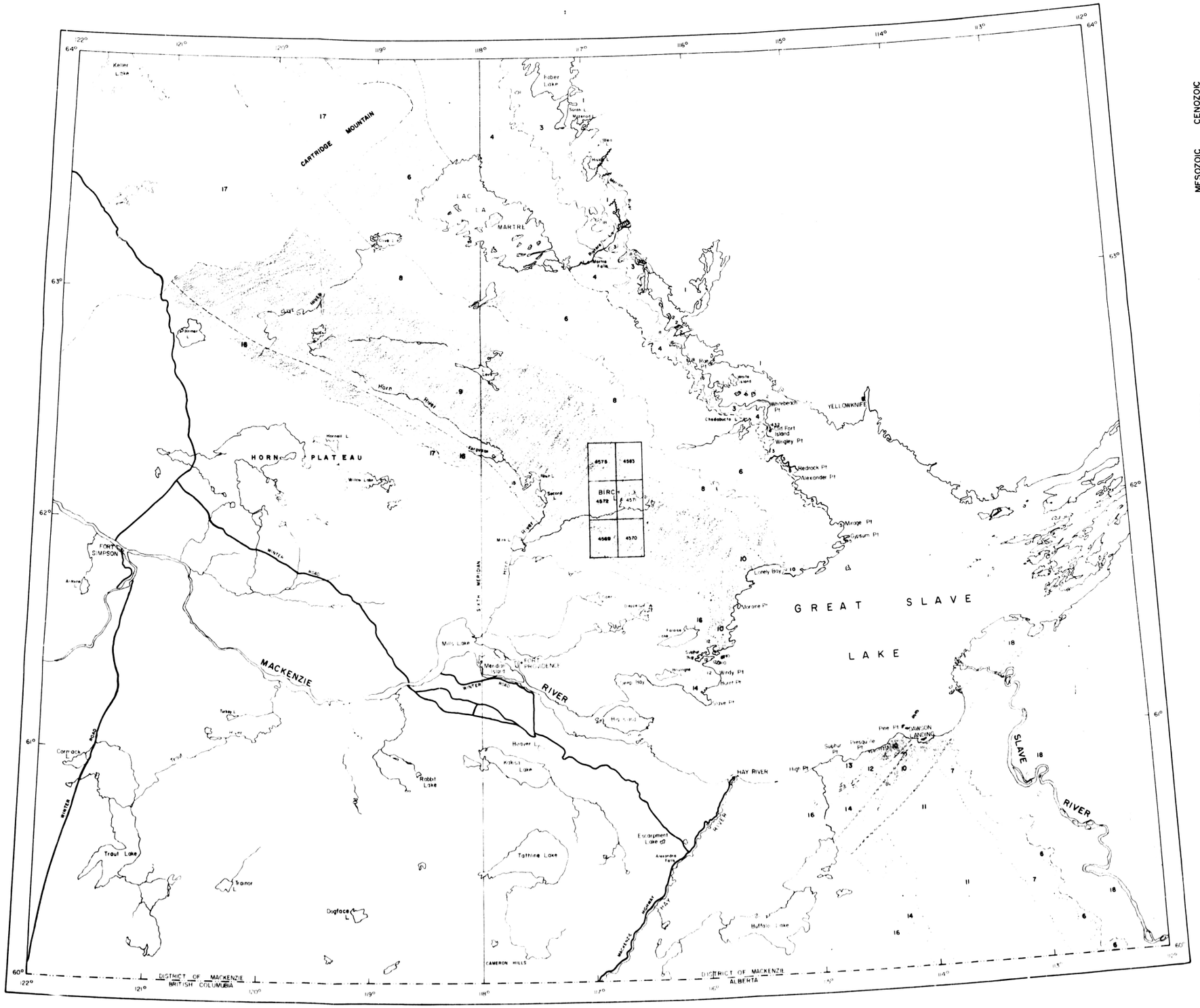

LEGEND

CENOZOIC

PLEISTOCENE AND RECENT
- 18 — 13 SULPHUR POINT FORMATION

MESOZOIC

CRETACEOUS
- 17

PALAEOZOIC

DEVONIAN

UPPER DEVONIAN
- 16 FT SIMPSON FORMATION

MIDDLE DEVONIAN
- 15 HORN PLATEAU FORMATION
- 14 SLAVE POINT FORMATION
- 12 PRESQU'ILE FORMATION
- 10 PINE POINT FORMATION
- 9 CHINCHAGA FORMATION
- 9 HORN RIVER FORMATION
- 8 LONELY BAY FORMATION
- 11 NYARLING FORMATION

ORDOVICIAN

UPPER ORDOVICIAN
- 4 CHEDABUCTO LAKE FORMATION

MIDDLE ORDOVICIAN & OLDER
- 3 LA MARTRE FALLS FORMATION
- 2 OLD FORT ISLAND FORMATION
- 5 MIRAGE POINT FORMATION

PRE-CAMBRIAN

ARCHAEAN & PROTEROZOIC
- 1
- 7 LITTLE BUFFALO FORMATION

FAULT

FAULT (trace in basement rocks)

REPORT REFERENCE MAP for

PERMIT No's.

4575, 4583, 4572,

4571, 4569, 4570.

and surrounding areas.

SCALE : 1" = 16 MILES

Modified after Norris et al, GSC. Mem. 322.

Older to Upper Ordovician, mainly because of its correlation with the Chedabucto Lake and La Martre Falls Formations.

Reservoirs may exist in the sands and/or brecciated units of the Mirage Point Formation.

MIDDLE DEVONIAN

GENERAL

Middle Devonian rocks outcrop in a northwest-trending band varying in width from about 45 to 90 miles. The western edge of the outcrop belt is a contract with the overlying Upper Devonian while the eastern edge is formed by virtue of erosion through the unit, into the underlying Ordovician. The eastern edge of Middle Devonian exposures lies approximately 2 to 4 miles west of the west shore of the northwest arm of Great Slave Lake

and the western edge passes through the south-east corner of the Permits. Waters of the west arm of the lake cover the outcrop(s) 30 miles south of the Permits. The Middle Devonian outcrop belt passes beneath rocks of Cretaceous age about 110 miles northwest of the Permits. A total thickness of 1,285 feet of Middle Devonian beds is represented in the area immediately south-west of Windy Point.

Sedimentation during the Middle Devonian was dominated by carbonates and evaporites. Late Middle Devonian carbonates are thickest and mostly biogenic on the flanks of positive Pre-Cambrian features such as the Tathlina "High". Evaporites occur south of and marginal to the coarse porous dolomites of the Presqu'ile formation and the fine, porous dolomites of the Pine Point formation.

Middle Devonian outcrops on the northwest side of Great Slave Lake between Mirage Point and Slave Point include the Chinchaga, Pine Point, Horn River, Presqu'ile and Sulphur Point formations. Abrupt facies changes in Middle Devonian strata is indicative of shifting environments.

A basal Middle Devonian evaporitic unit, the Chinchaga formation, is present throughout the area. A short distance south of Great Slave Lake the Chinchaga formation is overlain by a thin carbonate unit named the Little Buffalo Formation. The latter is succeeded by a thick evaporitic unit, the Nyarling formation. Northward the Chinchaga is overlain by various facies of the Pine Point formation and by the Lonely Bay formation.

The exposed lower part .....

of the Pine Point formation on the north shore of Great Slave Lake consists of limestone and argillaceous limestone of the Lonely Bay Member. A covered interval likely representing a tongue of Horn River Shale separates the Lonely Bay Member from an unnamed Upper Limestone Member.

The Presqu'ile formation overlies the Pine Point formation. Presqu'ile strata in the Sulphur Bay area is composed in ascending order of fine-grained dolomite and coarse, vuggy dolomite. The Presqu'ile dolomite grades southward into limestones of the Sulphur Point formation. Oil seeps are present along the Presqu'ile outcrop belt.

A thin shaley unit, the Watt Mountain formation and its rough equivalent, the Amco Shale overlie the Presqu'ile and Sulphur Point formations. The shale units are in turn overlain by the Slave

Point formation. Slave Point limestone also overlies the Nyarling, Presqu'ile and Sulphur Point formations in various parts of the study area.

In the outcrop area, most of the Pine Point formation and all the Presqu'ile, Sulphur Point and Slave Point carbonates grade laterally northwestwards into shales of the Horn River Formation.

The youngest known Middle Devonian unit, the Horn Plateau formation, outcrops at approximately 62° 05' N. latitude, 117° 40' W longitude. The unit outcrops at this one locality only and is comprised of reefoid limestones.

The Horn River Formation is present in all wells west and immediately north of the Tathlina "High". However, since it is possible

that carbonate time equivalents of the Pine Point and Presqu'ile or Sulphur Point formations may be present within the Horn River shales in the subsurface on the Permits, these formations are also discussed later in this report.

Outcrops of the Watt Mountain and Slave Point formations have not been recognized in the Permit area. However, a possible Watt Mountain equivalent, the Amco Shale is present locally in the subsurface immediately south of Great Slave Lake and the Slave Point formation crops out on both the north and south shore of Great Slave Lake. Since the formations are part of the normal regional pre-Upper Devonian sequence, they are discussed later in this report.

