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GEOLOGY AND OIL AND GAS EXPLORATION OF ANTICOSTI ISLAND, GULF OF ST. LAWRENCE, QUEBEC: PRELIMINARY RECONNAISSANCE

PRELIMINARY REPORT 1

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GEOLOGY AND OIL AND GAS EXPLORATION OF ANTICOSTI ISLAND GULF OF ST. LAWRENCE, QUEBEC: PRELIMINARY RECONNAISSANCE

DP-505

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ABSTRACT

Preliminary investigations to re-appraise the geology and the oil and gas prospects of the Anticosti Basin began in 1975, with a helicopter-supported, reconnaissance survey of Anticosti Island, in the Gulf of St-Lawrence. Approximately 70% of the roughly 8,000 kilometres^2 (3,000 miles^2) island was systematically examined and sampled.

In Western Anticosti, six predominantly carbonate formations outcrop and dip about 2^o southwest as a homocline or northeast facing cuesta comprising a ± 1200 m (3900 ft.) panel of sediments; downsection, they are: Chicotte (± 30 m/± 100 ft.), Jupiter (± 190 m/ ± 620 ft.) Gun River (± 190 m/ ± 620 ft.), Becscie (± 205 m/ ± 670 ft.) Ellis Bay (± 100 m/ 330 ft.), Vauréal (± 480 m/ 1575 ft.). The total stacked thickness of surficial exposures is closer to the equivalent subsurface stratal interval in the ARCO-Anticosti No. 1 hole than all previous estimations.

The formational contacts are mainly gradational but apparently conformable. Formation lithofacies are similar, that is, predominantly fine-grained calcarenites, but they range from lime mudstones, calcisiltites, bioclastic wackestones, packstones and grainstones, boundstones (biohermal) to intraformational conglomerates, with relatively minor, interbedded calcareous shales and argillaceous, siliciclastic sandstones (the latter mainly in the southeast of the island).

Visual porosities are rarely developed, however, significant porosity is inferred in the highly calcareous claystone zone (40 m/132 ft.) in the lower to middle Jupiter in southcentral Anticosti, and in the siliciclastic sandstones that comprise about 35% of the Vauréal and Ellis Bay on the northeast coast. The relatively thin bioherms (ca. 1 to 8 m/ 3 to 26 ft.) and thicker reefoid zones in the upper parts of the formations are not visibly porous; the granular, highly encrinitic, bank-like and reefoid, uppermost Jupiter and Chicotte seem dense, but could contain an intergranular or fracture porosity.

A light-coloured oil bleeds from fractures in scattered and isolated fossils in the upper Vauréal. Highly fetid, organically laminated grainstone beds occur in the middle Vauréal. Elsewhere, gas is trapped in coarse to granular limestones in the upper zones of the formations.

An anomalous natural gas and brine spring was discovered near the lower Chaloupe River in southeastern Anticosti; the quantity of dissolved salts is about three times that of normal sea water, moreover, the high percentage of chlorides suggests that the flow is from considerable depth.

Structural features, other than joints, are subtle and difficult to map, however, some low amplitude folding is associated with normal faulting. To date, maximum observed fault displacement in surface exposures is about 5 m (17 ft.) but the average is about 2 m (7 ft.). Although the island has not been subjected to major tectonic deformation, up-dip structural and possibly stratigraphic traps are present in the subsurface. The transitional carbonate-siliciclastic intertonguing, in the formations in the southeastern region of Anticosti, appear to be favourable prospective targets for hydrocarbons.

No appreciable mineralization has been observed on the island. Two vertical, 8 to 15 m (26 to 50 ft.) thick, mafic dykes intrude the Vauréal limestones and shales on the northcentral coast, but associated wall rock mineralization was not observed.

Three seasons of surface exploration are envisaged on Anticosti Island. A wide range of physical, geochemical and paleontological analyses are proposed, or are underway. This information is to be integrated and correlated with subsurface geophysical data to complete the basin analysis.

GEOLOGY AND OIL AND GAS EXPLORATION OF ANTICOSTI ISLAND, GULF of ST. LAWRENCE, QUEBEC

PRELIMINARY REPORT OF 1975-76 (part) INVESTIGATIONS

INTRODUCTION

Location

Anticosti Island is situated in the Gulf of St. Lawrence and marks the entrance to the St. Lawrence Estuary. Geologically, it is a part of the St. Lawrence Platform, and lies between the Precambrian Canadian Shield to the north and the sinusoidal, northeasternmost segment of the Appalachian Chain: that is, to the southwest in the Gaspé Peninsula, the Notre-Dame Mountains, and to the east-southeast, in the western Newfoundland, the Newfoundland Highlands (see Figure 1).

Previous studies

The hydrocarbon potential of the Anticosti Basin has been recognized by petroleum exploration geologists since 1962: Lowlands Exploration Limited (subsidiary of Imperial Oil Limited) and Gamache 1965; Roliff 1968; Duff 1969; Atlantic Richfield Canada Limited (ARCO, now Petro-Canada Exploration Inc.) and Consolidated Developments Limited 1970; SOQUIP and Scurry-Rainbow 1974; SOQUIP 1974[1].

