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THE GEOLOGIC HISTORY OF THE FORILLON PENINSULA AND CAPE BON AMI PROVINCIAL PARK

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QUEBEC DEPARTMENT OF NATURAL RESOURCES
Honorable Paul-E. Allard, Minister

MINES BRANCH



THE GEOLOGIC HISTORY
of the
FORILLON PENINSULA
and
CAPE BON AMI PROVINCIAL PARK

by H.W. McGerrigle

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The reader will find in Popular Geology Series No. 1 an introductory section on "Gaspé Peninsula and Geologic History" which outlines some of the main ideas and laws of geology as a science, particularly as these apply to the peninsula. This publication is a road-log that pin-points many geologic features to be seen along or near Route 6.

FOREWORD

The Geological Services of the Québec Department of Natural Resources are preparing a series of non-technical pamphlets on the geology and geologic history of many parts of the Province. This series is intended to introduce to residents of the Province and to tourists some of the fundamentals of the long geologic history through which particular areas, and the Province as a whole, have passed before the present landscape or scenery was produced. Great lengths of time and great changes as time moved on are the essence of geologic history.

The description of each area is accompanied by a generalized geologic map of the area and by photographs of the main features of both land forms and of geology.

The photographs in this pamphlet are by the Geological Services of the Québec Department of Natural Resources unless specifically acknowledged.

PAUL-E. GRENIER,
Director of Geological Services

Québec, 1968

Cover photograph is of the north side of the Forillon peninsula as seen from Cape Rosiers: — Cape Gaspé at extreme left; Cape Bon Ami a little left of center; Cape Bon Ami Park at right edge. Photo by Al Cassidy of Cassidy's Photo Studio, Gaspé, Que.

The Geologic History
of
THE FORILLON PENINSULA
and
CAPE BON AMI PARK
Eastern Gaspé, Québec

Cape Bon Ami Park (Plates I and II) is on the northern side of Forillon peninsula at "le Quai" or about 1½ miles northwest of Cape Bon Ami (see accompanying map). The Forillon peninsula is a spine of land 5 to 7 miles long (depending on where you place its base) and averaging ¾ of a mile wide (Plate III). The peninsula is made up of a southward-dipping succession of rocks of Devonian age (see Geologic Time Table and definition of terms, last pages), with an average angle of dip or slant of 25 degrees away from the horizontal (Plate X). As these rocks have been tilted southward, the oldest rocks of the succession are to the north and the youngest to the south. Thus, the oldest are along the shore of the Gulf of St. Lawrence and the youngest are on the shore of Gaspé bay. Stated in another way, the rocks of the peninsula are on the northern limb or side of a large down-fold (syncline) the axis or median line of which lies under Gaspé bay. The rocks (Gaspé Sandstones) on the south shore of Gaspé bay all dip or slant northward into the bay and form part of the southern limb of the down-fold. The dip or slant of the rocks, plus erosion by waves, is largely responsible for the cliffs (almost vertical in places and up to 500 feet high) along the north side of the Forillon peninsula (Plates I to V and Plate VII). The gentle slope to sea-level on the south side is in sharp contrast, because the dip or slant of the rocks does not give the waves so much chance to undermine them (Contrast Plates VI and VII). The peninsula once extended out at least as far as the American Banks, which are about 20 miles out to sea and in line with the peninsula and only 100 to 300 feet below sea-level. Gaspé bay, after all, is really the drowned continuation of the Dart-



Plate I — Part of Cape Bon Ami Park. Sea-cliffs in background cut in Devonian rocks rise 350 to 500 feet above the sea. Cape Bon Ami is the point of land behind the flag pole. (Photo Québec Tourist Branch).

mouth River valley, and the Forillon peninsula is part of the northern side of this valley.

