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EAST CENTRAL GASPE PROJECT

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SUBMISSION TO DEPARTMENT OF NATURAL RESOURCES

PROVINCE OF QUEBEC

EAST CENTRAL GASPÉ PROJECT

BY

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LICENCES 218-222, 224-229, 232-238

GASPÉ PENINSULA, QUEBEC

JANUARY/69

IN SUPPORT OF
AN AFFIDAVIT
DATED:________________

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ATTACHMENTS

Beland, J., 1969, Report on Parts of the Third Lake Fault, the Mississippi Anticline and the St. John Anticline, 9 p., 2 maps.

Vescey, G.E., 1968, Examination of Selected Rock Samples from the Silurian, Gaspé, Quebec, 6 p.

Field Base Maps, 1" = 1320', East Central Gaspé, 1 copy each of:

22A/14 N.E.	22A/14 N.O.
22A/14 S.E.	22A/10 N.E.
22A/15 N.O.	22A/15 S.E.
22A/15 S.O.	22H/3 S.O.
22A/15 N.E.	22H/4 S.E.
22A/13 N.E.	

East Central Gaspé Geological Compilation.

EAST CENTRAL GASPÉ PROJECT

SUMMARY

The interest which Gulf Oil Canada Limited has taken in the Gaspé Peninsula, Quebec occupies general literature studies started in 1957 with a general report on the geology and oil prospects of the Gaspé and neighboring regions, to the currently completed specific, geological and geophysical (seismic reflection survey) field investigations. Through 1966 to 1968, Gulf Canada filed on and was successful in acquiring permits in East Central Gaspé totalling 863,525 acres. Work commitments on these permits have been fulfilled in 1967 and 1968 by photo geologic, surface geologic studies and a geophysical survey. It appears then, after the large amount of geological surface work carried out, that future work commitments will take the form of drilling programs. Hence it is the objective of this report to bring together all geological studies.

In the 1968 field season, geological field work was carried out in the east-central Gaspé area by a party comprised of two staff geologists of Gulf Canada and two summer students from the period May 25 to September 8. Additional studies by Dr. J. Beland of the University of Montreal were carried out from June 25 to July 25, 1968. A total of 316 man days were spent in field operations. Two four-wheel drive vehicles were utilized in the period, an International Scout and a Dodge-300 Powerwagon. For the time that Dr. Beland was present an International Travelall 4WD was rented from Avis in Montreal.

The breakdown with respect to man days in the field is as follows:

Licence No.:	224 - 229	218 - 222	232 - 238
	55 man days	98 man days	163 man days

Field studies in 1968 were concentrated mainly in areas of newly acquired acreage, i.e. Licence Permits 232-238 which lie north and west of the Dartmouth River and previously unmapped areas in Licence Permits 224-229 which lie south of the York River and which were acquired from Laduboro Oil Ltd. Detailed mapping of the carbonates of the Northern Silurian Outcrop Belt was carried out, as well as the York Lake and Madeleine River areas near Murdochville, and the Lake Ascah area.

Detailed petrographic studies have been carried out at Gulf Canada's research laboratories in Calgary on selected rock samples from the Northern Outcrop Belt collected in the 1967 field season (see attached report, Vescey, 1968).

Reconnaissance geological mapping of Bonnecamp, Deville, Walbank, Gastonguay, Sirois and Laforce townships was accomplished.

Scintillometer studies were carried out in areas south of the St. John River where the Ordovician core of the St. John Anticline surfaced and terrigenous clastics were present. No abnormal radiation was detected.

Seismic operations by Teledyne Ltd. of Calgary were carried out along the York River in Licence Permits 219-222 inclusive and 225-227 inclusive. The seismic results are discussed in a separate report.

GENERAL STATEMENT - PROSPECTS

For several reasons the area is considered prospective:

1) Approximately 80 boreholes have been put down to date with the majority of them having oil and/or gas shows (some have produced on a small scale for local consumption). Thus the occurrence of oil in small quantity has been established.

2) The presence of oil seepages (noted as early as 1836) along faulted contacts and associated fractures in vicinity of anticlinal crests attests to hydrocarbons at depth. Historically it is interesting to note that the first productive oil wells drilled in the U.S. and Canada, namely, the Drake well in Pennsylvania and the Oil Spring well in Ontario were both drilled near oil seepages. Turner Valley field was initially drilled near a seepage.

3) Broad surface structures are present throughout the whole area.

4) Potential reservoir and trap rocks occur. For example, carbonate deposits interpreted as biohermal reefs and banks are present in the surface and may extend into the subsurface under favourable surface structures.

5) Seismic reflection data indicate structures at depth.

6) The fact that all boreholes to date have not encountered commercial quantities of hydrocarbons need not detract from further drilling in this area because;

   a) the boreholes have been drilled to a shallow depth (3000 feet average) and only evaluated a sand-silt-shale sequence (York River Formation) or dense limestone sequence (Grande Greve Formation),

b) all possibilities have not been tested such as carbonate deposits (Sayabec Formation and Madeleine Member) and a quartz sandstone within the Silurian sequence,

c) most boreholes were not favourably located relative to crests of anticlines and were not deep enough to test closed horizons.

General

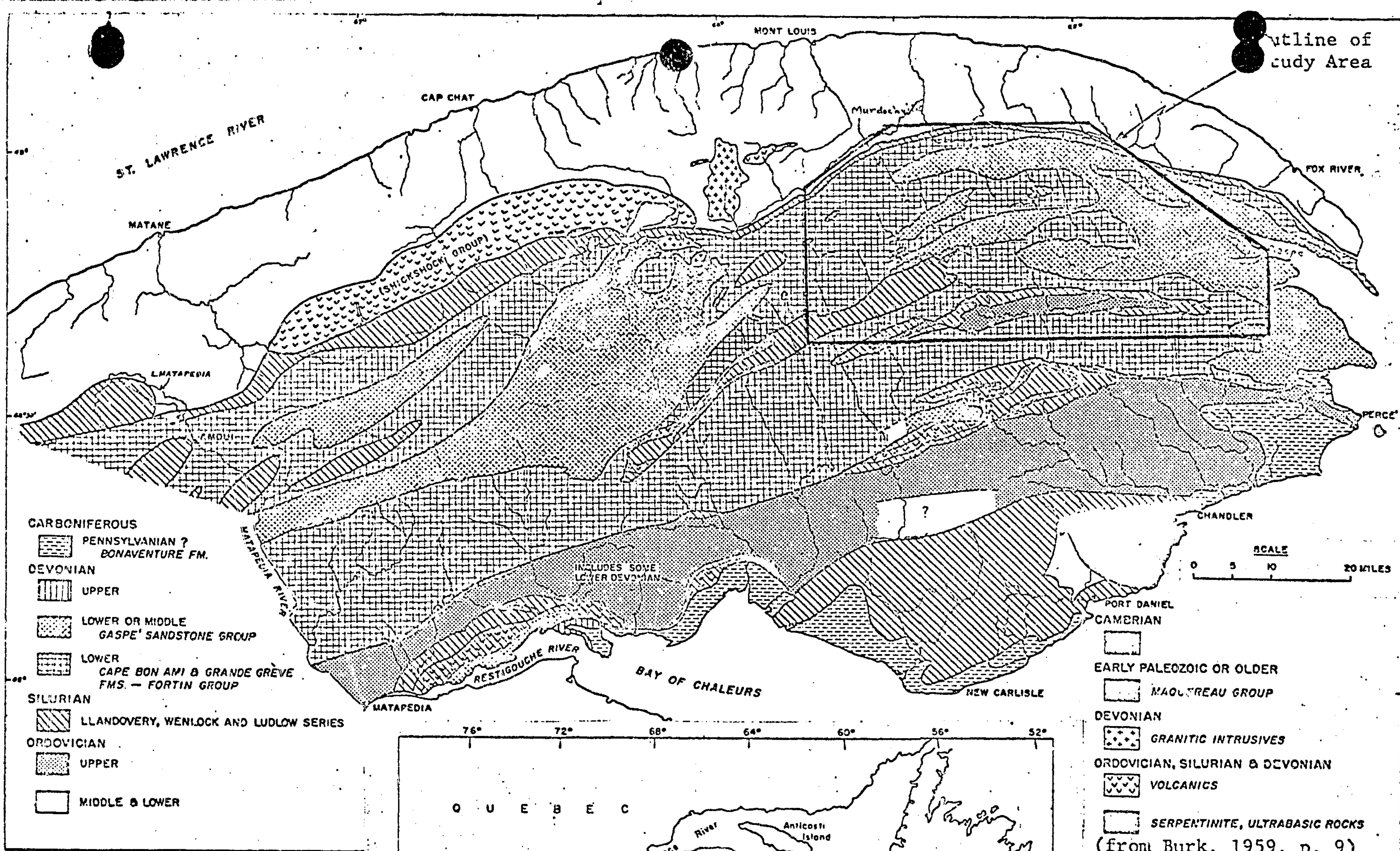
The Gaspé Peninsula (latitudes 48°00' and 49°15' N. and longitudes 64°00' and 67°30' W.) lies in Eastern Quebec with the St. Lawrence River separating it from the Mainland to the north and the Bay of Chaleur dividing it from New Brunswick to the south. Its western boundary is defined by the Matapedia River. The peninsula is approximately 75 miles wide in a north-south direction by 150 miles long in an east-west line (see Fig. 1).

A paved highway parallels the shoreline of the whole peninsula. Secondary highways, mainly forestry and lumber roads, promote access into the interior parts. The peninsula is very heavily forested and quite rugged in certain areas.

The town of Gaspé on its eastern end is a centre for this part of the peninsula and it was here that the Gulf Canada field office had its headquarters during the 1967 and 1968 field seasons.

Land

In late 1966, Gulf Oil Canada Limited made application for six licences (permits) in East Central Gaspé and was successful in acquiring Licences #224-229 (see Fig. 2) which consisted of 292,625 acres. An additional 287,800 acres (Licences #218-222) was acquired in December, 1967, followed by another 283,100 acres (Licences #232-238) in January, 1968.



