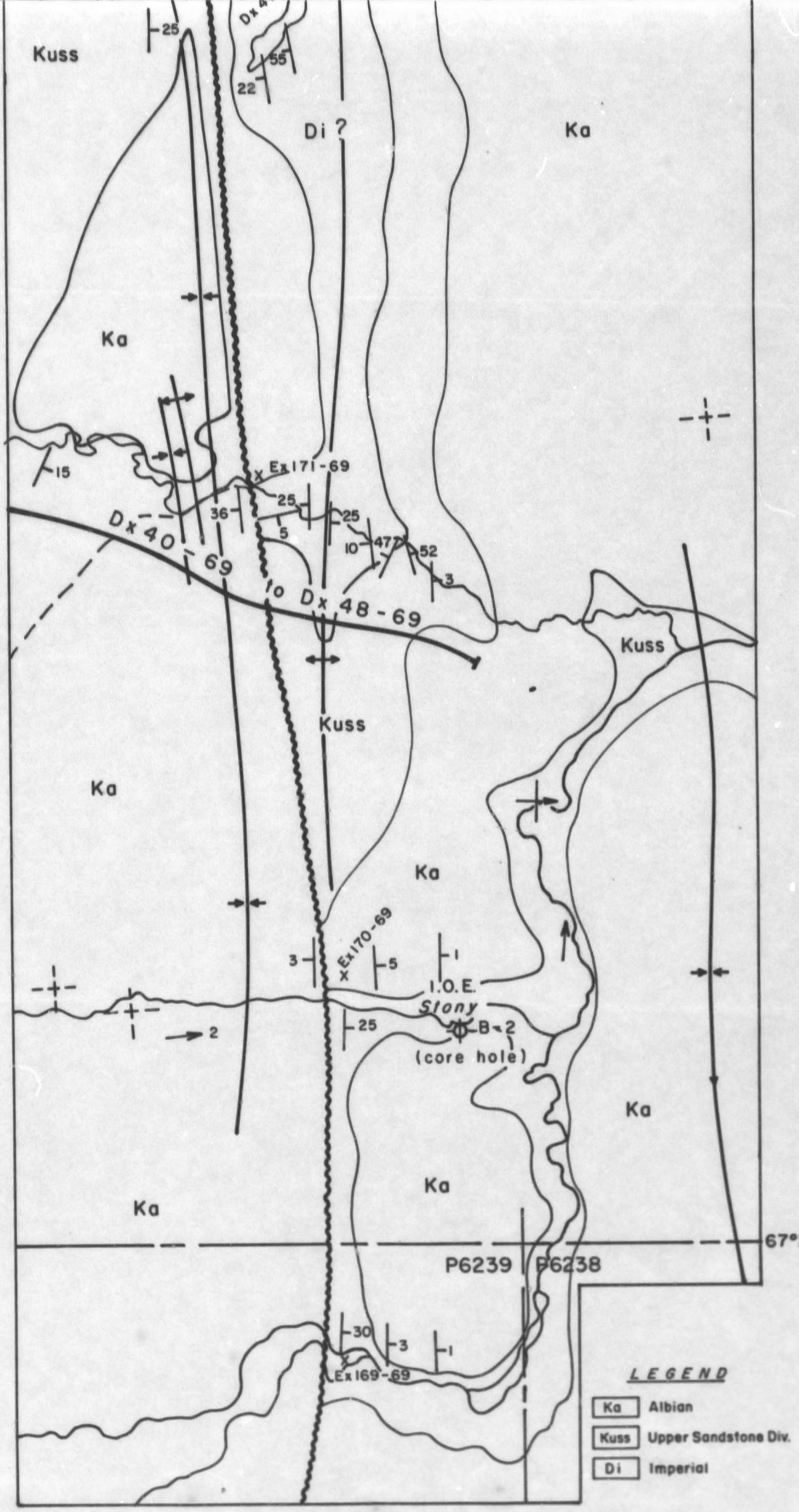
Scale: 1" = 4000'

South Stony Structure

The South Stony structure is very poorly defined due to poor exposure. The structure lies on the south branch of Stony Creek at latitude 67°18'; longitude 135°40'.

The structure is very complex and poor exposure makes it difficult to map. The structure is bounded on the west by the major strike-slip fault. Albian shale has been mapped to the north, east and south which is the basis for mapping the structural high. The majority of beds exposed have been included in the Upper Sandstone Division but they could be Imperial Formation or Mississippian clastics. Several traverses did not yield any fossils. At least one outcrop of shale appears to be Imperial.

The structure is too poorly exposed and too complex to map accurately and no structure contours could be drawn. The structure is quite large however and probably has vertical closure of 1000 feet and aerial closure of 3500 acres.



AMOCO CANADA
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FT. McPHERSON AREA, SURFACE GEOLOGY

STONY CREEK ANTICLINE

G.R. FXB - 100
Figure No: 56

Compiled By: C. H. RIDDELL
Date: OCTOBER, 1969
Scale: 1" = 4000'

2 of 2

Stony Creek Anticline

The Stony Creek anticline is a north-south trending faulted anticline crossing Stony Creek at latitude 67°24' - longitude 135°32'. The south half of the structure is relatively well exposed but exposure deteriorates to the north.

The anticline is eroded below the Upper Sandstone Division to rocks mapped as Imperial Formation but these may be part or entirely Upper Shale-Siltstone Division. The east flank of the structure dips about 40° near the crest and decreases to 2-3° within half a mile. Minor faulting and folding was observed on the limb. The west limb of the anticline is faulted less than half a mile from the crest of the structure. Closure has been mapped to the north and south but exposures make especially the north closure uncertain.

The Stony Creek anticline is ten miles long and about one mile wide. The vertical closure is about 500 feet and the aerial closure is about 6000 acres.

Stony Creek Anticline

The Stony Creek anticline is a north-south trending faulted anticline crossing Stony Creek at latitude 67°24' - longitude 135°32'. The south half of the structure is relatively well exposed but exposure deteriorates to the north.

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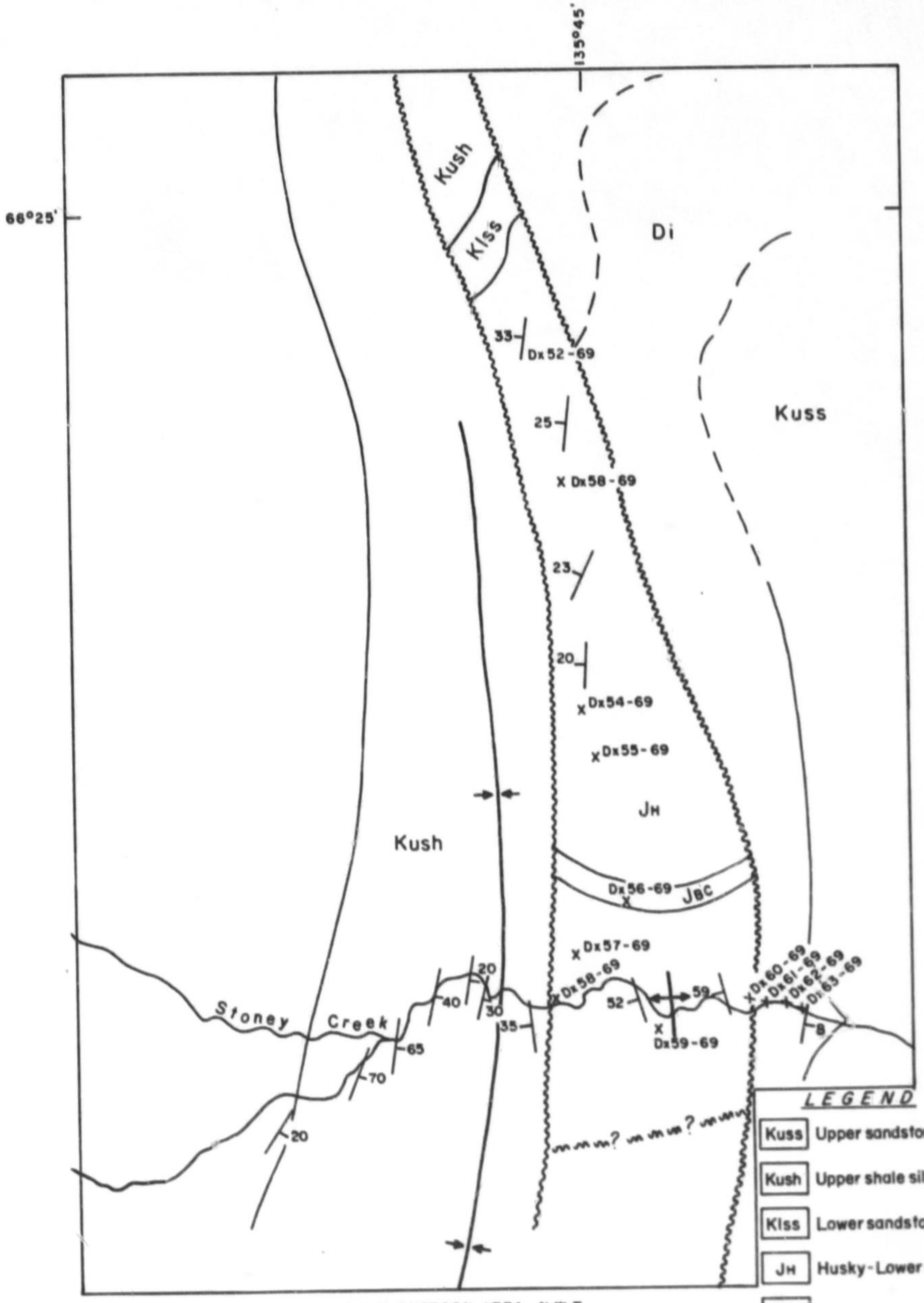
The Stony Creek anticline is ten miles long and about one mile wide. The vertical closure is about 500 feet and the aerial closure is about 6000 acres.



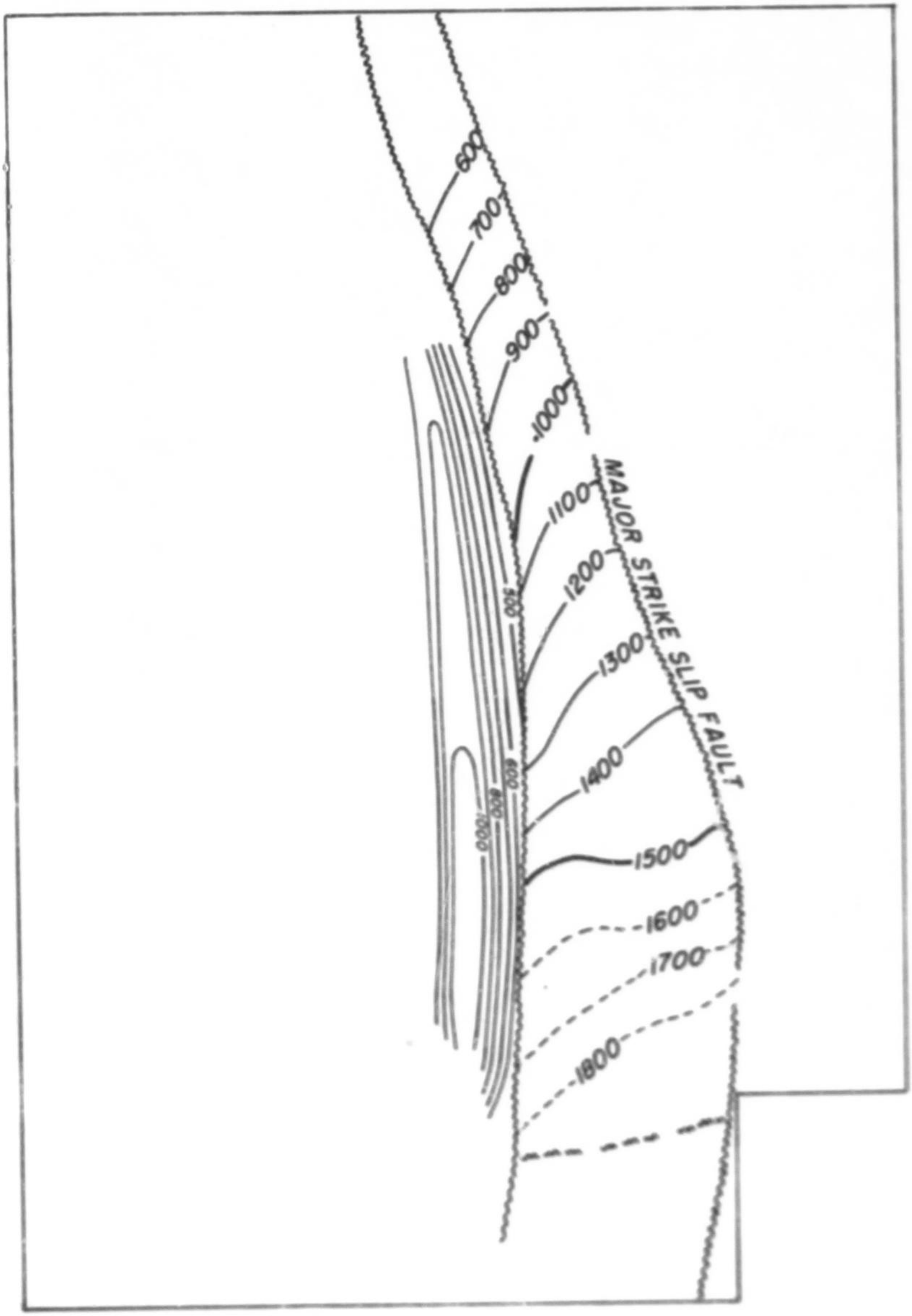
LEGEND

Kuss	Upper sandstone Div.
Kush	Upper shale siltstone.
Klss	Lower sandstone Div.
JH	Husky-Lower shale siltstone
JBC	Bug Creek.
Di	Imperial.

FORT McPHERSON AREA, N.W.T.
MOUNT TOUGHENOUGH HORST
SURFACE GEOLOGY

G.R. FXB-100
Figure No: 58

Compiled By: C.H. RIDDELL
Date: OCTOBER, 1969.
Scale: 1" = 4000'



BASE OF JURASSIC S.C.M.

C.I.: 100'

57


67°00' +136°00'
+135°00' 67°00'
OSDrrpc
Dfc
Di
Jss
Jsc
Kush
Kuss
M
Ka
€c
€sh
Dpcl
A-12-69
A-11-69
D-5-69
Ka
May include M
U
D
R I C H

1 of 2

LEGEND & COLOR CHART

- ☐ Upper Cretaceous. - Uk
- ☐ Albian Shale Siltstone Division.- Ka
- ☐ Upper Sandstone Division.- Kuss
- ☐ Upper Shale - Siltstone Division.-Kush
- ☐ Lower Sandstone Division.- Klss
- ☐ North Branch (JNB) - Husky (JH), Lower Shale Siltstone.
- ☐ Bug Creek & Older Jurassic.- Jbc
- ☐ Triassic.- Tr
- ☐ PPcl Clastics.
- ☐ PPl Permo Penn Limestone.
- ☐ M Mississippian.
- ☐ Di Imperial
- ☐ Dfc Fort Creek Shales.
- ☐ Dpcb Prongs Creek Biostrom.
- ☐ OSDrrpc Road River - Prongs Creek Shale.
- ☐ €c Cambrian carbonate.
- ☐ €sh Cambrian shale.
- ☐ €bl Basal Cambrian limestone.
- ☐ P€ Precambrian - phyllite, carbonate, schist.
- ☐ Jurassic Undivided.
- ☐ D-M All Units shale out southward.

LEGEND

Contact mapped from air or ground.
Contact mapped photogeologically.
Contact inferred.
Fault U up D down
Strike - Slip.
Attitude measured.
Attitude estimated from the air.
Horizontal
Approximately horizontal dipping slightly as indicated.
Vertical.
Location of measured section.
Structural notes taken.

EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

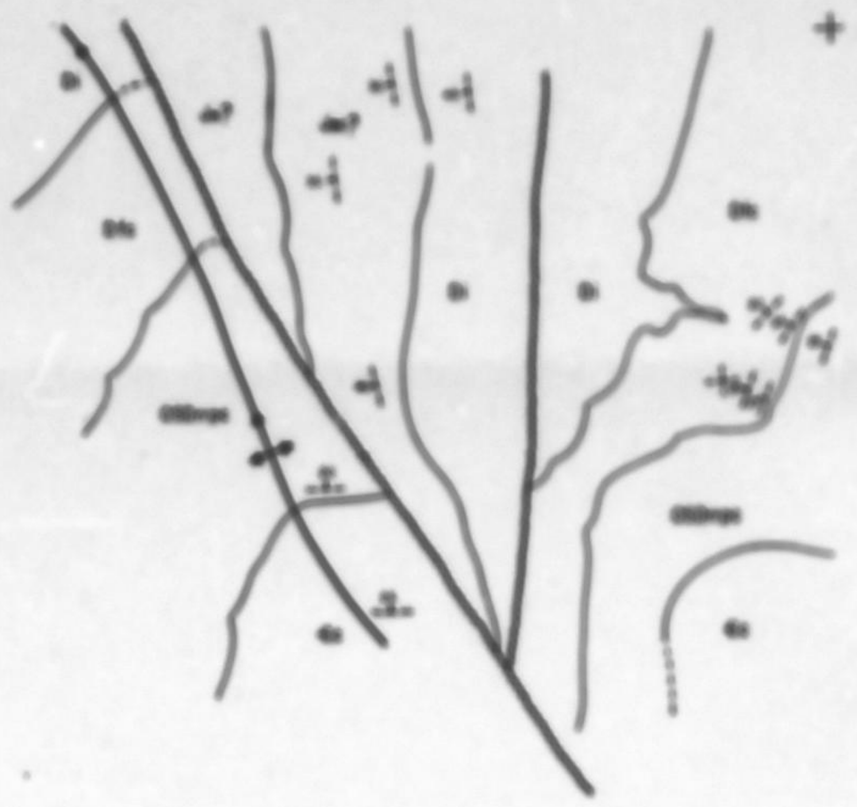
SURFACE GEOLOGY

G.R. FXB-100 Compiled By: C.H. RIDDELL & T. BOLEANTU
Plate No: 2. Date : OCTOBER, 1969.

CS-6

2 of 2

67°00'00" + 137°00'00"



+ 136°00'00" + 67°00'00"

BLANK

66°00'00 + 137°00'00"

+ 136°00'00" + 66°00'00"

LEGEND & COLOR CHART

☐ Upper Cretaceous. - Uk
☐ Albian Shale Siltstone Division. - Ka
☐ Upper Sandstone Division. - Kuss
☐ Upper Shale-Siltstone Division. - Kush
☐ Lower Sandstone Division. - Klss
☐ North Branch - Husky, Lower Shale Siltstone. (Jnb, Jh)
☐ Bug Creek & Older Jurassic. - Jbc
☐ Triassic. - Tr
☐ PPcl Clastics.
☐ PPl Permo Penn Limestone.
☐ M Mississippian.
☐ Di Imperial
☐ Dfc Fort Creek Shales.
☐ Dpcb Prongs Creek Biostrom.
☐ OSDrrpc Road River - Prongs Creek Shale.

☐ €c Cambrian carbonate.
☐ €sh Cambrian shale.
☐ €bl Basal Cambrian limestone.
☐ P€ Precambrian - phyllite, carbonate, schist.
☐ Jurassic Undivided.
☐ D-M All Units shale out southward.

LEGEND

Contact mapped from air or ground.
Contact mapped photogeologically.
Contact inferred.
Fault U up D down
Strike-Slip.
Attitude measured.
Attitude estimated from the air.
+ Horizontal
Approximately horizontal dipping slightly as indicated.
Vertical.
Location of measured section.
Structural notes taken.

EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

G.R. FXB-100 Compiled By: C.H. RIDDELL & T. BOLEANTU
Plate No: 1. Date: OCTOBER, 1969.

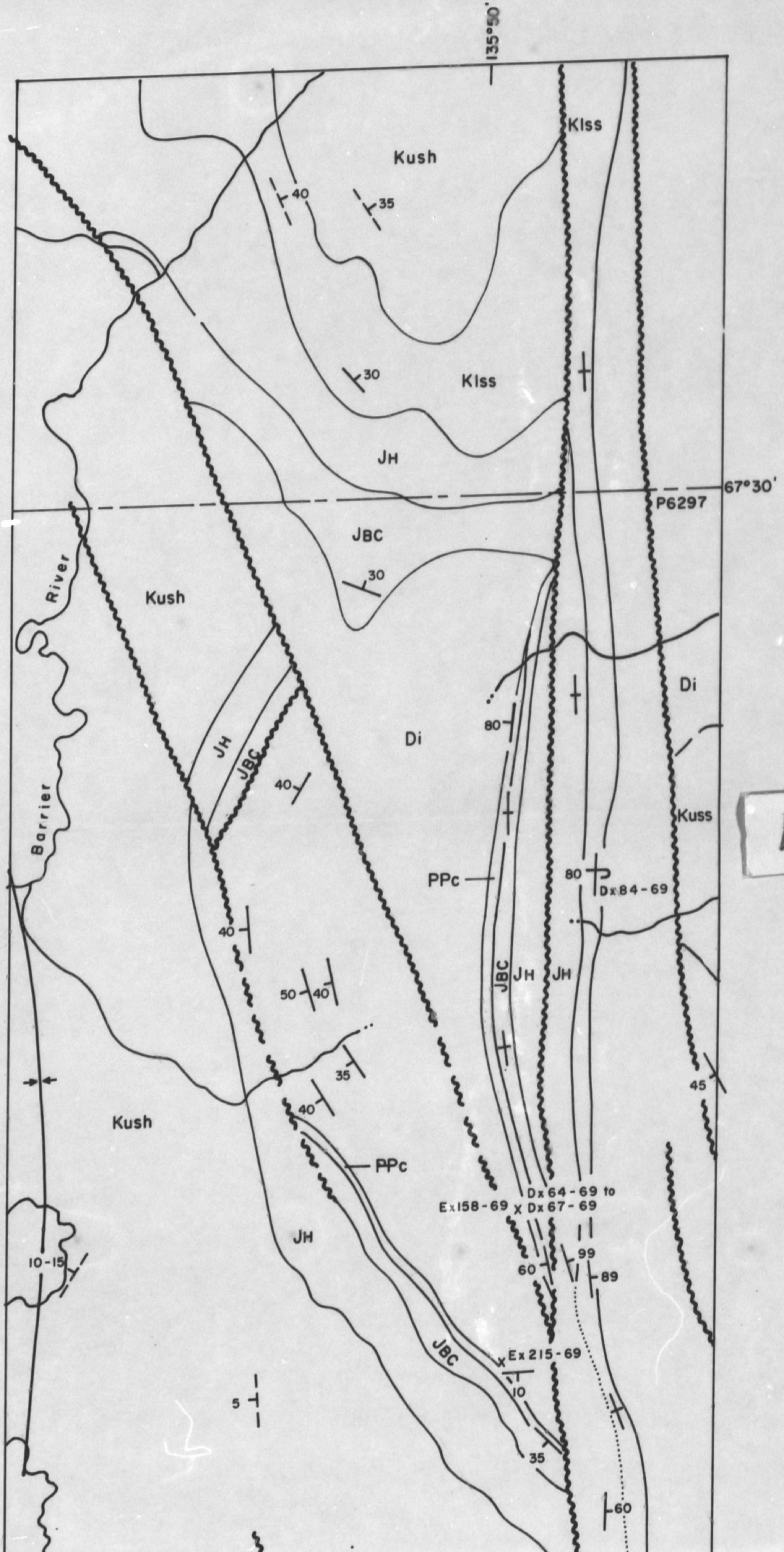
CS-9

Mount Toughenough Structure

Mount Toughenough structure has topographic expression at Mount Toughenough (latitude 67°24', longitude 135°45'). Steeply dipping and contorted Imperial Formation is exposed in the core of the structure.

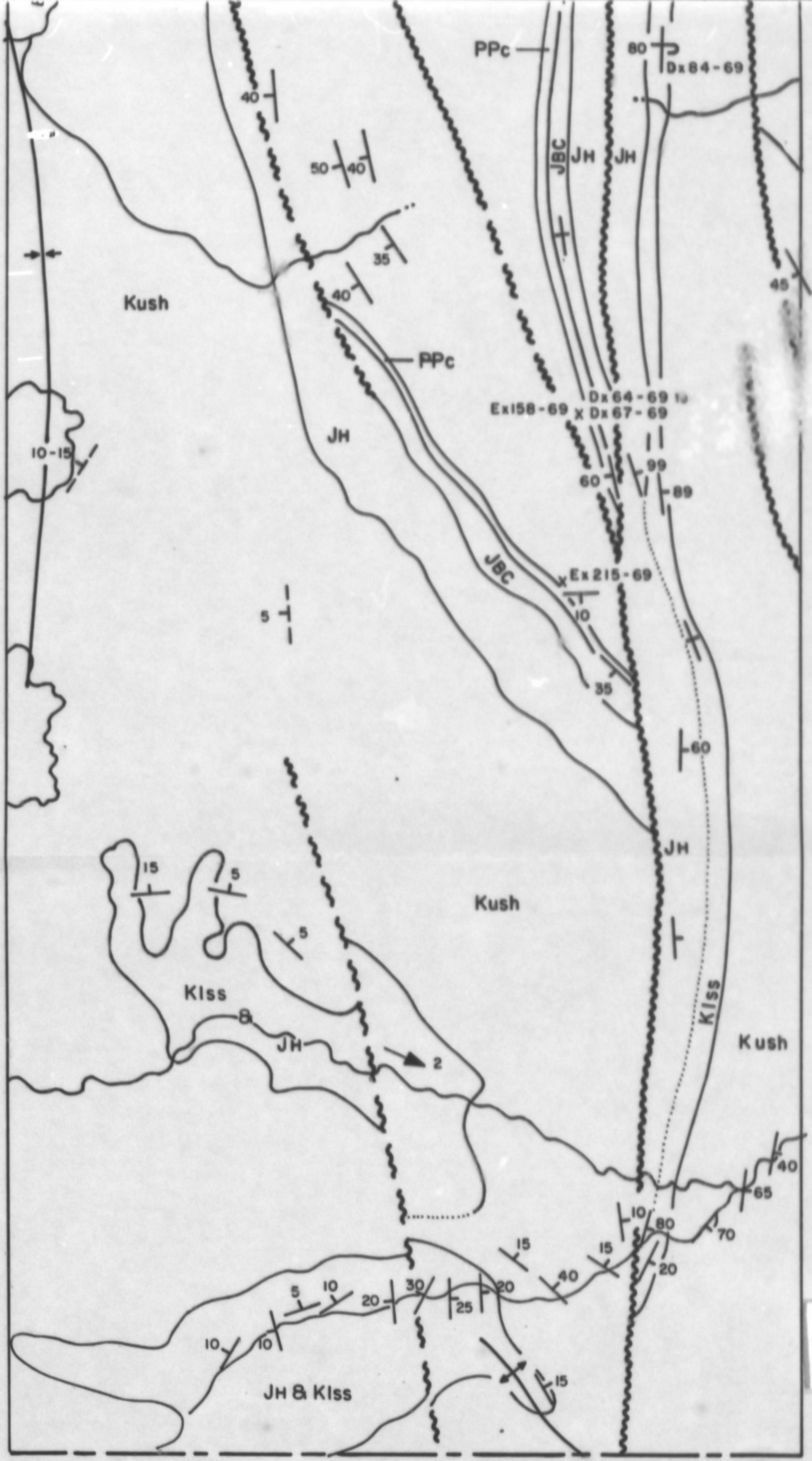
The culmination of the structure is at Stony Creek. Poor exposures southward make mapping difficult but no Imperial was noted indicating rapid south plunge (or fault). The east flank of the structure is the major strike-slip fault with Imperial and Upper Sandstone Division east of the fault. The west flank is formed by a steeply dipping normal fault with a syncline of Upper Shale-Siltstone Division exposed west of the fault, northward, the structure plunges steadily for about two miles where Upper Shale-Siltstone Division is at surface.

The Mount Toughenough horst is about five miles long and one-half to one mile wide with aerial closure of about 2000-2500 acres. The south closure is uncertain and the structure could be considerably larger.



135°50'
Klss
Kush
40
35
Klss
30
JH
67°30'
P6297
JBC
30
River
Kush
Di
Di
80
JH
JBC
40
Kuss
Barrier
PPc
80
Dx84-69
40
JBC
JH
JH
50
40
35
45
Kush
40
PPc
Dx64-69 to
Ex158-69 x Dx67-69
JH
10-15
60
99
89
JBC
x Ex215-69
10
5
35
60

107



2 of 2

AMOCO CANADA
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FT. McPHERSON AREA, SURFACE GEOLOGY
WEST TOUGHENOUGH STRUCTURE

G.R. FXB - 100
Figure No: 60

Compiled By: C.H. RIDDELL
Date: OCTOBER, 1969

Scale: 1" = 4000'

LEGEND

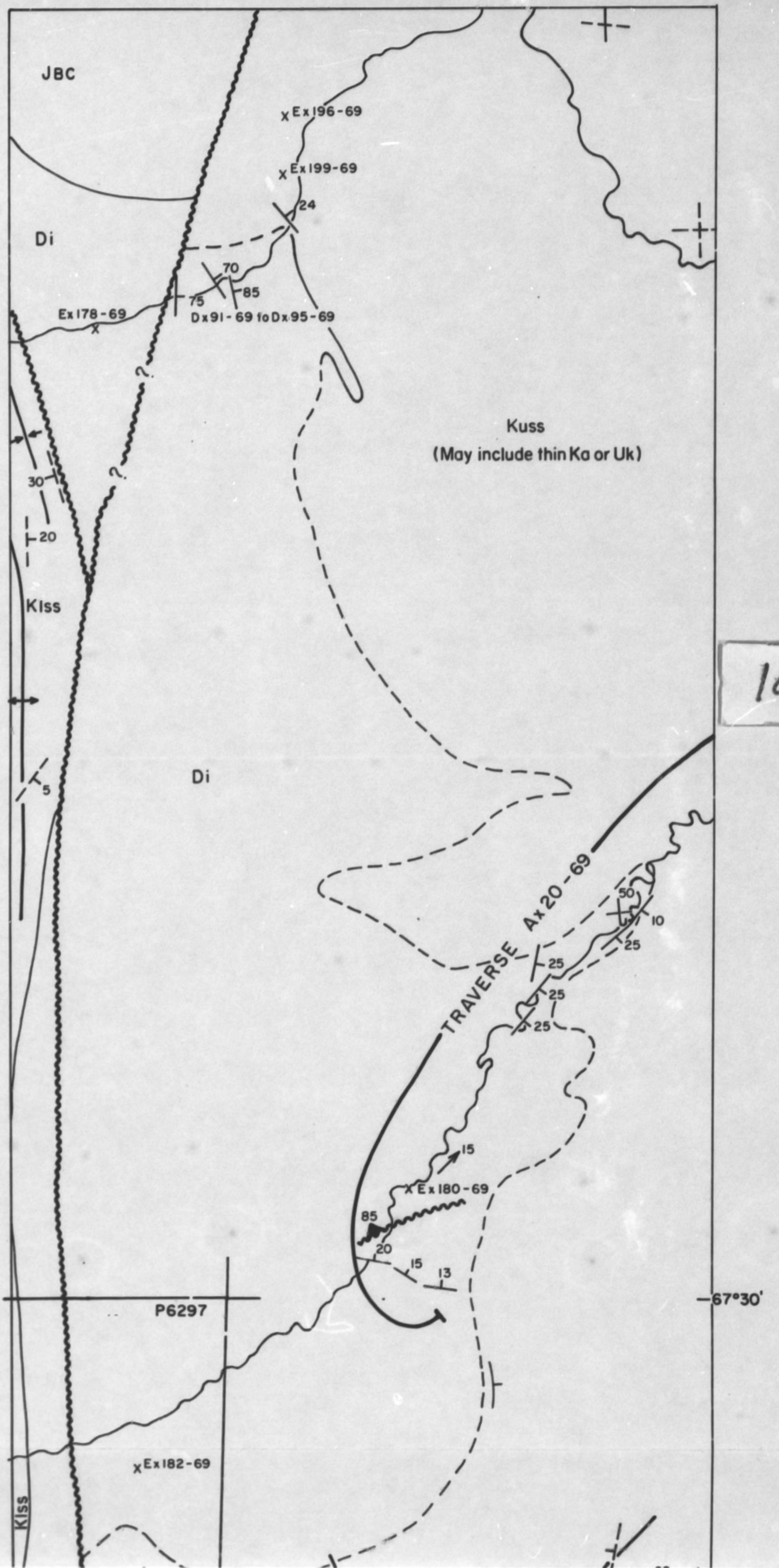
Kuss	Upper Sandstone Div.
Kush	Upper Shale Siltstone Div.
KIss	Lower Sandstone Div.
JH	Husky
JBC	Bug Creek
PPc	Permo Penn carbonate
Di	Imperial

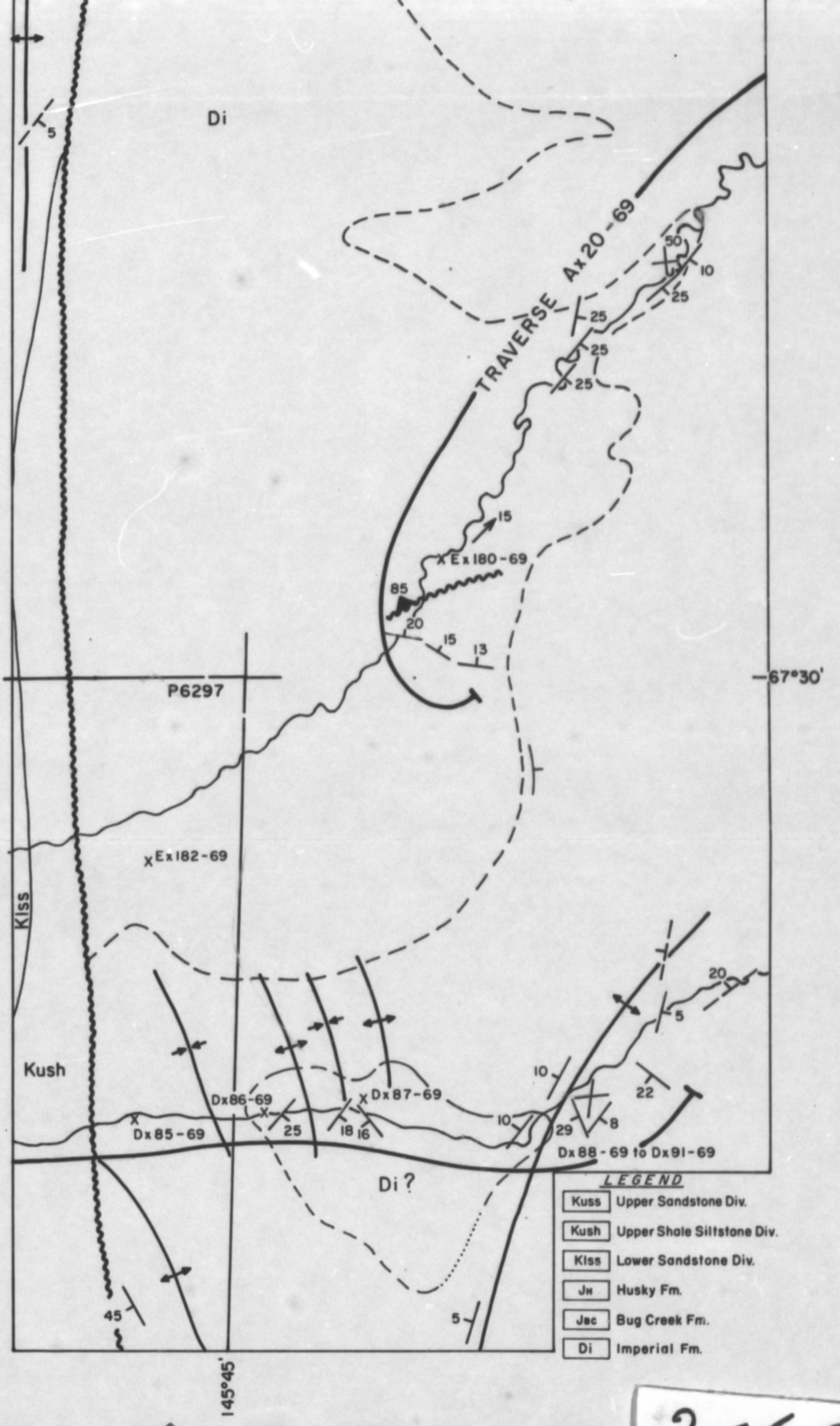
West Toughenough Anticline

The West Toughenough Anticline is one of the largest and best defined structures in the area. It lies on the northwest corner of the Permit area at latitude 67°27', longitude 135°52'. Exposures are good and closure in all directions is well defined.