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[1] *The references cited have well or seismic and other reports on open file at the Exploration Division, Energy Branch, of the Quebec Department of Natural Resources (MRN).*

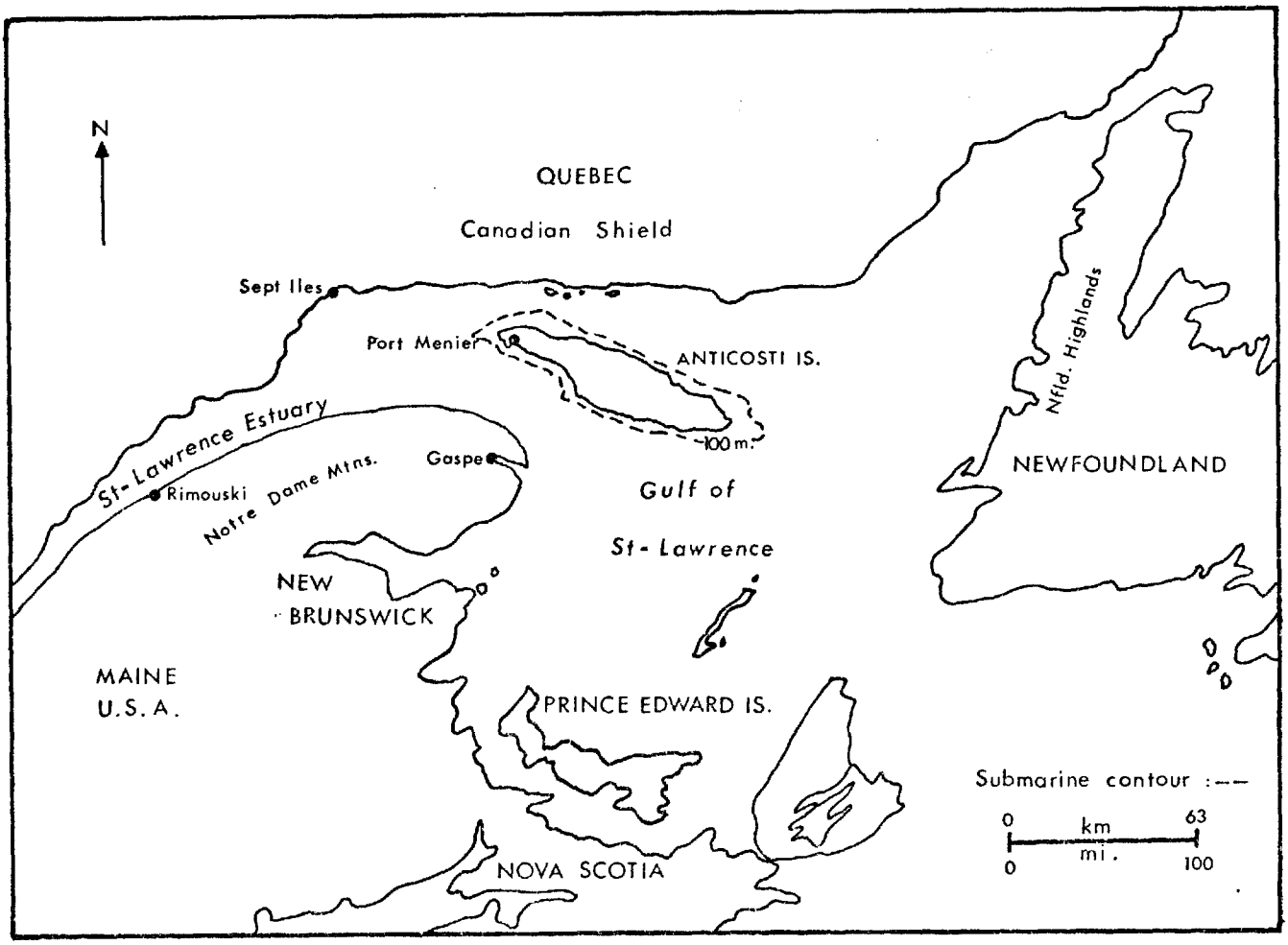

FIGURE 1. Location Map, Anticosti Island, Quebec

Eight exploratory tests have been drilled, seven in the western half, and the most recent one near the eastern tip of the island. Non commercial oil and gas shows were found, and recent geochemical analyses of subsurface formations for the Quebec Department of Natural Resources indicate the presence of favourable zones for oil and /or gas.

Surface geological exploration of the island, however, was begun in 1856 by Richardson, for the Geological Survey of Canada. Later, expanded studies were done by Schuchert and Twenhofel (1910) and Twenhofel (1921, 1926, 1928). These early efforts were mainly confined to coastal areas.

The latest major contributions of surface and subsurface areas have been advanced by Bolton (1961, 1972) and Roliff (1968), respectively. Only now, however, have the relatively inaccessible interior areas of the southcentral and eastern half of the island been investigated.

