

**REPORT ON THE GEOLOGICAL SURVEY**

**of**

**PERMITS 3082 - 3083**

**WRIGLEY AREA - NORTHWEST TERRITORIES**

**Prepared for**

**SHEEKY AND COMPANY**

**New York, N.Y.**

**by**

**LINK DOWNING COOKE & CO., LTD.**

**1961**



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## SUMMARY & CONCLUSIONS

The consulting firm of Link Downing Cooke & Co. Ltd. was retained by Sheeky and Company, New York, N. Y. to conduct a geological survey of Permits 3082 and 3083 in the Northwest Territories during the 1961 field season. The regional location of these permits is illustrated on the map that follows this summary. The survey was planned to provide some detailed stratigraphic descriptions to complement data gathered on limited aerial reconnaissance by Cessna and Helicopter.

Prospects for generation and accumulation of oil and gas in the sedimentary section underlying the report area are considered above average. However, the permits are located very close to thrust fault structures of the Mackenzie Mountain area and therefore should be considered as secondary target areas for any test hole. Primary targets for petroleum exploration are the broad, unfaulted anticlinal folds that have been mapped in the central plains to the east of the Camsell Scarp and in the Mackenzie Plain to the west of Wrigley.

The geology of the area has been described previously by G. S. Hume\*, under the title, "North Nahanni and Root River

\* Hume, G. S., 1922

**Areas and Caribou Island, Mackenzie River District, Canada"**

**Department of Mines, Summary Report, 1921 part B. Hume's\* descriptions of structures, stratigraphy and formation distribution have been of great assistance and we are in general agreement with Hume's findings. The survey has supplemented this earlier work with detailed stratigraphic sections and a geological map of the report area.**

With the assistance of the recent classification of Devonian strata by Bassett\*\* we have been able to define formations with some detail as to age and stratigraphic character. Hume's subdivision of the Devonian above the Lone Mountain Formation has also been preserved in the report. Detailed correlations of stratigraphy and paleontology are not possible but the general stratigraphic zones are summarized in the Stratigraphic Table (Page 25).

The data gathered on this survey introduces some controversial questions. These questions are summarized here in conjunction with the summation of additional information available in the report.

1. This report has adopted Bassett's recent nomenclature, wherein the Lone Mountain Formation is considered \*\*\* Lower Devonian in age. Kindle suggests that the Lower Devonian

\* Hume, G. S., 1922

\*\* Bassett, H. G., 1961

\*\*\* Kindle, E. M. & Beswirth, T. O., 1921

is absent, the Middle Devonian resting directly on the Silurian.

2. The formation boundaries between the Hume Formation (Middle Devonian) and Lone Mountain Formation (Lower Devonian) was readily definable in the detailed stratigraphic sections on the basis of lithological changes and fossil content in the Hume Formation. Hume considered the upper fossiliferous Middle Devonian to be a continuous lithological unit with the lower unfossiliferous Lone Mountain dolomite. The presence of intra-strata coarse crystalline dolomite in both of the formations above and below the contact would certainly lead to this conclusion. This coarse crystallization is believed to be secondary however, and it has intrusive characteristics, which suggest the formation boundary may have reflected a depositional break in the form of intra-strata permeability as might occur at a disconformity.
3. The discovery of an additional Upper Devonian Subdivision (D-8) comprised mainly of siltstones, may provide an answer for the anomalous conditions discussed by Hume\* (Mem. 273, 1954) in the Imperial Formation. Rather than consider a lithological change from siltstone and sandstones at Norman Wells to limestones at Root River, this report suggests the possibility that

\* Hume, G. S., 1954

the lower limestone is the Kee Scarp Formation of Middle Devonian age and the siltstones of the Upper Devonian Imperial Formation are stratigraphically higher and are perhaps correlative from north to south.

It would appear that much confusion has arisen from correlating certain species of fossils from one area to another. It has been our experience that *Leiorhynchus* and *Spirifer* type brachiopods are widespread throughout the Upper Devonian strata. As a result correlations should perhaps be carried from one area to the next only via complete stratigraphic sections. This method of course requires the gradual accumulation of information as gathered on detailed section work over the years. The Root River-North Nahanni area requires additional work in this regard.

4. The thickness of the Imperial Formation (not including the Hare Indian or Kee Scarp Formations) is 5,500 feet. This thickness is greater than has been reported in the literature covering the Mackenzie River area to date. An additional thickness of Upper Devonian section, may be present above the D-8 siltstone subdivision of this report or these additional sediments may be of Cretaceous age.
5. The age of the *Leiorhynchus* zone as interpreted in this report has been defined as Middle Devonian (Dr. S. J. Nelson\*).

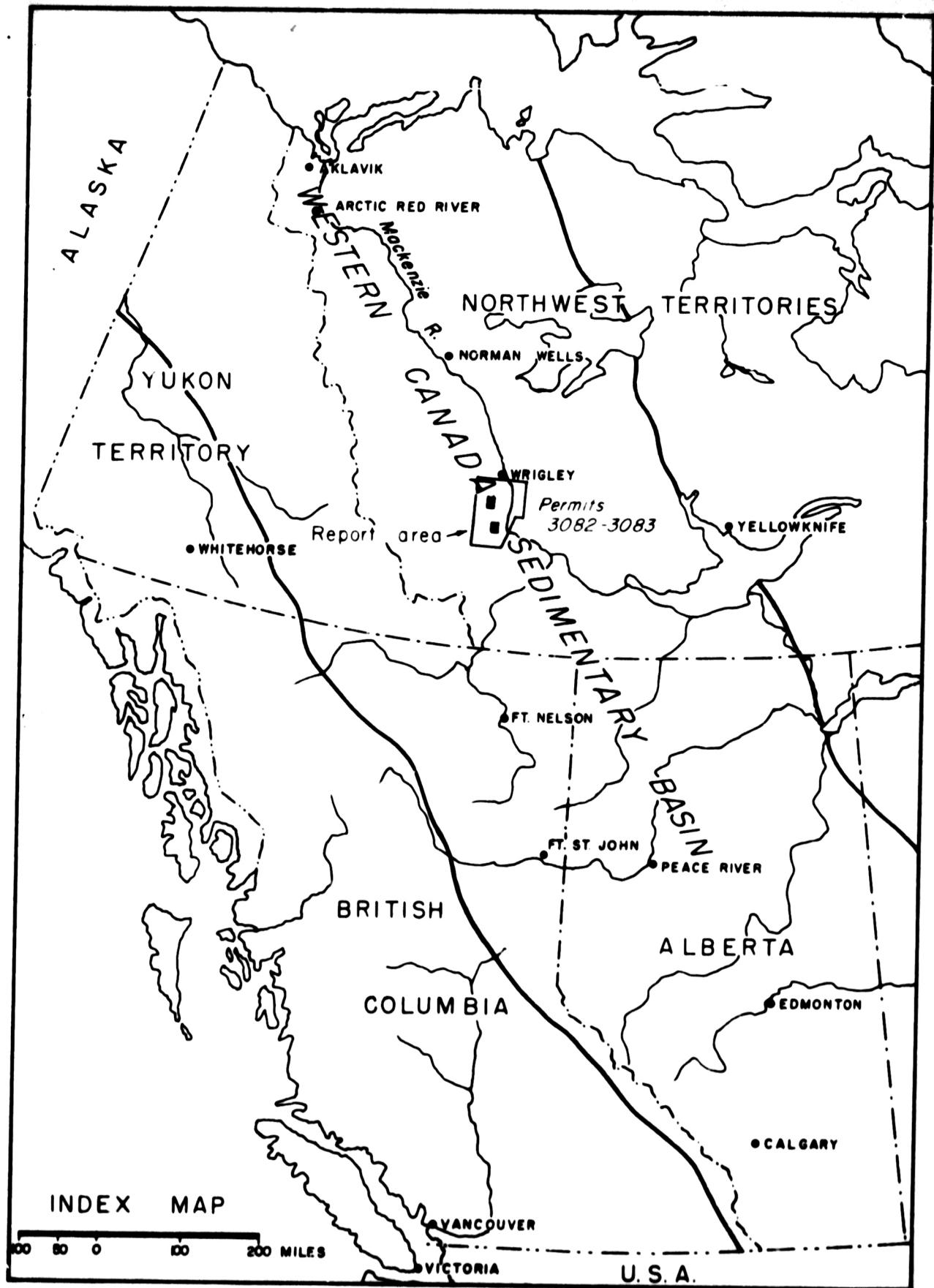
\* Nelson, S. J., 1961

\*\* e.g. *Nudirostra mesacostalis* of the D-8 zone is a *Leiorhynchus* type.

This age dating has led to a conjectural correlation of this zone to the Kee Scarp Formation (Photos - Pages ii and vi).