The core of the anticline exposes Imperial Formation with steeply dipping Jurassic and Lower Createaceous on the flanks. Several steep faults cut the structure. The north south trending anticline plunges steeply in both directions. Major faults occur at each end of the structure.

The anticline is eight miles long and over two miles wide at the culmination. The vertical closure is about 1500 feet and the aerial closure is 8,000-10,000 acres.


JBC
Ex196-69
Ex199-69
24
Di
70
85
75
Ex178-69
Dx91-69 to Dx95-69
?
?
Kuss
(May include thin Ka or Uk)
30
20
Klss
5
Di
TRAVERSE Ax20-69
50
10
25
25
25
25
15
Ex180-69
85
20
15
13
-67°30'
P6297
Ex182-69
Klss



2 of 2

AMOCO CANADA

PETROLEUM COMPANY LTD.

FT. McPHERSON AREA, SURFACE GEOLOGY

BARRIER RIVER ANTICLINE

G.R.FXB - 100 Compiled By: C.H. RIDDELL
Figure No: 62 Date: OCTOBER, 1969.
Scale: 1" = 4000'

Barrier River Anticline

Along the east side of the major strike-slip fault north of Stony Creek exposures are very poor but generally the rocks dip east and locally may plunge north or south forming a series of structures similar to the Cripples Creek anticline, but not as well defined. One of the largest of these features lies at latitude 67°32', longitude 135°52'.

This structure is very poorly exposed and the rocks that are exposed are difficult to identify due to a lack of fauna. However, rocks in the core have been tentatively identified as Imperial with Upper Sandstone Division on the flanks.

Closure in all directions is suspect due to the poor exposures but it is felt that west closure is supplied by the strike-slip fault with east closure supplied 5-10° east dip.

The structure as mapped is ten miles long and two to four miles wide but it could extend much further north or south. The vertical closure is over 500 feet and the aerial closure over 15,000 acres.

Gypsum Intrusions

Two gypsum intrusions were studied during the field season one on the south branch of the Vittrekwa River at 66°59' and 135°06' and one on the Donna River at 68°12' and 135°27'. The one on the Donna River has been described extensively in the literature as have others in the immediate vicinity but no publications refer to the Vittrekwa intrusion.

The Vittrekwa River intrusion is about 1000 feet long and about 100 feet wide. It intrudes into the lower portion of the Fort Creek shales and perhaps the upper part of the Prongs Creek-Road River units. The attitudes of the beds vary greatly in the vicinity of the intrusion and the detailed structure was not worked out but the intrusion comes up along or near a fault which trends about 135° which is oblique to the structural trend in the area. The gypsum mass is elongate parallel to the fault.

The contact between the gypsum and the siliceous Fort Creek shales was not seen but as the contact was approached the siliceous shales (which are almost like chert in this area) become highly fractured and are almost frangible. The top of the gypsum, near the contact is a very hard, highly fractured carbonate which is cryptocrystalline and structureless. This may be some type of cap rock. The gypsum itself was white and contains some white clayey material. No exotics were seen in the intrusion.

The Donna River gypsum intrusion is also elongate trending about 080° which is oblique to the structural trend in the area. The outcrop is a similar size to the Vittrekwa River intrusion. It is intruded into shales of the Upper Shale-Siltstone Division. The intrusion differs from the one on the Vittrekwa in that it has many exotics or inclusions which form up to 50 per cent of the rock. The intrusion has been described by many other geologists and exception is taken to their description. Firstly, the fragments are, surprisingly and inexplicably, often rounded, and often well rounded rather than angular. Secondly, the fragments are mainly basic igneous material although there are a great variety of fragments and some are sedimentary but the age or origin of most could not be identified. The matrix is apparently partly anhydrite. The contact with the lower Cretaceous shales is exposed at the east end. The shale is sheared and slickensided and contains broken up siltstone slabs within it. The shale is rusty for a few inches near the contact.

The age and/or source of the gypsum is unknown and it is not known whether the two come from a similar source. The gypsum on the Vittrekwa River must be at least pre-Devonian as it intrudes beds of this age. No gypsum is known within the Paleozoic section in the Richardson Mountains area. Farther east Cambrian gypsum has been described and Proterozoic gypsum is also known. Extensive Permian gypsum deposits occur in the Arctic Island and some workers suggest the Donna River gypsum is Permian. Several samples of gypsum were collected and it may be of interest to do sulphur isotope ratio analysis to determine the age of the gypsum. If evaporite tectonics are important in the area it would be advantageous to know the source of the evaporites. Thin gypsum bands 1/4"-1/2" thick occur in soft black mudstones within the central portion of the Fort Creek Formation at A-12-69 but it is doubtful that this is the source of the gypsum.

OIL AND GAS SHOWS

No oil or gas seeps were seen on the permit areas but other signs of hydrocarbon were seen.

At Ex136-69 on the Caribou River, five miles southeast of Caribou Lake (latitude 66°10', longitude 134°54') a very bituminous shale or oil shale was located. It has a tarry-like substance oozing over the surface and when placed in a flame it gave off a distinct oily odor. The shale is dark grey, poorly fissile with occasional siltstone interbeds and contains occasional plant fragment (Calamites). The shale is near the base of the Mississippian clastic unit near the southern limit of this unit. Similar shales were seen on the Peel River but they were apparently less petrotiferous. Red shales from this interval along the Peel River are probably the result of burning of the shales, removing the bituminous material. A seventy-five pound bulk sample was taken at Ex136-69 on the Caribou River.

At Ex164-69 on Stony Creek (latitude 67°19'N, longitude 153°33'W) the lower member of the Upper Sandstone Division has a brown oil stain and a strong petroliferous odor. The fine grained well sorted occasionally conglomeritic sandstone bed is six feet thick. Several samples were taken at this locality.

At Section D-10-69, (latitude 66°56', longitude 136°01') veins of gilsonite mixed with calcite occur within the Road River Formation. Gilsonite is a rare carbon mineral.

On the Peel River at Section D-4-69, poor vuggy porosity was found in the Prongs Creek biostrom and bitumen occasionally filled the vugs.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

During 1969, a field party under the supervision of the writer, studied the Paleozoic straigraphy as it pertained to the McPherson Block Permits and did detailed mapping on and near these permits. Prospective reservoir beds beneath the permits include the Mississippian clastics, the Imperial Formation and the Middle Devonian to Cambrian carbonates and reefs.

The Mississippian clastics section had some fair porosity and good permeability but is breached in all the structures and very shallow over most of the permit area (where present) and thus is not too prospective. No good clean porous sands were seen in the Imperial Formation but this sequence is probably at least 10,000 feet thick beneath part of the permits and could be prospective.

The primary objective beneath the permits will be the lower Paleozoic reefs and carbonates. With the exception of several patches of reefoid Emsian to Eifelian carbonate, only the basinal shale facies is exposed along the Richardson Mountains, the facies boundary being to the east and probably passing beneath the subject permits. It may be controlling the major strike-slip fault which passes through the area which is also the limit of intense deformation.

No unconformity was seen and none is postulated within or at the top of the Prongs Creek Formation and it is felt that the Richardson Mountains were basinal from Cambrian through to late Devonian.

The Mesozoic section is probably not prospective on the permits as it is thin and shallow. The numerous sands present in this part of the section would make an excellent prospective horizon where buried although most outcrops of these units had a great deal of silica cement.

Important orogenies occurred within or near the Permit areas in the Upper Devonian, Permo Pennsylvanian, Pre Jurassic and Pre Cretaceous with several other epeirogenic movements. The area is characterized by several steeply dipping faults which may have important strike-slip movement. These are somewhat arcuate but roughly parallel the north-south mountain trend. Several quite large closed structures occur on and near the permit areas and these have been mapped in detail (but only the Laramide movement can be mapped).

The next step in the exploration of these permits will be a detailed seismic program which has already begun. This program should be able to solve several problems including (a) outlining the Lower Paleozoic shale-carbonate boundary, (b) delineating the pre-Cretaceous structure, (c) determine if the shallow Laramide structural mapping accurately portrays the deeper structure, (d) determine the thickness of Imperial beneath the permits and thus the depth to the prime objectives.

In conclusion, the area seems to offer excellent prospects for oil and/or gas accumulation within the Devonian and older carbonates and reefs. The surface studies along with the seismic mapping should provide several potential drilling locations on the permits.

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APPENDIX I

INDEX OF MEASURED SECTIONS

Section No.	Air Photo	Lat.	Long.	Age and Formation	
A-7-69		66°00'	134°42'	U. Dev.-Miss.	Boleantu & Streeton
A-8-69		66°25'	135°35'	Cambrian	Boleantu & Smith
A-9-69		67°09'	135°32'	U. Sandstone to U. Dev.	Boleantu & Smith
A-10-69		67°25'	135°30'	Cretaceous-Road River	Boleantu & Smith
A-11-69		67°39'	135°25'	Mississippian Clastics	Boleantu & Smith
A-12-69		67°39'	135°42'	Road River to Imperial	Boleantu & Smith
A-14-69		67°13'	135°57'	Imperial	Boleantu & Smith
A-18-69		67°49'	135°31'	Mississippian Clastics	Boleantu & Smith
A-19-69		67°37'	135°	Brat Creek Fm.	Boleantu & Smith

Ax OUTCROP LOCATIONS

Station	Air Photo	Lat.	Long.	Age and Formation	Samples	Remarks
Ax13-69		66°15'	135°25'	Precambrian		
Ax15-69		67°12'	135°33'	Imperial-Cret.		
Ax16-69		66°59'	135°43'	Jurassic-Miss. Clastics		
Ax17-69		67°04'	135°43'	Imp-Jurassic-Cret.		
Ax20-69		67°29'	135°46'	Imperial-Cretaceous		
Ax21-69		67°51'	136°00'	Cambrian		
Ax22-69		68°12'	135°29'	Donna R-gypsum plug		
Ax23-69		67°18'	135°45'	Imperial-Cret.		
Ax24-69						
Ax25-69		67°32'	135°09'	Imperial		
Ax26-69		67°30'	135°07'	Imperial		
Ax27-69		67°27'	134°51'	Imperial		

Cx OUTCROP LOCATIONS

Station	Air Photo	Lat.	Long.	Age and Formation	Samples	Remarks
CX9-69	A14133-32	67°28'	135°52'	Imperial-Jurassic		
Cx13-69	A13754-133	66°59'	135°55'	Vittrekwa-gypsum dome		

Section No.	Air Photo	Lat.	Long.	Age and Formation	
D-1-69	A12847-178	67°18'	134°50'	L. Cret. U. Sandstone Div.	Renolds & Smith
D-2-69	A13489-17	67°09'	135°06'	L. Cret. U. Sandstone Div.	Renolds & Smith
D-3-69	A13753-25	65°52'	134°50'	Ft. Creek-Road River	Renolds & Streeton
D-4-69	A13753-25	65°52'	134°50'	Prongs Creek-Road River	Renolds, Streeton & Smith
D-5-69	A14133-114	66°37'	135°40'	Upper Cambrian-Cretaceous	Renolds & Streeton (excellent sect
D-6-69	A14133-122	67°04'	135°40'	Miss.-U. Sandstone Div.	Renolds & Streeton
D-7-69	A12847-12	66°13'	134°40'	Mississippian Clastics	Renolds & Streeton
D-8-69	A13754-137	66°43'	135°47'	Cambrian-Devonian	Renolds, Streeton & Smith
D-9-69	A14133-22	67°02'	135°52'	Jurassic to Road River	Renolds & Smith
D-10-69	A11975-54	66°57'	136°03'	Prongs Creek to Fort Creek	Renolds & Streeton
D-11-69	A14133-134	67°39'	135°32'	U. Sandstone Div.	Renolds & Streeton
D-12-69	A14363-18	67°52'	136°08'	Imperial-Permian	Renolds & Streeton
D-13-69	A14363-12	67°43'	136°04'	Permian-Jurassic	Renolds & Streeton
D-14-69	No photo coverage	68°02'	135°27'W	Jurassic-Permian-Ft. Creek	Renolds & Streeton

Dx OUTCROP LOCATIONS

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Dx-1-69	A14133-26 Fl.1.	67°09'	135°45'	North Branch?	Fossil	
Dx-2-69	A14133-26 Fl.1.	67°09'	135°45'	North Branch	Porosity	
Dx-3-69	A14133-26 Fl.1.	67°09'	135°44'	U. Shale Silst.	Fossil	
Dx-4-69	A14133-26 Fl.1.	67°09'	135°44'	U. Shale Silst.	Fossil	
Dx-5-69	A14133-26 Fl.1.	67°09'	135°43'	U. Shale Silst.	Palynology	
Dx-6-69	A14133-26 Fl.1.	67°09'	135°42'	U. Shale Silst.	Palynology	
Dx-7-69	A14133-26 Fl.1.	67°09'	135°42'	U. Shale Silst.	Palynology	
Dx-8-69	A14133-26 Fl.1.	67°09'	135°41'	U. Shale Silst.	Palynology	
Dx-9-69	A14133-26 Fl.1.	67°09'	135°41'	U. Shale Silst.	Palynology	
Dx-10-69	A14133-26 Fl.1.	67°09'	135°40'	U. Shale Silst.	Porosity	
Dx-11-69	A14133-26 Fl.1.	67°09'	135°40'	U. SS Div.	Porosity	
Dx-11A-69						
Dx-12-69	A14133-128 Fl.9	67°16'	135°43'	U. Shale Siltst.??	Palynology	
Dx-13-69	A14133-128 Fl.9	67°16'	135°43'	U. Shale Siltst.U.SS.Div.	Porosity 2 Fossil.	
Dx-14-69	A14133-128 Fl.9	67°16'	135°42'	U.Shale Silst/U. SS??	Palynology	
Dx-15-69	A14133-128 Fl.9	67°16'	135°42'	U. SS Div.?	Palnology	
Dx-16-69	A14133-128 Fl.9	67°17'	135°40'	U. SS Div.?	Fossil-Plants	
Dx-17-69	A14133-128 Fl.9	67°17'	135°40'	U. SS.Div.?	Palynolgy	
Dx-18-69	A14133-128 Fl.9	67°17'	135°39'	U. SS.Div.?	Palynology	
Dx-19-69	A14133-128 Fl.9	67°17'	135°38'	?Albian	Palynology	
Dx-20-69	A14133-122 Fl.9	67°02'	135°30'	?Albian	Palynology	
Dx-21-69	A14133-122 Fl.9	67°02'	135°30'	U. SS. Div.	Fossil	
Dx-22-69	A14133-122 Fl.9	67°02'	135°30'	U. SS. Div.	Palynology	
Dx-23-69	A14133-122 Fl.9	67°02'	135°30'	Miss.	Foss. Plants	
Dx-24-69	A14133-122 Fl.9	67°02'	135°30'	Miss.	Palynology	
Dx-25-69	A14133-122 Fl.9	67°02'	135°30'	Miss. ? Imperial	Palynology	
Dx-26-69	A14133-122 Fl.9	67°02'	135°32'	Miss.-Imperial	Palynology	
Dx-27-69	A14133-122 Fl.9	67°02'	135°34'	Miss.	Porosity	
Dx-28-69	A14133-120 Fl.9	66°58'	135°28'	U. SS. Div.	Palynology & Fossil	
Dx-29-69	A14133-120 Fl.9	66°58'	135°28'	U. SS. Div.	Fossil	
Dx-30-69	A14133-120 Fl.9	66°58'	135°28'	U. SS. Div.	Palynology	

Dx OUTCROP LOCATIONS continued

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Dx-30-69	A14133-120 Fl.9.	66°58'	135°28'	U. SS. Div.	Palynology	
Dx-31-69	A14133-120 Fl.9	66°58'	135°29'	U. SS. Div.	Palynology	
Dx-32-69	A14133-120 Fl.9	66°58'	135°29'	U. SS. Div.	Fossil	
Dx-33-69	A14133-120 Fl.9	66°58'	135°32'	U. SS. Div.	Fossil	
Dx-34-69	A14133-130 Fl.9	67°24'	135°44'	?Imperial-U. SS. Div.	Palynology	
Dx-35-69	A14133-130 Fl.9	67°24'	135°43'	U. SS. Div.	Porosity	
Dx-36-69	A14133-130 Fl.9	67°24'	135°42'	U. SS. Div.	Palynology	
Dx-37-69	A14133-130 Fl.9	67°21'	135°40'	U. SS. Div.	Fossil-talus	
Dx-38-69	A14133-130 Fl.9	67°21'	135°39'	U. SS. Div.	Porosity	
Dx-39-69	A14133-130 Fl.9	67°21'	135°35'	U. SS. Div.	Palynology	
Dx-40-69	"	67°21'	135°35'	U. SS. Div.	Fossil	
Dx-41-69	"	67°21'	135°35'	U. SS. Div.	Fossil	
Dx-42-69	"	67°21'	135°35'	U. SS. Div. or Albian	Palyn. & Fossil	
Dx-43-69	"	67°21'	135°34'	U. SS. Div.?	Palynology	
Dx-44-69	"	67°21'	135°33'	Albian or Shale/Silst.	Palynology	
Dx-45-69	"	67°21'	135°32'	? Imperial	Palynology	
Dx-46-69	"	67°21'	135°31'	?Shale Silst./U.SS. Div.	Porosity & Palynology	SS or U.SS. Div.
Dx-47-69	"	67°21'	135°30'	?Imperial & U.SS. Div.	Palynology	
Dx-48-69	"	67°21'	135°30'	?U. SS. Div.	Fossil Plants	
Dx-49-69	"	67°24'	135°31'	U. SS. Div.	Fossil - talus	No outcrop
Dx-50-69	"	67°24'	135°32'	?U. SS. Div.	Palynology - talus	
Dx-51-69	A14133-130 Fl.9	67°24'	135°33'	?U. SS. Div.	Palynology - talus	
Dx-52-69	A14133-30 Fl.8	67°23'	135°44'	Husky (Jurassic)	Palynology	
Dx-53-69	A14133-30 Fl.8	67°23'	135°44'	Husky (Jurassic)	Palynology	
Dx-54-69	"	67°23'	135°44'	Husky (Jurassic)	Fossil	
Dx-55-69	"	67°23'	135°44'	Husky (Jurassic)	Fossil	
Dx-56-69	"	67°22'	135°44'	?Bug Creek (Jurassic)	Fossil	
Dx-57-69	"	67°22'	135°44'	Imperial?	Palynology	
Dx-58-69	"	67°22'	135°44'	Imperial	Palynology	
Dx-59-69	"	67°22'	135°44'	Imperial	Palynology	
Dx-60-69	"	67°22'	135°44'	Imperial	Palynology	
Dx-61	"	67°22'	135°42'	U. SS. Div.	Fossil	

Dx OUTCROP LOCATIONS continued

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Dx-62-69	A14133-30 Fl.8	67°22'	135°42'	U. SS. Div. or Imperial	Palynology	
Dx-63-69	"	67°22'	135°41'	?Albian	Palynology	
Dx-64-69	A14133-30 Fl.8	67°26'	135°49'	?Bug Ck. (Jur)	Palynology	
Dx-65-69	A14133-30 Fl.8	67°26'	135°49'	Bug Cr. or Husky	Palynology	
Dx-66-69	A14133-30 Fl.8	67°26'	135°49'	Permian	Fossil-talus	
Dx-67-69	A14133-30 Fl.8	67°26'	135°48'	Bug Ck. or Husky	Palynology	
Dx-68-69	A14133-36	67°38'	135°53"	Jurassic	Palynology	
Dx-69-69	"	67°38'	135°53'	Jurassic, Fort Ck.(Dev.)	Fossil & Palyn.	Shale-Ft.Ck.SS-talus-Jur.
Dx-70-69	"	67°38'	135°53'	?Penn.or Lr. Paleozoic	Lithology	
Dx-71-69	"	67°38'	135°53'	?Sil/Dev.	Microfossil	
Dx-72-69	"	67°38'	135°53'	?Sil/Dev.	Microfossil	
Dx-73-69	"	67°38'	135°53'	?Sil/Dev.	Conodont	
Dx-74-69	"	67°38'	135°53'	?Sil/Dev.	Microfossil	
Dx-75-69	A14133-36	67°38'	135°53'	?Penn or Sil/Dev.	Microfossil	
Dx-76-69	"	67°38'	135°53'	? Sil/Dev.	Microfossil	
Dx-77-69	"	67°38'	135°53'	? Sil/Dev.	Microfossil	
Dx-78-69	"	67°38'	135°53'	? Lr. Paleozoic	Fossil	Fossil in pebbles in cgl.
Dx-79-69	"	67°38'	135°53'	?Permian	Palynology	
Dx-80-69	"	67°38'	135°53'	? Lr. Paleozoic	Microfossil	
Dx-81-69	"	67°39'	135°54'	? Permian	Palynology	
Dx-82-69	"	67°39'	135°54'	?Permian	Lithology	
Dx-83-69	"	67°39'	135°54'	? Permian	Microfossil	
Dx-84-69	"	67°40'	135°55'	Fort Creek (Devonian)	Palynology	
Dx-85-69	A14133-30 Fl.8	67°27'	135°47'	? U. SS. Div.	Lithology	
Dx-86-69	"	67°27'	135°44'	? U. SS. Div.	Plants	
Dx-87-69	"	67°27'	135°44'	? U. SS. Div.	Palynology	
Dx-88-69	"	67°27'	135°41'	U. SS. Div.	Lithology	Basal porous sandstone.
Dx-89-69	"	67°27'	135°40'	? U. SS. Div.	Palynology	
Dx-90-69	"	67°27'	135°40'	U. SS. Div.	Fossil	
Dx-91-69	"	67°27'	135°39'	U. SS. Div.-Albian	Palynology	
Dx-92-69	"	67°33'	135°41'	? Lr. Cret.	Palynology	
Dx-93-69	"	67°33'	135°41'	? Lr. Cret.	Palynology	

Dx OUTCROP LOCATIONS continued

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Dx-94-69	A14133-30 Fl. 8	67°33'	135°41'	?Imperial	Palynology	
Dx-95-69	A14133-30	67°33'	135°40'	U. Sandstone Div.	Fossil	Basal SS.
Dx-100-69	No photo coverage	67°50'	135°45'	Cambrian	Fossil, microfossil & lithology	

Ex OUTCROP LOCATIONS

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Ex101-69	FL 13 A12847-181	67°25'	134°55'	Cretaceous	Palyn, Porosity, Fossil	
Ex102-69	FL 13 A12847-181	67°26'	134°55'	Cretaceous & Imperial?	Palyn-A - Palyn-B Imperial	*
Ex103-69	FL 22 A12847-228	67°09'	135°01'	Basal? Cretaceous	Lith.	
Ex104-69	FL 13 A12847-175	66°13'	134°47'	Imperial or Cretaceous	Palyn.	*
Ex105-69	FL 13 A12847-181	67°22'	134°52'	Basal Cretaceous?	Por.-Lith. Palyn-MicroPaleo	*
Ex106-69	FL 12 A13753-6	67°06'	134°53'	Upper Sandstone Div.	Porosity	
Ex107-69	No photo coverage	66°40'	133°05'	Albian Cretaceous	Palyn	
Ex108-69	No photo coverage	66°51'	133°08'	Basal Cretaceous	Palyn Porosity	
Ex109-69	No photo coverage	66°58'	133°12'	Imperial?	Palyn A-Microfossil B	*
Ex110-69	No photo coverage	67°20'	133°43'	Imperial	Microfoss. Porosity	
Ex111-69	No photo coverage	67°32'	133°45'	Imperial	Lithology	
Ex112-69	FL 9 A14133-123	67°04'	135°31'	Cret. Imperial or M??	Palyn-Microfoss.Por. & Lith.	*
Ex113-69	FL 9 A14133-121	66°59'	135°36'	Cretaceous?	Palyn	*
Ex114-69	FL10 A13754-164	66°24'	135°20'	Mississippian?	Porosity & Lith.	
Ex115-69	FL10 A13754-164	66°24'	135°21'	Mississippian?	Lith.	
Ex116-69	FL10 A13754-166	66°27'	135°25'	Imperial	No Sample	
Ex117-69	F110 A13754-166	66°27'	135°21'	Miss.? or K.	Palyn	*
Ex118-69	FL10 A13754-166	66°27'	135°22'	Miss.?	Lith.	
Ex119-69	FL11 A13489-29	66°28'	135°05'	Cret. or Miss.?	Palyn.	*
Ex120-69	FL11 A13489-29	66°27'	135°08'	Miss.?	Lith.	
Ex121-69	FL10 A13754-168	66°39'	135°17'	Cret.	Palyn.	*
Ex122-69	FL 9 A14133-123	67°05'	135°43'	Cret.	Palyn. or Micropaleo.	*
Ex123-69	FL 8 A14133-21	66°59'	135°38'	Cret. or Miss.?	Wood Fracs, Palyn.	*
Ex124-69	FL 8 A14133-19	66°52'	135°38'	Miss.?	Lith., Fossil? Lith	
Ex125-69	FL 8 A14133-21	67°01'	135°53'	Ft. Ck. Prongs Cr.-Road R.?	Microfoss A, B, C.	
Ex126-69	FL 8 A14133-21	66°59'	135°54'	Ft. Ck. Prongs Cr.	A-gypsum, B-Cap rock C-dol breccia	gypsum intrusive
Ex127-69	FL12 A12847-224	67°20'	135°06'	U.Sh.siltst. Div.-Cret.	Palyn, Fossil	
Ex128-69	FL10 A13754-162	66°16'	135°24'	Cambrian or poss. Hume?	Fossil & Lith.	*
Ex129-69	FL10 A13754-162	66°17'	135°26'	C. or Devonian	Microfossil	
Ex130-69	FL 8 A14133-15	66°39'	135°43'	Prob. Jurassic. U. Dev.??	Fossil	*

Ex OUTCROP LOCATIONS continued

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Ex131-69	FL 9 A14133-113	66°36'	136°35'	Fort Creek sh.	No sample	
Ex132-69	FL10 A13754-162	66°15'	135°23'	Pre C.?	Mineral Sample	
Ex133-69	FL10 A13754-162	66°15'	135°18'	Miss?	Porosity & Lith	
Ex134-69	FL10 A13754-162	66°15'	135°14'	Triassic	Fossil	
Ex135-69	F114 A12847-126	66°15'	134°51;	Miss.?	Porosity, Microfossil	*
Ex136-69	A13 A13753-20	66°13'	134°49'	Fort Cr. Miss. Dev.	Lith (oil hole)	
Ex137-69	FL14 A12847-126	66°13'	134°47'	Fort Creek, Miss or Dev.	Microfossil	*
Ex138-69	FL15 A12847-13	66°13'	134°38'	Cret.?	Microfossil plant fracs	
Ex139-69	FL15 A12847-13	66°14'	134°37'	Cret.	Palyn.	*
Ex140-69	FL12 A13753-140	66°28'	135°02'	Cret.	Palyn.	
Ex141-69	FL11 A13489-29	66°27'	135°15'	Miss.?	Lith & Por. Microfoss.	*
Ex142-69	FL10 A13754-164	66°26'	135°14'	Cret. or Miss.	Por & Lith, Palyn, Plant Fracs	
Ex143-69	FL10 A13754-166	66°28'	135°21'	Cret./ Miss?	Sample A-Micro paleo Cret. B-Plant frags Cret. C-Palyn. Miss.	
Ex144-69	FL11 A13489-29	66°27'	135°13'	Cret. or Miss.	Microfossil	
Ex145-69	FL 8 A14133-15	66°43'	135°44'	Road River	Fossil Sample	
Ex146-69	FL10 A13754-162	66°17'	135°23'	Cambrian S.L.	Microfossil	
Ex147-69	FL10 A13754-162	66°17'	135°23'	Cambrian or Pre Ls.	Microfossil	
Ex148-69	FL10 A13754-160	66°13'	135°20'	Cambrian-Pre C.	Lithology	
Ex149-69	FL10 A13754-160	66°12'	135°18'	Devonian Limestone	Fossil	
Ex150-69	FL10 A13754-160	66°12'	135°07'	Fort Creek - Devonian Ls.	Lith. Microfossil	
Ex151-69	FL11 A13489-35	66°08'	135°08'	Devonian Ls.	Fossil	
Ex152-69	FL12 A13753-24	66°07'	135°03'	Mississippian	Lithology	
Ex153-69	FL 9 A14133-111	66°25'	135°31'	Prongs Creek-Road River	No sample	
Ex154-69	FL 9 A14133-113	66°34'	135°36'	Devonian Carbonate	Fossil	
Ex155-69	FL 9 A14133-113	66°33'	135°36'	Devonian Carbonate Dfc	Fossil	
Ex156-69	FL 9 A14133-125	67°11'	135°41'	Cret. or Imperial?	Micropaleo	
Ex157-69	FL 9 A14133-125	67°09'	135°34'	Cret. Or Imperial?	Micropaleo	
Ex158-69	FL 8 A14133-31	67°25'	135°50'	Imperial P. Cret.	Fossil, Microfossil	