Project objectives

The acquisition of Anticosti Island by the Province of Quebec in 1974, energy and mineral requirements and the incomplete exploration of the Anticosti Basin, have prompted the Quebec Office of Planning and Development (O.P.D.Q.) to subvention this research project, proposed by the Exploration Division of the Quebec Department of Natural Resources.

Heretofore, no detailed, comprehensive geological surface and subsurface basin analysis has been attempted. Moreover, exploratory targets were largely pre-Upper Ordovician, and therefore, approximately 40% of the upper Ordovician and Silurian upper basinal strata have been inadequately appraised. It is, in part, because of this fact that the basin analysis was proposed.

The long term objectives of this project are, therefore to integrate geological, geophysical and geochemical information, and to evaluate the hydrocarbon prospects of the Anticosti Basin.

Work of the first stage

The first stage, to reassess the geology and subsequently the oil and gas prospects of the Anticosti Basin, was initiated in the summer of 1975 with a helicopter-supported, reconnaissance field survey of Anticosti Island. The following preliminary report describes the field and laboratory work done up to April 1976. It is comprised of:

1 - a description of the personnel, vehicles and air support.

2 - statistical data.

3 - methods and sampling.

4 - general geology.

5 - lithostratigraphy of western Anticosti: a composite section.

6 - remarks on a newly discovered natural gas and brine spring seep.

7 - a geological map which denotes areas traversed, location of traverses that pertain to the composite stratigraphic section (both enclosed in pocket), location of well sites, gas and brine seep and base camps.

8 - a composite lithostratigraphic section of western Anticosti (in pocket).

9 - a generalized lithostratigraphic column of western Anticosti denoting reefs and reefoid zones.

10 - remarks on current and subsequent exploration and research.

Personnel, vehicles and air support

The three months of field work was accomplished by a team of fourteen (14) men, four of whom were support staff (two cooks, a helicopter pilot and mechanic), and operated out of two base camps, one at Becscie in the southwest, and the other at Patate in the northeast sector of the island. Satellite or fly camps were operated from (northwest to southeast) La Loutre, Jupiter 24 miles, Jupiter-by-the-Sea, Saumon River bridge, Chaloupe, on Batterie Creek, Mill Bay, Prinsta Bay, and at Heath Point, the southeastern tip of the island (see geologic map, in pocket).

Geological observations were recorded by graduates in geology. Periodically, visits were made by provincial, federal and university earth scientists.

Three four-wheel-drive vehicles were used on gravel roads but, in the latter half of the season, helicopters (Bell, G2, G5 and S55 Sikorsky) were deployed, at different times, in the relatively inaccessible eastern and south-central regions of the island.

Statistical data

Almost three-quarters of the approximately, 8,000 square kilometres (220 by 37 km) or 3000 square miles (138 by 23 mi.) of the island was surveyed on a reconnaissance basis, that is, with about 3.2 to 16 kilometres, (2 to 10 mi.) between traverse lines[1].

About 1000 stratigraphic control points were established, and

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[1] *The southcentral part of the island was not adequately surveyed.*

some 2000 rock specimens collected; the sample interval ranges from about 0.5 to 20 metres, (2 to 65 ft.).

Total helicopter ferrying time was 132 hours.

METHODS AND SAMPLING

Field methods

Conventional stratigraphical, sedimentological, petrographical, paleontological and structural data were recorded and samples collected on foot-traverses along major rivers on about one third of the available coastline, and on principal, secondary and logging roads (see enclosed geological, traverse location map; in pocket). Geographical control was maintained with aerial photographs, topographic maps, and pedometer and compass. Where it was convenient a modified Jacob staff was used to directly measure strata thickness. Most composite stratigraphic thickness evaluations, however, were computed trigonometrically.

In general, representative rock samples were collected between 0.5 to 5, or 10 to 20 metre (ca. 2 to 65 ft.) stratigraphic intervals. Traverses were approximately 3.2 to 16 kilometres (2 to 10 mi.) apart. Sampling was for lithological, paleontological, clay mineral, organic carbon and porosity-permeability analyses.

Stratigraphic thickness measurements

It is important to appreciate the problems encountered in determining stratal thicknesses on Anticosti Island. The difficulty arises in areas where there are no vertical outcrop sections present, that is, on the wave-cut terrace that fringes most of the island, and in areas of little or no exposures, along the coasts, rivers and island roads. The extremely low dips (ca. 1° to 3°), the presence of local and broad structural warps, and the irregularly wavy and lenticular bed forms preclude

any facile evaluation of stratal thicknesses. Consequently, precise dip measurements using a compass-clinometer, are often not possible. Moreover, the paced distances of different individuals vary in accuracy. Therefore, based solely on the above factors, a considerable range in the thicknesses of strata is to be expected. For example, a subtle change of dip from 1^{o} to 2^{o} doubles the strata thickness for the same interval considered.

