GM 16552

GEOLOGICAL REPORT, PERMIT NO. 156

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GEOLOGICAL REPORT

P. & N. G. PERMIT No. 156

GASPE PENINSULA, QUEBEC

On two groups

PUBLIC

Ministère des Richesses Naturelles, Québec
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Habitant Gas & Oil Limited

October, 1960

J. C SPROULE AND ASSOCIATES LTD
OIL AND GAS ENGINEERING AND GEOLOGICAL CONSULTANTS

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TABLE OF CONTENTS

	Page No.
INTRODUCTION	1
Topography and Vegetation	1
Description of the Permit Acreage	2
Accessibility	2
HISTORY OF PETROLEUM EXPLORATION IN GASPE	3
Table of Wells Drilled	4
GENERAL GEOLOGY	8
STRATIGRAPHY OF THE MATAPEDIA-RIMOUSKI AREA	8
Table of Formations	9
Description of Formations	11
Ordovician	11
Silurian	12
Devonian	17
Recent and Pleistocene	20
STRUCTURAL GEOLOGY OF THE MATAPEDIA-RIMOUSKI AREA	21
PETROLEUM AND NATURAL GAS POSSIBILITIES OF THE MATAPEDIA-RIMOUSKI AREA	22
Ordovician and Cambrian	22
Silurian	22
Devonian	23
Structural Possibilities	23
STRATIGRAPHY OF THE EASTERN GASPE AREA	25
Table of Formations	25
Description of Formations	26
Lower Ordovician	26
Middle Ordovician	26
Devonian-Silurian	26
Lower Devonian	28
Middle or Lower Devonian	29
Triassic or Pennsylvanian	30
Quaternary	30
STRUCTURAL GEOLOGY OF THE EASTE GPE AREA	31

Table of Contents - Continued

	Page No.
PETROLEUM AND NATURAL GAS POSSIBILITIES OF THE EASTERN GASPE AREA	32
PROPOSED DEEP TESTS AND COST ESTIMATES	33
Tests Recommended	33
Cost Estimates	35
SUMMARY AND CONCLUSIONS	36
BIBLIOGRAPHY	38

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GASPE PENINSULA, QUEBEC

INTRODUCTION

At the request of Dr. W. R. Newman of the Habitant Gas & Oil Limited, Toronto, Ontario, a field and office study was made of P. & N. G. Permit No. 156 held by the Habitant Company. The Permit consists of two parts, one in the Matapedia-Rimouski area, and the other in Eastern Gaspe area. The purpose of this study was to determine the possibilities of finding commercial quantities of oil and/or gas in the Permit acreages.

Three days were spent in Quebec City at the Quebec Department of Mines reviewing records of drilling for oil in the Gaspe area. Ten days were spent in the field; this period included travelling time between the two areas. During the latter few days in the field the senior author was joined by Angus G. MacKenzie and by Dr. W. R. Newman of Habitant Gas & Oil Limited.

The authors are grateful to the Quebec Department of Mines who gave freely of their time and knowledge. A one-day field trip was spent in the Rimouski area, escorted by Dr. J. Beland, Mr. Jean Lajoie and Mr. Claude Hubert, Senior Geologists with the Quebec Department of Mines. Several hours were also spent discussing the lithology and historical geology of the area south of Rimouski with Dr. Beland.

We are also grateful to Mr. L. D. Hudon, President and General Manager, New Peninsular Oil Limited, for permission to use data on P.C. No. 1 well in his letter dated October 14, 1960.

Topography and Vegetation

In the Matapedia-Rimouski area on the Permit acreage, the surface of the land is quite hilly, with elevations of 900 feet to 1,000 feet above the sea level (Plate 1A). The country to the south, underlain by the Fortin Slate series, is more rugged than the hilly country to the north.

Birch, maple, "dogwood," cherry, poplar and spruce trees, with some pine trees in the south acreage, grow profusely in the Permit area. With the exception of the lumber concessions in the south, a great deal of the land has been cleared for farming. Lichen mosses are more evident in the south of the area than to the north.

In the Eastern Gaspe Permit acreage the foliage is not too different, although the area generally is not as heavily wooded. The topography is less accentuated, although sections along the sea coast are marked by steep cliffs as high as 50 feet, such as at Haldimand Point.

In both acreages, the ground was firm under foot with the exception of a few small areas adjacent to streams.

The photogeological work was carried out by Dr. J. C. Sproule.

Various publications of geological literature listed in the accompanying bibliography were utilized in order to make a quick appraisal of sections and formations to visit in the field.

Description of the Permit Acreage

Habitant Gas & Oil Limited hold two Permit acreages in the Matapedia-Rimouski and Gaspe areas. The Matapedia-Rimouski block, approximately 548,500 acres, covers sections of Avantjish, Nemtaye, Pinault, Jette, Masse Townships, all of Rencevenux Township, all land south of the Seigneurie of Lake Mitis to the New Brunswick border, and to the southeastern edge of Cuimet Township, and to approximately 68° 08' Longitude to the west. This Permit does not include the Seigneurie of Lake Mitis.

The Permit acreages are marked on the geological map and photo mosaics accompanying this report. The acreage outline was traced from the Quebec Department of Mines "land" office and the acreage then calculated using a planimeter. Accuracy is dubious without more detailed work because of the complex nature of the township, range and lot numbers upon which the Permit boundary is based. Difficulty was also experienced in transferring this information to the photo mosaics.

The Gaspe acreage, approximately 44,200 acres, consists of the central and southern portions of Gaspe-Sud Township and small sections of North York and Douglas Townships. There are several varied exclusions within the Permit acreage. Some of the simpler exclusions are shown on the accompanying photogeological map, but there are several smaller private lots in the Gaspe village and vicinity not shown on the map. The total acreage calculated was 44,180 acres. Of this total, 10,625 acres are under the sea.

Accessibility

Each of the Permit areas is readily accessible by motor vehicle. Range roads and lumber roads traverse all sections of the areas under discussion. (Plate 2A). The transportation of heavy equipment via preliminary roads would present no problem except in the spring of the year. Principal roads in the area are asphalt base.

Rimouski and Gaspe village have harbour facilities; there is a branch line of the Canadian National Railway between Matapedia and Gaspe village. The main line of the Canadian National Railway services Rimouski, Mont Joli and Matapedia from Quebec City.

Airports are located at Rimouski, Mont Joli and Gaspe village. "Quebecair" have a daily flight between Quebec City, Rimouski and Mont Joli. There is a small airline operating throughout the Gulf of St. Lawrence area; it services Mont Joli, Murdochville and Gaspe village, but little is known concerning its reliability.

HISTORY OF PETROLEUM EXPLORATION IN GASPE

The occurrence of petroleum seepages was reported in the Gaspe region as early as 1836, and in 1860 the first wells were drilled to test the sandstones near two of these showings. Approximately fifty wells were drilled between 1890 and 1903. Imperial Oil Company drilled two wells, one in 1939-40 and the other in 1941-42 (McGerrigle, 1950).(1)

In total, there have been approximately eighty well locations made. None of the drilled wells produced commercial oil or gas, although several oil showings indicate the presence of high gravity oils. None of these wells has been drilled through the total sedimentary column of rock believed to be present in the Gaspe region.

The Imperial Oil Company tested Ordovician oil-bearing shales in the Port Daniel River area. The project was abandoned, as the best yield of oil was one gallon per ton of shale (Reliff, 1960).

During 1955 or 1956 the California Standard Company are reported to have run a type of seismic survey east of Murdochville, Quebec, and it is rumoured that they estimated a vertical depth of 16,000 feet of section to the basement rocks. Their survey lines crossed the New Peninsular Oil No. 1 (P.C. No. 1) (Ford, 1960), and this well was terminated in the St. Alban formation at 8,138 feet. Therefore, the basement rock in this case may be Devonian granite or Precambrian rocks, and the Ordovician and Cambrian formations are probably included in this 16,000-foot estimate.

One of the most interesting holes relative to the Habitant Gas & Oil Limited's Matapedia acreage was the Causapscal No. 1. This hole penetrated 4,635 feet of St. Leon (Silurian), but did not reach the Silurian Sayabec limestones. This hole has indicated a greater thickness of St. Leon than was previously believed to exist in this area, i.e., 6,000 feet plus (Stearn, 1959).

Following is a list of the wells drilled in the Gaspe region for the Quebec Department of Mines Oil and Gas Department:

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(1) Name and year in parenthesis refer to bibliography at the end of this report.

EXPLORATION WELLS IN THE GASPE AREA

Well No.	Well Name	Year Drilled	Elev. Above M.S.L. Feet	Total Depth Feet	Thickness of Formation Penetrated					Remarks
					Devonian				Silurian	
					B.P.	Y.R.	G.G.	C.R.A.	St. Alban	
1	Well being drilled, no information available.									
2	Assoc.Devel.Causapscal No. 1	1957?	582	4696						Silurian St. Leon - 4696'
3	Bald Mtn. No. 2	1952-53	925	6624					6624	
4	Canada Petroleum Corp. No. 1	1899	350	1565		1565				
5	" " " No. 2	1899	320	1556		1556				Oil show, York R. fm.
6	" " " No. 3	1899	200	2438		2150	288			Gas and Oil show.
7	" " " No. 4	1899-01	360	2100		2100				
8	" " " No. 5	1900	285	2200		2150	50			Oil show.
9	" " " No. 6	1900	345	2360		2320	40			
10	" " " No. 7	1900	100	2065		2046	19			Gas and oil show.
11	" " " No. 8	1900	300	2394		2340	54			Oil show.
12	" " " No. 9	1900	100	2226		2215	11			Gas show.
13	" " " No.10	1901	35	2383		2360	23			Gas show.
14	" " " No.11	1901	240	1924		1900	24			
15	" " " No.12	1901	380	1500		1500				
16	Haldimand No. 1	1941-42	415	4776	1397	3379				Gas show.
17	Mississippi No. 1	1939-40	1502	5995			1240	3740	1015	
18	Asphalt Base No. 1	1953-54	365	2673		323	2350			Oil show.
19	Continental Gaspe No. 1	1948-49	615	1375			1375			Oil show.
20	Continental Gaspe Deep Test No. 1	1952-53	1150	3225		335	2890			
21	Continental Petrol.Ltd.No. 1	1943	600	2735			2735			
22	Continental Petrol.Ltd.No. 2	1944-45	501	2902		2332	570			Water-oil ratio 1:1, Oil show, York R. fm., Oil show, Grand Grève fm.

