

BULLOCK, HUGHES & TILLMAN LTD.

CIVIL AND QUARRYING

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A project carried out between May 27 and June 10,
1957 in the field; and from October 15 to October 31,
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B. Hughes, F. Eng.

October 31, 1957.

BULLOCK, HUGHES & TILLMAN LTD.

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FERRIT 1006

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Figure 1: GENERALIZED GRAPHIC
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OF FO RT NELSON AND
LEFTH FORMATIONS

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A B S T R A C T

Permit 1006 comprises 51,807 acres located in the Kootenai River area, Northwest Territories. It is reasonably accessible from Liard River.

A preliminary surface geological survey of the acreage during the field season of 1957 confirmed C. C. Hage's earlier conclusions. Strata of Late Upper Cretaceous, Kootenai, and Ft. Nelson formations outcrop on the Permit. It is underlain by a thick marine section containing beds of Pennsylvanian, Mississippian, Devonian, Silurian, Ordovician, and Cambrian age. The Permit covers a portion of the east limb of Labiche anticlinal structure which is also the west limb of Liard synclinal structure. If closed structures occur within the Permit area, it will be as a result of the superimposition of eastward convergence of rock units on eastward regional dips. Fracture reservoirs in competent beds at tensional local on the east flank of Labiche uplift may occur within the acreage.

Permit 1006 appears to have about one-third of the requisites required for a good oil prospect. Adverse factors account for one-third of the deficiency and "the unknown" accounts for the final third. Additional detailed geological data are required to assess properly the Permit.

INTRODUCTION

This report deals with the geology of a Territorial Oil and Gas Permit located on the southeast flank of Pointed Mountain in the lower part of the Kotancieles River drainage basin.

The Permit acreage is reasonably accessible from the Liard River. The most favourable season for drill-hole and seismic exploration in this area is after freeze-up when the Kotancieles River can be used as a means of surface ingress. Heavy equipment can be moved to the mouth of the Kotancieles River by barge from either the Alaska Military Highway via Fort Nelson, or Ray River via Fort Simpson. Winter tractor trains move supplies from Fort Nelson to Fort Liard late in the winter months.

The nature of the work carried out in 1957 was a preliminary surface geological examination of Permit 1006 in conjunction with a similar study of Permit 1007. Much of the time spent on the program was used in preparation and travelling to the permit area. The writer and his associate, Mr. Tillman, left Vancouver on May 27 and arrived in Fort Nelson on the same day, where they were met by Mr. Bullock. The period from May 28 to June 1 was spent in Fort Nelson arranging for transportation, outfitting, and obtaining an experienced riverman. June 2 and 3 were spent in travelling by boat to Fort Liard where a rendezvous had been scheduled with a helicopter crew and aircraft. Permits 1006 and 1007 were studied by helicopter out of a base camp at Fort Liard on June 4, 5 and 6. The helicopter was released and proceeded to Fort Simpson on June 7. Our field party proceeded by boat to Fort Simpson and arrived there on June 10.

Personnel on the project included the following:

Mr. J. L. Tillman, P. Eng., consulting geologist, who was engaged on this program from May 27 to June 10, 1957.

Mr. S. B. Hughes, P. Eng., consulting geologist, who was engaged in the field from May 27 to June 10, 1957.

Mr. H. Dickie, riverman and cook, who was engaged from May 30 to June 10, 1957.

Mr. S. Cronan, helicopter pilot, who was engaged on the mapping program from June 5 to June 7, 1957.

Mr. S. Aiken, helicopter engineer, who was engaged on the mapping program from June 5 to June 7, 1957.

The techniques employed during the program are those outlined in Notes: Field Geology. A Bell Model 42 helicopter was used to expedite the survey work. Seasonal high water in the creek and river channels prevented landings at numerous places which would have provided heliports later in the year when the waters are low. It is recommended that future surface geological work in this area be carried out in August and early September.

The assistance of the abovementioned personnel is gratefully acknowledged. The help and hospitality shown the party by Mr. Stewart, manager of the H. B. Co. post at Fort Liard, is much appreciated.