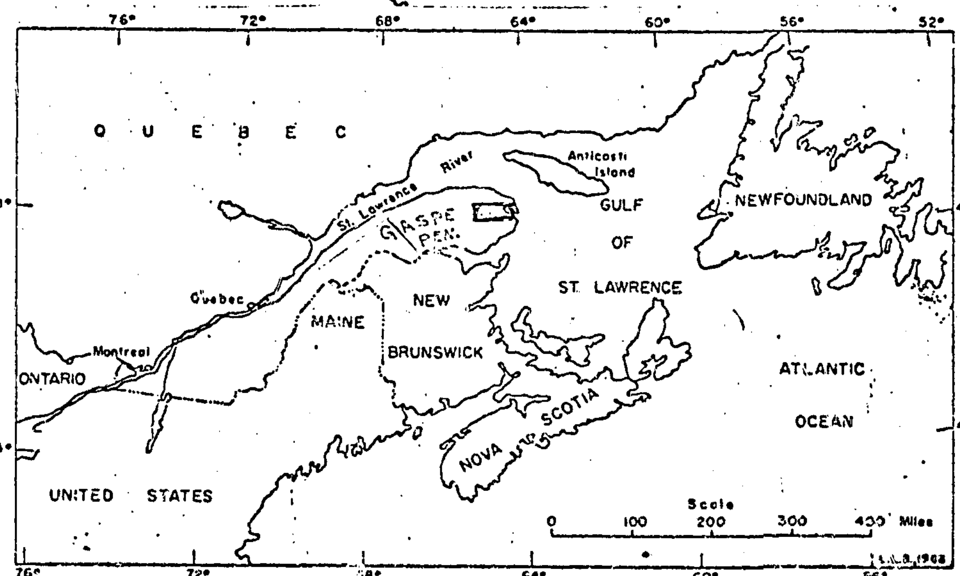


Figure I - Index Map and Geologic Map of Gaspe Peninsula

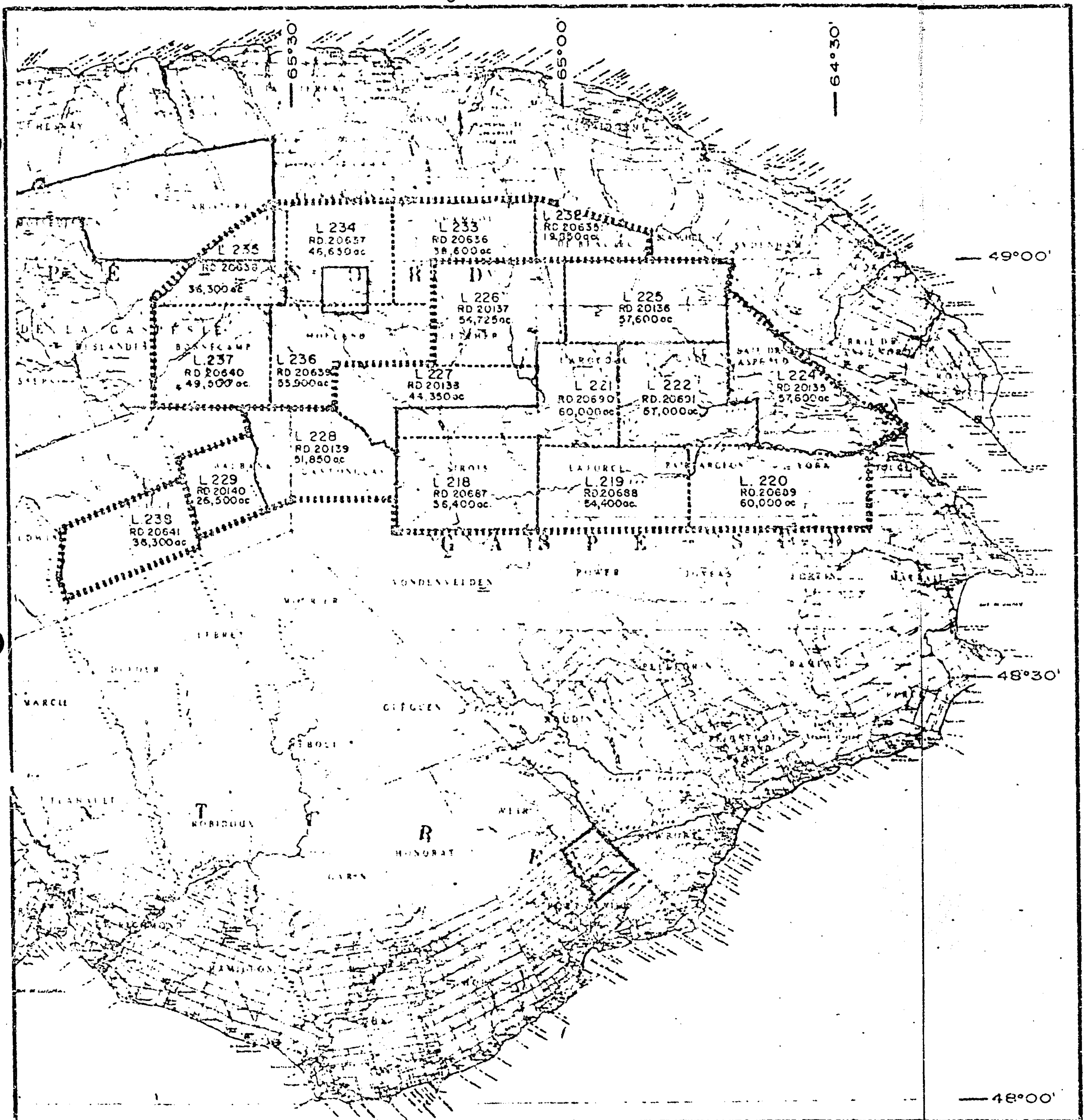


FIGURE 2.

GULF CANADA EXPLORATION
PERMITS
EAST CENTRAL GASPE

As a result of all this filing, Gulf Canada has permit rights to 863,525 acres (Fig. 2). Licences #218-222 were transferred from Laduboro Oil Ltd., Quebec, who have a 5% overriding royalty. On the other two large blocks of land (Licences #224-229 and Licences #232-238) Gulf Canada controls 94% and Royalite 6%.

The permits have a five-year life and are renewable for an additional five years. Rentals are 3¢/acre, while work commitments start at 20¢/acre for the first year, followed by 40¢, 60¢, 80¢ and $1.00/acre for successive years. Work commitments have been fulfilled to date by surface geological studies and seismic work. Maximum lease selection is 50%.

For oil and gas regulations in the Province of Quebec, see The Mining Act of Quebec, 1966.

(In Western Gaspé, Gulf Canada, Sun Oil, et al successfully filed on Licence No. 210 and drilled a well, Sun et al La Redemption #1, which was dry and abandoned in the spring of 1968. Plans are currently underway for a second well. Prospects here are the same as that in East Central Gaspé.)

Previous Work

Since Sir William Logan of the Geological Survey of Canada first carried out field studies in 1843, numerous geological studies have been done, most of these by the Quebec Department of Mines. The reader is referred to McGerrigle (1950) and Burk (1964) for a comprehensive bibliography of Gaspé geological studies. Generally these studies are on stratigraphic and paleontologic aspects. Because of the inaccessibility of much of the area and sporadic outcrops throughout, work in the area has been slow and confined to broad aspects. Only recently are more detailed studies on, for example, sedimentology being carried out. Dr. J. Beland, University of Montreal, will be publishing some detailed studies of the structural aspects in the near future.

Gulf Canada's field investigations began in the summer of 1958 with a two-man surface geological party and continued through to 1962. After acquiring six licences in 1966, Gulf Canada re-initiated geological field studies in 1967 concentrating studies on specific surface structures; namely, Bald Mountain, Hay Creek and Mt. Serpentine areas. In addition, the Siluro-Devonian rocks of the Northern Outcrop Belt were studied from Murdochville to Forillon Peninsula.

Present Studies

During the 1968 field season, a geological surface party directed its field studies to surface structures in the Lake Ascah (eastern terminus of the St. John Anticline), Mississippi, Galt, Holland and Bonnecamp regions. In addition, the carbonate deposits of the Northern Silurian Outcrop Belt were studied in detail. Samples were collected and sent to the Gulf Canada Laboratory, 330 - 9th Avenue S.W., Calgary, Alberta for further analysis (thin-sections, peels, etc.). The results of this study are not yet complete. Oil samples from old wells and rock samples from all formations were also collected and sent to the Gulf Laboratory in Pittsburgh for analysis to try to determine if there is any sort of source relationship between the oils and rocks. This study is a continuation of a program initiated in 1968 (see Table 2).

A seismic crew contracted from Teledyne Ltd., Calgary also did reflection surveys over the area (see geophysics for seismic lines). Geological and seismic operations were combined for best positioning of seismic lines.

It is hoped that the compilation of geological and seismic data will result in one or more drillable locations for Gulf Canada in its permit areas.

Field Operations

The party consisted of two staff geologists, A.J. Jenik and B.L. Whelan, and university assistants (T. Pontin and M. Kimberley). Dr. J. Beland, University of Montreal, assisted the party for three weeks.

During the 1968 geological field studies, 316 man-days were spent in field operations, with only three days lost to inclement weather. The party worked six days per week.

A field office was set up in Gaspé at the Ash Inn. Drafting tables were available and hence all field data could be plotted on base maps (1" = 1320' scale) while in the field. (Copies of these maps are attached.) Traverses were carried out along existing lumber and forestry roads and along streams, rivers, etc. Outcrop is very sporadic throughout the area. At times loose debris was used as a clue to the underlying bedrock.

One of the assistants, M. Kimberley, collected field data for a B.Sc. thesis project at University of Western Ontario, London, Ontario.

Furthermore 4 to 5 days were spent showing the local geology to Messrs. R.H. Carlyle, A.D. Baillie, W.F. Gacek and G.W. Fawcett of Gulf Oil Canada Limited, Calgary, Alberta.

Acknowledgements

Dr. J. Beland, University of Montreal, who acted as Party Chief in 1967, assisted the 1968 field party from June 26 to July 22 unravelling the structural complexities in the vicinity of the Third Lake Fault and other areas (see attached report, Beland, 1969). His invaluable help and generous discussion of the geological problems in the region are very much appreciated.

Very able assistance was provided by M. Kimberley (3rd year, Western University) and T. Pontin (graduate, Carleton University). Both carried out independent traverses at times.

Thanks are also extended to Mr. A. Bourque, graduate student, University of Montreal, for showing the writer some Silurian carbonate rock outcrops near Murdochville and for his remarks on the Siluro-Devonian stratigraphy and sedimentation along the Northern Outcrop Belt from west to east.

Dr. B. Skidmore and Mr. P. Simard of the Quebec Department of Mines were very cooperative and kind in assisting the field party operations.

Mr. B. Jones, a local pulp and lumber contractor, was a big help to the party in providing geographical information for the area. His kindness and many courtesies are much appreciated.

Appreciation is also extended to Mr. T. Nelson, a local prospector, for showing the writer the carbonate rock outcrops near Mt. Alexander.