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Well No.	Well Name	Year Drilled	Elev. Above M.S.L. Feet	Total Depth Feet	Thickness of Formation Penetrated: Devonian M.P.	Devonian Y.R.	Devonian G.G.	Devonian C.B.A.	Silurian St. Alban	Remarks
23	Imperial Gaspe No. 1 (Formerly Bald Mtn. No. 1)	1947-48	900	6345					6345	Oil show, St.Alban fm.
24	Eastern Canada Co. No. 1	1913	275	2950	2950					Fresh H_2O.
25	Campbell Well	1860	300	600		600				Good H_2O flow.
26	Gaspe Mining Co. No. 1	1860	15	600	600					
27	Conant (Adams) Well		335							
28	Venture No. 1	1946-47	1575	2409		1235	1174			
29	Venture No. 2	1947-48	1475	2460		1930	530			Oil show.
30	Venture No. 3	1948-49	1475	2334		1935	399			Acidized. Oil show, Grande Greve fm.
31	International Oil Co. No. 1		345			Started here.				Oil seep adj. to well.
32	C2 (McMaster W.R.)	1945	340	795	590	205				Oil show.
33	Mineraux et Pet.de Gaspe No. 1	1937-38	150	837	837					
34	New Peninsular Oil Ltd.P.C.No. 1	1951-54	1650	8138				3440	4698	Gas show, St.Alban fm. Gas and oil show, Salt water.
35	Petroleum Oil Trust No. 1	1889-91	345	2430	600	1830				Gas and oil show.
36	" " No. 2	1890	200	2477	1595	882				Gas and oil show.
37	" " No. 3	1890-91	20	2225	2225					
38	" " No. 4	1890-91	160	2970	1000	1970				Oil scum on water, Oil show.

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Well No.	Well Name	Year Drilled	Elev. Above M.S.L. Feet	Total Depth Feet	Thickness of Formation Penetrated Devonian B.P.	Devonian Y.R.	Devonian G.G.	Devonian C.B.A.	Silurian St. Alban	Remarks
39	Petroleum Oil Trust No. 5	1891-92	61	2612?		2430?	182?			Gas and oil show.
40	" " No. 6	1892	135			Started here.				Oil show.
41	" " No. 7	1892-93	40	2839		2357	482			Gas and oil show.
42	" " No. 8	1892-93	275	2650	1000	1650				
43	" " No. 9	1894	245	2704	2704					
44	" " No.10	1895	80	1372		1372				Gas and oil show.
45	" " No.11	1893-95	175	2917		2160	757			Oil show.
46	" " No.12	1894	30	2897		2595	302			Gas and oil show.
47	" " No.13	1894	150	2038		2038				Salt water flow. Gas and oil show.
48	" " No.14	1895-97	100	2736		2211	525			
49	" " No.15	1895	250	2092		1880	212			Gas and oil show.
50	" " No.16	1895	411	2925		2840	85			Gas and oil show.
51	" " No.17	1895-97	445	2537		1987	550			Oil show.
52	" " No.18		475	1946		1851	95			Oil show.
53	" " No.19	1895-96	415	2236		2186	50			Dry.
54	" " No.20	1896	503	2152		2129	23?			Oil flow at cellar occasionally.
55	" " No.21	1896-97	860	1807		1440	367			Sul. water.

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Well No.	Well Name	Year Drilled	Elev. Above M.S.L. Feet	Total Depth Feet	Thickness of Formation Penetrated: Devonian E.P.	Devonian Y.R.	Devonian G.G.	Devonian C.R.A.	Silurian St. Alban	Remarks
56	Petroleum Oil Trust No.22	1896-97	1095	3095		2738	357			
57	" " No.23	1896-97	143	1755		1310	445			
58	" " No.24	1896	350	1214		84	1130			
59	" " No.25	1895-97	670	1100		690	410			
60	" " No.26	1896	165	2945		2720?	225			
61	" " No.27	1897	315	2100		2000	100			
62	" " No.28	1897-98	1010	3525		3525				Salty water.
63	" " No.29	1897-98	230	2121		2038	83			
64	" " No.30	1898-99	325	1570		1570				
65	" " No.31	1898-99	270	2770		2455	315			Oil show.
66	" " No.32	1899	305	1925		1825	100			Oil show.
67	" " No.33	1899-01	300	2595		2595				Gas show.
68	" " No.34	1900	380	1652		1652				
69	" " No.35	1901	500	1796		1786	10			
70	" " No.36	1901	750	1780?		1780?				
71	" " No.37	1901	900	2527		2527				Fresh water.
72	" " No.38	1901-02	877	2071		2071				
73	" " No.39	Location Only.								
74	" " No.40	1901-02	827	2305		2305				Fresh water flow, very small.
75	" " No.41	1902-03	475	454		49	405			
76	" " No.42		455	2000?						Oil show.
77	Quebec Oil No. 1	1950-51?	1200	2432			1752	680		
78	Quebec Oil No. 2	1951-52	350							
79	Tar Point No. 1	1952-53	250							
80	No name		39							Gas show, salty water.

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In compiling the table of wells drilled, Quebec Department of Mines Report No. 35 was utilized as well as the records of the Gas and Oil section of the Quebec Department of Mines. The oil and gas showings are indicated in the formation tested when this information is known; some of the showings are from present conditions at the well site. Approximately fifty of the wells were drilled prior to or close to 1900 and the results are therefore not completely reliable.

As far as is known, all the wells except one were drilled with a cable tool type rig. Most of the older holes were fractured prior to testing. The only well reported to have used a rotary type drill was the New Peninsular Oil No. 1 (P.C. No. 1). Schlumberger ran an E-M and laterlog in this well but the logs were not available in Quebec City.

In summation, the majority of these wells were drilled in the Eastern Gaspe region. None of the wells penetrated favourable horizons with the exception of perhaps the New Peninsular Oil No. 1 (P.C. No. 1). This well penetrated the St. Alban formation containing reefy limestone around 8,000 feet. The few wells placed on favourable structures were not drilled to sufficient depth.

GENERAL GEOLOGY

The Gaspe region is part of the Appalachian Mountain system. Paleozoic sediments and minor volcanics have been folded and faulted by the Taconic orogeny at the close of the Ordovician and by the Acadian orogeny at the latter part of the Devonian. In the central portion of the Gaspe Peninsula, volcanics of contemporaneous age have accompanied the sediments. Devonian granite and accompanying alteration are present in the Murdochville area and to the west.

The geology of the Matapedia-Rimouski area and of the Eastern Gaspe area will be discussed in detail separately.

STRATIGRAPHY OF THE MATAPEDIA-RIMOUSKI AREA

The Ordovician, Silurian and Devonian consolidated rocks outcrop in the Matapedia-Rimouski Permit area, overlain by glacial gravels and tills. The total maximum thickness of Silurian-Devonian strata in the Matapedia-Rimouski basin is estimated to be 29,000 feet. The total vertical depth of sediments to the Ordovician sedimentary complex is probably 10,000 to 11,000 feet in the northern part of the Permit block. The depth to Ordovician rocks in the south of the area is probably well in excess of 11,000 feet.

The following table gives the stratigraphic section for the Matapedia-Rimouski area:

Table of Formations

Era, Period, Stage	Formation	Description	Thickness Feet
CENOZOIC			
Quaternary	Recent and Pleistocene	Moraine and outwash deposits, recent gravels, sand and silt.	
PALEOZOIC			
Late Devonian	Intrusive rocks	Gabbro, diorite and acidic rocks.	
Middle or Lower Devonian			
Onodaga?	Lake Branch	Red, impure sandstone and siltstone.	4000+
Hamilton	York River-York Lake (undivided)	Grey and green impure sandstone; siltstone and shale; minor calcareous sandstone at base.	10,000-14,000
Oriskany	Fortin Group	Dark grey phyllitic slate and siltstone (in places calcareous); minor impure sandstone locally conglomeratic.	5000+
	Cape Bon Ami-Grand Greve	Calcareous mudstone; cherty to silty limestone; calcareous siltstone; argillaceous limestone; calcareous shale.	5000
Silurian			
Cayugan?	St. Leon	Siltstone, sandstone, shale; minor limestone; limestone conglomerate.	5000-7000
	Sayabec	Fossiliferous limestone; silty limestone.	500-2900
	Val Brillant	Hard quartzose sandstone.	400-500
	Avantjish	Green to grey shale.	50-1000

Table of Formations - Continued

Era, Period Stage	Formation	Description	Thickness Feet
	Cabano	Shale, siltstone; boulder conglomerates locally; hard shale near top.	-3000
		- ANGULAR UNCONFORMITY -	
	Post Quebec Group intrusive	Serpentinite, diorite.	
Upper Ordovician	Matapedia Group	Limestone, slate, sandstone.	
Middle to Lower Ordovician	Quebec Group	Phyllitic slate, quartzite, sandstone, basic volcanics.	

