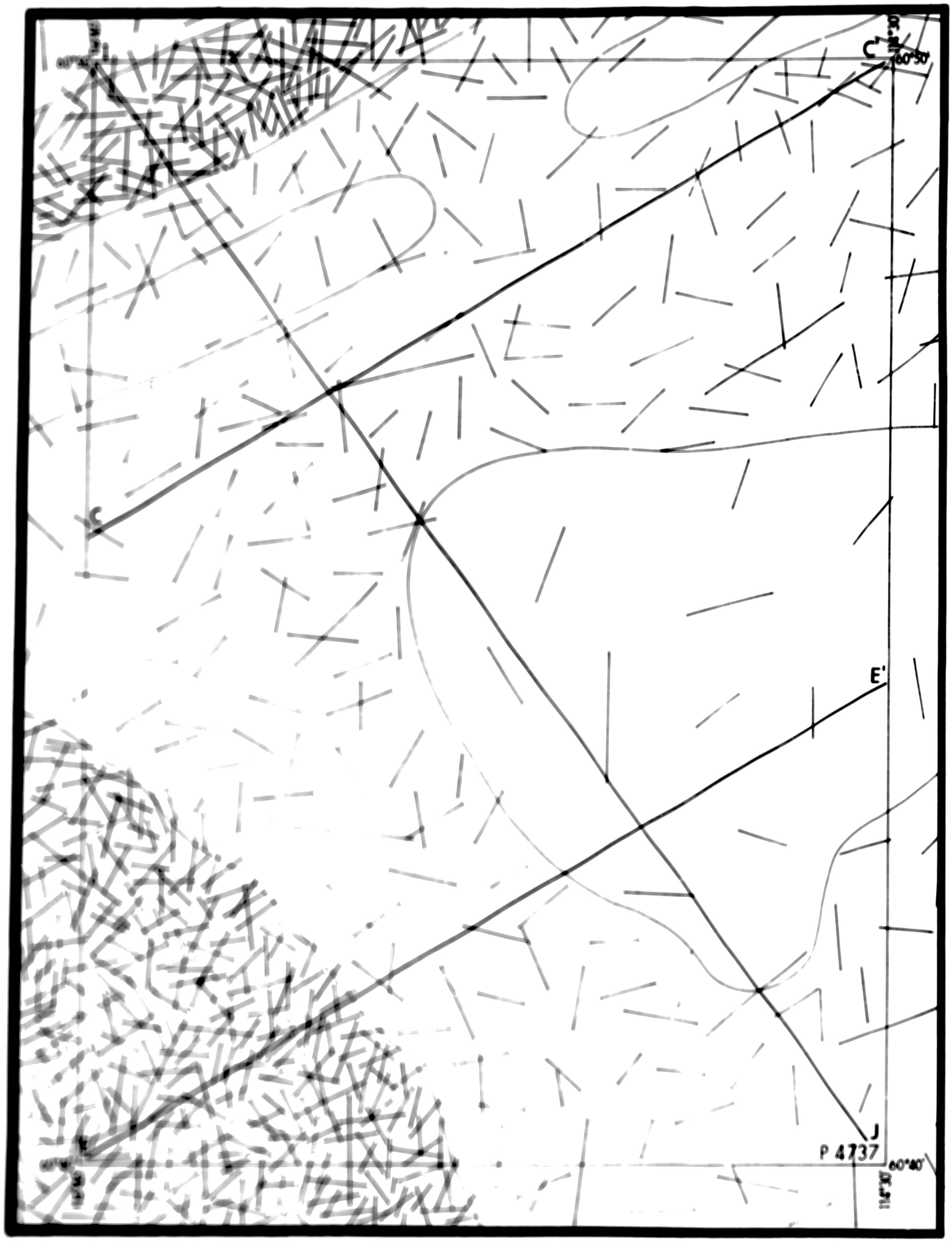
CARSON HOLDINGS LTD.

