GM 27078

GEOLOGICAL REPORT ON CENTRAL GASPE, SURFACE PARTY 1970

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SURFACE PARTY 1970

by

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Distribution:

Geological Dept. Files
Denver
Government of Quebec

Calgary, Alberta,
April, 1971

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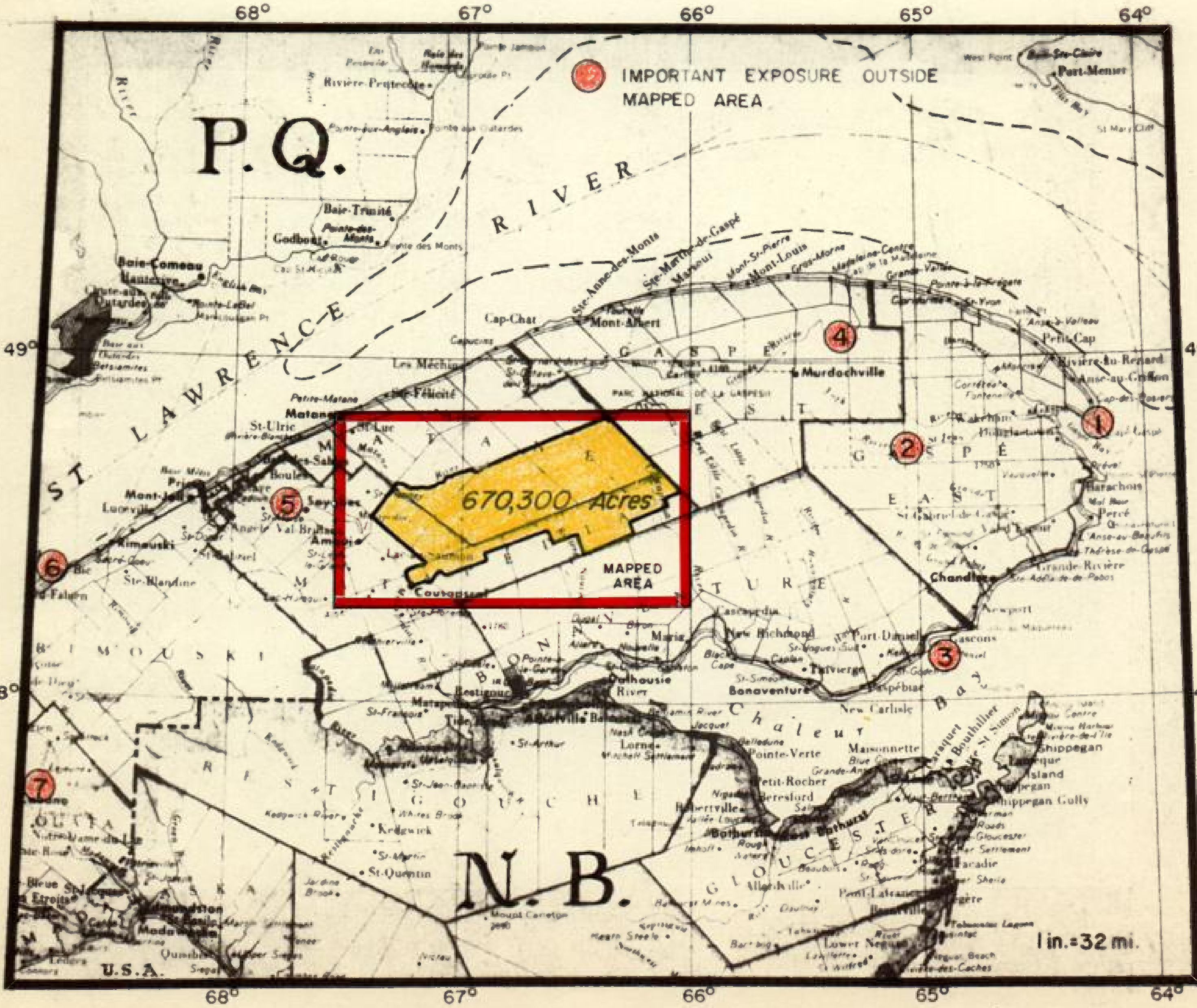
INTRODUCTION

LOCATION:

The Gaspe Surface Party 1970 was carried out to evaluate Quebec Permits #349, 350, 352, 353, 354, 355, 357, 358, 359, 360 and 361 located on the Gaspe Peninsula to the east of the Matapedia Valley and to the south of the Shickshock Mountains. (See Figure 1.) Exploration rights

FIGURE I: LOCATION MAP



for these permits totalling 557,500 acres were granted to La Societe Acadienne de Recherches Petrolieres Ltee. (SAREP) on May 30, 1969. Since that time, exploration rights for two permits, #269 and 270 just to the south of the original holdings have been acquired through an agreement with Tenneco Oil & Gas Ltd. These permits bring SAREP's total acreage on Gaspe to 670,300 acres and the party's plans were revised to include evaluation of these additional permits.

Besides work on the permits, a portion of the summer was spent visiting important exposures located throughout Gaspe. These areas, numbered one-seven on Figure 1, are (1) the Forillon Peninsula, (2) the St. Jean River Anticline, (3) the Bay of Chaleur region, especially West Point, (4) the Madeleine Reef in Lefrancois Twp., (5) the Sayabec area, (6) the St. Lawrence shore near St. Fabien and (7) the Cabano area. This work outside the permits added important stratigraphic and palaeogeographic information as well as verifying the work of V. Zay Smith's photogeologic mapping program. A more detailed account of the time spent at each of these areas is given under "Field Work".

PARTY ORGANIZATION, FIELD CREW, AND ACKNOWLEDGEMENTS:

Party Chief	- G. E. Huff
Consultants	- Drs. J. Beland, C. Hubert, J. Lajoie and P.J. Lesperance, in rotation.
Party Seniors	- B. A. Skinner and J. G. St. Hilaire
Party Juniors	- R. Sinclair and M. Verge
Camp Attendant	- J. Huff

In general, field mapping was carried out as three separate mapping crews: normally, the Consultant working with G. Huff, B. Skinner with R. Sinclair and J. St. Hilaire with M. Verge, but on several occasions J. Huff served as a Party Junior as well. After becoming familiar with regional stratigraphy and mapping procedures, the crews, led by B. Skinner and J. St. Hilaire, carried out mapping traverses while the Consultant and G. Huff verified the work of the other crews, attempted to solve stratigraphic or structural problems, or continued the independent mapping. The success of this field party is to a large measure attributable to the co-operation, geological skill and hard work of the party seniors and juniors. The Consultants' knowledge of Gaspe geology and working methods greatly facilitated the party's operations.

LOGISTICS AND FIELD METHODS:

Three four-wheel drive vehicles, leased for the summer, provided the mobility for the mapping crews. Accommodation and meals were furnished by Forestry Camp Two in Matane Park for the first half of the summer, and at the Central Hotel, Causapscal for the remainder. For each crew, camping equipment was supplied but was only occasionally used because road access was better than anticipated. Traverses were carried out along roads, and in many areas control achieved in this manner proved sufficient for our mapping. Stream and river traverses were necessary to increase control in certain areas, but, in general, outcrops along river banks were not as fresh or reliable as those seen along roads.

The heavy forest and vegetation cover made the search for outcrops away from roads or rivers a fruitless undertaking. Road outcrops are particularly good on Gaspe because lumbering companies are continually building new roads which are allowed to deteriorate, and when the area is lumbered again 25-30 years later, new roads are built. Without maintenance, the lumber roads become impassable within 6 or 7 years of their construction so that it is imperative to have the most recent air-photo coverage available in order that outcrops along roads can be accurately plotted.

The Matapedia Valley region is rolling, farming country, but to the east the land is higher and rockier and is suitable only for forestry. Although much of Gaspe has considerable relief, with high plateaus and steep-sided, deep, river valleys, the interior portion, where most of our acreage lies, is a relatively undissected plateau. (See Plate I.)

Although we were warned to expect considerable precipitation during the field season, the summer of 1970 was very warm and dry throughout most of eastern Canada, and at times there was a high forest fire hazard which almost closed the Gaspe forests.

MAPPING PROCEDURES:

In the field, outcrops were plotted and assigned station numbers, either on one inch to one-quarter mile air-photos, or maps at that scale. Measurements of bedding attitude, axial-plane cleavage attitude and b-lineation direction and plunge were made wherever possible and recorded in a field note book, along with a lithologic description and formation name. In areas of particular interest such as the

PLATE I: CENTRAL GASPE HIGHLANDS

Located approximately 35 miles northeast of Causapscal on the Lacroix road, this shows the dense forest cover of spruce and birch and the typical relief in the region of the Causapscal Anticline.

Causapscal Anticline and the northern Silurian outcrop belt, all passable roads were traversed and all roadside outcrops plotted. Also, a number of streams and rivers were traversed, where needed, to improve control.

At night all outcrops and measured attitudes were plotted in ink on a set of 1 inch = ¼ mile maps. A colour code was used to indicate the formation mapped at each station.

After the mapping of an area was completed, formation contacts and generalized structural data were transferred to a 1 inch = 1 mile base map. At the end of the field season, the field data were used in conjunction with the earlier photogeologic work to produce the geological map which accompanies this report. (See Map 1, TEX-6036.)

PREVIOUS WORK:

Geological mapping on Gaspe has been in progress since Sir William Logan's time. Recent one inch to one mile mapping, covering SAREP permits are: Beland 1960, Carbonneau 1959, Mattinson 1964, McGerrigle 1954, Ollerenshaw 1967 and Stearn 1965.