T O P O G R A P H Y

Permit 1006 is situated in the major physiographic division termed the Liard Plateau by H. S. Postock (1948).¹ Postock specifies regionally: "North of Liard River the eastern system (of the Canadian Cordillera) is continued by Liard Plateau, the southern unit of Mackenzie Mountain area. This is an area of broad, even-topped ranges of hills rising in their higher parts to about 4,300 feet above sea-level and presenting a distinct accordance of summit levels." Permit 1006 is located in a small dissected plateau lying at the south end of the Liard Range and immediately eastward of the south extension of Lehigh Range. Relief ranges within the acreage from 800 feet in Kotenelee River valley to 2,100 on the highest hill. Regionally valleys occupy areas of softer strata such as shales whereas sandstones and carbonate rocks form mountains and hills. A ridge of Fort Nelson formation sandstones traverses the Permit north-northeastward from its southwest corner. This ridge reaches a maximum altitude of 1,800 feet above sea level. Kotenelee River in its upper part is subsequent where it flows parallel to Liard Range. In its lower part where it crosses Permit 1006 it appears to be superimposed although it may, in part, have been controlled by the distribution of Upper Cretaceous sandstone beds.

Forests of white spruce are present on the uplands of the area under discussion. Lodgepole pines grow along the sandstone trends. Aspen and poplar occur in the permit both admixed in the spruce forests and as separate stands.

¹See Bibliography.

STRATIGRAPHY

strata of Upper Cretaceous age are exposed in the mapped area. The permit is underlain by strata of Lower Cretaceous, Jurassic (T), Pennsylvanian, Mississippian, Upper Devonian, Middle Devonian, Silurian, Ordovician, and Cambrian age. The stratigraphic terminology employed by the Geological Survey of Canada and the Alberta Society of Petroleum Geologists is used in this report. Discussion and notes on the rock units from younger to older follow:

SURFACE UNITS

Late Upper Cretaceous

Beds of Late Upper Cretaceous age crop out in a hill east of Kotaneesee River. These are non-marine in origin and comprise a sequence described by C. C. Hage (1949) as banded, medium-to coarse-grained, feldspathic, buff-weathering sandstones with coal seams which reach a thickness in excess of 20 feet. The sequence is equivalent to the Wapiti group of Peace River region. It conformably overlies the Kotaneesee formation.

Kotaneesee Formation

The Kotaneesee formation forms the bedrock of all of the central area of Permit 1906. It is marine in origin and yields ammonites and inoceramids which provide a correlation of the Kotaneesee with the upper Wapitabi formation of Santonian age. It appears to exceed 500 feet in thickness on Kotaneesee River within the mapped area. Hughes examined a partial section there and saw shale outcrops 200 feet high with sandstone interbeds. The sandstones are both coaly and glauconitic, carry pelecypod fossils, weather gray and blocky, and are locally silty.

C. C. Hage (1949) measured a section on Kotaneesee River, about 7 miles above its mouth, in which neither the formation's upper nor lower contacts were

exposed. His description is given below:

Top of Section	Thickness feet
Shale, dark gray, with concretions	150
Sandstone, beads, medium-grained	8
Shale, sandy	20
Shale, gray, chunky, brown, with ironstone concretions	<u>150</u> 328

Fort Nelson formation

The Fort Nelson formation crosses the western part of Permit 1006 as an eastward-dipping band. C. C. Hage (1947) gives an estimated thickness of 500 to 600 feet for the Fort Nelson in this area. C. R. Steick (1955), discussing the relationship of Cardium formation sedimentation to the Dunvegan delta, wrote: "The northern end of the delta, near the Liard River, was uplifted on effective gross of 1,000 feet, as the upper Cardium conglomerate in this area lies directly on the Fort Nelson conglomerate and, indeed, may contribute in no small measure to the uppermost conglomerates of the Fort Nelson conglomerate. This amount of erosion or missing stratigraphic interval seems to have eliminated all of the upper Dunvegan strata, all of the Keskapuv Formation, and all of the lower Cardium equivalents in the Liard area."

Hughes examined a section of the Fort Nelson on the north bank of the Ketanseele and found 20 to 25 feet of massive, blocky weathering, buff weathering sandstone overlying 50 feet of rusty, fine blocky weathering, shaly silt-stone. Tillman studied the formation on the Ketanseele River and has illustrated a composite section of its lower part (see Figure 1). He describes the predominant 40 foot sandstone as "dirty tight silty and conglomeratic sandstone with weathered iron stained surface medium grey on fresh exposure. Sandstone is conglomeratic at the base and somewhat limy at some horizons. Whole outcrop is blocky fracturing." The sequence is overlain by dark grey to black bentonitic soft shale.

