FINAL

GEOLOGICAL REPORT

on

THE NELSON - LIARD RIVER AREA

N.W.T. (Canada)

IMPERIAL OIL LTD., CANOL PROJECT

Assignment No. 8.

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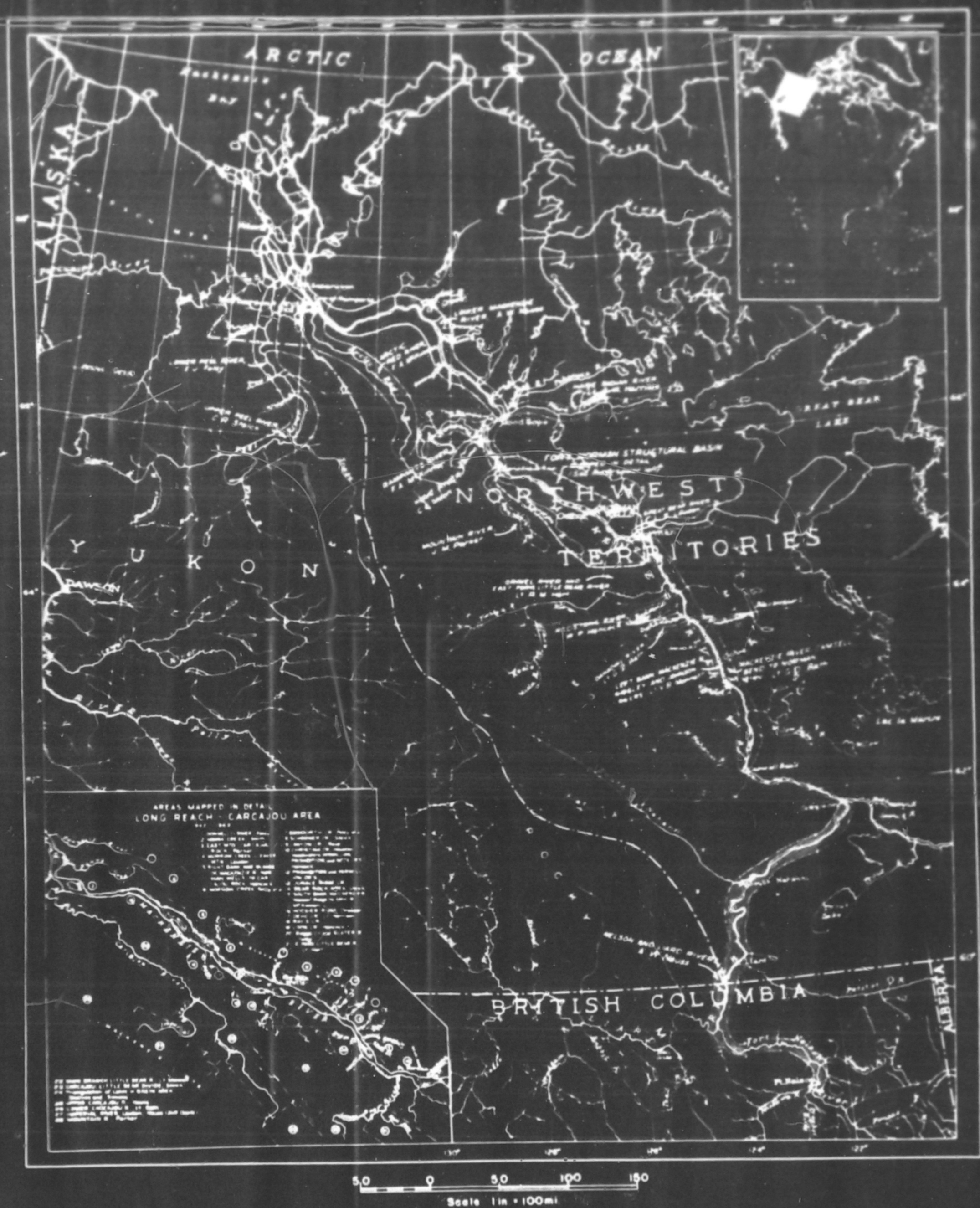
N.W.T. (Canada)

A B S T R A C T

In the Nelson-Liard River area, rocks ranging in age from Silurian to Upper Cretaceous are exposed. Siliceous dolomites, tentatively assigned to the Silurian and correlated with the Bear Rock, are the oldest rocks in the area. These are disconformably overlain by Middle Devonian dolomitic limestone. The Simpson shale and Hay River limestones and shales, corresponding to the Fort Creek and Bosworth formations of the Norman Wells area, overlie the limestones. Carboniferous limestones, dolomites, shales and sandstones lie above the Devonian formations and make the stratigraphy of this area distinctive from other areas in the Mackenzie Basin. The Cretaceous sediments consist of sandstones, shales and some coal seams together with a 400 foot resistant conglomerate formation in the middle of the section.

The Nelson-Liard area lies near the angle in the mountain front where the Mackenzie Mountains join the Rocky Mountain front. The ranges of the Mackenzie Mountains are clearly marked and the most southerly ones are anticlines whose ends are in echelon arrangement. Farther north the mountain ranges are formed, each by a thrust fault. Near the south end of these structures, the Devonian limestone prospective reservoir beds are deeply buried and there is, hence, a chance for petroleum production. The unfavorable features of these structures are: they plunge southward about six degrees, and the Simpson shale is not as highly petroliferous as at Norman Wells. One very small structure was found in the Liard Rapids on the crest of which Hay River limestones are exposed.



INDEX MAP OF
NORTH WESTERN CANADA SHOWING
THE NELSON AND LIARD RIVERS AREA

Chapter I.

I N T R O D U C T I O N

The area described in this report lies along the Nelson and Liard Rivers from Fort Nelson to Fort Simpson on the Mackenzie River. The distance along the river is approximately 350 miles (Plate I).

On May 8, Party "I" consisting of H. E. Reidford, W. L. Clemis, and A. W. Mauss arrived at Fort Nelson with all necessary equipment. A truck was obtained and all equipment was unloaded into canoes where the Alaska Highway crosses the Muskwa River. The survey to the mouth of the Liard River was completed in one month.

A map of the Fort Nelson River was not available, and a track survey was made. The Liard River had been similarly mapped by McConnell (1891, Sheet 4 and 5). Outcrops were located by pace and compass traverses, and elevations were obtained with an aneroid barometer. No aerial photographs were available at the commencement of this survey. Vertical photographs are available for the lower 40 miles of the Liard River, but these were not used in compiling the base map for this report, but were studied for geologic information. A large part of the South Nahanni River has been photographed from the air.

Accessibility

The Nelson-Liard area is near the Alaska Highway; in fact, its southern end, at Fort Nelson, is connected to the Highway by a gravel road. A winter road extends in a more or less direct line from Fort Nelson to Ft. Simpson on the Mackenzie River. The road's greatest distance from the Liard is about fifty or sixty miles.

In building roads into any part of the Nelson-Liard area from

the Alaska Highway, mountainous terrain can be avoided by keeping the road east of the Liard River if possible. This country is flat, but muskegs are not nearly so numerous as farther north in the Norman Wells region.

The Liard and Nelson Rivers have been used as a transportation route to bring supplies by boat from Fort Simpson to the trading posts along these rivers, however, navigation on them is difficult. The first obstacle on the upstream trip from Simpson is the Liard Rapids, twenty miles from the mouth of the Liard. These rapids are so swift that all supplies are reloaded into long, narrow rapid boats. Above the rapids barges can again be used, but the current is swift to Nelson Forks. The Nelson River is shallow and can only be ascended by tug boats and barges when the water is high. Local inhabitants have given the information that July and August are the best months for navigation on the Nelson River.