P. & N.G. PERMIT 4737

SCALE IN MILES

1 0 1 2 3

THIS IS AN UNCONTROLLED MOSAIC AND SHOULD NOT BE TAKEN AS AN



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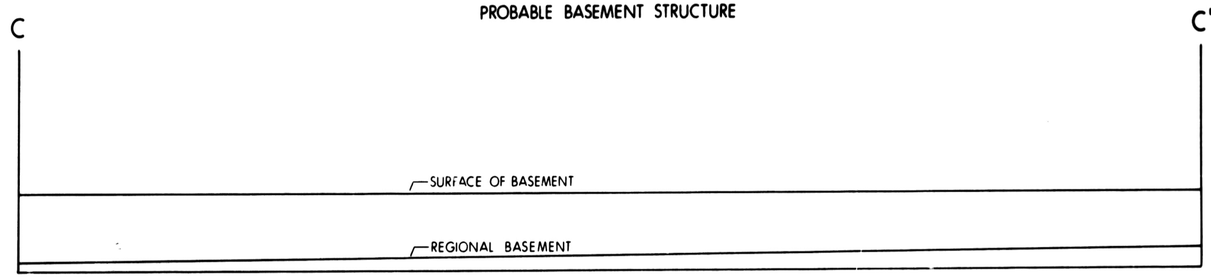
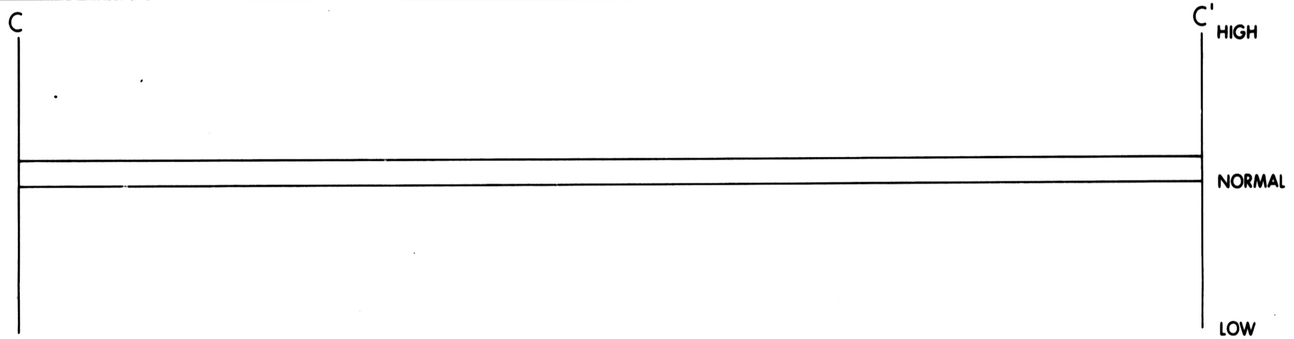
TOTAL FRACTURE PATTERN

SCALE IN MILES

0 1 2 3

PROBABLE BASEMENT STRUCTURE





FRACTURE INTENSITY CROSS SECTION

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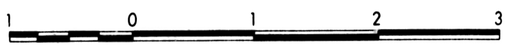
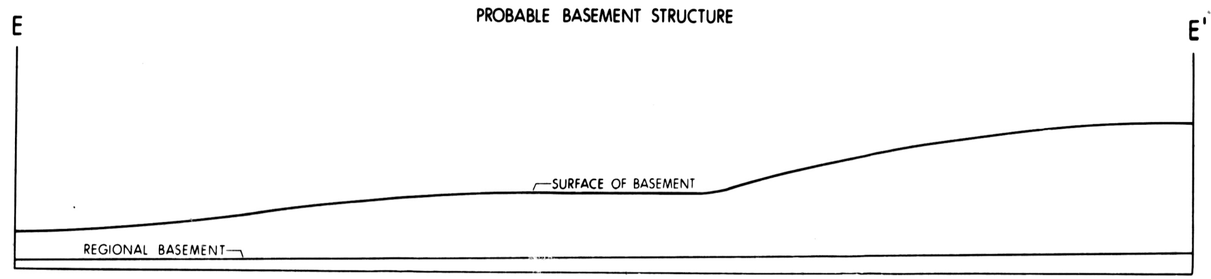
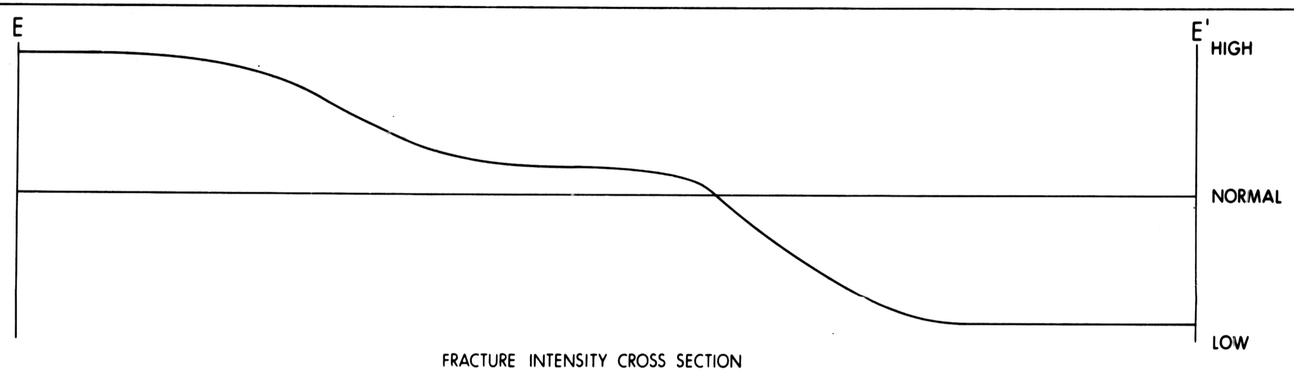
SCALE IN MILES







FRACTURE INTENSITY CROSS SECTION

CARSON HOLDINGS LTD.

