GM 27783

REPORT ON A GEOLOGICAL SURVEY OF PART OF ANTICOSTI ISLAND

GAMACHE EXPLORATION AND
MINING COMPANY LIMITED

REPORT ON A GEOLOGICAL SURVEY OF PART OF ANTICOSTI ISLAND, P. Q.

SUMMER, 1955

TABLE OF CONTENTS

Page No.

McPHAR GEOPHYSICS LIMITED

GAMACHE EXPLORATION AND MINING COMPANY LIMITED

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SUMMER, 1955

INTRODUCTION

Early in 1955 Gamache Exploration and Mining Company Limited requested McPhar Geophysics Limited of Toronto to plan and supervise a geological survey of Anticosti Island in the Province of Quebec. In conference with Mr. H. Freeman, Manager of Gamache Exploration and Mining Company Limited, it was decided that the initial season should be occupied mainly with reconnaissance geology with work to be concentrated on the north coast of the island where outcrop was known to be plentiful. In conjunction with the programme it was decided to check any significant geophysical anomalies obtained by an airborne geophysical survey, which had been scheduled to start by mid-June 1955.

The above programme was to be undertaken by two parties, each of two men, with additional personnel added if necessary. Planning and direction of the survey was undertaken by Dr. E. G. Robinson of McPhar Geophysics Limited.

An airphoto interpretation and mosaic of the island was prepared by Photographic Survey Corporation. This report became available on May 25 and was used in the initial planning stages.

Two men arrived at Port Menier, Anticosti Island, on May 30 followed by the balance of the personnel on June 1.

Field work in the Port Menier area was commenced on June 3, following the necessary on the spot planning.

The geological survey parties consisted of the following men:

S. B. MacEachern	Senior Party Chief
D. E. Hill	Party Chief
J. S. MacGregor	Assistant Geologist
J. A. Armour	Helper
E. G. Robinson	Consultant

Two bushmen were made available by Consolidated Paper Corporation.

SUMMARY

Anticosti Island is composed of a series of flatly dipping shallow water marine sediments of Ordovician and Silurian Age. Limestones and shales are the most abundant rock types and grade one into the other. The rich marine life of this period is excellently preserved in these unaltered sediments. The Anticostian section is of great geologic interest in that it constitutes the only rocks known to outcrop in Canada which bridge the time between the Ordovician and Silurian periods.

Known igneous activity is limited to two diabase dikes on the north coast. Metamorphic alteration of the sediments is not known. Weak sulphide mineralization is known to occur only in two limited areas.

Extensive gravel deposits form important sources of aggregate and road material. The calcareous shales might be suitable for

cement production and should be tested. Limited petroliferous strata occur on the island which point to a possible potential for oil and gas. Exploration for these materials are firmly recommended.

PURPOSE AND SCOPE OF SURVEY

The main purpose of the geological survey was to investigate and interpret the geological formations and structures of Anticosti Island in order to assess their economic potential. To achieve this end a reconnaissance survey, concentrating on the north coast area of the island was conducted during the summer of 1955. Air photographs on a scale of 1" to 5000' were used as a basis for geological mapping and for the preparation of base maps. Control was maintained by pin point locations on the air photographs along with pace and compass traverses. A continual check of the economic possibilities was made with the use of geiger counters, geochemical testing of soils and streams, and direct field observations. Air photo interpretation aided by stereoscopic examination was used in the study of topography and structural lineaments.

The planned interpretation and field investigation of airborne geophysical data, could not be undertaken as results were not available up to the time that the field season closed on September 17th.

METHODS

Reconnaissance was concentrated on the north coast of the island. This area was selected on several grounds.

Cliffs rising steeply out of the sea, along with a rapidly rising, step-type topography close to the coast, provided good outcrop exposures of a large part of the stratigraphic sequence. The shallow southerly dip of the beds approximates the gentle slope of the south portion of the island. This produces an almost dip-slope topography in which the beds change little over a given distance in comparison with the sections exposed by the steeper topography of the northern portion. Access to the exposures near the north coast involves less arduous travelling than would study of the same sections where observable in the south part of the island.

The characteristically indented coast line of the eastern half of the north coast was considered to be influenced by rock structures and the detailed examination in this area was influenced by this probability.

The two field parties covered the whole of the north coast from West Point to East Point. Base camps were successively established at Port Menier, Riviere d'Huile, MacDonald Bay, Vaureal River, Salmon River, and Fox Bay. The intervening areas were worked from fly-camps.

A remarkably developed debris-free wave-cut terrace is essentially continuous around the island. This provided an excellent medium for observing both structures and rock type. Bare and steep inland cliff faces - both on the shore and inland proved excellent media for the observation of the stratigraphic sequence.

The rivers also provided excellent outcrop along their banks and in the stream beds. Since they flow essentially at right angles to strike good stratigraphic sections were obtainable.

Stereographic examination of air photographs was used to study structures, drainage patterns, and topography.

Each party was equipped with transistor type geiger counters as well as McPhar type geochemical test kits for testing the heavy metal content of both soils and water.

LOCATION

The island of Anticosti is an elliptically shaped island of some 3152 square miles situated in the mouth of the St. Lawrence, approximately two thirds of the way between the tip of the Gaspe peninsula and the port of Havre St. Pierre on the north shore. Its length is about 140 miles from east to west and the maximum width is in the order of 35.2 miles. The long axis of this elliptical island is oriented approximately N65°W.

West Point, on the western extremity is located at latitude 49° 51-1/2'W; longitude 64° 31-1/2'N. The most easterly point, East Point, is situated at latitude 49° 08'W; longitude 61° 40'N.

ACCESS

Access to and from Anticosti Island, is possible by both sea and air. The Anticosti Shipping Company maintains a sailing schedule between Quebec City, Port Menier on Anticosti Island, the the port of Gaspe. This service is available during the summer months. A local schedule between Port Menier and Gaspe has a longer season. Quebecair provides a scheduled air service to Port Menier from Seven Islands and from Gaspe.

On the island, access by boat is most convenient to points on the coast. Small harbours, or more precisely, gaps in the wave cut terrace or "reef", are generally located near the mouths of the larger rivers. Consequently weather conditions are an important factor in travelling especially along the south coast of the island.

A limited road system is maintained in the Port Menier area, with one good haulage road extending eastwards to beyond Oil River, a distance of some 75 miles. Smaller lateral roads and tracks extend from this main artery. The road to Harve Girard provides a useful link with the north coast.

Beaches are plentiful and the wave cut terrace is essentially continuous. These form an excellent pathway at low tide. The bluff headlands, especially on the north coast, provide effective barriers against shore travel at high tide.

The bulk of the rivers are not suitable for navigation, due to very low water except during quick spring run off. The Jupiter and the Salmon Rivers however, are navigatable by canoe for some distance under good water conditions. Many of the stream beds form good means of access by foot into the centre of the island during periods of low water. This method was used extensively during the very dry summer of 1955 when many of the water courses dried up.