Description of Formations

Ordovician

Quebec Group

Rocks of the Quebec Group are exposed on the limbs of a syncline in the north portion of the Matapedia-Rimouski Permit area. The Quebec Group in this area is composed of phyllitic slate and quartzite. The quartzite, called the Kamouraska Quartzite, is well exposed one and one-half miles east of the village of La Redemption.

The Kamouraska Quartzite forms prominent east-west trending hills, rising approximately 50 feet above the land surface. The Kamouraska consists of hard, green, arkosic, partially foliated, altered, coarse to medium-grained quartzite with a pitted weathering surface. The feldspars have been altered leaving well-rounded, smoky white, subangular, coarse quartz grains standing out on the weathered surface.

Minor sections of the Kamouraska are coarsely conglomeratic with angular shale and rounded quartz pebbles. The matrix is similar to the rock described above as arkosic quartzite.

The relation of the Kamouraska quartzite and phyllite of the Quebec Group to the underlying strata is unknown. In the La Redemption and Lake Matapedia areas the Val Brillant Quartzite of the Silurian overlies the Quebec Group with an angular unconformity. East and south of St. Marcellin, the Cabano formation of the Silurian overlies the Quebec Group with an angular unconformity.

The Quebec Group is believed to be Lower Ordovician in age. Exposures of Kamouraska-type quartzite are found further east in the Madeleine River area (McGerrigle, 1959).

Matapedia Group

The Matapedia Group is a series of folded and faulted low grade metamorphic rocks exposed for twenty-eight miles up the Matapedia River from the confluence of the Matapedia and Restigouche Rivers.

Along road cuts between L'Ascension and St. Francois, exposures examined consisted of green-grey, phyllitic, calcareous, buff-weathering slates, grey, micaceous, platy, grey-weathering slates, and grey, hard, argillaceous, blue-grey weathering limestone (Plate 2B), impregnated with numerous white calcite veins and fine stringers.

The Matapedia Group is in faulted contact with the Fortin Group immediately south of the Permit area. The relation of the Matapedia Group to the underlying strata is unknown.

The thickness is unknown along the Matapedia River valley. Eastward from the Matapedia Valley this group of rocks forms a continuous band for

sixty-five miles as far as the Little Cascapedia River. Possible correlatives further east from the Little Cascapedia are the Pabos and White Head formations. These rocks are Upper Ordovician in age and the White Head formation is estimated to be greater than 5,000 feet thick.

Post Quebec Group Intrusives

A serpentinite mass outcrops in the Permit area approximately two miles east of La Redemption. The rock is a green, fairly hard, highly altered ultrabasic. Trenches have been made in order to examine the rock for chromite content.

This altered ultrabasic has been intruded into rocks of the Quebec Group. The surface expression of the intrusion more or less parallels the strike of the Kamouraska Quartzite of the Quebec Group.

Silurian

Awantjish Formation

The largest measured discontinuous section of the Awantjish shale, 1,000 feet approximately, is on a small tributary of the West St. Pierre River, approximately two miles south of St. Cleophas. The name was given to the shale sequence by Dr. Beland of the Quebec Department of Mines. The section was previously called the "St. Pierre Shale," but the name was changed because of repetition in the geological nomenclature. "Awantjish" is the name of the township in Quebec Province where the shale outcrops.

The Awantjish formation consists of green and red fossiliferous shale with small brachiopods associated with the green shale. Carbonate vein material also occurs in the green shale.

The Awantjish formation overlies the Quebec Group supposedly with angular unconformity and is conformably overlain by the Val Brillant Quartzite. South of St. Cleophas the Awantjish is in faulted contact with the Silurian St. Leon. The St. Leon at this locality forms a twenty to twenty-five-foot waterfall facing north, with the Awantjish formation outcropping in the stream bed a short distance below the waterfall.

As mentioned previously, the Awantjish is approximately 1,000 feet thick south of St. Cleophas. This sequence can be traced westward, to near the eastern extremity of the serpentinite mass. At this point the measured thickness is considerably less than the section south of St. Cleophas. In Lesseps Township, Central Gaspe, 200 feet upstream from the road bridge on Isabelle Creek, there is a well-exposed section of fossiliferous shale and minor interbedded, white, coquinoid limestone, presumably the lateral time equivalent of the Awantjish formation. Fossils in this section are predominantly crinoid stems and brachiopods (Atrypa articularus) (Burk, 1960). The shales are buff to brown, calcareous, blocky to fissile, fossiliferous and rusted on the weathered surface. The shale underlies a sandstone lithologically similar to the Val Brillant Quartzite of the Matapedia Lake area. The bottom of the section is covered.

The age of the Awantjish formation is considered to be Lower Silurian.

Cabano Formation

This formation is named after the village of St. Mathias de Cabano, a village on the west shore of Lake Temiscouata. The type section is located a few miles south of the village.

The Cabano formation is composed of dark green slate, sandstone, siltstone and shale. Interbedded with the series is a coarse basal-type conglomerate. The basal-type conglomerate occurs at various stratigraphic intervals within the formation. The thickest section of this conglomerate outcrops a few miles west and south of Lake Chic Choc in Flynn and Varin Townships. Near the top of the section there is a series of hard, dark green sandstone, siltstone and shale volcanically impregnated with felsite granules. Some of the rocks in this unit are possibly tuffs. The latter upper member can be distinguished in the field from the rest of the Cabano formation on the basis of hardness. Restricted basin conditions are indicated by the presence of black, graptolitic, pyritic shales near the base of the Cabano formation (Beland, 1960).

The Cabano formation presumably overlies the Quebec Group with an angular unconformity, and conformably underlies the Val Brillant Quartzite.

The Cabano formation has been mapped by the Quebec Department of Mines from the type section near Lake Temiscouata east and north to Lake Neigette and Lake des Eaux Morts in Quimet Township and southeast of Quimet Township. This latter area is within the Permit boundary. The Cabano formation is in excess of 5,000 feet (Beland, 1960).

The Cabano formation underlies the Val Brillant Quartzite southwest of St. Marcellin, but to the southwest the relation of the formation to the overlying strata is not entirely clear as there are few outcroppings of rock. This formation more than likely occurs under the Permit area in excess of 2,000 feet.

The Cabano formation is Silurian in age. It is probably the lateral time equivalent, in part, of the Awantjish formation further to the east. It is possible that the Lower Cabano is older than the Awantjish formation. The suggestion here is that the euxinic environment of the Lower Cabano may indicate the beginning of the first stage of subsidence in the general area during early Silurian times, and that the land mass in the St. Cleophas area had not then begun to subside.

Val Brillant Quartzite

The Val Brillant Quartzite is named after the village of Val Brillant, Lake Matapedia Seigneurie, located on the west shore of Lake Matapedia. The type section is located on the south shore of Lake Matapedia.

The Val Brillant Quartzite is a quartzose sandstone, fine to medium grained, white to brownish white, generally massively bedded, commonly laminated, with well sorted, rounded grains. The sand grains are cemented with silica and the rock is hard, forming prominent mound-shaped outcrops. The composition and character of this sedimentary horizon is persistent throughout

the country. Black slates are interbedded with the sandstone near the base of the section in the Lunette Lake area, Macpes Township (Lajoie, 1960). Northeast of La Redemption, the upper part of the sandstone has a dolomitic cement. Locally, the Val Brillant is pyritiferous and weathers a reddish brown. Burk (1959) reports abundant brachiopods locally. Generally speaking, this sand is non-porous and non-permeable. The upper dolomitised section in the La Redemption area requires further field study with regard to porosity and permeability characteristics.

The Val Brillant Quartzite conformably overlies the Cabano and Awantjish formations. At Isabelle Brook this relationship with the underlying shale is exposed. The relation of the Val Brillant with the overlying Sayabec limestone is conformable and gradational. Four to five miles northeast of La Redemption the gradational zone between the Val Brillant and Sayabec is marked by calcareous siltstone and dolomitic calcarenite. In the lower quarry nearest to Lake Matapedia, one-half mile north of Val Brillant village, the upper Val Brillant Quartzite is a hard, calcareous siltstone. This, again, is a gradational zone between the Val Brillant and the Sayabec Limestone.

The Val Brillant is well exposed four to five miles northeast of La Redemption, two miles east of La Redemption, and approximately two miles west of St. Marcellin. There are several good exposures in the Lake Matapedia area. On Isabelle Brook, Lessep Township, there is a minimum of thirty feet of Val Brillant(?) exposed. The extent of the Val Brillant underlying the Permit area is strictly conjectural. The sand is well exposed on Lake Matapedia and to the west exposures are recorded near Lake des Eaux Morts. It is probable that the Val Brillant extends south to St. Zenon and Lake Chasseur and possibly even further to the south.

The relationship of the Val Brillant to the St. Leon in Ouimet Township is not discussed, as little is known concerning this relationship.

The Val Brillant Quartzite is Silurian in age. Sorting and cross-bedding studies of the Val Brillant in the area south of Rimouski have shown that this well-washed sandstone is probably a third cycle sandstone. The first sand is believed to have been deposited during Precambrian time, and the third cycle derived from a sand in Cambrian to Ordovician beds. The direction of transportation was from the north-northeast (Lajoie, 1960), so that the basin side of the early seas was to the south.

Sayabec Limestone

The Sayabec Limestone is named after the village of Sayabec, in the Lake Matapedia Seigneurie. The type section was originally measured in a small quarry about two and one-half miles east of the village of Sayabec. This quarry is now filled in with debris (Beland, 1960), but a larger quarry one mile north of Val Brillant is reported to have exposures of Sayabec similar to the original type section.

