PRELIMINARY GEOLOGICAL REPORT

LIARD RIVER AREA, N. W. T.

Field Season 1957

Prepared for

Sun Oil Company

Murphy Corporation

and

Stanwell Oil & Gas Limited

December, 1957

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PRELIMINARY GEOLOGICAL REPORT

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INTRODUCTION

The present report has been prepared for joint use of Sun Oil Company, Murphy Corporation and Stanwell Oil and Gas Limited. The field work on which the report is based was conducted during the summer season of 1957.

The Project acreage is located in the Liard River Area, N.W.T., between Latitudes 60° 30' and 61° 50', and Longitudes 122° 00' and 123° 30'. The gross acreage included within areas taken under permit amounts to a total of approximately 997,524 acres of which 362,736 acres belong to Sun Oil Company, 332,508 acres to Stanwell Oil and Gas Limited, and 302,280 acres to Murphy Corporation. The scattered nature of the Permits necessitated the reconnaissance of a much larger area than the above; a gross area in excess of 35 million acres. The areas covered by the Permits and those covered by the regional reconnaissance are shown on the accompanying Figures I and II and on the photomosaics. In detail, the Permit numbers owned by each company are:

Sun Oil Company - 1036, 1037, 1038, 1039, 1040, 1041.
Stanwell Oil and Gas Limited - 1028, 1029, 1030, 1031, 1032, 1033, 1048.
Murphy Corporation - 1034, 1035, 1045, 1046, 1047.

The procedure followed in carrying out the survey of the project area was:

1. A preliminary photogeological study of air photographs was carried out and air photomosaics were prepared.

2. Helicopter fuel caches were distributed during the previous winter season throughout the area to be investigated.

3. Field reconnaissance of the project area was carried out by helicopter and by ground and stream traverses. The parties were serviced by commercial fixed wing aircraft, operating out of Fort Nelson and Hay River.

4. Because of the scarcity of outcrop in the immediate vicinity of the Permit areas, and because of the excellence of outcrop in nearby foothills and mountain areas and along the larger streams in the area, detailed stratigraphic studies of the geological section projected beneath the Permit acreage were carried out.

5. Studies of the results of deep wells drilled in the vicinity of the project acreage were also made, with a view to assisting in overall regional correlation problems.

6. Following completion of the field work a second detailed review of the photomosaics was made to improve our interpretation of field observations.

The field work was carried out under the supervision of G.K. Williams, assisted by geologists K. W. Lyle, N.N. Peterson, and student-assistant L.A. Singleton. In addition to the geological personnel, the party consisted of a boatman-cook, H. Lindley and Mrs. H. Smith (part-time cook), and the helicopter crews; R. F. Ross, and H. Smith for the first part of the season and D.L. Sides and H. Lazaros for the latter part.

Due to the inaccessibility of the area, most of the transportation was by air. During the first month a Model G-1 helicopter owned by J.C. Sproule & Associates was used. This was replaced by a Bell Model G-2 contracted from General Helicopters of Santa Barbara, California, for the remainder of the season. Major camp moves and the distribution of fuel caches were carried out by chartered airplane. Other means of transportation included a canoe, a rubber boat and rented river barges.

Field operations began in early June. The first base camp was established near Nahanni Butte, at the confluence of the South Nahanni and Liard Rivers. One field party, working from fly camps, studied Paleozoic sections in the mountains. From the Nahanni Butte camp two senior geological sub-parties scouted and traversed parts of the Permit area.

A second base camp was located on Liard River, near the mouth of Poplar River, for the period July 8 to July 16. From this camp the remaining parts of the Permit and surrounding areas were studied.

A third camp was established at Fort Liard and from there, studies north along the Liard and its tributaries were made, traverses of the Kotaneelee and Petitot Rivers were made and sections were examined on Labiche Range. During this time a party examined sections in the vicinity of the North Nahanni River. The field work was concluded about the middle of August.

PREVIOUS SURVEY WORK

Previous geological surveys of the region date back to 1882 when

R.G. McConnell (12) explored the Yukon and Mackenzie Basins. Subsequent reports include those by G.S. Hume (8) and M.Y. Williams (18) in 1922 and one by A.E. Cameron (2) in 1935. In 1943 E.D. Kindle (10) descended the Fort Nelson River to its mouth and ascended the Liard as far as Hell's Gate. In 1944 C.O. Hage(5) followed the same route but from the mouth of the Fort Nelson River descended the Liard River for a distance of 200 miles to Birch River.

Geologists with several oil companies have covered much of the area, but most of their work is unpublished.

A selected bibliography is presented with this report.

PHYSIOGRAPHY AND GLACIATION

The predominant topographical features of the area are the Liard River and the Martin Hills.

The Liard is a large, muddy river with generally low, muddy banks. The valley is very broad with no notable break with the plains areas on either side.

The Martin Hills (Plates I-A and IV-A) are prominent topographic highs which clearly stand out above the surrounding plains. They have nearly flat tops and rounded contours on the sides, with the exception of the south-east facing slopes where cliffs are present.

The remainder of the area is best described as swampy country, (Plate III-A) with low relief and few topographic features.

One such feature is a belt of morainal hills and associated lakes which runs in a northwesterly direction from the southern half of Trout Lake towards the mouth of the Blackstone River. The country in this belt is quite rough, with a relief of approximately a hundred feet.

North of this line of hills the country is a low featureless swamp until the Upper Devonian reef scarp is reached. North of the scarp the country is again swampy with the exception of the long, narrow, glacial flutings and drumlin type hills (Plate II-A) east of the headwaters of the Poplar River.

South of the line of the morainal hills the country is more rolling. The tributary valleys of the Muskeg and Arrowhead Rivers are several hundred feet deep and very broad, representing a mature drainage system.

The main streams of the area are the Poplar, Birch, Blackstone, Arrowhead and Muskeg Rivers which run west or north into the Liard, and the Martin, Natou and Grainger Rivers which drain the country northwest of the Liard. The former rivers, draining the country south and east of the Liard, are all fairly small, fast running streams cut into boulder clay and only rarely exposing bedrock. The Martin, Natou and Grainger, like the remaining small streams and

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tributaries, are generally slow, lazy streams with indefinite banks, meandering through the muskeg country and only occasionally forming rapids or fast water where restricted by beaver dams, concentrations of boulders or, very rarely, bedrock.

Muskeg is widely distributed over the area. The low relief and the nature of the moss cover reduce the drainage of the country to mainly seepage and evaporation. Even on most of the hills and far up the slopes, which for lack of contrasting relief are called "scarps," muskeg is present.

A large part of the ground is covered by permafrost, which exists in patches surrounded by deep, soft, muskeg. Where present the permafrost generally exists within a foot of the surface, well insulated by a cover of moss and a few unhealthy looking spruce trees. The depth of the permafrost was not tested but it is probably 20 to 30 feet thick. Muskegs vary in thickness from a few inches of soggy moss lying on a good clay soil to seemingly bottomless concentrations of black, stinking muck, covered by a few inches of water or growing moss. Some of these quake quite noticably when one attempts to walk on them; these are probably pot-holes or lakes overgrown or filled by rotting vegetation.

The entire area shows evidence of being overriden by the continental ice sheet. A layer of till, probably 0 to 300 feet thick overlies the bedrock.

Stream cuts indicate two main types of till; a lower dark clay till and an upper brown sandy till. It may indicate two periods of glaciation but more likely the lower clay till is the ground moraine while the upper sandy till is a superficial outwash deposit. The sandy till, where seen, is connected with ice crack patterns, drumlins or fluting.

No evidence of interglacial deposits was observed in the area.

One line of morainal hills has been previously mentioned, running northeast from Trout Lake. This belt is quite rough and hilly with numerous lakes.

A common glacial feature in this part of the north is the abundance of long, very straight, narrow, low hills separated from each other by troughs. These features, which we call glacial fluting, parallel the direction of ice movement. The mechanics of their formation is unknown but they must be related to drumlins as gradations between the two forms are common. Where glacial fluting is marked, it can usually be assumed that the area is topographically higher than the surrounding country and that the drift is fairly thick.

The normal direction of the fluting (and ice movement) is in a direction slightly south of west. The Martin Hills apparently deflected the ice flow, for north of Sibbeston Lake the direction of the fluting is northeast.

ACCESSIBILITY

The Liard River serves as the main highway through the area during the brief period of navigation which lasts from about May 20 until September

30th. Steeper Brothers, the Hudson's Bay Co. and Ed Cooper have scheduled trips down the Liard throughout the summer season. Float planes can land nearly anywhere on the Liard and crude facilities are available at Fort Liard and at Nahanni Butte.

In periods of high water the Muskeg and Blackstone Rivers are navigable for short distances above the outlets by canoe.

For purposes of our work a helicopter on floats was essential to locate and examine outcrops. Several of the small streams were traversed by rubber boat, a very satisfactory means of transportation in wet years such as this one, for nearly all the streams are bounded by a dense, tangled, jungle-like growth which makes walking a tedious ordeal.

For winter vehicular traffic two roads exist; the Simpson trail, which lies east of the Permit area, and could be used as an access road for equipment coming in from Fort Nelson and the road from Hay River, N.W.T. which now extends to the east side of Trout Lake.

Bulldozed roads could be built easily, almost anywhere in the area after freeze up. If roads are planned it would be wise to avoid the moraine belt running northwest from the south part of Trout Lake and also the area of pronounced glacial fluting east of the Birch River.

We were requested by Mr. Thoms, of the Department of Northern Affairs and National Resources, to evaluate the country as to the best route for an all weather road from Fort Nelson to Fort Simpson. We offer the following comments on that subject:

The Simpson Trail does not lie in a country practical for an all weather road. For most of its course it traverses desolate muskeg in a country devoid of potential farm land.

A road could be constructed along either bank of the Liard River on solid ground which could be easily drained by a system of culverts similar to the construction of the Northwest Territories part of the Mackenzie Highway. This route has the advantages of serving the existing population centers and providing access to the most promising soil and timber areas of the region. Its disadvantage lies in its increased length over the next route proposed.

A route, from Fort Liard to Fort Simpson on relatively solid ground could be found by going north-northeast from Fort Liard through the lake and hill country towards the crook in the Netla River where the Lower Fort St. John sand outcrops. From there northeast it would follow the gentle slope which is formed by this sandy unit. This stretch of country is relatively free from muskeg. From here the road would cross the Blackstone River and follow the top of the escarpment formed by the Upper Devonian "reef" as far as the Poplar River. From somewhere just short of the Poplar River the road would have to force its way through muskeg to the banks of the Liard River, which it would follow to Fort Simpson.

Probably the best and cheapest all weather road into the area at this time could be built from the east, from the Mackenzie Highway at Nakisa Lake, and west along a Devonian rock escarpment that enters the project area in the vicinity of the headwaters of the Blackstone River. This route is already traversed by a winter road which extends as far as the Simpson Trail.

GENERAL GEOLOGY

Outcrops of bedrock are so scarce and so scattered in this area that at best we can only piece together a rather general regional picture of the structure and the distribution of formations.

The Permits are located in the southern portion of the Mackenzie Basin. It might also be described, and possibly more accurately, as the northern extremity of the Alberta Basin. The curve of the Upper Devonian reef scarp indicates the regional strike of the Devonian strata. It reflects a very broad, southeast plunging syncline.

Bedrock underlying the Permit area is Upper Devonian and Cretaceous. The erosional contact between the Devonian and the Cretaceous runs east-west through the south central Permits. South of this contact, Cretaceous rocks underlie the drift and to the north, Upper Devonian rocks form the bedrock. The Martin Hills are a synclinal remnant of Cretaceous strata north of the Liard River.

The Devonian-Cretaceous boundary reflects a marked angular unconformity. Pre-Cretaceous erosion becomes progressively deeper to the north and west. South of the Permit areas Mississippian and Pennsylvanian rocks underlie the Cretaceous. It is possible that some Carboniferous rocks may be present in the southern Permits. North of the Liard River the unconformity cuts deep into the Devonian, the upper lime and sand section having been eroded off, whereas the Cretaceous rests on lower shales of the Upper Devonian.

Following is a table of formations of the rocks outcropping in the area and in the mountains to the west.

Table of Formations

Age	Group or Formation	Lithology	Thickness Feet
PLEISTOCENE		Boulder clay, gravel, sand.	0-300 +
TERTIARY?		Rusty weathering gravels near the top of the Martin Hills.	10-20
UPPER CRETACEOUS	Wapiti?	Non-marine sandstone and coal.	0-25

Table of Formations - Continued

Age	Group or Formation	Lithology	Thickness Feet
	Kotaneelee	Marine, fossiliferous shale with thin sands.	0-500 +
	Fort Nelson	Upper member: Conglomerate and sandstone.	200 ±
		Lower member: Sandstone, sandy shale, minor conglomerate.	250 ±
LOWER CRETACEOUS	Lepine	Marine, dark grey, sandy and fissile shale.	2000 ±
	Scatter	Marine, fine-grained sandstone	350 ±
	Garbutt	Marine, sandy shale.	450 ±
	Basal conglomerate	Chert and quartz pebble conglomerate, sandstone.	100 ±
	- UNCONFORMITY -		
TRIASSIC	Unnamed	Green and maroon shale and sandstone.	0-300
PERMIAN	Unnamed	Chert zone: Siliceous sandstone, bedded chert and shale.	0-500
PERMO-PENNSYLVANIAN	Unnamed	Sandstone, with shaly bands, ironstone concretions and coal.	0-3000 ±
MISSISSIPPIAN	Rundle?	Crinoidal limestone and shaly limestone.	0-400
	Banff?	Cherty and argillaceous limestone, calcareous shale and sandy shale.	0-1200
	Exshaw?	Black shale with ironstone concretions, non-calcareous.	0-400
	Basal sand	Sandstone and dark grey shale.	0-500
UPPER DEVONIAN	Wabamun-Trout River	Silty and argillaceous limestone, shale, basal sandstone.	700 ±

Table of Formations - Continued

Age	Group or Formation	Lithology	Thickness Feet
	Grumbler	Silty and shaly limestone with an upper reefoid member.	200 ±
	Green shale	Greenish-grey shale, calcareous sandstone.	2000 ±
	Black shale	Black, bituminous shale containing pyrite.	200 ±
MIDDLE DEVONIAN	Ramparts-Slave Point(1)	Limestone, in part organic.	350-800
DEVONIAN-SILURIAN	Bear Rock	Dolomite breccia.	350 ±
	Lone Mountain	Alternating light and dark grey dolomites, basal quartzite.	1400 ±
	- UNCONFORMITY -		
UPPER ORDOVICIAN	Unnamed	Mottled, fossiliferous dolomite and dark grey dense dolomite.	990
	- ANGULAR UNCONFORMITY? -		
CAMBRO-ORDOVICIAN	Unnamed	Reddish and buff sandy dolomite, dolomitic sandstone, quartzites and siliceous shales.	557 +

Description of Formations

Cambro-Ordovician

Strata assigned to the Cambro-Ordovician include the silty dolomites, quartzite and siliceous shales underlying the Upper Ordovician. They form a distinctive red weathering zone (Plate XVII-B) exposed for a few miles along the east face of the Nahanni Range about 10 miles south of Little Doctor Lake. Possible correlatives include sandstones of similar weathering characteristics seen by Keele (Hume (7)) in the upper Carcajou River area and thought to belong to the Cambrian.

(1) Questionably correlated with the Ramparts.

The rocks included in the Cambro-Ordovician, outcrop only in the previously described location south of Little Doctor Lake and appear to dip slightly steeper into the mountain range than the overlying Ordovician thus indicating an angular discordance.

The basal 517 feet of the section consists of pink and buff, dense, silty and sandy dolomite (Appendix I and Figure V), with minor interbeds of buff and pink quartzite, shiny black chert and a thin conglomerate of quartzite pebbles in a dolomite matrix, near the base. The lowest bed seen consists of a buff and pink quartzite with interbedded green shale. The quartzite is overlain by a thick section (90 feet) of sandy dolomite which contains thin conglomerate beds.

The upper 60 feet of the section consists of buff and cream weathering quartzite with interbedded black fissile shale. This zone ends abruptly with the appearance of coral-bearing dolomite of the overlying Upper Ordovician. The sharp contact suggests a disconformable relation.

The only evidence of life in the entire section was that of Amphipora-like markings in a zone 227 feet above the base.

The Cambro-Ordovician was measured at Red Rock Pass (Appendix I, Figure V). A minimum thickness of 577 feet was recorded.

The most conspicuous distinguishing feature of the section is the characteristic red weathering which forms a sharp contrast to the drab grey color of the overlying Upper Ordovician. The Cambro-Ordovician consists predominantly of siltstone and sandstone in contrast to most other pre-Mississippian rocks which are largely shales and carbonates.

Upper Ordovician

The limits of this rather thick section of dolomite are the underlying Cambro-Ordovician and a basal quartzite of the overlying Lone Mountain formation. Beds of Upper Ordovician age are not reported in the Franklin and Mackenzie mountains. However, it is believed by some (Stelck, personal communication) that at least part of the mapped Silurian actually belongs to the Ordovician. Ordovician graptolite-bearing shales have been reported by Stelck (Hume (7)) in the Peel River Area.

The only complete section of the Upper Ordovician was observed at Red Rock Pass (Appendix I, Figure V), where the measured thickness was 990 feet. To the north and south from this point, along the face of the Nahanni Range, the exposed portion of the section decreases until to the south of Bluefish Lake (Appendix III, Figure VII), only 80 feet of Upper Ordovician beds are present. To the north, on a creek south of Little Doctor Lake (Appendix II, Figure VI) 740 feet are exposed.

At Red Rock Pass the Upper Ordovician may be divided into a lower unit, which is 160 feet thick, consisting mainly of mottled dolomite and an upper unit, composed of grey dolomite which has a thickness of 830 feet.

The lower unit consists of black, dense, highly fossiliferous mottled dolomite. The mottling is caused by spherical lumps of white crystalline secondary dolomite (Plate XVIII-A) with fair vuggy porosity on the weathered surface.

The upper unit consists of dark grey to black, dense dolomite. A zone containing fossil fragments occurs 200 feet above the base, and a coral zone was found near the middle of the unit. Dolomite veining is common throughout the unit and is most frequent in the upper part. In places minor nodular brown chert was noticed. An argillaceous dolomite bed, approximately 10 feet thick, and a few thin black fissile shale beds occur near the base of the unit.

The lower portion of the Upper Ordovician is highly fossiliferous. Corals collected at the Red Rock Pass section (Appendix I, Figure V) were identified by C.R. Stelck (November 1957) as Catenipora, sp., Lobocorallium, sp., Favosites, and Streptelasma, sp., which, according to Stelck, indicate Upper Ordovician age. Other fossil horizons include the aforementioned zone with fossil fragments and the coral zone containing Catenipora near the middle of the unit.

The lower portion of the Upper Ordovician is characterized by the development of shoal reefs that are overlain by the bioclastic or chemical carbonates of the upper unit. Towards the end of Upper Ordovician time emergence took place, which was followed by erosion and subsequently by deposition of the Silurian or Devonian basal sandstone of the overlying Lone Mountain formation.

P.S. Warren (personal communication) indicated on his paleogeographic map of the Upper Ordovician the existence of widespread seas in the N.W.T. and the Yukon.

Devonian-Silurian

Lone Mountain Formation - In the present report the term Lone Mountain is applied to a sequence of banded dolomite beds which underlie the Bear Rock formation and that are overlying the Upper Ordovician. Therefore, the name Lone Mountain is used here in a restricted sense.

Originally Kindle (11) defined the formation as comprising all dolomitic beds lying between the coralliferous limestones of Middle Devonian age (our Ramparts) and cherty dolomites belonging to the Upper Ordovician. Kindle's unit included a persistent thick zone of brecciated dolomite which occurs near the top, and that is now generally known under the name of Bear Rock formation. In view of the confusion that arose because of the inconsistent usage of the term Lone Mountain by subsequent authors, we have adopted in this report our own arbitrary definition, as quoted above.

The Lone Mountain formation (Appendices II and III, Figures VI and VII) consists of medium to thick dolomite beds, alternating dark brownish grey and light grey in color, which produce a conspicuous banded effect on the cliff face when viewed from some distance (Plates XVI-A and B). The dolomite is largely coarsely crystalline and unfossiliferous, with the exception of a few beds containing small poorly preserved structures suggestive of Amphipora, crinoid fragments and possibly corals. Some brecciation and vuggy porosity

were noticed in places. The contact of the Lone Mountain with the dolomite breccias of the overlying Bear Rock formation appears to be gradational in the Nahanni Range, but Hume (7) mentions the existence of a distinct unconformity at this stratigraphic position on the west flank of the Norman Range. The base of Lone Mountain was observed at various places in the front range of the Nahanni Mountains between Little Doctor Lake and Bluefish Lake. It consists of hard, poorly sorted quartzose sandstone, 30 feet thick, and of a type that is commonly associated with unconformities. Thin varicoloured lenses of chert pebble conglomerate may be found and in some sections a dolomite pebble conglomerate was noticed. Most probably the sandstone represents the basal sand that commonly accompanies the sub-Devonian unconformity.

Hage (5) placed the Lone Mountain formation in the Silurian, but the fossil evidence he cited appears to be inconclusive. As proper age determination of the Lone Mountain is impossible due to the lack of fossils, the age of the formation is referred to as Devonian-Silurian. The thickness of the Lone Mountain formation is approximately 1,400 feet.

Complete sections were observed at a creek south of Little Doctor Lake (Appendix II, Figure VI) where 1,656 feet of undifferentiated Lone Mountain and Bear Rock were measured, and near Bluefish Lake (Appendix III, Figure VII) where the Lone Mountain is 1,420 feet thick.

Bear Rock Formation - As previously noted the term Bear Rock is applied to the highly brecciated and recrystallized dolomites overlying the Lone Mountain formation. The Bear Rock formation is conformably overlain by the Middle Devonian Ramparts formation. The term Bear Rock was used by the Canol geologists and its type section is at Bear Rock, Fort Norman. At Bear Rock, the term is used to describe "the brecciated and non-bedded dolomite and limestone lying below Middle Devonian strata and above a sharp disconformity with well-bedded Silurian limestone below it," (Hume (7)).

Along Nahanni Range the Bear Rock forms a fairly consistent 350 foot interval of light grey weathering rock immediately overlying the light and dark grey banded Lone Mountain formation (Plate XVI-B). Brecciation may vary locally as no division of the Bear Rock and the underlying banded dolomite was made at Nahanni Butte (Hage (5)) or at Lone Mountain (Kindle (11)). No division was made at a creek south of Little Doctor Lake (Appendix II, Figure VI) although good brecciated zones were observed both north and south of this section.

The upper contact is marked by the occurrence of dense dolomitic limestone of the overlying Ramparts formation. The lower contact is transitional and is arbitrarily picked above the crystalline and bedded dolomites of the Lone Mountain formation.

The Bear Rock formation (Appendix III, Figure VII) consists of dark grey to brown and black, coarsely crystalline, poorly bedded dolomite, that is commonly brecciated. The dolomite is generally veined with secondary dolomite and calcite. The breccias consist of angular black dolomite fragments in a matrix of white coarsely crystalline dolomite and calcite (Plate XVII-A).

Cavernous and intercrystalline porosity is often well developed.

The present breccia appears to occur in a sequence of rock that originally consisted of carbonates and evaporites. Subsequently, leaching of salt and anhydrite took place, which was followed by collapse of the limestone. Previous authors have advanced the above theory and the evaporite concept is based on the fact that gypsum is, in places, associated with the formation.

No fossils were observed in the Bear Rock sections studied.

At Bluefish Lake (Appendix III, Figure VII) 340 feet of the Bear Rock formation were measured. Close to 300 feet are present at Grainger River, while over 400 feet are reported at Little Doctor Lake.

Middle Devonian

Ramparts Formation - The Ramparts formation is represented by dolomitic limestone, often reefal, overlying the Bear Rock formation with apparent conformity and underlying Upper Devonian shales.

Our usage of the name Ramparts is based on a tentative broad correlation with the Middle Devonian of the Fort Norman area. Application of the term Ramparts was modified by Hume (7) in the Lower Mackenzie area to include an upper and lower limestone member separated by a middle shale member. The middle shale member is not developed along the Nahanni Range. Hume (7) includes the Beavertail and Ramparts as defined by Kindle and Bosworth in his Upper Ramparts. He places the Hare Indian River shale in his Middle Ramparts and a limestone member, not previously described, in his Lower Ramparts. Hage (5), at Nahanni Butte proposed the name Nahanni for the assemblage. Since correlation of the Nahanni and Ramparts is broadly established, the term Nahanni is dropped.

The Ramparts formation forms the dip slope of the Nahanni Range (Plate XV-A) and is readily observed for the entire length of the range. No evidence of unconformable relations with underlying and overlying formations was observed.

The Ramparts formation (Appendices II and III, Figures VI and VII) consists largely of dark grey, dense to finely crystalline, bedded dolomitic limestone, which is, in part, so rich in corals and stromatoporoids, that it could be called "reefal." Minor argillaceous limestone (Plate XV-B) zones were observed in all sections, as well as a brecciated zone in the Bluefish Lake section (Appendix III, Figure VII).

The Ramparts formation was deposited under marine conditions and it shows evidence of cyclic sedimentation, which is characteristic of shoal reefs. A fine cyclic (2 inch) appearance was especially noted at a creek south of Little Doctor Lake (Appendix II, Figure VI). At the same section larger cycles were also apparent. In the latter case hiati occur every 20 or 30 feet, and directly above each hiatus occurs an abundantly fossiliferous zone up to two feet in thickness. Locally small bioherms are developed in the Ramparts. (Bluefish Lake, Appendix III, Figure VII.)

The formation is commonly fossiliferous with brachiopods, crinoid stems, trilobites, stromatoporoids and solitary, colonial and branching-type corals observed. Stringocephalus was found at the Ramparts section at Little Doctor Lake.

Thicknesses of 663 feet and 689 feet were observed at a creek south of Little Doctor Lake (Appendix II, Figure VI) and at Bluefish Lake (Appendix III, Figure VII) respectively. Other outcrops studied in the Nahanni Range include those at Grainger River, where the Ramparts is 580 feet thick, and at Little Doctor Lake, where it is 800 feet thick.

Upper Devonian

The nomenclature of the Upper Devonian of the Great Slave Lake area has been applied, where possible, to the Upper Devonian of the Liard area. The breakdown from bottom to top is as follows: A basal black bituminous shale unit, a green shale unit, the Grumbler formation and the Wabamun-Trout River (undivided).

Black shale unit - The black shale unit represents a thin but widespread zone of marine black shale overlying the Slave Point limestone. The top is marked by the appearance of green shale. The unit is likened to Hunt's (9) Spence River formation which occupies the same stratigraphic position and has a similar lithology. Law (13) points out that the Spence River shale in northern Alberta does "... not form a well defined unit such as is present in the Fort Simpson area."

The only place where the black shale unit was observed in outcrop was on Nahanni Butte, where a small wedge occurs in a faulted section just east of the highest part of the Butte. Here it consists of dark grey to black, bituminous shale interbedded with greenish grey, fissile shale, but a large part of the section is covered. Small exposures of Upper Devonian black shale occur on the Liard and Blackstone Rivers, but the stratigraphic position of these outcrops is doubtful, and it is likely that they belong to a younger portion of the section than the black shale unit of the Plains. Well data furnish substantial evidence that it is present throughout the Permit area. Well samples from Westerol Liard Rapids 1A, Westerol 3A and 4A (Appendices XII to XIV) indicate a thickness of close to 200 feet. A thinner section is reported to the south of Imperial Island River No. 1.

Well samples indicate that the shale is black to dark brown, silty, bituminous and commonly pyritic with minor interbeds of grey-green shale. The unit is represented on electric logs by an interval showing high resistivity, indicative of bituminous shales which follows directly above the Slave Point limestone.

Green shale unit - The green shale unit includes a thick sequence of predominantly grey-green shales that underlie the Grumbler formation. The green shale unit plus the underlying black shale unit are probably equivalent to the thick black and silty shales observed by Hume (8) in the North Nahanni area. The latter shale may be called Fort Creek. To the south our black shale and green shale facies units can be equated to the "Shale Unit" described by Law (13) in northern Alberta.

Outcrops of the green shale unit were observed on Birch River and on the Liard River near the mouth of Matou River. Similar outcrops were encountered on a tributary of the Martin River and near Fort Simpson on the Mackenzie River. Other outcrops of the Unit include the Liard Rapids section just below the mouth of Poplar River. The Upper Devonian shales were no where observed west of Nahanni Range in the vicinity of Nahanni Butte. Here the interval is represented by a wide, heavily vegetated valley. Part of the unit is present in the Westerel wells 1A, 3A and 4A, and is completely represented in Imperial Island River No. 1.

In outcrop the shale is grey-green, but brownish when wet, unfossiliferous, micaceous, slightly calcareous, and it contains minor siltstone. Tentatively included in the green shale unit is the grey, calcareous sandstone and grey-green shale section exposed on the banks of the Liard River below the mouth of Poplar River (Liard Rapids Section, Appendix X). Well samples show the shale to be grey-green, slightly calcareous and micaceous, with interbeds of dark grey and brown, and minor black, bituminous shales.

Information concerning the thickness of the unit is limited. The nearest estimate may be obtained from the Westerel Liard Rapids 1A well (Figure XIII). The thickness here is close to 2,000 feet, with probably most of the unit represented. On the correlation chart (Table I) the combined thickness of the green and black shale units is given as approximately 2,200 feet. The green shale unit may be represented in the North Nahanni area by a black shale and silty shale section with an aggregate thickness of 2,000 feet, that overlies a more than 1,000 foot thick bituminous shale unit.

Grumbler Formation - The name Grumbler formation was proposed by Crickmay (3) for Devonian beds outcropping on Hay River above Alexandra Falls. In the Liard area the formation is overlain by the Trout River formation and underlain by the green shale unit. In the Permit area the Grumbler formation is represented by an upper reefoid member, which is readily traced back to the type section, and by a lower silty limestone member. It is difficult to establish the base of the Grumbler formation in the Liard area due to facies changes. The silty limestone which causes the Liard rapids should possibly be included in the Grumbler, and thus it would also form the lower part of Law's (13) "Silty Limestone Unit."

The upper reefoid member, exposed on Birch River (Plate IX-A) of the Grumbler formation forms the low west and southwest-trending escarpments south of the Liard River. This reefoid unit varies from bedded silty, fragmental limestone to organic biostromal limestone. Commonly it contains reef-building fossils such as platy stromatoporoids and colonial corals. Below the upper member, silty argillaceous limestones are exposed on the Blackstone River. The total thickness of the formation is between 200 and 500 feet.

In the North Nahanni area (Appendix IX) the term Grumbler has been applied to a cyclic series of dark grey and greenish grey silty shales and sandstones with minor limestone. Perhaps these beds are not the exact equivalent of the Grumbler, but they occupy a similar position in the stratigraphic column and contain elements of the same lithology and fauna. It may also be noted that the reefoid member is not as widespread in the North Nahanni area as it is to the east and southeast.

Wabamun-Trout River (Undivided)- The Wabamun group has been recognized in most wells in northern Alberta. It consists of 600 to 700 feet of limestone and may be correlated without difficulty with the type section near Edmonton. During the course of the field program the Wabamun was mapped together with the underlying Trout River formation as one lithologic unit.

The Trout River formation was named and described by Crickway (3). It consists of 170 feet of light buff-colored silty limestone, and it represents the upper one-third of the "Silty Limestone Unit" as described by Law (13) in wells in northern Alberta. The Trout River may be correlated with the Graninia formation of central Alberta. The contact of the Trout River with the underlying Grumbler formation is disconformable and coincides with a widespread faunal break that may be recognized in the field without difficulty.

As the base of the Trout River can be mapped in the field, and because in the area under consideration, the poorly exposed Wabamun is of similar lithology as the Trout River, the two stratigraphic units have been combined as Wabamun-Trout River in the present report. However, on the accompanying maps and cross-sections the entire interval is referred to as the Trout River formation only.

The Wabamun-Trout River was found in only one outcrop within the map area (Plate VIII-A) located on Blackstone River, where it is exposed as limestone containing the brachiopod Leiorhynchus. Outcrops examined to the east near Deep Lake, Trout River and at other localities consisted of silty, sandy and argillaceous limestones, with calcareous sandstone commonly present at the base. The lack of exposed Wabamun and Trout River in the Liard area may suggest that here this interval is more shaly. In the North Nahanni area (Appendix X) a thick series of greenish grey, fine-grained sandstones and interbedded greenish grey, sandy mudstones is tentatively correlated with the Trout River formation.

The thickness of the combined Wabamun and Trout River in the map area is unknown, but nearby well data indicate a thickness of approximately 700 feet.

Mississippian

Rocks assigned to the Mississippian include shales, sandstones and limestones that are underlain by Upper Devonian clean quartzose siltstone, and overlain by Permo-Pennsylvanian quartzose sandstone. The lower contact, seen at Jackfish Gap (Appendix VI, Figure X) is relatively sharp, but it does not bear signs of an unconformity. The upper contact is gradational and is arbitrarily chosen at the disappearance of limestone beds. According to Nage (5), Hume first observed Mississippian strata in the Liard area in 1923, and also determined the age on the basis of a Kinderhook fauna.

Approximately 2,500 feet of Mississippian were observed at the Jackfish Gap section (Appendix VI, Figure X) some 30 miles west of Nahanni Butte. Along Bluefish Range close to 3,000 feet of Mississippian are believed to be present. Outcrops examined at the latter locality include those described as a composite Mississippian section (Appendix V, Figure IX) and a black shale section west of Grainger Canyon (Appendix IV, Figure VIII) that may belong to the basal Mississippian.

Information regarding the distribution of Mississippian strata in the Plains is limited due to the small number of outcrops and the sparse well data. Known Mississippian outcrops include a limestone section on the west flank of the Bovie Lake structure (Plate VII-B), limestone beds exposed east of Bovie Lake on the Petitot River and scattered limestone with chert in several localities on the Liard River between Fort Liard and Nahanni Butte.

Well information is sparse, but close to 1,400 feet of detrital limestone and shale are reported at Imperial Island River No. 1. This is the farthest east that Mississippian is reported in wells in the Northwest Territories.

The most complete Mississippian section was seen in outcrop at Jackfish Gap (Appendix VI, Figure X). Here close to 2,500 feet are almost entirely exposed. A tentative lithological breakdown in accordance with Alberta nomenclature, has been applied to the Jackfish Gap succession. It must be emphasised that this subdivision is not based on faunal evidence but on lithological similarities to the Alberta section. However, Hage (5) does report a faunal affinity of the Mississippian in the Nahanni area to the Banff and Rundle formations.

An unfossiliferous unit, 500 feet thick, is thought to form the basal part of the Mississippian at Jackfish Gap, it consists of interbedded brownish grey, fine-grained, argillaceous sandstone, silty shale and mudstone. This unit may be called the "Basal sandstone" of the Mississippian. Overlying the "Basal sandstone" follow 400 feet of black, fissile, concretionary shale which are lithologically similar to the Exshaw. Above the Exshaw occurs a 1,200 foot unit which is predominantly shaly and is tentatively called Banff (Plates XIII-A and B). The shale unit is generally dark grey, calcareous and fissile, and it is interbedded with numerous argillaceous, fossiliferous limestone beds and with minor argillaceous sandstone. Overlying the Banff occurs a section predominantly composed of crinoidal limestone which is called Rundle. This succession includes close to 400 feet of brownish grey, crystalline, fossiliferous cherty limestone with some interbedded dark grey shale. The composite section on Bluefish Range (Appendix V, Figure IX), although largely covered, shows some lithological similarity to that at Jackfish Gap, and it is believed that at least the Rundle and Banff formations are represented. A cherty limestone interval near the middle of the Banff is believed a marker in both sections. At Bluefish Range the Banff formation appears to contain more sandstone than at Jackfish Gap. Stratigraphically below the Bluefish Range composite section (Appendix V, Figure IX) occurs a covered zone of approximately 1,000 feet (estimated from aerial photographs), and below the covered zone, a 460 foot black, fissile, silty shale zone was found which is described in the Grainger River, Bluefish Range section (Appendix IV, Figure VIII). This unfossiliferous shale zone has been tentatively placed in the basal part of the Mississippian. It is probably equivalent to the "Basal Sandstone" of Jackfish Gap, and exhibits similar ridge-forming characteristics (Plate XIV-B). The ridge is prominent in front of both the Bluefish Range and the Range in which Jackfish Gap occurs.

The Mississippian was deposited in marine environment under constantly fluctuating conditions, resulting in a rather heterogeneous mixture of detrital limestone, shale and sandstone.

The limestones of the Mississippian are commonly fossiliferous and contain crinoid fragments, brachiopods, large horn corals, colonial corals and cephalopods.

The complete Mississippian section as measured at Jackfish Gap comprises 2,502 feet of sediment. A thickness of 3,000 feet for the Mississippian along Bluefish Range has been estimated on the basis of the following observations:

1. A composite section (Appendix V, Figure IX) measuring 1,552 feet forms the upper part of the Mississippian.

2. A 1,000 foot interval is covered by soil and vegetation (thickness estimated from aerial photographs).

3. A 460 foot zone consisting of silty shale (Appendix IV, Figure VII) is questionably placed in the basal Mississippian.

Permo-Pennsylvanian

The Permo-Pennsylvanian is represented by a thick series of sandstones and shales that are underlain by Mississippian limestone and overlain by Permian chert. As it was mentioned previously, the contact between the Mississippian and the Permo-Pennsylvanian is chosen at the top of the uppermost limestone beds of the Mississippian. The upper contact is arbitrarily chosen at the first appearance of a thick chert zone which is believed to be Permian. Fossils collected above and below the chert zone indicate Permian age. Hage (5) reports late Mississippian or possibly early Pennsylvanian fossils from sections examined at Pointed Mountain and Labiche Range.

In the mountains west of Fort Liard and west of Nahanni Butte the Permo-Pennsylvanian is represented by sections consisting of over 3,000 feet of sandstone and shale. Drastic truncation to the east is evidenced by the fact that on a small tributary of the Liard, north of the Muskeg River, only 395 feet of Permo-Pennsylvanian was measured. This is believed to be nearly a complete section since Mississippian beds are exposed below the section and Cretaceous strata lie on top.

The Permo-Pennsylvanian sediments are predominantly composed of sandstone with numerous interbeds of shale, although the shale is seldom exposed. The quartzose sandstone is buff to brown, fine to coarse-grained, generally clean and well sorted. However, the basal 1,000 feet, as examined on Labiche Range (Appendix IX), is, in many places, argillaceous, carbonaceous and micaceous, giving the sandstone a dirty appearance. The fine, hard and dirty, brown sandstone, the brown shale and coal, seen in a tributary of the Liard north of the Muskeg River are believed to represent the basal part of the Permo-Pennsylvanian. Above the basal argillaceous beds exposed in the mountains, the sandstone is cleaner, fossiliferous in part and, where not calcareous or quartzitic, is quite porous (Plate XI-A). The porous zones are generally not over 20 feet thick, but where developed they exhibit excellent reservoir conditions in clean, well sorted, unconsolidated quartzose sandstone. Near the top of the Permo-Pennsylvanian section on Labiche Range (Appendix XI) two thin crinoidal limestone beds occur about 50 feet below the base of the Permian chert.

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The interbedding of sandstone and shale with minor detrital limestone and coal beds typify near-shore and continental conditions during deposition.

The Permo-Pennsylvanian sediments are largely unfossiliferous, but some sandstones and crinoidal limestone beds in the upper half of the section examined on Labiche Range (Appendix XI) are highly fossiliferous, containing crinoid fragments, brachiopods and pelecypods.

A total of 3,160 feet of Permo-Pennsylvanian strata were measured on Labiche Range (Appendix XI) while 3,800 feet of Permo-Pennsylvanian are reported at Jackfish Gap. It is not certain if the 3,800 feet at Jackfish Gap include the overlying Permian. As previously mentioned, a minimum thickness of 395 feet of the Permo-Pennsylvanian was measured on a tributary of the Liard north of Muskeg River.

The Permo-Pennsylvanian is distinguished by its sheer, inaccessible cliffs along the Liard Range and by the long, gently dipping sandstone exposures with numerous covered intervals, along the east side of the Labiche Range.

Permian

The Permian succession consists of a relatively thin interval of chert and silicified sandstone beds that show an obvious contrast to the underlying Permo-Pennsylvanian sandstones, and to the overlying shales and sandstones of questionable Triassic age. The Permian age is based on fossils found above and below the predominantly cherty zone. Kindle (10) reports Permian fossils from a sandstone directly overlying the chert at Mount Merrill in the Yukon. Permian fossils were also collected below the chert by our field parties during the past season.

The chert zone of the Permian was observed on, and to the west of Labiche Range. Probably it is completely removed by erosion east of the mountains in the Plains. This is fortunate, as the chert would present a definite drilling problem.

The Permian chert zone is well exposed on the Labiche Range (Appendix XI), where 441 feet of section were measured. Here it consists of bedded light grey chert, with interbedded black fissile shale near the base, and interbedded dark grey, fine-grained, silicified sandstone and chert throughout the remainder of the section. The section weathers predominantly buff and light grey (Plate X-B) with some dark grey zones. The chert zone is overlain by a 20 foot thick buff, medium-grained, clean, quartzose sandstone at the Labiche Range section (Appendix XI). The sandstone occurs in scattered hummocks on the dip slope, possibly indicating a disconformity. No fossils were found, but this is presumably the sandstone in which Kindle (10) observed Permian fossils on Mount Merrill in the Yukon.

Presumably the Permian was predominantly a sandstone section, laid down under much the same conditions as the preceding Permo-Pennsylvanian.

A fossil horizon, indicative of Permian age, was found underlying the chert zone. A fossil collection included Waagenoconcha cf. irginae var.,

irginiformis. Kindle (10) found, at Mount Merrill, Fenestellid bryozoa, Productus sp., Spirifer sp., Marginifera sp. and Sphenotus sp. in the sandstone overlying the chert zone. The latter group was identified by A.E. Wilson, "... and regarded as almost certainly of Permian age."

Triassic

The Triassic includes shales and sandstones that overlie the Permian chert zone and that underlie the Cretaceous basal conglomerate. Microfaunal collections indicate that the unit is Triassic in age or possibly older. Thick Triassic sections are reported by Kindle (10) along the Liard River near its junction with the Toad. To our knowledge the Triassic has not been reported previously along the Liard River north of the British Columbia-Northwest Territories boundary. The Triassic was observed only on the Kotaneelee River, where it was measured and described (Appendix VII, Figure XI). In contrast to the thick Triassic section (1,500 to 3,000 feet), encountered by Kindle (10) in the Toad River area, only 294 feet were measured on the Kotaneelee River, and this is believed to be a complete section. The Triassic is either thinning to the north or partially removed by erosion, or, possibly both. It is definitely not present in the Plains area to the east, since the Cretaceous basal conglomerate lies directly on Permo-Pennsylvanian rocks on a small tributary of the Liard, north of the Muskeg River.

The Triassic consists predominantly of green and maroon, fissile, soapy, marine shale, interbedded with minor dark grey, fine-grained sandstone. The succession is overlain by a Cretaceous conglomerate bed. At the base of the Triassic is light to dark green, very fine-grained, argillaceous sandstone overlies a thin chert bed, which possibly belongs to the Permian. If the chert is indeed Permian in age, then a complete Triassic section is present.

A microfauna, collected from trenched shale samples, were questionably identified as conodonts by Miss G. Stewart of Canadian Stratigraphic Services. It was stated that these forms do not occur in beds that are younger than Middle Triassic.

Lower Cretaceous

The nomenclature used by Kindle (10) in the Toad River area of British Columbia, has been adopted for the Lower Cretaceous beds of the Liard area. The subdivision is based on lithology and comprises a Basal Conglomerate, overlain by the Fort St. John Group which includes, from bottom to top, the Garbutt formation, the Scatter formation and the Lepine formation.

Basal Conglomerate - The Basal Conglomerate includes close to 150 feet of conglomerate and sandstone resting on older Mesozoic and Paleozoic strata, and underlying the Garbutt shale. The conglomerate zone had not been reported previously in the Liard area, but it is thought to be basal Cretaceous, due to its stratigraphic position. It is definitely overlain by Cretaceous shale, and, in the three localities where it was observed, it overlies rocks of different age, including Triassic shale, Permo-Pennsylvanian sandstone and Devonian shale.

The Basal Conglomerate is probably quite widespread although it outcrops only in a few places. On the Kotaneelee River where it overlies Triassic shales, the zone is well exposed, and 142 feet were measured. Forty feet of conglomerate and sandstone overlying the Permo-Pennsylvanian are reported on a small tributary of the Liard, north of the Muskeg River. A thin section of Cretaceous sand overlies Devonian green shale on a tributary of the Blackstone River. The Basal Conglomerate is probably present at the Lower Cretaceous boundary which crosses the Permit areas in a northeast and east direction, although it outcrops in just two places.