The composite stratigraphic section in this report has been constructed on the basis of direct measurements, supplemented by computations. Dip measurements were compared with published dip values (where they were available, ... and they are rare) and several computations were made using different dip values. Until more direct measurements of thicknesses and dips are made in the field, the formational thicknesses are considered tentative.

Lithologic terminology

Three major lithologic groups are recognized: carbonates, shales, siliciclastics. The carbonates have been distinguished by their textures and particle size. The textural terms are used in the sense of Dunham (1959): lime mudstone, wackestone, packstone, grainstone, boundstone and crystalline carbonates; the names are qualified by conventional detrital and other particle sizes, and the relative abundance of the conspicious, macroscopic-size bioclasts. Two other particles size categories are "calcisiltite" (micrograined clastic carbonate particles; 0.0039-0.0625 mm) and intraformational conglomerate (2-256 mm, generally thin flat pebble limestone (with or without, minor shale) fragments of very local origin, that have undergone little or no transportation).

The terms, reef(al), reefoid and bioherm(al) are as defined in the A.G.I., Glossary of Geology 1973, p. 595; reefoid, however, is modified to include stratified biogenic material. Bioherm is employed as originally defined by Cumings (1930, p. 207).

The siliciclastics (Baunstein, 1961, p. 2017) are composed

largely of detrital quartz and silicate minerals of silt to boulder size. They are predominantly argillaceous, calcareous sandstones or arenites and minor conglomerates.

The shales or mud rocks are defined as in Ingram (1953) but no tripartite shale scheme is recognized. Their composition, however, is generally calcareous; some are calciclastic and/or siliciclastic.

The rock-types recognized are based on field and laboratory (binocular microscopic) studies; the carbonates are distinguished, essentially, at a field level of precision. Detailed thin section studies will be made at a later date.

Other linear, quantitative and qualitative parameters used are explained in the upper heading of the composite lithostratigraphic section enclosed.

GENERAL GEOLOGY

The stratigraphy, regional distribution of formations, 1975 traverse locations, and drill hole locations are shown on the enclosed, slightly modified geological map by Bolton (1972).

Stratigraphy

The sedimentary strata that outcrop on Anticosti Island have been subdivided lithologically and, in part, paleontologically, into six formations and, informally, into several members. The formations are, upsection: Vauréal, Ellis Bay, Becscie, Gun River, Jupiter and Chicotte. The basal English Head Formation (Twenhofel, 1914, 1928) is included in an expanded Vauréal Formation (Bolton 1972, p. 3). The informal member scheme of Bolton (ibid.) is tentatively adopted (see Table of Formations); stratigraphic problems and nomenclature will be discussed in a subsequent report.

PERIOD	SERIES	FORMATION thickness m & ft	MEMBER	Description
SILURIAN	ALEXANDRIAN-NIAGARAN	CHICOTTE 30 ±m/98 ±'		Granular crinoidal limestones; reefoid
		JUPITER ±188m/616'	? 5 4 3 2 1	Mainly argillaceous limestones interbedded with calcareous shale; range texturally from lime mudstones to granular bioclastic grainstones; minor siliciclastic admixtures; reefoid near top.
		GUN RIVER ±188m/623'		Generally as Jupiter Fm., but conspicuous intraformational conglomerates; bioherms near top.
		BECSCIE ±205m/672'		Mainly lime mudstones to medium-grained packstones ± grainstones; common intraformational conglomerates; minor reefoid zone in mid.± & upper parts.
UPPER ORDOVICIAN	RICHMONDIAN	ELLIS BAY ±103m/345'	6 5 4 3 2 1	Mainly argillaceous, fine-grained, ± nodular calcarenites, ± lime mudstones, interbedded with calcareous shale; bioherms near top.
		English Head ?! VAUREAL 482m±/1581±'	Dykes	Mainly argillaceous, fine-grained calcarenites, common intraformational conglomerates, with minor shale interbeds; increased calcareous shale at formation top, ± bottom; bioherms near top and minor siliciclastics; 2 Very local, mafic dyke intrusions.

TABLE OF FORMATIONS, WESTERN

ANTICOSTI ISLAND, QUEBEC

Time

The two lower formations, Vauréal and Ellis Bay, are regarded by most paleontologists to be of Upper Ordovician age and the latter four, Becscie, Gun River, Jupiter, Chicotte, of Lower and Middle Silurian age. Others, however, locate the Ordovician-Silurian boundary between the Vauréal and Ellis Bay formations, or in the latter (Boucot and Berry, in Ayrton et al. 1969.). The temporal sequence is considered to be essentially uninterrupted (Richardson 1857, Twenhofel, 1928, Bolton 1961, Riva 1969, and Copeland 1970).

Lithologies, reefs and porosity

The sedimentary rocks are predominantly fine-grained limestones interbedded with shale but punctuated locally by relatively thin, blanket-like biohermal reefs. The limestones range from lime mudstones to granular to skeletal packstones or calcirudites. Towards the southeast of the island, however, the carbonate facies give way to, and intertongue in varying proportions with calcareous, argillaceous and argillaceous clastic facies. The siliciclastic facies is, for the most part, confined to the uppermost Vauréal and to the Ellis Bay Formation.