At this locality near the type section, the Sayabec Limestone consists of oolitic and pelletoidal limestone, well-bedded, grey, fossiliferous limestone

with fossiliferous, grey, argillaceous shale partings, and a coarsely mottled, grey limestone, in ascending order. Near the village of La Redemption the Sayabec Limestone is a coarsely-bedded series of silty, grey, fairly soft limestone, and highly fossiliferous, coarsely clastic, grey, petroliferous limestone (Plate 3B). The clastic, erosion resistant beds are composed almost entirely of corals, pieces of stromatopora (Plate 4A), crinoid stems and brachiopods. On the northern limb of this synclinal structure, four to five miles northeast of La Redemption, there is a three-foot bed of limestone composed predominantly of two- to three-inch brachiopods (Pentamerus oblongus). In this same area there is a thirty-foot section of dolomitized quartz sandstone near the base of the Sayabec Limestone that weathers to a very porous, permeable, friable rock near the sharp contact with the limestone. This sand has been traced 2,000 feet along strike (Lajoie, 1960).

The limestone beds in this area are generally petroliferous, although only the base of the section was studied. An analysis of hydrocarbon content in the Sayabec Limestone near La Redemption gave 0.17% hydrocarbons (Aubert de la Rue, 1941).

Two miles west of St. Marcellin, along a tributary of the Little Neigette River, the Sayabec consists of mottled, grey limestone with minor beds of calcareous siltstone. Farther south across the fields the Sayabec is exposed as medium-bedded, grey, silty limestone with minor argillaceous limestone partings. This section is described in descending order.

In summary, pelletoidal and oolitic limestones are found near the base of the Sayabec. This silty and oolitic-type limestone grades up into interbedded, silty limestones and coarsely clastic reefoid limestone with many corals and other fossil fragments. A mottled limestone with siltstone matrix is generally found near the top of the section.

The Sayabec Limestone overlies Val Brillant Quartzite with a gradational, conformable contact. This zone of contact is 150 feet thick, four to five miles northeast of La Redemption. In a quarry, a mile north of Val Brillant, this transition zone is probably less than twenty-five feet. The Sayabec underlies the St. Leon Siltstone conformably. This transition zone may extend over 1,000 feet through the section. The first indication that the top of the Sayabec is being approached in section is the occurrence of a green-grey, calcareous siltstone. The percentage of siltstone gradually increases until no Sayabec-type limestone remains.

The largest recorded thickness of Sayabec (and Silurian) Limestone in the Gaspe-Rimouski-Matapedia area is on the south limb of the syncline near La Redemption. At this locality, the interbedded reefoid and silty limestone is close to 2,000 feet thick (Lajoie, 1960). On the north limb the beds are close to 1,700 feet thick. In the quarry near Val Brillant, the type section of the Sayabec is about fifteen feet thick. It is obvious that a new type section should be made of the Sayabec for the La Redemption area.

The continuation of the Sayabec under the Permit area is again conjectural. Beland (1960) feels that the limestone disappears south of Ouimet

Township. A good thickness of Sayabec Limestone probably underlies Awantjish, Nemtayo and Masse Townships, possibly in excess of 800 feet.

The Sayabec Limestone is Silurian in age. In the La Redemption area the limestone sequence contains a three-foot bed near the base containing abundant brachiopods (Pentamerus oblongus), an index fossil for the Silurian (Lajoie, 1960).

St. Leon Siltstone

The St. Leon Siltstone is named after the village of St. Leon-le-Grand, Pinault Township, and the type section for this formation is located near the village of the same name.

The St. Leon is characteristically a grey-green, calcareous, green-grey weathering siltstone. This siltstone is found commonly throughout the section.

One of the better exposures of the St. Leon outcrops to the northeast of the highway going southeast from St. Blandine in Macpes Township. Intervals in the section are covered but some of the units in this section will be discussed in ascending order. The first unit consists of siltstone, sandstone and conglomerate. An outcrop of it is located between the church and the graveyard in the village of St. Blandine on the east side of the road. The siltstone is typical green-grey, with the occasional small brachiopod imprint; the siltstone is five feet thick. The sandstone is ten feet in thickness, fine-grained, calcareous, brownish grey and micaceous, and it is in sharp contact with the siltstone. The overlying limestone conglomerate is again in sharp contact with the sandstone. The conglomerate is approximately 50 feet in thickness and consists of coarse, bioclastic, fragmented pebbles cemented by the St. Leon-type grey-green siltstone. The pebbles are tightly packed and contain crinoid stems, pieces of coral and brachiopods. The conglomerate also contains minor grey, shale pebbles. The sandstone generally occurs as lenses within the conglomerate (Beland, 1960). Proceeding across the fields to the south, there is a large covered zone, then a bedded series of siltstone, sandstone, limestone conglomerate, sandstone, calcarenite and limestone.

Approximately three miles along the highway from St. Blandine, on the southwest side of the road, there is an exposure of interbedded coarse-grained, calcarenitic sandstone, siltstone and pebble conglomerate. This latter section measures approximately thirty feet and the conglomerate in this unit, which occurs near the top of the St. Leon, is called the "Three Nuns' Conglomerate" (Beland, 1960). This conglomerate has a siltstone matrix; the pebbles are well rounded to subangular and they are composed of chert and siltstone, possibly of Ordovician age.

Limestone conglomerates, similar to the conglomerate which outcrops in the village of St. Blandine, occur throughout the St. Leon section. The conglomerates vary in the degree of sorting and rounding of the limestone and shale pebbles, but the limestone is generally of the same blue-grey to grey, silty limestone, or bioclastic limestone, which is similar in appearance to the

Sayabec-type limestone. However, the fossil assemblages found in the limestone pebbles are not the same age as the Sayabec, but are St. Leon in age (Hubert, 1960).

By far the most interesting outcrop of this St. Leon conglomerate is located at Neigette Falls, on the North Neigette River in Neigette Township. This 200-foot section of limestone boulder conglomerate is reported to be approximately midway in the St. Leon Siltstone section. The limestone blocks, which average eight to ten feet across, are composed of bioclastic limestone. The cementing material is a green-grey siltstone (Plate 6A). Fossils in the boulders include corals (Favosites, Halysites), crinoid stems, and stromatoporoids up to three feet across the base (Plate 6B). Fossils are also found in the siltstone matrix.

In this section there are 150-foot lenses of finely crystalline, grey limestone containing the occasional crinoid stem. This limestone is completely different in character and appearance from the surrounding second cycle clastic limestone. Oolites and pellets have been observed in thin sections of rock from this finely crystalline limestone (Lajoie, 1960).

The assemblage of coarse boulders and the associated, distinctly different, crystalline limestone suggests shallow water off-reef conditions. The size of the limestone blocks precludes the possibility of the blocks having been transported very far from their place of origin.

Two miles east of Wallace-Mills, Awantjish Township, there is approximately fifty feet of limestone and shale pebble conglomerate, siltstone and minor red siltstone beds.

The contact of the St. Leon with the underlying Sayabec is gradational in nature. The transition takes place over 1,000 feet in section. The rock is called St. Leon when the percentage of siltstone is greater than the percentage of limestone. The St. Leon is reported to be conformably overlain by the Cape Bon Ami-Grand Greve formation of Devonian age. However, as pointed out by Beland (1960), this may not prove to be the case, particularly in the Lake Temiscouata area to the west where the Devonian lies in fault contact or angular unconformity with the Silurian.

The St. Leon covers a good portion of the north half of the Permit area. It is probably 6,000 to 7,000 feet thick on the Permit block. The St. Leon is the uppermost Silurian rock recorded in the Permit area.

Devonian

Cape Bon Ami-Grand Greve Formation

The Cape Bon Ami-Grand Greve has been mapped as one formation as the two units are not distinguishable in the field.

The type section for the Cape Bon Ami for the Gaspe region is at Perillon Peninsula in Eastern Gaspe. The name is derived from a point of land

at this locality called Cape Bon Ami.

The type section of the Grand Greve is also at Forillon Peninsula. The Peninsula forms a continuous cliff as high as 700 feet, facing north. At the type locality the Grand Greve is well-bedded, cherty limestone and calcareous siltstone while the Cape Bon Ami is shaly to finely sandy, softer limestone. Inland, these formations are considerably thicker. In the Murdochville area these formations are distinguishable (Ford, 1960), but further to the west, as mentioned previously, the separation of the two is impossible in the field.

The Cape Bon Ami-Grand Greve consists of medium- to massive-bedded, blue-grey, silty limestone and calcareous siltstone with minor, softer, grey, calcareous shale. Fossils are found in most outcrops.

Six miles southeast of St. Blandine, Macpes Township, the Cape Bon Ami-Grand Greve is a soft, calcareous, blue-grey mudstone. The formation forms prominent hills in the north-central part of the Permit acreage. Two miles southwest of Wallace-Mills, Awantjish Township, at the junction of two roads, the Cape Bon Ami-Grand Greve is a finely crystalline, grey, grey-weathering limestone with a fetid odour. Approximately one mile southeast of Gauthier Lake, the formation consists of hard, grey, calcareous siltstone, slightly petroliferous (Plate 8B). Three miles east of Val Brillant, on the main highway, Cape Bon Ami-Grand Greve rocks exposed in a road cut are composed of grey, laminated, calcareous siltstone 100 feet in thickness. The beds dip sixty degrees to the south and a plane of schistosity makes a small angle with the bedding plane. Immediately south of Causapscal, Casupscull Township, the Cape Bon Ami-Grand Greve is a massively bedded, grey, locally laminated, silty limestone (Plate 8A).

