

GEOLOGICAL REPORT

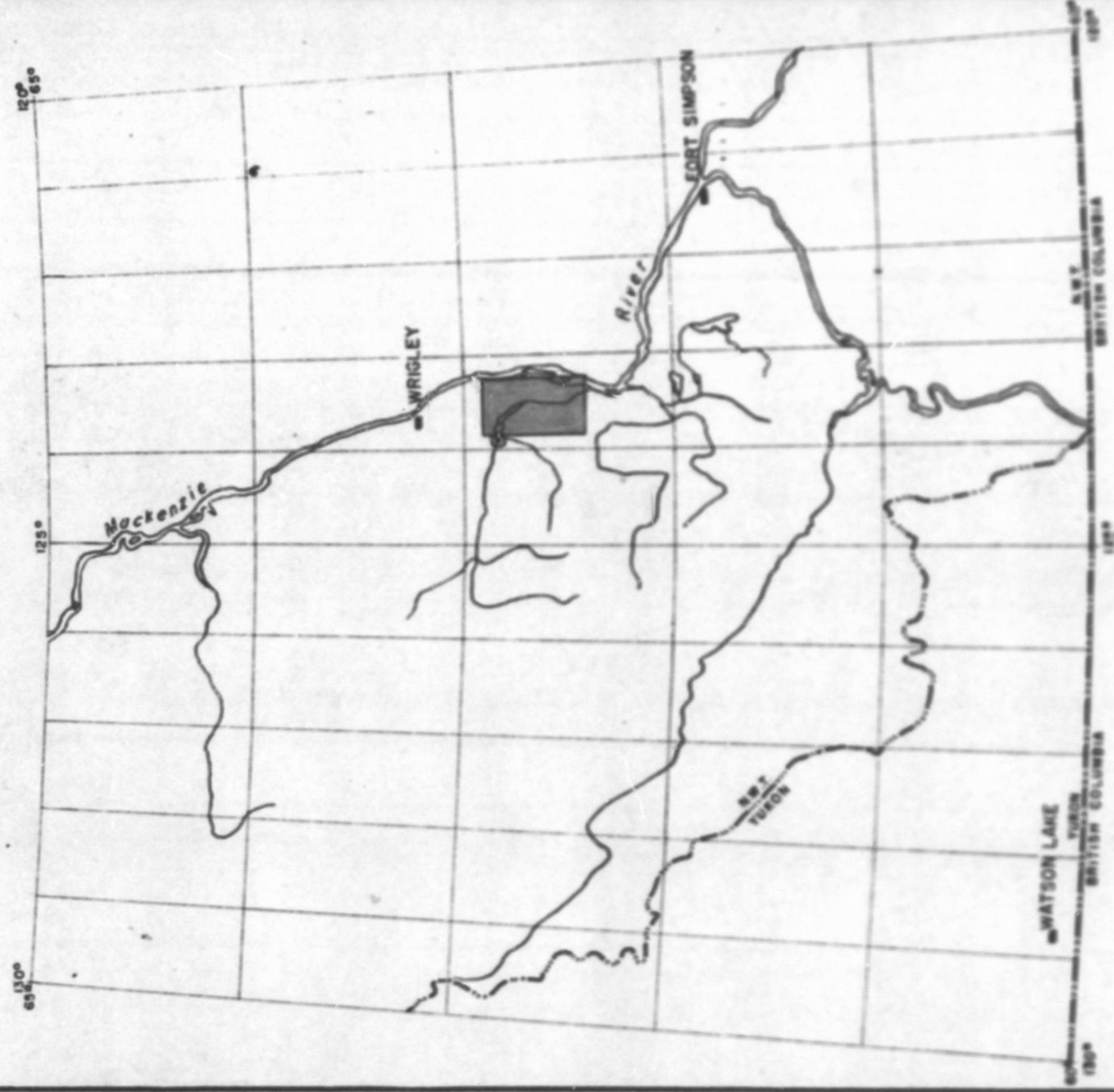
on

LOWER ROOT RIVER AREA
NORTHWEST TERRITORIES*For*
French *Pate.*
Y.
Transmission Gas

By D. E. Duff

December 12, 1960





INDEX MAP
LOWER ROOT RIVER AREA

AREA COVERED BY REPORT.



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INTRODUCTION

GENERAL

During the period August 16th to September 10th, 1960, the writer studied and mapped the Paleozoic geology of an area in the Northwest Territories, here designated the Lower Root River area. The area examined is bounded on the east and west by longitudes 123° 15' and 124° 00' respectively, and extends from latitudes 62° 20' to 62° 55'. The total area covered was approximately 1,000 square miles.

The work was undertaken with the object of checking a photogeological interpretation prepared by V. Zay Smith and Associates and, further, to examine available sections for reservoir potential underlying the subject acreage, a portion of which is held under lease jointly by French Petroleum Company of Canada Ltd. and Tennessee Gas Transmission Company.

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HISTORICAL

One of the earliest accounts of the area was done by E. M. Kindle (1), in which some references are made to the General Root River area.

Camsell and Malcolm (2) make generalizations of the area in a composite of personal and other work, but the report contains little detail.

Hume (3) contains the first report on descriptions of the formations recognized, their distribution, lithology, structure, thickness and fossil content. The report by Hume is the only published report on the area.

During the war years, Bath (4) did a reconnaissance report on the Canol project, which is in part almost a summary of the Hume report.

- | | | | |
|-----|-----------------------------|---|---|
| (1) | Kindle, E. M. | - | The Discovery of a Portage Fauna in the Mackenzie River Valley: Geol. Surv. Can. Mus. Bull. 29, 1919. |
| (2) | Camsell, C. and Malcolm, W. | - | The Mackenzie River Basin: Geol. Surv. Can., Memoir 100, 1921. |
| (3) | Hume, G. S. | - | North Nahanni and Root River Area, and Caribou Island, Mackenzie River District: Geol. Surv. Can. Summ. Report Pt. B, 1921. |
| (4) | Bath Lt. C. D. | - | Mackenzie River area from Camsell. Sent to Fort Norman: Canol Rept. A, No. 30, 1944. |

FIELD WORK

Over the greater portion of the map area the bedrock is overlain by a mantle of glacial drift, river deposits, muskeg and trees. In general, only along some of the streams where they have been cut entirely through the surface deposits, or where resistant portions of formations are left in stream cuts, were natural exposures seen. In the Camshell Range on the west side of the subject acreage, fair, but discontinuous, sections of outcrop were observed.