CHINCHAGA FORMATION

The Chinchaga formation is the basal unit of the Middle Devonian Elk Point Group. Type

section is in a well drilled at Lsd. 2, Section 22, Township 117, Range 5, West of the Sixth Meridian. At the above location 205 feet of light gray to brown anhydrite with minor amounts of brownish gray cryptocrystalline dolomite is present in the interval from 5,475 to 5,680 feet.

Chinchaga strata is absent over the Tathlina "High", but thickens northeastward to between 300 and 400 feet and northwestward to more than 250 feet.

The Chinchaga formation outcrops in a 12 to 40 mile wide northwest-trending belt approximately five miles east of the northeast corner of the Permits and 45 miles east of the southeast corner.

Exposures of the Chinchaga formation exhibit a sequence of evaporites, some dolomite and

limestone breccia. The unit lies unconformably on the dolomite of the Upper Ordovician Chedabucto Lake and the red beds of the Mirage Point formation respectively, and is overlain by the Lonely Bay formation and a variety of facies of the Pine Point formation.

The basal portion of the Chinchaga consists of evaporites at most places although thin sequences of limestone and limestone breccia are exposed very near the base in the area between Chedabucto and Marian Lakes. The basal breccia consists of dark brown aphanitic to fine-grained limestone fragments up to six inches in diameter. In the area west of Chedabucto Lake gypsum is typical of the lithology in the lower half of the unit. The upper half contains 48 feet of breccia comprised of angular fragments up to 2.5 feet in diameter of dark brown, aphanitic to fine-grained

limestone with local traces of poorly preserved stromatoporoids, corals and brachiopods. A solution and collapse origin is likely for the breccias. Sparse fauna collected from the Chinchaga is Middle Devonian in age.

On Big Island in Lac La Martre 14 feet of light gray to olive, massive, in part brecciated, argillaceous dolomite and argillaceous limestone is overlain by a dolomite breccia. Evaporites outcrop along the west shore and the southwest end of Lac La Martre.

At Rae Point the exposed lower beds of the Chinchaga formation are comprised of pale brown to light gray, thinly to thickly bedded to massive, gypsiferous, extremely vuggy limestone.

Vuggy and brecciated carbonates are good reservoir rocks and when coupled with

rapid facies changes or drape over deeper structure could result in good trap conditions similar to those present in the Zama Member in northwest Alberta and northeast British Columbia.

LONELY BAY FORMATION

The Lonely Bay formation comprises a resistant carbonate unit which correlates with the Lonely Bay Member of the Pine Point formation. Outcrops of the formation occur in an eight to ten mile wide northwest trending band that cuts across the extreme northeast corner of the Permits.

Good exposures of the Lonely Bay formation and the Lonely Bay Member occur along an escarpment on the northeast side of the southern part of the belt. The lower part of Lonely Bay formation comprises limestone, pale to dark brown to light to dark gray, fine-grained to aphanitic,

slightly dolomitic in part, argillaceous in part, massive to medium to thinly bedded, fossiliferous in part and bituminous in part near the top of the succession. The upper beds consist of a lower unit of dark to medium brown, fine-grained, massive limestone and an upper unit of limestone, medium brown, fine-grained, irregularly thin-bedded, interbedded with nodular limestone. At the southern end of Lac La Martre the limestones are fetid in part. On Clive River the exposures consist of olive gray, aphanitic to fine-grained, argillaceous, rubbly bedded and in part highly fossiliferous limestone. Thickness of the formation along the outcrop belt is estimated to range from 120 feet in the south to 280 feet in the north. The Lonely Bay formation is conformably underlain by the evaporitic Chinchaga formation and overlain by shale and limestone of the Horn River formation. A fauna of corals, stromatoporoids and brachiopods

has been used to date the Lonely Bay formation as Middle Devonian.

About ten miles form the north shore of Great Slave Lake the equivalent unit is referred to as the Lonely Bay Member, basal unit of the Pine Point formation. The lower beds of the Lonely Bay Member consist of limestone, medium brown, aphanitic, thick to thin-bedded, argillaceous in part, dolomitic in part, richly fossiliferous in part. Oil staining is present in places along fractures in some beds.

The Lonely Bay formation occupies the same stratigraphic position as the Keg River formation in the subsurface of northwestern Alberta. Local reef complexes may have grown from the Lonely Bay platform at favorable locations seaward from the Presqu'ile barrier in the vicinity

of the Permits. The reef (s) would likely be enclosed in the Horn River shale and from stratigraphic traps similar to those present in the Upper Devonian Leduc Formation at the edge of the Ireton green shale basin of central Alberta. The presence of a relatively shallow reef mass surrounded by shale could be detected by a gravity meter survey. Stratigraphic traps effected by variations in permeability may be present in the Lonely Bay "platform" unit.

HORN RIVER FORMATION

Horn River shale outcrops in a northwest trending belt 25 to 35 miles wide. The formation crops out over the entire Permit Block, with the exception of the northeast and southwest corners. Outcrops at the type section on Horn River, just above Ferguson Creek consist of shale, dark gray, non-calcareous, soft, fissile, iron-stained in part, sulphur encrusted in part, and thin interbeds of

limestone, medium gray, nodular, medium to thick-bedded, in part richly fossiliferous. The Horn River formation includes all the dark shales and interbedded limestones which overlie the limestones of the Lonely Bay formation or lower part of the Pine Point formation and are unconformably overlain by green shale of the Fort Simpson formation or in the Mirage Point to Sulphur Bay area, by the limestone member of the Pine Point Formation. Fauna forms of the Horn River shale range from Sulphur Point to Pine Point to those similar to Upper Devonian.

Exposures on Clive River are olive-gray to brownish gray, aphanitic to fine-grained and rubbly-bedded shale.

In the area north of Deep Bay the Horn River formation varies in thickness from 145 feet

to 318 feet and appears to have developed at the expense of the Slave Point and Presqu'ile formations, and to some extent the Sulphur Point and Pine Point formations. Beds in this area consist of shale, brown to brownish gray, slightly calcareous in part, inter-bedded with limestone, buff, gray, aphanitic, argillaceous in part. The unit overlies the Lonely Bay formation or lower Pine Point formation and grades upward into green shale of the Fort Simpson formation. The fossil assemblage suggests that the Upper part of the Horn River shale is more or less equivalent to the Upper Member of the Pine Point formation in the immediate vicinity of Great Slave Lake.

Subsurface contact between the Horn River and Fort Simpson shales is placed at the strong gamma-ray "kick".

HORN PLATEAU FORMATION

Reefal beds outcrop in a circular hill about

one-quarter of a mile in diameter approximately 2.5 miles west of Fawn Lake near 62° 05' N. latitude, 117° 40' W. longitude. The lower part of the section is comprised of limestone, light to medium brown, very coarse-grained, richly fossiliferous, grading upwards into reefal limestone, pale brown, fine to coarse-grained, massive and more resistant. The base of the outcrop is about 50 to 100 feet higher in elevation than the top of limestones exposed on Horn River about 15 miles northwest. Fossils include Middle Devonian brachiopods, corals and crinoid fragments which are distinct from anything seen to date in Devonian beds of the MacKenzie basin. The assemblage is younger than the Pine Point - Presqu'ile succession and earlier than basal Beaverhill Lake. Some of the fossils correlate with those present in the Sulphur Point formation in the vicinity of Presqu'ile Point while others are correlative with those present in the Slave

Point formation in a well near Hay River.

It is not known whether the reefoid limestone of the Horn Plateau formation rests on and is contained at least in part within the Horn River Shale or if it occupies a continuous interval from the Lonely Bay formation through the Horn River Shale. The reef mass may have accumulated in response to Pre-Cambrian-associated highs on the ocean floor and/or salt solution-associated highs. In any event, the Horn Plateau formation is a highly attractive exploration target the presence of which might be detected by the gravity meter. A relatively "tight" gravity grid is recommended on the Permits because of the limited areal extent of the reefoid mass exposed at the outcrop.

Gas seeps have been reported from recent bore holes at the outcrop and mineral claims have been staked over and around the exposed reefoid mass.

PINE POINT FORMATION

Crop-outs of the Pine Point formation are present along the north and south shores of Great Slave Lake in bands generally less than ten miles wide. The formation contains five or more distinct facies which occupy the interval between the evaporitic Chinchaga and the base of the coarse dolomite of the Presqu'ile formation or tis stratigraphic equivalent, the limestone of the Sulphur Point formation. In the Slave Lake area Pine Point strata varies rapidly from limestone to dolomite to gypsum. The Pine Point formation is bituminous.

Outcrops on the north side of Great Slave Lake exhibit a basal limestone, the Lonely Bay Member (previously described), a covered interval which may represent a tongue of the Horn River Shale, and an upper argillaceous unit referred to

as the Upper Limestone Member. The Upper Member is divided into a lower part consisting of limestone, pale brown to light gray, fine-grained to aphanitic, dolomitic, nodular, thinly bedded, and an upper part composed of limestone, light olive gray, medium-grained, richly fossiliferous, thickly bedded, interbedded with thin calcareous shale stringers. The dolomite is vuggy and petroliferous in part. Middle Devonian fossils contained within the interval correlate with some present in the upper part of the Horn River Shale.

Pine Point strata comprises a 595 foot sequence in the Windy Point well.

On the south shore of Great Slave Lake the Pine Point formation has been divided in ascending order into the Fine Grained Dolomite Member, the Bituminous Shale and Limestone Member and the Buffalo River Shale Member or equivalent Brown

Limestone Member facies.

