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Geologic Report

Great Slave-Great Bear Lakes Area

Northwest Territories 85-77

Prepared By

V. Zay Smith Associates Ltd.

Calgary, Alberta, 1966

GEOLOGIC REPORT

ON THE

GREAT SLAVE - GREAT BEAR LAKES AREA

NORTHWEST TERRITORIES

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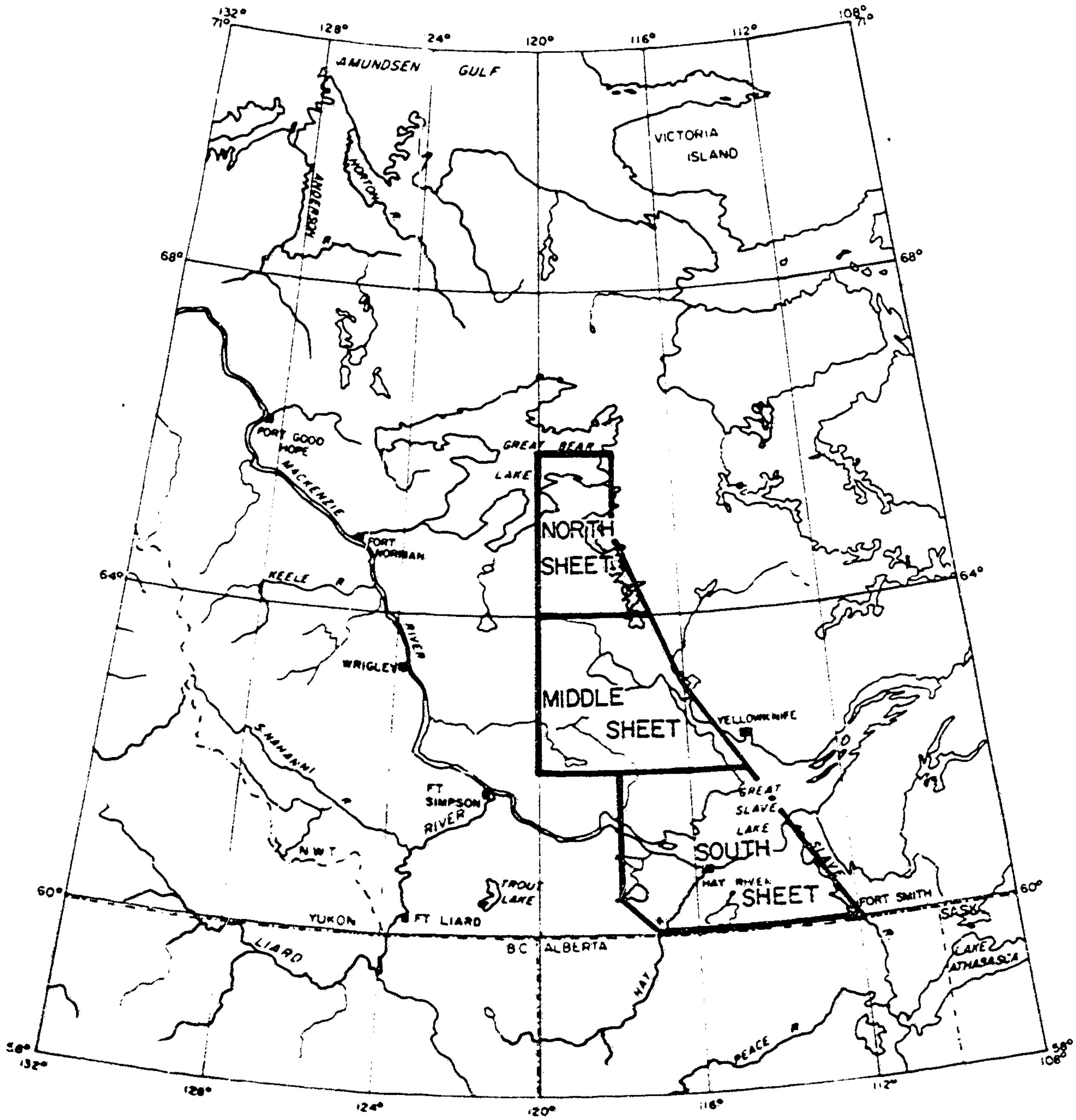

REGIONAL LOCATION MAP

GREAT SLAVE - GREAT BEAR LAKE AREA

NORTHWEST TERRITORIES

V ZAY SMITH ASSOCIATES LTD., 1966

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ON THE

GREAT SLAVE - GREAT BEAR LAKES AREA

NORTHWEST TERRITORIES

INTRODUCTION

The Great Slave - Great Bear Lakes area covers approximately 51,000 square miles in the southern Northwest Territories. Figure 1 shows the regional location of the report area in the eastern part of the Interior Plains. The study was undertaken to gather stratigraphic information for Upper Devonian and older strata which form bedrock in the report area. Some of these units are prospective as oil and gas reservoirs in the subsurface. The stratigraphic information obtained is presented by three types of illustrations as follows:

1. Areal Geology and Structural Interpretation Maps

As illustrated on Figure 1, the areal geology maps are presented in three sheets. They have been prepared at the scale of 1 inch to 4 miles using topographic base maps obtained from the Dominion government. The maps were prepared using geologic information from the following sources:

a. stereoscopic examination of air photographs, b. study of air photomosaics and topographic maps, c. field geology by V. Zay Smith Associates Ltd. in the summer of 1966, d. subsurface well control and e. pertinent published and open file reports.

2. Composite Outcrop Sections

Stratigraphic information obtained during outcrop examination in in the summer of 1966 is presented in 10 composite sections. The locations of outcrops examined are shown on the areal geology maps, Figures 5, 6, and 7. The composite sections were prepared at the vertical scale of 1 inch to 25 feet. They provide basic stratigraphic data and were assembled with a minimum of interpretation.

Rock samples and lithologic descriptions were obtained at many outcrops during the course of the field work. The localities visited together with the numbers assigned to the samples are indicated on the accompanying areal geology maps (Figures 5, 6, and 7). The samples are stored in Calgary and are available for examination.

3. Stratigraphic Cross Sections

The interpreted relationships of stratigraphic units in the report area are presented in a series of generalized stratigraphic cross sections (Figure 8). Section A-J trends north-south from Leith Peninsula on the shore of Great Bear Lake, south to the Cameron Hills west of Hay River. The remaining sections extend generally east from the northerly trending section to basement rocks on the Precambrian Shield. The sections are presented at a horizontal scale of 1 inch to 8 miles and a vertical scale of 1 inch to 1,000 feet. They provide the known and interpreted correlation, facies, lithology, thickness and distribution of stratigraphic units in the report area.

FIELD WORK

Geologic field investigations were conducted in the Great Slave - Great Bear Lakes area during the summer season of 1966. The field party was supported by helicopter and fixed-wing aircraft and operated from base camps along the Mackenzie and Great Slave highways and also at Sawmill Bay on the southern shore of Great Bear Lake.

The V. Zay Smith Associates geological field effort consisted of a four-man geologic party and supporting personnel. J.F. Conrad served as party chief.

Transportation was provided by a Bell model G-2 helicopter chartered from Associated Helicopters Ltd., Edmonton.

Fixed-wing support was provided by Northward Aviation Ltd. of Yellowknife who employed a Cessna 180 and a de Havilland Otter aircraft equipped with floats.

Field investigations were conducted from four base camps in the Great Slave - Great Bear Lakes area. The base camps were located as follows:

1. Approximately 1 mile south of the airstrip at Pine Point,
2. Mile 76 on the Great Slave highway between Fort Providence and Rae,
3. On the east side of Frank Channel at the north tip of Great Slave Lake,
4. Sawmill Bay on the south shore of Great Bear Lake.

Transportation along the Mackenzie and Great Slave Highways was provided by a one-half ton truck and a four-wheel drive Jeep Station Wagon.

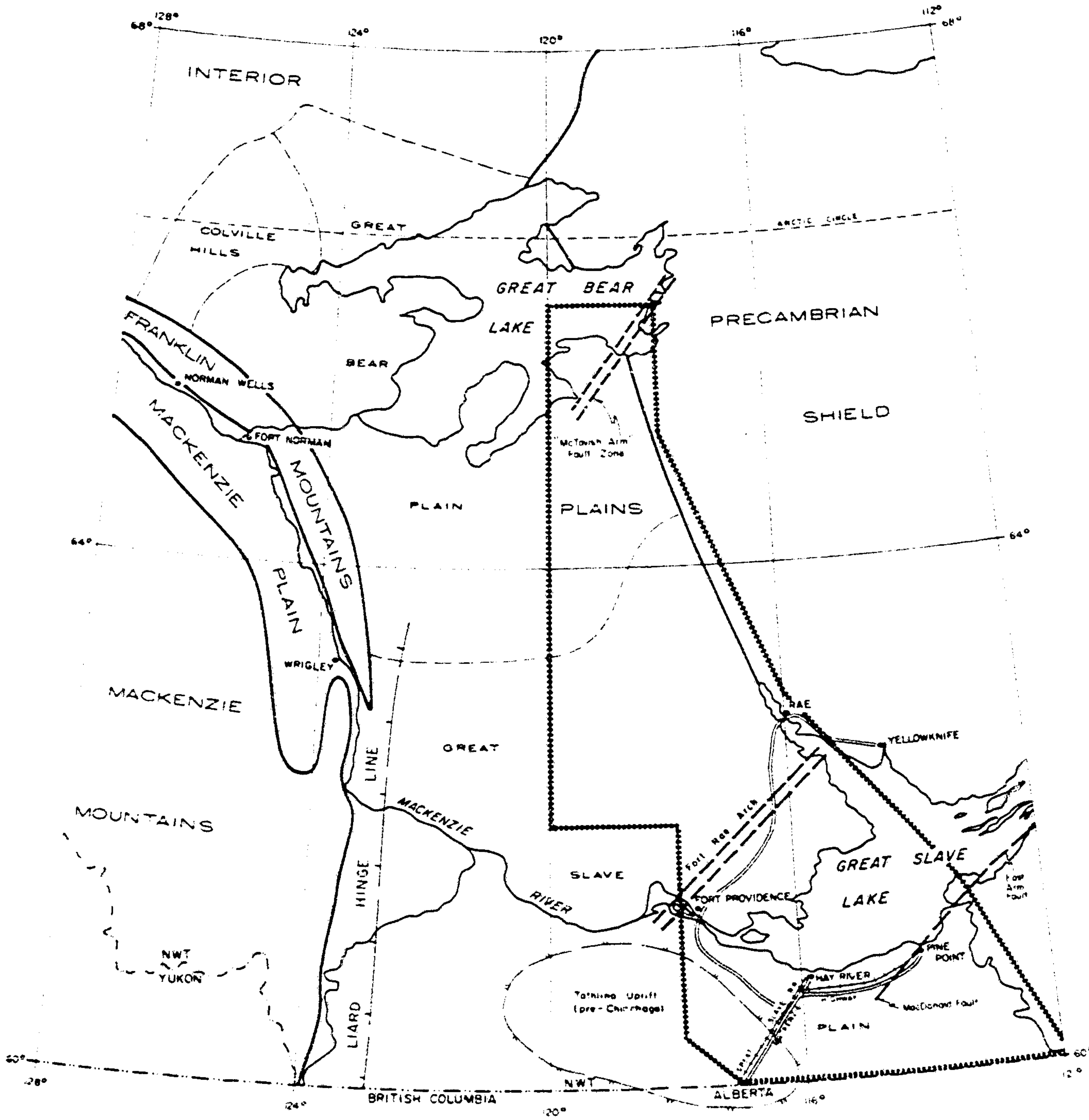
ACCESSIBILITY

The main settlements in the Great Slave Lake area are Hay River, Fort Providence, Rae, Yellowknife, Fort Resolution and the mining community at Pine Point. Fort Smith lies in the south-east corner of the map area. In the Great Bear Lake region the main settlements are Sawmill Bay and also Port Radium, which lies just off the northeast corner of the map area.

A major part of the map area is accessible only by air. Parts of the project can be reached conveniently along all-weather gravel roads. Some areas, including Great Slave Lake, Great Bear Lake and the Mackenzie River are accessible by boat. Rail service is provided for the town of Hay River and the Pine Point mining center.

file

FIGURE 2



PHYSIOGRAPHIC AND STRUCTURAL FEATURES

Scale 1 inch to 47 miles

Great Slave - Great Bear Lakes Area

To accompany geologic report on the Great Slave - Great Bear Lakes Area, 1966

V. Zay Smith Associates Ltd

The map area is accessible by an all-weather gravel road, the Mackenzie Highway, which connects the Peace River area of northern Alberta with the town of Hay River on the south shore of Great Slave Lake. Similar roads lead to the community of Pine Point and also westward from Enterprise around the western side of Great Slave Lake (Great Slave Highway) to Rae and Yellowknife. An all-weather road leading from Hay River to Fort Smith in the southeast corner of the map area is presently under construction.

Scheduled commercial airline service is available from Edmonton to Hay River, Fort Smith and Yellowknife. The Department of Transport maintains airfields at Fort Providence and Fort Resolution, and an airstrip is maintained at Pine Point by Pine Point Mines Ltd. At Sawmill Bay on the south shore of Great Bear Lake, an airstrip large enough for DC-4 aircraft is maintained by the Great Bear Lodge.

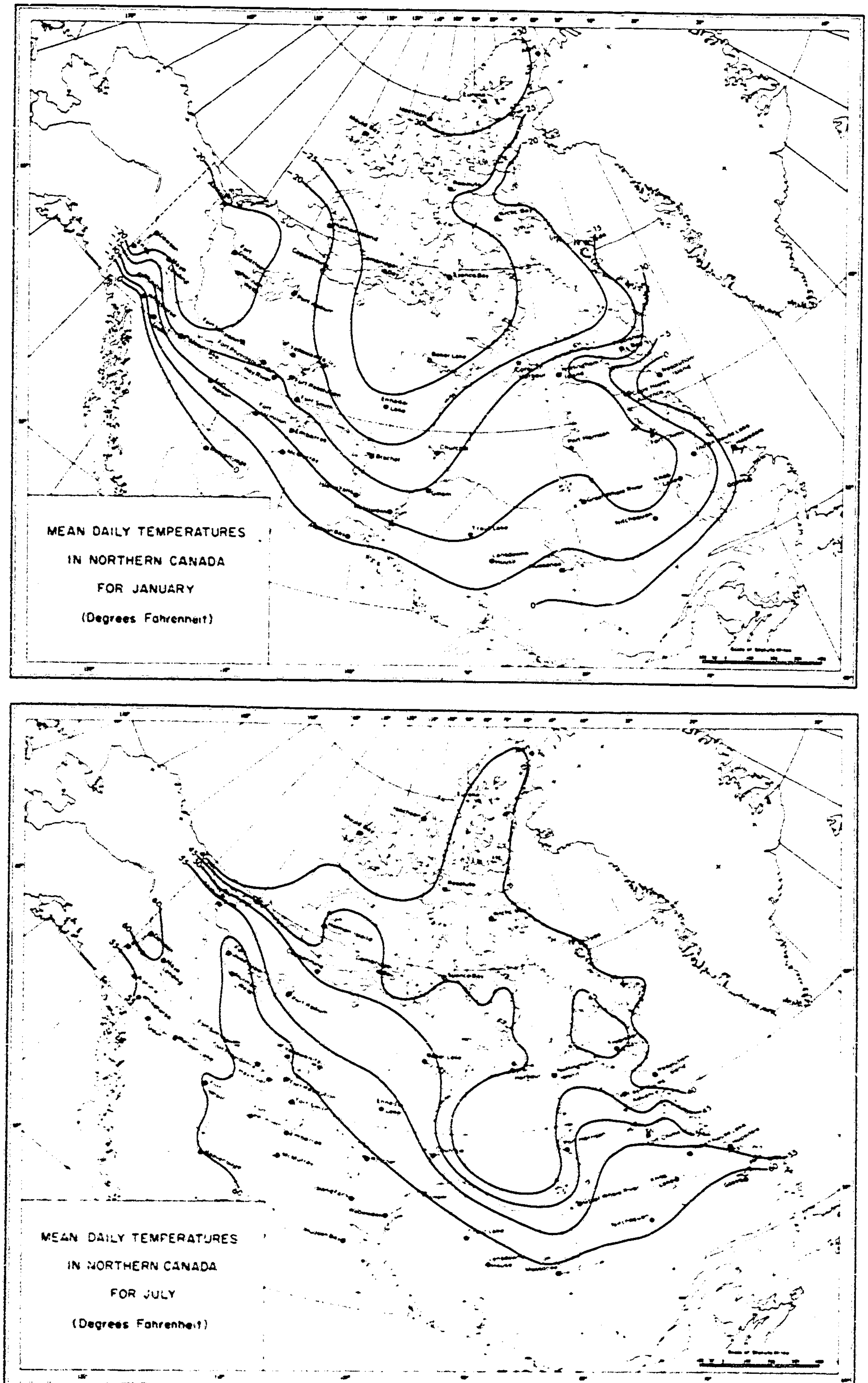
PHYSIOGRAPHY

The Great Slave - Great Bear Lakes area includes parts of two major physiographic subdivisions: the Precambrian Shield and the Interior Plains. The physiographic features of the map area are illustrated by Figure 2.

The Interior Plains occupy a vast area of low relief between the Precambrian Shield on the east and the Canadian Cordillera on the west. Much of the map area lies in the Interior Plains. The Precambrian Shield being located along the eastern boundary. The Interior Plains stand at elevations ranging from 513 feet on the shores of Great Slave and Great Bear Lakes to 2,700 feet at the crest of the Cameron Hills in the southwestern corner of the map area. The topography is gently undulating and over much of the report area stands at elevations between 700 and 1,000 feet. Plateaus formed of flat-lying Cretaceous strata occur along the western boundary of the map area and typically arise abruptly about 1,000 feet above the surrounding terrain.

Much of the map-area is drained by rivers and streams which flow either into Great Slave or Great Bear Lakes. These lakes are drained in turn by the Mackenzie and Great Bear Rivers respectively. Numerous lakes, both large and small, and muskeg are plentiful, especially where evaporites of the Chinchaga and Nyarling Formations form bedrock.

FIGURE 4 file



MEAN DAILY TEMPERATURES IN NORTHERN CANADA FOR JANUARY (Degrees Fahrenheit)

MEAN DAILY TEMPERATURES IN NORTHERN CANADA FOR JULY (Degrees Fahrenheit)

Reproduced from Thompson, 1965

The Interior Plains have been subjected to multiple continental glaciation. At most places bedrock is mantled by a variable thickness of glacial drift. Great Slave Lake is a remnant of a glacial lake which was much more extensive. At one time the shores lapped against the Cameron Hills and the Horn Plateau. Thus, the lakeshore was probably 400 to 500 feet higher than at present. Great Bear Lake is also believed to be the remnant of a much larger glacial lake.

The landscape of the Interior Plains consists of a stream-dissected plains region that had reached the late mature stage in the erosional cycle prior to the Pleistocene. Subsequently, it was subjected to multiple continental glaciation and in places reverted to the initial stage.

The physiography of the Canadian Shield within the map area is comparable in many respects with that of the Interior Plains. However, the land surface of the shield typically has more local relief due to the erosional characteristics of the crystalline basement rocks. The land surface of the western edge of the shield within the map area stands at elevations on the order of 600 to 700 feet. Color Plate No. 34 illustrates terrain typcial of the Precambrian Shield in the Yellowknife area.

Locally the shield is marked by northeasterly trending topographic highs formed by resistant crystalline rocks associated with faulting and/or intrusive activity. Locally these features rise 400 to 500 feet above the surrounding land surface. The "McTavish Arm" fault zone on the southern shore of Great Bear Lake, is marked by a northeasterly trending series of topographic highs which locally rise 1,000 feet above the surrounding terrain.

BREAK-UP and FREEZE-UP

Climatic extremes of the Great Slave - Great Bear Lakes area are illustrated by Figure 4. This illustration shows the mean daily temperatures in northern Canada for the months of January and July, normally the coldest and warmest months of the year respectively.

Surface waters including Great Slave Lake, Great Bear Lake and the Mackenzie River are frozen over each winter. Break-up and freeze-up dates are provided by Allen (1964). Freeze-up of Great Slave Lake normally begins in early October and is completed by middle December. In the spring the break-up of Great Slave Lake ice typically occurs in the second week of June.

Break-up for the Mackenzie River at Fort Providence begins about May 10th and is normally complete by June 12th. Freeze-up normally occurs from about the middle of October to sometime in December. However, freeze-up is unpredictable for the Mackenzie River. At Fort Providence it has occurred as early as November 29th, and as late as January 31st.

Great Bear Lake typically freezes over in the period from late October to mid-November. Break-up occurs in the period from the middle of June to the middle of July. However, recorded break-up dates for Great Bear Lake at Port Radium are as late as July 25th.

STRATIGRAPHY

PRECAMBRIAN

Precambrian igneous rocks crop out along much of the eastern margin of the map area where they form the western portion of the Canadian Shield. Both igneous and metamorphic rocks are present.