The field party was supervised by D. E. Duff, French Petroleum Company of Canada Ltd., and assisted by W. A. Bell, Tennessee Gas Transmission Company.

The party was serviced by an Associated Helicopters Bell Model G-2 helicopter - CF-FCC, with O. Fisher, pilot, and H. Eskelson, engineer.

R. McBean cooked for the camp.

The field party arrived in Wrigley on August 19th and the camp was set up at Fort Wrigley, on the west side of the Mackenzie River, on August 20th, 1960.

With the exception of a four-day delay for helicopter repairs, field work continued uninterrupted to September 7th, 1960, when camp was broken.

In general, the weather was reasonable for the time of the season. Outcrop was very sparse and dominantly very inaccessible. The amount of continuous section encountered was very disappointing and a lack of continuous markers in the Upper Devonian further made the interpretation in the field most difficult.

ACKNOWLEDGEMENTS

Acknowledgement is due the Department of Transport, particularly Mr. R. Manderfield at Wrigley airport, for providing the party with meals and accommodation prior to, and after, breaking of the camp. Mr. I. Gardner of the Hudson's Bay Company at Fort Wrigley also is to be thanked for the many services and personal kindnesses extended to the field party.

GENERAL CHARACTER OF THE AREA

TOPOGRAPHY

The Lower Root River area, as defined in this report, occupies the southeast portion of the Mackenzie Plain physiographic region.

The Camsell Range, which is a unit of the Franklin Mountains, lies on the west side of the area and is in accord with the trend in other ranges within this region. The range forms an abrupt escarpment which extends the entire length of the subject area, except at the gap where the Root River has cut through. The peaks on the Camsell Range are not high, the highest point in the area of interest being 4,154 feet.

On the east side of the map area flows the Mackenzie River, bounded by broad flat plains, predominantly muskeg, dotted with small lakes, and locally densely to sparsely wooded.

Between the two above-mentioned features is situated a rather large north-south trending ridge, which attains a maximum surface elevation of just over 2,500 feet and is herein referred to as the Root River Anticline. Erosional processes have caused the ridge to assume an asymmetrical shape with the steeper flank on the west side.

The area, as a whole, has been subjected to glaciation and glacial debris was found over the entire area at elevations of up to 3,300 feet.

DRAINAGE

The main stream is the Root River and it flows into the Mackenzie in the southeast corner of the mapped area. The Root River has its source in the Mackenzie Mountains to the west of the area under discussion. The river flows in an easterly direction in almost its entirety, excepting that portion of it in the Root River map area. Within the map area, the river flows east through the Root River Gap, then slowly swings to a south direction, flowing on the west side of the Root River Anticline. At the southern end of the anticline the river flows easterly and enters the Mackenzie.

The Root River has remarkably few permanent tributary streams and in late fall many are dry, or contain insignificant streams. Within the map area the fall of the river averages about 5 feet per mile.

CULTURE

The map area does not contain any community centers. The closest habitation is Fort Wrigley, some thirty miles from the north end of the map area.

FAUNA AND FLORA

Although the map area is relatively inaccessible, wildlife is not abundant. During the field season, one small black bear and two moose were observed at the south end of the area on Root River and two caribou were noted in the upper Root River, west of the Camsell Range. No other wildlife was noted, nor were any fish to be found in the lower Root River, or its tributary streams.

Forest growth is locally quite dense, but the trees are very thin, generally not exceeding three to four inches in diameter. Fallen timber and regrowth make traversing very difficult. Principal trees are spruce, birch and tamarack. Some poplar was observed, particularly along the lower ground peripheral to the rivers and streams.

Muskeg conditions prevail over the greater portion of the area, including some of the high ground on the Root River Anticline.

STRATIGRAPHY

GENERAL

The exposed rocks of the lower Root River area are restricted to Middle and Upper Devonian strata. Pleistocene and Recent, consisting of deposits of gravel, sand, clay and a thin soil mantle are very prominent.

TABLE OF FORMATIONS

<u>ERA</u>	<u>PERIOD OR EPOCH</u>	<u>FORMATION</u>	<u>LITHOLOGY</u>	<u>THICKNESS IN FEET</u>
Cenozoic	Recent	-	Silt, sands, gravels, clays.	0 - 300
	Pleistocene	-	Tillite, gravel, sand and clay.	
Paleozoic	Upper Devonian		Shales, lime- stone, some sandstones and siltstones	10,525 +
	Middle Devonian	Middle Dev. Limestone Unit		1,500 - 2,200

PALEOZOIC FORMATIONS

MIDDLE DEVONIAN

The Middle Devonian rocks dominate the horizon since being more resistant to erosion and weathering they form the high escarpment which runs through the western one-third of the map area. Good sections of Middle Devonian strata are exposed along this scarp face, but in most places the strata are inaccessible. The only place in the map area which permitted a reasonable examination of the strata was on the north side of Root River where it cuts through the Camsell Range.

Within the subject area the Middle Devonian limestone unit is restricted to the uplifted fault block of the Camsell Range. In general, it was found impossible to divide the Middle Devonian, and the strata in outcrop appear to be a lithologic unit of thin bedded limestone and argillaceous limestones with some shales. Fossils, when found, were rather poorly preserved and have a rather large vertical range.

The only accessible section in the area was measured at the Root River gap, in the Camsell Range (LW-34). The section is not complete, but is representative of the general lithology of the Middle Devonian limestone unit as observed in the map area. The top of the section is within about 100 feet of the Upper Devonian shales.