The writer wishes to acknowledge the assistance of the Imperial Oil Geologists on the Canol Project for information obtained from them during discussions. The fossils were identified by C. R. Stelck and Plate A of the Appendix was prepared by K. Huff and N. D. Slusar. H. K. Reidford and W. L. Clemis ably assisted the writer in the field.

Chapter II.

T O P O G R A P H Y

The Nelson River flows through a more or less flat plain to within 35 miles of Nelson Forks (Photo No. 1). It then cuts through a plateau, bordered on the east by an escarpment which rises 1000 feet above river level. This feature is caused by a resistant bed of conglomerate which dips westward (Photo No. 2). The Nelson River flows through a low plain for the last fifteen miles of its course.

From Nelson Forks to the mouth of the Petitot River, the Liard flows through a gently undulating plain. Hills, which have a maximum height of 500 feet, are common. The Liard River gradually approaches the mountains to the west. The highest peaks in the front ranges are about 4000 feet above river level. Some of these mountains are anticlinal uplifts, others are due to thrust faults which bring the harder Paleozoic rocks to a high elevation (Photo No. 3).

From Fort Liard to Nahanni Butte the Liard flows near the mountains which have steep cliffs on their east side and gentle dip slopes on their west side. The plain through which the Liard flows east of the mountains has a few low ridges.

At the mouth of the South Nahanni River the Liard turns to the northeast, leaves the mountains, and flows through a flat featureless plain to Simpson. For fifty miles northeast of Nahanni, the banks of the Liard are low and flat. The last 40 miles of the river is in a narrow valley several hundred feet deep. The valley walls are steep and almost vertical. Rapids are common for ten miles along the river to a point twenty miles from Simpson. These rapids occur where the

Liard cuts through the resistant southward dipping Hay River limestone.

West of Simpson a long prominent hill, which shows up prominantly on the oblique photographs, can be seen from the top of Nahanni Butte. This may be an erosion remnant of some hard bed or the topographic expression of an anticline.

Between Fort Nelson and Nelson Forks, only two streams of any consequence join the Nelson River. These are: the Satanah River and Deer River. The Satanah River (Snake River in English) is a stream about fifty feet wide. The lower two miles of its course is in a valley about 200 feet deep. Several small boulder rapids occur and cut banks fifty to one hundred feet high are numerous and expose boulder clay. The Deer River is a smaller and more sluggish stream. The largest rivers joining the Liard between Nelson Forks and Simpson are: the Petitot River and the Nahanni River. The Petitot River rises in Lake Bistcho 150 miles east of Fort Liard in the northwest corner of Alberta (Plate I). It is reported by the local inhabitants at Fort Liard that in high water the river can be descended by canoe from Lake Bistcho to the Liard River. The lower five miles of the Petitot is in a valley 200 feet deep. Numerous cut banks expose Cretaceous sandstones and shales. The South Nahanni River is about one half as large as the Liard itself. It is a very swift river which can be ascended by canoe with extreme difficulty.

Chapter III.

S T R A T I G R A P H Y

General

Sediments belonging to the Cretaceous, Carboniferous, and Devonian systems are exposed in the Nelson-Liard River area. The age of the oldest formation on Nahanni Butte is not definitely known because of lack of fossil evidence. It may be either Early Devonian or Silurian, and will be referred to in this report as the "Lone Mountain Dolomite". Sandstones and shales exposed on Hume Mountain may belong to the Permian.

No outcrops occur on Nelson River between Fort Nelson and Deer River. Five miles below Deer River, the Nelson cuts through the Flat Top Hills. From this point to ten miles below Fort Liard Cretaceous rocks are exposed in scattered outcrops. The next twenty miles of the river are underlain by Mississippian rocks. From Nahanni River to the mouth of the Liard only Devonian rocks are exposed.

The following is a generalized stratigraphic column:

(Stratigraphic column on next page)

Age	Thickness in feet	Description
Upper Cretaceous	400	Dark grey shale and silty shale ironstone concretions, sulphur.
	350	Interbedded soft medium-grained sandstone, grey silty shale and some coal.
CRETACEOUS (2160 feet)	---------- Covered interval ----------	
	400	Conglomerate, some coarse grained salt and pepper sandstone.
	---------- Covered interval ----------	
	720	Massive buff-weathering sandstone, platy sandstone and some silty shale, *Inoceramus*.
	300	Dark grey silty shale.
	---------- Covered interval ----------	
PERMIAN (?) (1300 feet)	200	Hard siliceous shale.
	40	Hard dark grey flaky shale.
	100	Soft calcareous fossiliferous sandstone.
	245	Chert, shale and some sandstone.
	715	Grey and dark grey limestone and dolomitic limestone with some interbedded grey shale.
MISSISSIPPIAN (1080 feet)	20	Blocky granular buff dolomite.
	---------- Covered interval ----------	
	95	Grey quartz sandstone.
	75	Covered and grey flaky shale.
	170	Fine-grained non-calcareous rusty-weathering sandstone, consisting mainly of angular grains of quartz.
	150	Covered, shale.

M (Cont'd)			
I S S I S S I P P I A N		170	Grey massive crystalline limestone, interbeds of grey platy shale.
		300	Grey coarsely crystalline blocky limestone, fossiliferous, nodules of flint at the top.
		60	Bluish grey flaky shale in thin small flakes.
		40	Dark grey blocky limestone.
----------Covered interval----------			
D E V O N I A N	Hay River Formation (300 + ft.)	100	Grey flaky shale, some thin limestone beds.
		200	Flaggy fossiliferous limestone, thin grey shale beds.
	Simpson Shale.	500	Greenish and bluish grey shale.
	Ramparts-Beavertail	600	Dark grey dolomitic limestone, some quartz and calcite veins.
----------Disconformity----------			
S I L U R I A N (?)	Lone Mountain Dolomite	500	Light grey siliceous dolomite cut by abundant quartz veins.

Total: 6,440 ft.

SILURIAN

Lone Mountain Dolomite

Light grey siliceous dolomite with numerous veins and dikes of quartz are the oldest sedimentary rocks exposed in the Nelson-Liard River area. The quartz veins are so abundant in places as to make up more than fifty percent of the rock. No fossils were found in this unit. At Nahanni

Butte at the mouth of Nahanni River, the lowest beds of this formation were observed, and there the base is cut off by a fault which has thrust Silurian dolomite over Simpson shale. The upper contact with the Middle Devonian beds is a disconformity. The stratigraphic position and lithology of these beds suggest that they are a correlative of the upper part of the Lone Mountain dolomite at the North Nahanni River (Kindle and Bosworth p.44). The lithology of the Lone Mountain dolomite on Nahanni Butte suggests a correlation with the Bear Rock dolomite of the Norman Wells area. The total observed section is 500 feet.

DEVONIAN

Ramparts-Beavertail (Middle Devonian)

Six hundred feet of dark grey dolomitic massive limestone overlies the Lone Mountain dolomite disconformably. The limestone is cut by a few quarts and calcite veins. No shale beds are interbedded with these limestones, which are well exposed on Nahanni Butte. The most characteristic fossil of the upper part is a Prismatophyllum of the same species that occurs in the Beavertail on the Carcajou River near Norman Wells. The fauna of the formation indicates a correlation with the Ramparts - Beavertail (Plate III). This formation is more dense than the coralline portions of the Beavertail in the Macdougal Range, and no petroliferous beds were observed in it. It should not be condemned, however, as a reservoir bed.