GENERAL HISTORICAL SKETCH

The bedrock of Anticosti Island belongs to the Ordovician and Silurian periods of geologic time. Three hundred to three hundred and fifty million years ago calcareous mud was being deposited on the floor of shallow, warm seas. Early forms of life thrived, leaving a record in their mud bed home, which later was lifted above sea level by earth crustal stresses and compacted by its own weight. This sequence required millions of years. During this long period of uplift great and small river valleys were formed and no doubt great thicknesses of beds were eroded. Finally, in the last million years, the Pleistocene ice age arrived. Four major ice advances and four long retreats are recognized, each advance burying all of Canada under thousands of feet of ice. As in other parts of Canada, the great weight of the ice depressed the "island" below sea level. Slow rejuvenation after the retreat of each glacier produced remarkable modifications in the local topography.

ORDOVICIAN, SILURIAN CONDITIONS

About 500 million years ago, after 80% of geological time prior to the present had expired, the first geological processes to affect directly the present island began to take place. To the east of the modern Atlantic coast of North America a great land mass called "Appalachia" rose slowly out of the sea while the present east coast and much of Canada was submerged under shallow Ordovician seas. The eastern border of what is now North America was then a broad, gradually sinking, geosynclinal trough which was rapidly filling with pebbles, sand, mud, and calcium carbonate precipitate all derived from the rapidly eroding land mass, Appalachia.

The oldest visible beds on the island have been dated by paleontological evidence as late Ordovician and early Silurian in age. It is probable, however, that great thicknesses of Ordovician and older strata underlie the outcropping beds and that the Pre-Cambrian basement underlie these strata at great depth.

The stratigraphic section of the island is of very great paleontological significance. Nowhere else in North America is there a complete and continuous record of life throughout the transition from Ordovician to Silurian time. In other areas there is a large gap in geologic records due to temporary breaks in sedimentation. Anticosti beds reveal luxuriant marine life, indicating ideal environmental conditions throughout the entire thickness of the Anticostian section, which is estimated roughly as 2400 feet at the thickest point. (G. S. C. Memoir 154, pp 15).

Few beds on the island are absolutely unfossiliferous while many beds virtually consist of an agglomeration of brachiopods, corals, molluscs and, to a lesser extent, other marine animals. The rich abundance of marine life and in particular the great masses of corals suggest shallow seas and tropical climate similar to the habitat of the modern coral. Shallow water conditions are also suggested by the numerous conglomerate beds scattered throughout various horizons. Associated with the conglomerate beds extensive ripple marked beds occur which also are indicative of shallow water deposition.

The composition of the present rocks indicate that the bulk of the sedimentary constituents graded from fine calcium carbonate marine precipitates to a fine aluminous mud. Locally quartz sand was left in the vicinity of Grindstone Bay area. This evidence coupled with a considerable local increase in conglomerate and ripple marked beds suggest an area of stronger marine currents causing a relative thinning of the beds.

As the lime, mud, and small pebbles formed deposits of increasing thickness, the geosynclinal basin gradually sank, due partly to the weight of the sediment and partly to replace the vacuum left in the subterranean zone of flowage by the rising of Appalachia. This combination of sedimentation and sinking allowed great thicknesses of deposition relatively constant depth.

As each bed became covered with the next, earth pressures and sheer weight of the overlying beds began to compact mechanically and aid in chemical binding of the mud and ooze into hard beds of rock.

DESCRIPTION OF FORMATIONS

Anticosti Island is composed of a sedimentary sequence consisting chiefly of limestones and shales. They form a complete and unbroken sequence which spans the period between the Ordovician and Silurian periods of geologic time. As a consequence these strata are of unique interest in that they form the only known bridge in Canada between the above geologic periods. Elsewhere, beds of this age are not known to exist in Canada due either to non-deposition or erosion.

The wealth of marine fauna, both in abundance and diversity of species, makes the Anticostian beds of considerable interest.

The undisturbed and unaltered strata would permit detailed and fruitful study of paleontology and stratigraphy. The G. S. C. Memoir 154 by W. H. Twenhofel describes the diversity of Anticostian fauna. Twenhofel has divided the rocks into the following formations. This division has been made essentially on the fossil content of the strata.

TABLE OF FORMATIONS
(After Twenhofel)

		Formation	Major Rock Types
Silurian	Niagaran	Chicotte	Limestone - 73 feet
Silurian	Niagaran	Jupiter	Limestone Shale 653 feet Limestone
Silurian	Anticostian	Gun River	Alternating limestone and shale 308 feet
Silurian	Anticostian	Becscie	Limestone with shaly partings 199 feet
	Gamachian	Ellis Bay	Shale, limestone little sandstone 200 feet
Ordovician	Richmondian	Vaureal	Limestone and shale interbedded 730 feet
Ordovician	Richmondian	English Head	Limestone and shale 228 feet
	Mohawkian	Macasty	Black shale

The stratigraphy of the beds indicates a continuous sequence of deposition. No stratigraphic discontinuities are known to occur and the lack of unconformities indicate no marked structural or depositional variations. This results in a similarity throughout Anticostian rock types. As a consequence the strata can only be divided into their various formations by means of variations in fossil content.

The several formations as described by Twenhofel have been used as a basis in this survey. The formational boundaries as indicated by G. S. C. Memoir 154 appear to be correctly located.

LIMESTONES

These form the most abundant rock type outcropping on the island. Their mode of formation and their physical and compositional properties vary considerably. Certain varieties appear to be derived from fine carbonate muds while others are composed largely of the fossiliferous remains of marine life. In composition, these limestones range from almost pure calcium carbonates to calcareous shales.

For the purposes of field identification and mapping, they have been divided into several types. This division has not been made on a paleontological basis because of the generally high fossil content of most of the limestones and the complexity of their faunal content.

In general the limestones are more resistant to weathering and frequently form steep cliffs or steep portions of composite cliff faces.

DENSE GREY LIMESTONES

This type of limestone is present in most localities and forms much of the present wave cut terrace. It consists of a fine grained massive rock which often breaks with a conchoidal fracture. The fossil content is generally minor with small molluscs predominating. In many localities this so called dense grey limestone is present in nodular form and the interstices are filled with calcareous shale material. Nodular limestone was best observed in the cliff faces east of Vaureal River.

At Metallic Bay a vertical cliff face consists of interbedded grey dense limestone, nodular limestone, subcrystalline to crystalline limestone and calcareous shale. There is much evidence of flowage in the limestone beds. The beds appear and disappear producing beautiful pinch and swell effects. This flowage occurs in beds of subcrystalline limestone which are underlain by a competent bed and overlain by an incompetent bed of limestone thus allowing the topmost part of the bed to flow. It has also been found that in places the whole bed has been subjected to flowage. This flowing is possible by the recrystallization of the calcite and development of glide planes in the crystals.