Mount St. Alban (upper right corner of Plate III) is $1\frac{1}{4}$ miles northwest of Cape Bon Ami Park and a mile in from the shore. Its shoreward or eastern and northern sides are in part cliffs. Its summit is 1,120 feet above the sea. Three-quarters of a mile to the west a hill with a micro-wave telephone mast rises steeply (on its north side) to 1,175 feet above the sea. This summit can be reached by automobile (preferably by 4-wheel drive) from the highway over a short and, in places, steep gravel road (see map).

Plate II — Cape Bon Ami Park. Top of cliffs on the flank of St. Alban mountain is 1,000 feet above the sea. (Photo Québec Tourist Bureau).

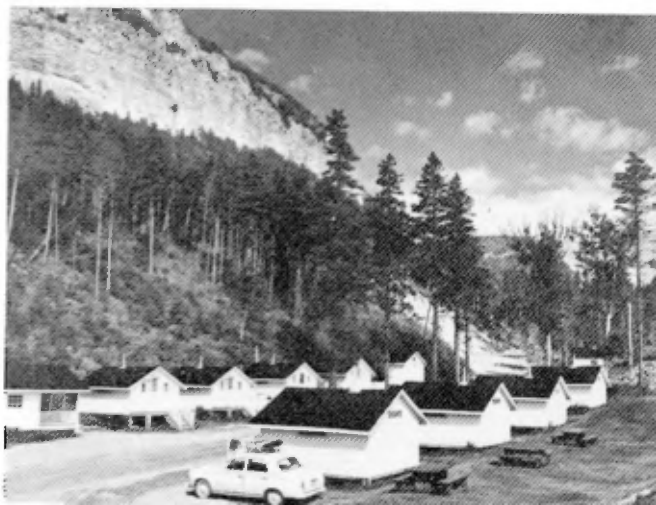
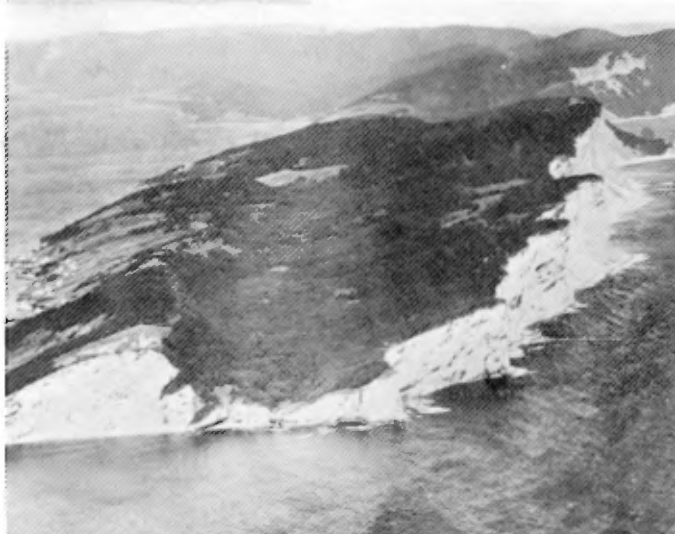


Plate III — Cape Gaspé and the Forillon peninsula. Gaspé bay to the south (left) and the Gulf of St. Lawrence to the north. (Photo La Cie Aérienne Franco-Canadienne for Québec Dept. of Roads, 1927).



The force of sea waves as an erosive agent is shown not only by the cliffs along the north side of the peninsula but by effects at the seaward end of the peninsula, at Cape Gaspé or Shiphead. The peninsula actually ends in a double cape with a cove between (Plate X). The southern cape is the higher and on it stands the Shiphead lighthouse, and off its point stood (until 1851) a sea-stack known to some as La Vieille (The Old Woman) and to others as the Flowerpot; this sea-stack was separated or cut out by wave erosion from the rocky shore cliffs. The base of this former sea-stack is still visible at low and medium tide (Plate XI).