GEOLOGY

General Statement

Geologically the peninsula forms the extreme northeastern end of the Appalachian mountain system on the continental mainland. Rocks, carbonate-sand-shale sequences, range in age from Cambrian to Carboniferous for the whole peninsula, but Siluro-Devonian sediments are predominant in East Central Gaspé. The rock layers are strongly folded and at least two major periods of folding occurred, one at the close of Ordovician time (Taconic Orogeny) and the other in Late Devonian time (Acadian Orogeny). The Gaspé region was little affected by the Appalachian Orogeny of Permian time.

Regional Stratigraphy and Sedimentation

The youngest consolidated rocks are Carboniferous in age (Cannes Roche and Bonaventure formations) which occur south of the project area, near Perce, as do also the oldest rocks of Cambrian age (Corner of the Beach and Murphy Creek formations). Also occurring south of the project area is a series of rocks called the Macquereau Group of Pre-Ordovician age which may be older than the recorded Cambrian age rocks.

Within the project area - East Central Gaspé Belt - rocks range from Ordovician to Devonian age. Table 1 shows the stratigraphy of the region, physical rock formations, their order of succession and probable ages as obtained from published literature and Gulf Canada field studies. Because of limited outcrop control (size and continuity) and structural complexities, most thickness determinations are approximate and, hence, subject to change.

AGE		FORMATION	DESCRIPTION	FOSSILS	REMARKS
		Intrusive Rocks	Diabase dykes and sills, porphyries and volcanic tuffs (?)		Diabase dyke cuts Battery Point and York River Formation at Tar Point; tarry oil in amygdules. Mineralization common in Murdochville area.
~~ ACADIAN ~~~					
DEVONIAN	MIDDLE	Battery Point	Sandstone, greenish grey to brown, feldspathic; red beds toward top, minor conglomerates	Plants	Oil shows in some boreholes in Haldimand area. Present only along coast; thickening oceanward (east).
DEVONIAN	LOWER	York River (1800-3500'+)	Sandstone, greenish grey feldspathic, numerous sedimentary structures. Fracture porosity and fine matrix porosity. Some thin interbedded volcanic tuffs (?)	Plants; Spiriferid brachiopods at base	Outcrop pattern follows E-W synclinal positions. Many small oil shows in boreholes.
DEVONIAN	LOWER	York Lake	Interbedded thin beds of York River Sandstone and Grande Greve Limestone		Transitional facies. Oil shows in this interval
DEVONIAN	LOWER	Grande Greve (2000-3200')	Limestone, dark grey, calcilutite, silty to cherty; hard, highly fractured (2 strong directions); uneven bedding; argillaceous partings common. Fracture porosity	Few brachiopods; worm imprints	Known oil seepages commonly associated with Grande Greve and York River Formations. Oil shows (minor) in some boreholes.
DEVONIAN	LOWER	Cap Bon Ami (2000-4000'+)	Siltstones-mudstones, calcareous to limestones, argil-silty, dark grey; even bedded, softer than Grande Greve Formation	Brachiopods locally	The Grande Greve and Cap Bon Ami Formations are excellent petroleum source rocks
SILURIAN	LOWER	300'-500'	Alternating Cap Bon Ami and St. Leon type lithologies	Graptolites	Gradational interval
SILURIAN	LOWER	St. Leon (500'-6600'+)	Siltstones-mudstones to fine sandstone, green, calcareous in part; red beds toward top	Graptolites	Acts as a seal for prospective underlying carbonate reservoir(s).
SILURIAN	LOWER	Madeleine Sayabec Val Brillant Awantjish	(See Figure 4 for (regional relationship (between different (facies	Corals, brachiopods, stromatoporoids, crinoids, bryozoans	Potential petroleum carbonate reservoir completely enclosed by impermeable siltstones-mudstones. Intergranular & intrafossil porosities; bitumen in pores
~~ TACONIC ~~~					
ORD.		Cape Rosier, Honorat	Slates, quartzites, phyllites, dense limestones	Graptolites, brachiopods	Different age in north from south. Probable oil source rocks

TABLE #1 Stratigraphic Column of Siluro-Devonian Rocks, East Central Gaspe Peninsula

Cambro-Ordovician

In the Mount Serpentine area, a small belt of rocks known as the Lady Step Complex consisting of metavolcanic and metasedimentary lithologies are of probable Cambro-Ordovician age (see Beland, 1968). Gravity surveys and lithology types suggest that the Lady Step Complex may be an eastern extension of the Shickshock Group of Central Gaspé. Faulting conditions along the northwest Arm Fault have brought this group of rocks up to the surface. Two serpentinite bodies were observed to intrude the Lady Step Complex. Severe shearing and brecciation, predominant schistosity and degree of metamorphism indicate a complex post-depositional history.

Ordovician

Ordovician rocks occur mainly in two areas, immediately north of the Northern Silurian-Devonian outcrop belt and within the core of the St. John Anticline to the south. In the north they are given the name Quebec Group (Cape Rosier Formation) where an indeterminate thick sequence of alternating slates, limestones, sandstones and limestone conglomerates are present. The rocks show the effect of at least two periods of deformation.

In the St. John Anticline, rocks belonging to the Honorat or Matapedia Groups are Ordovician to Silurian age and, hence, younger than the rocks in the north. These rocks consist of limestone, shales and mudstones with a definite imprint of metamorphism (an obvious sheen to the shales and schistosity). Lesperance (1968) and others suggest that there is no evidence for a major unconformity here as there is to the north. If this is so, then Knipping's (1959) suggestion that the St. John area was a topographic high (sill) during succeeding Silurian deposition would have to be modified. Possibly it is just a matter of degree, that is, because isopach of overlying strata (St. Leon Formation) seem to thin towards the southern flank of the St. John Anticline and because the facies indicate relatively shallow and agitated depositional conditions (for example, the occurrence of bioclastic and "reef" like limestones), then the area may have been a submarine shoal, rather than a subareal feature. Additional field studies are required in the St. John area. Certainly the area is prospective (for example, the Lake Ascah area) for petroleum accumulations.

Silurian

Following the Taconic Orogeny (Disturbance) of late Ordovician time, Silurian sediments were probably initially deposited on an irregular, eroded surface. A regional thinning from the south and southwest towards the north and northeast indicates the direction of transgression and/or difference in rate of sedimentation. A number of physical rock units are recognized within the Silurian.

Basal Conglomerate - Breccia - Griffon Cove River Formation

Basal conglomerates and breccias are present in a number of localities along the eastern end of the northern Siluro-Devonian Outcrop Ridge where thicknesses are variable. Their framework consists of poorly sorted, sand to boulder size, gneiss, slate, quartzite and limestone, compositional fragments surrounded by a matrix of finer shreds of the same materials and green chloritic minerals. The unit grades upwards into finer sediments (sands and shales). No porosity was observed.

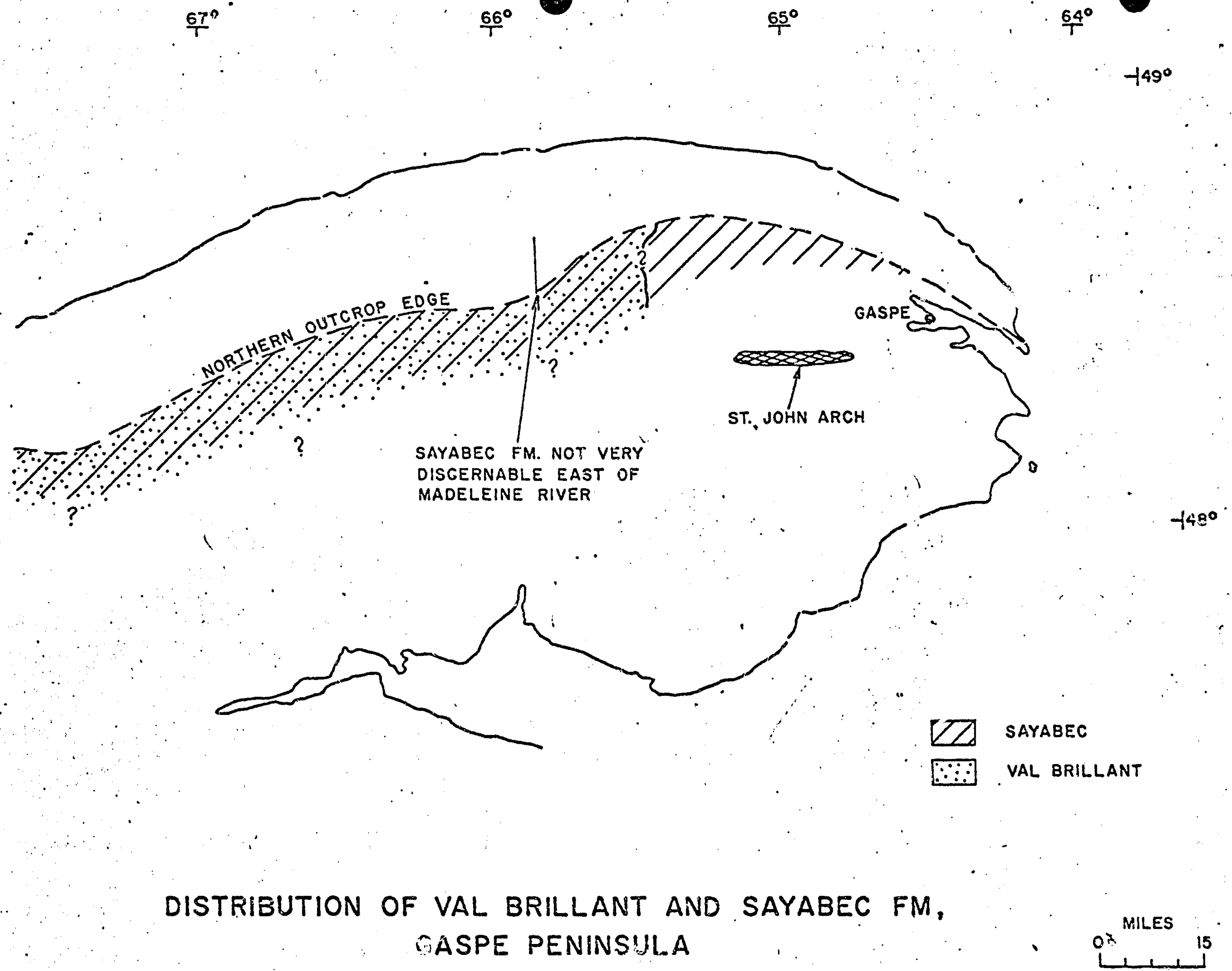
Red and green mudstone - siltstones occur at the top of the unit at Griffon Cove River section. The Owl Capes Conglomerate to the south on the St. John Anticline may be the equivalent of the Griffon Cove River Formation to the north.