Other publications which add important geologic information are: Ayrton et al 1967, Hubert et al 1970, Lajoie et al 1968, and Lesperance and Bourque 1970. The report produced by Lajoie and Lesperance 1969, describing their 1969 field work on Permits #269-274 which were then held by Tenneco, was also helpful. The account of field work submitted to SAREP by Drs. Beland, Hubert, Lajoie and Lesperance in November 1970, forms the basis of this report.

SAREP had also done preliminary work prior to the 1970 field season. First, the published aeromagnetic maps for Gaspe were studied to reveal the presence of major igneous bodies and to define their extent. Also, the thickness of sedimentary section was estimated from the available aeromagnetic control. A photogeologic study of the Gaspe Peninsula was commissioned to V. Zay Smith and Associates, Ltd. The maps produced by this study proved valuable in the field and in several cases field evidence supported the photogeologic interpretation where it differed from published mapping.

During the summer of 1970 and shortly thereafter, vibroseis lines were shot for SAREP along two roads crossing the Causapscal Anticline. The interpretation of these lines has made possible the definition of the internal structure of the Causapscal Anticline. The top of the Sayabec Formation has been mapped and the seismic events seen on Line 2 have been incorporated in the construction of cross section J-J'.

FIELD WORK:

The party began operations June 2, 1970 after making the necessary arrangements in Camp 2, on June 1. After two days spent together near Camp 2 the whole crew travelled to the Sayabec area and with the valuable assistance of Yvon Heroux, mapped and sampled Val Brillant and Sayabec strata exposed there. The whole party visited important exposures near Sayabec for six days and returned to Camp 2 on the evening of June 9. The period June 10 to June 15 was devoted to measuring a section through the St. Leon Formation along the road paralleling the Cap Chat River, although on the afternoon of June 15 the crew travelled to Gaspe Town.

Pierre Andre Bourque was a helpful guide for a visit to the St. Jean River Anticline made on June 16. On June 17 the Forillon Peninsula was visited and on June 18th the section at Fox River was seen. Then the party separated into two groups, with B. Skinner and J. St. Hilaire and their juniors returning to Camp 2 to commence field mapping on the permits, while G. Huff and the Consultant (Dr. P.J. Lesperance) travelled to Perce and visited exposures there.

On June 19, while the other two crews began independent mapping near Camp 2, G. Huff and Dr. Lesperance travelled along the Bay of Chaleur to visit exposures at Gascons-Est, and West Point. Then on June 20, this team returned to Camp 2 via Square Forks and Causapscal.

June 21 and 22 were devoted to independent mapping of the northern Silurian outcrop belt by all three crews. On June 23, B. Skinner and J. St. Hilaire's crews continued the independent mapping. G. Huff and Dr. Lesperance travelled to the Cabano region and visited exposures in that area on June 23, 24 and 25, returning to Camp 2 on June 25.

After spending June 26 in preparation, G. Huff, Dr. Lesperance and J. Huff travelled to the Madeleine River in Lefrancois Twp. and set up a camp there. On the morning of June 28, after crossing the Madeleine River, this party climbed to the top of a high, steep-sided hill to see exposures of the Lefrancois Member (Lesperance and Bourque 1970) where it forms the Madeleine Reef Complex. On June 29, exposures of off-reef breccia near the Madeleine Reef were seen; then these three visited exposures at Ruisseau Isabelle and returned to Camp 2.

June 30 to July 18 were employed mapping the northern Silurian outcrop belt mostly within the Matane Park. Dr. Beland joined the crew on July 2 and Dr. Lesperance departed July 5.

On July 15, Dr. Hubert arrived, and on July 18th, Dr. Beland left. On the 18th of July the crew left Camp 2 and moved to Causapscal. Mapping of the Causapscal Anticline and land to the north began immediately and continued with few interruptions until the end of the field season.

F. J. Morey of SAREP visited the party August 10, 11 and 12. Dr. J. Lajoie joined the crew August 12 to replace Dr. C. Hubert as Consultant. The latter left on August 14. Besides completing the mapping of the Causapscal Anticline, teams carried out mapping to the north to fill the gap between the Causapscal area and the northern Silurian outcrop belt. Also B. Skinner's team spent August 19, 20, 21, and 23 in the La Redemption-Sayabec area carrying out detailed sampling of the Sayabec Formation.

On August 28, G. Huff and Dr. Lajoie visited Quebec Group exposures near St. Fabien. The last part of August and early September saw a change in the weather, with heavy rain severely limiting field work. Nevertheless, a few traverses in the eastern end of the permits were carried out. The party left Causapscal September 4 and dispersed, except that G. Huff met Dr. C. Hubert at Quebec City and visited Quebec Group exposures in the area on September 9 and 10. This field work, along with the day spent near St. Fabien with Dr. J. Lajoie, completed a survey of most of the important outcrops dealt with in Hubert, Lajoie and Leonard, 1970.

GENERAL GEOLOGY:

A broad synclinorium, trending NE-SW, filled with Silurian and Devonian rocks, has been mapped through central Gaspe. In the eastern part of this basin a number of oil seeps and shows have been encountered in Devonian rocks, but the Silurian throughout this basin is all but untested.

Where the contact is exposed, Silurian sediments overlie with angular unconformity, a basement complex uplifted and metamorphosed during the Middle Ordovician Taconic Orogeny. These rocks outcrop to the north in the Shickshock Mountains and dip to the southeast through the area of interest. In the central part of the basin, however, it appears that the Taconic Orogeny was quite weak and perhaps deposition was continuous through the Ordovician and into the Silurian.

The Awantjish green and grey shales are the oldest Silurian rocks exposed along the northwestern edge of the basin in the immediate area. To the southwest, however, several thick clastic units occur below the Awantjish and may be present here as well.

A withdrawal of the sea followed the Awantjish deposition and when the sea returned, a blanket of washed and sorted sands was deposited marking successive positions of the strand line. The Val Brillant quartzose sandstones laid down in this manner show some porosity in outcrop especially near the top of the unit, but most samples are tight from pressure welding. In the shallow waters seaward of this strand line, a rich fauna and flora deposited the Sayabec limestone formation.

TABLE OF FORMATIONS

AGE		FORMATION	LITHOLOGY	THICKNESS IN FEET
DEVONIAN	ONONDAGA[1]	BATTERY POINT	SANDSTONE, ARKOSIC TO FELDSPATHIC WITH PINK FELDSPAR; COARSE-GRAINED. MINOR GREEN AND RED MUDSTONES; MINOR CONGLOMERATES.	
DEVONIAN	ONONDAGA[1] / SCHOHARIE	YORK RIVER LAKE BRANCH	SANDSTONE, ARKOSIC AND FELDSPATHIC; FINE TO MEDIUM-GRAINED; GREEN TO GREENISH-GREY OR RED (LAKE BRANCH MEMBER). ABUNDANT PLANT DEBRIS. MINOR GREEN AND RED MUDSTONES.	600 to 7000
DEVONIAN	ESOPUS	YORK LAKE	ARKOSIC SANDSTONES INTERBEDDED WITH LAMINATED, CALCAREOUS SILTSTONES. MARINE FAUNA ABUNDANT.	1200 to 2400
DEVONIAN	ORISKANY	GRANDE GREVE	UPPER MM. SILTSTONE; CALCAREOUS, GREY TO GREENISH-GREY, LAMINATED, VERY DENSE. MINOR CHERT.	1400 / 2300 to 3000
DEVONIAN	ORISKANY	GRANDE GREVE / IGNEOUS COMPLEX	LOWER MM. CLAYSTONE AND MUDSTONE; DARK GREY AND GREENISH-GREY, NOT CALCAREOUS, MASSIVE. / TUFFS, ANDESITIC EXTRUSIVES; MINOR DIORITE AND GABBRO.	900 / 2300 to 3000
DEVONIAN	HELDERBERG	CAP BON AMI	LIMESTONE; ARGILLACEOUS AND SILTY, DARK GREY. MINOR CALCAREOUS MUDSTONES. MASSIVE.	2000 to 3000
SILURIAN	PRIDOLI / LUDLOW	ST. LEON	SILTSTONE AND SANDSTONE; GREY AND GREENISH-GREY, MAROON NEAR TOP. MINOR LIMESTONE.	5800 to 6500
SILURIAN	LUDLOW / WENLOCK	SAYABEC	LIMESTONE, PURE, GRAINSTONE, BOUNDSTONE, NODULAR LIMESTONE AND MINOR CALCAREOUS SILTSTONE; RARE SECONDARY DOLOMITE.	50+ to 1700
SILURIAN	WENLOCK / LLANDOVERY C (UPPER)	VAL BRILLANT	QUARTZ ARENITE (ORTHOQUARTZITE); FINE TO COARSE-GRAINED. CALCITE CEMENT IN UPPERMOST PART.	50 to 500
SILURIAN	LLANDOVERY C (UPPER)	SOURCES	LIMESTONE, ARGILLACEOUS, DARK GREY, THINLY BEDDED. MINOR SUB-LITHOGRAPHIC LIMESTONE.	180 to 300
SILURIAN	LLANDOVERY C (UPPER)	AWANTJISH	SHALE, GREY AND GREENISH-GREY, FOSSILIFEROUS. MINOR STRATIFIED LIMESTONE.	20 to 300
CAMBRIAN AND ORDOVICIAN			UNCONFORMITY	
CAMBRIAN AND ORDOVICIAN		QUEBEC AND SHICKSHOCK GPS.	STRONGLY FOLDED (QUEBEC GROUP) OR METAMORPHOSED (SHICKSHOCK GROUP) PELITIC ROCKS WITH MINOR LIMESTONE.	