Reefal and reefoid buildups are commonly found in the upper part of each of the formations that outcrop in the western part of the island; in the eastern regions, they also occur in the lower to middle Ellis Bay and at the base of the Jupiter Formation. They range from 3 to 6 metres (10 to 20 ft.) thick, and from about 30 to more than 100 metres (100 to 400+ ft.) in length or width.

The granular and predominantly crinoidal grainstones of the upper Jupiter and Chicotte formations are interpreted as reefoid bank deposits, interspersed locally with organic boundstone reefal elements.

Porosity

The bioherm boundstones contain no visible leached or vugular porosity, however, a dense, fracture porosity may be present. In contrast, the granular calcirudites in the upper Jupiter and throughout the Chicotte are somewhat loosely cemented, and probably contain an intercrystalline and/or intragranular porosity.

Two other regions where formations contain apparent porous zones are, the south-central coast around Jupiter River and the northeast coast from Batterie Point to Renard (Fox) Point. Along the south-central coastal region, the middle to lower members (4 and 5) of the Jupiter Formation exhibit a high degree of friability, chalkiness and, therefore, significant porosity. The zone is about 40 metres (132 ft.) thick and is comprised of sandy to silty argillaceous, lime mudstones and/or silty, calcareous claystones.

The siliciclastic influx in the upper Vauréal and Ellis Bay formations increases substantially towards the southeast of the island, that is, along the northeast coast. The sandstones are generally argillaceous, calcareous, micaceous, thin to very thick, current bedded, locally "slumped" and friable. Minor, relatively clean, quartz granule to pebble conglomerate lenses occur locally. Lateral variation in bedding form and thickness is common. Intervening zones are silty to sandy shale and/or sandy calcarenites and grainstones. Sandstone zones range from about 1 to 7 metres (3 to 20 ft.) in thickness.

Approximately 35% of the exposed Ellis Bay Formation (ca. 90 metres or 300 ft.) between Cap aux Meules (Grindstone Cape) and Pointe du Renard (Fox Point) is siliciclastic sandstones. Porosity is probably intergranular and is rated as fair to good.

If the provenance for the siliciclastics lies generally to the east (offshore), then an increase in volume and a decrease in argillaceous

content is probable in the upper Vauréal, Ellis Bay and,most likely, in the succeeding formations. As a consequence, porosities may be higher where clays have been winnowed and by-passed basinward.

Although a significant volume of the carbonate facies on the island is highly and coarsely bioclastic, (and apparently deposited in a high energy hydrodynamic regime), no apparent porosity was observed in the field except for some lenses of intrafossilifereous (coquinoidal) porosity. This, however, does not preclude the possibility of porosity development in similar facies in the subsurface through some diagenetic vagary.

Structure

Anticosti Island is a homocline with its rock strata generally inclined to the southwest about ± 1° to 2°. Locally, the strata form low, open folds and usually plunge in the same direction as the regional dip. Some folding seems to be associated with normal faults that, on surface at least (to date), are of apparently small displacement (ca. 3 metres or 10 ft.). In general, structures are subtle and difficult to detect.

Large scale, often parallel undulations of about 15 to 30 metres (50 to 100 ft.) in the Jupiter and Chicotte Formations that outcrop at the "Jumpers", southeast of Sud-Ouest (Southwest) Point on the southcentral coast, appear to be of primary, bank-like origin.

Contacts between the formations are most often gradational and apparently conformable, and extend northwest-southeast across the island (see map in pocket).

Igneous rocks and mineralization

An anomalous occurrence of two vertical mafic dykes of about 8.5 and 15.2 metres (28 and 50 feet) thickness, cut the Puyjalon Cliff,

on the north central coast, and strike inland about 6 kilometres (ca. 4 mi.). No significant associated mineralization has been reported in the interbedded Vauréal limestone-shale host rocks.

Traces of widely disseminated or replacement pyrite occurs in all formations, but more conspicuously in the upper Jupiter and Chicotte.

Cubic galena is found in trace amounts in the bioherm at the base of the Jupiter Formation, at East Point in the extreme southeast of the island.

COMPOSITE LITHOSTRATIGRAPHIC SECTION , WESTERN ANTICOSTI ISLAND.

Lithostratigraphy

Figure 2, the lithostratigraphic section enclosed in two parts and at a scale of 2.54 centimetres (or 1 inch) equals 10 metres (or about 33 ft.), represents some of the more salient field and laboratory observations and parameters of the rock strata that outcrop northwest of Jupiter River, in the western part of Anticosti Island. A generalization of this log is presented in Figure 3.

An attempt to estimate the relative percentages of lithologies has been made to facilitate comparisons with subsurface lithologs of cuttings and/or cores. This task is difficult because of the often gradational nature of the carbonate-shale interbedding, gradational textures in the carbonate beds, and the absence locally of outcrop control (see column immediately to the left of the lithologies).