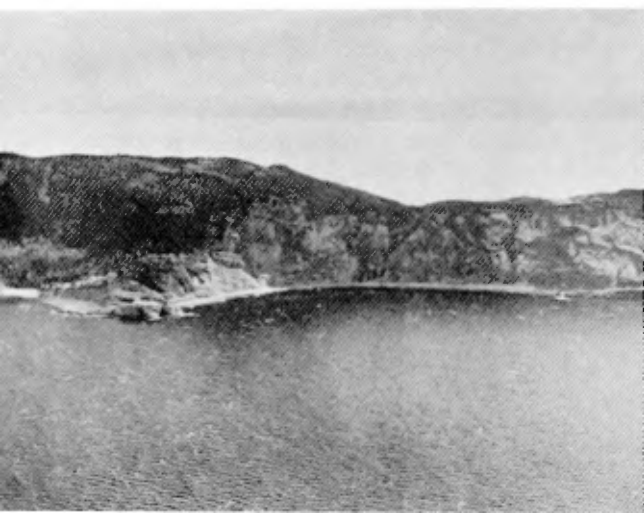


Plate IV — The cliffed north side of the Forillon. Note that the rock layers at Cape Bon Ami (toward the left side of the photo) dip landward (south) into the cliff. (Photo La Cie Aérienne Franco-Canadienne for the Québec Dept. of Roads, 1927).



Plate V — The gently sloping south (Gaspé bay) side of the Forillon peninsula along the Grande Grève shore. The general slope of the land surface coincides with the slope (dip) of the underlying rock. The "Cape Road" crosses to Cape Bon Ami Park at the low point on the ridge. (Photo La Cie Aérienne Franco-Canadienne for the Québec Dept. of Roads, 1927).

The northern lobe of the cape is Cape Gaspé proper, and there is the remnant of an irregular limestone pillar or sea-stack here also, which can be reached only at low tide, and which some referred to as Le Vieux (The Old Man).

Four geologic or rock formations, all of Lower Devonian age (or averaging about 365 million years old), make up the Devonian succession in the Forillon area. The oldest formation is the St. Alban limestone and shale and it is followed upward in order by the Cape Bon Ami shale and limestone, Grande Grève limey and cherty siltstone, and Gaspé Sandstone formations. The distribution of these formations is shown on the accompanying map. It will be noted that the Devonian succession of rocks rests on top of rocks that are identified as Lower Ordovician. The Ordovician rocks here are something like 80 million years older than the Devonian rocks. In other words, at this place there is a gap in the geologic record of

Plate VI — The Grande Grève Formation along the shore eastward from Petit Gaspé cove dips at angles of 25°-30° into Gaspé bay. Waves do not undercut so easily here as on the north side of the Forillon. Contrast with Plates VII and VIII.



that length of time. (However, elsewhere in Gaspé much of this gap is filled by rocks of younger Ordovician age and by rocks of Silurian age). The original contact (an unconformity) between the Lower Devonian and the Lower Ordovician rocks is at the base of the St. Alban Formation and may be seen only at low low-tide 150 feet south of the northern end of the sea-cliffs (Plate XII; Pt a of map). The northern end of the sea-cliffs is marked by a vertical fault (Plate XIV), the Devonian rocks having dropped down against the Ordovician rocks. Northward from here along the shore to the Cape Rosiers lighthouse and beyond, the rocks exposed are all of Ordovician age (Plate XIII).



Plate VII — Undercutting of the St. Alban cliffs. The strata (layers; beds) dip inland and so are undercut by waves.

Plate VIII — "Le Quai"
 at Cape Bon Ami Park.
 The rock here is more
 resistant than most
 along the north side
 of the Forillon but is
 also being undercut.
 The layers (strata;
 beds) are well shown;
 they dip toward the
 camera and also a
 little to the left (in-
 land).