Well indurated Precambrian sediments form bedrock over much of the Leith Peninsula on the south shore of Great Bear Lake. Much of the succession is made up of vari-colored, partly cross-bedded quartzites although minor amounts of aphanitic, dense dolomites are present. The beds have been intruded by diabase sills. The quartzites are buff, pink and purple and are made up of well-rounded, well-sorted quartz grains up to 3 millimeters in diameter. Green lichen are typically abundant on the weathered surface.

A thickness of more than 1,500 feet of mainly quartzite beds was measured southwest of Yeta Lake (see composite section L). The upper and lower boundaries of the quartzite succession were not observed in the field. It is believed that the beds unconformably overlie crystalline basement rocks and are in turn unconformably (?) overlain by Cambrian or Upper Ordovician rocks. The interpreted relationships with adjacent strata are illustrated by stratigraphic cross sections A-J and B-K (Figure 8).

The distribution of the Precambrian quartzite succession is limited to that area northwest of the "McTavish Arm" fault zone. Southeast of that structural feature Ordovician sediments overlie Precambrian igneous rocks characterized mainly by granite.

The Precambrian quartzite beds of Leith Peninsula are not known to have been referred to in published literature. On the basis of lithologic similarities they may correlate with either the Coppermine River Group or the Hornby Bay Group both of which form bedrock along the western margin of the Canadian Shield north of Great Bear Lake. These units are mapped by the Geological Survey of Canada (Map 30-1963). In that area the Coppermine and Hornby Groups are in part characterized by quartzite, dolomite and igneous rocks. The Geological Survey of Canada assigns a Middle Proterozoic age to both the Coppermine River and Hornby Bay Groups.

CAMBRIAN

Rocks of probable Cambrian age form bedrock on the Leith Peninsula on the south shore of Great Bear Lake. They are characterized by quartzites and are believed to unconformably overlie similar strata of late Precambrian age. The age designation is based upon lithologic similarity between the Leith Peninsula succession and beds of late Paleozoic and Cambrian age exposed in the Hornaday River area north of Great Bear Lake on the Arctic Coast (Dr. H.S. Scherp, personal communication).

The dominant lithology of the Cambrian (?) succession is quartzite. A thickness of approximately 400 feet of beds is indicated on the Leith Peninsula (see stratigraphic cross section A-J, Figure 8). At sample stations 156C and 157C, about 11 miles west of Yeta Lake, the section consists of pale-buff quartzite made up of well-rounded, well-sorted quartz grains between 2 and 3 millimeters in diameter. The beds weather pale pinkish-buff with abundant green lichen. Beds of Cambrian or probable Cambrian age are not known to crop out elsewhere in the map area and are presumed absent in the subsurface.

ORDOVICIAN or OLDER

OLD FORT ISLAND FORMATION

The Old Fort Island Formation consists mainly of white and light buff, friable, porous, quartzose sandstone. It unconformably overlies Precambrian basement rocks along the eastern edge of the Interior Plains. It is conformably (?) overlain by the La Martre Falls Formation of Middle Ordovician age.

At the type section on Old Fort Island in the North Arm of Great Slave Lake (Norris, 1965), the formation consists of orange-brown, buff, quartzose sandstones with excellent porosity and permeability and some thin beds of greenish grey and red siltstone and shale. The basal sandstones of the formation are cross-bedded (see Color Plate 35).

The Old Fort Island Formation is regarded as the basal sandstone unit of the Ordovician System. It is believed that the beds were deposited as beach sands on the eroded Precambrian surface. Thus the Old Fort Island beds are believed to be restricted to that portion of the map area where overlying Ordovician strata have protected them from subsequent erosion. The interpreted southern limit of Ordovician rocks is indicated on the central areal geology map sheet (Figure 6) north of the Horn Plateau in the general area of latitude 62° 30' N.

Exposures of the Old Fort Island Formation are shown on the areal geology maps accompanying this report (Figures 5, 6 and 7) in the North Arm of Great Slave Lake at White Beach Point, and at Old Fort Island. They also occur on the southwestern shore of Marian Lake near the settlement of Rae. To the north the Old Fort Island sandstones crop out a few miles north of Marian Lake, on the south shore of Shoti Lake and also further to the north in the Hardisty Lake area.

The distribution and thickness of the Old Fort Island Formation is controlled in large part by topography of the eroded Precambrian surface. The formation ranges in thickness from the depositional edge to approximately 75 feet near the settlement of Rae (see composite section R). It is probably thicker in places in the subsurface and is absent over the Fort Rae arch, a broad southwesterly trending positive feature which extends from near Rae Point to the southwest and was active in early Paleozoic time (see Figure 2). The Old Fort Island sandstones are absent in the Imperial Windflower well north of the Horn Plateau but are present to the northwest in the Imperial Lac Tache and Cartridge wells, where the formation is 80 and 25 feet thick respectively.

South of the Horn Plateau the basal sandstones which overlie basement rock are believed to be Middle Devonian in age and are assigned to the Mirage Point Formation (discussed elsewhere in this report). These beds may include reworked sandstones of the Old Fort Island Formation.

As illustrated on the stratigraphic correlation chart (Figure 3) the Old Fort Island Formation may correlate with basal units of the Franklin Mountain Formation in the Norman Wells and Blackwater Lake areas to the northwest.

The age of the Old Fort Island Formation is not known as it is generally unfossiliferous. An indeterminate organic (?) fragment was collected from the formation at locality 32W in a gravel pit on the south side of Great Slave highway at Mile 143.9. The fragment can only be identified as a possible brachiopod. The formation is overlain by the La Martre Falls Formation which contains Middle Ordovician fossils in its upper part. Thus the Old Fort Island Formation can be dated only as Middle Ordovician or older. As the formation is believed to be a basal sandstone marking the advance of Ordovician seas, it is considered to be Ordovician in this report.

ORDOVICIAN

The Ordovician System in the Great Slave - Great Bear Lakes area includes the Chedabucto Lake and La Martre Falls Formations and probably the Old Fort Island Formation. These beds unconformably overlie the Precambrian basement and are in turn unconformably overlain by red beds and evaporites believed to be equivalent to the Elk Point Group of northern Alberta. The southern limit of Ordovician rocks in the map area is interpreted as a subcrop below Middle Devonian (?) red beds of the Mirage Point Formation.

Although an Ordovician age is suggested for the unfossliferous Mirage Point Formation by Norris (1965), Belyea and Norris (1962) and also earlier workers, an alternate interpretation is shown on the illustrations accompanying this report (cross sections A-J and G-M, Figure 8). South and east of the Horn Plateau an unfossiliferous succession of red beds overlie basement and underlie the Chinchaga Formation and thus occupy the stratigraphic position of known Ordovician rocks to the north. The red beds are termed the Mirage Point Formation and also occupy a stratigraphic position similar to the lower Elk Point units of northern Alberta. The Mirage Point Formation is lithologically more similar to Elk Point beds than to the Ordovician succession. Accordingly they are interpretated as basal units of the Middle Devonian System (see discussion of Mirage Point Formation).

Based on work compiled after that of Norris and published in 1963, Douglas et al have indicated the southern limit of Silurian and Ordovician rocks within the present map area to be similar to that shown on Figure 6 along the north flank of the Horn Plateau. Thus, Ordovician rocks are presumed absent to the south.

LA MARTRE FALLS FORMATION

The name La Martre Falls Formation was proposed by Norris (1965) for a highly variable sequence of red beds comprising shale, mudstone, sandy and argillaceous dolomite with minor evaporites. It overlies the Old Fort Island Formation and is overlain by Chedabucto Lake dolomites. Over parts of the map area the Old Fort Island Formation is believed to be absent and La Martre Falls beds rest on the basement. In the area between Hislop and Faber Lakes a conspicuous scarp-forming dolomitic member, named the Mazenod by Norris, is developed in the lower part of the formation.

In the area west of the North Arm of Great Slave Lake, the La Martre Falls Formation is made up mainly of soft green shales. Northwest along the outcrop belt the formation contains an increasing amount of dolomite and siltstone at the outcrop (see composite outcrop sections W, R, M, C and H). The formation was penetrated in the Imperial Windflower, Imperial Cartridge and Imperial Lac Tache wells west of Lac La Martre. There the beds are characterized by arenaceous dolomites and to a lesser extent by shale and anhydrite.

The type section of the La Martre Falls Formation extends along a one and one-half mile stretch of Rivère La Martre immediately below La Martre Falls (see Color Plates 38 and 39). There the formation consists mainly of green and dusky red, soft, fissile shales interbedded with fine-grained, ripple-marked, dolomitic, red and green sandstones and maroon weathering siltstones. The succession becomes increasingly argillaceous toward the base and contains indications of a shallow water depositional environment including abundant worm burrowings, salt casts, ripple marks and mud cracks (see composite outcrop section M).

The La Martre Falls Formation forms bedrock in a northwesterly trending band extending from the west side of the North Arm of Great Slave Lake northwestward to beyond Hottah Lake. South of the Hislop Lake area at latitude 63° 30' N, the formation is recessive. To the northwest it becomes increasingly resistant and, as in the area south of Hottah Lake, the upper beds form a high, broad, east-facing escarpment. The escarpment rises some 700 feet above the Precambrian land surface to the east.

The depositional thickness of the formation ranges from about 90 feet in the Whitebeach Point area in the North Arm of Great Slave Lake to approximately 800 feet in the area southwest of Hottah Lake. It thins to about 50 feet at Old Fort Rae on the Fort Rae arch. In the subsurface west and south of Lac La Martre the formation ranges in thickness from 115 feet in the Imperial Lac Tache test to 445 feet in the Imperial Windflower well. The southern limit of the La Martre Falls Formation in the map area is believed to be a subcrop below Middle Devonian rocks (see stratigraphic cross sections A-J and G-M, Figure 8).

The "McTavish Arm" fault zone marks the northern limit of La Martre Falls beds in the map area. As illustrated on stratigraphic cross-sections A-J and B-K, the La Martre Falls Formation is absent northwest of this structural zone due to nondeposition and/or pre-Chedabucto Lake erosion. Absence due to nondeposition is regarded as the most probable explanation. This is suggested by the present relatively high topography of the "McTavish Arm" fault zone and the Leith Peninsula to the northwest. These rocks are more resistant than the adjacent basement rocks to the east and presumably were topographically high before being covered by Ordovician deposition. Thus, Ordovician rocks may not have covered this topographic feature until Chedabucto Lake time.

The La Martre Falls Formation contains Middle Ordovician fossils at the type section below La Martre Falls. Fossils collected include Sowerbyella, Hyolithes, Concularia, Desmograptus, Diplograptus, Ischadites, and also unidentified bryozoa, crinoids, arthopods and worm burrowings (composite outcrop section M and Norris, 1965). To the north in the area west of Faber and Hottah Lakes the La Martre Falls Formation locally contains abundant algal masses (see Color Plate 50 and composite outcrop section H).

On the basis of similar lithology and stratigraphy position and to a lesser extent on fossil evidence, the La Martre Falls Formation can be correlated with the Franklin Mountain Formation to the west. Both of these units are characterized by an upper dolomite succession and an underlying green and red shale unit. The Franklin Mountain and La Martre Falls Formations contain algal structures and worm burrowings (Dr. H.S. Scherp, personal communication) and are apparently conformably overlain by beds containing Upper Ordovician fossils (Douglas and Norris, 1963; Norris, 1965). The accompanying stratigraphic correlation chart, Figure 3, illustrates the interpreted correlation with Ordovician beds of the Franklin Mountains.

Mazenod Member

In the Hislop-Faber Lakes area the lower unit of the La Martre Falls Formation consists of resistant, scarp-forming dolomites and oolitic dolomites. Norris (1965) has proposed the name Mazenod Member after Mazenod Lake near the type section. Locally the member overlies ridges and knolls of Precambrian rocks. The Mazenod Member is discontinuously exposed and forms a distinctive scarp at the outcrop (see Color Plate 36). The member consists of grey, bedded dolomite and also distinctive orange-brown weathering, sandy, calcareous, oolitic, cross-bedded dolomite with interbeds of quartzose sandstone showing ripple structures and fucoidal markings. Norris reports that where the Mazenod Member overlies ridges and knolls of the Precambrian, the basal beds consist of a boulder conglomerate made up of angular fragments of igneous rocks.

At the type section southwest of Mazenod Lake, 75 feet of light-brown, medium and coarse-grained, oolitic, partly sandy and cross-bedded dolomites are exposed. (see composite outcrop section M and Color Plate 37). A similar thickness is anticipated at the outcrop elsewhere in the map area. The subsurface distribution of the Mazenod Member is generally unknown. It has not been recognized in wells drilled down-dip to the west but may correlate with dolomitic units in the lower part of the La Martre Falls Formation of that area.

With the exception of fucoidal markings reported by Norris (1965) the Mazenod Member is not known to be fossiliferous. In this report and on the accompanying illustrations it has been assigned to the Ordovician System.

CHEDABUCTO LAKE FORMATION

Overlying the La Martre Falls Formation with apparent conformable contact is a succession of thick-bedded and massive, highly-resistant, scarp forming, aphanitic, light and medium grey, fossiliferous, partly porous dolomites. The name Chedabucto Lake Formation was proposed by Norris (1965) for the beds which are unconformably overlain by the Middle Devonian Chinchaga Formation. Locally, as in the area south of Marian Lake and southwest of Leith Peninsula, the formation rests on or abuts against the eroded Precambrian surface (see cross sections G-M and A-J). The type section is in the vicinity of Chedabucto Lake, west of the North Arm of Great Slave Lake (see composite outcrop section W).

The lithology of the Chedabucto Lake Formation in the subsurface south and west of Lac La Martre is characterized by partly porous, light and medium-brown, generally aphanitic, dolomite and to a lesser extent by light-grey and white gypsum and anhydrite. The upper 110 feet of beds assigned to the formation contain fair vuggy porosity in the Imperial Windflower G-77 well, southwest of Lac La Martre.

At outcrops examined during the field season, the Chedabucto Lake Formation is characterized by resistant, partly porous, aphanitic, brownish-grey, fossiliferous dolomite which typically weathers orange-brown and blocky with orange lichen. Numerous indeterminate fossil fragments are characteristically expressed on the weathered surface of the beds. On the fresh surface only larger specimens can be recognized. Thus the aphanitic dolomites of the Chedabucto Lake Formation are believed to be recrystallized from biogenic and partly bioclastic carbonate rocks, probably limestones. In some beds organic material appears to have made up to as much as 60% of the rock.

A brecciated facies occurs in the lower beds of the Chedabucto Lake Formation in the Great Bear Lake area southwest of Leith Peninsula (see composite outcrop section L). Seventy feet of section examined in that area are made up mainly of pale brownish-grey, dolomite breccia. The breccia fragments are up to 3 inches in diameter and make up approximately 80% of the rock. They are expressed only on the weathered surface. The breccia is of angular to sub-rounded fragments of grey brown, aphanitic dolomite in a matrix of silty, grey, aphanitic dolomite. The beds weather orange-brown and contain poor vuggy porosity in the upper 40 feet.

The Chedabucto Lake Formation thickens to the northwest from about 90 feet at Whitebeach Point in the North Arm of Great Slave Lake to about 280 feet in the area immediately west of Faber and Hottah Lakes, and to 485 feet in the Imperial Lac Tache dryhole west of Cartridge Mountain. The formation is thinner at Old Fort Rae where an approximate total thickness of 50 feet of beds was measured by Norris (1965). Thus, the Fort Rae arch is indicated to have been slightly positive before and/or during Chedabucto Lake time.

The Chedabucto Lake Formation is present over much of the project north of the Horn Plateau. The interpreted southern limit of the beds is indicated on Figure 6 and is believed to be a subcrop below rocks equivalent to the Elk Point Group of northern Alberta (see stratigraphic cross sections A-J and G-M). Deposition of the Chedabucto Lake Formation was locally restricted by Precambrian knobs and ridges which were positive through all or part of Chedabucto Lake time. Several such basement features are illustrated on cross section G-M in the Horn Plateau - Rae area and by cross section B-K in the Hottah Lake area. West of Hottah Lake, and on the northwest flank of the "McTavish Arm" fault zone, the Chedabucto Lake Formation rests upon the eroded Precambrian surface. The La Martre Falls Formation is absent due to nondeposition and/or pre-Chedabucto Lake erosion. Nondeposition is considered to be the more likely explanation.

Dolomites of the Chedabucto Lake Formation are the most resistant Paleozoic rocks in the Great Slave Lake area. The northeastern edge of the outcrop belt is marked by a conspicuous, northeast-facing escarpment which extends from the North Arm of Great Slave Lake northwest beyond Lac La Martre. The height of the scarp is typically about 100 feet above the surrounding terrain. (Color Plate 40).

The Chedabucto Lake Formation is generally fossiliferous and locally highly fossiliferous. An Upper Ordovician (Richmond) age for the formation is indicated by the presence of Paleofavosites (Nelson, 1965, pp. 10 and 70), Catenipora (Nelson, 1965, pp. 10 and 68) and Streptelasma (Norris, 1965, p. 26). Other fossils collected from the formation and identified mainly by H.S. Scherp are as follows: ?Paleophyllum, Bighornia, Rhynchotrema, Dawsonoceras, Synaptophyllum, "cabbage-head" stromatoporoids, crinoids, gastropods, indeterminate solitary and colonial corals, brachiopods and numerous organic fragments.

As illustrated by Figure 3, the Chedabucto Lake Formation is believed to correlate with the Mount Kindle Formation of the Franklin Mountains area. This suggested correlation is based primarily on fossil content and to a lesser extent on lithologic similarities and stratigraphic position. Both formations locally consist of biogenic dolomites containing ?Rhynchotrema, Catenipora, and Dawsonoceras (H.S. Scherp, personal communication).

MIDDLE DEVONIAN

SUMMARY

Red beds and evaporites, regarded as correlatives of the Middle Devonian Elk Point Group of northern Alberta, form the base of the Devonian succession of the Great Slave - Great Bear Lakes area. The red beds are termed the Mirage Point Formation in this report and are believed restricted to the area generally southeast of the Horn Plateau. The overlying Chinchaga Formation, which consists mainly of evaporites, is the most widespread unit of the map area, and can be dated at least in part as possible early Middle Devonian (Eifelian) age.

The Chinchaga Formation is overlain conformably by the Little Buffalo Formation south of the Pine Point mining area, by various members of the Pine Point Formation beneath the Great Slave Lake area, and by the Lonely Bay Formation to the north. The Little Buffalo and Lonely Bay Formations consist mainly of carbonate rocks and occupy roughly the same stratigraphic position as the Keg River Formation in the subsurface of northwestern Alberta.

The Pine Point Formation has been separated into several members on the basis of lithology. The lowermost beds of the formation correlate with the Little Buffalo and Lonely Bay Formations. An interpretation of the facies relationships and correlation of the various members of the Pine Point Formation is shown on the south areal geology map sheet (Figure 7). The formation consists mainly of dolomite, limestone and to a lesser extent of calcareous and bituminous shales.

MIDDLE DEVONIAN CARBONATE BANK

The upper two-thirds of the Pine Point Formation together with carbonates of the overlying Presqu'ile, Sulphur Point and Slave Point Formations form a northeasterly trending carbonate bank separating evaporites of the Elk Point Group (Nyarling Formation) to the southeast from dark marine shales of the Horn River Formation to the northwest. This carbonate build-up can be referred to as the Middle Devonian carbonate bank. It is bounded to the northwest by a line extending from north of Kakisa Lake generally northeast to beyond Dieppe Lake. The southeast boundary is less well defined but extends from the headwaters of Hanbury Creek, a few miles southeast of the Pine Point airstrip, generally southwest to Buffalo Lake and beyond. The limits of the Middle Devonian carbonate bank are locally indicated on Figures 7 and 8.

Grayston et al (1964) apply the term "Presqu'ile Barrier Reef" to this build-up. The dolomites of the Presqu'ile Formation are regarded as recrystallized reefal beds and are equivalent to the Sulphur Point Formation which is characterized by fossiliferous limestones.

The Nyarling Formation forms the upper evaporitic unit of the Elk Point Group and is made up primarily of gypsum at the outcrop. It is present southeast of the Pine Point mining area where an abrupt facies change takes place and carbonates of the Sulphur Point, Presqu'ile and upper part of the Pine Point Formations are replaced by evaporites. Northwest of Great Slave Lake, carbonate rocks of the upper part of the Pine Point Formation, the Presqu'ile and Sulphur Point Formations and possibly the Slave Point Formation change facies abruptly to dark marine shales. These beds form the shale facies northwest of the Middle Devonian carbonate bank. They are termed the Horn River Formation and occur above Lonely Bay carbonates and below Upper Devonian shales of the Hay River Formation. This abrupt facies change marks the approximate northwestern limit of the Middle Devonian carbonate bank and is indicated on the southern areal geology map sheet (Figure 7). The northwest limit of the Slave Point Formation may be, in part, a subcrop below Hay River beds as inferred on cross section A-J (Fig.8).