Awantjish Formation

At the Madeleine River Mountain sections a partly exposed 0-200 foot (?) unit of grey siltstones with interbedded limestone is present. Since it has not been everywhere observed, it is presumed to be of local occurrence, possibly a quiet embayment or lagoonal environment.

Val Brillant Formation

The Val Brillant Formation consists of ≈ 40 feet of quartz sandstone at the Madeleine River Mountain section. A quartz cement surrounds closely packed, well rounded and well sorted quartz grains. Sorting, rounding and cross-bedded structures indicate that the Val Brillant was deposited in a constant, periodically agitated environment. Observation of Figure 3 shows that it is absent east of the Madeleine River area. Possibly it is present beneath younger rocks towards the south and southeast or has been removed by subsequent erosion toward the east. The other interpretation is that its present distribution is similar to its original depositional distribution, but regional paleogeographic studies suggest that the northern part of the peninsula was a shallow shelf area and, hence, it probably would have been deposited in the northeastern Gaspé Peninsula. Lesperance (1968) states that it grades laterally into the basal Griffon Cove River Formation (a breccia conglomerate). Intergranular porosity could be expected. Baland (1962) observed that the Val Brillant becomes more massive, the quartz less rounded, less sorted and more angular, cross-beds less common, and interbeds of shales and siltstones common as the formation is studied from north to south in the Rimouski-Matapedia region. Possibly the same relation holds true in East-Central Gaspé.



DISTRIBUTION OF VAL BRILLANT AND SAYABEC FM, GASPE PENINSULA

FIGURE # 3

(TAKEN FROM KNIPPING, 1960)

Sayabec - Madeleine River Formations

The Sayabec and Madeleine Formations will here be discussed together for it is not really obvious from outcrop that they are two separate and different formations since lithologically they are similar. The name Sayabec is an old term while Madeleine was introduced by Lesperance (1968) for a biohermal shaped carbonate deposit near the Madeleine River. Lesperance suggests that the Sayabec is a diachronous unit becoming younger from west to east and from south to north, and furthermore that the Madeleine occurs above the Sayabec Formation in the west and is replaced by the Roncelles Formation (to be discussed) in the east. The correlation is supported by fossil evidence. Bourque's (1968) M.Sc. thesis study also supports this interpretation.

The Sayabec-Madeleine Formations consist of beds and lenses of coarse bioclastic limestones cemented by sparry calcite, limestone pebble conglomerate lenses surrounded by greenish-red siltstone and crinoid and stromatoporoidal biolithites (reefs). The lenses of bioclastic limestones are commonly interbedded with St. Leon type green laminated siltstone-mudstone.

Roncelles Formation

As mentioned above, the Roncelles may be an eastern facies of the Madeleine Formation (as defined by Lesperance, 1968) to the west. It consists of silty to argillaceous calcisiltite limestones, with discontinuous to pinch and swell bedding. Occasional fossiliferous beds occur in the section. It is about 135 feet thick at Cape Rosier and 900 feet thick at Fox River.

St. Leon Formation

The St. Leon Formation is an areally widespread physical rock unit. It outcrops consistently along strike on the Northern Silurian-Devonian Outcrop Belt, as the core of the Bald Mountain Anticline and in the St. John Anticline of the project area. A few sparse outcrops are also present in the Bonnecamp area. The formation thickens from north and northeast towards the south and southwest.

The formation consists of greenish mudstones, siltstone and fine sandstones, calcareous in nature, commonly laminated in some intervals. Truncated, small-scale cross-laminated fine sandstone lenses are also present. Bioclastic limestone and limestone pebble conglomerate lenses are common in some intervals. The formation grades upward into red siltstones and mudstones and forms a gradational contact with the overlying Cap Bon Ami Formation where lithologies of both formations alternate. At Bald Mountain, a 2-4" bed of barite nodules is present near the top of the formation.

Devonian

Cap Bon Ami Formation

The Cap Bon Ami Formation consists of soft, dark grey, silty calcilutite limestones alternating with calcareous siltstones to shales. Bedding is fairly regular with average thickness varying between 1 and 3 inches. Laminations are common but the formation becomes more massive towards the top. Brachiopods giving a lower Devonian age are present.

Within the project area the Cap Bon Ami Formation thickens and becomes more silty from north to south. For example, it is 1000 feet thick at its type section at Forillon, 2000 feet at Dartmouth River, 3740 feet in the Mississippi No. 1 well south of Bald Mountain and 4000 feet in the St. John River area.

It is areally widespread but outcrops only in a few places south of the Northern Silurian-Devonian outcrop ridge.

Where a contact relationship is visible in outcrop between the underlying St. Leon Formation and the overlying Cap Bon Ami Formation, it is gradational through alternation of both lithologies. For example at Fox River (see Fig. 4) and on Bald Mountain an alternation of St. Leon greenish siltstones and mudstones with Cap Bon Ami dark greyish silty to argillaceous limestones to calcareous siltstones and mudstones is present. At Fox River an interval of at least 450 feet is present which represents transitional zone between these two formations (Fig. 4). An interesting relationship was observed in the Mt. Serpentine area where Cap Bon Ami type lithology rests directly upon the Silurian reef limestone. This may be explained by the above alternation of lithologies or an overlap situation of Cap Bon Ami towards the northeast. It may also be a faulted contact.

The upper contact with the overlying Grande Greve Formation is somewhat arbitrarily defined for the contact is also gradational. The following table taken from Brumner (1966) lists diagnostic features of each formation:

Feature	Cap Bon Ami	Grande Greve
Bedding	Even	Uneven, small scale, lenticular
Fracture	Even	Conchoidal
Hardness	Soft - Rock can easily be scratched	Very hard - Rock is siliceous
Luster	Dull	Vitreous

The Cap Bon Ami and Grande Greve Formations are similar in appearance in some areas and hence difficult to separate.

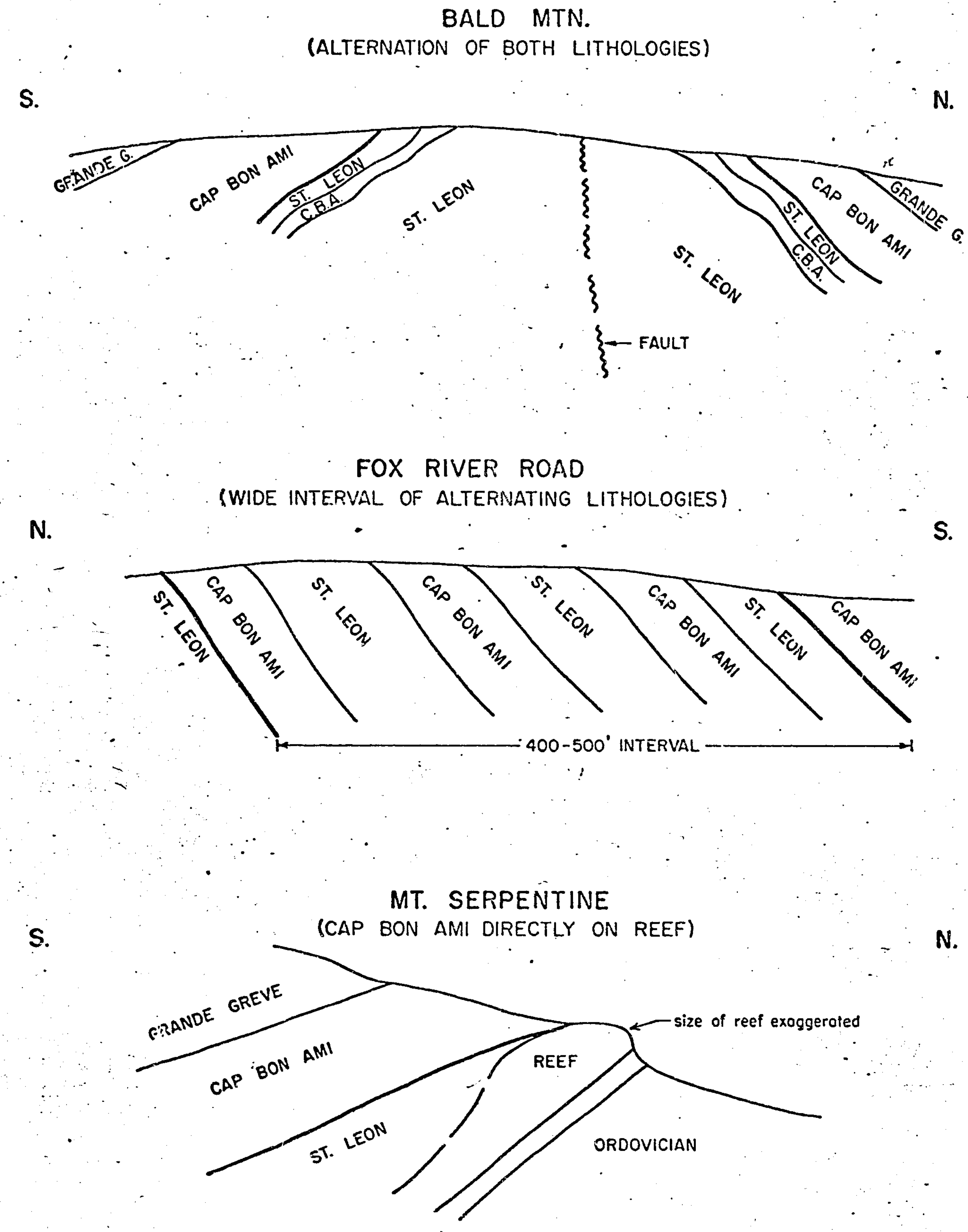


FIGURE #4

CROSS-SECTIONAL SKETCHES ILLUSTRATING
CAP BON AMI-ST. LEON CONTACT RELATIONSHIPS

Grande Greve Formation

The Grande Greve Formation, a prominent ridge former, consists of dark grey to brown, hard, silty to cherty calcilutite limestones with calcareous siltstones. Thin shaly partings between 1 to 3-inch thick beds are common. The high silica content (up to 60%) suggests that the cherty limestone is actually a limy siltstone. The silica is caused by the abundance of siliceous sponge Spicules and some replacement. Discontinuous laminations characterize individual beds which commonly show a wavy bedding. Bentonite and glauconite beds are present in the Forillon section. Distinctive marker bed(s) are lacking within the Grande Greve Formation making stratigraphic thickness difficult to compute.