Simpson shale (Upper Devonian)

The name Simpson shale was applied by A. E. Cameron (1918, p.26) to outcrops across the Mackenzie River from Fort Simpson. At this place 140 feet of smooth greenish grey shale is exposed. The Simpson shale is exposed along the Liard River between Simpson and the foot of Liard Rapids

and consists of bluish-grey, thin bedded, flaky, shale with some thin beds of limestone. It grades upwards into Hay River limestones and shale. At Nahanni Butte the Simpson shale overlies Middle Devonian limestone and is cut off at the top by a thrust fault which has pushed the Lone Mountain dolomite over the Simpson shale.

No bituminous beds similar to those occurring in the Lower Fort Creek at Norman Wells were observed in this unit. However, only the upper part of the formation was observed. The thickness of these shales, on the lower part of the Liard, is about 500 feet. The base is not exposed here, and the total thickness of the formation is probably much greater. The Simpson shale would make an excellent cap rock for the retention of oil in structures. In an outcrop of Simpson shale, about twenty five miles up the Mackenzie River from Simpson, sixty five feet of greenish to bluish shale is exposed (Kindle 1919, p.2). From this outcrop the following fossils were identified by E.M. Kindle:

Cyrtina glabra Kindle

Buchiola retriostriata Von Buch

Paracardium doris Hall

Entomis serratostriata (Sandberger)

Entomis variostriata Clarke

Entomis brookei Kindle

On the basis of these fossils and others from an outcrop near Wrigley, Kindle correlates the Simpson shale with the Upper Devonian Portage group of New York. The Simpson shale may be correlated with the Fort Creek shale of Norman Wells.

Hay River formation (Upper Devonian)

This formation overlies the Simpson shale with a gradational contact and consists of interbedded flaggy and platy limestone and grey shale. The limestone is thin bedded and contains numerous fucoids and a few ripple marks which suggest shallow water deposition. The upper part of the formation is predominantly grey shale with a few limestone beds.

The only place where this formation was observed is at the Liard rapids. The limestone bands are the cause of the various rapids. The Hay River formation causes rapids and falls on Jean Marie, Trout, Redknife, and Bouvier Rivers which enter the Mackenzie from the south, to the east of Liard River, (Whittaker 1923 pp. 88-94). These rapids and falls occur where the southward dipping Hay River limestones come to the surface. The underlying Simpson shale is eroded more quickly.

Three hundred feet of beds belonging to the Hay River formation crop out on the Liard, but the top of the formation is not exposed, and the total thickness is probably much greater than three hundred feet. The fossils collected from the Hay River formation are listed on Plate III. These fossils indicate that the Hay River limestone is the correlative of the Bosworth sandstone of Norman Wells area.

CARBONIFEROUS

In the mountains to the west of the Liard River, a heterogeneous series of limestone, dolomite, chert, shale, and sandstone is exposed. These strata were observed on Flett Mountain, Liard Range, Hume Mountain, and in several outcrops along the Liard River from ten to thirty miles below Fort Liard. The lithology is described on Plates IV and V. Fossils collected from this Late Paleozoic succession were identified by C. R. Stelck and are listed on the Plates.

It is believed that Lower Mississippian limestones overlie shales of the Hay River formation but the contact was not seen. The limestones, dolomites, and shales at Flett Mountain are fossiliferous (Plate IV). G. S. Hume (1923 B) collected the following fossils from this same locality:

* Productus gallatensis Girty	Girtyella sp.
Camarotoechia tuta (Miller)	Dielasma sp.
*Camarotoechia metallica White?	Spirifer sp.
Camarotoechia 2 species	Platyceras sp.
Spiriferina subtexta White	

* Also occur in Madison limestone.

From an outcrop on the Liard (Outcrop 39), Hume collected the following fossils from a bed which is included in the Flett Mountain section:

Spirifer grimesi Hall

Spirifer gregeri Weller

Spirifer versenensis Swallow

Cliothyridina obmaxima (McChesney)

Brachythyris chouteauensis Weller?

Productus sp.

Pseudosyrinx sp. nov.

Schellwienella sp.

Leptaena analoga (Phillips)

Phillipsia sp.

According to Hume these fossils indicate a Lower Mississippian age. This age determination is supported by the fossils identified by C. R. Stelck. On Hume Mountain the Late Paleozoic rocks are well exposed

(Photo No. 4). This section and the fossils collected are given on Plate 5. The lowest bed examined on Hume Mountain is a very fossiliferous blocky granular buff dolomite. It is believed that this lower dolomite bed is Mississippian in age. This determination agrees with that of Hume (1923 B) who collected the following fossils from this bed on Hume Mountain:

Spirifer missouriensis Swallow

Spirifer veronensis

Productella sp.

Pseudosyrinx sp. nov.

Above this blocky dolomite bed there is about 1300 feet of interbedded limestone, dolomite, shale and sandstone, (Photo No. 4) of which the age is uncertain, but it might be Permian. E. D. Kindle[1] states that he found sandstones of Permian age on Beaver River of Hume Mountain. C. R. Stelck, who studied the writer's collection from Hume Mountain, states that a Neospirifer similar to Neospirifer dunbari in this collection, suggests a Pennsylvanian or Permian age.[2]

CRETACEOUS

Rocks of Cretaceous age underlie the Nelson and Liard Rivers from Fort Nelson to ten miles below Liard. The most conspicuous element, and the best marker bed in the Cretaceous of this region is the 400 foot bed of conglomerate which forms the Flat Top Hills and causes prominent ridges along the eastern front of the mountains west of Liard River (Plate II). The conglomerate formation is useful in determining the stratigraphic position of other beds.

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1. Letter dated November 30, 1943.
2. Memorandum dated, January 20, 1944.

The beds which underlie the conglomerate consist of sandstones and marine shales. At Fort Nelson a well (Fort Nelson No. 2) was drilled for water to depth of 1440 feet by the U. S. Army. At 730 feet some of these marine shales were encountered. The log of Fort Nelson No. 2 is as follows:

0 - 730	Glacial deposits
730 - 960	Dark grey to black flaky shale.
960 - 970	Light grey somewhat indurated siltstone.
970 - 1000	Dark grey chunky shale.
1000 - 1020	Light grey siltstone some quartz particles and glauconite.
1020 - 1100	Dark grey shale, some siltstone.
1100 - 1180	Light grey slightly, indurated siltstone, some dark grey shale, small flow of gas.
1180 - 1440	Dark grey shale.

The section on the east flank of Hume Mountain, below the conglomerate marker, is shown on Plate VI. The sandstones in this section contain abundant plant material and a few pelecypods of the genus Inoceramus.

The conglomerate marker is 400 feet thick and consists of hard, scarp-forming, fine grained, conglomerate (Photo No. 5 and 6). It exhibits marked cross-bedding. The pebbles are quartzite, chert, hard black shale, green shale, and quartz. In places the pebbles are embedded in a matrix of coarse sand and in others in a fine conglomerate, having a grain size of one sixteenth to one eighth of an inch. The conglomerate is so well cemented that it is broken with difficulty. It is jointed in such a manner that it breaks into large blocks up to 30 feet across. The joints on the Flat Topped Hills and Roche-qui-trempe-a-l'eau have a direction of N. 70 degrees W., and they are the controlling factor for the

direction of the river at this place. The joints are more pronounced in the sandy beds than in the coarser conglomerate. This formation becomes thinner and finer grained toward the northeast.

Overlying the conglomerate is 350 feet or more of interbedded soft medium grained sandstone, grey silty shale, and some coal. A seam of coal, several feet thick, is exposed about seven miles up Sutherland River. Another thin seam of coal occurs on the right bank of the Liard about eight miles below the mouth of the Nelson River. The sandstones contain abundant plant remains and suggest continental deposition.