1. The New York stage names for the Devonian have been employed because of their general use in current literature.

Fossil remains of algae, stromatoporoids, crinoids and coral occur abundantly in very coarse grainstones and boundstones which form part of a carbonate bank development 1,700 feet thick in the Sayabec-La Redemption region just to the west of the mapped area with a minimum thickness observed elsewhere of fifty feet of nodular limestone. Local dolomitization seen at three localities, has created an excellent but discontinuous reservoir rock with vuggy and intercrystalline porosity within the Sayabec.

The St. Leon Formation is a 5,800' to 6,500' thick siltstone unit deposited for the most part by turbidity currents in deep quiet water. The St. Leon is Upper Silurian to lowermost Devonian in age and is overlain by the Cap Bon Ami and Grande Greve Formations, each varying from 2,000' to 3,000' thick. These units are mostly calcareous siltstones and mudstones, usually dark grey in colour which have good source rock but little reservoir potential.

Above these calcareous units a thick sandstone sequence called the Gaspe Sandstones occurs. Three formations are distinguished, namely: the York Lake Formation, 1,200' to 2,400' thick which is a transitional zone characterized by interbedded Grande Greve and York River lithologies; the York River Formation, ranging from 600' to 7,000' in thickness, which is a green, arkosic sandstone containing abundant plant debris; and the Battery Point Formation, a red felspathic sandstone with some conglomerate and shale beds. The Gaspe sandstone sequence indicates marine regression through the Lower and Middle Devonian.

The Middle to Upper Devonian Acadian Orogeny folded the Silurian-Devonian sequence on Gaspe. In New Brunswick to the south and near Murdochville to the northeast, granite intrusion and metamorphism accompanied the folding, but in the SAREP block no metamorphic effects were observed.

The Causapscal Anticline is the structure of interest on SAREP's land. This fold is doubly plunging and trends NE to SW over a distance of 25 miles. The southeastern limb is rather more steeply dipping than the northwestern and the width of the surface structure at the Cap Bon Ami-St. Leon contact ranges from two to three miles.

Refer to Map 1 (TEX-6036) which displays the relationships discussed above and the generalized field data collected in 1970. Contacts beyond the areas of detailed mapping are based on a recent photogeologic study.

STRATIGRAPHY

1. Pre-Silurian

Phyllites, interbedded with calcareous siltstones resembling rocks of the Quebec Group outcrop in the fault zone, south of the "Shickshock fault". They contain limestone conglomerate horizons similar to the ones found along the North Gaspe coast near Kamouraska, Rimouski and Matane.

The rocks of the Quebec Group have sedimentological characteristics of flysch sequences. They are interpreted to have been deposited in a deep-water marine trough, off a carbonate-sandstone shelf located north of the Appalachian trough (see Hubert, Lajoie and Leonard, 1970).

Within the Shickshock Mountain Belt these rocks have been highly metamorphosed, but elsewhere it appears that little metamorphism has occurred although the rocks are complexly folded and faulted.

2. Pre-Val Brillant Units

The Pre-Val Brillant units include the Awantjish and the Sources Formations and a clastic unit reminiscent of the Griffon Cove River Formation found in Eastern Gaspe.

a.) Unnamed Clastic Unit

The clastic unit exposed between the Go-Ashore Brook and Joffre Lake consists of massive feldspathic sandstone underlain by rocks of the Shickshock Group and dipping under well-bedded strata of the Val Brillant Formation. Thickness cannot be estimated for lack of outcrops.

b.) Awantjish Formation

The Awantjish Formation consists of grey and greenish-grey shale, interbedded with rare limestone beds. The shales are in places highly fossiliferous (e.g., Isabelle Brook).

The Awantjish Formation seen to the east of the Matapedia Valley ranges in thickness from 20 to a maximum of 300 feet. On the Cap Chat River, 20-40 feet are exposed. At other localities the basal Silurian sections are not complete and there, the Awantjish may have a maximum thickness of 300 feet. To the west of the mapped area thicknesses to 2,000' have been seen (Lajoie et al 1968).

Where dated the Awantjish is Upper Llandovery (C_3) (Lajoie, Lesperance and Beland, 1968).

c.) Sources Formation

The Sources Formation occurs in the Cap Chat River section below the Val Brillant and above the Awantjish; this represents its westernmost and only known occurrence west of its type area (East of Murdochville). The Sources consists of 180 feet of exposed strata on Cap Chat River. As at the type section, lithographic (micritic) thin-bedded limestones constitutes 5% of the exposures. The remainder is composed of finely crystalline argillaceous and very argillaceous limestones, grading into very limy mudstones. Some of the limestone beds are highly fossiliferous.

3. Val Brillant Formation

The Val Brillant Formation outcrops all along the Silurian belt studied, from the Tamagodi outliers to the Go-Ashore Brook.

The formation is composed generally of fine to medium grained quartz sand, cemented by silica. The sandstone becomes locally calcareous and/or dolomitic and coarser grained towards the top of the formation and passes through a sandy limestone and dolomite into the overlying Sayabec Formation. The base of the formation is very sharp.

The exposed thickness of the Val Brillant varies from 300 to 500 feet at Tamagodi to 50 feet at Cap Chat River and 100 feet in the Courcelette area. It appears that the Val Brillant thins towards the Go-Ashore Brook from the Tamagodi exposures.

The Val Brillant is dated C_6 of Upper Llandovery to Wenlock. Part of the Val Brillant sand was deposited in very shallow water and reworked by wave action; part was wind blown. The dolomitic horizon has been interpreted as beach or near beach environment. The formation is indicative of a transgressive sea. (See Lajoie, 1968.)

4. Sayabec Formation

The Sayabec Formation refers to limestones between the Val Brillant quartz-sandstones and the St. Leon Formation; both contacts are transitional. The formation cannot be traced continuously eastward from Matapedia Lake; it outcrops only near the Bonjour and Matane Rivers, was not observed on Go-Ashore Brook, and is thin along the Cap Chat River road.

The lower beds of the Sayabec generally consist of dolomitic limestone overlain by grainstones, packstones and wackestones, highly fossiliferous with a rich flora and fauna of algae, brachiopods, corals, and stromatoporoids; (see Plates II-IV), a few boundstones occur as well but grainstones are most abundant. Conglomeratic grainstones are present in the Bonjour River section, but they pinch out westward and are absent near Matane River. The upper Sayabec is generally composed of bedded nodular finely crystalline limestones and highly silty lime mudstone. At certain localities, such as at La Redemption, the Sayabec contains much grainstone and boundstone and reaches considerable thickness (1,700'). At Bonjour River the Sayabec includes at its base 10 to 15 feet of vuggy coarsely crystalline dolomite. In the La Redemption area, secondary dolomitization of a minor amount of grainstone has produced a very porous rock. (See Plate V.) This dolomitization is very discontinuous however.

The thickness of the Sayabec Formation in the Cuoq-Langis area is estimated at 500 feet (Ollerenshaw, 1967); it is 200 to 250 feet at Bonjour River and 200 feet at Matane River. In the La Redemption area a thickness of 1,700' is attained.

The age of the Sayabec is Wenlock to Ludlow. Its abundant fossils, very coarse particle size and near absence of detrital material suggest a clear, shallow, and warm water site of deposition, with high wave energy at times. Reef growth at suitable locations is to be expected under these conditions, but at most exposures it is a biostromal unit. See the Appendix following this report for thin section descriptions of Sayabec Formation samples from the Sayabec and La Redemption areas.

PLATE II: SAYABEC FORMATION OUTCROP

This outcrop of Sayabec limestone near La Redemption (HF 13E) shows a transition from coarse packstone or grainstone (extreme left) to very coarse grainstone (centre) to stromatoporoid and algal boundstone (right). The very irregular bedding typical of the Sayabec is clearly shown.

PLATE III: SAYABEC FORMATION - GRAINSTONE

Grainstone composed primarily of coral debris (HF13)

PLATE IV: SAYABEC FORMATION-BOUNDSTONE

Very coarse coral packstone or boundstone (HF13)

PLATE V: SAYABEC FORMATION-DOLOMITE

This picture at HF12D shows typical Sayabec Formation after dolomitization. Large vugs with very coarse dolomite rhombohedrons are abundant and often take the general shape of fossils apparently dissolved during or after dolomitization. The pink colour is attributed to oxidized iron.

5. St. Leon Formation

The St. Leon Formation is characterized by grey and greenish-grey, rarely brown, calcareous claystones and siltstones. The lower part of the St. Leon in this area contains a number of 10 to 80 foot limestone horizons somewhat similar in lithology to the upper beds of the Sayabec described above. Higher up in the section, the St. Leon consists of interbedded sandstones and the characteristic claystones and siltstones.

Fine to very fine grained sandstones within the St. Leon Formation form between one to two thirds of the formation. These beds are commonly 8 inches thick, and most show features typical of turbidite deposition. Within the upper few thousand feet of the formation on the Cap Chat River road, medium-grained sandstone in beds up to 30 feet thick, interbedded with gray shales were seen. On the whole, the upper St. Leon Formation in Gaspe (except at the Causapscal anticline) is characterized by a turbidite, shale-sandstone sequence.

The lower part of the exposed St. Leon in the Causapscal anticline is of the turbidite sequence. However this lower part is overlain here by a sequence of green and maroon mudstones, the thickness of which ranges from 850 feet in the East to 2,050 feet in the West.