The Basal Conglomerate consists predominantly of white and dark grey chert pebbles and boulders, embedded in a light grey, coarse-grained, sandstone matrix. It is commonly interbedded with light grey and green, coarse-grained, salt and pepper sandstone which is often carbonaceous.

The zone reflects extensive erosion which occurred in Mesozoic time before deposition of the Cretaceous.

Garbutt Formation - In the Liard area the Garbutt formation consists of approximately 450 feet of marine shale with minor sandstone, overlying the Lower Cretaceous Basal Conglomerate and grading upward into the sandstone of the Scatter formation. Kindle (10), in the Toad River area, reported about 2,000 feet of dark friable shales. He considered the shales to be an equivalent of the Moosebar formation of Peace River Valley in the Fort St. John district, and also of the lower part of the Buckinghorse formation of the Sikanni Chief area, south of Fort Nelson.

No complete section of the formation was observed, but the upper part was found exposed on the Kotaneelee River (Appendix VII, Figure XI), and scattered outcrops occur east of the Liard River, north of Big Island. Outcrops of the Garbutt formation were observed within the Permit area on Netla River and on two tributaries of the Blackstone River.

The Garbutt formation consists of grey, sandy shale, with minor greenish-brown, fine-grained, salt and pepper sandstone towards the top. The formation contains ironstone concretions and commonly weathers rusty.

The formation is unfossiliferous except for some plant material found near the top on the Kotaneelee River.

The thickness of the Garbutt formation was estimated on the Kotaneelee River where approximately 450 feet, most of it covered, could be calculated, mainly from aerial photos.

Scatter Formation - The Scatter formation is represented predominantly by marine sandstone which is overlain conformably by shale of the Lepine formation and underlain conformably by shale of the Garbutt formation. Kindle (10), in the Toad River area, described and named the formation which he equated, on the basis of faunal evidence, to "... the Commotion formation of the Pine River area, and probably with the Gates formation of the Peace River foothills."

The formation was observed on the Netla River within the Permit area where 320 feet of sandstone were measured, and outside the Permit area on Rabbit Creek, Petitot River (Appendix VIII, Figure XII) and the Kotaneelee River (Appendix VII, Figure XI). The presence of the formation is inferred (Figure II) in the southern part of the Permit area, on the basis of a topographically high area observed on aerial photos.

Adjacent to the Permit area, the Scatter caps the Cretaceous remnant straddling the South Nahanni fault and is probably also represented in the Martin Hills. The above features have been mapped as undifferentiated Fort St. John on the maps and photomosaics.

The Scatter formation was measured and described on the Netla River, on the Kotaneelee River where a complete section is believed to be present, and at the mouth of the Petitot River where a major portion of the formation was observed. The formation consists mainly of grey-green, fine-grained, salt and pepper sandstone, which is, in part, carbonaceous, argillaceous and concretionary. Interbedded with the sandstone are minor amounts of sandy shale, mudstone and siltstone.

No fossils were observed in the measured sections but Kindle (10), in the Toad River area, reports a fauna belonging to the late Lower Cretaceous Gastroplites zone. Forminifera, from the Cretaceous straddling the South Nahanni fault, were identified by Miss G. Stewart, Canadian Stratigraphic Services. According to Miss Stewart these belong to "... the Fort St. John Group, Commotion formation correlative 'Gates' of the Peace River, British Columbia."

The measured thickness of what is believed to be a complete section of the Scatter formation on the Kotaneelee River, is 375 feet. Over 300 feet of the formation is present at the mouth of the Petitot River.

Lepine Formation - The Lepine formation is represented by a thick marine shale succession, overlying the Scatter formation and underlying the Fort Nelson formation of the Upper Cretaceous. Kindle (10), in the Toad River area, applied the name Lepine to a "... 2,000 feet thick series of grey and black marine shales that overlie the Scatter formation." The fauna collected by Kindle indicated late Lower Cretaceous age.

An outcrop of the Lepine formation was observed on the Arrowhead River within the Permit area while outside the area the formation was measured and described, on the Petitot and Kotaneelee Rivers, as well as exposures and structural complications would permit. The formation underlies a large part of the southeastern corner of the Permit area.

Although much of the formation is covered on Kotaneelee River, a thickness of approximately 2,000 feet was arrived at by a combination of data from measured sections and estimated thicknesses from aerial photos. Also on the Kotaneelee River it was observed that the shale can be divided into two units, including a lower interval of dark grey, blocky, selenitic, concretionary, sandy shale which is fossiliferous in part, and an upper unit consisting of black, fissile, sulphurous, bituminous shale, containing bentonite beds.

The Lepine formation is not as well exposed on the Petitot River due to folding and faulting but a similar breakdown to that of the Kotaneelee River section is indicated, with the upper fissile unit being at least 500 feet thick on both rivers. Detailed descriptions of the formation are included in Appendices VII and VIII, while strip logs are included with the illustrations as Figures XI and XII.

An abundantly fossiliferous zone, containing mainly pelecypods, near the middle of the formation was observed on the Kotaneelee River. Fish scales have been reported from the black, fissile shale zone in the upper part of the Lepine formation. They were observed on the Petitot River about three miles above its confluence with the Liard River.

Upper Cretaceous

In the present report the Upper Cretaceous-Lower Cretaceous boundary is placed at the base of the Fort Nelson conglomerate. Fish scales, as previously mentioned, have been reported in the upper part of the Lepine formation but it is not known how far below the Fort Nelson formation they occur.

Fort Nelson Formation - The Fort Nelson formation consists of approximately 500 feet of conglomerate, sandstone and sandy shale, overlying the Lepine formation and underlying the Kotaneelee formation. Kindle (10) named the formation which is exposed near the Fort Nelson and Liard Rivers, and suggested that it is the northern equivalent of the Dunvegan sandstone.

Within the Permit area outcrops of the Fort Nelson formation were observed on the Arrowhead River. Estimates of the thickness were made on the Kotaneelee and Petitot Rivers (Appendices VII and VIII, Figures XI and XII). The formation was mapped in the southeastern portion of the Permit area on the basis of a topographically high area observed on aerial photos.

The Fort Nelson formation in the Liard area has been divided into two members consisting of an upper, mainly conglomerate zone from 150 to 250 feet thick and a lower sandstone, shale and minor conglomerate zone, from 200 to 300 feet thick. The upper conglomerate consists of varicolored chert and quartzite pebbles, up to two inches in diameter, embedded in a light grey, coarse-grained sandstone matrix. Where the conglomerate is not severely weathered, it is well cemented. The lower member is composed of light grey, coarse-grained, salt and pepper sandstone, sandy shale and minor pebble conglomerate.

Observed and estimated figures for the thickness of the Fort Nelson were obtained along the Petitot and Kotaneelee Rivers. On the Petitot River (Plate V-B), outcrop sections reached a total thickness of 470 feet, representing a minimum for the formation. On the Kotaneelee River (Plate V-A) a combination of measured section and estimated covered intervals gave a conservative 450 feet. Exposures on both rivers are nearly flat-lying and form canyons.

Kotaneelee Formation - The Kotaneelee formation comprises the uppermost beds of the Upper Cretaceous examined in the Liard area. The formation was named by Hage (5) and the type section lies about seven miles above the mouth of the Kotaneelee River. On the basis of faunal evidence, Hage (5)

correlates the formation with "... the upper Wapiabi formation in the central and southern Foothills of Alberta."

It is believed that the Kotaneelee formation is not present within the Permit area. The formation is well exposed on the Kotaneelee, Petitot and Liard Rivers.

On the Kotaneelee River (Appendix VII, Figure XI) a combination of two exposures gave a total section of 578 feet of marine, black, slightly silty, sulphurous shale, dark grey, sandy shale, dark green, fine-grained sandstone and minor thin pebble conglomerates (Plate IV-B). This thickness represents a minimum since no top was established.

On the Petitot River, Hage (5) reported 345 feet of Kotaneelee sandy shale, sandstone and conglomerate at the lower end of the canyon.

The Kotaneelee formation is commonly fossiliferous and collections made by Hage (5) have been identified and listed in his report on the area.

Wapiti (?) Formation - No outcrops of these late Upper Cretaceous beds were observed. Hage (5) reported a banded, medium to coarse-grained, feldspathic, buff-weathering, calcareous sandstone, in part associated with coal, in localities along the Liard River above Fort Liard.

Hage (5) felt that a non-marine origin is indicated by coal and carbonaceous material and correlated the formation with the Wapiti group of Alberta.

The Wapiti (?) formation is believed to have been completely removed by erosion within the Permit area.

Tertiary (?)

There is a possibility that the rusty weathering gravels observed on Martin Hills (Figure II) is Tertiary in age. The zone has a thickness of only 10 to 20 feet.

Correlation of Mountain Outcrops with the Subsurface Section in the Plains

The problem of correlation of the Middle Devonian and older rocks in the mountain outcrops with those encountered in the subsurface of the adjacent Plains is difficult. Obviously, rapid thickening of sediments is taking place towards the west, and radical facies changes may be noticed in the same direction.

Some correlations that were made, strictly on the basis of lithological similarities, are discussed below:

1. The Ramparts formation is tentatively correlated with the Slave Point. The first limestone to be encountered below the Upper Devonian shales in the Plains is the Slave Point, and in the mountains it is the Ramparts. They are of comparable lithology. In the Plains

the Slave Point has a thickness in the order of 250 feet. In the mountains the Ramparts is 600 to 800 feet thick.

Objections to this correlation may arise from the fact that the well known Middle Devonian fossil, Stringocephalus, occurs in the Ramparts of the mountains while near Great Slave Lake the Slave Point occurs in outcrop above the Presqu'ile formation which contains Stringocephalus. Warren (15) believes the Slave Point to be the off-reef facies of the Presqu'ile, while Law (13) correlates the Slave Point with part of the Upper Devonian Fort Creek shales. As previously mentioned, we have found that in many respects the lithology of Ramparts sections in the mountains is similar to that of the Slave Point as encountered in bore holes in the Plains. On this basis we have tentatively correlated the Slave Point with the Ramparts.

It is possible that a structurally positive belt similar to the Peace River Arch, was in existence in Devonian and pre-Devonian time from Great Slave Lake west to the Mahanni Mountains. In this case there may have been isolation or partial separation of the early depositional basins south and north of this feature. As a result similarities in lithology of rock units in the two different basins may be insufficient to serve as a basis for correlation.

It is possible, for instance, that the Slave Point formation shales out westward from the Westerol wells and that it is equivalent to part of the black shale unit in the mountains. The Ramparts formation may wedge out to the east or, more likely, it may be continuous with the Muskeg and Keg River formations of Northern Alberta.

2. The carbonate breccia of the Bear Rock plus the underlying Lone Mountain formation appear to be equal to most, if not all, of the anhydrite and carbonate section which underlies the Slave Point in the subsurface, as seen at Westerol 3A (Figure XIV) and B.A.-H.B. Trail Creek No. 1 (Figure XVI).

3. The fossiliferous dolomites of Upper Ordovician age, seen in the mountain sections, are not recognized in the subsurface. The fact, that this thick section is not present to the east in the wells examined, suggests the possibility of wedging out, either because of non-deposition or due to erosion prior to Devonian-Silurian sedimentation.

4. The red dolomites, encountered in the basal part of Westerol 3A (Figure XIV), could conceivably be correlated with the "Red Beds" that are commonly recognized in most wells in the southern N.W.T. and northern Alberta. The age of these beds is uncertain and correlation with the mountain section is uncertain but, strictly on the basis of red color they could be equivalent to those dolomites and sandstones called Cambro-Ordovician in the outcrop sections.

STRUCTURAL GEOLOGY

The project area is located on the northern edge of the Alberta Basin and in the southern end of what is commonly referred to as the Mackenzie Basin. The outcrop pattern of the Grumbler reefoid member indicates a very broad regional syncline plunging to the southeast. The area may also be described as being located on the Upper Mackenzie Plains area, immediately to the east of the Liard Mountains.

Any consideration of the regional or local structure is made more interesting by the fact that to the southwest the Rocky Mountain System is broken and gives way to an en echelon system of mountains, of which the Liard and Mahanni Mountains represent oblique "steps" to the Mackenzie Mountain System. At the same time we feel that this regional crustal break is probably the result of an older tectonic trend that extends eastward from the Northern Liard Basin area, and may be related to the Great Slave Lake (Pine Point, etc.) regional tectonic trend. Furthermore we think it likely that this trend has a relationship to the old Peace River Arch and the Lake Athabasca tectonic trend.

Another, possibly more local point of interest, is that such structural features as the Bovie Lake anticline is probably a reflection of the Mahanni Mountain overthrust, etc., and that there are also probably other related lines of structural weakness crossing the area. These conflicting tectonic trends, of course, make the area a most interesting one from the standpoint of both oil source and reservoir potentialities.

In the plains area north of the Devonian surface scarp there is such a lack of outcrop that local structures are not definable. It is apparent, however, that over most of the area the regional dip is low to the south or southeast.

South of the above reefoid scarp the area is underlain mainly by Cretaceous strata. The rock outcrop there is sufficient to give a regional picture but local structures are poorly indicated.

The mountain structure west of the project area involves a series of north-south open folds with little apparent thrust faulting, separated from the plains on the east by fairly high angle west-dipping thrust faults. The mountain structure here differs from typical Rocky Mountain structure further south in Alberta in that there is very little thrust faulting, and where thrusts do occur they appear to be higher angle and with relatively little apparent horizontal movement.

A.J. Goodman (4) suggests that shortening of the crust resulted in high angle "trap door" thrust faults in the crystalline basement. The effect of this on the comparatively thin cover of overlying strata was folding and, in some cases, thrust faulting. Uplifts within the mountains and plains of the area are believed to be a result of such basement faulting.

Following is a brief discussion of the more prominent features observed within the area, most of which were mapped with the aid of aerial photographs.

Martin Syncline

The Martin Syncline is the only definite structure observed north of the reef scarp and east of the mountains. It consists of a southeast plunging syncline with minor, parallel anticlines. Cretaceous strata are exposed, probably overlying beds of the Upper Devonian. The exact lengths and locations of this group of structures is unknown due to a scarcity of outcrops. Furthermore, since several small folded features are evident in the Martin Hills, it would appear likely that extensions of these as well as other folded (?) features are present in the area.

Arrowhead Syncline

The Arrowhead Syncline trends northeast-southwest and represents a broad gentle reversal along the edge of the Alberta Basin extending over a distance of approximately 20 miles. The syncline preserves Upper Cretaceous strata overlying those of the Lower Cretaceous. The structural cross section B-B' (Figure IV) cuts the syncline and illustrates the shallow westerly dip. Both the Arrowhead and Martin Syncline interpretations are based essentially on a stereoscopic study of aerial photographs. Whether or not these synclinal features flank well-defined anticlines is, at this time, purely conjectural.

South Nahanni Fault

The postulated (?) South Nahanni fault trends in a northwesterly direction along the valley of the South Nahanni River over a known distance of approximately 25 miles. The surface trace of this fault forms a distinct angle with the faults of the mountain front. It is thought to be a normal fault and to have preceded the late Cretaceous thrusting. The fault trace is, in part, covered by later Cretaceous strata and no evidence for a fault scarp is apparent. However, the upper Grumbler reefoid member, which generally shows up well on aerial photographs and as a scarp on the surface, could not be found reappearing to the west and the green shale unit appears to directly underlie Mississippian strata. As no unconformity is believed to exist between the Upper Devonian and Mississippian a reasonable explanation for the missing Grumbler formation and the Trout River formation is a fault with a stratigraphic displacement of approximately 5,000 feet. The fault is possibly of basement origin, of the type described by Goodman (4). Cross section A-A' (Figure III) shows this fault.

An alternate interpretation of the above relationship, without the fault, is also shown on Figure III. In this case the Grumbler reefoid member and Trout River formation are shown underlying a Cretaceous cover. Northwest of the line of cross section, however, the Cretaceous has been removed and here again no evidence was found of the reef scarp. Should the reefoid member occur at the surface it would very probably outcrop where the Liard River intersects it. All aspects of the situation considered, the fault interpretation is accepted, for the time being, as the most probable.

Foothills Type Folding

A series of tight, unbroken folds, similar to those of the Rocky Mountain foothills, occur along the Liard River to the southwest of the Permit

area. These are at a slight angle with, and just to the east of, the main thrusts of the Liard Range. Dips range from 5° to 20° and the largest has an axis extending for four or five miles. These were possibly formed by the same forces that built the mountains to the west and are the result of compression on a more competent, thicker series than is found to the north where the softer, Upper Devonian and Cretaceous shales absorbed the compression without folding.

Bovie Lake Uplift and Fault (?)

The Bovie Lake structure, which lies to the south of the area, extends for 30 miles or more and plunges out to the northwest. South of the Permit area strata of Mississippian age are exposed surrounded by Cretaceous rocks. While this structure is generally mapped as a thrust fault diminishing into a north plunging anticline, it could also exist as a tight fold over basement faulting at depth, of the type described by Goodman (4). Texaco N.F.A. Bovie Lake No. 1, was abandoned at a depth of 1,400 feet. As this is classified as a current wildcat no further information is available.

The only outcrops, related to the Bovie Lake structure, were on the Petitot and Arrowhead Rivers where it intersects these rivers. Further information is necessary in order to determine whether the uplift is faulted or not. If faulted, the Texaco N.F.A. Bovie Lake No. 1 well, which spudded in the Mississippian, might re-enter the Lower Cretaceous. Release of this well information will add to our knowledge of the structure.

Upper Petitot River Uplift

Very little is known of this structure, as only two outcrops were found on the Upper Petitot River. West-dipping crinoidal limestones of Mississippian age were observed, followed downstream to the west by a short covered interval, followed in turn by west-dipping black fissile shales, identified as probable Cretaceous. The river was travelled to its intersection with the Fort Simpson trail without finding any further outcrops to indicate either closure or faulting Unlike the Bovie Lake structure no topographic highs are related to this Paleozoic outcrop area. Where seen, the limestones were nearly flat-lying or only very gently west dipping and the structure is probably a broad gentle flexure. Due to the lack of outcrop nothing is known of the areal extent of the structure.

In our opinion, however, this outcrop represents an important regional feature, and it could affect a part of the project area. It is, in fact, quite likely that this feature is a continuation of the Nahanni fault (?) or scarp. The fact that no marked topographic expression of this Paleozoic outlier is evident is some indication that the Mississippian is base-leveled along the same early Mesozoic unconformity that is evident in the Klaskstone River area. As we interpret the photogeological information, the northeast side of this projected fault lines i structurally high, between the Nahanni and Petitot River area.

OIL AND GAS PROSPECTS

Several potential oil and gas horizons are known in the stratigraphic section in the Liard area. Following is a list and brief discussion of each known potential horizon.

"Granite Wash" Equivalent

As in other parts of Western Canada the "Granite Wash" represents a prospective reservoir. Little is known of it in the area as most of the wells studied did not reach it. The horizon was tested at the Imperial Island River well but results are not available.

Upper Ordovician

The coral reef zone in the basal part of the Upper Ordovician, with its cavernous and intercrystalline porosity, would appear to be another good potential horizon. From the limited available well evidence the zone is not recognized in wells drilled to the east of the Permit area. This means that the zone is either represented in the wells as an off-reef facies or has wedged out before reaching the wells, possibly in the Permit area. In either case the edge of the porosity could form a potential stratigraphic trap.

Bear Rock Formation

Hume (7) states, "The Bear Rock formation is perhaps the most widespread porous rock in the Mackenzie Valley area." Even though it is not as well developed in the study area as it is further north, the formation represents an important potential hydrocarbon reservoir in the Liard area. Cavernous zones up to 15 feet thick were seen in the Bear Rock and the underlying Lone Mountain formations. In addition much of the Bear Rock showed fair intercrystalline porosity. A limiting factor of the Bear Rock formation, as a reservoir, is the presence of an apparent evaporitic sequence in its place in the Plains area. However, brecciation is difficult to recognize in well samples and, bearing this in mind, much of the reported evaporitic and dolomitic sequence could be brecciated and therefore a potential horizon.

Ramparts Formation

In outcrop, much of the Ramparts is dense, with its best hydrocarbon reservoir possibilities occurring in reef developments. On the Plains, in the Slave Point, which, in this report, is questionably correlated with the Ramparts, both intercrystalline and intergranular porosity were observed in samples from the Westerol wells. No drill stem tests are reported from these wells.

Grumbler Formation

The upper reefoid member of the Grumbler formation could represent a shallow potential horizon through the eastern part of the Permit area, under favorable structural conditions or trapping at its truncated edge.

Rundle Group

Coarse crystalline limestones of the Rundle probably represent the best potential horizon of the Mississippian. Mississippian limestones encountered in the Imperial Island River well apparently did not warrant testing. It appears that the crystalline, crinoidal limestone of the Rundle, seen at Jackfish Gap, is either not developed at the Island River well or has been removed by erosion. In either case truncation or pinch-out of the porosity to the west, and probably in part of the Permit area, should present definite possibilities.

Other Horizons

Secondary objectives which might warrant testing include; the sandstones and siltstones in the upper part of the Upper Devonian green shale unit, the limestones of the Trout River formation, the clean, porous, quartzose sandstones of the Permo-Pennsylvanian, the Basal Conglomerate of the Cretaceous, the Scatter sandstone and the Fort Nelson formation.

It must be pointed out that hydrocarbon possibilities in sediments of Upper Devonian age and younger are limited to the southeastern part of the project area and Carboniferous rocks to the western part of the project area (Figure I).

The most probable structural trap within the limits of the project area would be a fault trap in the downthrown block of the postulated South Mahanni fault. The Upper Devonian Grumbler reefoid member should lie at a depth of approximately 3,000 feet and would be the shallowest objective. Other possibilities in connection with the same structure would be trapping on the upthrown side of the block. If no fault exists truncation of the Grumbler and other horizons by pre-Cretaceous erosion should provide suitable trap conditions (Figure III).

Due to heavy cover it is highly likely that many structures have remained masked. Geophysical or structure test work on the flanks of the Arrowhead and Martin synclines, and on extensions of the Bovie and Mahanni structures, might indicate the presence of associated structures.

Other structural possibilities include the foothills type folding along the front of the Liard Range. These will require more investigation to see how far into the Permit area their effect is felt.

Truncation of potential hydrocarbon horizons, including the Grumbler, the Rundle and possibly the Permo-Pennsylvanian, and subsequent covering by the Cretaceous sediments probably offer the most promising traps to be found in the area. This type of trap is probably best located by deep tests.

CONCLUSIONS AND RECOMMENDATIONS

The project area is located on the northern end of the Alberta Basin, also referred to as the southern part of the Mackenzie River Basin. The area is bounded to the west by the Liard and Mahanni Mountain Ranges, to the north by the Mackenzie River, to the east by the Simpson Trail and to the south by the Petitot River. The group of Permits involved, owned by Sun Oil Company, Murphy Corporation and Stanwell Oil and Gas Limited, contains approximately 997,524 acres, of which Sun holds 362,736 acres, Murphy Corporation holds 302,280 acres and Stanwell holds 332,508 acres.

The area is best described as an area of low relief and few prominent topographic features. The main topographic features are the Martin Hills, the Liard River and the Upper Devonian reef scarp. Other topographic features are the morainal hills near Trout Lake, and the narrow glacial flutings or drumlin type hills east of the Poplar River headwaters.

The main access routes include the Liard River during the summer, and the Simpson trail from Fort Nelson and the D. Todd Briggs trail from the east in the winter.

The entire area shows evidence of being overridden by the continental ice sheet. A layer of till, varying in thickness up to 300 feet or more, overlies the bedrock.

The principal structural and stratigraphic features of the area may be summarized as follows:

a) A marked angular unconformity occurs at the erosional contact of the Devonian and Cretaceous sediments. Another probably related feature is the rapid disappearance of Carboniferous rocks, in a west to east direction. This may be interpreted either as normal faulting or strong truncation (Figure III).

b) The main regional structural feature is the northern end of the Alberta Basin, which is outlined so well by the upturned edges of both Devonian and Cretaceous sediments. (Figure I)

c) Another important feature, which is indicated by comparison of sections in the mountains to the subsurface of the Plains, along the northern edge of the Alberta Basin, is the thinning of section from west to east or loss of section in the subsurface, suggesting the presence of a regional positive structural feature, probably of basement origin throughout most of the area.

d) The feature responsible for the disappearance of the Carboniferous rocks to the east suggests, as previously mentioned, a normal fault (the South Mahanni fault) or truncation.

The principal known drilling objectives over limited parts of the area are Cretaceous and Permo-Pennsylvanian sandstones, Mississippian limestones, Upper Devonian reefs and the reefs of Upper Ordovician. The Ramparts or Slave

Point with their associated reefs, the Bear Rock breccia, and the "Granite Wash," provide deeper prospective horizons over the entire project area.

In consideration of the above, our recommendations are as follows:

1. Carry out either a seismograph or a structure test survey of the South Nahanni fault. If results show no fault, at least the position of rapid pinch-out of the Carboniferous should show.

2. Carry out either a seismograph or a structure test survey of the Arrowhead and Martin synclinal features to check the possibility of finding associated folds which may reflect Paleozoic structure (or topography). Where the drift mantle is not too heavy, structure test work, especially in areas underlain by Devonian strata, should prove the most economical.

3. Carry out a program of shallow stratigraphic tests south of the Cretaceous erosional boundary with the object of locating the truncated edge of the Grumbler reef horizon.

4. Carry out seismograph or structure test work across the south-western part of those permits involved to check the effect of the possible extension of the Bovie fault and the Upper Petitot uplift through the Permit area.

In conclusion, it is our opinion that the several permits belonging to the three companies involved all have good prospects for the occurrence of oil and gas reservoirs, given the proper structural conditions. Several structural prospects are indicated, as above noted, but they all require some further investigation before deep holes can be drilled.

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TABLES

STRATIGRAPHIC CORRELATION CHART
LIARD AREA, N.W.T.

SHOWING LOCATION OF MEASURED SECTION AND SIGNIFICANT OUTCROPS

ERA		LABICHE RGE., LIARD RGE., FT. LIARD AREA	SOUTH NAHANNI AREA	NORTH NAHANNI AREA	PLAINS AREA
CRETACEOUS	UPPER	KOTANEELEE FM. 578+			
		FT. NELSON FM. 450+			FT. NELSON FM. 470+
		LEPINE FM. 2000+			8 LEPINE FM. ?
	LOWER	SCATTER FM. 375+			SCATTER FM. 320' (Netla R.)
		7 GARBUTT FM. 450±			GARBUTT FM. ?
		BASAL CONGLOMERATE 142'			BASAL CONGL. or SS. 40'
TRIASSIC		294'	Probably not present.		Not Present
PERMIAN		11 440'			Not Present
PERMO-PENNSYLVANIAN		3160'	3800' (Reported at Jackfish Gap)		395' (Liard R.)
MISSISSIPPIAN		1000'+	6 5 4 3502'		160' (Bovie L. Fault)
DEVONIAN	UPPER	Not Exposed	Not Exposed	IMPERIAL FM.	WABAMUN & TROUT R. (undifferentiated) 700' est.
				9 GRUMBLER "EQUIV."	GRUMBLER FM. Reefoid Mem. 30' to 110' / Silty Ls. Mem. 100' est.
				SHALE UNIT	10 GREEN SHALE UNIT 2200±
	MIDDLE	Not Exposed	RAMPARTS FM. 689'	RAMPARTS FM. (Hume)	* SLAVE POINT FM. 250'±
DEVONIAN - SILURIAN		Not Exposed	3 BEAR ROCK FM. 340' / 2 LONE MOUNTAIN FM. 1420'	LONE MOUNTAIN FM. (Kindle)	EVAPORITES & CARBONATES
ORDOVICIAN	UPPER	Not Exposed	FOSSILIFEROUS DOLOMITE 990'		Probably not present.
CAMBRO-ORDOVICIAN		Not Exposed	1 SANDY DOLOMITE 577'+		

* Correlation with Ramparts Fm. is questionable.

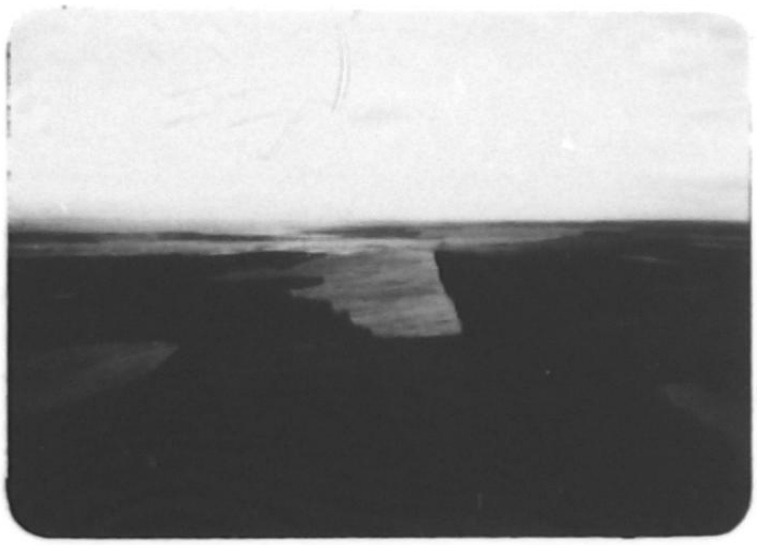
7 Measured Section.

J. C. SPROULE & ASSOCIATES, CALGARY.

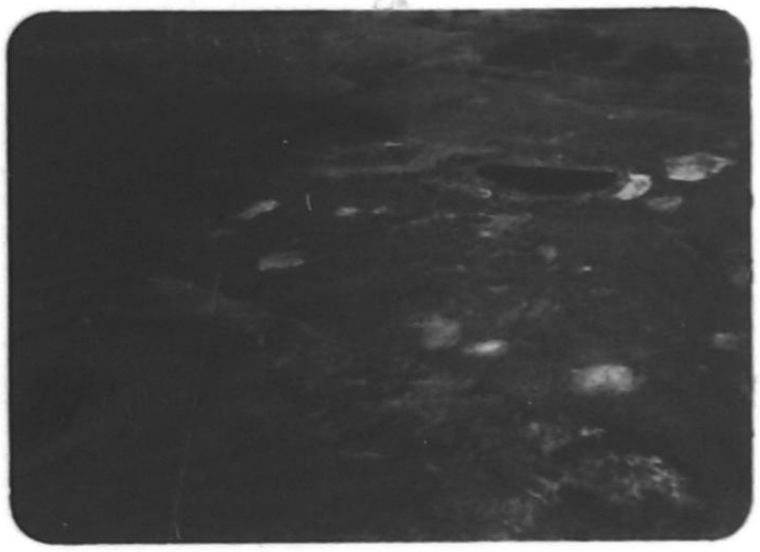
GENERAL TOPOGRAPHY

A. View of the Plains from Nahanni Butte. The Liard River is on the right. The Martin Hills show faintly in the left background. Photo by G.K. Williams.

B. Air view southwest from a point east of Sibbeston Lake. Nahanni Butte shows on the horizon. Photo by G.K. Williams.



A. Glacial fluting near Sibbeston Lake. Photo by K.W. Lyle.



B. Typical muskeg. Photo by G.K. Williams.

A. Topography of Plains area. View is to the east from forks of Martin River. Photo by G.K. Williams.

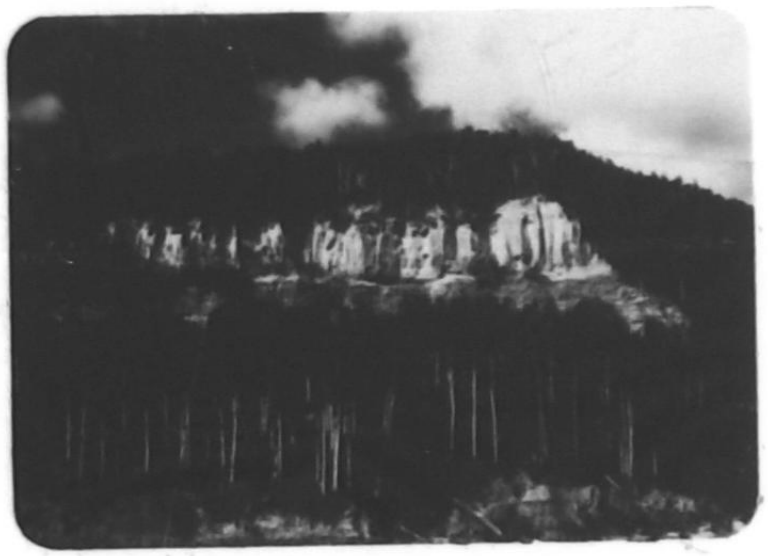
B. Helicopter on muskeg. Photo by G.K. Williams.

A. Martin Hills, an outlier of Lower Cretaceous. Photo by G. K. Williams.

GEOLOGY OF PLAINS

B. Kotaneelee formation in the Kotaneelee River valley. Photo by K.W. Lyle.

A. Conglomerate of the Ft. Nelson formation on the Kotaneelee River. The rubber dinghy was a convenient means of transportation for certain streams. Photo by K.W. Lyle.



B. Massive sandstones of the lower part of the Fort Nelson formation on the Petitot River. Photo by N.N. Peterson.

A. Lepine formation on the Petitot River. Photo by N. N. Peterson.

B. Exposure of Scatter formation on Netla Creek. Photo by N. N. Peterson.

A. Garbutt formation on the Arrowhead River. Photo by G.K. Williams.

B. Outcrop of Mississippian limestone on the Petitot River on the west flank of the Bovie Lake structure. Photo by G.K. Williams.

A. Leiorhynchus zone, Trout River formation on the Blackstone River. Photo by N. N. Peterson.

B. Outcrop of the reefoid member of the Grumbler formation on the Blackstone River.

A. Reefoid member of the Grumbler formation on the Birch River.

B. Reefoid member of the Grumbler formation on the Poplar River.

A. Outcrop of Upper Devonian, green shale zone on the Blackstone River. Photo by N.N. Peterson.

GEOLOGY OF MOUNTAINS

B. Permo-Pennsylvanian - Permian (chert zone) contact on Labiche Range. Stratigraphic Section No. 11 (Appendix XI). Photo by K.W. Lyle.

A. Lower part of Permo-Pennsylvanian on Labiche Range. Stratigraphic Section No. 11 (Appendix XI). Photo by K. W. Lyle.

B. Mississippian at Jackfish Gap. Stratigraphic Section No. 6. Photo by G. K. Williams.

A. Mississippian at Jackfish Gap. Stratigraphic Section No. 6. Photo by G. K. Williams.

B. Mississippian at Jackfish Gap. Stratigraphic Section No. 6. Photo by G. K. Williams.

A. Lower Mississippian shale on Bluefish Range. Stratigraphic Section No. 4. Photo by K.W. Lyle.

B. Mississippian-Devonian contact at Jackfish Gap. Stratigraphic Section No. 6. Photo by G.K. Williams.

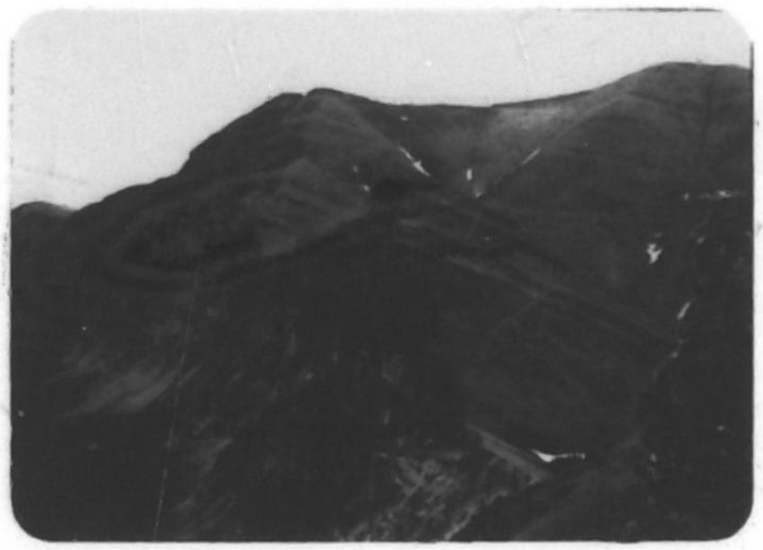
A. Ramparts formation on dip slope of Nahanni Range north of Stratigraphic Section No. 2. Photo by G. K. Williams.

B. Argillaceous limestone zone in Ramparts formation at Stratigraphic Section No. 2. Photo by K. W. Lyle.

A. Ramparts, undifferentiated Bear Rock and Lone Mountain formations at Stratigraphic Section No. 2. Photo by K. W. Lyle.

B. Ramparts, Bear Rock and Lone Mountain formations along the north side of Little Doctor Lake. Photo by G. K. Williams.

A. Breccia of Bear Rock formation at Bluefish Lake. Stratigraphic Section No. 3. Photo by N. N. Peterson.



B. Cambro-Ordovician - Upper Ordovician contact at Red Rock Pass. Stratigraphic Section No. 1. Photo by K. W. Lyle.

A. Fossiliferous mottled dolomite of basal Upper Ordovician. Stratigraphic Section No. 1. Photo by K. W. Lyle.

B. Cambro-Ordovician at Red Rock Pass. Stratigraphic Section No. 1. Photo by K. W. Lyle.

APPENDICES

STRATIGRAPHIC SECTION NO.1

RED ROCK PASS, FIGURE I

Measurement of Middle Devonian to Cambrian sediments on Nahanni Range at approximately 61° 50' north latitude. Measurement by pogo stick and tape from bottom to top converted to read from top to bottom.

Interval Feet	Thickness Feet	Description
DEVONIAN-SILURIAN		Lone Mountain Formation
0-10	10	Quartzite - light grey to buff, round coarse grains, thin bedded and platy in part. Weathers rust and buff.
10-38	28	Quartzite and dolomite - quartzite as above with light grey, finely crystalline, cream weathering silty dolomite interbeds. The zone is partially covered.
38-72	34	Quartzite - as above.
UPPER ORDOVICIAN		
72-74	2	Dolomite - light grey, finely crystalline, silty, massive. Weathers cream.
74-78	4	Covered.
78-184	106	Dolomite - dark grey to black, dense to finely crystalline, minor brown chert in nodules and 1 inch to 8 inch beds, minor secondary dolomite, thin-bedded. Weathers light grey.
184-244	60	Dolomite - dark grey to black, dense to finely crystalline, minor secondary dolomite, thick-bedded to massive. Weathers light grey.
244-257	13	Covered.
257-274	17	Dolomite - dark grey, dense to finely crystalline, interbedded dolomite and 2 inch, black shale beds at base, thin-bedded.
274-289	15	Covered.

Interval Feet	Thickness Feet	Description
289-379	90	Dolomite - light grey, finely crystalline, silty, minor chert, one 3 foot bed of secondary dolomite; one 2 foot bed of light grey quartzite, thin-bedded. Weathers light grey.
379-408	29	Covered.
408-448	40	Dolomite - medium grey to dark grey, dense to finely crystalline, minor chert, minor secondary dolomite, thin to thick-bedded. Weathers in light and dark grey bands.
448-462	14	Covered.
462-499	37	Dolomite - black, dense, black and brown chert, vugs (1/2 inch in diameter) on weathered surface, Halysites at base, thin-bedded but massive weathering. Weathers dark grey.
499-541	42	Dolomite - black, dense, numerous small vugs, minor brown bedded chert, massive, rubbly. Weathers light grey.
541-556	15	Covered.
556-600	44	Dolomite - black, dense to finely crystalline, minor black chert, minor secondary dolomite, massive, rubbly. Weathers dark grey.
600-630	30	Dolomite - light to dark grey, dense to finely crystalline, thin-bedded (6 inch to 1 foot beds). Weathers light grey.
630-640	10	Argillaceous dolomite - light grey, dense, thin-bedded, well-bedded. Weathers buff.
640-690	50	Dolomite - as above.
690-705	15	Dolomite - black, dense, composed mainly of fossil fragments and secondary dolomite, massive, rubbly. Weathers black.
705-715	10	Thin-bedded dolomite - as above.
715-730	15	Covered.
730-785	55	Dolomite - dark grey, dense, fractured, minor secondary dolomite, massive. Weathers dark grey.
785-835	50	Covered.

Interval Feet	Thickness Feet	Description
289-379	90	Dolomite - light grey, finely crystalline, silty, minor chert, one 3 foot bed of secondary dolomite; one 2 foot bed of light grey quartzite, thin-bedded. Weathers light grey.
379-408	29	Covered.
408-448	40	Dolomite - medium grey to dark grey, dense to finely crystalline, minor chert, minor secondary dolomite, thin to thick-bedded. Weathers in light and dark grey bands.
448-462	14	Covered.
462-499	37	Dolomite - black, dense, black and brown chert, vugs (1/2 inch in diameter) on weathered surface, Halysites at base, thin-bedded but massive weathering. Weathers dark grey.
499-541	42	Dolomite - black, dense, numerous small vugs, minor brown bedded chert, massive, rubbly. Weathers light grey.
541-556	15	Covered.
556-600	44	Dolomite - black, dense to finely crystalline, minor black chert, minor secondary dolomite, massive, rubbly. Weathers dark grey.
600-630	30	Dolomite - light to dark grey, dense to finely crystalline, thin-bedded (6 inch to 1 foot beds). Weathers light grey.
630-640	10	Argillaceous dolomite - light grey, dense, thin-bedded, well-bedded. Weathers buff.
640-690	50	Dolomite - as above.
690-705	15	Dolomite - black, dense, composed mainly of fossil fragments and secondary dolomite, massive, rubbly. Weathers black.
705-715	10	Thin-bedded dolomite - as above.
715-730	15	Covered.
730-785	55	Dolomite - dark grey, dense, fractured, minor secondary dolomite, massive. Weathers dark grey.
785-835	50	Covered.

Interval Feet	Thickness Feet	Description
835-845	10	Dolomite - dark grey, dense to finely crystalline, contains speckles of white dolomite crystals, massive, rubbly. Weathers light grey.
845-882	37	Dolomite - dark grey, dense to finely crystalline, thin-bedded, fractured. Weathers buff.
882-902	20	Covered.
902-1022	120	Mottled Dolomite - black, dense, dolomite mottles are secondary forming 50% of the rock, highly fossiliferous, massive, rubbly. Weathers mottled black and white.
1022-1062	40	Mottled Dolomite - black, dense, interbedded black fissile shale beds up to one foot thick, abundant Halysites, thin irregular beds, rubbly. Weathers mottled black and white.
CAMBRO-ORDOVICIAN		
1062-1082	20	Quartzite - light grey, fine grained, regular interbeds of black fissile shale up to 3 feet thick, thin-bedded. Weathers buff to cream.
1082-1095	13	Quartzite - white to dark grey, vitreous and shadowy, coarse grained, porous, thick-bedded, well-bedded. Weathers grey and rust.
1095-1122	27	Quartzite - black, fine grained, regular interbeds of black fissile shale up to 10 feet thick, thin-bedded, well-bedded and fractured. Weathers rust.
1122-1225	103	Silty dolomite - greenish brown, dense, minor thin beds of quartzite, minor quartz, thin to thick-bedded, well-bedded. Weathers greenish buff.
1225-1327	102	Silty dolomite - pink and greenish brown, dense, minor interbeds (one foot thick) of light brown to pink, coarse grained, buff weathering quartzite, thin-bedded, fractured. Weathers pink and buff.
1327-1387	60	Silty dolomite - pink and greenish brown, dense, minor conglomerate beds to two inches thick containing dolomite pebbles, thin-bedded, well-bedded. Weathers pink and buff.
1387-1412	25	Dolomite - dark grey to black, dense to finely crystalline, slightly silty, thin interbeds of shiny black chert, blebs of black chert. Weathers buff.

Interval Feet	Thickness Feet	Description
1412-1429	17	Sandy dolomite - brownish pink to green to black, dense, argillaceous, minor quartz veining, massive. Weathers buff to pink.
1429-1437	8	Dolomite - black, dense, sandy, interbedded shale, thin-bedded. Weathers buff.
1437-1487	50	Sandy dolomite - as above.
1487-1497	10	Dolomite - as above.
1497-1540	43	Sandy dolomite - as above.
1540-1545	5	Conglomerate - dark grey quartzite pebbles to 1 inch in long diameter in a sandy dolomite matrix, minor chert pebbles. Weathers cream.
1545-1635	90	Sandy dolomite - as above. Minor thin conglomerate and quartzite beds.
1635-1639	4	Quartzite - buff to pink, coarse grained, interbeds of green shale, secondary dolomite, thin-bedded. Weathers buff, pink, and green.

Description by K. W. Lyle and
L. A. Singleton.

STRATIGRAPHIC SECTION NO. 2

CREEK SOUTH OF LITTLE DOCTOR LAKE, FIGURE I

Measurement of Middle Devonian and Silurian sediments on Nahanni Range at approximately 61° 56' north latitude. Measurement by pogo stick and tape from top to bottom.