6. The presence of the D-8 zone on the North Nahanni River requires that a complete section of the D-7 or third shale zone must be present in the report area not eroded and not overlain by Cretaceous as suggested by Hume\*. The greater portion of this shale zone is described on the lithological log for Section 3 where it exists as a continuous series below the D-8 zone.
7. The Imperial Formation described by Monnett (Hume, 1954) on the west branch of the Wrigley River must actually be a description of strata within the first shale zone, or Hare Indian Formation. This conclusion is reached from the study of formation distribution as illustrated on the geological map of this report. The siltstone described in Monnett's section could correspond with the "minor" siltstone reported in the first shale zone on Deceiver Creek (Section 4). No siltstone was noted in the second shale interval and the possibility of a correlation to the siltstone of D-7 and D-8 is not considered feasible because the Hume fauna Favosites limitatus Rominger and ?Billingsastraea sp. of Middle Devonian age was collected from the Kee Scarp (D-4 zone) where it outcrops at Root River and is in a higher stratigraphic position than the outcrop on Wrigley River.

8. The fossil Cyrtospirifer whitneyi (Hall) occurs in the D-6 zone of the report and has been reported in Hume's D-5 and D-6 zones. Atrypa sp. occurs in the D-4 zone of both reports. Favosites schuchertella and Atrypa sp. occur in the Hume of this report and Lower Ramparts Limestone of G. S. Hume\*. There are no further paleontological correlations other than these gross similarities.



## INTRODUCTION

The area of this geological field survey is bounded by latitudes  $62^{\circ} 00'$  to  $63^{\circ} 15'$  north and longitudes  $123^{\circ} 0'$  to  $124^{\circ} 30'$  west. This area includes all of the outcrop west of the Mackenzie River adjacent to permits 3082 and 3083 held by Sheekey and Company under permit from the Government of Canada. The firm of Link Downing Cooke & Cc. Ltd. was retained to do a geological survey of the permit areas for the purpose of describing the stratigraphy and compiling a geologic map showing formation distribution and structure. Detailed stratigraphic studies were made at three different locations and represent 5,200 feet of formation thickness. These sections include description of the Lone Mountain, Bear Rock, Hume and Upper Imperial Formations. A fourth cursory examination traversed 5,000 feet of stratigraphic thickness along the bed of Deceiver Creek. This traverse was an attempt to correlate the information gathered on the other three detailed sections and it includes descriptions of the Hume, Hare Indian, Kee Scarp and lower Imperial Formations. A geological map constructed on the scale of 1 inch equals 4 miles is included in the report. Data from the stratigraphic sections and data collected from fixed wing and helicopter reconnaissance were used to compile the map.

The geological field party consisted of five geologists who were transported and supplied by aircraft out of Fort Nelson, B.C. Geologists were F.J. Halkow, C.D. McCord, R.G. Perry, H.K. Roessingh and H.R. Young. A G-2 helicopter of Associated Helicopters Ltd. piloted by D. McKay and serviced by T. Manning and a float equipped Cessna-180 of Gateway Aviation, piloted by J. Evans provided full time support to the survey operations. The field cook was W.E. O'Reilly of Dawson Creek, B.C.

The sectioning and reconnaissance was conducted from a field camp located at the west end of Carlson Lake in the better part of July, 1961. Some preliminary mapping of the area was done at an earlier date on over flights from Wrigley to Fort Nelson.

The drafting of the map and sections was done by R. Hoenson of Link Downing Cooke & Co. Ltd. The author extends his appreciation to all of the above personnel for their efforts and co-operation in the successful completion of the geological survey.

Fossil identification appearing in the report and on the stratigraphic sections was made by Dr. Samuel J. Nelson of the Department of Geology, University of Alberta.

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## ECONOMIC GEOLOGY

The prospects for discovery of oil or gas in this area are considered to be above average. The biostrome reefs present in the Middle Devonian shales of the report area (Photo Page v) represent an environment similar to that at Norman Wells where oil was discovered in a Devonian reef in the subsurface. Other prospective reservoirs for accumulation of hydrocarbons in the subsurface of the report area include the Hume Formation, Bear Rock Formation, Lone Mountain Formation and strata of Silurian and Ordovician age. Prospects for all horizons younger than Silurian age are slight on the permit areas because of the up-thrust and erosion of the Devonian section.

All horizons below the Middle Devonian-Hare Indian Formation are prospective in nearby areas where deformation has not been so severe but where folding is present. The most promising structure of this type lies immediately east of the Camsell Range scarp and has been referred to as the Root River anticline by Dann\*. He reports the cover in this area to be of Upper and Middle Devonian age. The location of the anticline as shown in this report is observed from the air during this past field season.

Another promising structure is present to the northwest of Permit 3082 and in fact may continue southward and terminate within Permit 3082. This structure, called the Wrigley anticline by Dann may have a closure comparable to the 2,000 foot topographic relief that has resulted from erosion of the structure. Dann reports D-3 and D-4 zone cover over the anticline. These zones are the Hare Indian and Kee Scarp Formations of this report.

## STRUCTURAL GEOLOGY & TOPOGRAPHY

Both Permits 3082 and 3083 are located west of and adjacent to the Camsell Range, a long, narrow range of mountains that rises abruptly on the western limit of the interior plains (Photos Page i). This range has not been included in a mountain division because of its isolated nature. The McConnell Range which is an echelon continuation of the Camsell Range, belongs to the Franklin Mountains division. The Canyon Ranges to the west belong to the Mackenzie Mountain division. With reference to the physiographic divisions defined by Bostock\* (1948) the Camsell Range would belong in the Mackenzie Plain division of the Mackenzie Mountain area. This mountain area is a huge eastward arcing extension of the eastern system of the Canadian Cordillera.

The mountains of the Camsell Range have a topographic character that reflects their structure and stratigraphy. They have been uplifted on a narrow asymmetrical anticline that has been ruptured on its east flank by a west dipping thrust fault. The bedded sequence of dolomite and dolomitic limestones in the Lone Mountain Formation outcrop along the face of the fault scarp and their rubbly weathering character has preserved this scarp in a very striking fashion (Photo Page i). The dip slope of the fault scarp

\* Bostock, H.S., 1948

or the west limb of the asymmetrical anticline is capped by very resistive Hume Formation limestones. Young "V" shaped valleys frequently have cut through the Hume strata at short intervals all along the range. The resultant characteristic features are the resistive "flat iron" shaped west dipping Hume remnants (Photo Page ii). West of the "flat irons" the Middle and Upper Devonian shale strata of the Hare Indian and Imperial Formations underlie a low rounded topography that in the most part supports a lush vegetation. Subdued cuesta shaped ridges reflect more resistive siltstone or limestone horizons within these shale formations (Photo Pages v and vi). Further west in the vicinity of Carlson Lake the Middle and Upper Devonian Formations have been folded in repetitious shallow synclines and anticlines. Outcrop is good on the occasional steep mountain slopes that have resulted from erosion on these structures.

A second abrupt fault scarp is present to the west of the Camsell Range scarp and its position coincides with the west boundary of Permit 3083. This scarp is also paralleled for 20 miles by the North Nahanni River. The mountains that comprise this fault scarp have also been folded in an asymmetrical anticline and the scarp is in the main comprised of Lone Mountain Formation. However,

the limestones of the Hume Formation are present as a thin discontinuous veneer on both the shallow dipping west slope and vertically dipping east scarp. The sequence from Lone Mountain to Hume to Hare Indian to Imperial Formation is repeated here as it is on the Camsell Range and the physiographic expression of each formation is also repeated. Two characteristic features of this fault scarp are:

1. the near vertical smooth slabs of Hume Formation limestones that are present on the east scarp face;
2. the rugged canyon stream valleys that cut through the thin resistive Hume strata into the rubbly weathering Lone Mountain dolomites.

The displacement on the North Nahanni scarp is 6,000 feet as estimated from formation thicknesses measured in this report. Similarly the fault displacement on the Camsell Range scarp ranges from 4,500 feet at Camsell Bend to 5,400 feet at Root River. The distribution of Devonian strata east of the Camsell Range has been accepted as mapped by G. Dann\* in 1953. The topographic relief displayed by these scarps represent over one-half of the stratigraphic displacement in that the Camsell Range rises 3,000 feet above the plains to the east, and the scarp to the west rises 2,500 to 3,000 feet above the North Nahanni River level.

\*Dann, G., 1953

## CLIMATE

The climate of the area is extreme, ranging from summer highs in the order of +95° to winter lows in the -70° range. In addition seasonal temperatures are often extreme, ranging throughout +30° to +95°. A considerable variation was noted during the past field season in the different topographic regions. In regard to the annual variations the main characteristics that affect the field operations during the season are the amount of precipitation and the date of the spring break up. Break up of ice on the lake at Wrigley Airport occurred on May 30, 1961. There were still considerable amounts of floating ice in the Mackenzie River at this time.