The limestones contained in the St. Leon Formation and those of the Sayabec Formation are with the Val Brillant quartzose sandstones, possible reservoir rocks. It must be emphasized that limestones are widely distributed within or above the St. Leon Formation in Gaspe and in the region southwest of the Matapedia River. They occur:

a) in the Cabano region to the west: the Lac Sauvagesse Member is composed partly of boundstones within the St. Leon; the Crooked Lake Formation is composed of miscellaneous limestones and dolomites above the St. Leon Formation; (see Lesperance and Grenier 1969)

b) Bay of Chaleurs: the West Point Formation, a reefal limestone very similar to the Sayabec Formation, can be viewed as a limestone unit within St. Leon lithology; (see Plates VI-IX)

c) East of Murdochville: the Lefrancois Member is present just above the base of the St. Leon Formation. This member is an enormous lentil of but slightly broken bioclastic material, with very abundant crinoidal and stromatoporoid fragments. (See Plates X-XIII.)

The passage from St. Leon into Cap Bon Ami is generally quite abrupt, and the contact is easily drawn within 200 to 300 stratigraphic feet. Within the present area, the St. Leon Formation has an estimated thickness ranging from 5,800 to 6,500 feet. Mattinson (1964) with different attitudes of bedding arrived at 7,000 feet (above basal limestones).

The age of the St. Leon Formation ranges from Lower Ludlow to Lower Devonian.

6. Cap Bon Ami Formation

The Cap Bon Ami Formation observed in the present area is very typical of the mid-Gaspe Cap Bon Ami. The formation consists mostly of dark grey, massive, very argillaceous and silty lime-mudstones which are locally interbedded with calcareous siltstones. At several

PLATE VI: WEST POINT FORMATION - OUTCROP

The West Point Formation is best exposed along the shore of the Bay of Chaleur where wave action and solution have etched the limestone's surface. This photograph at West Point (HF55) shows the typical outcrop aspect.

PLATE VII: WEST POINT FORMATION - BOUNDSTONE

At Gascons-Est, (HF52) the West Point Formation is well exposed. Here a branching stromatoporoid can be seen in growth position.

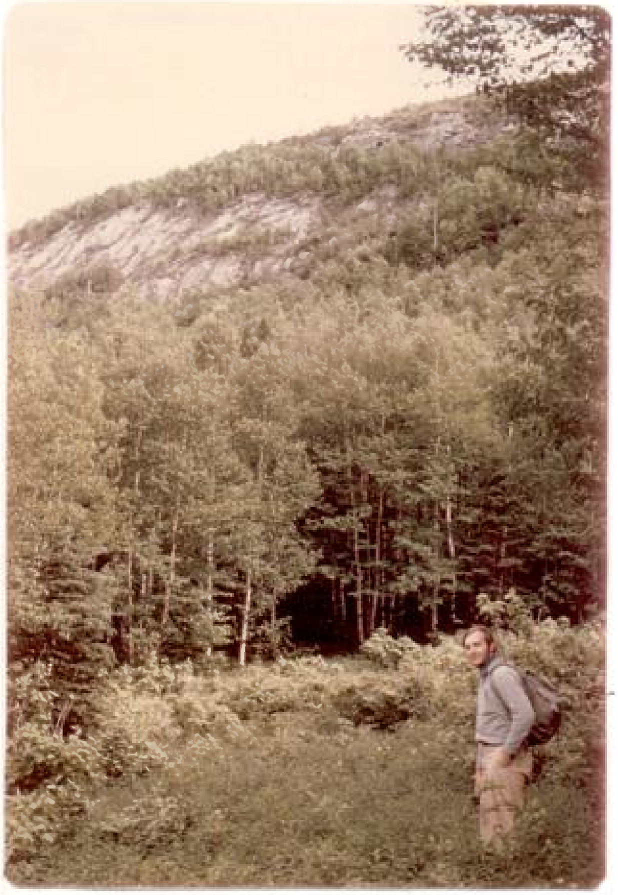
PLATE VIII: WEST POINT FORMATION - GRAINSTONE

This very coarse grainstone shows the etching typical of exposures at West Point (HF55). Very large stromatoporoid fragments like the one at upper left and crinoid columnals are abundant in this unit.

PLATE IX: WEST POINT FORMATION - BOUNDSTONE

Algal and stromatoporoid boundstones as seen here form approximately ten percent of the West Point Formation (HF55).

PLATE X: MADELEINE REEF COMPLEX



The steep hill shown here results from the resistant nature of the Lefrancois Member compared to the St. Leon siltstones which enclose it. Limestones similar to the Sayabec but slightly younger occur here approximately thirty miles east of the SAREP acreage.

PLATE XI: MADELEINE REEF - GRAINSTONE

Very large stromatoporoid cobbles and boulders are here enclosed in a grainstone composed mostly of crinoid columnals. This lithology is often seen at the Lefrancois reef.

PLATE XII: MADELEINE REEF - GASTROPOD

This very well preserved gastropod also at the Lefrancois reef indicates the diversity of depositional conditions present during the reef's development.

PLATE XIII: MADELEINE REEF - STROMATOPOROID

This photo shows the size and complexity of structure attained by stromatoporoids at this location.

localities the Cap Bon Ami has a fetid odour when struck. In fractured Cap Bon Ami, about 1 mile downstream from Matane-Truite River confluence, a few drops of light yellowish green oil were seen (Ollerenshaw, 1967) and confirmed in field observation during 1970.

The lower contact of the formation with the St. Leon was placed below the first appearance of limestone at the base of the transition zone. On the Causapscal anticline and in the immediate vicinity, the upper contact was placed below non calcareous very hard mudstones, grey and greenish-grey in colour. Here no transition zone exists. A 15 foot horizon of tuff generally marks the top of the Cap Bon Ami in this same area.

The thickness of the Cap Bon Ami in the Cap Chat River area was estimated by Mattinson (1964) to be 2,500 feet. In the Courcelette area it is 3,000 feet thick. In the Cuoq-Langis area the 3,000 feet which we measured compares with the thickness obtained by Ollerenshaw (1967). On the Causapscal anticline the estimated thickness is 2,000 feet.

The age of the Cap Bon Ami is uppermost Silurian to Lower Devonian (Helderberg).

7. Grande Greve Formation

The Grande Greve is usually recognized by its hard siliceous calcareous siltstones, siliceous limestones, and chert. In this area the term Grande Greve was applied to the strata occurring between the Cap Bon Ami and the York Lake.

The formation was subdivided into two members at the Causapscal anticline. The lower member (about 1,000 feet thick) consists of grey and greenish-grey, generally non-calcareous, massive claystones and mudstones. The upper member (about 1,400 feet thick) is composed of hard calcareous siltstone, grey, and in well laminated four inch to two foot-beds. The siltstones are locally interbedded with calcareous mudstone and shale. Chert beds were observed only at one locality.

We have recognized the York Lake Formation in this area as a transitional rock unit between the Gaspe "limestones" and the Gaspe "sandstones". The contact of the Grande Greve with the York Lake was placed at the first occurrence of feldspathic sandstone. The thickness of the Grande Greve thus computed on the Causapscal anticline is about 2,400 feet. In the Cuoq-Langis area, north of Casault Lake, we have not found the lower member of the Grande Greve which is present at the Causapscal anticline. The thickness of the Grande Greve there is 2,300 feet. These thicknesses cannot be compared to those obtained by Ollerenshaw (1967) or Stearn (1965) as their Grande Greve Formation was defined differently.

In other parts of Gaspe the Grande Greve is dated Oriskany (Lower Devonian).

8. <u>Cap Bon Ami - Grande Greve Igneous Complex</u>

At the eastern extremity of the Causapscal anticline conformable masses of vesicular (calcite and chlorite) andesite are found at about 300 feet above the base of the Cap Bon Ami Formation. Small basic and intermediate intrusive bodies are also present. Coarse to fine-grained tuffs are abundant. These igneous rocks were traced eastward to the Duniere-Boutet Township line where they are found within the Upper Member of the Grande Greve Formation.

Cap Bon Ami and Grande Greve strata observed in the vicinity of the igneous rocks are slightly harder than normal but show no evidence of contact metamorphism. Lavas, with concentric rings of vesicles have been found at three localities. (See Plate XIV.) The pillows range in size from 6 inches to 4 feet.

Carbonneau (1959) also notes the presence of andesite and basalt within the Grande Greve and York Lake north of the Berry Mountain Lake.

9. Fortin Group

To the southeast of the St. Marguerite Fault, rocks of the Lower to Middle Devonian Fortin Group outcrop. These are calcareous siltstones and mudstones with some sandstones which, both in age and lithology, are very similar to the Cap Bon Ami and Grande Greve units. Poor exposure, rugged topography and a very thick, poorly bedded and indivisible rock unit, make the unravelling of structures within the Fortin belt an extremely difficult task. Also, the crumpled nature of these rocks in outcrop suggests that no competent unit such as the Val Brillant or Sayabec occurs beneath the Fortin. A lithofacies interpretation (Skidmore 1970) shows a thick shale and limestone unit rather than the limestone unit of Wenlock age (Sayabec) occurring beneath the Fortin belt. No thickness for the Fortin Group can be estimated from the information at hand.

PLATE XIV: CAP BON AMI-GRANDE GREVE IGNEOUS COMPLEX, PILLOW LAVA

This outcrop at HF 26A shows a circular pattern of vesicles in cross sections through very fine crystalline adesitic rocks. Such a pattern is interpreted as evidence of pillow lava deposition. The interstitial material is a very friable non-calcareous mudstone. Interstratified with these pillow lavas are very coarse tuffs.

10. York Lake Formation

York Lake as used in this report refers to the transitional sequence between the marine Grande Greve and the terrigenous York River.