ROOT RIVER LW-34 SECTION OF MIDDLE DEVONIAN LIMESTONE UNIT

Overlying beds Upper Devonian shales

Interval Covered	Thickness in Feet
Limestone, dark grey to black, dense, tight, argillaceous, somewhat fossiliferous-brachiopods and corals. Abundant calcite infillings up to 3" thick. Locally rudely bedded, essentially massive, few localized zones of leached apparent porosity which does not extend to depth in cliff face.	103
Limestone, dark grey, dense, tight, argillaceous, fossiliferous.	
Shale, grey to dark grey, fissile, indurated, calcareous. Section is thin bedded, 2" lenses and stringers of shale and 4" to 7" lenses and thin beds of limestone.	18

Interval Covered	Thickness in Feet
Limestone, dark grey, dense, tight, argillaceous, locally quite fossiliferous-corals and brachiopods.	4.5
Limestone and shale interbeds, as above, locally poorly fossiliferous, but generally unfossiliferous. Limestone very hard.	88
Limestone, light grey to grey, dense, tight, slightly argillaceous, metallic ring, crumbly, total section shows rude bedding, unfossiliferous.	59
Limestone, dark grey to black, dense, tight, very indurated, argillaceous, thin bedded up to 18". Few thin to very thin shale partings, fractures, few fossil traces.	72
Limestone, light brown, dense, tight, thin bedded, argillaceous.	9.5
Limestone, black to dark grey, dense, tight, argillaceous, very hard. Lower 31' is very badly faulted and broken and heavily infilled with secondary calcite. Locally fair blind vuggy porosity. Vugs up to 6" by 20". Open fractures up to 4" in width.	133
Fault dip 14° West.	
Limestone, dark grey, dense, tight, slightly argillaceous, very hard, brecciated and infilled with calcite, <u>fair porosity as above.</u>	29
Limestone, light grey to grey, dense, tight, slightly argillaceous, rudely bedded, badly fractured, locally traces fossil.	42
Limestone, grey, crystalline, some poor crystalline porosity, <u>argillaceous, some fossils, locally lenses of very calcareous shale up to 1' thick.</u> Streaks with porosity are patchy and not continuous throughout the zone. Whole zone has rubbly appearance.	39
Limestone, dark grey to black, dense, tight, calcite infilling gives face brecciated appearance, no good fossils, possibly small fault at top of this zone.	5

Thickness
in Feet

Interval Covered

Limestone, dark grey, crystalline, traces porosity, strong sulphur odour. Pyrobitumen of a black crystalline type is spotty throughout zone. Locally is infilled with calcite. Where pyrobitumen is absent, limestone is light to medium grey.

3.5

Limestone, dark grey to black, dense, tight, slightly argillaceous, locally has spotty calcite infilling which gives brecciated appearance to cliff face.

49 +

THICKNESS OF MEASURED MIDDLE DEVONIAN
LIMESTONE UNIT

654.5'

Fossils taken from the above section were mostly undiagnostic, but two specimens, Hexagonaria sp. and Favosites sp. have been identified and hence place the section in the Middle Devonian. Coral reefs and indications of reefs have been noted elsewhere in the Middle Devonian, but within the map area no specific coral reef zones were observed.

As no complete section of Middle Devonian was found in the area, it was difficult to obtain any measure of true thickness of Middle Devonian strata in the map area. Section measurements prepared by Kelsh plotter indicate the Middle Devonian limestone unit (Ramparts) to have a thickness of about 2,200 feet. Field observation utilizing an altimeter on the face of the escarpment gave an estimated average thickness of about 1,500 feet. This latter figure compares favourably with estimates of other workers in the area.

UPPER DEVONIAN

Overlying the Middle Devonian limestones, apparently disconformably with a sharply defined contact, are a series of shales, limy shales and thin limestone units which are considered to be of Upper Devonian age from their fossil content and stratigraphic position.

One of the main difficulties in the area was the lack of good continuous marker beds to correlate. In the area to the west of the Camsell Range, many rapid facies changes occur in the section and, from field observation, the same holds true for the area to the east of the Camsell.

Another problem which plagued the field party was the rather nebulous lumping of units by Hume in his original interpretation in the area.

Essentially, the field party was able to get an approximate five-fold breakdown in the area. Description of the individual units, as observed in the field, follows:

UNIT 1

Unit 1 overlies, apparently disconformably, the Middle Devonian limestone unit and from its position in the stratigraphic column and fossil content, agrees roughly in age with the lower Simpson shale zone of Douglas (5).

The shales are generally clay shales, grey to dark grey in colour, fissile to platy and locally somewhat bituminous appearing. The shales weather rather readily and complete sections were not found in, or peripheral to, the map area. Within the shales, some thin layers of argillaceous limestone from 1 inch to 4 inches in thickness were observed, as were small ironstone nodules and concretions, but these were most common near the top portion of the zone. Fossils were generally absent.

Correlation within the zone was not found to be feasible, but the lower limit was observed in several places on the west side of the Cammell Range, directly overlying the Middle Devonian limestone unit. The upper limit was placed at the base of a very limy zone which was locally developed. Kelsh plotter information gave a thickness varying from 2,489 feet to 2,573 feet. This thickness was checked by extrapolated distances in the field and a figure of 2,500 feet was derived. However, it is felt this figure of 2,500 feet is probably more than maximum thickness. In many places in the field the dips and strikes of the shale zone varied rapidly and small drag folds were not uncommon. Folding within the shales undoubtedly accounts for a thicker section than is actually present.

UNIT 2

Unit 2 conformably overlies Unit 1 and is comprised, where present, of fossiliferous limestone and shale bands, or sandstones and shales. Within the confines of the area of interest no complete sections of this unit were observed and the unit is not continuous but only locally developed. The thickness of the unit in the map area varied from zero to an estimated maximum of 275 feet.

(5) Douglas, R. J. W.: Great Slave and Trout River Map Areas, N.W.T.; Geol. Surv. Can. Paper 56-11, 1959.