On Sutherland River and along the Liard near the mouth of this river, there are abundant outcrops of dark grey and bluish grey shale with a few thin beds of sandstone. Ironstone concretions containing molluscan fragments are numerous. Considerable sulphur occurs on the outcrops. This shale unit overlies the continental deposits with a gradational contact and represents the highest beds observed.

Chapter IV.

S T R U C T U R E

General

The regional dip of about one degree between Fort Nelson and Nelson Forks is toward the west. Along the mountain front from the mouth of Beaver River to Fort Liard the dip is toward the east at two to fifteen degrees. A synclinal axis separates these two regional dips and crosses the Liard near the mouth of Sutherland River. This is thought to be part of the regional syncline which borders the Rocky Mountains and extends southward into Alberta.

From Fort Liard to Nahanni Butte the dips are irregular and the Liard has cut into one of the mountain structures near the end of Flett Range. The regional dip may be toward the east in this area.

Along the lower fifty miles of the Liard the regional dip is to the southwest. A regional syncline probably borders the mountains east of Nahanni Butte, and these southwest dips may represent the gentle northeastern limb of this syncline.

Two types of mountain structures occur west of the Liard River. West of Fort Liard three ranges were observed which are anticlinal in structure with faults playing a minor role. To the north of Fort Liard the ranges are straight, have a saw-tooth profile, steep eastern edges, and gentle western dip slopes (Photo No. 7). These ranges are caused by thrust faults.

Hume Anticline

The Hume Range lies west of the Liard River at a distance of fourteen miles to the nearest point. Its southern end is near the sixtieth parallel (the Northwest Territories - British Columbia border).

Its highest peaks rise to elevations of nearly 6000 feet.

Hume Range is one large anticline which is four or five miles wide and considerably more than thirty miles long. The anticline has an arcuate shape with the concave side of the arc toward the west. South of Hume Mountain the anticline gradually curves to the west until, near its southern end, it has a direction of S. 22 degrees W. To the north of Hume Mountain the range is nearly straight and has a direction of N. 25 degrees W.

On the flanks of the Hume anticline the dips are as high as seventy-one degrees (Photo No. 4). The plunge is toward the south at about six degrees. (Photo No. 10). The oldest beds exposed at the crest of the anticline at Hume Mountain are of Mississippian age. Towards the north older strata probably occupy the crest.

The La Biche River cuts across the Hume Range through a valley nearly a mile wide. Since the range seems to be slightly offset south of La Biche River, the valley may follow a transverse fault. This possible fault, if impervious, would cause the southern end of the Hume anticline to be a closed structure in which the Devonian limestones are buried. The Devonian limestones may be exposed on Hume anticline farther to the north, but there is a possibility that the plunge of the anticline is reversed farther to the north beyond the area investigated, and that Devonian limestones are not exposed on this anticline. Because there is some chance of obtaining oil from the deeply buried Devonian limestones on this structure, the whole anticlinal range should be examined in detail. Other similar neighboring anticlines should also be surveyed geologically (Photo No. 9).

Liard Range

The Liard Range is a long straight mountain Range with a saw-tooth profile (Photo No. 7). The south end of this range is at Fort Liard and it extends northward for at least thirty miles. The peaks gradually become higher and more rugged toward the north. The general direction of the range is N. 25 degrees W. Its east side is a cliff with a talus slope at the base. The west side is a gentle slope. The eastern edge of the Liard Range is bounded by a thrust fault which brings Mississippian rocks above Cretaceous strata at the south end of the range. This fault can be seen off the end of the mountain range in the valley of Petitot River. It probably dies out a short distance south of the Petitot River.

On top of the Liard Range Mississippian chert strikes N. 65 degrees W. and dips southwest at twelve degrees. Since the direction of strike is different from the trend of the range, older rocks are exposed on the mountain to the north, and at the southern end of the range the Mississippian rocks plunge southward at about six degrees and are carried below the surface at the edge of Liard River.

On Liard River (to the east of the Liard Range) Cretaceous rocks dip eastward at about four degrees. This dip brings the Mississippian to the surface about ten miles below Fort Liard. From the point of view of a petroleum trap the Liard structure is a westward dipping fault which truncates eastward dipping beds, but since the fault is not parallel to the strike of the Cretaceous strata the structure has a southward plunge which would allow oil to migrate northward. Because the Devonian limestones are deeply buried for thirty miles on the south end of this structure, it cannot be completely condemned as an oil

prospect, but on account of the steep southward plunge and the doubt regarding the nature of the fault plane, it cannot be classed as a good prospect.

Liard Rapids Structure

In the Liard rapids the dip of the Hay River limestone is toward the south and southwest, and rarely exceeds one half degree. At one locality, thirty miles up the Liard River from Fort Simpson, the Liard turns toward the south, and for half a mile the apparent dip is either flat or gently downstream as observed on the south bank. The beds are not as well exposed on the north bank and no evidence of this reversal in dip was seen. South of this reversal, on top of the Liard Valley bank, the country is flat and no outcrops were seen. Two miles farther downstream a small creek enters the Liard from the south. In this creek only southward dipping beds were observed. The apparent closure along the Liard River on this structure is about fifty feet. Hay River sandstones are exposed on its crest and the Middle Devonian limestones are covered by the total thickness of the Simpson shale. The nearest known exposure of bituminous shale in the lower part of the Simpson shale (Fort Creek) is at Root River, ninety miles northwest of this structure, where it was observed by Lt. G. D. Bath. It is not known whether or not this is a closed structure but it is probably small. The shape of the structure could best be determined with a seismograph, since the anticline is only thirty miles from Simpson.

Jean Marie River.

Jean Marie River is east of the Liard River and flows northward to the Mackenzie. At the nearest point it is only twelve miles from Liard Rapids. The whole stream was surveyed geologically by E. J Whittaker

(1923). Hay River limestones are exposed along the greater length of the river. In regard to the geologic structure along Jean Marie River, Whittaker states (1923, p.100); "The rock formations, where exposed, are nearly flat lying and fold structures are almost absent. A low dome on Jean Marie River produces the middle gorge. Small, local dips of two degrees to three degrees occur in many localities, but they are never persistent or uniform and usually die out within a hundred yards Oil possibilities are practically negligible except perhaps at the dome of the middle gorge. This is, however, commercially inaccessible". This dome is only fourteen miles east of the Liard Rapids and suggests that there may be a number of small structures in this area. It is recommended that a geologist be landed on McGill Lake on Jean Marie River to study the geology of the river and to examine the "dome" at the middle gorge.

Chapter V.

OIL AND GAS MANIFESTATIONS.

No definite oil seepages or petroliferous limestone beds were seen in the Nelson-Liard area. On the east side of Flett Range, about one hundred yards west of Liard River, an irredescent film was observed on the water of a small stream. This film had the appearance of oil since it would not break into angular fragments when disturbed with a stick. No petroliferous odor could be detected.

In Nelson No. 2 well a small flow of gas was obtained from a siltstone within Cretaceous shale at a depth of 1100 to 1180 feet. The officer in charge at the Fort Nelson camp informed us that there was probably enough gas to supply the Fort Nelson camp.

Indians report seepages 35 miles up the Muskeg River, and 65 miles up the Petitot River. Another seepage was reported at the south end of Trout Lake. All of these reports may be unreliable, but should be checked if the opportunity is afforded.

Chapter VI

CONCLUSIONS AND RECOMMENDATIONS

The anticlines to the west of Fort Liard have Mississippian rocks on their exposed crests. Therefore the Devonian limestones are deeply buried, at least on their southern ends. The geology of the area, in which these anticlinal mountains occur, should be studied in detail. The thrust fault structures north of Fort Liard are inferior as petroleum prospects to the anticlinal mountains mentioned above. The Liard Rapids structure may be too small to merit exploitation, but seismic reflection work might disclose a better prospect. The dome mentioned by E. J. Whittaker on Jean Marie River should be investigated.