The formation is best defined as consisting of interbedded Grande Greve and York River type lithologies, in the form of well laminated, calcareous, siltstones and claystones, interbedded with arkosic and/or feldspathic sandstones. The siltstone and claystone contain an abundant brachiopod fauna; the partings in the sandstones often contain plant fragments.

The lower contact of the York Lake Formation was placed below the lowest bed of feldspathic sandstone; the upper contact was placed above the uppermost laminated siltstone. The thickness of the formation is 2,400 feet at the Causapscal anticline thinning to 1,200 feet north of Casault Lake in the Cuoq-Langis area.

The York Lake Formation as defined here corresponds to the lower part of the York River Formation as shown by Stearn (1965) in the Causapscal area and by Ollerenshaw (1969) in the Cuoq-Langis area. The fossils collected by these geologists indicate an Esopus-Schoharie age for the Formation (Etymothyris-Amphigenia "zones").

11. York River and Lake Branch Formations

The York River Formation is here restricted to fine-to-coarse grained arkosic and feldspathic sandstones.

Sedimentary structures such as parallel laminations, trough cross-bedding (dunes), ripple marks, and mud cracks are abundant in the formation. Plant fragments are abundant. Beds up to 6 feet thick form stacked wedges 6 to 20 feet long. The York River sands are generally green or grey.

The term Lake Branch was introduced by McGerrigle (1950 Ms) and used by Carbonneau (1959) and Stearn (1965) for a sequence of red feldspathic sandstones and shales overlying the York River. Carbonneau and Stearn found the Lake Branch identical in composition to the York River, although with a red, hematite-limonite pigment.

Our work south of the Causapscal anticline has not been exhaustive, but we have seen most of the outcrops placed on the Causapscal map sheet by Stearn. Apart from the red pigment we find very little difference between the York River and the Lake Branch sandstones. Furthermore if coarser-grain sizes, red feldspars, and rock fragments are distinctive features of the Battery Point (Carbonneau, 1959), the rocks mapped as Lake Branch by Stearn at Jollet Brook are Battery Point.

The recent photogeological interpretation commissionned by SAREP has suggested the presence of unconformable relationships between the Battery Point and York River - Lake Branch Formations in the Big Berry syncline. Such an unconformity could also be postulated for the Battery Point south of the Causapscal anticline, but unequivocal evidence is not at hand. That such an unconformity possibly exists should however be kept in mind.

Previous workers have postulated enormous thicknesses for the York River. Stearn (1965) reports 8,000 feet on Jollet Brook and 11,000 feet at the Matapedia Valley, (from Grande Greve to Lake Branch).

Assuming that no unconformity exists below the Battery Point Formation, our mapping suggests that the York River - Lake Branch Formations south of the Causapscal anticline, have a combined thickness of 7,000 feet.

Eastward the relationship between the York Lake, York River and Lake Branch are more uncertain. Our traverses south of the Grande Greve contact have yielded only York Lake lithology all the way to the belt of Fortin Group, with south facing dips much shallower than those southwest of Jollet and Chasseurs Brooks. North of Casault Lake (Cuoq-Langis area), the York River remaining above the York Lake is 300 feet thick.

To sum up, it would appear that the Lake Branch is a facies of the York River Formation, and that the formation is very variable in thickness both along and across strike and that it could intertongue with the York Lake.

The age of the York River - Lake Branch suggested by previous workers is <u>Amphigenia</u> "zone" (Schoharie).

12. <u>Battery Point Formation</u>

At the type section in eastern Gaspe the sandstones of the Battery Point Formation are distinguished from the underlying York River sandstones by their generally coarser grain size, abundant rock fragments and by the presence of red feldspar grains. Rocks with lithologic character similar to the Battery Point occur in two areas within the region covered by this report. In a small area to the south of the Causapscal anticline, outcrops mapped as Battery Point Formation have been seen. Rocks of the Battery Point Formation reach their greatest thickness in the very large Big Berry Syncline covering approximately the southeastern quarter of the mapped area. Carbonneau (1959) has estimated a thickness of 8,000 to 11,000 feet for the Battery Point here.

STRUCTURAL GEOLOGY

1. Folds

The enlarged part of the Silurian outcrop belt north of the acreage corresponds to an anticlinal structure named here the Truite anticline. The anticline plunges southwest at 30 degrees and is cut off on the northeast by the Shickshock fault, which trends obliquely to the Silurian belt. An oblique, en echelon fold pattern occurs throughout the Northern outcrop belt of gently folded Siluro-Devonian rocks.

In this region the other folds besides the Truite anticline are minor structures. All are open folds with characteristic southwesterly plunges. Local crumplings occur close to the Shickshock fault.

The Causapscal fold is an asymmetric doubly plunging anticline, characterized by a gently dipping north limb and a steeply dipping south limb. It extends in a N65E direction (at the top of the Cap Bon Ami Formation level) from a point located three miles east of Causapscal village to the ~~Petite~~ Nouvelle River, where its trend changes to N35E. Structural section J-J' shows the configuration of the anticline at the Lac-des-Dix-Huit-Milles road, near the culmination point.

Several minor folds were observed on the north and south limbs of the Causapscal anticline, in the region east of its culmination.

A structural terrace is present along most of the north limb of the Causapscal anticline. East of the culmination the terrace widens considerably (to 4 miles) and disappears in a series of minor folds plunging very gently towards the northeast.

The Causapscal anticline with its inferred extension (see maps) is possibly significantly different from the cluster of folds to the west. Its trend aligns with the St. Marguerite Fault and the suggested palaeogeographic shelf edge. To the south of this shelf edge the Siluro-Devonian calcareous sequence undergoes a facies change to a deeper water clastic sequence and a thick Awantjish and possibly also Upper Ordovician shale section may be present. The position and orientation of the Causapscal Anticline may be controlled by the presence of marginal rise at the ancient platform edge, i.e. a barrier reef.

Between the Causapscal anticline and the Shickshock fault is a series of northeasterly trending synclines and anticlines. The Causapscal and Albertville anticlines are separated by a very shallow fold here named the Lac-des-Huit-Milles Syncline. North of the Albertville anticline is another major fold here named the Lac Casault syncline. It is a very shallow fold which plunges northeasterly south of the lake, and southwesterly north of the lake. No dip exceeds 20 degrees, the average being 10 degrees. Very careful measurements have demonstrated the presence of minor folds within the syncline. These minor folds can be traced to the southwest into the cluster formed by the Amqui and Humqui folds, and to the northeast into the Truite anticline and its bordering synclines. The major and minor folds are doubly plunging. The minor folds could either die out or steepen at depth. Should they extend at depth, closures could constitute oil traps. In the western half of the acreage, access is good enough that seismic exploration for closed highs at depth is feasible.

2. Faults

One of the major structural elements of the present area is the Shickshock fault which runs the whole length of the area and marks the northern boundary of the Silurian-Devonian outcrop belt, with the exception of the Tamagodi outliers. The Shickshock fault in the area studied is a fault zone constituted of slivers bounded by sheared zones.

Sheared zones vary from a few feet to tens of feet in thickness. Commonly, within the sheared zones, drag folds or sigmoid folds bounded by major slip planes can be seen. Most folds have a steep axis (subvertical) and point to right lateral movement (dextral). It appears that the Shickshock fault is essentially a tear fault. Other drag folds however have shallow plunges and point to vertical movements. Silurian slivers along the fault zone, as at Matane River, clearly indicate that there was step faulting with southern downthrown components. The emplacement of ultrabasics along the Shickshock fault zone to the northeast of the mapped area indicates that the latter has been a zone of weakness since the early stage of the geosyncline.

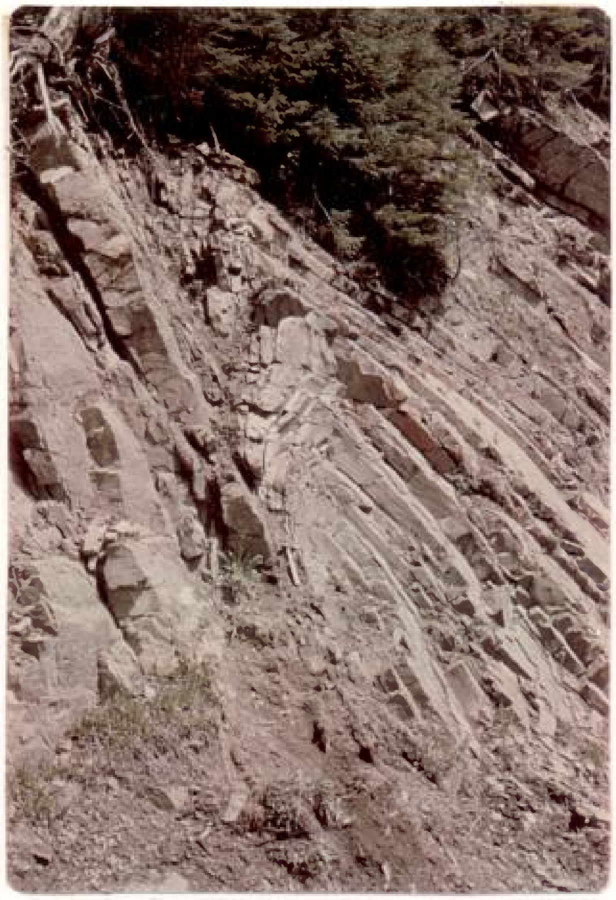
Because the ultrabasics are pre-Silurian, it can be concluded that the Shickshock fault has been the locus of early rifting, later followed by tear and gravity movements. It is likely that the gravity movement was operative during the rising and tilting of the Shickshock block which led to the juxtasposition of the garnet-biotite zone present at the southern border of the block, with the non-metamorphosed Silurian to the south.