P. & N.G. PERMIT 4737

SCALE IN MILES

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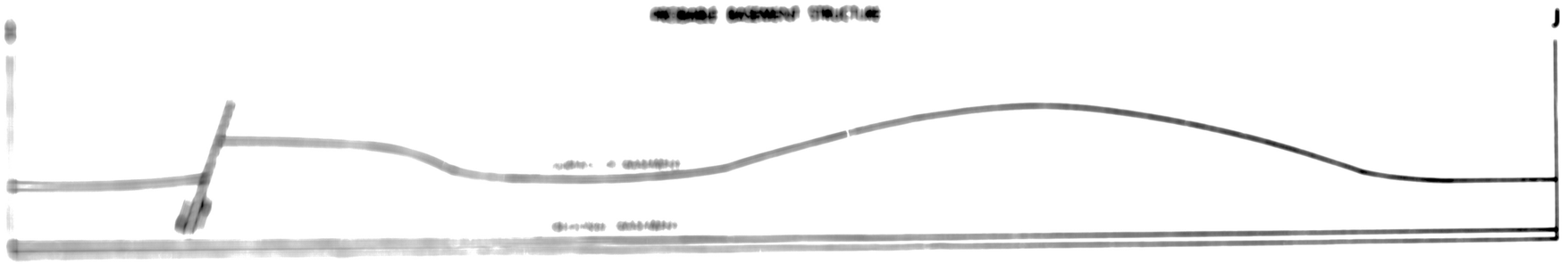

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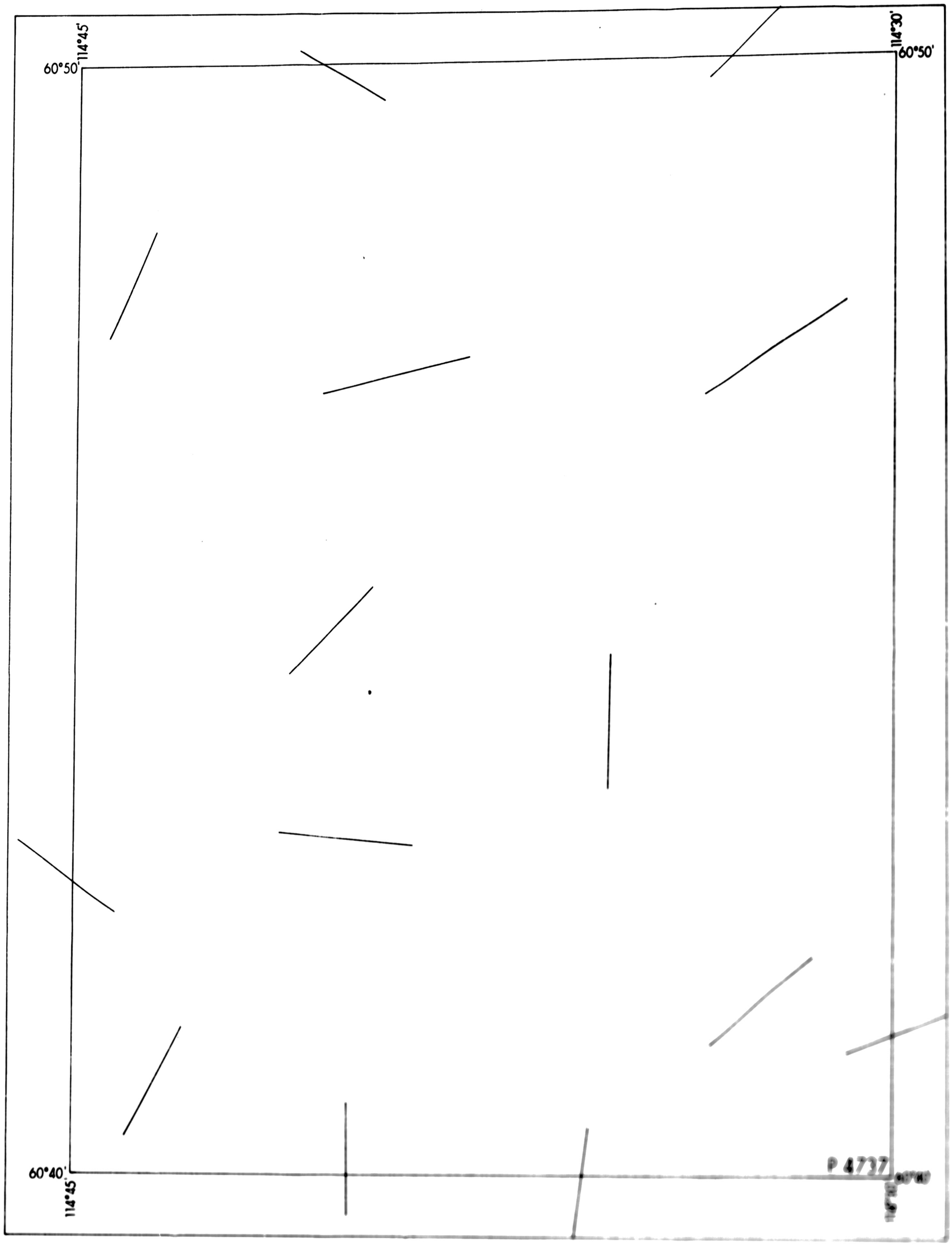