SURFACE AND SUBSURFACE UNITS

Fort St. John group

The Fort St. John group is best exposed in this region along the Petitot River where C. C. Hage (1945) subdivides it into:

Upper fissile shale unit (Lepine formation)	1,625 feet
Middle arenaceous unit (Auster formation)	625
Lower shale unit (Garbutt formation)	2,000

Tillman examined a section of the Lepine formation equivalent immediately underlying the Fort Nelson formation on Kotanclee River. His stratigraphic observations are shown in Figure 1.

SUBSURFACE UNITS

Triassic undivided

The nearest known Triassic beds to Permit 1006 are found on Mount Merrill (60°02'N. and 124°20'W.). The recent Geological Map of Yukon published by the Geological Survey of Canada shows Tond and Grayling formations undivided at that locality. E. B. Rindie (1948) wrote: "The lower and middle Triassic strata thicken considerably towards the west from the confluence of Liard and Tond Rivers. Near the mouth of the Tond the Tond formation is about 500 feet thick, and no beds of the Liard formation are present. Eight miles due southwest the Tond formation has increased to an estimated 1,500 feet in thickness, and overlying beds of Liard formation have made their appearance with a minimum thickness of 600 feet." At present it is not known whether Triassic beds or their erosional edge underlie Permit 1006 but both possibilities seem extremely unlikely.

Pennsylvanian and/or Mississippian

A section of sandstones interbedded with dark gray shales and overlain by an upper chert member were assigned a Pennsylvanian and/or Mississippian age on the basis of contained faunas by C. C. Hage (1945). One spot locality of

this sequence was examined by Hughes on the south side of Labiche River at the cairn on the Labiche Range. Here are found hard sandstones which are light gray, locally calcareous, dolomitic, silty, and pebbled. The beds contained isolated poor specimens of brachiopods.

C. C. Hage (1945) describes an upper (614 feet) part of the unit on pointed Mountain, a lower (640 feet) sequence on Sawmill Mountain, and basal (500 feet) beds on Liard Range 2 miles west of Big Island. A more pertinent, though incomplete, section was measured by C. C. Hage (1945) on Labiche Range near Labiche River:

<u>Top of section</u>	<u>Thickness</u> feet
sandstone, medium-grained (not measured)	
Shale, black, fissile, bituminous, fossiliferous	10
Concreted	40
Sandstone, gray, buff weathering	22
Concreted	75
Sandstone, light buff	10
sandstone, calcareous, fossiliferous	10
Shale, thinly bedded, calcareous	45
Concreted	45
limestone, light gray, bedded, cherty, fossils	18
Sandstone, light gray, crossbedded	29
Limestone, dense, some chert	12
Sandstone, light buff	30
Limestone, light gray, dense	10
sandstone, light gray, calcareous	20
Sandstone, medium-grained, cross bedded	60
Limestone, light gray, beds 1 to 4 feet thick, some sandy others cherty, fossils	130
Total thickness	<u>607</u>

Hage writes: "The contact between the later Carboniferous beds and those of definite Mississippian age may be at the top of the uppermost limestone bed or at the base of the lowest sandstone."

A. H. S. Henderson (1954) notes: "Hage had been unable to ascertain if Cretaceous shales lie directly on the 650 feet, or more, of sandstones, shales and chert which he had described at Pointed Mountain about 20 miles northwest of Fort Liard, and which he had referred to the Pennsylvanian and/or Mississippian. Raskevitch had found a few hundred feet of similar beds which he believed to lie below Hage's section." Henderson also reports that Lamn measured about 950 feet of quartzitic sandstones at Twisted Mountain about 15 miles above the mouth of the South Nahanni. These beds belong to the lower part of Hage's Pennsylvanian and/or Mississippian division.

This whole late Paleozoic division is overlain by 55 feet of conglomerate on Pointed Mountain. These coarse clastics comprise chert fragments in a sandstone matrix and could be a basal Mesozoic, possibly Jurassic, conglomerate.

Mississippian undivided

Mississippian beds on Labiche Range region consist of an interbedded sequence of limestone, cherty limestone with much shale in the lower section. W. H. H. Patton (1956) delivered a paper on Mississippian Succession in South Nahanni River Area, Northwest Territories to the Alberta Society of retroicous geologists. The abstract of this very important contribution follows:

"A thick section of Mississippian rocks is exposed west of Jackfish River in the Labiche Range of the Mackenzie Mountains near South Nahanni River, Northwest Territories.