In the vicinity of the Tathlina "High", limestone facies of the Pine Point formation vary to dolomite. The section is generally less than 100 feet and comprises brown, fine to medium-crystalline dolomite with euhedral crystals and good intercrystalline porosity. The dolomite is present in irregular masses in the bedded carbonates.

The Pine Point formation is correlative with the Keg River and Muskeg formations of northern Alberta. An equivalent carbonate facies may be developed in the subsurface on the Permits and could contain significant quantities of hydrocarbons.

PRESQU'ILE FORMATION

Presqu'ile strata outcrops on the northwest side of Great Slave Lake in a north-south trending

belt 21 miles long and up to four miles in width. Exposures consist of a light-colored, coarsely recrystallized, massive, vuggy dolomite and a darker colored, fine-grained dolomite, both of which appear to have replaced reefal limestone. The Presqu'ile formation rests on various facies of the Pine Point formation and is overlain by the Sulphur Point or Slave Point formations. Locally the upper surface of the Presqu'ile dolomite is highly irregular. In the outcrop area the formation varies from zero to about 150 feet in thickness, mainly at the expense of overlying beds. Maximum thickness of Presqu'ile penetrated near the south shore of Great Slave Lake is about 230 feet. Undolomitized reefal and associated limestone facies into which the coarsely recrystallized dolomite grades laterally is placed in the Sulphur Point formation. Stromatoporoids, corals, gastropods, trillobite fragments and crinoid fragments are included in the

fauna. Fossil dating indicates a Middle Devonian Age for the Presqu'ile formation.

The west side of the outcrop area is a relatively straight, abrupt contact with the Upper Devonian Hay River Formation. A fault-controlled front is suggested by the linear nature of the western contact. Erosion has resulted in an irregular eastern contact edge with the underlying Pine Point formation. The northerly trend of the Presqu'ile outcrop on the north shore of the West Arm of Great Slave Lake is not in keeping with the general regional northwest outcrop trend of other formations.

In the Windy Point - Sulphur Bay area fissures are sometimes filled with calcite, but are more often open and petroleum seeps along dolomite bedding planes and from the fissures. The seepage is frequently accompanied by strong flowing

cold water sulphur springs that leave deposits of sulphur and sulphur salts and occasionally carbonaceous salts of lime and magnesium.

Galena, sphalerite and minor marcasite are present in vugs and caverns and along bedding planes of the Presqu'ile formation in the Pine Point area on the south side of Great Slave Lake. A lucrative mining operation is presently in progress in the Pine Point area.

A correlative carbonate facies may be developed in the subsurface on the Permits and could contain either hydrocarbons or significant mineralization in association with porosity.

SULPHUR POINT FORMATION

A typical Sulphur Point section crops out in the Windy Point to Burnt Point area where the

sequence consists of limestone, stromatoporoidal, argillaceous, aphanatic, dolomitic in part, clastic in part, petroliferous near the central part and massive reef in part. Locally this unit grades laterally into the coarsely crystalline dolomites of the Presqu'ile formation where the latter is developed and into the brown and black shales of the Horn River formation in the area north of Deep Bay. The Sulphur Point formation overlies the various facies of the Pine Point formation or locally, the Presqu'ile dolomite. Sulphur Point strata is overlain by limestones of the Slave Point formation or locally, by the interbedded shale and limestone of the Watt Mountain formation. The Sulphur Point formation has a maximum thickness of 347 feet in the Northwest Territories Deep Bay No. 1 well at 61° 18' N. latitude and 116° 42' W. longitude and is thinnest over the Tathlina "High". Farther south the Sulphur Point grades into a dolomitic tongue between the First and Second Red Beds and is

thus equivalent to the Dawson Bay formation. Abundant Middle Devonian fossils have been collected from the Sulphur Point Formation.

The Sulphur Point section is porous, bituminous and has been oil stained where encountered in the subsurface.

WATT MOUNTAIN FORMATION

Type section of Watt Mountain formation is in a well located at Lsd. 2, Section 22, Township 117, Range 5, West of the Sixth Meridian. Watt Mountain strata comprises varying quantities of shale, siltstone, sandstone, arkose, limestone breccia, anhydrite and dolomite. The formation attains a maximum thickness of 155 feet in the subsurface of northwestern Alberta although only 58.5 feet is present in the type section. Contact with the overlying Slave Point formation is sharp while the lower contract is grad-

ational into the Sulphur Point formation.

The Watt Mountain formation correlates eastwards with the First Red Beds of the Elk Point area.

SLAVE POINT FORMATION

The Slave Point formation outcrops along the northwest side of Great Slave Lake at Slave Point and along the south side of the lake from Sulphur Point to High Point. Exposures exhibit a sequence of limestones, dark gray to yellowish-gray to brown, stromatoporoidal in part, fragmental in part, argillaceous in part, medium grained to aphanitic, massive to thickly bedded, slightly bituminous, dolomitic in part, locally sandy, locally gypsiferous, locally cherty, locally with thin mudstone beds. In northern Alberta a lower anhydritic unit, the Fort Vermilion Member, is present. Where Presqu'ile is present, the base of the Slave Point is arbitrarily placed at the contact

between the limestone and underlying coarse dolomite, although the presence locally of facies common to both formations make the pick a difficult one. Where the Nyarling is present the contact is placed at the top of the evaporites. Where the Amco marker is present beds beneath it may be placed in the Sulphur Point. In areas west and south of the outcrop belt the base of the Slave Point formation is picked at the change in lithology from dense limestone to the underlying blue-green waxy shale or locally brecciated dolomite. On the electric log the contact is taken at the top of the characteristic low self potential curve and the corresponding extremely high gamma ray "kick". The Slave Point formation is overlain by shales of the Upper Devonian Fort Simpson formation. Maximum thickness of Slave Point of 310 feet is present in the Northwest Territories Deep Bay No. 2 well at 61° 18' N. latitude, 116° 48' W. longitude.

Fossil dating of the Slave Point formation places it in the Middle Devonian although fossils from beds overlying the west flank of the Presqu'ile formation north of Sulphur Bay are Upper Devonian in age. These beds have, however, been assigned to the Upper Devonian Fort Simpson formation.

The Slave Point is porous, bituminous and has been oil stained where encountered in the subsurface.

UPPER DEVONIAN

FORT SIMPSON FORMATION

The Fort Simpson formation as used in this report includes, in the broad sense, the shales bounded beneath by Middle Devonian limestone or shale and above by the limestones of the Upper Grumbler formation. Fort Simpson strata consists

of shale, dark greenish-gray fissile, flakey, slightly calcareous, finely laminated with thin interbeds of dark greenish-gray sandstone and sandy limestone. Where correlatable carbonate or predominantly carbonate beds are present in the subsurface, the Fort Simpson formation has been broken into four units.

The basal unit includes the brown to gray and greenish gray calcareous shales and limestones of the Hay River formation. Type section is along the Hay River where a total thickness of about 1,300 feet is present. On the north side of Great Slave Lake in a north to northwest trending contact the Hay River formation unconformably overlies the Slave Point, Sulphur Point, Presqu'ile, Pine Point and Horn River formations. The eastern outcrop edge of the Hay River formation passes through the southwest corner of the Permits where

it overlies Horn River shale. The next unit, in ascending order, is the Alexandra formation named for the 136 foot carbonate interval outcropping at Alexandra Falls on the Mackenzie River. Strata contained in this unit consists of 114 feet of limestone and an overlying 22 feet of magnesian limestone. On Hay River, the formation includes a basal 12 foot bed of calcareous dolomite and sandstone. To the northwest the formation breaks into two separate limestone units and eventually grades into the Fort Simpson shale in the vicinity of Kakisa River.

The unit overlying the Alexandra formation comprises the lower part of the Grumbler formation. Varicolored shales are interbedded with nodular, argillaceous, rich fossiliferous limestone which is reefoid towards the top. Carbonates of this unit grade northwestward into the Fort Simpson shales.

A greenish to reddish gray shale and gray siltstone unit overlies the lower Grumbler and is equivalent to the Middle Grumbler.

POST-FORT SIMPSON

The above unit is overlain by a cyclic sequence of pale yellowish brown, bioclastic, sandy limestone, sandy and silty argillaceous limestone and sandy calcareous mudstone that is correlative with the Upper Grumbler formation. Erosion to the north of the study area has removed evidence of any facies change. An overlying unit comprising stromatoporoidal reefoid limestone and sandy bioclastic and coralliferous limestone with some calcareous sandstone has been recognized and may represent a rather localized reefoid development of the previous unit.

The youngest Upper Devonian units in the study area are, in ascending order, the Trout

River and Palliser formations. Trout River beds consist of yellowish, silty limestone, locally interbedded with shale and calcareous siltstone; Palliser beds comprise pure pale limestone.

PENNSYLVANIAN through CRETACEOUS

Strata of Pennsylvanian, Permian, Mississippian, Triassic, Jurassic and Cretaceous age have not been observed in the immediate vicinity of the Permits.

PLEISTOCENE and RECENT

The main physiographic elements in the map area were likely present before Pleistocene time. Evidence indicates that the major river valleys were

deeper piror to glaciation than they are now.