CARSON HOLDINGS LTD

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MEGA FRACTURE PATTERN

SCALE IN MILES

1 0 1 2 3

654-2-4-8

GENERAL GEOLOGY

&

FRACTURE ANALYSIS SURVEY

of

P. & N. G. PERMIT NO. 4737

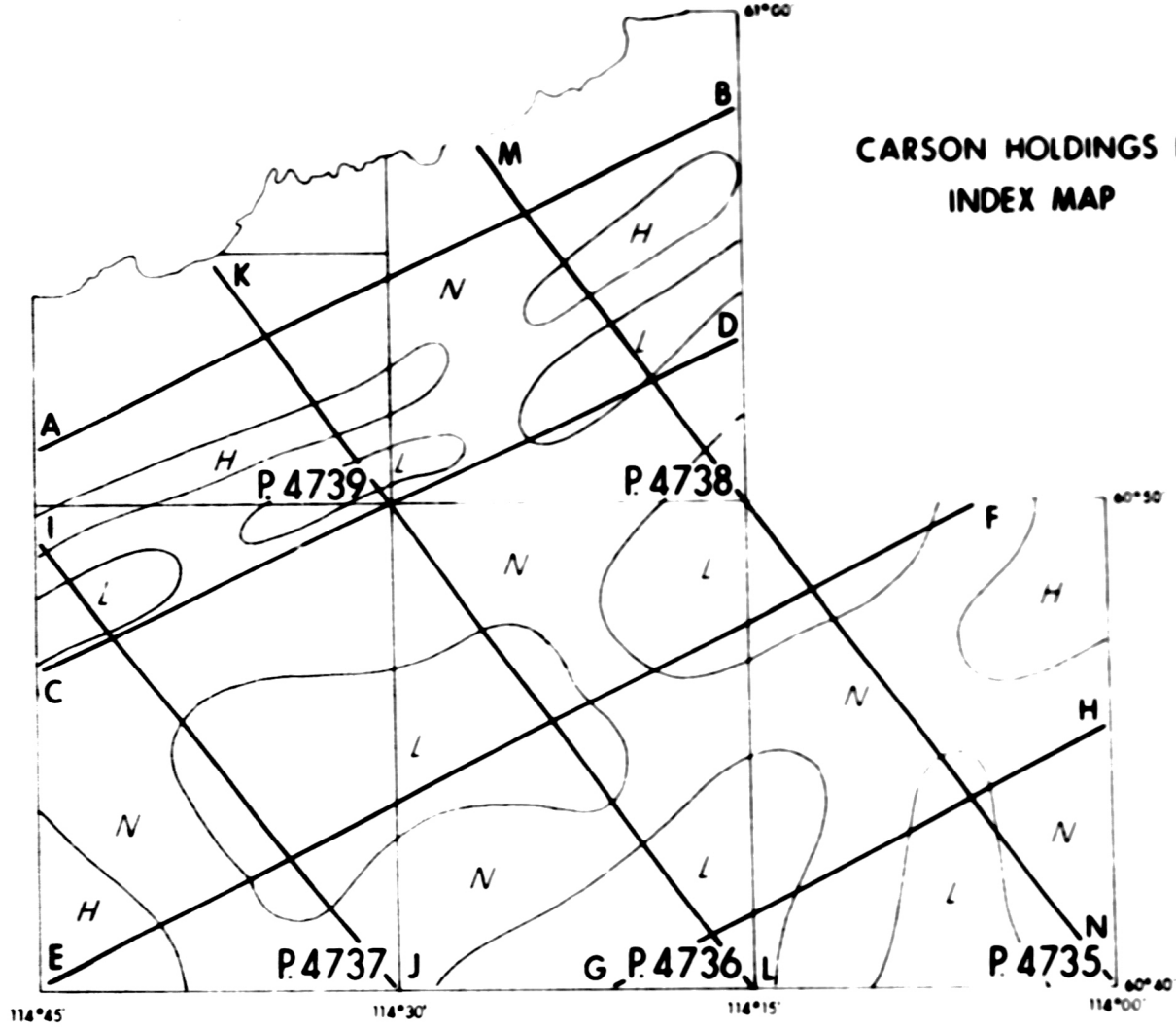
for

CARSON HOLDINGS LTD.

by

RAYALTA PETROLEUMS LTD.

CARSON HOLDINGS LTD.
INDEX MAP



INTRODUCTION

This report discusses the results of a Fracture Analysis Survey carried out within, and in the immediate vicinity of, Petroleum and Natural Gas Permit No. 4737. This Permit is located in the Northwest Territories and is held under the Canada Oil and Gas Land Regulations and is located between 114° 30' to 114° 45' longitude and 60° 40' to 60° 50' latitude. The Permit is 500 miles north of Edmonton and 100 miles west of Yellowknife.