Ex OUTCROP LOCATIONS continued

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Ex159-69	FL 6 A14138-57	67°01'	135°56'	Age? Carbonate	Porosity, Fossil? Lithology	
Ex160-69	FL 6 A14138-57	67°02'	135°56'	Age? Carbonate	No sample taken	
Ex161-69	FL 8 A14133-25	67°08'	135°52'	Jurassic-Perm-Di.	Lith. Microfossil	
Ex162-69	FL 8 A14133-21	66°55'	135°51'	Dfc-Road River-Prongs Creek	Lith.	
Ex163-69	FL 8 A14133-21	66°55'	135°52'	Road River	No sample	
Ex164-69	FL 8 A14133-21	66°55'	135°53'	Cambrian?	Lith.	
Ex165-69	FL 6 A14368-57	67°00'	135°57'	Imperial	No sample	
Ex166-69	FL18 A12247-121	65°55'	134°	U Dev. shale	Lith A - Yellow map B - Bit. sh. C - Marcusite	
Ex167-69	FL 8 A14133-29	67°25'	135°42'	Imperial?	Micropaleo	
Ex168-69	FL 8 A14133-29	67°16'	135°46'	Husky???	No sample	
Ex169-69	FL 9 A14133-127	67°19'	135°33'	Upper Sandstone Div	Section-several samples- Lith, Oil, Sand, Fossil	
Ex170-69	FL 9 A14133-129	67°21'	135°33'	Upper Sandstone Div.	Imp. Fossil	
Ex171-69	FL 9 A14133-129	67°24'	135°34'	Upper Sandstone Imp.	Fossil	
Ex172-69	FL 9 A14133-131	67°29'	135°31'	Sandstone Div.	Fossil	
Ex173-69	FL 9 A14133-127	67°14'	135°36'	Upper Sandstone Div.	No sample	
Ex174-69	FL 9 A14133-127	67°15'	135°38'	Albian?	Microfossil	*
Ex175-69	FL 9 A14133-127	67°15'	135°35'	Upper Sandstone Div.	Fossil	
Ex176-69	FL 9 A14133-127	67°16'	135°37'	Upper Sandstone Div	No samples	
Ex177-69	FL 9 A14133-127	67°16'	135°40'	Cret - Jurass. or Di.??	A Microfoss B Plant remains C Microfossil	*
Ex178-69	FL 8 A14133-33	67°36'	135°47'	Cret - Jurass. or Di.??	Microfoss	
Ex179-69	FL 9 A14133-133	67°34'	135°36'	Upper Sandstone?	Talus fossil	*
Ex180-69	FL 8 A14133-33	67°30'	135°43'	Upper Div.??	Microfossil	*
Ex181-69	FL 5 A14368-39	67°02'	136°13'	???	Microfossil	*
Ex182-69	FL 8 A14133-31	67°29'	135°46'	Imperial??	Microfossil	*
Ex183-69	FL12 12847-222	67°22'	134°59'	Cret or U. Dev?	Microfossil	*
Ex184-69	FL 8 A14133-35	67°34'	135°53'	Imperial?	Microfossil	*

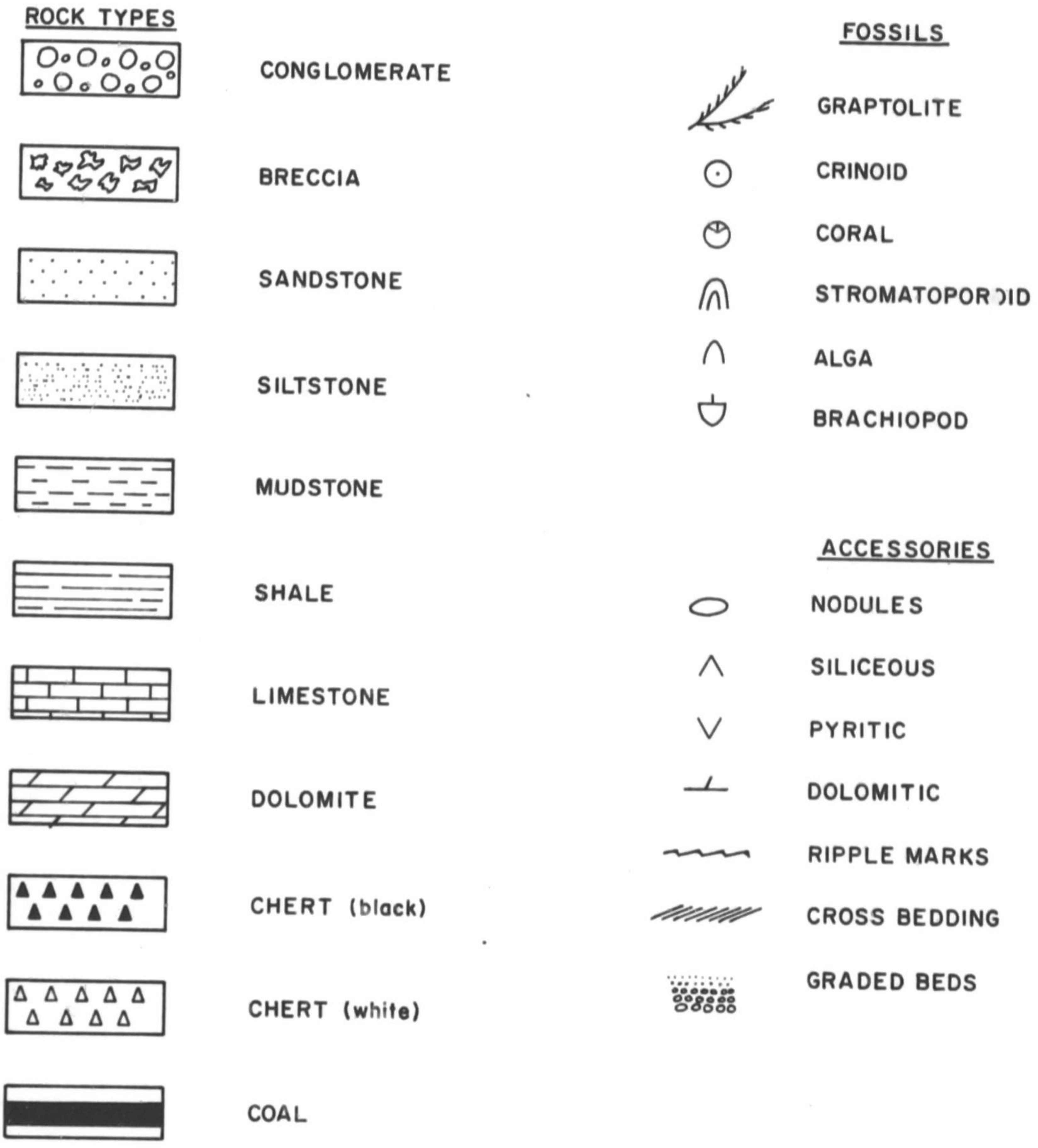
Ex OUTCROP LOCATIONS continued

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Ex185-69	FL 8 A14133-35	67°40'	135°44'	Jurassic? or Tr. or P.	Lithology	
Ex186-69	FL10 13754-186	67°35'	135°13'	Cretaceous or Imperial	Lithology	
Ex187-69	Fort McPherson	67°26'	134°53'	Imperial?	Microfossil	*
Ex188-69	FL 8 A14133-39	67°41'	135°49'	Pennsylvania?	Lithology	
Ex189-69	FL 6 A14363-17	67°50'	136°00'	Permian?? & Fort Cr. or S.I.??	Microfossil A Microfossil B	
Ex190-69	FL 6 A14363-12	67°44'	136°01'	J-K, Perm? U. Dev.??	Microfossil	
Ex191-69	FL13 A12847-179	67°20'	134°51'	Upper D. or K.?	Microfossil, Talus fossil	
Ex192-69	FL13 A12847-175	67°12'	134°51'	Upper Sandstone Div.?	Lith.	
Ex192-69	FL11 A13489-13	67°23'	135°04'	Upper Sandstone Div.	No sample	
Ex194-69	FL 9 A14133-133	67°32'	135°31'	Upper Sandstone Div.	Microfossil	
Ex195-69	FL 9 A14133-133	67°33'	135°32'	Albian? or U. Cret, Upper Sandstone Div.	Microfossil & Fossil	
Ex196-69	FL 9 A14133-133	67°37'	135°44'	Upper Sandstone Div	Lith.	
Ex197-69	FL 8 A14133-35	67°41'	135°44'	Brat Creek	Lithology	
Ex198-69	FL 9 A14133-131	67°28'	135°36'	Lower Cret.	Microfoss.	
Ex199-69	FL 8 A14133-33	67°36'	135°44'	Lower Cret of J.??	Microfoss.	
Ex200-69	FL 8 A14133-35	67°40'	135°49'	Below U. sh. silt. (Lss. or KH or B.C.)	Lith.	
Ex201-69	No Photo coverage	67°45'	135°59'	J-K to Fort Creek sh.	Microfossil	Traverse down Mtn. cast of Rat Lake
Ex202-69	FL 6 A14363-12	67°43'	136°05'	Permo-Penn.	Lithology, Microfoss Plant Mat.	
Ex203-69	FL 6 A14363-13	67°43'	136°04'	Permo. Penn.	Lithology	
Ex204-69	FL 6 A14363-12	67°41'	136°02'	J. or R.P. To Prongs Creek	Microfossil, Fossil	
Ex205-69	FL 5 A14363-70	67°36'	136°17'	Permian	No sample	
Ex206-69	No Photo coverage	67°46'	136°00'	Mid Dev or older	Lith.	East of Rat Lake ½ mile N of Ex-201

Ex OUTCROP LOCATIONS continued

Station	Air Photo	Lat.	Long.	Age & Formation	Samples	Remarks
Ex207-69	FL 8 A14133-35	67°40'	136°00'	J - Lower K	Microfossil	
Ex208-69	FL 8 A14133-39	67°51'	135°53'	Permo-Penn & Older-(Fort Cr.)	Microfossil	
Ex209-69	No photo coverage	68°02'	135°28'	Permo-Penn & Dfc.	A Lith B Microfoss C Jurassic Butte	
Ex210-69	No photo coverage	68°12'	135°27'	Gypsum plug	Lithology	Donna River
Ex211-69	FL 9 A14133-137	67°51'	135°40'	Upper Sandstone Div.	Lithology	
Ex212-69	FL 9 A14133-137	67°51'	135°31'	Upper Cret.	Fossil? Microfossil	
Ex213-69	FL 5 A14361-64	67°52'	136°09'	Dfc.	Microfoss.	
Ex214-69	FL 5 A14361-64	67°52'	136°10'	Lower Paleozoic Carbonate	Microfoss.	
Ex215-69	FL 8 A14133-31	67°25'	135°50'	Permo-Carbonif. or U. Devonian	Fossil, Microfossil	
Ex216-69	FL 5 A14361-70	67°34'	136°15'	Jurassic	Lithology	
Ex223-69	No photo	67°50'	135°52'	Cambrian L.S.	Microfossil	
Ex224-69	No photo	67°51'	135°52'	Cambrian L.S.	Trilobite	
Ex217-69	No photo	67°27'	134°13'	Imperial?	Lithology	
Ex218-69	No photo	67°22'	134°10'	Imperial? or Cret.	Palyn.	
Ex219-69	No photo	67°17'	134°28'	Imperial or Cret?	Palyn.	
Ex220-69	FL 6 A14363-5	67°26'	135°58'	Upper shale siltstone	Palyn.	
Ex221-69	No photo coverage	67°46'	136°03'	Dfc. or Dpc. or OSrr.	Microfossil	
Ex222-69	No photo coverage	67°47'	136°02'	Dfc. or Dpc. or OSrr.	Microfossil	

McPHERSON PARTY SECTION LEGEND



ROCK TYPES

- CONGLOMERATE
- BRECCIA
- SANDSTONE
- SILTSTONE
- MUDSTONE
- SHALE
- LIMESTONE
- DOLOMITE
- CHERT (black)
- CHERT (white)
- COAL

FOSSILS

- GRAPTOLITE
- CRINOID
- CORAL
- STROMATOPOROID
- ALGA
- BRACHIOPOD

ACCESSORIES

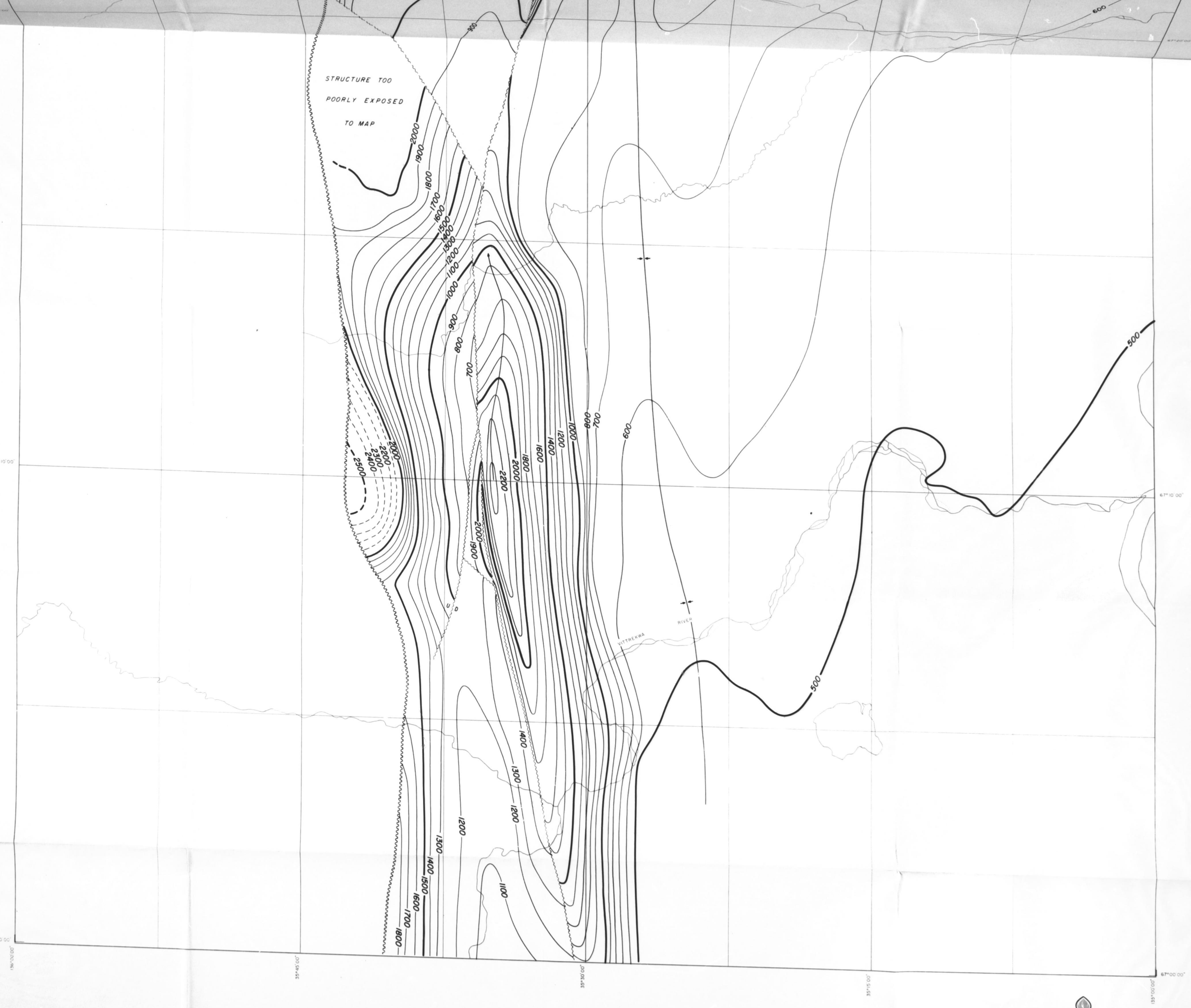
- NODULES
- SILICEOUS
- PYRITIC
- DOLOMITIC
- RIPPLE MARKS
- CROSS BEDDING
- GRADED BEDS

APPENDIX 2


MACKENZIE
RICHARDSON MOUNTAINS
NORTHWEST TERRITORIES
YUKON TERRITORY
CS-7
SURFACE GEOLOGY


67°30'00"
136°00'00"
135°45'00"
135°30'00"
135°15'00"
135°00'00"
67°30'00"
BARRIER RIVER
NORTH CLOSURE POORLY DEFINED
STONY CREEK
67°20'00"
67°20'00"
STRUCTURE TOO POORLY EXPOSED TO MAP
67°10'00"
67°10'00"
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500

1 of 2



CT-6/SW/SE

1" = 4000'

STONY CR., VETTREKWA R. NWT

S.C.M.

BASE OF ALBIAN SHALE

SILTSTONE DIVISION

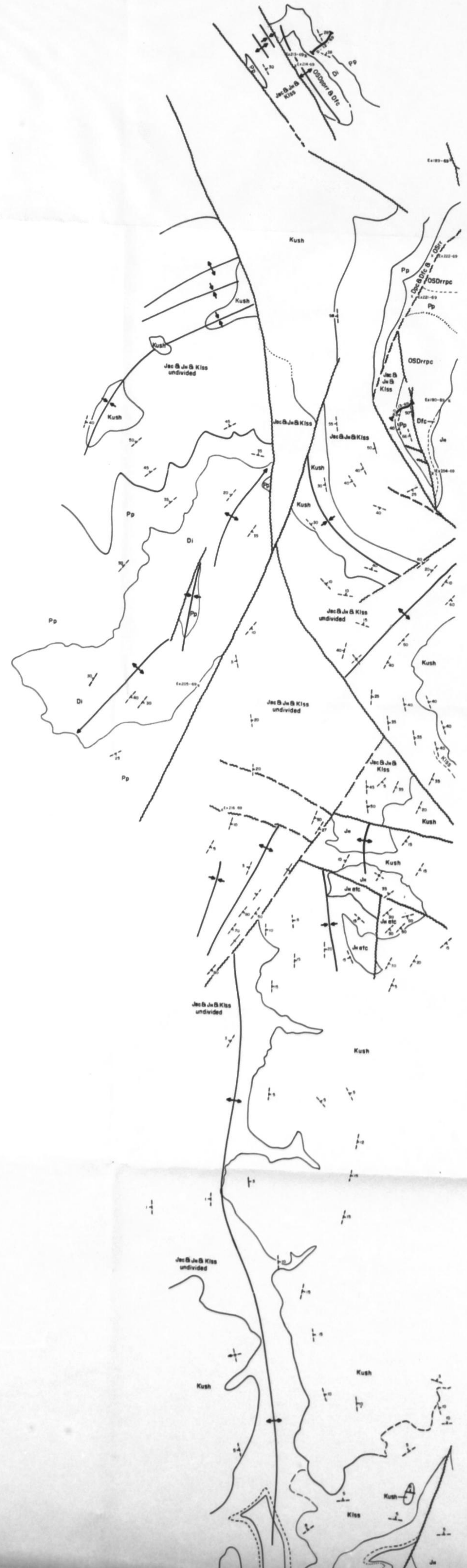
G.R. FXB-100 Compiled By: C.H. RIDDELL

Plate No: 10 C.I. 100' Date OCTOBER, 1969

2 of 2

68°00' +137°00'

136°00' +68°00'



1 of 2

LEGEND & COLOR CHART

☐ Upper Cretaceous. - Uk
☐ Albian Shale Siltstone Division. - Ka
☐ Upper Sandstone Division. - Kuss
☐ Upper Shale - Siltstone Division. - Kush
☐ Lower Sandstone Division. - Kiss
☐ Jnb North Branch - Jh Husky, Lower Shale Siltstone.
☐ Bug Creek & Older Jurassic. - Jsc
☐ Jurassic Undivided.
☐ Triassic. - Tr
☐ PPcl Clastics
☐ PPl Permo Penn Limestone.
☐ M Mississippian.
☐ Di Imperial
☐ Dfc Fort Creek Shales.
☐ D-M All Units shale out southward.
☐ Dpcb Prongs Creek Biostrom.
☐ OSDrrpc Road River - Prongs Creek Shale.
☐ €c Cambrian carbonate.
☐ €sh Cambrian shale.
☐ €bl Basal Cambrian limestone.
☐ P€ Precambrian - phyllite, carbonate, schist.

LEGEND

Contact mapped from air or ground.
Contact mapped photogeologically.
Contact inferred.
Fault U up D down
Strike - Slip.
Attitude measured.
Attitude estimated from the air.
Horizontal
Approximately horizontal dipping slightly as indicated.
Vertical.
Location of measured section.
Structural notes taken.

EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

G.R. FXB-100
Plate No: 4

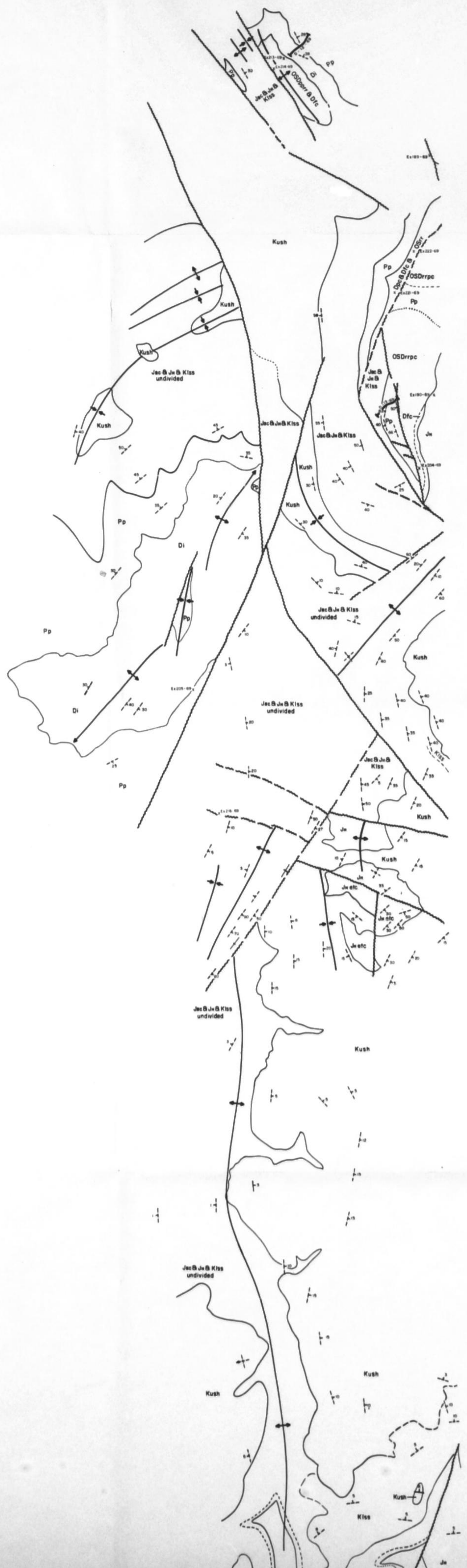
Compiled By: C.H. RIDDELL & T. BOLEANTU
Date: OCTOBER, 1969

2 of 2

CT-5

68°00' +127°00'

126°00' +68°00'



1 of 2

LEGEND & COLOR CHART

☐ Upper Cretaceous. - Uk
☐ Albian Shale Siltstone Division. - Ka
☐ Upper Sandstone Division. - Kuss
☐ Upper Shale - Siltstone Division. - Kush
☐ Lower Sandstone Division. - Klss
☐ North Branch - Husky, Lower Shale Siltstone. (JNB, JH)
☐ Bug Creek & Older Jurassic. - Jsc
☐ Jurassic Undivided.
☐ Triassic. - Tr
☐ PPcl Clastics
☐ PPl Permo Penn Limestone.
☐ M Mississippian.
☐ Di Imperial
☐ Dfc Fort Creek Shales.
☐ D-M All Units shale out southward.
☐ Dpcb Prongs Creek Biostram.
☐ OSDrrpc Road River - Prongs Creek Shale.
☐ €c Cambrian carbonate.
☐ €sh Cambrian shale.
☐ €bl Basal Cambrian limestone.
☐ P€ Precambrian - phyllite, carbonate, schist.

LEGEND

Contact mapped from air or ground.
Contact mapped photogeologically.
Contact inferred.
Fault U up D down
Strike - Slip.
Attitude measured.
Attitude estimated from the air.
Horizontal
Approximately horizontal dipping slightly as indicated.
Vertical.
Location of measured section.
Structural notes taken.

EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

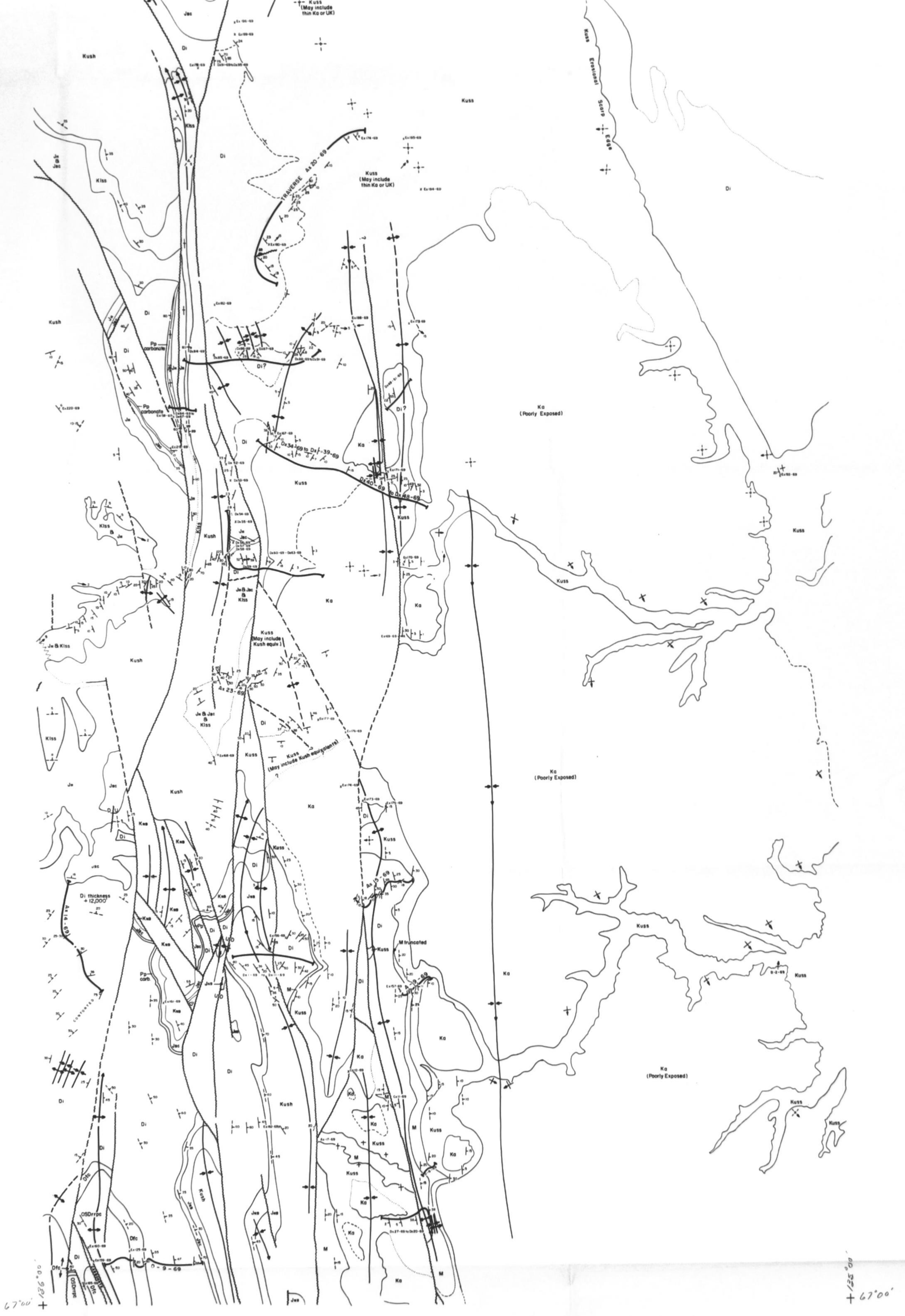
SURFACE GEOLOGY

G.R. FXB-100 Compiled By: C.H. RIDDELL & T. BOLEANTU
Plate No: 4 Date: OCTOBER, 1969

2 of 2


68°00'
68°00'
Kush
Pp
Jsc & Jw & Kiss
Kuss
€ shale & OSrr
€ shale & OSrr May include Dfc & Dpc
Ex223-69
Ex224-69
Ex208-69
Ex212-69
Ex211-69
Dpc & Dfc
OSDrrpc & Dfc
OSD
Ex201-69
U-K
Q
Jsc
Kuss (May include thin Ka or UK)
Jsc & Jw & Kiss
Jw & Kiss May include some Jsc or Kush
Ex200-69
Ex197-69
Ex185-69
Dfc & Dpc
Devonian & older see Dx68-69 to Dx84-69
Dfc
Dpc
OSDrr
Ax 19-69
May include older Rx in Anticline
Di
Ex196-69
Ex199-69
Ex178-69
Dx91-69 to Dx95-69
D-11-69
Kiss
Jw & Jsc
Kuss Erosional Scarp Edge
TRAVERSE Ax 20-69
Ex174-69
Ex195-69
Ex194-69
Ex180-69
Ex182-69
Pp carbonate
Di?
Dx85-69
Dx64-69
Dx86-69
Dx87-69
Dx88-69 to Dx91-69
Ex198-69
Ex175-69
Ex220-69
Ex218-69
Ex167-69
Dx34-69 to Dx39-69
Dx40-69 to Dx48-69
Ex171-69
Ka
Ka (Poorly Exposed)
Kiss & Jw
Jw & Kiss
Dx54-69
Dx55-69
Dx56-69
Dx57-69
Dx58-69
Dx60-69 - Dx65-69
Ex170-69
Ex193-69
Jw & Jsc & Kiss
Kuss (May include Kush equiv.)
Ax 23-69
Ex177-69
Ex176-69
Ex168-69
Kuss (May include Kush equivalents)
Jw

1 of 2



LEGEND & COLOR CHART

☐ Upper Cretaceous. Uk
☐ Albian Shale Siltstone Division. Ka
☐ Upper Sandstone Division. Kuss
☐ Upper Shale-Siltstone Division. Kush
☐ Lower Sandstone Division. Kiss.
☐ North Branch (Jnb) - Husky (Jh), Lower Shale Siltstone.
☐ Bug Creek & Older Jurassic. Jsc
☐ Jurassic Undivided.
☐ Triassic. Ŧ
☐ PPcl Clastics.
☐ PPl Permo Penn Limestone.
☐ M Mississippian.
☐ Di Imperial
☐ Dfc Fort Creek Shales.
☐ D-M All Units shale out southward.
☐ Dpcb Prongs Creek Biostrom.
☐ OSDrrpc Road River - Prongs Creek Shale.
☐ €c Cambrian carbonate.
☐ €sh Cambrian shale.
☐ €bl Basal Cambrian limestone.
☐ P€ Precambrian - phyllite, carbonate, schist.

LEGEND

Contrct mapped from air or ground.
Contact mapped photogeologically.
Contact inferred.
Fault U up D down
Strike-Slip.
Attitude measured.
Attitude estimated from the air.
Horizontal
Approximately horizontal dipping slightly as indicated.
Vertical.
Location of measured section.
Structural notes taken.