Time lost because of bad weather along the Mackenzie River and particularly in the Camsell Range was at a minimum during this past field season. Generally the summer was warm and dry and infrequent rain storms were of short duration. It was evident on several occasions that there was inclement weather to the west in the Mackenzie Ranges that did not extend eastward to the Mackenzie Plain. The Middle and Upper Devonian shale which outcrops west of the Camsell Range scarp supports a lush vegetation suggestive of an area of high precipitation (Photos Page vi). This impression was particularly strong in the vicinity of Carlson Lake

The precipitation is higher at this latitude than it is to the north but part of the reason for an increase in vegetation is due to the Devonian shales. They support vegetation to a much higher degree than do the carbonates of the Middle Devonian and earlier periods. These carbonates are widespread in any mountainous area and the Devonian shales outcrop in low intermontane valleys such as the Carlson Lake portion of the Mackenzie Plain. The annual precipitation is reported in the Atlas of Canada at 15 inches, of which 5 inches falls during the summer field season, June to August.

## ACCESSIBILITY

Transportation for heavy equipment anywhere along the Mackenzie River is provided on a two-week schedule by the Dominion Government owned Northern Transportation System out of Hay River, Alberta. Heavy equipment could be moved on to the permit areas via the gravelly, graded valleys of the North Nahanni and Root Rivers, in the winter time, or during a select low water period in the summer months.

For survey purposes the transportation system on the Mackenzie, Liard and Nelson Rivers was utilized for transporting provisions, camping equipment and fuel down stream from Fort Nelson, B.C. A fuel cache was laid down at Wrigley Airport and was flown into Carlson Lake. Transportation of fuel, provisions and personnel was achieved with the use of a Cessna 180 float equipped aircraft and a G-2 helicopter. Carlson Lake and the Mackenzie River provided very adequate landing spots for the float plane. The area encompassing the two permits of this report could be readily reached by G-2 helicopter from Carlson Lake, however, clear landing spots are scarce west of the Camsell Range.

## OBJECTIVE OF SURVEY - FIELD & REPORT PROCEDURE

The survey was designed to provide a map showing structure and formation distribution compiled from four key stratigraphic sections and aerial reconnaissance. The procedure of the field survey and report was intended to produce material that will supplement the report by G. S. Hume in 1922.

The survey party was organized and equipped to measure and describe the sample sections in the field with the detailed aspects of these requirements in mind. The first section was measured across the complete outcrop exposed in the Camsell Range 15 miles south of Wrigley. A steel tape was used for measurement and slope angles were taken every 100 feet. The attitude of the strata was measured wherever possible and samples were collected and described to represent approximately every 17 feet of stratigraphic thickness. This information has been recorded and presented in the report on a stratigraphic log similar to those used for subsurface tests in the Central Plains. Information gained from microscopic examination of crushed hand samples has been included in this stratigraphic log.

Two other detailed sections were measured, one to check the thickness and stratigraphy of the Hume Formation due east of Carlson Lake, another to describe what is believed to be the uppermost

strata of the Imperial Formation which outcrops in a resistive cuesta west of Carlson Lake. A fourth section was of a reconnaissance nature and entailed a foot traverse for a distance of 3 miles up Deceiver Creek, located within the boundaries of Permit 3083. This section provides an unbroken lithological description of strata from the Hume Formation upwards to top of the D-6 zone in the Imperial Formation. Four detailed stratigraphic logs of these sections are included with this report and the correlation of one section to the other is outlined in the stratigraphic table.

It would appear that there is a considerably greater thickness of Imperial Formation than has been reported by Hume and other geologists\* since his time. Exact correlation to Hume's section was not found to be possible with the data gathered on this survey, but the zones outlined by him are preserved in a general way in this report. Definition of the zones of the Imperial Formation does not seem to be feasible by use of paleontology. The general correlation here has been made via stratigraphic similarities. An additional upper zone of the Imperial Formation (D-8), has been added as a result of the anomalous stratigraphy and structural position of Section LDC-3.

\*G. Dann reported a thickness of 4,966' for the Upper Devonian in the North Nahanni River area. The thickness of 5,250' of Imperial Formation measured west of the Camsell Range in this report agrees very closely to his earlier estimate. The thickness for the Devonian subdivisions does not agree however, and it is noted that the distribution of these units on the respective geological maps are not the same.

The author regrets that economic limits on the survey prevented more definition of the Hare Indian, Kee Scarp, Imperial Formation relationships and thicknesses and facies changes within the units of the Imperial Formation.

The geological map included here presents the formation distribution with a relatively continuous cover by color legend. This representation may be misleading in regard to the impression of available outcrop in the area. Vegetation cover is almost complete and formation distribution is interpretive over a large percentage of the map area. The main control for the mapping of the zones of the Middle and Upper Devonian strata has been the resistive D-4, D-6 and D-8 zones that can often be traced through areas that do not have rock outcrop (Photo Page vi ).

## STRATIGRAPHY

All of the outcrop mapped in the report area was comprised of the sedimentary strata of the Devonian Period. Rocks of older and younger age were not examined and did not outcrop in the map area with the exception of Cretaceous strata that has been reported by Hume\* on the Wrigley River and which also may be present to the west of Carlson Lake.

Kindle and Besworth\*\* described 500 feet of dark grey massive coralline limestones at the base of the type section on Lone Mountain. They thought that the poorly preserved corals represented a Silurian Age. These corals may correlate to those collected at Section 1 where they were located above the Bear Rock Formation. Section 1 of the report represents a 3,200 foot thickness of strata including the Hume and Lone Mountain Formations, all believed to be Post Silurian in age. The total thickness of 2,500 feet for the same stratigraphic interval on Lone Mountain can easily be accommodated in this more recent measurement of the Devonian section, even if the total Hume Formation is not present on Lone Mountain. In addition, the fact that the strata described by Hume is limestone is strong evidence for the consideration of this basal section to be of Lower Devonian age. The Devonian-Silurian contact in outcrop areas to the north of Wrigley is represented

\*Hume, G.S. & Link, T.A., 1945  
\*\*Kindle, E.M. & Besworth, T.O., 1921

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by a lithologic change from dolomite of Silurian age to limy dolomite and limestones of Devonian age. Positive identification of the Lone Mountain Formation as Lower Devonian age is not possible because of the poorly preserved sparce fossil content. In fact it is possible that the Lone Mountain Formation transcends the time boundary between the Silurian and Devonian Periods. However, the Lone Mountain Formation is a stratigraphic unit distinct from earlier Silurian sedimentary strata.

The Middle Devonian Period is represented in this report by the Hume, Hare Indian and Kee Scarp Formations. These formation divisions and nomenclature have been adopted from Bassett\*. These divisions differ somewhat from the equivalent divisions by G. S. Hume\*\* in that the Lone Mountain Formation is placed in the Lower Devonian and the Hume Formation is in the Middle Devonian as are the Hare Indian and Kee Scarp Formations (see Stratigraphic Table Page 25). The Middle Devonian classification is supported by the fossil data collected on this survey. The fossiliferous limestone zone at the top of the Hare Indian Formation (Shale Zone 1) is referred to as Kee Scarp Formation and is interpreted to be equivalent to the *Leiorhynchus* zone of G. S. Hume\*\*. A correlation of this zone to the oil reservoir at Norman Wells is conjectural and is made solely on the basis that the zone is biohermal in part

\* Bassett, H. G., 1961

\*\* Hume, G. S., 1922

and is of Middle Devonian rather than Upper Devonian age (Photo Page v).

The Imperial Formation studied in this report includes Shale Zone 2 and Shale Zone 3 as defined by Hume and they are divided by an interbedded shale and limestone sequence that probably is equivalent to the Athyris angelica zone. This section was examined in a reconnaissance traverse along Deceiver Creek and the description of the strata present is not as detailed as descriptions of formations in other sections.

An upper zone of the Imperial Formation that has not been described in the literature of the North Nahanni area was sectioned west of Carlson Lake. This zone consists of massive bedded fossiliferous siltstone with shale and occasional limestone beds and it is underlain by Shale Zone 3. Unfortunately the stratum that is present above the siltstone further to the west was not examined and consequently it is not known whether this siltstone represents the top of the Imperial Formation or if there is additional Upper Devonian section yet to be described.

From a review of previous work in areas to the north and west of this report area, it is possible to predict that the Devonian section exposed on these permits is underlain by an additional 5,000' + of sedimentary section. The pre-Devonian section is

comprised of rocks belonging to the Cambrian, Ordovician and Silurian Periods. The most prospective formations for the exploration for hydrocarbons would be those of Ordovician and Silurian age. These sediments are marine dolomites that contain zones of prolific fauna and are known to contain variable degrees of porosity. The Devonian strata of the report area provides an excellent impervious cover for any older porous formations and consequently the conditions for accumulation for hydrocarbons in anticline structures in the area are very favourable.