Most of the area is covered by Wisconsin Laurentide drift deposited by an ice sheet which had its center of origin in the Keewatin District. No evidence of Cordilleran glaciation has been found. Physiographic forms and striae indicate a westward by southwestward ice movement which was modified to a southward movement by some major stream valleys. At Cameron Creek in the Cameron Hills and at about mile 25 along the MacKenzie Highway a stratified section of till overlying sand and gravel contains pebbles of crystalline rocks and Athabasca-type sandstone that was likely transported originally by glaciers from the Pre-Cambrian Shield to the east. The average trend of striae is 69 degrees west. A set of northwest-trending striae along Hay River is suggestive of an earlier glaciation

and the strong northwest grain of Cartridge Plateau was imparted by glacial action. Some of the striae which existed on high ground have been removed by weathering.

The dominant glacial features in the area are strand line features and bottom deposits of glacial Lake McConnel. In the area immediately north of the western-most portion of the West Arm of Great Slave Lake ice-flow features may be observed down to about 675 feet and indistinct beach ridges are found up to 800 feet on some of the higher hills. Adjacent to the south end of Horn Plateau strand lines are discoutinuous and not found above 800 feet. Maximum stand of the lake was about 925 feet above sea level, along its eastern boundary and decreasing westward. The glacial lake drained southward initially, through the valley now occupied by the Slave River.

Drainage may have been reversed when a lower outlet to the north became available. Glacial Lake McConnel probably extended from the north side of Great Bear Lake to the lower parts of the valleys of the Peace and Athabasca Rivers, and part of the west end of Lake Athabasca basin. Sand dunes have resulted from reworking of lake sediments by the wind. Forms vary from irregular hummocks and hills to long straight ridges with crescentric ridges at the northwest end. Present day vegetation has stabilized the dune types. In places, a heavy mantle of boulder clay has prevented the streams from cutting down to the underlying rock. Present control indicates drift thicknesses up to 380 feet.

On the high land glaciation is evidenced by ice-flow features such as drumlines and flutings.

The general direction of ice retreat was eastward. A temporary halt of the glacier is indicated by patches of end moraine in the area between Cameron Hills and Trout Lake. Isostatic rebound appears to be about two feet per mile when deltas near Fort Simpson at 500 feet elevation are correlated with beaches near Faber Lake at 925 feet elevation.

Near the Paleozoic subcrop edge, gray and brown post-glacial lake and stream silts and clays are common. They were likely deposited in broad, shallow lakes during the retreat of the post-Pleistocene sea. In most places they are covered by a little peat and in general are a jumble of small clay hummocks caused by the action of heaving frost.

Eskers, moraines and outwash sand plains are present in the barren Pre-Cambrian grounds east of Faber and Marian Lakes. The longest eskers trend west or a little south of west and parallel the approximate direction of ice movement. Some of the largest morainal areas are commonly associated with eskers and trend about west. The depressions between hummocks in the morainal areas are filled by muskeg and numerous tiny rounded lakes.

An extensive post-Pleistocene sea is indicated in the Pre-Cambrian area by the presence of cobble beaches. The deposits are comprised of well-rounded cobbles from three inches to one foot which lie at various elevations. Many of the beaches are terraced and lie in gullies and small embayments on the sides of the hills. It is likely that the beach-fringed hills projected above the sea as islands.

Other deposits consist of rock floor laid down by streams flowing primarily from the east, although local ice caps were responsible for west-flowing streams in the area. The deposits lie at levels above the present streams and have level upper surfaces.

Recent lacustrine clays and sands of fluvial, flood plain and delta deposits comprise the remaining cover in the area. The deposits commonly form a mantle less than 100 feet thick.

STRUCTURE

An accurate study of structural features on the Plains is hampered by the presence of glacial drift. Limestone gravels formed by wave and wind action mask structures present on the shores of Great Slave Lake.

The dominant structural feature in the study area is the gentle southwest dipping homocline formed by Paleozoic rocks. Regional dip between the outcrop base of the Pine Point formation and that present in the Windy Point Well is 18 feet whereas the Mirage Point formation dips 26 feet per mile between the same two control points. In the Sulphur Bay area the strike of the beds is close to north, parallel to the long axis of the Presqu'ile. The general strike swings to the common north west regional strike at the north end of the Presqu'ile outcrop. Subsurface control on the Slave Point

formation southwest of Great Slave Lake indicates a general strike of 315 T and a general dip of 35 feet per mile to the southwest. Amount of regional dip to the south generally varies with change in thickness of a formation.

Middle Devonian strata ranges in thickness from 1,300 feet along the southwestern edge of the outcrop belt to less than 300 feet in the subsurface immediately west of Mills Lake. The Mills Lake region appears to have been an up-lifted area.

Late Upper Devonian strata strikes nearly west in the area west of Kakisa River under the influence of the Tathlina "High".

The Cretaceous shales of Horn Plateau are quite horizontal or dip very gently toward the southwest, although some small folds with a maximum dip of three degrees are present locally. Horn

River shales are much jointed and fractured with one set of joint planes running about ten degrees north and a less conspicuous set running due north and south.

The Presqu'ile distribution suggests association with the southeast flank of a Basement "high" in the vicnity of Fort Providence and Rabbit Lakes. The "high" is possibly related to the trend of escarpments associated with Basement faults on the East [illegible] basal Slave Lake. Northwest of Sulphur [illegible] diately west of the Presqu'ile outcrop, shales of the Hare Indian River formation dip up to 12 degrees to the west. A fault is present and the east side appears to be up-thrown about 90 feet relative to the west side. Upper Devonian strata overlaps on both sides of the fault suggesting that displacement occurred between post-Presqu'ile and pre-basal Fort Simpson time. Other faults measured

in the area dip almost vertically and in one instance displacement is about 40 feet with the north side up relative to the south.

The Rabbit Lake fault strikes N. 55° E. about parallel with Pre-Cambrian faults exposed on the East Arm of Great Slave Lake; it is a normal fault with southeast side down thrown. In the subsurface in nearby northwest Alberta, other faults with the same trend have been indicated by drilling and aeromagnetic data.

Lineaments along the Middle Devonian and Older (?) subcrop edge are mainly southwest-trending although a north-south trend occasionally predominates and less common southeast trending features occur. The trend of lineaments comprises faults and fault-associated quartz stockworks.

Long, nearly straight depressions on the Pre-Cambrian filled with drift and water are common, mostly where the underlying rock is granite. They are randomly oriented and in places are faulted and bounded by abrupt walls. The longest valleys trend north. Lake shore lines are parallel for long stretches to the trend of underlying rocks. Many faults are present and marked by nearly straight topographical features such as rivers, lakes, valleys, scarps or by diabase or large quartz stockworks. Most of the known faults are nearly vertical and an offset of half a mile common, although an offset of about seven miles is inferred in one instance. On the Pre-Cambrian surface on the southeast side of the East Arm of Great Slave Lake the northeasterly-trending faults are mainly linear features with minor splays or arranged en echelon. Pre-Cambrian diabase dikes cut the faults and relatively little post-diabase movement is indicated.

However, Paleozoic to Recent movement similar to that evidenced along the Presqu'ile front may have taken place along potential lines of weakness. Drift and water conceal the majority of faults in the Pre-Cambrian.

Control data suggests the presence of a Pre-Cambrian trough with axis somewhere along a line from Whitebeach Point to northwest Windy Point. The location of the trough may have been controlled by Basement faulting. A Pre-Cambrian arch trending about 250 T is present between Fort Rae and the northeast side of the Horn Plateau.

Compaction folds in late Ordovician and Middle Devonian carbonates may have been produced by topographical relief on the underlying Pre-Cambrian surface. Near Dawson Landing minor folds in the Pine Point formation may be indicative of post-Devonian movements.

RECOMMENDATIONS

Knowledge of the geometry of fault systems that may be present and the location of any gross lithologic changes in the sedimentary section on the Permits is essential in the early phases of exploration. It is recommended that the most favorable structural and stratigraphic traps be sought in the early phase of exploration by a combination gravity-magnetometer survey.

Seismic surveys might be conducted during the second period of the life of the Permits. Near surface structure and lithology could be checked by means of helicopter-mounted drilling rigs in the summer months. Tract mounted rigs would be able to add to or deepen the existing stratigraphic test holes during the winter months. Exploration activities might culminate in the drilling of a "Basement" test (s).

Respectfully submitted by:

RAYALTA PETROLEUMS LTD.

William G. Crook

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P. Geol.