Build-ups (bioherms ?) of carbonate rock occur locally northwest of the carbonate bank. The Horn Plateau Formation, a bioherm exposed immediately east of the Horn Plateau, and the reefal beds which crop out at the Falaise Lake topographic anomaly are examples (see Plates 1,2,20-23). Stratigraphic cross-sections A-J and H-P show several additional carbonate build-ups interpreted to underlie other geomorphic anomalies northwest of the carbonate bank.

The Watt Mountain Formation, lying below the Slave Point Formation in northern Alberta, is not recognized at the outcrop in the Great Slave Lake region. It is present in the subsurface in the Deep Bay area and to the southwest. There it lies between the Sulphur Point Formation below and Slave Point Formation above. The Watt Mountain Formation consists of green waxy shale interbedded with greenish-grey and brown limestone. It appears to have a discontinuous distribution and a maximum thickness of about 25 feet.

Stromatoporoidal limestone of the Slave Point Formation overlies the Presqu'ile, Sulphur Point and Nyarling Formations and forms the upper rock unit of the Middle Devonian Series in the Great Slave Lake area and to the south. The upper surface of the Middle Devonian Series is overlain unconformably (?) by shales of either the Hay River or Fort Simpson Formations.

Stratigraphic nomenclature for Middle Devonian rocks of the Great Slave Lake area has a long and complex history, partly because these strata form bedrock over most of the map area and partly due to the many abrupt facies changes and shifting depositional environments which characterize Middle Devonian rocks. The terminology and relationships of the many rock units within the area are illustrated by the accompanying stratigraphic correlation chart (Figure 3) and generally correspond to the work of Norris (1965). In that comprehensive study of Middle Devonian and older Paleozoic rocks, formation names are applied to units of predominantly one lithology or a combination of lithologies. Thus each major facies of the Middle Devonian Series has formational rank. These units are discussed in the following paragraphs.

MIRAGE POINT FORMATION

A succession of red beds is present above the crystalline basement and below the Chinchaga Formation in the Horn Plateau area and to the southeast. The beds are characterized by anhydrite, gypsum, salt, red and gypsiferous dolomite, sandstone and green and red shale. A sandstone unit, more than 100 feet in thickness in the Windy Point area, typically occurs at the base of the succession.

The upper beds are exposed discontinuously on the west shore of the North Arm of Great Slave Lake between Alexander and Gypsum Points; the lower part is covered by Great Slave Lake. Norris (1965) assigned the name Mirage Point Formation to the beds after Mirage Point near the southern end of the exposures.

The well closest to the outcrop belt of the Mirage Point Formation is the Northwest Windy Point No. 1, located about 58 miles southwest of Gypsum Point. There a typical section of Mirage Point beds was penetrated. The section is made up of interbedded red shale, salt, anhydrite, and gypsum with some dolomite beds. The formation is 705 feet thick. At the base are 110 feet of red and reddish-brown sandstones which overlie the Precambrian basement.

A similar sandstone is present at the base of the Mirage Point Formation in other wells drilled in the Great Slave Lake area. These include the Cominco Sulphur Point G-4 test where 15 feet of sandstone were encountered, the Northwest Territories Desmarais Lake test where the sandstone unit is 20 feet thick, and the Imperial Triad Willow Lake dryhole where 27 feet of sandstones overlie Precambrian rocks. Previous workers have correlated this sandstone unit with the Ordovician or older Old Fort Island Formation which crops out to the northeast (Norris, 1965; Dept. of Northern Affairs, 1964; Belyea and Norris, 1962 and others).

The Mirage Point Formation is apparently unfossiliferous. On the basis of stratigraphic position and lithology, the formation is correlated with the lower part of the Elk Point Group of northern Alberta. Thus the Mirage Point Formation is believed to be Middle Devonian in age. Grayston, Sherwin & Allan (1964, p. 50) suggest that the Mirage Point beds penetrated in the Northwest Windy Point No. 1 well, on the north shore of Great Slave Lake, are the equivalent of the Lotsberg and Cold Lake Formations of the Elk Point Group of central Alberta. The correlation of Mirage Point and lower Elk Point beds has gained wider acceptance in recent years among petroleum industry and government geologists (personal communications).

An Ordovician age for the Mirage Point red beds is indicated by Norris (1965), the Department of Northern Affairs (1964), Belyea and Norris (1962) and others. The beds were considered of Silurian age by Cameron (1922a). Douglas et al (1963, Fig. 4) have inferred the beds to be of Cambrian and Ordovician age. However in this report and the accompanying illustrations, the Mirage Point Formation is regarded as correlative with the lower portion of the Elk Point Group as discussed in the preceding paragraph.

Distribution of Mirage Point beds was largely controlled by topography of the early Middle Devonian landmass. The formation is thickest in the Sulphur Bay area where more than 700 feet of beds were deposited. The Mirage Point Formation thins to the southwest and is absent over the Tathlina uplift. In the Pine Point area, on the south shore of Great Slave Lake, between 200 and 300 feet of Mirage Point red beds were deposited. Northward from the Tathlina uplift the thickness increases to more than 500 feet beneath the Horn Plateau. As illustrated on cross sections A-J and G-M, Mirage Point deposition was restricted to the north by the south-facing escarpment marking the southern limit of Ordovician rocks. This scarp is thus comparable to the Meadow Lake escarpment of east central Alberta and central Saskatchewan which formed a similar restriction during the deposition of the lower beds of the Elk Point Group.

The approximate position of the escarpment which limited Mirage Point deposition in the map area is shown on the central areal geology map sheet (Figure 6). It trends generally east-west in the vicinity of latitude 62° 30' N. from the north flank of the Horn Plateau, east-southeast over the Fort Rae arch to Redrock Point in the North Arm of Great Slave Lake. The height of the scarp is believed to generally correspond to the thickness of Ordovician strata exposed in the scarp face prior to the deposition of Mirage Point beds. Thus the height of the scarp increases from about 200 feet in the Redrock Point area to approximately 700 feet on the west edge of the map area north of the Horn Plateau (see cross sections A-J and G-M).

CHINCHAGA FORMATION

The name Chinchaga Formation was introduced by Law (1955a,b) for the basal unit of the Elk Point Group in the subsurface of northwestern Alberta. This unit can be traced in the subsurface into the Great Slave Lake region where it has been referred to as the Fitzgerald dolomites by Cameron (1922a), and as the Fitzgerald Formation by Law (1955b, Figure 5) and Campbell (1957).

At the outcrop the Chinchaga Formation is composed mainly of gypsum and includes some limestone and dolomite. It is easily eroded and does not produce good outcrops. The gypsum is typically white, or banded light and dark grey and in places is contorted and brecciated. The formation also contains a variety of carbonate rocks that form resistant units near the base, middle and upper parts of the formation. These units are believed to change facies rapidly and are frequently brecciated. A thin limestone and brecciated limestone unit, termed the Hay Camp Member by Norris (1965), occurs near the base of the formation between Great Slave Lake and Fort Smith.

In the subsurface, the Chinchaga Formation consists mainly of anhydrite and dolomite with some gypsum. The percentage of anhydrite increases to the west and is accompanied by a corresponding westward decrease in the percentage of carbonate and gypsum. Poor and locally good, vuggy and intercrystalline porosity occurs in limestone beds from 50 to 150 feet above the base of the Chinchaga Formation in the Imperial Cartridge and Windflower exploratory wells. Porous limestones were examined at the outcrop and locally contain good vuggy porosity (see composite outcrop sections C, R and W).

North of the Horn Plateau the Chinchaga Formation unconformably overlies Ordovician Rocks and locally, as in the area south of Marian Lake, it overlies Precambrian hills and ridges. South of the Horn Plateau, the formation is believed to rest conformably on red beds of the Mirage Point Formation and unconformably on the Precambrian basement over the flanks of the Tathlina uplift. Evaporites of the Chinchaga Formation were deposited over all but the highest part of the Tathlina uplift. They were the first beds to cover the south facing escarpment which marks the southern limit of Ordovician rocks in the Horn Plateau area. The Chinchaga Formation is conformably overlain by a variety of Middle Devonian rock units. These include the Little Buffalo Formation in the south, several different facies of the Pine Point Formation in the Great Slave Lake area, and the Lonely Bay Formation to the north. The formation is the most widespread unit in the map area. In the subsurface west of the outcrop belt it ranges in thickness from the depositional edge on the Tathlina uplift, west of the map area, to more than 400 feet west of Lac La Martre. In general it thickens to the east and north from the Tathlina uplift. The thickness of the formation throughout much of the report area is between 200 and 300 feet.

The outcrop belt of Chinchaga beds is characterized by numerous lakes and playa lakes with rounded outline and also by low, flat, plain-like areas. South of Great Slave Lake the Slave River delta has developed along the outcrop belt. To the north, several large lakes including Lac La Martre and Lac Grandin have formed mainly within the relatively soft evaporitic rocks of this unit. The western limit of the Chinchaga outcrop belt is usually marked by an irregular, eastward-facing scarp capped by resistant beds of the overlying Little Buffalo or Lonely Bay Formations.

The Chinchaga Formation is sparsely fossiliferous due to the evaporitic nature of the deposits. Algal laminations were observed in an outcrop section some 17 miles west of Red Rock Point. Poorly preserved fossils were collected by Norris (1965) from beds near the middle of the formation in the Great Slave Lake area. These include Cladopora-like organisms, ? Spinatrypa and ? Anatrypa. The Hay Camp Member, in the lower part of the Chinchaga Formation, and probable correlative beds have yielded a number of Middle Devonian fossils (Norris, 1965). In addition fossils provisionally dated by Norris (1963) as Middle Devonian were collected from the Fitzgerald dolomite which occurs below the Hay Camp beds at outcrops on the Slave River southeast of the map area.

The Chinchaga Formation of the Great Slave Lake - northern Alberta area correlates generally with the Bear Rock Formation of the Franklin and Mackenzie Mountains to the northwest.

LITTLE BUFFALO FORMATION

The Little Buffalo Formation is a resistant escarpment-forming carbonate unit lying between evaporitic beds of the Chinchaga Formation below and the Nyarling Formation above. The formation is restricted to the southern part of the map area south of the Pine Point mining community. It is approximately equivalent to the lower part of the Pine Point Formation to the north and was named by Norris (1965) after Little Buffalo River where it is exposed in the immediate vicinity of the falls some 28 miles west of Fort Smith (see Color Plate 14). In that area and to the north the formation caps an east-facing escarpment and can be traced northward for about 50 miles to the southern limit of the Great Slave Lake region. The outcrop belt is marked locally by sinkholes probably resulting from solution of evaporites in the underlying Chinchaga Formation.

The Little Buffalo Formation consists of medium-grey and medium-brown, generally aphanitic, nonporous limestones and dolomites at the type section near Little Buffalo Falls. (see composite outcrop section B). It is apparently conformable with the underlying Chinchaga and overlying Nyarling Formations. The formation is moderately fossiliferous. It typically contains crinoids and brachiopods. The following forms have been identified: Atrypa, Spinatrypa, Emanuella, Mastigospira and also Michelinoceras, indeterminate cup corals, gastropods and pelecypods (Norris, 1965, page 39).

At the outcrop the Little Buffalo Formation is about 120 feet thick. It has not been recognized in the subsurface in wells where it correlates with the lower beds of the Pine Point Formation, the Lonely Bay Formation, the Hume Formation (?) and the Keg River Formation. The stratigraphic position of the Little Buffalo Formation between two evaporitic sequences, the Chinchaga and Nyarling Formations, is analagous to that of the Keg River Formation of northwestern Alberta which occurs between the evaporitic Chinchaga and Muskeg Formations.

LONELY BAY FORMATION

The name Lonely Bay Formation was applied by Norris (1965) to a resistant scarp-forming carbonate unit conformably overlying the evaporitic Chinchaga Formation and overlain conformably by shale and limestone of the Horn River Formation. It may be regarded as a northwestward equivalent of the lower unit of the Pine Point Formation (Lonely Bay Member) exposed on the northwest side of Great Slave Lake. It correlates generally with the Little Buffalo Formation to the southeast and probably with the Keg River Formation to the southwest in Alberta. It is also regarded as a probable correlative of the Hume Formation of the Franklin and Mackenzie Mountains (Bassett, 1961). The Lonely Bay and Hume Formations are analagous in that they are the upper carbonate unit of the Middle Devonian Series.

The Lonely Bay Formation consists almost entirely of limestones. They are medium and dark-grey, medium-brown, typically aphanitic, moderately fossiliferous, and at the outcrop are hard and dense. Locally, as in the Lonely Bay beds described in composite outcrop section R, numerous indeterminate fossil fragments are evident on the weathered surface. Indications of organic remains are rare on the fresh surface of these beds which can be described as aphanitic, dense limestones. Thus the Lonely Bay Formation is believed to be partly made up of biogenic, partly bioclastic beds, recrystallized to aphanitic limestone. The lower beds of the formation exhibit poor and fair vuggy porosity in the subsurface north of the Horn Plateau (Imperial Windflower, Cartridge and Lac Tache wells). The formation includes about 50 feet of very calcareous, porous sandstone at its base in the Imperial Lac Tache dryhole. Thin interbeds of anhydrite and gypsum were encountered in the Lac Tache and Windflower tests.

The thickness of the formation increases to the northwest from about 123 feet in the Dessert Lake area, south of the community of Rae, to 327 feet in the Imperial Cartridge well southwest of Cartridge Mountain. In the Fort Providence area, west of Great Slave Lake, the Lonely Bay Formation ranges in thickness from 376 feet in the Punch Deep Bay No. 2 well to 208 feet in the No. 5 well. It is reported to be 160 feet thick in the Northwest Territories No. 1 dryhole near the town of Fort Providence (see stratigraphic cross section A-J).

In the area between Fort Providence generally northeast to Dessert Lake, the Lonely Bay Formation lies northwest of the Middle Devonian carbonate bank. The relationship between the Lonely Bay Formation and the facies boundary marking the northwestward limit of the carbonate bank is outlined at the beginning of the discussion of Middle Devonian stratigraphy and is illustrated on Figure 8.

The southeastern limit of the Lonely Bay Formation is arbitrarily placed along the facies boundary marking the northwestward limit of the Middle Devonian carbonate bank. Southeast of this boundary, limestones equivalent to the Lonely Bay Formation are referred to as the Lonely Bay Member of the Pine Point Formation after Norris (1965). The outcrop belt of the Lonely Bay Formation is marked along its northeast side by a prominent escarpment which is locally as much as 100 feet above the lake covered terrain to the northeast where Chinchaga evaporites form bedrock. In the Dessert Lake area and for approximately 70 miles to the northwest, the outcrop belt of Lonely Bay beds is characterized by relatively high, flat ground and contrasts markedly with the surrounding terrain which is low, flat, and on which there are numerous lakes and muskeg. Sinkholes are developed locally in the Lonely Bay Formation outcrop belt. These distinctions become less evident northwest of Duport River.

Norris (1965) reports the best exposures of the Lonely Bay Formation (type section ?) are along the prominent escarpment marking the northeast side of the outcrop belt south of Raccoon Lake.

The Lonely Bay Formation marks the earliest appearance of relatively abundant Middle Devonian fossils on the north side of Great Slave Lake. The following fossils were collected from the formation during the field work and were identified by H.S. Scherp: Aulapora, Alveoites, Syringopora, ? Favosites, ? Leiorhynchus, Atrypa, Euomphalus, together with indeterminate brachiopods, crinoids, gastropods, stromatoporoids and colonial corals.

PINE POINT FORMATION

The name Pine Point Formation was proposed by Cameron (1918) to apply to what he thought was the lower unit of the Middle Devonian succession in the Great Slave Lake area. The name was applied to strata exposed in the vicinity of Fort Resolution and at Pine Point on the south shore of Great Slave Lake. In the years since Cameron's early work, data obtained by drilling in the Great Slave Lake area have provided additional information. The Pine Point Formation and associated beds have been discussed in many published and open file reports. Norris (1965 p. 45) reviews the history of Pine Point terminology and presents a revised definition for the Pine Point Formation and related beds.

In this report the term Pine Point Formation is used in a sense corresponding to that of Norris. Thus the Pine Point Formation includes the rocks occupying the stratigraphic interval between the top of the evaporites of the Chinchaga Formation and the base of the coarse dolomites of the Presqu'ile Formation, or the base of the limestones of the Sulphur Point Formation, the approximate stratigraphic equivalent of the Presqu'ile Formation. The Pine Point Formation consists of a variable succession of dolomites, limestones and shales and can be described as the platform beds of the northeasterly trending Middle Devonian carbonate bank of the Great Slave Lake area (see summary of Middle Devonian stratigraphy). Thus the formation is restricted to a generally northeast trending band, bounded on the southeast by the Pine Point mining area and on the northwest by a line extending from near Kakisa Lake northeast beyond Dieppe Lake (see middle areal geology sheet, Figure 6 and cross sections, Figure 8). Great Slave Lake covers much of the area believed underlain by the Pine Point Formation. It is exposed on the south and northwest shores of the lake and has been penetrated in the subsurface by exploratory wells.

The formation is conformable with the underlying evaporitic beds of the Chinchaga Formation. The boundary between Pine Point limestones and Presqu'ile dolomites is not necessarily a time line. In the Pine Point area and also east of Prairie Lake the upper beds of the Pine Point Formation are believed to grade laterally into dolomites and calcareous dolomites assigned to the Presqu'ile Formation (see Figures 7 and 8 and also outcrop section N).

The thickness of the Pine Point Formation increases generally to the northeast from 345 feet in the Shell Alexandra No. 4 test, southwest of Tathlina Lake, to 550 feet in the Cominco Pine Point No. 1 test in the Pine Point mining area, and to 595 feet in the Northwest Windy Point well on the north shore of Great Slave Lake. Subsurface information indicates local variations in the northeasterly thickening, as in the Deep Bay area where the formation is about 300 feet thick. West of Buffalo Lake a thickness of 610 feet was penetrated in the Murphy Alexandra Falls No. 2 dryhole.

On the south side of Great Slave Lake the Pine Point Formation contains a number of units separated by Norris (1965) on the basis of lithology and designated by him as members. In approximate ascending order these are: 1. Limestone Member 2. Fine-Grained Dolomite Member, 3. Bituminous Shale and Limestone Member, 4. Brown Limestone Member and 5. Buffalo River Shale Member. These members grade or intertongue with one another, and with the exception of the Buffalo River Shale Member, all are exposed for surface study. An interpretation of the distribution and general relationship of these beds is shown on the south areal geology sheet accompanying this report. (Figure 7).

Composite outcrop section S, assembled from exposures on the south shore of Great Slave Lake, is generally representative of the Pine Point Formation in that area. In descending order the section of Pine Point rocks can be summarized as follows:

<u>TOP</u>

Overlying beds: Sulphur Point Formation (contact covered)

<u>Pine Point Formation</u>

<u>Buffalo River Member</u>

Covered interval believed underlain by shale, blue-grey to dark green, fissile calcareous ------------------------ 186' ±

Bituminous Shale and Limestone Member

Interbedded limestone and shale: limestone dark-brown, aphanitic, very petroliferous shaly, fossiliferous, locally calcarenitic; shale dark-grey, calcareous, bituminous and fossiliferous ----------------------	126' ±

Fine-Grained Dolomite Member

Dolomite, dark and grey and dark brown, aphanitic, slight petroliferous odor, thin-bedded, sparsely fossiliferous, fair vuggy porosity ------------------------------	225' ±

Limestone Member (Resolution area)

Limestone, dark-grey, aphanitic, thin-bedded, with shale interbeds, sparsely fossiliferous --------------------------	92' ±
Total Pine Point Formation	629' ±

Underlying beds: Chinchaga Formation (covered)

BOTTOM

On the north shore of Great Slave Lake, the Pine Point Formation consists of an upper and lower limestone unit and a middle shale. These have been designated as members by Norris (1965). In ascending order they are as follows: Lonely Bay Member, Horn River Tongue and Upper Limestone Member. Limestones of the Lonely Bay and Upper Limestone Members are exposed on and near the northwest shore of Great Slave Lake from South Cranberry Island to east of Lonely Bay. Composite outcrop section N, compiled from exposures on the north shore of Great Slave Lake, is representative of Pine Point exposures there. The section can be summarized in descending order as follows:

TOP

Basal beds of the Presqu'ile Formation,

Dolomite grey, calcareous, aphanitic, vuggy with abundant Cladopora (?Amphipora), gastropods.

Upper Limestone Member of Pine Point Formation

Limestone, biogenic in upper part, medium-grey, aphanitic. Lower beds contain worm burrowings, ripple marks, large crinoid stems. Richly fossiliferous in upper part with abundant Coenites (?Amphipora). ------------------ 160' ±

Horn River Tongue of Pine Point Formation

Covered interval believed underlain by dark shales variably interbedded with argillaceous limestones. ------------------------------ 100' ±

Lonely Bay Member of Pine Point Formation

Limestone, grey, aphanitic, massive, nodular argillaceous in upper part, brachiopods, gastropods, ostracods. ------------------- 130' ±

Total Pine Point Formation 390'

Chinchaga Formation (contact covered)

BOTTOM

The outcrop belt of the Lonely Bay Member of the Pine Point Formation is marked along its eastern edge by an east-facing escarpment variable in height but reaching up to about 60 feet. Numerous sinkholes are developed where the Lonely Bay Member limestones form bedrock. They may result from solution of the underlying evaporites in the Chinchaga Formation.