The Cape Bon Ami-Grand Greve is believed to conformably overlie the St. Leon. Further study near Temiscouata Lake may prove that, in this area at least, the relationship is one of angular unconformity (Beland, 1960). The Devonian over Silurian in this area may be in fault contact but the two systems have been found in the field fifty feet apart with no evidence of faulting. During the 1961 field season the Quebec Department of Mines will attempt to uncover this fifty-foot zone to establish definitely the contact relationship between the Devonian and Silurian.

The Cape Bon Ami-Grand Greve may be overlain conformably by the York River.

The Cape Bon Ami-Grand Greve is estimated to be 5,000 feet at its thickest point. The formation outcrops in the northeastern part of the Permit area and in a band a few miles wide in an approximate east-west direction across the centre of the Permit block.

The Cape Bon Ami-Grand Greve is Lower Devonian in age and it is considered by Beland (1960) to be, in part, the lateral time equivalent of the Fortin Slate. McGerrigle (1950) has found, further to the east, beds of Grand Greve-type limestone in the lower Fortin. However, at the same time he

has found at another locality, tabular, well-rounded Grand Greve limestone fragments in a basal-type conglomerate of the Fortin.

Fortin Slate

The Fortin Slate is named after Fortin Township in the Gaspe Peninsula. The type locality is not obvious from the literature.

The Fortin Slate is a series of highly folded and faulted slate, siltstone and minor conglomeratic sandstone. The predominant rock type is a green-grey, calcareous, phyllitic slate impregnated with quartz and carbonate vein material. The rocks are usually steeply dipping, and there are good exposures of the phyllitic slate near St. Florence, Matalic Township, (Plates 7A & B) and along Price Brothers lumber roads in Ronceveaux Township. In general, the sediments in the Fortin are coarser to the east than to the west (Beland, 1960).

The contact relationship of the Fortin Slate and the underlying sediments is conjectural due to conflicting evidence. Beland (1960) and McGerrigle (1950) feel that the Fortin Slate may be equivalent, in part, to the Cape Bon Ami-Grand Greve. McGerrigle has found beds of Grand Greve type limestone in the Fortin, but at another locality he has found rounded slabs of Grand Greve limestone in a basal-type Fortin conglomerate, suggesting erosion of the Grand Greve during early Fortin time. The relation of the Fortin Slate to the York River formation in the Permit area is unknown. McGerrigle (1950) feels that, to the east, these two formations occupy much the same stratigraphic position.

The Fortin Slate occupies a twenty-mile wide belt that trends across the Permit block roughly from east to west. This band of slate can be traced east from the Matapedia River almost to Malbaie Bay, a distance of approximately one hundred and twenty-five miles. The thickness in the Permit block of the Fortin is difficult to estimate because of the degree of folding and faulting. Beland (1960) has estimated the thickness to be 5,000 feet or greater.

Correlation within the Fortin Slate was attempted by staff of the British American Oil Company, but it is reported that they met with little success (Hubert, 1960). The age of the Fortin has been given as Lower Devonian.

York River-York Lake (Undivided)

The name York is derived from the York River and York Lake areas of Eastern Gaspe and it was in these areas that the formations were first described. The York River and underlying York Lake are discussed as one formation. The sandstones of the York River are generally coarser and less argillaceous than those of the typical York Lake, and beds of limestone are unique to the York Lake. The York River-York Lake in the Permit area consists of grey and green, arkosic sandstone, siltstone and shale, with minor calcareous

sandstone near the base of the section.

Southeast of the south end of Lake Mitis, the York River is a fine- to medium-grained, grey, arkosic, brown-weathering, massive-bedded, semi-indurated sandstone containing numerous imprints of plant fragments. The imprints are one-half inch by three to four inches long.

The York Lake sandstone of Lower Devonian age is believed to be the lateral time equivalent of the Fortin Slate (McGerrigle, 1950). In the central Permit area the Fortin would presumably overlie the Cape Bon Ami-Grand Greve formation. The nature of the contact is unknown but there is a transition from Grand Greve to York Lake in Eastern Gaspe. The Lake Branch overlies the York River-York Lake series of sandstones.

The York River-York Lake extends across the southern part of the Permit area from east to west, averaging five miles in width. The series widens from east to west and a field distinction between York River and York Lake has been made west of the Mistigougeche River. Thickness of the complex series has been estimated to be 10,000 to 14,000 feet.

The York River-York Lake is Middle to Lower Devonian in age. The lithology of these formations in the Permit area is strikingly similar to the same series of rocks in Eastern Gaspe.

Lake Branch

The term "Lake Branch" was introduced by McGerrigle (1950) to apply to a band of red sandstones and shales located principally in Dunière and Richard Townships of Central Gaspe. The name is derived from the Lake Branch of the Cascapidia River. There is no type section for the Lake Branch due to inadequate continuous exposures.

The Lake Branch in the Permit area consists of red, impure sandstone and siltstone. The formation conformably overlies the York River. The contact between the two formations in the Richard-Gravier area is graiational (Carbonneau, 1959).

Beland (1960) has estimated the thickness of the Lake Branch to be 4,000 feet. The Lake Branch outcrops between Heppel and St. Florence in Casupscull Township, a distance of approximately two miles. The rocks form part of the Heppel syncline which trends east-west.

The Lake Branch is Middle Ordovician in age.

Recent and Pleistocene

Unconsolidated sand, silt and boulders of Pleistocene to Recent age are found covering the rocks of the Permit acreage. In the southern part of the Permit the depth of glacial overburden is greater than the cover to the north.

STRUCTURAL GEOLOGY OF THE MATAPEDIA-RIMOUSKI AREA

Devonian and Silurian sediments occur in a broad synclinorium in the Matapedia-Rimouski region. Ordovician rocks outcrop to the north and south of the Permit acreage.

Ordovician rocks have been complexly folded and faulted by the Taconic and Acadian orogenies. The Devonian and Silurian strata have been folded at the time of the Acadian revolution, which was at the close of Devonian time.

Devonian and Silurian rocks are folded along a northeast-southwest axis in the Permit area, and the direction of plunge of the folds is to the northeast. The anticlines and synclines formed generally have amplitudes of two to three miles. The folds are fairly complex with sympathetic fracturing near crests and drag folding along the limbs. In the southern Permit area, the structural deformation was intensified, and the plane of schistosity in the Fortin Slate belt is nearly vertical.

The Devonian and Silurian strata are in fault contact with Ordovician rocks in the north and south Permit areas. To the north, the approximate Ordovician boundary between Devonian and Silurian is marked by the Matapedia Lake Fault. The Matapedia Lake Fault is a complex, en echelon type of normal fault with the south side down. The transcurrent movement is not known, but near La Redemption the vertical displacement would appear to be close to 4,500 feet or greater.

The Fortin Slate is in fault contact with Ordovician rocks south of the Permit boundary. Although this fault is not readily apparent in the field, it is a prominent feature on the aerial photographs. The Fortin Slate is overthrust over the York River on the north contact of the Fortin Slate.

Pre-Devonian-Silurian highs probably existed in the basement rocks. These highs may have been caused by Precambrian granite masses or by intrusive masses of later age. The Humqui Lake and Amqui anticlines may mark an area of early high basement relief (Figure III). The lithology of the sediments of Devonian and Silurian rocks changes from the north and to the south of the Humqui Lake anticline, suggesting the existence of a barrier between these two areas during Devonian and Silurian time. The sequence of conformable rocks of Devonian and Silurian age in the northern Permit area was derived from a source rock from the north-northeast. The source direction of the Fortin Slate and older rocks is unknown, except that the source direction is probably not from the north.

In summary, the area may be divided into two areas of structural deformation; first, the Permit area to the north, which has been folded and faulted with fracturing along crests of the folds; and secondly, the Permit area to the south, which has been intensely compressed with near-vertical cleavage in the rocks.

PETROLEUM AND NATURAL GAS POSSIBILITIES OF THE MATAPEDIA-RIMOUSKI AREA

Ordovician and Cambrian

Shales of Ordovician age in the Port Daniel area to the east have been tested for the commercial extraction of oil by Imperial Oil Limited (Reliff, 1960). Although geographically removed from the Permit acreage, the environmental conditions, if not the same, may have been similar in the basin of deposition to the west. There is no lithological or obvious structural reason why these two areas were not the same basin during Ordovician times. Therefore, Ordovician and/or Cambrian rocks could underlie the Fortin Slate-York River belt of sediments.

The migration and accumulation of petroleum products from Ordovician and Cambrian strata into Devonian and Silurian rocks may have taken place during the Acadian orogeny.

Silurian

Sayabec Limestone

The most favourable potential source bed in the Matapedia-Rimouski area is the Sayabec Limestone. Lajoie (1960) has measured a thickness of 2,900 feet in the La Redemption area for this coral-bearing, petroliferous limestone. The Sayabec Limestone exhibits porous weathering (Plate 4A).

The gradational contact of the underlying Val Brillant to the Sayabec Limestone is marked by the occurrence of porous, dolomitic sandstone lenses. The dolomite occurs as a cementing material to the well-rounded quartz grains, and solution of the dolomite at depth would produce a very favourable zone of porosity and permeability. Northeast of the village of La Redemption, this porous sand has been traced for 2,000 feet along strike and the sandstone is thirty feet thick. The uppermost part of the unit, nearest the limestone, appears to contain the maximum weathering porosity and permeability. The Sayabec Limestone underlies the sandstone at this locality, and the Sayabec is in part pelletoidal.

Near the top of the Sayabec there are hard, silty, beds of limestone which would present excellent reservoir beds, because of induced porosity by fracturing and faulting during late Devonian time.