In some localities the flowage pattern is developed to such an extent that the rock product can be called a flow breccia. At one particular location immediately west of Salmon River this is well developed. Here the limestone has flowed around broken fragments of more competent rock producing a breccia. This particular breccia is immediately associated with a green calcareous shale which also forms the matrix of the brecciated limestone. Approximately one mile east of Fox River a beautiful breccia exists which seems to have been formed by a combination of flowing and fracturing. Fracturing is probably the major agent. The beds are approximately one foot in thickness and are composed of very highly fractured dense brown limestone. This particular breccia is overlain by a band of very fine limestone containing numerous fossils such as bryoza, brachiopods, crinoids and horn corals. The latter bed is approximately 1/2 inch in thickness.

PETROLIFEROUS LIMESTONE

In the vicinity of MacDonald Bay the wave cut terrace consists of a nodular type limestone which has a dark grey to black colour. When freshly broken this rock has a marked odour of crude oil.

This rock continues to outcrop for some two miles to the east along the terrace. Its known thickness is at least 7 feet, but may greatly exceed this as its base is below sea level. At the cliff face immediately east of MacDonald Bay some three or four narrow beds of similar character outcrop at the base of the cliff. Black surface staining is common in this locality.

The origin of the organic material producing the characteristic odour of crude oil is not definitely known. It is possible that it was deposited along with the original limestone. If this be the case, then its occurrence in limited horizons may be readily explained. However, the organic material may have migrated upwards from the underlying Macasty shale, filling the interstices of the nodular limestone which acted as a stratigraphic host.

SUBCRYSTALLINE TO CRYSTALLINE LIMESTONES

Many of the sedimentary beds encountered on Anticosti Island have been described as fine subcrystalline to crystalline limestones. These beds are very consistent all along the coast and little variation can be seen. Most of these beds are hard and when associated with shale they stand out as erosion resistant beds. They contain many remains of poorly preserved highly compacted fossils. These beds have also suffered much flowage and best illustrate the "pinch and swell" effect mentioned previously. Toward the east end of the island and particularly east of Gullcliff Bay, the limestone becomes more crystalline and produces a granular type of rock. The bed here is approximately 5 feet in thickness and contains numerous small coral reefs. This same bed was observed at mileage 11 on the Salmon River, where it has undergone a great deal of flowage and can almost be termed a breccia. The whole area east of Fox River differs from other localities, in containing many coral heads and it is possibly on this fact that Twenhofel based some of his subdivisions.

The most completely crystallized limestone that was observed occurs at the mouth of the Chicotte River on the south coast of the island. Here the limestone has been recrystallized to a marble with very few traces of fossils remaining. This has been classified by Twenhofel as the Chicotte formation.

SHALES

Calcareous shales form a great percentage of the rocks on Anticosti Island. These shales are blue, grey, green and lilac in colour. The black shale, known as the Macasty shale, has not been found in situ but is believed to exist immediately below the English Head formation. It is highly bituminous and when freshly broken gives a distinct odour of crude oil.

At river mileage 3.5 on Salmon River a bed of greenish micaceous (biotite) shale was observed. This micaceous shale was also located in areas east of Salmon River.

Shales are found all along the north coast of the island interbedded with other rock types. They are very highly fractured and have suffered a great deal of weathering. Especially where thinly bedded they weather out very easily, giving rise to a type of clay. Many of the shale beds contain very well preserved fossils of several species. Because the beds are so soft these fossils can easily be obtained. As was already mentioned these shales are associated with dense grey limestone nodules to form nodular limestone.

INTRAFORMATIONAL CONGLOMERATES

Intraformational limestone conglomerates have been found in many localities and serve as horizon markers. The matrix of these conglomerates is essentially a fine subcrystalline limestone. The pebbles range from very small to 4-1/2 inches in diameter. Some are rounded and others are angular thus indicating very little transportation. At mileage 13 on Salmon River, four distinct beds of limestone conglomerate were observed over a total thickness of approximately 4 feet. These limestone conglomerates were observed as far east as Gullcliff Bay. They possibly represent changes in conditions for deposition. They could represent a great increase in the transporting power of the water, or old scour channels, enabling it to carry coarse material and pebbles. Possibly the angular fragments are a result of sun drying and cracking of unconsolidated beds. Not all, but some of the pebbles are of essentially the same material as the matrix.

IGNEOUS ROCKS

Known igneous activity on Anticosti is limited to two diabase dikes which are located in the area of du Puyjalon cliff on the north coast. These dikes are approximately half a mile apart and outcrop on the terrace at the base of the cliff. Their greater resistance to erosion makes them stand out as walls in the enclosing limestone.

The larger dike lies to the west and strikes northwest extending for some 1000 feet. It is approximately vertical and has a width varying between 50 and 60 feet. This rock is a fine grained, banded diabase. The easterly dike is considerably smaller and strikes at N30W.

Minor contact metamorphism has accompanied these intrusives producing narrow bands of hard, altered limestone. This contact zone has been weakly fractured and jointed along with the dikes. Such fractures are now filled with calcite.

SEQUENCE OF DEPOSITION IN CERTAIN LOCALITIES

To give a better picture of the rock types present in the area the sequence of deposition for certain localities will be noted.

1. <u>West Cliff</u>

    1) Sub to crystalline limestone.

    2) Grey highly fractured calcareous shale.

    3) Crystalline limestone.

    4) Dense grey limestone.

2. <u>First cliff approximately one mile east of Vaureal River</u>

    1) Hard, dense grey limestone.

    2) Intraformational limestone conglomerate with pebbles up to 4 inches in diameter.

    3) Nodular, brecciated grey dense limestone.

    4) Hard dark grey dense limestone.

    5) Brownish grey dense limestone.

    6) Hard subcrystalline limestone, much evidence of flowage and consequent brecciation. Some of these beds show the effect of flowage on the top, others on the bottom and again others on both the top and bottom.

    7) Nodular grey limestone.

    8) Subcrystalline limestone.

    9) Nodular limestone.

    10) Highly compacted fossiliferous subcrystalline limestone. Most of these beds have fine shaly parting.

3. <u>Guy Point (East of Vaureal)</u>

    1) Dense bluish grey limestone.

    2) Intraformational limestone conglomerate.

3) Nodular limestone (consists of dense grey limestone and calcareous shale).

4) Grades from sub to crystalline limestone.

5) Dense grey limestone.

6) Nodular limestone, as above.

7) Grades from sub to crystalline limestone.

8) Intraformational limestone conglomerate.

The above sediments represent a thickness of approximately 15 feet.

9) Nodular limestone.

10) Dense grey limestone.

11) Nodular limestone.

12) Hard crystalline limestone.

13) Nodular limestone.

14) Dense grey limestone.

15) Nodular limestone with calcareous shale filling the interstices. Further up cliff there is a great increase in the amount of calcareous shale.

4. <u>Mileage 13.5 on Salmon River</u>

1) Siliceous looking almost dense grey limestone.

2) Dense light grey limestone.

3) Minutely banded fine subcrystalline limestone.

4) Intraformational limestone conglomerate.

5) Dark grey minutely banded subcrystalline limestone.

6) Dense grey limestone.

7) Intraformational limestone conglomerate.

8) Minutely banded subcrystalline limestone.

9) Crystalline limestone.

10) Intraformational limestone conglomerate.

11) Light grey dense limestone.