From fossil evidence rocks of Kinderhook, Onondaga, Meramec, and Chester ages are known to be present.

strata with a Kinderhook fauna equivalent in age to the Shaff formation are present. They are followed by a sequence of rocks with Osgoe, Meramec, and Chester fossils and consisting of interbedded argillaceous limestones and calcareous shale overlain by a great thickness of sandstone with minor shale and coal beds. Fossil plants, Stigmaria sp. and Lepidodendron sp., and coal were found in sandstones below the Meramecian Leptifer cf. pellissensis zone.

Microspores from the coal were identified by R. A. Hagubara of the Coal Research Branch of the Geological Survey of Canada, Sydney, Nova Scotia, and were found to indicate a Lower Carboniferous or Mississippian (Tournesian, partly Viséen) flora. Spores in the coal are unlike those found in Mississippian coal of Utah but are very similar to those described from the Lower Carboniferous of the Ukraine by geologists of the U.S.S.R.*

U. C. Hoge (1947) described an 850 foot section measured on the west slope of a small mountain about two miles west of Big Island in Lard River thusly:

<u>Top of section</u>	<u>Thickness</u> <u>Feet</u>
Limestone, gray, bedded; contains dark gray chert in thin beds and irregular discontinuous bodies, fossiliferous	150 +
Shale, brown; interbedded with brown weathering limestone, fossiliferous	100
Shale, dark gray, fissile; with ironstone concretions; in part concealed	200
Limestone, interbedded with calcareous shale; fossiliferous	200
Limestone, dark gray, finely crystalline; interbedded with minor amount of shale, fossiliferous	100

Shale, calcareous; with some beds

of crinoidal limestone

100

Total thickness

800

Two miles farther west younger Mississippian beds are exposed in addition to a repetition of the upper beds of the previous Mississippian sequence. Hoge described these:

<u>Log of section</u>	<u>Thickness</u> feet
Base of inter carboniferous section Limestone,	
crinoidal and crystalline; interbedded with gray	
shale; some black fissile shale; fossiliferous	100
Limestone, dark gray, fine, crystalline; interbedded	
with shale; fossiliferous	60
Concreted	140
Limestone, dark gray, fine, crystalline; some black	
chert; interbedded with some black shale	
containing eolinite	100
Total thickness	400

S. A. S. Henderson (1924) reported the discovery by Mann at Twisted Mountain on the South Nehanni River of "over 1500 feet of beds with the base not exposed, consisting chiefly of limestones and which belong lithologically to the Mississippian section which Hoge had described in the region."

Upper Devonian

Mississippian strata are underlain by Upper Devonian beds in the region under discussion. C. O. Hoge (1945) measured 800 feet of shales in a partial section exposed on the saddle on Nehanni Butte. These shales range from dark gray to greenish gray in colour, from hard to fissile, are columnar, and locally friable. Limestones of Nehanni and pre-Nehanni age probably

both eventually will be found present within the region of the Permit acreage as more detailed surface and subsurface studies are carried out. In Imperial Big Island River No. 1, the nearest well to the Permit, upper Devonian beds measured 4,710 feet thick.

E. A. O. Henderson (1954) states that the Simpson formation, of upper Devonian age, measures between 3000 and 5000 feet in thickness near Gamali Bend on the Mackenzie River.

Middle Devonian

C. C. Hage (1949) proposed the new formational name Behanni for a middle Devonian sequence resting disconformably on Silurian beds on Behanni Butte. The section of Behanni formation on the Butte has a thickness of 450 feet and is described as "bedded, dark gray, light gray weathering, dense, dolomitic limestones and finely crystalline and dense limestones." The section is profoundly faulted.

Imperial Big Island River No. 1 penetrated 560 feet of Slave Point (middle Devonian) beds and 931 feet of alk Point and older beds overlying the Precambrian basement.