Brachiopods indicate a high Lower Devonian age. Excellently preserved worm imprints abound in some of the shaly partings which suggest that burrowing may be responsible for the lack of stratification in some of the homogeneous beds.

The gradational contact with the underlying Cap Bon Ami Formation has already been mentioned. The upper contact with the overlying York River Formation is sharp as far as lithology changes are concerned, but in some localities, Hay Creek, Bald Mountain and Holland Creek, a transitional interval intervenes between the two formations. This interval is called the York Lake Series and consists of alternating thin beds characteristic of each formation.

At the type section on the Forillon Peninsula, the Grande Greve Formation is 885 feet thick. It thickens to the south and southwest to at least 3000 feet. For example, it is about 2500 feet at Hay Creek and 3000 feet south of Bald Mountain. At the Sydenham River section near the northern outcrop belt the Grande Greve Formation is about 1700 feet thick.

No porosity is evident in the Grande Greve Formation, except for line intergranular pore space caused by surface leaching of lime leaving the silica framework behind.

York Lake Formation

As has already been mentioned, the York Lake Formation appears to be transitional between the underlying Grande Greve Formation and overlying York River Formation, containing lithologies diagnostic of both formations. Since it occurs along a trend from Holland Creek to Bald Mountain to Hay Creek, this suggests that it probably subparalleled the initial depositional shoreline to the north and probably represents the littoral facies between the Grande Greve and York River Formations. Its thickness was not determined.

York River Formation

The York River Formation consists of greenish-grey, fine to medium grained, feldspathic sandstones. Grains are usually subangular to subrounded, surrounded by a greenish argillaceous matrix. Siltstone and shales are common in some parts of the sequence. The rock is very slightly calcareous, probably due to tiny calcite and rare carbonate grains. Sedimentary structures which are very common throughout the sequence, consist of small scale cross-laminations, rib and furrow cross-laminations, planar cross-beds (truncated), current ripple marks, bedding plane parting lineation cut and fill, mud cracks, and burrowed structures. The bedding is usually not very continuous laterally and lenses are common. The formation has carbonaceous material throughout and some bedding plane parting is due to a concentration of this material. Most of this carbonaceous material is probably of plant origin for numerous plant stems and leaves are present.

Large, unbroken plicated spiriferid brachiopods are present towards the base of the formation indicating a marine environment at this stratigraphic level. Most of the sequence is indicative of continental to littoral sedimentary environments.

The lower contact with the Grande Greve Formation has already been discussed, while the upper contact with the Battery Point Formation appears to be a change into increasingly red-colours and feldspar compositional change.

The York River Formation is an areally widespread unit and observation of a geological map shows that it characteristically occupies synclinal positions. Its absence in the Bonnecamp area may be due to removal by differential erosion associated with this igneous intruded area. On the other hand, this area may have been a topographic high and hence the York River may have been thin over the Bonnecamp area and hence more easily removed by subsequent erosion.

Since the York River Formation is usually not overlain by succeeding formations, except along the eastern coast, no complete section has ever been observed, but there does appear to be an increase in thickening toward the south and southeast. For example, it is between 1800 to 2300 feet thick near the Mississippi - York River area and about 4500 feet thick at Tar Point.

Battery Point Formation

The Battery Point Formation is a coarse/medium grained feldspathic sandstone with conglomeratic zones locally. Unlike the greenish York River Formation, the Battery Point is red and brownish. Variegated red and greens are common in some parts of the sequence. Cross-beds are quite common.

Because the Battery Point is present only along the eastern coastal region and because thicknesses increase from west to east, it appears that the outcrop pattern reflects somewhat the depositional "sub basin" of Battery Point deposition.

Igneous Rocks

The reader is referred to McGerrigle's (1950, p. 101-103) discussion of the igneous rock occurrences. Besides outcropping at various scattered localities in the area, some boreholes show igneous rock cuttings. The rocks are generally of diabase composition and intrude (dykes and sills) the highest Devonian aged sediments in the area.

REGIONAL STRUCTURE

Discussion of structure pertaining only to oil trapping will be of concern here. Folding within Ordovician rocks is the result of both Late Ordovician (Taconic Orogeny) and Late Devonian (Acadian Orogeny) deformations while that of the Siluro-Devonian sequence is related primarily to the Acadian Orogeny. Ordovician rocks are characterized by a greater degree of deformation, strong cleavage and sharp drag-folding as well as a complex faulting pattern. On the other hand, Siluro-Devonian rocks are characterized by folding of intermediate intensity, the folds being fairly broad, but having a smaller order of folds superimposed on them. The general plunge of the folds is to the east, but westward plunges do occur. Domed structures such as at Hay Creek and on the Galt stream are common. Thrust and wrench faulting accompanied this period of folding, while normal faults (which are transverse to the fold axis) are probably of post-Carboniferous age. The fold axes trend combined with dominant south-southwest dip of fault planes point to compression from the south.

Many of the folds, for example Bald Mountain and Hay Creek, show closure necessary for petroleum accumulation, while traps against fault planes could be a common occurrence providing a reservoir rock existed. The precise location of fold axes is complicated by a second order of folding on the major folds combined with numerous small scale faults. Wedging and slipping of beds is very common within the Grande Greve Formation. These features also result in difficulty in determining thicknesses of formations.

Similar type folding indicated by thinning and thickening of beds is characteristic of the St. Leon Formation and probably the Cap Bon Ami Formation. This fact coupled with faulting and overturning of beds in the Bald Mountain anticline may account for the large thickness of the St. Leon Formation in the Bald Mountain #2 and Imperial Gaspé #1 wells.

The Grande Greve Formation is characterized by parallel folding whereby the shape of the folds vary with depth, but beds maintain their same thicknesses. The result is wedging and faulting (small scale common) of beds throughout, once again making thickness determinations, such as in the Mississippi anticline, difficult.

Minor faults are evidenced by such observations as rapid change in strike and dip within short distances, small vertical displacement, and numerous fractures (fracture and shear cleavages).

Jones (1936, p. 27-28) proposes an interesting suggestion with regard to the folding within the Grande Greve and York River formations. He states that on the eastern extension of Bald Mountain the Grande Greve Formation maintains an easterly plunge while the overlying York River Formation does not. This indicates to him that the Grande Greve Formation was folded prior to the York River Formation and hence it is possible to have structure on top of the Grande Greve Formation suitable for petroleum trapping where the exposed York River Formation appears unfavourable. The idea is intriguing, but unfortunately the lack of reservoir beds in the Grande Greve Formation overshadows the prospectiveness of the play.

Actually, Parks (1929, p. 49-56) had the same idea and investigated boreholes to see if any irregularities exist on the Grande Greve surface and if these irregularities are in any way related to the productivity of the wells. He found that irregularities on the surface of the Grande Greve Formation have some bearing on the productivity of the wells. One would expect the somewhat sudden change in sedimentation from basically limestone to sandstone to be shown by an unconformity, but no direct evidence has yet been found.

ECONOMIC GEOLOGY; PETROLEUM

General Statement

Gulf Canada's prime interest in the Gaspé Peninsula is in the exploration of petroleum. A scintillometer was carried around in the field when doing field work around the St. John Anticline, where conglomeratic rocks are known to be present, but no radioactivity was detected. Small galena showings were observed in vugs of the Grande Greve Formation in some localities. Drilling, oil seepages, prospective oil-bearing rocks and surface structures indicate the area is favourable for petroleum accumulation.

Drilling & Oil Analysis

Of the over 80 boreholes drilled to date, most encountered shows of oil and/or gas in the York River and Grande Greve Formations. In fact, some of the wells drilled in the late 1800's still continue to flow to the present day. The first well was drilled in 1860 near a seepage. The reader is referred to Parks (1929, p. 7-10) and McGerrigle (1950, p. 119-151) for an outline of drilling development in Gaspé. In addition, a report by the Quebec Department of Mines (1960) by R. Dablois, et al, presents data on wells drilled in the Gaspé Peninsula.

Seepages

Numerous oil seepages, as well as sulphur and salt water springs, are known to be present in the Gaspé Peninsula and most of these occur in East Central Gaspé. They usually occur in the vicinity of faults and associated fractures and are most commonly associated with the York River and Grande Greve Formations, which leads one to suspect that the oil occurs only within these formations.

In other words, since no seeps have been observed coming out of the lower formations, Cap Bon Ami and St. Leon, then there is probably no communication by fractures at depth into the Grande Greve and York River Formations. Hence the oil in these formations is probably indigenous as also appears to be indicated by borehole tests.

Gulf Canada has had some analyses made of two of these oil seeps (see Table 2), but it is difficult to say whether or not they resemble the oil from wells. At least four kinds of seepages are present:

(1) associated with major faults or related fractures, in particular the fault contact of York River and Greve Formations (e.g. near P.O.T. 41 and P.O.T. 42 a dark viscous oil is escaping along a fault).

(2) associated with crestal positions on anticlinal structures (e.g. anticline near Patewegia Brook).

(3) commonly present within York River and Grande Greve Formations in vugs and fractures (e.g. vugs and fractures within Grande Greve Formation near Lake Ascah; green oil within York River Formation on Hay Creek Structure; at contact of Grande Greve and York River Formations on Roaring Bull Brook, near Mt. Serpentine).

(4) associated with daibase dykes (e.g. at Tar Point where a heavy, viscous oil occurs in cavities (druzes and amygdules) of a diabase rock; permeability is very low. The presence of oil in the vesicles is interpreted as coming about by the dyke intruding through an oil bearing horizon and incorporating some oil within it).

It is important to keep in mind that besides indicating the presence of oil in the subsurface formation(s), surface seepages may also point to the fact that the oil accumulations have been depleted.

Prospective Oil-Bearing Rocks

The more prospective oil-bearing rocks are to be found in the Silurian-Devonian formations, mainly in reefoid carbonate rocks, sand-shale sequences, and in some conglomeratic horizons. The Silurian-Devonian succession attains more than 20,000 feet (Jones, 1962) in the project area. The Ordovician rocks are considered non-prospective because of subjection to at least two periods of deformation. Hence retention of any commercial quantities of petroleum is probably very low. Oil shales and solid bitumen (albertite) attest to the presence of hydrocarbons in the rocks and thus the Ordovician rocks may have furnished some petroleum to the overlying Silurian-Devonian rocks.

Silurian Rocks

The Silurian rocks, namely, the Val Brillant, Sayabec and Madeleine Formations, are the most promising prospects for oil-reservoir rocks. A quartz sandstone rock type, the Val Brillant occurs in the lowest portion of the Silurian sequence. Intergranular porosity has been observed in places and overlying and underlying impermeable siltstones and mudstones would provide a seal.