St. Leon Siltstone

Limestone beds with corals (Favosites, Halysites), stromatoporoids and crinoids occur throughout the stratigraphic sequence of the St. Leon siltstone. These reef-type fauna are possibly explained by local, or even continuous, shore conditions caused by basement highs during the period of St. Leon deposition. Where these fossiliferous limestones occur, the occurrence of hydrocarbons can be anticipated. One of the most favourable areas for possible off-shore reef conditions during St. Leon time would be on the north limb of the Amqui anticline. (Figure III). This anticlinal limb may represent the southern limit of the Awantjish basin deposition, the barrier to sedimentation to the south being the previously discussed pre-Silurian basement high.

The varied lithology of the St. Leon Siltstone may possess horizons of shale, sandstone or siltstone that may have updip lithological changes which could entrap hydrocarbons. Permeable sandstones were observed in the St. Blandine area, and facies changes may be expected along strike.

Sympathetic fracturing and faulting along crests of anticlines and synclines would cause induced porosity for the retention of hydrocarbons.

Devonian

Cape Bon Ami-Grand Greve

The Cape Bon Ami-Grand Greve is mildly petroliferous in the Wallace-Mills area of Awantjish Township. It caps the Silurian strata in much of the northern Permit area, and its non-porous, non-permeable nature should be borne in mind.

Other Devonian Strata

In Dr. Beland's "Preliminary Report on the Oak Bay Area", (1958), he mentions "Coquina-like beds a few inches thick and several thick coralline and algae reefs were noted in the southwestern part of the zone between the St. Fidele Road and Ristigouche River." These reefs have been dated paleontologically as possible Devonian (Beland, 1960). Beds of similar type possibly underlie the Fortin Slate on the subject Permits.

Structural Possibilities

Basement Highs

The northern section of the Permit area is more favourable to photo interpretation, as marker beds are more readily traceable. The folding, which reflects irregularities in the basement, may have caused induced porosity along the nose of folds where the fracturing and faulting were intensified during deformation. The south Permit area is covered with overburden and many aspects of the underlying structure are obscured. The southern section is jointed, faulted, and in general appears to have been subjected to a higher degree of structural deformation than the northern area. There are structural highs in the Fortin formation, possibly reflections of Ordovician or earlier basement highs. Dependent on the lithological character of the sediments underlying the Fortin, these highs could be of economic significance. Two areas of locally strong structural relief shown on the photomosaics from photo-interpretation are of special interest.

Faults

The Matapedia Lake Fault is probably a normal fault along which the south side has moved down. The northern limit of the Mitis Lake syncline against the plane of the fault could act as a seal to hydrocarbons within the Sayabec Limestone, or within the St. Leon Siltstone.

The overthrusting of the Portin Slate on permeable, porous York River sandstone in the central subject Permits presents interesting structural possibilities for the entrapment of hydrocarbons.

Folds

The nature of the structural deformation in the north Permit area is such that fracturing and faulting on the nose of folds may have produced induced porosity. Four localized areas along the St. Charles, Mistigougeche and Humqui anticlines and along the eastern anticline of the Mitis Lake have been marked on the photomosaics as being areas of special interest because of the evidence of local fracturing and/or shearing that should result in improved porosity conditions. Although we have not carried out detailed work in the field or photogeologically along the structures concerned, we are prepared to recommend that, assuming the presence of these anticlinal structures as shown, the best locations along the structures are at the positions indicated on the photomosaics. Two locally fractured areas along structural features south and southwest of the town of La Redemption are of particular interest.

STRATIGRAPHY OF THE EASTERN GASPE AREA

Parts of the stratigraphic sequence have been studied at various localities in Eastern Gaspe. The following list of formations includes only those which have a bearing on the Company holdings, namely, Permit No. 156.

Table of Formations

Era, Period Stage	Formation	Description	Thickness Feet
CENOZOIC Quaternary	Recent and Pleistocene	River, lagoon, bar deposits, gravels.	
MESOZOIC or PALEOZOIC Triassic? Pennsylvanian?	Basic Dikes	Diabase, usually amygdaloidal	
PALEOZOIC Middle or Lower Devonian Hamilton	Battery Point	Arkosic sandstone, conglomerate with red beds near top.	5000-7000
Hamilton	York River-York Lake (undivided)	Arkosic sandstone and shale local limestone and conglomerate.	1000-6000
Lower Devonian Oriskany	Grand Greve	Cherty and silty limestone, calcareous siltstone.	2000-4500
Oriskany	Cape Bon Ami	Soft, grey limestone, sandy limestone.	1050-6000
Devonian-Silurian	St. Alban (includes Griffon Cove River Beds)	Soft, clastic limestone with red and green shale, calcareous siltstone, reefy limestone.	330-3000
	Dartmouth and St. Jean River series.	Similar to St. Alban will probably occur in subsurface.	2500±

- ANGULAR UNCONFORMITY -

Table of Formations - Continued

Era, Period Stage	Formation	Description	Thickness Feet
Middle Ordovician	Beds at Griffon Cove to Gros Ruisseau	Mostly dark shales	
Lower Ordovician	Cape Rosier Beds	Dark grey shale and limestone, local red and green shale, local conglomerate and sandstone.	50?

Description of Formations

Lower Ordovician

Cape Rosier Beds

The upper portion of the section of the Cape Rosier beds examined immediately underlying the Silurian at Cape Rosier consisted of medium-bedded, laminated grey limestone interbedded with dark grey to black shales. The rock is veined with white calcite. The Cape Rosier beds rest under Silurian strata with sharp, angular unconformity.

Middle Ordovician

Beds at Griffon Cove to Gros Ruisseau

Beds of this age and description are referred to in the geological literature simply as "Beds at Griffon Cove to Gros Ruisseau" (McGerrigle, 1960). In a road cut one mile southwest of Griffon Cove on the Griffon Cove Road there is an outcrop of fairly hard, silty, grey, rust-brown weathering, shale. Similar beds occur along the sea coast at Griffon Cove.

Devonian-Silurian

Dartmouth and St. Jean River Series

Rocks of this age do not appear in outcrop on the Permit area but are almost certain to be present in the subsurface. Where exposed, they attain thicknesses of up to 2,500 feet and are composed of greenish grey to light green, soft, argillaceous and silty limestone. The lowest stratigraphic unit in the St. Jean River area is a massive limestone, fine-grained, dark grey, with scattered pebbles and conglomerate lenses. One of these lenses, in the St. Jean River area, is over 1,000 feet thick. Generally speaking, formations in this group (Silurian-Devonian) appear to thicken and thin irregularly. On Wooden Bottom Brook, the conglomerate zone is overlain by a thick section of greenish grey, shaly limestone which is reefal in character. Such reef fossils

as corals and stromatoporoids, though poorly preserved, are locally abundant. Where exposed, this reefal limestone is invariably petroliferous. Similar outcrops of reefal limestone, as described above, also occur in a continuous belt through southern Fortin and Jencas Townships and are exposed in part to the west in Power Township. To the west, there is an extensive exposure at the corner of Sireis, Gastonguay, Holland and Fletcher Townships, and to the north and northeast are exposures in northeastern Fletcher and Galt Townships and west-central Baie-Gaspe Sud Township (see Figure IV).

St. Alban Formation (Includes Griffon Cove River Beds)

The type section of the St. Alban formation is on the sea coast at the foot of Mount St. Alban, two and one-quarter miles south of Cap des Rosiers village in the Forillon Peninsula area. The type section represents the minimum thickness of the formation (McGerrigle, 1960).

At the type section, the rock consists of green and red silty shales with minor argillaceous limestone, and soft grey, fossiliferous limestone, medium-bedded at the base. The section is fossiliferous throughout with the lower section containing corals, stromatoporoids, brachiopods and crinoid stems. Farther to the west, the St. Alban is less fossiliferous.

The St. Alban overlies the Cap Rosier beds of Lower Ordovician age with angular unconformity. The St. Alban is in sharp contact with the overlying Cape Bon Ami formation. This latter contact appears to be conformable.

At the type section, the St. Alban formation is 336 feet thick, but on the Dartmouth River the St. Alban increases to 1,100 feet (McGerrigle, 1950). The St. Alban extends from Forillon Peninsula in a belt averaging one-half mile in width parallel to the coast line as far as Dartmouth River. On the Sydenham River, McGerrigle (1950) has recorded 2,350 feet of strata. Further inland, where this formation has been penetrated by drilling, considerably greater thicknesses are indicated, for example, sections from Imperial Gaspe No. 1, Bald Mountain No. 2 and P.C. No. 1. Sections of the St. Alban are definitely reefal and provide a good drilling target.

The lowest part of the St. Alban formation is designated as the Griffon Cove River beds. The Griffon Cove River beds are exposed in road-cuts along the Fox (Renard) River Road and, according to Kindle (1936), on the Sydenham River. They are considered to be Keyserian, equivalent to the lowest part of the St. Alban formation, and varying in thickness from 200 to 400 feet. The Griffon Cove River beds are locally reefal and contain such fossil assemblages as ostracods and corals (see Figure IV).

On the basis of brachiopod zones, McGerrigle (1950) has mapped the St. Alban as Lower Devonian. Cumming (1959) and Burk (1959) have mapped this unit as Silurian on a basis of graptolite fauna (Monograptus).

Lower Devonian

Cape Bon Ami Formation

The type section for the Cape Bon Ami formation is in the cliffs on the north side of Forillon Peninsula. The formation is named after a cape of the same name at this locality.

The Cape Bon Ami consists of medium to coarse, well-bedded, soft grey limestone with minor argillaceous limestone partings.

The Cape Bon Ami, in sharp contact with the underlying St. Alban, appears to be conformable. The Cape Bon Ami is conformably overlain by the Grand Greve formation.