Fossils are typically abundant in the Pine Point Formation. The following were collected during the field work: Emanuella, Meristoides, Leiorhynchus, Atrypa, Spinatrypa, Euomphalus, Platyceras, Tentaculites, Coenites, ?Amphipora together with indeterminate crinoids, trilobites, stromatoporoids, ostracods, brachiopods and worm burrowings. In addition, numerous other Pine Point fossils are reported by Norris (1965).

The Pine Point Formation is regarded as an approximate correlative of the Muskeg and Keg River Formations of northern Alberta. The lower Pine Point beds (Lonely Bay Member of the north shore and Limestone Member of the Resolution area) correlate approximately with the Little Buffalo Formation to the south and the Lonely Bay Formation to the north. The upper beds of the Pine Point Formation are equivalent to the lower part of the Nyarling Formation to the southeast and the lower part of the Horn River Formation to the northwest. These relationships were shown in a general way on Figure 3 and are discussed elsewhere in this report (summary of Middle Devonian rocks).

NYARLING FORMATION

The name Nyarling Formation was proposed by Norris (1965) for a unit consisting mainly of gypsum lying between the Little Buffalo Formation below and the Slave Point Formation above. Neither the lower nor upper contacts are exposed. It is presumed to be conformable with underlying strata and may interfinger with part of the Slave Point Formation above. The Nyarling Formation is discontinuously and poorly exposed in a southeasterly trending outcrop belt, extending from the Pine Point mining area southeast to latitude 60° N. This belt is characterized by flat terrain, muskeg, lakes, playa lakes and sinkholes. At the outcrop, the Nyarling Formation is composed mainly of gypsum with minor dolomite and limestone beds. The gypsum is white, light-buff, and occurs in massive, laminated and brecciated beds. The carbonate units are present as thin interbeds and are generally gypsiferous, light-brown, aphanitic and locally porous (composite outcrop section B and Color Plate 15).

The name of the formation is after Nyarling River, the main tributary of the Little Buffalo River in the outcrop belt. No fossils have been found in the Nyarling Formation. On the basis of stratigraphic position the beds are assigned a Middle Devonian age. The Nyarling Formation is possibly the stratigraphic equivalent of the upper two-thirds of the Pine Point Formation, all of the Presqu'ile and Sulphur Point Formations and, as suggested by Norris, it appears to be equivalent in places to the lower part of the Slave Point Formation. The formation is also regarded as roughly the stratigraphic equivalent of the combined Muskeg and Watt Mountain Formations and Fort Vermilion Member of the Slave Point Formation of northwestern Alberta.

The thickness of the Nyarling Formation is calculated to be about 438 feet at the outcrop, assuming a southwest regional dip of 13 feet per mile. The northwest limit of the Nyarling Formation evaporites is a facies change to limestones and dolomites of the Middle Devonian carbonate bank (described elsewhere). This facies change is believed to extend from northwest of Buffalo Lake, generally northeast to the headwaters of Hanbury Creek, southeast of the Pine Point mining area (see cross section I-S and Figure 7).

PRESQU'ILE FORMATION

Cameron (1918) proposed the name "Presqu'ile dolomites" for strata exposed at Presqu'ile Point and on the Burnt Islands east of Pine Point on the south side of Great Slave Lake. He also included strata exposed in the vicinity of Windy Point, and Sulphur Bay and Prairie Lake on the northwest shore of Great Slave Lake. Later revisions by Cameron (1922a) and the results of diamond-drill holes in the Pine Point area and in the Windy and Sulphur Bay areas are reviewed by Norris (1965). A restricted definition of the term Presqu'ile Formation was proposed by Norris who applied the term to the upper part of the stratigraphic interval between the top of the Chinchaga Formation and the base of the Slave Point Formation. Moreover, the term Presqu'ile Formation is restricted mainly to a light-colored, coarsely recrystallized, variably vuggy, massive dolomite which is generally presumed to have replaced reefal limestone. These beds overlie various facies of the Pine Point Formation and are in turn overlain by the Sulphur Point or Slave Point Formations. The Presqu'ile Formation also includes darker, fine-grained dolomites in the Sulphur Bay and Windy Bay areas. These beds surround and interfinger with the coarsely recrystallized dolomite. In some areas the coarsely recrystallized dolomites grade into and interfinger with undolomitized reefal and associated limestone facies which Norris excludes from the Presqu'ile Formation and names the Sulphur Point Formation.

In this report and on the accompanying illustrations, Presqu'ile and Sulphur Point nomenclature are used in the sense proposed by Norris. Thus the Presqu'ile Formation consists mainly of coarsely crystalline, light-colored dolomites and is regarded as a facies equivalent of biogenic, in part reefal limestone beds of the Sulphur Point Formation.

Coarsely crystalline dolomite of the Presqu'ile Formation is exposed in the Pine Point mining area (composite section P) and also east of Prairie Lake (composite section N). In the subsurface the formation is believed to be restricted mainly to an extensive area bordering the southwest shore of Great Slave Lake. The southeastern limit of the Presqu'ile dolomites is believed to be approximately coincident with that of the Middle Devonian carbonate bank and extends from north of Buffalo Lake, generally northeast to the Pine Point mining community. The northern limit is believed to be generally along the south shore of Great Slave Lake from the Pine Point mining area west to the town of Hay River and northwest to near Point Desmarais. The southwestern limit of Presqu'ile beds is generally unknown. The beds are thickest in the Northwest Territories Desmarais Lake No. 1 dryhole where 260 feet of dolomites were penetrated. Presqu'ile dolomites are absent to the southwest in the Shell Alexandra No. 4 dryhole. The thickness of the Presqu'ile Formation is generally between 100 and 200 feet where present in subsurface wells. Cross sections A-J, H-P and I-S show the interpreted distribution of the Presqu'ile Formation and its lateral facies relationship to limestones of the Sulphur Point Formation.

Presqu'ile dolomites are exposed on the northwest side of Great Slave Lake in the vicinity of Sulphur Bay. The outcrop belt trends north and extends from near Windy Point northward through Windy and Sulphur Bays, along the east side of Prairie Lake to a point about due west of Moraine Point. The west side of this outcrop belt is remarkably straight and is believed to be fault controlled (see cross section H-P). Movement along this fault in Presqu'ile time may have controlled reef growth. The west limit of Presqu'ile beds in the Prairie Lake area represents an abrupt wedging out of the coarsely crystalline dolomite facies and is probably a reef front. (Color Plate 25 and Figure 8).

At the main pit of Pine Point Mines Ltd. in the Pine Point mining area, the Presqu'ile Formation is composed of light and medium grey, extremely vuggy, medium to very coarsely crystalline dolomite. Locally, lead and zinc sulphides have replaced the dolomites and are the main ore beds being mined in the Pine Point area (see Color Plates 11 through 13). The concentrations of galena and sphalerite appear to be most abundant along or generally parallel to vague bedding planes.

With regard to the origin of the lead and zinc deposits in the Presqu'ile dolomites, Baragar (1966, pages 52 and 53) reports that " ... one or two of the east arm faults pass almost directly beneath the Pine Point deposits with a trend that roughly coincides with that of the ore bodies and the Presqu'ile Formation. Many geologists believe that this is more than coincidental". Baragar suggests that a ready channelway to molten rocks at depth is certainly provided by the faults which pass beneath the deposits.

Minor amounts of galena, sphalerite, marcasite and calcopyrite are present in the coarsely recrystallized dolomites of the Presqu'ile Formation on the northwest side of Great Slave Lake (Cameron, 1917, 1918, 1922 and Hume, 1921). The Presqu'ile Formation there appears to be essentially the same as it is on the south side of the lake. Oil filled vugs and small oil seeps are present on the shores of Sulphur and Windy Bays. Vugs up to a diameter of one foot were observed at station 90C (see Figure 7 and Color Plate 26). Sulphur seeps were observed at Horncastle Point and on either side of Sulphur Bay along the distinctive linear western edge of the Presqu'ile outcrop (see Color Plate 27).

The Presqu'ile Formation is generally unfossiliferous presumably because of recrystallization. Locally, as in the exposures east of Prairie Lake, the formation contains some fossils. The following forms were gathered during the field season: Cladopora, ?Amphipora and Atrypa together with indeterminate gastropods, brachiopods and fossil fragments. Other fossils are reported in the Presqu'ile Formation by Norris (1965) including moulds strongly suggestive of Stringocephalus.

As illustrated on the stratigraphic correlation chart accompanying this report (Figure 3) the Presqu'ile Formation is believed to be equivalent to all of the Sulphur Point Formation and to part of the Horn River and Hare Indian Formations.

SULPHUR POINT FORMATION

The name Sulphur Point Formation was proposed by Norris (1965) for a succession of limestones and locally interbedded limestones and dolomites that overlies the Pine Point Formation and is in turn overlain by limestones of the Slave Point Formation. Locally in the subsurface the Sulphur Point Formation is overlain by shale and limestone of the Watt Mountain Formation. The formation is regarded as the undolomitized equivalent of the Presqu'ile dolomite. In places, as in the subsurface in the Pine Point mining area, Sulphur Point limestones overlie the coarsely recrystallized dolomites of the Presqu'ile Formation.

The type section of the Sulphur Point Formaton is designated by Norris as the succession occurring above a depth of 172.6 feet in the Cominco G-4 test near Sulphur Point on the south shore of Great Slave Lake. The uppermost beds of the formation are eroded at the G-4 well, but they are mapped at the surface a short distance to the west (see Figure 7).

At exposures on Presqu'ile Point and Sulphur Point and in the G-4 well, the Sulphur Point Formation is made up of limestone and dolomite. The limestone is partly sublithographic and in the lower beds contains abundant corals and stromatoporoids. The dolomites are generally aphanitic, locally contain corals and also some gypsum beds. The exposed beds are limestones, medium grey and medium brown, locally porous, generally aphanitic and contain Stringocephalus moulds, Coenites, Amphipora and indeterminate stromatoporoids, brachiopods and crinoids. Similar exposures of Sulphur Point limestones were examined on the northwest shore of Great Slave Lake in the vicinity of Burnt Point (Color Plate 30). They are locally biogenic and contain many brachiopods and corals.

The thickness of the Sulphur Point Formation, where present in the subsurface southwest of Great Slave Lake, is generally on the order of 150 feet. The thickness of the formation increases regionally to the northeast from about 65 feet in the Tathlina-Buffalo Lakes area to more than 200 feet in the Deep Bay area. In the Northwest Territories Deep Bay No. 1 well, the formation is indicated by the Department of Northern Affairs (1964) to be 347 feet thick.

Distribution of the Sulphur Point Formation, a limestone facies equivalent to the Presqu'ile dolomites, is restricted to portions of the Middle Devonian carbonate bank (described elsewhere). Thus, the Sulphur Point limestones are present over that portion of the Middle Devonian carbonate bank where Presqu'ile dolomites are absent. The northwest limit of the formation is placed along the facies change to shales of the Horn River Formation. A carbonate build-up is indicated along this front by the thickness of Sulphur Point beds in the Northwest Territories Deep Bay No. 1 well (see cross section A-J). To the southeast the limestones of the Sulphur Point Formation give way to Nyarling evaporites and are absent beyond a line from Buffalo Lake to near the Pine Point mining centre.

Fossils identified from the Sulphur Point Formation, in addition to those listed above at exposures on the shores of Great Slave Lake, are listed by Norris (1965).

The Sulphur Point Formation correlates with all of the Presqu'ile Formation with the upper part of the Nyarling Formation and also with part of the Horn River and Hare Indian Formations.

HORN RIVER FORMATION

The name Horn River shale was proposed by Whittaker (1922) for shales exposed discontinuously along the banks of the Horn River above the mouth of Ferguson Creek. Douglas and Norris (1960) included these beds in the Horn River Formation. The Horn River Formation was redefined by Norris in 1965 as a unit consisting largely of dark shales, variably interbedded with limestones, which overlies limestones of the Lonely Bay Formation and is unconformably (?) overlain by green shales of the Fort Simpson or Hay River Formations.

The beds exposed on the Horn River are made up of 30 feet of shale, which is black, fissile, noncalcareous, and locally has sulphurous incrustations and rare concretions to a diameter of 2 feet. Limestone talus found at the outcrop, and reported by Norris (1965) to overlie the shale succession, is medium-grey, aphanitic, shaly and contains Leiorhynchus and Tentaculites.

Similar beds overlie the Lonely Bay Formation in the area north and northeast of Fort Providence and are included in the Horn River Formation. A representative section was penetrated in the Imperial Triad Davidson Creek well where 244 feet of black and dark brown, generally noncalcareous shales containing silty and limy interbeds were penetrated. The lower portion is slightly bituminous. The Horn River Formation underlies a generally greenish succession of soft calcareous shales assigned to the Upper Devonian Hay River Formation.

The Horn River Formation makes up the shale facies lying northwest of the Middle Devonian carbonate bank (described elsewhere). The southeastern limit of Horn River shales lies along a facies change to carbonate and shale of the carbonate bank. The facies change extends from north of Kakisa Lake, generally northeast beyond Dieppe Lake to near Dessert Lake. (Figures 6 and 7).

The Horn River shales are thus equivalent to the upper two-thirds of the Pine Point Formation, all of the Presqu'ile and Sulphur Point Formations and probably part of the Slave Point Formation. As suggested on the accompanying stratigraphic correlation chart (Figure 3) the Horn River shales of the Great Slave Lake area correlate with the Hare Indian and possibly part of the Kee Scarp Formations of the Norman Wells area to the northwest.

The Horn River Formation underlies the map area northwest of the Middle Devonian carbonate bank and down-dip from the outcrop belt. Where covered by the Upper Devonian Hay River Formation, the Horn River Formation thickens to the east from 160 feet in the Westeroi 3-A well near Fort Simpson (west of the map area) to 244 feet in the Imperial Triad Davidson Creek well. A composite section some 350 feet in thickness is indicated on outcrop section R and was assembled from the outcrop belt northeast of the east end of the Horn Plateau.

WATT MOUNTAIN FORMATION

The term Watt Mountain Formation was introduced by Law (1955a and b) for a unit of varying lithology, lying between the Muskeg Formation below and the Slave Point Formation above, in the subsurface of northwestern Alberta. The formation is recognized in the subsurface west of Great Slave Lake but is not known to crop out into the map area. It is recognized only where covered by Slave Point limestones and thus is limited to south of a line extending from near Slave Bay on Great Slave Lake generally west on the north side of Deep Bay and southwest to north of Kakisa Lake.

Beiyea and Norris (1962) proposed a modification of the Watt Mountain Formation to exclude beds they believe to be equivalent to the Sulphur Point Formation. The Watt Mountain Formation, restricted, is recognized in the area west and south of Great Slave Lake where it consists almost entirely of green waxy shale and locally contains thin siltstone and sandstone beds. Belyea and Norris describe the upper contact with the Slave Point Formation as sharp, whereas the lower contact is gradational with the Sulphur Point Formation. In places the Watt Mountain Formation cannot be separated from Sulphur Point beds where they also contain green waxy shales.

The Watt Mountain Formation is very thin, typically less than 10 feet thick. Locally, as in the Northwest Territories Desmarais Lake well, it is absent between Presqu'ile dolomites below and Slave Point limestones above.

The Watt Mountain Formation is probably a regolith. It may represent detritus reworked from the Sulphur Point or Presqu'ile Formations.

SLAVE POINT FORMATION

The name Slave Point limestones was proposed by Cameron (1918) for the upper beds of the Middle Devonian succession exposed along the south shore of Great Slave Lake from Presqu'ile Point to High Point and on Buffalo River. Also included were beds exposed on the northwest shore of the lake at Slave Point, and along the shore from near Jones Point north to Moraine Point. Subsequent work by Cameron (1922), Campbell (1950, 1957), Law (1955), Belyea and Norris (1962) and more recently by Norris (1965) has resulted in the restriction of the name Slave Point Formation to those beds underlying the shales of the Hay River Formation and overlying the Watt Mountain Formation or the Amco marker bed and locally the Presqu'ile dolomites.

The Slave Point Formation overlies Watt Mountain beds west and south of Great Slave Lake. In the Pine Point mining area and to the southwest the Watt Mountain Formation is locally absent and the base of the Slave Point Formation is arbitrarily selected as the base of the Amco marker bed by Norris (1965). The Amco unit is a distinctive, 11 foot-thick shale which typically overlies coarsely recrystallized dolomites of the Presqu'ile Formation where they are developed. In other areas, as in the Northwest Territories Desmarais Lake well where the Amco marker bed and the Watt Mountain shale are both absent, the base of the Slave Point Formation is placed at the top of the Presqu'ile dolomites.

The Slave Point Formation consists of grey to brown, fine grained limestone and calcarenite, slightly argillaceous with some interbeds of dark shale, dolomitic limestone and dolomite. Some zones contain abundant Amphipora and locally, as on the Buffalo River, stromatoporoids make up much of the rock (Color Plate 4).

The beds originally described as Slave Point limestones by Cameron (1918) now include the lower beds of the Hay River Formation in the Prairie Lake area, the Slave Point Formation, the Sulphur Point and Presqu'ile Formations and the upper beds of the Pine Point Formation according to currently accepted stratigraphic terms. Only the limestones exposed at Slave Point, on the northwest shore of Great Slave Lake, remain within the restricted Slave Point Formation as used in this report. The beds available for study at Slave Point occur as a pavement below water level and consist of about 2 feet of limestone. medium brown and pale brown, biogenic and petroliferous with numerous stromatoporoids and corals (?) (see Color Plate 32). These beds comprise what is left of the "type section" of the Slave Point Formation.

The known distribution of Slave Point limestones is limited to the Middle Devonian carbonate bank (described elsewhere) and to the southeast. Thus, the northern limit of Slave Point beds extends from near Slave Bay on the northwest shore of Great Slave Lake, westward to north of Deep Bay and generally southwestward to north of Kakisa Lake (see Figure 7). The Slave Point Formation is not recognized to the northwest and is presumed absent due to facies change to Horn River shales (Belyea and Norris, 1962, Figure 2) and/or sub-Hay River erosion as inferred on stratigraphic cross section A-J (Figure 8 this report).

Limestones of the Slave Point Formation may occur locally in the area northwest of the Middle Devonian carbonate bank. As shown on the south areal geology map sheet (Figure 7) an alignment of topographic anomalies in the Caen Lake area may reflect the trend of near-surface isolated carbonate (reef?) masses, or perhaps a northwesterly extension of the Slave Point limestones.

The thickness of Slave Point beds is on the order of 200 feet west and south of Great Slave Lake within the map area. The formation thins to approximately 50 feet over the Presqu'ile dolomitized reef in the Northwest Territories Desmarais Lake well and thickens to more than 300 feet in the Northwest Territories Deep Bay No. 2 test, as illustrated on cross section A-J.

The Slave Point Formation, beneath Great Slave Lake and the area to the south, forms the upper unit of the Middle Devonian Series and probably correlates with the productive reefal beds of the Kee Scarp Formation at Norman Wells. The Slave Point Formation may also be equivalent in part to the reefal limestones of the Horn Plateau Formation exposed east of the Horn Plateau.

The Slave Point Formation is typically more fossiliferous over the Middle Devonian carbonate bank than it is in the area to the southeast where bedded limestones with some brachiopods characterize the formation. Fossils identified from the Slave Point Formation include Atrypa, Emanuella, Cladopora and Amphipora together with indeterminate brachiopods, stromatoporoids, crinoids and ?corals. Color Plate 4 illustrates the abundant stromatoporoids on the weathered surface of Slave Point beds at Mellor Rapids on Buffalo River, west of the Pine Point mining area.

HORN PLATEAU FORMATION

The name Horn Plateau Formation was proposed by Norris (1965) for reefal limestones exposed at a dome-shaped hill three miles west of the south tip of Fawn Lake, east of the Horn Plateau. The beds crop out near the boundary of the Hay River and Horn River Formations and are presumed to have been unconformably overlain by the Hay River shales of early Upper Devonian age. As suggested on cross section G-M (Figure 8) the reefal beds may interfinger with shales of the Middle Devonian Horn River Formation or they may represent reef growth associated with the underlying Lonely Bay limestones.

The section exposed consists of biohermal and coarsely granular, biogenic limestones. The beds are richly fossiliferous being made up in large part of corals, brachiopods and crinoids. Some 45 feet of beds are exposed, the lower portion of which consists almost entirely of corals in growth position. Good, fair and poor interparticle porosity were observed in the upper part of the section.

The thickness of the reefal beds of the Horn Plateau Formation is unknown. About 90 feet of beds are indicated by the outcrop which rises that height above the surrounding terrain. An interpreted total thickness of about 200 feet is indicated on the composite outcrop section R. However, it is conceivable that the reef is much thicker.