Grains sizes, bedding thickness and type, carbonate appearance, percent larger,bioclasts (fossils),paleocurrent trends and azimuths,deformational structures ("slump") are recorded. Grain sizes are commonly related to their respective lithologies and conspicuous fossils.

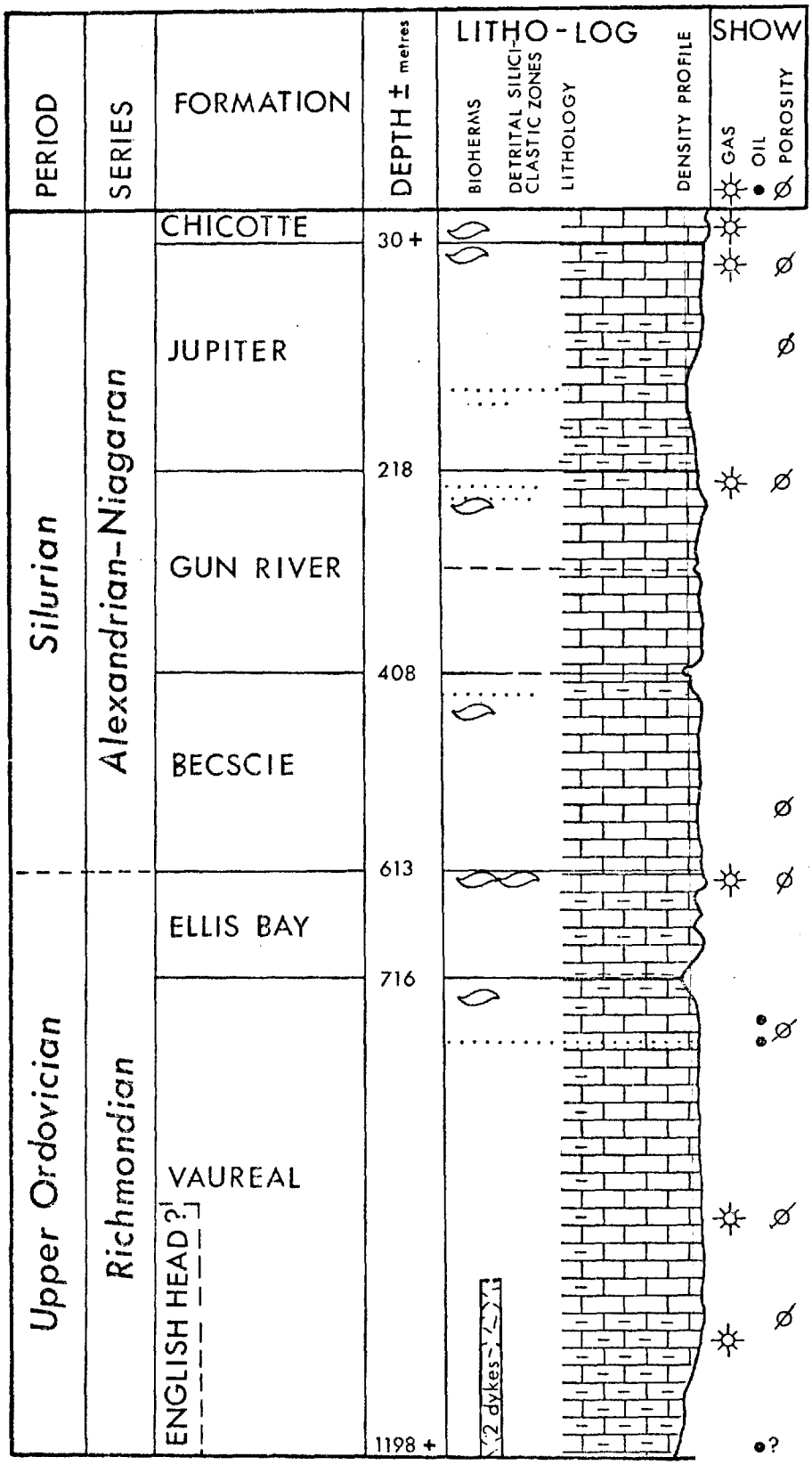

FIGURE 3. Generalized Litho-log, Western Anticosti Island, Quebec.

The more obvious diagenetic changes that have affected the original sediments and the presence of visible and apparent porosity are noted to help locate zones that may serve as reservoirs for oil and gas.

Lastly, traces of oil and/or gas and detrital organic matter are noted,to delimit possible reservoirs and/or source rocks.

Here, in summary form, is a description of the formations, down section:

Chicotte Formation (30 ± metres, or 98 ± feet)

Packstones to grainstones to boundstones, minor mudstones; generally light hues: greenish, locally pinkish; medium to coarse grained; ± argillaceous partings and irregular wavy lenses; thin to thick, lensy to broadly wavy bedded; highly fossiliferous: crinoids, bryozoans, pentamerids and other brachiopods, corals, stromatoporoids and other biota; partly biohermal; traces of fetid gas.