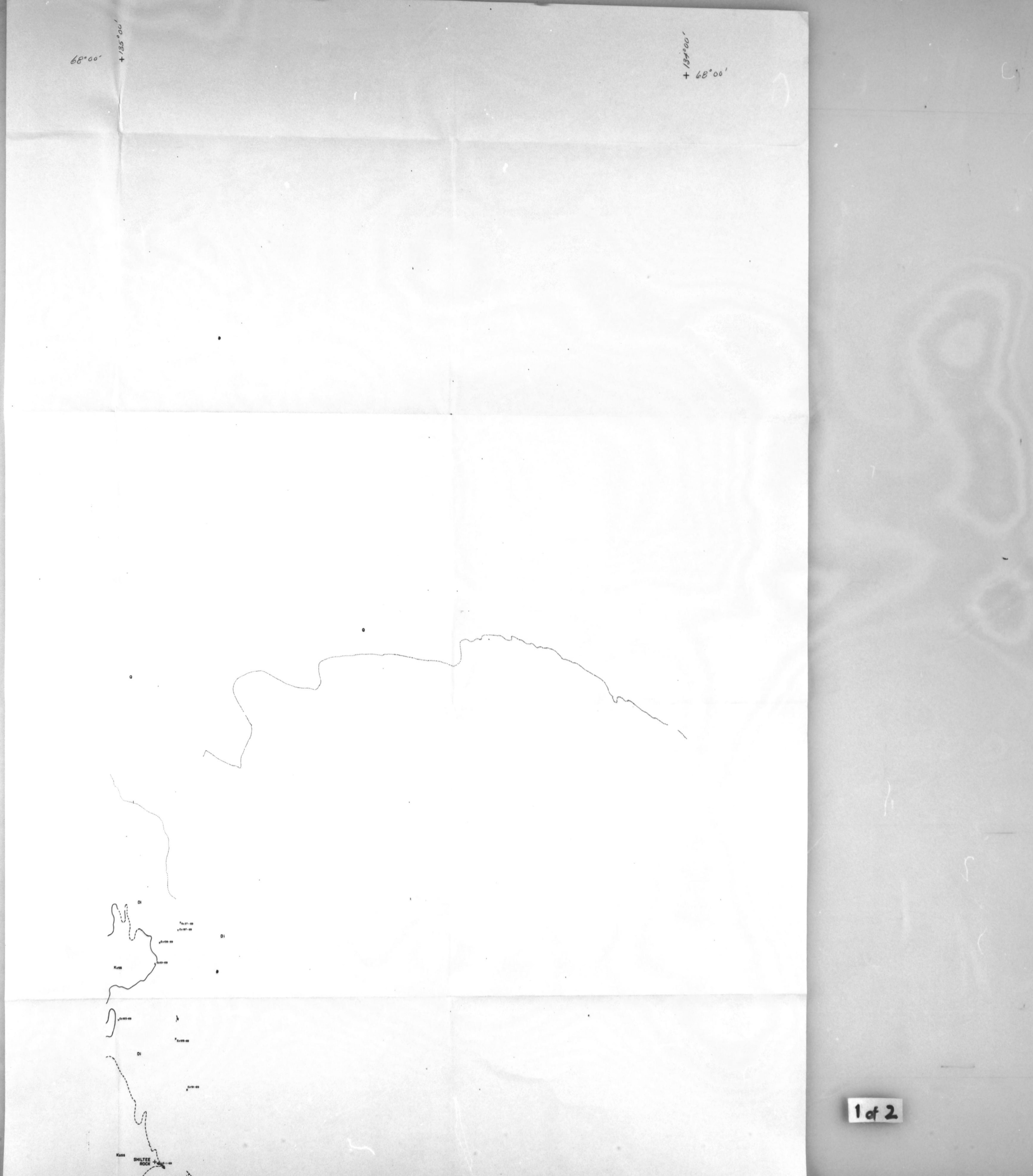
EASTERN RICHARDSON MTNS, YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

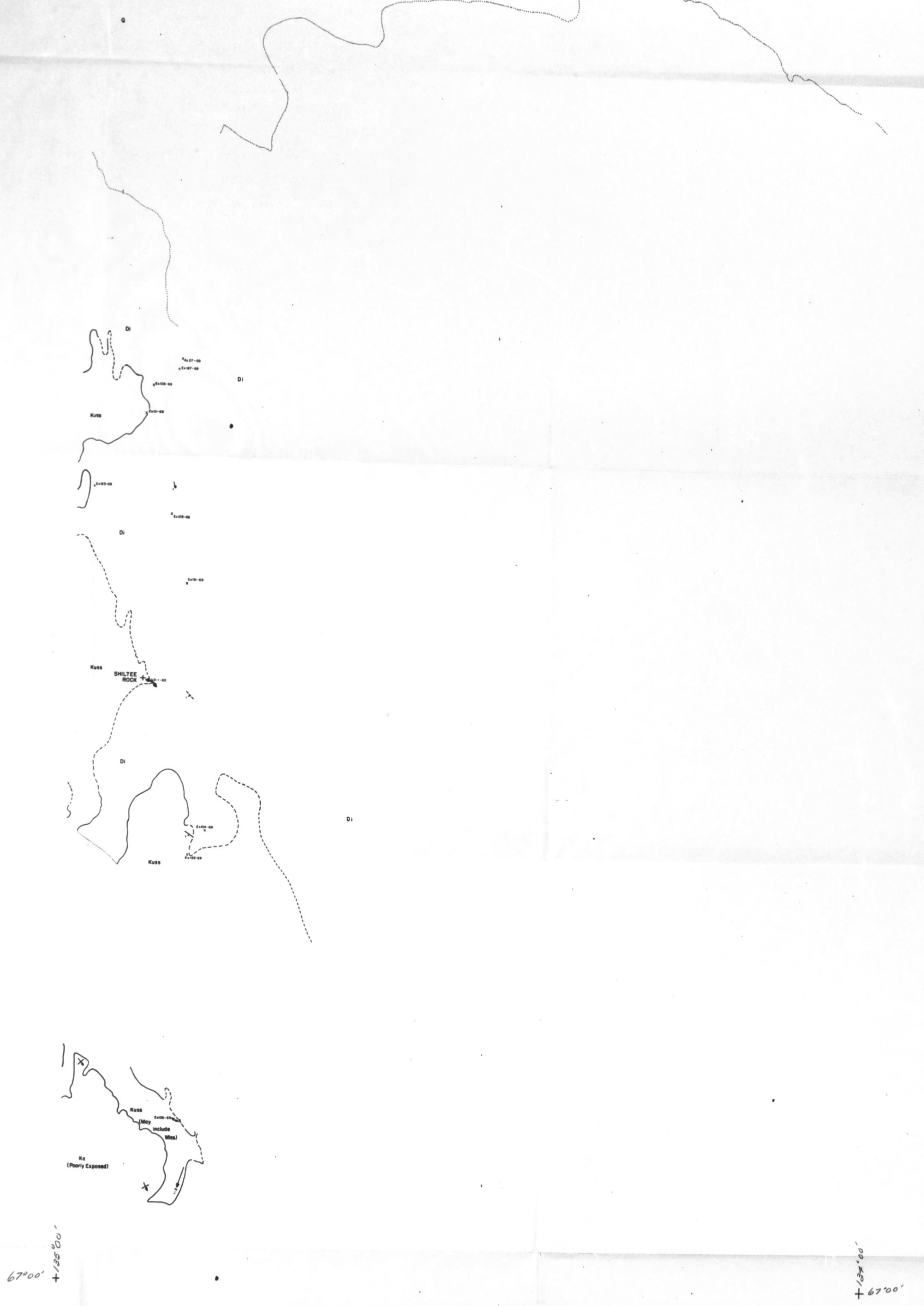
G.R. FXB-100
Plate No: 5
Compiled By: C.H. RIDDELL & T. BOLEANTU
Date: OCTOBER, 1969

CT-6

2 of 2


68°00'
+135°00'
+134°00'
+68°00'
Di
Ax 27-69
Ex 107-69
Di
Ex 108-69
Kuss
Ex 101-69
Ex 103-69
Ex 105-69
Di
Ex 101-69
Kuss
SHILTEE
ROCK
D-1-69

1 of 2



LEGEND & COLOR CHART

☐ Upper Cretaceous. - Uk
☐ Albian Shale Siltstone Division. - Ka
☐ Upper Sandstone Division. - Kuss
☐ Upper Shale-Siltstone Division. - Kush
☐ Lower Sandstone Division. - Klss
Jnb Jh
☐ North Branch - Husky, Lower Shale Siltstone.
☐ Bug Creek & Older Jurassic. - Jsc
☐ Jurassic Undivided.
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LEGEND

Contact mapped from air or ground.
Contact mapped photogeologically.
Contact inferred.
Fault U up D down
Strike - Slip.
Attitude measured.
Attitude estimated from the air.
Horizontal
Approximately horizontal dipping slightly as indicated.
Vertical.
Location of measured section.
Structural notes taken.

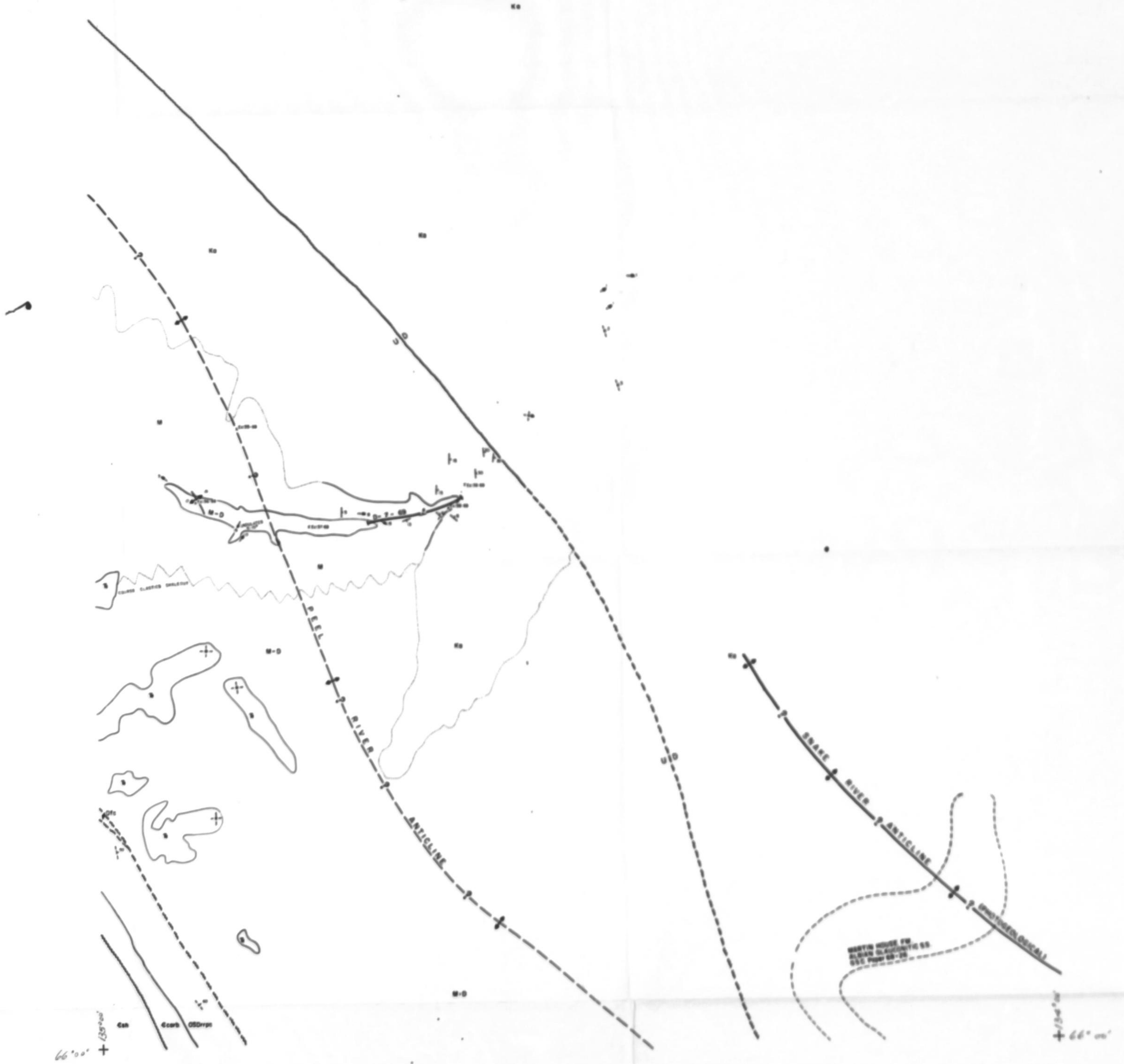
EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

G.R. FXB-100
Plate No: 6
Compiled By: C.H. RIDDELL & T. BOLEANTU
Date: OCTOBER, 1969

2 of 2

1 of 2



LEGEND & COLOR CHART

- ☐ Upper Cretaceous. - Uk
- ☐ Albian Shale Siltstone Division. - Ka
- ☐ Upper Sandstone Division. - Kuss
- ☐ Upper Shale-Siltstone Division. - Kush
- ☐ Lower Sandstone Division. - Klss
- ☐ North Branch (Jsa) - Husky (Jh), Lower Shale Siltstone.
- ☐ Bug Creek & Older Jurassic. - Jsc
- ☐ Jurassic Undivided.
- ☐ Triassic. - Tr
- ☐ PPcl Clastics.
- ☐ PPl Permo Penn Limestone.
- ☐ M Mississippian.
- ☐ Di Imperial
- ☐ Dfc Fort Creek Shales.
- ☐ D-M All Units shale out southward.
- ☐ Dpcb Prongs Creek Biostrom.
- ☐ OSDrrpc Road River - Prongs Creek Shale.
- ☐ Єc Cambrian carbonate.
- ☐ Єsh Cambrian shale.
- ☐ Єbl Basal Cambrian limestone.
- ☐ PЄ Precambrian - phyllite, carbonate, schist.

LEGEND

- Contact mapped from air or ground.
- Contact mapped photogeologically.
- Contact inferred.
- Fault U up D down
- Strike-Slip.
- Attitude measured.
- Attitude estimated from the air.
- Horizontal
- Approximately horizontal dipping slightly as indicated.
- Vertical.
- Location of measured section.
- Structural notes taken.

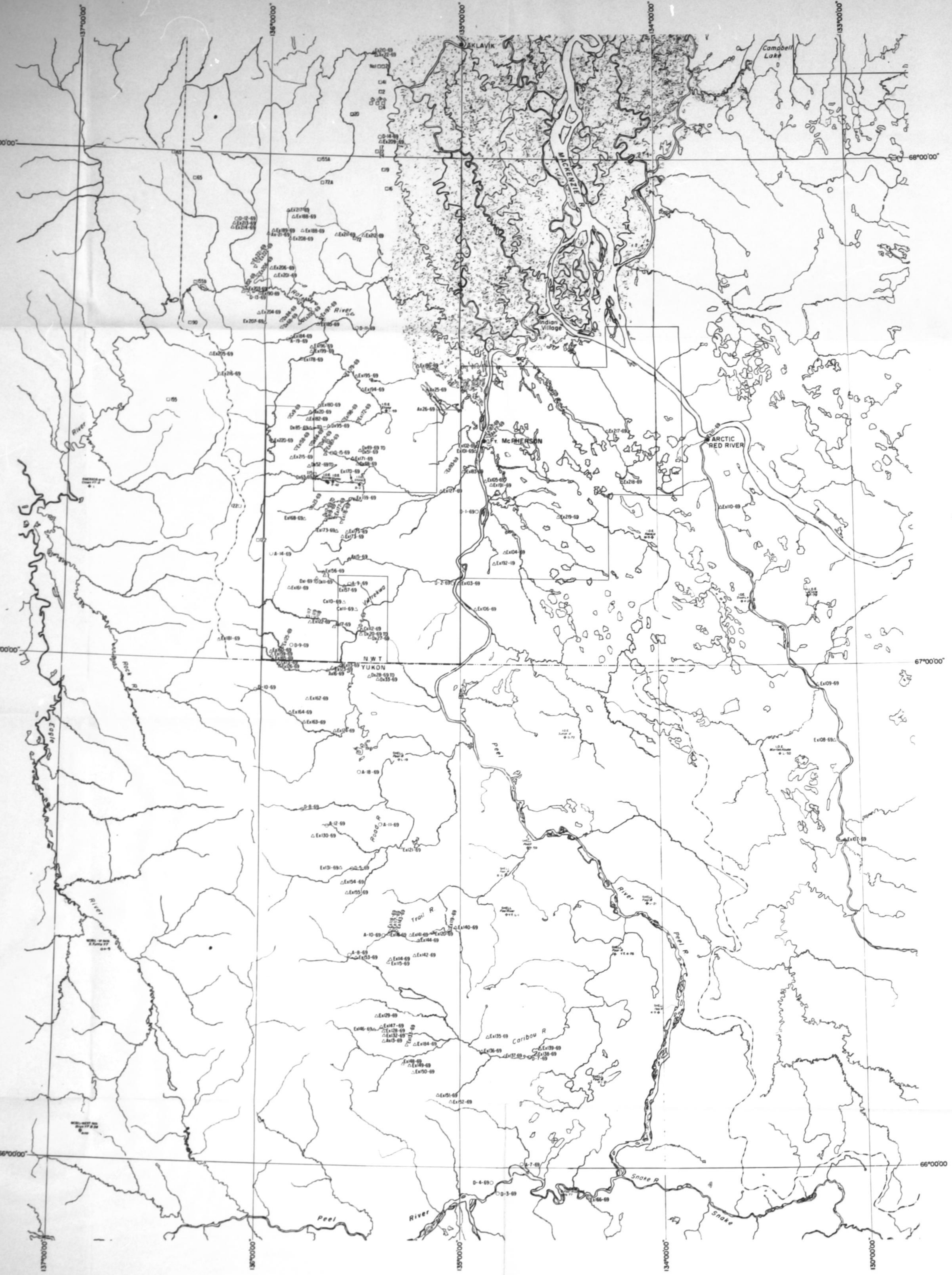
EASTERN RICHARDSON MTNS, YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

GR.FXB-100
Plate No. 3
Compiled By: C.H.RIDDELL & T.BOLEANTU
Date: OCTOBER, 1969

CS-F

2 of 2



LEGEND

○ SECTIONS

△ STRUCTURAL LOCATIONS

☐ PUBLISHED G.S.C. SECTIONS

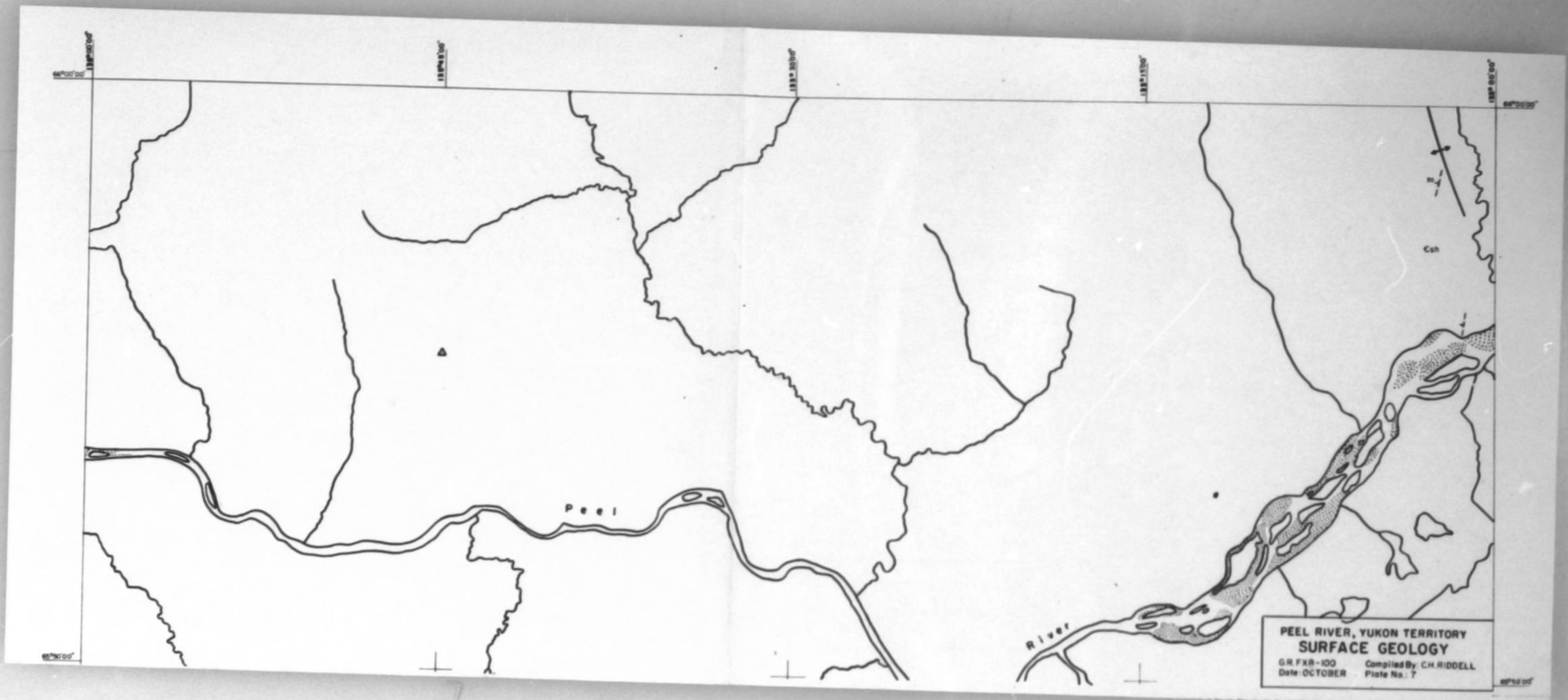
AMOCO CANADA
PETROLEUM COMPANY LTD.

FORT McPHERSON AREA, YUKON & N.W.T.

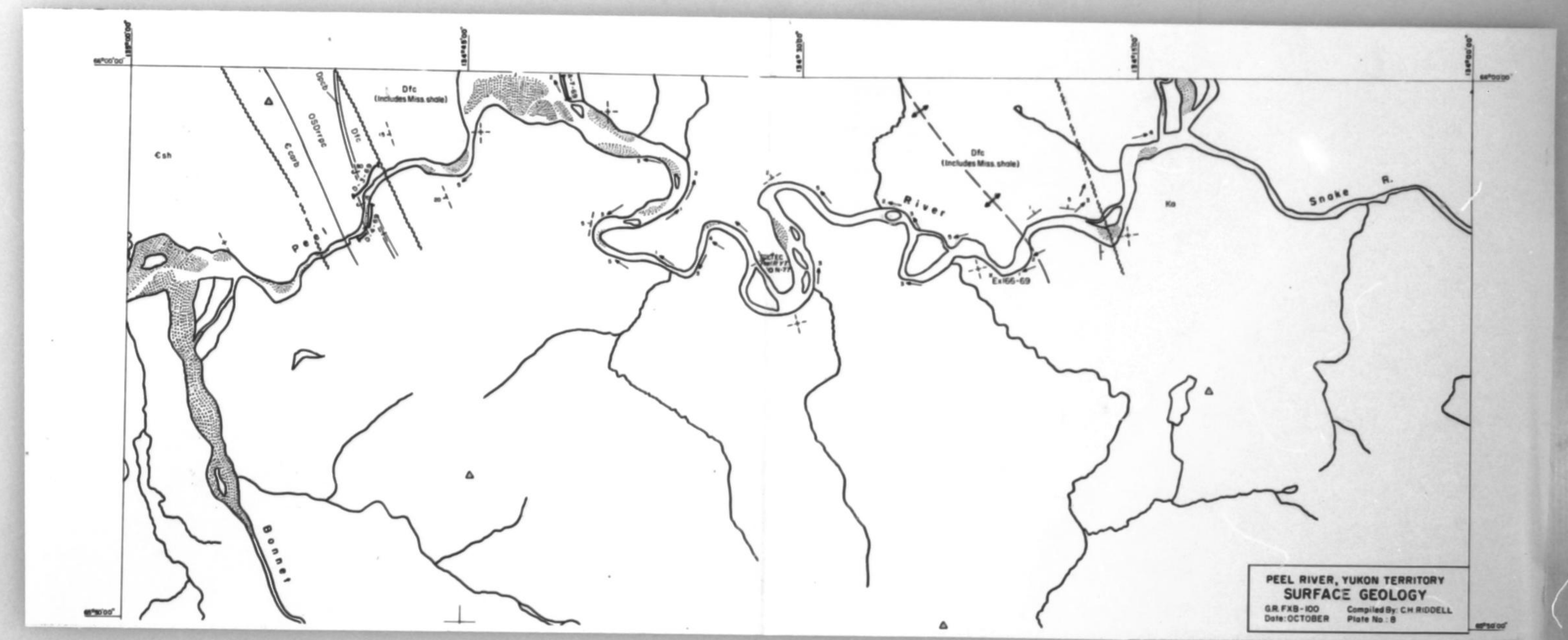
SECTION LOCATION MAP

G.R. FXB-100
Plate No: 9
Scale: 1" = 32,000'
Compiled By: C.H. RIDDELL
Date: DECEMBER, 1969

PLATE 9

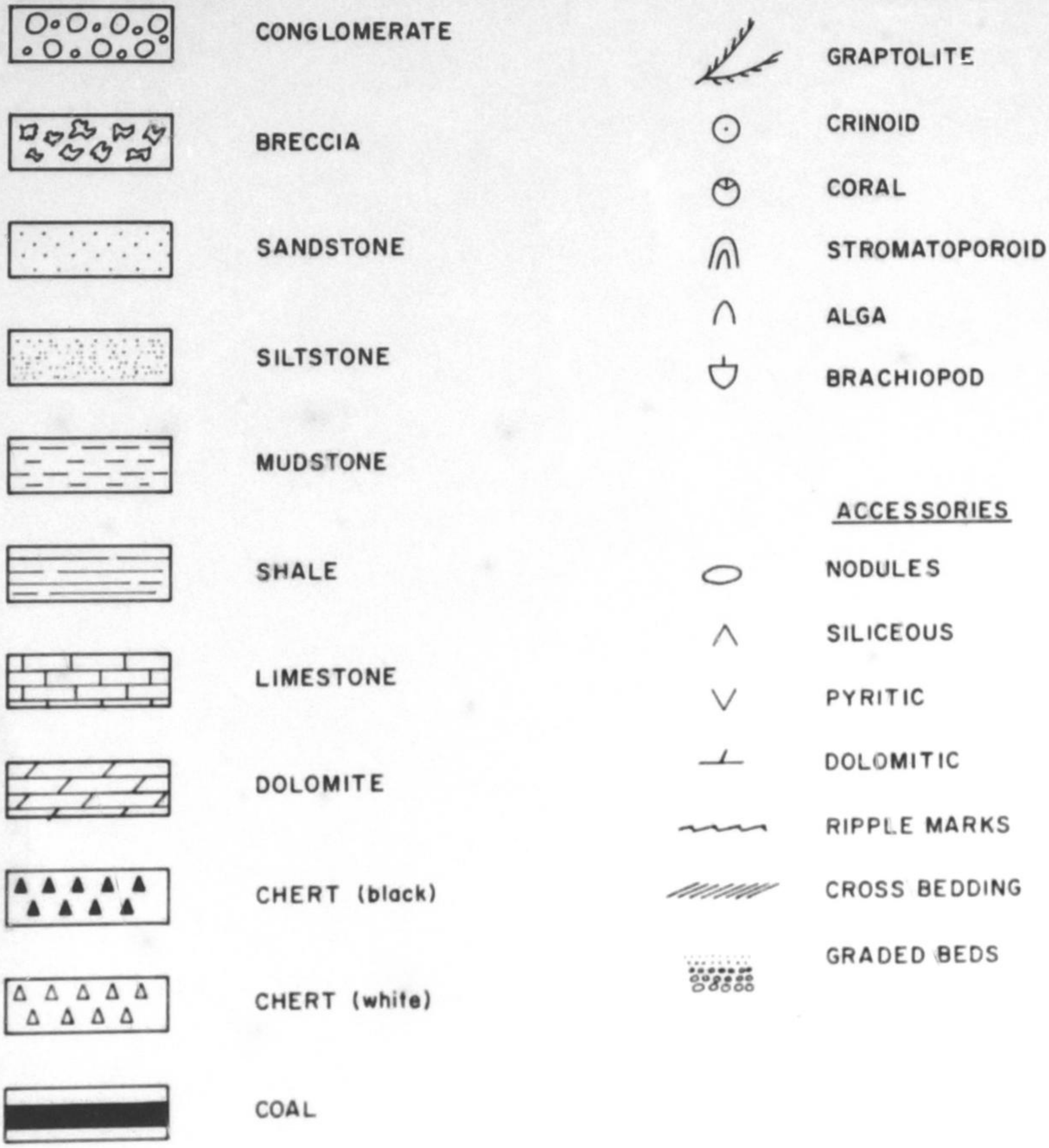


PEEL RIVER, YUKON TERRITORY
SURFACE GEOLOGY
G.R. FXB-100
Date: OCTOBER
Compiled By: C.H. RIDDELL
Plate No.: 7



PEEL RIVER, YUKON TERRITORY
SURFACE GEOLOGY
G.R. FXB-100
Date: OCTOBER
Compiled By: C.H. RIDDELL
Plate No.: 8

McPHERSON PARTY SECTION LEGEND



ROCK TYPES

- CONGLOMERATE
- BRECCIA
- SANDSTONE
- SILTSTONE
- MUDSTONE
- SHALE
- LIMESTONE
- DOLOMITE
- CHERT (black)
- CHERT (white)
- COAL

FOSSILS

- GRAPTOLITE
- CRINOID
- CORAL
- STROMATOPOROID
- ALGA
- BRACHIOPOD

ACCESSORIES

- NODULES
- SILICEOUS
- PYRITIC
- DOLOMITIC
- RIPPLE MARKS
- CROSS BEDDING
- GRADED BEDS

APPENDIX 2

FORM 470c 7-69

AMOCO CANADA PETROLEUM COMPANY LTD.

January 15, 1970

Mr. M. L. Renolds
Room 708 - Bentall Bldg.

Dear Mike,

The following samples requested by T. Boleantu, have been examined as per request dated October 9, 1969.

AX-20-69	#3	Barren
	#4	Barren
	#5	Barren
	#7	Barren
	#12	Barren
DX-92-69		Barren
DX-93-69		Barren
DX-94-69		Barren
D-3-69 #1		Barren

Yours sincerely,

C. A. Pollock

CAP/mb
CC - D. W. Paape
J. R. Century

FORM 470 2-57

PAN AMERICAN PETROLEUM CORPORATION

Tulsa, Oklahoma

November 14, 1969

Re: Palynological analysis of 7 outcrop samples from the McPherson Area, Northwest Territories and Yukon, Canada

File: Technical Service File No. 5083 PZ
Locality Nos. 5128 to 5133 inclusive.

H. A. Baker
Amoco Canada

Dear Sir:

Attached is a memorandum by D. R. Mishell reporting results of palynologic analysis of the subject outcrop samples. Results were reasonably good and ages of Upper Devonian and Lower Mississippian are reported.

Very truly yours,

WILLIAM R. WALTON

By: Charles F. Upshaw
Charles F. Upshaw

CFU:mjh

attachment

cc: J. R. Century
D. W. Paape
T. Boleantu

FORM 470 2-57

PAN AMERICAN PETROLEUM CORPORATION

Tulsa, Oklahoma
November 10, 1969

Re: Palynological analysis of 7 outcrop
samples from the McPherson Area,
Northwest Territories and Yukon, Canada

File: Technical Service File No. 5083 PZ
Locality Nos. 5128 to 5133 inclusive.

MEMORANDUM

Charles F. Upshaw
Research Center

SUMMARY

Seven outcrop samples from the McPherson area of the Northwest Territories and the Yukon have been processed and analyzed. The palynomorphs are generally well preserved and the assemblages moderately diverse. The recorded palynomorph assemblages are summarized in the attached log. On the basis of palynology the age assignments interpreted for these samples are as follows:

EX-143-69 & EX-143-69B: Early Kinderhookian (Lower Mississippian).

EX-156-69: Frasnian (Upper Devonian).

EX-105-69: Upper Devonian (possible Frasnian).

CX-11-69-5: Upper Devonian (possible Frasnian or possible Famennian).

EX-104-69 & EX-157-69: Upper Devonian (Frasnian or Famennian).

INTRODUCTION

The seven samples received for palynological analysis represent more or less isolated surface samples from six sections in the Northwest Territories and the Yukon of Canada (see attachment).

The samples were processed by employing standard palynological techniques. Recovery of spores was generally good, and "suspension" fractions of concentrated spore residues were obtained from the float fraction of three of the samples (P-39741, P-39744, and P-39745).

It should be noted that we have not yet had an opportunity to generate biostratigraphic data, based on palynology, through the Devonian Period, in a form compatible with normal Pan American procedures. Consequently, these analyses have been performed entirely on the basis of information available in publications. This method of working is more or less adequate for the purposes of the present analyses, but obviously will not suffice when future requirements become more detailed.