Interval Feet	Thickness Feet	Description
MIDDLE DEVONIAN		Ramparts Formation
0-229	229	Dolomitic limestone - light to dark grey and black, dense to coarsely crystalline, minor 2 inch wavy interbeds of dark brown to black calcareous dolomite which gives cyclic appearance to portions of the section; calcite veinlets vertical to and parallel to the bedding planes are common; highly fossiliferous, including solitary, colonial and branching type corals, brachiopods, crinoids, trilobites, worm borings and algae balls. Every 20 or 30 feet distinct breaks in the zone occur, these breaks erode readily and are abundantly fossiliferous at the base. The zone is a cliff former and forms the dip slope of the range. Thin bedded to massive, often shows hackley fracture. Weathers light grey.
229-236	7	Argillaceous dolomitic limestone - black, dense, undulating, one inch calcareous shale interbeds, thin bedded. Weathers dark grey to black.
236-271	35	Covered, presumably as above.
271-381	110	Dolomitic limestone - as above, abundantly fossiliferous towards the base.
381-445	64	Argillaceous dolomitic limestone - light to dark grey, dense to finely crystalline, calcareous shale interbeds, abundant calcite veins, abundant Spirifers, minor corals and fossil fragments, thin-bedded, rubbly. Weathers light grey to rust.
445-663	218	Dolomitic limestone - light grey to black, dense to finely crystalline, numerous calcite veins, includes two foot mottled limestone bed at base, includes one foot dolomite concretion zone, the dolomite is dark grey, crystalline and contains fossil fragments and pyrite, the concretions are encased in sandy clay, includes two Amphipora beds two to three feet thick,

Interval Feet	Thickness Feet	Description
		minor branching corals and fossil fragments, thin-bedded, well-bedded, probably very thin shale interbeds. The thin-bedded characteristic of the section makes it quite distinct. The basal 121 feet contains thicker shale interbeds giving slight change in slope. Weathers light grey.
DEVONIAN-SILURIAN		Bear Rock and Lone Mountain Formations (Undifferentiated)
663-1904	1241	Banded dolomite - light to dark grey to black, dense to coarsely crystalline, dolomite veining, vuggy beds representing cavernous porosity occur frequently throughout the zone. Five such zones from two feet to fifteen feet thick with numerous thinner ones are present. Most vugs are encased with dolomite crystals and to a minor degree calcite crystals with the diameter of the vugs varying from one to two inches with exceptional ones as large as two feet; minor sand and silt; fossils are scarce with only one coral, a few crinoid stems and a two foot Amphipora bed seen; thin-bedded to massive, well-bedded. The zone is a thick series of black and light grey banded dolomite overlain by light grey weathering dolomitic limestone and underlain by light grey weathering dolomite. Weathers banded black and light grey.
1904-2185	281	Dolomite - brownish grey, predominantly dense to finely crystalline, minor chert and sandy dolomite interbeds, thin-bedded to massive at base. Weathers light grey and shows a peculiar black and white speckled pattern, caused by lichen.
2185-2206	21	Dolomite - light buff to light grey, dense to finely crystalline in part, thin-bedded, rubbly. Weathers buff, distinct weathering break from light grey of above zone.
2206-2228	22	Covered.
2228-2236	8	Dolomite - as above.
2236-2252	16	Covered.
2252-2256	4	Quartzite - white, rounded coarse grains, massive. Weathers reddish brown.
2256-2259	3	Dolomite - as above.
2259-2263	4	Quartzite - as above, slightly irregular contact with dolomite below.
2263-2295	32	Dolomite - light to dark grey, dense, thin-bedded, well-bedded. Weathers light grey.

Interval Feet	Thickness Feet	Description
2295-2315	20	Covered - fragment of conglomerate containing dolomite pebbles in sandstone matrix found in talus.
2315-2319	4	Quartzite - as above, banded grey and rust.
UPPER ORDOVICIAN		
2319-2372	53	Dolomite - light to dark grey, dense, silty in part, thin-bedded, well-bedded. Weathers dark grey to black.
2372-2379	7	Covered.
2379-2473	94	Dolomite - as above, minor chert tracery. Weathers light grey.
2473-2552	79	Covered - one two foot black argillaceous dolomite outcrop.
2552-2596	44	Dolomite - as above, contains four foot bed of dark grey, massive, black weathering, silty dolomite breccia with quartzite and pyrite.
2596-2609	13	Covered.
2609-2613	4	Silty dolomite - dark grey, finely crystalline, chert blebs, abundant corals, massive, Weathers dark grey.
2613-2649	36	Dolomite - dark grey, medium crystalline, chert common, thin-bedded. Weathers light grey.
2649-2744	95	Covered.
2744-2909	165	Dolomite - dark grey to black, dense to finely crystalline, massive. Weathers black.
2909-3025	116	Covered.
3025-3059	34	Dolomite - medium grey to dark grey, dense to finely crystalline, thin-bedded. Weathers light grey.

Description by K. W. Lyle and
L. A. Singleton.

STRATIGRAPHIC SECTION NO. 3

BLUEFISH LAKE, FIGURE I

Measurement of Middle Devonian to Ordovician sediments on Nahanni Range at Bluefish Lake . Measurement by pogo stick from top to bottom.

Interval Feet	Thickness Feet	Description
MIDDLE DEVONIAN		**Ramparts Formation**
0-325	325	Dolomitic limestone - black, dense to finely crystalline, dolomitic resulting in mottled appearance, calcite veining, coral fragments, Amphipora, brachiopods, crinoid stems, 55 feet from the top a highly fossiliferous limestone occurs, 75% of which is Amphipora and corals; 60 feet from the top, solitary corals were collected from an argillaceous zone in which caves are readily formed and calcite veining is common; generally massive with minor thin bedding at base and thick bedding towards top. Weathers light grey and buff grey.
325-360	35	Dolomitic limestone - dark grey, dense to finely crystalline, dolomite causes mottled appearance; calcite veining, 10 foot vertical quartz vein which consists of quartz blocks in quartz matrix; thick-bedded (3 to 4 feet), rubbly. Weathers light grey.
360-382	22	Dolomitic limestone - as above, contains chert coral fragments 12 feet from the top, numerous Amphipora beds and minor solitary corals.
382-462	80	Dolomite breccia - dark grey, finely crystalline, dark grey angular dolomite blocks in white coarsely crystalline dolomite matrix, fossil remains, thin-bedded, rubbly. Weathers light grey.
462-470	8	Dolomite breccia - as above, abundant chert and fossil remains. Weathers dark grey.
470-477	7	Dolomite breccia - as above, no chert.
477-481	4	Limestone - black, dense, cherty fossil fragments, minor mottling, thick-bedded. Weathers light grey.

Interval Feet	Thickness Feet	Description
481-501	20	Dolomite - dark grey, coarsely crystalline, abundant secondary dolomite, poorly preserved fossils, vuggy on weathered surface, thin-bedded, rubbly. Weathers very light grey.
501-535	34	Dolomitic limestone - dark grey to black, dense to finely crystalline, thin-bedded. Weathers light and dark grey.
535-563	28	Dolomite - black and dark brown, coarsely crystalline, bedded black chert at base, fossiliferous, fossils composed of black and brown chert, poorly bedded, rubbly. Weathers light and dark grey.
563-568	5	Limestone - black, finely crystalline, argillaceous, solitary and branching corals, thin-bedded, rubbly. Weathers dark grey.
568-613	45	Covered.
613-624	11	Limestone - black and light grey, dense to finely crystalline, fossiliferous, crinoid stems and corals, minor black calcareous dolomite tracery which appear to be poorly preserved solitary and branching corals. Weathers light grey.
624-645	21	Dolomitic limestone - black, dense to finely crystalline, calcite veining, basal 4 feet has distinct calcareous dolomite tracery, massive, rubbly. Weathers light grey.
645-689	44	Dolomitic limestone - as above, possible coral fragments near base.
DEVONIAN-SILURIAN		Bear Rock Formation
689-726	37	Dolomite breccia - dark brown to black, coarsely crystalline, angular dark colored dolomite encased with buff and white dolomite and calcite, porous, massive. Weathers speckled buff and black.
726-745	19	Covered.
745-751	6	Dolomite - buff-grey, coarsely crystalline, massive, Weathers mottled black and white.
751-843	92	Dolomite - dark grey to black, coarsely crystalline, minor secondary calcite and dolomite, minor breccia, massive. Weathers banded dark grey and light grey.
843-849	6	Dolomitic limestone - black, dense, massive. Weathers light grey.

Interval Feet	Thickness Feet	Description
849-927	78	Covered.
		Lone Mountain Formation
927-1031	104	Dolomite - dark grey to black, coarsely crystalline, secondary dolomite, vuggy, porous, minor quartz, massive. Weathers banded dark and light grey.
1031-1080	49	Covered.
1080-1120	40	Banded dolomite - light to dark grey, finely to coarsely crystalline, minor secondary dolomite and quartz, in general the dark grey dolomite is coarsely crystalline while the light grey dolomite is finely crystalline, massive, poorly bedded. Weathers banded light and dark grey.
1120-1188	68	Banded dolomite - black, coarsely crystalline, vuggy, secondary dolomite and quartz, massive. Weathers banded light and dark grey.
1188-1263	75	Banded dolomite - light and dark grey, coarsely crystalline, minor secondary dolomite, abundant dolomite veining, minor breccia, massive. Weathers banded light and dark grey.
1263-1403	140	Banded dolomite - light grey to dark grey, finely to coarsely crystalline, sugary, minor secondary calcite, dolomite veining, thick-bedded to massive. Weathers banded light and dark grey.
1403-1533	130	Covered.
1533-1688	155	Banded Dolomite - light grey to dark grey, dense to coarsely crystalline, minor secondary calcite, dolomite veining, fractured, thick-bedded. Weathers banded light and dark grey.
1688-1689	1	Dolomite breccia - geodes (2 to 3 inches in diameter) filled with white crystalline dolomite which encase angular black dolomite.
1689-1789	100	Banded dolomite - as above.
1789-1791	2	Dolomite breccia - as above.
1791-2033	242	Banded dolomite - as above.
2033-2035	2	Dolomite - light grey, finely crystalline, porous, minor calcite.

Interval Feet	Thickness Feet	Description
2035-2101	66	Dolomite - brownish grey, dense to finely crystalline, dolomite veining, thick-bedded to massive. Weathers light grey.
2101-2151	50	Dolomite - dark grey to brownish grey with minor maroon, coarsely crystalline, sugary, minor dolomite veining, minor vugs, fair porosity, massive. Weathers light and dark grey.
2151-2266	115	Dolomite - brownish grey, light and dark grey, dense to finely crystalline, minor dolomite veining, minor small vugs, thin to thick-bedded (4 inches to 5 feet). Weathers light grey.
2266-2281	15	Dolomite - medium grey to brown, dense to finely crystalline, brown and medium grey dolomite is finely interbedded and patchy, minor secondary dolomite, thin-bedded. Weathers buff.
2281-2353	72	Covered.
2353-2383	30	Dolomite - brown to light and dark grey, dense to finely crystalline, silty, argillaceous, minor small vugs, thin-bedded (2 inches to 2 feet) and platy (1/2 inch). Weathers light grey and buff.
2383-2388	5	Quartzite - light brown to white, coarse grained, rounded grains; pebble conglomerate, composed of rounded, varicolored chert pebbles (to 1/2 inch in long diameter) in basal 6 inches, thin-bedded. Weathers brown.
2388-2420	32	Dolomite - as above, silty in upper part.
2420-2425	5	Quartzite - as above.
2425-2428	3	Dolomite - brownish grey, dense, interbeds of quartzite. Weathers green.
2428-2448	20	Quartzite - as above, well cemented pebble conglomerate at the base. Weathers pink.
2448-2451	3	Pebble conglomerate - as above, regular thin interbeds of quartzite. Weathers brown.
UPPER ORDOVICIAN		
2451-2534	83	Dolomite - light to medium grey, dense to finely crystalline, slightly silty in part, minor dolomite veining, thin-bedded (2 inches to 6 inches). Weathers light grey.

Description by K. W. Lyle and
L. A. Singleton.

STRATIGRAPHIC SECTION NO. 4

UPPER GRAINGER RIVER, FIGURE I

Measurement of Mississippian sediments just east of Bluefish Range. Measured by pogo stick top to bottom.

Interval	Thickness Feet	Description
MISSISSIPPIAN		
0-110	110	Shale - black, fissile, silty, resistant; 2-inch highly carbonaceous shale band occurs near base. Weathers greenish rust.
110-180	70	Shale - Black, fissile, silty, highly polished shale fragments seen in talus. Weathers greenish buff.
180-181	1	Sandstone - dark grey, fine-grained, dirty. Weathers rust.
181-253	72	Shale - as above, resistant.
253-273	20	Shale - black, fissile, silty, soft. Weathers black with abundant rust and yellow staining.
273-298	25	Shale - black, fissile, silty, resistant, white crystalline salty residue on weathered surface.
298-335	37	Shale - black, fissile, silty, soft. Weathers dark grey to black.
335-337	2	Shale - black, silty, thin-bedded (2-inch beds). Weathers as a rusty massive bed.
337-460	123	Shale - black, fissile, silty, soft, platy habit; calcareous silty zones resemble concretions and weather rusty. Weathers rust and black.

Description by K. W. Lyle and
L. A. Singleton.

APPENDIX V

STRATIGRAPHIC SECTION NO. 5 (COMPOSITE)

BLUEFISH RANGE, FIGURE I

Measurement of Pennsylvanian and Mississippian sediments on Bluefish Range at approximately 61° 22' north latitude, and Mississippian sediments on Bluefish Range at approximately 61° 32' north latitude. Measurement by pogo stick and tape top to bottom.

Interval Feet	Thickness Feet	Description
PERMO-PENNSYLVANIAN		
0-110	110	Sandstone - white, coarse grained, quartzose, very minor angular black chert, fair porosity, basal part becomes fine to medium grained and sugary, massive. Weathers dark grey and rust.
110-123	13	Covered.
123-142	19	Sandstone - white, fine grained, argillaceous stringers, very thin interbeds of shale giving rubbly effect to outcrop, worm borings, thin-bedded (1 to 2 inches). Weathers dark grey.
142-176	34	Sandstone - white, fine grained, minor thin shale partings, sugary, massive. Weathers rusty and dark grey.
176-216	40	Covered.
MISSISSIPPIAN		
216-230	14	Crinoidal limestone - brownish grey, coarsely crystalline, abundant crinoid stems, brachiopods, minor bedded black chert replete with crinoid stems, thin-bedded. Weathers buff.
230-239	9	Covered.
239-249	10	Crinoidal limestone - as above.
249-271	22	Limestone - brownish grey, finely crystalline, minor crinoidal limestone beds, minor platy argillaceous limestone partings, bedded black chert and chert blebs, thick-bedded. Weathers buff.
271-315	44	Covered.

Interval Feet	Thickness Feet	Description
315-331	16	Limestone - dark brownish grey to black, dense to finely crystalline, argillaceous, interbeds of platy shale up to 1 foot thick, thin-bedded. Weathers buff.
331-802	471	Covered
802-813	11	Limestone - brownish grey, finely crystalline, crinoid stems, solitary and colonial corals, shale interbeds, thin-bedded. Weathers buff.
813-827	14	Covered.
827-832	5	Limestone - dark brownish grey, coarsely crystalline, highly fossiliferous, large horn corals, colonial corals, massive. Weathers buff.
832-855	23	Covered.
855-868	13	Limestone - brownish grey, finely crystalline, rubbly, highly fossiliferous, brachipods, cephalopods, branching and colonial corals, crinoidal limestone at base, thin-bedded. Weathers buff.
868-885	17	Covered.
885-893	8	Limestone - brownish grey and black, dense to finely crystalline, partings of argillaceous limestone, abundant crinoid stems, brachiopods and corals, thick-bedded. Weathers buff.
893-907	14	Covered.
907-918	11	Limestone - brownish grey and dark grey, finely crystalline, fossil fragments, crinoid stems and colonial corals, thin-bedded. Weathers buff.
918-925	7	Covered.
925-962	37	Limestone - dark grey, finely crystalline, argillaceous limestone partings, abuniant bedded black chert up to 4 inches thick, crinoid stems, fossil fragments, large solitary corals, thick-bedded. Weathers buff.
962-972	10	Covered.
972-992	20	Limestone - as above, minor thin coquina beds.
992-1091	99	Covered.
1091-1096	5	Sandy limestone - light grey, finely crystalline, brachiopods and algae balls, argillaceous stringers, thin-bedded, rubbly. Weathers rust.

Interval Feet	Thickness Feet	Description
1096-1116	20	Covered.
1116-1123	7	Sandy limestone - as above.
1123-1267	144	Covered.
1267-1268	1	Crinoidal limestone - composed almost entirely of crinoid stems.
1268-1285	17	Limestone - dark grey, dense to finely crystalline, argillaceous limestone partings and bedded black chert, thin-bedded. Weathers reddish buff.
1285-1312	27	Covered - presumably black fissile shale.
1312-1316	4	Crinoidal limestone - light grey, green or maroon, coarsely crystalline, abundant crinoid stems, fossil fragments, massive. Weathers rust.
1316-1329	13	Sandstone - buff, fine grained, micaceous laminae, very thin-bedded, thin shale partings. Weathers buff.
1329-1409	80	Shale - dark grey, fissile, silty, interbeds of above sandstone near top, minor crinoidal limestone. Weathers dark grey and brown.
1409-1411	2	Crinoidal limestone - as above, sandy.
1411-1429	18	Sandstone and shale - buff, fine grained, micaceous laminae, regularly interbedded with black, slightly silty, fissile shale; very thin-bedded. Weathers buff.
1429-1449	20	Shale - black, fissile, slightly silty.
1449-1462	13	Sandstone and shale - as above.
1462-1538	76	Shale - black, fissile, minor thin siltstone beds and one thin crinoidal limestone bed near top, minor bedded limestone and sandstone nodules throughout shale. Weathers dark grey.
1538-1540	2	Crinoidal limestone - as above.
1540-1562	22	Covered - presumably shale.
1562-1572	10	Limestone - brownish grey, finely crystalline, sandy, unfossiliferous except for crinoid stems near top, thin-bedded. Weathers buff.
1572-1605	33	Shale - dark grey to brownish grey, fissile, soapy, soft. Weathers dark grey.

Interval Feet	Thickness Feet	Description
1096-1116	20	Covered.
1116-1123	7	Sandy limestone - as above.
1123-1267	144	Covered.
1267-1268	1	Crinoidal limestone - composed almost entirely of crinoid stems.
1268-1285	17	Limestone - dark grey, dense to finely crystalline, argillaceous limestone partings and bedded black chert, thin-bedded. Weathers reddish buff.
1285-1312	27	Covered - presumably black fissile shale.
1312-1316	4	Crinoidal limestone - light grey, green or maroon, coarsely crystalline, abundant crinoid stems, fossil fragments, massive. Weathers rust.
1316-1329	13	Sandstone - buff, fine grained, micaceous laminae, very thin-bedded, thin shale partings. Weathers buff.
1329-1409	80	Shale - dark grey, fissile, silty, interbeds of above sandstone near top, minor crinoidal limestone. Weathers dark grey and brown.
1409-1411	2	Crinoidal limestone - as above, sandy.
1411-1429	18	Sandstone and shale - buff, fine grained, micaceous laminae, regularly interbedded with black, slightly silty, fissile shale; very thin-bedded. Weathers buff.
1429-1449	20	Shale - black, fissile, slightly silty.
1449-1462	13	Sandstone and shale - as above.
1462-1538	76	Shale - black, fissile, minor thin siltstone beds and one thin crinoidal limestone bed near top, minor bedded limestone and sandstone nodules throughout shale. Weathers dark grey.
1538-1540	2	Crinoidal limestone - as above.
1540-1562	22	Covered - presumably shale.
1562-1572	10	Limestone - brownish grey, finely crystalline, sandy, unfossiliferous except for crinoid stems near top, thin-bedded. Weathers buff.
1572-1605	33	Shale - dark grey to brownish grey, fissile, soapy, soft. Weathers dark grey.

Interval Feet	Thickness Feet	Description
1605-1610	5	Limestone - dark grey to brownish grey, finely crystalline, thin-bedded, argillaceous, minor thin partings of slightly silty shale. Weathers buff.
1610-1664	54	Shale - as above.
1664-1673	9	Limestone - dark grey, finely crystalline, bedded nodules on weathered surface, fossiliferous, resistant, massive, basal three feet is brown, sandy, soft shale containing limestone nodules. Weathers buff.
1673-1704	31	Shale - brown, blocky, sandy, soft. Weathers buff.
1704-1706	2	Limestone - dark grey, coarsely crystalline, sandy, fossil fragments near top, massive. Weathers buff.
1706-1737	31	Covered - presumably shale.
1737-1768	31	Shale - brownish grey, fissile, soapy; tiny, bedded, rusty weathering concretions; four 1 foot interbeds of limestone which is dark grey, finely crystalline, thin-bedded, containing brachiopod fragments and crinoid stems, weathers buff, minor thin interbeds of brown, sandy, soft, buff weathering shales. Weathers dark grey.

Description by E. W. Lyle and
L. A. Singleton

APPENDIX VI

STRATIGRAPHIC SECTION NO. 6

JACKFISH GAP, FIGURE I

Permo-Pennsylvanian, Mississippian and Devonian measured by pogo stick from bottom to top, converted to read from top to bottom.

Interval Feet	Thickness Feet	Description
PERMO-PENNSYLVANIAN		
	3800	Sandstone - white, rusty, maroon, fine to medium grained, partly coarse-grained, quartzose grains sub-angular to sub-rounded, frosted(?), fair sorting, carbonaceous plant fragments, oscillation ripple marks, partly unconsolidated, fair to good porosity, interbedded with finaly sandy and silty intervals and shale, semi fissile; thick bedded, rusty weathering. A four foot interval of coal with Pennsylvanian plant spores has been reported 700 feet above the base of the section.
0-25	25	Shale - ochre weathering limestone layers, one foot thick at the base.
MISSISSIPPIAN		Rundle Formation (?)
25-39	14	Shale - dark grey, interbedded with limestone, grey, finely crystalline, nodular.
39-117	78	Limestone - light grey to grey-brown, crinoidal coquina, coarsely crystalline, glauconitic, hard, massive to thick-bedded. Weathers grey - large Rundle type blocks.
117-167	50	Limestone - light brown-grey, crystalline, very crinoidal, interbedded with equal amount of dark grey shale, medium-bedded. Weathers brown-grey.
167-210	43	Limestone - brown-grey, crystalline, fine crinoidal coquina, numerous black chert nodules, minor thin shaly interbeds. Weathers light brown-grey, cliff-forming.
210-317	107	Shale - dark grey, interbedded with equal amount of limestone, grey to brown-grey, crystalline to finely crystalline, finaly crinoidal. Limestone layers nodular, varying in thickness from 1/2 to 2 feet. Weathers grey. In upper 44 feet limestones dominate.

Interval Feet	Thickness Feet	Description
317-332	15	Limestone - grey, crystalline, crinoidal coquina, abundant black chert nodules, hard, thin to thick-bedded. Weathers grey.
332-337	5	Shale - dark grey, soft.
337-348	11	Limestone - dark grey, finely crystalline, argillaceous, with fine fossil detritus breaking in thin slabs.
348-353	5	Limestone - brown-grey, crystalline, finely crinoidal, with numerous nodules and bands of black chert, hard. Weathers light grey.
353-402	49	Limestone - grey, crystalline, dense, crinoidal coquina, thin to thick-bedded, weathered surface pitted. Interbedded with equal amount of dark grey shale. Relatively soft interval.
		Banff Formation (?)
402-416	14	Shale - dark grey to black, slightly calcareous.
416-463	47	Siltstone - grey to light grey, argillaceous, numerous hairline micaceous shale streaks, numerous worm burrows, nodular, thin-bedded. Weathers greenish-grey to rusty.
463-483	20	Shale - dark grey, slightly calcareous, numerous interbeds of limestone, argillaceous, tight, very fossiliferous, finely crinoidal, beds up to 2 feet thick. Most abundant are bryozoa, Fenestella and branching types, also brachiopods. Limestone weathers greyish ochre.
483-488	5	Limestone - grey-brown, crinoidal coquina, tight, hard. Weathers rusty.
488-596	108	Shale - dark grey, non-calcareous, with bands of more or less argillaceous limestone. Limestone is almost a crinoidal coquina, with abundant Fenestella and scattered Spirifers, in bands some 5 to 20 feet apart. At 100 feet above base crinoidal sandstone, fine-grained, grey, rusty weathering, one foot thick interval, poorly exposed.
596-624	28	Sandstone - grey to greenish grey, fine grained, thin argillaceous streaks, blocky. Weathers rusty.
624-626.5	2.5	Shale - silty, dark grey, non-calcareous.
626.5-632.5	6	Sandstone - brown to greenish grey, finely interbedded with thin shaly streaks at irregular intervals, blocky. Weathers greenish grey to rusty. Sandstone similar to basal Mississippian sandstone.

Interval Feet	Thickness Feet	Description
632.5-644.5	12	Shale - grey to dark grey, silty, flaky, with numerous fine sandstone bands, abundant crinoid fragments and Fenestella. Weathers greenish grey to rusty.
644.5-789.5	145	Shale - dark grey, calcareous, with bands of argillaceous limestone 2 feet thick and some 8 to 15 feet apart. Poorly exposed interval.
789.5-794.5	5	Limestone - dark brown, very crinoidal, brachiopods (Reticularia), few scattered vugs inside fossils, nodular, irregular thin and medium bedding.
794.5-798.5	5	Shale - dark grey, calcareous, flaky weathering.
798.5-841.5	43	Shale - dark grey, calcareous, and argillaceous limestone. Poorly exposed.
841.5-854.5	13	Limestone - dark brown-grey, finely crystalline, argillaceous, streaks of abundant crinoid ossicles, alternating intervals of 2 feet with more and less argillaceous content. Weathers light brown.
854.5-864.5	10	Limestone - shaly and calcareous shale, poorly exposed.
864.5-899.5	35	Covered - largely calcareous, dark grey shale.
899.5-919.5	20	Limestone - brown to grey, finely crystalline, finely disseminated fossil material, siliceous in part, slightly nodular, massive to thick-bedded. Weathers light brown.
919.5-921.5	2	Shale - dark grey, calcareous.
921.5-927.5	6	Limestone - grey-brown, argillaceous, rich in fine fossil debris, some scattered dark brown to black chert nodules, petroliferous odor.
927.5-947.5	20	Covered.
947.5-952.5	5	Limestone - dark grey, finely crystalline, very argillaceous, abundant scattered brachiopods, rubbly. Weathers light brown.
952.5-954.5	2	Limestone - grey-brown, very crinoidal, richly fossiliferous with brachiopods and bryozoa.
954.5-956	1.5	Shale - calcareous and very argillaceous, limestone.
956-959	3	Limestone - grey-brown, very crinoidal, slightly nodular (Manff type crinoidal limestone), very fossiliferous, brachiopods (Orthothetes), bryozoa (Fenestella), horn corals, Spirifers.

Interval Feet	Thickness Feet	Description
959-961	2	Limestone - dark grey, finely crystalline, argillaceous.
961-962.5	1.5	Limestone - brown-grey, crystalline, crinoidal. Weathers light brown.
962.5-985.5	23	Shale - dark grey, calcareous, with few hard limestone bands containing crinoid fragments and scattered brachiopods.
985.5-999.5	14	Limestone - crinoidal coquina with thin shale interbeds, thick to medium-bedded.
999.5-1001	1.5	Shale - dark grey, calcareous.
1001-1015	14	Limestone - crinoidal coquina, beds separated by thin shale bands, thick-bedded.
1015-1018	3	Limestone - as above, shale intervals of 6 inches thick, and chert nodules.
1018-1023	5	Limestone - crinoidal, horn corals and small scattered chert nodules, thick-bedded.
1023-1027	4	Shale - dark grey to black, fissile.
1027-1032	5	Limestone - brown-grey to dark brown-grey, bituminous odor, possibly some rare fine intercrystalline porosity, massive. Weathers light brown-grey.
1032-1038.5	6.5	Limestone - dark grey, very argillaceous, very fossiliferous, crinoid and bryozoa fragments, rubbly. Weathers light ochre.
1038.5-1043.5	5	Shale - dark grey, calcareous, soft.
1043.5-1068.5	25	Limestone - grey to dark grey, finely crystalline, tight, hard, abundant chert nodules and bands up to 6 inches thick, horn corals, massive, cliff-forming. Weathers light ochre grey.
1068.5-1070.5	2	Shale - dark grey, hard.
1070.5-1072	1.5	Limestone - dark brown-grey, crystalline, crinoidal coquina, scattered brachiopods. Weathers brown-grey.
1072-1072.5	.5	Shale - black, calcareous, hard.

Interval Feet	Thickness Feet	Description
1072.5-1078.5	6	Limestone - dark brown-grey, crystalline, crinoidal coquina, scattered brachiopods.
1078.5-1090.5	12	Shale - dark grey, soft, fissile.
1090.5-1095.5	5	Limestone - dark grey-brown, argillaceous, or very calcareous shale, coarsely flaky. Weathers orange-brown.
1095.5-1167.5	72	Shale - dark grey, soft, fissile.
1167.5-1178.5	11	Limestone - dark grey, argillaceous, scattered crinoid fragments and brachiopods.
1178.5-1192.5	14	Shale - dark grey, fissile, soft.
1192.5-1198.5	6	Limestone - dark grey to grey, finely crystalline, argillaceous, fossiliferous.
1198.5-1203.5	5	Shale - dark grey, calcareous, soft.
1203.5-1206.5	3	Limestone - as above, brachiopods.
1206.5-1226.5	20	Shale - dark grey, calcareous, fissile.
1226.5-1232.5	6	Limestone - argillaceous, fossils rare.
1232.5-1234.5	2	Limestone - dark grey, very argillaceous, soft.
1234.5-1239.5	5	Limestone - brown, finely crystalline, argillaceous, hard, slight bituminous odor. Weathers grey-brown.
1239.5-1372.5	133	Shale - dark grey, calcareous, fissile, with scattered thin ironstone beds and lenses.
1372.5-1382.5	10	Limestone - dark grey, finely crystalline, very argillaceous. Weathers yellowish brown.
1382.5-1434.5	52	Shale - dark grey, calcareous, soft, fissile.
1434.5-1442.5	8	Limestone - dark grey, argillaceous, slightly fissile. Weathers ochre-brown.
1442.5-1445.5	3	Shale - dark grey, calcareous, soft, fissile.
1445.5-1460.5	15	Shale - dark grey, calcareous, slightly fissile. Weathers ochre-brown.
1460.5-1470.5	10	Covered.

Interval Feet	Thickness Feet	Description
1470.5-1473.5	3	Shale - dark grey, calcareous, fissile.
1473.5-1478.5	5	Covered.
1478.5-1484.5	6	Shale - dark grey, calcareous, firm, rare fossils, pelecypod. Weathers brown.
1484.5-1489.5	5	Shale - dark grey, calcareous, soft, fissile.
1489.5-1491.5	2	Shale - dark grey, calcareous, firm, harder band, irregular platy, Ammonite(?) in talus nearby outcrop. Weathers brown - similar to lower Banff of Bow Valley.
1491.5-1498.5	7	Shale - dark grey, calcareous, soft, fissile.
1498.5-1503.5	5	Covered.
1503.5-1508.5	5	Shale - dark grey, calcareous, slightly indurated.
1508.5-1518.5	10	Covered.
1518.5-1592.5	74	Shale - dark grey, thin, flaky, calcareous, numerous thin ironstone concretions, fossiliferous near base.
		Exshaw Formation (?)
1592.5-1992.5	400	Shale - black, non calcareous, paper thin fissile. Numerous flat oval ironstone concretions, some thin beds of ironstone, rarely larger septarian nodules up to one foot diameter, some small pyritic geodes. Section somewhat distrubed by drag folding, thickness approximate.
		Basal Sandstone
1992.5-1994.5	2	Sandstone - brown-grey, fine-grained, finely micaceous, slightly argillaceous, tight, massive. Weathers dark brown to rusty.
1994.5-1996.5	2	Siltstone - dark grey, finely sandy and argillaceous, hard. Weathers flaky or platy.
1996.5-2006.5	10	Sandstone - brown-grey and grey, roughly bedded, as above.
2006.5-2031.5	25	Shale - black, non calcareous, with equal amount of thin layers of fine sandstone up to 1/4 inch thick, occasional thin ironstone beds.

Interval Feet	Thickness Feet	Description
2031.5-2075.5	44	Shale - dark grey, non calcareous, less silty and sandy than above, fissile, finely micaceous.
2075.5-2109.5	34	Sandstone - dark grey to brown grey, fine-grained, silty and argillaceous, finely micaceous, finely laminated in part, interbedded with shale and mudstone. Weathers rusty brown.
2109.5-2148.5	39	Shale - dark grey, silty, non calcareous, thin-bedded.
2148.5-2160.5	12	Mudstone - platy, interbedded with silty shale, beds up to 4 inches thick.
2160.5-2187.5	27	Shale - dark grey, silty, thinly bedded, rubbly. Weathers dark grey-brown.
2187.5-2191.5	4	Sandstone - silty, argillaceous, finely micaceous, hard, thin-bedded, platy, interbedded with shale beds up to 6 inches thick.
2191.5-2216.5	25	Shale - dark grey, finely silty and micaceous.
2216.5-2231.5	15	Sandstone - dark grey, fine-grained, silty and argillaceous, in part thinly laminated. Weathers brown.
2231.5-2236.5	5	Mudstone - platy.
2236.5-2259.5	23	Sandstone - dark grey, silty, argillaceous, fine-grained.
2259.5-2484.5	225	Sandstone and argillaceous siltstone - dark grey, fine-grained, platy, finely micaceous, non fossiliferous, in part worm burrows.
2484.5-2527.5	43	Sandstone - grey, silty, argillaceous, roughly bedded, tight. Weathers brown.
DEVONIAN		Contact with Mississippian sharp and straight. No coarse sand in basal Mississippian sandstone.
2527.5-2551.5	24	Shale - grey and dark grey, silty, finely micaceous, semi-fissile, firm, with finely quartzose silty bands.
2551.5-2637.5	86	Sandstone - light grey, fine-grained, quartzose (more pure than the Mississippian sandstone), numerous fine shale laminae.

APPENDIX VII

STRATIGRAPHIC SECTION NO. 7 (COMPOSITE)

KOTANEELEE RIVER, FIGURE I

Compilation of Cretaceous section studied on the Kotaneelee River. Estimated thicknesses of covered intervals were made by dip projection on aerial photos.

Thickness Feet	Description Top to Bottom
UPPER CRETACEOUS	Kotaneelee Formation
150	Shale - black, slightly silty, sulphurous. Weathers dark grey.
8	Sandstone - buff, coarse grained, quartzose, abundant angular black chert grains and a few granules, argillaceous, thin-bedded, bedded concretions, cliff former. Weathers buff.
205	Shale - dark grey, dark greenish grey at base, blocky, minor bedded and solitary concretions, minor bedded carbonaceous material, fossiliferous, transitional with pebbly sandstone at base and argillaceous sandstone at top, shale at top contains abundant fossiliferous and carbonaceous material in concretions and abundant selenite crystals.
1	Sandstone - granules and scattered pebbles of vari-colored chert in dark green tough matrix. Weathers buff and dark green.
9	Shale - dark grey to black, sandy, blocky, contains scattered small bentonite like concretions. Weathers rusty and dark grey.
2	Sandstone - as above.
8	Shale - dark grey to black, sandy, blocky. Weathers rusty and dark grey.
1	Conglomerate - vari-colored chert pebbles in sandstone matrix, pebbly surface. Deeply weathered.
13	Sandstone - dark green, very fine grained, well cemented, rounded vari-colored chert granules, minor mica, possible fossil, massive, cliff former. Weathers buff and rust.

Thickness Feet	Description Top to Bottom
6	Sandy selenitic shale - dark grey to black, abundant selenite crystals, blocky. Weathers dark grey and rust.
3	Sandstone - dark grey, green, brown and white rounded chert granules in dark grey dense matrix, massive. Weathers buff.
13	Shale - black, sandy, blocky, cellular plant fragments at base.
5	Sandstone - green, rounded brown chert or quartzite granules in dense green matrix, argillaceous, dirty, solitary brown chert pebbles to 1/2 inch in long diameter, shattered, massive. Weathers buff and rust.
49	Sandy selenitic shale - dark grey to black, abundant selenite crystals, bedded and solitary concretions up to 6 inches across, blocky. Weathers dark grey and rusty.
105	Covered.
	Fort Nelson Formation - Upper Member
50	Pebble conglomerate - dark grey quartzite and white, green and milky white chert pebbles in light grey, coarse grained sandstone matrix, rounded pebbles to 2 inches in long diameter, poorly cemented, cross-bedded, minor white clay pebbles, carbonaceous fragments. Weathers buff.
50	(Estimated) Sandy shale - dark grey to black.
50	(Estimated) Conglomerate - as above, contains lenses of sandstone, light grey, very coarse grained, quartzose, granules of vari-colored chert, scattered rounded black chert pebbles, carbonaceous fragments on bedding planes, beds 3 feet thick.
	Fort Nelson Formation - Lower Member
300	(Estimated) Thin outcrops exposed as follows:
	Outcrop No. 1
15	Shale - greenish brown, sandy blocky. Weathers green.
6	Sandstone - light grey, coarse grained, quartzose, grains of vari-colored chert, well cemented, carbonaceous frond impressions, thick bedded.

Thickness Feet	Description Top to Bottom
	Outcrop No. 2
6	Sandstone - light grey, greenish cast, medium grained, quartzose, black chert, well cemented, micaceous, thin-bedded, interbedded sandy shale with 6 inches carbonaceous shale bed at top. Weathers greenish buff.
15	Sandstone - light grey, greenish cast, coarse grained, quartzose, granules of angular white and black chert, massive, minor green chert, poorly cemented, cross-bedded.
	Outcrop No. 1
35	Sandstone - light grey, coarse grained, quartzose, black and white chert up to granule size, laminated, poorly cemented, carbonaceous plant fragments on bedding planes, massive. Weathers buff.
64	Sandstone and sandy shale regularly interbedded. Sandstone - light grey, greenish cast, fine grained, quartzose, black chert, well cemented, selenite, worm borings, carbonaceous material, laminated, thin-bedded. Weathers rusty and dark grey.
LOWER CRETACEOUS	Lanine Formation
300	(Estimated) Covered.
200	Shale - black, fissile, sulphurous, bituminous, bentonite beds to 4 inches thick, one 4 inch bed of brown sandstone containing grains of white chert.
30	(Estimated) Covered.
50	Sandy shale - dark grey, slight greenish cast, blocky, selenite, plant stems, worm borings, bedded concretions.
300	(Estimated) Covered interval.
155	Sandy shale - dark grey, slight greenish cast, blocky, selenite, plant stems, worm borings, bedded ellipsoidal concretions to 6 feet in diameter, fossiliferous, frond impressions, interbedded very thin, rusty weathering sandstone - light grey, fine grained, quartzose, black chert well cemented, less than 1 inch thick.
1000	(Estimated) Covered interval.

Thickness Feet	Description Top to Bottom
	Scatter Formation
130	Sandstone - light grey, greenish cast, fine grained, quar zose, black chert, argillaceous, mica, thin to thick-bedded, laminated, cross-bedded, interbedded silty shale, bedded and solitary ironstone concretions, worm borings, well cemented, cliff former. Weathers buff.
49	Covered.
4	Sandstone - light grey, greenish cast, coarse grained, quartzose, black chert, laminated, thick-bedded, cross-bedded, plant stems, interbedded sandy shale with ironstone concretions. Weathers greenish buff.
11	Covered.
2	Sandstone - as above.
30	Covered.
70	Sandstone - as above.
22	Covered.
12	Sandstone - light grey, greenish cast, fine grained, quartzose, black chert, well cemented, laminated, thick-bedded, silty shale interbeds up to 6 inches thick, solitary ironstone concretions. Weathers buff.
7	Sandy shale - dark grey. Weathers dark grey and rusty.
15	Sandstone - light grey, greenish cast, fine grained, well cemented, quartzose, black chert, bedded ironstone concretions. Weathers buff.
9	Sandy shale.
4	Sandstone - medium grey, fine grained, quartzose, black chert, laminated, thin-bedded, well cemented, interbedded sandy shale. Weathers rusty and dark grey.
8	Shale - dark grey, sandy muddy habit. Weathers rusty and dark grey.
2	Sandstone - greenish brown, fine grained, quartzose, black chert, argillaceous, well cemented. Weathers buff and grey.
	Garbutt Formation ?
130	Covered - cellular plants and pebble sized ironstone concretions collected from talus.

Thickness Feet	Description Top to Bottom
10	Sandy shale - dark grey. Weathers rusty and dark grey.
4	Sandstone - greenish brown, fine grained, quartzose, black chert, argillaceous, mica, laminated, thick-bedded, worm borings. Weathers greenish buff.
9	Sandy shale - as above.
5	Sandstone - as above.
300	(Estimated) Covered - presumably shale.
	Basal Conglomerate
40	Sandstone - light grey, greenish cast, coarse grained, quartzose, abundant green chert, minor black chert, argillaceous, bituminous, massive, white chert pebbles which become abundant at the base, plant stems and worm borings. Weathers buff and minor rust.
8	Sandstone - green, coarse grained, thin-bedded, quartzose, green and black chert grains, undulating, interbedded, cross-bedded, minor thin black silty shale. Weathers buff and green.
1	Conglomerate - white, milky white and black chert pebbles from 1/4 inch to 4 inches in long diameter in sandstone matrix.
6	Sandstone - light grey, coarse grained, quartzose, black chert, argillaceous, carbonaceous, sub-angular, grains poorly cemented, thin-bedded, granules and pebbles of white chert. Weathers buff and light grey.
5	Conglomerate - angular white, milky white, light green and dark grey chert pebbles to 2 inches in long diameter, carbonaceous fragments, light grey sandstone matrix.
6	Sandstone - light grey, medium grained, quartzose, black chert, well cemented, thin-bedded, plant fragments. Weathers buff.
4	Conglomerate - angular and rounded, white, dark grey and light green chert pebbles up to 1 inch in long diameter in light grey, coarse grained sandstone matrix, poorly cemented. Conglomerate thins to 2 feet, 30 feet up dip.
4	Conglomerate - as above, thin interbeds of light grey, fine grained sandstone containing argillaceous and carbonaceous partings.
25	(Estimated) Covered.

Thickness Feet	Description Top to Bottom
10	Sandy shale - dark grey. Weathers rusty and dark grey.
4	Sandstone - greenish brown, fine grained, quartzose, black chert, argillaceous, mica, laminated, thick-bedded, worm borings. Weathers greenish buff.
9	Sandy shale - as above.
5	Sandstone - as above.
300	(Estimated) Covered - presumably shale.
	Basal Conglomerate
40	Sandstone - light grey, greenish cast, coarse grained, quartzose, abundant green chert, minor black chert, argillaceous, bituminous, massive, white chert pebbles which become abundant at the base, plant stems and worm borings. Weathers buff and minor rust.
8	Sandstone - green, coarse grained, thin-bedded, quartzose, green and black chert grains, undulating, interbedded, cross-bedded, minor thin black silty shale. Weathers buff and green.
1	Conglomerate - white, milky white and black chert pebbles from 1/4 inch to 4 inches in long diameter in sandstone matrix.
6	Sandstone - light grey, coarse grained, quartzose, black chert, argillaceous, carbonaceous, sub-angular, grains poorly cemented, thin-bedded, granules and pebbles of white chert. Weathers buff and light grey.
5	Conglomerate - angular white, milky white, light green and dark grey chert pebbles to 2 inches in long diameter, carbonaceous fragments, light grey sandstone matrix.
6	Sandstone - light grey, medium grained, quartzose, black chert, well cemented, thin-bedded, plant fragments. Weathers buff.
4	Conglomerate - angular and rounded, white, dark grey and light green chert pebbles up to 1 inch in long diameter in light grey, coarse grained sandstone matrix, poorly cemented. Conglomerate thins to 2 feet, 30 feet up dip.
4	Conglomerate - as above, thin interbeds of light grey, fine grained sandstone containing argillaceous and carbonaceous partings.
25	(Estimated) Covered.

Thickness Feet	Description Top to Bottom
20	Sandstone - light grey, coarse grained, quarzose, black chert grains sub-angular, well cemented, carbonaceous partings, plant stems, thin to thick-bedded. Weathers buff.
8	Conglomerate - white, milky white, and dark grey chert pebbles up to 4 inches in long diameter, pebbles angular and rounded, in light grey, coarse grained sandstone matrix. Weathers light buff.
15	Covered.
TRIASSIC	
40	Shale - dark greenish brown when wet, green when dry, slightly silty, fissile, soapy, bedded soft nodules (bentonite like material). Weathers green.
63	Covered.
64	Shale - green and maroon and non-silty, micaceous. Weathers maroon.
1	Sandstone - light grey, fine grained, quartzose, black chert, well cemented. Weathers buff.
2	Shale - black, non-silty, fissile, soapy.
5	Sandstone - dark grey, fine grained, quartzose, black chert, dirty, well cemented, minor carbonaceous plant fragments, massive. Weathers buff.
95	Covered.
24	Sandstone - light to dark green, very fine grained, quartzose, black chert, argillaceous grading to a sandy shale at top, thin bedded to shaly habit, interbedded sandy shale. Weathers green and buff.
PERMIAN ?	
5	Chert - medium grey, minor scattered rusty weathering concretions, carbonaceous.