12) Intraformational limestone conglomerate.

These last three beds are separated by fine shaly partings.

5. <u>One mile east of Fox River</u>

1) Intraformational limestone conglomerate.

2) Dense brownish grey limestone.

3) Intraformational limestone conglomerate.

4) Subcrystalline dark grey limestone.

5) Highly fractured, brecciated dense brown limestone.

6) Finely banded lighter brown subcrystalline limestone.

7) Same as No. 5.

8) Same as No. 6.

9) Same as No. 5.

10) Intraformational limestone conglomerate.

11) Slaty fine subcrystalline dark grey limestone.

12) Same as No. 5.

13) Fine intraformational limestone conglomerate.

The above sequence represent approximately 10 feet.

14) Same as No. 5.

15) Finely banded subcrystalline limestone.

16) Same as No. 5.

17) Intraformational fine pebbled limestone conglomerate.

6. Cape Sandtop

The first 15 feet of the cliff consists mainly of dense brown limestone interbedded with calcareous shale. At the 10 foot level there is a highly fossiliferous bed of dense brown limestone containing brachiopods, bryozoa, crinoid stems and trilobites.

At the 15 foot level there is a bed of intraformational limestone conglomerate.

17 feet - Limestone conglomerate.

20 feet - Limestone conglomerate.

20 feet to 23 feet - Dense brown limestone, subcrystalline limestone and calcareous shale.

23 feet - Intraformational conglomerate.

23 feet to 50 feet - Repetition of previous beds.

50 feet - Intraformational limestone conglomerate.

55 feet - Bed of limestone conglomerate containing many grapholites.

From here to 100 feet the sequence consists of interbedded subcrystalline limestone, crystalline limestone, limestone conglomerate, brown dense brecciated limestone and calcareous shale. Many of these beds are highly fossiliferous.

7. Approximately 1 mile west of Gullcliff Bay

The first 15 feet consists of brown dense limestone, calcareous shale and subcrystalline limestone.

A striking feature is that this first 15 feet contains abundant coral heads, unlike many areas previously mapped. The last 15 feet is of similar sediments but lacks the great abundance of coral heads.

8. One mile east of Gullcliff Bay

Sequence consists of subcrystalline to crystalline limestone showing much evidence of crenulation and flowage, which forms thick beds of limestone breccia. This exposure also contains numerous coral heads but is in no other way similar to the last exposure containing numerous coral heads.

SUBSEQUENT STRUCTURE

The next stage in the formation of the rocks was one of uplift. The time is not known excactly, but it is probable that the uplift occurred during the period when the Gaspe and Appalacian beds were intensely folded. This was at the end of the Ordovician period and continued through early Silurian when the great mountain building known as the Taconic orogeny, some 300,000,000 years ago took place. Between Anticosti and the Gaspe there is a large fault (Logan's Line) running up the St. Lawrence River from the Gulf of St. Lawrence. To the south the rocks are highly folded, while in Anticosti to the north the rocks have only a gentle dip of 1° - 5° to the south.

Anticosti structure is essentially simple. The beds are generally flat dipping to the south at 1° - 5°. This general dip is modified by anticlinal and synclinal folds whose axes trend generally north-south.

These folds may more appropriately be called rolls as they are so small that detection would be extremely difficult except for the sensitive indicator lineations visible on the wave cut terrace.

The main set of joints trends from 275° to 285°. These are parallel to strike and do not appear to be deflected by the smaller rolls.

The lesser or secondary set of joints trend generally in a direction perpendicular to the primary. These are explained by the stresses set up in the formation of the small rolls. These joints trend from 10° - 30° T and are parallel to the axes of the folds.

Folding and tilting of rocks set up internal stresses which disturb the continuous bedding plane. Where a thick series of beds is folded there is a stress built up tending to make the beds slip between their bedding planes. The effect is the same as folding the pages of a book or a pack of cards. Depending on the competency of the rock beds the result of these stresses may be faulting, jointing or brecciation.

The Anticosti beds are both brecciated and jointed but as the jointing cuts the brecciation it is indicated as younger. Brecciation is very widespread throughout the whole cross section, varying in intensity from a minor shattering effect to local horizons up to 6 feet in thickness consisting of contorted, dragged, and rolled up beds. Between Joseph Point and Table Head brecciation is strongest, rolling up thin beds like jelly rolls and causing others to flow like putty.

Conditions for brecciations began with the Taconic uplift and consequent folding of the then young Ordovician and contemporary Silurian mud beds. At this stage the rock was relatively soft and subject the deformation under the tremendous pressure of its own weight. The stresses set up due to the tendency to slip down dip and to slip between beds on a roll or fold were relieved by either a fine shattering of the individual bed or by flowage or both. The nodular type limestone of the island is a typical result of this condition. In many such beds there is a tiny shaly film between two limestone beds. These probably are produced directly by the friction of the beds which suffered slight movement. In such cases the movement has been only great enough to shatter the rock without flowage.

The next degree of brecciation is caused by greater movements which produced fracturing and shattering of the more competent beds and flowage on those less competent. This type of brecciation is very widespread. Flowage lineations, generally following old bedding planes, can be seen with sharp angular inclusions of the underlying or overlying harder beds. Certain flowage beds include small rollers of the competent beds between which they flow giving on the cross section surface a conglomeratic appearance such as in the cliff on the east side of MacDonald Bay.

Brecciation displacement becomes more pronounced eastward reaching its peak near Table Head after which the motion appears to be less. This, however, may be due to absorption of a disproportionate amount of the total displacement by certain horizons.

From Joseph Point to Table Head there are two discontinuous horizons each about 6 feet in thickness which display a highly contorted breccia flow. Here large sharp drags, which often are overthrust, create a very impressive etching effect on the weathered surface. In some places in this area beds have been rolled up like a jelly roll within the flowage horizon.

Within the strongly brecciated area from Joseph Point to Table Head a high silica content is apparent in many of the bands. The silica weathers out as very fine sand grains and produces a sand beach such as is rare on the island. Also associated are biotite flakes which give rocks in the area lineations varying from slaty cleavages to a biotite schist.

The brecciation brought about a major main variation in rock type. Before this process the beds probably were a very uniform muddy grey in colour. Earth stresses caused beds with certain proportions of impurity to react differently than did others with different composition. The muddy beds appear to have flowed readily while the purest beds of limestone, which were generally an agglomeration of marine fauna, flowed and crystallized, but not without leaving traces of brachiopods. Other less pure limestones developed a micro-crystalline texture. Muddier calcareous beds were left with a fine clayey texture while the muddiest were transformed into fine grained shales. Superimposed on this generality of rock types are the flowage schists and pressure slates. The sandy phase was a second variational factor which aided in formation of biotite schist, and beds of lesser cleavage as well as sandstone beds. The conglomerate beds were generally competent though many have apparently flowed and are brecciated.