The Silurian away from the fault zone shows signs of disturbance indicated by minor slips and crumpling often accompanied by large scale shattering, but close examination of these disturbed zones does not reveal any major stratigraphic displacement. Intersecting minor slippage and rotation of blocks seem to have been the principal types of disturbance. Nowhere has conclusive evidence of major stratigraphic displacement been observed along those faults outside the main fault zone close to the Shickshocks. (See Plate XV.)

The evidence presented by Ollerenshaw (1967) for the Lac Chandler fault is not conclusive. The topographic differences cited by Ollerenshaw as evidence of this fault could be attributed to differential erosion of the Grande Greve and the Cap Bon Ami Formations. Furthermore, no stratigraphic separation can be seen or deduced. Also, the faults within the Silurian near Matapedia Lake, as shown by Ollerenshaw (1967), appear to be unnecessary because this St. Leon (Ollerenshaw) appears lithologically identical to the Upper Grande Greve Formation.

Two minor faults have also been observed on the southern flank of the Causapscal anticline. One of these is a reverse fault which is responsible for the repetition of part of the St. Leon and Cap Bon Ami Formations near the crest of the anticline. The other fault is a normal fault which cuts partly through the Cap Bon Ami and Grande Greve Formations at the southern flank of the anticline.

PLATE XV: ST. LEON FORMATION - CAP CHAT RIVER ROAD



In the section measured along the Cap Chat River road, several faults were seen. This fault (HF19) along the near vertical bedding plane at the geological hammer has allowed slippage with the block on the right moving up. The offset is small and close examination shows that slippage has taken place between almost all of the four inch to one foot very fine sandstone beds. Bedding plane slippage of a similar nature is believed to account for the increased thickness of the St. Leon Formation at the Causapscal Anticline's crest.

HYDROCARBON POSSIBILITIES

Within the Silurian, the Causapscal anticline is the only structure in the acreage that has good closure. Hydrocarbons, if they exist at depth, could easily be trapped in this structure, considering that the thick St. Leon claystones and siltstones are good cap rocks.

Potential reservoir rocks occur in the Silurian. The Sayabec which outcrops to the west of Matapedia Lake is reefoid in places and elsewhere is better described as biostromal. But with or without the "reefs" the Silurian could offer good potential reservoirs related to fracturing of the more competent units (Val Brillant and Sayabec) at depth, at the core of the anticlinal structures. Such fracturing is to be expected with the type of folding observed at the surface. Also, primary porosity still present within the Val Brillant arenites or within reef or reefoid strata, or porosity resulting from dolomitization of the Sayabec limestones should not be discounted. Dolomitization within the northern Silurian outcrop belt is rare, but nonetheless present in some fractures and in some limestone beds (e.g. the Sayabec at Bonjour River). Such dolomitization may in fact be more prevalent in the more highly fractured core of the anticlinal structures.

The potential source rocks are difficult to assess in the Lower Silurian as so little of the Lower Silurian outcrops in this area. One potential source rock in the Silurian would be the Awantjish fossiliferous shale. Where it outcrops north of the acreage, the formation is thin and not highly bituminous but to the southwest, the Awantjish may reach 2,000 feet in thickness (Lajoie et al 1968), and it is highly fossiliferous. The Awantjish if present under the Causapscal structure could be as thick as the sections measured to the west in the Porc Epic syncline, which is along strike with the Causapscal fold. Its thinning to the north is to be expected due to the transgressive nature of the Lower Silurian deposits. It should also be noted that the Awantjish exposed to the northeast as at Isabelle Brook on the Transgaspesian Highway is very fossiliferous.

The large domal structure constituted by the Causapscal anticline has a closure in the order of 2,500 to 2,700 feet between the culmination on cross section J-J' and the highest spill point. The lithology of the St. Leon Formation exposed at the crest of the anticline is an efficient cap rock, being composed of intermixed shale and siltstone. The fold is of the flexural slip type and a basal shear zone (decollement surface) can be expected below the basal Sayabec - Val Brillant Formations. Such zone could have developed within the Awantjish shales if these rocks are present underneath the dome.

The nature and inter-relationships of source and reservoir rocks as they exist beneath the Causapscal anticline are of course critical to the hydrocarbon potential of this structure. However, surface and subsurface data are insufficient to make a reliable assessment at this time.

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APPENDIX

Thin section descriptions of Sayabec Formation Samples from the Sayabec and La-Redemption Areas.

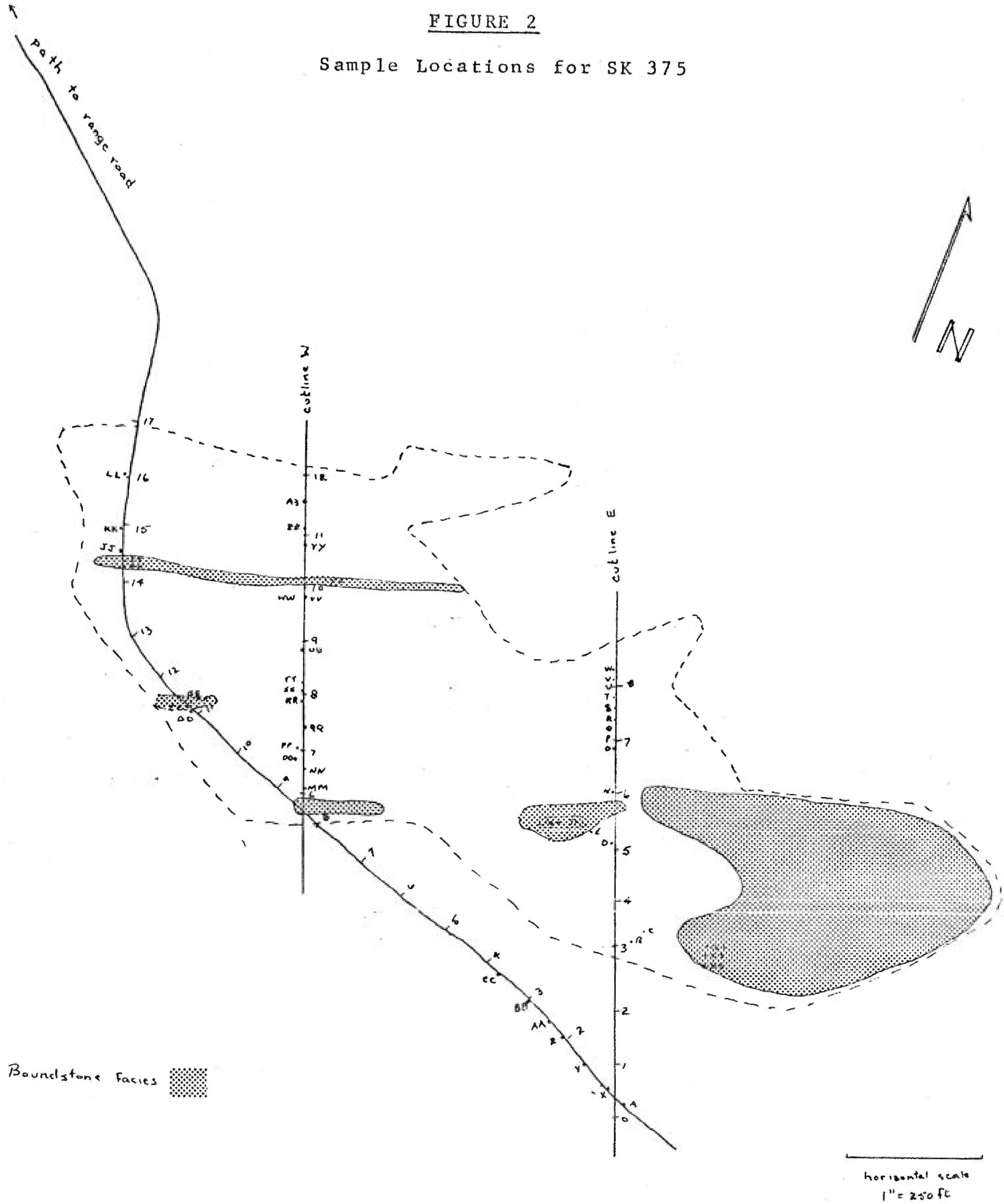
B. A. Skinner

*Indicates a thin section of particular interest

See Map 2 for sample station locations

FIGURE 2

Sample Locations for SK 375



Sample Location SK-375

Grid Reference 865670

Approximately 1.5 miles east of La Redemption

B. A. Skinner
Aug 19, 1970

Location: Sk 375, near Sayabec, Quebec
Date: August 19, 1970
Collected By: B. A. Skinner

Sample	Description
Sk 375 A	Limestone, Skeletal-detrital grainstone, partially dolomitized ($<$ 10%), very coarse grains of stromatoporoid and algal debris with moderately sorted infilling of skeletal and detrital material (coral, crinoids, ostracod, brach). Qtz. 10%, v.f. well rounded. Dolomitization is "patchy", concentrated in detrital material. Energy index = 12.
Sk 375 B	Arenaceous Limestone, detrital grainstone, well sorted, v. coarse grained detrital material. $\approx$50% carbonate grains $\approx$50% well rounded qtz. grains. Sparry calcite cement. No evidence of any fine material. Energy index = 13.
Sk 375 C	Limestone, detrital skeletal grainstone, well sorted coarse grained. $\approx$25% well rounded qtz. grains. Organic debris includes gastropods, crinoids, bryozoan, strom. One grain shows algal overgrowth. Sparry calcite cement, (in optical continuity with crinoids). Energy index = 12.
Sk 375 D	Limestone, detrital skeletal grainstone, moderate sorting, med. to v. coarse grained. Organic debris includes brach. crinoid, bryozoan, strom. Well rounded qtz. grains $\approx$25%. Sparry calcite cement (optical continuity with crinoids). Sheltering effect below brach. Energy index = 13.
Sk 375 E	Limestone, skeletal-detrital grainstone, moderate sorting, coarse to v. coarse grains. Organic debris includes crinoid strom. coral, bryozoan, brach, gastropod. Winnowed and abraded. Energy index = 12.
Sk 375 F	Limestone, skeletal-detrital packstone, poorly sorted. Organic debris including crinoids, brachs, gastopods, coral with detrital grains and interstitial mud. Energy index = 8.
* Sk 375 G	Limestone, algal boundstone, partially recrystallized. Algal material completely surrounding coral and enclosing "pockets" of lime mud and organic debris. Organic material includes algae, coral, crinoids.