The Sayabec and Madeleine Formations, which may be one and the same formation but with different physical expressions, constitute the most promising prospects. They consist of bioclastic (or lenses), bio-accumulated (banks) and bioconstructed (reefs) carbonate rocks, enclosed completely by dense siltstone and mudstones of the St. Leon Formation. An analogy could be drawn to the Devonian Leduc-Ireton relationships in the Western Canada Sedimentary Basin. Some porosity (leached?) has been observed and the presence of solid bitumen in fossil pores is known.

The occurrence of these Silurian rocks in the subsurface under surface structures would have to be determined by drilling.

Devonian Rocks

The lowermost formation of the Devonian, the Cap Bon Ami, is generally non-prospective for the rock types consist of generally dense, non-porous calcareous siltstones to shales and argillaceous, calcilutite and calcisiltite limestones. The Cap Bon Ami may have been an oil-source rock though, for a strong petroliferous odour emanates from a freshly broken surface. Ubiquitously disseminated carbonaceous material is also present throughout the formation.

The dense, hard siliceous to cherty to silty calcilutite limestones of the Grande Greve Formation make poor reservoir rocks, but tectonic fracturing could have produced a potential reservoir. Some of the boreholes which have penetrated the Grande Greve have oil shows, the oil presumably being located in fracture porosity. If this oil is not indigenous to the formation (fine carbonaceous plant material is common within the rocks), then it must have migrated into these fractures from a lower horizon, possibly the Cap Bon Ami or the Silurian formations or even the Ordovician rocks. Hence the migration of oil would have to be post-Acadian orogeny.

Overlying the Grande Greve is the York River Formation which consists of alternating sequences of sandstones and siltstones to mudstones. Most of the wells drilled into the York River Formation had oil and/or gas shows. No obvious porosity was seen in field samples (or well cuttings), but when water was put on the surface of the rocks, it disappeared fairly quickly into the rock. One concludes that a very fine porosity is present in the matrix of the rock. Well cuttings commonly show vein calcite where hydrocarbon occurrences are present, thus suggesting there are fractures present. Fracture porosity could be developed without all fractures being completely filled with calcite (or some other mineral).

The same comments apply for the York River as for the Grande Greve Formation, regarding source of oil. Stratigraphic traps may be many, being due to rapid facies changes (outcrops certainly indicate this).

Occurring between the Grande Greve and York River Formations is an interbedded sequence of thin limestone beds with thin sandstone beds having affinities to the underlying and overlying formations. A potential trap exists here. Indeed, some of the boreholes indicate oil shows from this contact zone.

The uppermost Battery Point Formation may have traps similar to the York River Formation. Oil shows have been found in the Battery Point in some wells.

Structures

Large folds, with both eastward and westward plunges, indicate favourable conditions for petroleum accumulation. In addition there are possibilities for traps against fault planes as well as against intrusive rocks (i.e. Tar Point). In particular, anticlines such as the Bald Mountain, Hay Creek, Mississippi and Gault are prospective traps against the NW Arm, Third Lake and other numerous faults, providing reservoir rocks exist in the subsurface.

Quality of Oil

A number of workers (Ells, 1902-03 and Parks, 1929) have pointed out that oils of lighter colour and grade are characteristic of the York River Formation, while the darker, heavier oils are characteristic of the Grande Greve Formation. McGerrigle (1950) is of contrary opinion, observing that dark oils occur just as frequently in the York River Formation as do light oils. Furthermore he states (p. 128) that seeps show that a particular oil is not limited to a particular formation.

The occurrence of light or dark oils in one or the other formation does not necessarily mean that the oil is indigenous to that formation (or characterizes that formation). It may just be a matter of distance travelled during migration of the oil to its final reservoir rock. Figure 5 shows the general occurrence of oil seeps.

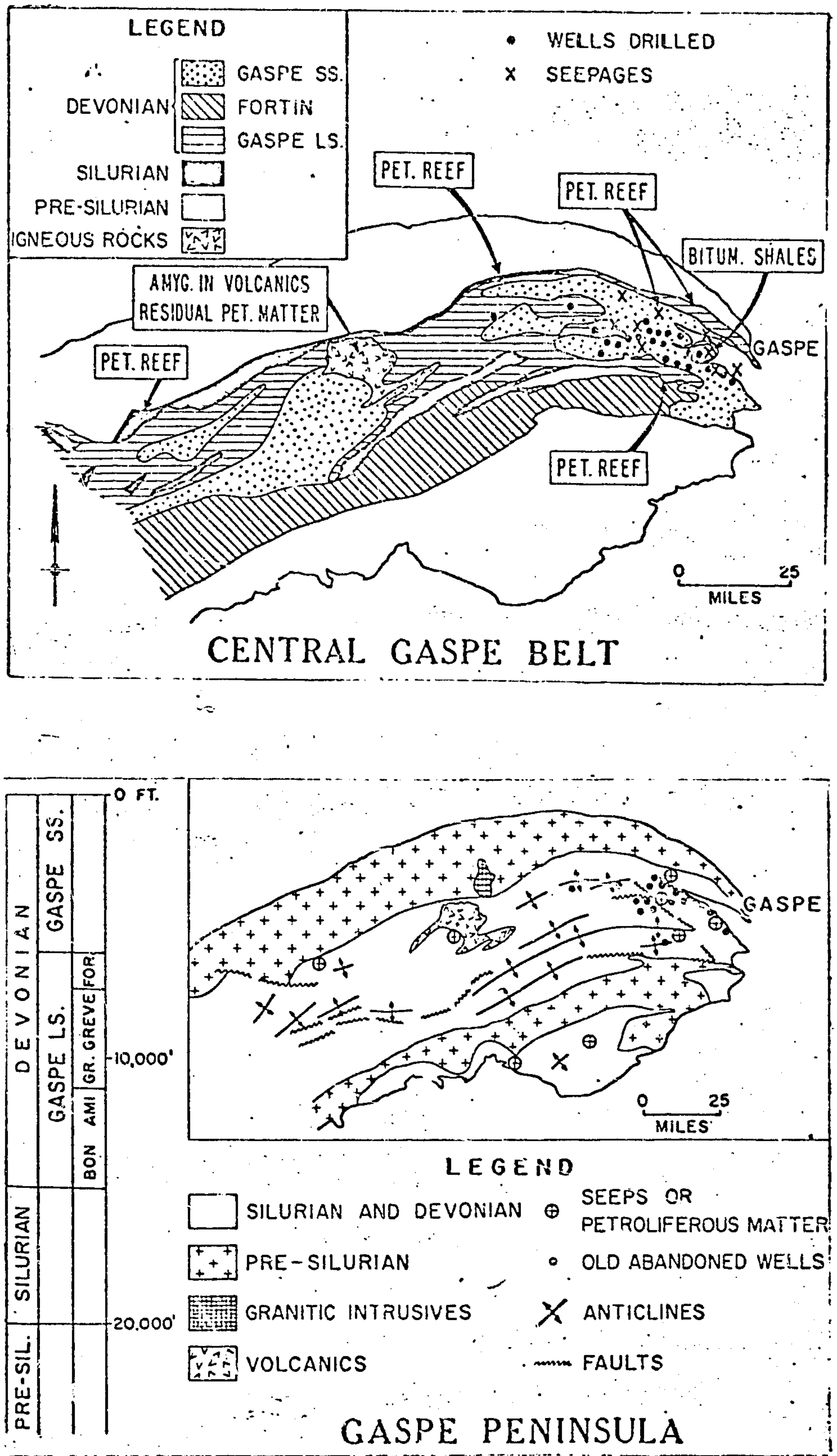
Table 2 shows a compositional analysis of oil samples from three wells and two seepages collected by the 1967 field personnel. Analysis was carried out by the Gulf Research and Development Company, Pittsburgh, Pennsylvania.

Spectroscopic analysis of the six samples submitted showed five to be samples of petroleum and the sixth (#85) to be a sample of dimethly phthalate (possibly from an insect repellent).

Two of the oil well samples (#86, #88) were nearly identical and were typical examples of crude petroleum. A third oil well sample (#87) was unusual in that it was a clear, wide-range petroleum liquid with asphaltic material absent (or possibly removed by percolation through porous rock strata?). The remaining two samples were extensively weathered, thus making it difficult to extrapolate their present composition to their original composition for comparison with the other samples.

Additional oil analyses carried out by the Quebec Department of Mines are available on file.

During the 1968 field season, quart-size oil samples from P.O.T. #5, P.O.T. #20, and P.O.T. #23 wells were again collected. But in addition, 10-pound size rock samples from the Ordovician Madeleine-Sayabec, St. Leon, Cap Bon Ami, Grande Greve and York River Formations were also collected. All samples, oil and rock, have been sent to the Gulf Research & Development Company to try to find out if some sort of relationship exists between a particular oil and particular rock formation.



(after Roliff, 1955)

Figure # 5 Petroleum Occurrences,

Gaspe Peninsula

Field Location	P.O.T. #5 Well	P.O.T. #23 Well	P.O.T. #20 Well	Oil Seepage Near Mt. Serpentine on Roaring Bull Creek	Oil Seepage Near P.O.T. #40 Well	Oil Seepage Eden Brook, East of Mt. Serpentine
Sample	PR 86-67	PR 88-67	PR 87-67	PR 84-67	PR 83-67	PR 85-67
Source	Abandoned oil well	Abandoned oil well	Abandoned oil well	Sulfur spring oil scum	Pool	Sulfur spring
Appearance of Isolated "oil"	Brown, non-transparent	Same as #86	Transparent, pale yellow liquid	Brown-yellow	Black, viscous	Pale yellow syrup
NMR Spectrum	Alkyl-substituted, condensed and uncondensed aromatics in medium quantity. Cyclohexane present	Similar to #86	Alkyl-substituted, uncondensed aromatics in medium to low quantity. Cyclohexane present	Alkyl-substituted, condensed and uncondensed aromatics in low quantity	Alkyl-substituted, condensed and uncondensed aromatics in high quantity	Identical with that of dimethyl phthalate (plus impurities)
IR Spectrum	Trace of carbonyl compounds	Similar to #86	Highly n-paraffinic. No carbonyl compounds	Similar to #86	Relatively high carbonyl content (i.e., oxidation)	Identical with that of dimethyl phthalate (plus impurities)
Total Sulfur (%) Content	0.06	0.06	0.04	not analyzed	0.29	Not anlayzed
Initial BP (°F)	-85	-31	-85	320	430	Not analyzed
Final BP (°F)	>1050	>1050	>1050	>1050	>1050	
Median Carbon Number	16.6	15.0	12.9	21.3	26.7	
n-Paraffin Content	Lower than #88	Lower than #87	High	Relatively low	None apparent	

TABLE #2 . EAST CENTRAL GASPE PENINSULA OIL ANALYSIS

In other words, does the oil from P.O.T. #5 well show any affinities to the analysis of residue (hydrocarbon) or isotopes, etc. of, say, the York River Formation.