The unconformable contact between the Devonian and Ordovician rocks gives some very important information, even though there is a time break here of some 80 million years. In the first place, the Ordovician rocks below the contact were deposited or formed in a sea as obviously parallel, essentially flat-lying, thin, alternating layers of black, grayish green and reddish gray muds with some thicker layers of limey mud, silt, sand and gravel. These sediments hardened into layers of rock. Many millions of years later (at or towards the end of Ordovician time) this rock and other Ordovician and older rocks between Gaspé and southern Vermont and Pennsylvania (Taconic mountains) were bent and folded by earth pressures



Plate IX — Looking
 north from "Le Quai"
 along the cliffs under
 Cape Bon Ami Park. No-
 te the low ground to
 the right in the photo —
 underlain by Ordovician
 rocks. Dark, vertical band
 near the apparent mid-
 length of the cliff is a
 dike (see Plate XVIII).

and elevated well above the sea to form mountain ranges. Then followed a long period of erosion (many millions of years again; or through much of Silurian time) during which the Ordovician mountains were greatly reduced in height. At the end of Silurian time, subsidence put some of the Ordovician rocks below sea-level again, and here, in oldest Devonian time, they were covered by sediments (limey muds, that correspond to the base of the St. Alban Formation (Plate XII).



Plate X — Cape Gaspé at the tip of the Forillon. Note that the layers dip to the left (south) at about 25 degrees, and that strong, widely spaced joints dip steeply to the north or vertically. Wave erosion working along joints can separate sea-stacks from the parent cliff, and one appears to be forming at the extreme left of the cliff face. (Photo courtesy of Dr. S.C. Ball, Peabody Museum, Yale University, New Haven, Conn.).

If you compare the Ordovician rocks with the Devonian rocks it will be obvious that the former have been much more disturbed (bent, folded, broken; Plates XV, XVI, XVII) than the latter. This is particularly evident near their contact, and also along the shore around Cape Rosiers (Lighthouse point) where Lower Ordovician rocks only are to be seen (Plate XIII). Except for minor faults, the Devonian rocks of the Forillon peninsula are merely tilted southward to an average of about 25 degrees away from the horizontal.



Plate XI — Base of former sea-stack (La Vieille) at medium tide off the southern point of Cape Gaspé. (Photo from near Cape Gaspé light).



Plate XII — Unconformity (visible only at low low-tide) between the Devonian St. Alban limestone above (light gray with dark streaks) and the underlying Ordovician Cape Rosiers slates. The Devonian dips 25° south; the Ordovician dips 60° south and is overturned. (Photo by Dr. L.M. Cumming, Geological Survey of Canada, Ottawa).

At Cape Rosiers the Ordovician is continuously exposed from the corner of the beach near the highway to the point under the lighthouse and beyond, and can be examined readily at medium to low tide. The rocks include dark and gray slates, some red to purple and green slates, and interbeds of greenish gray sandstone, some gray limestone, and a few limestone conglomerates. The limestone conglomerate beds at the cape are of particular interest because they are composed of relatively large fragments (pebble to small boulder size) of limestones of probable Cambrian age — fragments of other types of rock in the conglomerate are very rare. About 100 feet northwest of the lighthouse a lens of limestone conglomerate carries some pyrite nodules. Fossils (graptolites) are present in black shaly slate northwest of the lighthouse.

Interesting as the rocks themselves are here, the main feature to note is that the strata (layers; beds) of rock have been folded into small anticlines (up-folds) and synclines (down-folds) and that these folds all dip or slant to the south (Plates XV, XVI). This indicates that the push or thrust in the Earth's crust that produced these folds came from the south. It must be understood, of course, that these happenings took place many millions of years ago, at a time when the rocks now exposed at the Earth's surface were buried under a great thickness of overlying rock. (Recognition of the great lengths of time involved, and of the great changes that have taken place everywhere over the Earth's surface and in its crust as time moved on, is essential to any real understanding of geology.)