## STRATIGRAPHIC TABLE

Period	Formation	Thick-ness	# Hume	Paleontological Record	Section Correlation
UPPER DEVONIAN	Imperial* Formation (5250')	1250'	D-8?	<u>Nudirostra mesacostalis</u> (Hall) <u>Cyrtospirifer whitneyi</u> (Hall) <u>Martiniopsis</u> <u>Syringopora</u> sp. <u>Marticoceras oxy</u> (Clarke) <u>Atrypa</u> sp. cf. <u>A. blackberryensis</u> (Fenton & Fenton)	Section 3
		1000'	(3rd D-7 shale)		
		1000'	D-6	<u>Cyrtospirifer whitneyi</u> (Hall) **Hume's <u>Athyris angelica</u> <u>Billingsastraea</u> n. sp. zone	
		2000'	D-5 (2nd shale)		
MIDDLE DEVONIAN	Kee Scarp*	100 300	D-4	<u>Coenites</u> sp. <u>Elytha compacta</u> (Meek) ? <u>Atrypa</u> sp. <u>Favosites limitatus</u> <u>Billingsastraea</u> sp.	** Hume's Leiorhynchus zone Section 4
	Hare Indian*	1600'	D-2/D3 (1st shale)		
	Hume*	650'	D-1	<u>Favosites alpenensis</u> <u>Schuchertella adoceta</u> <u>Atrypa</u> Gastropod moulds	Sec. 2
LOWER DEVONIAN	Lone Mt. (upper)	1740'			
	Bear Rock Lone Mt. (lower)	270' 535'+		Poorly preserved tabulate Corals.	Section 1

## Description of Formations

### Devonian Period

#### Lower Devonian

##### Lone Mountain Formation

The Lone Mountain Formation was defined by Kindle and Bosworth\* who described a type section on Lone Mountain at Cam-sell Bend. The formation here is a homogeneous thick series of thin bedded, light grey and black banded "dolostones" and dolomitic limestones. In the map area this formation is divided into two units referred to as the lower and upper.

The breccia of the Bear Rock Formation could be considered a facies that separates the two units of the Lone Mountain Formation. A full discussion on the distribution and origin of the Bear Rock breccia is presented below in the consideration of the Bear Rock Formation.

The lower unit of the Lone Mountain Formation is comprised of 535 feet of dolomite brown-grey, green-grey and tan-grey, cryptocrystalline in part argillaceous, alternating thin and thick bedded and weathering with a mottled tan or yellow-orange-grey to dark grey color; minor brecciation and some deformation suggests possible adjustment along bedding planes. The upper unit of the Lone Mountain Formation is comprised of 1,740 feet of dark brown-grey microcrystalline, sometimes microgranular dolomite alternately

\*Bosworth, T.O., 1921

interbedded with subordinate light grey dolomite. Fossils are rare and porosity is scattered and poor.

Both the upper and lower units have a unique characteristic in that there is present a very high percentage of crystalline dolomite that has an intrusive character. This feature appears to be related to, or originated from the boundaries with the Bear Rock Formation and Hume Formation. The coarse crystalline material is present as beds between the stratified Lone Mountain cryptocrystalline dolomites. Possibly the dolomite crystallized as a result of an intrusion of magnesium bearing solutions, prior to or during orogeny, along and adjacent to the Lone Mountain-Hume Formation contact (which probably is a disconformity) and along the Bear Rock Formation. This interstrata coarse crystallization also extends up into the Hume Formation and is of importance there, as it is in the lower formations, in that fair to good intercrystalline and vuggy porosity has been noted to be developed in relation to the crystallization (see Section 2).

The only fossils collected in the Lone Mountain Formation in this area were very poorly preserved tabulate corals which have a Devonian like aspect. Detailed lithologic descriptions of the formation are presented in stratigraphic Section LDC-1 of this report.

### Bear Rock Formation

The Bear Rock Formation has been redefined by Stelck\*.

The type section for the formation is located at "Bear Rock" near Fort Norman on the Mackenzie River. It was noted in the above discussion that the Bear Rock Formation could be considered a unit of the Lone Mountain Formation in that the formation boundaries are based entirely on a textural change. The present limestone breccia of the Bear Rock is considered to represent an evaporite zone that was deposited during Lower Devonian time in a large basin that extended over the present location of the McConnell Ranges eastward to the Middle Devonian subcrop and along the Mackenzie Valley as far north as Arctic Red River. The southern boundary is located at Root River in the Camsell Range. The west boundary is not known. The evaporite basin attains a continental dimension when the correlations are made of the Bear Rock Formation to the extensive Lower Devonian evaporite beds in the subsurface of Alberta and Saskatchewan.

Initial Bear Rock brecciation is considered to have been penecontemporaneous in origin. The contrast of abundant limestone, present in this narrow brecciated zone, to the thick dolomite sequence in which it is enclosed, suggests that brecciated primary dolomites have been de-dolomitized in a zone that was permeable to migrating solutions. It is possible that the intruded coarse crystalline dolomite

in the strata above and below this zone and along the Hume-Lone Mountain Formation boundary resulted from re-crystallization of the magnesium picked up by solution of the Bear Rock Formation.

Direct evidence of the original presence of salt in this formation such as the location of actual anhydrite or gypsum was not found in Section 1. However, gypsum has been described in the formation where it was examined in the north end of Bear Rock by Stelck\* and in Imperial Redstone No. 1, 70 miles northwest of Wrigley.

In Section 1 of the Camsell Range the Bear Rock is 300 feet thick and is a breccia comprised of limestone and dolomite fragments of light and dark grey color in an earthy dolomitic limestone matrix. The breccia is veined with white coarse crystalline calcite and it weathers rubbly with a variety of boxwork and rounded solution cavities. No fossils were found in this formation.

#### Middle Devonian

##### Hume Formation

The Hume Formation outcrops continuously along the west dip slope of the Camsell Range (Photo Page ii). The formational contact between the Hume and Lone Mountain Formations always appears conformable, but because of the intrastrata coarse crystallization, mentioned above, and the abrupt change in fossil content and lithology, this boundary is considered to be a disconformity. Sections 1

and 2 of this report describe the Hume Formation, the Lone Mountain Formation and the characteristics of the boundary between these formations.

The Hume Formation is 630 feet thick at Section 1 and 520 feet thick at Section 2. The thickness includes all of the Hume strata up to the eroded dip slope bed of the Camsell Range in both cases. However, the Hume-Hare Indian Formation contact was not included in these sections and the thicknesses, although very close to being true thicknesses, must be considered minimum figures. The formation is comprised of a limestone, dark brown-grey to black, crypto-crystalline, tight, fossiliferous and in part argillaceous. The formation is predominantly thin bedded and contains coarse crystalline calcite veins and inclusions, particularly near the Hume-Lone Mountain Formational boundary. The limestone weathers into a tan-grey to brown-grey, angular rubble.

Fossils collected in the formation on the Camsell Range include Favosites alpenensis Winchell and Schuchertella adoceta Crickmay of Middle Devonian (Eifelian) age. They occurred in thin bedded, tight strata and were well preserved. The coral zones reported by Hume\* to be 20 feet above the fossil zone containing Favosites and Schuchertella sp. on Mount Camsell and on Lone Mountain would lie in the Hume Formation of this report and would be potential zones for

\* Hume, G.S., 1922

oil and gas generation or accumulation in areas with Upper Devonian cover. These zones were not identified in Sections 1 and 2 but a 100 foot porous zone near the base of the Hume Formation in Section 2 may be related to such a coral zone. Organic material was suspected to be present in this zone but fossil evidence has been destroyed by the intrusion of coarse crystalline dolomite.

Abundant colonial corals were also observed in the Hume Formation where it outcrops on the top of the North Nahanni River fault scarp at the south end of the map area. The fossils Favosites limitaris Rominger Columnaria rhenana (Frech)? Utaratuia acupicta Crickmay were collected during a brief stop at this outcrop. Dr. Nelson\* has identified this assemblage to be of Middle Devonian (Eifelian) age, and characteristic of the upper half of the Hume Formation.

Both the lower and upper boundaries of the Hume Formation appear to be conformable but because of the lithological change, the increase in fossil content and the presence of intruded coarse crystalline dolomite, it is proposed that the lower boundary is a disconformity.

#### Hare Indian Formation

The Hare Indian Formation as defined by Bassett\*\* includes two units (D-2 and D-3) that comprise Shale Zone 1 in G. S. Hume's\*\*\* classification. This formation has not been included in a detailed

\* Nelson, S. J., 1961

\*\* Bassett, H. G., 1961

\*\*\* Hume, G. S., 1922

section of this report, but its thickness has been estimated to be 1,600 feet from the reconnaissance traverse on Deceiver Creek (Section LDC-4). The formation is comprised of shale which is dark brown to black, fissile, micro-micaceous and which becomes more resistive and platy towards the base of the section. At one point in mid-section of the formation, minor siltstone beds up to 5 feet thick were described. The siltstone was light grey, hard, tight, indurated and contained abundant brachiopods and gastropod fragments. The siltstone weathers angular with a yellow-buff color, the shale weathers a brownish black.