About a hundred million years later, the old Taconic mountain range that had formed to the south had been peneplaned and again were submerged. At the end of the Permian period these beds began to rise and then were folded into the present Appalachian mountain range system. This activity extended north of the Gaspe coast only to the Logan fault about 20 miles south of Anticosti. It is reasonable to assume the rocks of Anticosti were affected. It appears that this time the island was again uplifted by forces very similar to those by which it was affected during Taconic orogeny. The rock now was much more compacted and brittle than during the first uplift. The stresses set up by the second uplift were mainly absorbed by jointing with probably little or no brecciation.

The jointing, considered as being controlled by the regional dip and the small rolls, is remarkably constant. In practically all areas two general joint directions are noted. The primary direction is the strike joint trending about 175° - 185° T. This set is caused by the traverse stresses set up by the tilting of the beds to their present dip. The joints are considered primary because of their larger size and remarkable straightness, even when cutting through rolling structure. The secondary joints are perpendicular to the first and strike between 10° and 30°. They are the product of stresses set up parallel to the direction of the axis of the small anticlinal and synclinal folds. As a result of the very uniform dip and small rolls this joint pattern is generally constant although it shows small variations in some areas. The uniformity of the structure and homogenity of the rocks has apparently aided in the uniform distribution of stresses in brecciation and jointing so that faulting has been negligible.

PLEISTOCENE MODIFICATIONS

Since Permian time no major earth movements have affected the Anticosti strata. The area continued to be eroded until the present epoch. During this period the great Laurentian River trough formed north of the island and a great valley developed to the south along Logan's line leaving the "island" a high area in the centre. Such were conditions up to 1,000,000 years ago when the first modern glacier began to move down from the north to cover essentially the whole of Canada and the Northern United States.

As the continental type glacier advanced it scoured and plucked, scratched and gouged the existing topography under the weight of thousands of feet of ice. The accumulation of such thickness of ice over half a continent set up stresses which disturbed the balance of the earth's crust. As the glacier advanced the earth's crust which was affected began to settle slowly. The old Laurentian River Valley was depressed below present sea level, submerging also what is today Anticosti Island. Ice flowing over the island gouged out old river valleys and plucked at the flat southward dipping beds. The island was ice bound for some 100,000 years being released only as the climate became warmer. With the removal of the ice another readjustment of the earth's crust was necessary and the glaciated area began to rise.

As the top of the island began to emerge from the sea, wave action was the dominant erosional agent. When the flattened area became too large to be cut by waves as fast as it rose the first flat terrace emerged from the sea. Waves then began to cut cliffs into the sides of the island and built another terrace at a lower level. The process of terrace and cliff erosion was repeated several times during the emergence of the island.

Two hundred thousand years after the retreat of the first continental glaciers the second ice front began to advance, then the process was repeated. Four such glaciations occurred, submerging and scouring the island, the last one withdrawing less than 25,000 years ago. Each time the island rose the terraces became longer, cutting back deeper into the cliffs and piling up gravel and glacial sediments, cut from the terraces, as marginal beaches.

The evidence of glacial modifications of topography is confined largely to the last glaciation as repeated scourings and submersions destroyed most of the evidences left by previous glaciation. The present topography of the island has largely developed since the last glacier. There is however, some evidence of integlacial topography. Many river valleys show the effects of glaciation and must therefore be at least interglacial in age. Rivers such as Oil, Potato, Vaureal, Jupiter and the Salmon all show such effects. Glacial modifications in the form of wide U shaped valleys, exist in the lower portions of many rivers. The Vaureal Falls have cut back to their present position since the last glaciation.

The Potato River shows best the effects of glaciation. The lower part of its valley is filled with glacial clay to an estimated depth of 100 feet. This clay was probably deposited under water trapped between the northerly retreating ice and the watershed to the south. Into this lake was dumped fine glacial material which settled out into what is now a very thick deposit of varved clay. About a mile up the Potato River there is a thick terminal moraine of absolutely unsorted till varying from fine clay up to 15 inch boulders.

In the Dion or Observation River an esker was found in-bedded in the clay. Here a subglacial river had apparently cut gently into the terrace under the ice. There it deposited gravel and fines to form an esker. As the ice melted a lake developed in the old valley and clay was deposited, burying the esker. Overlying this clay is raised beach material which probably was caused by sea action when the retreat of the ice allowed the sea into the sunken Laurentian Valley. Since the clay has been set down on top of a terrace and since terraces can be cut only during the rising of the island, at least one period of submergence occurred before the last glacier. This is the only observed evidence of such repeated movements. As the island was depressed by the last continental glacier it is evident that the three preceding ones would have had, however, the same effect of depression and subsequent rejuvenation.

From observation beyond the present terrace it appears that the terrace step effect of the island continues far out to sea and at depths far below the present wave cutting limit. Hydrographic charts seen did not contain conclusive detail but indicated that terraces do continue out under sea level and follow closely the contours of the present shoreline. Such evidence appears to indicate that the island suffered other emergences, and has in the past emerged to a considerably greater height than it is at present. This is to be expected as the island appears to be still rising, and as in previous interglacial periods there was a much longer period during which the island could rise (up to 100,000 years between glaciers as compared with not more than 25,000 years since the last retreat).

The elevation leaves physical evidence in the general topography of the island. The wave cut terrace, the cliff faces, coastal water falls, strike line coast line, and gravel deposits, are all products of the rejuvenation.

The forces which built the series of terraces are still at work today cutting the present remarkably large "reef" which extends out from the shoreline in most parts of the island, in some places up to a mile. Wave motion is not merely a surface effect but a system of currents reaching down to a depth of one half a wave length. With wave lengths of 60 feet common around the island, erosive action works at least to a depth of 30 feet.

The strike line coastline displays a text book example of uniformity of structure. At least from MacDonald River to Fox Bay and possibly from Bay Martin to Heath Point the same hard bed from place to place is believed to be exposed. This bed is in many places conglomeratic with hard micro-crystalline pebbles which change to coral pebbles towards the east end of the island, while the matrix is a fine grained white weathering siliceous limestone, relatively very hard. The horizon forms a thick massive bed and is as such, quite distinguishable from the other island beds. The cliff faces are generally anticlinal rolls while the bays are generally synclinal. This is reverse to the normal text book occurrence due to weaknesses which develop in streched anticlinal folds, and it is believed that in this case the hard bed is the controlling factor. Without this decisive hardness the synclinal rolls would form the cliff promontories and the anticlines would become bays. This unusual effect appears to have been caused by waves coming in contact with the south dipping harder bed farther from shore on the synclinal troughs than on the anticlinal counterpart. This gives more erosional time to the syncline as anticlines are eroded by wave force much diminished by the extra length of terrace over which they must pass before their effect is felt.

The conglomerate bed consequently appears along the shore in many non rolling sections and on the cliff points in anticlinal sections. The overall effect is one of a strike line coastline with modifying erosional characteristics such as bays. The more detailed modification of jointing on the coastline tends to direct the coastline in zig-zags striking 280° and 20°. The formal controlling factor of the present coastline and of the older shore cliffs is therefore the undulating structure which is responsible for both the strike line of the hard beds and the jointing pattern.