WGC/jp

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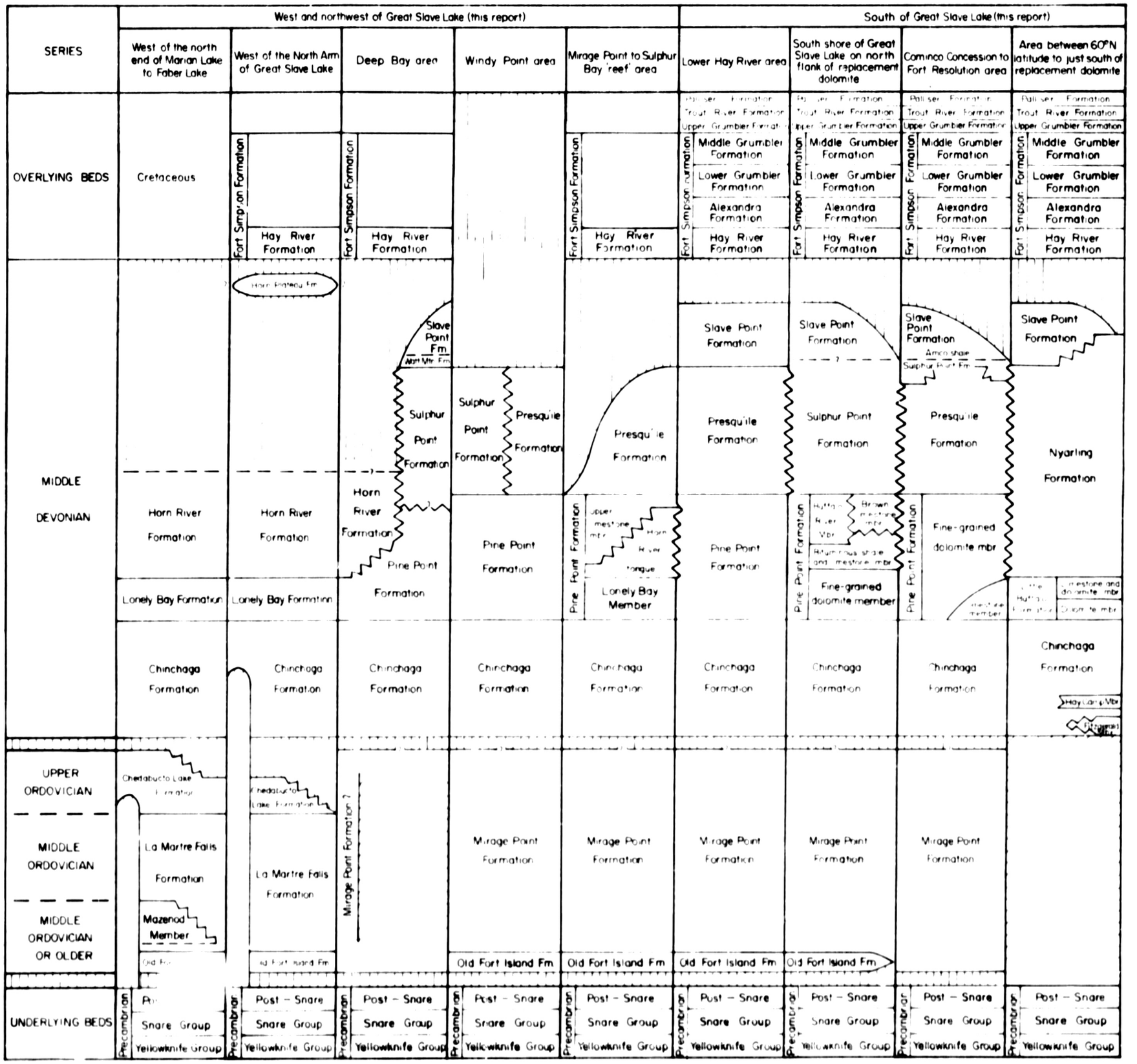

Nomenclature and relationship of Middle Devonian and Ordovician rock units of the Great Slave Lake region, District of Mackenzie

513-1-4-11

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Abstracted for
Geo-Science Data Index

Date

GENERAL GEOLOGY

of the

BIRCH LAKE AREA, N. W. T.

P. & N. G. PERMITS

4569, 4570, 4571,
&
4572, 4575, 4583

for

CHERMARC DEVELOPMENTS LTD.

by

RAYALTA PETROLEUMS LTD.

CONTENTS

INTRODUCTION

LOCATION & SIZE OF PERMITS

The Permits lie within the southwestern District of MacKenzie, Northwest Territories, where they are situated as follows:

Permit No. 4569	61°	50'	to 62°	00'	N.	latitude,
	116°	45'	to 117°	00'	W.	longitude;
Permit No. 4570	61°	50'	to 62°	00'	N.	latitude,
	116°	30'	to 116°	45'	W.	longitude;
Permit No. 4571	62°	00'	to 62°	10'	N.	latitude,
	116°	30'	to 116°	45'	W.	longitude;
Permit No. 4572	62°	00'	to 62°	10'	N.	latitude,
	116°	45'	to 117°		W.	longitude;
Permit No. 4575	62°	10'	to 62°	20'	N.	latitude,
	116°	45'	to 117°	00'	W.	longitude;
Permit No. 4583	62°	10'	to 62°	20'	N.	latitude,
	116°	30'	to 116°	45'	W.	longitude.

Each Permit encompasses approximately 95 square miles.

METHOD & PURPOSE OF STUDY

A study was made of selected published material on the area included within a 200 mile radius of the Permits in order to summarize the geological features of the sedimentary rocks that relate to their evaluation as a potential source of hydrocarbons. The mineral potential of Paleozoic carbonates and Pre-Cambrian rocks is also summarized. Terrain, climate, access, transportation, exploration activity and Oil and Gas regulations have also been studied in order to determine their effect on the development and marketing of hydrocarbons.

GEOGRAPHY & PHYSIOGRAPHY

All of the Permits are located in the Mackenzie Lowland subdivision of the Great Central Plain Physiographic region, west of the Laurentian Plateau and east of the Cordilleran region. The Mackenzie Lowlands slope gently northward and extend from the western end of Great Slave Lake down the Mackenzie River to the Arctic coast.

North of Great Slave Lake and west of the North Arm the area is a low-lying, poorly drained, nearly level plain with many shallow lakes and muskegs. Ridges of glacial drift separate low-lying areas on the rolling plain which stands only slightly higher than the lake. The subdued to gently rolling countryside is interrupted by a few low, sharp escarpments and rises gently to the base of Horn Plateau and Cartridge Mountain.

Escarpments of about 1,400 feet and 1,200 feet bound Horn Plateau and Cartridge Mountain respectively. The Horn Plateau has a steep southern face, a gentle north slope, and a summit that stands about 2,600 feet above sea level. These two elevated topographical features are plateaus of circumdenudation carved out of horizontal beds of Cretaceous rock.

An eastward-facing escarpment in the Ordovician runs from the vicinity of Redrock Point on the west side of the North Arm of the Lake northwestward to the west side of Faber Lake. The cuesta is supported by a resistant dolomite unit, underlain by soft, shaly evaporitic strata and overlain by evaporitic beds.

An eastward-facing escarpment formed in Middle Devonian strata is present on the north side of Great Slave Lake. It can be traced northwestward from east of Lonely Bay more or less parallel to the North Arm of the Lake to the south end of

Lac La Martre. Beds underlying the resistant carbonates and east of the escarpment are evaporitic. The overlying beds are presumed to be shale.

Forest covers the greater part of the Interior Plain, though a number of large prairies occur in the western part, north of the outlet of the Lake. Belts of heavily wooded terrain alternate randomly with muskeg that is treeless to sparsely covered with spruce. The ground is otherwise covered by a thick moss which acts as an insulator to the extent that permafrost generally exists below six inches to six feet. Horn Plateau and Cartridge Mountain are very sparsely treed. The occasional tree, where present on the Plateau, evidences the prevailing wind direction by virtue of southeast pointing limbs and scarred and limbless northwest sides.

The largest river in the vicinity of the Permits is the Mackenzie. Headwater of the Mackenzie is at the west end of Great Slave Lake from whence the river flows west and north into the Arctic Ocean. The Mackenzie River has been a main waterway for travel in the north country since earliest time. Tributaries exhibit dendritic patterns reflecting gentle structures in the nearly flat-lying bedrock. Drainage on the Permits is into Birch Lake, southward via small streams into Mink Lake, via Horn River into the Mackenzie River, and then northward to the Arctic Ocean.

Lakes in the area vary in outline from smooth to narrow and linear to very irregular. Great Slave Lake, largest body of water in the area, is about 300 miles long, over 60 miles wide at one place, and encompasses approximately 10,700 square miles. The lake is fifth largest on the continent. Heads of bays on the

north side of the lake are in most cases low and swampy, and low, muddy or marshy flats are present in the Cretaceous shales on the western-most shores. Lakes underlain by Paleozoic outcrops are mostly wide spaced with comparatively well-rounded outlines. Lake geometry in the area underlain by Chinchaga evaporites is controlled mainly by bed rock composition, but is modified to some extent by glacial deposits. Some of the lakes are ephemeral and bordered by broad flats of light-colored gypsiferous mud. The basin occupied by Lac La Martre was formed within soft rocks of the Chinchaga Formation. Birch Lake, on the Permits, has a willowy and marshy northwest side and a boulder to gravel southeast beach formed under the influence of prevailing winds from the northwest. The northeast alignment of many of the smaller bodies of water on the Permits is most likely controlled by landforms related to glaciation. Elevations on the Permits

range from about 700 to 800 feet.

Pre-Cambrian rocks adjacent to the Paleozoic subcrop edge are generally well exposed in low hills and knobs of about 100 to 200 feet relief. Maximum relief in the area underlain by rocks of the Pre-Cambrian Shield is about 800 feet. Low areas are covered by lakes and glacial deposits. Rock basins are connected by streams with rapids and falls. Some of the lakes together with some of the streams form linear drainage patterns and lakeshores are parallel for long stretches to the trend of the underlying rock. Massive granitic rocks underlie nearly all areas of small, highly irregular and very closely spaced lakes.

North of Great Slave Lake the Pre-Cambrian is rocky and rolling with scant vegetation that is confined to the low ground between rocky ridges.

The Pre-Cambrian area has a good cover of timber for the most part, especially those areas which are underlain by sedimentary and volcanic rocks. Stunted spruce and poplar grow in the mossy muskeg.