RESULTS

(See attachment)

EX-104-69 (P-39740)

Preservation, density and diversity of palynomorphs is good. The genus Hystricosporites occurs fairly frequently in this assemblage, and probably represents several species. The occurrence of this taxon with Lycospora magnifica indicates a probable Upper Devonian age. Geminospora sp. is very similar to the specimen illustrated from Middle Frasnian rocks of the Hay River Formation of the Northwest Territories (McGregor and Owens, 1966, plate 24, Fig. 1). However, the composition of the assemblage is sufficiently indecisive to preclude a more detailed assignment to the Frasnian or Famennian.

EX-105-69 (P-39741)

Preservation, density and diversity of palynomorphs is good, especially enhanced by the recovery of a "suspension" fraction. Several types of Hystricosporites are present, and the genus as a whole is well represented in frequency of occurrence. Lophozonotriletes cristifer would indicate a Famennian age, but only one questionable specimen in a poor state of preservation was observed. Archaeoperisaccus is entirely restricted to Frasnian rocks. Only two specimens were observed here, which were insufficiently well preserved to assign to the genus with any confidence.

Foveosporites pertustus has been recorded from the Frasnian of Spitzbergen (Vigran, 1964) and the Famennian of Bathurst Island (McGregor and Owens, 1966). Convolutispora cf tuberculata was recorded from the Givetian and Frasnian of Spitzbergen (Vigran, 1964). Tholisporites densus was described from the Upper Devonian of Melville Island (McGregor, 1960).

This assemblage of spores in combination with Lycospora magnifica, indicates an assignment to the Upper Devonian, with a possibility of its being Frasnian in age rather than Famennian.

EX-143-69 & EX-143-69B (P-39742 & P-39743)

These two assemblages are essentially similar, although the latter (P-39743) is poorly preserved.

The absence of typical Upper Devonian spores (eq. Hystricosporites spp.), and the presence of Lophozonotriletes cristifer with Knoxisporites literatus, Reticulatisporites cancellatus, Retusotriletes incohatus, Convolutispora vermiformis, and Stenozonotriletes clarus indicates an early Kinderhookian age for both of these samples.

EX-157-69 (P-39744)

Preservation, density and diversity of this assemblage is fair to good.

The presence of the genus Hystricosporites (representing several species) with Lycospora magnifica indicates an Upper Devonian age. However, the composition of the assemblage is sufficiently indecisive to preclude a more detailed assignment to the Frasnian or Famennian.

EX-156-69 (P-39745)

Preservation, density and diversity in this assemblage is good, especially enhanced by the recovery of a "suspension" fraction.

The presence of several well preserved specimens of Archaeoperisaccus timanicus, together with Hystricosporites spp., Lycospora magnifica, and Densosporites devonicus, indicates a Frasnian (Upper Devonian) age assignment for this sample.

CX-11-69-5 (P-39746)

Preservation of this assemblage is moderate, with a good diversity of spores.

Although several whole specimens of Hystricosporites were observed, this genus is mainly represented by detached ornamental spines.

The presence of Lophozonotriletes cristifer with Hystricosporites spp., and Lycospora magnifica suggests a Famennian (Upper Devonian) age. However, alternatively, the presence of poorly preserved and questionable specimens of Archaeoperisaccus spp. suggests a possible Frasnian age assignment. The third alternative is late Frasnian to early Famennian, but published data is insufficient to reach a firm conclusion at the present time.

Two Scolecodont specimens were observed in this sample, which suggests a marine environment of deposition. These two specimens were the only indication of marine conditions encountered during the examination of slides from these seven samples.

David R Mishell
David R. Mishell

DRM:mjh

Attachments

REFERENCES

McGregor, D. C., 1960: Devonian spores from Melville Island, Canadian Arctic Archipelago; Palaeontology, Vol. 3, Pt. 1, pp. 26-44.

McGregor, D. C., & Owens, B., 1966: Devonian spores of Eastern and Northern Canada; Geol. Surv. Canada, Paper 66-30, ("Illustrations of Canadian Fossils").

Vigran, Jorunn, O., 1964: Spores from Devonian deposits, Mimerdalen, Spitsbergen; Norsk Polarinst., Skrifter Nr. 132, 32 pp.

D.R.M. Nov. 1969

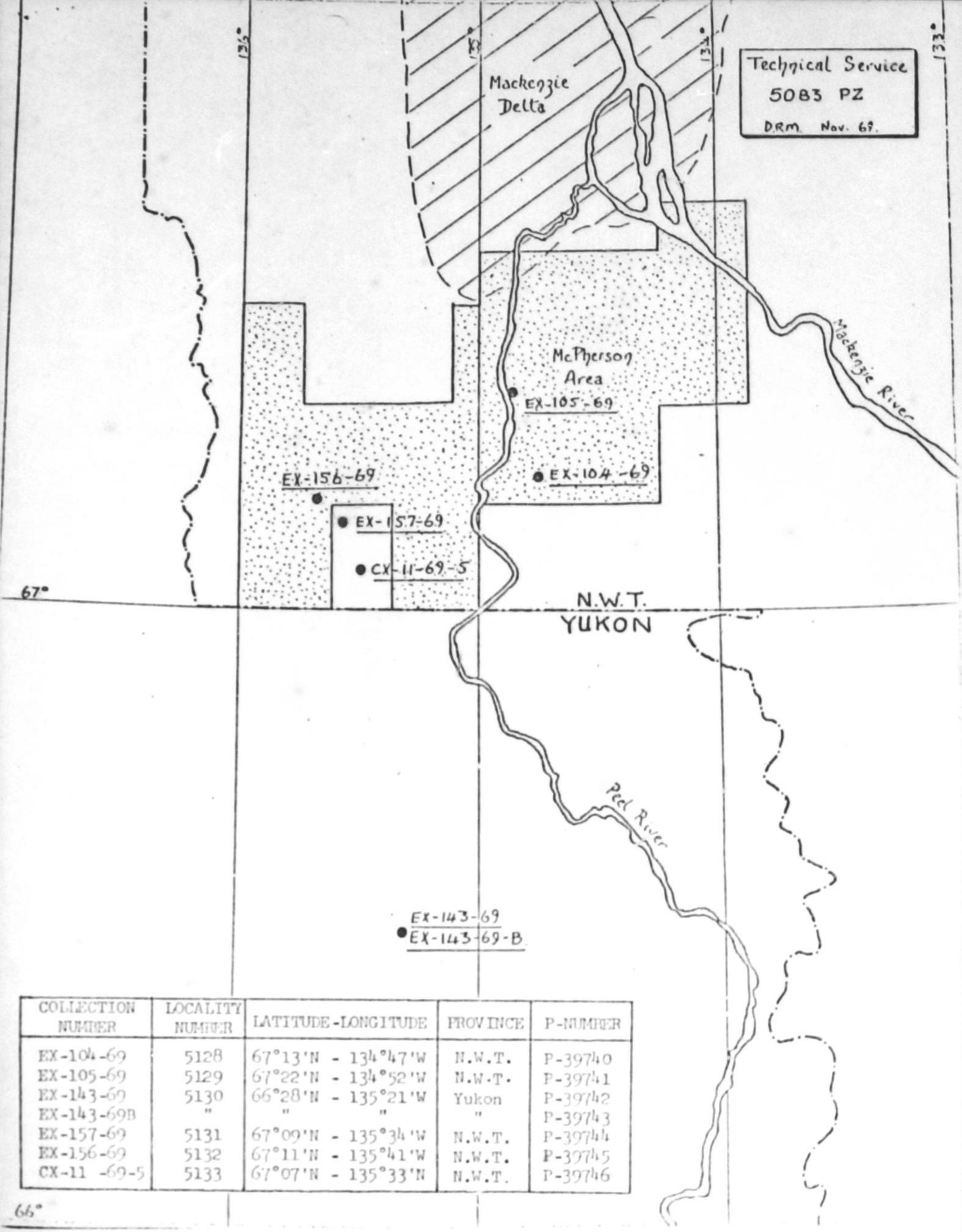
F Number	Collection Number	Retusotriletes spp.	Grandispora spp.	Hymenozonotriletes spp.	Hystricosporites spp.	Dictyotriletes spp.	Lycospora magnifica	Spinozonotriletes spp.	Geminospora spp.	Lophozonotriletes cristifer	Tholisporites densus	Foveosporites pertusus	Archaeoperisaccus timanicus	Archaeoperisaccus spp.	Dictyotriletes (Retic.) ancoralis	Convolutispora cf. tuberculata (Vigran)
39740	EX-104-69	X	?	X	X	X	X	X	X							
39741	EX-105-69				X		X			?	X	X	?	?	cf	X
39742	EX-143-69									X						
743	EX-143-69 B									X						
39744	EX-157-69	X			X		X	X			?					
39745	EX-156-69	X			X		X	X			?		X			
39746	CX-11-69-5	X	X		X		X		X	X			?	?		

F Number	Collection Number	Knoxisporites literatus	Perotrilites perinatus	Reticulatisporites cancellatus	Retusotriletes incohatus	Convolutispora usitata	Convolutispora vermiformis	Convolutispora spp.	Stenozonotriletes clarus	Cristatisporites sp.	Acanthotriletes sp.	Densosporites devonicus	Calyptosporites sp.	Perotrilites spp.	Scolecodont spp.	Palynomorphs Interpretation
39740	EX-104-69															Upper Devonian - Frasnian or Famennian.
39741	EX-105-69															Upper Devonian - possible Frasnian.
39742	EX-143-69	X	X	X	X	cf	X									Early Kinderhookian.
743	EX-143-69 B		X	X			X	X	X							Early Kinderhookian.
39744	EX-157-69							X		X	X					Upper Devonian - Frasnian or Famennian.
39745	EX-156-69											X	?			Upper Devonian - Frasnian.
39746	CX-11-69-5													X	X	- possible Famennian Upper Devonian - possible Frasnian.

Palynomorph taxa recorded in isolated samples.
Technical Service 5083 PZ.

X = Palynomorph taxa recorded as present
cf - Compares favourably with
? = Questionable identification

Technical Service
5083 PZ
D.R.M. Nov. 69.



COLLECTION NUMBER	LOCALITY NUMBER	LATITUDE-LONGITUDE	PROVINCE	P-NUMBER
EX-104-69	5128	67°13'N - 134°47'W	N.W.T.	P-39740
EX-105-69	5129	67°22'N - 134°52'W	N.W.T.	P-39741
EX-143-69	5130	66°28'N - 135°21'W	Yukon	P-39742
EX-143-69B	"	" "	"	P-39743
EX-157-69	5131	67°09'N - 135°34'W	N.W.T.	P-39744
EX-156-69	5132	67°11'N - 135°41'W	N.W.T.	P-39745
CX-11 -69-5	5133	67°07'N - 135°33'N	N.W.T.	P-39746

FORM 470 2-57

PAN AMERICAN PETROLEUM CORPORATION
Tulsa, Oklahoma
November 6, 1969

MEMORANDUM

Don Paape
Amoco Canada - Calgary

Following the conversations in Calgary, I would like to outline my plans for palynologic work in the McPherson - Peel Plateau, and Beaver River - Liard areas. For convenience, I have attached a check list of materials I would like wherever possible.

Beaver River - Liard Area

In broad terms the problems here are concerned with regional biostratigraphic relationships within the Mattson Sand section (Upper Mississippian and part Permian) and within the Lower Mississippian shale section. What is needed is the development of some firm time-lines within each section, in order to gain some understanding of the biostratigraphic geometry of the Mattson Sand, and the expansion of the Mississippian shale section from the plains into the Beaver River - Liard area.

These two problems fall within the scope of the palynology project here, and both can be studied more or less concurrently. Attacking these two problems will, in fact, give us an opportunity to evaluate existing Mississippian palynologic data, whilst attempting to develop it further.

Itwould appear now that the best way to start attacking these two problems would be to analyze the Mattson Sand and Mississippian shale sections in a well close to the Mattson wedge-edge. There seem to be several wells suitably placed, which would contain approximately 300 to 1000 feet of Mattson Sand (e.g. the B. C. Oil Lands Bekani Lake, the Imperial - Pan American Tattoo, and the Imperial - Pan American Viscount). Furthermore, in the area of these wells the Mississippian (Banff) shale, resting on the D-1 Wabamum Carbonate, is comparatively thinner than the expanded section seen in the Beaver River - Pointed Mountain wells to the West.

I feel we should obtain sample coverage, as soon as possible, from at least one well close to the Mattson wedge-edge, for palynologic analysis. (Sample coverage should extend from above the Mattson Sand to below the Mississippian (Banff) shale). The ideal well would be one which contains from 200 to 400 feet of Mattson Sand. Also, of course, if any of the wells near the wedge-edge should have cored sections in the Mattson or Mississippian shale, this would give us a greater degree of control.

The results from palynologic analysis of the two sections in question, from a well close to the Mattson wedge-edge, could then be compared to pre-existing palynologic data from the thicker sections in the Beaver River and Pointed Mountain wells. This approach to the problems should:

1) Be the speediest method of obtaining some degree of bio-stratigraphic control in both the Mattson Sand and the Mississippian shale from the plains area to the Beaver River-Pointed Mountain area.

2) Help determine which parts of previous analyses in the Beaver River and Pointed Mountain wells most need revision or further analysis.

At some future date, it may prove to be necessary to obtain palynologic data on the Mattson from a well intermediate in position between the Beaver River wells and the Pointed Mountain wells. The Canso North Beaver River well is ideally situated for this, but our sample coverage is from 6060 feet downwards, and does not include any Mattson. It is possible that, at some future date, I may request the use of your reserve vial samples in this interval of the Canso North Beaver River for palynologic analysis. If I should make this request, could your vial samples be considered expendable?

For the time being, however, I feel that our immediate efforts should be concerned with obtaining and analyzing a well from close to the wedge-edge.

McPherson-Peel Plateau area of the Yukon and Northwest Territories

Palynologic work on the outcrop sections from this area is probably best directed towards age determinations in the parts of the sections devoid of megafossils. Thus restricted, the palynologic work is probably best handled on a Technical Services basis, to be completed as time permits. In this way, a greater part of the palynologic effort can be directed towards the more time-consuming Mattson and Mississippian shale problems.

Parts of the section in this area where palynologic analysis might be beneficial would include:

1) The Fort Creek (or Canal) shale - probable Devonian.

2) The underlying "Pale Shale" (where present) - probable Devonian.

3) Shales immediately below the mid-Devonian Limestone (underlies "Pale Shale"), in an attempt to determine the age of this limestone by bracketing it.

4) Least Crinoidal parts of the mid-Devonian Limestone (Although these latter lithologies still appear unsuitable for the preservation of palynomorphs, we can do no harm in trying them-at least from one locality such as D-5-69, Road River).

5) General age determinations on samples from parts of sections of greatly questionable age. For example, the samples indicated as questionable Upper Devonian (Imperial Formation) or Mesozoic? in age.

Since there are few samples available (or needed) from each of these sections (e.g. approximately 10 samples of Fort Creek Shale, and less of the "Pale Shale"), they could be processed and analyzed fairly readily over a period of a few months at the most. On a routine basis, allowance must be made for a time-lag of a couple of weeks or more for samples to complete processing in the laboratory.

In addition to the above age determinations, some samples (approximately 30), from the Lower Paleozoic could be processed to determine the presence or absence of palynomorphs such as Chitinozoa or Acritarchs. At the present time this would have to be on quite a low priority basis. A suitable section for such a study would be the Ordovician and Silurian of the Road River Locality (D-5-69), using parts of the remaining rock samples after Jim Derby has completed his studies of the megafossils. It is doubtful we could spend very much time working with any Chitinozoa or Acritarchs that are recovered from this section in the near future, unless the need for a higher priority becomes apparent. However, I feel that we should at least establish whether such palynomorphs are present in the Lower Paleozoic of this area. Chitinozoa and Acritarchs can be recovered from drill cuttings, and they would offer good zonal potential should any future drilling in the area penetrate Ordovician or Silurian rocks.

----00----

Finally, I would like to express my thanks to you all for some interesting and stimulating discussions. I feel I have received considerable benefit from visiting the office in Calgary and discussing the geology and the problems first hand.

David R. Mishell

DRM:mjh
Attachments
cc: W. R. Walton
C. F. Upshaw
J. Century
J. Shaw
T. Boleantu
R. L. Evans
R. W. Duschatko
G. J. Verville

CHECK LIST OF MATERIALS

Beaver River-Liard Area

1) A copy of the large base map showing well locations from the Beaver River-Pointed Mountain area, eastward onto the plains. This is the map onto which Byron Richards was plotting the Mattson wedge-edge and outcrop data at the time I was in his office. I would be grateful if the line of the Mattson wedge-edge could be sketched onto this copy - (a simple pencil line would suffice).

2) Rock samples from one, or possibly two wells from just within the Mattson wedge-edge. Ideally, a well where the Mattson is 200 to 400 feet thick. If such a well is not available, I would like one as close to this thickness limit as possible (e.g. the next choice would be a well where the Mattson Sand is from 400 to 800 feet thick). Sample coverage should extend from just above the Mattson to below the Mississippian (Banff) shale. If there should be any conventional or sidewall cores, these would be the most suitable.

CHECK LIST OF MATERIALS

McPherson-Peel Plateau Area

1) A copy of the large version of the map showing location of the sections.

2) Samples from the Fort Creek (Canal) shale from several localities. (Approximately 10 samples available? - Technical Service basis).

3) Samples from the "Pale Shale" from several localities. (Approximately 6 samples available? - Technical Service basis).

4) Samples of shales from immediately below the mid-Devonian Limestone, and of the least crinoidal parts of the mid-Devonian Limestone from one (or possibly two) localities, eg. the Road River section, D-5-69. (Probably amounts to no more than 10 samples? - Technical Service basis).

5) Some of the more critical samples of highly questionable age from the various localities (i.e. the samples designated as "U. Devonian or Cretaceous?" or "Imperial Formation?" etc.). A gross, or non-detailed, age determination on such samples should not require a great deal of time on the microscope. (Probably no more than 20 to 30 of these samples could be handled at the present time - Technical Service basis, please indicate at the time of transmitting these samples, where you are only seeking a gross age determination.).

October 31, 1969

Mr. R. L. Evans
Room 817 - IBM Building

The following samples submitted by the C. Riddle Field Party at Ft. McPherson, N.W.T. were checked for foraminifera and conodonts.

Ex-102-69 A		Barren
Ex-102-69 B		Barren
Ex-130-69		Barren
Ex-137-69		Lower Cretaceous
Ex-196-69 A		Age Indeterminate
Ex-196-69 B		Barren
Ex-[illegible]-69		Barren
Ex-214-69		Barren
Ex-214-69 A		Barren
Ex-214-69 B		Lower Devonian (Siegenian)
Ex-[illegible]-69 A		Age Indeterminate
Ex-219-69 B		Age Indeterminate
Ex-[illegible]-69		Barren
D-9-69	#110	Barren
	#[illegible]	Barren
	#165	Barren
	#[illegible]	Barren
	#[illegible]	Barren
Cn-9-69	#1	Lower Cretaceous
	#11	Barren
	#21	Barren

C. A. Pollock

CAP/mb
CC - D. W. Pompe
J. C. Century
K. Mohan

T. Boleantu
October 24, 1969

RIDDELL PARTY - East Richardson Mountains - McPherson Area

Field Sections - Palaeontological Study

1-A Definition of Silurian-Devonian contact within lithologically similar shales, from differing graptolites. This will help determine the shale thickness of the Prongs Creek formation, Middle Devonian.

1-B Definition of age of coquina bands within the Prongs Creek formation and to determine type of off-reef/transported facies. These should correlate the graptolitic shales (to west) with reef/bank carbonates (to east) and in dating of future well cuttings.

1-C Definition of age and facies of biostromal carbonate unit immediately overlying Prongs Creek (probable Eifelian age).

1-D Define major age boundaries between Devonian/Cretaceous and Devonian/ Mississippian clastics, as well as within Paleozoic and Mesozoic. This will aid in the structural interpretation of structures and faulting. Facies changes near the major faults result in difficult correlations by lithology alone.

2 Definition of Pale shale zone age, between Eifelian carbonates (1-C) and Fort Creek formation. This will help to date the Fort Creek formation, where few fossils are present.

3-A Attempt to date Cambrian shales and limestones, including environment of deposition as preliminary studies of the Cambrian.

3-B Precise age dating of stages within Jurassic/Cretaceous to aid in interpretation of fault movement.

3-C Definition of Fort Creek age using conodonts. This involves visual examination of siliceous to cherty shales (occasional spot checks only).

3-D Define contact of Fort Creek formation (Mid. Dev.) and Imperial formation (U. Dev.) as to ages above and below contact.

3-E Define age range within Imperial formation (U. Dev.).

4-A To aid in regional studies of the Ordovician-Silurian and Devonian in the N.W.T. the samples from A-1, A-2, A-3, A-4, D-1, Inuvik area should be studied.

4-B Precise age-dating if possible of Cambrian or Proterozoic dolomites and slates in core of Campbell Lake high, Inuvik area.

FORM 470c 7-63

AMOCO CANADA PETROLEUM COMPANY LTD.

October 9, 1969

Mr. Jack Century
Room I 818

In order to evaluate a structure bordering the McPherson Block, I would appreciate (Priority 1) dating of the following 11 samples of possible Devonian age (Imperial Formation) by micropaleo. or palynology :

Ex-180-69		Shale	U. Dev.?	67°30'	135°43'
-182-69		Shale	U. Dev.?	67°29'	135°46'
A_x-20-69	#3	Shale	U. Dev.?	67°30'	135°47'
	#4	"	"		
	#5	"	"		
	#6	"	"		
	#7	"	"		
	#12	"	U. Dev./Cret.?		
D_x-92-69		Shale	U. Dev./Cret.?	67°33'	135°41'
-93-69		"	"		
-94-69		"	U. Dev.?		

The following 14 samples are of unknown Paleozoic and/or Permian Age. Priority 2.

D_x-70-77	Limestone	Paleozoic?	67°38'	135°53'
78	Shale (Fossil)	Permian?		
79-83	Shale/Siltstone	Permian?		

Boleantu

T. Boleantu

TB/dw

T. Boleantu
tober 9, 1969

AGE DETERMINATIONS

The following sections are essentially Priority 3 for age dating except for the following Priority 2 samples #

A_1-10-69	#3 samples	Graptolites	Silurian/Devonian
	#4 samples	Coquina	
A_3-10-69	#5 samples	M. Paleo./Paly.	U. Dev.?/Miss.
A-12-69	#3 samples	Graptolites	Silurian/Devonian
	#1 sample	Conodonts	Silurian/Devonian
	#7 samples	Coquine	Dev. (Eifelian?)
	#5 samples	M. Paleo./Conodonts	Dev. (Givetian?)

The following samples contain Pelecypods

A-9-69	#3
A_x-16-69	#2, 7
A_x-17-69	#2
A-19-69	#13, 20, 23, 24
A_x-20-69	#14

The following sample contain Ammonites

A_x-16-69	#6

The following samples contain Belmnites

A_x-17-69	#3
A-7-69	

A-8-69 L-5

3	Claystone	M. Paleo.		Cambrian
10	"	"		
21	"	"		
33	Limestone	"		
47	"	"	(2 bags)	
49	"	"	(2 bags)	
53	"	"		
58	"	"		

A-9-69

3	Shale	Pelecy.	L. Cret.?
11	"	M. Paleo./Paly.	"
17	"	"	"
24	"	"	Miss.?

AGE DETERMINATIONS

A-9-69 con't

29	Shale	M. Paleo./Paly.	Miss.?
34	"	"	"
39	"	"	Miss./U. Dev. (Imperial)
40	"	"	

A_1-10-69

60-101	Shale & minor Ls.	M. Paleo.	Sil./Dev.
#61	Shale	Graptolites	"
#71	"	"	
#90	"	"	
#70	Limestone	Coquina	Dev.? (Prongs Crk.)
#85	"	"	"
#98	"	"	"
#99	"	"	"

A_2-10-69

131	Shale	Micro. Paleo./Paly.	Imperial/Ft. Crk.
133	"		
136	Mudstone	Micro. Paleo./Paly.	Imperial
144	"	"	"
152	"	"	

A_3-10-69

#154	Mudstone (2 bags)	Micro. Paleo./Paly.	Imperial (U. Dev.)/Miss.
#158	Shale	"	" ?
#161	"	"	Miss.?
#169	Shale/Slst./Coac.	Paly.	"
#174	S.S. Cabonaceous Plant frags.	Paly.	"

A-11-69		L-2
5	Shale	Paleo.
11	"	Micro.-Paleo.
13	Shale	"
15	"	"
24	"	"
27	"	"

A-12-69

1-11	Black Shale	Graptolitic/Conodonts	Sil./Dev.?
5	"	Conodonts	"

A-12-69 con't

#4, 5, 6	Black Shale	Graptolites	
#11-17	Limestone	Crinoidal, Coquina	Dev. (Eifelian?)
#18-22	Silty Mudstone	Micro-Paleo./Conodonts?	Dev. (Givetian)
23	Siliceous Shale		Dev.-Ft. Crk. (Frasnian?)
25	"		"
28-30	Mudstone, Silic. Shale		"
32	Siliceous Shale		"
33	Mudstone		Dev.-Imperial (Frasnian?/ Famennian?)
34	"		

A-13-69

11	Limestone	M. Paleo.	Cambrian
13	Siltstone	"	"
14	Siltstone	"	"

A_x-14-69

A_x-15-69

1	Silty Mudstone	M. Paleo./Paly.	Cretaceous?
5	Shale & S.S.	"	U. Dev. (Imperial?)
8	Shale	"	"

A_x-16-69

1	Shale	Micro.-Paleo.	Dev./Jur./Cret.?
2	SS.	Fossil. (Pelec.)	Jurassic
6	SS.	Ammonite	Cret.?
7	Shale	Pelecy.	U. Dev. (Imperial)/Cret.?
10	Sh./SS.	Paly.	Miss.
16	Sh./SS.	Paly.	Miss.
17	Sh.	Paly.	"

A_x-17-69

1	Sh.	M. Paleo./Paly.	U. Dev. (Imperial Fm.)
2	SS.	Pelec.	Cret.
3	SS.	Belemnites	"
4	SS.	M. Paleo./Paly.	"

AGE DETERMINATIONS

A_x-18-69

A-19-69

1	Shale/Siltstone	Paly.	Dev.-Imperial (Frasnian? Fmennian)
2	"	Paly.	"
3	"	"	"
5	"	"	Jurassic
7	Coal.	Paly.	"
13	SS.	Pelec.	"
20	SS.	"	"
23	SS.	Echinoderm/Pelec.	Jur./Cret.
21	"	(2 bags)	"
24	"	Pelec.	"

A_x-20-69

3	Shale	M. Paleo./Paly.	U. Dev. (Imperial Fm.)
4	"	"	"
5	"	"	"
6	"	"	"
7	"	"	"
12	"	"	Cret.?
14	SS.	Pelec.	"
15	Sh.	Micro.-Paleo.	Jur./Cret.?

A_x-21-69

2	Siltstone/Shale	Paly.	Permian
9	Limestone	M. Paleo.	Permian?

A_x-23-69 Sent down for Analysis

2
6
8
10
11

October 6, 1969

Dr. [illegible]
IBM Building--8th Floor

The following samples submitted by the C. Riddle field party at Ft. McPherson, N.W.T. were checked for foraminifera and conodonts, to assist in dating the rocks.

EX-104-69-A	Barren
-B	Barren
EX-104-69	Barren
EX-10[illegible]-69	Barren
EX-109-69	Barren
-B	Barren
EX-112-69	Barren
EX-113-69	Upper Devonian (fragmented Palmatolepis)
EX-117-69	Mississippian
EX-119-69	Cretaceous
EX-121-69	Lower Cretaceous
EX-1[illegible]-69	Lower Cretaceous
EX-1[illegible]-69	Cretaceous (Early Albian)
EX-13[illegible]-69	Barren
EX-1[illegible]-69	Mississippian
EX-14[illegible]-69	Barren
EX-142-69	Barren
EX-143-69-A	Mississippian
-B	Barren
-C	Barren
EX-14[illegible]-69	Mississippian - Cretaceous boundary
EX-150-69	Barren
EX-15[illegible]-69	Barren
EX-1[illegible]-69	Barren
GA-[illegible]-69-A	Barren
EX-1[illegible]-69	Barren
EX-184-69	Barren
EX-187-69	Barren
EX-189-69-A	Barren
-B	Barren
EX-190-69	Barren
EX-191-69	Barren
EX-194-69	Barren
EX-195-69	Lower Cretaceous
EX-198-69	Lower Cretaceous
EX-199-69	Barren
EX-207-69-A	Barren
-B	Lower Cretaceous

EX-169-69	Barren
EX-174-69	Lower Cretaceous
EX-177-69-A	Barren
-B	Barren
-C	Barren
EX-176-69	Barren
EX-179-69	Upper Cretaceous
EX-180-69	Barren
EX-181-69	Lower Cretaceous
EX-182-69	Barren
A-2-69-14 ([illegible]')	Barren
-16 (300')	Barren
-30 (722')	Devonian
-43 (1060')	Barren
-51 (1161')	Barren
A-3-69-4 (50')	
-17 (325')	Barren
-22 ([illegible]')	Barren
A-4-69-2 (15')	Lower Devonian
-5 ([illegible]')	Barren
-22 ([illegible]')	Barren
EX-51-69	Lower Cretaceous
EX-52-69	Barren

The remaining samples are in the process of [illegible] worked up and will be reported on when completed.

Yours very truly,

C. A. Pollock

CAP/[illegible]
CC - J. C. Century
D. J. Ronge
E. Mohon

FORM 470 2-57

PAN AMERICAN PETROLEUM CORPORATION
Tulsa, Oklahoma
June 18, 1970

Report No.: M70-G-11

Re: Palynology of five surface sections in the McPherson - Richardson Mountains area, Yukon Territory

File: Technical Service No. 5087 PZ
Localities 5214 to 5218 inclusive

SUMMARY

Forty-five samples, from five surface sections in the McPherson-Richardson Mountains area of the Yukon Territory, have been processed and analyzed.

Useful assemblages of palynomorphs of Upper Devonian age have been obtained from samples assigned to the Imperial Formation, and samples questionably assigned to the same formation. Recovery of palynomorphs from the Devonian Pale Shale and Fort Creek intervals was very poor, and little biostratigraphic data could be obtained from these intervals. The Prongs Creek and "Mid. Devonian Limestone" intervals were found to be entirely barren.

It appears, both from this and a previous study (Memorandum, D. R. Mishell to C. F. Upshaw, Nov. 10, 1969), that palynology could be a useful biostratigraphic tool in the Upper Devonian of this study area, but not in the older sediments.

INTRODUCTION

Results from palynologic analysis of 7 samples from the study area were reported earlier (Memorandum, D. R. Mishell to C. F. Upshaw, November 10, 1969). These 7 samples were taken from 6 surface sections, and required age determinations in order to place their biostratigraphic positions. Palynologic analysis indicated that all 7 samples could be placed in the Imperial Formation (Upper Devonian to early Kinderhookian).

Subsequently, 45 samples, from 5 surface sections in this same study area, were transmitted to Tulsa for palynologic analysis and age determinations. These 45 samples are from a wider range of Paleozoic rock units, as shown on the attached tables (Silurian Prongs Creek to Upper Devonian Imperial Formation, or possibly younger). The 5 surface sections and their assigned locality numbers are as follows:-

Locality 5214 - Peel River section, D-3-69, Richardson Mountains (S.E.), latitude 65° 52' N., longitude 134° 50' W., Yukon Territory.

Locality 5215 - Road River Tributary section, A-12-69, Richardson Mountains (S.E.), latitude 66° 40' N., longitude 135° 37' W., Yukon Territory.

Locality 5216 - Road River section, D-5-69, Richardson Mountains, latitude 66° 37' N., longitude 135° 40' W., Yukon Territory.

Locality 5217 - Vittrekwa River section, D-10-69, Richardson Mountains, latitude 66° 57' N., longitude 136° 03' W., Yukon Territory.

Locality 5218 - Road River Tributary section, B-3-69 (D-8-69), Richardson Mountains, latitude 66° 43' N., longitude 135° 47' W., Yukon Territory.

The locations of the 5 sections are shown on the accompanying map.

PROCEDURES

Samples from the Pale Shale, Fort Creek, and Imperial stratigraphic units were prepared in the laboratory by standard processing techniques. These samples are designated by "S" on the attached tables of sample data. Spores, acritarchs and Chitinozoa can be recovered by these standard techniques, although the procedures tend to cause damage to chitinozoan specimens.