North of Liard River and west of the Beaver River, McConnell (1891, Sheet 4) indicated a "great bay in the mountains floored by Cretaceous rocks". Triassic, Permian and Mississippian rocks have been reported from the edge of this basin. Since more stratigraphic units are present in this region and complex folding and faulting absent, it may be considered as a good prospective oil province. The area is also of especial interest because of its proximity to the Alaska Highway.

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10. Williams, M.Y. 1923, Reconnaissance across northeastern British Columbia and the Geology of the northern extension of the Franklin Mountains, N.W.T. Canadian Geological Survey Summary Report for 1922, pt. B, pp. 65 - 87.

Photo No. 1. Fort Nelson River above Beer River showing the low banks.

Photo No. 2. Looking south from a point on Nelson River, at the westward dipping escarpment formed of Cretaceous conglomerate.

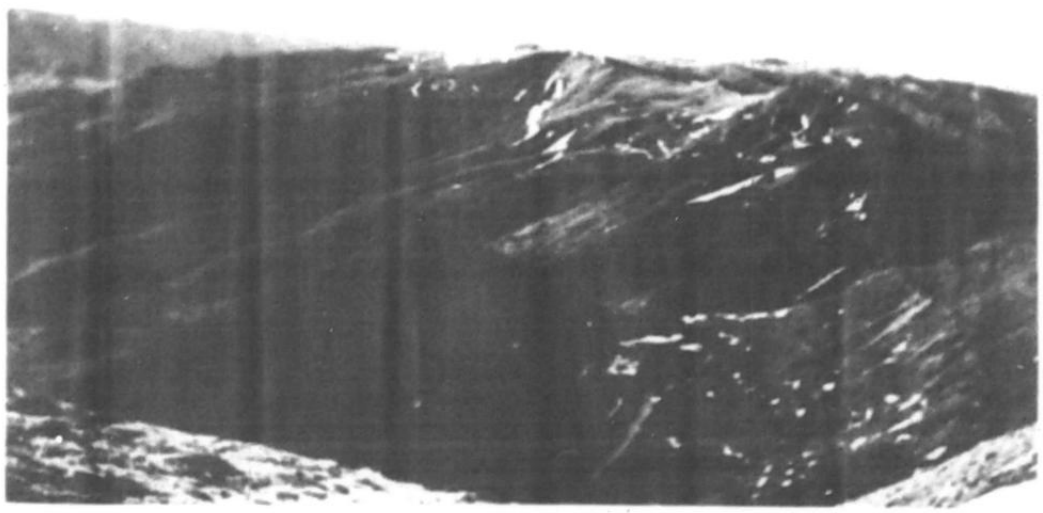


Photo No. 3. Looking north from the top of Hume Mountain showing the topography on top of the Hume Range.

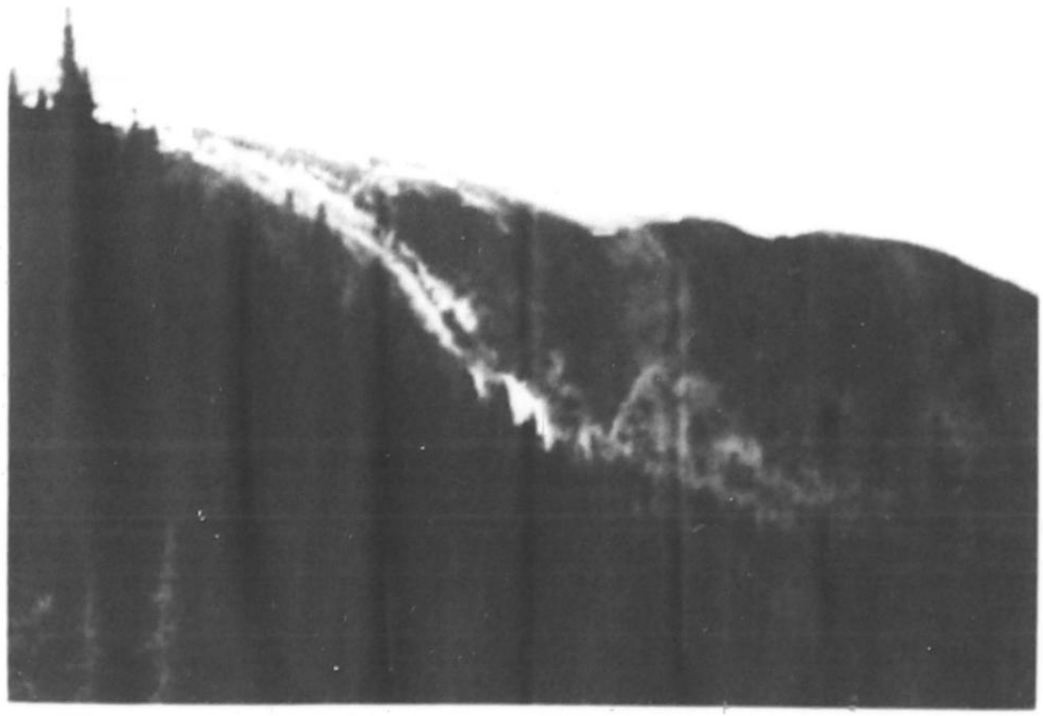


Photo No. 4. Looking north at the east flank of Hume anticline, showing about 1500 feet of Carboniferous strata.

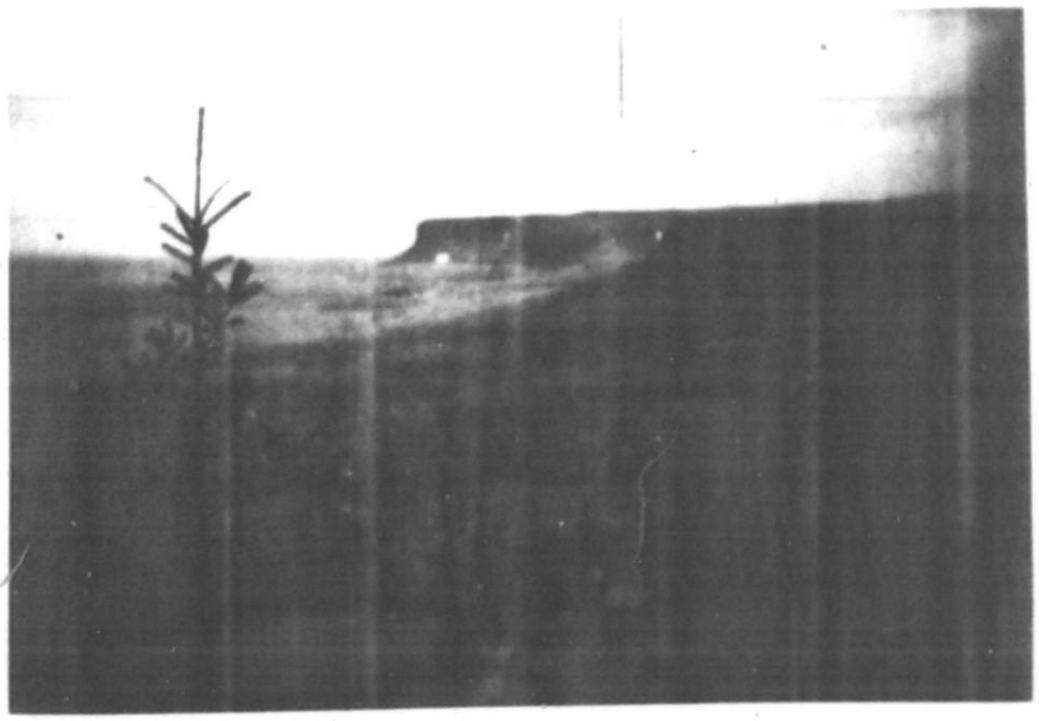


Photo No. 5. Looking south at the eastern edge of the Flat Top Hills, formed of Cretaceous conglomerate

Photo No. 6. Outcrop of Cretaceous conglomerate at Roche-qui-trempe-a-l'eau on Fort Nelson River.