At the type section, the Cape Bon Ami is 1,085 feet, but thicknesses up to 2,000 feet have been recorded on the Dartmouth River (McGerrigle, 1950). The maximum thickness measured in outcrop occurs on the south limb of the Malbaie syncline, where it appears to be in the order of 6,000 feet thick. According to McGerrigle (1950) this thickening is due to the addition of clastic beds up to 800 feet thick in the lower part of the formation. The clastics are medium-grained feldspathic sandstone and dark greenish grey to brownish, silty and calcareous shale. Conglomeratic beds vary in thickness up to eight feet with a matrix of hard feldspathic, medium-grained sandstone (see Figure IV). The Cape Bon Ami is found throughout the northern part of the Gaspe sedimentary trough. In many places, freshly broken pieces of the Cape Bon Ami emit a fetid odour, and in several localities it emits a definite petroliferous odour when freshly broken.

Early workers (Dresser and Denis, 1944) assigned the Cape Bon Ami to Lower Devonian age. Cumming (1959) tentatively places the lower portion in the Silurian, although Burk (1959) retains the Cape Bon Ami as Lower Devonian. We have followed the latter. According to McGerrigle (1950) faunal relationships between the Cape Bon Ami and the Grand Greve are overlapping.

Grand Greve Formation

The type section of the Grand Greve formation is in the north-facing cliffs of Forillon Peninsula. The name was probably given to the formation by Logan (McGerrigle, 1950) who was the first person to describe the section.

The Grand Greve at the type section is composed of dark grey, siliceous to cherty limestones and calcareous siltstones, generally well bedded in one- to six-inch beds. Though minor variations in lithology do occur, the entire Grand Greve could be described as siliceous limestone and shale with local chert nodules, and bentonite seams, and in part calcareous siltstone. It is remarkably well and thinly bedded, and abundantly fossiliferous.

The Grand Greve conformably overlies the Cape Bon Ami formation and appears to be conformably overlain by the York River-York Lake series of sandstones.

The trend of the Grand Greve outcrops is parallel to the Gaspe Peninsula, from the Matapedia-Rimouski area to the Forillon Peninsula. At the type section, the minimum thickness of 1,387 feet was measured, but some three miles to the west of the Forillon area it appears to be around 1,600 feet thick, and still further to the west is estimated at 2,500+ feet. On the Bald Mountain and Mississippi anticlinal structures, the thickness of the Grand Greve has been estimated to be about 4,000 feet. In one other locality a thickness of some 4,500 feet is indicated. Thus, this formation, like the Bon Ami, appears to thicken in the general area from Griffon Cove southwest to the St. Jean River (see Figure IV). The Grand Greve is Lower Devonian in age and, like the Cape Bon Ami, is locally petroliferous.

Middle or Lower Devonian

York River-York Lake (Undivided)

The type locality of the York River is along the York River and in the York Lake area. The York River consists of predominantly grey, arkosic sandstone and shale. In central Gaspe there are acid dyke and sill rocks of similar age associated with the formation.

The type section for the York Lake series as mapped by Jones (1935) is in the general vicinity of York Lake. The York Lake series consists of interbedded shale, sandstone and limestone and appears to be a transition zone between the York River formation and the Grand Greve formation. The York Lake series may not be present on the acreage but a facies equivalent, a light grey to white, medium-grained, quartzose sandstone with small interbeds of a hard, dense, (siliceous?) limestone up to thirty-five feet thick will likely be present.

Because of the difficulty in distinguishing between the York River and York Lake sandstones, they are included together for purposes of this report. The York River-York Lake conformably overlies the Grand Greve and is conformably overlain by the Battery Point formation. The contacts are gradational in each case. As a general field distinction, the York River-York Lake formation has grey, plagioclase feldspars in the sandstone, while pink feldspars are found in the Battery Point sandstone.

The York River-York Lake outcrops extensively in the Gaspe area. It can and does vary in thickness considerably. The thickness of the formation in the Permit area would probably be 4,000 to 5,000 feet.

The York River-York Lake formation contains a prolific fauna of bryozoa, brachiopods, pelecypods and gastropods. On the fossil evidence, it is placed in the Middle Devonian Hamiltonian.

There are many reported oil seeps in the York River-York Lake formation. In fact, most of the oil seeps reported occur in the York River-York Lake relatively close to the contact with the Grand Greve.

Battery Point Formation

The type section of the Battery Point formation is along the sea coast where the Battery Park Hotel stands, just east of Gaspe village. The section was first measured in 1863 by Logan and it includes 7,036 feet of shore section. He called it the "Gaspe sandstone" (McGerrigle, 1960).

On the north shore of Haldimand point, the formation is medium- to coarse-grained, greenish grey, friable sandstone, locally conglomeratic (Plate 10B), and contains occasional fossil fragments. The sandstone is generally crossbedded, massive and cliff forming at this locality. This section is approximately fifty-five feet thick and weathers in a porous fashion (Plate 10A).

Along the Sydenham River in Sydenham Township, the Battery Point formation was found to consist of 1,500 feet or more of sandstone and shale. The top 500 feet of the section consists of medium- to coarse-grained feldspathic sandstone with interbeds of green and red sandy shale. The sandstone beds are locally concretionary and conglomeratic. The lower 1,000 feet of section consists of massive to platy sandstone with minor grey shale partings.

The Battery Point conformably overlies the York River-York Lake. It has been penetrated by drilling to 1,400 feet on the Haldimand structure. It has a total thickness between 5,000 and 7,000 feet. While there has been considerable discussion as to the exact age of the Battery Point formation (William, H.S., 1910 and Boucot and Cumming, 1953), we are inclined to agree with McGerrigle (1950) who assigned it to the Middle Devonian Hamilton.

Triassic or Pennsylvanian

Basic Dikes

In the general area of the eastern Permit, several basic dikes have been mapped. The best known is the Tar Point diabase which has been described as follows (McGerrigle, 1950), "Dark grey, fairly coarse-grained diabase, in which druses, amygdules and joints generally are lined with chalcedony and often filled with liquid petroleum or with pitch. The dike is about 35 feet wide." Five other dikes have been mapped in the area north of Gaspe Bay, all cutting the Battery Point formation. Cuttings of igneous rocks have been noted in samples from well drilling elsewhere in Baie de Gaspe Sud and Galt Townships, all apparently in the York River-York Lake formation. Their significance, as far as petroleum possibilities are concerned, is that they could, under proper structural conditions, form a trap and should not be completely overlooked or misinterpreted.

Quaternary

Glacial History

The glaciology of the Gaspe Peninsula is not too clear as yet, but the consensus seems to be that all or part of the Gaspe was invaded by Laurentide ice. It appears that the general movement was to the southeast and that it was strongest in the Matapedia area. With the retreat of the Laurentide

ice, local glaciers formed in the Tabletops and the Beland-Upper York Highland. Radial distribution of erratics of local origin took place and probably a small and very local period of glaciation followed as an aftermath of the Tabletop-Beland ice, centered primarily in the Mount Albert area and the eastern Shickshocks (Prest, 1957).

Recent and Pleistocene

Sand and gravel deposits occur throughout the region in the form of river, lagoon and bar deposits. Glacial deposits of the kame or esker type are not abundant. Few of these deposits are very thick over an extended area and for the most part consist of an aggregate of pebbles, cobbles and sand with locally an admixture of clay.

Clays of Pleistocene to Recent age were noted by McGerrigle (1950) along the north shore of Gaspe Bay from the Peninsula westward for about three miles and also at St. Marjorique. These are irregular pocket fillings that have no defined thickness over any great area. In general, these clays are calcareous, moderately stratified and alternate from dark to light greys. Some of this material has been used with some success in brick making and could probably be used for ceramics.

STRUCTURAL GEOLOGY OF THE EASTERN GASPE AREA

The Permit acreage lies within the central belt of Paleozoic rocks of the Gaspe Peninsula. This belt is underlain by Silurian and Devonian formations that exhibit the effects of Acadian (Shickshockian) folding. This central belt can be considered as a broad synclinorium which has been differentiated into areas of subsidiary anticlinal and synclinal structures. Many of these subsidiary folds are major structures; the Galt, the Mississippi and the Haldimand anticlines occur within the Permit area. These complex fold structures are relatively broad.

Major faulting in the area in part parallels the folding. The most prominent fault is the Northwest Arm thrust which extends from Gaspe village northwest through Baie de Gaspe-Sud Township into Blanchet Township, and then on a more westerly course into De Beaujeu Township, where it apparently dies out.

The Galt anticline appears to die out as it approaches the Northwest Arm fault to the east. The Mississippi anticline becomes more complex as it approaches the Third Lake fault zone which is present to the west of the Permit area.

The Haldimand anticlinal structure, as shown on the accompanying photogeological mosaic, trends southeast from the village of Gaspe. Although it was suggested by Parks (McGerrigle, 1950) that the Haldimand anticline might be terminated to the northwest by a fault in the vicinity of Gaspe village, this interpretation was not accepted by McGerrigle. We have considered the structural feature west of Gaspe village and immediately south of the Northwest Arm fault to be a possible extension of the Haldimand anticline.

PETROLEUM AND NATURAL GAS POSSIBILITIES OF THE EASTERN GASPE AREA

The history of exploration for oil and gas in the Eastern Gaspe region goes back as far as 1836. In the period 1836 to 1860 many seepages were discovered and/or reported. In 1860, two shallow wells were drilled in the vicinity of two of these seepages with negative results. During the period 1890 to 1903, interest in the oil and gas possibilities of Gaspe was again activated and about fifty-five shallow wells were drilled. About half these shallow wells indicated fair to good shows of oil and minor amounts of gas. It must be remembered that the main objective of all this drilling was primarily to test the Gaspe Sandstone series (Battery Point, York River-York Lake). It must also be remembered that practically all of these early wells were located without regard to local or regional geological features. For example, all twenty wells in the Mississippi Brook area and eight of the eighteen drilled in the Silver Brook area were located close to the axis of a syncline. There were many others that were "located" with as much abandon. According to McGerrigle (1950), thirty-six of the fifty-eight wells drilled prior to 1903 were located in the York River synclinal structure, which roughly parallels the south side of the Habitant Permit area. The fact that even a few of these shallow wells gave shows of oil at various horizons in the sandstones is very encouraging.