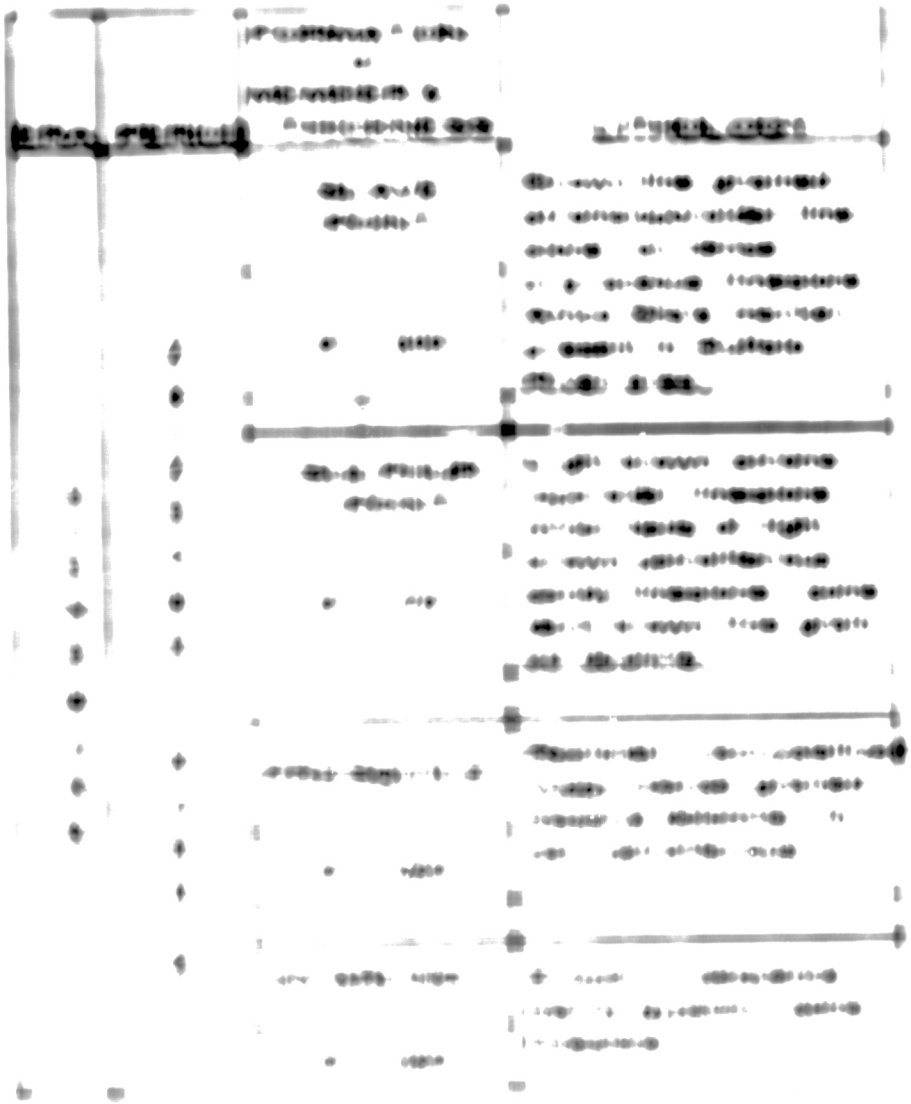
The Pine Point Highway passes through the Permit as does the Highway to Fort Smith. These are the only roads which service the area. Access to the Permit itself is by helicopter or on foot during the summer or by vehicle during the months when the ground is frozen. However, there are no side roads in the area and considerable road construction would be required to reach any particular area.

The surface of the Permit is quite flat lying and total relief does not exceed 240 feet. There is only a poorly developed drainage pattern within this area and a few intermittent streams flow to the north towards Great Slave Lake. A layer of very soft muskeg covers this part of the North west Territories and this muskeg is so soft that it is impassable to all but specialized vehicles.

Vegetation consists of thick stands of thin evergreen trees interspersed with many open areas. These oper areas are covered by muskeg grass and scrub deciduous growth. The evergreen trees show up as a medium gray tone on the mosaic and the open areas are a lighter gray. A few small patches of deciduous trees are present.

There is no topographic form or aerial photo feature present which immediately suggests the presence of any geologic structure.

[redacted]



STRATIGRAPHY

TABLE OF FORMATIONS

ERA	PERIOD	FORMATION or MEMBER & THICKNESS	LITHOLOGY
		(Lime ground) DOLOMITE MEMBER 0 680	Brown, in part vuggy and petroliferous fine grained granular dolomite. Also sandy and minor coarse grained dolomite.
		(Brown) LIME STONE MEMBER 10	Thinly bedded, brown fine grained fossil ferous limestone. brown platey, partly petroliferous lime-stone medium brown to coarse grained vuggy dolomite.
		BUFFALO RIVER MEMBER 0 81	Green to bluish grey fossiliferous shale. some iron sulphide

STRATIGRAPHY

TABLE OF FORMATIONS

ERA	PERIOD	FORMATION or MEMBER & THICKNESS		LITHOLOGY
PALEOZOIC	MIDDLE DEVONIAN	PINE POINT	BITUMINOUS SHALE & LIMESTONE MEMBER 0' - 200'	Dark to medium brown thinly bedded limestone, partly petroliferous and dolomitic; also dark brown, fine grained thinly bedded and nodular limestone, interbedded with black bituminous shale.
			?	
			LIMESTONE MEMBER 0' - 110'	Medium brown fine grained to aphanitic limestone, interbedded limestone and brownish gray shale.
			CHINCHAGA 300'	Gypsum limestone dolomite, limestone & dolomite breccia, salt and minor green shale.
				Red beds of dolomite,

STRATIGRAPHY

TABLE OF FORMATIONS

- 4 -

ERA	PERIOD	FORMATION or MEMBER & THICKNESS		LITHOLOGY
PALEOZOIC	MIDDLE DEVONIAN	UPPER to MIDDLE ORDOVICIAN or OLDER	MIRAGE POINT ± 595'	dolomitic silty mudstone breccia, gypsiferous and sandy dolomite shale, siltstone anhydrite & salt
			OLD FORT ISLAND 0' - 110'	White friable quartzose sandstone and minor greenish grey siltstone and green shale.