UNIT 3

This unit conformably and gradationally overlies Unit 2 and is predominantly an alternating series of shales and limestone bands which become increasingly more calcareous toward the upper portion. As was the case with most observed shale sections in the area, complete sections of this zone were not found on, or peripheral to, the map area. Where observed, the shale was generally dark grey, fissile to blocky, calcareous, with a few thin, very argillaceous limestone bands and stringers up to 3 inches in thickness.

Locally, isolated sections were measured and siltstones and sandstones were observed, and the section below is rather typical of what was observed within the lower and middle portions of Unit 3.

LW-9 SECTION OF UPPER DEVONIAN UNIT 3

Overlying beds covered

	Thickness in Feet
Shale, dark grey, fissile to crumbly, somewhat distorted.	38.0 +
Sandstone, green-grey, fine grained, tight, hard, very calcareous, in part an arenaceous limestone. Section very fossiliferous - abundant brachiopods (Atrypas) corals and crinoids noted.	12.0
Shale, grey to dark grey, crumbly to fissile, few thin limestone bands up to 7" in thickness, locally few fossils. Brachiopods and corals noted.	210. +
MEASURED THICKNESS	260 +

Thickness of this unit varied from 1,050 feet to 1,300 feet, but these figures are estimated from available outcrop data.

UNIT 4

This unit is well exposed over many portions of the map area and provides one of the key markers for stratigraphic placement of other units as well as control for structural interpretation.

In general, Unit 4 comprises a yellow to buff and grey weathering argillaceous limestone with thin interbeds of shale. Locally, the shale units are thicker or thinner, but in general the unit is a limestone rather than a shale

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sequence. It is relatively resistant to erosion and is marked by the abundance of brachiopods of the *Leiorhynchid* or *Mudriostrota* genus. In particular, in Unit 4 the species *Basileorhynchus basilicum* is most dominant and in places the limestone is composed of from 20% to 40% of these brachiopods.

Several sections were measured and the LW-15 outcrop section detailed below is rather typical of the exposed sections of Unit 4.

LW-15 SECTION OF UPPER DEVONIAN UNIT 4

Overlying beds shale and thin limestone bands

Contact Conformable

	Thickness in Feet
Limestone and shale interbeds, shale grey-green, fissile, fossiliferous. Limestone, grey, massive, dense, argillaceous. Both units contain abundant fossils (<i>Leiorhynchids</i>).	58.0
Limestone, grey to grey-brown, buff weathering, hard, argillaceous, few thin shaly bands highly fossiliferous, abundant fossils (<i>Leiorhynchids</i>).	37.0
Shale, green-grey, fissile, very fossiliferous (<i>Leiorhynchids</i>) with thin 1" to 2" interbeds of highly fossiliferous limestone.	67.0
Limestone, grey to grey-brown, dense, tight, hard, fossiliferous (<i>Leiorhynchids</i>).	<u>2.4</u>
TOTAL THICKNESS	164.4

Contact Conformable

Underlying beds shale, green-grey, blocky to rubbly and fissile, unfossiliferous.

The thickness of the unit was measured by Kelsh plotter as attaining thicknesses from 170 feet to 250 feet and in the complete measured section a figure of 164 feet was obtained.

UNIT 5

Overlying conformably Unit 4 is a series of shales and calcareous shales and thin limestones which were found to be indivisible by lithologic examination in the field. The

age of these shales and limestones is undoubtedly uppermost Devonian and they attain a thickness in front of the Camsell Range in excess of 7,000 feet. Indications are that a portion of this uppermost section is of Mississippian age, but nothing diagnostic was found to substantiate this assumption nor to divide this portion of the unit from the suspected Devonian portion. Where partial sections were observed, they were comprised of shale, grey-green, very fissile, soft, with few, very thin lenses of argillaceous limestone. Locally, at horizons of from 800 feet to 1,200 feet above Unit 4, Leiorhynchids were observed, but generally the section was unfossiliferous.

CENOZOIC FORMATIONS

PLEISTOCENE

Unconsolidated tillite, gravel, sand and clay of glacial origin occur in many places over the area. The tillite contains a variety of rock fragments, including granite and other igneous rock, along with limestones of local origin. Locally, in some of the stream beds considerable numbers of cobbles and boulders derived from the till were observed. The gravels, sands and clays are predominantly glacial-fluvial or outwash deposits.

Some small glacial ridges of gravel and till were observed locally, and the general direction of the glacial lineation is northwest.

Glacial erratics were observed on the tops of all the high land visited within the map area.

RECENT

Silts, marls, sands and gravels of Recent origin occur throughout the area peripheral to the major bodies of water and rivers and over much of the area peat moss occurs.

STRUCTURAL GEOLOGY

GENERAL

The Franklin Mountains are essentially a series of four semi-arcuate fault blocks composed predominantly of Paleozoic rocks and appear to represent the easternmost zone of mountain structure bordering the Interior Plains.

The Camsell Range comprises the approximate western one-third of the map area and has smooth sloping west faces and rocky precipitous east faces. To the east, the Camsell Range is flanked by an embayment of the Interior Plains which penetrates the general line of the front of the Franklin Mountains. This area is comprised of a low plain partly occupied by the Mackenzie River on the east side of the map area and backed by hills and plateaus that reach elevations in excess of 2,000 feet on the west in front of the Camsell Range.

The faults underlying the above-mentioned fault-blocks usually dip westward and, though some east-dipping faulting undoubtedly does occur, none was noted in the map area. Forces undoubtedly arising in the west and acting in an easterly direction have raised the Paleozoic strata to elevations above their original position.

The displacement of the faults varies locally, but throws of up to 6,000 feet are suspected. Net slip undoubtedly greatly exceeds this figure but it cannot at this time be accurately determined.

The semi-foothill type structures found in front of the Camsell were undoubtedly formed, folded and faulted by the forces that raised the mountains, so that they reflect in part the trends of the adjacent mountain front.

Transverse faulting is not generally the rule in either the foothills or mountains, but transverse faults are not uncommon.