Sample	Description
Sk 375 H	Limestone, algal boundstone, partially recrystallized. Slide shows infilling of cavities by sparry calcite. Rapid deposition of lime mud and organic debris.
Sk 375 I	Limestone, stromatoporoid
Sk 375 J	Limestone, stromatoporoid with algal overgrowths(?) Cavities infilled with skeletal wackestone.
Sk 375 K	Limestone, detrital packstone, moderate sorting, med. to coarse grains, 10% well rounded qtz.
Sk 375 L	Limestone, boundstone, stroms. with cavities infilled with detrital wackestone.
*Sk 375 M	Limestone, skeletal detrital packstone, poor sorting, lime mud almost completely recrystallized. Skeletal material includes crinoids, brachs, strom. Well rounded qtz grains to 1.5 mm. Energy index = 8.
Sk 375 N	Limestone, detrital skeletal wackestone, poorly sorted, partially recrystallized. Irregular detrital carbonate grains and well rounded qtz. grains (to 1 mm). Stroms and algal tubes. Energy index = 8.
Sk 375 O	Limestone, detrital packstone, poorly sorted, lime mud almost completely recrystallized. Irregular detrital grains and organic debris including gastropods, stroms and crinoids. Energy index = 8.
Sk 375 P	Limestone, detrital skeletal packstone, poorly sorted, lime mud almost completely recrystallized. Irregular detrital grains and organic debris including strom, brach, gastropod and crinoid. Energy index = 8.
Sk 375 Q	Limestone, detrital skeletal packstone, moderate sorting, med. grains, stroms and algal debris. Energy index = 7.
Sk 375 R	Limestone, coral packstone, moderate sorting of detrital and organic debris around corals (aligned), partially recrystallized and dolomitized. Energy index = 7.

Sk 375 S — Limestone, detrital packstone, poorly sorted partially recrystallized (< 20%). Energy index = 8.

Sk 375 T — Limestone, detrital-skeletal packstone, moderate sorting, (predominantly med. grains) partially recrystallized. Organic debris includes brach. crinoid. Energy index = 7.

Sk 375 U — Limestone, strom.-coral boundstone? partially recrystallized with infilling of detrital material including v.f. qtz. grains (< 5%).

Sk 375 V — Limestone, skeletal-detrital packstone, partially recrystallized, poor sorting, organic debris includes coral, strom, crinoid. Energy index = 8.

Sk 375 W — Limestone, skeletal-detrital packstone, partially recrystallized. Sorting is good on individual laminae, good alignment of grains, graded bedding. Energy index = 6.

Sk 375 X — Limestone, skeletal packstone, moderatly sorted, strom., ostracods, brach, crinoid, coral debris. One ostracod shows qtz. infilling. Energy index = 7.

Sk 375 Y — Limestone, crinoid-wackestone, moderate sorting of grains - predominantly crinoids. Energy index = 4.

Sk 375 AA — Limestone, skeletal wackestone, partially recrystallized and silicified. Coral, brach and algal (?) material, poorly sorted. Energy index = 5

Sk 375 BB — Limestone, skeletal packstone, partially recrystallized (< 25%) and silicified. Grain contact appears to be due to compactions. Organic debris includes brachs, crinoid. Energy index = 7 (?)

Sk 375 CC — Limestone, skeletal packstone, moderate sorting of organic debris - predominantly crinoids and brachs. Energy index = 7.

Sk 375 DD — Limestone, detrital-skeletal packstone, locally completely recrystallized, coral, crinoid, gastropod, poor sorting. Energy index = 7.

Sk 375 EE — Limestone, skeletal-detrital grainstone, moderate sorting; strom, coral, brach and crinoid fragments - some suggestion of boundstone relationship in strom. Occ. crinoid plate shows encrusting algae. Detrital grains are irregular shaped, very coarse. Energy index = 13.

Sk 375 FF — Limestone, skeletal-detrital grainstone, poor to moderate sorting, overcrowding of grains due to compaction. Organic debris includes corals, stroms, crinoids, brach. Detrital grains are med. sized and rounded. Energy index = 11.

Sk 375 GG — Limestone, skeletal wackestone, partially recrystallized (up to 50%) and slightly dolomitized ($< 10\%$). Organic debris includes gastropods and crinoids. Energy index = 4

Sk 375 HH — Limestone, skeletal detrital wackestone, partially recrystallized. Organic debris includes corals, crinoids, and brachs. Occ. qtz. grains. One coral shows encrusting algae. Energy index = 4.

Sk 375 II — Limestone, skeletal packstone, partially recrystallized ($< 25\%$). Organic debris includes corals, brach, crinoid and algae. Several examples of encrusting algae. Energy index = 8.

Sk 375 JJ — Limestone, boundstone, coral encrusted by a stromatoporoid. Secondary pressure solution.

Sk 375 KK — Limestone, stromatoporoid boundstone. Stroms and corals with abundant organic debris.

Sk 375 LL — Limestone, skeletal grainstone (?), strongly recrystallized destroying most of the original fabric. Organic debris includes crinoids, brachs and bryozoa.

Sk 375 MM — Limestone, detrital grainstone (?), strongly recrystallized Fine to med. grain size. Qtz grains $< 10\%$. Energy index = 10.

Sk 375 NN — Limestone, detrital grainstone, partially recrystallized. Moderate sorting, medium grain size. Energy index = 11.

Sk 375 OO — Limestone, detrital skeletal packstone, partially recrystallized (recrystallization concentrated in lime mud). Coral, strom, brach in coarse fragments with fine detrital grains. Energy index = 7.

Sk 375 PP — Limestone, detrital-skeletal packstone, lime mud completely recrystallized. Evidence for grain support and mud support. Good sorting of fine detrital and organic grains with a few very coarse fragments of stroms and corals. Algal overgrows. Energy index = 7.

Sk 375 QQ — Limestone, skeletal detrital packstone, lime mud completely recrystallized. Coarse grained organic debris (gastropods, strom, coral, brach) and fine grained detrital material. Encrusting algae. Energy index = 8.

Sk 375 RR — Limestone, detrital skeletal packstone, partially recrystallized and slightly dolomitized ($< 10\%$), moderate sorting. Coarse organic and detrital grains; predominantly fine detrital material. Some micro lamination. Energy index = 7.

Sk 375 SS — Limestone, skeletal packstone, partially recrystallized; *Cladopora*, strom and algal material. Energy index = 8.

Sk 375 TT — Limestone, detrital grainstone, partially recrystallized. Well sorted, fine grained detrital material with one very coarse strom fragment. Energy index = 10.

Sk 375 UU — Limestone, skeletal grainstone, partially recrystallized. Very coarse grains of strom and brach with infilling of detrital debris. Energy index = 13.

Sk 375 VV — Limestone, skeletal grainstone, partially recrystallized, poorly sorted with fragments of strom, coral, bryozoan and detrital grains. Energy index = 13.

Sk 375 WW — Limestone, detrital packstone, partially recrystallized, good sorting, fine grained. Energy index = 7.

Sk 375 XX — Limestone, recrystallized stromatoporoid.

Sk 375 YY — Limestone, skeletal packstone, partially recrystallized, poorly sorted organic debris - stroms, Cladopora, etc. and fine detrital grains. Energy index = 8.

Sk 375 ZZ — Limestone, skeletal packstone, lime-mud completely recrystallized. Moderate sorting. Average grain size approximately 0.5 mm. Energy index = 7.