Limestones capable of providing a platform for growth of the Horn Plateau reef are known in the area. About 12 miles northwest of the outcrop of the Horn Plateau Formation are exposures of limestones of the upper Horn River Formation. These limestones are richly fossiliferous and are approximately 100 feet lower in the section than the outcrop of the Horn Plateau reef. In the subsurface they may provide the platform on which the reef developed. However, these limestones are thin and may be local in extent. An alternate interpretation is that the upper limestones of the Horn River Formation are absent in the vicinity of the Horn Plateau reef and that carbonates of the Lonely Bay Formation act as a platform. If so, reef growth on the order of 300 feet is indicated (see cross section G-M).

HORN PLATEAU REEF

VERTICAL AIRPHOTO STEREOSCOPIC PAIR

R.C.A.F. Photography Exposure No. A 11030 – 167 & 168

SCALE: 1 inch to 2750 feet

V. ZAY SMITH ASSOCIATES LTD.

FALAISE LAKE TOPOGRAPHIC ANOMALY

Dominion Government photograph No. 334-A11334

SCALE: 1 inch to 3000± feet

V Zay Smith Associates Ltd. 1966

The outcrop of the Horn Plateau Formation forms a dome-shaped hill roughly circular in plan, which rises some 90 feet above the surrounding terrain. The hill is about 2,500 feet in diameter, the entire surface of which is occupied either by areas of outcrop or near-surface bedrock obscured by thin mantle. On vertical air photographs the Horn Plateau reef forms a well-defined feature in sharp contrast to the surrounding, generally flat, tree covered plain (see Plate 2). The hill is visible in profile from a great distance. In close-up aerial view, the circular pattern and "stack and pillar" erosional character are distinctive (see Color Plates 20 and 21). The best exposures occur on the north slope of the hill. The expression of bedding in the massive, biogenic limestones is rare but was locally observed. The beds dip gently away from the reef proper (Color Plate 22) and were probably deposited with this attitude on the flanks of the bioherm.

The depth to which the Horn Plateau reef extends, and its present subsurface configuration can be surmised to a degree by observing surface features and geology and by comparison with the subsurface characteristics of nearby areas in which reefing patterns are better known. The exposed upper surface of the Horn Plateau reef is believed to have been only slightly modified by erosion. Thus, present topography may also indicate the dimensions of reef growth. Accordingly a structure contour map has been prepared on the surface of the Horn Plateau reef (Plate 9).

Wave-cut terraces at the east end of the Horn Plateau, and the presence of widespread Quaternary lacustrine deposits indicate the former presence of the ancestral Great Slave Lake. At one time it covered a much larger area and was probably 400 feet deeper than at present. Several arcuate alignments east and south of the Horn Plateau reef (see Plate 2) are probably strand lines formed along resistant bedrock masses. The presence of a subtle topographic high extending northwest from the reef outcrop may reflect a similar ridge of reef build-up in the subsurface (see Figure 9). Thus a much larger reef mass may be present below the exposed beds.

In some respects the surface expression of the Horn Plateau reef is similar to that of the Falaise Lake topographic anomaly to the southeast near Great Slave Lake. The aerial view of these two features can be compared on Plates 1 and 2. The Falaise Lake anomaly rises almost 200 feet above Falaise Lake and is underlain by at least 693 feet of biogenic and reefal limestones as this thickness of beds was penetrated in the Western

FIGURE 9

STRUCTURE CONTOUR MAP

ON THE SURFACE OF

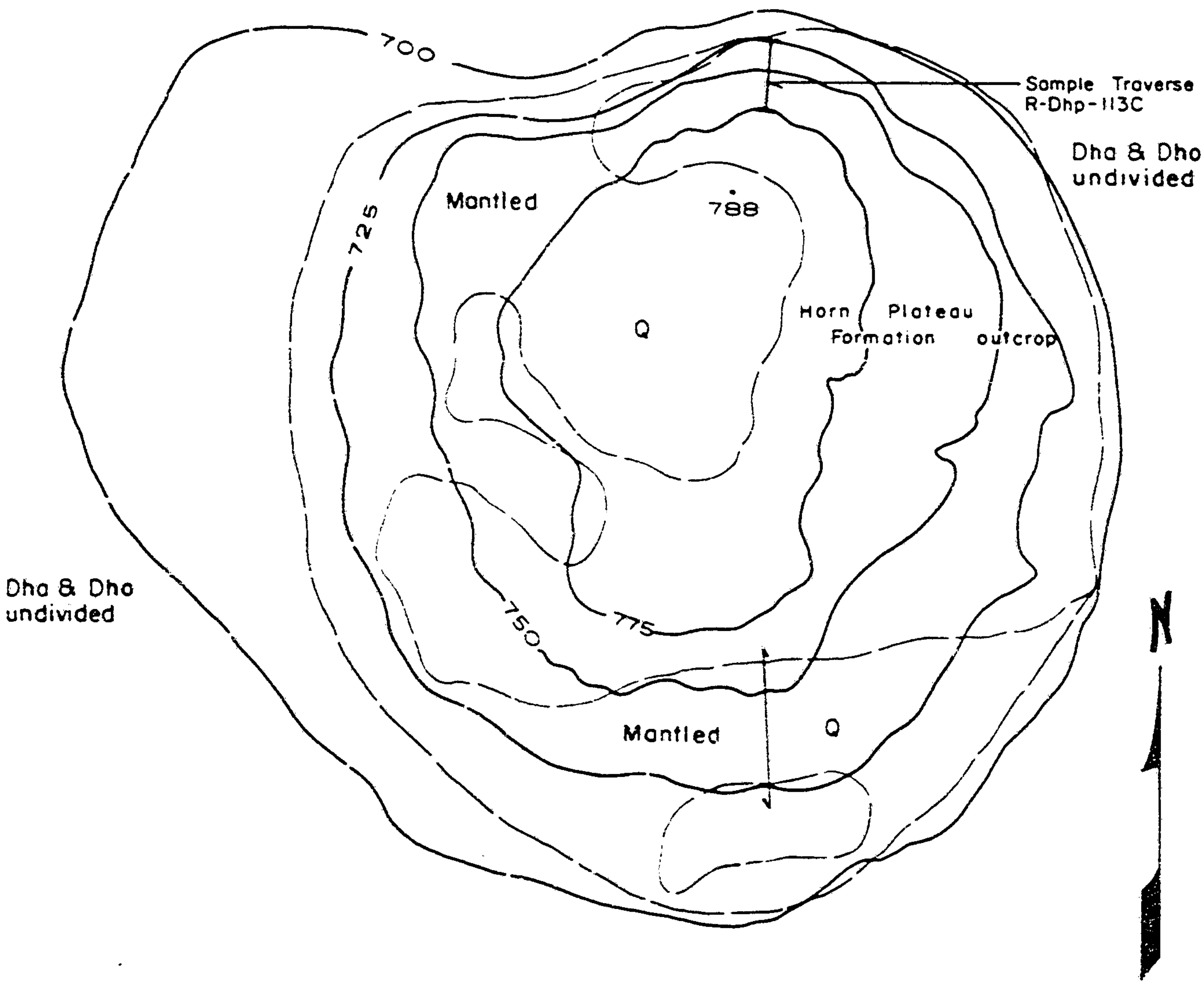
HORN PLATEAU REEF

SCALE: 1 inch to 500 feet

CONTOUR INTERVAL 25 feet

DATUM: Sea level (approximate)

Compiled photogrammetrically using a Kelsh plotter



Decalta Falaise Lake No. 1 test hole. Angular fragments of these beds are available for surface study near the location of this well and are similar in lithology to the Pine Point Formation. However, the surface beds and those penetrated in the Falaise Lake test hole have not been identified and may correlate with the Pine Point, or Sulphur Point Formations or perhaps the Hay River Formation (see cross section H-P). As is the case with the Horn Plateau reef, the Falaise Lake topographic anomaly is regarded as the surface expression of a carbonate build-up perhaps resting on equivalents of the Lonely Bay Formation or younger beds.

Subsurface occurrences of reefs similar to the Horn Plateau Formation offer attractive targets for oil and gas exploration. Two generalized trends are considered most favorable for such reef development. They are 1. downdip to the southwest and 2. along strike to the northwest and southeast. The trends along strike and downdip are indicated by fault zones and facies boundaries of probable tectonic association which trend both to the northeast and northwest (see structural discussion).

Fossils from the reefal limestones of the Horn Plateau Formation include brachiopods, bryozoa, corals, crinoids, pelecypods and trilobites. They were identified during the field work by Dr. H.S. Scherp and are listed on composite outcrop section R. Brachiopods and corals are the most abundant forms.

Correlation of the Horn Plateau Formation is complicated by the intriguing aspect that many of the fossils identified from the unit have not been recognized elsewhere in the southern part of the Northwest Territories. It seems very unlikely that these forms are restricted to the small area where Horn Plateau reefal beds are exposed. Thus additional beds of a similar nature are anticipated in the subsurface.

The formation appears to be younger than the Pine Point beds and is probably correlative with or younger than the Sulphur Point, Presqu'ile and Slave Point Formations and probably the Kee Scarp Formation. McLaren and Norris (1964) report that corals of the Horn Plateau Formation suggest a mid-to-late, but not latest, Givetian age (late Middle Devonian).

UPPER DEVONIAN

Rocks assigned to the Upper Devonian Series form bedrock in the southwest portion of the Great Slave - Great Bear Lakes area. Outcrop sections of parts of the succession are exposed in the valleys of major rivers flowing north into Great Slave Lake and the Mackenzie River, notably along Hay River and Kakisa River. To the southwest, Upper Devonian rocks are buried below the Cretaceous and are known from bore-holes.

The formational names currently in use for Upper Devonian rocks correspond closely to those revised and introduced by Belyea and McLaren (1962) in a comprehensive study of available surface and subsurface information from Hay River west to the Liard River and south to the Peace River arch. Earlier formational names, such as those introduced by Cameron (1918), Whittaker (1922, 1923), Crickmay (1953, 1957), Law (1955) and Douglas (1959), were modified where necessary; new names were proposed for units mappable at the outcrop or in the subsurface.

In ascending order the formational names assigned to Upper Devonian rocks in the map area are as follows: Hay River, Twin Falls, Tathlina, Redknife, Kakisa, Trout River, Tetcho and Kotcho. The thickness and gross lithology of these units in the Cameron Hills area is indicated on stratigraphic cross section A-J (Figure 8). Correlative beds and general facies changes are shown on the stratigraphic correlation chart (Figure 3).

On the basis of gross lithology the Upper Devonian succession can be separated into a lower shale unit (the Hay River Formation) and an upper unit made up mainly of limestones with sandstones and siltstones. The lower beds of the upper carbonate and clastic unit, made up of strata from the base of the Escarpment Member to the top of the Tathlina Formation, are limited to the area generally south of Kakisa Lake. To the northwest, the limestones, sandstones, siltstones and shales which comprise these formations grade into greenish grey and grey mudstones and shales of the Fort Simpson Formation. Shales of the Hay River Formation are also included in the Fort Simpson Formation. Thus, the lower, shaly portion of the Upper Devonian Series is also referred to as the Fort Simpson Formation west of the map area.

In the paragraphs that follow the stratigraphy of Upper Devonian units which form bedrock in the map area will be discussed briefly. These include the Trout River and older formations.

HAY RIVER FORMATION

The Hay River Formation comprises all beds exposed along Hay River from the base of Alexandra Falls down section, and also the shales penetrated in the Frobisher Hay River No. 4 well down to the Middle Devonian limestone (Belyea and McLaren, 1962). The Hay River Formation forms the basal unit of the Upper Devonian succession and rests unconformably(?) on the Slave Point limestones or the Horn River shales.

The Hay River Formation is approximately 1,300 feet thick in the subsurface. Two members are recognized. An upper carbonate unit termed the Escarpment Member and an informally designated lower member made up mainly of shale.

The lower or shaly member of the Hay River Formation ranges in thickness from about 950 feet to 1,000 feet. It consists mainly of greenish-grey shales and mudstones, variably calcareous, with scattered interbeds of argillaceous limestone. It overlies the Middle Devonian Slave Point Formation and is in turn overlain by the Escarpment Member.

Escarpment Member

The upper, predominantly carbonate unit of the Hay River Formation consists of medium-grey and brownish-grey, partly bioclastic, thin-bedded limestones with richly fossiliferous, biohermal and biostromal limestone bodies irregularly developed throughout. The most prominent of these carbonate build-ups forms Louise Falls (see Color Plate 8). The Escarpment Member is regarded as a carbonate facies developed in the upper part of the Hay River Formation. It grades into and intertongues with shales of the Hay River Formation to the south-west and to the northwest (Figure 8). The member increases in thickness from the facies boundary to a maximum of about 400 feet. The Escarpment Member crops out as a northeast facing escarpment along the Mackenzie Highway from north of Desmarais Lake, southeast beyond the town of Enterprise. The scarp is typically between 70 and 100 feet in height. It is the dominant topographic feature in the relatively flat plain southwest of Great Slave Lake. The Escarpment Member is overlain conformably by the Twin Falls Formation.

TWIN FALLS FORMATION

The Twin Falls Formation includes the beds exposed along Hay River from a point 1 mile above Grumbler Rapids, downstream to the base of Alexandra Falls. A supplementary type section was designated by Belyea and McLaren (1962) in the Murphy Alexandra Falls No. 2 well.

The formation has an estimated thickness of 521 feet on Hay River and is 435 feet thick in the Alexandra Falls No. 2 well. It has been separated into an informally designated upper member, 420 feet thick and a lower Alexandra Member, approximately 135 feet thick at Alexandra Falls (see composite outcrop section S and Color Plate 9).

The upper member of the Twin Falls Formation is made up of variably bioclastic, locally reefoid, limestones and bioclastic limestones with some sandstone and siltstone beds. Belyea and McLaren report "small and medium-sized coral-stromatoporoid bioherms are developed at several horizons within the formation, the highest being the resistant unit which forms Grumbler Rapids on Hay River". Others are shown on Figure 7. The Alexandra Member consists of bioclastic and biohermal, light-gray, medium bedded to massive, resistant limestones. It forms the drop of Alexandra Falls on Hay River and Lady Evelyn Falls on Kakisa River.

Belyea and McLaren correlate the Twin Falls Formation with part of the Grosmont carbonates of the Red Earth area in northern Alberta, with part of the Ireton Formation of the Alberta subsurface, and with the lower part of the Southesk Formation of the Alberta Rocky Mountains. West of the map area in the vicinity of Foetus and Rabbit Lakes, the formation grades to shale and is included in the Fort Simpson Formation. Thus, the Twin Falls Formation of the map area forms a transition zone of intertonguing limestones, silty and argillaceous limestones and shales separating the Grosmont carbonate complex to the southeast from the Fort Simpson shales to the west.

TATHLINA FORMATION

The type section of the Tathlina Formation is in the Briggs Tathlina Lake No. 3 well at a depth between 340 and 780 feet (Belyea and McLaren, 1962). There it consists of grey calcareous siltstones, variably bioclastic, silty limestones, and sandy mudstones. The basal beds of the formation are exposed from about two and one-half to about four miles upstream from Grumbler Rapids on Hay River. They are made up bioclastic, sandy limestones interbedded with argillaceous limestones.

The Tathlina Formation overlies the Twin Falls Formation and is in turn overlain by calcareous sandstones and siltstones of the Redknife Formation.

The silty limestones and biogenic limestones of the formation give way to shales of the Fort Simpson Formation in the Kakisa Lake area and to the northwest.

REDKNIFE FORMATION

The type section of the Redknife Formation is on Trout River west of the map area where 231 feet of beds are exposed (Beiyea and McLaren, 1962). The formation has been divided into two members. The upper consists of greenish grey and maroon mudstones and shales with interbeds of limestone and calcareous sandstone. The lower, termed the Jean-Marie Member, is made up of argillaceous limestone with abundant fossil fragments. The upper member is about 250 feet thick and the Jean-Marie Member ranges in thickness from 30 to 50 feet.

The Redknife Formation is overlain by resistant silty limestones of the Kakisa Formation. The Redknife Formation can be mapped in the subsurface to the southwest into northwestern Alberta. There the formation looses identity and gives way to a continuous shale sequence.

KAKISA FORMATION

The type section of the Kakisa Formation is on Trout River west of the map area. There the formation is 187 feet thick and is made up of grey, silty, dolomitic limestones with bioclastic or reefoid developments occurring throughout.

The formation has been recognized in northeastern British Columbia and as far south as the flanks of the Peace River arch (Belyea and McLaren, 1962). South of the arch in central Alberta, the formation probably intertongues with the Graminia Formation and is locally missing probably as a result of pre-Trout River erosion.

The boundary between the Kakisa and the overlying Trout River Formations typically corresponds with a sharp change in lithology from biogenic limestones below to calcareous sandstones above.

TROUT RIVER FORMATION

The Trout River Formation as restricted by Belyea and McLaren (1962), consists of 130 feet of sandy limestones and calcareous sandstones that overlie the Kakisa Formation on Trout River.

The formation forms bedrock in the extreme southwest corner of the map area but is not exposed. There it is unconformably overlain by Cretaceous rocks. In the subsurface west of the map area, it is overlain by the Tetcho Formation. The irregular thickness of the Trout River Formation suggests it was deposited on the uneven surface of the underlying Kakisa beds. Belyea and McLaren report that the faunal break between the Kakisa and the overlying Trout River Formations is one of the most important in the Paleozoic. The Kakisa Formation carries a rich coral-stromatoporoid reef fauna and the Trout River Formation contains a sparse fauna of brachiopods.

CRETACEOUS

Cretaceous shales and sandstones unconformably overlie the eroded Paleozoic surface in several places along the western edge of the map area. They are resistant and form plateaus which stand between 700 and 1,200 feet above the surrounding terrain. As shown on the accompanying illustrations (Figures 5, 6, 7, and 8) Cretaceous rocks make up the Cameron Hills, Horn Plateau, Cartridge Mountain and also an unnamed plateau south of Leith Peninsula.

Cretaceous rocks are very poorly exposed in the map area but have been penetrated in exploratory wells. The thickest section is that of the Cameron Hills where approximately 1,800 feet of beds is present. They are characterized by an upper sandstone and siltstone unit (Fort Nelson Formation) and a lower shale succession (Fort St.John Group).

The Fort St. John Group is regarded as Lower Cretaceous and is typically about 1,000 feet thick. In the plains area to the west it is composed mainly of dark-grey, fissile, rusty weathering shales with ironstone concretions.

Shales of the Fort St.John Group are gradational with sandstone and shale comprising the Upper Cretaceous Fort Nelson (Dunvegan) Formation. The Fort Nelson Formation is characterized by coarse-grained, cross-bedded, massive sandstone with blocky mudstones, occasional coal beds and lenses of conglomerate.

Cretaceous beds overlie progressively younger, erosionally truncated beds from the Great Slave Lake area to the west. At one time they probably covered the entire map area but have since been largely removed, mainly by Cenozoic erosion.

QUATERNARY

Bedrock over much of the map area is mantled by a variable thickness of Quaternary deposits made up for the most part of glacial drift. Lake deposits are widespread in the areas near Great Slave and Great Bear Lakes and were deposited when these bodies of water were much larger than at present, during the glacial retreat. Stabilized sand dunes, formed from reworked lake sands, occur in the area north of Buffalo Lake and also west of the map area near Fort Simpson. Recent alluvium in the flood plains of major rivers also serves to conceal bedrock over parts of the map area.

In order to portray bedrock areal geology, Quaternary deposits have been mapped only in the valley of the Slave River, east of Pine Point, where they obscure all morphological expression of the underlying bedrock.

STRUCTURE

MAPPING TECHNIQUES

The structural interpretation presented on the areal geology maps accompanying this report (Figures 5, 6, and 7) is based on a variety of mapping techniques: field geology, subsurface geology, photogeology, structural cross-section work and geomorphic analysis, and also data from published and open file reports.

In those areas where bedding is well expressed, stereoscopic examination of contact prints of vertical air photographs provided the control for structural interpretation. Rates of dip of strata were estimated and assigned to dip classifications as shown on the legend of the maps. Faults and axes of folds observed on the air photographs were traced on them and transferred to the base maps. In other areas where the expression of bedding is poor and bedrock is mantled, the structural interpretation is locally based on geomorphic analysis. This involves the study of drainage patterns and development, topography, glacial geology, raised beaches, photographic tone, - in fact, all elements that make up the landscape. In these areas several geomorphic anomalies were mapped. A geomorphic anomaly may be described as a surface feature defined by geomorphic analysis and is interpreted to have positive structural and/or stratigraphic significance. Many are defined by radial and/or annular drainage patterns. They may also be based on and are sometimes accompanied by delicate tonal and/or topographic features observed on the air photographs.

Distinctive alignments, interpreted to indicate fractures, either joints or faults, are also shown on the areal geology maps. They are indicated by solid lines labelled "DA".