Photo No. 7. Looking northwest, from Hume Mountain, at the saw-toothed Liard Range and the intervening synclinal valley.

Photo No. 8. Looking south, from Hume Mountain, at the southern end of Hume Range.

Photo No. 9. Looking west, from the top of Liard Range at the southern end of the range west of Fish Lake. The plunge of the end of the anticline may be seen.

Photo No. 10. Looking south, from the top of Rume Mountain showing the low hills, off the end of the range, which are the topographic expression of the anticline on the Cretaceous plain.

APPENDIX

Edmonton, Alberta,
Feb. 12, 1944.

TO: Dr. T. A. Link
RE: Fossil Identification

The attached list is a tentative identification of fossils collected by Dr. A. W. Nauss on Assignment No. 8, Nelson and Liard Rivers. This suite was numbered by Dr. Nauss 2000 - 2200 and later reindexed to conform with the accession number system.

C. R. Stelck

KH/tm

FOSSIL IDENTIFICATION - NELSON TO LIARD RIVERS

Suite No.	Date	Location	Fossil	Accession No.	Age
---	May 20	Top Hume Mt. Sandy ls. bed, Liard River	Geisonoceras	41150	Carboniferous
				2000	
				2004	
				2026	
"	"	"	Productus	41151	"
				2001	
				2002	
				2008	
				2009	
				2010	
				2011	
				2013	
				2014	
				2017	
				2023	
				2024	
				2025	
				2020	
				2029	
				2031	
				2018	
"	"	"	Productus sp. 2.	41152	"
				2005	
"	"	"	Chaetetes	41153	"
				2003	
				2016	
				2021	
"	"	"	Spirifer	41154	"
				2006	
				2015	
				2019	
				2028	
"	"	"	Crinoid stems	41155	"
				2007	
				2012	
				2022	
"	"	"	Zaphrentis	41156	"
				2027	
---	May 20	Top Hume Mt. Sandy ls. bed, Liard River	Chonetes ?	41157	Carboniferous
				2030	
---	---	At base Hume Mt. on E. side Liard River	Inoceramus	41158	Cretaceous
				2032	
				2033	
---	---	High on Eastern edge Hume Mt. from Chert. Liard River	Chert	41159	---
---	---	From bed 3 on E. edge Hume Mt. Liard River	Geisonoceras	41160	Carboniferous

Fossil Identification

Suite No.	Date	Location	Fossil	Accession No.	Age
				2035 2036	
---	---	ls. top Hume Mountain, Liard River	Chaetetes	41161 2045 2048	Carboniferous
"	"	"	Spirifer with Productus	41162	"
				2046	
---	May 17	E. Bank Sutherland River, Liard River	Viviparus	41163	Cretaceous
				2039 2041 2042 2043 2044 2038	
"	"	"	Rock specimen	41164	"
---	May 30	Top Nahanni Butte ls. ridge extending S. Liard River	Stromatoporoid	41165 2049 2050 2051	Beavertail-Ramparts
"	"	"	Prismatophyllum	41166 2052	"
---	May 23	Sta. 6 E. Side Liard River 10 mi. above Ft. Liard, Liard River	Oxytoma	41167 2053 2054 2055	U. Cretaceous
"	"	"	Baculites	41168 2056	"
---	May 26	Outcrop 39, Liard River	Spirifer sp. 1	41169 2057 2059 2066 2071	Carboniferous
"	"	"	Athyris cf. - spiriferoides	41170 2060 2076 2082	"
			Actinoconchus	41171 2061 2073 2081	
"	"	"	Spirifer sp.2	41172 2062 2063 2074 2075 2077	"
"	"	"	Spirifer sp.3	41173 2064 2079	"
"	"	"	Productus	41174 2058	"

Fossil Identification

Suite No.	Date	Location	Fossil	Accession No.	Age
---	---	Outcrop 39. Liard River	Zaphrentis	41175 2065 2067 2070	Carboniferous
"	"	"	Crinoid stems	41176 2068	"
"	"	"	Fenestella	41177 2072	"
"	"	"	Phillipsia	41178 2080 2084	"
"	"	"	Brachythyris	41179 2083	"
---	May 27	ls. bed top of Mtn. Liard River	Lithostrotion	41180 2085	Carboniferous
---	May 27	Bed B. Liard River	Syringopora	41181 2086 2087	Carboniferous
"	"	"	Cladopora ?	41182 2088	"
---	May 27	Bed C. Liard River	Fenestella	41183 2089	?
"	June 4	N.W. Shore Liard rapids from sh. Liard River	Atrypa	41184 2090 2091 2092 2094	Hay River
---	June 4	ls. Liard Rapids. Liard River	Cyrtospirifer (flat Sulcus)	41185 2095 2096 2097 2098	Hay River
---	June 4	ls. Liard Rapids, Liard River	Pteria ?	41186 2099	Hay River
"	"	"	Atrypa	41187 2100	"
"	"	"	Alveolites	41188 2101	"
---	June 4	S. Side River Liard Rapids, Liard River	Streptelasma	41189 2102 2104	Hay River
"	"	"	Fucoid	41190 2103	"
"	"	"	Atrypa	41191 2105	"
---	May 27	150' below top of Mtn. below outcrop 39. Liard River	Proetus	41192 2106	Hay River
---	June 4	Opp. side Liard Rapids. Liard River	Atrypa	41193 2107 2108 2109 2110	Hay River

Fossil Identification

Suite No.	Date	Location	Fossil	Accession No.	Age
---	June 5	Liard Rapids, Liard River	Stropheodonta	41194 2111 2115	Hay River
"	"	"	Atrypa reticularis	41195 2112 2114	"
"	"	"	Pugnoides	41196 2113	"
"	"	"	Actinopteria	41197 2116	"
---	June 5	---- Liard River	Cyathophyllum	41198 2117 2118	Hay River
"	"	"	Camarotoechia	41199 2119	"
"	"	"	Atrypa reticularis	41200 2120 2123 2124	"
"	"	"	Streptelasma	41201 2121 2125 2126	"
"	"	"	Chonetes	41202 2122	"
---	June 5	Bottom ls. bed, Liard River	Atrypa reticularis	41203 2127 2128 2131 2133	Hay River
"	"	"	Streptelasma	41204 2129	"
"	"	"	Cyathophyllum	41205 2130	"
"	"	"	Atrypa	41206 2132	"
---	June 5	Liard Rapids, Liard River	Atrypa reticularis	41207 2134 2135 2137	Hay River
"	"	"	Pugnax	41208 2136	"
"	"	"	Uncites ?	41209 2138	"
---	June 5	Liard Rapids, Liard River	Atrypa reticularis	41210 2139 2141	Hay River
"	"	"	Spirifer sp. 1	41211 2140	"
---	May 26	Outcrop 39, Liard River	Actinoconchus	41212 2142 2143	Carboniferous