OVERBURDEN

Gravel and sand are produced by erosion of cliffs and terraces. The overburden of the island is largely composed of beach materials. In the older valleys glacial sediments are found but are of relatively minor importance. Much of the raised terraces are covered with gravel and fines with the fines predominating to make the gravel of less economic value. There are, however, large areas overlain by gravel to considerable depths as well as old beach lines which are now large ridges of beach gravel. These beaches generally follow the contours of the present shoreline and their lineations can easily be determined from air photo interpretation.

ANALYSIS OF THE LATEST UPLIFT

Evidence of uplift and discussion of the forces of uplift has already been dealt with in a general fashion as it concerns the terraces, the shore cliff pattern, the raised beaches, and the island drainage. In analysing the present uplift more specific and unspoiled evidence is available which discloses a tendency for the island to rise differentially. The north side of the island apparently is rising at a rate significantly greater than is the south side. One possible factor causing the disproportionate rising may be that the north side of the island was depressed farther by the glacier mass. The difference may be due to lack of elasticity along the Logan fault to the south.

Evidence of the greater uplift on the north side of the island is afforded by study of the island's drainage pattern. If the island were rising at a uniform ratio the drainage pattern would be generally simple and constant, with rivers cutting steadily downward and backward from the coasts to the highest points of land. These would be the first terrace to emerge and would generally be equidistant from the present north and south coasts. That, however, is not the case is plainly seen from the air photo mosaic. In the first place, northward facing shore cliffs are visible only three miles from the south coast. These possibly represent the first terrace to emerge. The greater part of the island has since risen north of this terrace. Many of the major shore cliffs to the north rise to a greater height than this initial terrace.

The drainage pattern follows the course to be expected from this condition. When the first terrace emerged ground waters would run both north and south, cutting valleys in the structurally and lithologically less competent areas. As the island continued to rise another flat terrace would be elevated to the north; water would spill down from the cliff to the north, finding a channel to the sea. The source of the north flowing rivers would largely be the valley already cut in the first terrace, the slope being steeper than the angle of inclination to the south caused by the extra rise of the north side. As the island continued to rise the south slope becomes greater and as a consequence, the sources of the south flowing streams move further and further north. This process will continue as long as the island continues to follow its present pattern of uplift.

The sources of the south flowing rivers are now found to be well north of the centre of the island and in one case, a stream rises only one mile from the north coast. As the sources of these rivers are north of many of the north facing shore cliffs the streams appear to flow up and over the cliffs. In reality what probably happened is that deep valleys had cut into those north facing shore cliffs in the period shortly after uplift. As the land continued to rise to the north, drainage across the new north facing terrace reversed as the south slope increased. This caused the north flowing river to back up until a lake was formed, trapped in the old valley. Many instances of such lakes are to be noted on the aerial photographs today. As the land to the north continued to rise, each lake became longer and deeper till eventually spilled it back over the south end of the scarp and made its way as a stream unhindered to the south. Erosion then slowly drained the lake by enlarging and deepening the stream channel. In some cases, the lake has entirely disappeared and only its old outline can be seen.

In some cases, as the lakes built up in the old valleys, a river formed, flowing along the edge of the cliff. Such river would travel along the edge of the cliff until another valley with a lake trapped in it was reached. The additional water would then accelerate the backward cutting of a new valley. Some of the lakes still exist as they have not cut the barrier to the south, and their water escapes through a channel already cut in a neighbouring valley.

Stream piracy by the south flowing streams is very prevalent. This is revealed in detail by stereoscopic examination of the watershed area. North flowing streams are being diverted to the south in small and in some cases relatively large pieces. Former north flowing rivulets have in many cases reversed or dried up. These streams seem to blend into swamps at their source and nowhere appear to be cutting. Conversely the sources of the south streams are cutting rapidly into overburden and rock forcing their way farther and farther north.

Another effect of the differential rate of rising is that water falls cut back into the terrace about a mile from the sea on most of the north flowing streams. The larger rivers have cut back several miles to their falls. The Vaureal Falls (250-300 feet high) are eight miles from the sea and the Potato River Falls about nine miles inland. In contrast to the fast flowing and falling rivers to the north, the southern rivers generally cut slowly along their sources, most of them over gravel beds exposing very little outcrop on their sides. Falls on the south rivers are negligible.

The south coast shows relatively little signs of uplift. Southward facing shore cliffs extend inland up to a maximum of approximately three miles. The areas between these shore cliffs and the present coast are largely covered with a thick layer of gravel and fines. As the land gradually rose gravel spits have been built up in bays and in front of the rivers giving the south shore a comparatively straight coastline. These spits have grown southward as more gravel washed up from the sea leaving many small salt "lakes" which have been trapped. These lakes become fresher with distance from the sea. Such lakes gradually become silted up, and though many exist today many more have entirely silted up. The former lake beds are easily distinguished on air photos from the surrounding gravel. This process of spit building probably explains the great depth of gravel in the pits of the Ellis Bay area.

From the air the unbalanced emergence of the island is very nicely displayed. One can see the general slope of the whole island towards the south. Each individual terrace has its own slope. The present northern terrace is flat while the second one inland dips slightly to the south. The slope on the third is greater and on the fourth greater still. Even the old terraces on the south side of the island slope to the south. This effect is gradually increasing slope is to be expected because as the old terraces are developing and increasing their southward slope, the newly cut terraces are emerging flat and begin to develop their own slope only after cutting has finished.

RATE OF UPLIFT

The speed of the uplift and especially the speed of the north side relative to the south side is impossible to determine upon the known evidence except in a very general fashion. The speed of the uplift and the rate of difference of speed of the north and south side both appear to have varied locally, and varied also at different periods of time. A crude estimate of maximum speed may be made by considering the highest point of the island, which is now 625 feet above sea level. Uplift to at least that height since the last retreat of glaciation must have taken place. If 25,000 years is allotted to the last glacial free period, the island at that point must have risen at least one foot every forty years. In reality the rate must have been greater, the assumption that the island was at sea level when its rejuvenation began is not valid, there being other shore cliffs to the south. The estimate also assumes that rejuvenation began immediately after the ice retreated. Such assumption is not necessarily valid.

Emergence on the south shore has been much less and in some places especially near the southeast end of the island the total rise may not reach thirty feet. Radioactive carbon tests on beach clams and whale bones which are found inland in gravel deposits may provide a more accurate time estimate.

EFFECTS OF STRUCTURE ON TOPOGRAPHY

The major topographic features of Anticosti Island are considered to be the result of Pleistocene to recent environmental conditions. These have been described above. The structures predating these periods, however, have exerted a strong influence on the present day topography. The manner in which the pattern of headland and bay on the island coastline, both present and past, have been built and modified by gentle anticlines and synclines in conjunction with jointing, has been explained.

One of the noticeable features of the easterly portion of the north coast is the marked parallelism displayed on the straight sides of the bays. Careful examination of this feature showed that in each case this phenomenon is due to erosion along the secondary joint pattern which strikes 10° - 30°.