The 55 degrees mean summer temperature equates with that east of Lake Winnipeg in Manitoba. Daily summer temperatures occasionally approach 90 degrees Fareinheit, although the temperature drops in the evening during which time it is seldom above 50 degrees Fahreinheit. Great Slave Lake effects a lower summer temperature because of the presence of ice until late June or July. Freeze-up usually occurs by early October and coldest temperatures are recorded in January when the thermometer may drop as low as - 75 degrees Fahreinheit. Blizzards are somewhat subdued in comparison to those which occur on the Prairies because of the tree cover. Spring

conditions generally commence in April. Total precipitation ranges between 15 and 20 inches annually.

A wide variety of wild life is present in the general area. Animals include black bear, beaver, muskrat, lynx, foxes, mink, martin, fisher, wolverine, wolf, weasel, skunk, rabbit and woodland caribou (south of 62 degrees north latitude). Ducks and geese migrate through the area, while spruce grouse and ptarmigan remain throughout the year. Whitefish, lake trout, pike, sucker, grayling, pickeral, goldeye and inconnu are present in the waters. Fish and caribou are the only game that occurs in sufficient quantities to form reliable sources of food. Men are forbidden to hunt or trap within the boundaries of the Yellowknife Preserve unless in dire need of food.

Although conditions of climate and terrain are severe, indications are that they will not prevent development of the vast petroleum potential of the area.

ACCESS

The Mackenzie Highway runs northward from Grimshaw on the Edmonton - Fort St. John Highway and terminates at Hay River on the south shore of Great Slave Lake. An all-weather road leaves the Mackenzie Highway about 30 miles south of Hay River and connects with Yellowknife on the north shore of the Lake via Fort Providence and Rae. The road passes through the southeast corner of the Permits about 40 miles north of Fort Providence.

A railroad more or less parallels the Mackenzie Highway and then turns east along the south shore of the Lake where it serves to collect and transport ore from the mines at Pine Point on the first leg of the journey south to smelters.

The Mackenzie River has been a main route of travel since earliest time. Tributaries of the Mackenzie are navigable along their lower parts during early summer although rapids and falls make travel difficult.

Aircraft have been used extensively to transport the personnel and supplies essential to exploration programs. Helicopter transport of equipment for operations including the drilling of tests in nearby areas has been employed. Under difficult terrain conditions helicopter transport is more economical than conventional modes of operation. Use of this form of transportation has enabled many companies to work practically all year around. A number of companies have a wide variety of aircraft available for charter from Yellowknife, 70 miles northeast of the Permits. An aircraft landing strip is also present at Fort Providence.

Facilities available at the nearby town of Yellowknife include telephone, telegraph, hotels, post office, bank, hospital, mining recorder office, airport and float plane base. A daily commercial air service links Yellowknife with Edmonton, 700 miles to the south. A trading post, R.C.M.P. detachment, and a Mission are located at both Fort Providence and Fort Rae.

Northern trucking ranges from 20 cents to 50 cents per mile. Air freight on fairly short hauls is about $2.00 per hundred weight per mile, but larger hauls with larger aircraft may cost as low as 50 cents. Boats and aircraft with floats can normally operate from about June 7th to October 7th and aircraft on skis from about December 1st until April 15th.

LAND ACQUISITION & OBLIGATIONS

The various phases of oil and gas operations in the Northwest Territories are administered by the Department of Northern Affairs and Natural Resources, specifically by the oil and gas section of the Resources Management Division.

A master grid map which shows all areas under Permit and those lands available for filing is kept at the Resource Management Division in Ottawa. An applicant may request any of the grids that have not been filed on and be given a Permit which allows him to explore for oil and gas. A fee of $250.00 is charged and a deposit that guarantees work commitments will be fulfilled must be made at the time application is made for a Permit. The deposit is returned when work commitments have been satisfactorily completed. The holder of a Permit is required to spend 5 cents per acre during

the 18-month initial evaluation period, with work commitments gradually increasing thereafter up to 50 cents per acre in the final years. Permits may be extended to cover a ten-year period. A Permit may be kept in good standing over the ten-year period for a total work commitment of $2.90 per acre.

Leases may be acquired in the area for which a Permit is held. The leases may range in size from one section to 50 per cent of the sections contained in the Permit area. Leases are valid for 21 years and are renewable. Rentals are 50cents per acre for the first year and $1.00 per acre for subsequent years. The portion of the Permit not acquired at the time a lease is taken returns to the Crown. An option to acquire the Crown's portion for the payment of an additional royalty is granted to the Permittee. Royalties on the original leases vary from 5 per cent to 20

percent for oil and from five percent to ten percent for gas, depending on production rates. In the event that the option is not exercised the lands return to the Crown and may subsequently be sold by tender as oil and gas leases in one of three ways - cash bonus, work bonus or cash bonus plus a commitment to drill a well to a specified depth.

Federal oil and gas regulations provide for a large grouping of Permits and lower work requirements and oil royalties than Provincial regulations covering the more highly explored areas in southern Canada. Filing activity in the Northwest Territories has been heavy over the past few years and most of the choice acreage is presently held under Permit.

HYDROCARBON SHOWS & MARKETING POTENTIAL

The presence of asphaltic and oil-bearing rocks in the Mackenzie Basin and on the shores of Great Slave Lake has been known ever since the earliest explorers visited that part of the Northwest Territories, but until recently the remoteness of the region has hampered the exploration for and exploitation of these resources. The high potential of the Northwest Territories as an oil and gas producing region was realized with the discovery in 1920 of the 419 million barrel field at Norman Wells, 360 miles northwest of the Permits. In recent years significant quantities of gas have been established to the southwest at Rabbit Lake, Celibeta Lake, Netla, Pointed Mountain and Beaver River in the Northwest Territories, and prolific oil reserves at Rainbow and Zama in northwestern Alberta.

Density of drilling in sedimentary rocks north of the Provinces is presently only about one wildcat per 800,000 acres. The increased tempo of land acquisition in the study area suggests that it is reasonable to expect a considerable increase in exploration activity in the near future. Active exploration programs could result in the discovery of significant reserves of hydrocarbons. In the event that additional successful exploratory wells are drilled in the nearby Steen River area of Alberta, it is likely that existing pipeline facilities will be extended northward to that locale.

GENERAL GEOLOGY

The Permits are situated within the northern continuation of the petroliferous sedimentary rocks of the Interior Plains of western Canada. Geological exploration of the Upper Mackenzie River region began more than a century ago. However, lack of well control and the presence of glacial drift make it impossible to be able to predict the position of contact of the various rock types, their stratigraphic thicknesses or the amount of dip on their surfaces at any particular location in the Permit area.

The Permits are underlain by Pre-Cambrian, Ordovician, and Older (?) and Devonian strata. Pleistocene and Recent deposits mantle the greater part of the area and bedrock rarely crops out in the Plains. Exposures are relatively abundant on the escarpments and stripped surfaces of Ordovician

rocks, along the shores of Great Slave Lake and the main rivers, in sink-holes and around Pre-Cambrian hills projecting through the Paleozoic cover. Outliers of Cretaceous rock are present on Horn Plateau and Cartridge Mountain. Physical features of the topography reflect in varying degrees the nature of the underlying rock and facilitates the extrapolation of certain rock types.

Contact of the Pre-Cambrian Shield on the east and the Interior Plains on the west is marked by an irregular northwest-trending line which follows the Slave River valley from the Alberta - Northwest Territories boundary, passes beneath Great Slave Lake, along the west shore of the North Arm of the Lake, along Marion River and Hislop, Sarah and Faber Lakes.

A monoclinal dip of 1 to 2 degrees to the west or southwest is present on the Pre-Cambrian.

Paleozoic sediments laid down on this floor thicken in general southwestward into northern Alberta and westward into the Cordilleran Geosyncline as the distance from the edge of the Pre-Cambrian Shield increases. North of the West Arm of Great Slave Lake the Pre-Cambrian surface dips regionally to the southwest at the rate of 24 feet per mile, although variations due to local land forms and later flexturing and faulting are present. The main local structural features are north-easterly trending faults with minor splays or arranged en echelon as along the southeast side of the East Arm of Great Slave Lake. Deposition was influenced to a considerable extent by the presence in the Tathlina Lake area of a Pre-Cambrian flexture, the Tathlina "High". Ordovician sediments wedge out about 20 miles north of Tathlina Lake in the vicinity of Kakisa Lake against the north flank of the high and then gradually thicken to about 900 to 1,000 feet near 64° north latitude, 122° west, longtitude. The absence of Silurian and Lower

Devonian rocks indicates the area was uplifted during that time interval.

Sedimentation during the Paleozoic was dominated by carbonates and evaporites while shale dominated the Mesozoic sequence. Regional unconformities are present at the base of the Paleozoic, Middle Devonian and late Lower Cretaceous intervals. Oil and gas seeps are present in Middle Devonian outcrops. Numerous structural traps as well as stratigraphic traps formed by facies changes and regional unconformities are likely present in the area.

GEOLOGIC HISTORY

A long period of exposure with some very shallow submergence is indicated by the nature of Ordovician and Older (?) sediments. No rocks of Silurian age have been found in the study area, thus indicating severe erosion and/or non-deposition during that time interval.