Fossil Identification

Suite No.	Date	Location	Fossil	Accession No.	Age
---	May 26	Outcrop 39, Liard River	Zaphrentis	41213 2144 2145 2148	Carboniferous
"	"	"	Spirifer sp. 2	41214 2146	"
"	"	"	Proetus	41215 2147	"
---	May 27	------ Liard River	Diphyphyllum	41216 2149 2150	Carboniferous
---	May 30	Top ls. ridge extending S. Nahanni Butte, Liard River	Cyathophyllum	41217 2151 2152	Beavertail-Ramparts
"	"	"	Cladopora	41218 2153	"
"	"	"	Prismatophyllum	41219 2154	"
---	May 30	Nahanni Butte, Liard River	Prismatophyllum	41220 2155 2156	Beavertail-Ramparts
"	"	"	Cyathophyllum	41221 2157 2159 2160 2161	"
"	"	"	Cystiphyllum	41222 2158	"
---	---	From cliff on N. Ridge of Nahanni Butte, Liard River	Favosites	41223 2162 2163 2165	Ramparts
"	"	"	Cyathophyllum	41224 2164	"
---	June 4	From shale across river -Liard Rapids, Liard River	Atrypa	41225 2166 2167 2168 2169	Hay River
---	June 4	Liard Rapids, Liard River	Goniatite ?	41226 2170	Hay River
---	June 4	Across River - Liard Rapids, Liard River	Atrypa	41227 2172 2173 2176	Hay River
"	"	"	Crinoid stems	41228 2174 2177	"
"	"	"	Phillipsastrea	41229 2175	"
---	May 30	Top ls. ridge extending S.Nahanni Butte,	Prismatophyllum	41230 2178 2179	Beavertail-Ramparts

Fossil Identification

Suite No.	Date	Location	Fossil	Accession No.	Age
---	June 4	Across River Liard Rapids, Liard River	Atrypa	41231 2182 2183 2184	Hay River
"	"	"	Gephyroceras	41232 2181	"
---	June 4	------ Liard River	Tentaculites	41233 2185 2188 2189	----?
---	June 4	------ Liard River	Cyrtospirifer (flat sulcus)	41234 2186 2187	----?
---	June 4	Across River, Liard Rapids, Liard River	Atrypa	41235 2190 2194 2196 2197	Hay River
"	"	"	Gephyroceras	41236 2192	"
"	"	"	Alveolites	41237 2193	"
"	"	"	Zaphrentis	41238 2195	"
"	"	"	Algial concreation	41239 2191 2198	"

70 2T

PLATE II

GEOLOGIC MAP OF NELSON-LIARD RIVER AREA

SCALE 1"=10 MILES

ASSIGNMENT NO. 8

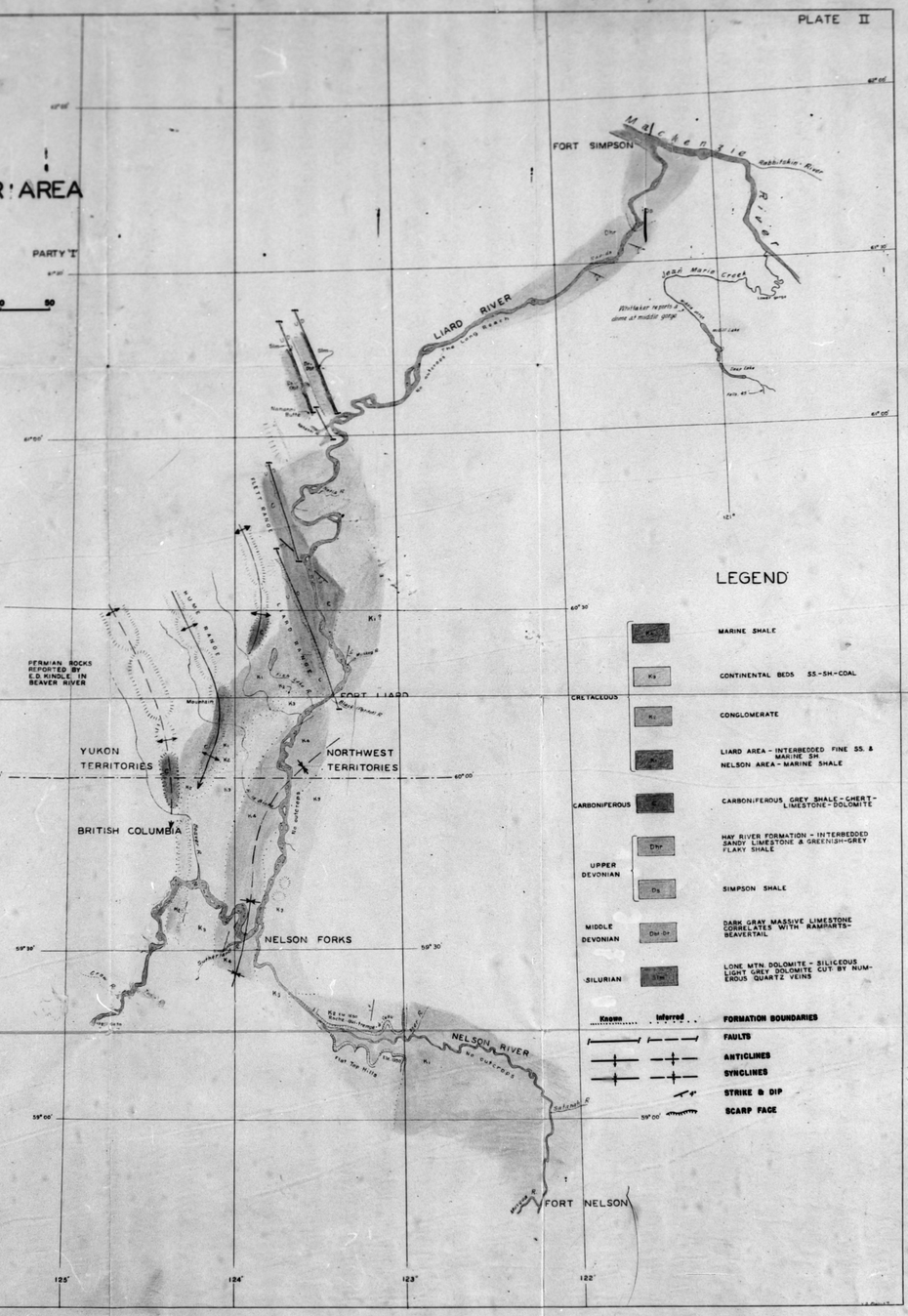
PARTY "I"

GRAPHIC SCALE

10 5 0 10 20 30 40 50

MILES

95-4



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COLUMNAR SECTION

DEVONIAN FORMATIONS AS EXPOSED AT

95-4

NAHANNI BUTTE AND LIARD RAPIDS

SCALE 1" = 100 FEET

ASSIGNMENT Nº 8

PARTY I

Age	Formation	Column	Thickness	Description	Fossils
UPPER DEVONIAN	HAY RIVER FORMATION		300'±	Covered, shale?	
			100'	Grey flaky shale, thin fossiliferous limestone layers	Pteria?, Atrypa, Alveolites, Proetus, Phillipsastrea, Gephyroceras, Zaphrentis.
			200'	Grey, platy, sandy limestone, some interbedded grey shale	Stropheodonta, Atrypa reticularis, Pugnoides, Actinopteria, Pugnax, Uncites, Streptelasma, Manticoceras, Gephyroceras, Camarotoechia, Tentaculites, Cyrtospirifer.
	SIMPSON SHALE		500'+	Grey flaky shale, a few thin limestone layers	Cyathophyllum, Camarotoechia, Atrypa reticularis, Streptelasma, Chonetes.
MIDDLE DEVONIAN	RAMPARTS-BEAVERTAIL		600'	Massive grey crystalline magnesian limestone and dolomite. This rock breaks into small angular pieces. Veins of calcite and quartz occur.	Prismatophyllum, Cladopora, Cyathophyllum. Stromatoporoid, Favosites, Cyathophyllum, Cystiphyllum
Disconformity					
SILURIAN OR DEVONIAN	LONE MOUNTAIN DOLOMITE		500'	Light grey siliceous limestone and dolomite cut by numerous quartz veins and dikes. In places the quartz makes up over 50% of the rock.	