#### Kee Scarp Formation

The name Kee Scarp Formation is applied here to the upper-most Middle Devonian strata identified in the report area. The term is in accordance with the Devonian nomenclature proposed by Bassett\*. However, the zone referred to here is also believed to be the same as the *Leiorynchus* zone described by G. S. Hume\*\*, a zone that was considered by him to be of Upper Devonian age and to be in a higher stratigraphic position than the Kee Scarp of Norman Wells.

The Kee Scarp Formation was first examined in an outcrop of a biostrome reef development 4 miles east of Carlson Lake, where the fossils listed below and on the stratigraphic log for Section LDC-4, were collected. This biostrome thins and apparently shales out to the north and south but it is still represented by limestone strata in

\* Bassett, H. G., 1961  
\*\* Hume, G. S., 1922

Section 4 which is 12 miles to the south.

At Section 4 two 100 foot thick limestone outcrops are separated by 100 feet of limy shales and a possible disconformity is present between the shale and upper limestone. The exact correlation of either or both of these limestone outcrops to the bioherm further north is not known and the 300 foot limestone shale section is taken as a general correlative to the Kee Scarp Formation or G.S. Hume's\* D-4 Zone.

The lower limestone on Section 4 is brown-black, crypto-crystalline, argillaceous and grades to shale at the base. The bedding is extremely well defined and is thin to platy with thickness of 1/2" to 2". The outcrop weathers a buff-grey. The upper limestone outcrop is a brown to black color, crypto-crystalline, argillaceous, tight, hard and is bedded up to 8" in thickness; it weathers a tan-grey. The shale between the two limestone outcrops is brown-black, limy, hard and platy and becomes more limy downwards until it grades into the underlying limestone.

The limestones are probably fossiliferous, but fossils were not recognized on the reconnaissance traverse. The fossils collected from the section to the north were very poorly preserved and were found only after a considerable amount of time had been spent examining the outcrop.

\* Hume, G.S., 1922

Fossils collected from the biostrome are Middle Devonian but more detailed age determinations cannot be made; the fossils include:

Stromatoporoids; indet.  
Coenites sp.  
Elytha compacta Meek?  
? Atrypa sp.

It is possible that the upper boundary of the Kee Scarp Formation should be placed below the upper limestone outcrop which would result in a 200 foot Kee Scarp-Canol Formation zone overlain by Shale Zone 2 that locally has a 100 foot limestone development at its base. However, lack of paleontological data prohibits such a division and both limestone outcrops are grouped together in a zone separating Shale Zone 1 from Shale Zone 2.

The Kee Scarp Formation is one of three resistive horizons in the Middle and Upper Devonian shale sequence that are continuous mappable units in the report area. The limestone was examined at a third location on the left bank of the Root River where the Upper Devonian fossils, Favosites limitatus and Billingsastrea were collected. The formation is believed to continue to the northwest and is represented by intermittent resistive cuestas between the tributary creeks of the Wrigley River. Similarly, the formation can be projected southwards through Permit 3083 following a tree covered resistive cuesta. The location of the formation is interpretive

and is represented by a divisional line along the North Nahanni River between the Hare Indian Formation and the Imperial Formation.

Upper Devonian

Imperial Formation

The Imperial Formation in the map area is estimated to be 5,250 feet thick and is comprised of all strata stratigraphically above the Kee Scarp Formation. This strata has been divided into four subdivisions called the D-5 (second shale), D-6, D-7 (third shale) and D-8. These divisions are believed to be equivalent to those divisions defined by Hume\* wherein the D-6 subdivision is Hume's Athyris angelica zone. The D-8 division has been added as an addition to Hume's report.

The D-5 (second shale zone) has been described in Section LDC-4 on Deceiver Creek. The zone is believed to be comprised of 2,000 feet of dark grey to black shale that has ironstone concretions and becomes increasingly limy and resistive in the lower half of the section. The thickness of this zone is estimated from calculations using the attitude of the strata and scaled distances from vertical aerial photos.

The D-6 subdivision (Athyris angelica zone) has also been described in the Deceiver Creek traverse. Its minimum thickness is estimated to be 970 feet. It is comprised of interbedded

\* Hume, G. S., 1922

shales and limestones wherein the maximum individual bed thickness is 1 foot. The shale is brown-grey to black, fissile, in part silty, resistive with conchoidal fractures. It weathers a dark brown with a rusty stain on laminations. The limestone is buff-grey, very finely crystalline, dolomitic, slightly argillaceous, hard and resistive; it contains shale laminations and the occasional zone with abundant fossils. It weathers a brown-grey.

The upper 100 feet of the zone is mostly comprised of a limestone that is buff to green-grey, cryptocrystalline, tight, argillaceous and thin bedded with subordinate interbeds of green-grey to dark grey-brown limy shale. Fossils are prominent in the occasional thin beds. Fossils collected in this zone include Cyrtospirifer and Billingssastraea which are considered to represent an Upper Devonian age.

The D-6 zone is a resistive mappable unit within the thick Upper Devonian shale series. The formation has been mapped fairly continuously on the flanks of a syncline that runs from the Root River south to the North Nahanni River.

The D-7 subdivision (third shale zone) has been described in the detailed Section LDC-3. Its thickness is estimated to be 1,000 feet, of which 750 feet is exposed. The shale is dark grey, it is massively bedded but is very fissile and recessive except in the upper

third of the zone, where the occasional siltstone and limestone bed hold up the shale strata. Two fossils, Atrypa sp., cf. and A. hancockensis (Fenton & Fenton), were collected from a siltstone bed in the upper part of the zone and are probably representative of the Upper Devonian Period. The upper boundary of this zone has been placed at the base of the first massive siltstone outcrop immediately above 30 feet of silty, black, fissile shale that suggests a gradational change from Zone 7 to Zone 8.

The D-8 subdivision of the Imperial Formation was also described in Section LDC-3 which is located to the west of Carlson Lake. This zone represents an additional stratigraphic section above the Imperial Formation described in prior literature. The zone has been measured to be 1,240 feet thick, it is comprised of massively bedded siltstone with subordinated interbeds of shale and limestone. The siltstone is olive-green, very argillaceous in part micaceous, fossiliferous, massive to platy bedded, resistive and cliff forming. In the lower half of the zone the siltstones are commonly limy and grade in part to silty limestone. Limestone beds occur in this lower section also, they are medium brown-grey, very finely crystalline, dense, siliceous, hard, thin to thick bedded and commonly fossiliferous. They weather dark grey to black with rusty staining in part.

Approximately forty percent of the central portion of the D-8 subdivision is comprised of shale. The shale is massively interbedded with the siltstones and limestones described above. It is olive green-grey in color, soft, fissile and contains the occasional bulbous brachiopoda. Siltstones become very argillaceous and grade to silty shales in two minor 30 foot zones.

This subdivision of the Imperial Formation was mapped by means of its resistive continuous expression in outcrop extending for 20 miles to the north from Carlson Lake. Resistive cuestas were observed to the west of the zone that appear to contain strata in a conformable, higher stratigraphic relation to the D-8 subdivision. Helicopter landing spots are not available in this area and as a result the outcrop was not examined and its age has not been determined. The outcrop at Section 3 was similarly inaccessible by helicopter.

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## SUMMARY

of

### STRATIGRAPHIC SECTION LDC - 1

Co-ordinates:  $63^{\circ} 02' N$  &  $123^{\circ} 43' N$

Geographic Range: Camsell Range  
Location: 15.5 miles S.W. ( $215^{\circ}$ ) of Wrigley Airport

Geologists: H. K. Roessingh, F. Halkow & H. R. Young

Date

Measured: June 9, 11 & 27, 1961 & July 27, 1961

Formations  
Described:

#### Thickness

Middle Devonian		Thickness
Hume	630'	
Lower Devonian		complete ?
Upper Lone Mtn.	1740	
Bear Rock	300	
Lower Lone Mtn.	<u>535</u>	incomplete
Total	3205'	

Sample Record: Bagged - 165 samples, at approx. 17' stratigraphic intervals of exposed section

Crushed - 165 samples in 4 boxes

Sample Identification:-

Box 1	June 11	HR 201-HR 242
Box 2	June 9	HR 101-HR 139
Box 2	June 27	HR 140-HR 155
Box 3	June 27	HR 156-HR 191
Box 3	July 27	YH 20-YH 400
Box 4	July 27	YH 425-YH 675

Air Photo

Reference: A-12701-255

Photographs: Page (ii)

## SECTION 1

This section completely traversed the Camsell Range.