Structure of the Pine Point and Sulphur Bay mining areas is known from the many test holes drilled there in the exploration for minerals. The results of this exploration were reported by Malcolm (1956) and Campbell (1950, 1957) and were reviewed by Norris (1965).

STRUCTURAL GEOLOGY

The Great Slave - Great Bear Lakes area can be separated into two major structural provinces. These are the Interior Plains and the Precambrian Shield to the east. These structural units coincide with physiographic features and are shown on Figure 2. The map area lies along the eastern edge of the Interior Plains, a vast broad gentle structural basin. Strata of the map area dip regionally very gently to the southwest at about 12-35 feet per mile. The sedimentary succession has undergone very little deformation and the structural pattern reflects the relatively stable environment which has persisted since Precambrian time.

On the basis of origin, four types of structural features are known or can be expected in the map area. In the approximate order of their abundance and importance they are: 1. tectonic features such as faults and folds which presumably involve basement rocks, 2. compaction folds over irregularities such as basement hills and ridges, reefs and buried sedimentary escarpments such as the escarpment along the southern limit of Ordovician rocks. 3. solution collapse phenomena, which are not now known in the map area but may occur in beds overlying the Chinchaga evaporites (Horn River and Lonely Bay Formations) and also in limestones overlying the Nyarling Formation (Slave Point Formation) and 4. structures resulting from the intrusion of igneous rock. Igneous intrusions are known only in the Precambrian sedimentary rocks of the Leith Peninsula but may also occur in younger sediments. Mineral deposits resulting from hydrothermal action are known in the Pine Point mining area and may be associated with the East Arm fault zone.

Structural features of tectonic origin are known at many localities in the map area. Included are faults, folds and broad uplifts active both during and after the deposition of the sedimentary cover. Tectonic trends to the northeast, and perhaps also those to the northwest, are partly responsible for depositional limits and marked facies changes in early Paleozoic rocks in the map area. In other cases deposition was restricted by irregularities on the Precambrian surface which have remained basically unchanged since Middle Ordovician time.

Thus, irregularities on the Precambrian surface can be separated into two general categories for discussion. These are: 1. tectonically active features such as broad uplifts and fault zones which have been active during and/or after the deposition of Ordovician and Devonian beds and 2. irregularities on the Precambrian surface such as hills and ridges, which have remained basically unchanged since Middle Ordovician time.

Irregularities of the Precambrian surface, which are known or are assumed to have been tectonically active since Precambrian time are widespread in the map area. They include broad uplifts and depressions. Of these the Tathlina uplift is the largest feature and has had the greatest effect on the sedimentary section. Silurian and Ordovician rocks are absent over the uplift, probably due to emergence and erosion during the Caledonian orogeny in late Silurian and/or early Devonian time. An alternate interpretation is that Silurian and Ordovician rocks are absent over the uplift due to nondeposition. The Tathlina uplift slowly subsided during the deposition of Mirage Point and Chinchaga beds but was not covered by Middle Devonian seas until early Pine Point time. Since then the uplift has apparently been tectonically stable in comparison with the surrounding Precambrian terrain. However, subsequent local structural movements, such as gravity and block faults, probably have taken place and followed pre-existing structural trends and patterns probably with a northeast and/or northwest orientation.

A southwesterly trending Precambrian high, named the Fort Rae arch (Douglas and Norris, 1960) is indicated along an approximate line trending southwest from Old Fort Rae to near Fort Providence (central and southern areal geology map sheets, Figures 6 and 7). Exposures along the west edge of the Precambrian Shield indicate the Fort Rae arch was mildly positive before and/or during the deposition of Middle and Upper Ordovician rocks. This is suggested by the absence of Old Fort Island sandstones at Old Fort Rae and by thinning in the overlying La Martre Falls and Chedabucto Lake Formations which are exposed southwest across the North Arm of Great Slave Lake. Moreover, a series of Precambrian hills and ridges, which form a topographically high area on the eroded Precambrian surface, are exposed south of Old Fort Rae. Beds of the La Martre Falls Formation wedge out against the Precambrian features. To the southwest the Fort Rae arch is believed to merge with the Tathlina uplift. Thus the southwestern portion of the Fort Rae arch is believed to have a tectonic history similar to that of the Tathlina uplift. The outcrop belt of the Lonely Bay Formation suggests that mild tectonic activity along the Fort Rae arch may have influenced these beds also.

Topographic features on the eroded Precambrian surface, which are presumed to have persisted more or less unchanged since early Paleozoic time, are known at many localities northwest of Great Slave Lake. For the most part they are hills and ridges of resistant crystalline rock which are locally as much as 500 feet higher than the surrounding Precambrian surface. Cross-section G-M (Figure 8) illustrates several such features in the area southwest of the community of Rae. Inliers of Precambrian rocks are mapped in the Ordovician and in some cases in the Devonian outcrop belts at many localities on the central and northern areal geology map sheets northwest of Great Slave Lake. In the Lac La Martre - Hottah Lake area, ridges of Precambrian rock, comprising faults and quartz stock works (giant quartz veins) extend from the western edge of the Precambrian Shield beneath the sedimentary cover. Their orientation is between 209° and 246° true. Northwesterly trending tectonic features, including Precambrian ridges presumed to be giant quartz veins, distinctive alignments and faults occur in the area west and northwest of the North Arm of Great Slave Lake. Structural features with a northwesterly trend are less well developed and less abundant than those to the northeast. No evidence was observed for post-Precambrian movement. Ordovician, and in some cases Devonian strata wedge out against the ridges and hills. Similar features are probably common in the subsurface west and northwest of Lac La Martre.

Faults and fault zones, typically trending to the northeast, are indicated in at least six localities of the map area. From south to north these include the Bell Rock area, Pine Point area, Prairie Lake-Sulphur Bay area, Gypsum Bay - Lonely Bay area, the northwest limit of the Middle Devonian carbonate bank and also the "McTavish Arm" fault zone. The structure of these features can be summarized as follows.

Faulting is indicated in an outcrop of the Middle Devonian Chinchaga Formation at Bell Rock in the extreme southeast corner of the map area (See Color Plate 3). Brecciated carbonates occur on the east side of the fault which strikes about north 20° east and dips nearly vertically. Norris (1965) reports the apparent vertical displacement is about 12 feet or probably more and that the east side, with brecciated beds, is downthrown. The breccias may result from tectonic movement during their deposition.

In the Pine Point mining area and to the northeast along the East Arm of Great Slave Lake is a zone of faulting referred to as both the East Arm and the MacDonald Fault zone (Burwash, 1957; Douglas, 1959b; Norris, 1965; G.S.C. Map 4-1965 and Baragar, 1966). Recurrent movement of faults on the shield along the East Arm of Great Slave Lake is reported by Burwash. Three major faults are reported there, northeast of the delta of Slave River, and can be traced to the western limit of the Precambrian Shield. A graben is developed along the south shore of the lake. The walls of the graben are composed predominantly of granite gneiss. The floor is underlain by gently dipping conglomerates and quartzites. This structural trend extends to the southwest and closely corresponds to several features in the Pine Point area and along a trend southwest toward Buffalo Lake. These include lineaments and aeromagnetic anomalies interpreted as faults by Douglas (1959b) and Sikabonyi and Rogers (1959) and also numerous closely spaced, gentle flexures in the form of anticlines, synclines, domes and basins as well as minor faults, all trending more or less between 240° and 245° true (Campbell, 1950 and 1957 in Norris, 1965). The southeastern limit of the Middle Devonian carbonate bank (described elsewhere) also closely corresponds with the southwesterly trend of the East Arm tectonic zone and is believed to be controlled in part by this feature. Thus fault movement and folding along this structural trend are indicated in Precambrian time and both during and after Middle Devonian deposition. Moreover, Baragar suggests that a ready channelway to molten rocks at depth is certainly provided by the faults which pass beneath the sedimentary succession in the Pine Point area. Baragar suggests this may be the origin of the lead and zinc mineralization in the Presqu'ile dolomites.

On the northwest shore of Great Slave Lake a north-trending fault zone is indicated in the Windy and Sulphur Bay areas and along the east side of Prairie Lake. There the west margin of the Presqu'ile Formation is a remarkably straight line trending about north 10° east and is believed to be fault controlled (see cross section H-P and Color Plate 25). Movement along this fault in Presqu'ile time may have controlled reef growth. The west limit of the Presqu'ile beds in the Prairie Lake area represents an abrupt wedging out of the coarsely crystalline dolomite facies and has been referred to as a reef front (Norris, 1965). The Hay River Formation of Upper Devonian age, overlies Presqu'ile dolomites in the area southeast of Prairie Lake

(Color Plate 24) and is believed to have been deposited after fault movement along the Prairie Lake - Windy Bay zone.

A distinctive, south-facing escarpment was observed on the northwest shore of Great Slave Lake, trending west from Gypsum Bay, to north of Lonely Bay (see south areal geology map sheet, Figure 7). The scarp extends for some 30 miles and is locally as much as 75 feet in height. The western portion is underlain by limestones of the Lonely Bay Member of the Pine Point Formation and lies along an easterly-trending development of sinkholes in that formation. It is believed that this scarp may be the surface expression of a fault. Faults such as this may have locally controlled the northwestern flank of the Middle Devonian carbonate bank (described elsewhere).

The approximate northwestern limit of the Middle Devonian carbonate bank extends from north of Kakisa Lake, generally northeast beyond Dieppe Lake to about latitude 62° north. The carbonate front may be locally controlled by faulting. A north-easterly trending fault is mapped in the area south of Fort Providence. The south side is downthrown. This may represent post-Devonian movement along a structural trend as described above.

The "McTavish Arm" fault zone, on the south shore of Great Bear Lake, trends about north 40° east and extends from beneath the Cretaceous cover west of Hottah Lake, generally northeast for many miles beyond the map area. Movement on the fault zone has greatly influenced the sedimentary succession of the Leith Peninsula to the northwest. Subsidence of the Leith Peninsula northwest of the fault zone is indicated in late Precambrian and perhaps again in Cambrian (?) time. The Leith Peninsula and rocks along the "McTavish Arm" fault zone were uplifted above sea level prior to or during the deposition of La Martre Falls beds. Tectonic activity along the "McTavish Arm" fault zone is interpreted from brecciation in the Chedabucto Lake dolomites in the area west of Hottah Lake. Post-La Martre Falls movement along the fault zone is also indicated in the area 8 miles south of Yeta Lake. There La Martre Falls beds dip to the southeast away from the fault zone (see Color Plate 52). Dolomites of the Chedabucto Lake Formation were offset by the fault zone (see cross section A-J) probably during movement which affected the La Martre Falls Formation as described above. Cretaceous rocks cover the southwesterly extension of the fault zone and are apparently not offset. The possibility of movement along the "McTavish Arm" fault zone during or after Devonian time can be inferred from the history of similar tectonic trends in the map area. However, post-Ordovician, pre-Cretaceous rocks are absent along the outcrop.

HISTORICAL GEOLOGY

Precambrian rocks of the Canadian Shield adjacent to the Great Slave - Great Bear Lakes area were emplaced or deformed during two major Precambrian orogenies (Geological Survey of Canada, Map 4-1965). The earliest of these orogenies is termed the Kenoran and took place in the Archaean Eon some 2.4 billion years ago. Precambrian rocks generally east and southeast of the village of Rae are made up for the most part of granitic intrusions and gneisses emplaced or metamorphosed during the Kenoran orogeny.

The next phase of orogenic activity occurred in early Proterozoic time during the Hudsonian orogeny, 1.7 billion years ago. The crystalline basement west and northwest of Rae is made up in large part of granitic intrusions emplaced at this time.

The northeast shore of Great Bear Lake is indicated by Map 4-1965 to be underlain by late Proterozoic, unfolded or gently folded rocks which include sandstone, dolomite, basalt and gabbro sills. Similar rocks underlie Leith Peninsula on the south shore of Great Bear Lake and thus may have been deposited in late Proterozoic time during subsidence of the Leith Peninsula northwest of the "McTavish Arm" fault zone. Subsequently, strata of the Leith Peninsula were intruded by diabase sills, then probably uplifted and eroded before Cambrian time.

The geological history of the Cambrian Period is generally unknown. Sandstones of probable Cambrian age were deposited on the Leith Peninsula. Elsewhere in the map area Cambrian rocks are believed absent due to nondeposition and/or pre-Middle Ordovician erosion. Cambrian rocks may have been deposited over the map area as they are present to the north in the Hornaday River area, to the west in the Mackenzie Mountains and to the south in central Alberta.

The map area is believed to have been positive in early Ordovician time. Gradual subsidence began in Middle (?) Ordovician time and beach sands of the Old Fort Island Formation were deposited over much of the area during the marine advance. Later in Middle Ordovician time most of the map area was covered by a shallow, partially restricted sea in which red and green interbedded shales, dolomites and siltstones of the La Martre Falls Formation were deposited. The beds contain many shallow water indications such as salt casts, ripple marks, mud cracks and worm burrowings. Part of the Great Bear Lake area, northwest of the "McTavish Arm" fault zone, remained positive or was uplifted during La Martre Falls time. Approximately 800 feet of La Martre Falls beds accumulated in the area to the south (west of Hottah Lake). Thus, the southeastern margin of the "McTavish Arm" fault zone may have been a scarp 800 feet or more in height formed before and/or during the deposition of La Martre Falls strata.

Subsidence continued into late Ordovician time and in less restricted waters, biogenic and partly bioclastic carbonates, probably limestones, were deposited. The beds have subsequently been recrystallized to aphanitic dolomite (Chedabucto Lake Formation). From time to time, at least in the western portion of the area, the Chedabucto Lake seas were restricted and thin evaporite beds were deposited. Brecciated dolomites accumulated in the area southwest of Leith Peninsula perhaps as a result of fault movement along the "McTavish Arm" fault zone.

Marine deposition may have continued from late Ordovician into Silurian time in the Great Slave - Great Bear Lakes area. If so it was terminated in the map area and also over western Canada by Caledonian earth movements in late Silurian and early Devonian time. As suggested by Grayston et al (1964) the surface of the resulting landmass is believed to have been hilly. These hills were formed in several areas of western Canada including the Tathlina and Fort Nelson uplifts and the Peace River arch. During and following Caledonian earth movements, the landmass was eroded. Ordovician and Silurian rocks were removed from the Tathlina uplift - Great Slave Lake area as far north as the Horn Plateau. Thus, prior to subsidence in Middle Devonian time, a south facing escarpment marked the southern limit of Ordovician beds and extended from north of the Horn Plateau east to the North Arm of Great Slave Lake. South of the escarpment stood the Fort Rae arch (?) and Tathlina uplift with Precambrian rocks at the surface.

The deposition of Mirage Point beds began in Middle (?) Devonian time with the slow submergence of the landmass and the accumulation of beach sandstones. The basal sandstones are thickest in the Sulphur Bay area. Subsidence continued and a variable succession of red beds was deposited under arid climate conditions in a shallow generally restricted sea which slowly advanced over the flanks of the Tathlina uplift. The marine advance continued and during the deposition of evaporites of the Chinchaga Formation the seas nearly covered the Tathlina uplift. Chinchaga evaporites covered the Ordovician escarpment north and east of the Horn Plateau.

The remarkably widespread evaporites of the Chinchaga Formation indicate a restricted lagoonal environment over a vast stable shelf and deposition in an arid climate. The restricted Chinchaga seas extended from north of the Peace River arch (Grayston et al, 1964, page 52) north to the Great Slave Lake area and northwest along the northeast flank of the Tathlina uplift beyond the map area to the site of the present Franklin Mountains (Douglas et al, 1963, Fig. 10). Thus the seas were restricted to the south by an eastern extension of the Peace River arch, to the west by the Tathlina uplift and to the northwest by a positive (?) area developed along the approximate trend of the present Franklin Mountains.

A gradual transition to more normal, open marine conditions is indicated by widespread carbonate rocks which were layed down on the Chinchaga evaporites. These carbonates include the Little Buffalo dolomites and limestones, the lower mainly limestone unit of the Pine Point Formation, the Lonely Bay Formation and the Keg River carbonates.

Subsidence continued and in early Pine Point time, the first beds of the Middle Devonian carbonate bank were deposited in the Great Slave Lake area. The carbonate bank persisted until late Slave Point time. The carbonate bank consists of limestones and dolomites with some shale, and is bounded to the southeast by a line trending from the northwest side of Buffalo Lake generally northeast to the Pine Point mining area. It is bounded to the northwest by a line trending from north of Kakisa Lake generally northeast beyond Dieppe Lake (see Figures 7 and 8).

During the accumulation of Nyarling evaporites, the Middle Devonian carbonate bank restricted marine circulation and separated the evaporitic environment to the south (Nyarling Formation) from a restricted marine environment to the northwest where dark shales (Horn River Formation) accumulated in a humid climate. Biostromes and bioherms developed in Presqu'ile time over portions of the carbonate bank, as in the area between the Pine Point mining centre and Alexandra Falls, and also east of Prairie Lake. It is believed that these beds have subsequently been recrystallized to mainly coarse crystalline, vuggy dolomites (Presqu'ile Formation).

The Middle Devonian carbonate bank may have resulted in part from movement along northeasterly trending faults in Middle Devonian time. Locally the main facies changes on the flanks of the carbonate bank, and reef growth on the crest, show a relationship to faulting. A similar relationship between facies changes, reef growth and regional tectonic features including faults is reported by Sikabonyi and Rogers (1959, page 216), Dyson and Hays (Oilweek, January 10, 1966) and Norris, (1965, page 88).

Isolated carbonate build-ups are known northwest of the carbonate bank at two localities, and are interpretated elsewhere (see discussion of Horn Plateau Formation). The two known carbonate build-ups are the Horn Plateau Formation and the Falaise Lake build-up northwest of Sulphur Bay (see cross-sections A-J and H-P and Plates 1 and 2). Limestones of the Lonely Bay Formation, or perhaps younger beds, may have formed the platform for the development of these reefal beds.

The green shales and reworked (?) deposits of the Watt Mountain Formation suggest a minor marine regression in the area west and south of Great Slave Lake. Later, in the area southeast of Great Slave Lake, the evaporitic environment of the Nyarling facies changed rather abruptly to open marine conditions. Thus, during Slave Point time, fossiliferous limestones were deposited over the Nyarling evaporites and also over the Middle Devonian carbonate bank. The absence of Slave Point limestones northwest of the carbonate bank is believed primarily due to facies change to shales of the Horn River Formation and is possibly due to pre-Hay River erosion.

A minor marine regression may have occurred over the map area at the close of Middle Devonian time. Upper Devonian sedimentation began with deposition of the thick Hay River shales. The shale basin extended some distance to the west and as far south as central Alberta where the beds grade into carbonates. As Upper Devonian subsidence and deposition continued, the carbonate front marking the boundary between carbonates to the southeast (shallow water deposits) and shales to the northwest (deeper water deposits) progressed slowly to the west across northern Alberta (Belyea, in A.S.P.G., 1964, page 83).

A similar migration of the carbonate front to the west and northwest during Upper Devonian time is indicated for the Great Slave Lake area. The carbonate front was generally within, or northwest of, the map area during the deposition of the Escarpment Member of the Hay River Formation and the Twin Falls and Tathlina Formations. The front extended in a west-southwesterly direction across the southern tip of Kakisa Lake. To the northwest, shales accumulated in deeper water (Fort Simpson Formation). The general westward migration of the Upper Devonian carbonate front continued, and during the deposition of Redknife and younger beds, was well west of the map area. During the deposition of the Tetcho and Trout River carbonates, the carbonate front lay in northeastern British Columbia and extended in a northerly direction into the Northwest Territories.

Belyea (in A.S.P.G., 1964, page 83) reports that the Grosmont carbonates, which correlate readily with the Tathlina and Twin Falls Formations of the map area, become increasingly silty eastward and northeastward, suggesting the possibility that the source lay in that direction. Sandstone and siltstone are common, and locally abundant, in the Twin Falls, Tathlina, and Redknife Formations of the Great Slave Lake area. A similar northeasterly source for these terrestrial clastics seems probable.

The history of late Upper Devonian to early Cretaceous time must be inferred from rocks present elsewhere in western Canada as strata of these ages are absent in the Great Slave - Great Bear Lakes area.

Over the Peace River arch to the south, deposition appears to have been continuous from Devonian to Mississippian and into at least early Pennsylvanian time. Uplift followed in late Pennsylvanian to early Permian time and the Carboniferous and Devonian rocks were truncated. Subsequent cycles of marine transgression, uplift and truncation are recorded in the sedimentary succession of the Peace River area. These include uplift and erosion in late Permian to early Jurassic time, late Triassic to early Jurassic time and also in late Jurassic to early Cretaceous time.

However, it is believed that the late Pennsylvanian to early Permian period of erosion removed the greatest volume of Carboniferous and Devonian beds and produced the greatest angular discordance on the eroded Paleozoic surface of the Peace River area. Accordingly, the greatest volume of Devonian rocks may also have been removed from the Great Slave - Great Bear Lakes area during late Pennsylvanian to early Permian erosion. Carboniferous rocks may have covered the map area prior to this period of erosion.