The main uplifts in the area are probably the Oligocene and subsequent Pliocene orogenies from which have resulted the present structural configuration in the area.

GEOLOGICAL STRUCTURES IN THE LOWER FOOT RIVER MAP AREA

On and within the Camsell Range, structural configurations are present and were observed. The significance of these structures for oil and gas potential is questionable and, being outside of the project area, they are not discussed herein.

Underlying and east of the Camsell Thrust are a series of Upper Devonian shales and limestones which exhibit from

surface data a structural configuration herein designated the Root River Anticline.

This structural feature has been known to exist for a considerable number of years and many geological observers have examined the area. The structure in surface expression is about 21 miles long and approximately 3 miles wide and exhibits closure on both sides as well as both north and south plunge. Surface data would indicate the presence of a small transverse fault on the south end of the structure.

Dips on the west side of the structure are from 10° to 20° to the west, and about midpoint on the west side of the feature some very steep dips from 50° to 60° were observed. Dips on the east flank of the structure are less than those on the west, varying from 3° to 14° . From the available surface data the axis of the anticline is about North 15° East.

There is a possibility that the structure was formed by compressional forces yielding a sole fault and represents only folding of the incompetent Upper Devonian rocks. Seismic shooting would be necessary to confirm the structure.

SUMMARY

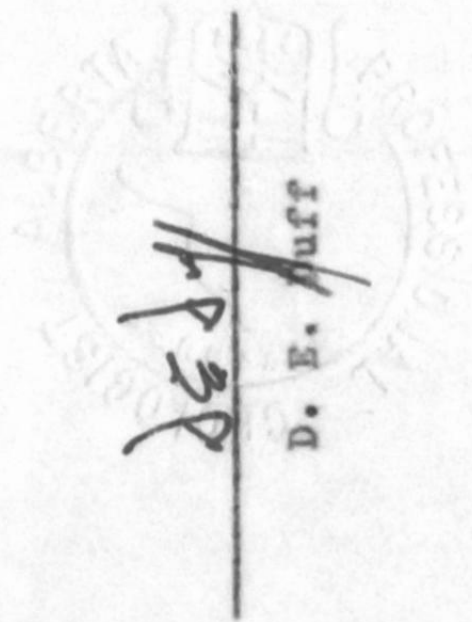
Field examination of the exposed Middle and Upper Devonian in the map area and published data and outcrop examined outside the area indicated favourable structural conditions could underlie certain portions of the subject acreage.

Exposed outcrop in the area did not indicate any good potential reservoirs, but under suitable structural and stratigraphic conditions development of suitable reservoirs could be anticipated.