PLATE IV

COLUMNAR SECTION AT FLETT RANGE

SCALE 1" = 100 FEET

ASSIGNMENT Nº 8

PARTY I

Age	Formation	Column	Thickness	Description	Fossils
MISSISSIPPIAN				Eroded	
			95'	Grey quartz sandstone	
			75'	Covered and grey flaky shale	
			170'	Fine grained, non-calcareous, rusty-weathering sandstone consisting mainly of angular grains of quartz.	
			150'	Covered, shale	
			10'	Massive grey crystalline limestone	
			40'	Interbedded, grey platy shale and shaly limestone.	Fenestella
			90'	Grey massive crystalline limestone.	
			30'	Covered interval	
			300'	Grey coarsly crystalline, blocky limestone, nodules of flint, some thin beds of grey flaky shale.	Spirifer, Sp. 1, 2 & 3 Athyris cf. spiriferoides Actinoconchus, Zaphrentis Crinoids, Fenestella Phillipsia, Brachythyris Proetus, Syringopora Lithostrotion
			60'	Bluish-grey flaky shale in thin small flakes.	
			40'	Dark grey blocky limestone.	

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30x

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PLATE V

COLUMNAR SECTION AT HUME MOUNTAIN

SCALE 1" = 100 FEET

ASSIGNMENT Nº 8

PARTY I

Age	Formation	Column	Thickness	Description	Fossils
? PERMIAN ?	Unnamed		200'	Hard siliceous shale	
			40'	Hard dark grey flaky shale	
			100'	Soft calcareous sandstone	Geisonoceras, Corals, Neospirifer
			30'	Hard grey chert	
			215'	Chert, shale and some sandstone	
? MISSISSIPPIAN ?			715'	Grey and dark grey limestone and dolomitic limestone with some interbedded gray shale	
			20'	Blocky granular buff dolomite	Geisonoceras, Productus, Cheeteles, Spirifer, Crinoids, Zaphrentis

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COLUMNAR SECTION

CRETACEOUS ROCKS

NELSON – LIARD RIVER AREA

SCALE 1" = 100 FEET

ASSIGNMENT № 8

PARTY I

Age	Formation	Column	Thickness	Description	Fossils
UPPER CRETACEOUS	K_4		400'	Dark grey shale and silty shale, ironstone concretions, sulphur	Viviparus
	K_3		350'+	Interbedded soft medium grained sandstone, grey silty shale and some coal.	Oxytoma, Baculites
				Covered interval	
	K_2		400'	Conglomerate, some coarse grained salt and pepper sandstone. Pebbles in the conglomerate are well rounded and water worn consisting of quartzite, chert, argillite, quartz and sufficient green shale to impart to the rock a slightly greenish tinge. The maximum size of the pebbles is 3 inches. The sandstone is cross-bedded.	
				Covered interval	
			200'	Massive buff-weathering sandstone.	
			20'	Grey shale	
CRETACEOUS	K_1		340'	Green, buff-weathering, cross-bedded sandstone; some silty shale.	Inoceramus
			100'	Rusty, platy sandstone and sandy shale.	
			50'	Buff platy sandstone.	
			300'	Dark grey shale.	

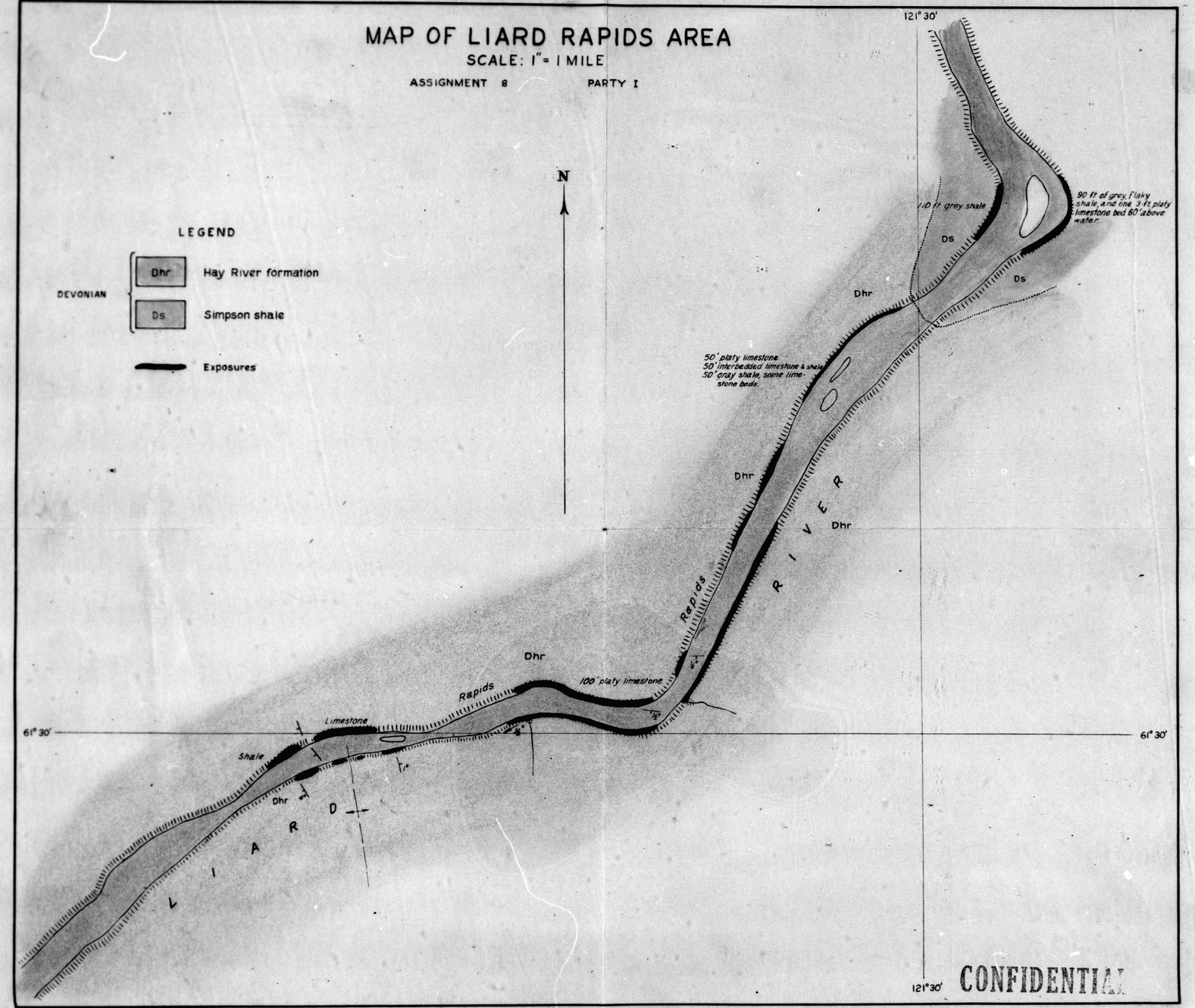
28

PLATE VII

MAP OF LIARD RAPIDS AREA

SCALE: 1" = 1 MILE

ASSIGNMENT 8 PARTY I



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