Many of the rivers show a marked preference for certain directions of flow. This produces a characteristic pattern for the majority of the rivers. The preferred directions are those of the jointing. Examination of river banks and cliffs confirm this observation. Jointing is the major structure controlling the direction of rivers on both a large and a small scale.

ECONOMIC GEOLOGY

MINERAL POTENTIAL

The geological survey conducted during the summer of 1955 was directed principally towards investigating the economic potential of Anticosti Island. The field crews were equipped with geochemical field kits for testing heavy metal content of both soils and water. Each party used geiger counters throughout the survey. This equipment was used extensively, but only in one instance was even a low geochemical anomaly obtained.

Although only a portion of the island was investigated, the survey indicates that the possibility of economically significant metallic deposits on the island is very poor. The unaltered character of the strata combined with a lack of major structures point to a low metallic mineral potential.

Elsewhere in Canada metallic sulphides are usually intimately and genetically associated with igneous intrusion. Such intrusion invariably alters the invaded rock and produces a characteristic metamorphic alteration. No such alteration was observed. Major structures, such as faults, frequently act as channelways for the ore-bearing fluids and may also provide physical conditions suitable for mineral deposition. No such major breaks have, as yet, been located.

In only two locations were any metallic minerals located during the summer. The more significant consists of a pyrite-rich zone approximately 3 miles east of Fox Bay. This zone is some 2-1/2 feet thick and is known to extend for at least 650 feet. Its general appearance suggests a syngenetic origin. Geochemical testing of the soil in the area indicates the presence of heavy metals, other than iron and manganese, in appreciable amounts. Field tests gave results ranging from 50 parts per million to 250 parts per million in combined metallic content. The average content in the area is approximately 50 ppm and as a consequence the 250 ppm is considered significant. This mineralized area is located on a small magnetic "low" near the east side of the steepest magnetic "high" on the airborne magnetic sheets of the island. The two fractures combined suggest that further work in this area should be done.

Some weakly disseminated pyrite was found on the Salmon River between mileage 4 and mileage 7. Traces of fine grained pyrite cubes occur along this entire belt. Geochemical testing in this area showed no anomalous results. It is considered that this is syngenetic pyrite and it is unlikely that the area merits further investigation.

NON METALLICS

1. Construction Material

Anticosti Island contains an inexhaustible supply of gravel and pebble beds suitable for road material and possibly for concrete aggregate. These have been used exclusively for road material on the island.

The location of such beds is quite simple as they consist essentially of raised beaches which are readily distinguishable on air photographs. Shallow overburden in most known instances make the testing of such deposits a relatively simple problem.

The location of future roads on the island will undoubtedly be influenced by the size, grade and location of these deposits.

2. Cement

Limestones and shales are the chief constituents of the Anticostian rocks. These two grade one into the other so that argillaceous limestones and calcareous shales are common rock types. Consequently it is expected that bulk analyses of the rock types will prove their suitability for the manufacture of cement. It is considered that the iron and magnesium content will be sufficiently low for Portland Cement but that the silica content may not come up to required specifications in many areas. Those rocks outcropping along the northeast coast probably contain sufficient silica (12-15%) for this purpose.

The prevalence of cliff faces, combined with the flat dip of the strata would facilitate quarrying. These conditions are best found on or near the coast where a ready means of transportation is available.

3. Hydrocarbons

The possible potential for both oil and gas on Anticosti Island at this stage is highly interesting. Rocks of similar age and type are known to contain oil and gas bearing horizons in the Gaspe peninsula. To date there are no known economic deposits in Gaspe, but exploration is continuing in the area.

Certain beds of Anticosti are known to contain significant amounts of hydrocarbons. The Macasty shale, immediately underlying the English Head formation, is one of the better known petroliferous rocks of the area. This is considered to outcrop just below the sea level and is of undetermined size. Although these formations are probably of limited thickness, they indicate favourable conditions for the deposition of hydrocarbons. Other buried strata may contain much richer concentrations.

The apparent lack of structures favourable for the accumulation or concentration of oil and gas does not rule out the possibility of concentration by other means. Coral reefs are known to exist and at the present surface are more abundant on the east and central areas of the island. These reefs form a comparatively porous bed or "sponge" which would be capable of absorbing considerable quantities of gas and oil if repeated at depth. In other coralline bearing areas, reefs trend to occur over a considerable vertical range, essentially one below the other.

The evaluation of the oil and gas potential of Anticosti

Island should take into account the possibility of oil bearing reefs. Future exploration along these lines may prove that the oil and gas potential is greater than would be expected from only a casual examination.

ACKNOWLEDGEMENTS

The geological staff is indebted to those kindly people of Port Menier along with the various light house keepers on the island. In all manner of ways they have aided the survey and shown a friendly interest in our work.

Especially may we thank Mr. Girard, the island manager, Mr. Charley MacCormick and Mr. Grant Meyer, for their knowledge, help and courteous assistance at all times.

Mr. Horace Freeman, Research Director of Consolidated Paper Corporation and Manager of Gamache Exploration and Mining Company Limited, at all times helped us with his knowledge of the island, his understanding and enthusiasm.

McPHAR GEOPHYSICS LIMITED

E. G. Robinson,
Geologist.

Dated: February 10th, 1956.

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GAMACHE EXPLORATION AND MINING LIMITED

LIST OF SPECIMENS COLLECTED ON

ANTICOSTI ISLAND, QUEBEC

1955

Specimen Number	Serial Number	Rock Type	Location
1	D8/6-3	Calcareous-clay-shale and brachiopods	Ance au Fraise
2	D8/6-1	Black pebble conglomerate	"
3	S-18-1	Shaly limestone	West Cliff
4	S-18-2	Subcrystalline limestone	"
5	S-18-3	Subcrystalline limestone	"
6	S-18-4	Subcrystalline limestone	"
7		Macasti shale	
8	D6/23/1A	Micro-crystalline limestone	Oil River Valley
9	D6/23/1B	Micro-crystalline limestone	"
10	D6/23/1C	Crystalline-limestone fossiliferous	"
11	D6/23/2	Micro-crystalline limestone	"
12	D6/23/3	Micro-crystalline limestone	"
13	D6/23/3A	Micro-crystalline limestone	"
14	D6/23/3B	Crystalline limestone	"
15	D6/23/3C	Micro-crystalline limestone	"
16	D6/23/9	Macasti shale	"
17	D6/23/14A	Clayey-calcareous shale	"

Specimen Number	Serial Number	Rock Type	Location
18	D6/23/14B	As above with fossils	Oil River Valley
19	D6/23/14C	Crystalline limestone showing	"
20	S-23-3	Subcr stalline limestone	Eastward from Oil River
21	S-23-4	Brownish grey shaly limestone	"
22	S-23-5"	Subcrystalline limestone	"
23	S-23-5'	Nodular shaly limestone	"
24	S-23-1	Intraformational limestone conglomerate	"
25	S-25-1	Subcrystalline limestone	"
26	S-25-1"	Dense grey limestone	"
27	S-25-2	Reddish fine crystalline limestone	"
28	S-25-3	Reddish sub-crystaline limestone	"
29	S-25-4	Intraformational limestone conglomerate	"
30	S-25-5	Fossiliferous shalv limestone	"
31	S-25-6	Dense fossiliferous grey limeston	"
32	S-25-7	Calcareous shale	"
33	S-25-8	Dense grey limestone	"
34	S-25-8	Dense grey limestone	"
35	S-26-1	Subcrystalline limestone	"
36	S-26-1'	Dense grey limestone	"
37	S-26-2	Calcareous shale	"
38	S-26-2'	Subcrystalline limestone	"