Although it has been completely measured, the Hume is mostly covered at this location. A better exposed Hume was examined four spurs south and the data incorporated into one composite section. The Hume and Upper Lone Mountain comprise the western dip slopes of the range, the Bear Rock the crest or ridge, and the Lower Lone Mountain the scarp face on the east side. Attitudes vary from  $345^{\circ}$  strike and  $30^{\circ}$  SW dip in the Hume to  $360^{\circ}$  strike and  $53^{\circ}$  W dip at base of Bear Rock to  $005^{\circ}$  strike and  $49^{\circ}$  NW dip near base of Lower Lone Mountain. Except locally, the slope on the west side ranges from  $15^{\circ}$  to  $36^{\circ}$ , whereas the gradient of the scarp face ranges from  $40^{\circ}$  to a near vertical cliff.

SUMMARY  
of  
STRATIGRAPHIC SECTION LDC - 2

Co-ordinates: **62° 27'N and 123° 33' W**

Geographic Location: **Camsell Range  
8 miles west (273°) of mouth of Root River**

Geologists: **R. G. Perry, F. Halkow**

Date Measured: **July 24, 1961**

Formations Described:

	<u>Thickness</u>
Middle Devonian	
Hume	<u>521'</u>
Lower Devonian	
Upper Lone Mtn.	<u>134</u>
Total	<b>655</b>

Thickness complete ?  
incomplete

Sample Record: **Bagged - 44 samples, at approx. 12' stratigraphic intervals of exposed section  
Crushed-43 samples in 1 box  
Sample Identification:-  
Box 1 July 24 HP 1 - HP 1018**

Air Photo Reference: **A 11019-9**

Photographs: **Nil**

## SECTION 2

Section 2 is located along the steep east facing scarp that in here is a thrust fault of the Camsell Mountains. Measurement commenced in the upper Lone Mountain Formation at the bottom of a gully that notches the ridge of the Range. The traverse proceeded up the flank near the scarp face and terminated in Hume rocks at the highest exposures on the west dip slope of the mountain. Succeeding strata, well down the flank of the Range, appear to be shales of the Hare Indian Formation and it is believed that most if not all Hume beds had been measured and examined.

Strike of beds is  $340^{\circ}$  while dip is an average of  $23^{\circ}$  W.

**SUMMARY**

of

**STRATIGRAPHIC SECTION LDC - 3**

**Co-ordinates:**  $62^{\circ} 26' N$   $123^{\circ} 56' W$

**Geographic Location:** Two miles west of Carlson Lake Campsite

**Geologists:** H. R. Young & C. D. McCord

**Date Measured:** July 25, 1961.

<b>Formations Described:</b>	<b>Thickness</b>
Upper Devonian	
Imperial Formation	
D-8 (?)	1250'
D-7 (3rd shale zone)	<u>750 +</u>
Total	2000'

**Sample Record:** Bagged - 75 samples, averaging 25' stratigraphic intervals of exposed section

Crushed - 75 samples in 2 boxes

**Sample Identification:**

Box 1	Mc 0 - Mc 1575
Box 2	Mc 1575 - Mc 2550

**Air Photo Reference:** A 11019-4

**Photographs:** Page (iii)

### SECTION 3

A steep cuesta scarp was measured and described in this section. The scarp is capped with massive siltstone beds and is underlain by soft recessive shales.

The strata strikes at  $165-180^{\circ}$  and dips  $12^{\circ}$  southwest. The section was measured on a bearing ranging between  $45^{\circ}$  and  $110^{\circ}$ , but because of consistently steep slope ( $30-40^{\circ}$ ) and the flat attitude of the bedding, thicknesses were calculated with corrections only for slope angle.

Helicopter landing spots are not available on these ridges because of the vegetation and for this reason traverses must be made from the foot of the cuesta.

The stratigraphic log is considered to be a true record of the upper 2,000 feet of the Imperial Formation. Faulting or repetition of section is not in evidence.

## SUMMARY

91

**STRATIGRAPHIC SECTION LDC - 4**

Co-ordinates:  $62^{\circ} 19' N$  and  $123^{\circ} 40'$  to  $123^{\circ} 34' W$

**Geographic Location:** Deceiver Creek

**Geologists:** H. K. Roessingh & F. Halkow

Date      Measured: July 25, 1961

**Formations Described:** **Thickness**

Middle Devonian	
Hume (D-1)	15
Hare Indian (D-2-)	
D-3 1st shale )	1610
Kee Scarp (D-4)	310
Upper Devonian	
Imperial (D-5)	2030
(D-6)	970
Total	4935'

Sample Record: Bagged - 15 samples from 10 stations of examination were collected

Air Photo  
Reference: A11348-272 & 274

**Photographs: Nil**

#### SECTION 4

This section was a traverse along Deceiver Creek, a tributary of the North Nahanni River. The section was not measured but consisted of spot examinations beginning at the first prominent outcrop of the D-6 member of Imperial Formation some distance above the mouth of the Creek and terminated in the Hume Formation on the western dip slope of the main range of the Camsell mountains. Thicknesses were calculated from observed strikes and dips and distances measured on air photos. The section is generally well exposed and easily accessible. Dips vary from  $25^{\circ}$  W to  $49^{\circ}$  W and strike is between  $330^{\circ}$  to  $350^{\circ}$ . A faulted and distorted section was noted in the Hare Indian (1st Shale) Formation where a sequence of bedded siltstones is folded, fractured, up-ended and repeated.

## DESCRIPTION OF PERMITS

### Permit 3082

Grid Area bounded on south by  $62^{\circ} 50'$  Lat., on north by,  
 $63^{\circ} 00'$  Lat., on east by  $123^{\circ} 45'$  Long., and on west by  
 $124^{\circ} 00'$  Long.

### Permit 3083

Grid Area bounded on south by  $62^{\circ} 10'$  Lat., on the north by,  
 $62^{\circ} 20'$  Lat., on east by  $123^{\circ} 30'$  Long., and on west by  
 $123^{\circ} 45'$  Long.

**REPORT DISTRIBUTION**

**2 Copies      Sheeky and Company,  
                 Room 912 - 150 Broadway,  
                 New York, N. Y.**

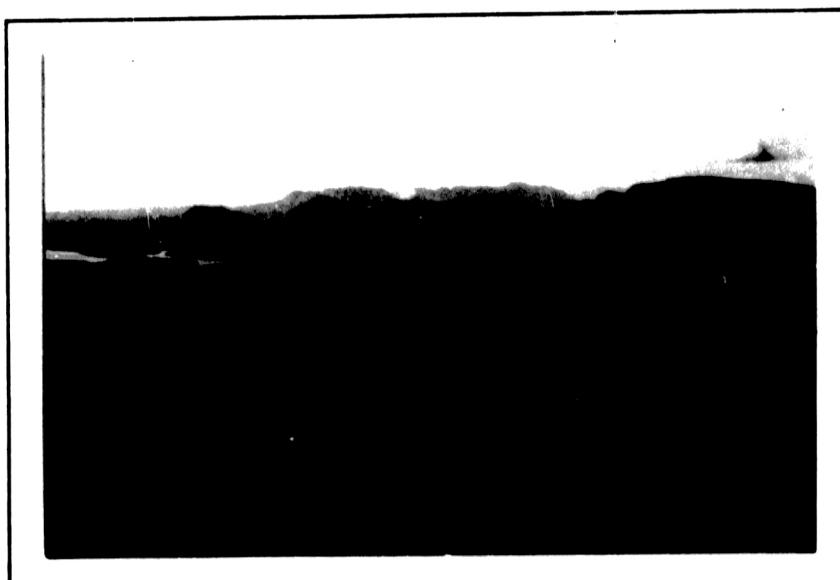
**3 Copies      Government of Canada,  
                 Department of Mines and Technical Surveys,  
                 Ottawa, Ontario.**

**1 Copy      Link Downing Cooke & Co. Ltd.,  
                 Calgary, Alberta.**

(i)

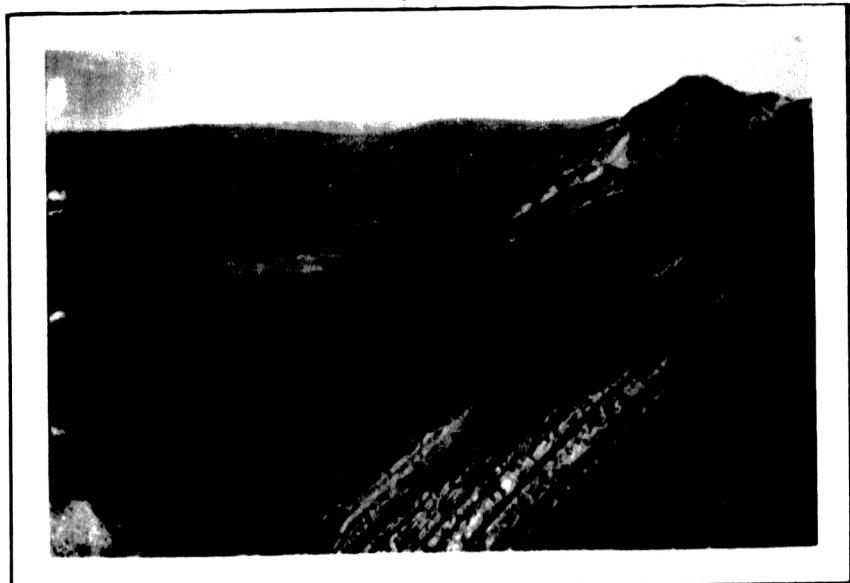


Aerial view to northwest along the east facing Camsell Range fault scarp. The aircraft was between Mt. Camsell and Camsell Bend when the photograph was taken. The northeast corner of Permit 3083 includes the south end of this mountain range. The scarp is comprised of Middle Devonian Lone Mountain and Hume Formations. Low mountains in left background are of upper Devonian shales.