To see the Devonian rocks in close view one may walk southeast along the beach from the Devonian-Ordovician contact as far as Le Quai. This should not be attempted except at low tide. In any event, it would be wise not to go any farther than about 3,300 feet, to where a dike (Plate XVIII) appears in the cliff face. This dike is 1,600 feet northwest of Le Quai, but it is not easy to get to the dike from here. The shore can be followed on foot from Le Quai southeastward for about 2 miles or almost to Cape Bon Ami. Please note that there is always the danger of falling rocks along cliffed shores such as these — and the piles of broken rock along the beach near Cape

Bon Ami warn of rock slides that take place — every year. Perhaps you will be satisfied to take an easier and less dangerous course and only look at the rocks along the road leading to Cape Bon Ami Park. There are (as seen in 1966) two exposures of rock on this road. The first is 1,000 feet by road up from the base of the hill and consists of St. Alban greenish shales and siltstones. The second is 500 feet farther up the road and is dark gray Cape Bon Ami shaly limestone. Both are on the right hand side as one goes up the hill. Beyond these outcrops most of the loose rock at the sides of the road, and in the tree-covered slope of rock débris (talus) on the southwest side of the road as far as the Park, and on the top of the main hill on the "Cape road", comes from the Grande Grève Formation. (The road itself has been surfaced in places with gravel hauled up from the beach.) At the top of the hill on the Cape road (1,500 feet southeast of the Park office) the road is cut into, and floored by, rocks that are just about at the contact between the Grande Grève and Cape Bon Ami formations.

The St. Alban Formation is about 350 feet thick, the lower part being gray limestone and limey shale carrying fossils, including corals, brachiopods, pelecypods, gastropods, and trilobites, and the upper part being red and green shales and siltstones with fewer fossils but including graptolites. This formation begins at the northern end of the sea-cliffs about a mile north of Le Quai (or southeast of the base of the hill on the road to the Park) and extends south along the shore for 1,600 feet.

The Cape Bon Ami Formation extends along the whole north face of the Forillon peninsula except where the St. Alban occurs. It includes the gray limestones and shales at Le Quai (Plate VIII) where, in the cliff just to the west, there is a zone 20 feet thick of corrugated or wrinkled limestone and shale; the corrugations were the result of gravity slump or unequal settling before the muds had hardened to solid rock. About 1,600 feet north along the shore from Le Quai a diabase dike (Plate XVIII) about 8 feet wide intrudes the Cape Bon Ami Formation. It trends about west, is nearly vertical, and extends some 50 feet up the cliff face. The rock of the dike is quite different



Plate XIII — Cap des Rosiers lighthouse — the tallest along the St. Lawrence river and gulf — built on a 50-foot terrace of Pleistocene to Recent age cut by the sea on folded Ordovician slate, siltstone, sandstone and conglomerate. (Photo Québec Tourist Branch).

from the shales and limestones which it intrudes or cuts. It is **igneous** in origin, and so was hot and liquid (or at least viscous) and was able to work its way upward from a bigger, parent mass below. We know it was hot because the intruded rocks were hardened (baked) a little when intruded by the dike, and this thin baked zone may be seen along both borders of the dike. On the north side of the dike the upper 2 feet of shale carry rounded, pebble-like masses which contain pyrite ("fool's gold"; iron-sulphur mineral) and, in some cases, bits of fossil "honeycomb" coral. Two small horizontal faults have offset the upper and lower parts of the dike towards the north.

The Cape Bon Ami Formation does not carry as many fossils as the underlying St. Alban or the overlying Grande Grève formations. Brachiopods are the most common forms but there are some corals, cephalopods and graptolites as well as marine plants and fragments of some of the oldest land plants known. Sinuous markings on the rock surfaces at Le Quai may represent Devonian sea-weeds. Le Quai itself probably owes its shape and origin to an accident of erosion,

although the limestones which compose it are actually tougher (more resistant) than most of the limestones of the formation.