Jupiter Formation (188 ± metres, or 616 ± feet)

Lime mudstones, calcisiltites, wackestones, packstones,grainstones; light hues; ± argillaceous, slightly siliciclastic (in lower, members, 3 and 4); micritic to very coarse grained (uppermost transition to Chicotte Formation); generally very thin to medium, regular (planar, ± laminar) wavy to lenticular bedded; commonly limestones, ± grade to green shale interbeds; rarely (base of formation) to abundantly fossiliferous (upper part of formation and into Chicotte): crinoids, bryozoans, pentamerid and other brachiopods (coquinas), corals, stromatoporoids, sponges and other biota; partly biohermal or banks; traces of fetid gas mainly in uppermost part of formation.

Gun River Formation (190 ± metres, or 623 ± feet)

Lime mudstones, calcisiltites, packstones, grainstones; light to

dark hues; micritic to medium but, generally, very fine to fine grained; locally common to rare intraformational conglomerates; generally, very thin to medium, regular (planar) to lenticular wavy to nodular bedded; minor calcareous, green shale interbeds and partings; rare (basal half of formation) to commonly fossiliferous (upper part of formation): brachiopods, corals, bryozoans, cephalopods, stromatoporoids, ostracodes and other biota; minor sandy, siliciclastic admixtures or sandstones (near top and base of formation) and increased shale content (at top of formation); minor very thin, reefal bioherm bed near top of formation; fetid gas in reefal bed.

Becscie Formation (205 ± metres, or 672 ± feet)

Lime mudstones, calcisiltites, packstones, grainstones and intraformational (granule to medium pebble) conglomerates (common); grain size generally fine, but range from micritic to very coarse to pebble conglomeratic; very thin to medium (generally thin), regular (planar) to lenticular wavy to nodular bedded, but generally long lenticular, local irregular boulder-like distortions, "slumps" and/or "ball-ups"; minor to abundantly fossiliferous (upper formation): brachiopods (part virgianids, ± coquinas) corals, crinoids, bryozoans, stromatoporoids, algae, ostracodes and other biota; generally minor green, calcareous shale interbedding or parting; minor sandy siliciclastic admixtures and reefoid zones near top of formation; top of formation green, argillaceous, ± nodular, very fossiliferous.

Ellis Bay Formation (103 ± metres, or 345 ± feet)

The Ellis Bay is the thinnest formation on Anticosti, yet, stratigraphically, it apparently exhibits more lithologic and facies changes than the other exposed formations on the island. Based on the same stratigraphic interval, Richardson (1857) and Logan (1863) recognized 11 zones (1914, 1921, 1928), and Bolton (1961, 1972) modified this to 6 member units. It is the latter informal, 1 to 6 member scheme that is represented in the composite section. The type-section was only

cursorily examined in the 1975 field season. The lithologies are summarized below.

Lime mudstones, calcisiltites, packstones, ± wackestones, grainstones, interbedded with greenish, calcareous shale; rare intraformational conglomerates and very local boundstones; light hues except when fine grained; very thin to medium, but generally, thin, regular (planar), wavy to planar to nodular (argillaceous) bedded; locally highly fossiliferous (mainly where very argillaceous: members 1, top of 2 and 3): brachiopods, bryozoans, crinoids, beatricias, pelmatazoans, gastropods, pelecypods, corals, cephalopods, trilobites, stromatoporoids and other biota; reefal bioherms near top of formation; fetid gas in coarse-grained, very thin, encrinitic grainstones overlying bioherms.

Vauréal Formation (482 ± metres, or 1581 ± feet)

Tentatively, no clear dicotomy between a predominantly limestone upper member and a shaly lower member is made, as recognized by Bolton (1972). Possibly, the lowermost beds on the island are a highly shaly interval exposed in the cliffs southeast of Cap de Rabast and along the northwest coast; this interval has not been included in the Vauréal thickness evaluation. Further examinations of these beds are required to clearly determine their stratigraphic relationship. The formations lithologies are summarized below.

Lime mudstones, calcisiltites, packstones, wackestones, grainstones, rare boundstones and rare to common intraformational conglomerate zones; light, medium to dark hues locally laminated with organic matter; micritic to coarse-grained to pebble conglomerate but, generally very fine to fine; very thin to medium, long to short lenticular to wavy to nodular bedded; ± argillaceous and minor to commonly interbedded or intercalated with dark greenish, calcareous shale; traces of dolomitization and minor dolomite pebbles; rarely minor sandy, siliciclastic

admixtures (in upper part of formation); rare to abundantly fossiliferous, (generally common but abundant in upper part of formation where increased shale content): brachiopods, crinoids, corals, bryozoans, pelecypods, cephalopods, ostracodes, trilobites, stromatoporoids and other biota; thin reefal bioherms near top of formation; traces of oil in fossils (corals mainly) in upper part of formation; fetid gas in middle and lower part of formation.