The Prongs Creek interval is considered to be mostly Silurian in age. Samples in this interval were prepared by modified techniques, designed primarily to recover undamaged Chitinozoa. Samples from the "Mid. Devonian Limestone" interval were also pre-processed by these modified preparation techniques. The samples processed by the modified chitinozoan techniques are designed by "C" on the tables of sample data.

The modified techniques are an adaptation of our standard preparation procedures designed:

1) to minimize loss of sculptural ornament and fracturing of any Chitinozoa which may be present, and

2) to concentrate any Chitinozoa from the dispersed organic residues.

To minimize specimen damage, settling and decantation methods are substituted for the use of centrifuges in the processing procedures. After acid treatment, a 53 microns screen is used to separate the residue into a coarse and fine fraction. Chitinozoa and large acritarchs would then be concentrated in the coarse (+53 microns) fraction, which is examined with a stereoscopic microscope. Wet mounts of the fine (-53 microns) fraction were examined with a compound microscope for small acritarchs. The Prongs Creek samples were not processed beyond this point.

In the case of the "Mid. Devonian Limestone" samples, after the coarse fraction was examined with the stereoscopic microscope, it was re-combined with the fine fraction. Preparation then proceeded from the heavy-liquid separation stage of the standard processing schedule. This procedure was employed in order to finish with potentially spore-bearing organic residues.

At present we have little pre-Mississippian biostratigraphic data, based on palynology, in a form compatible with normal Pan American procedures. Consequently these analyses have been performed with reference to information available in publications only. This method of working appears to be satisfactory for these analyses.

RESULTS

Prongs Creek interval (7 samples; Localities 5214, 5216, 5217, and 5218).

Coarse fractions (+53 microns) of the organic residues were examined with a stereoscopic microscope, and were found to be devoid of Chitinozoa or large acritarchs. The fine fractions (-53 microns) were examined with a compound biological microscope, and were found to be devoid of acritarchs. The residues consisted entirely of carbon fragments.

"Mid. Devonian Limestone" interval (6 samples; Localities 5214, 5215 and 5216).

The screened, plus and minus 53 microns fractions, and final organic residues, after standard processing, were all found to be entirely barren of any forms of palynomorphs.

Pale Shale interval (10 samples; Localities 5215 and 5216)

The four samples in Locality 5215 (Road River Tributary, A-12-69) were found to be entirely barren, with the residues consisting entirely of carbon fragments.

In Locality 5216 (Road River, D-5-69) the lower two samples (P-40123/D-5-69-108, and P-40124/D-5-69-109) were entirely barren. The upper four samples (P-40125/D-5-69-111, to P-40128/D-5-69-115) contained scolecodont and chitinozoan fragments, with sparse, very poorly preserved spores. These spores are mostly small (less than 70μ), simply organized forms, which are carbonized, corroded, and pitted. Generally they are unidentifiable. The genera Punctatisporites, Leiotriletes, and, more doubtfully, Retusotriletes appear to be present. Little can be deduced from these poor assemblages, other than that they appear to indicate a marine environment of deposition, since scolecodonts and chitinozoans are present. They yield no significant age data, other than indicating a probable Devonian age by the combination of spores with Chitinozoa.

<u>Fort Creek interval</u> (14 samples; Localities 5214 to 5218 inclusive)

The samples of this interval in Locality 5214 (Peel River, D-3-69), Locality 5216 (Road River, D-5-69), and Locality 5217 (Vittrekwa River, D-10-69) were found to be entirely barren.

In Locality 5215 (Road River Tributary, A-12-69) the upper of two samples was found to be barren. The lower sample (P-40119/A-12-69-21B) contains carbonized, corroded, and pitted Chitinozoa, scolecodonts and spore remains. The spores could not be identified with any degree of certainty, beyond some of them appearing to be simple Punctatisporites forms. Some of the heavily corroded spores appear as more or less carbonized "ghosts". Little can be deduced from this residue, other than a possible marine Devonian interpretation.

In Locality 5218 (Road River Tributary, B-3-69 (D-8-69)) the lower two samples are barren. The upper sample (P-40149/B-3-69-44) contains highly degraded and partly carbonized organic debris and spores. Most of these spores are unrecognizable, apart from Punctatisporites forms, and two specimens with large corroded 'grapnel tipped' ornament which would belong to either of two morphologically similar genera. The two genera are Hystricosporites and Ancyrospora, both of which are restricted to the Devonian.

<u>Imperial and questionable Imperial interval</u> (8 samples; Locality 5216)

Some of the samples in this interval in Locality 5216 (Road River, D-5-69) have yielded useful palynological assemblages. Preservation and density of spores in these samples is fair. Identifications are shown on the attached palynologic log.

The lower three samples in this interval contain highly corroded and partially carbonized organic debris and spores. No meaningful identifications could be made of the spores.

Sample number P-40134 (D-5-69-164) contains several forms of the genus Hystricosporites, and two specimens of the genus Archaeoperisaccus.

In addition, it also contains a spore similar to the unidentified form in McGregor and Owens (1966) figured in plate 27, figure 19. The association of spores in this sample indicate an Upper Devonian age, probably Frasnian.

Sample number P-40135 (D-5-69-168) contains several forms of the genus Hystricosporites, together with Torispora-1, and Lycospora magnifica. The record of Densosporites orcadensis represents a single questionable identification. The spores in this sample indicate a probable early to middle Famennian age.

Sample number P-40136 (D-5-69-176) contains several forms of Hystricosporites, together with several specimens of Torispora-1. The record of Archaeoperisaccus sp. represents one corroded specimen, doubtfully assigned to this genus. The genus Calyptosporites is more typical of Lower to Middle Devonian rocks, and the presence of one specimen in this sample does not appear to be significant. The association of Hystricosporites spp. and Torispora-1 indicates a probable early to middle Famennian age.

Sample number P-40137 (D-5-69-181) contains Hystricosporites spp., and Torispora-1. The spore recorded as Lophozonotriletes sp. in this sample is similar to an unidentified form recorded from the early to middle Famennian by McGregor and Owens (1966, plate 27, figure 10). The association of spores in this sample indicates a probable early to middle Famennian age.

Sample number P-40138 (D-5-69-184) contains a useful suite of spores. The association of Hystricosporites spp., Torispora-1, Torispora-2, and Lophozonotriletes-3 alone would suggest a Famennian age. However, the presence of Hymenozonotriletes lepidophytus, in large numbers, in this sample is significant. Streel (1966 and 1969) and other workers have shown that H. lepidophytus occurs in large quantities in a restricted stratigraphic interval, and on a wide geographic basis. The taxon has been found to be very useful for the delimitation of the Devonian - Carboniferous boundary (see Sullivan, 1966). Streel applied biometric methods to populations of this taxon, and has demonstrated a progressive stratigraphic variation in size for the populations.

The maximum diameters of 200 specimens of H. lepidophytus were measured from this sample. The results are plotted on the attached histogram, which shows the size/frequency distribution for this population. The total size range, inter-quartile range, and mean of this distribution compares closely to a position between levels 15 and 16 of Streel's (1969, fig. 1) results. This population, therefore, indicates an uppermost Famennian (Fm2 β) age for this sample.

DISCUSSION OF RESULTS

The seven samples initially analyzed from this study area, under technical service 5083 PZ (memorandum, Mishell to Upshaw, November 10, 1969) contained assemblages of Upper Devonian to early Kinderhookian age, indicating they belonged to the Imperial Formation. During the present study, samples from the Imperial and questionable Imperial sequences yielded useful palynological assemblages of Upper Devonian age. These samples can, therefore, all be satisfactorily placed in the Imperial Formation.

There appears to be a significant break in the recovery of useful palynomorphs below the Imperial Formation. Samples from the Pale Shale and Fort Creek intervals were mostly barren. Some palynomorphs, in very poor state of preservation, were recovered from a few of the samples, but were of little use. Samples from the "Mid. Devonian Limestone" and Prongs Creek intervals were found to be barren.

CONCLUSIONS

In any future studies of this region, palynology should prove to be a useful tool in effecting correlations and age determinations in the Imperial and equivalent strata. It is doubtful that we could provide significant help in biostratigraphic studies of the pre-Imperial sequence, down to, and including, the Prongs Creek. The thick sequence of Road River Shales, lying below the Prongs Creek interval, have not been tested for content of palynomorphs.

David R Mishell

David R. Mishell

DRM:mjh

Attachments

REFERENCES

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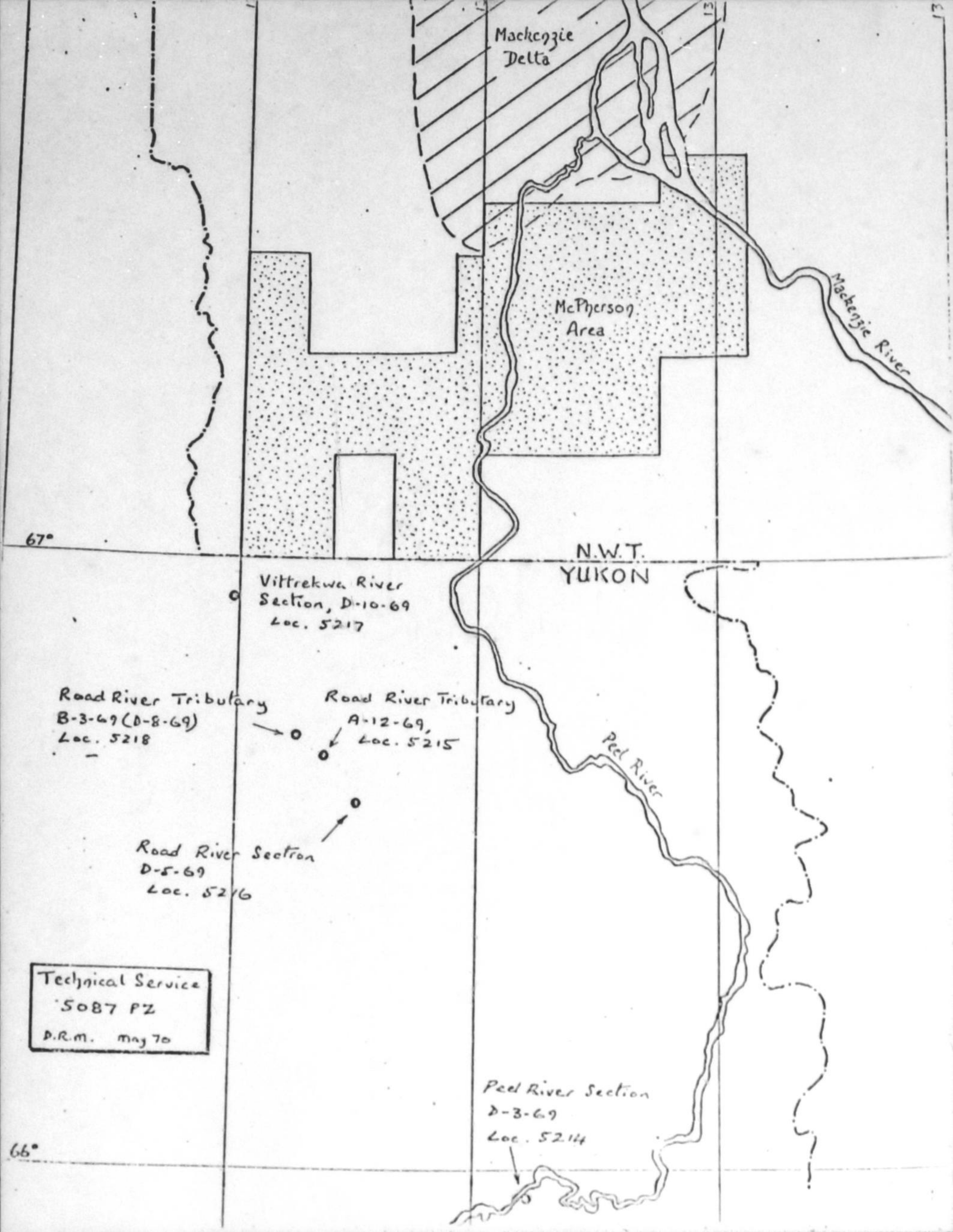

13
13
Mackenzie Delta
McPherson Area
Mackenzie River
67°
N.W.T.
YUKON
Vittrekwa River Section, D-10-69 Loc. 5217
Road River Tributary B-3-69 (D-8-69) Loc. 5218
Road River Tributary A-12-69, Loc. 5215
Road River Section D-5-69 Loc. 5216
Peel River
Technical Service 5087 PZ D.R.M. May 70
Peel River Section D-3-69 Loc. 5214
66°

Locality 5217: Vittrekwa River Section (D-10-69)

Collection No.	Feet	P-Number	Prep.	Strat. Interval
D-10-69-20	1164	P-40144	S	Fort Creek
D-10-69-17	880	P-40143	S	Fort Creek
D-10-69-13	590	P-40142	S	Fort Creek
D-10-69-12	496	P-40141	S	Fort Creek
D-10-69-11	494	P-40140	C	Prongs Creek
D-10-69-10	450	P-40139	C	Prongs Creek

Locality 5218: Road River Tributary (B-3-69 (D-8-69))

Collection No.	Feet	P-Number	Prep.	Strat. Interval
B-3-69-44	3525	P-40149	S	Fort Creek
B-3-69-41	3010	P-40148	S	Fort Creek
B-3-69-40	2870	P-40147	S	Fort Creek
B-3-69-39	2635	P-40146	C	Prongs Creek
B-3-69-35	2375	P-40145	C	Prongs Creek

Locality 5216: Road River Section (D-5-69)

Collection No.	Feet	P-Number	Prep.	Strat. Interval
D-5-69-184	13555	P-40138	S	Imp. or Miss. or Cret.
D-5-69-181	13035	P-40137	S	Imperial or Miss.
D-5-69-176	12261	P-40136	S	Imperial or Miss.
D-5-69-168	11678	P-40135	S	Imperial or Miss.
D-5-69-164	11590	P-40134	S	Imperial
D-5-69-158	8300	P-40133	S	Imperial
D-5-69-150	6800	P-40132	S	Imperial
D-5-69-141	5410	P-40131	S	Imperial
D-5-69-131	4965	P-40130	S	Fort Creek
D-5-69-118	4411	P-40129	S	Fort Creek
D-5-69-115	4325	P-40128	S	Pale Shale
D-5-69-113	4265	P-40127	S	Pale Shale
D-5-69-112	4235	P-40126	S	Pale Shale
D-5-69-111	4118	P-40125	S	Pale Shale
D-5-69-109	4097	P-40124	S	Pale Shale
D-5-69-108	4052	P-40123	S	Pale Shale
D-5-69-102	3867	P-40122	C	Mid. Devonian Lst.
D-5-69- 98	3712	P-40121	C	Prongs Creek

Locality 5214: Peel River Section (D-3-69)

Collection No.	Feet	P-Number	Prep.	Strat. Interval
D-3-69- 3	74	P-40105	S	Fort Creek
D-3-69- 8	215	P-40106	S	Fort Creek
D-3-69-10	570	P-40107	S	Fort Creek
D-3-69-13	575	P-40108	C	Mid. Devonian Lst.
D-3-69-21	793	P-40109	C	Mid. Devonian Lst.
D-3-69-27	845	P-40110	C	Prongs Creek
D-3-69-30	1209	P-40111	C	Prongs Creek

Locality 5215: Road River Tributary (A-12-69)

Collection No.	Feet	P-Number	Prep.	Strat. Interval
A-12-69-23	968	P-40120	S	Fort Creek
A-12-69-21B	821	P-40119	S	Fort Creek
A-12-69-22	780	P-40118	S	Pale Shale
A-12-69-21A	660	P-40117	S	Pale Shale
A-12-69-20	565	P-40116	S	Pale Shale
A-12-69-19	525	P-40115	S	Pale Shale
A-12-69-18	493	P-40114	C	Mid. Devonian Lst.
A-12-69-17	473	P-40113	C	Mid. Devonian Lst.
A-12-69-15	435	P-40112	C	Mid. Devonian Lst.

TAXA SAMPLES	Hymenozonotriletes lepidophytus	Torispora - 1	Retusotriletes spp.	Dictyotriletes spp.	Pustulatisporites spp.	Torispora - 2	Hystricosporites spp.	Convolutispora spp.	Grandispora spp.	Lophozonotriletes - 3	Lophozonotriletes lebedianensis	Stenozonotriletes sp.	Lophozonotriletes grandis v. minor	Calamospora spp.	Lophozonotriletes spp.	Verrucosisporites spp.	Archaeoperisaccus spp.	Punctatisporites spp.	Perotrilites spp.	Calyptosporites sp.	Hymenozonotriletes sp.	Densosporites orcadensis	Lycospora magnifica	INTERPRETATION
P-40138	x	x	x	x	x	x	x	x	x	x														Uppermost Famennian
P-40137		x	x				x	x			x	x	?	x	x									Probable early to middle Famennian
P-40136		x					x							x		x	?	x	x	x				
P-40135		x	x	x			x	x						x	x			x	x		x	?	F	
P-40134			x		x		x									x	x							Probable Frasnian
P-40133	Degraded organic residues, no meaningful identifications can be made.																							
P-40132																								
P-40131																								

LEGEND

x = present

? = questionable identification

F = cf. (similar)

Locality 5216; Road River section, D-5-69.

Palynologic Log of Imperial and questionable Imperial samples.

D.R.M. May 1970.

TAXA SAMPLES	Hymenozonotriletes lepidophytus	Torispora - 1	Retusotriletes spp.	Dictyotriletes spp.	Pustulatisporites spp.	Torispora - 2	Hystricosporites spp.	Convolutispora spp.	Grandispora spp.	Lophozonotriletes - 3	Lophozonotriletes lebedianensis	Stenozonotriletes sp.	Lophozonotriletes grandis v. minor	Calamospora spp.	Lophozonotriletes spp.	Verrucosisporites spp.	Archaeoperisaccus spp.	Punctatisporites spp.	Perotrilites spp.	Calyptosporites sp.	Hymenozonotriletes sp.	Densosporites orcadensis	Lycospora magnifica	INTERPRETATION
P-40138	x	x	x	x	x	x	x	x	x	x														Uppermost Famennian
P-40137		x	x				x	x			x	x	?	x	x									Probable early to middle Famennian
P-40136		x					x							x		x	?	x	x	x				
P-40135		x	x	x			x	x						x	x			x	x		x	?	F	
P-40134			x		x		x									x	x							Probable Frasnian
P-40133	Degraded organic residues, no meaningful identifications can be made.																							
P-40132																								
P-40131																								

LEGEND

x = present

? = questionable identification

F = cf. (similar)

Locality 5216: Road River section, D-5-69.

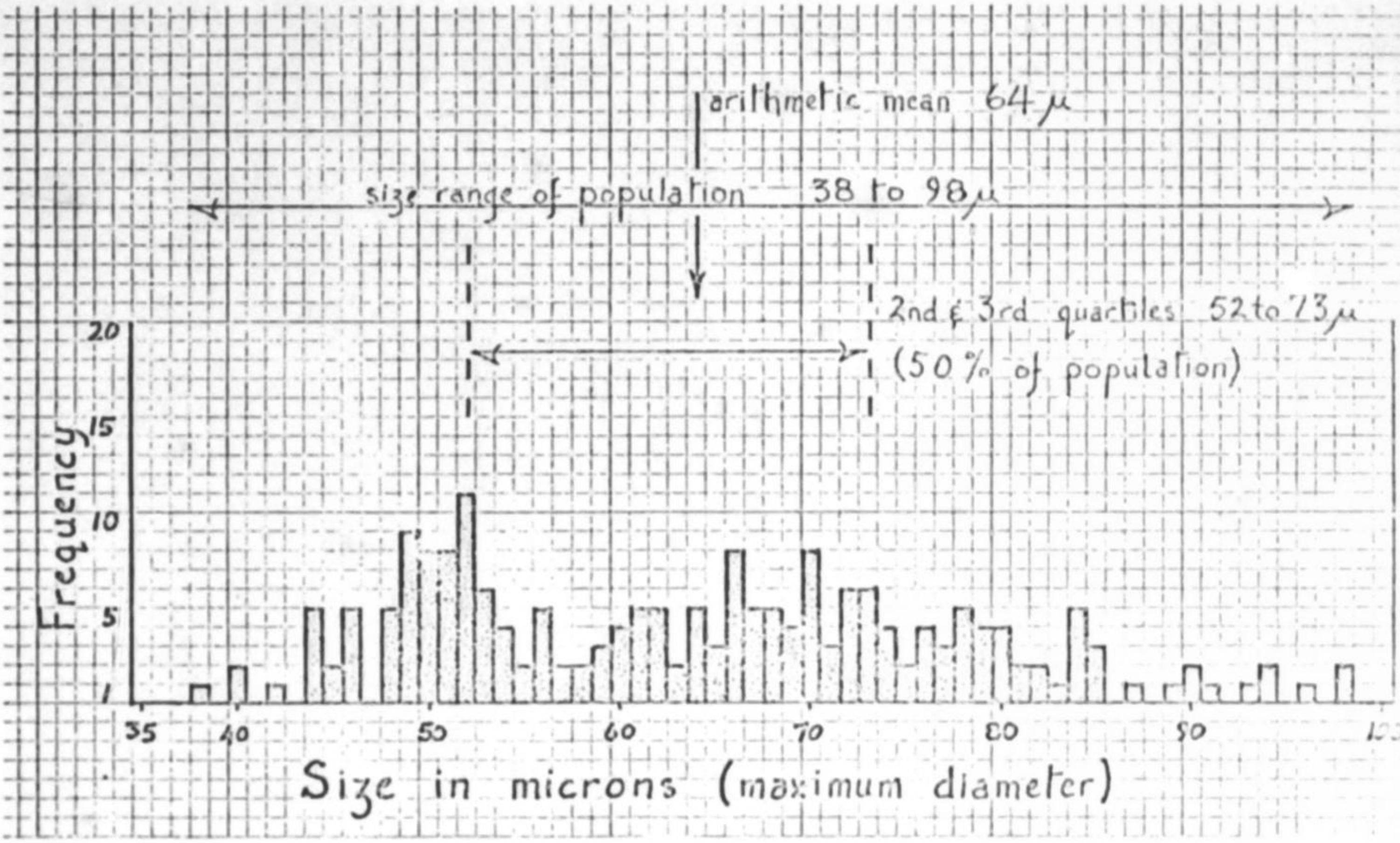
Palynologic Log of Imperial and questionable Imperial samples.

D.R.M. May 1970.

ROAD RIVER SECTION, D-5-69, RICHARDSON MOUNTAINS, YUKON TERRITORY, CANADA.

Locality No. 5216. Sample D-5-69 /184. P-No. P-40138.

Size frequency distribution of *Hymenozonotriletes lepidophytus*, on maximum diameter of 200 specimens.



D.R.M. Jan. 1970

August 1974

10x

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105 M.M.

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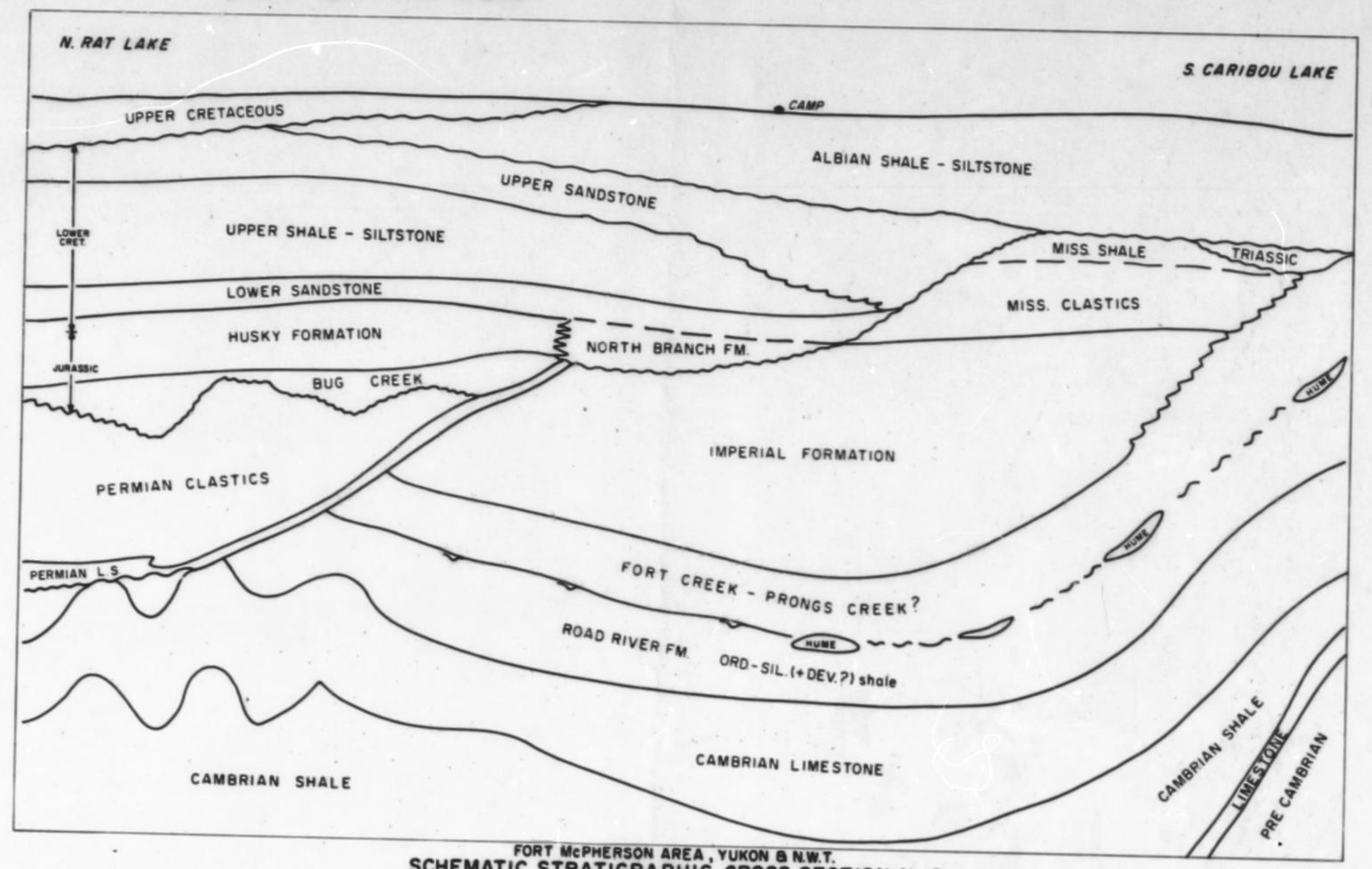
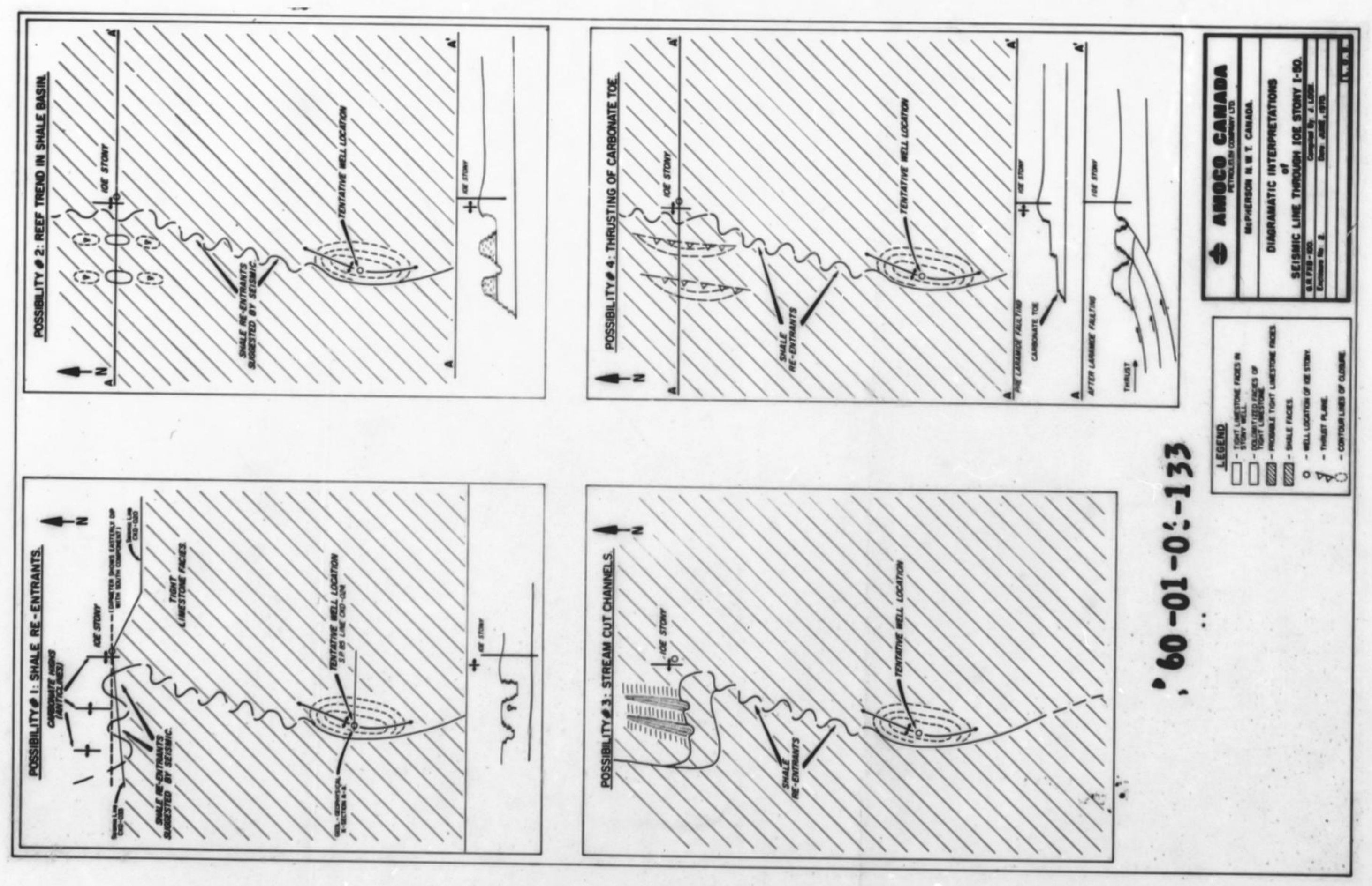