The earliest Devonian deposits in the plains and adjacent mountains of western Canada were deposited in an open seaway which occupied the central Cordilleran region. Gradual transgression occurred to the extent that almost the entire eastern platform to the present edge of the Shield was immersed in marine waters of very high salinity. The Tathlina "High" was emergent throughout most of this time but may have been covered near the close of the interval. Initial fringing deposits of the Middle Lower Elk Point

on the Anderson-Great Slave shelf were derived from nearby Basement highs on the Shield to the east. These terrigenous clastics are composed of reddish-colored sandstones, siltstones and shales. Anhydrite and evaporitic dolomite deposition followed. Strata of that sequence is placed in the Chinchaga, uppermost formation of the Lower Elk Point Group. A disconformity is evidenced at the top of the Chinchaga by the halo of sandstone, shale and restricted dolomites containing sandy interbeds and floating sand grains present around the Tathlina "High". Severe brecciation is indicative of the number and/or thickness of evaporitic beds that were present.

Withdrawal of the sea from the shelf to a position near the edge of the Cordilleran Trough at the end of Chinchaga time gave way to a transgression during which open marine limestones of the Keg River (i.e. Lonely Bay) formation were

deposited. The shoreline was carried eastward to a position beyond that of the underlying Lower Middle Devonian. Lower Keg River strata consists of shaly to clear limestones which contain crinoild, brachiopod and solitary coral fauna with skeletal material common adjacent to the platform margins. The Keg River ranges in thickness from nearly 250 feet along the platform margin to 50 feet along the northeastern shelf margin.

Reefs or carbonate banks subsequently developed across the entire platform during slight shallowing of the sea. The organic reef facies consist of abundant colonial organisms such as corals, stromatoporoids or calcareous algae. Barrier reefs built up along the platform margin in northeastern British Columbia. Open marine limestone and shale were deposited in front of the barrier, while biohermal reef and carbonate mud banks developed back of the barrier in areas of more rapid subsidence. The reef masses built

up to heights of as much as 700 feet above the platform in the Rainbow area while the mounds in the more stable areas of the Shelf in the Prairie Provinces developed up to heights of only 300 feet above the platform. Thickening of sediments associated with transgression, and regression westwards towards the shelf margin suggests that the transgressions were due to subsidence rather than a rise on sea level.

Growth of the main carbonate barrier bank in northeastern British Columbia resulted in change from open to restricted marine environment on the Interior Shelf of the Prairie Provinces. At this time carbonate "reef" deposition ceased, salinity increased, and evaporite and evaporitic carbonate deposition began. Algal and amphiporoid carbonate in the predominantly anhydritic Muskeg Formation indicate the intermittent presence of fresh, lagoonal

water. The Muskeg Formation becomes increasingly evaporitic southeastwards from the Barrier complex and grades into thick salt sections in northeastern Alberta and the Williston basin. In some instances, salt was deposited directly on open marine limestone. Increased subsidence at and near the barrier edge is suggested by the transgressive carbonate member which overlies the Muskeg evaporite in the Rainbow area and grades southeastward into evaporites. This unit is represented at the barrier edge by the biostromal Presqu'ile Formation and by the Sulphur Point carbonates in the area back of the barrier. The Presqu'ile grades seaward in the area of study into the Horn River shales.

The location of the barrier front in the vicinity of Great Slave Lake is along the south-western projection of several major fault line scarps in the Pre-Cambrian and is coincidental with a very strong aeromagnetic trend in the Basement.

Shallow seas invaded the area in post Watt Mountain time and deposited the restricted to semi-restricted limestones of the Slave Point Formation. A narrow reef grew along the edge of the carbonate shelf complex in a position approximating the Presqu'ile barrier front. Shelfward, evaporites comprising the Fort Vermilion Member were diachronously deposited. The seaward facies is represented by the terrigenous muds that formed the shales of the latest Middle Devonian unit, the Horn River Formation.

Middle Devonian strata is truncated to the west by the pre-Late Devonian unconformity. The regional stratigraphy suggests the presence of a pre-Fort Simpson unconformity in the area of study.

Units of the Fort Simpson sequence represent an open marine shale and limestone deposit of a vast transgressive sea which invaded the interior

isolated reef complexes associated with fault-controlled Basement "highs" may be present on the Permits "seaward" from the Presqu'ile front.

Regional uplift occurred over the Peace River "high" - west Alberta ridge at the end of Muskeg time, and erosion was followed by the deposition of a regressive sandstone and shale unit, the Watt Mountain Formation. A disconformity is present at the base of the Watt Mountain Formation over most of the shelf area of Alberta. Although the effects of post-Muskeg uplift diminish to the northwest a subtle disconformity can nevertheless be recognized as far north as the central MacKenzie River area.

Shelf in earliest Late Devonian time. The formation thins by onlap onto the Peace River-western Alberta "highs" as well as topographic highs which formed at the end of Slave Point time. A reefal complex, the Swan Hills Member of the Beaverhill Lake (i.e. Fort Simpson) Formation developed on a shelf, much farther east than any of the earlier carbonate barriers. In northern Alberta the Fort Simpson Formation consists of a series of limestone tongues in an open marine shale. The majority of the carbonates appear to grade rather gradually into open marine shales and siltstones, although one such carbonate tongue terminates abruptly in a stromatoporoidal reef.

On a regional basis the younger carbonate platforms move progressively eastwards through Devonian time, thus demonstrating the basic transgressive character of Devonian seas during this interval.

Strata representing the interval from Fort Simpson through Mississippian , Pennsylvanian, Permian, Triassic and Jurassic is absent in the study area. The bulk of Cretaceous strata is represented by marine shales. Pleistocene and recent sediments are present in the form of glacial and non-glacial fluvial and lacustrine deposits and wind blown deposits.

STRATIGRAPHY

PRE-CAMBRIAN

GENERAL

The Pre-Cambrian is partly hidden by unconsolidated Pleistocene and Recent deposits and covered by many shallow lakes through which numerous rocky islands project. Exposures of Pre-Cambrian rocks consist of Archaean and Proterozoic granite, granodiorite and allied rocks, although andesite, greywacke, slate, quartzite, schist and gneiss of the Yellowknife Group is fairly common.

The Pre-Cambrian surface dips gently in a southwestern direction beneath the Paleozoic sedimentary cover and locally, beneath the waters of the north arm of Great Slave Lake. Topographical features trend in general southwest, south or southeast as do lineaments and faults. Knobs,

linear ridges and irregular hills rise from 400 to 800 feet above the surrounding peneplain. These monadnocks are underlain mainly by quartz, porphyritic granite and conglomerate, slate, andesite, schist and gneiss of the Snare Group, and are associated with quartz veins and large stockworks. Greatest relief is developed on the porphyritic granite whereas numerous large, northwest-trending quartz stockworks form linear ridges. Less relief is present where the stockwork cuts rock of the Snare Group or the porphyritic granites. Glaciation likely modified the Pre-Cambrian surface to a small extent. The quartz stockworks occupy faults in most cases and are the result of many different periods of fracturing and recementation. Pitchblende, silver and minor amounts of gold are associated with the giant quartz veins. Any wells drilled into the Pre-Cambrian on the Permits should be watched closely for mineral shows.

Present day Pre-Cambrian topography is likely very similar to that which existed prior to the deposition of Paleozoic strata. Near the Ordovician subcrop edge in the Mazenod-Marian Lakes area, Pre-Cambrian hills rise about 350 feet above the surrounding Paleozoic sediments. Monadnocks likely existed as islands in at least part of the Paleozoic seas and had a strong influence on the pattern of sedimentation.

It is important to ascertain the gravity and magnetic characteristics of rocks which form the Pre-Cambrian topographic highs where they are exposed, in order to be able to recognize their subsurface presence in the Permit area to the west. The most favourable areas for drape in the overlying Paleozoic sediments may thus be located and the rough geometry of depression-filling basal Paleozoic sand outlined.

YELLOWKNIFE GROUP

The oldest rocks present in the area are placed in the Archaean Yellowknife Group, and divided into a lower unit of andesitic lavas with minor dacite, basalt, rhyolite and tuff, agglomerate and breccia, occasionally metamorphosed to amphibole and chlorite schist, and an upper unit of greywacke, slate, arkose, quartzite and phyllite. The Group was intruded by granitic rocks, folded, and subjected to erosion long enough to expose the granitic rocks before the close of the Archaean. Greywackes adjacent to the intrusives grade laterally into knotted quartz-mica schists and gneisses. Total thickness of the Yellowknife Group is not known because of its complex structure but the Group appears to comprise a conformable series.

Rocks of the Yellowknife Group generally dip steeper than 65 degrees and in some places are overturned as much as 25 degrees. The

sedimentary rocks are present in a series of tight, nearly isoclinal folds that strike almost parallel to the border of the enclosing granitic rocks. Very little shearing is present along the contract of volcanic and sedimentary members.

An assemblage of granite, granodiorite and associated rocks of Archaean and Proterozoic ages are included into the Yellowknife Group, and in part through an unconformity into the overlying Snare Group. The latter Group in places unconformably overlies the aforementioned intrusives.

SNARE GROUP

Sedimentary rocks of the Proterozoic Snare Group were laid down on the erosional surface of the Yellowknife Group. Rocks of the Snare Group vary considerably in composition and consist of shale, slate, argillite, greywacke, course white

cross-bedded quartzite, and dolomite, with minor basic lavas and intrusives. The rough metamorphic equivalents consist of phyllite, quartzite, quartz-mica schist, knotted quartz-mica and gneisses. It is not known in exactly what order the total sequence was deposited. In most places the basal rocks are white quartzites, pink arkoses and pebbly quartzite or conglomerate. The basal clastics are overlain by dolomite or banded argillaceous rock that grades upwards into a thick series of inter-bedded argillaceous rocks, greywackes, cross-bedded and ripple-marked white quartzites and dolomite. Algal-like structures are present at some localities.