Description by K. W. Lyle and
L. A. Singleton.

STRATIGRAPHIC SECTION NO. 8 (COMPOSITE)

PETITOT RIVER, FIGURE I

Compiled from several discontinuous Cretaceous outcrops, the thickness of strata between the various outcrops is unknown.

Thickness Feet	Description
UPPER CRETACEOUS	Fort Nelson Formation - Upper Member
	Outcrop No. 1
250	Conglomerate - medium to dark grey, sand matrix, hard, pebbles tend to fracture rather than break from matrix. Pebbles composed of black, green and white chert; vary widely in size from very coarse sand grains to pebbles 1 1/2 inches in diameter, with the majority being from 1/8 to 1/3 inches. Occasional lenses of softer, coarse grained, salt and pepper sandstone which may be as thick as 6 feet. Weathers as a massive buff unit with bedding planes every 10-20 feet.
	Fort Nelson Formation - Lower Member
	Outcrop No. 2
40	Sandstone - light buff, very coarse grained, with occasional scattered pebbles 1/2 inch in diameter, loosely consolidated, no bedding but pebble laminae indicate cross bedding. Weathers buff.
20	Conglomerate - grey, very sandy, pebbles are small, poorly consolidated. (It is possible this conglomerate may be much lower in section than is shown.)
20	Sandstone and Shale - (inaccessible) interbedded, sand and shale alternate every 1 foot.
15	Sandstone - light grey and brown, fine grained, salt and pepper, in part calcareous, hard, well cemented, well bedded, beds to 6 feet thick.
70	Sandstone and shale - (interbedded) sandstone - medium grey, very fine to fine grained, calcareous in part, carbonaceous flecks along bedding planes, selenite, platy and laminated. Shale - dark grey to black, fissile, in part silty, some selenite, only slightly rusty on weathered surface.

Thickness Feet	Description
	Outcrop No. 3
15	Sandstone - brownish grey, fine grained, salt and pepper, in part calcareous, fine intergranular porosity, massive and cross bedded, beds as thick as 2 feet. Weathers buff.
10	Covered - talus suggest medium grey, fine grained, platy sandstone.
30	Sandstone - brown, coarse grained, salt and pepper, black chert very common (30%?), very loosely consolidated, friable, no bedding evident. Weathers as very massive, soft unit.
	NOTE: The Lower member of the Fort Nelson formation is quite probably thicker than shown.
LOWER CRETACEOUS	Lepine Formation
	Outcrop No. 4
250	Shale - dark grey to black, non silty, non-calcareous, very fissile, soft and has soapy feeling, probably betonitic as outcrop was very slick and prone to mudslides, selenitic, has high percentage of yellow sulphur crystals, some ironstone concretionary layers.
	Outcrop No. 5
100	Shale - as above, near base are numerous thin sand laminae 1/8 inch thick. Sand is light grey, fine to medium grained, quartzose and well sorted.
	Outcrop No. 6
112	Shale - dark grey to black, sandy and silty throughout, occasional thin calcareous sandstone layers, ironstone concretions, harder and less fissile than underlying unit. Weathers rusty.
30	Covered.
110	Shale - dark grey to black, in part sandy and silty, but generally pure shale, soft, rubbly to fissile. Occasional thin (1/2" to 1") bands of fine grained, calcareous, laminated sandstone. A few ironstone concretions.
	Scatter Formation
	Outcrop No. 7
35	Sandstone - medium greenish grey, fine grained, quartzose,

Thickness Feet	Description
	carbonaceous, laminated and cross-laminated, ironstone layers, some very fine porosity. Weathers buff.
	Outcrop No. 8
2	Sandstone - grey-green, very fine grained, argillaceous, carbonaceous, soft, irregular bedding.
3	Sandstone - medium grey, very fine grained, calcareous, hard, well cemented.
82	Argillaceous siltstone or silty mudstone - dark grey to black, some sand and silt, highly carbonaceous, occasional plant stems, bedding is either poor and irregular or non-existent. A massive, buff weathering unit.
70	Sandstone - medium grey - in part with a greenish cast, very fine grained to silt size, carbonaceous, few dark minerals, laminated, occasional thin argillaceous bands, some very fine porosity.
142	Sandstone and mudstone - interbedded; Sandstone - medium greenish grey, very fine grained, quartzose, glauconitic, carbonaceous, sandstone layers from 1 to 5 feet thick with beds up to 2 feet thick, laminated in part and laminations produce platy effect on weathering, worm burrows perpendicular to bedding. Mudstone - dark grey to brown, very silty and sandy, ironstone concretions and concretionary layers, non-stratified units of mudstone reach the thickness of 3 feet.
9	Mudstone - as above, high sand content results in rock being somewhat harder than normal shale.
12	Sandstone and mudstone - as above.
1	Sandstone - dark greenish grey, very fine grained, glauconitic irregularly bedded, beds 1/4 inch to 3/4 inch, laminated.

Description by N. H. Peterson.

STRATIGRAPHIC SECTION NO. 9

NORTH NAHANNI RIVER, FIGURE I

Summary from top to bottom of Upper Devonian sediments measured near Army Camp Lake. A tentative formation breakdown has been applied.

Thickness Feet	Description
UPPER DEVONIAN	Trout River Formation ?
150	Sandstone - greenish grey, fine grained, calcareous zones with abundant brachiopods including Spirifer whitneyi and Leiorhynchus, platy, beds 2 to 3 inches thick, cliff-forming. Weathers brown.
199	Interbedded mudstone, shale and sandstone Mudstone - greenish grey, fine-grained, finely sandy, finely micaceous, platy. Weathers grey brown. Shale - grey to greenish grey, finely micaceous, flaky. Sandstone - greenish grey, fine-grained, slightly calcareous, scattered Leiorhynchus, massive to platy. Weathers brown.
	Grumbler Formation ? Upper Member
85	Shale - grey-green, fissile.
111.5	Interbedded shale, sandstone and limestone Shale - grey to brown-grey and greenish grey, fissile. Sandstone - grey to greenish grey, fine grained, calcareous, contains fossiliferous limestone nodules in part, massive. Limestone - grey, finely crystalline, tight, numerous brachiopods, Leiorhynchus, Spirifer whitneyi-type; fossils form vugs on weathered surface, massive. Weathers brown.
	Grumbler Formation ? Lower Member
328.5	Interbedded sandstone, shale and mudstone Sandstone - grey to greenish grey, minor red and green mottling near top, fine-grained, calcareous, minor nodular limestone, silty and argillaceous in part, crinoid fragments and small brachiopods in lower half of section, thin-bedded to massive. Weathers brown.

Thickness Feet	Description
	Shale - grey to greenish grey, fissile, finely micaceous, silty in part, abundant thin brown rusty streaks toward base of section.
	Mudstone - greenish grey, finely micaceous, platy occasional oscillation ripple marks, minor worm trails, minor crinoid fragments toward base of section.
132	Sandstone - light brown, in part mottled maroon and greenish grey, calcareous, slightly argillaceous, tight, irregular lenses and a 6 inch layer of comminuted fossil debris containing small Chonetes (?) and disseminated reddish stained grit. Top 3 inches contain scattered crinoid fragments and abundant Syringopora-type corals with small Disphyllum-type corals occurring near the base. Cyclic sandstone, mudstone and shale with basal 15 feet composed of mudstone.
	Shale Unit
203	Interbedded shale and sandstone Shale - grey to greenish grey, fissile, finely micaceous, silty and finely sandy. Sandstone - grey to greenish grey, fine-grained, finely micaceous, slightly calcareous, scattered Atrypa. Weathers greenish brown.
666	Interbedded shale and mudstone Shale - grey to brown-grey, fissile, finely micaceous in part, slightly silty in part, minor ironstone concretions, scattered thin rusty banding near top. Weathers grey to brown-grey. Mudstone - grey-brown to dark grey-brown, thinly laminated in part, Chonetes and Atrypa found in upper part of section, platy. Weathers brown-grey.

STRATIGRAPHIC SECTION NO. 10

LIARD RAPIDS, FIGURE I

Summary from top to bottom of Upper Devonian Sediments exposed on the east bank of Liard River near the north end of the rapids below the mouth of Poplar River.

Thickness Feet	Description
	Sandstone and gravel outwash.
UPPER DEVONIAN	
58	Shale - grey to dark grey with greenish cast, finely fissile, occassional thin siltstone or fine sandstone layers.
37.5	Interbedded sandstone and shale Sandstone - grey, fine to medium-grained, calcareous, finely micaceous, argillaceous, gastropods, Atrypa and other brachiopods near top. Shale - grey to dark grey with greenish cast, thin interbeds of siltstone and sandstone.
70.5	Interbedded sandstone and shale Sandstone - light grey to buff-grey and greenish grey, fine to medium grained, slightly calcareous, micro-micaceous in part, argillaceous, scattered oscillation, ripple marks, scattered lenses with abundant brachiopods including Productella, Atrypa, Strophodonta, Bellerophon; scattered solitary corals and gastropods. Occasional patches of dark brown to black pyrobitumen partly impregnating fossils in the lower part of the unit. Weathers grey-buff to greenish buff. Shale - greenish grey to dark grey, generally poorly exposed.
85.5	Interbedded sandstone and shale Sandstone - light grey to buff, fine grained, calcareous, argillaceous, finely micaceous, nodular in part, poorly bedded, rubbly and blocky. Shale - greenish grey to grey, slightly rusty in part, abundant thin interbeds of calcareous and argillaceous sandstone, interbedded argillaceous limestone towards base.
40	Interbedded shale and sandstone Shale - greenish-grey, soft, fissile. Sandstone - greenish grey, calcareous, argillaceous, abundant worm borings, appears as thin bands throughout shale.

Thickness Feet	Description
50	Shale - greenish grey, soft, fissile, thin layers of brown sandy limestone.
5	Limestone - light grey, red and green mottling, coarsely crystalline, abundant shaly streaks, fossiliferous with Productella and crinoid stems.
25	Shale - greenish grey, soft, fissile, stringers of sandy shale.

STRATIGRAPHIC SECTION NO. 11

LABICHE RANGE, FIGURE I

Summary of section observed on Labiche Range at approximately 60° 25' north latitude.

Thickness Feet	Description
PERMIAN	
440	Interbedded sandstone, siliceous sandstone and chert. The sandstone is limited to the upper part of the unit and is medium-grained, quartzose, well sorted, massive and clean. Downwards in section, the sandstone becomes siliceous, thin-bedded, and contains small chert inclusions. The chert outcrops near the base of the section and constitutes the greater part of the unit. The chert is grey, mottled light and dark brown, bedded, and has occasional thin shale interbeds. One continuous chert zone extends for 130 feet. Weathering colors vary from dark grey to light buff.
PENNO-PENNSYLVANIAN	
83	Interbedded sandstone and very minor crinoidal limestone. The sandstone is very fine grained, slightly calcareous, well cemented and contains minor shaly interbeds. The limestone occurs in two thin beds and is light grey, coarsely crystalline, with an abundance of white chert fossil fragments, crinoid stems and brachiopods.
770	Buff, fine-grained, quartzose, calcareous sandstone, containing minor black chert. Sandstone varies from well cemented to sugary with the latter exhibiting excellent porosity. The upper part of the unit is quartzitic, and quite calcareous becoming less calcareous downward. Fossils are concentrated in a few thin (5 inch) beds. Bedding is generally thick to massive with some thin-bedding.
1150	Sandstone much as above but non-calcareous, generally thin-bedded and ripple marked. Crinoid stems and brachiopods are present.

Thickness Feet	Description
1160	Sandstone, much as above but becoming more argillaceous downwards. The argillaceous content is in the form of fine laminae. In part micaceous and carbonaceous, generally well cemented. Worm borings and ripple marks are common and the strata are thin-bedded.

None of the above units are completely exposed and some of the covered areas, especially in the lower part may be shale.

WESTERN LIARD RAPIDS NO. 1A

Location:	Latitude 60° 27' N Longitude 121° 27' 40" W
Elevation, K.B.:	777'
Total Depth:	2,467'
Date Completed:	March 10, 1954

Depth in Feet	Description
PLEISTOCENE	
0-100±	Glacial Drift.
UPPER DEVONIAN	Green Shale Unit
100±-390	This zone contains much glacial drift but enough fine to medium grained quartz sandstone and dark grey sandy limestone to suggest that the sandstone beds which produce the nearby Liard Rapids are included in this interval.
390-400	Shale - grey-green, micro-micaceous to dark black-brown, micaceous, slightly bituminous and silty.
400-410	Shale and sandstone - shale as above, interbedded with grey green, fine grained argillaceous, slightly calcareous sandstone.
410-450	Sandstone - as above, minor shale and limestone laminae.
450-1350	Shale - grey to dark grey, micaceous, slightly calcareous, uniform, becoming more fissile and somewhat darker downwards.
1350-1380	Shale - as above, interbedded with brown to brown grey, slightly micaceous, shale.
1380-1390	Shale - predominantly brown, slightly calcareous.
1390-1420	Shale - grey green, micaceous, indurated.
1420-1430	Shale - interbedded, brown, bituminous and grey green, as above.
1430-1490	Shale - grey green, micro-micaceous, slightly calcareous, in part sandstone.

Depth in Feet	Description
1490-1530	Shale - dark brown to chocolate brown, bituminous, slightly calcareous, minor interbeds of green grey shale.
1530-1650	Shale - grey green, as above.
1650-1660	Shale - grey green, as above, interbedded with brown, bituminous slightly calcareous shale and thin brown limestone beds.
1660-1700	Shale - grey green, as above.
1700-1710	Shale - interbedded, grey green, micaceous, calcareous and dark brown, bituminous, calcareous.
1710-1940	Shale - grey green, as above, with thin scattered beds of brown shale and argillaceous limestone.
1940-1970	Shale - grey green, slightly calcareous, fissile; thin interbeds of grey green, dense, argillaceous limestone and brown shale partings.
	Black Shale Unit
1970-2000	Shale - as above, brown bituminous shale more predominant.
2000-2040	Shale - as above, interbeds of dark black silty, foliaceous shale with dark reddish cast, highly bituminous.
2040-2090	Shale - as above, predominantly black to brown with interbeds of grey green fissile shale.
2090-2180	Shale - dark brown to black, highly bituminous with interbeds of green grey, micaceous, slightly calcareous fissile shale.
MIDDLE DEVONIAN	Ramparts ? - Slave Point
2180-2290	Limestone - dark brown, crypto-crystalline, carbonaceous, some chalky phases, becoming lighter in color downwards and in part granular textured, interbeds of green and brown to black shale.
2290-2320	Limestone - light grey brown to brown, granular, chalky to crypto-crystalline texture.
2320-2340	Limestone - dark amber, crypto-crystalline, carbonaceous.
2340-2350	Limestone - light cream-grey, crypto-crystalline to micro-crystalline.
2350-2360	Limestone - brown to dark brown, crypto-crystalline to micro-granular.

Depth in Feet	Description
2360-2370	Shale - grey green, micro-micaceous, non-calcareous, splintery, minor interbeds of brown black, micro-granular limestone with very bituminous shale.
2370-2380	Interbedded Limestone and Shale Limestone - as above, in part amber to brown, crypto-crystalline and chalky. Shale - as above, 30-40% of sample.
2380-2390	Interbedded Limestone and Shale Limestone - light brown to chalky white, crypto-crystalline. Shale - as above, 10-20% of sample.
2390-2400	Interbedded Limestone and Shale Limestone - dark amber, micro-granular, calcareous, 30-40% of sample. Shale - light green, micro-micaceous, splintery, 60-70% of sample.
2400-2440	Limestone - in part as above, in part coarsely granular to fragmental in texture, becoming darker and predominantly fragmental downwards.
2440-2450	Limestone - light grey, crypto-crystalline, uniform.
2450-2460	Limestone - dark brown to amber, dense to fragmental, carbonaceous, as above, local finely crystalline, dolomitic limestone beds.
2460-2465	Shale - grey green, splintery, non-calcareous, minor interbeds of grey, crypto-crystalline limestone.
2465-2467	Limestone - light brown to amber, crypto-crystalline to micro-granular and in part fragmental.

Description by K.W. Lyle.

Depth in Feet	Description
2360-2370	Shale - grey green, micro-micaceous, non-calcareous, splintery, minor interbeds of brown black, micro-granular limestone with very bituminous shale.
2370-2380	Interbedded Limestone and Shale Limestone - as above, in part amber to brown, crypto-crystalline and chalky. Shale - as above, 30-40% of sample.
2380-2390	Interbedded Limestone and Shale Limestone - light brown to chalky white, crypto-crystalline. Shale - as above, 10-20% of sample.
2390-2400	Interbedded Limestone and Shale Limestone - dark amber, micro-granular, calcareous, 30-40% of sample. Shale - light green, micro-micaceous, splintery, 60-70% of sample.
2400-2440	Limestone - in part as above, in part coarsely granular to fragmental in texture, becoming darker and predominantly fragmental downwards.
2440-2450	Limestone - light grey, crypto-crystalline, uniform.
2450-2460	Limestone - dark brown to amber, dense to fragmental, carbonaceous, as above, local finely crystalline, dolomitic limestone beds.
2460-2465	Shale - grey green, splintery, non-calcareous, minor interbeds of grey, crypto-crystalline limestone.
2465-2467	Limestone - light brown to amber, crypto-crystalline to micro-granular and in part fragmental.

Description by K.W. Lyle.

WESTEROL NO. 3A

Location:	Latitude 61° 46' 26" N Longitude 120° 43' 48" W
Elevation K.B.:	470'
Total Depth:	2,422'
Date Completed:	July 31, 1952

Depth In Feet	Description
PLEISTOCENE	
0-70	Not available for logging.
70-90	Sand - medium grained, fragments of Precambrian rocks compose large part of sample.
90-190	Sand - as above, including very occasional brown dolomitic limestone fragments.
190-520	Sand - as above, plus some greenish grey shale.
UPPER DEVONIAN	Green Shale Unit
520-910	Shale - greenish grey, slightly calcareous, various amounts of surface cavings.
910-1090	Shale - greenish grey, slightly calcareous with some darker shales.
	Black Shale Unit
1090-1135	Shale - as above, half of samples non-calcareous dark brownish grey to black shale.
1135-1245	Shale - non-calcareous, very dark grey but somewhat lighter at 1145.
1245-1265	Shale - dark brown and grey to black.
1265-1305	Shale - as above, occasional pyrite.

Depth in Feet	Description
MIDDLE DEVONIAN ?	Remarks ? - Slave Point
1305-1310	Limestone - finely mottled, dark brown and grey, fragmental; much of sample black shale cavings.
1310-1340	Limestone - as above but not so dark in color and fewer cavings.
1340-1350	Limestone - as above but more light grey limestone and some calcite crystals. Traces of intergranular porosity.
1350-1365	Limestone - medium brown, fine crystalline, dense, some fragmental limestone as above, some evidence of bitumen; poor sample at 1365.
1365-1370	Limestone - brown and grey mottled, fragmental.
1370-1375	Limestone - medium brown, fine crystalline, dense, some fragmental limestone as above, some evidence of bitumen.
1375-1380	Limestone - light to medium brown, fine crystalline, dense.
1380-1455	Limestone - mottled light grey to brown, fine crystalline to fragmental; sample at 1440 light in color; poor sample at 1455.
1455-1480	Limestone - as above but darker brown and bituminous looking.
1480-1482	Limestone - light grey, slightly mottled, fragmental.
1482-1485	Limestone - medium brown, fine grained, sub-lithographic.
1485-1490	Dolomite - limy, medium brown, fine crystalline, intergranular porosity.
1490-1495	Limestone - light grey to grey brown, fine grained.
1495-1500	Limestone - dark grey brown, fine grained to fragmental.
1500-1505	Limestone - medium grey brown, slightly mottled, fragmental.
1505-1510	Limestone - light grey to grey brown, fine grained.
1510-1512	Limestone - medium grey brown, slightly mottled, fragmental, with bitumen.
1512-1520	Limestone - as above but without bitumen.
1520-1530	Limestone - as above with trace of intergranular porosity.

Depth in Feet	Description
1530-1545	Limestone - light to dark brown, mottled, fragmental.
1545-1555	Dolomite - grey brown, fragmental, occasional crystal of clear dolomite.
1555-1565	Dolomite - grey brown, fine crystalline, some intergranular porosity.
1565-1570	Limestone - light to medium brown, fine crystalline to fragmental.
1570-1575	Dolomite - grey brown, fine crystalline, some intergranular porosity.
1575-1580	Dolomitic limestone - light to medium, fragmental.
1580-1585	Dolomite - light to dark grey brown, fine crystalline, trace of intergranular porosity.
1585-1590	Dolomite - as above, with some fragmental texture.
1590-1595	Dolomite - as above, but intermixed dolomite and limestone.
1595-1600	Dolomitic limestone - light grey, fine grained.
1600-1605	Limestone - grey brown, fine grained.
1605-1610	Dolomitic limestone - mottled, light to medium brown, traces of bitumen.
1610-1625	Limestone - light grey, fine grained.
1625-1630	Dolomitic limestone - light to medium grey brown, fine grained to fragmental. Traces of pyrite.
1630-1660	Dolomitic limestone - as above but with traces of pyrite and becoming more argillaceous with depth.

DEVONIAN-SILURIAN

1660-1662	Anhydrite - light grey, fine grained.
1662-1665	Dolomitic limestone - light to medium grey brown, fine grained, traces of anhydrite.
1665-1666	Anhydrite - light grey, fine grained.
1666-1675	Anhydrite - grey brown, massive.
1675-1725	Anhydrite - grey brown to light grey, fine crystalline.

Depth in Feet	Description
1725-1730	Dolomitic limestone - medium grey brown, fine grained.
1730-1770	Anhydrite - grey brown to light grey, fine crystalline.
1770-1775	Dolomite - medium brown, fine grained.
1775-1780	Anhydrite - light grey.
1780-1785	Anhydrite - medium brown.
1785-1790	Dolomitic limestone - light grey brown with inclusions of crystalline anhydrite.
1790-1800	Anhydrite - light brown.
1800-1835	Anhydrite - grey brown.
1835-1840	Dolomitic limestone - medium brown, fine grained.
1840-1845	Anhydrite - grey brown.
1845-1855	Dolomitic limestone - light to dark brown, fine grained; intermixed with anhydrite.
1855-1965	Anhydrite - grey brown.
1965-1970	Dolomite - reddish brown, fine grained, intermixed with anhydrite.
1970-1975	Dolomite - as above, but sample mostly anhydrite.
1975-2023	Anhydrite - medium grey brown.
2023-2025	Anhydrite - medium grey brown, with trace of red coloration.
2025-2030	Poor sample.
2030-2045	Anhydrite - medium grey brown with some reddish brown fine grained dolomite.
2045-2065	Anhydrite - as above but some of anhydrite has clinker texture possibly resulting from dissolving of salt.
2065-2080	Poor samples, mud probably in poor shape may represent salt contamination.
2080-2195	Anhydrite - medium grey brown.
2195-2205	Dolomite - medium brown, fine crystalline, some intergranular porosity, some anhydrite.
2205-2220	Dolomite - as above with considerable anhydrite.

Depth in Feet	Description
2220-2240	Dolomite - medium grey to brown, fine grained.
2240-2245	Dolomite - as above with considerable anhydrite.
2245-2275	Dolomite - red to pink fine grained, silty.
2275-2280	Dolomite-as above with fine grained siltstone containing multi-colored grains.
2280-2285	Dolomite - red to pink, fine grained, silty.
2285-2290	Dolomite - red, fine grained, silty with traces of siltstone.
2290-2340	Dolomite - red to pink, fine grained, silty.
2340-2350	Poor samples but less red dolomite and more grey dolomite.
2350-2375	Dolomite - light grey, fine grained, silty with grey anhydrite.
2375-2390	Dolomite - light grey and red, silty, fine grained, mixed with light grey anhydrite.
2390-2420	Dolomite - as above, plus kaolinized arkosic siltstone.

Description by K.W. Lyle.

WESTEROL NO. AA

Location:	N 61° 46' 49" W 121° 14' 26"
Elevation:	577'
Total Depth	1,888'
Date Completed:	Sept. 11, 1952.

Depth in Feet	Description
PLEISTOCENE	
0-1070	No samples available at G.S.C.
1070-1110	Sand - predominantly rounded quartz grains.
UPPER DEVONIAN	Green Shale Unit
1110-1260	Shale - light grey, micaceous, slightly silty, slightly calcareous.
1260-1390	Shale - grey-green and light grey, micaceous, calcareous, becoming dark brown and bituminous towards base, minor light brown micro-crystalline limestone.
	Black Shale Unit
1390-1410	Shale - dark brown-grey, micaceous, bituminous, pyritic.
1410-1420	Shale - medium brown, bituminous, slightly calcareous and shale as above.
1420-1520	Shale - dark brown as above, interbedded grey-green shale.
MIDDLE DEVONIAN ?	Ramparts ? - Slave Point
1520-1590	Limestone - light brown, micro-crystalline, interbedded light buff, chalky limestone.
1590-1680	Limestone - as above, interbedded dark brown, fine granular, bituminous limestone containing pyrite.
1680-1700	Limestone - light and dark brown, micro-crystalline.
1700-1750	Limestone - dark brown, granular, varying amounts of bituminous material, interbedded light buff, micro-crystalline limestone.

Depth in Feet	Description
1750-1830	Limestone - buff, micro-crystalline, chalky in part, interbedded dark brown granular limestone.
1830-1850	Limestone - as above, minor light buff granular limestone.
1850-1888	Limestone - buff, granular, interbedded buff micro-crystalline limestone; minor white, finely crystalline dolomite near base.

Description by K.W. Lyle.

B.A. HUDSON'S BAY TRAIL CREEK NO. 1

Location:	Latitude 62° 04' 30" N Longitude 122° 12' W
Elevation K.B.:	405'
Total Depth:	1,520'
Date Completed:	October 5, 1952

Depth in Feet	Description
UPPER DEVONIAN	Green Shale Unit
300-500	Shale - greenish grey, non-calcareous. A few thin silty dolomite layers. Color changes gradually from greenish grey to grey.
	Black Shale Unit
500-520	Shale - dark grey and medium grey; silty ironstone.
520-550	Shale - medium to dark grey.
550-590	Shale - dark grey, brown streak, pyrite, micro-micaceous, some silty shale.
590-600	Shale - dark grey, brown streak, silty, pyrite.
600-650	Shale - black, brown streak, hard, micro-micaceous, pyrite.
MIDDLE DEVONIAN ?	Remarta ? - Slave Point
650-660	Limestone - dark brownish grey, crypto-crystalline, argillaceous.
660-720	Limestone - grey, crypto-crystalline, fine crystalline, in part chalky, calcite abundant.
720-740	Limestone - brownish grey to light grey, crypto-crystalline to chalky; some calcite.
740-760	Limestone - grey and brownish grey, crypto-crystalline, mottled with chalky limestone.
760-770	Limestone - dark grey, crypto-crystalline, argillaceous.

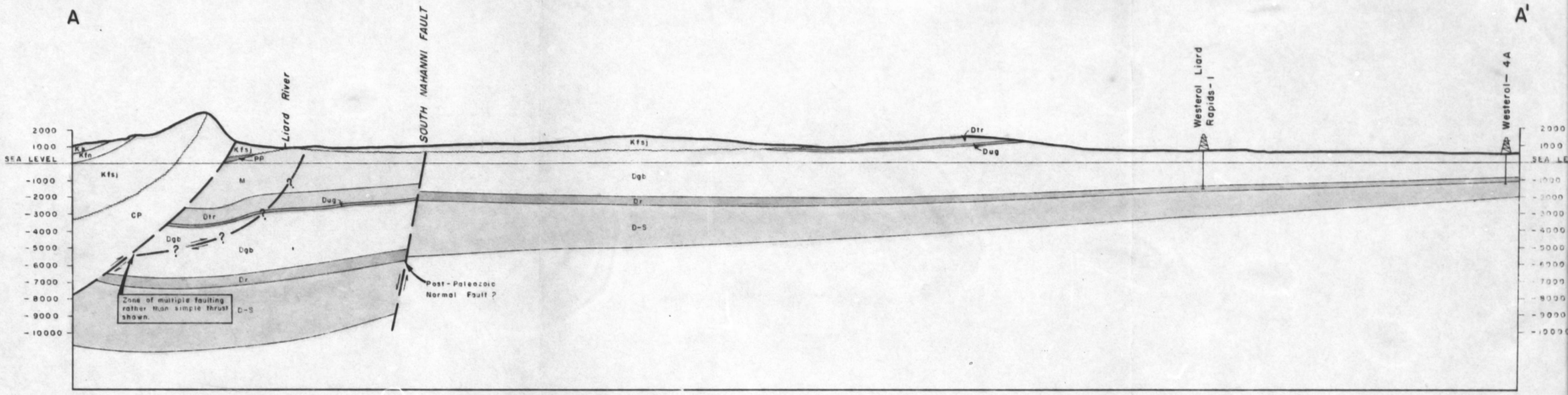
Depth in Feet	Description
770-810	Limestone - grey, brownish grey and dark grey, crypto-crystalline, mottled with chalky limestone.
810-820	Limestone - dark grey, finely crystalline, calcite.
820-840	Limestone - light to dark brownish grey, finely crystalline, in part chalky.
840-850	Limestone - brown, dense.
850-890	Limestone - as from 820-840, some dense limestone.
890-960	Limestone - brown, dense, some chalky limestone.
960-970	Dolomite - dark brownish grey, finely crystalline, tight.
970-990	Dolomite - light brown, crypto-crystalline to very finely crystalline.
990-1060	Limestone - light brown, dense; some greenish grey shale.
1060-1070	Limestone - as above, abundant calcite.
1070-1090	Dolomite - brown, crypto-crystalline.
1090-1110	Dolomite - brown, crypto to very finely crystalline, traces of porosity.
1110-1200	Dolomite - brown, finely crystalline. Quartz crystals at 1170 and 1180.
1200-1230	Dolomite - brown to grey, crypto to finely crystalline; some greenish grey shale.
1230-1260	Dolomite - light brownish grey, crypto-crystalline; some greenish grey shale.

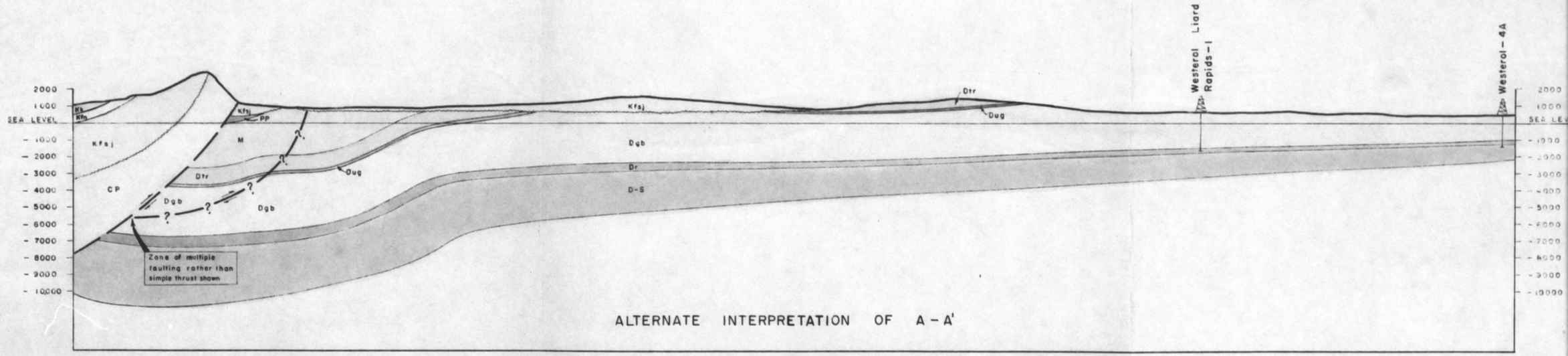
DEVONIAN-SILURIAN ?

1260-1270	Dolomite - as above; trace of anhydrite.
1270-1520	Anhydrite - light grey, dense, some greenish grey shale; dolomite as above.

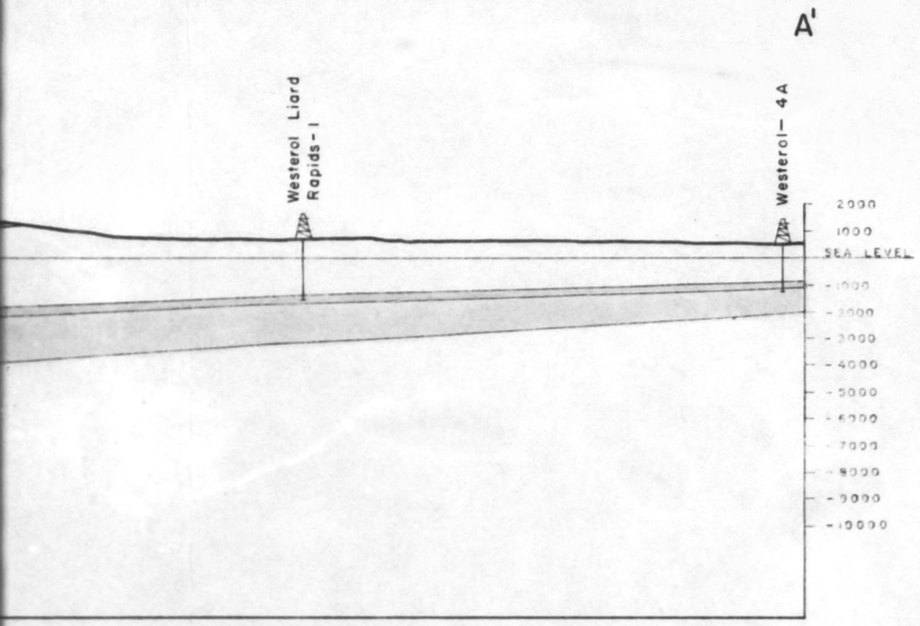
Description by G.K. Williams.

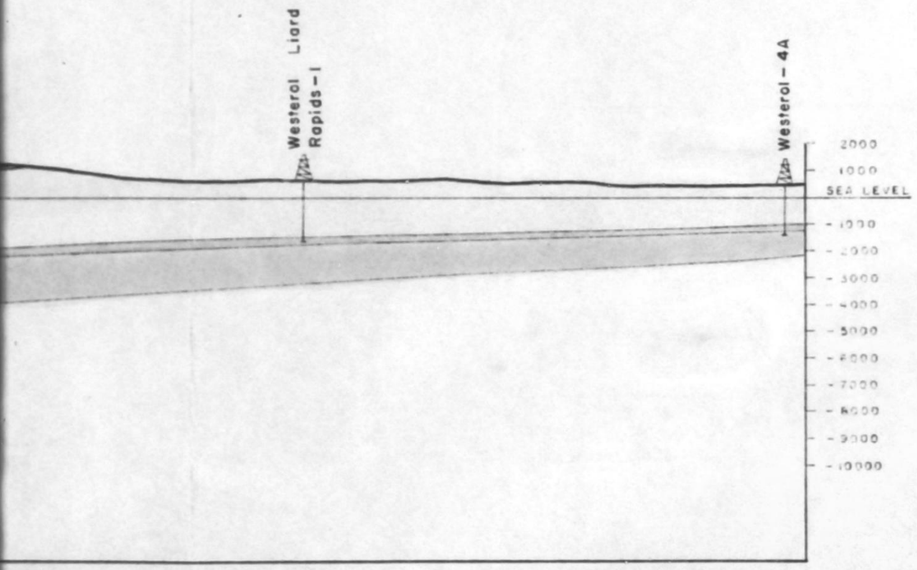
To accompany Geological Report to Sun Oil Company, Murphy Corporation, Stanwell Oil & Gas Limited, Dec 1957





ALTERNATE INTERPRETATION OF A – A'





GEOLOGICAL LEGEND

CRETACEOUS	
UPPER CRETACEOUS	
Kotaneelee Fm.	Kk
Ft. Nelson Fm.	Kfn
LOWER CRETACEOUS Undifferentiated	Kfsj
PERMO-PENNSYLVANIAN	PP } CP
MISSISSIPPIAN	M } CP
DEVONIAN	
UPPER DEVONIAN Undifferentiated	Du
Trout River Fm.	Dtr
Grumbler Fm.	
Upper Reefoid Member	Dug
Lower Silty Limestone Member	
Green Shale Unit	Dgb
Black Shale Unit	
MIDDLE DEVONIAN Ramparts Fm.	Dr
MIDDLE DEVONIAN & OLDER	D-S

STRUCTURAL CROSS SECTION A-A'

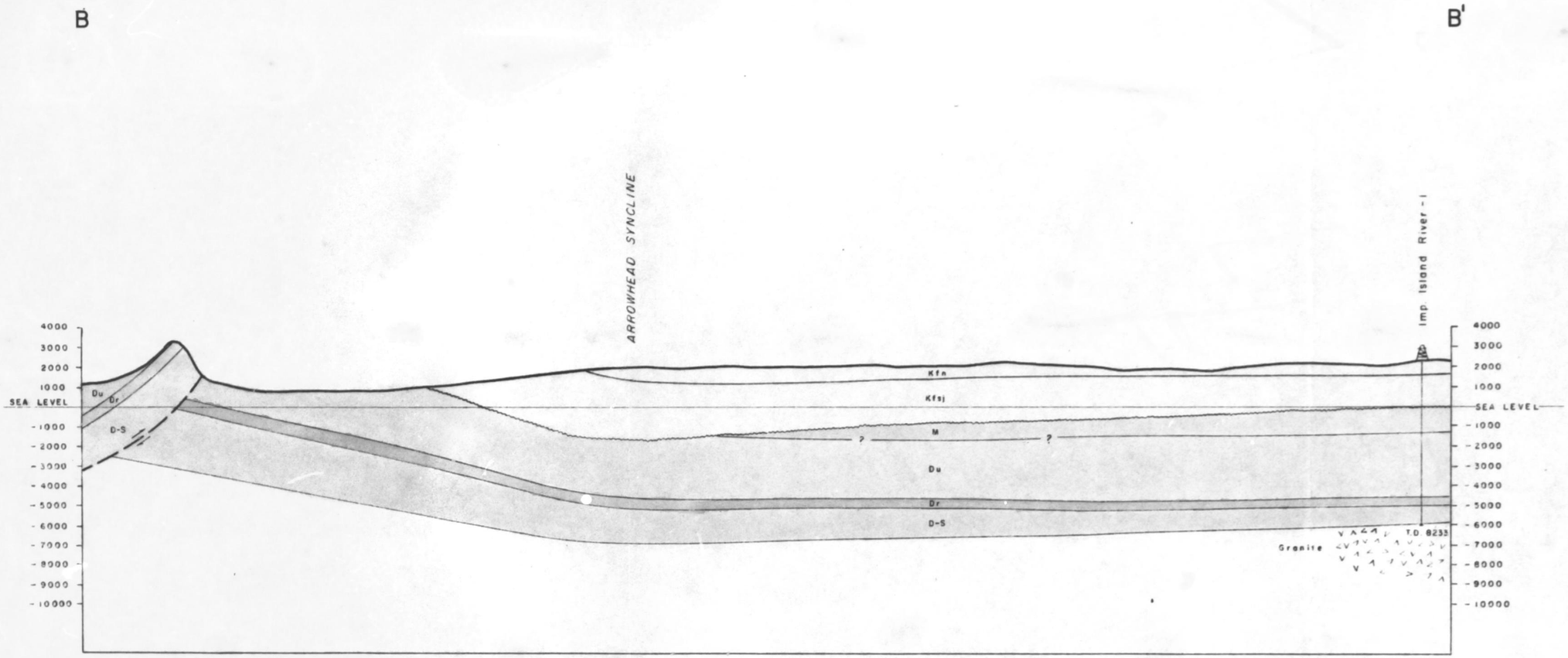
LIARD RIVER AREA

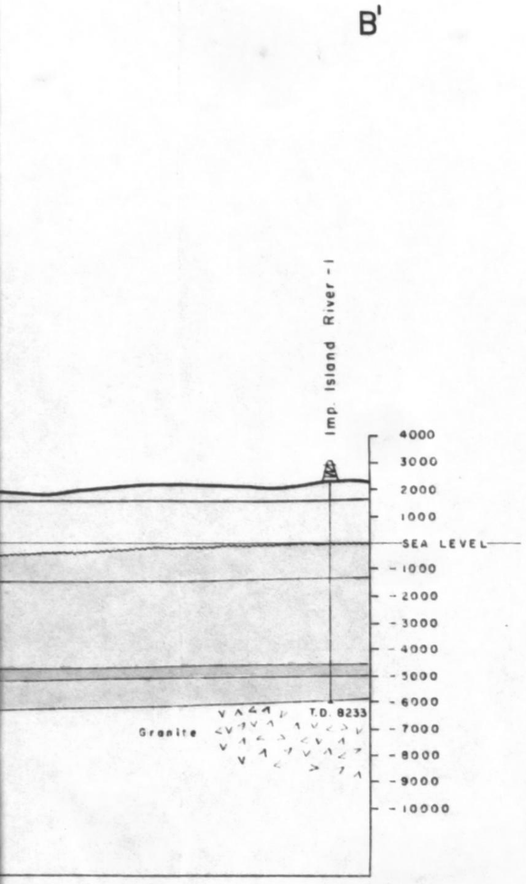
VERTICAL SCALE: 1" = 5000'

HORIZONTAL SCALE: 1" = 8 Miles

J.C. SPROULE & ASSOCIATES, CALGARY

To accompany Geological Report to Sun Oil Company, Murphy Corporation, Stanwell Oil & Gas Limited, Dec. 1957





GEOLOGICAL LEGEND

CRETACEOUS		
UPPER CRETACEOUS		
Kotaneelee Fm.	Kk	
Ft. Nelson Fm.	Kfn	
LOWER CRETACEOUS Undifferentiated	Kfsj	
PERMO-PENNSYLVANIAN	PP	CP
MISSISSIPPIAN	M	CP
DEVONIAN		
UPPER DEVONIAN Undifferentiated		Du
Trout River Fm.		Dtr
Grumbler Fm.		
Upper Reefoid Member		Dug
Lower Silty Limestone Member		Dgb
Green Shale Unit		Dgb
Black Shale Unit		Dgb
MIDDLE DEVONIAN Ramparts Fm.		Dr
MIDDLE DEVONIAN & OLDER		D-S

STRUCTURAL CROSS SECTION B-B'
LIARD RIVER AREA

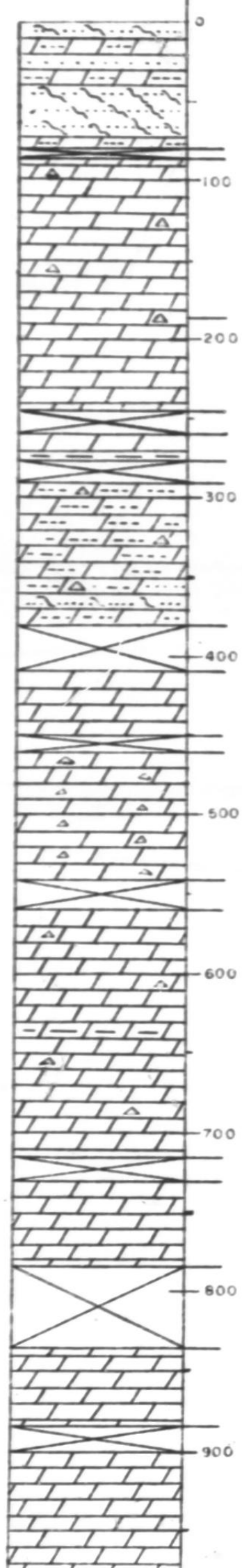
VERTICAL SCALE: 1" = 5000'

HORIZONTAL SCALE: 1" = 8 Miles

STRATIGRAPHIC SECTION Nº 1

RED ROCK PASS, NAHANNI RANGE

N. W. T.

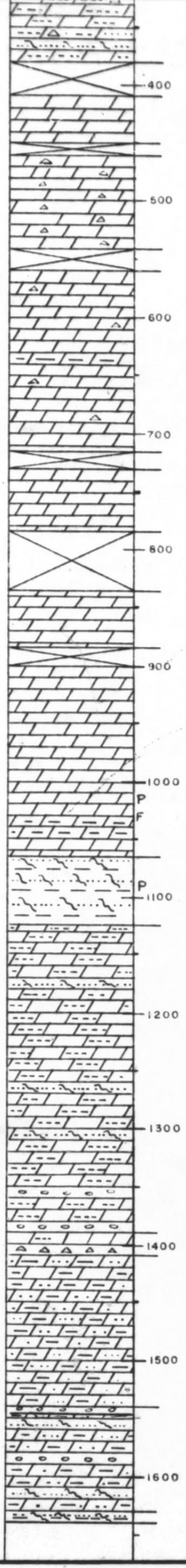
AGE		FM.	LITHOLOGY	THICKNESS	DESCRIPTION
PALEOZOIC	DEVONIAN-SILURIAN	LONE MOUNTAIN		0	Qtzite - lt gr to buff, cg, rounded grains, i/b lt gr, f x, silty dol.
	UPPER ORDOVICIAN			100	Covered. Dol - lt gr to blk, dense to f x, secondary dol, minor brn ch.
				200	Dol - dk gr to blk, dense to f x, secondary dol.
					Covered. Dol - dk gr, dense to f x, i/b blk sh.
				300	Covered. Dol - lt gr, f x, silty, minor ch, minor secondary dol, minor qtzite.
				400	Covered. Dol - m gr to dk gr, dense to f x, minor secondary dol.
					Covered. Dol - blk, dns, blk & brn ch, vuggy.
				500	Covered. Dol - gr & blk, dense to f x, minor blk ch, minor secondary dol, arg i/p.
				600	
				700	Covered. Dol -dk gr, dense, minor secondary dol.
				800	Covered. Dol - dk gr, dense to f x, speckles of wh secondary dol.
				900	Covered. Mot dol - blk, dense, abundant secondary dol giving mot effect, fair porosity, Halysites, arg i/p.