M. A. Kingston (1950) carried out a stratigraphic reconnaissance along the upper South Behanni River and found sections of Cambrian, Ordovician, Silurian, and Devonian present. He reported that neither the upper nor the basal contact of the Devonian was seen in the area. A total of 4,540 feet of apparently unfaulted Devonian beds were measured. Briefly: the oldest (Devonian) measured beds consist of black fissile shale shot with pyrite concretions and free sulphur. Interbedded with these shales are thin beds of limestone. This sequence grades upwards into cycles of thin-bedded, platy, black, shaly limestone and platy, black shale. Upward the limestones increase until they predominate and shale is present only in rare thin beds. Upwards gray, coralline, reef limestones are

introduced and dolomites appear. Kingston described a prominent unconformity within the Devonian 2,140 feet above the base of the measured section. The section above the unconformity comprises cliff-forming massive, irregularly bedded, reef-like limestones. The beds are said to be locally petroliciferous as well as porous. Kingston remarks on a similarity between the cliff-forming limestones and the ramparts formation of the Mackenzie Mountains. It is interesting to note that W. H. S. Henderson (1954) suggested the possibility that some part of the "Ramparts" formation might be of Lower Devonian age.

Silurian

Strata of Silurian age were discovered by D. H. Kingston (1950) in the upper South Nahanni River country. He measured 750 feet of Silurian beds overlying Ordovician strata and comprising massive dolomitic limestone with silicified fossils and abundant coralline material. "The lower part consists of cycles of massive, light gray, dolomitic limestone containing abundant silicified corals." Higher in the section ten, thin-bedded, fine-grained limestone is introduced. The upper part consists of "thin-bedded, dark gray, shaly, dolomitic limestone; massive, black, nodular, dolomitic limestone; and massive, light gray, porous, coralline, dolomitic limestone." Tentative fossil identifications indicate a Niagara age.

Ordovician

A stratigraphic section of Ordovician, 2,600 feet thick was measured by Kingston in the same general area on South Nahanni River where Devonian and Silurian sections were studied. The Ordovician occurs as a cyclic sequence that alternates between thin-bedded, black, nodular limestone, and massive, black, medium-grained limestone. Upward in the section the black nodular limestone is replaced by thin-bedded, dark gray, shaly, nodular limestone. Abundant primary pyrite is reported in the section 440 feet above the base and would

appear to suggest basinal sedimentation under an-aerobic conditions. Six faunal zones are present in the Ordovician and indicate a Black River age for the strata.

Cambrian

The Cambrian of the South Nehanni River is reported by Kingston to measure 2,160 feet and to resemble, in part, the Cambrian section in the Mackenzie Mountains to the north. He writes: "Cambrian rocks as exposed in this area appear to consist of a cyclic sequence that alternates between shallow-water, tan, quartz sandstones and siltstones, and less shallow-water calcareous beds." Beds of Cambrian age appear to be absent in Imperial Sigisla River No. 1 well to the east.

STRUCTURAL GEOLOGY

Portions of two local structures are present in permit 1006. The axis of a synclinal structure trends northward close to the east boundary of the permit. In conjunction with the position of the synclinal axis the permit also may be said to cover a major breadth of the east flank of Labiche anticlinal structure. Both structures plunge southward, the Labiche anticlinal structure steeply in contrast to the low plunge angle of the Liard synclinal structure.

The Labiche anticlinal structural extends at least from Jackfish River, possibly from the South Nahanni River, southwards to within three or four miles of the British Columbia boundary. It is flanked on the east by a synclinal structure which lies close to the Koteneesee River, trends northwards and then swings easterly to cross the South Nahanni River near Yohin Lake. This synclinal structure loses its identity close to sharp bend where the Koteneesee makes a right-angled turn eastward. Its relationship to the Liard synclinal structure is unknown in any detail; however, the probability exists that a low uplift may occur between the two axes as a southward extension of Pointed Mountain anticlinal structure. The Liard synclinal structure in turn loses its identity at its north end where it abuts against Liard Range uplift. This synclinal structure is a major regional structure and extends southwards for a distance of more than 65 miles.

Local cross-faulting is suggested by linears observed in aerial photographs of the acreage. Thrust-faults were not seen in the field.

A. J. Goodman (1974) has published a stimulating paper on the tectonics of the Mackenzie Mountains, however, this paper with its thesis of basement control is considered by the writer to have been somewhat premature since so little is known even now about the regional geology of the Northwest Territory

mountains. In any case Goodman wrote that: "The Mackenzies have no foothills comparable with the Rockies. Instead there is a foreland area in which narrow mountain ridges are separated by wide flat areas for the most part covered with muskeg. The Nahanni Range is one such ridge. Its continuation to the north is called the Gensell Range. The Franklins, the Norman Range, and the Imperial Mountains are similar ridges.