Permian, Triassic and Jurassic rocks are not present in the map area but are known to the southwest and west and may at one time have been deposited as far east as Great Slave Lake. If so they were probably quite thin and were removed by erosion before the early Cretaceous marine advance.

In early Cretaceous time the Great Slave - Great Bear Lakes area subsided and shales of the Fort St. John Group were deposited. Subsidence continued into Upper Cretaceous time during accumulation of the sandstones and siltstones of the Fort Nelson Formation. A period of uplift and possible erosion is indicated in post-Fort Nelson time (Turonian) west of the map area along the Liard River, where the Fort Nelson Formation is overlain by the Kotaneelee Formation. Rocks of Turonian age appear to be absent and, as suggested by Williams and Burk (in A.S.P.G., 1964, p. 188), the area may have been a source for sands of the Cardium Formation of Alberta.

The map area again subsided later in Upper Cretaceous time and deposition of clastic rocks probably continued until broad regional uplift occurred in early Tertiary time. The Great Slave - Great Bear Lakes area has probably remained positive from early Tertiary time to the present.

OIL and GAS PROSPECTS

The oil and gas potential of the Interior Plains within and west of the Great Slave - Great Bear Lakes area is considered excellent. Strata regarded as potential reservoir beds in the subsurface are exposed in the map area where they locally contain oil and signs of oil and excellent porosity. The stratigraphic succession contains numerous potential source rocks for oil and gas. Possible traps include bioherms, updip-pinchouts of porous and permeable zones, and structural closure resulting from folds and faults.

The presence of hydrocarbons in the Great Slave Lake area is indicated by oil seeps such as those on the northwest shore of the lake (see Color Plates 26 and 27) and bituminous shales such as on the south shore of the lake in the Pine Point Formation and also those at the base of the Horn River Formation. From a regional basis, gas is produced from the Slave Point Formation to the southwest in northeastern British Columbia. Production from the Rainbow member of the Keg River Formation in northwestern Alberta enhances the prospectiveness of the report area, as correlatives are present in the Lonely Bay limestones. To the northwest oil is produced at Norman Wells from reefal beds which are correlated approximately with the Slave Point and possibly with the Horn Plateau Formations. Several wells west of the map area in the Northwest Territories are classified as capable of production. These include wells with oil or gas in the Slave Point Formation and Elk Point Group or their correlatives. In the Cordilleran Region of the southern Northwest Territories, gas has been discovered in Middle Devonian carbonates in the Kotaneelee and Pointed Mountain areas. In the Interior Plains significant gas discoveries have been made in Middle Devonian carbonates in the northern part of the Liard Basin at Imperial Sun Netla F-7, on the Celibeta uplift and in Slave Point reefs in the Island River and Trainor Lake areas south and southeast of Trout Lake. Shows of gas were encountered in the Briggs Rabbit Lake No. 1 and No. 3 wells located about 20 miles west of Kakisa Lake. Shows of oil and gas have also been recorded during drillstem tests in other wells.

Rocks regarded as potential source beds for oil and gas are present within and west of the map area. These include the basal shale succession of the La Martre Falls Formation, the shales and bituminous shales of the Pine Point Formation, the shales and bituminous shales of the Horn River Formation, biostromal and biohermal beds of the Middle Devonian carbonate bank, and shales of the Hay River and Fort Simpson Formations. In addition, bioherms, biostromes and carbonates with interfingering shales are present in the Upper Devonian succession southwest of Great Slave Lake and are also regarded as potential source rocks.

Several types of traps can be visualized. Up-dip pinchouts and wedge outs of porous and permeable beds are prospective in Ordovician and Middle Devonian units. Carbonate build-ups including biostromes and bioherms are known on the Middle Devonian carbonate bank (described elsewhere) and also to the northwest. Thus, the sedimentary succession offers many potential targets for petroleum exploration.

In the paragraphs that follow the oil and gas prospects of possible reservoir beds in the map area are discussed.

Rocks of Ordovician and probable Ordovician age contain several zones which are regarded as potential stratigraphic traps for oil and gas. These include beach sandstones of the Old Fort Island Formation, oolitic dolomites of the Mazenod Member of the La Martre Falls Formation and vuggy, biogenic dolomites of the Chedabucto Lake Formation. Where present, the Old Fort Island Formation is made up mainly of very porous and permeable sandstones which would be excellent reservoirs. The formation is believed absent over topographic highs on the eroded Precambrian surface. Thus, up-dip wedge outs can be anticipated. Fine-grained shales of the overlying La Martre Falls Formation constitute the only apparent source for any oil and gas now trapped in the Old Fort Island sandstones. The Mazenod Member of the La Martre Falls Formation would be an excellent reservoir. It occurs near the base of the formation and has a setting similar to the Old Fort Island Formation in that it occurs at the base of the sedimentary succession. The overlying shales of the La Martre Falls Formation are also regarded as the most likely source beds for any oil and gas trapped in the Mazenod Member which is locally porous and oolitic. The subsurface distribution of the Mazenod Member is somewhat more predictable than the Old Fort Island sandstones and may be expected at sufficient depth for petroleum exploration in the Cartridge Mountain - Lac La Martre area. Where present the Mazenod Member probably does not exceed 100 feet in thickness.

The upper beds of the Chedabucto Lake Formation often contain poor and locally fair vuggy porosity and are biogenic. It is possible to envision stratigraphic traps resulting from up-dip pinchouts of porous beds in the formation in the western portion of the map area, north of the Imperial-Windflower dryhole. However, it is believed that a more attractive region for Chedabucto Lake stratigraphic traps lies west of the map area, southwest along the trend of the "McTavish Arm" fault zone. Reef growth in the Chedabucto Lake beds may be present there in association with fault movement. Reefal development in beds regarded as correlative with the Chedabucto Lake biogenic dolomites is known in the Mt. Kindle Formation farther west.

Additional stratigraphic oil accumulations can be visualized where porous Ordovician beds are sealed by overlying Devonian rocks including possible erosional outliers south of the Ordovician escarpment (discussed elsewhere).

Oil accumulations may occur in the basal sandstone unit of the Mirage Point Formation comparable to those in the Gillwood sandstones of the Peace River arch and northern Alberta. Up-dip pinchouts of the basal sandstones and other porous and permeable beds in the Mirage Point Formation are prospective especially where they wedge out to the northeast against the Ordovician escarpment.

Limestones of the Chinchaga Formation locally exhibit fair and good interparticle and vuggy porosity. These beds occur mainly in the middle and upper part of the formation and should be regarded as potential oil reservoirs. Traps could be formed by up-dip pinchouts of porosity and permeability within and west of the map area.

Limestones of the Lonely Bay Formation may have formed a platform for the development of isolated reef masses in the area generally northwest of the Middle Devonian carbonate bank (described elsewhere in this report). Isolated carbonate build-ups are known northwest of the carbonate bank at two localities, and can be interpreted from geomorphic evidence elsewhere. The two known carbonate build-ups are the Horn Plateau reef, which crops out a few miles east of the east end of the Horn Plateau, and the Falaise Lake build-up northwest of Sulphur Bay (see cross sections A-J and H-P and Plates 1 and 2). Geomorphic anomalies such as those indicated on the areal geology maps (Figures 6 and 7) may also be the surface expression of biohermal development resting on Lonely Bay or younger limestones. Similar carbonate build-ups may also occur down-dip from the Horn Plateau Formation outcrop and to the southeast. The down-dip or southwesterly trend is suggested by the trend of the Middle Devonian carbonate bank and other stratigraphic features which are believed to be partly controlled by faults. Biohermal development in the Lonely Bay (or younger) beds invites comparison with the prolific Rainbow Member of the Keg River Formation of northwestern Alberta (Hriskevich, 1966).

The Middle Devonian carbonate bank (discussed elsewhere), comprising the Pine Point, Presqu'ile, Sulphur Point and Slave Point Formations of the Great Slave Lake area offers a variety of potential stratigraphic traps for oil and gas. Outstanding among these are biostromal and biohermal build-ups such as those of the Presqu'ile Formation. The white, coarsely crystalline, extremely vuggy dolomites of the Presqu'ile Formation would be excellent reservoirs.

Limestones and dolomites of the Middle Devonian carbonate bank are locally petroliferous, oil stained, oil saturated, and in the Sulphur Bay area, contain oil and sulphur seeps. Petroliferous zones in the Pine Point Formation such as the bituminous shale and limestone member, exposed on the south shore of Great Slave Lake are regarded as excellent source beds.

Carbonate build-ups in the Slave Point Formation along the northwestern front of the Middle Devonian carbonate bank such as occurs in the Deep Bay area, are anticipated elsewhere.

Bioherms and biostromes are present in the Upper Devonian carbonate unit southwest of Great Slave Lake, within and beyond the map area. They are known in many of the formations above the Hay River shale and offer prospective targets for shallow drilling.

Respectfully submitted,

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Plate 5

Sulphur seep near Mellor Rapids on Buffalo River.

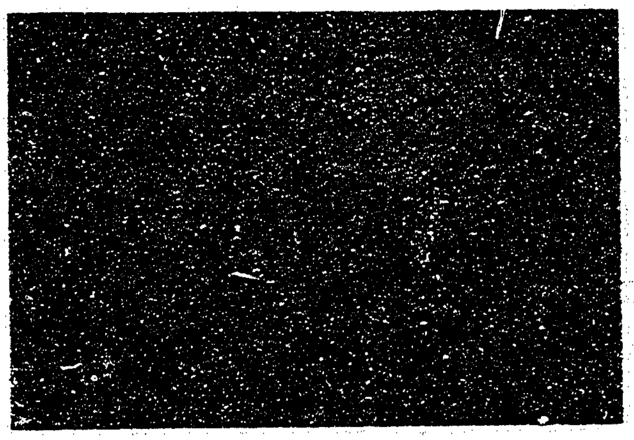

Plate 6

Pitted surface resulting from weathering of stromatoporoids in talus of Pine Point Formation, one half mile southeast of Pine Point on Great Slave Lake.

Plate 9

Section below Alexandra Falls on west bank of Hay River. View downstream (north) showing Upper Member (upper 20 feet of section) and underlying Alexandra Member of Twin Falls Formation.

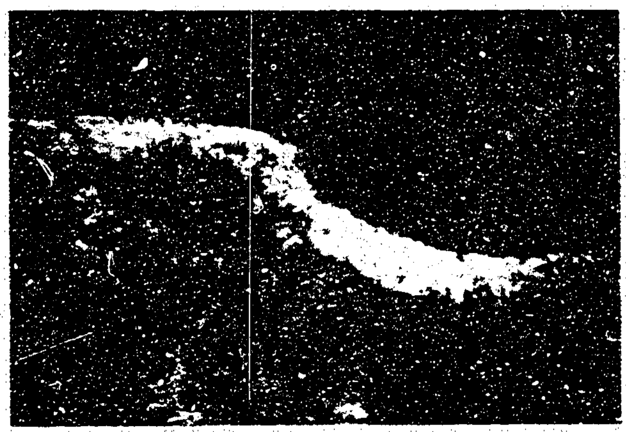

Plate 10

White cliff formed in gypsum of the Chinchaga Formation, 3 miles below falls on Little Buffalo River west of Fort Smith, view north.

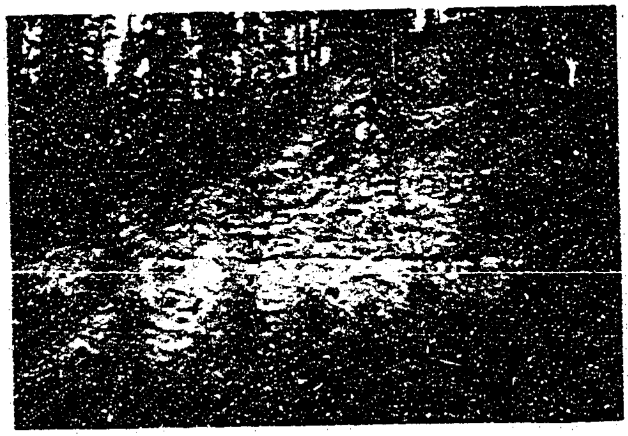

Plate 15

Nyarling Formation exposed in sinkhole 52 miles west of Bell Rock. Gypsum (white) and dolomite (buff).

Plate 16

Core from Pine Point area boreholes stored near north end of Pine Point airstrip.

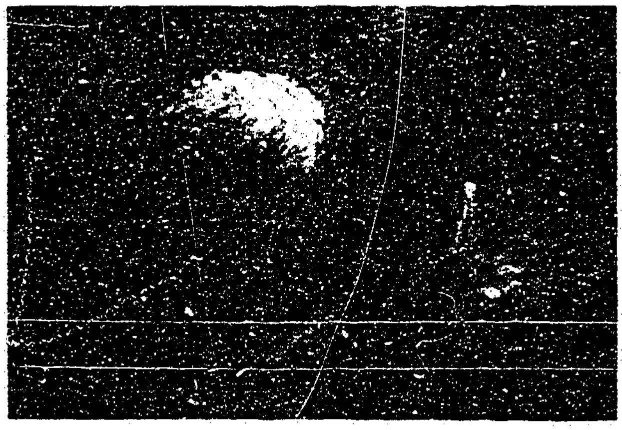

Plate 17

Sinkhole in Slave Point Formation 28 miles south of Pine Point airstrip. Sinkhole is about 100 feet deep. Note fire tower and cabin.

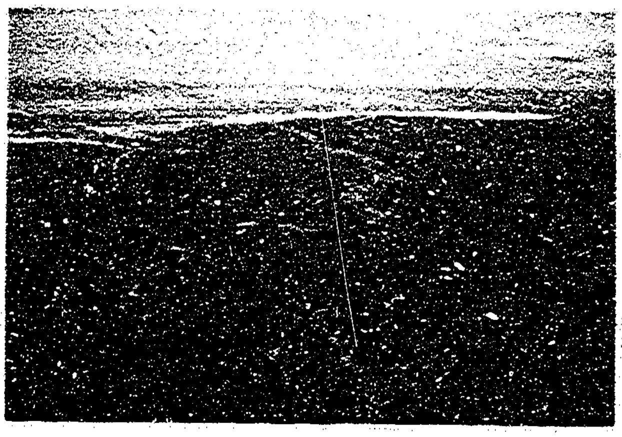

Plate 18

South shore of Great Slave Lake. View east from 3000 feet above mouth of Buffalo River. Breynat Point in foreground, Sulphur Point in middleground.

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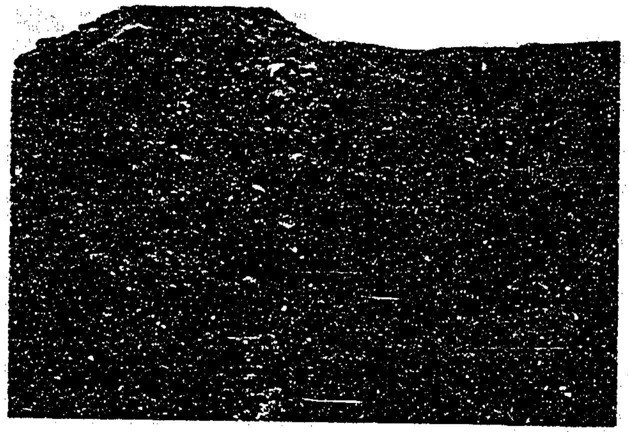


Plate 3

Faulted breccia of the Chinchaga Formation at Bell Rock near Fort Smith.

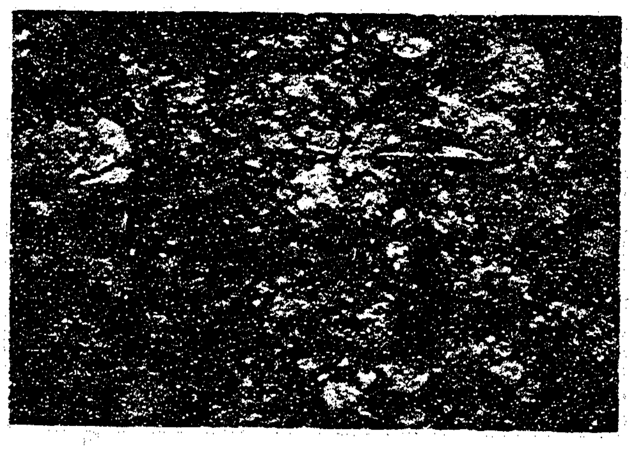


Plate 4

Stromatoporoids on weathered surface of Slave Point Formation at Mellor Rapids on Buffalo River.

Plate 7

Typical lake-shore outcrop. Pine Point Formation at Pine Point on Great Slave Lake, view southwest.

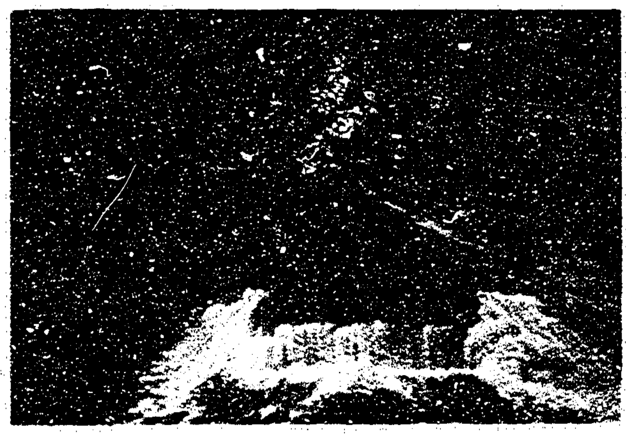


Plate 8

Louise Falls on Hay River. Drop of the falls is in the Escarpment Member of the Hay River Formation.

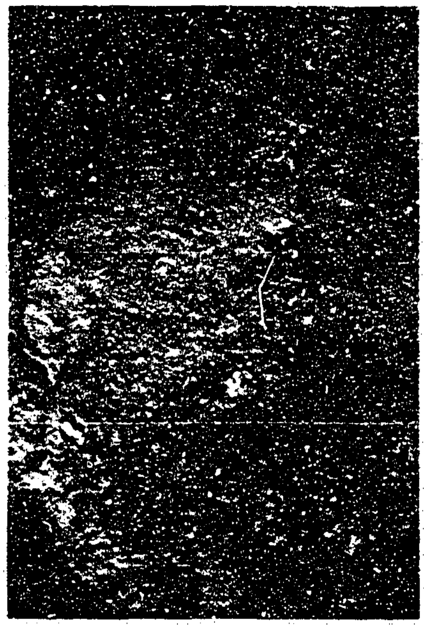


Plate 13

High grade lead sulphide ore from main pit of Pine Point Mines Ltd. at Pine Point.

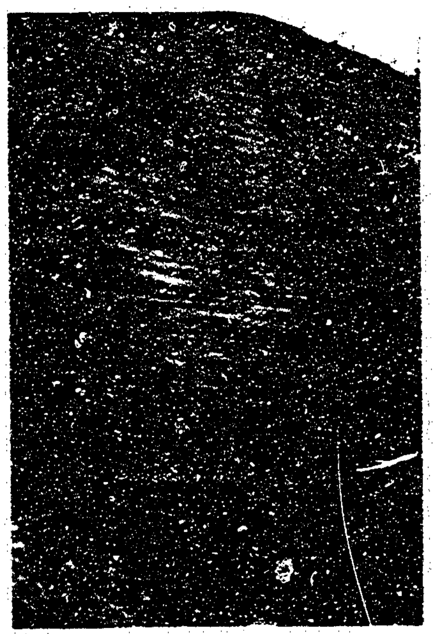


Plate 14

Section at falls on Little Buffalo River west of Fort Smith. Limestones and dolomites of the Little Buffalo Formation overlying Chinchaga Formation gypsum (white bed at base of cliff).

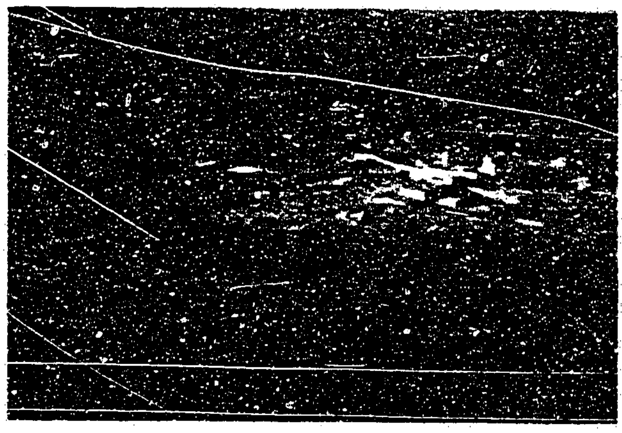


Plate 19

Concentrator at Pine Point. Capacity of 5,000 tons of lead and zinc ore per day.