SLAVE POINT FORMATION

This formation marks the upper limit of the Middle Devonian (Givetian) and consists of a thin grained fragmental argillaceous and limestone with algal nodules near the top. Conodonts are fairly [illegible] with numerous [illegible] including Amphipora, Atrypa, Cladopora, Stromatopora and Emanuella. There are minor amounts of brown asphaltic limestone containing [illegible] with fairly well-bedded fine grained grey-tan stone and massive dolomitized sandy limestone. Although some features are obscured the rock has been [illegible]

The Slave Point formation is underlain by an 11 foot bed of grey shale and argillaceous limestone which served as a marker bed for the bottom of the Slave Point formation in the Buffalo River area. This 11 foot bed is believed to be the remnants of the Watt Mountain formation to the south (Law 1951) and is

Presqu'ile and below the Amco shale. In another area the Sulphur Point formation appears to interfinger with the upper part of the Pine Point formation.

PRESQU'ILE FORMATION

The Presqu'ile formation, overlain by the Slave Point formation and Sulphur Point formation, is exposed in certain outcrops close to Pine Point Mines. This formation is composed of a light colored coarsely recrystallized variably vuggy massive dolomite. The recrystallized dolomite is a replacement for reefal limestone, the original type of rock of which the reef was composed.

There is some debate as to the type of reef that forms this formation, although the barrier reef idea is popular.

The dolomite on the surface, appears to wedge southward from the Pine Point area and disappears into the fringing Elk Point sea in the subsurface.

coarsely recrystallized dolomite underlies a cresent shaped area fringing the south side of Great Slave Lake.

South of Presqu'ile Point, the dolomite is a medium gray to purplish gray, coarsely to medium crystalline, vuggy to cavernous, massive and weathers light gray to brown. The formation is very irregular to the east with thickness varying considerably.

The Presqu'ile formation overlies the Fine Grained Dolomite Member of the Pine Point formation.

NYARLING FORMATION

An evaporitic area of gypsum and minor thin bedded, brown fissile, fine grained to aphanitic limestone, with occasional dark brown carboniferous streaks, occupies the southern part of this area. The name applied to this formation is the Nyarling

formation and it is thought to be the stratigraphic equivalent of the upper portion of the Pine Point formation, the whole of the Presqu'ile and Sulphur Point formation.

Because of the soft erosive nature of this unit, very few outcrops were observed.

PINE POINT FORMATION

BUFFALO RIVER MEMBER

The Buffalo River Member is the youngest unit of the Point Point formation. Penetration by two drill holes, immediately west of Buffalo River revealed a bluish gray to dark green fissile, limy shale with occasional iron sulphide, approximately 100 feet thick. It was overlain by fine grained porous dolomite and underlain by the Bituminous Shale and Limestone Member of the Pine Point formation.

This formation was also present in Cominco's G-4 well, with 105 feet being present.

FINE GRAINED DOLOMITE MEMBER

The Fine Grained Dolomite Member of the Pine Point formation is the largest and thickest member of that formation, and may possibly be given formation status in the future.

In Cominco's G-I well the Fine Grained Dolomite Member comprises the upper 460 feet of the Pine Point formation, which is itself 540 feet thick. In this area, the Fine Grained Dolomite Member is overlain by the Presqu'ile formation and overlies the Limestone Member of the Pine Point formation.

At Cominco's G-4 well, the member is overlain by the Bituminous shale and Limestone member, and overlies the Chinchaga formation. It consists of a sandy vari-colored dolomite and minor limestone, which interfingers with the Buffalo River Shale.

In the G-1 well area where the member is thickest the basal beds consist of a gray, finely crystalline compact, vuggy, fractured dolomite, about 35 feet thick. Overlying the basal dolomite are two beds of green shale and argillaceous dolomite, separated by three feet of dark brown dolomite. Campbell (1950) referred to these as the E-2 (lower) and E-1 (upper) horizons.

The overlying 310 feet between the top of the E-1 horizon and the Presqu'ile formation consists mainly of a light brown, fine grained sandy porous dolomite. Coal-like carbonaceous material is present between 100 feet and 130 feet above the E-1 marker bed.

BROWN LIMESTONE MEMBER

This unit is equivalent to the upper part of the Fine Grained Dolomite and is exposed in a series of escarpments between 1 and 1.7 miles southwest of Dawson Landing.