1

PALEOZOIC

UPPER ORDOVICIAN

CAMBRO - ORDOVICIAN



Covered.
Dol - m gr to dk gr, dense to f x, minor secondary dol.

Covered.
Dol - blk, dns, blk & brn ch, vuggy.

Covered.
Dol - gr & blk, dense to f x, minor blk ch, minor secondary dol, arg i/p.

Covered.
Dol -dk gr, dense, minor secondary dol.

Covered.
Dol - dk gr, dense to f x, speckles of wh secondary dol.

Covered.
Mot dol - blk, dense, abundant secondary dol giving mot effect, fair porosity, Halysites, arg i/p.

Qtzite - lt gr to blk, f g to c g, i/b sh, i/p porous.

Silty dol - grn-brn & pink, dense, i/b qtzite i/p, minor thin i/b pebble cgl.

Dol - dk gr to blk, dense to f x, sl/silty, i/b ch.
Sdy dol - brn-pink to grn to blk, dense, arg, minor qtz veining, i/b sh i/p.

Cg^{t} - dk gr qtzite pebbles & ch pebbles in sdy dol matrix.

Sdy dol - as above, minor cgl & qtzite.

Qtzite - buff to pink, c g, i/b grn sh, secondary dol.

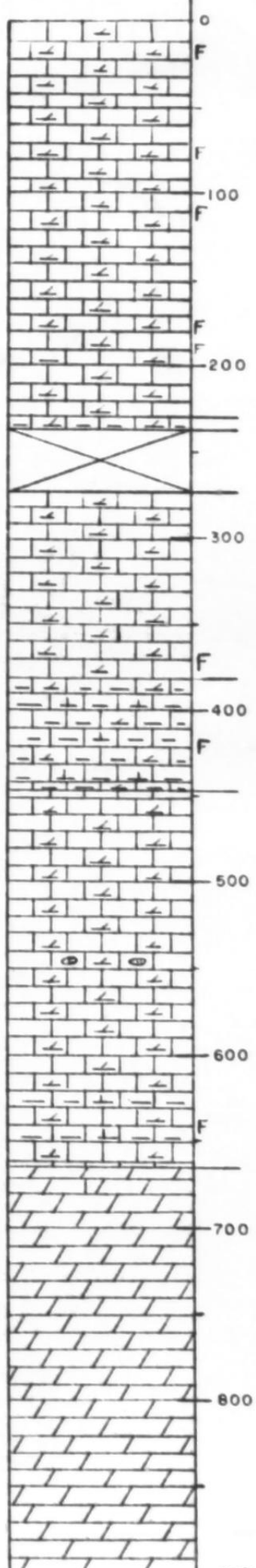
J.C.SPROULE & ASSOCIATES, CALGARY

FIGURE- V

STRATIGRAPHIC SECTION Nº 2

CREEK SOUTH OF LITTLE DOCTOR LAKE, NAHANNI RANGE

N. W. T.

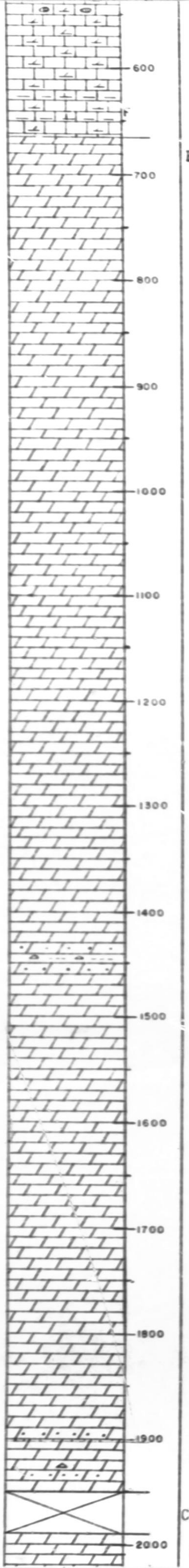
AGE	FM.	LITHOLOGY	THICK-NESS	DESCRIPTION
MIDDLE DEVONIAN	RAMPARTS			Dol ls - lt to dk gr, dense to c x, calc veining.
				Arg Dol Ls - blk, dense, i/b calc sh, thin bedded. Covered.
				Dol Ls - as above.
				Arg Dol Ls - lt to dk gr, dense to f x, i/b calc sh, calc veining.
				Dol Ls - lt gr to blk, dense to f x, calc veining, minor conc, i/b calc sh near base.
				Banded Dol - lt to dk gr to blk, dense to c x, dol veining, bedded secondary dol in part, minor ss, silt & ch. Banded weathering.

1 of

PALEOZOIC

DEVONIAN – SILURIAN

LONE MOUNTAIN and BEAR ROCK (Undifferentiated)



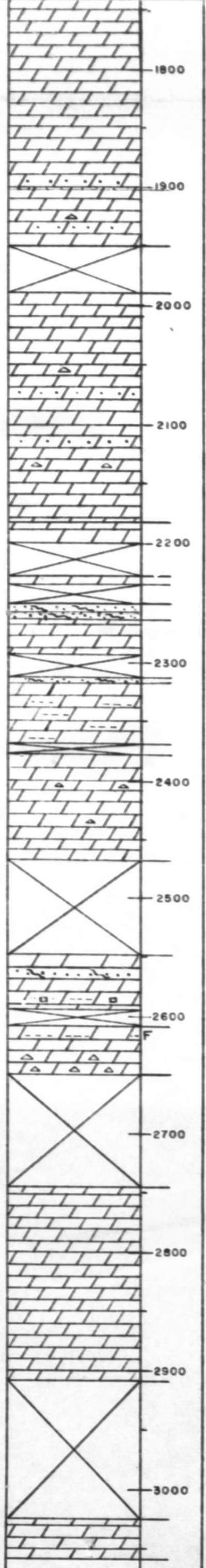
Banded Dol - lt to dk gr to blk, dense to c x, dol veining, bedded secondary dol in part, minor ss, silt & ch. Banded weathering.

Dol - brn gr, dense to f x, minor ch & ss.

Covered.

Dol - as above.

2 of



UPPER – ORDOVICIAN

Dol - brn gr, dense to f x, minor ch & ss.

Covered.

Dol - as above.

Dol - lt buff to lt gr, dense.

Covered.

Dol - as above.

Covered.

Qtzite - wh, c g, rounded grains, i/b dol.

Dol - lt to dk gr, dense.

Covered.

Qtzite - as above.

Dol - lt to dk gr, dense, silty.

Covered.

Dol - as above, minor ch tracery.

Covered.

Dol - as above, minor silty dol breccia w/ Qtzite & pyrite.

Covered.

Dol - dk gr, f x, silty at top, ch.

Covered.

Dol - dk gr to blk, dense to f x.

Covered.

Dol - m to dk gr, dense to f x.

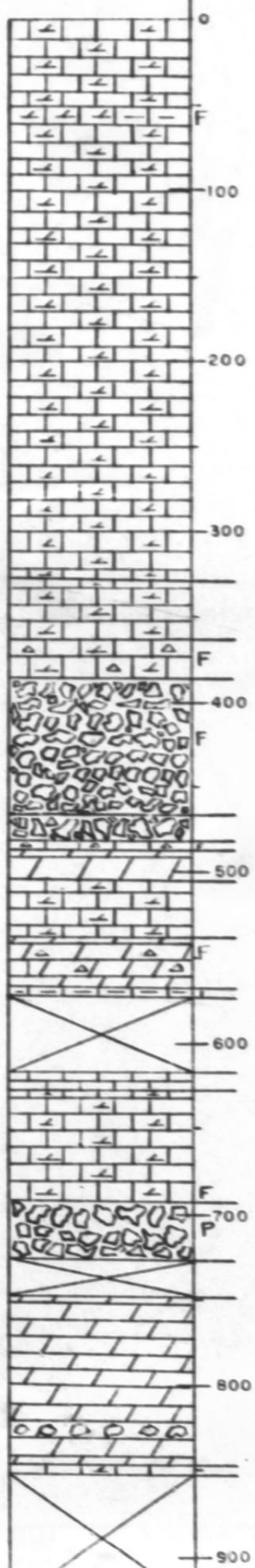
J.C. SPROULE & ASSOCIATES, CALGARY

FIGURE-VI

STRATIGRAPHIC SECTION Nº 3

BLUEFISH LAKE, NAHANNI RANGE

N. W. T.

AGE	FM.	LITHOLOGY	THICKNESS	DESCRIPTION
MIDDLE DEVONIAN	RAMPARTS		0	Dol ls - blk, dense to fx, calcite veining, arg, cave forming i/p.
			100	
			200	
			300	Dol ls - dk gr, dense to fx, calcite & qtz veining.
				Dol ls - as above, ch fossil fragmer .
			400	Dol breccia - dk gr, fx, angular blocks in wht x matrix.
				Dol breccia - as above, ch.
				Ls - blk, dense, ch.
			500	Dol - dk gr, cx, abundant secondary dol.
				Dol ls - dk gr to blk, dense to fx.
				Dol - blk, cx, bedded ch.
				Ls - blk, fx, arg.
			600	Covered.
				Ls - blk, fx, minor tracery.
				Dol ls - blk, dense to fx, calcite veining, tracery.
	BEAR ROCK		700	Dol breccia - dk brn, cx, angular blocks in wht x matrix, calcite veining.
				Covered.
			800	Dol - dk gr, minor buff gr, cx, minor calcite & secondary dol, minor dol breccia.
				Dol ls - as above.
			900	Covered.

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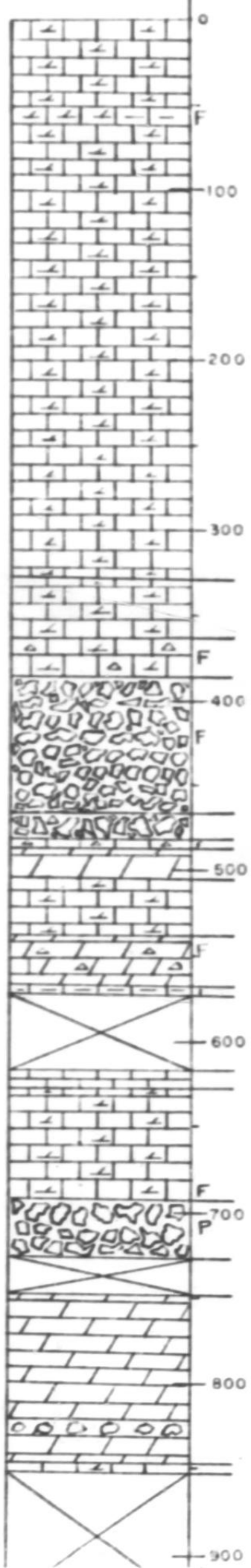
STRATIGRAPHIC SECTION № 3

BLUEFISH LAKE, NAHANNI RANGE

N. W. T.

AGE	FM.	LITHOLOGY	THICKNESS	DESCRIPTION
MIDDLE DEVONIAN	RAMPARTS		0	Dol ls - blk, dense to fx, calcite veining, arg, cave forming i/p.
			F	
			100	
			200	
			300	
				Dol ls - dk gr, dense to fx, calcite & qtz veining.
			F	Dol ls - as above, ch fossil fragments.
			400	Dol breccia - dk gr, fx, angular blocks in wht x matrix.
			F	
			F	Dol breccia - as above, ch.
				Ls - blk, dense, ch.
			500	Dol - dk gr, cx, abundant secondary dol.
				Dol ls - dk gr to blk, dense to fx.
			F	Dol - blk, cx, bedded ch.
				Ls - blk, fx, arg.
			600	Covered.
				Ls - blk, fx, minor tracery.
				Dol ls - blk, dense to fx, calcite veining, tracery.
			F	
	BEAR ROCK		700	Dol breccia - dk brn, cx, angular blocks in wht x matrix, calcite veining.
			P	
				Covered.
				Dol - dk gr, minor buff gr, cx, minor calcite & secondary dol, minor dol breccia.
			800	
				Dol ls - as above.
				Covered.
			900	

1

PALEOZOIC

DEVONIAN - SILURIAN

BEAR ROCK

LONE MOUNTAIN

[illegible] - dk [illegible] to x [illegible]lcite veining, tracery.

Dol breccia - dk brn, cx, angular blocks in wht x matrix, calcite veining.

Covered.

Dol - dk gr, minor buff gr, cx, minor calcite & secondary dol, minor dol breccia.

Dol ls - as above.

Covered.

Dol - dk gr, cx, secondary dol.

Covered

Dol - lt to dk gr, f to cx, minor secondary dol & qtz - vuggy i/p.

Dol - as above, abundant dolomite veining, minor dol breccia.

Dol - as above, minor dol veining.

Covered.

Dol breccia - geodes filled w/ wh x dol which encases angular blk dol.

Dol - as above.

Dol breccia - as above,

Dol - as above.

Dol - lt gr, f x, calc.

Dol - brn gr, dense to f x, dol veining.

Dol - as above, minor dol veining granular, fair porosity

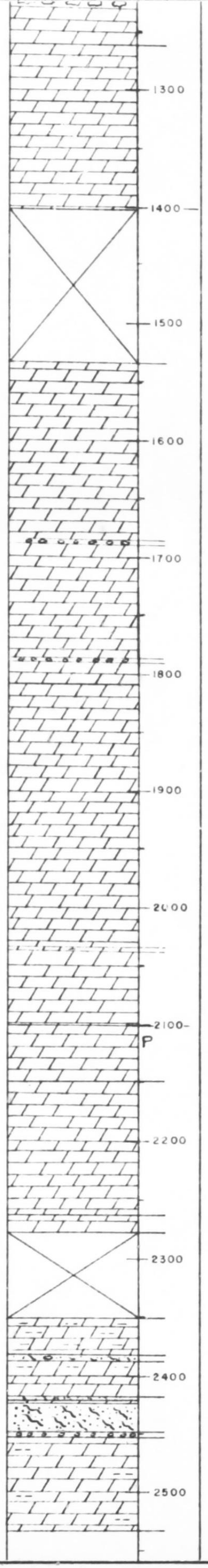
2 of

PALEOZOIC

DEVONIAN - SILURIAN

LONE MOUNTAIN

UPPER ORDOVICIAN



Dol - as above, minor dol veining.

Covered.

Dol breccia - geodes filled w/ wh x dol which encases angular blk dol.

Dol - as above.

Dol breccia - as above.

Dol - as above.

Dol - lt gr, f x, calc.

Dol - brn gr, dense to f x, dol veining.

Dol - as above, minor dol veining, granular, fair porosity.

Dol - brn-gr, lt & dk gr, dense to f x, minor dol veining.

Dol - gr to brn, dense to f x, minor secondary dol.

Covered.

Dol - as above, silty, arg.

Qtzite - lt brn to wh, c g, rounded grains, minor pebble cgt.

Dol - as above, silty in upper part.

Dol & qtzite - as above.

Pebble cgt - rounded varicolored ch pebbles to 1/2 inch.

Dol - lt to m gr, dense to f x, sl/ silty, minor dol veining.

J.C. SPROULE & ASSOCIATES, CALGARY

FIGURE-VII

STRATIGRAPHIC SECTION № 4

GRAINGER RIVER, BLUEFISH RANGE

N. W. T.

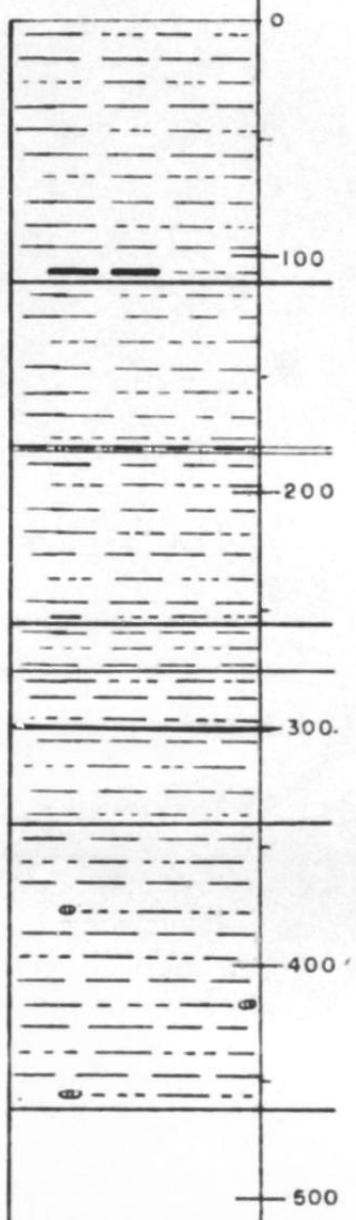
AGE		FM.	LITHOLOGY	THICK-NESS	DESCRIPTION
PALEOZOIC	MISSISSIPPIAN			0	Sh - blk, fissile, silty, carb near base.
				100	Sh - blk, fissile, silty, polished.
					Ss - dk gr, fg, dirty.
				200	Sh - as above.
					Sh - blk, fissile, silty, soft, stains rust & yellow.
					Sh - blk, fissile, silty, w/ x residue on weathered surface.
				300	Sh - blk, fissile, silty.
					Sh - blk, fissile, silty, calc conc.
				400	
				500	

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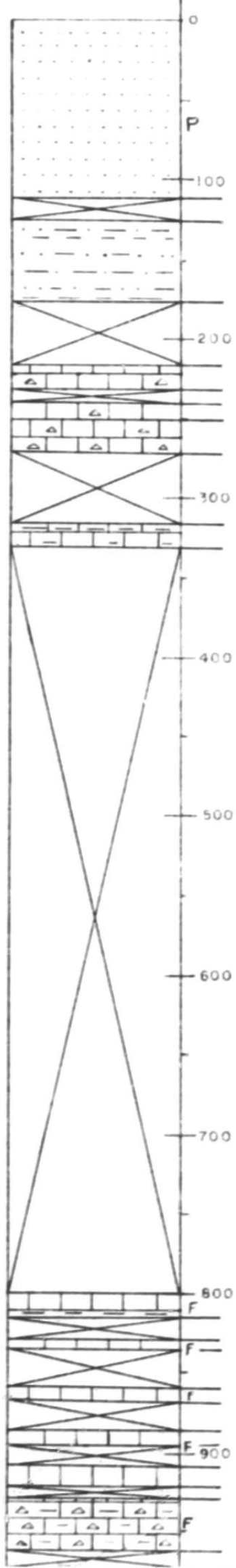
FIGURE-VIII

STRATIGRAPHIC SECTION Nº 5
(COMPOSITE)

BLUEFISH RANGE

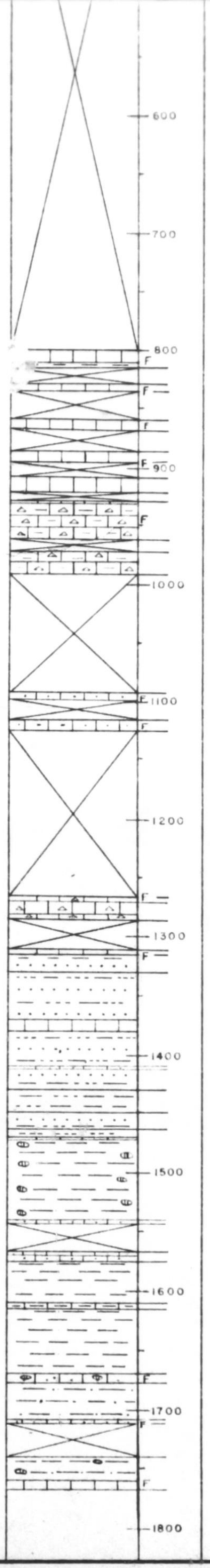
N. W. T.

AGE	FM.	LITHOLOGY	THICKNESS	DESCRIPTION
PERMO - PENN.			0	Ss - wh, c g, qtzose, minor blk ch.
			P	
			100	Covered.
				Ss - wh, f g, arg, sugary, i/b sh.
			200	Covered.
				Ls - brn-gr, c x, crinoidal, minor bedded blk ch.
				Ls - as above.
				Ls - brn-gr, f x, bedded ch.
			300	Covered.
				Ls - dk brn-gr, dense to f x, arg, i/b sh.
			400	
			500	Covered.
			600	
			700	
PALEOZOIC			800	Ls - brn-gr, f x, i/b sh.
			F	Covered.
			F	Ls - dk brn-gr, c x.
				Covered.
			F	Ls - as above.
				Covered.
			E 900	Ls - as above.
				Covered.
				Ls - brn-gr & dk gr, f x.
				Covered.
			F	Ls - dk gr, f x, arg, bedded blk ch.
				Covered.

1 of

PALEOZOIC

MISSISSIPPIAN



Ls - brn-gr, f x, i/b sh.
Covered.
Ls - dk brn-gr, c x.
Covered.
Ls - as above.
Covered.
Ls - as above.
Covered.
Ls - brn-gr & dk gr, f x.
Covered.
Ls - dk gr, f x, arg, bedded blk ch.
Covered.
Ls - as above.

Covered.

Sdy ls - lt gr, f x.
Covered.
Sdy ls - as above.

Covered

Ls - brn-gr, c x, crinoidal, minor bedded blk ch.
Ls - dk gr, dense to f x, bedded blk ch.
Covered.
Ls - gr-grn & maroon, c x, crinoidal.
Ss - buff, fg, qtzose, laminated, i/b sh.
Sh - dk gr, fissile, silty, i/b ss, minor crinoidal ls.

Ls - gr-grn & maroon, cx, sdy, crinoidal.
Ss - buff, f g, qtzose, laminated, i/b sl/ silty sh.
Sh - blk, fissile, sl/silty.
Ss - as above.
Sh - blk, fissile, i/b slt stn & crinoidal ls near top, nodular.

Ls - gr-grn & maroon, c x, sdy, crinoidal.
Covered.
Ls - brn-gr, f x, sdy.
Sh - dk gr to brn-gr, fissile, soapy, soft.
Ls - dk gr to brn-gr, f x, arg.
Sh - as above.

Ls - dk gr, f x, nodular, sdy near base.
Sh - brn, sdy, blocky, soft.
Ls - dk gr, c x, sdy.
Covered.
Sh - brn - gr, fissile, soapy, nodular, i/b ls & sdy sh.

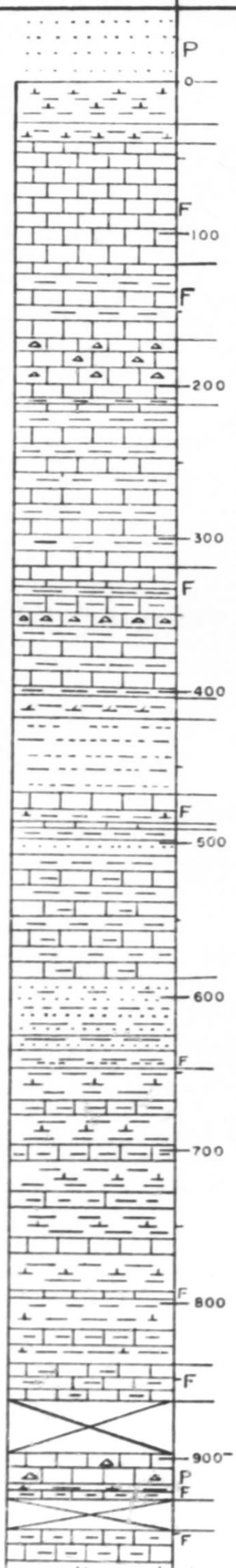
J.C. SPROULE & ASSOCIATES, CALGARY.

FIGURE - IX

STRATIGRAPHIC SECTION Nº 6

JACKFISH GAP

N. W. T.

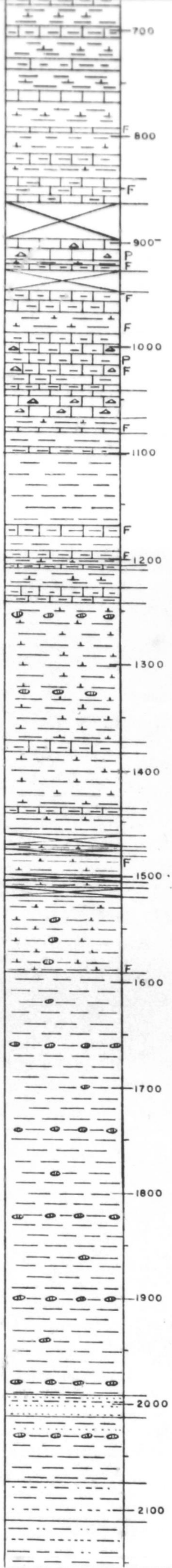
AGE	FM.	LITHOLOGY	THICKNESS	DESCRIPTION
PERMO-PENN.			P 0 F 100 F 200 300 F 400 F 500 600 F 700 F 800 F 900 P F F	Ss - wh, rusty, maroon, f to m g, carb plant fragments, i/b sltstn & sh.
	RUNDLE ?			Sh - blk, ochre weathering ls layers.
				Sh - dk gr, i/b ls. Ls - lt gr, c x, crinoidal coquina, massive.
				Ls - lt brn-gr, x, crinoidal, i/b dk gr shale.
				Ls - brn-gr, x, crinoidal, nodular ch, minor i/b sh.
				Sh - dk gr, i/b ls as ab.
				Ls - gr & brn-gr, f x and dense, i/b arg ls and sh, nodular ch in part.
				Sh - dk gr to blk, sl/ calc. Sltstn- gr to lt gr, arg.
				Sh - dk gr, sl/ calc, i/b ls, crinoidal. Ls - gr-brn, coquina. Sh - dk gr, i/b arg ls, minor ss.
				Ss - gr to grn-gr, arg, i/b sh & silty sh.
				Sh - dk gr, calc, i/b arg ls.
				Ls - dk brn-gr, f x, arg, crinoidal. Covered. Ls - brn to gr, f x, ch, i/b cal sh & arg ls. Covered. Ls - gr-brn, f x, arg, abundantly fossiliferous, i/b calc sh, minor ch.

1 of

PALEOZOIC

MISSISSIPPIAN

BANFF ?



Ls - dk brn-gr, f x, arg, crinoidal.

Covered.

Ls - brn to gr, f x, ch, i/b cal sh & arg ls.

Covered.

Ls - gr-brn, f x, arg, abundantly fossiliferous, i/b calc sh, minor ch.

Ls - gr to dk gr, f x, ch.

Sh - blk, calc, i/b ls.

Sh - dk gr, fissile, soft, calc in part, i/b arg, f x, ls.

Ls - dk gr, f x, arg.

Sh - dk gr, calc, fissile.

Ls - dk gr & brn, f x, arg.

Sh - dk gr, calc, fissile, minor bedded conc.

Ls - dk gr, f x, very arg.

Sh - dk gr, calc, soft, fissile.

Ls - dk gr, arg, sl/ fissile.

Sh - dk gr, calc, fissile.

Covered.

Sh - as above.

Covered.

Sh - dk gr, calc, festn conc.

EXSHAW ?

Sh - blk, fissile, bedded & solitary conc.

Ss - brn-gr, fg, finely micaceous, sl/ arg i/p, i/b dk gr, arg sltstn.

Sh - blk & dk gr, finely micaceous i/p, i/b ss i/p, bedded conc i/p.

Ss- dk gr to brn-gr, fg, silty & arg, finely micaceous, i/b sh & mud

Sh - dk gr, silty, i/b mud stn.

2

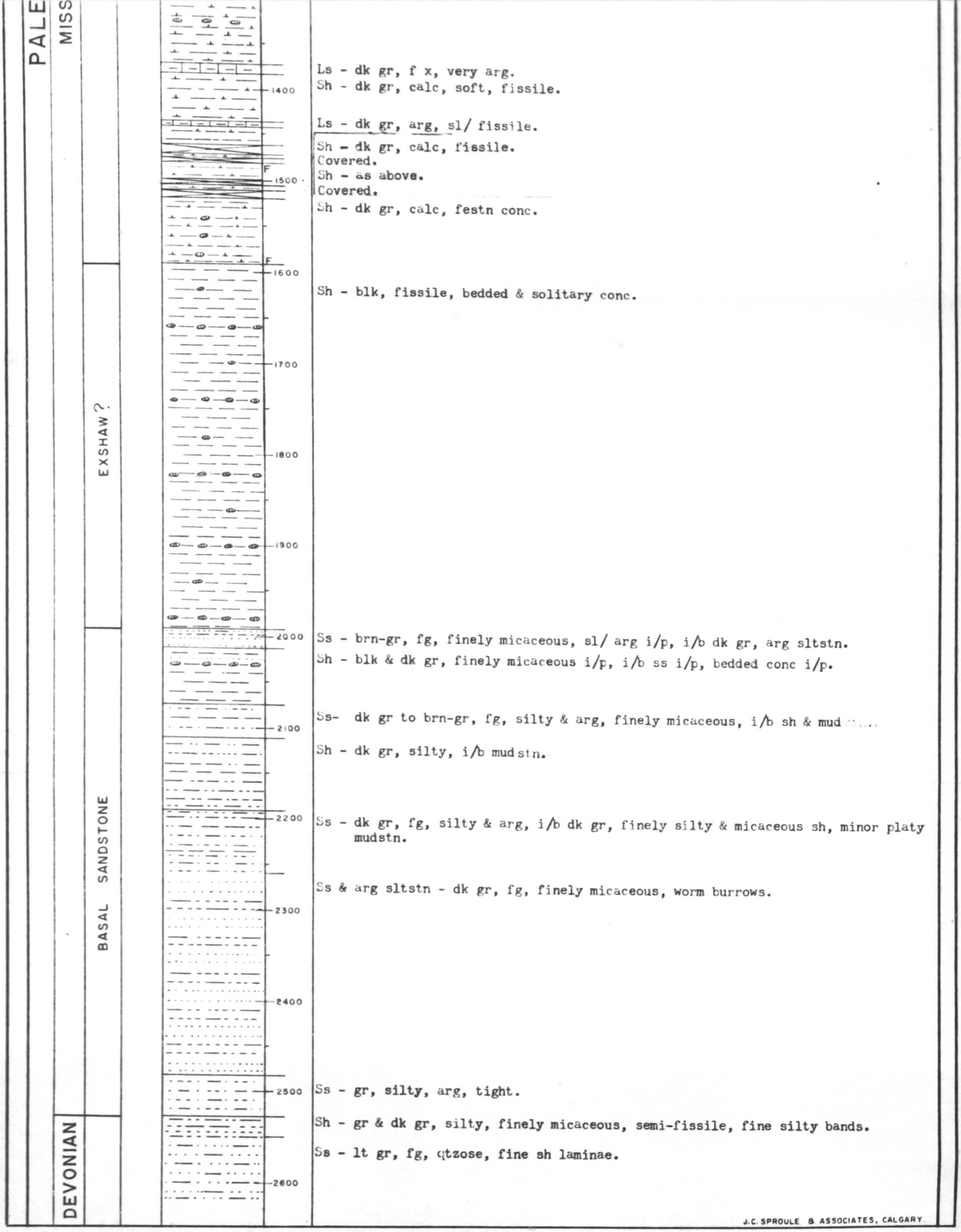

PALE
MISS
EXSHAW?
BASAL SANDSTONE
DEVONIAN
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
Ls - dk gr, f x, very arg.
Sh - dk gr, calc, soft, fissile.
Ls - dk gr, arg, sl/ fissile.
Sh - dk gr, calc, fissile.
Covered.
Sh - as above.
Covered.
Sh - dk gr, calc, festn conc.
Sh - blk, fissile, bedded & solitary conc.
Ss - brn-gr, fg, finely micaceous, sl/ arg i/p, i/b dk gr, arg sltstn.
Sh - blk & dk gr, finely micaceous i/p, i/b ss i/p, bedded conc i/p.
Ss- dk gr to brn-gr, fg, silty & arg, finely micaceous, i/b sh & mud
Sh - dk gr, silty, i/b mud stn.
Ss - dk gr, fg, silty & arg, i/b dk gr, finely silty & micaceous sh, minor platy mudstn.
Ss & arg sltstn - dk gr, fg, finely micaceous, worm burrows.
Ss - gr, silty, arg, tight.
Sh - gr & dk gr, silty, finely micaceous, semi-fissile, fine silty bands.
Ss - lt gr, fg, qtzose, fine sh laminae.
J.C. SPROULE & ASSOCIATES, CALGARY

FIGURE - X

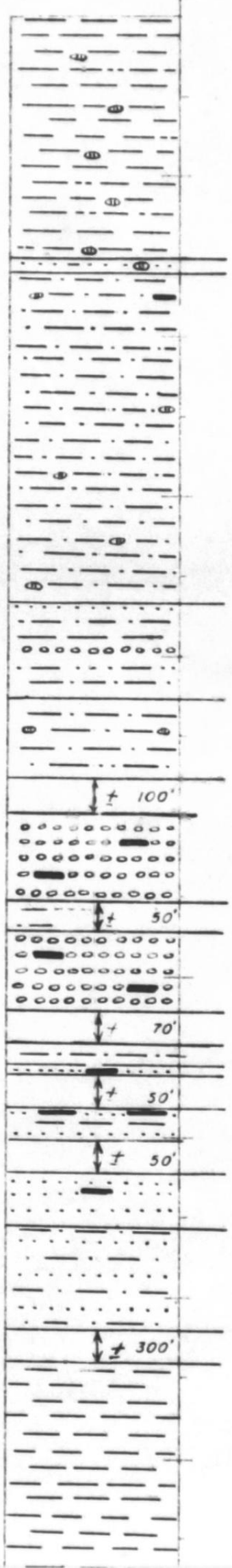
STRATIGRAPHIC SECTION № 7
(COMPOSITE)

KOTANEELEE RIVER
FIGURE I.

N. W. T.

Estimated thicknesses of covered intervals were made by dip projection on aerial photos.

Scale of measured section 1" = 100ft

AGE	FM.	LITHOLOGY	THICKNESS	DESCRIPTION
UPPER CRETACEOUS	KOTANEELEE			Sh - dr gr to blk, sl/silty, sulphurous, conc. Ss - buff, cg, qtzose, s & p, arg, bedded conc. Sh - dk gr, sdy, selenitic i/p, minor conc, minor carb material, fossiliferous. Ss - dk grn & gr, fg, ch granules, minor mica, arg i/p, i/b ch pebble cgt, i/b dk gr sdy sh. Sh - dk gr to blk, sdy, selenitic, conc. Covered Cgt - dk gr qtzite & wh, grn & milky wh ch pebbles in lt gr, cg, ss matrix, rounded pebbles to 2 inches in long diameter, carb fragments. Sdy sh - dk gr to blk. Covered Sh - grn-brn, sdy. Ss - lt gr, cg, qtzose, ch granules, carb. Covered Ss & sh - thin bedded w/ 6 inch carb sh at top, ss as above. Ss - as above. Covered Ss - lt gr, cg, qtzose, s & p, ch granules, laminated, carb material. Ss - lt gr & grn-brn, qtzose, s & p, laminated, well cemented, selenitic, i/b sdy sh. Covered Sh - blk, fissile, sulphurous, bituminous, bentonitic, minor brn ss, minor ch granules.
	UPPER FT. NELSON			
	LOWER FORT NELSON			
MESOZOIC				

± 100'
± 50'
± 70'
± 50'
± 50'
± 300'

1 of

Cgt - dk gr qtzite & wh, grn & milky wh ch pebbles in
gr, cg, ss matrix, rounded pebbles to 2 inches in long diameter, carb fragments.

Sdy sh - dk gr to blk.

Covered

Sh - grn-brn, sdy.
Ss - lt gr, cg, qtzose, ch granules, carb.

Covered

Ss & sh - thin bedded w/ 6 inch carb sh at top, ss as above.
Ss - as above.

Covered

Ss - lt gr, cg, qtzose, s & p, ch granules, laminated, carb material.

Ss - lt gr & grn-brn, qtzose, s & p, laminated, well cemented, selenitic, i/b sdy sh.

Covered

Sh - blk, fissile, sulphurous, bituminous, bentonitic, minor brn ss, minor ch granules.

Covered

Sh - dk gr, sdy, blocky, selenitic, bedded conc.

Covered

Sh - dk gr, sdy, blocky, selenitic, bedded conc, fossiliferous, minor thin, lt gr, fg, qtzose, s & p ss.

Covered

Ss - lt gr, grn cast, fg, qtzose, s & p, laminated, conc, arg, mica, i/b silty sh.

Covered - presumably blk, sdy, blocky sh, minor ss as above.

Ss - as above.

Covered

Ss - as above, i/b silty & sdy sh.

Covered

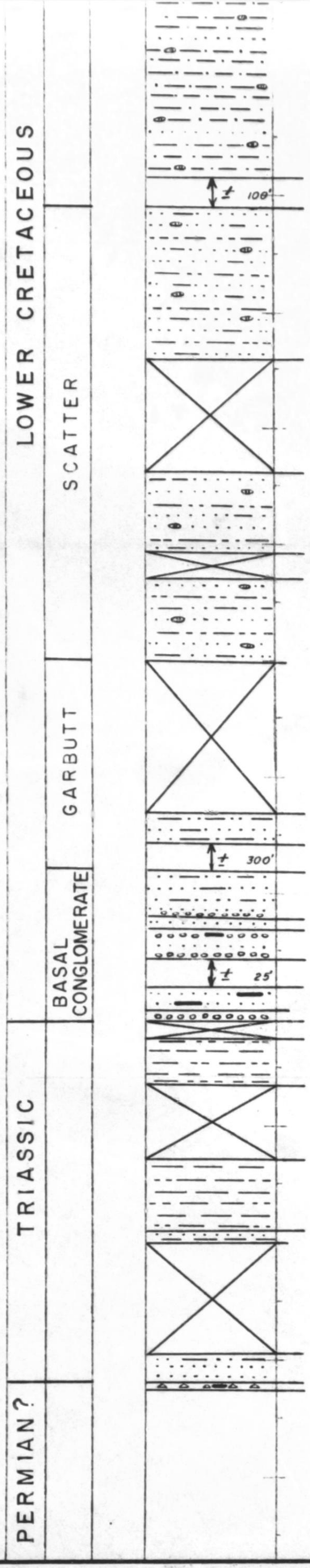
I/b dk gr sdy sh & grn-brn, fg, qtzose, s & p, arg ss.

Covered

Ss - lt gr, grn cast, cg, qtzose, s & p, laminated, arg, minor wh ch pebbles.
Ss - grn, cg, qtzose, blk & grn ch.
Cgt - varicolored, angular & rounded ch pebbles in ss matrix, carb, i/b ss as above.

Covered

2 of



Sh - dk gr, sdy, blocky, selenitic, bedded conc, fossiliferous, minor thin, lt gr, fg, qtzose, s & p ss.

Covered

Ss - lt gr, grn cast, fg, qtzose, s & p, laminated, conc, arg, mica, i/b silty sh.

Covered - presumably blk, sdy, blocky sh, minor ss as above.

Ss - as above.

Covered

Ss - as above, i/b silty & sdy sh.

Covered

I/b dk gr sdy sh & grn-brn, fg, qtzose, s & p, arg ss.

Covered

Ss - lt gr, grn cast, cg, qtzose, s & p, laminated, arg, minor wh ch pebbles.

Ss - grn, cg, qtzose, blk & grn ch.

Cgt - varicolored, angular & rounded ch pebbles in ss matrix, carb, i/b ss as above.

Covered

Ss - lt gr, cg, s & p, carb.

Cgt - as above.

Sh - grn, sl/silty, fissile, nodular.

Covered

Sh - grn & maroon, silty i/p, mica.

Ss - dk gr, fg, qtzose, s & p, i/b blk fissile sh.

Covered

Ss-grn, fg, s & p, i/b sdy sh.

Ch - m gr, carb.

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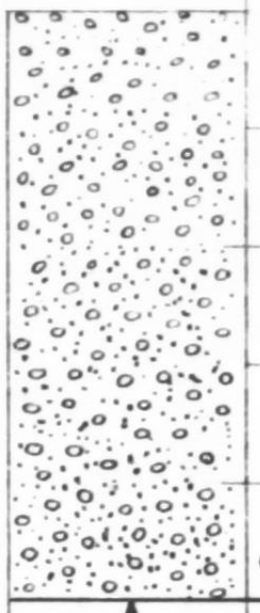
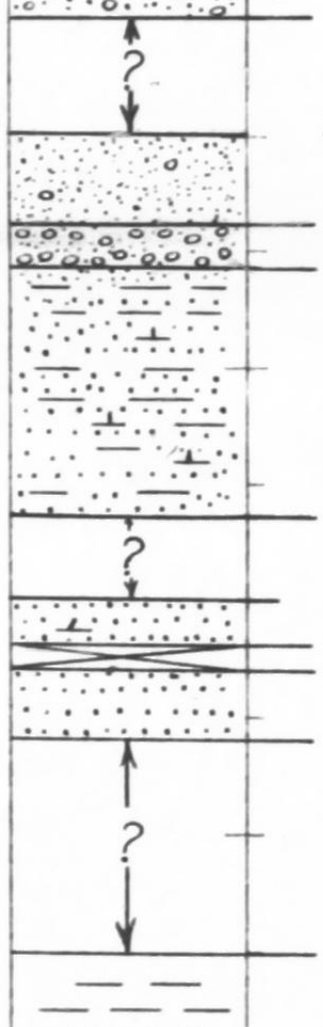
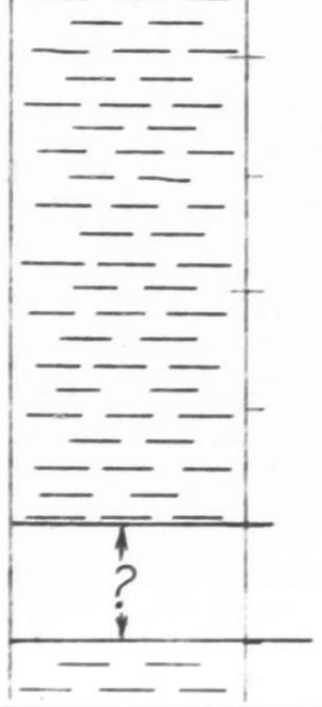
FIGURE-XI

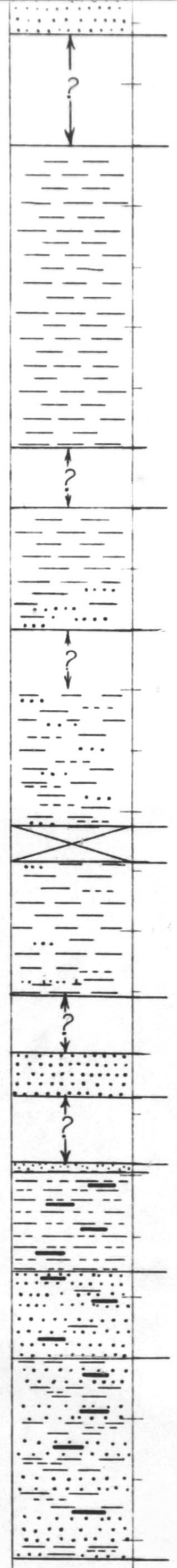
STRATIGRAPHIC SECTION NO. 8
(COMPOSITE)
PETITOT RIVER
N. W. T.

Compiled from several discontinuous Cretaceous outcrops, the thickness of strata between the various outcrops is unknown.

Scale of measured section 1" = 100'ft.

AGE	FM.	LITHOLOGY	THICKNESS	DESCRIPTION
UPPER CRETACEOUS	UPPER FORT NELSON		0	Cgt - ch pebbles in ss matrix, some i/b ss.
	LOWER FORT NELSON			Ss - lt buff, vcg, scattered pebbles. Cgt - gr, v sdy, small pebbles Ss - gr & brn, vf to fg, in part calc i/b w/ Sh - dk gr to blk, fissile, in part silty Ss - brn-gr, fg, s & p, in part calc. Ss - brn, c g, s & p.
MESOZOIC	LEPINE			Sh - dk gr to blk, fissile, soft, bentonitic?, conc layers.