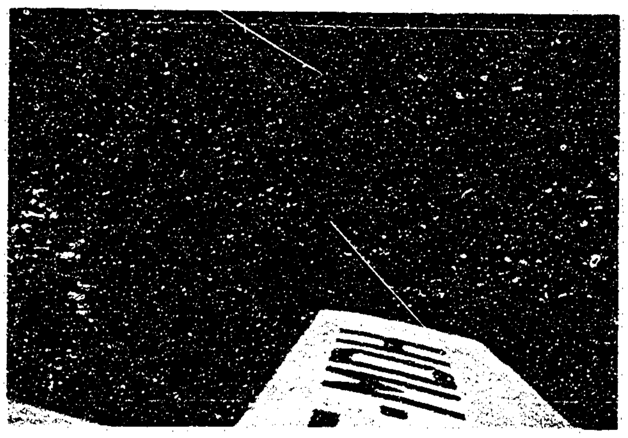


Plate 20

Horn Plateau reef. View east showing circular pattern

Plate 21

Horn Plateau reef. View southeast over north edge. Note "stack and pillar" erosional character.

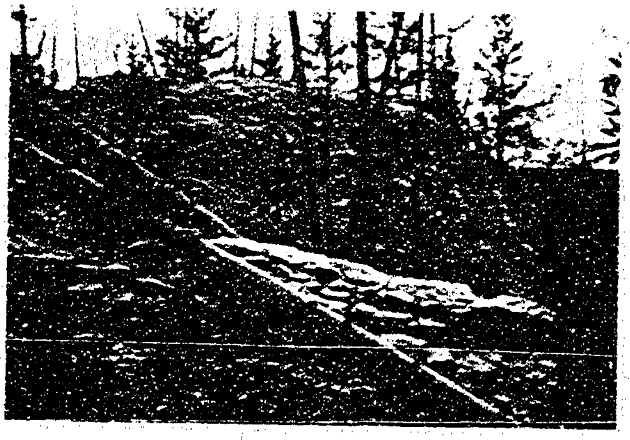


Plate 22

Horn Plateau reef. Limestones dipping 4°± to right (north) away from reef proper. View west at north end of Horn Plateau Formation exposures.

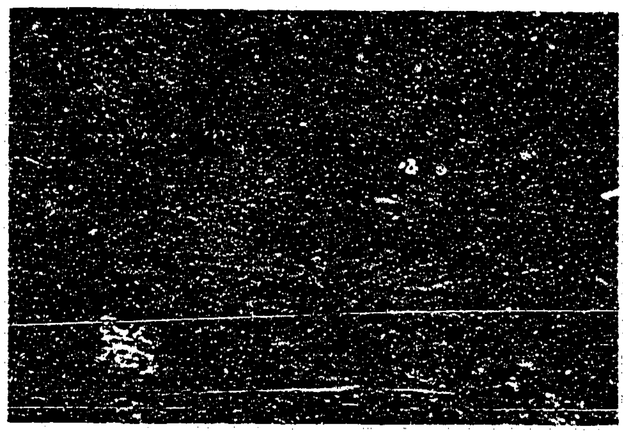


Plate 23

Biohermal limestones of Horn Plateau Formation. 90% of rock made up of coral. Note large ?Favosites below hammer.

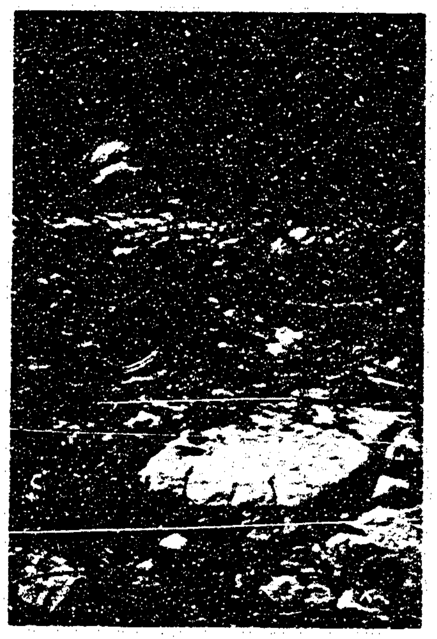


Plate 24

Limestones of the Hay River Formation (beneath pack) overlying Presqu'ile Formation dolomites (foreground). Two miles south-east of Prairie Lake.

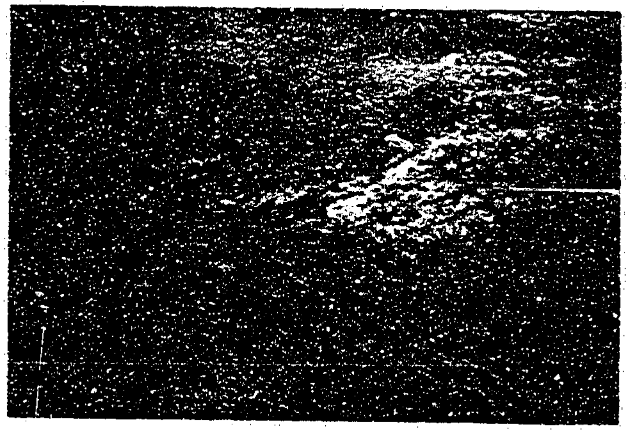


Plate 25

Western edge of Presqu'ile Formation outcrop (rough terrain) and contact with Hay River Formation (to left). View north from one mile southeast of south tip of Prairie Lake. Beds dip 26° west at contact.

Plate 26

Oil seep along joint in Presqu'ile Formation dolomites. Shore of Great Slave Lake 1.5 miles southeast of Horncastle Point. Note shadow of helicopter bubble (upper left) and large vugs.

Plate 27

Oil saturated sand in sulphur seep on south shore of Sulphur Bay, 2.6 miles west of Goose Point.

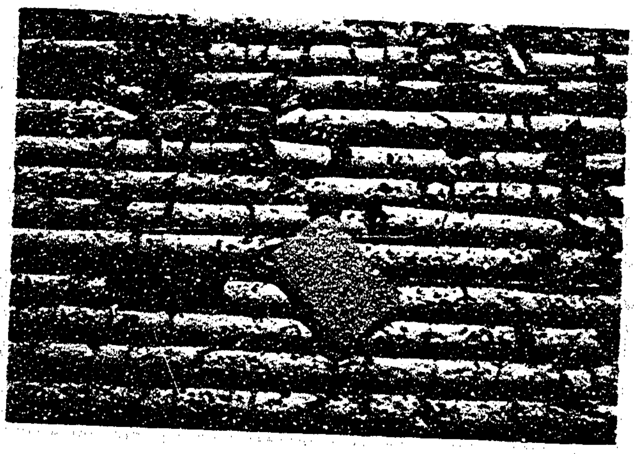


Plate 28

Core from the Prairie Lake core camp. Pine Point Formation limestones (upper four rows), and Presqu'ile Formation dolomites. Note vugs.

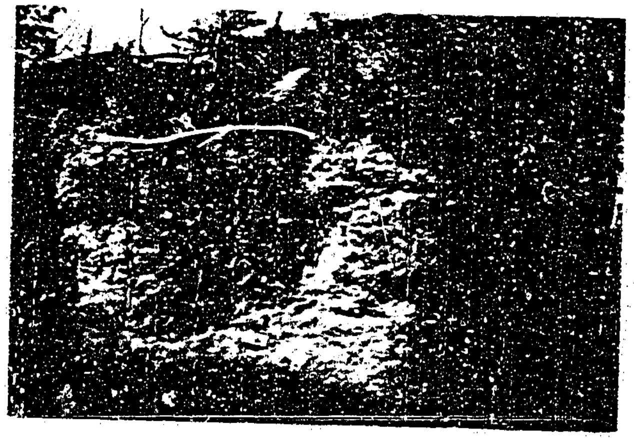


Plate 29

Bedded and nodular dolomites of the Presqu'ile Formation exposed 3 miles northeast of Prairie Lake.

Plate 30

Biogenic limestones of the Sulphur Point Formation exposed on the shore of Great Slave Lake 1 mile north of Burnt Point.

Plate 31

Large crinoid stems in the Pine Point Formation talus, 1/4 mile southwest of René Point on Great Slave Lake.

Plate 32

Biogenic limestones at the type section (below water) of Slave Point Formation, 1/3 mile northeast of Slave Point on Great Slave Lake. View northeast showing ice and Burnt Point on the Horizon.

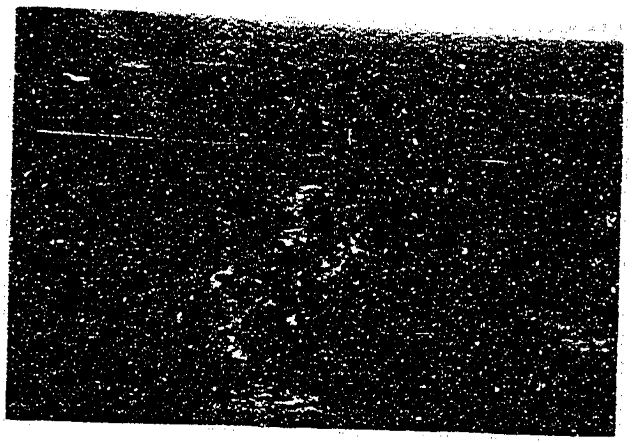


Plate 33

Escarpment formed by Escarpment Member of Hay River Formation east of Heart Lake. View north.

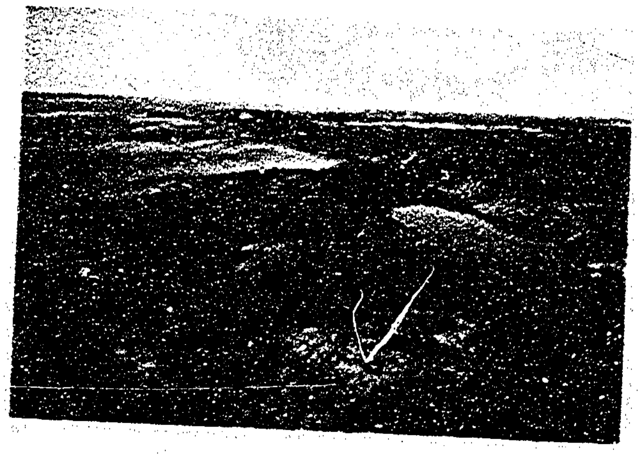


Plate 34

Typical terrain of Precambrian Shield. View south, Yellowknife in background.

Plate 35

Basal cross-bedded sandstones of the Old Fort Island Formation. South shore of Old Fort Island in the North Arm of Great Slave Lake.

Plate 36

Mazenod Member of La Martre Falls Formation at the type section 1.5 miles southwest of south tip of Mazenod Lake. View east. Large blocks and orange-brown color are typical of Ordovician dolomites.

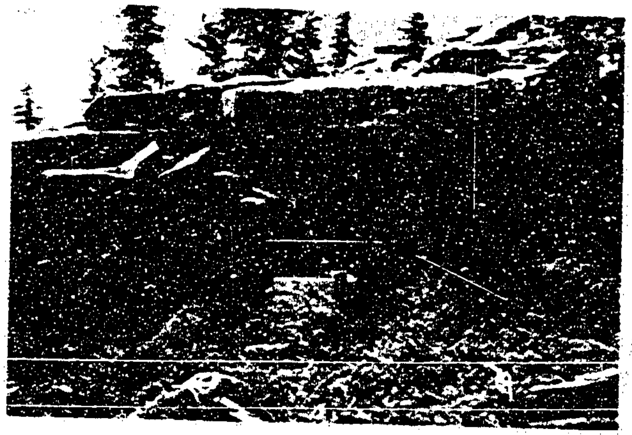


Plate 37

Cross-bedding in oolitic, sandy dolomites of the Mazenod Member of the La Martre Falls Formation at the type section near Mazenod Lake.

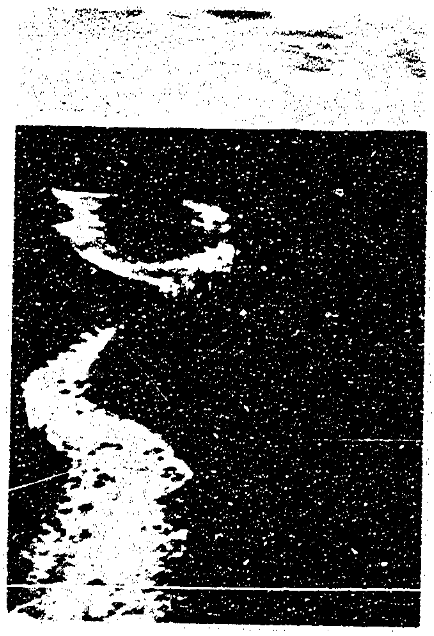
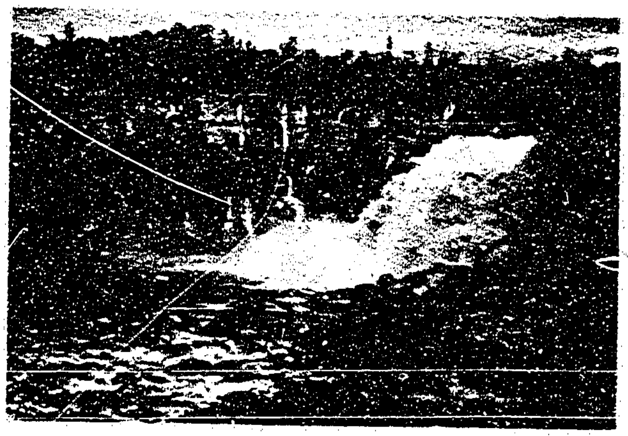


Plate 38

La Martre Falls on Rivière La Martre. View southwest showing type section of La Martre Falls Formation in partially covered interval below cliff in foreground.



Pate 39

La Martre Falls on Riviere La Martre. Lip of the falls formed by lowermost beds of the Chedabucto Lake Formation. La Martre Falls Formation below.

Plate 40

Escarpment formed by lower beds (dolomites) of the Chedabucto Lake Formation. View west from 4 miles east of La Martre Falls.

Plate 41

Fossiliferous dolomites of the Chedabucto Lake Formation exposed near Mile 143 on the Great Slave Highway. The color is typical of Ordovician dolomites.

Plate 42

Redbeds of the Mirage Point Formation at Gypsum Point. View north.

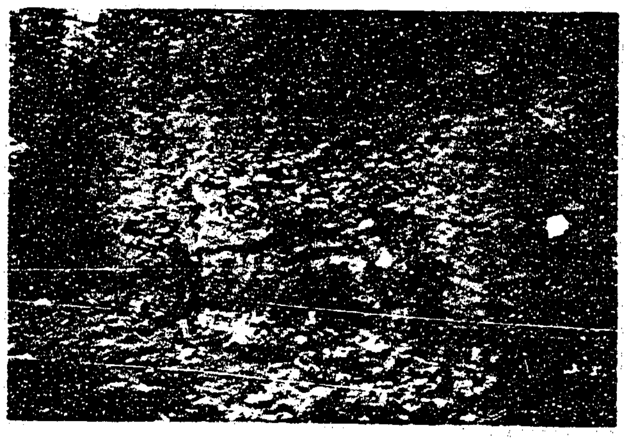


Plate 43

Limestones and dolomites of the Chinchaga Formation exposed on north tip of Big Island in Lac La Martre.

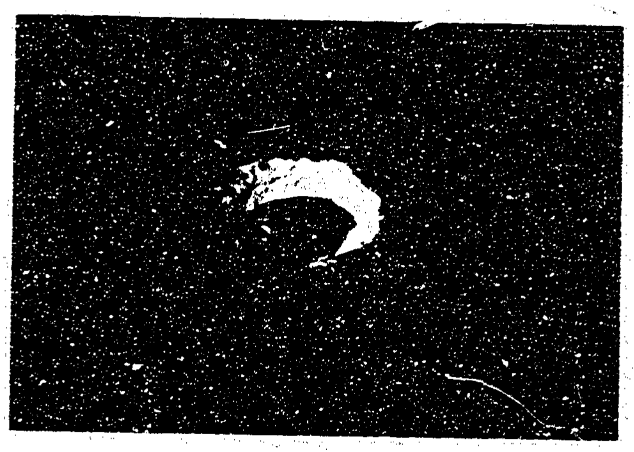


Plate 44

Sinkhole exposure of Lonely Bay Member of Pine Point Formation 14 miles northwest of Lonely Point. Sinkhole is about 80 feet deep.

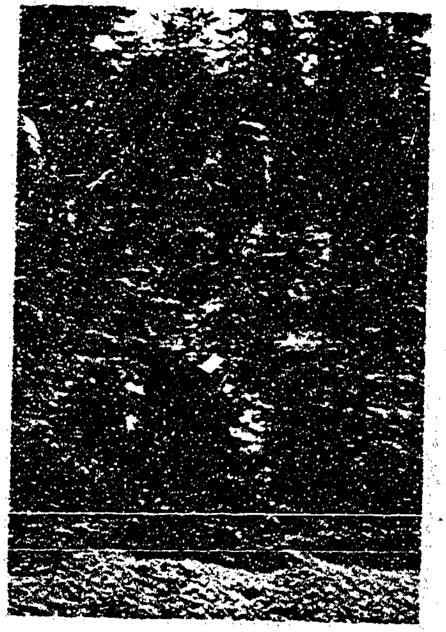


Plate 45

Shales of the Horn River Formation exposed on Horn River above Horseshoe Rapids.

Plate 46

Cross-bedded, purple and tan quartzites of the Precambrian. Outcrop is 4 miles southwest of Yeta Lake near Great Bear Lake.

Plate 47

Typical exposure of Precambrian quartzites with green lichen. Exposed on Leith Peninsula 11 miles southwest of Yeta Lake.

Plate 48

Sinkholes in lake bottom 3 miles northeast of Neiland Bay, Great Bear Lake. Sinkholes range up to 50 feet in diameter and possibly are the result of solution of underlying Precambrian dolomites.

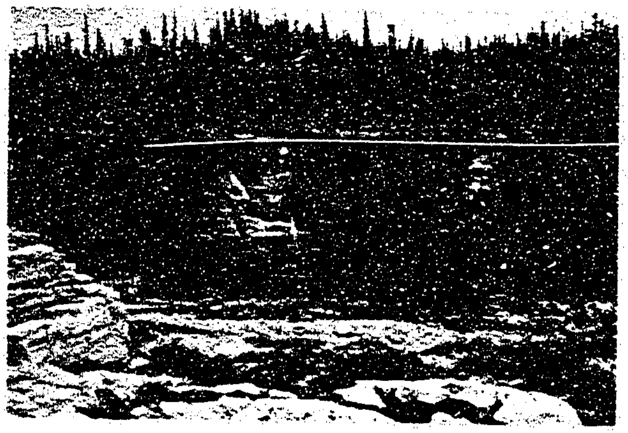


Plate 49

Typical exposure of La Martre Falls Formation. Beds are red and green dolomites, shales and siltstones below falls, 12 miles west of Bell Island in Hottah Lake.

Plate 50

Algal masses in La Martre Falls Formation. Beds form lip of falls 12 miles west of Bell Island in Hottah Lake.

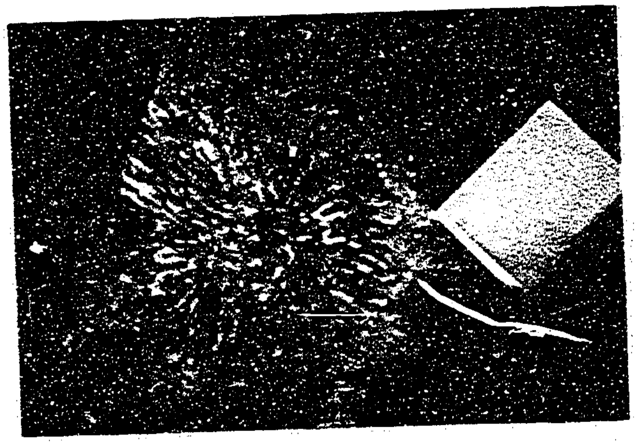


Plate 51

Fossils of the Chedabucto Lake Formation. Large colonial coral in centre, Catenipora lower left and Dawsonoceras lower right. Exposed 2 miles northeast of Dennison Lake.

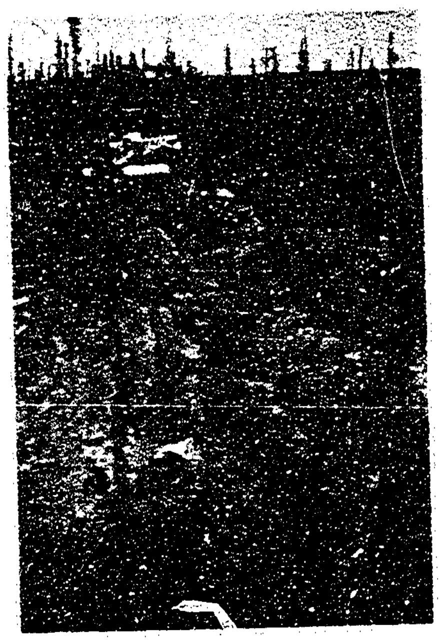


Plate 52

Sandy, calcareous dolomites of the La Martre Falls Formation exposed 8 miles south of Yeta Lake. Beds dip 5° to southeast (away from "McTavish Arm" fault zone). Large blocks are typical for outcrops of Ordovician dolomites.