A second period of folding affected rocks of both the Snare and the Yellowknife Groups. Rocks of the Snare Group dip less than 65 degrees in most places and commonly dip less than 45 degrees although beds are overturned as much

10 degrees in some places. The Snare sequence in many places forms elongated northeast to northwest-trending basins in granitic rocks.

POST-SNARE

Both of the aforementioned Pre-Cambrian Groups are intruded by large and small stocks and veins of feldspar porphyry and feldspar quartz porphyry. The youngest Pre-Cambrian rocks are the relatively recent dikes of diabase and gabbro.

ORDOVICIAN & OLDER(?) PALEOZOIC

GENERAL

Ordovician and Older(?) Paleozoic rocks form the northeastern margin of the Interior Plains and outcrop in a narrow two to eight mile wide, northwest-trending belt bordering the Pre-Cambrian

Shield. The outcrops pass about 60 miles east of the southeast corner and 35 miles east of the northeast corner of the Permits. In the northern part of the study area the succession consists of four units named in ascending order the Old Fort Island Formation, LaMarte Falls Formation with Mazenod Member near the base, and Chedabucto Lake Formation. Only the upper two rock units have definitely been dated on the basis of fossil evidence as Middle Ordovician. In the south a rock unit named the Mirage Point Formation occupies the combined interval of the upper three and in places the four units developed in the north. Ordovician rocks are particularly well exposed in a narrow belt along the North Arm of Great Slave Lake. Rocks of the Ordovician rest on the Pre-Cambrian and are unconformably overlain by Middle Devonian strata.

The 750 feet of Ordovician present in the Northwest Territories Windy Point No. 1 well at 61° 19' N. latitude, 115° 52' W. longitude thins to less than 200 feet at Rae Point and Old Fort Island and then thickens to 1,000 feet near Faber Lake. A Pre-Cambrian arch with summit located between Marian Lake and Wrigley Point is thus indicated. The arch may trend southwest in accordance with other major tectonic trends evident in the general study area. This "high" may have had a favorable effect with respect to Middle Devonian carbonate sedimentation along a trend passing beneath the Permits.

Hydrocarbon saturated reservoirs may be present in the Cambro(?)-Ordovician basal sand sequence in flextures over Pre-Cambrian topographic highs, in differential salt solution areas, in fault controlled traps and against updip permeability barriers. Clues to the presence of the afore-

mentioned traps on the Permits might be gained from gravity meter and magnetometer surveys.

OLD FORT ISLAND FORMATION

Type section of the Old Fort Island formation is on Old Fort Island where exposures consist of sandstone, white to varicolored, quartzose, occasionally cross-bedded in the lower part, thin to thick-bedded, fine to coarse-grained, mostly porous, loosely consolidated; thin beds of siltstone, greenish grey to red; occasional thin green shale parting. At numerous places along the west shore of the North Arm of Great Slave Lake between Red Rock and Wrigley Points, and along a 1.5 mile stretch in the canyon immediately below La Martre Falls 100 to 125 feet of predominantly shale sections are present. Beds in the former locality are composed of shale, olive-green, rarely black, soft, fissile, non-calcareous; thin interbeds of sandstone, whitish grey to greenish

grey to white, friable, quartzose; some gypsum, varicolored, primary and secondary; thin beds of dolomite, dark brownish grey, sandy and silty. Strata exposed below LaMartre Falls consist of shale, green and dusky red, soft, fissile, ferrugenous; thin beds of sandstone, fine-grained, dolomitic, ripple-marked; fairly thick units of dolomite, pale greenish-grey and light grey, sandy, silty and resistant. Further north the formation is composed of fine-grained sandstone and varigated shales with local salt-crystal molds and sandy dolomites.

Strata of the Old Fort Island Formation rest on the Pre-Cambrian and is overlain by the La Martre Falls Formation in the north and the Mirage Point Formation in the south. The formation fills portions of depressions on the Pre-Cambrain and is missing in the subsurface where sufficient

relief is present on the Pre-Cambrian surface. A maximum thickness of 110 feet is present in the Northwest Windy Point No. 1 well at 61° 19' N. longitude, 115° 52' W. latitude.

Age of the unfossiliferous Old Fort Island formation is dated as Middle Ordovician by virtue of the presence of Middle Ordovician fossils in the upper part of the overlying Mirage Point and La Martre Falls formation.

Potential reservoir rocks are contained in the sandstones of the Old Fort Island Formation. The Formation may harbour an oilfield(s) similar to that which exists at "Red Earth" in northern Alberta.

La MARTRE FALLS FORMATION

Type section of LaMartre Falls Formation is in Rivere La Martre canyon immediately below

La Martre Falls, where the 1.5 miles of exposures consist of shale, green, red, fissile, soft, ferrugeneous; thin interbeds of sandstone, fine-grained, dolomitic, ripple-marked; dolomite, pale greenish gray and light gray, sandy, silty and resistant. Contact of this red bed sequence with the underlying Old Fort Island Formation, where present, is transitional and placed where the brick red silty mudstone grades into the underlying quartzose siltstone. The upper contract is gradational over a very limited interval with the Chedabucto Lake dolomite. Middle Ordovician graptolites are present near the top of the La Martre Falls formation at the type section.

A total thickness of 345 feet is estimated for the formation in the type section area whereas a 90 foot thick section is present on Old Fort Island. It is anticipated that thickness of the La Martre Falls formation in the area of study will vary considerably

in reaction to Pre-Cambrian topography and varying degrees of salt deposition and solution.

Although no good reservoir beds have been observed in the formation itself, sufficient salt may have been leached locally at various time intervals to provide good traps in overlying beds. Draping in overlying beds will occur if remenant salt blocks are present. Such a low density feature might readily be detected by the gravity meter.

MAZENOD MEMBER

Type area of the Mazenod Member is south-west of Mazenod Lake where exposures consist of dolomite, gray, nodular, bedded; dolomite, oolitic, variably calcareous; dolomite gray, medium-grained with interbeds of ripple-marked and cross-laminated sandstones. Adjacent to Pre-Cambrian highs the dolomite beds grade laterally into boulder conglo-

merates composed of angular fragments of igeneous rocks and conglomeratic, silty, sandy dolomites. The Mazenod Member is about 125 feet thick southwest of Mazenod Lake and pinches out completely to the southeast within the lower part of the La Martre Falls formation. The unit is unfossiliferous except for fucoidal markings.

The Mazenoc dolomite is mostly dense, to finely porous, but may be highly fractured due to differential compaction over Basement highs or collapse in areas where salt has been solutioned from underlying beds. However, it is possible that e Member is not developed in the vicinity of the Permits.

CHEDABUCTO LAKE FORMATION

Type section of the Chedabucto Lake formation is a composite of outcrops in the Chedabucto Lake area consisting of dolomite, medium brown to

purplish mottled in the southern area of exposure, fine-grained, granular, local pinpoint vug porosity, resistant, massive, thick-bedded, chert nodules and veins in part and fossiliferous in part. The formation varies considerably in thickness, partly in response to undulations on the Pre-Cambrian surface. A maximum of 250 feet is present in the area west of Faber Lake whereas the unit thins to zero south of Alexander Point. The formation merges with the upper beds of the Mirage Point Formation southward from Red Rock Point. Chedabucto Lake dolomite conformably overlies the La Martre Falls formation and is unconformably overlain by the Middle Devonian Chinchaga formation. The youngest definitely dated Upper Ordovician fossils are present in the Chedabucto Lake formation. Part of this unit forms a protective cap for a very distinctive scarp that can be traced from Red Rock Point to west of Faber Lake at 64° N. latitude.

Hydrocarbons may be trapped in the Chedabucto Lake Formation when finely porous and/or fractured dolomite is draped over Pre-Cambrian highs or where drape over remenant salt blocks is present. A facies change from porous dolomite to impermeable rock would also create an effective trap.

MIRAGE POINT FORMATION

Exposures of the Mirage Point Formation are present discontinuously between Alexander and Gypsum Points and consist of dolomite, red to purple to orange, argillaceous in part, sandy in part, gypsiferous, mudstone, dolomitic; sandstone, very fine-grained, dolomitic; shale, red and green, gypsiferous in part with some bedding surfaces exhibiting mud cracks; gypsum and satin spar. Water covers the lower part of the unit. A maximum thickness of about 180 feet may be represented by the outcrop composites. The Mirage Point Formation is

present in the Imperial Windy Point No. 1 well between 1,045 and 1,640 feet where it consists of 595 feet of red shale, gypsum, anhydrite and salt, with red and brownish red sandstone at the base. In the Pine Point area about 190 to 290 feet of the formation has been encountered in different wells and consists of mudstone, red and green, silty, quartz siltstone; dolomite, gypsiferous and silty dolomite; gypsum; anhydrite; and an upper brecciated unit of angular fragments of dolomitic silty mudstone and dolomite, in a clay and gypsum matrix. The formation thins southward to zero where it abuts the Tathlina High.

Rocks of the Mirage Point Formation are felt to range in age from Middle Ordovician or