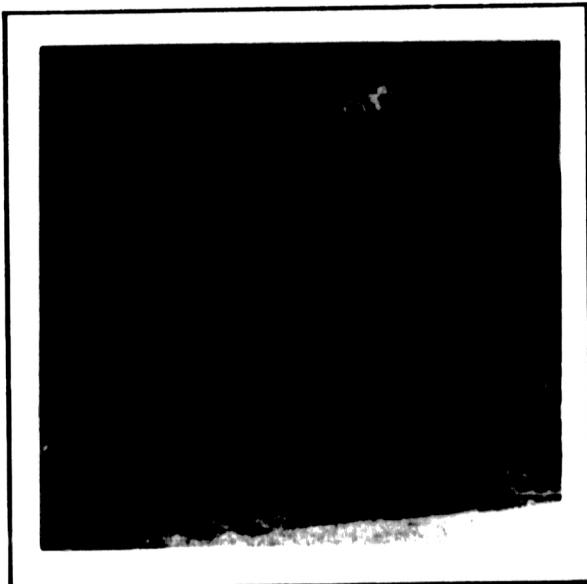


A view to the southwest from the northeast corner of Permit 3083 on the Camsell Range. This view is the exact reverse of that above. Mount Camsell is in the center ground. Lone Mountain is to the left behind the North Nahanni River and to the right of the Mackenzie River. The Nahanni Range continues southward in the distance.

(ii)

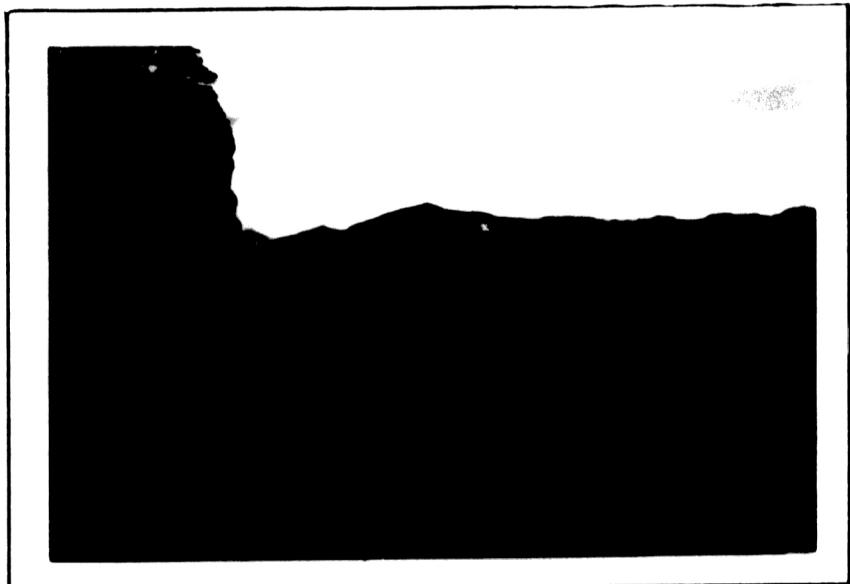


Location of stratigraphic study at Section 1 on Camsell Range 15.5 miles southwest of Wrigley Airport. View is to the northwest showing west dipping Hume Formation flat irons resting on Lone Mountain strata. The low hills in the background are comprised of gently folded Upper Devonian, Hare Indian and Imperial Formation shales.

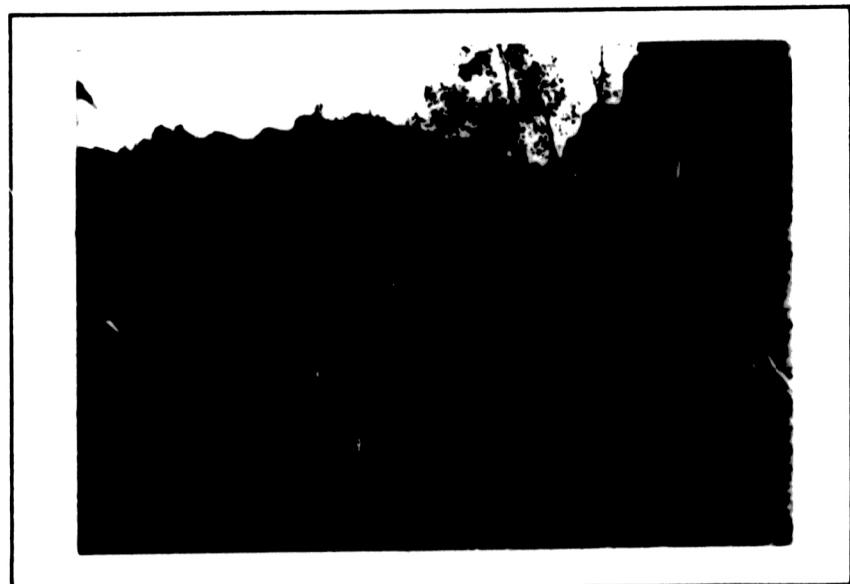


A view of a biostromal reef mass located between the Hare Indian and Imperial Formations. View is to the north from the left bank of the Root River sixteen miles southwest of Section 1. This reef is in an equivalent position to the Kee Scarp Formation at Norman Wells.

(iii)



View eastward from Section 3 at west end of Carlson Lake. Upper Devonian Shales are exposed in an anticline centerground. The Camsell Range rises on a thrust fault in the background.

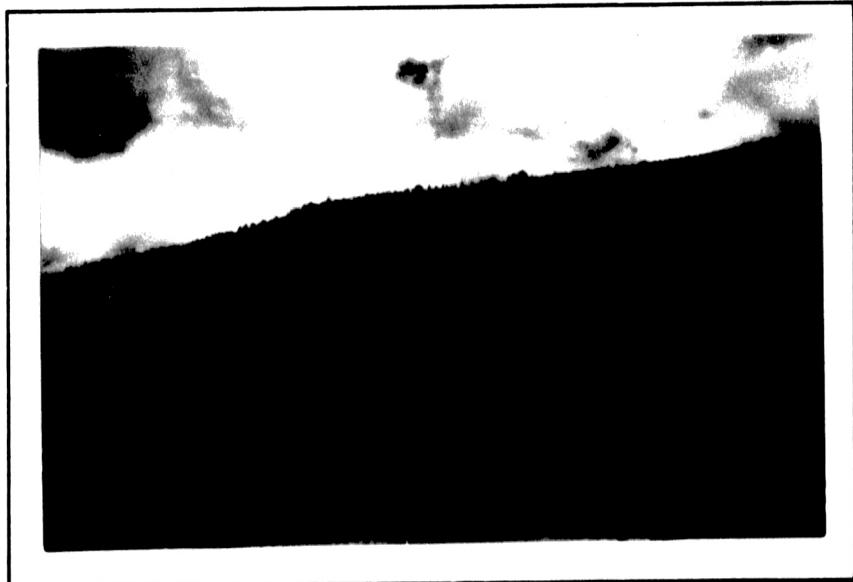


Close up view of Upper Devonian outcrop on Section 4. Hackley, recessive weathering shales contain thick resistive beds of fossiliferous, silty limestone. Geologist is H. R. Young.