The upper part consists of greyish brown [illegible] to fine grained limestone, containing irregular dark siliceous [illegible]. The Limestone Member of the Pine Point Formation is considered to be the upper unit of this formation and is the stratigraphic equivalent of the slightly fine grained dolomite located at the base of the fine grained dolomite member in [illegible] well

LOWER MIDDLE DEVONIAN
and
ORDOVICIAN

Underlying the Pine Point formation is the evaporitic Chinchaga formation a regular unit of between 310 feet - 325 feet thick, encountered at 675 feet in Cominco's G-I well and 709.5 feet in Cominco's G-4 well. This formation is composed mainly of gypsum, argillaceous limestone, anhydrite, and salt, with minor limy dolomite. There is some possibility that this formation may be, in part, Upper Silurian, but, the evidence is inconclusive.

A large unconformity separates the Chinchaga from the underlying Upper Middle Ordovician-Mirage Point Formation. These beds are composed of red and green beds of silty mudstone quartz siltstone, dolomite, gypsum anhydrite and dolomite in a matrix of clay and gypsum.

In Cominco's G-1 well, the Mirage Point formation overlies the igneous Pre-Cambrian and in Cominco's G-4 well 20 feet of the Old Fort Island formation, a quartzose, silty sandstone separates the Mirage Point formation from the Pre-Cambrian.

STRUCTURE

If one interprets the Presqu'ile reef as being a barrier reef migrating northward over the fore-reef deposits of the Pine Point formation, it would restrict the circulation of sea water in the back-reef area to the south, resulting in the deposition of evaporites. Such an evaporite exists as the Nyarling Formation. There is a general dip of 20 feet - 25 feet per mile to the south-west, but the local structure is not well known, due to lack of well control.

The Presqu'ile reef is probably in part, biostromal and biohermal. Dips of 5 degrees - 10 degrees are common, and occasionally much higher. Large gentle folds parallel the reef trend.

The Slave Point Formation seems to have been deposited on the western flank of the undolomitized equivalent of the Presqu'ile Formation, (the Sulphur Point Formation) extending over a broad westward tilting shelf, which may have been restricted in cir-

culation, of sea water, resulting in some anhydrite being deposited. When normal conditions returned (the top of the Prodgville being eroded, or the depth of water sufficiently increased) limestone was laid down.

OIL & NATURAL GAS PROSPECTS

[redacted]

FRACTURE ANALYSIS

This section of the report discusses the results of a Detailed Fracture Analysis Survey carried out on the area under discussion. An aerial mosaic (scale 1.5 inches equals approximately 1 mile) made from Dominion Government aerial photographs accompanies this report. These same photographs were examined stereoscopically and the fractures plotted on the individual photographs, then transferred to the mosaic for analysis.

The theory that the earth's crust is abundantly and methodically fractured is the basic premise on which is built the exploration technique known as Fracture Analysis. A Fracture is defined as "...generally abundant, natural lineation discernible on aerial photographs".

Fracturing is largely caused by external stresses

on the surface. The most important are:

(a) earth tides

(b) radial acceleration of the earth along its radius vector.

(c) a gradual decrease of the earth's rate of rotation.

As stated above, the earth is systematically fractured and the fracture system would approach symmetry if the crust were homogeneous. It is considered that irregularities are caused by regional heterogeneous conditions within the earth's crust. Local departures from the norm are caused by structural or stratigraphic anomalies.

The term "photogeophysics" was introduced by Blanchet (1956) and deals with mapping, analysis and interpretation of fracture traces as recorded on aerial photographs. In a more general way "photogeophysics" can be defined as the methodical statistical analysis of linear features seen on aerial photographs and this

system is applied by any method recording all observable lineations, or the totality of a certain type of linear feature, and the statistical presentation of the data on contoured intensity maps of dry plotting the fractures directly on the mosaic.

In this report a megafracture is longer than one mile and a microfracture is shorter than one mile.

GENERAL STATEMENT

ORIGIN OF FRACTURES

Fracturing is largely caused by [illegible] on the earth, although [illegible] minor roll. The [illegible] are the diurnal earth tides due to the gravitational attraction of the sun and moon, the changes in [illegible] of the earth along its orbital path, the periodic decrease in the earth's rate of rotation, the possible rhythmic action of these and other [illegible] principal cause of the [illegible] over most of the earth. [illegible] these tides are [illegible] likely generated by the [illegible] result of these processes [illegible] over millions and millions of years [illegible] the same manner [illegible]

VEGETAL LINEAMENTS

Vegetal lineaments are the most common in the cultivated and muskeg areas of western Canada and many excellent examples of fractures can be seen on almost any aerial photograph of northern Saskatchewan, Alberta or British Columbia. Straight lines of both deciduous and evergreen trees as well as scrub growth are universally visible. However, the most common vegetal lineament seen by this writer is a straight 'edge' to a clump of trees or bushes. In many cases these fractures control the size and shape of cultivated fields. Excellent examples of this latter expression of fractures are present in the western part of the Peace River district.

SOIL TONAL LINEAMENTS

These reflect differentiation in soil moisture and general ground water conditions. These are common

in the southern parts of Alberta and Saskatchewan, especially near large rivers.