1 of



MESOZOIC

LEPINE

LOWER CRETACEOUS

SCATTER

Ss - brn, c g, s & p.

Sh - dk gr to blk, fissile, soft, bentonitic?, conc layers.

Sh - as above, ss laminae near base.

Sh - dk gr to blk, sdy & silty, conc,
thin calc ss layers.

Sh - dk gr to blk, in part sdy & silty.
A few thin calc ss bands.

SS - grn-gr, fg, qtzose.

Ss - gr & grn, vfg.

Arg sltstn or silty mudstone, highly carb.

Ss - m g, grn cast, vfg, carb, arg bands.

Ss - grn-gr, vfg, qtzose, glauc, carb, in part
laminated, i/b w/

Mudstone-dk gr to brn, v silty & sdy, conc.

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FIGURE XII

LITHOLOGICAL CONVENTIONS

Limestone

Dolomite

Shale

Siltstone

Sandstone

Conglomerate

Quartzite

Coal

Covered Section

Calcareous

Dolomitic

Carbonaceous

Breccia

f Fossil

Concretion

Chert

P Porosity

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ABBREVIATIONS USED ON GRAPHIC WELL LOGS

anhy	anhydrite or anhydritic
aren	arenaceous
arg	argillaceous
bent	bentonite or bentonitic
bit	bituminous
blk	black
bl	blue
brn	brown
calc	calcareous
carb	carbonaceous
cgl	conglomerate
ch	chert or cherty
choc	chocolate
conc	concretion or concretionary
c g	coarse grained
c x	coarse crystalline
dk	dark
dol	dolomite or dolomitic
f g	fine grained
f x	fine crystalline
ferr	ferruginous
frag	fragmental
glauc	glauconite or glauconitic
gr	grey
gran	granular
grn	green
gyp	gypsum or gypsiferous
i/b	interbedded
icp	intercrystalline porosity
igp	intergranular porosity
lith	lithographic
lt	light
ls	limestone
mic	micaceous
mot	mottled
m g	medium grained
m x	medium crystalline
p or P	porosity
ppp	pin-point porosity
pyr	pyrite or pyritic
qtz	quartz
qtzose	quartzose
rdd	rounded
sd	sand
sdy	sandy
sh	shale
sl/	slightly
sltst	siltstone
ss	sandstone
sublith	sublithographic
suc	sucrose
s & p	salt and pepper
tr	trace
v	very
w/	with
wh	white
yel	yellow
x	crystalline
xtals	crystals

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ABBREVIATIONS USED ON STRATIGRAPHIC SECTIONS

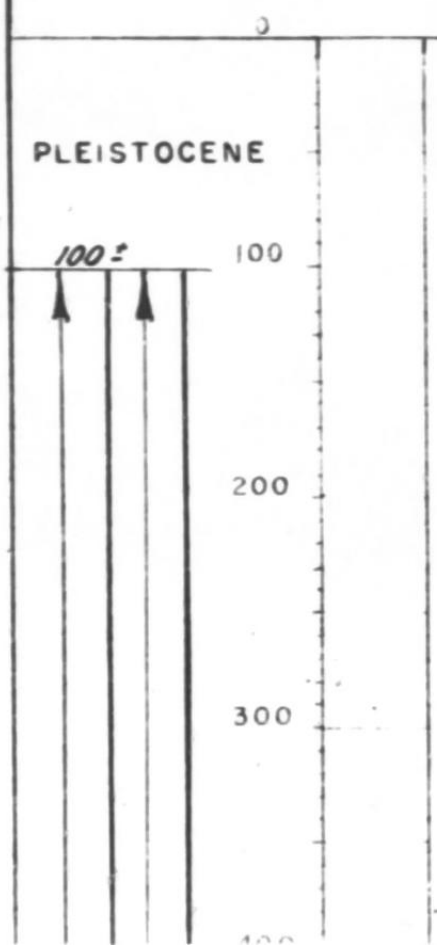
arg	argillaceous
blk	black
brn	brown
c	coarse
calc	calcareous
carb	carbonaceous
ch	chert
cgt	conglomerate
conc	concretion
dk	dark
dol	dolomite or dolomitic
f	fine
festn	ironstone
g	grain
gr	grey
grn	green
i/b	interbedded
i/p	in part
ls	limestone
lt	light
m	medium
mudstn	mudstone
mot	mottled
qtz	quartz
qtzite	quartzite
qtzose	quartzose
sd	sand
sdy	sandy
sh	shale
sltstn	siltstone
sl/	slightly
s & p	salt & pepper
ss	sandstone
v	very
w/	with
wh	white
x	crystal

COMPANY :	AREA N. W. T.
WELL NAME : WESTEROL LIARD RAPIDS	Nº 1 A
LOCATION : LAT. 61° 27' N. LONG. 121°47'40" W.	
ELEVATION : KB : 777'	G. D. 770'
SPUDDED : 23-3-1953	COMPLETED : 10-3-1954
TOTAL DEPTH : 2467'	STATUS : ABANDONED
LOGS RUN : Halliburton E-Log 477-2467'	
CASING RECORD : 7" x 470' C 125	
PRODUCTION TESTS :	

REMARKS

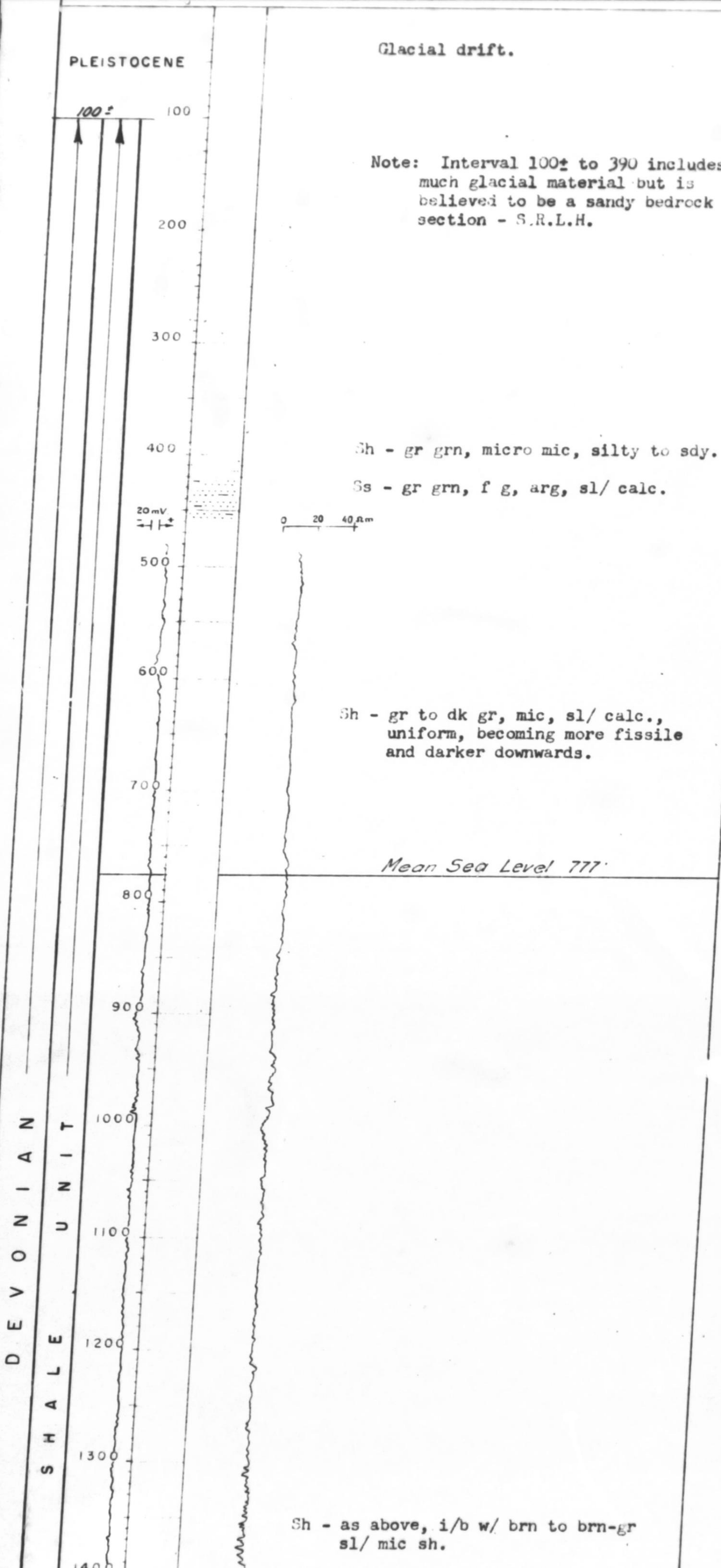
LITHOLOGICAL LEGEND

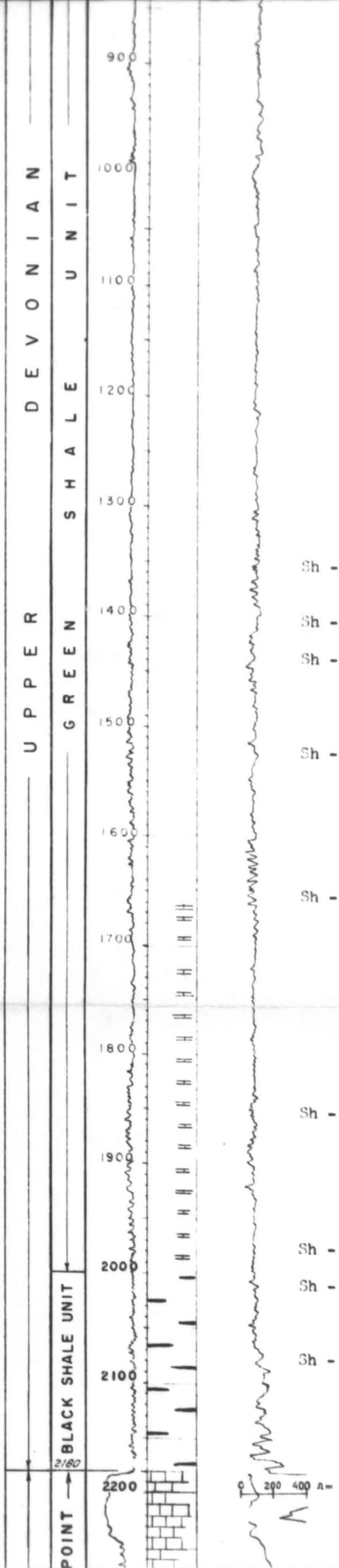
SANDSTONE	SILTY SHALE	DOLOMITE
SHALE	BITUMINOUS SHALE	DOLOMITIC LIMESTONE
SANDY SHALE	COAL	CALCAREOUS (SH. SS. ETC.)
SHALY SAND	ANHYDRITE or GYPSUM	DOLOMITIC (SS. ETC.)
CONGLOMERATE	SALT	BASEMENT ROCK
SILTSTONE	LIMESTONE	LITHOLOGY UNKNOWN



Glacial drift.

Note: Interval 100± to 390 includes much glacial material but is believed to be a sandy bedrock section - S.R.L.H.


PLEISTOCENE
Glacial drift.
100±
100
Note: Interval 100± to 390 includes much glacial material but is believed to be a sandy bedrock section - S.R.L.H.
200
300
400
Sh - gr grn, micro mic, silty to sdy.
Ss - gr grn, f g, arg, sl/ calc.
20 mV
0 20 40 Ωm
500
600
Sh - gr to dk gr, mic, sl/ calc., uniform, becoming more fissile and darker downwards.
700
Mean Sea Level 777'
800
900
1000
1100
1200
1300
Sh - as above, i/b w/ brn to brn-gr sl/ mic sh.
1400
DEVONIAN
SHALE UNIT



Sh - as above, i/b w/ brn to brn-gr sl/ mic sh.

Sh - brn sl/ calc.

Sh - brn, bit, & gr grn fissile.

Sh - dk brn to choc brn, bit, sl/ calc, i/b w/ minor gr grn sh.

Sh - gr grn & brn, bit as above, thin i/b of brn, f g ls.

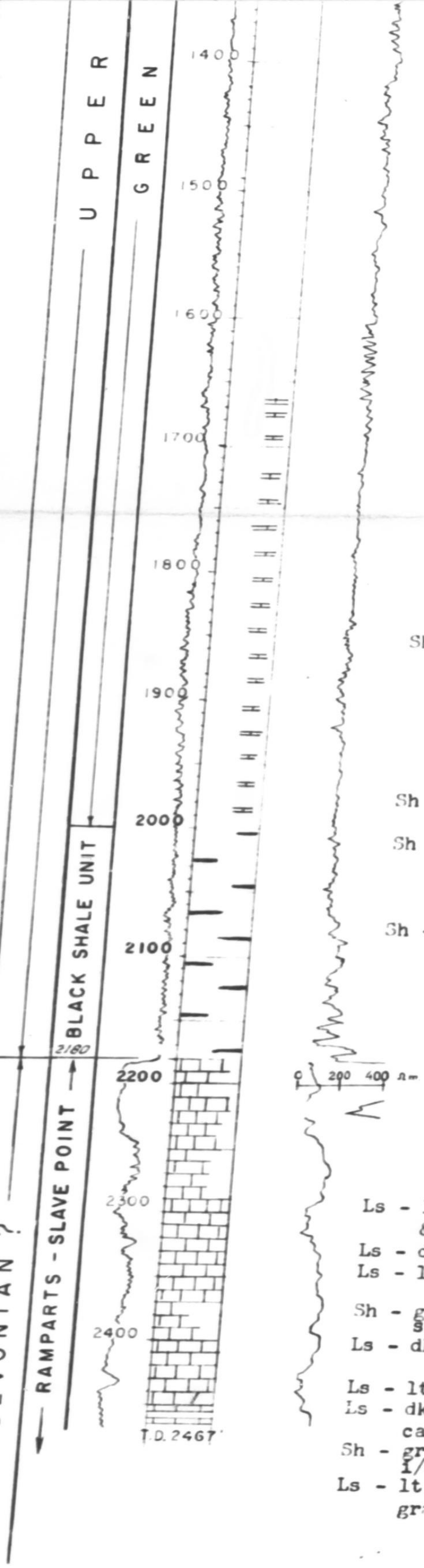
Sh - gr grn i/b w/ thin beds brn sh & arg ls.

Sh - brn, bit.

Sh - as above w/ i/b of dk to blk silty, foliac sh, highly bit, dk reddish cast.

Sh - as above, blk to brn w/ i/b gr grn fissile sh.

Ls - dk brn, crypto x, chalky phases becoming lighter colored downwards w/ gran texture. Thin i/b grn & blk sh.



Sh - as above, i/b w/ brn to brn-gr sl/ mic sh.

Sh - brn sl/ calc.

Sh - brn, bit, & gr grn fissile.

Sh - dk brn to choc brn, bit, sl/ calc, i/b w/ minor gr grn sh.

Sh - gr grn & brn, bit as above, thin i/b of brn, f g ls.

Sh - gr grn i/b w/ thin beds brn sh & arg ls.

Sh - brn, bit.

Sh - as above w/ i/b of dk to blk silty, foliac sh, highly bit, dk reddish cast.

Sh - as above, blk to brn w/ i/b gr grn fissile sh.

Ls - dk brn, crypto x, chalky phases becoming lighter colored downwards w/ gran texture. Thin i/b grn & blk sh.

Ls - lt gr brn to brn, gran to chalky & crypto x.
Ls - dk amber, crypto x.
Ls - lt to m gr, crypto x to micro x.

Sh - gr grn, micro mic, non-calc, splintery.
Ls - dk amber, micro gran, carb.

Ls - lt gr, crypto x, uniform.
Ls - dk brn to amber, dense to frag, carb w/ local thin f x dol & ls beds.
Sh - gr-grn, splintery, non-calc, minor i/b gr crypto x ls.
Ls - lt brn to amber, crypto x to micro gran, in pt. frag.

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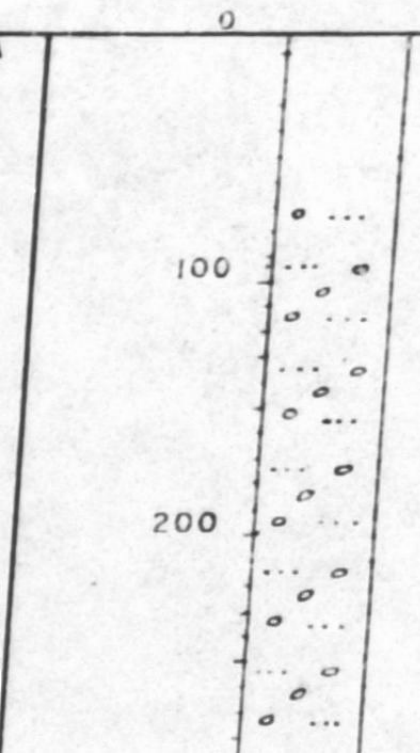
COMPANY : PETCAL LTD.	AREA N.W.T.
WELL NAME : WESTEROL	Nº 3 A
LOCATION: LAT. 61° 46' 20", LONG. 120°43'48" W.	
ELEVATION KB: 470'	GRD. –
SPUDDED: 14-7-1952	COMPLETED : 30-7-1952
TOTAL DEPTH: 2422'	STATUS ABANDONED
LOGS RUN: Halliburton E-Log 402'-2375'	
CASING RECORD: 7" x 402' C 56	
PRODUCTION TESTS :	
REMARKS	

LITHOLOGICAL LEGEND

SANDSTONE	SILTY SHALE	DOLOMITE
SHALE	BITUMINOUS SHALE	DOLOMITIC LIMESTONE
SANDY SHALE	COAL	CALCAREOUS (SH. SS., ETC)
SHALY SAND	ANHYDRITE & GYPSUM	DOLOMITIC (SS, ETC)
CONGLOMERATE	SALT	BASEMENT ROCK
SILTSTONE	LIMESTONE	LITHOLOGY UNKNOWN



Glacial drift.

1 of

Ss - as above, i/b silty & sdy sh.

Covered

I/b dk gr sdy sh & grn-brn, fg, qtzose, s & p, arg ss.

Covered

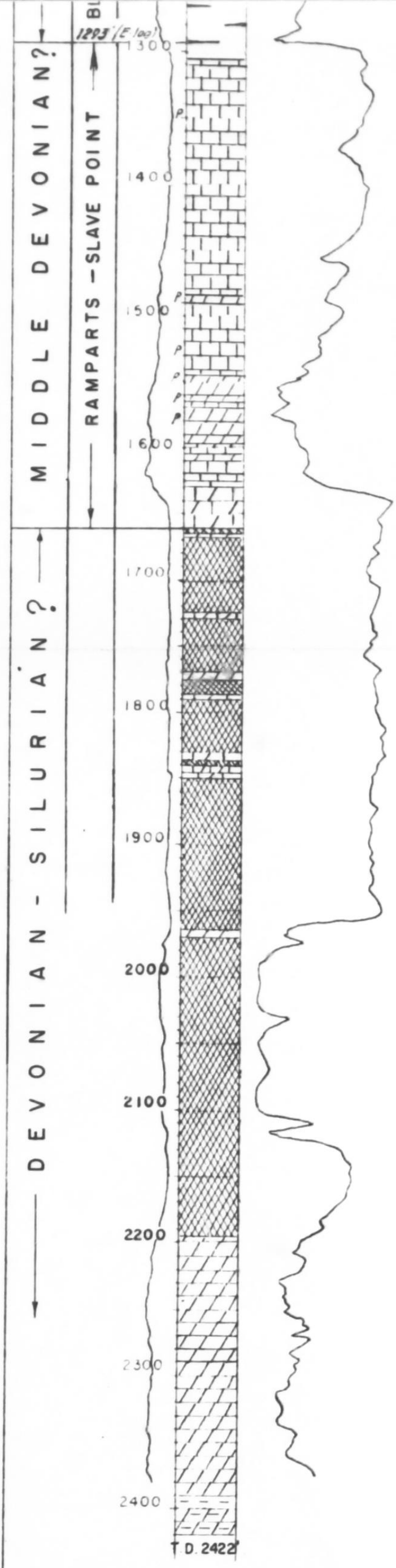
Ss - lt gr, grn cast, cg, qtzose, s & p, laminated, arg, minor wh ch pebbles.

Ss - grn, cg, qtzose, blk & grn ch.

Cgt - varicolored, angular & rounded ch pebbles in ss matrix, carb, i/b ss as above.

Covered

2 of



Sh - dk brn & gr to blk.

Ls - br to gr mottled, f x to frag, traces of bit.

Ls lt gr mottled f g to frag.

Dol - m brn, f x.
Ls - gr to brn f g to frag, tr bit 1510-1512.

Dol - gr brn, frag to f x.
Ls - lt to m brn, f x to frag.
Dol - gr brn, f x.

Ls - gr brn, f g.
Ls - dol, lt to m brn, mottled, tr bit c pyr.
Ls - dol, becoming arg.
Anhy - gr brn, massive.

Ls - dol.
Anhy - gr brn, f x.

Dol - m brn, f g and anhy.
Ls - dol and anhy.
Anhy - lt brn.

Ls - dol and anhy.

Anhy.

Dol - red brn, f g, w/ anhy.

Anhy - m gr to red brn.

Dol - m brn, f x, some anhy.

Dol - red to pink, f g, silty.

Dol - as above w/ f g sltst.

Dol - lt gr f g silty w/ gr anhy.

Dol - as above plus kaolinized arkosic sltst.

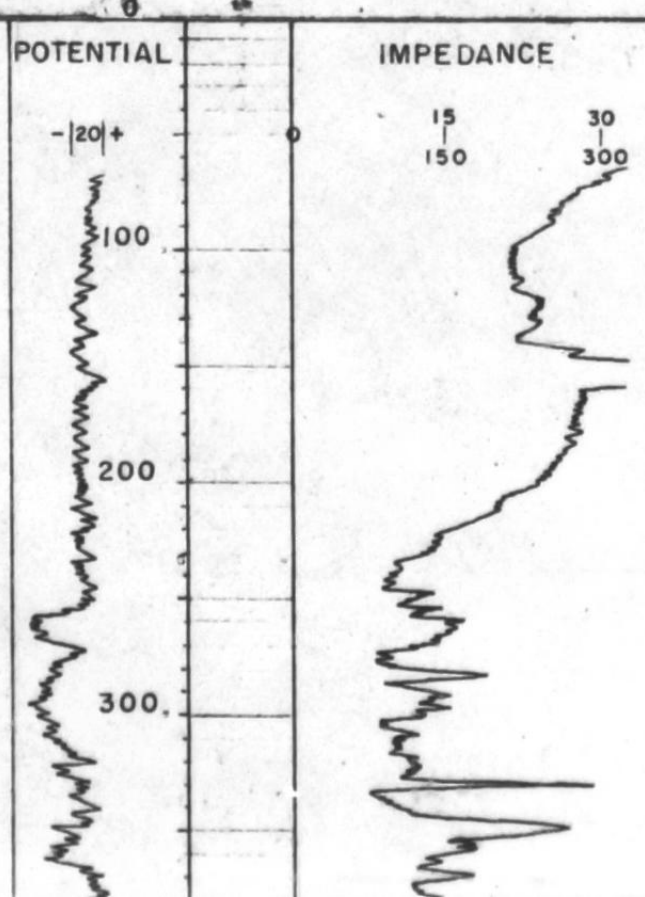
J.C. SPROULE & ASSOCIATES, CALGARY.

COMPANY: PETCAL LIMITED	AREA FT. SIMPSON
WELL NAME: WESTEROL	Nº 4 A
LOCATION: LAT. 61° 46' 49" N. LONG. 121° 14' 26" W.	
ELEVATION KB: 577'	GRD.
SPUDDED: 2-9-1952	COMPLETED: 11-9-1952
TOTAL DEPTH:	STATUS: ABANDONED
LOGS RUN: E. LOG - 70'-1888'	
CASING RECORD: NO SURFACE CASING	
PRODUCTION TESTS: NO DS.T's reported	

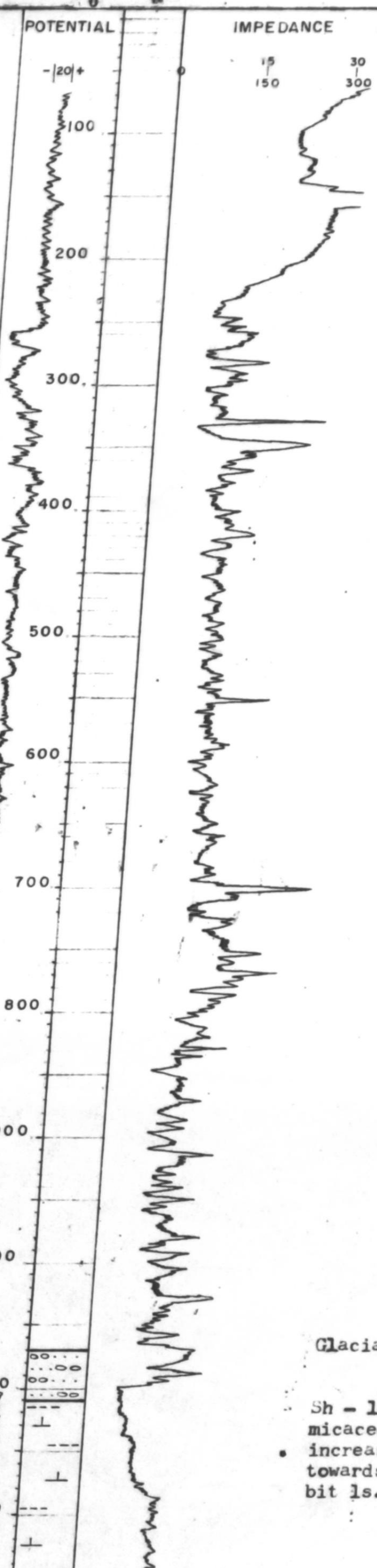
REMARKS

LITHOLOGICAL LEGEND

SANDSTONE	SILTY SHALE	DOLOMITE
SHALE	BITUMINOUS SHALE	DOLOMITIC LIMESTONE
SANDY SHALE	COAL	CALCAREOUS (SH., SS., ETC.)
SHALY SAND	ANHYDRITE or GYPSUM	DOLOMITIC (SS, ETC.)
CONGLOMERATE	SALT	BASEMENT ROCK
SILTSTONE	LIMESTONE	LITHOLOGY UNKNOWN



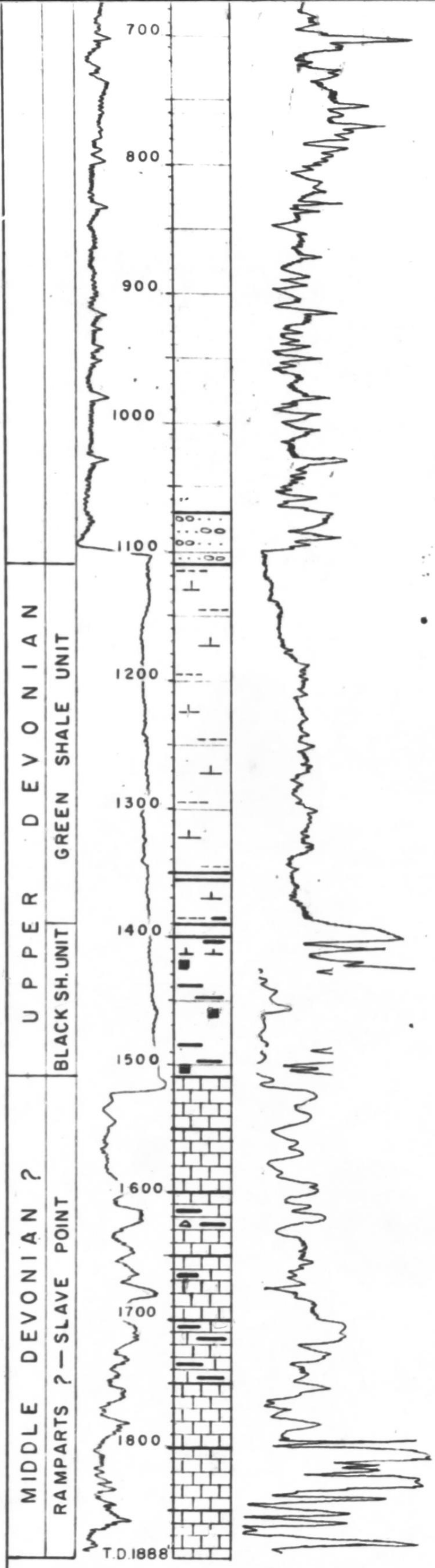
0' - 1070'
No samples available at
G.S.C. - K. W. L.



0' - 1070'
No samples available at G.S.C. - K. W. L.

Glacial drift.

Sh - lt & dk gr, gr-grn i/p, micaceous, sl/ silty & calc, increasing dk brn bit sh towards base, minor lt brn bit ls.



Glacial drift.

Sh - lt & dk gr, gr-grn i/p, micaceous, sl/ silty & calc, increasing dk brn bit sh towards base, minor lt brn bit ls.

Sh - dk brn, bit, pyrite, calc i/p.

Ls - lt brn, micro x, i/b lt buff chalky ls.

Ls - as above, minor i/b dk brn, f granular, bit ls, minor pyrite.

Ls - as above, i/b granular bit ls as above.

Ls - buff, granular, minor wh, f x dol near base.

J.C. SPROULE & ASSOCIATES, CALGARY

FIGURE-XV

To accompany Geological Report to Sun Oil Co., Murphy Corp., Stanwell Oil & Gas Ltd., Dec. 1957

COMPANY:	AREA
B.A. HUDSON'S BAY OIL & GAS CO. LTD.	N. W. T.

WELL NAME: TRAIL CREEK	**Nº** 1
LOCATION: LAT. 62° 04' 30" N, LONG. 122° 12' W.	
ELEVATION, KB: 405'	**GRD.**
SPUDDED:	**COMPLETED:** 5-10-1952
TOTAL DEPTH: 1520'	**STATUS:** ABANDONED

LOGS RUN:

CASING RECORD:

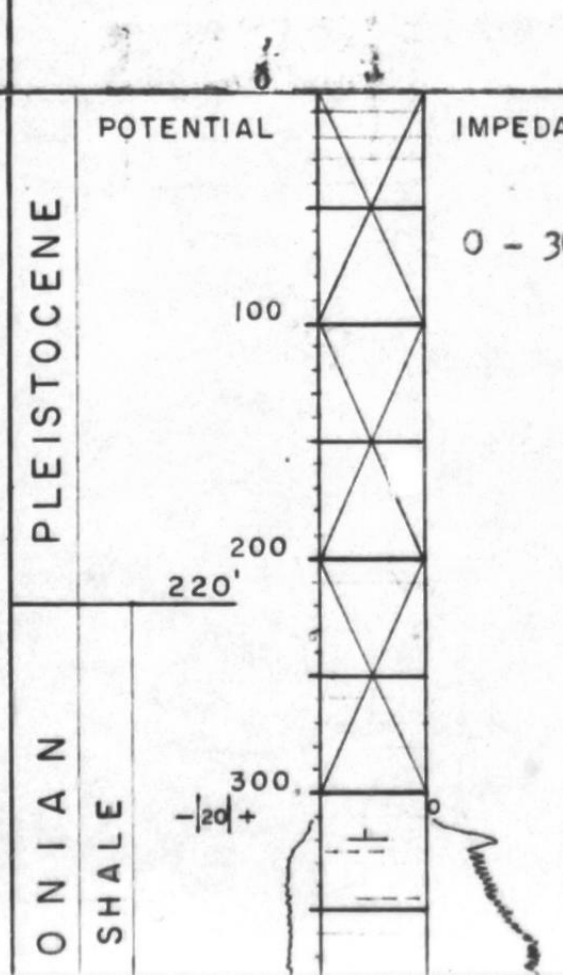
PRODUCTION TESTS:

REMARKS

LITHOLOGICAL LEGEND

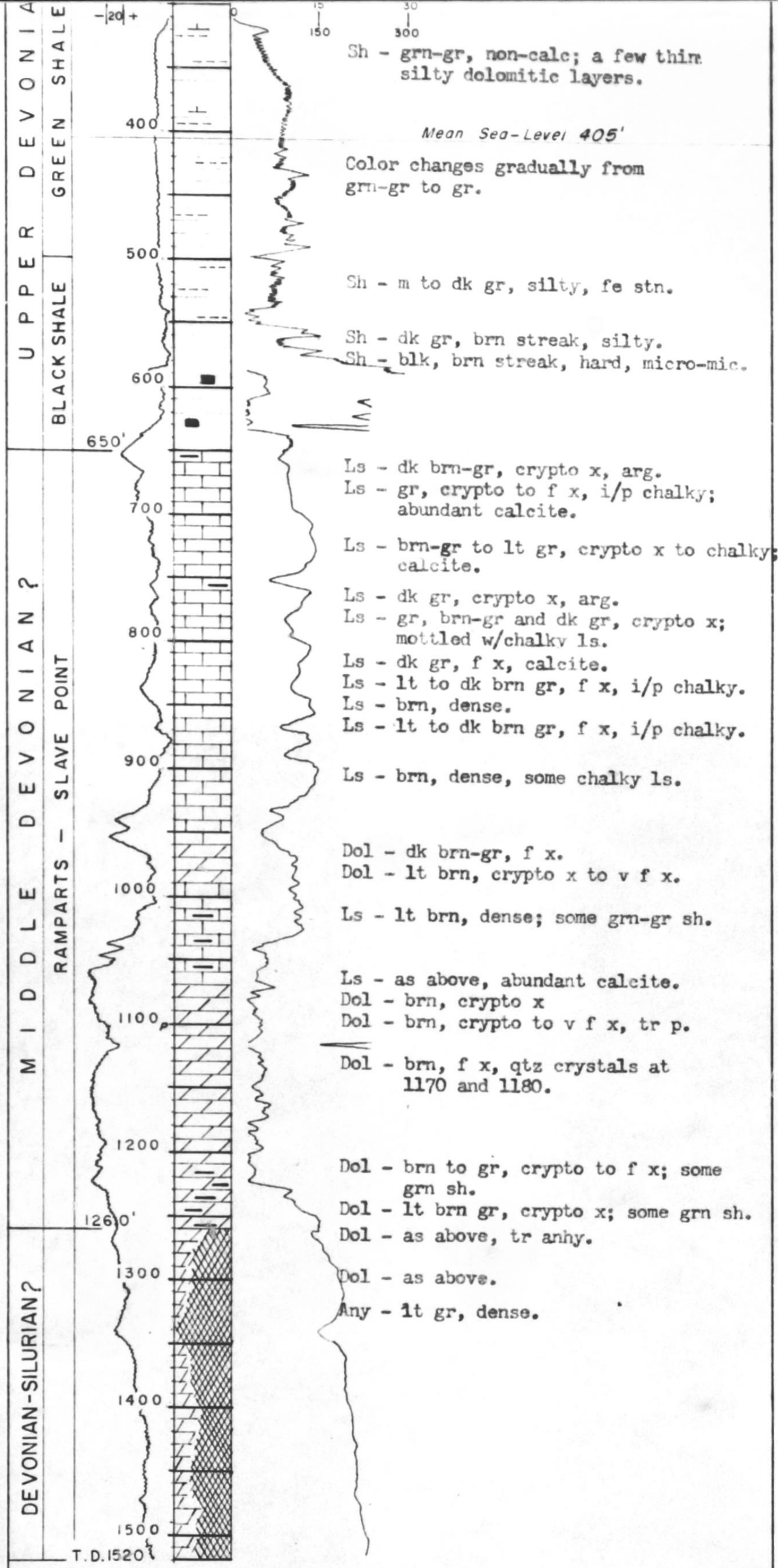
SANDSTONE	SILTY SHALE	DOLOMITE
SHALE	BITUMINOUS SHALE	DOLOMITIC LIMESTONE
SANDY SHALE	COAL	CALCAREOUS (SH., SS., ETC.)
SHALY SAND	ANHYDRITE or GYPSUM	DOLOMITIC (SS., ETC.)
CONGLOMERATE	SALT	BASEMENT ROCK
SILTSTONE	LIMESTONE	LITHOLOGY UNKNOWN

P Porous



0 - 300 No samples available.

Sh - grn-gr, non-calc; a few thin silty dolomitic layers.

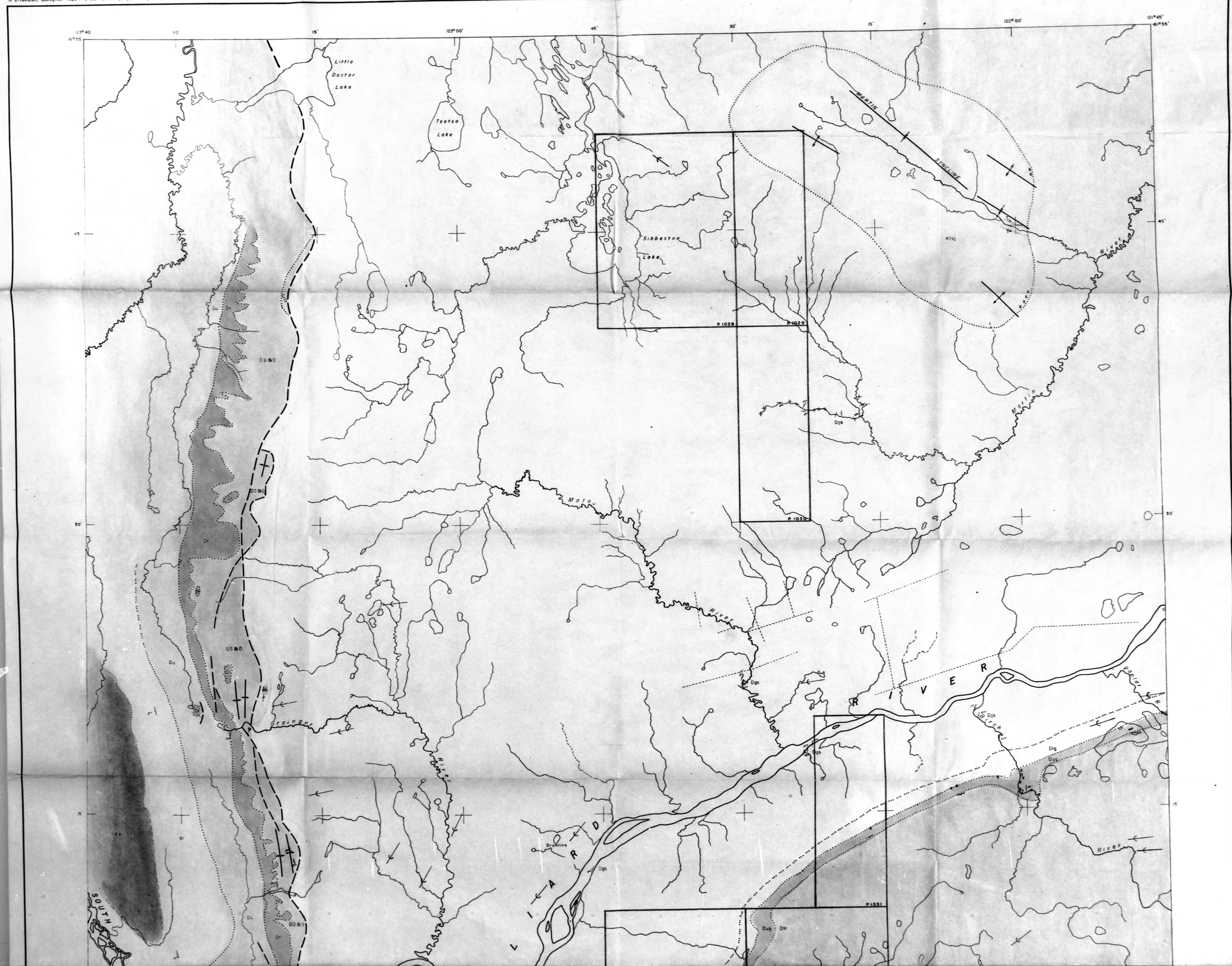


J.C. SPROULE & ASSOCIATES, CALGARY

FIGURE-XVI

To accompany Geological Report to Sun Oil Company, Murphy Corporation, Stanwell Oil & Gas Limited, Dec 1957

FIGURE-II



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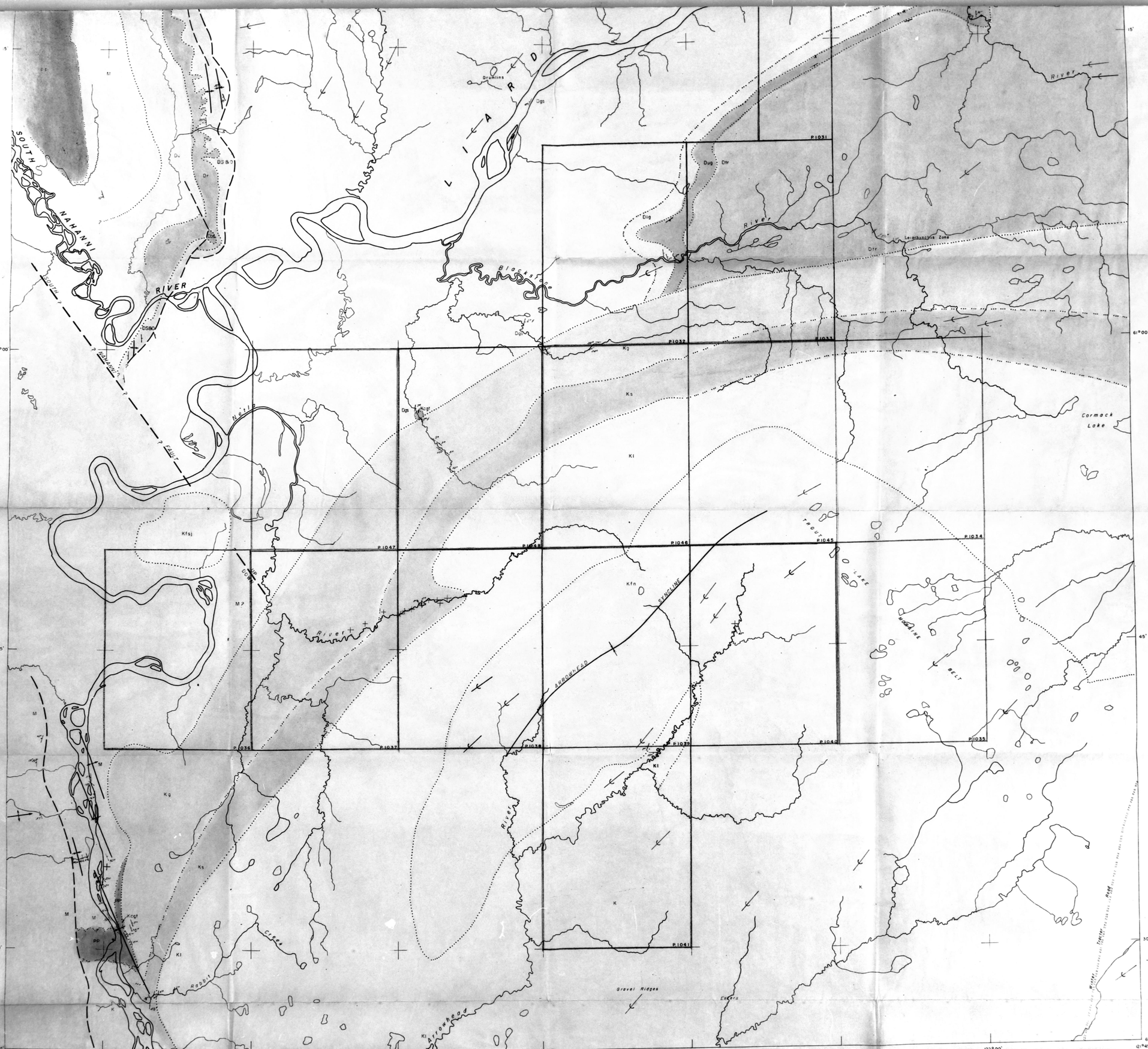
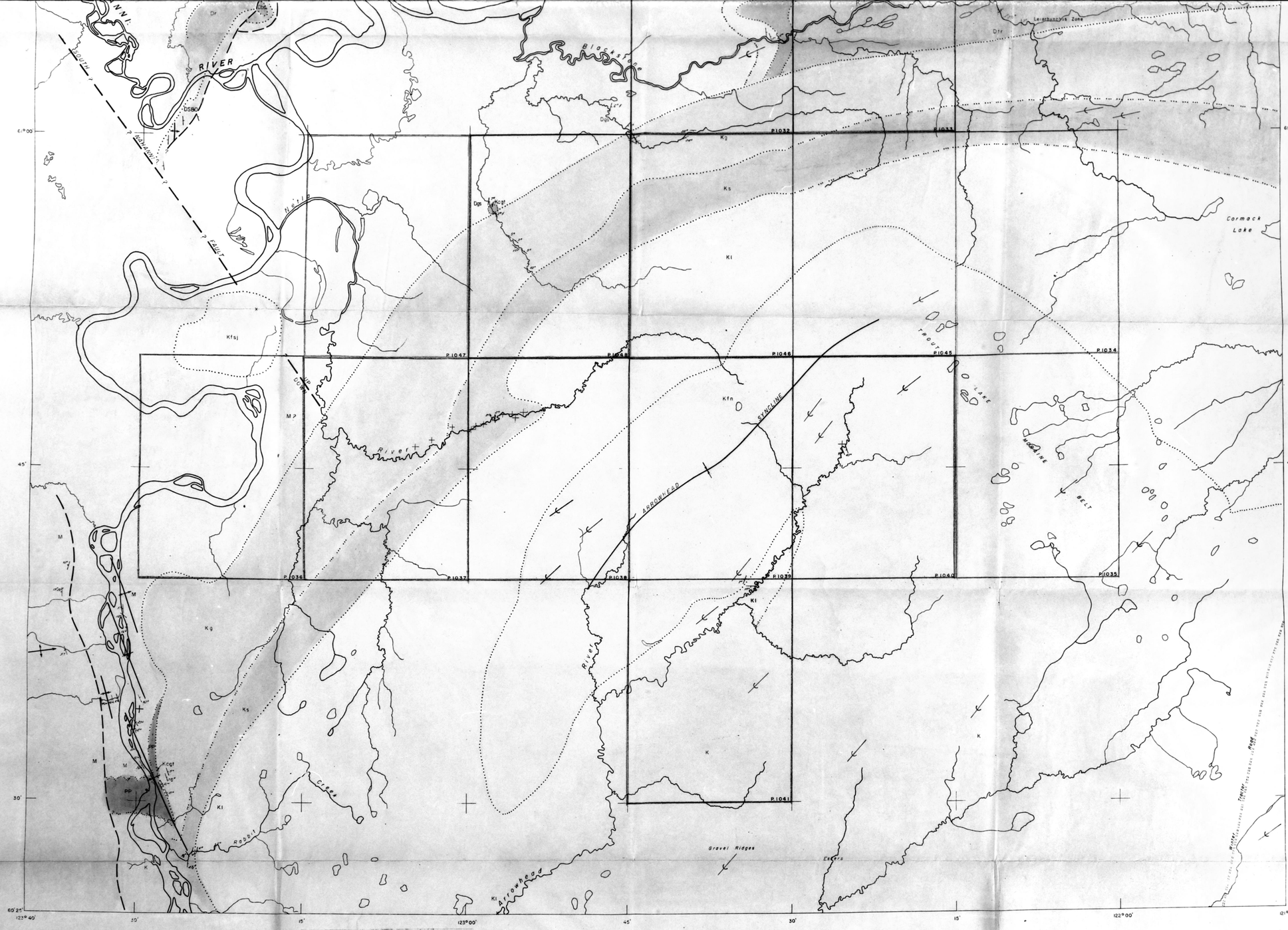

SOUTH NAHANNI RIVER
LIARD
RIVER
Blackstone
River
Drumlins
Dgs
Dug
Dtr
Dig
Leptosphaeria Zone
Cormack Lake
Ks
Ki
Kg
Kfsj
Kfn
Kq
K
M
M?
PP
Kcgt
Dr
DS80
P.1031
P.1032
P.1033
P.1034
P.1035
P.1036
P.1037
P.1038
P.1039
P.1040
P.1041
P.1045
P.1046
P.1047
P.1048
SYNCLINE
ARROWHEAD
TROUT
LAKE
MAGAZINE
BELT
Rabbit
Creek
Arrowhead
Gravel Ridges
Eskers
61°00'
60° 25'
121°45'
15'
30'
45'



GEOLOGICAL LEGEND

TERTIARY	T
CRETACEOUS	
Undifferentiated	K
UPPER CRETACEOUS	
Fort Nelson Fm	Kfn
LOWER CRETACEOUS	
Fort St John Group (Undiff.)	Kfsj
Lepine Fm	Kl
Scatter Fm	Ks
Garbutt Fm	Kg
Basal Conglom	Kcgt
PERMO-PENNSYLVANIAN	PP
MISSISSIPPIAN	M
DEVONIAN	
UPPER DEVONIAN	
Undifferentiated	Du
Trout River Fm	Dtr
Grumbler Fm	
Reefoid Member	Dug
Silty Limestone Unit	Dlg
Green Shale Unit	Dgs
Black Shale Unit	Dbs
MIDDLE DEVONIAN	
Ramparts Fm	Dr
DEVONIAN-SILURIAN & UPPER ORDOVICIAN	DSBO
CAMBRO-ORDOVICIAN	C-O

GEOLOGICAL CONVENTIONS

- Geological Fm. Contact
- Geological Fm. Contact (Indefinite)
- Anticlinal Axis
- Synclinal Axis
- Fault
- Attitude (inclined, horizontal, overturned)
- Rock Outcrop
- Direction of Glaciation
- Fossil Location
- Apparent Dip of Strata

LEGEND

- Seismic Trails
- Winter Tractor Road
- P.&N.G. Permits - Sun Oil Company
- P.&N.G. Permits - Murphy Corporation
- P.&N.G. Permits - Stanwell Oil & Gas Limited

GEOLOGICAL MAP
LIARD RIVER AREA, N.W.T.