RECOMMENDATIONS

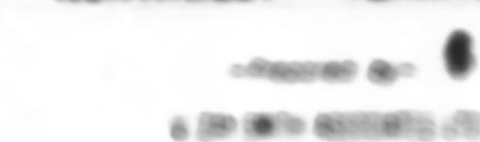
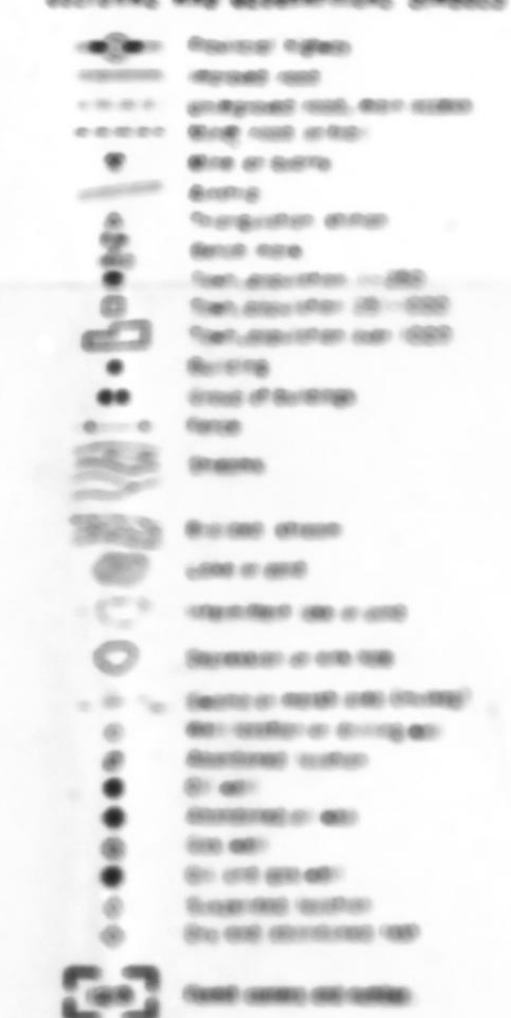
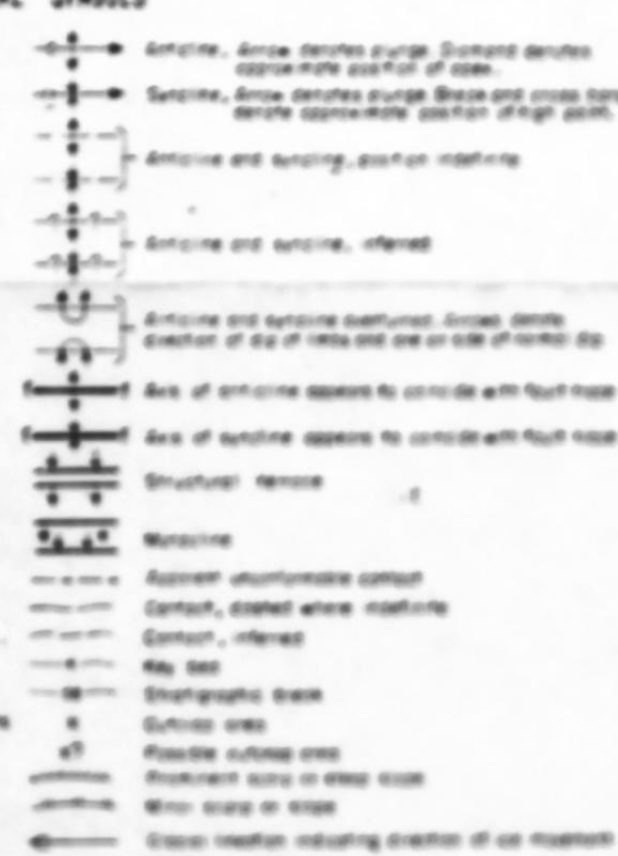
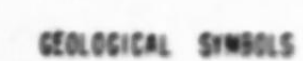
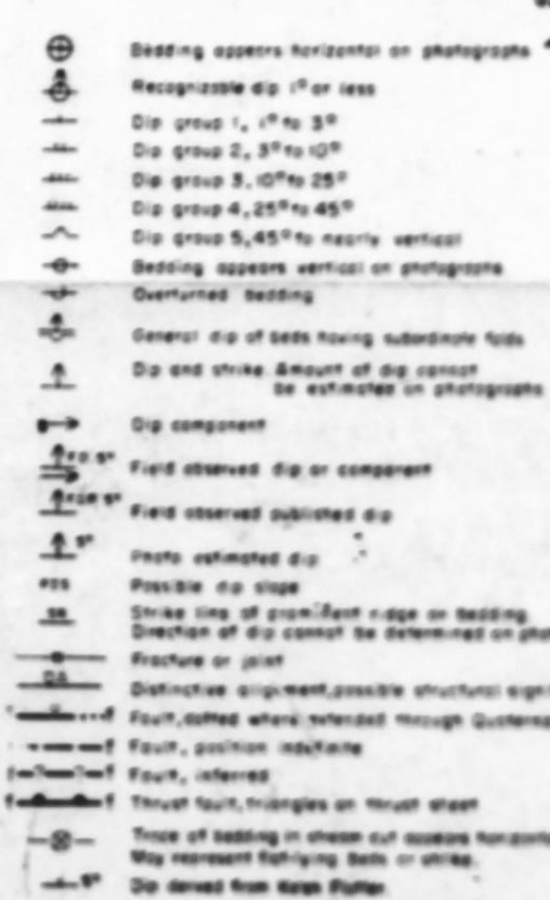
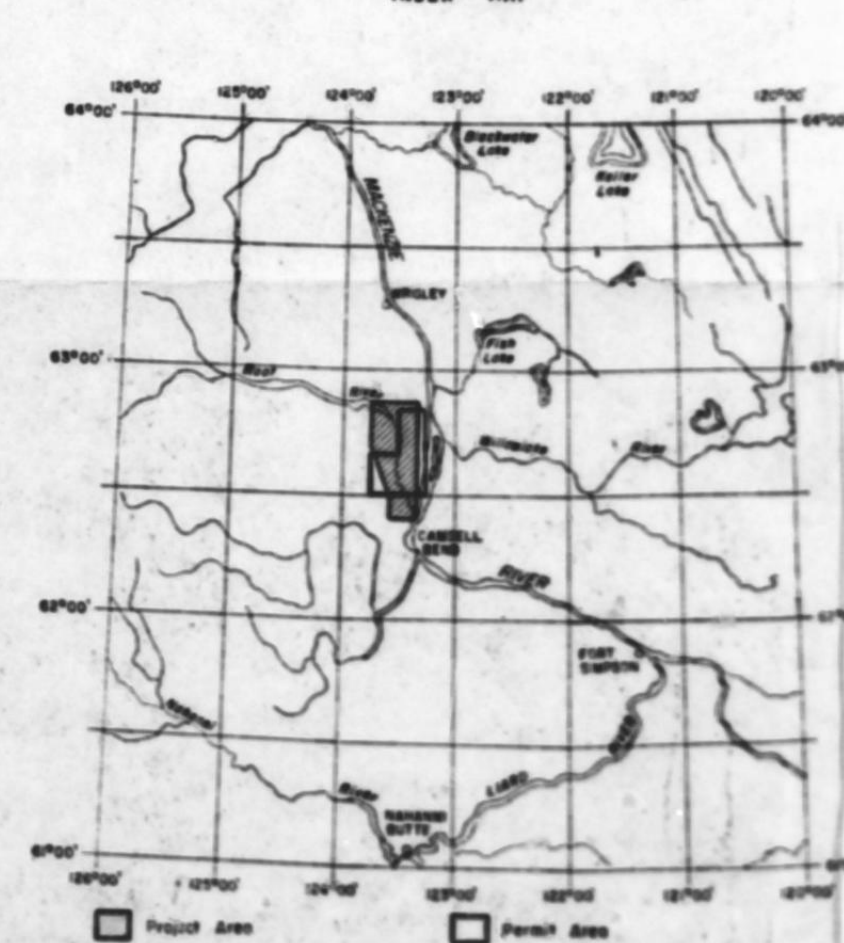
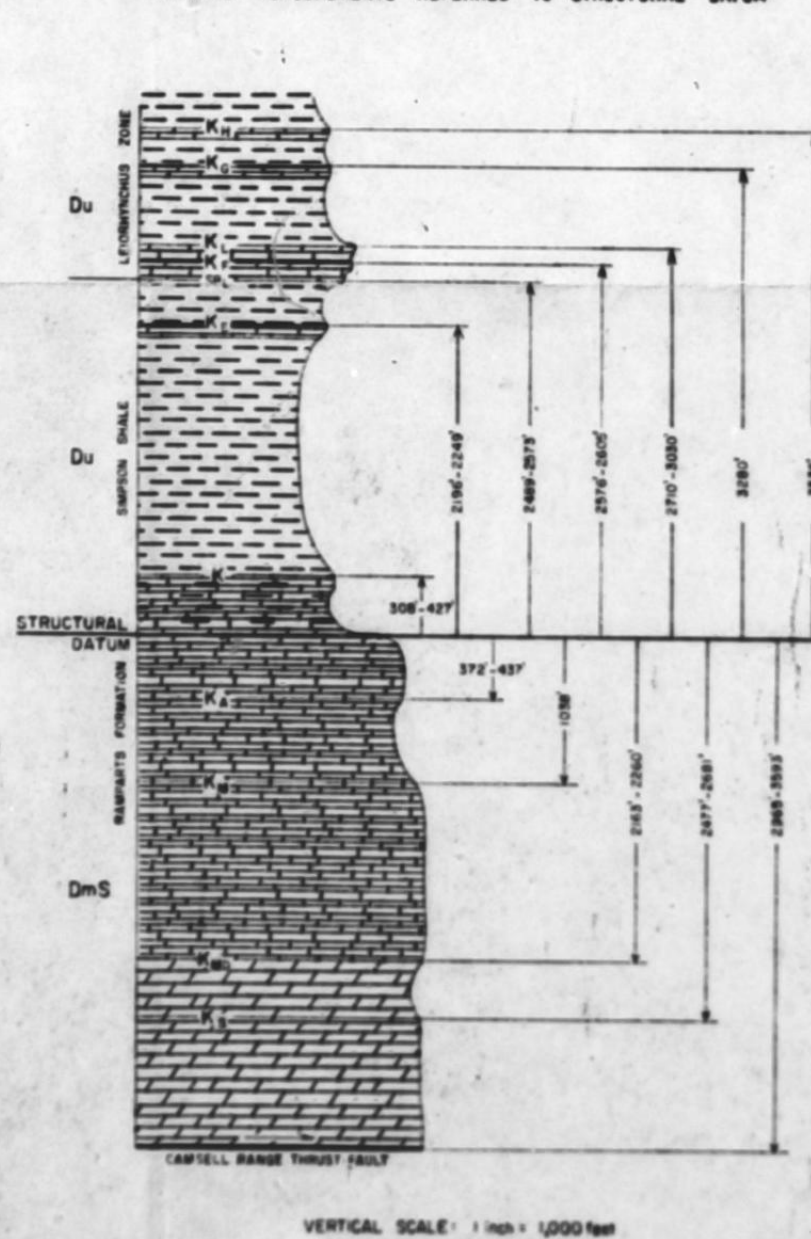