Hume examined parts of the Nahanni Range and recognized the faulted character of its eastern steep face. He estimated a throw of some 5,000 to 6,000 feet (1922)."

D. H. Kingston (1950) noted that in the upper South Nahanni River region orogenic deformation resulted in the Ordovician-Silurian section acting as a competent block whereas the basal Devonian shales acted as a gliding plane for thrust faults.

Until more is known about the regional and local mechanics of folding and faulting in the region under discussion it will be difficult to predict scientifically what tectonic antiformal structure is at depth. It may be a symmetrical fold, an asymmetrical fold, either a basement horst, or conceivably the resultant of a basement graben, or lastly a detached non-corresponding structure.

G. A. D. Henderson (1974) claims the discovery of evidence of Caledonian movements (late Silurian) in the Rocky Mountains of northern British Columbia and in the Mackenzie and Franklin Mountains of the Northwest Territories, and he states that evidence also indicates tectonic (late Ordovician), Archaean (Silurian), Brian (Middle Devonian) and Middle Devonian (sic) deformational movements.

OIL POSSIBILITIES

Oil possibilities of wildcat acreage are judged on the presence or absence of source beds, reservoir beds, seal, cap or cover beds, and trapping conditions.

The thick section of marine sedimentary rocks present in the region in which Permit 1006 is located favours the belief that source beds for hydrocarbons are present. Furthermore C. G. Hage (1945) stated that oil was distilled from Upper Carboniferous black bituminous shales collected on Labiche Range and Pointed Mountain, and that Upper Devonian marine shales are in part bituminous in this area. D. N. Kingston (1951) remarked on the petroliferous nature of Devonian beds on upper North Mahanmi River. The total unbroken sequence of the regional sedimentary sequence must exceed 16,000 feet of which 12,250 feet are post-Silurian in age and the remainder are pre-Devonian.

Three main types of rock reservoirs may be present in the subsurface of Permit 1006.

- These are: Class 1. sand reservoirs as a result of primary grain-size distribution.
- Class 2. carbonate reservoirs as a result of secondary dolomitization of fossil reefs and off-reef clastics.
- Class 3. fracture reservoirs in competent strata at tensional loci of folds.

Seal, cap or cover beds as they are commonly called are well distributed through the stratigraphic section and warrant no special discussion at this time.

Trapping conditions which enhance the accumulation of commercial quantities of petroleum often are not appreciated until after drilling has discovered them. Where sufficient surface and subsurface geologic data are

available oil traps can be specified by educated prediction. We know very little about the potential trapping conditions in Permit 1006 beyond a hastily acquired picture of surface manifestations plus a generalized knowledge of regional stratigraphy from the literature.

The most favourable possible oil trap targets in the acreage are:

1. A stratigraphic trap if westward shaling of Scatter formation occurs across the acreage (Class 1 reservoir).
2. Trapping in Carboniferous sandstones (Class 1) if local closure is obtained by the opposition of eastward regional dip by their eastward thinning.
3. Trapping in Devonian dolomitized reefs (Class 2) combined with a local closure obtained by the opposition of eastward regional dip to eastward thinning of Mississippian and Pennsylvanian strata.
4. Trapping in pre-Devonian fracture reservoir beds (Class 3) at flexure areas on the east limb of Labiche anticlinal structure.

CONCLUSIONS AND RECOMMENDATIONS

The present study has indicated that Permit 1006 appears to have about one third of the requisites required for a good oil prospect. Adverse geologic factors account for one third of the deficiency and "the unknown" accounts for the final third.

Additional regional stratigraphic information must be obtained before the acreage can be given an adequate analysis. These data could be obtained either by commitment work or possibly traded from companies (i.e. Mobil, British American) who have carried out such programs. It is to be emphasized that the most critical single geologic factor is rate of thinning of rock units across the Permit.

Richard David Hughes

A F W S B C L L

Data on Imperial Big Island River No. 1 well

Kelly bushing elevation	2285 feet
Mississippian	2100
Devonian	2207
Ireton shale	4769
Slave Point	6920
Big Point	7500
Total depth (Precambrian)	8231

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