Conclusions and Recommendations

The main concern in the project area is whether or not reservoir type rocks are present beneath large surface structures (with closure), or against fault planes or as stratigraphic pinchouts on the limbs of folds. Previous drilling into the York River and Grande Greve Formations has proven the presence of petroleum in either fractured or poorly porous sandstone and limestone sequences. Carbonate rocks (Sayabec - Madeleine River Formations), mainly bioclastic and bio-accumulated banks, in the Northern Silurian-Devonian outcrop belt contain bitumen which completely plugs intrafossil pore space. The Val Brillant quartzose sandstone is another potential reservoir bed. But the question is, do these potential reservoir units extend southward under the surface structures? Unfortunately paucity of data leaves the question unanswered. Regional thickening to the south and southwest points to basinal conditions and thus the lack of sands and carbonate rocks. On the other hand, faulting may be responsible for this increased thickening.

Assuming that reservoir-type rocks do occur towards the south, it still is not known if porosity would be present, for very little porosity is present in surface rocks. No evidence of dolomitization was observed or any extensive leaching.

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REPORT ON PARTS OF THE 3rd LAKE FAULT, THE MISSISSIPI ANTICLINE AND THE ST.JOHN ANTICLINE OF EASTERN GASPE QUEBEC.

by J. Béland

January 1969.

TO BRITISH AMERICAN OIL CO. LTD.

REPORT ON PARTS OF THE 3rd LAKE FAULT, THE MISSISSIPI ANTICLINE AND THE ST.JOHN ANTICLINE OF EASTERN GASPE, QUEBEC,

by J. Béland, January 1969.

C O N T E N T S

GENERAL STATEMENT

1. Field work was carried by the author from June 25th to August [July] 21st 1968 with the purpose of obtaining more precise data on the location and nature of the 3rd Lake fault which is one of the main structural elements of Eastern Gaspe and which seems to have played a major role in the accumulation and migration of oil here found.

Effectively 3rd Lake fault crosses an area where oil has been found accumulated in small pools that have been tapped by drilling in years past. Natural tar pits and seepages are also abundant.

3rd Lake fault is considered to be a very deep fault or system of faults of the transcurrent (tear) type which formed as folding of the area was taking place. It truncates or terminates three of the mayor anticlinal structures, namely, from N to S : -

The Bald Mountain anticline, the Mississipi anticline and the St. John anticline.

The area where the fault crosses the Mississipi anticline in Larocque and Galt townships is particularly interesting, first, because of abundant exposures along the main trunk and the northern tributaries of the Patewaga brook and, second, because of several known oil seepages.

Most of our work was therefore concentrated in that sector. Toward the end of our sojourn some time was spent at the east end of the St. John anticline where again the 3rd Lake fault had been previously traced.

2. 3rd Lake FAULT AND MISSISSIPI ANTICLINE AT PATEWAGA AND GALT BROOKS (Map 1)

2.1 Stratigraphy

The formations encountered in this area include the Grande Grève and the York River. At places in Gaspé an intermediate facies termed the York Lake facies separate the two but here it does not occur.

The Grande Grève is mostly dark grey hard siliceous limestones and limy siltstones with rare shaly facies. The York River which is above is mostly greenish grey arkosic sandstone interbedded with pelitic facies. Some thick sandstone beds are conglomeratic.

2.2 3rd Lake fault

The 3rd Lake fault as observed on the Patewaga brook is not a simple fault. It appears to be a series of en échelon faults or fault zones pretty well outlined by the step-like offsets of the stream.

The northernmost segment in Larocque township runs parallel to a segment of the brook and is a zone of upturned beds, brecciated, veined, recrystallized and cut by shears running about parallel to the general trend of the zone. The brecciae are 20 to 25 feet wide, made up of very angular fragments, $\frac{1}{4}$ to 5 inches across, and welded by coarse carbonate vein material. Small shears lined with thin graphitic smears cross the brecciae. Some brecciae fade out into zones of highly fractured rock but the fragments have not moved. One oil seepage at the southeast end of the Larocque segment is in a breccia.

Most shear planes are dipping steeply to the SW. Many show a striation which is at places subvertical and at other places subhorizontal. Movement in general has taken place between competent beds which constitute most of the Grande Grève Formation. Locally however shearing and brecciation are replaced by a crumpling into series of minor folds with wave lengths of 15 to 30 feet. Fold axes are subhorizontal or plunge moderately E or W thus pointing to an essentially vertical movement along the fault zone.

The fold axial planes are either vertical or steeply (50°-75°) inclined to the south suggesting a northerly directed thrust.

Between the northernmost Larocque segment just described and the next fault zone to the SE extends an area of northerly dipping strata of Grande Grève and York River slightly disturbed. But gentle undulations with wave lengths.... of 50 to 100 feet are recognized. The York River rests on the Grande Grève in normal stratigraphic contact. Fracturing is restricted to subvertical cross-jointing. Some joints are filled with coarse calcite that locally spreads into complex stockworks.

The southernmost fault zone which again coincides with a similarly trending segment of the Patewaga brook is much wider and probably longer than the northern fault. It appears to follow the crest of a sharp anticline and has been traced as far as Lizard brook. Dips of 50 to 60°N prevail on the N side whereas on the south they average about 65°S. Two oil seepages one at each end again characterize the fault zone. Breccias up to 25 feet wide are common.

Some show geodes 2 to 4 inches across partially filled with calcite. Shears dipping 70to 75°S and trending parallel to the fault zone border the brecciae. Many carry a striation pointing to subvertical movement and slickensides indicating upward moving of the south compartment.

Other shears however occurs in slip-cleavage fashion, 6 inches to 5 feet apart, and are separated by sigmoid folds with subvertical axes which suggest subhorizontal movement along the shear planes. The position of the S-folds requires dextral movement that is the southwest block moved horizontally northwestward. At places the parallel shears and the S-folds are in zones up to 25 feet wide.

On the other hand, in this fault zone as in the northernmost fault, crumpling of the strata point to subvertical movement. The minor folds axes are generally subhorizontal or plunge indifferently about 20°NW or SE. Axial planes are subvertical and in shaly facies an axial plane cleavage has developped. At the southeast end of the fault zone crumpling appears to have been restricted to some less resistant stratigraphic zones which have been severely plicated into chevron folds fading out into simpler and larger homoclinal structures. Many chevrons show ruptured cores with the core beds wedged into the flanks. Elsewhere dragfolding effects show very clearly that southwest blocks moved upward.

It appears therefore that both vertical and horizontal movements took place along the fault zone and that the displacement was generally directed from the south towards the north.

Away from the map area here presented but along the same 3rd Lake fault at a point located about 2 miles SE of 3rd Lake where the fault has caused the formation of a marked escarpment and brings into contact York River and Grande Grève a large drag fold in the Grande Grève with a subvertical axis points very clearly to a northwestward displacement of the southwestward compartment along the fault. And nearby in the York River, shear planes show subhorizontal striae confirming the subhorizontal nature of the movement.

The structural information gathered near the junction of Patewaga and Lizard brooks indicate that southwest of the major fault zone (map 1) a simple homoclinal structure with faint to moderate dips to the southwest prevail.

2.3 Oil seepage on Galt brook tributary.

In the south central part of map 1 at the headwaters of the western tributary of Galt brook an oil seepage (tar pit) occurs amidst but very gently disturbed strata of Grande Grève. It seems that the gentle homocline recognized at the junction of the Patawega and Lizard brooks extends to this point. A marked cross-jointing is conspicuous and some joints near the seepage are filled with calcite mixed with bituminous matter.

2.4 Mississipi anticline on Galt brook.

At Galt brook in the eastern part of map 1 Grande Grève Strata outline a broad anticlinal structure plunging about 10°E. Although this fold could be joined up with the anticlinal structure of Patewaga brook the two folds are entirely of different characters. The Galt structure is considerably less folded.

The Grande Grève Formation as at Patewaga brook passes abruptly into the York River without any transitional York Lake to speak of. The basal York River is however very calcareous on the south flank of the fold and contains few thin beds of calcareous siltstones at the north flank.

It should be mentioned that at about 1500 feet south of the axis of the fold the Grande Grève Strata are thrown into a few minor open folds all plunging 15 to 20°E. and with subvertical axial planes. This deformation is much milder than that encountered at the Patewaga brook. It may be assumed therefore that the 3rd Lake fault or its relayed segments runs between the gentle Galt brook fold and the gentle homocline exposed at the head waters of the western tributary of Galt brook.

3. ST. JOHN ANTICLINE - ASCAH LAKE AREA (MAPS)

3.1 Stratigraphy

The lowest formation in the section examined on the south flank of the E-W trending St.John Anticline is the Sirois Formation of Silurian age. It is followed by equivalents of Cap Bon Ami and Grande Grève Formations of the Devonian.

The Sirois Formation like its northern equivalent, the St.Leon, is mostly calcareous greenish and reddish siltstones. Unlike the common St. Leon however, it holds here many conglomeratic beds some of quartz pebbles and others of limestone pebbles. The quartz pebble conglomerates may reach as much as 12 feet in thickness. With the limestone conglomerates are associated beds of coarse calcarenite mostly of crinoidal material.

The Cap Bon Ami encountered contains more shales and siltstones than its northern relative. It has many affinities with the Fortin Group which occurs south of the St.John anticline.

It is likewise laminated and shows similar slump structures with abundant convolute beds. The lime component is largely replaced by detrital material.

The Grande Grève also appears to be transitional between the northern Grande Grève and the Fortin Group. It contains for instance, thick conglomeratic detrital beds several tens of feet thick. The conglomerate with quartz pebbles as much at places as 4 inches across constitute the basal parts of these beds. However, cherty limestone beds typical of the northern Grande Grève still form a large proportion of the formation.

3.2 Structure

The attitude of abundant minor folds throughout the whole section examined indicates clearly that the St. John Anticline here plunges easterly about 10 to 15°. The pelitic facies shows a marked flow-cleavage passing to a fracture cleavage in the siltier beds. Where minor folds are encountered it becomes obvious that the flow cleavage is an axial plane cleavage. It dips consistently like the axial planes 70 to 75°S. Intersections of the cleavage with the bedding confirms the easterly plunge of the overall structure.