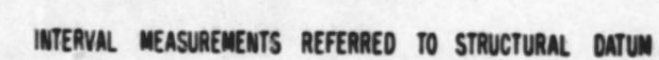
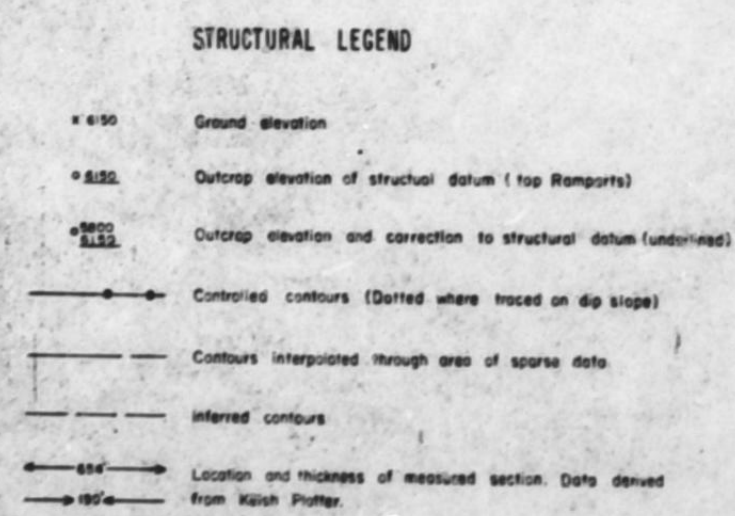
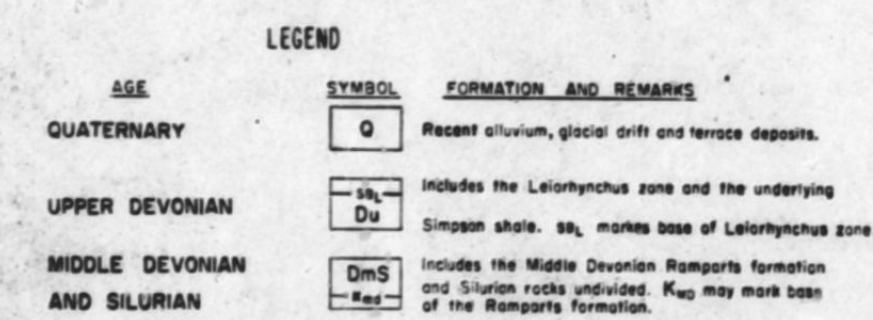
In consideration of the potential reservoirs and structural area indicated in the text of the report, the following recommendations are set out below for consideration.