Surface investigations have shown that fractures are associated with bedrock joints; however, in glaciated areas such as western Canada, the photo-analyst must take care to establish the direction of ice flow over an area before he begins to statistically plot and analyse the fractures. Most areas in western Canada show an abundance of grooves and flutes caused by the glacier and these must not be mistaken for fracture traces caused by subsurface structural conditions. In parts of the Lloydminster area of eastern Alberta the glacial scars are so deeply impressed on the surface that fracture analysis is at best difficult and often impossible.

INTERPRETATION OF FRACTURE DATA

The object of Fracture Analysis (Photogeophysics) is to locate shallow to deep-seated structural and

stratigraphic anomalies. The actual count of fractures per unit area is made and values are contoured on a "Fracture Intensity Map". In areas of known reefs the fracture intensity is 2-3 times greater on the flanks of the reef than directly above the reef.

In any fracture pattern there are two main systems of fractures: the axial system and the shear system. In both systems the fractures are sub-parallel and in general the two systems are at approximate right angles to each other.

Because of certain inherent limiting factors, Structure Incidence Surveys have a lower order of reliability than Detailed Fracture Analysis Surveys. To some extent at least, surface conditions affect the fracture count. In areas covered by lakes, sloughs and rivers, the fracture count is zero. Cultivated areas generally yield a lower count than adjacent virgin territory. Consequently, a difference or contrast

in fracture count (F/) between [illegible] may be in part due to structure, but also due in part to different surface conditions. To some extent this can be compensated for by applying appropriate weightings to the observed counts, but over- or under-compensations may result.

Nevertheless, in spite of these problems of [illegible] it has been demonstrated in [illegible] areas where abundant subsurface [illegible] that the [illegible] of fracturing is considerably greater [illegible] ing area immediately [illegible] flanks of the structure. This is [illegible] low or normal [illegible] also to a normal [illegible]

normal and there are three areas where the fracture intensity is less than normal. The high intensity areas are shown in red and the low intensity areas are shown in green. The average length of the fractures is about 2,800 feet and both mega and micro fractures are present. It is worthy of special note to mention the glacial problem in this area.

Reference to the mosaic will show that the area is moderately scarred with glacial grooves and striations and that the direction of ice flow was about north 60 degrees east. Some of these grooves are so deeply impressed on the surface that they control the shape of the lakes and of the growth in the area. In any area such as this the photogeologist is faced with the difficult problem of differentiating the glacial scars from the tectonic ones without creating false anomalies. The remainder of the fractures form a 10 1/2 degree

arc in any area will create fracture anomalies and it requires delicate weighting of the whole pattern to adjust for these effects.

In any fracture pattern there are two main systems of fractures: the axial system and the shear system. In both systems the fracture are at approximate right angles to each other. Within Petroleum and Natural Gas Permit No. 4737 the statistical mean direction of the axial system is north 35 degrees west and the statistical mean direction of the shear system is north 55 degrees east. A third minor system, here termed the sub-axial system, trends nearly north-south.

No regional fractures of great length can be seen and as these are conceded to originate within the Basement, it is assumed that all fractures plotted on the mosaic originate within the sedimentary section. As the surface of the Permit is relatively flat-lying

no azimuth correction is necessary for this study. It has been demonstrated that the low incidence anomalies on a mosaic are considerably larger than the subsurface feature which causes them.

There are three areas on the mosaic where the fractures are less intense than the surrounding area. Some fractures are always present within these areas but they usually have a lower incidence that the surrounding area. These low intensity areas are important and it is quite likely that they are due to some subsurface feature. The type of feature will be discussed in the next section of this report.

[redacted]

[illegible] Range Middle Devonian
[illegible] are present over most of the
[illegible] [illegible] and others could well
be present under the subject area

[illegible] TECTONIC FOLDING & FAULTING

The presence of tectonic folds is very
unlikely but some normal faulting is
probably present The Deadmans
[illegible] fault has been previously
discussed

[illegible] TOPOGRAPHIC RELIEF ON AN IMPERMEABLE SEDIMENTARY UNCONFORMITY

[illegible] to a possible source
of [illegible] [illegible] [illegible] but
within the [illegible] area is unlikely
that the relief on any unconformities
within the sedimentary section is great
enough to affect the [illegible] pattern

Reference to the Total Fracture Pattern Map which accompanies this report will show that there are two areas of "high" fracture intensity, and three areas of "low" fracture intensity(green). The general interpretation is that the low fracture intensity areas are underlain by topographic highs on the Basement. With this established, the deduction is that the Basement is high in the north and east-central parts of Permit No. 4737.

These Basement high features are most interesting from the oil and gas point of view. The general shape of both north features is such that the causative feature must be a fault on the Basement surface. A hill is probably the causative feature for the central-east anomaly as it is over one and one-half miles in

width. If a fault causes a fracture "low" the width of the low would be about one mile or less.

Three hypothetical structure cross-sections accompany this report and reference to them will show how Basement "highs" are inferred to be present beneath areas of low fracture intensity. Two profiles run at right angles to the strike of the Basement while the third is parallel to strike.

Respectfully submitted by:

RAYALTA PETROLEUMS LTD.

William G Cook

WGC/jp

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