A major fault indicated by a shear zone 20 feet thick marks the boundary of the Sirois and the Devonian formations on the south. This fault is strongly reminiscent of the fault zones constituting the 3rd Lake fault. Within the Grande Grève, movement has taken place in between the competent beds and has produced graphitic smears and much carbonate veining. The shear zone runs about parallel to the 3rd Lake fault recognized some 4 miles to the north and may actually be one of several elements constituting the 3rd Lake fault system.

Conspicuous subvertical cross-joints running NS are everywhere encountered.

4. CONCLUSIONS

The 3rd Lake fault appears to be a system of steeply dipping en échelon faults or fault zones which developped as the folding of the Siluro-Devonian strata took place. Movement along the faults was produced by interbed slippage combined with shearing and brecciation. The fault zones may reach far below to some kind of flat basal shear planes above or within the Cambro-Ordovician (or Precambrian) basement.

The attitudes of minor folds and striae observed in the fault zones indicate that the southwestern compartments were pushed upward and moved northwestward in altenate episodes. The overall faulting is thus a combination of thrust and tear. The major folds that formed as the basin was shortened were dragged along the steep faults and part of the Mississipi anticline southwest of the fault was squeezed and sliced up. The porous brecciae and fractured zones left presumably allows oil to reach the surface. All seepage encountered are in the faulted zones or in their immediate vicinity. Away from the faults the structure appears to be very gentle: gently folded arches or gently dipping homoclines prevail.

The St. John anticline at its east end is traversed by faults also belonging to the 3rd Lake fault system. Upward and northwestward movement of southwest compartments are here also indicated.

The lithofacies encountered at the St. John anticline although in many ways very similar to those of the northern formationsare nevertheless distinct enough to indicate marked changes of the depositional environment. Slumps, coarse detritus and graded beds for instance point a different relief within the basin.

Jacques Béland

January 1969.

EXAMINATION
OF SELECTED ROCK SAMPLES
FROM THE SILURIAN, GASPE, QUEBEC

by

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Selected rock samples were examined with the binocular microscope from the eastern central part of Gaspe, Quebec, to recognize the facies.

Section 1B - Madeleine River West Longitude 65° 28'

St. Leon Formation

Sample V-26A

Dark greenish grey siltstone with approximately 25% of fine clear quartz sand grains. The rock is composed mainly of subangular clear quartz grains, medium sorted, few amounts of argillaceous matrix, scattered small muscovite flakes. The rock is laminated to thinly bedded. Along side the bedding planes elongated thin vugs occur, possibly leached out fossils, Steinkern of Brachiopods.

The rock is a basinal deposit, possibly near shore.

Section 2 - Madeleine River East Longitude 65° 22'

Sample RMW 2-3

Limestone, light grey, crinoidal biosparrudite with scattered bryozoans and more brachiopod shells, and dense.

The rock is composed mainly of crinoidal columnals and other crinoidal ossicles. The columnals are large, 3-8 mm. in diameter. There are pairs of columns in which the columnals are not disconnected and they are composed of 4-8 columnals. The skeletal components of the rock are not fragmented, and their arrangement is random. Some crinoid columnals are recrystallized and frequently are surrounded by clear calcite overgrowths. The massive cryptostrome bryozoan skeletons are slightly worn. Among the skeletal grains coarse parry calcite is predominent but in spots microspar occurs, possibly recrystallized micrite. One fracture is filled by epigenic coarse sparry calcite. The constituents of the rock are; approximately 70% crinoidal ossicles, 2-3% bryozoan skeletons, 27-28% sparry calcite.

The original sediment was autochthonous bioaccumulated. The sedimentation took place in a quiet environment. The rock could be a coquinoil type, widespread bioaccumulated bank or biostrome.

Madeleine River Member, St. Leon Formation.

Sample RMW 3-2 (V-27C)

Limestone, crinoidal biosparrudite composed mainly of crinoidal columnals which are slightly worn, indicating a short transport or higher agitation than was in the case of sample RMW 2-3. Small (few mm.) irregular quartz silt lenses occur in the rock. A thin vein of coarse crystalline white calcite is present. The depositional area was intermittently or slightly agitated.

Madeleine River Member, St. Leon Formation.

Sample RMW 3-2

Limestone, light brownish grey, biosparrudite, composed mainly of crinoidal columnals with fragments of crinoid ossicles, with 5-10% of rod shaped stromatoporoidal fragments (aff. Paramphipora) rare coral fragments (aff. Paropora). The constituents are well packed. The rock is dense. Slightly to moderately agitated depositional environment.

Madeleine River Member, St. Leon Formation.

Sample Madeleine River Reef 1

Limestone, very light brownish grey, stromatoporoidal biolithite. The sample is composed mainly of stromatoporoids (aff. Hermatostroma) growing closely together. In one small spot crinoidal columnals occur with sparry calcite bonding material, possibly an original small niche among the stromatoporoids with the crinoidal material. Transported possibly during an occasionally highly agitated period from a fore reef crinoidal meadow and was dropped in a small protected area. The rock is dense because the original intraskeletal pores are filled by sparry calcite. The rock could represent bioconstructed reef proper.

Madeleine River Member, St. Leon Formation.

Sample RME 1-6 (a) East Madeleine River

Sandstone, medium grey, silty, highly fossiliferous, medium grained, calcite cement.

The rock contains approximately 55-60%, medium size, angular to subangular clean quartz grains, 20% sparry calcite, cement and 15-20% fossils which are mostly crinoidal ossicles and fewer brachiopods. The fossils are in random positions and are only slightly worn and fragmented indicating possible slight transport.

St. Leon Formation.

Sample RME 1-6 (b) East Madeleine River

Sandstone, medium greenish grey, silty fossiliferous and slightly argillaceous, fine grained sparse calcareous cement.

The main constituents of the rock is fine grained angular to subangular quartz. There are fair amounts of fine to coarse quartz silt present. The fossils are fairly well preserved crinoidal columnals and brachiopods. The rock is laminated to thinly bedded.

St. Leon Formation.

Sample RME 1-6 (c) East Madeleine River

Sandstone medium to light grey and greenish grey, fine gravel, silty, slightly argillaceous, fossiliferous, well preserved brachiopods, crinoidal columnals, and worn recrystallised Favosites colony. Very poor porosity.

St. Leon Formation.

Sample RME 2-2 (a)

Sandstone, medium greenish grey, coarse grained with fair amounts of fine quartz sand grains, argillaceous, unevenly developed calcareous cement, and fine fossiliferous sandstone, calcareous cement, argillaceous silt. In most of the fossils the original calcareous skeleton has been leached out. These may have been tabular corals, questionable bryozoans, and brachiopods.

St. Leon Formation.

Sample RME 2-2 (b)

Sandstone medium greeish grey. Main constituents are fine grained angular to subangular clear quartz, approximately 10% coarse quartz silt, few amounts of argillaceous matrix, horizontally arranged small vugs, possibly leached out fossils.

St. Leon Formation.

Summary

The samples RMW 2-3, RMW 3-2 (V27C) represent a crinoidal platform which is suitable as a solid substratum for colonial reef builders. The depositional environment had low energy.

The sample RMW 3-2 exhibits growing agitation in the area and the first colonial organismas occur (aff. Paramphipora). The quite delicate morphology of the stromatoporids indicates not too high agitation but the energy level had increased compared to the bottom part of the crinoidal platform.

The sample from the stromatoporoidal biolithite represents the sturdily bioconstructed reef proper.

The samples RME 1-6 (a), RME 1-6 (b), RME 1-6 (c), RME 2-2 (a) and RME 2-2 (b) were taken from the strata overlying the reef. The rock of this zone reflects subsidence and the killing of reef builders by the sandy-silty sediments. Some scattered coral remains occur, possibly at the basal part of the sand deposits.

Section 3 Northern Outcrop Belt Longitude 65^{o} 10'

St. Leon Formation

Sample RE 1 (a)

Crinoidal biosparrudite with scattered well rounded white quartz and greenish grey siltstone pebbles up to 6 mm in diameter. The main constituents are crinoidal columnals, a few bryozoan colonies. The skeletal material is slightly worn. The rock is dense.

Sample RF 1 (b)

Conglomerate, composed of pebbles of crinoidal biosparrudite, calcareous coarse sandstone pebbles, flat dark brownish grey shale particles in granular size, quartz granules and pebbles, well rounded; a large fragment of a tabulate coral colony (aff. Favosites). The bonding material in the rock is calcitic.

The source of the limestone pebbles may the Madeleine River West ree; the non-carbonate material could be transported from the basin and the basin rim.

Sample V28B

Siltstone, dark brownish grey and greenish grey, main constituents are coarse angular, well sorted quartz silt grains, minor argillaceous matrix and calcareous cement.

Very fine dark brown organic pigments are common, some fine muscovite flakes occur, and the rock is laminated to thin bedded. The rock is low energy basinal sediment.

Sample RME 1-2

Limestone, very light brownish grey, stromatoporoidal, crinoidal and bryozoan, disturbed biolithite, dense.

The constituents of the rock are stromatoporoid fragments 8-25 mm in diameter, some globular with visculate tissue (approx. 40-45%), in spots bryozoa and small crinoidal fragments accumulated and small brachiopod? shells occur (approx. 20-30%), algal incrusts are on some skeletal constituents. The bonding material is sparry calcite and a few places calcilutite.

Medium energy zone. Possibly deeper zone of talus deposition developed on a steep reef flank.

Sample RME 2-3 (V28B)

Limestone, crinoidal biosparrudite, light grey, scattered bryozoan colonies, rare stromatoporoid fragments with vasculate tissue, dense. The skeletal material except the stromotoporoid fragments seem to be not significantly transported. Possibly a crinoid meadow in the foreground of a reef.

Section 8

Salmon Hole Brook, Madeleine River Member, St. Leon Formation, Lower Silurian.

Sample Salmon Hole Brook, Madeleine River Member (2).

Limestone, light grey stromatoporoidal biolithite. The stomatoporoids are affixed to Hermatostroma and are growing closely together. The rock is dense since all of the original pores are filled by sparry calcite.

Sample Salmon Hole Brook 10

Limestone, light grey biolithite. The stromatoporoids have vasculate tissue (Stromatopora), and they are growing very close to each other. Coarse sparry calcite cement is in the interfossil spaces. There are places where light greenish grey sandstone is among the stromatoporoids which was probably transported by occasionally high agitation periods from the basin and was trapped in the reef.

The rock belongs to the bioconstructed reef proper.