The Grande Grève Formation forms the bulk of the surface rock of the peninsula (see map). It forms the south shore between Cape Gaspé at the outer tip of the peninsula to Petit Gaspé at its base. A feature that distinguishes this formation from the Cape Bon Ami is its hardness; this results from the abundant content of silty material and of many beds or layers that are cherty. Fossils may be found in these rocks at many places along the south side of the peninsula, and they include a great variety of species as well as all the classes mentioned as being present in the Cape Bon Ami. It should be noted that many of the fossil forms in the Grande Grève Formation along the Forillon peninsula are of the same species as found in Percé Rock. This, on a small scale, is an illustration of how geologists correlate (relate to the same age or to the same formation) rocks that appear in different parts of a region or in widely separated regions — even between such widely separated regions as Europe and North America. Forms of life that spread widely (as by ocean currents) and that have a short time range (some species last only a few hundred years) make the best "index fossils" or "time markers".

Beds of impure **bentonite** may be seen (but are not easy to reach) in the cliff directly below the Cape Gaspé lighthouse. Twelve beds at least are present here; one is 4 feet thick and most of the others are less than a foot thick. They are greenish to yellowish and have a waxy appearance. These layers are of interest because bentonite is clay formed by the decomposition of volcanic ash. Just where the volcano was that produced the ash is not known. The nearest known Devonian lavas are to the west in the center of Gaspé peninsula and some 70 miles distant, but no bentonite has been recognised westward of Cape Gaspé. So, it is quite possible that the source was to the southeast and now well covered by water. A distinguishing characteristic of bentonite is that after it has dried out and is placed in water it will swell and then break down into small particles.



Plate XIV — Fault near the base of the Devonian St. Alban Formation. The St. Alban and underlying Ordovician south (left) of the fault moved down against the Ordovician on the north side of the fault. Fault marked by dashed line.

The total thickness of the three Devonian formations that make up the Forillon peninsula is about 2,800 feet and all of this thickness can be examined by following the shore at low tide from the base of the succession in Cape Rosiers Cove to its top at Petit Gaspé cove where, and to the west, it is overlain by the Gaspé Sandstone. The rocks that make up this thickness were deposited in a Devonian sea as layers of mud and silt or of such chemical material as the cherty limestones of the Grande Grève Formation. With the passage of time, and by the loading of younger sediments on top of them and by chemical action, the layers of muds and silts hardened into layers of rock while still under the sea. Eventually they were tilted to the south to form part of the north side of the Gaspé Bay syncline, and, in part, were raised above sea-level; the cover of overlying rocks (Devonian Gaspé Sandstones) was stripped off by erosion, and now the Forillon rocks are themselves being slowly worn away and turned back into sedi-

ments that will eventually become rocks holding records of the Recent period of geologic time in which we now live. It may be mentioned in passing that fossils present in the Devonian rocks near both the old fire-lookout tower west of Route 6A and at the micro-wave mast to the east of 6A give absolute proof that these rocks were formed in the sea and have been raised 1,200 feet above present sea-level. Similar evidence in the Rocky Mountains of British Columbia, and in other mountain ranges throughout the world, shows that some rocks formed in the sea are now several miles above present sea-level.

The most recent geologic happenings along the Forillon have to do with changes of sea-level and the effects of such changes. Plates II, III and XIX show that on the flank of St. Alban mountain a cliff reaches almost to the mountain's summit, and that a lower cliff stands in front of it with its foot in the sea. The lower cliff quite obviously owes its development to erosion by the sea. The flat, or terrace-like, level (Plates XIX, XX) above and inland from the highest part of



Plate XV — Small anticline (up-fold) on left and syncline (down-fold) on right in Ordovician slates and siltstones on shore near Cape Rosiers lighthouse. Both folds are "overturned" to the north.

this cliff (this corresponds to the flat summit crossed by the road leading to the Park) is apparently also a product of erosion by the sea. This terrace averages about 325 feet above present sea-level, and it is probable that most of the development of the higher sea-cliff took place when the 325-foot terrace was being cut by the sea and (or) when the sea stood at a still higher level. It is probable, also, that the terrace and the higher sea-cliff were formed either during the Pleistocene Ice Age (see Geologic Time Table) or just after it.