PREPARED FOR

SUN OIL COMPANY
MURPHY CORPORATION
STANWELL OIL & GAS LIMITED

2 0 2 4 6 8 10

SCALE - 1" = 2 MILES

1957 Geological Fieldwork: G.K. Williams

J.C. SPROULE & ASSOCIATES, CALGARY

FIGURE - II

3 of 3

To accompany Geological Report to Sun Oil Company, Murphy Corporation, Stanwell Oil & Gas Limited, Dec. 1957

FIGURE-I

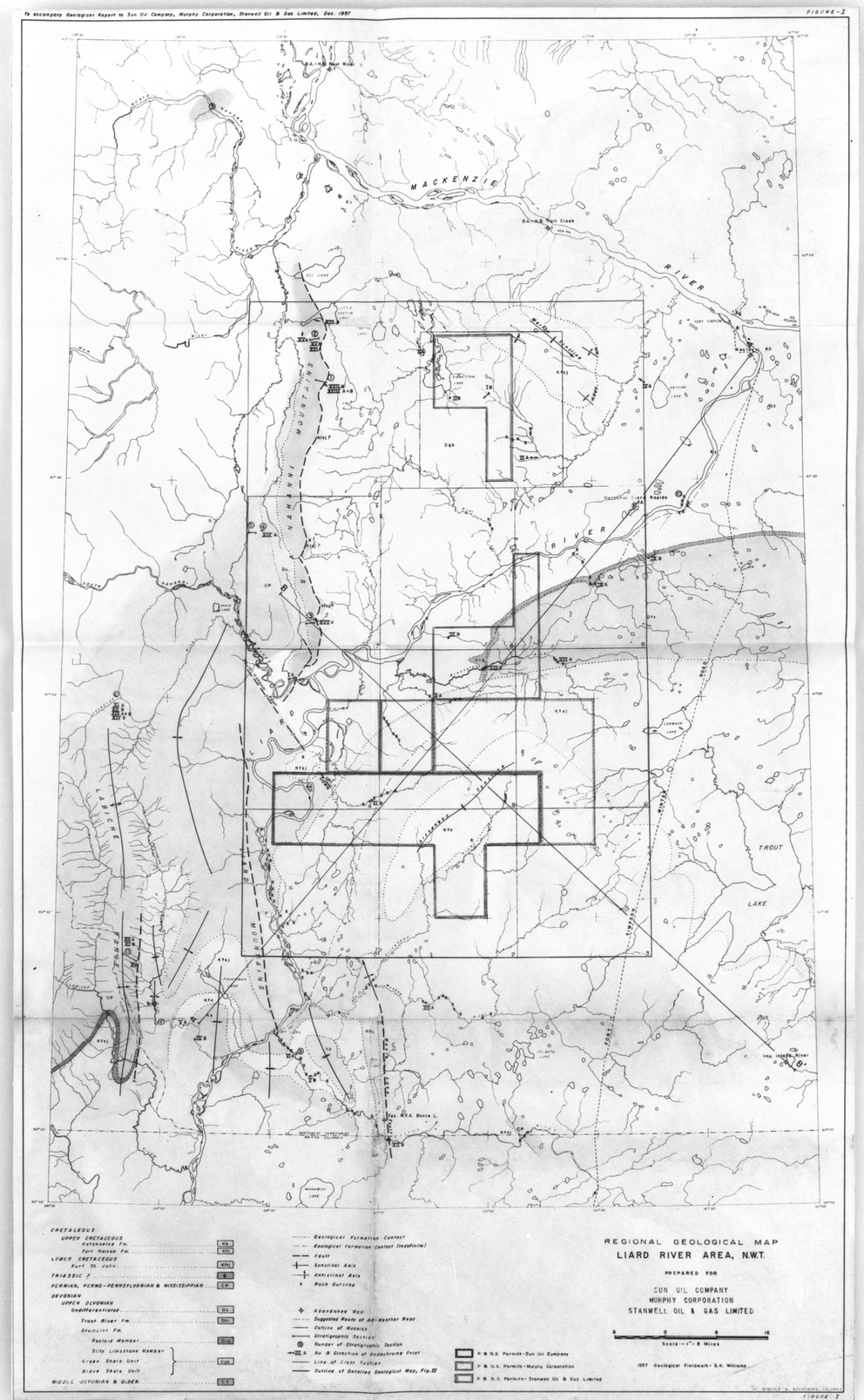


FIGURE I

PHOTO GEOLOGICAL MAP MOSAICS

FOR

PRELIMINARY GEOLOGICAL REPORT

LIAD RIVER AREA. N.W.T.

FOR

SUN OIL COMP.

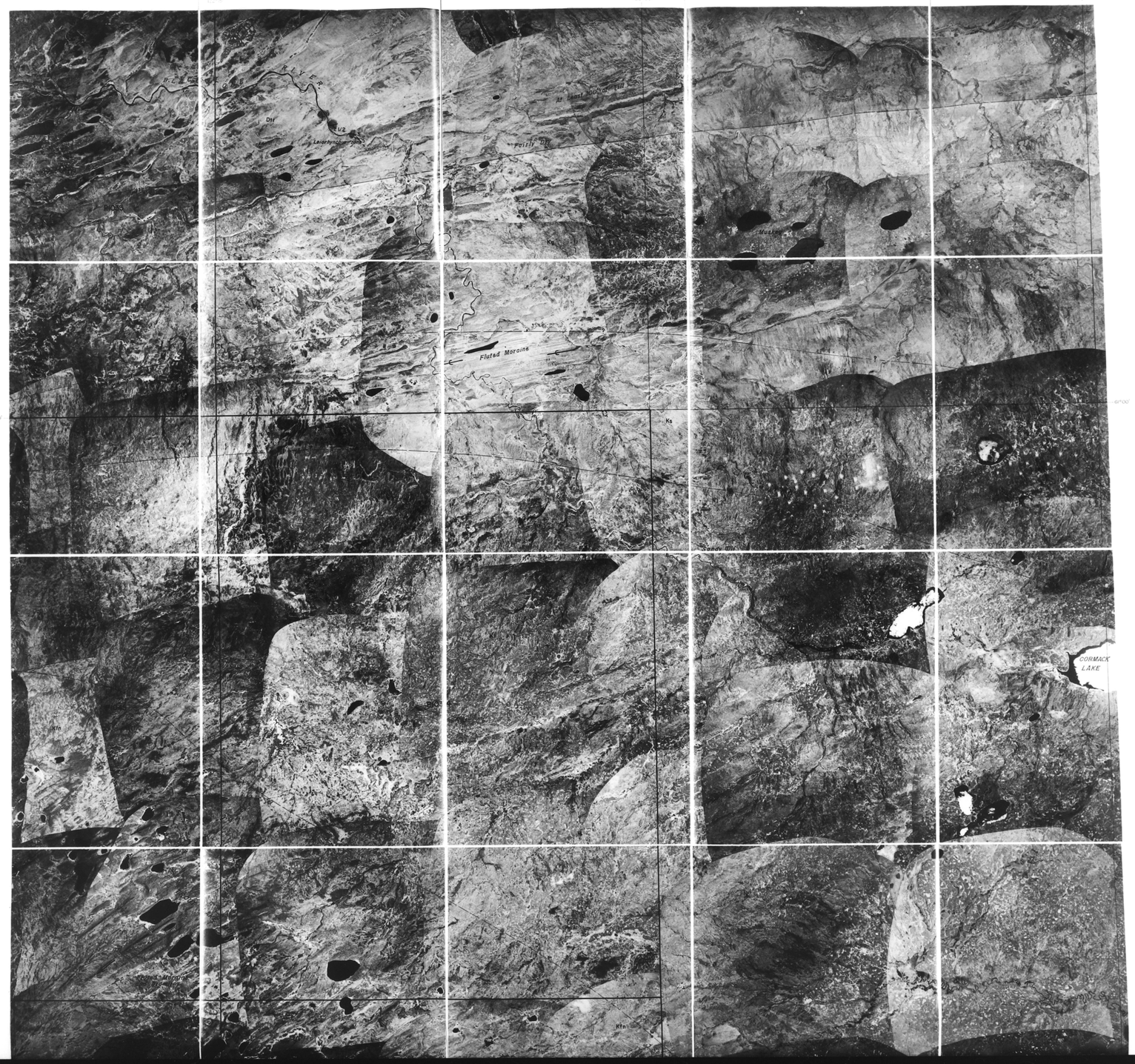
MURPHY CORPORATION

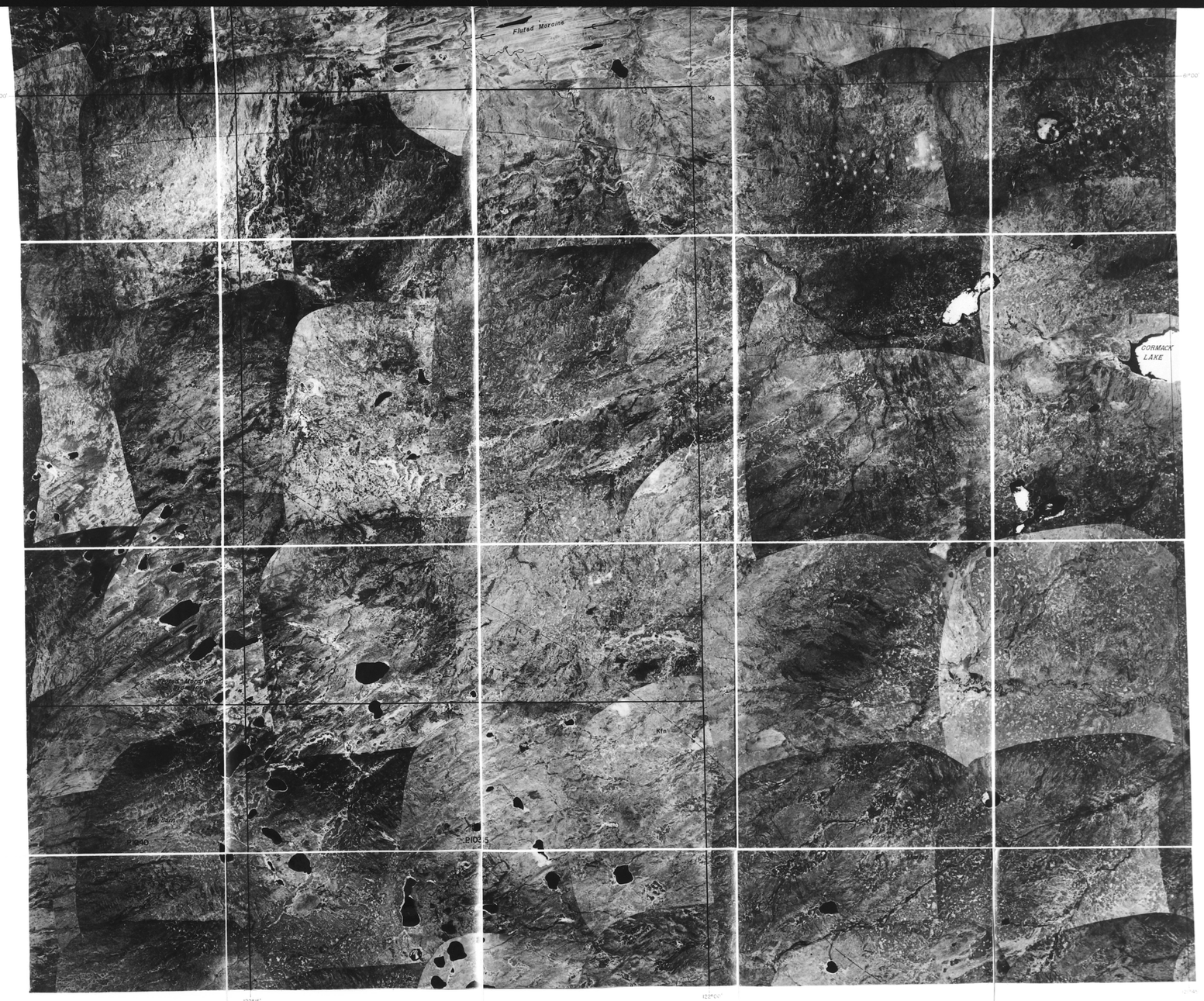
&

STANWELL OIL & GAS LTD

DEC. 1957

J.C. SPROULE Calgary


122°00'
122°45'
61°00'
Fluted Moraine
Ks
CONMACK LAKE



GEOLOGICAL LEGEND

CRETACEOUS	
Undifferentiated	K
UPPER CRETACEOUS	
Fort Nelson Fm	Kfn
LOWER CRETACEOUS	
Ft St John Group (undif.)	Kfsj
Lepine Fm	Kl
Scatter Fm	Ks
Gardiff Fm	Kg
Basal Conglomerate	Kcgl
PERMO-PENNSYLVANIAN	PP
MISSISSIPPIAN	M
DEVONIAN	
UPPER DEVONIAN	
Undifferentiated	Du
Trout River Fm	Dtr
Grumbler Fm	
Hoefold Member	Dug
Silty Limestone Unit	Dlg
Green Shale Unit	Dgs
Black Shale Unit	Dbs
MIDDLE DEVONIAN	
Ramparts Fm	Dr
DEVONIAN-SILURIAN & U ORDOVICIAN	DSUO
CAMBRO-ORDOVICIAN	€-O

PHOTO-GEOLOGICAL MOSAIC

LIARD RIVER AREA, N.W.T.

PREPARED FOR

SUN OIL COMPANY, MURPHY CORPORATION

AND

STANWELL OIL & GAS LIMITED

APPROXIMATE SCALE IN MILES

NOTE: This is an uncontrolled map-mosaic and should not be mistaken for an accurate geographic base

Geological Formation Contact
Geological Formation Contact (indefinite)
Synclinal Axis
Anticlinal Axis
Direction of Stratigraphic
Rock Outcrop
Bedding Attitude (horizontal, inclined)
Bedding Attitude (overturned beds)
General Dip of Outcrop
Fossil
Stratigraphic Section

INDEX MAP

TOPOGRAPHIC LEGEND

J C SPROULE & ASSOCIATES

2 of 2

SHEET-7


123°30'
123°15'
123°00'
61°15'
Dr
DS&O
M
Thick cover
Glacial Drift
No Bedrock Outcrops
Kl?
Dgs
Bg
NAHANNI
MOUNTAINS
Disturbed
Zone
(Poorly exposed)
DS
&
O
Dr
Dgs
Ms Outcrops

1 of 2

GEOLOGICAL LEGEND

CRETACEOUS		DEVONIAN	
Undifferentiated	K	UPPER DEVONIAN	
UPPER CRETACEOUS		Undifferentiated	Du
Fort Nelson Fm.	Kfn	Trout River Fm.	Dtr
LOWER CRETACEOUS		Grumbler Fm.	
Ft. St. John Group (Undif.)	Kfsj	Reefoid Member	Dug
Lepine Fm.	Kl	Silty Limestone Unit	Dlg
Scatter Fm.	Ks	Green Shale Unit	Dgs
Garbutt Fm.	Kg	Black Shale Unit	Dbs
Basal Conglomerate	Kcgf	MIDDLE DEVONIAN	
PERMO-PENNSYLVANIAN	PP	Ramparts Fm.	Dr
MISSISSIPPIAN	M	DEVONIAN-SILURIAN & U. ORDOVICIAN	DS&O
		CAMBRO-ORDOVICIAN	Є-O

PHOTO-GEOLOGICAL MOSAIC

LIARD RIVER AREA, N.W.T.

PREPARED FOR

SUN OIL COMPANY, MURPHY CORPORATION

AND

STANWELL OIL & GAS LIMITED

1 0 1 2 3

APPROXIMATE SCALE IN MILES

NOTE: This is an uncontrolled map-mosaic and should not be mistaken for an accurate geographic base.

Geological Formation Contact

? ? Geological Formation Contact (indefinite)

Synclinal Axis

Anticlinal Axis

Direction of Glaciation

X Rock Outcrop

Bedding Attitude (horizontal, inclined)

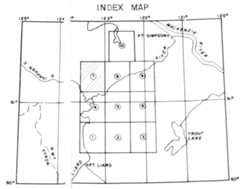
Bedding Attitude (overturned, photo)

4 General Dip of Outcrop

F Fossil

5 Stratigraphic Section

INDEX MAP



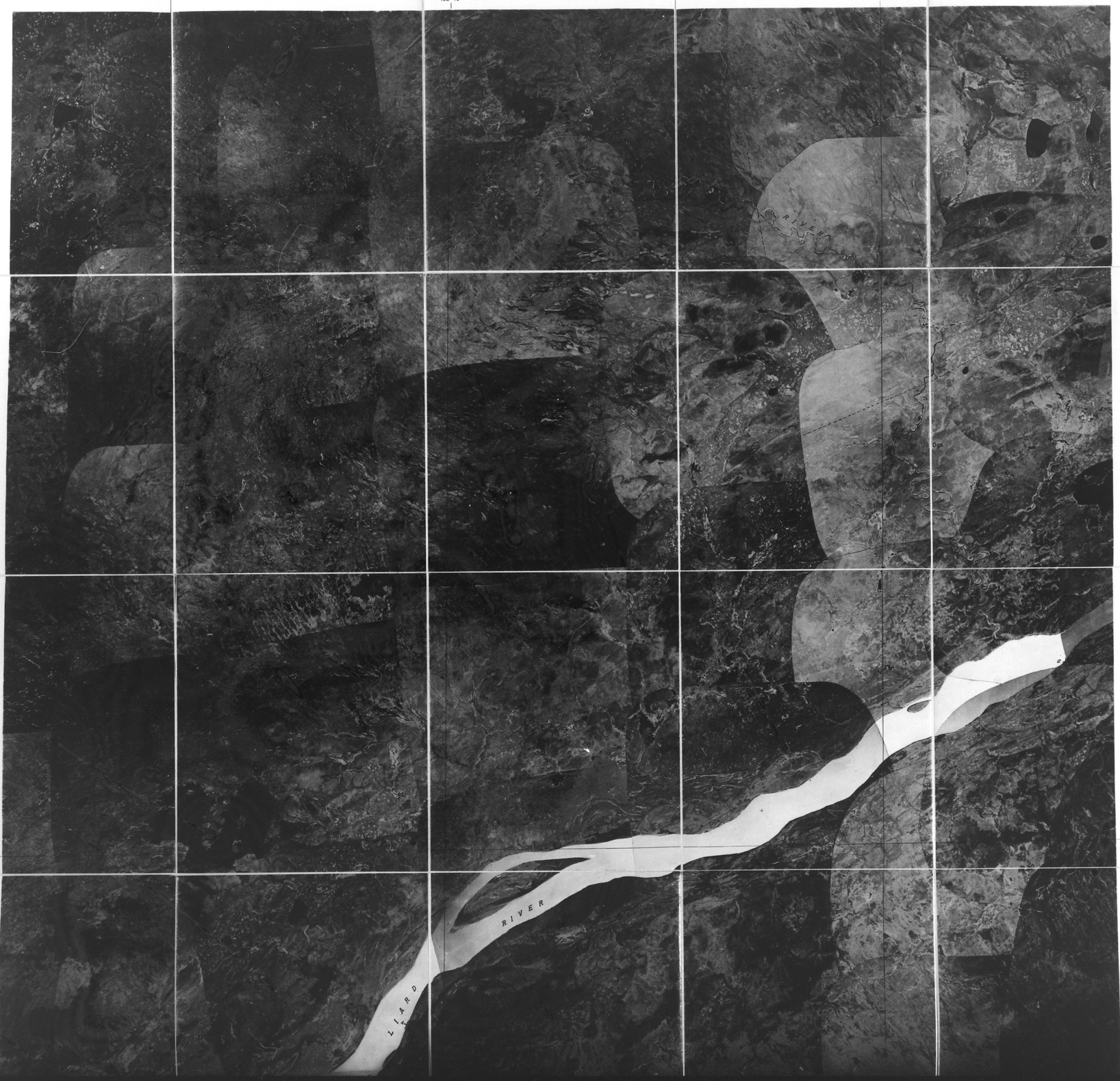
TOPOGRAPHIC LEGEND

1 Bush
2 Lake
3 Muskeg
4 River
5 Trail
6 Seismic Line

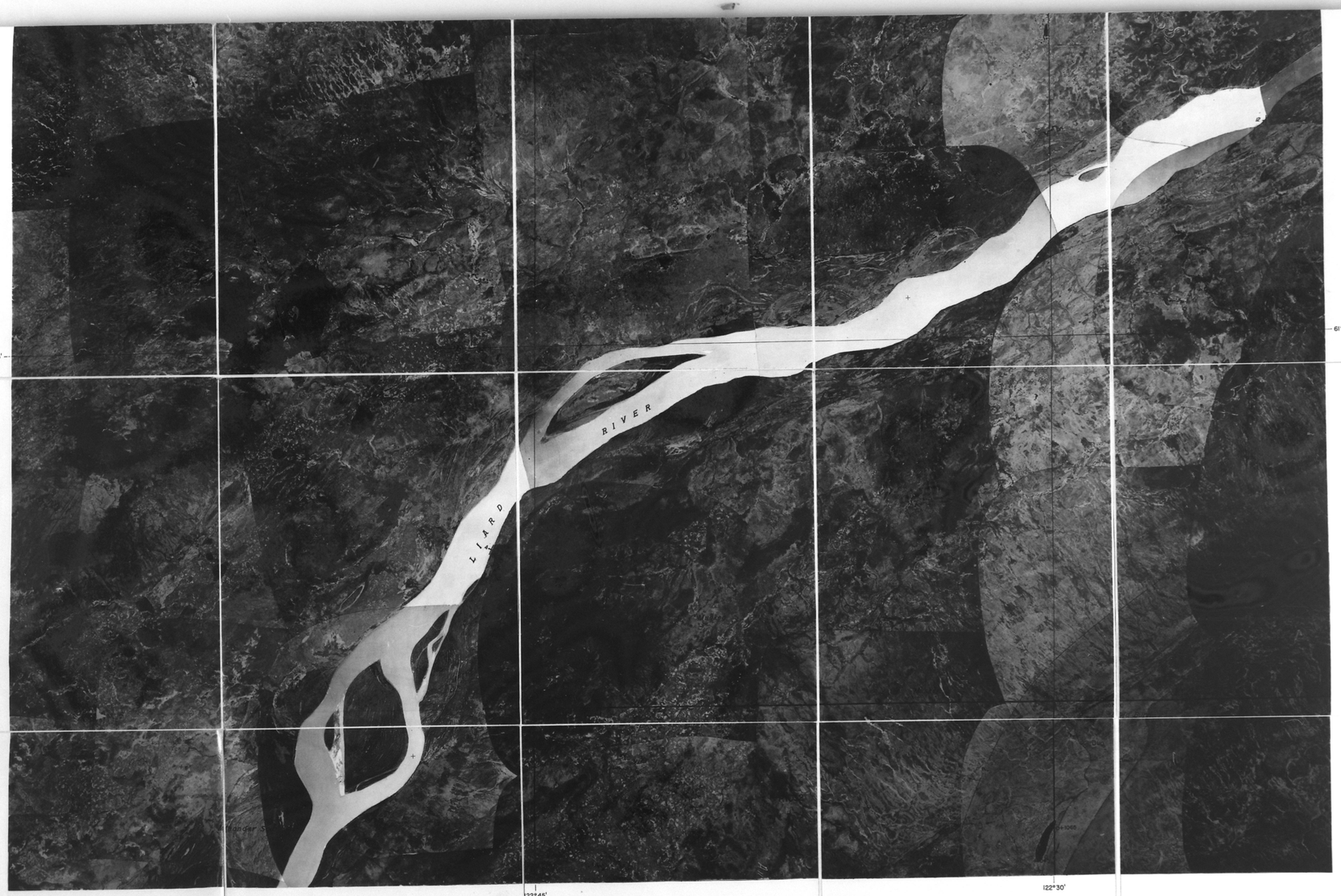
J.C. SPROULE & ASSOCIATES

2 of 2

SHEET-8



1 of 2



GEOLOGICAL LEGEND

CRETACEOUS		
Undifferentiated	K	
UPPER CRETACEOUS		
Fort Nelson Fm.	Kfn	
LOWER CRETACEOUS		
Ft. St. John Group (Undif.)	Kfsj	
Lepine Fm.	Kl	
Scatter Fm.	Ks	
Garbutt Fm.	Kg	
Basal Conglomerate	Kcgl	
PERMO—PENNSYLVANIAN	PP	
MISSISSIPPIAN	M	
DEVONIAN		
UPPER DEVONIAN		
Undifferentiated		Du
Trout River Fm.		
Grumbler Fm.		
Reefoid Member		Dug
Silty Limestone Unit		Dsg
Green Shale Unit		Dgs
Black Shale Unit		Dbs
MIDDLE DEVONIAN		
Ramparts Fm.		Dr
DEVONIAN-SILURIAN & U ORDOVICIAN		DSSO
CAMBRO-ORDOVICIAN		€-O

PHOTO-GEOLOGICAL MOSAIC

LIARD RIVER AREA, N.W.T.

PREPARED FOR

SUN OIL COMPANY, MURPHY CORPORATION

AND

STANWELL OIL & GAS LIMITED

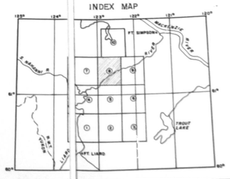
1 0 1 2 3

APPROXIMATE SCALE IN MILES

NOTE: This is an uncontrolled map-mosaic and should not be mistaken for an accurate geographic base.

- Geological Formation Contact
- ? ? Geological Formation Contact (indefinite)
- Synclinal Axis
- Anticlinal Axis
- Direction of Glaciation
- X Rock Outcrop
- + 6 Bedding Attitude (horizontal, inclined)
- 4 Bedding Attitude (overturned, photo)
- 4 General Dip of Outcrop
- 5 F Fossil
- Stratigraphic Section

INDEX MAP



TOPOGRAPHIC LEGEND

1 Bush
2 Lake
3 Muskeg
4 River
5 Trail
6 Seismic Line

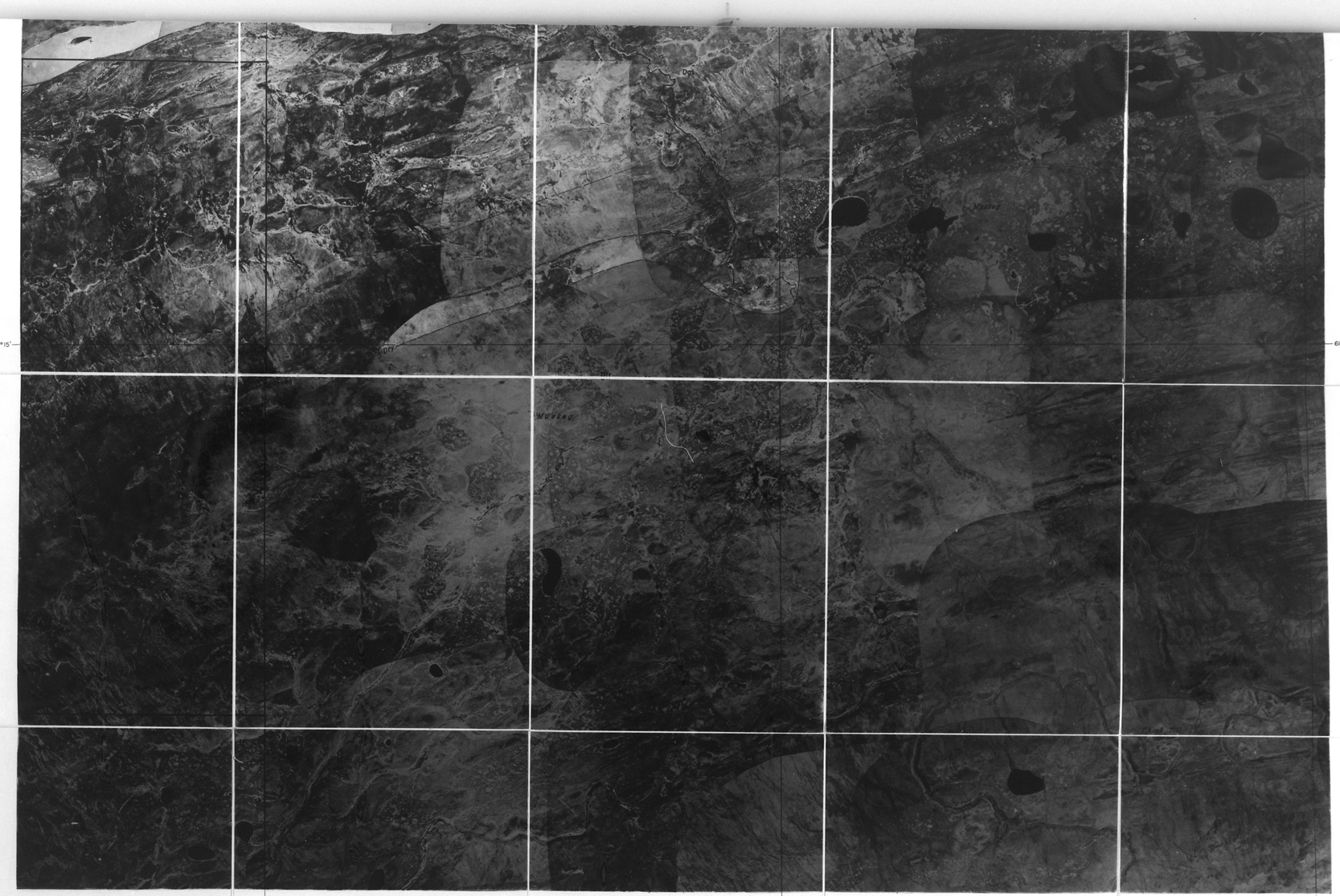
J.C. SPROULE & ASSOCIATES

2 of 2

SHEET-9


61°30'
122°15'
122°00'
121°45'
61°30'
Drumlin
Muskeg
LIARD
RIVER
Dgt
Muskeg
61°15'
61°15'
Muskeg

1 OF 2



GEOLOGICAL LEGEND

CRETACEOUS		
Undifferentiated	K	
UPPER CRETACEOUS		
Fort Nelson Fm.	Kfn	
LOWER CRETACEOUS		
Ft. St. John Group (Undif.)	Kfsj	
Lepine Fm.	Kl	
Scatter Fm.	Ks	
Garbutt Fm.	Kg	
Basal Conglomerate	Kcgt	
PERMO—PENNSYLVANIAN	PP	
MISSISSIPPIAN	M	
DEVONIAN		
UPPER DEVONIAN		
Undifferentiated		Du
Trout River Fm.		Dtr
Grumbler Fm.		
Fleefold Member		Dug
Silty Limestone Unit		Dig
Green Shale Unit		Dgs
Black Shale Unit		Dbs
MIDDLE DEVONIAN		
Ramparts Fm.		Dr
DEVONIAN-SILURIAN & U. ORDOVICIAN		DSlO
CAMBRO-ORDOVICIAN		€-O

PHOTO-GEOLOGICAL MOSAIC

LIARD RIVER AREA, N.W.T.

PREPARED FOR

SUN OIL COMPANY, MURPHY CORPORATION

AND

STANWELL OIL & GAS LIMITED

1 0 1 2 3

APPROXIMATE SCALE IN MILES

NOTE: This is an uncontrolled map-mosaic and should not be mistaken for an accurate geographic base.

- Geological Formation Contact
- ? Geological Formation Contact (indefinite)
- Synclinal Axis
- Anticlinal Axis
- Direction of Glaciation
- x Rock Outcrop
- Bedding Attitude (horizontal, inclined)
- Bedding Attitude (overturned, photo)
- General Dip of Outcrop
- F Fossil
- 5 Stratigraphic Section

INDEX MAP

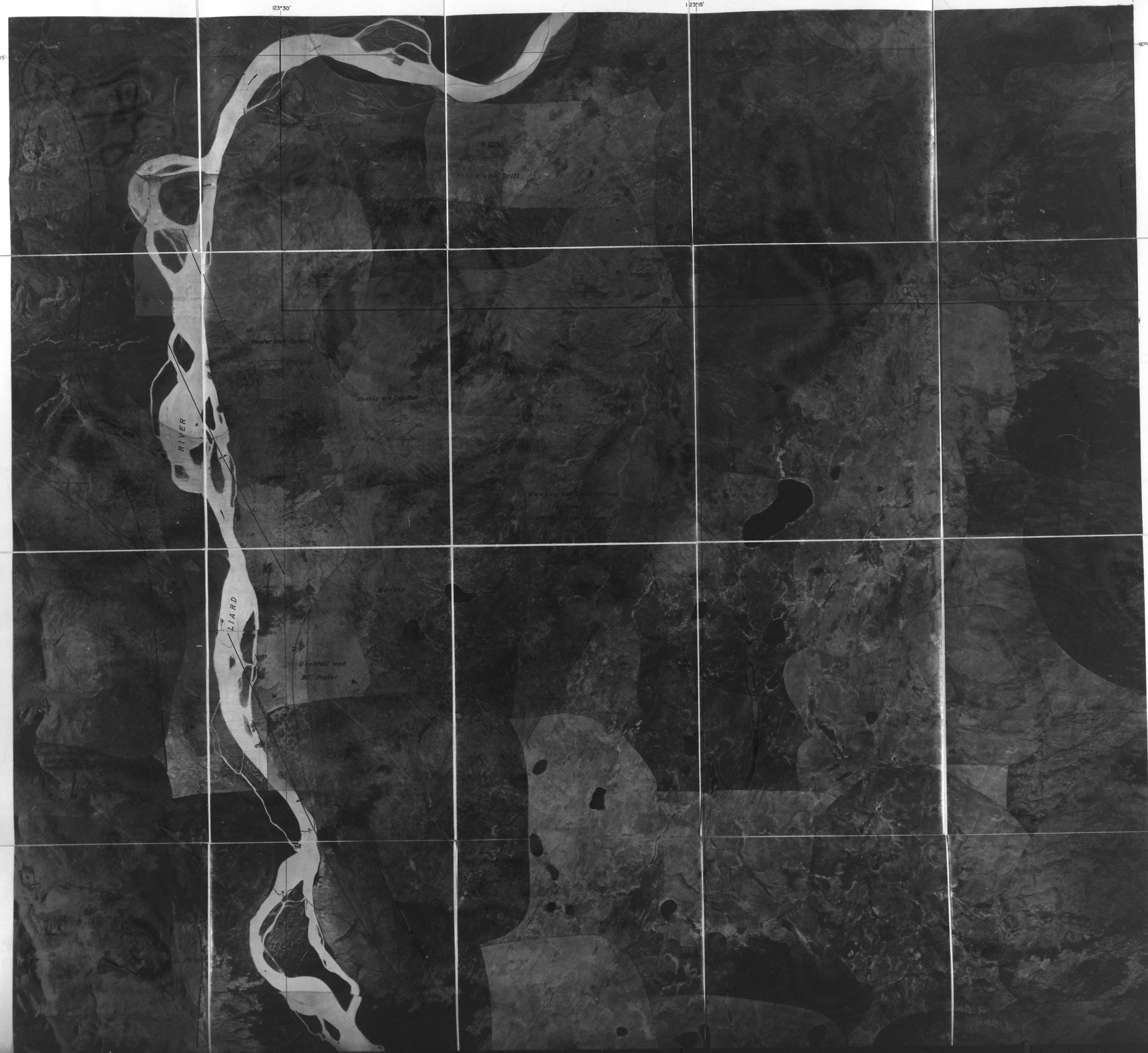
TOPOGRAPHIC LEGEND

1 Bush
2 Lake
3 Muskeg
4 River
5 Trail
6 Seismic Line

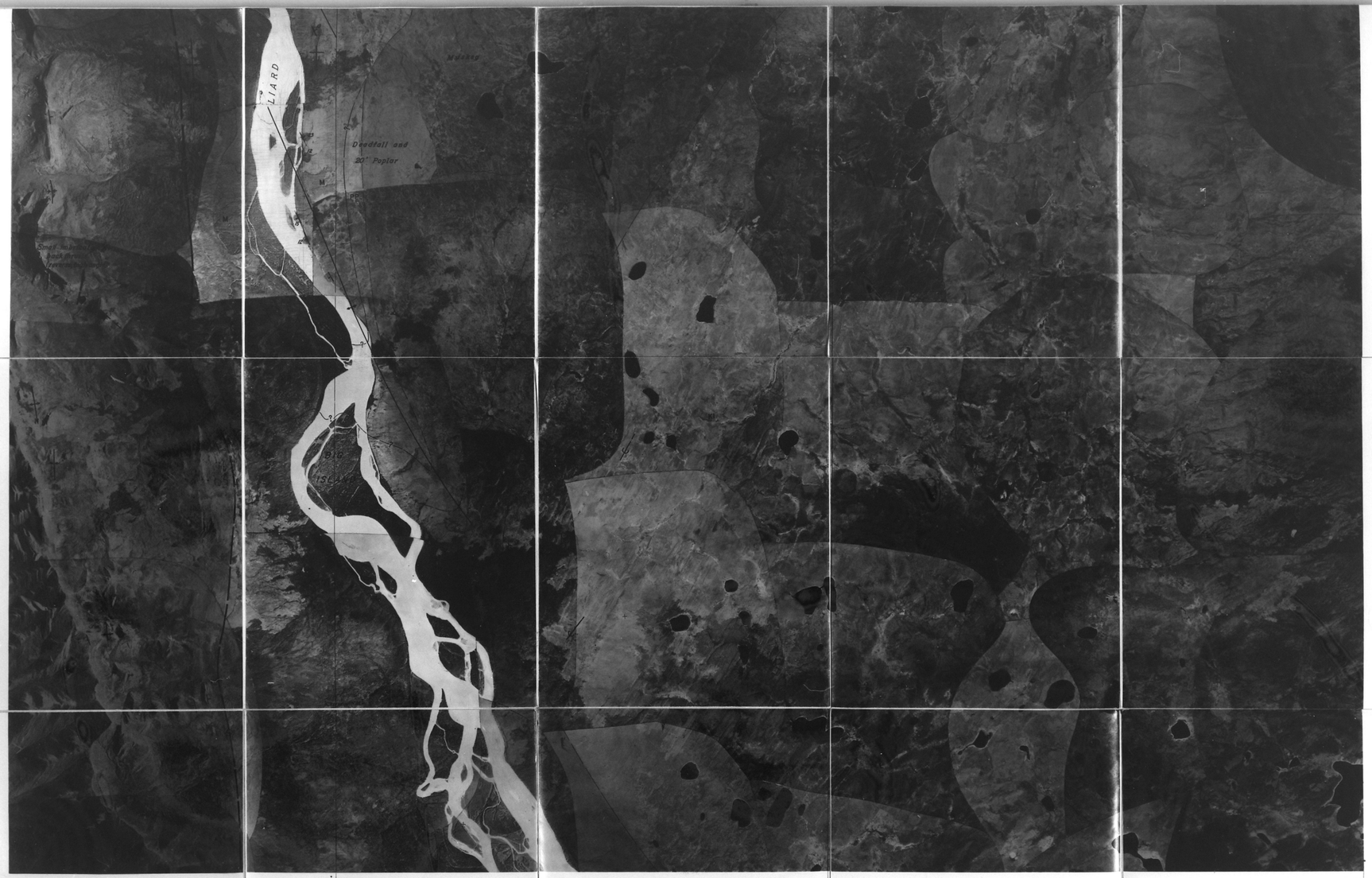
J.C. SPROULE & ASSOCIATES

2 of 2

SHEET-1



1 OF 2



GEOLOGICAL LEGEND

CRETACEOUS		
Undifferentiated	K	
UPPER CRETACEOUS		
Fort Nelson Fm.	Kfn	
LOWER CRETACEOUS		
Ft. St. John Group (Undif.)	Kfsj	
Lepine Fm.	Kl	
Scatter Fm.	Ks	
Garbutt Fm.	Kg	
Basal Conglomerate	Kbgr	
PERMO—PENNSYLVANIAN	PP	
MISSISSIPPIAN	M	
DEVONIAN		
UPPER DEVONIAN		
Undifferentiated		Du
Trout River Fm.		Dtr
Grumbler Fm.		
Reefoid Member		Dug
Silty Limestone Unit		Dlg
Green Shale Unit		Dgs
Black Shale Unit		Dbs
MIDDLE DEVONIAN		
Ramparts Fm.		Dr
DEVONIAN-SILURIAN & U. ORDOVICIAN		DSaO
CAMBRO-ORDOVICIAN		€-O

PHOTO-GEOLOGICAL MOSAIC

LIARD RIVER AREA, N.W.T.