1. A seismic program be initiated at minimum cost to more fully delineate the areal extent of the Root River Anticline and to determine whether the anticline persists at depth.
2. Further seismic activity, additional acreage acquisition and possible drilling in the map area be dependent upon the results of the initial seismic program.

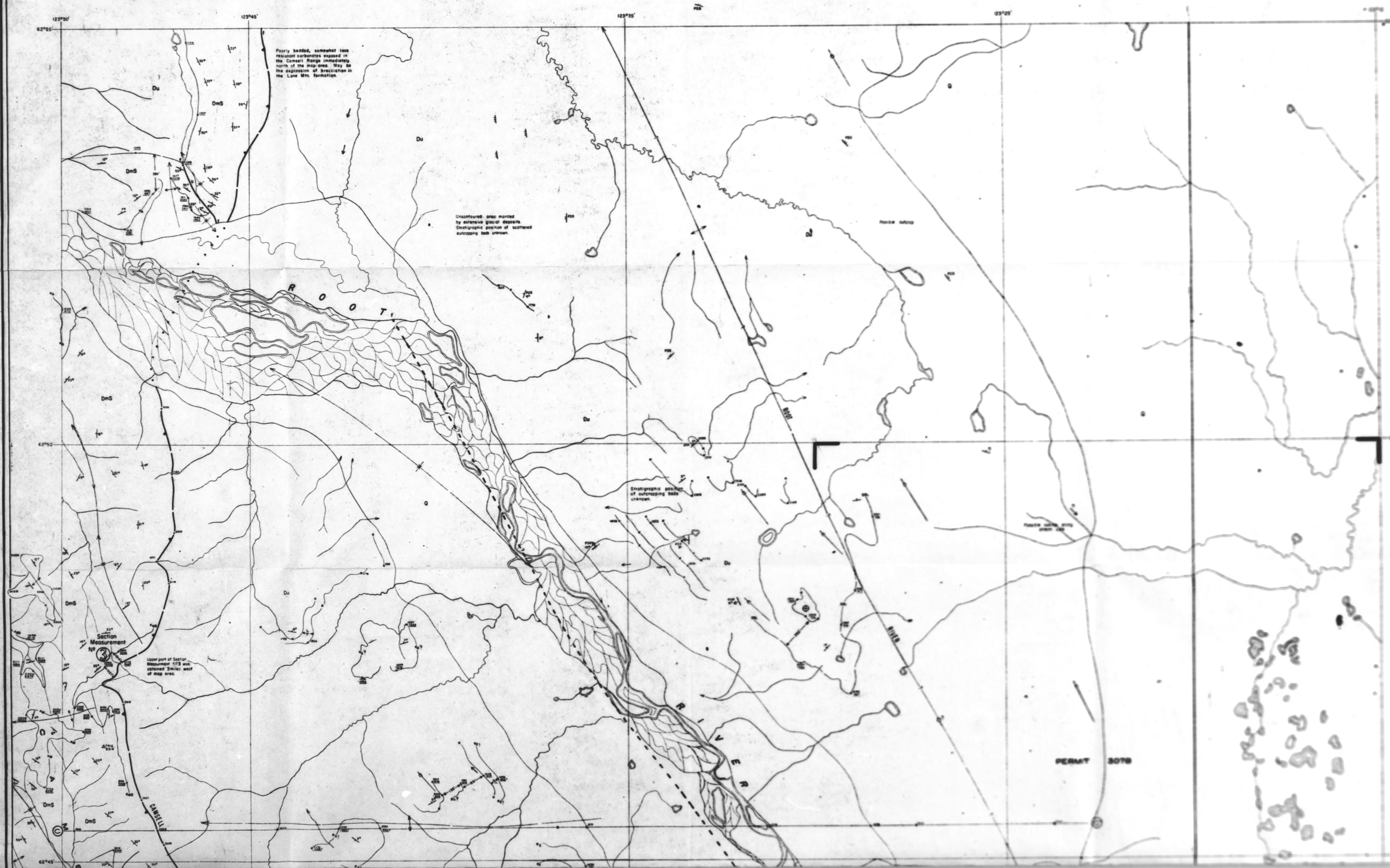
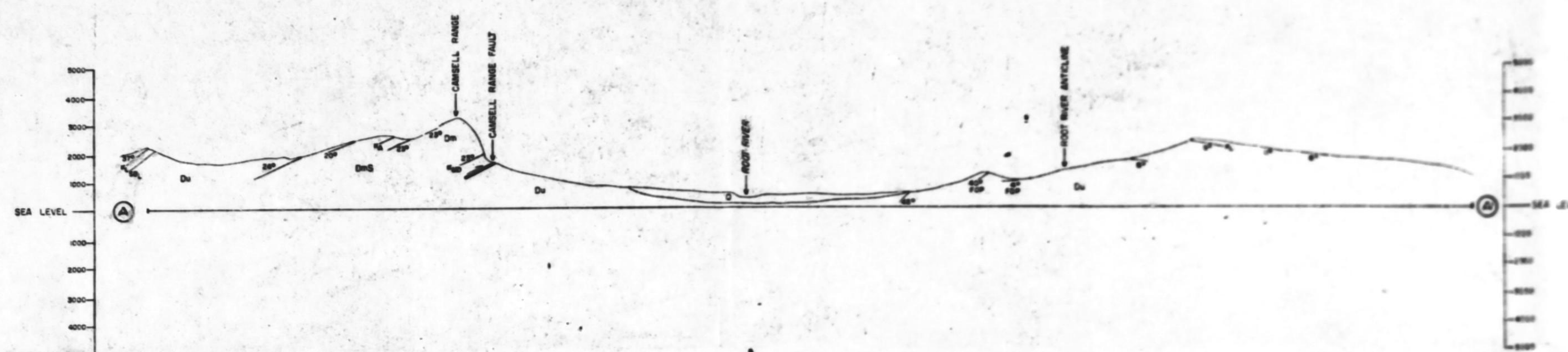
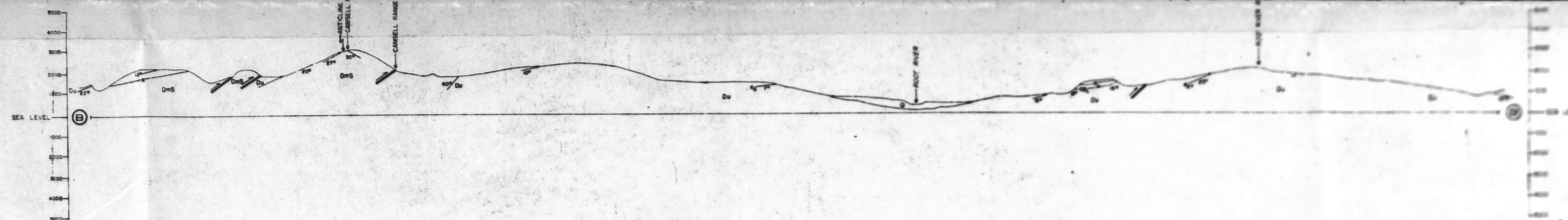

DEB
D. E. Huff

DED:dk

December 12, 1960







TOPOGRAPHIC PROFILES A-A', B-B' AND C-C'

HORIZONTAL AND VERTICAL SCALE: 1" TO 2500'