Specimen Number	Serial Number	Rock Type	Location
39	S-26-6	Grey subcrystalline limestone	Eastward from Oil River
40	S-26-7	Grey subcrystalline limestone	"
41	S-26-8	Cellular subcrystalline limestone	"
42	S-27-6	Cellular subcrystalline limestone	"
43	S-27-5'	Cellular subcrystalline limestone	"
44	S-27-5	Subcrystalline limestone	"
45	S-27-4	Subcrystalline limestone	"
46	S-27-3	Crystalline limestone	"
47	S-27-2	Intraformational limestone conglomerate	"
48	S-27-1	Intraformational limestone conglomerate	"
49	$S-28-7_3$	Subcrystalline limestone	"
50	$S-28-7_2$	Dense grey limestone	"
51	S-28-6	Cellular cyrstalline limestone	"
52	S-28-5	Subcrystalline limestone	"
53	S-28-4	Dense grey limestone	"
54	S-28-3	Subcrystalline limestone	"
55	S-28-2	Cellular looking subcrystalline limestone	"
56	S-28-1	Cellular looking subcrystalline Limestone	"
57	S-29-2	Blue shaly limestone	"

Specimen Number	Serial Number	Rock Type	Location
			(Proceeding East to MacDonald Bay)
59	$M-12-2_3$	Slightly metamorphosed limestone	Du Puyjallon Cliff
60	$M-12-2_2$	Slightly metamorphosed limestone	"
61	M-12-2	Diabase from dike	"
62	M-12-1	Slightly metamorphosed limestone	"
63	$M-11-2_3$	Subcrystalline limestone	"
64	$M-11-2_2$	Subcrystalline limestone	"
65	$M-11-2_1$	Calcareous shale	"
66	M-11-1		
67	M-9-3	Petroliferous limestone	"
68	M-9-1	Cellular looking subcrystalline limestone	"
69	$M-8-2_1$	Nodular shaly limestone	"
70	M-8-2	Subcrystalline limestone	"
71	M-8-1	Siliceous looking subcrystalline limestone	"
72	M-7-9	Subcrystalline limestone	"
73	M-7-8	Crystalline limestone	"
74	M-7-7	Hard dense grey limestone	"
75	$M-7-6_3$	Subcrystalline limestone	"
76	$M-7-6_2$	Calcareous shale	"
77	M-7-5	Greenish calcareous shale	"
78	M-7-4	Subcrystalline limestone	"

Specimen Number	Serial Number	Rock Type	Location
			(Proceeding East t[o] MacDonald Bay)
79	M-7-3	Crystalline limestone	Du Puyjallon Cliff
80	$M-7-3_3$	Intraformational limestone conglomerate	"
81	M-7-2	Subcrystalline limestone	MacDonald Bay
82	M-7-A	Petroliferous limestone	"
83	7-16-2A	Siliceous conglomerate	W of Vaureal River
84	7-16-2B	Siliceous conglomerate (matrix base)	"
85	7-15-1	Crystalline flow breccia	"
86	7-24		Vaureal River
87	7-24-14	Flow breccia	"
88	7-25-1	Flow breccia	"
89	7-25-5	Pearly pebble conglomerate	"
90	7-25-5A	Coral	"
91	M-20-3	Fossiliferous limestone (reddish fossils)	Eastward from Vaureal River
92	M-20-2	Crystalline limestone	"
93	M-20-1	Brown calcareous shale	"
94	E-12-1		E to Salmon River
95	E-18-2	Siliceous looking subcrystalline limestone	Salmon River
96	E-18-1	Siliceous looking subcrystalline limestone	"

Specimen Number	Serial Number	Rock Type	Location
97	E-18-2	Siliceous looking subcrystalline limestone	Salmon River
98	E-19-1	Fine crystalline limestone	"
99	E-17-2	Micaceous (biotite) calcareous shale	"
100	E-17-1	Micaceous (biotite) calcareous shale	"
101	E-15-2	Reddish crystalline limestone	"
102	E-15-1	Dense brown limestone	"
103	D8-19-6	Siliceous calcareous slate	"
104	D8-15-1	Siliceous fine texture crystalline limestone	"
105	D8-15-1A	Sandstone	"
106	D8-15-1B	Biotite calcareous siltstone	"
107	D8-15-1C	Biotite slate	"
108	D8-15-1D	Biotite slate	"
109	D8-15-1E	Biotite gneiss	"
110	D8-15-1F	Biotite slate	"
111	D8-15-1G	Biotite slate	"
112	D8-15-5	Coarse crystalline conglomerate breccia	"
113	D8-15-7	Sandy biotite gneiss	"
114	D8-15-9	Calcareous siltstone	"
115	D8-15-9A	Diorsidic gneiss	"
116	D8-15-9B	Biotite gneiss	"
117	D8-16-5	Sandy limestone	"

Specimen Number	Serial Number	Rock Type	Location
118	D8-16-8A	Micro-crystalline limestone	Salmon River
119	D8-16-8B	Sandy siltstone	"
120	D8-17-7	Biotite slate	"
121	D-8-23-11	Siliceous marl banded	W of Fox River
122	D-8-26-2	Breccia	"
123	D-8-26$_4$	Pearly pebble conglomerate	"
124	E-21-1	Fine intraformational limestone conglomerate	E from Fox River
125	E-21-2	Slightly schisted brown limestone conglomerate	"
126	E-22-4	Micaceous slaty limestone	"
127	E-22-3	Slightly metamorphosed limestone	"
128	E-26-1	Crystalline limestone	"
129	D6/17-1	Fossiliferous limey shale	Road E of Port Menier
130	D6/17-3	Crystalline breccia	"
131	D6/17-3A	Calcareous clayey shale	"
132	D6/17-4	Crystalline limestone	"
133	D6/17-5	Sandstone	"
134	D6/17-11	Flow breccia	"
135	D6/17-13	Flow breccia	"
136	D6/17-13A	Micro-crystalline breccia	"
137	D6/17-14	Clayey limey shale with mud cracks	"
138	D6/17-15	Micro-crystalline breccia	"
139	D6/17-15	Calcareous sandstone	"

Specimen Number	Serial Number	Rock Type	Location
140	D6/18-5		Road W of Port Menier
141	D6/18-5A		R
142			Jupiter River (0 Mi)
143 & 143A			Torn Breeches creek
144			16 miles
145			16 miles
146			22 miles
147			30 miles
148			32 miles
149			35 miles
150			35 miles
151			Chicotte River
152			"
153			"
154			"
155		Chicotte marble	"

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