Two general types of oil have been noted in wells and seepages in the Eastern Gaspe area, a light coloured, paraffin base oil as, for example, at P.O.T. 20, and a heavier, dark green to brownish black oil with an intermediate base, such as at Asphalt Base No. 1.

In summary it may be said that in spite of the number of wells that have been drilled in Eastern Gaspe, few of them were located on favourable structures. Further, those that were located with regard to geologic setting were not drilled deep enough to completely test the now recognized possible reservoir horizons in the basal Cape Bon Ami and the St. Alban formations.

On the Company holdings in the Eastern Gaspe area, three known major structures that deserve further investigation are the Galt anticline, the Mississippi anticline, and the Haldimand anticline. The potential of the possible reefy horizons in the basal Bon Ami and St. Alban has not been tested on any of these three structures.

Most published works on the Gaspe region point out the petroleum and natural gas possibilities. This has been true from the earliest geological investigations by Logan to the present day. McGerrigle (1950) sums up the Gaspe possibilities as follows:

> "The fact that the wells completed in recent years were failures, although located in the main with careful regard to the geology, is disappointing. However, the individual structures on which drilling was done are too large to be condemned by one failure or even several failures, in view of experiences in other and eventually productive fields. The drilling results to date have shown that commercial deposits of petroleum are not present

at shallow depths in this region. The fact that several of the wells did produce some oil in spite of unfavourable location, and the further fact that this production has come from any of three formations (Battery Point, York River, Grand Greve) may be considered encouraging.

"From such general considerations as the ages and nature of the rocks of the region and the nature of the folding, it must be concluded that in several localities conditions are quite favourable to the accumulation and net return of oil in commercial quantities, provided the initial source material was present. However, . . . it seems apparent that better chances for production rest in the Gaspe Limestone series (Grand Greve, Cape Bon Ami and St. Alban) than in the Gaspe Sandstone series."

PROPOSED DEEP TESTS AND COST ESTIMATES

Tests Recommended

Proposed Deep Test No. 1, of the two recommended, is located in the Eastern Gaspe Permit area (see Figures I and II and Photogeological Mosaic No. 7) approximately one mile north and three miles west of the village of Gaspe. This location is on a structural feature which may be a possible northwestward extension of the Haldimand anticline. The proposed No. 1 well site is shown to be on lands originally excluded from the Permit area but later acquired by the Company. This hole might reasonably be drilled to the top of the Ordovician Cape Rosier beds which probably underlie the Permit acreage at an estimated depth of from 9,000 to 11,000 feet. On the other hand, the main prospects are the reefoid beds of the St. Alban formation, which may be tested at maximum depths of 6,500 to 8,500 feet. The principal prospective zones in the Proposed Deep Test No. 1 and the depths which may be required to completely test each are as follows:

1. Possible porous limestones in the Grand Greve formation - 2,000' - 3,000'

2. Possible porous limestones or sandy limestones in the lower Cape Bon Ami formation - 4,000' - 6,000'

3. Reef limestones of the St. Alban formation - 6,500' - 8,500'

4. Reefs and conglomerate zones in the Dartmouth and St. Jean River series - 9,000' - 11,000'

Proposed Deep Test No. 2, located in the Matapedia-Rimouski Permit area, is in an area of possible induced porosity due to faulting and fracturing on the Mistigougeche anticline. The possibility of further detailed field studies in this area should be considered before the drilling of this second location is undertaken. Deep Test No. 2 should be drilled to the Silurian Val Brillant Quartzite, estimated to be present at this location at a depth of from

8,000 to 10,000 feet. The principal prospective zones and the depths which may be required to completely test each are as follows:

1. Sands or reef limestones of the St. Leon beds - 5,500' - 7,500'

2. Reefoid limestones of the Sayabec beds - 7,500' - 9,500'

3. Basal sand lenses of the Sayabec beds - 8,000' - 10,000'

With proper equipment and an efficient drilling contractor, the two proposed holes could be completed in approximately ten months by a large rotary drill. From experience gained in drilling P.C. No. 1, New Peninsular Oil Ltd. in Holland Township, Gaspe, it would seem that no great difficulties should be encountered in drilling to the proposed depths with rotary equipment.

Cost Estimates

The following cost estimates have been made to cover the cost of drilling the Proposed Deep Tests Nos. 1 and 2 to total depths of 11,000 and 10,000 feet, respectively, using rotary drilling equipment.

	Deep Test No. 1 (T.D. 11,000')	Deep Test No. 2 (T.D. 10,000')
Transportation, Calgary to Gaspe	$ 50,000	$
Transportation, railhead or dock to location	500	1,000
Road building and site preparation	300	300
Drilling cost for fully evaluated hole, logs run and properly abandoned	440,000	400,000
Removal of rig from location and return to Calgary	50,000	
Move from Eastern Gaspe to Rimouski-Matapedia area		22,800
Total Cost for Dry Hole	$ 540,800	$ 424,100
Total Cost for two Dry Holes	$964,900	

If possibilities for commercial production are indicated, the following costs per well would be additional:

Oil String, 11,000 feet of 5 1/2" casing, cement, cementing, float shoe, centralizers, scratchers and wellhead	$ 37,000	$ 37,000
Tubing, 11,000 feet, 2 7/8 EUE. pup joints, etc.	11,000	11,000
Total Cost for Producing Well	$ 588,800	$ 472,100
Total Cost for two Producing Wells	$1,060,900	

In the case of Proposed Deep Test No. 1, it is estimated that the cost of drilling with rotary equipment could be reduced from $540,800 to $385,000 if drilling to completely test the St. Alban formation at a maximum

depth of 8,500 feet should be considered. If, on the other hand, the operator is prepared to assume that the objective zones in the St. Alban formation may be reached at a maximum depth of 7,000 feet in the Proposed Deep Test No. 1 well, the cost of drilling with rotary equipment is estimated at $340,000.

It should be further noted that $100,000 has been charged to moving from Calgary to Gaspe and return and that if further wells are drilled in the area this charge will be reduced.

With respect to the possibility that the well may be drilled cheaper by a cable tool rig, we have contacted W. R. McMaster of Caledonia, Ontario, who does not wish to make a bid at this time, mainly because of the 7,000-foot depth and because of uncertainties as to water horizons.

SUMMARY AND CONCLUSIONS

The Matapedia-Rimouski and the Eastern Gaspe acreages contain strata and structures that are considered to be favourable to the accumulation and retention of hydrocarbons. Both areas are readily accessible to cheap water transportation, and are close to refineries. On the basis of our investigation, we recommend the testing of two structures, the first of which could be made immediately. The other should be subject to further study before an exact location is selected.

The first of the structures to be tested is located in the Eastern Gaspe Permit area. The proposed well site is approximately three miles west and one mile north of the village of Gaspe on lands originally excluded from the Permit area but later acquired by the Company.

The other of the two structures recommended for testing is the Mistigougeche anticline, located in the Matapedia-Rimouski Permit area. The approximate location selected is based on evidence of local fracturing and faulting and presupposes that porosity on the structure has been developed in this area. Further detailed field studies should be considered before the drilling of this second location is undertaken.

The costs of drilling Proposed Deep Tests Nos. 1 and 2, one on each of the recommended structures, with rotary drilling equipment, to maximum depths of 11,000 feet and 10,000 feet, respectively, to test all the formations which we consider prospective, have been estimated at $540,800 and $424,100.

With respect to Proposed Deep Test No. 1, it is estimated that the principal objectives are reefal zones in the St. Alban formation, and that this formation can be completely tested by drilling to a maximum depth of 6,500 to 8,500 feet. The cost of drilling this test to 8,500 feet with rotary equipment has been estimated to be $385,000. This estimate includes the $100,000 estimate for transporting a rig to and from Alberta, half of which cost would not be applicable to Proposed Deep Test No. 1 if a second test is to be drilled.

Although the operator may be willing to assume that the principal objective zones in Proposed Deep Test No. 1 can be reached at a maximum depth of 7,000 feet and that a cable tool rig could drill the test to this depth in six months, the cost of the hole is somewhat uncertain because Mr. W. R. McMaster, the only cable tool operator that we know of at this time in the general area, refuses to give an estimate. The cost by cable tool rig may or may not, therefore, be less than the cost by rotary. The cost of a 7,000-foot hole using rotary equipment and including total costs of transportation is estimated to be $340,000.

With respect to a further geological evaluation of the Permits, it should be kept in mind that the survey recently completed has been purely reconnaissance both as to field and photogeological work and that, therefore, further work of both types should be performed before the properties can be regarded as properly evaluated.

With this in mind, field work should be started in the Matapedia-Rimouski area at the earliest opportunity to map in detail the Sayabec Limestone, with particular reference to the basal section. The structural relation of the Sayabec to fault zones in the area should be accurately delineated. Highs in the St. Leon Siltstone should be mapped and an attempt at correlation made within the formation. The relationships between porous, permeable and non-porous facies within this formation should have a direct bearing on future exploration.

A field attempt should be made to determine the lithology of the formations underlying the Fortin formation.

This field work should be carried out over a full season with a geologist and an assistant geologist. The same two-man party should investigate the Permit area in Eastern Gaspe, as well as the Matapedia-Rimouski block.

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