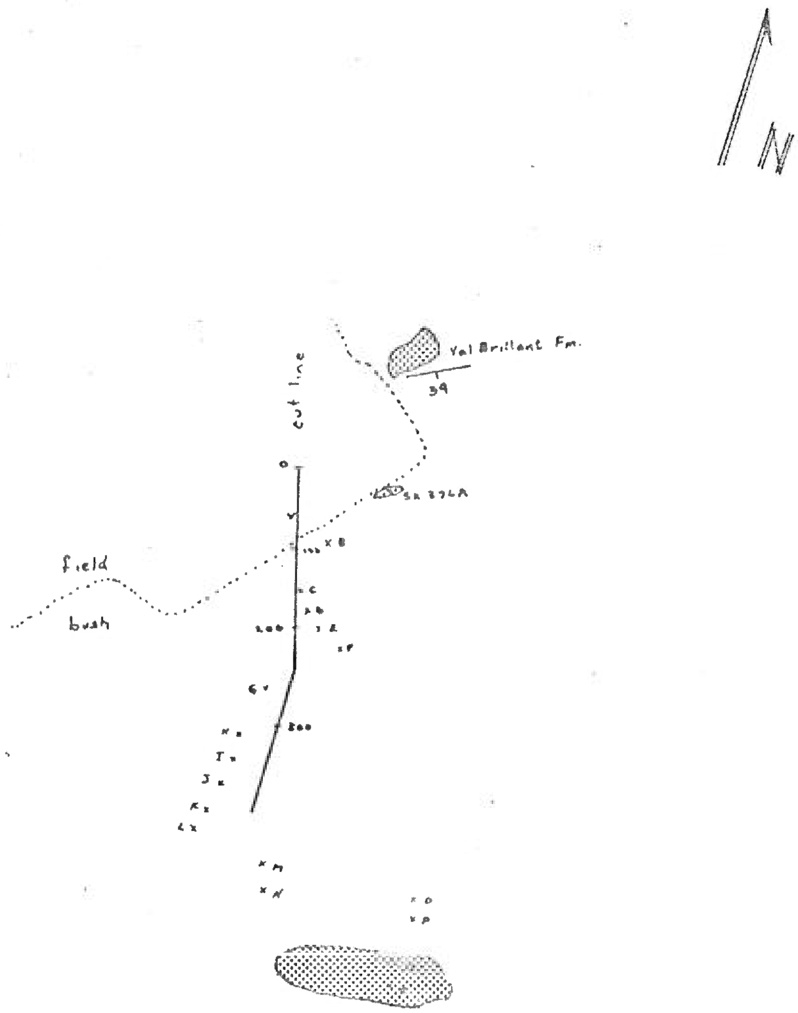
Sk 375 B3 — Limestone, coral. Slide shows partial infilling of coral with detrital material and initial stages of dolomitization.

Sk 375 C3 — Limestone, boundstone (?) strom and algal material with a skeletal wackestone of poorly sorted organic debris.

Sk 375 D3 — Limestone, skeletal-detrital wackestone - partially recrystallized. Mud supported organic debris includes crinoids, coral fragments, strom fragments. Section is part of "cavity infilling" of a strom boundstone.

FIGURE 3

Sample Locations for SK 376



Boundstone facies

horizontal scale
1 inch = 250 ft

Sample Location SK 376

Grid Reference 854707

Approximately 3.2 miles north-east of La Rempton

B.R. Skinner
Aug 22, 1970

GASPÉ 70 SAMPLE DESCRIPTIONS

Location: Sk 376, near Sayabec, Quebec

Date: August 21, 1970

Collected by: B. A. Skinner

Sample #	Description
Sk 376 A	Dolomite, fine to med. xtlline, completely altered with no original fabric preserved. Xtlline size and uniformity suggests that this was originally a packstone or grainstone which was fractured then dolomitized. $<$2% fracture and inter-xtlline Ø.
Sk 376 B	Limestone, detrital-skeletal grainstone, partially altered and dolomitized ($<$25%), moderate sorting (av. diameter 0.2 - 0.5 mm), sparry calcite cement. Rounded detrital grains (pellets?) and organic debris. Discrete dolomite rhombs and stringers associated with fractures. Very fine qtz. $<$5%. Energy index = 11.
Sk 376 C	Limestone, detrital-skeletal grainstone, partially altered and dolomitized ($<$25%), moderate sorting (av. diameter 0.1 - 0.3 mm), sparry calcite cement. Rounded detrital grains and organic debris (brachs, crinoids). Energy index = 10.
Sk 376 D	Limestone, detrital-skeletal grainstone, partially altered and dolomitized ($<$ 15%) poor sorting (v.f. to coarse grains) sparry calcite cement. Coarse detrital grains, fine detrital and organic grains coated by algal material, one coral fragment, several coated oolites. Fractures infilled with dolomite.
Sk 376 E	Limestone, skeletal-detrital grainstone, partially dolomitized ($<$10%). Moderate sorting, coarse to very coarse angular grains of coral, bryozoa, brachs, and detrital grains. Some algal overgrowths. Energy index = 13.
Sk 376 F	Limestone, skeletal-detrital grainstone, moderate sorting, med., rounded grains of organic debris and detrital material. Sparry calcite cement. Some algal overgrowths. Energy index = 11.

Sample #	Description
Sk 376 G	Limestone, skeletal-detrital grainstone, moderate sorting, coarse grained organic debris (gastropods, coral, strom, brach) and detrital material. Sparry calcite cement. Energy index = 12.
Sk 376 H	Limestone, skeletal grainstone, poor sorting, very coarse grained organic debris (strom and coral) with infilling of detrital and organic material. Energy index = 13.
Sk 376 I	Dolomite, med. xtlline. ≈ 40% limestone. Appears that limestone was completey recrystallized then dolomitized. No relic fabric preserved. $\angle$5% inter xtlline Ø.
Sk 376 J	Limestone, crinoidal-skeletal grainstone, moderate sorting, fine grained, partially recrystallized. Abundant crinoid material. Energy index = 10.
Sk 376 K	Limestone, skeletal-detrital grainstone, moderate sorting, fine grain size, partially recrystallized. Organic debris - back fragments, calcispheres (?) and detrital grains. Energy index = 10.
Sk 376 L	Limestone, skeletal-detrital grainstone, moderate sorting, fine - med. grain size. Organic debris - broken stroms, crinoids, brachs, gastropods and small rounded detrital grains. Energy index = 10.
Sk 376 M	Limestone, Skeletal packstone (?), poor sorting. Coarse to very coarse grains, partially recrystallized and dolomitized ($\angle$10%). Organic debris including stroms, bryozoans, gastropods, brachs, crinoids. Most of lime-mud matrix has been recrystallized. Energy index = 8.
*Sk 376 N	Limestone, skeletal-detrital grainstone, moderate sorting. Very coarse grains of broken stroms, corals, bryozoa, brachs, crinoids, gastropods and organic debris. Sparry calcite cement. Energy index = 13.

Sample #	Description
Sk 376 O	Limestone, skeletal-detrital grainstone, well sorted (hydraulic). Fine grained organic debris, partially recrystallized and slightly dolomitized. Recrystallization "corroding" crinoids.
Sk 376 P	Limestone, detrital-skeletal grainstone, moderate sorting. Coarse detrital grains, carbonate and rounded qtz. grains to 1mm, with crinoids and organic debris. Qtz. ≈20%. Energy index = 13.
Sk 376 Q	Limestone, stromatorporoid boundstone with cavity filling of poorly sorted organic debris.
Sk 376 R	Limestone, stromatorporoid boundstone (?), partially recrystallized and dolomitized.

Location: Sk 377, near Sayabec, Quebec
Date: August 23, 1970
Collected By: B. A. Skinner

Sample	Description
Sk 377 A	Sandstone, well rounded, medium grained quartz sandstone (< 5% feldspar), calcite cement.
Sk 377 B	Limestone, skeletal wackestone, partially recrystallized, slightly dolomitized (< 10%). Fine to medium organic debris including brachs, crinoids, and pellets. Dolomite concentrated in small fractures. Energy index = 5.
Sk 377 C	Limestone, skeletal wackestone, partially recrystallized and dolomitized (< 15%). Poorly sorted organic debris includes coral, crinoid, calcispheres. Energy index = 5.
Sk 377 D	Limestone, skeletal wackestone, partially recrystallized and slightly dolomitized (< 5%). Rounded silt sized quartz grains (< 5%). Organic debris includes coral and crinoid fragments. Energy index = 5.
Sk 377 E	Limestone, skeletal detrital packstone, partially recrystallized. Rounded v.f. qtz. grains (< 5%) and detrital grains (fine grained). Organic debris includes brachs, gastropods. Several grains show algal overgrowths. Energy index = 7.
Sk 377 F	Limestone, skeletal detrital wackestone, partially recrystallized. Organic debris includes brachs and gastropods (broken). Detrital material is v.f. grained (< 5% qtz.). Energy index = 4.
Sk 377 G	Limestone, detrital skeletal packstone, partially recrystallized. Rounded detrital grains (pellets ?) and organic debris including gastropod, brachs and crinoid. Energy index = 7.
Sk 377 H	Limestone, detrital packstone, partially recrystallized. Rounded detrital grains (pellets), well sorted. Slightly dolomitized along micro fractures. Energy index = 7.
Sk 377 I	Limestone, detrital skeletal wackestone, partially recrystallized. Detrital grains are fine grained and well rounded. Organic debris is coarse. Energy index = 5

Sample	Description
Sk 377 J	Limestone, skeletal wackestone, recrystallized (< 40%) and dolomitized (< 15%). Very coarse fragments of strom and coral (growth position ?) and infilling of fine skeletal and detrital material. Dolomite rhombs scattered throughout. Energy index = 5.
Sk 377 K	Limestone, skeletal wackestone, partially recrystallized. Ostracod, brachs and gastropods. < 5% detrital qtz. grains. Energy index = 3.
Sk 377 L	Limestone, skeletal packstone, partially recrystallized. Poorly sorted strom, coral, brach, crinoid and detrital grains. Energy index = 8.
Sk 377 M	Limestone, skeletal wackestone, lime mud locally completely recrystallized. Poorly sorted brachs, crinoid, gastropod and coral fragments. Two stages of calcite infilling Energy index = 5.
Sk 377 N	Limestone, strom-coral boundstone, coral is completely overgrown and killed by strom.
Sk 377 O	Limestone, crinoid grainstone, partially recrystallized. Well sorted med. grained with late infilling of lime mud. Energy index = 11.
Sk 377 P	Limestone, crinoid grainstone, partially recrystallized. Infilled with mud and silt. Grains are well sorted, predominantly crinoids. Energy index = 11.