PREPARED FOR

SUN OIL COMPANY, MURPHY CORPORATION

AND

STANWELL OIL & GAS LIMITED

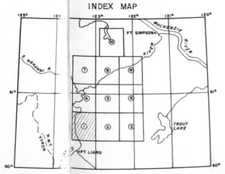
1 0 1 2 3

APPROXIMATE SCALE IN MILES

NOTE: This is an uncontrolled map-mosaic and should not be mistaken for an accurate geographic base

- Geological Formation Contact
- ? Geological Formation Contact (indefinite)
- Synclinal Axis
- Anticlinal Axis
- Direction of Glaciation
- X Rock Outcrop
- Bedding Attitude (horizontal, inclined)
- Bedding Attitude (overturned, photo)
- 4 General Dip of Outcrop
- F Fossil
- 5 Stratigraphic Section

INDEX MAP



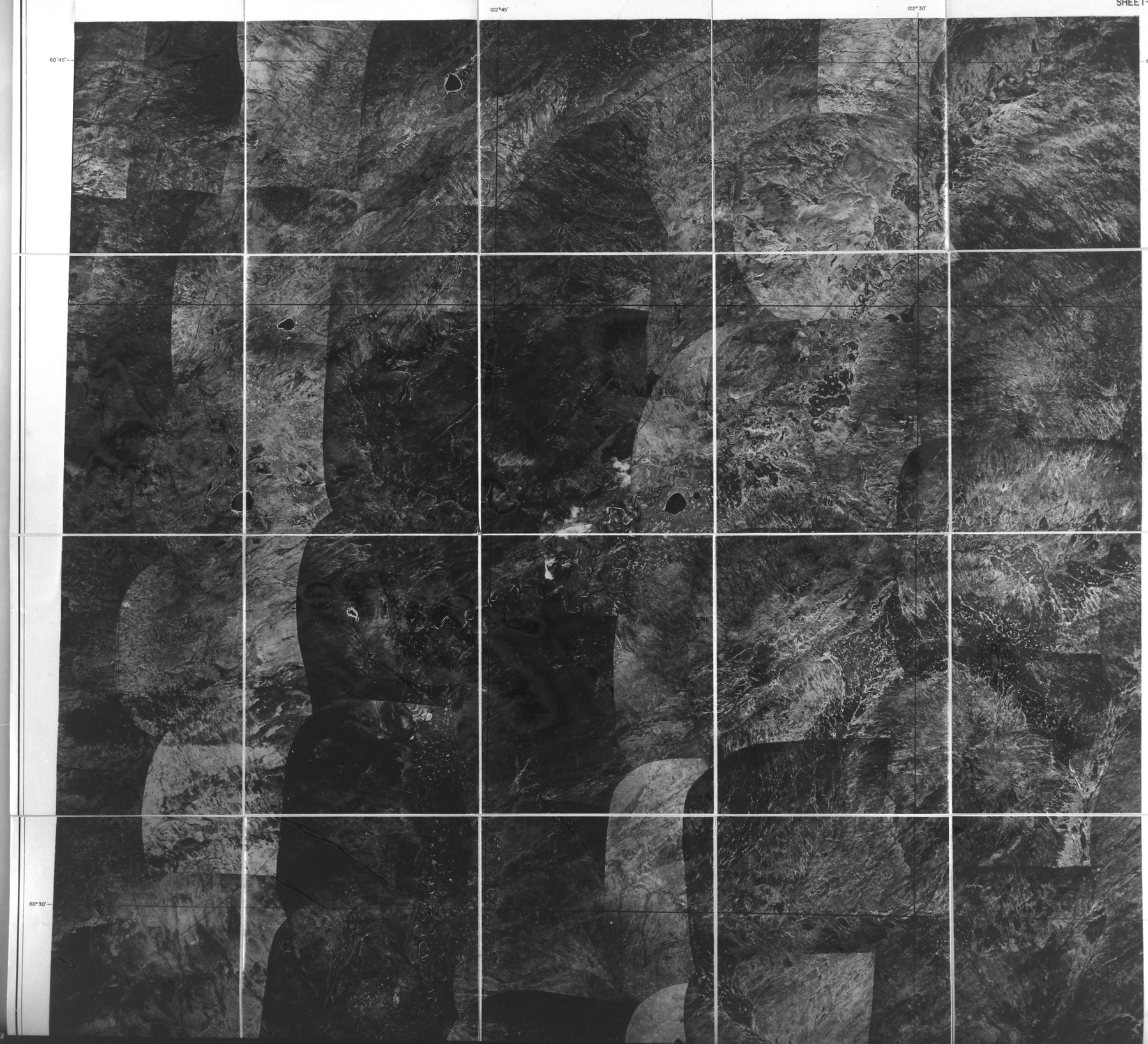
TOPOGRAPHIC LEGEND

1 Bush
2 Lake
3 Muskeg
4 River
5 Trail
6 Seismic Line

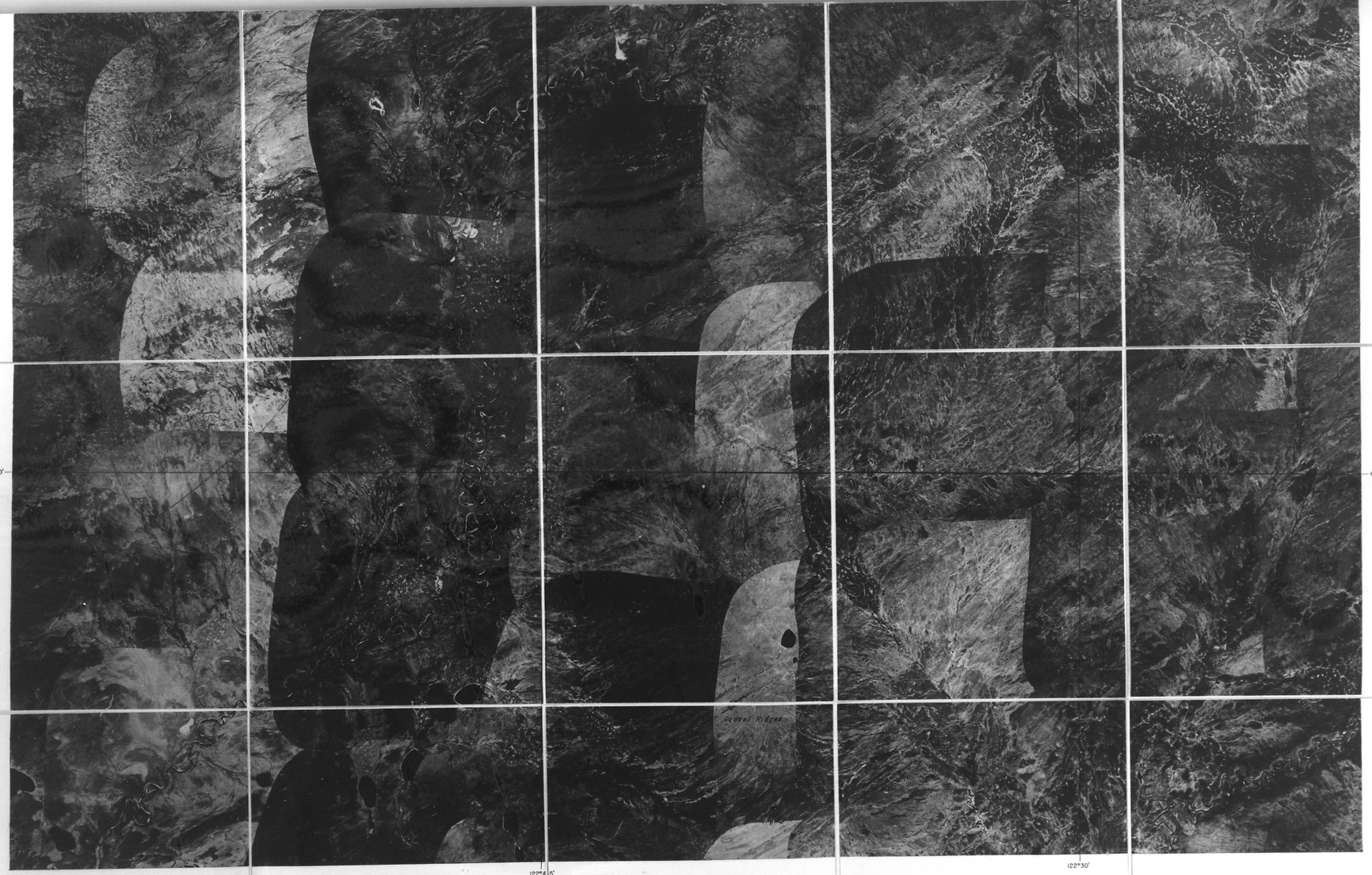
J.C. SPROULE & ASSOCIATES

2 of 2

SHEET-2



1 of 2



GEOLOGICAL LEGEND

CRETACEOUS	
Undifferentiated	K
UPPER CRETACEOUS	
Fort Nelson Fm.	Kfn
LOWER CRETACEOUS	
Ft. St. John Group (Undif.)	Kfsj
Lepine Fm.	Kl
Scatter Fm.	Ks
Garbutt Fm.	Kg
Basal Conglomerate	Kcgl
PERMO—PENNSYLVANIAN	PP
MISSISSIPPIAN	M
DEVONIAN	
UPPER DEVONIAN	
Undifferentiated	Du
Trout River Fm.	Dtr
Grumbler Fm.	
Reefoid Member	Dug
Silty Limestone Unit	Dlg
Green Shale Unit	Dgs
Black Shale Unit	Dbs
MIDDLE DEVONIAN	
Ramparts Fm.	Dr
DEVONIAN-SILURIAN & U. ORDOVICIAN	DS&O
CAMBRO-ORDOVICIAN	€-O

PHOTO-GEOLOGICAL MOSAIC

LIARD RIVER AREA, N.W.T.

PREPARED FOR

SUN OIL COMPANY, MURPHY CORPORATION

AND

STANWELL OIL & GAS LIMITED

1 0 1 2 3

APPROXIMATE SCALE IN MILES

NOTE: This is an uncontrolled map-mosaic and should not be mistaken for an accurate geographic base.

Geological Formation Contact

? ? Geological Formation Contact (indefinite)

Synclinal Axis

Anticlinal Axis

Direction of Glaciation

X Rock Outcrop

Bedding Attitude (horizontal, inclined)

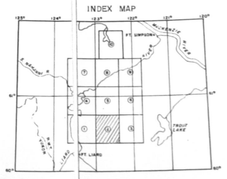
Bedding Attitude (overturned, photo)

4 General Dip of Outcrop

F Fossil

5 Stratigraphic Section

INDEX MAP



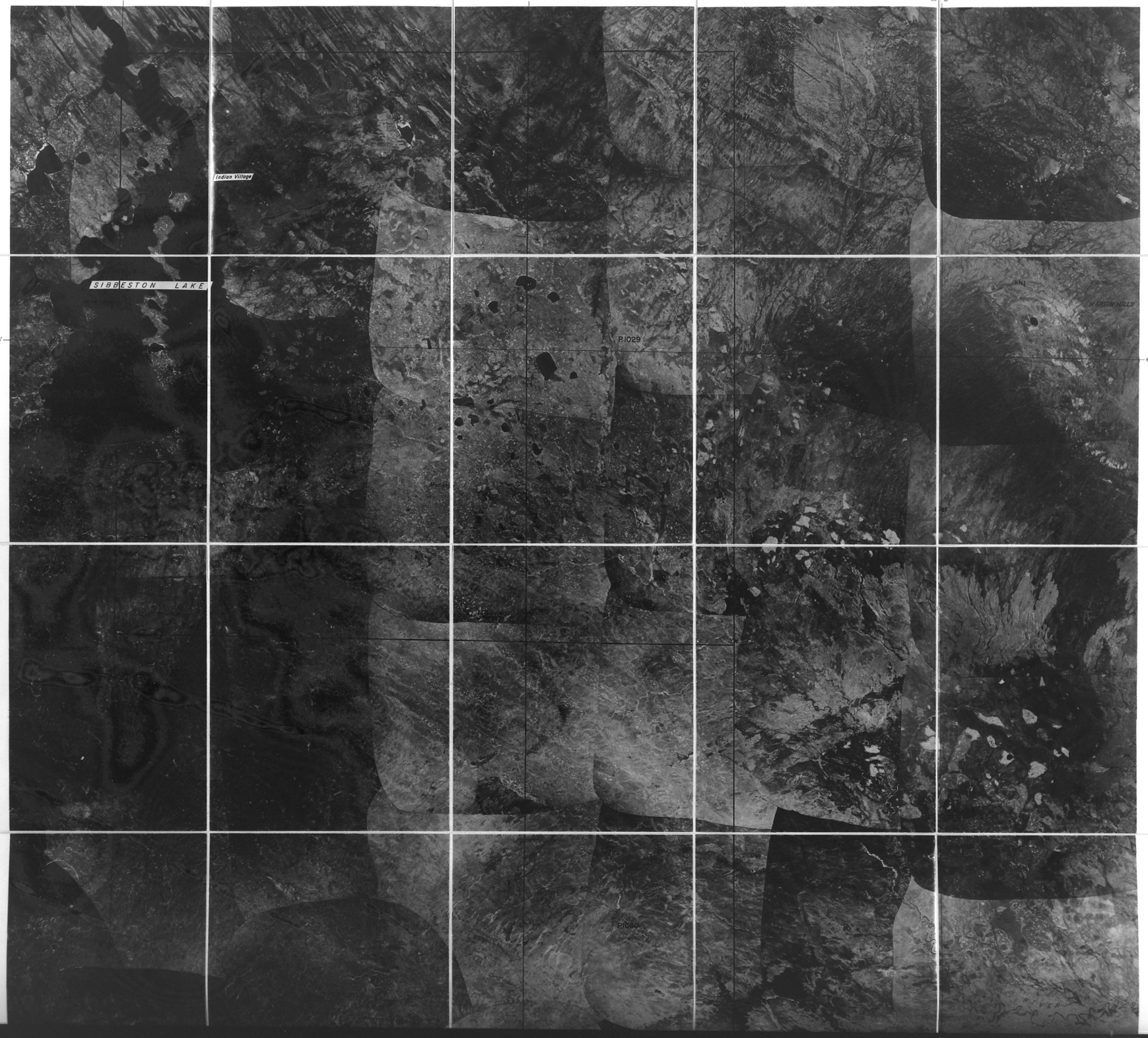
TOPOGRAPHIC LEGEND

1 Bush
2 Lake
3 Muskeg
4 River
5 Trail
6 Seismic Line

J.C. SPEOULE & ASSOCIATES

2 of 2

SHEET-10



SHEET-10

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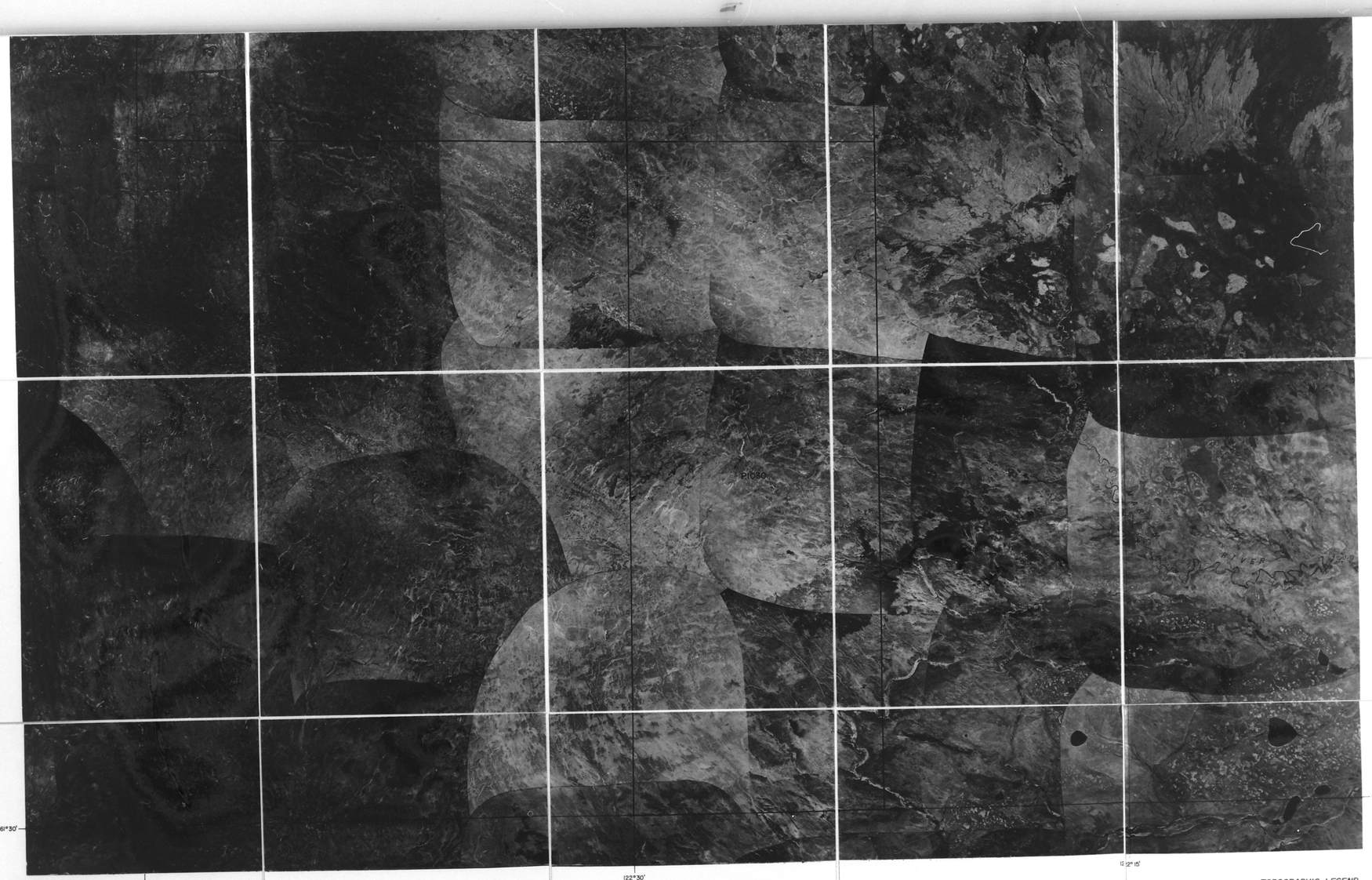

GEOLOGICAL LEGEND

CRETACEOUS	
Undifferentiated	K
UPPER CRETACEOUS	
Fort Nelson Fm.	Kfn
LOWER CRETACEOUS	
Ft. St. John Group (Undif.)	Kfsj
Lepine Fm.	Kl
Scatter Fm.	Ks
Garbutt Fm.	Kg
Basal Conglomerate	Kcgl
PERMO–PENNSYLVANIAN	PP
MISSISSIPPIAN	M
DEVONIAN	
UPPER DEVONIAN	
Undifferentiated	Du
Trout River Fm.	Dtr
Grumbler Fm.	
Reefoid Member	Dug
Silty Limestone Unit	Dig
Green Shale Unit	Dgs
Black Shale Unit	Dbs
MIDDLE DEVONIAN	
Ramparts Fm.	Dr
DEVONIAN-SILURIAN & U. ORDOVICIAN	DS&O
CAMBRO-ORDOVICIAN	Є–O

122°30'

PHOTO-GEOLOGICAL MOSAIC

LIARD RIVER AREA, N.W.T.

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AND

STANWELL OIL & GAS LIMITED

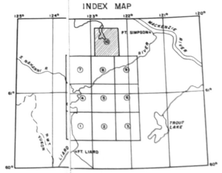
1 0 1 2 3

APPROXIMATE SCALE IN MILES

NOTE: This is an uncontrolled map-mosaic and should not be mistaken for an accurate geographic base.

Geological Formation Contact
Geological Formation Contact (indefinite)
Synclinal Axis
Anticlinal Axis
Direction of Glaciation
Rock Outcrop
Bedding Attitude (horizontal, inclined)
Bedding Attitude (overturned, photo)
General Dip of Outcrop
Fossil
Stratigraphic Section

INDEX MAP



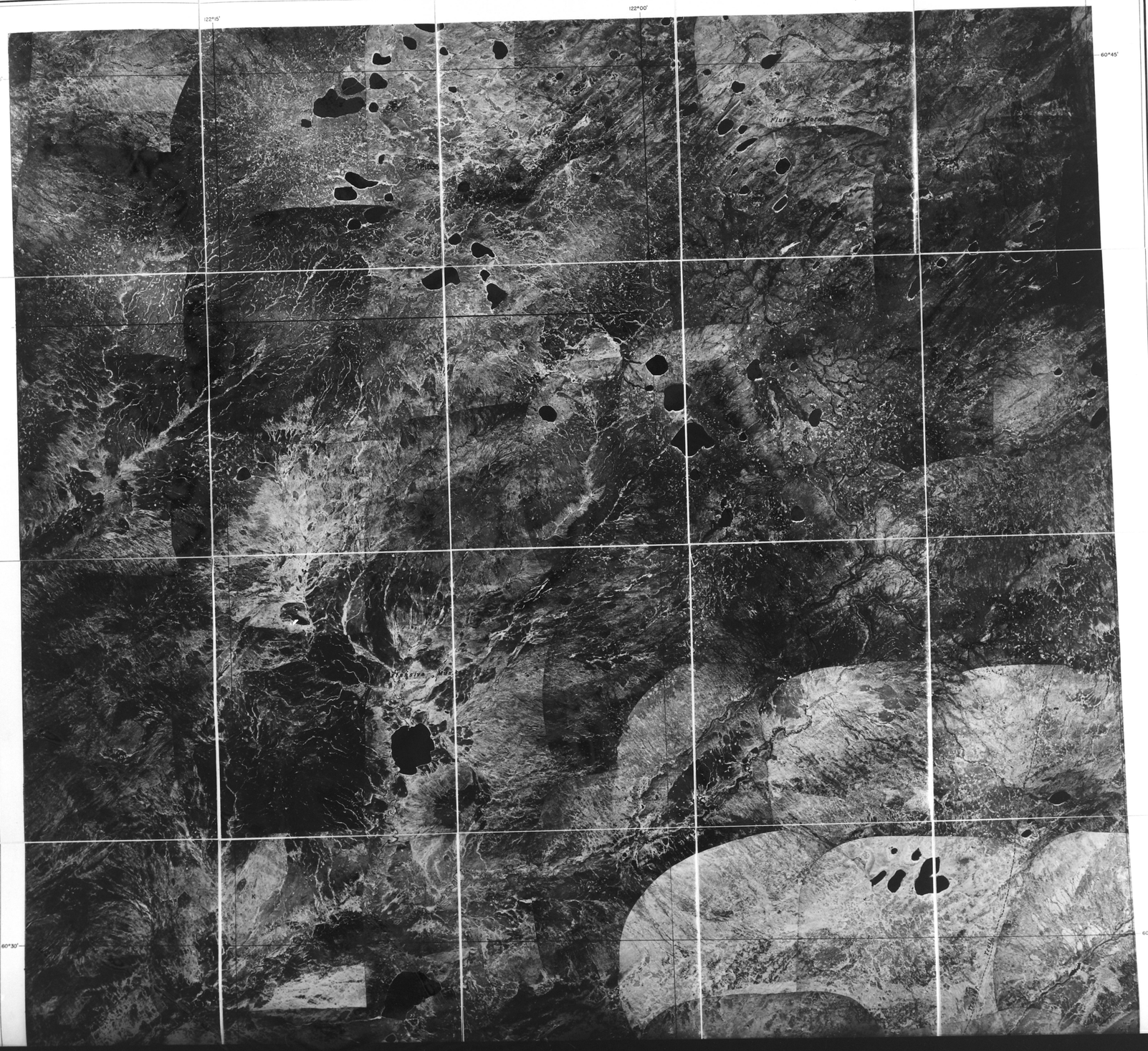
TOPOGRAPHIC LEGEND

1 Bush
2 Lake
3 Muskeg
4 River
5 Trail
6 Seismic Line

J.C. SPROULE & ASSOCIATES

2 of 2

SHEET-3



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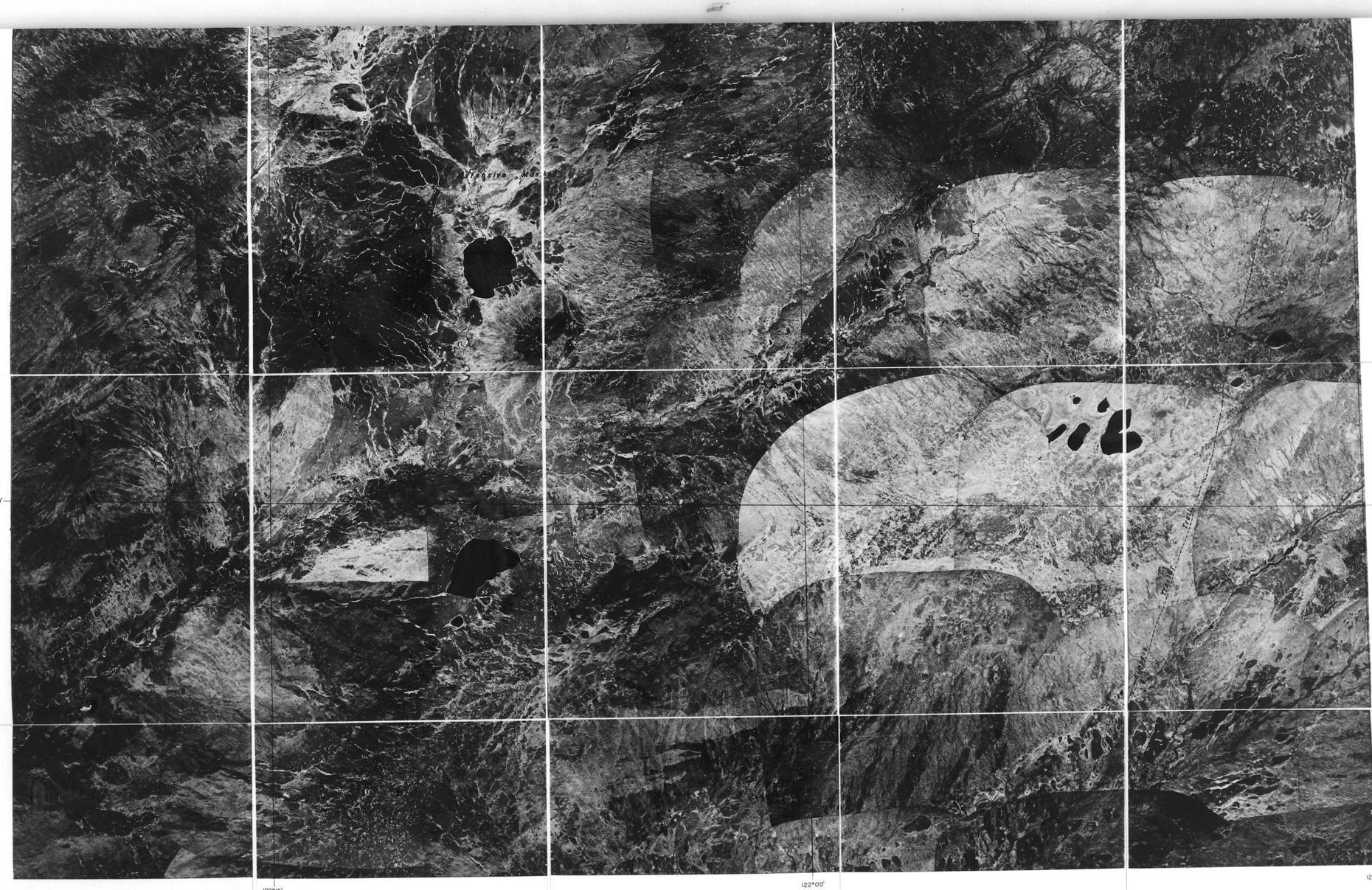

GEOLOGICAL LEGEND

CRETACEOUS		DEVONIAN	
Undifferentiated	K	UPPER DEVONIAN	
UPPER CRETACEOUS		Undifferentiated	Du
Fort Nelson Fm.	Kfn	Trout River Fm.	Dtr
LOWER CRETACEOUS		Grumbler Fm.	
Ft. St. John Group (Undif.)	Kfsj	Reefoid Member	Dug
Lepine Fm.	Kl	Silty Limestone Unit	Dlg
Scatter Fm.	Ks	Green Shale Unit	Dgs
Garbutt Fm.	Kg	Black Shale Unit	Dbs
Basal Conglomerate	Kcgl	MIDDLE DEVONIAN	
PERMO—PENNSYLVANIAN	PP	Ramparts Fm.	Dr
MISSISSIPPIAN	M	DEVONIAN-SILURIAN & U. ORDOVICIAN	DS&O
		CAMBRO-ORDOVICIAN	€-O

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LIARD RIVER AREA, N.W.T.

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AND

STANWELL OIL & GAS LIMITED

1 0 1 2 3

APPROXIMATE SCALE IN MILES

NOTE: This is an uncontrolled map-mosaic and should not be mistaken for an accurate geographic base.

- Geological Formation Contact
- ? ? Geological Formation Contact (indefinite)
- Synclinal Axis
- Anticlinal Axis
- Direction of Glaciation
- X Rock Outcrop
- 10 Bedding Attitude (horizontal, inclined)
- Bedding Attitude (overturned photo)
- 4 General Dip of Outcrop
- F Fossil
- 5 Stratigraphic Section

INDEX MAP

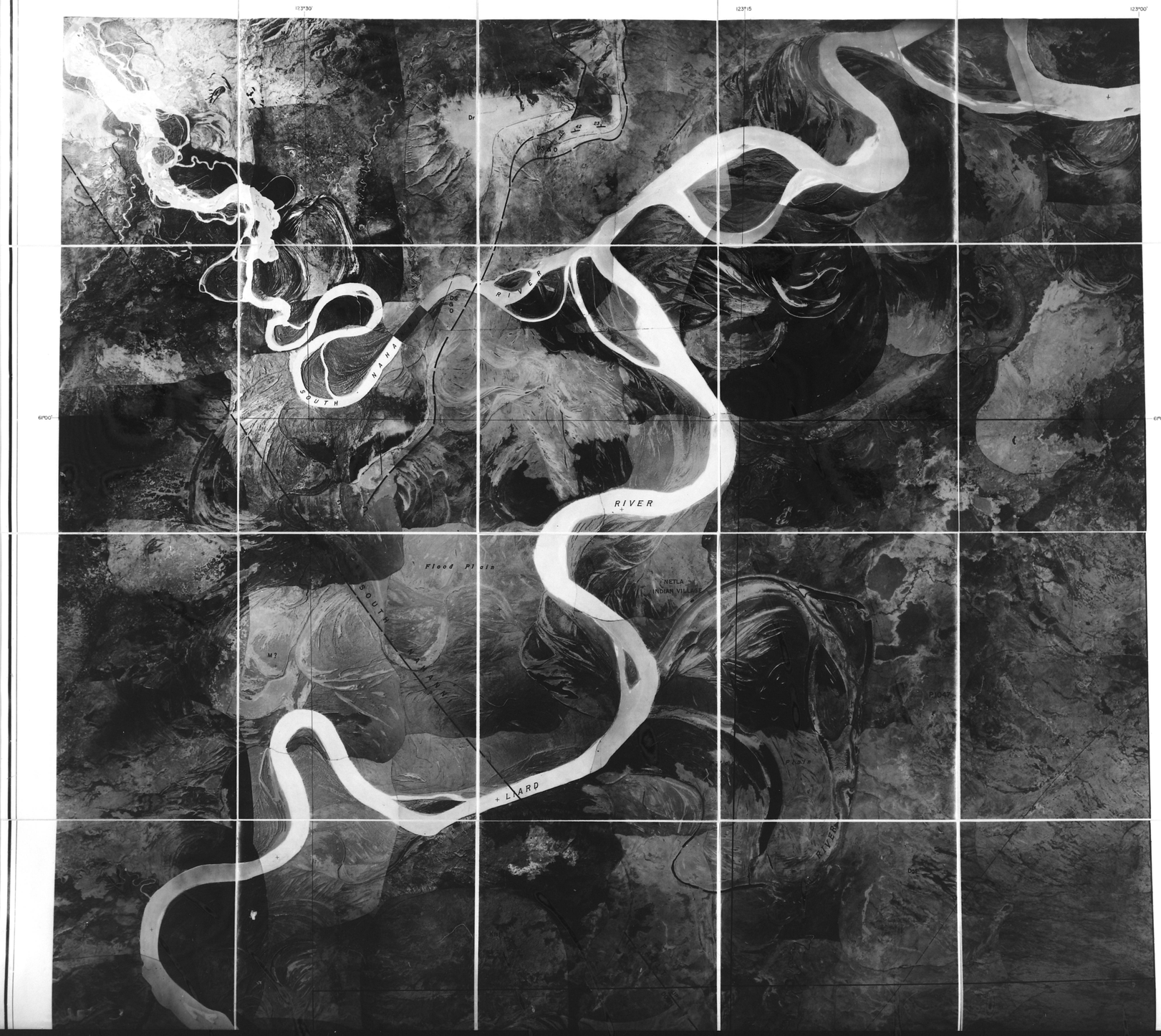
TOPOGRAPHIC LEGEND

1 Bush
2 Lake
3 Muskeg
4 River
5 Trail
6 Seismic Line

J.C. SPROULE & ASSOCIATES

2 of 2

SHEET-4



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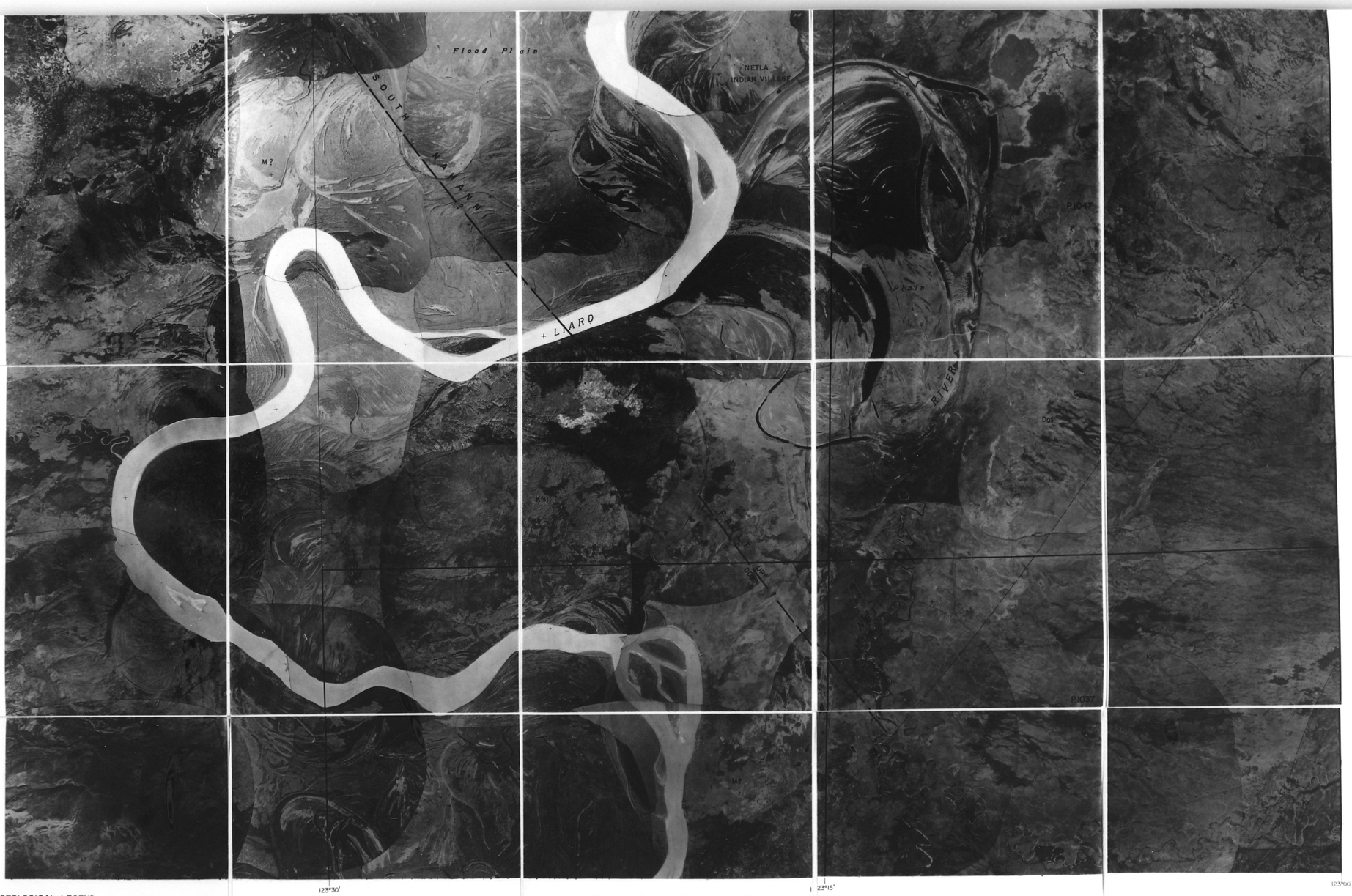

GEOLOGICAL LEGEND

CRETACEOUS		
Undifferentiated	K	
UPPER CRETACEOUS		
Fort Nelson Fm.	Kfn	
LOWER CRETACEOUS		
Ft. St. John Group (Undif.)	Kfsj	
Lepine Fm.	Kl	
Scatter Fm.	Ks	
Garbutt Fm.	Kg	
Basal Conglomerate	Kcgl	
PERMO—PENNSYLVANIAN	PP	
MISSISSIPPIAN	M	
DEVONIAN		
UPPER DEVONIAN		
Undifferentiated		Du
Trout River Fm.		Dtr
Grumbler Fm.		
Reefoid Member		Dug
Silty Limestone Unit		Dlg
Green Shale Unit		Dgs
Black Shale Unit		Dbs
MIDDLE DEVONIAN		
Ramparts Fm.		Dr
DEVONIAN-SILURIAN & U. ORDOVICIAN		DS&O
CAMBRO-ORDOVICIAN		C-O

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LIARD RIVER AREA, N.W.T.

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AND

STANWELL OIL & GAS LIMITED

1 0 1 2 3

APPROXIMATE SCALE IN MILES

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Geological Formation Contact

? ? Geological Formation Contact (indefinite)

Synclinal Axis

Anticlinal Axis

Direction of Glaciation

X Rock Outcrop

10 Bedding Attitude (horizontal, inclined)

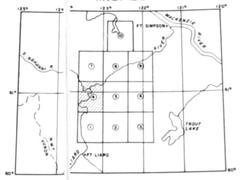
4 Bedding Attitude (overturned, photo)

General Dip of Outcrop

F Fossil

5 Stratigraphic Section

INDEX MAP

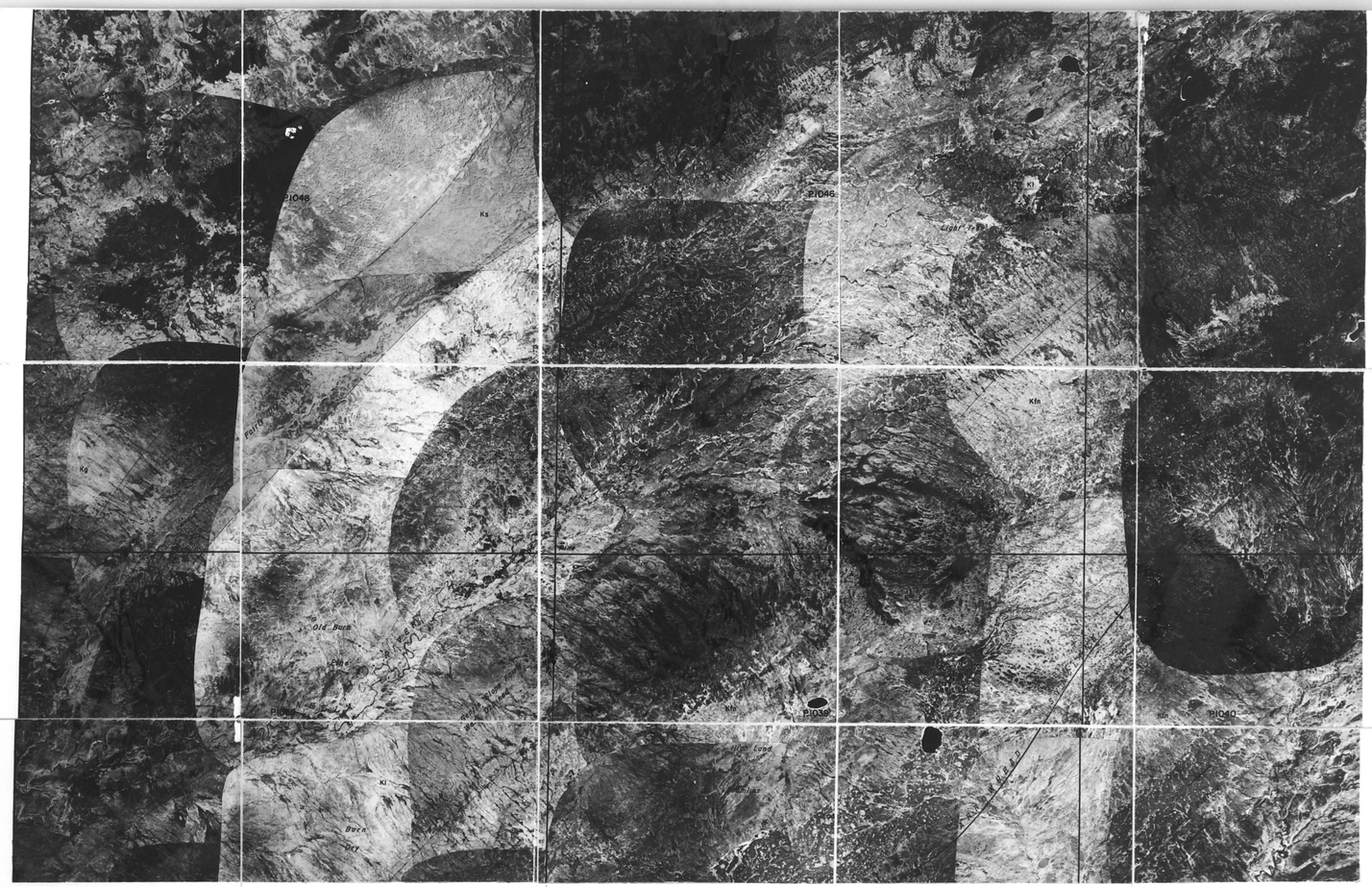


TOPOGRAPHIC LEGEND

1 Bush
2 Lake
3 Muskeg
4 River
5 Trail
6 Seismic Line

J.C. SPROULE & ASSOCIATES

2 of 2



GEOLOGICAL LEGEND

CRETACEOUS		**DEVONIAN**	
Undifferentiated	K	UPPER DEVONIAN	
UPPER CRETACEOUS		Undifferentiated	Du
Fort Nelson Fm.	KFn	Trout River Fm.	DMT
LOWER CRETACEOUS		Grumbler Fm.	
Ft. St. John Group (Undif.)	KFSJ	Hexford Member	Dug
Lepine Fm.	Kl	Silty Limestone Unit	Dsg
Scatter Fm.	Ks	Green Shale Unit	Dgs
Garbutt Fm.	Kg	Black Shale Unit	Dbs
Basal Conglomerate	Kcgr	MIDDLE DEVONIAN	
PERMO-PENNSYLVANIAN	PP	Ramparts Fm.	Dr
MISSISSIPPIAN	M	DEVONIAN-SILURIAN & U ORDOVICIAN	DS-SO
		CAMBRO-ORDOVICIAN	C-O

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1 0 1 2 3

APPROXIMATE SCALE IN MILES

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- Geological Formation Contact
- ? ? Geological Formation Contact (indefinite)
- Syncline Axis
- Anticline Axis
- Direction of Glaciation
- X Rock Outcrop
- Bedding Attitude (horizontal, inclined)
- Bedding Attitude (overturned, photo)
- General Dip of Outcrop
- F Fossil
- S Stratigraphic Section

INDEX MAP

TOPOGRAPHIC LEGEND

1. Bluff
2. Lake
3. Muskeg
4. River
5. Trail
6. Seismic Line

J C SPROULE & ASSOCIATES

1 of 2

2 of 2