Surface and subsurface thickness comparison: ARCO-Anticosti No. 1 Well

To date, attempts to correlate surface and subsurface units have not met with great success. In the ARCO-Anticosti No. 1 Well History Report by Petrie (1970; MRN, GM 26539), and a subsequent study by INRS-Pétrole (1974; MRN, DP 256) only rough but similar approximations of the formations were made: the Chicotte + Jupiter, Gun River + Becscie, and Ellis Bay + Vauréal were clumped into 3 broad stratigraphic units.

Although no detailed correlations have been attempted in this report, what is important is that the stacking of the surface strata in western Anticosti Island, represented by the composite lithostratigraphic section herein, is substantially closer to the equivalent stratal thickness in the ARCO-Anticosti No. 1 (1970) hole [1] than all previous total thickness evaluations; i.e. apparently about 70% less, compared with about 25% less in the former, than the equivalent ARCO well thickness, considering the various interpretations of depth to the top of the organically rich, black shale, Macasty Formation (Utica facies). However, the problems of stratigraphic correlation and subsurface structures will be discussed in a subsequent report, following detailed studies of the well logs and cuttings.

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[1] *This is the only well that transects all the surface and subsurface formations of Anticosti Island.*

NATURAL GAS AND BRINE SEEP

A newly discovered gas seep occurs about 6.3 kilometres (ca. 4 miles) upstream from the mouth of the Chaloupe River, in the south and eastern part of the island. The gas bubbles every few seconds through a spring which, in composition, is a brine. An analysis of the water by the Water Quality Branch, Quebec Department of Natural Resources, reveals that the quantity of dissolved salts is about three times that of normal sea water.[1] In addition, the high percentage of chlorides suggests that the brine is escaping from rock formations at considerable depth. The spring occurs along a clearly delineated, northwest-southeast fault line.

CURRENT AND SUBSEQUENT RESEARCH

The second phase of research began after the completion of the 1975 field season in September. Field notes, stratigraphic sections and samples were studied and reorganized to conform to a general plan of study.

Approximately one-quarter of the traverses and stratigraphic sections were verified as to geographic and stratigraphic location on air photographs and topographic maps; this work continues. In all cases, except where direct thicknesses were measured in cliff sections, stratigraphic sections and sample localities are based on trigonometric calculations; this work continues.

Binocular microscope studies of the field specimens has begun; part of the observaitons are recorded in the pocketed, composite stratigraphic section. Detailed petrographic studies of rock thin sections are pending.

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[1] *The water analysis data sheet is appended at the end of this report.*

Other physical and chemical analyses that are contemplated are: porosity and permeability, clay minerals, insoluble residues, trace elements, organic carbon, carbon reflectance, graptolitology[1], (chitinozoans)[2], conodontology[3], ostracodeology, algology, macropaleontology.

Subsequent preliminary reports will include more detailed lithostratigraphic, and structural surface and subsurface information. Interpretative models of the sedimentology, paleoenvironments, tectonism and related structures, possible source and reservoir rocks, and oil and gas prospects will be tendered.

To conclude this report, three summers of field work on Anticosti and one on the Mingan Islands and North Shore are planned. At the time of writing, the second season of field work had begun. The main objectives of the 1976 program were:

1) Examine the English Head, Vauréal and Ellis Bay type sections and areas.

2) Distinguish members in the Ellis Bay Formation.

3) Study the carbonate to siliciclastic facies changes in the Vauréal and Ellis Bay formations on the northeast coast from Saumon River.

4) Correlate, in detail, the predominantly carbonate facies of northwestern Anticosti with the siliciclastic-carbonate transitional facies of the Ellis Bay in the east.

Currently underway by: [1] J. Riva, Université Laval, Ste-Foy, Québec; [2] A. Achab, Université du Québec (INRS-Pétrole) Ste-Foy, Québec; [3] C.R. Barnes, University of Waterloo, Waterloo, Ontario; [3] L.E. Fahraeus, Memorial University of Newfoundland, St-John's, Newfoundland; [3] T.T. Uyeno, Geological Survey of Canada, Calgary, Alberta.

5) Sample for detailed control, and where stratigraphic gaps remain.

6) Traverse areas of the wave-cut terrace exposed at low tide, to fill stratigraphic gaps in the lower Vauréal.

7) On the basis of the lithologic sequence determined in 1 and 2, and lineaments on aerial photos, ascertain the presence of faults.

8) Re-sample the gaseous, brine spring on the Chaloupe River and look for similar seepages in the environs.

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QUEBEC DEPARTMENT OF NATURAL RESOURCES

WATER QUALITY SERVICE

Location: Anticosti Island
Spring: on Chaloupe River
Date: 24/09/75 Laboratory: 75-IY-82

SURFACE WATER ANALYSIS

CATIONS			PH
SiO_2	5.7		6.5
Ca	290.0		
Mg	2100.0	Fe	0.12
Na	29500.0	Mn	0.16
k	150.0		

ANIONS

SO_4? interference too high
Cl 78000.0

DISSOLVED SOLIDS

93746.0

CONDUCTIVITY (at 25^{o} C)

109,500.0