FORT McPHERSON AREA, YUKON & N.W.T.
SCHEMATIC STRATIGRAPHIC CROSS SECTION N-S
THROUGH PERMITS



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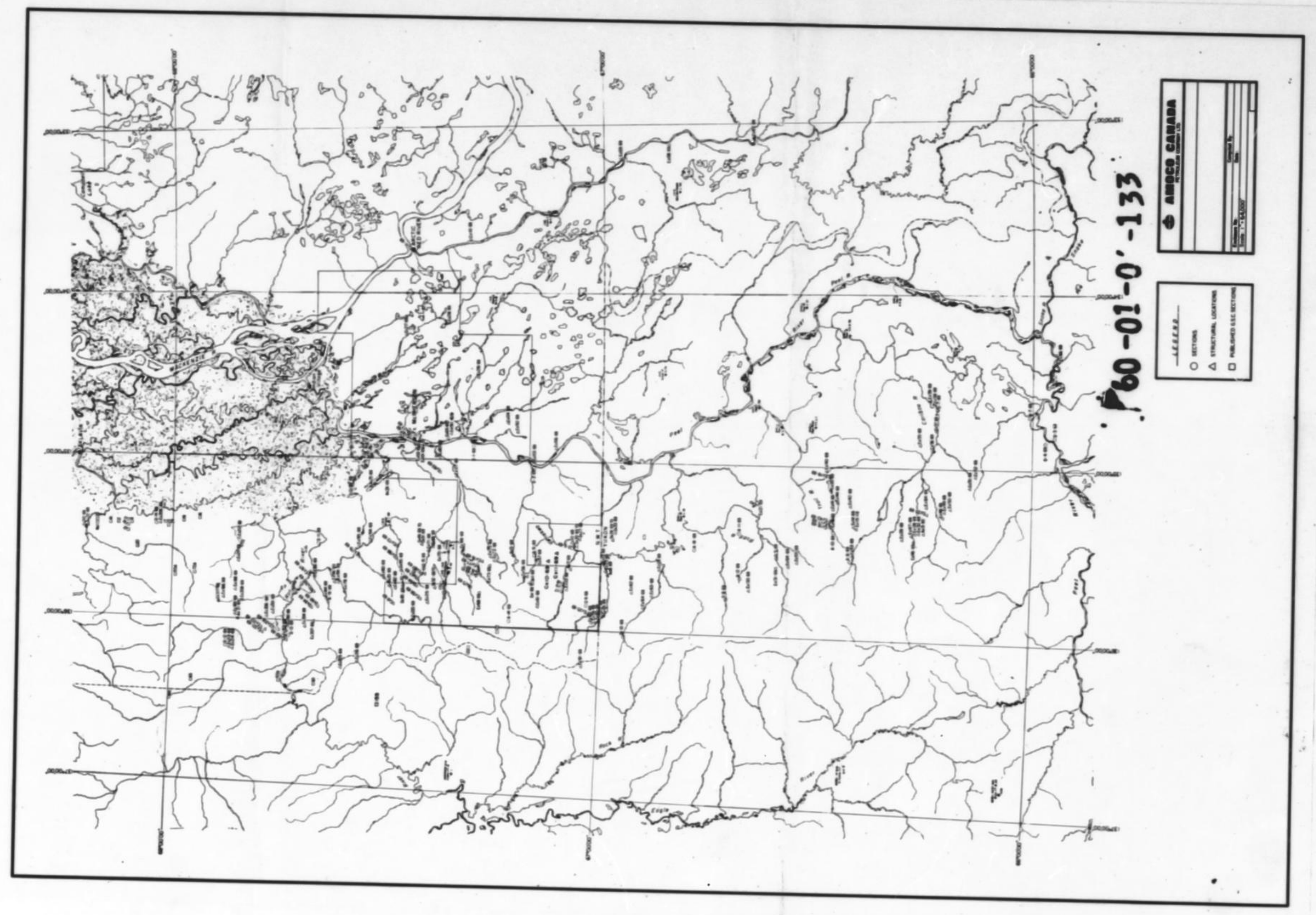
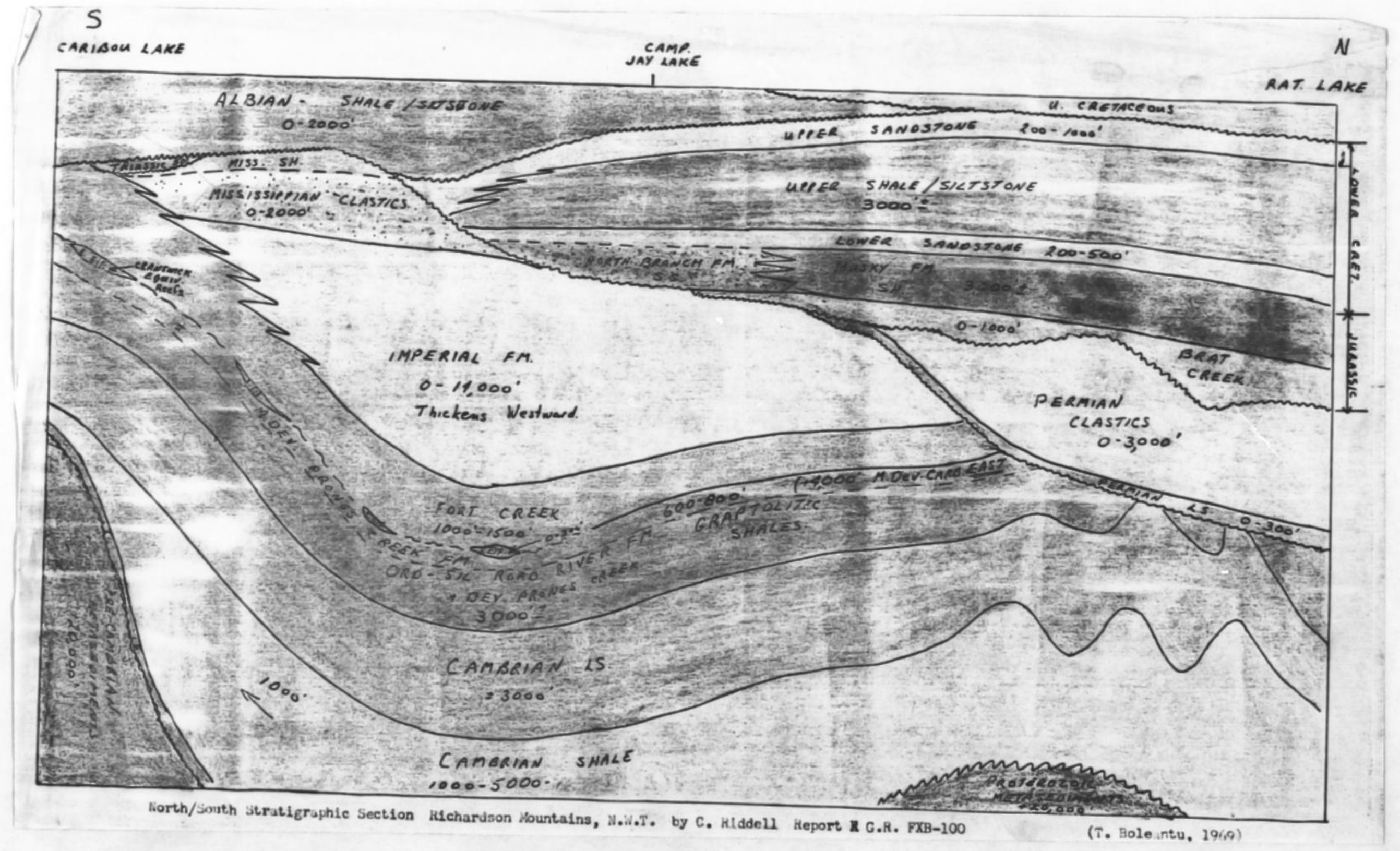




North/South Stratigraphic Section Richardson Mountains, N.W.T. by C. Riddell Report # G.R. FXB-100 (T. Boleantu, 1969)

60-01-06-84

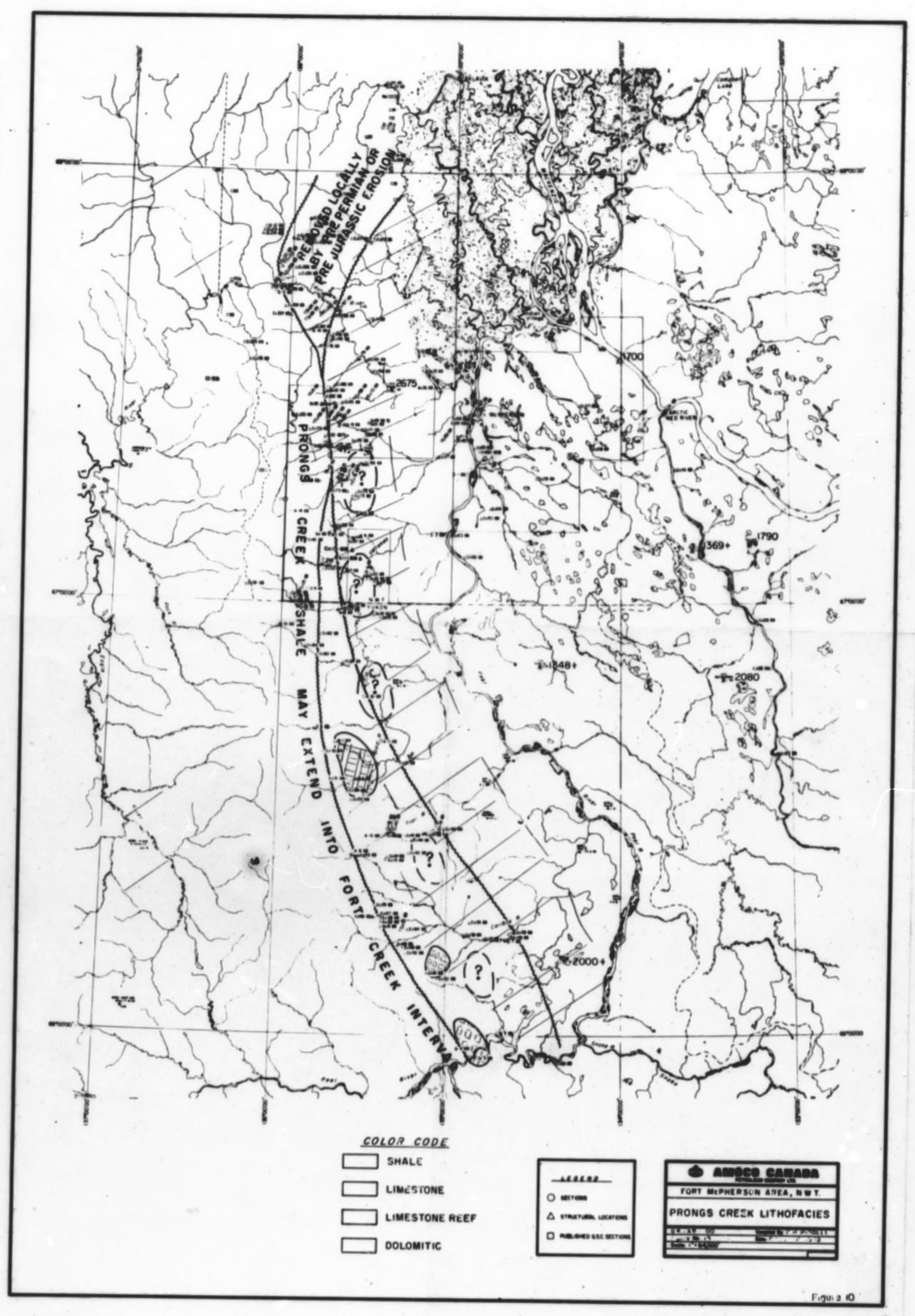


Figure 10

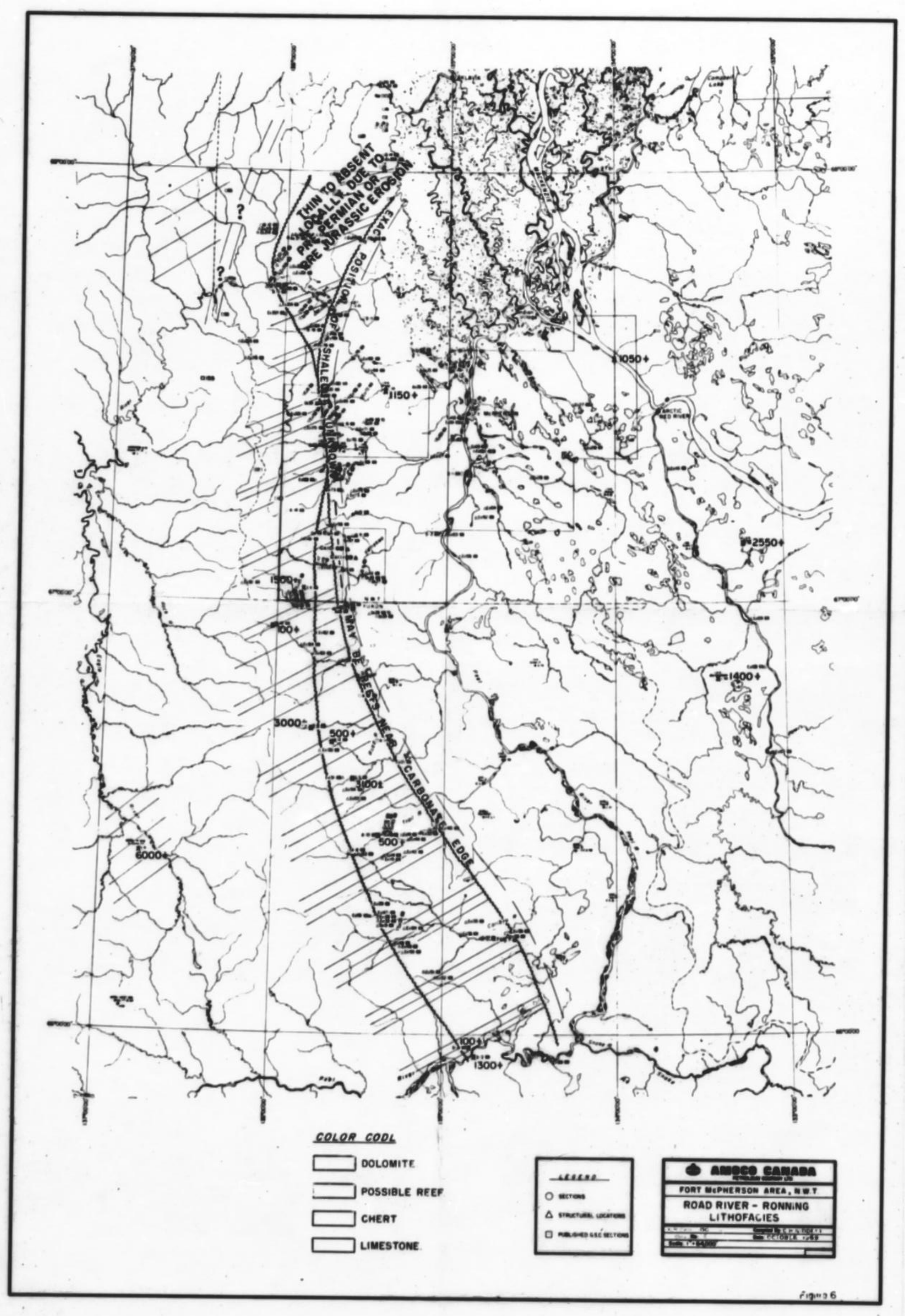

100+
1300+
COLOR CODL
DOLOMITE
POSSIBLE REEF
CHERT
LIMESTONE
LEGEND
SECTIONS
STRUCTURAL LOCATIONS
PUBLISHED G.S.C. SECTIONS
AMOCO CANADA
FORT McPHERSON AREA, N.W.T.
ROAD RIVER – RONNING
LITHOFACIES

Figure 6

P60-01-06-131

C H RIDDELL GEOLOGICAL CONSULTANTS LTD.

STRIP LOG

SECTION No B-[illegible]-[illegible] NTS 95N

AREA [illegible] LAT 63° 17' N

LONG 125° 40' W

MEASURED BY [illegible] DATE Aug 9th, 1971

PLOTTED BY [illegible] DATE Sept 13th, 1971

AGE AND FORMATION

METHOD Tape PHOTO No. [illegible]

REMARKS The Carbonate Rock ([illegible]) was sampled in 10' Intervals for Porosity.

LEGEND

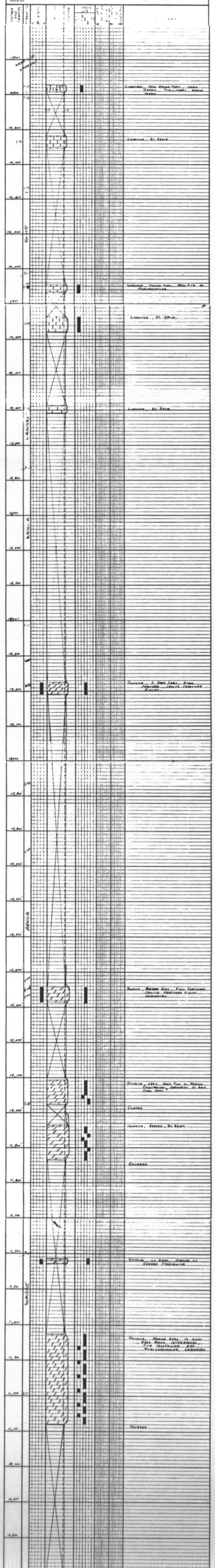
ROCK TYPES
- DRIFT
- CONGLOMERATE
- BRECCIA
- SANDSTONE
- SILTSTONE
- MUDSTONE
- SHALE
- COAL
- LIMESTONE (MICRITE)
- LIMESTONE (FRAGMENTAL)
- DOLOMITE
- EVAPORITES
- VOLCANICS
- IGNEOUS
- METAMORPHIC

ACCESSORIES
- ARGILLACEOUS
- SILTY
- SANDY
- CALCAREOUS
- DOLOMITIC
- SILICEOUS
- WHITE CHERT
- BLACK CHERT
- QUARTZ CRYSTALS
- EVAPORITIC
- GLAUCONITIC
- PYRITE
- MICACEOUS
- IRONSTONE NODULES
- PLANT REMAINS
- PHOSPHATIC
- SALT CASTS
- BITUMINOUS

FRAGMENT (NON SKELETAL)
- OOLITES
- LUMPS
- PELLETS
- INTRACLASTS

FRAGMENT (SKELETAL)
- FOSSILIFEROUS
- ALGAL
- CORAL
- STROMATOPOROID
- AMPHIPORA
- BRACHIOPOD
- MOLLUSK
- CRINOID

POROSITY TYPES
- INTERCRYSTALLINE INTERFRAGMENTAL
- VUGULAR
- PINPOINT
- EARTHY
- ORGANIC



60 - 01 - 06 - 89

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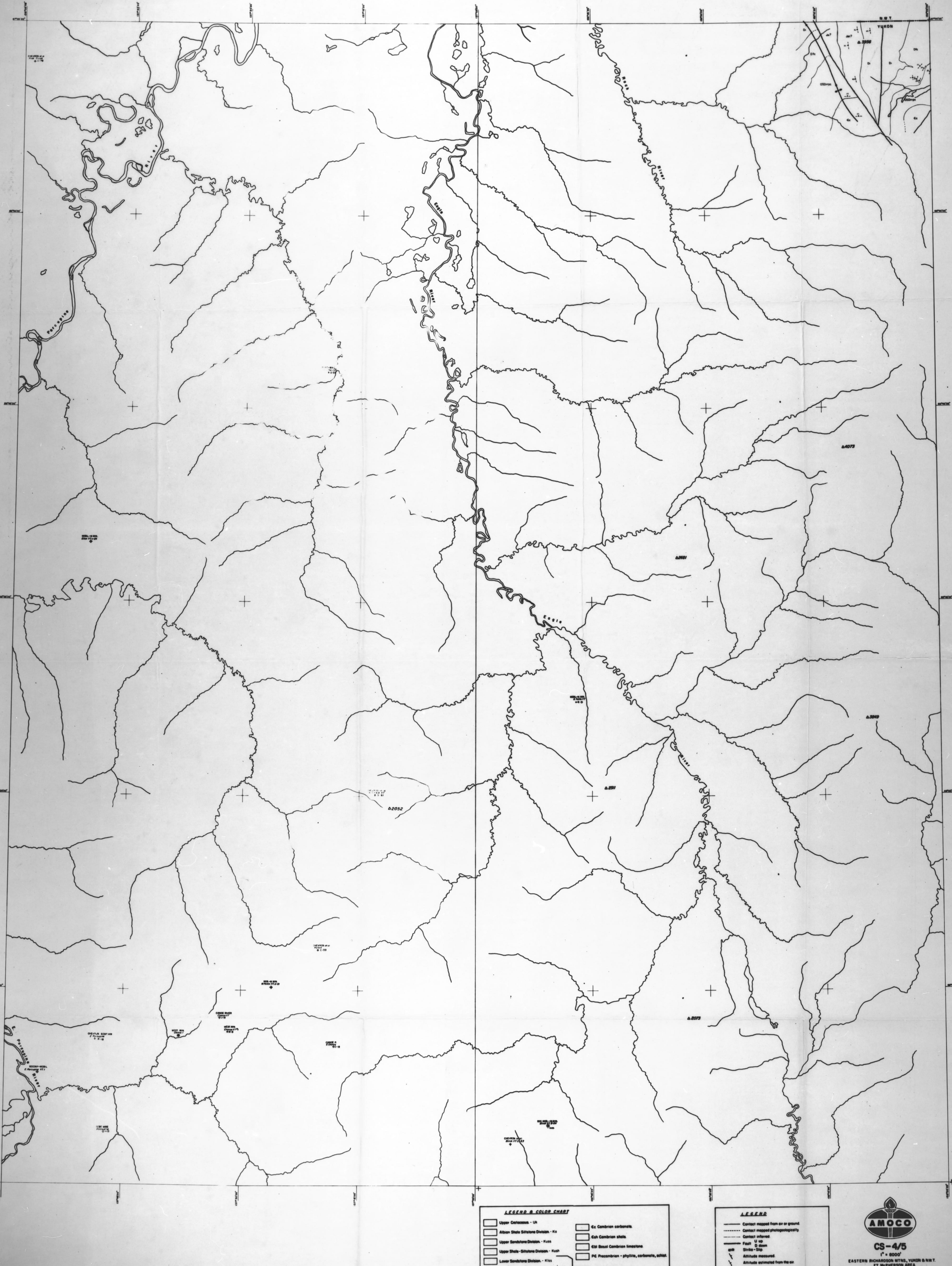
MICROMAT
105 M.M.

11x

August 1974



LEGEND & COLOR CHART

☐ Upper Cretaceous - Uk	☐ €c Cambrian carbonate.
☐ Albian Shale Siltstone Division. - Ka	☐ €sh Cambrian shale.
☐ Upper Sandstone Division. - Kuss	☐ €bl Basal Cambrian limestone.
☐ Upper Shale - Siltstone Division. - Kush	☐ P€ Precambrian - phyllite, carbonate, schist.
☐ Lower Sandstone Division. - Klss	
☐ North Branch - Husky, Lower Shale Siltstone. (Jnb, Jh)	☐ Jurassic Undivided
☐ Bug Creek & Older Jurassic. - Jsc	
☐ Triassic. - Tr	
☐ PPcl Clastics	
☐ PPl Permo Penn Limestone	
☐ M Mississippian	
☐ Di Imperial	☐ D-M All Units shale out southward.
☐ Dfc Fort Creek Shales	
☐ Dpcb Prongs Creek Biostrom	
☐ OSDrrpc Road River - Prongs Creek Shale	

LEGEND

Contact mapped from air or ground.
Contact mapped photogeologically.
Contact inferred.
Fault U up D down
Strike - Slip.
Attitude measured.
Attitude estimated from the air.
Horizontal
Approximately horizontal dipping slightly as indicated.
Vertical.
Location of measured section.
Structural notes taken.

AMOCO

CS-4/5

1" = 8000'

EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

G.R. FXB - 100 Compiled By: C.H. RIDDELL & T. BOLEANTU
Plate No: 1. Date: OCTOBER, 1969.

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CS - 5

60-01-06-184

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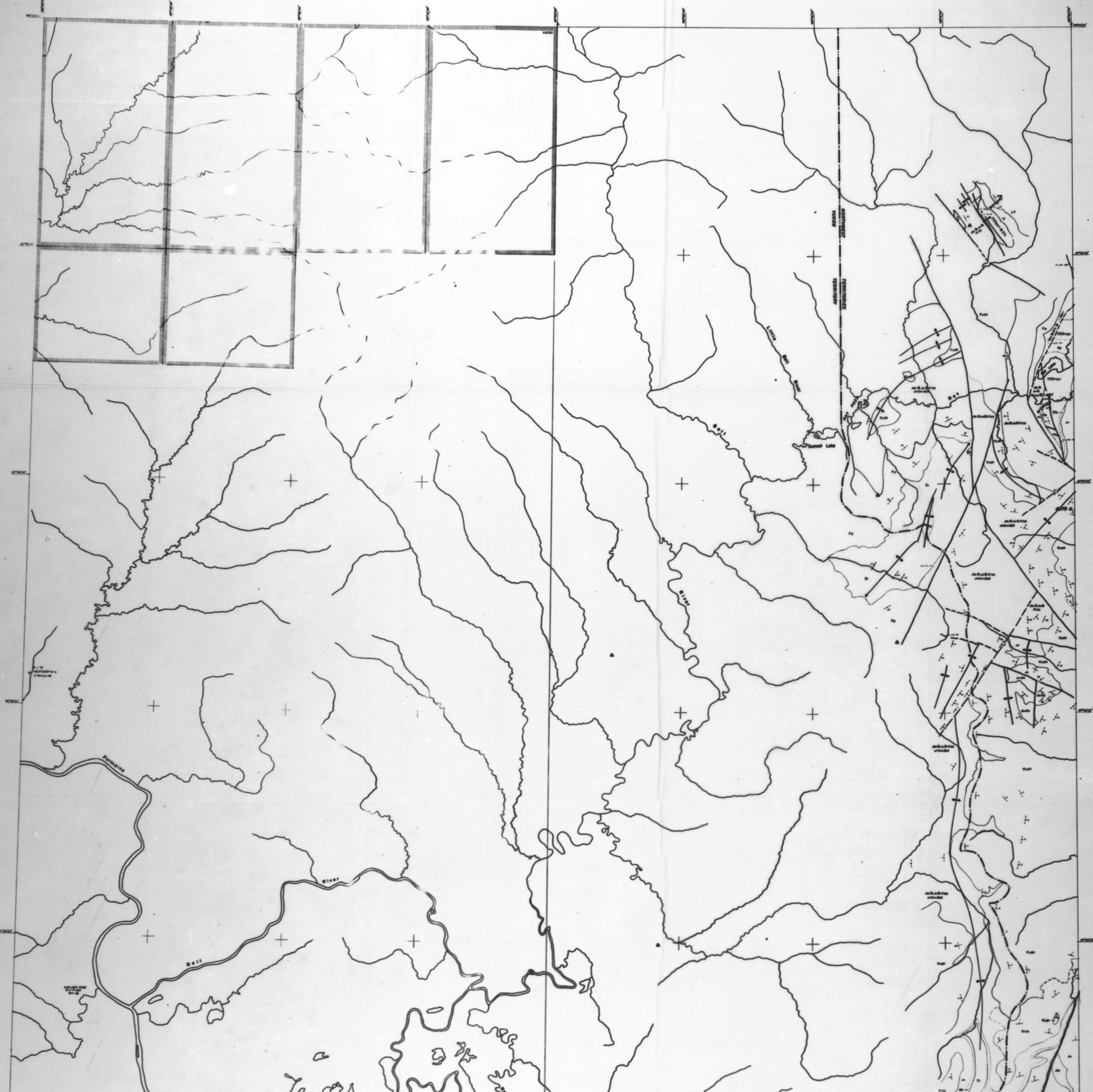
MICROMAT
105 M.M.

11x

August 1974



LEGEND & COLOR CHART

☐	Upper Cretaceous - Uk
☐	Albian Shale Siltstone Division - Ka
☐	Upper Sandstone Division - Kuss
☐	Upper Shale-Siltstone Division - Kush
☐	Lower Sandstone Division - Klss
☐	North Branch - Husky, Lower Shale Siltstone (Jnb, Jh)
☐	Bug Creek & Older Jurassic - Jbc
☐	Jurassic Undivided
☐	Triassic - Tr
☐	PPcl Clastics
☐	PPl Permo Penn Limestone
☐	M Mississippian
☐	Di Imperial
☐	Dfc Fort Creek Shales
☐	D-M All Units shale out southward
☐	Dpcb Prongs Creek Biostrom
☐	OSDrpc Road River - Prongs Creek Shale
☐	€c Cambrian carbonate
☐	€sh Cambrian shale
☐	€bl Basal Cambrian limestone
☐	P€ Precambrian - phyllite, carbonate, schist

LEGEND

Contact mapped from air or ground
Contact mapped photogeologically
Contact inferred
Fault U up D down
Strike - Slip
Attitude measured
Attitude estimated from the air
Horizontal
Approximately horizontal dipping slightly as indicated
Vertical
Location of measured section
Structural notes taken

AMOCO

CT-4/5

1" = 8000'
EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

GR FXB-100 Compiled By C.H. RIDDELL & T. BOLEANTU
Plate No. 4 Date OCTOBER, 1969

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60-01-06-84

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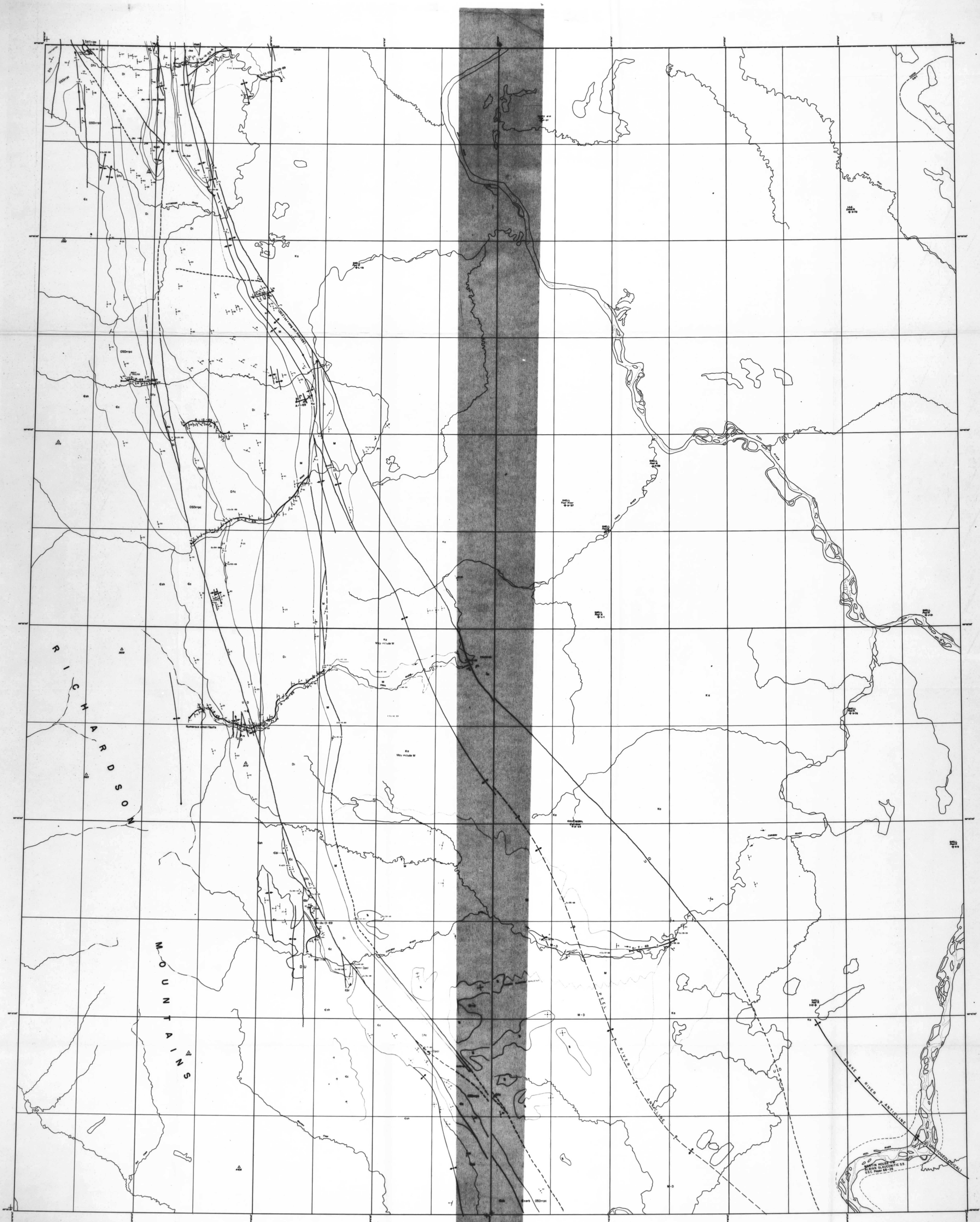
11x

August 1974



LEGEND & COLOR CHART

☐	Upper Cretaceous - Uk
☐	Albian Shale Siltstone Division - Ka
☐	Upper Sandstone Division - Kuss
☐	Upper Shale - Siltstone Division - Kush
☐	Lower Sandstone Division - Klss
☐	North Branch - Husky, Lower Shale Siltstone (Jnb, Jh)
☐	Bug Creek & Older Jurassic - Jbc
☐	Jurassic Undivided
☐	Triassic - Tr
☐	PPcl Clastics
☐	PPl Permo Penn Limestone
☐	M Mississippian
☐	Di Imperial
☐	Dfc Fort Creek Shales
☐	D-M All Units shale out southward
☐	Dpcb Prongs Creek Biostrom
☐	OSDrrpc Road River - Prongs Creek Shale
☐	€c Cambrian carbonate
☐	€sh Cambrian shale
☐	€bl Basal Cambrian limestone
☐	P€ Precambrian - phyllite, carbonate, schist

LEGEND

- Contact mapped from air or ground.
- Contact mapped photogeologically.
- Contact inferred.
- Fault U up D down
- Strike - Slip
- Attitude measured.
- Attitude estimated from the air.
- Horizontal
- Approximately horizontal dipping slightly as indicated.
- Vertical.
- Location of measured section.
- Structural notes taken.

EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA
SURFACE GEOLOGY
G.R. FXB-100 Compiled By: C.H. RIDDELL & T. BOLEANTU
Plate No: 2 Date: OCTOBER, 1969

LEGEND & COLOR CHART

Upper Cretaceous - Uk
Albian Shale Siltstone Division - Ka
Upper Sandstone Division - Kuss
Upper Shale - Siltstone Division - Kush
Lower Sandstone Division - Klss
North Branch - Husky, Lower Shale Siltstone
Bug Creek & Older Jurassic - Jbc
Jurassic Undivided
Triassic - Tr
PPcl Clastics
PPl Permo Penn Limestone
M Mississippian
Di Imperial
Dfc Fort Creek Shales
D-M All Units shale out southward
Dpcb Prongs Creek Biostrom
OSDrrpc Road River - Prongs Creek Shale
€c Cambrian carbonate
€sh Cambrian shale
€bl Basal Cambrian limestone
P€ Precambrian - phyllite, carbonate, schist

LEGEND

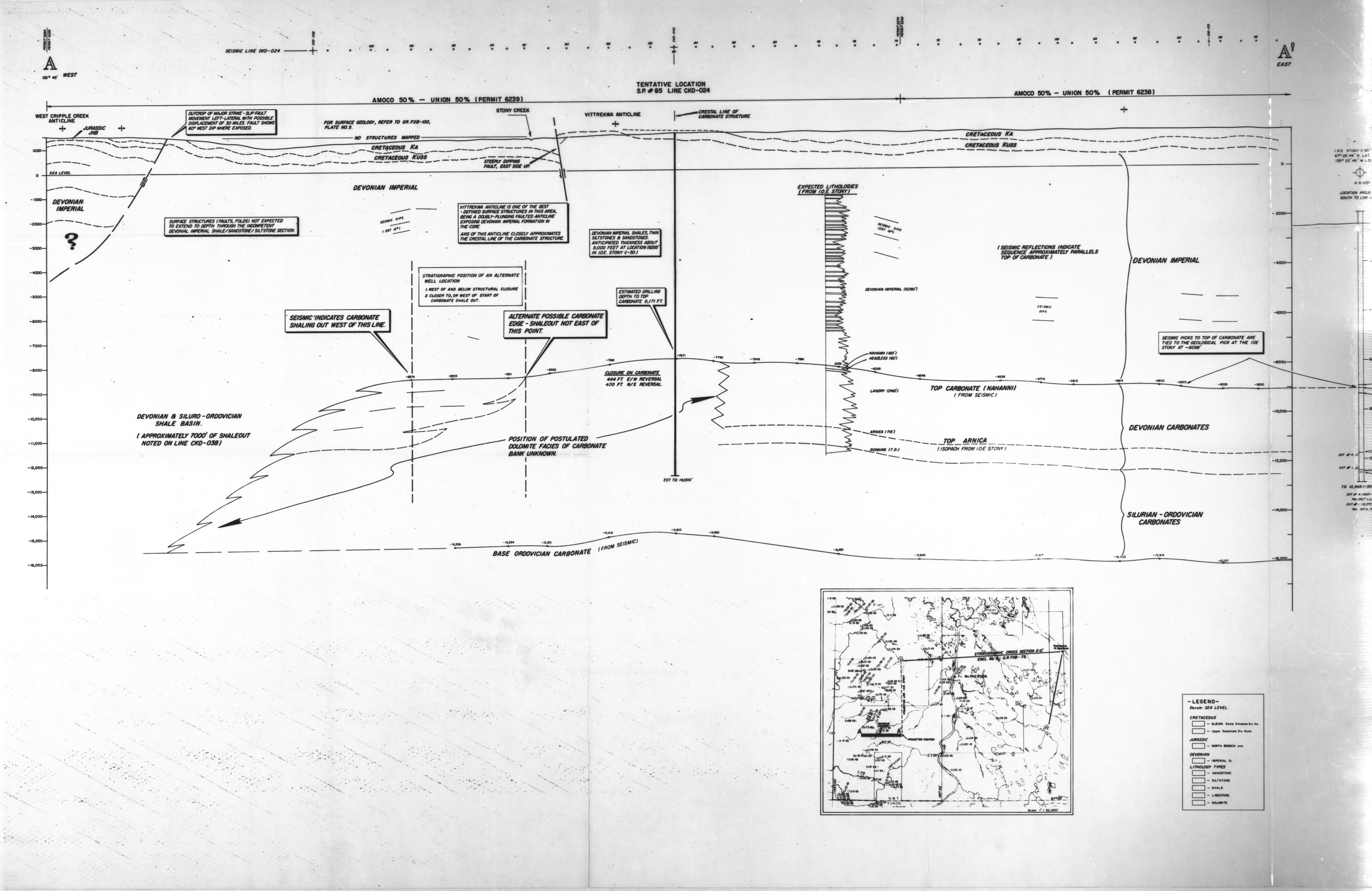
- Contact mapped from air or ground.
- Contact mapped photogeologically.
- Contact inferred.
- Fault U up D down
- Strike - Slip
- Attitude measured.
- Attitude estimated from the air.
- Horizontal
- Approximately horizontal dipping slightly as indicated.
- Vertical
- Location of measured section.
- Structural notes taken.

AMOCO

CS-6/7
1" = 8000'
EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA
SURFACE GEOLOGY
G.R. FXB-100 Compiled By: C.H. RIDDELL & T. BOLEANTU
Plate No: 3 Date: OCTOBER, 1969

60-01-06-133

CS-7


PERMIT 6284
PERMIT 6239
A
135° 45' WEST
SEISMIC LINE CKD-024
CKD-032
100
98
96
94
92
90
88
86
CKD-042
85
84
82
80
78
76
74
PERMIT 6239
PERMIT 6238
72
70
68
66
64
62
60
CKD-031
58
56
A'
EAST
TENTATIVE LOCATION
S.P. #85 LINE CKD-024
AMOCO 50% — UNION 50% (PERMIT 6239)
AMOCO 50% — UNION 50% (PERMIT 6238)
WEST CRIPPLE CREEK ANTICLINE
JURASSIC JNB
OUTCROP OF MAJOR STRIKE - SLIP FAULT. MOVEMENT LEFT-LATERAL WITH POSSIBLE DISPLACEMENT OF 30 MILES. FAULT SHOWS 60° WEST DIP WHERE EXPOSED.
FOR SURFACE GEOLOGY, REFER TO GR. FXB-100, PLATE NO. 5.
STONY CREEK
VITTREKWA ANTICLINE
CRESTAL LINE OF CARBONATE STRUCTURE.
NO STRUCTURES MAPPED
CRETACEOUS KA
CRETACEOUS KUSS
STEEPLY DIPPING FAULT, EAST SIDE UP.
SEA LEVEL
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000
-10,000
-11,000
-12,000
-13,000
-14,000
-15,000
-16,000
DEVONIAN IMPERIAL
DEVONIAN IMPERIAL
?
SURFACE STRUCTURES (FAULTS, FOLDS) NOT EXPECTED TO EXTEND TO DEPTH THROUGH THE INCOMPETENT DEVONIAL IMPERIAL SHALE/SANDSTONE/SILTSTONE SECTION.
SEISMIC DIPS (EST. 12°)
VITTREKWA ANTICLINE IS ONE OF THE BEST - DEFINED SURFACE STRUCTURES IN THIS AREA, BEING A DOUBLY-PLUNGING FAULTED ANTICLINE EXPOSING DEVONIAN IMPERIAL FORMATION IN THE CORE.
AXIS OF THIS ANTICLINE CLOSELY APPROXIMATES THE CRESTAL LINE OF THE CARBONATE STRUCTURE.
DEVONIAN IMPERIAL SHALES, THIN SILTSTONES & SANDSTONES. ANTICIPATED THICKNESS ABOUT 9,000 FEET AT LOCATION (6295' IN I.O.E. STONY I-50.)
STRATIGRAPHIC POSITION OF AN ALTERNATE WELL LOCATION
1. WEST OF AND BELOW STRUCTURAL CLOSURE
2. CLOSER TO, OR WEST OF START OF CARBONATE SHALE OUT.
ESTIMATED DRILLING DEPTH TO TOP CARBONATE 9,171 FT.
SEISMIC INDICATES CARBONATE SHALING OUT WEST OF THIS LINE.
ALTERNATE POSSIBLE CARBONATE EDGE - SHALEOUT NOT EAST OF THIS POINT.
-8574
-8553
-8511
-8266
-7881
-7671
-7790
-7846
-7881
CLOSURE ON CARBONATE
444 FT. E/W REVERSAL
400 FT. N/S REVERSAL.
DEVONIAN & SILURO-ORDOVICIAN SHALE BASIN.
(APPROXIMATELY 7000' OF SHALEOUT NOTED ON LINE CKD-038)
POSITION OF POSTULATED DOLOMITE FACIES OF CARBONATE BANK UNKNOWN.
EST. T.D. 14,000'
EXPECTED LITHOLOGIES (FROM I.O.E. STONY)
SEISMIC DIPS (EST. 16°)
DEVONIAN IMPERIAL (6290')
(SEISMIC REFLECTIONS INDICATE SEQUENCE APPROXIMATELY PARALLELS TOP OF CARBONATE.)
SEISMIC DIPS
DEVONIAN IMPERIAL
SEISMIC PICKS TO TOP OF CARBONATE ARE TIED TO THE GEOLOGICAL PICK AT THE IOE STONY AT -6098'
NAHANNI (160')
HEADLESS (60')
8091
-8266
-8546
-8636
-8714
-8812
-8814
-8826
-8903
-9029
-9020
LANDRY (2410')
TOP CARBONATE (NAHANNI)
(FROM SEISMIC)
ARNICA (715')
TOP ARNICA
(ISOPACH FROM I.O.E. STONY)
RONNING (T.D.)
DEVONIAN CARBONATES
SILURIAN - ORDOVICIAN CARBONATES
-15,326
-15,294
-15,301
-14,916
-14,810
-14,962
-15,651
-15,846
-15,917
-16,022
-15,914
-16,127
BASE ORDOVICIAN CARBONATE (FROM SEISMIC)
0
-2000
-4000
-6000
-8000
-10,000
-12,000
-14,000
-16,000
DST #4
DST #1
T.D. 10,968
STRATIGRAPHIC CROSS SECTION D-D'
ENCL. No. 6, G.R. FXB-75.
Indian Village
Ft McPHERSON
PROJECTION LINE I.O.E. STONY
TENTATIVE LOCATION
A
A'
PROJECTED POSITION
Vittrekwa
NWT
YUKON
136°00'
135°00'
67°20'
Scale: 1" = 32,000'.
-LEGEND-
Datum: SEA LEVEL.
CRETACEOUS
— ALBIAN Shale Siltstone Div. Ka.
— Upper Sandstone Div. Kuss.
JURASSIC
— NORTH BRANCH Jnb.
DEVONIAN
— IMPERIAL Di.
LITHOLOGY TYPES
— SANDSTONE.
— SILTSTONE.
— SHALE.
— LIMESTONE.
— DOLOMITE.

60-01-06-

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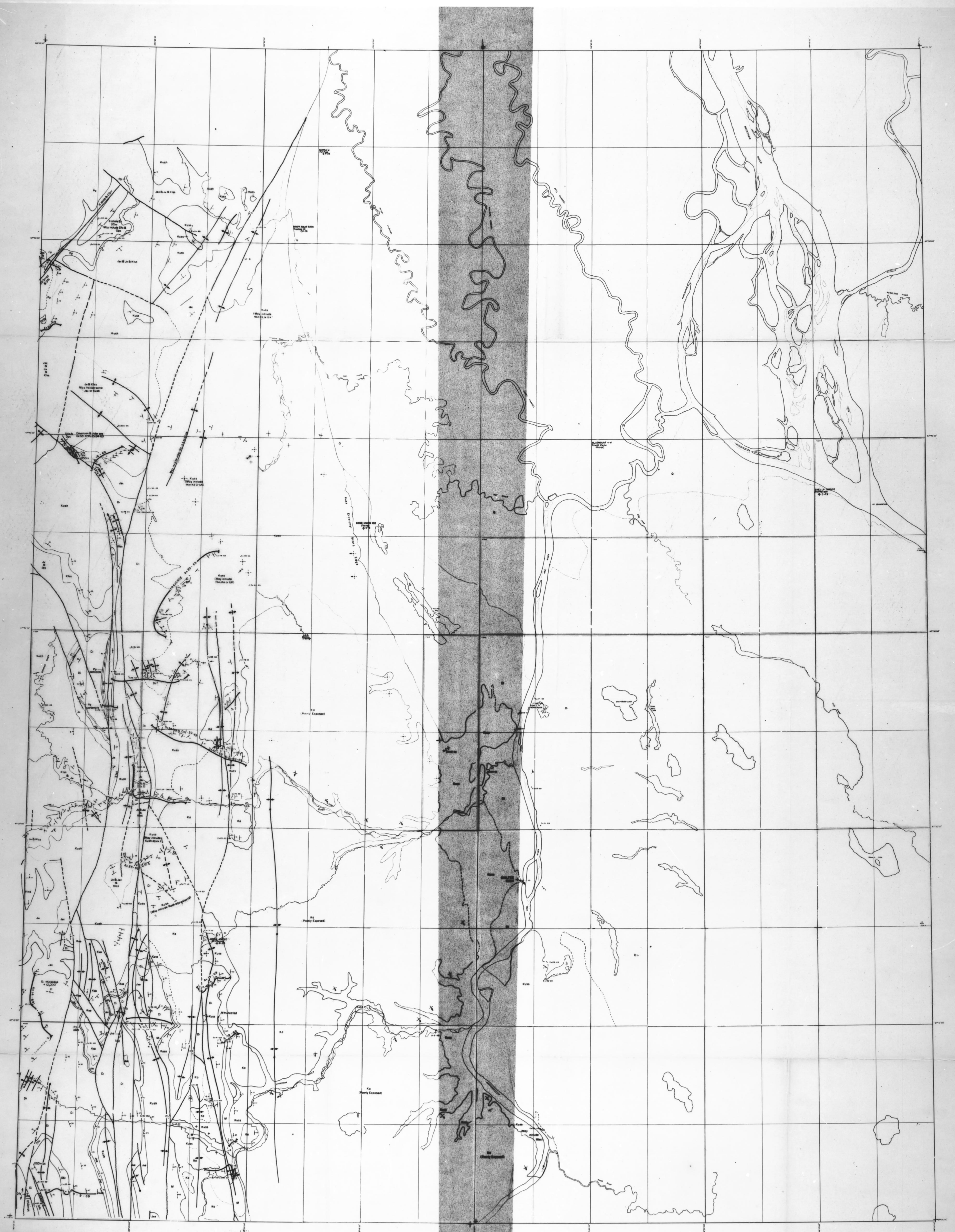
MICROMAT
105 M.M.

11x

August 1974



LEGEND & COLOR CHART

- Upper Cretaceous. Uk
- Albian Shale Siltstone Division. Ka
- Upper Sandstone Division. Kuss
- Upper Shale-Siltstone Division. Kush
- Lower Sandstone Division. Kiss
- North Branch - Husky, Lower Shale Siltstone. Jnb Jh
- Bug Creek & Older Jurassic. Jbc
- Jurassic Undivided
- Triassic. Ŧ
- PPcl Clastics
- PPl Permo Penn Limestone
- M Mississippian.
- Di Imperial
- Dfc Fort Creek Shales
- D-M All Units shale out southward.
- Dpcb Prongs Creek Biostrom
- OSDrrpc Road River - Prongs Creek Shale
- €c Cambrian carbonate
- €sh Cambrian shale.
- €bl Basal Cambrian limestone.
- P€ Precambrian - phyllite, carbonate, schist.

LEGEND

- Contact mapped from air or ground.
- Contact mapped photogeologically.
- Contact inferred.
- Fault U up D down
- Strike-Slip
- Attitude measured.
- Attitude estimated from the air.
- Horizontal
- Approximately horizontal dipping slightly as indicated.
- Vertical
- Location of measured section.
- Structural notes taken.

EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

GR. FXB-100 Compiled By C.H. RIDDELL & T. BOLEANTU
Plate No 5 Date OCTOBER, 1969

LEGEND & COLOR CHART

- Upper Cretaceous. - Uk
- Albian Shale Siltstone Division. - Ka
- Upper Sandstone Division. - Kuss
- Upper Shale-Siltstone Division. - Kush
- Lower Sandstone Division. - Kiss
- North Branch - Husky, Lower Shale Siltstone. Jnb Jh
- Bug Creek & Older Jurassic. - Jbc
- Jurassic Undivided.
- Triassic. - Ŧ
- PPcl Clastics
- PPl Permo Penn Limestone
- M Mississippian.
- Di Imperial
- Dfc Fort Creek Shales
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- Dpcb Prongs Creek Biostrom
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LEGEND

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- Contact mapped photogeologically.
- Contact inferred.
- Fault U up D down
- Strike-Slip
- Attitude measured.
- Attitude estimated from the air.
- Horizontal
- Approximately horizontal dipping slightly as indicated.
- Vertical
- Location of measured section.
- Structural notes taken.

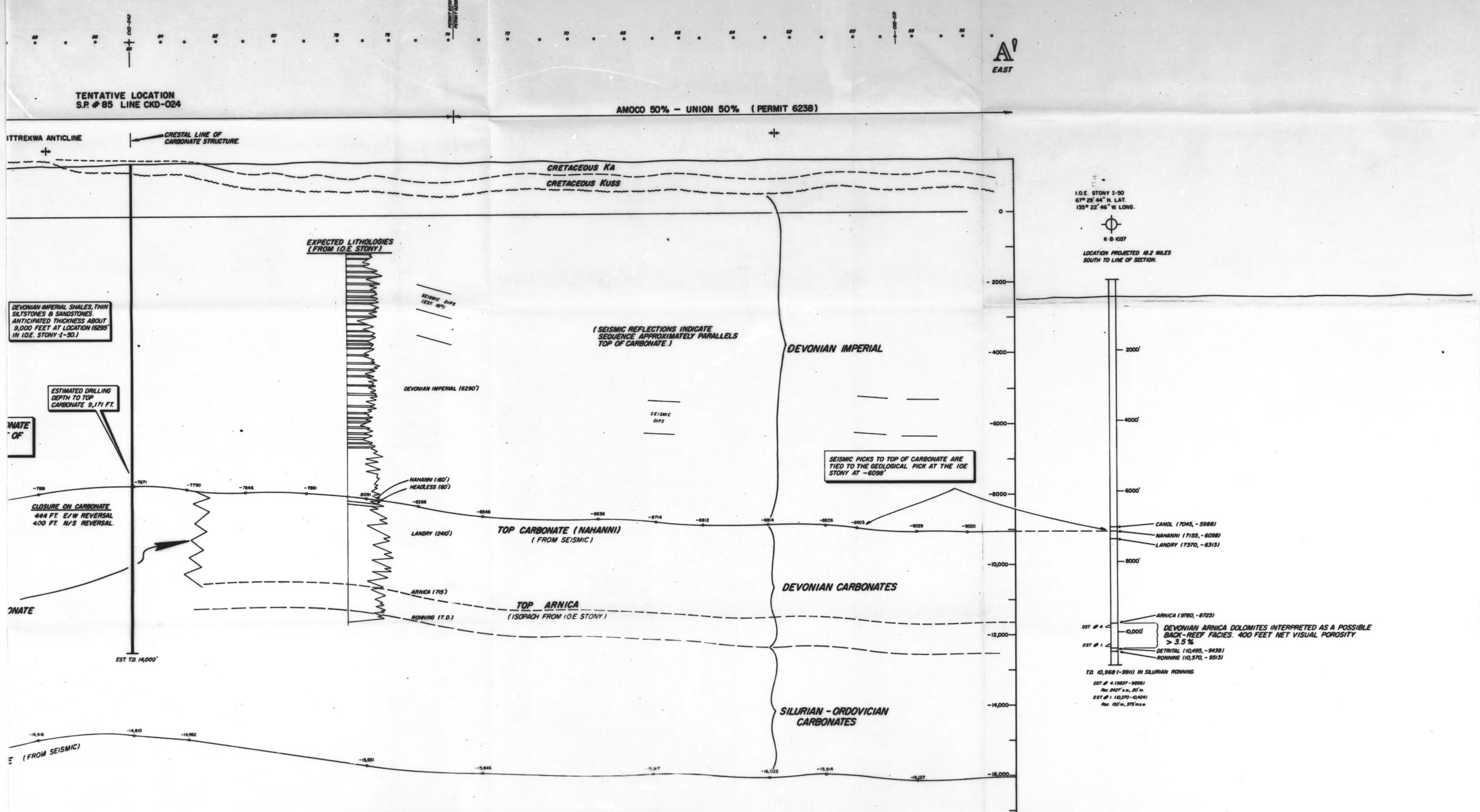
AMOCO

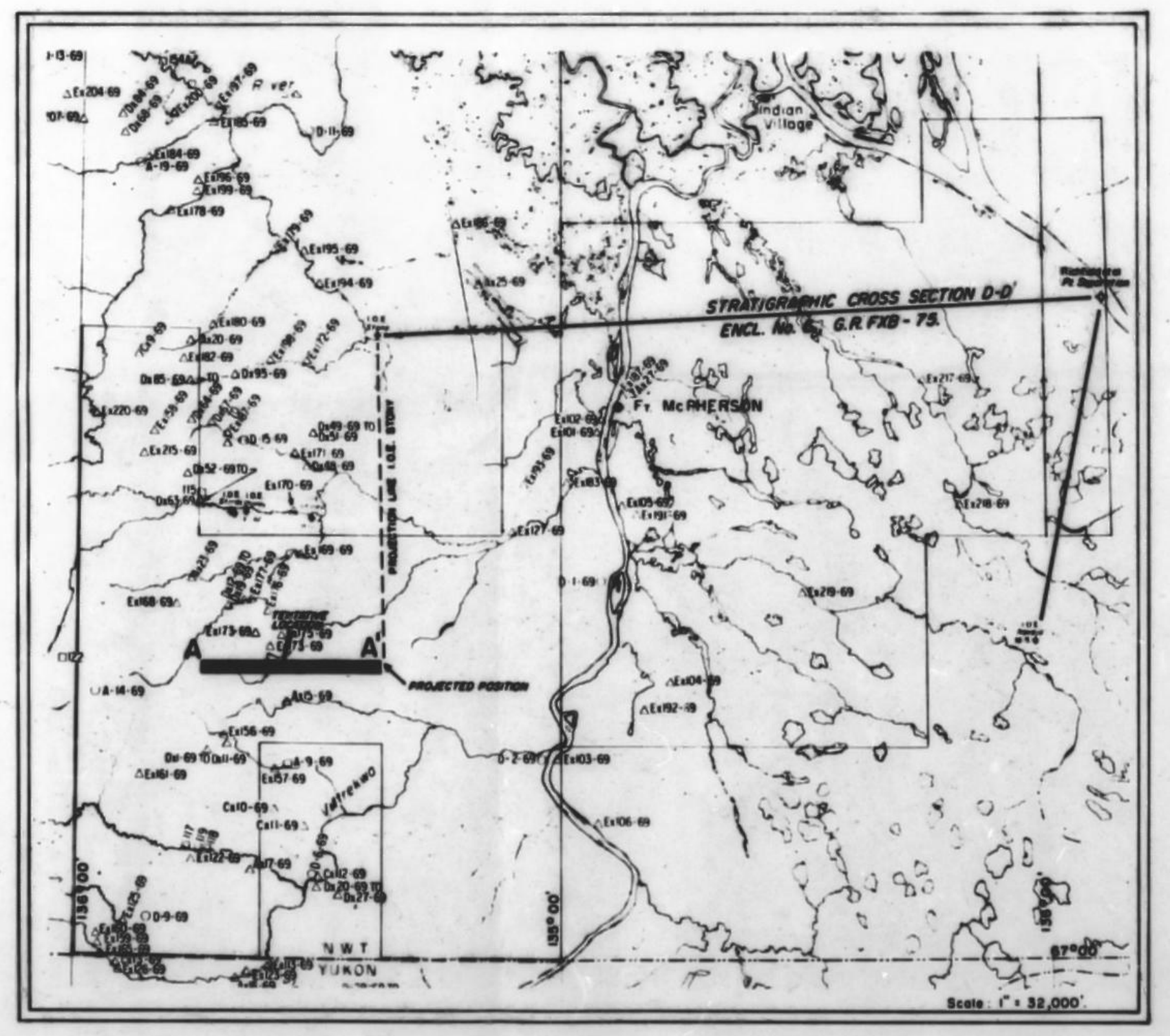
CT - 6/7
1" = 8000'
EASTERN RICHARDSON MTNS., YUKON & N.W.T.
FT. McPHERSON AREA

SURFACE GEOLOGY

GR. FXB-100 Compiled By: C.H. RIDDELL & T. BOLEANTU
Plate No: 6 Date: OCTOBER, 1969

60-01-06-133





- LEGEND -
Datum: SEA LEVEL.

CRETACEOUS
☐ - ALBIAN Shale Siltstone Div. Ka.
☐ - Upper Sandstone Div. Kuss.

JURASSIC
☐ - NORTH BRANCH Jnb.

DEVONIAN
☐ - IMPERIAL Di.

LITHOLOGY TYPES
☐ - SANDSTONE.
☐ - SILTSTONE.
☐ - SHALE.
☐ - LIMESTONE.
☐ - DOLOMITE.

60-01-05-133

AMOCO CANADA
PETROLEUM COMPANY LTD.

McPHERSON AREA, N.W.T. CANADA

GEOLOGICAL - GEOPHYSICAL STRUCTURAL X - SECTION A - A'

(W-E SECTION ALONG SEISMIC LINE CKD-024)

G.R. FXB - 100	Compiled By: J. LOOK.
Enclosure No:	Date: APRIL, 1970.
Vert. Scale : 1" = 1000'.	
Hor. Scale : 1" = 1000'.	L.O.S.

THE DIFFERENCE IN VELOCITY BETWEEN THE AREA SOUTH OF THE VITTREKWA RIVER AND I.O.E. STONY DUE TO AN ADDITIONAL BURIAL EQUIVALENT TO 500 MILLISECONDS MAY CAUSE DEPTHS TO BE 500' TO 800' HIGH.

VITTREKWA ANTICLINE IS ONE OF THE BEST DEFINED SURFACE STRUCTURES IN THIS AREA, BEING A DOUBLY-PLUNGING FAULTED ANTICLINE EXPOSING DEVONIAN IMPERIAL FORMATION IN THE CORE.

AXIS OF THE ANTICLINE CLOSELY APPROXIMATES THE CRESTAL LINE OF THE CARBONATE STRUCTURE.

APPROXIMATELY 400' CLOSURE INDICATED BY SEISMIC TIME STRUCTURE MAP AT NORTH END OF ANOMALY 20-C-70 (CRITICAL DIRECTION).

IMPERIAL FORMATION AT THE TENTATIVE LOCATION IS LITHOLOGICALLY SIMILAR TO THE IMPERIAL OF I.O.E. STONY.

TOP OF KNOWN WATER LINE -8780'. POSSIBLE GROSS SECTION AT TENTATIVE LOCATION ABOVE WATER IS 1109'.

SEISMIC DIPS WITHIN DEVONIAN IMPERIAL MAY BE RELATED TO THE SOUTH PLUNGE OF THE STONY CREEK ANTICLINE.

SEISMIC PICKS TO THE TOP OF THE DEVONIAN CARBONATE ARE TIED TO THE GEOLOGICAL PICK OF THE I.O.E. STONY WELL AT -6098' SUBSEA.

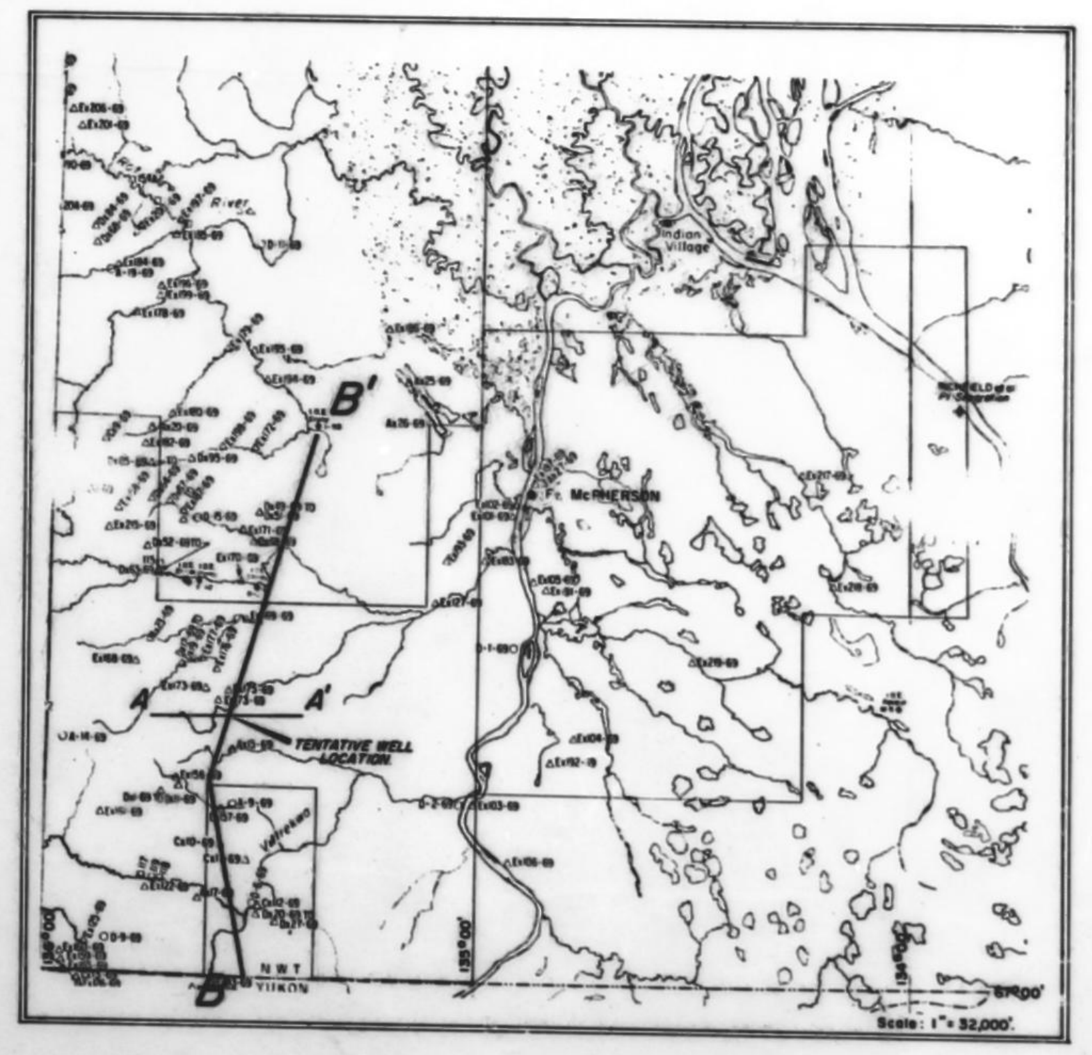
ARNICA
(715') dolomite interpreted as back reef facies with 400' of visual porosity >3.5%.

ARNICA DRILLSTEM TESTS

DST. 4: (-8780 to -8839)
Rec. 2127' s.w., 120' m.

DST. 1: (-9313 to -9367)
Rec. 150' m., 375' m.s.w.

NO RELIABLE SEISMIC PICKS ON BASE OF CARBONATE FROM S.P. 75-102 ON CKD-042 AND ON LINE CJK-022, 024 AND AT I.O.E. STONY.



– LEGEND –

CRETACEOUS
- Ka – ALBIAN SHALE SILTSTONE DIVISION.
- Kuss – UPPER SANDSTONE DIVISION.

MISSISSIPPIAN
- M – MISSISSIPPIAN CLASTICS.

DEVONIAN
- Di – IMPERIAL.

LITHOLOGY TYPES
- ☐ – SANDSTONE.
- ☐ – SILTSTONE.
- ☐ – SHALE.
- ☐ – LIMESTONE.
- ☐ – DOLOMITE.

J60-01-06-133

AMOCO CANADA
PETROLEUM COMPANY LTD.

FORT McPHERSON N.W.T.

GEOLOGICAL-GEOPHYSICAL X-SECTION B-B'
ALONG THE LONGTITUDINAL AXIS
OF THE CARBONATE STRUCTURE

G.R. FXB-100.	Compiled By: J. LOOK.
Enclosure No.: 3.	Date: JUNE, 1970.
Vert. Scale: 1" = 1000'.	Datum: SEA LEVEL.
Hor. Scale: 1" = 4000'.	L.O.S.

60-01-06-