(iv)

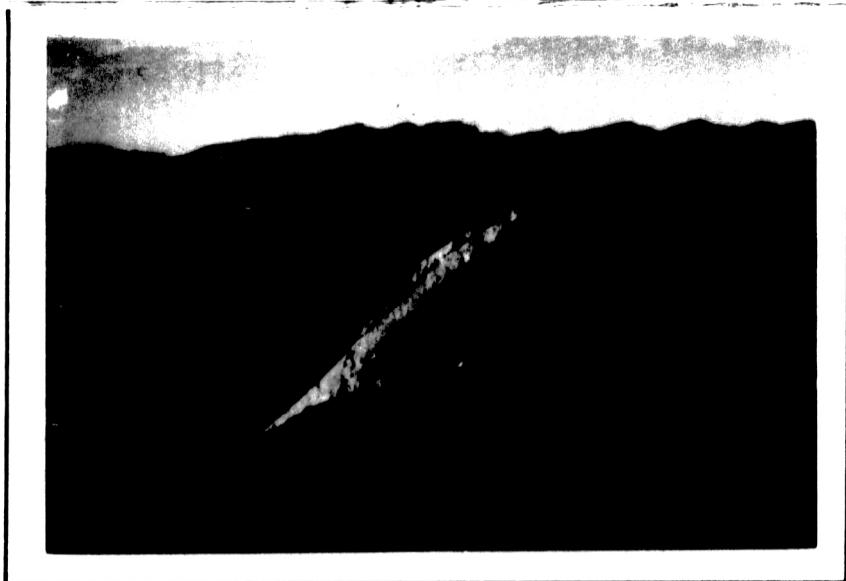


Hume Formation Limestone outcrop on left bank of North Nahanni River 6 miles south of Carlson Lake. The formation dips to the west on the upper plate of a thrust fault block.

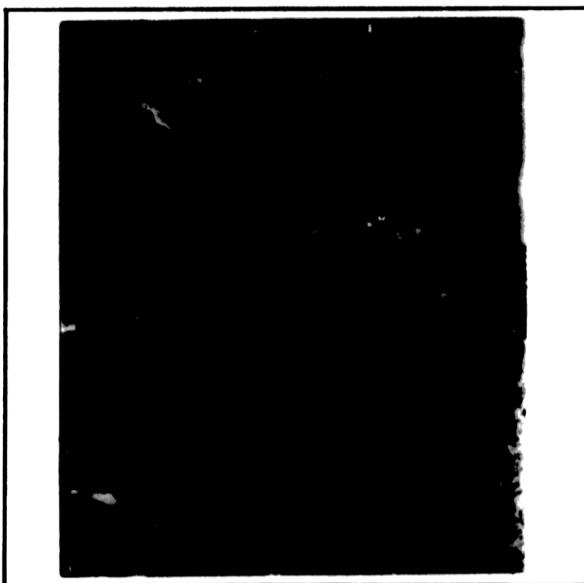


Hare Indian Formation shales outcropping on the north Nahanni River upstream from photo above. Both photos were taken within 2 miles of the northwest corner of Permit 3083.

(v)



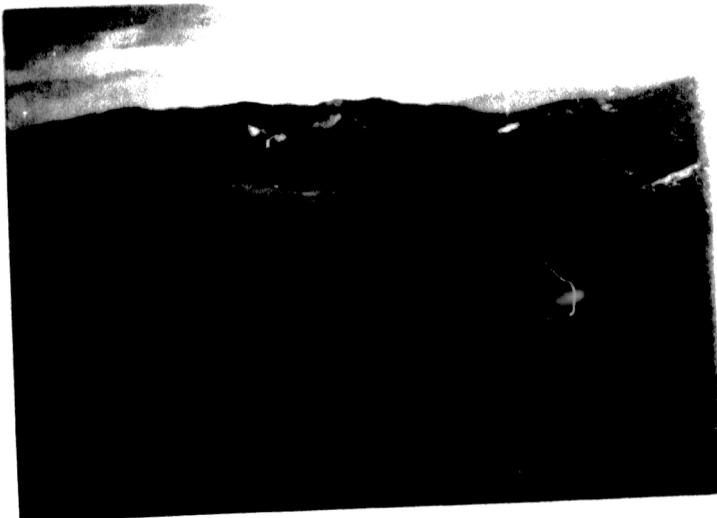
"Kee Scarp biostrome outcrop 5 miles east of Carlson Lake. Hare Indian Shales are the recessive, covered strata to the right (stratigraphically below the limestone reef). Imperial Formation outcrops to left stratigraphically above the reef. Camsell Range is on skyline. View is to the north.



Close up view of "Kee Scarp" outcrop in photograph above. The limestone biostrome was estimated to be 100 feet thick at the outcrop. The Limestone is comprised of abundant poorly preserved fossils including colonial corals, Coenites sp., Favosites limitatus Rominger & Billingsastraea sp.



Siltstone strata of the Imperial Formation caps the cuesta in middle ground. The foreground ridge is underlain by thin limestone strata in the stratigraphic position of the Kee Scarp bioherm, photographed 4 miles to the north Page (v). View is to the northwest from the north border of Permit 3083.



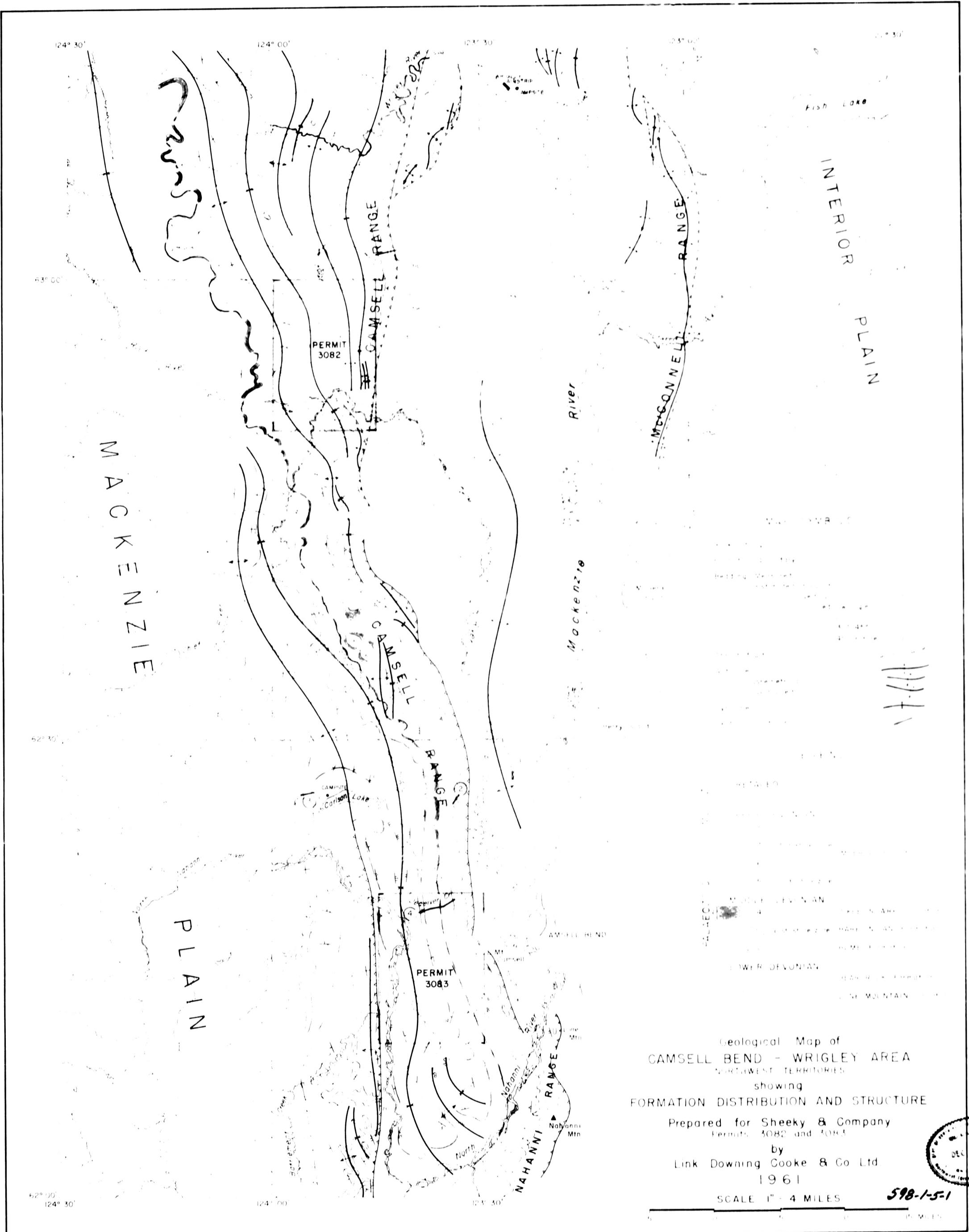
View of a synclinal fold in Imperial Formation strata on the north border of Permit 3083. The view is to the north from the center of the permit. The North Nahanni River is flowing from the west, turns and flows south to the left in the picture.











Geological Map of  
CAMSELL BEND - WRIGLEY AREA  
NORTHWEST TERRITORIES  
showing  
FORMATION DISTRIBUTION AND STRUCTURE

Prepared for Sheeky & Company

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Link Downing Cooke & Co. Ltd.  
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