The 325-foot terrace and the lower sea-cliff are well developed only near the northwest corner of the Forillon peninsula, at Cape Bon Ami Park. Southeast of the Park, the lower cliff merges with the higher one, and the two continue as one cliff out to the end of the Forillon (Plate III). Quite evidently marine wave erosion was, and is, stronger and more effective along the more open and more exposed shore to the southeast than toward the base of the peninsula.

A few small deposits of galena (lead mineral) with rare sphalerite (zinc mineral) along the north shore of Gaspé bay have been explored from time to time since 1665. Although these explorations or prospectings were not successful in finding a mine, the earliest of them, in 1665, marked one of the earliest mining ventures in Canada. The above-mentioned minerals have been seen at five localities between where Route 6 joins the Forillon Peninsula road and Indian Cove 6 miles to the east; three localities are indicated on the map. The minerals are in the calcite matrix of breccia (broken and cemented) zones or in calcite veins. The two most interesting localities are at Indian Cove (Anse Sauvage) and Petit Gaspé. At Indian Cove a wedge of Gaspé Sandstone is faulted down into the Grande Grève Formation. That is to say, a wedge of Gaspé Sandstone, with underlying Grande Grève, moved down between two faults. One fault appears to correspond with the trend (north-northeast) of the valley of the small brook that runs into Indian Cove. The other (west of the wharf) also trends north-northeast and corresponds roughly with the western side of the cove. The two faults probably come together in a "V" a short distance inland. Movement along the two faults allowed a wedge-shaped block to drop down and so to pre-

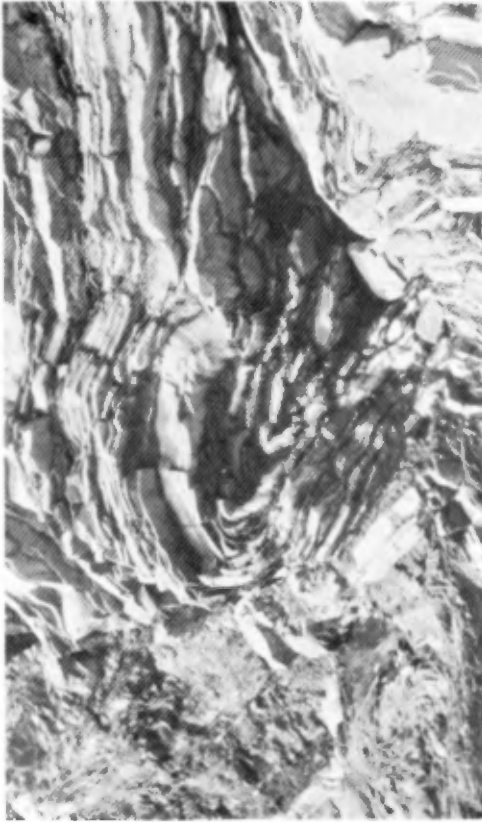


Plate XVI — Same rocks and general location as Plate XV. Broken and faulted syncline. A small anticline in the lower right corner.

serve a good-sized sample of the Gaspé Sandstones in the western part of the cove. In the sandstone-shale wedge, fragments of fossil plants and fossil fish bones may be seen if one looks hard enough.

Along the western fault a zone about 12 feet wide was shattered, and then re-cemented by calcite to form a breccia. The calcite cement and associated calcite veins carry a few grains of galena (lead). This fault is not now (1966) visible, having been covered by road-work fill, but rains may expose it again later on.

In Little Gaspé Cove, Gaspé Sandstones rest on the Grande Grève limestones, the change between the two being quite abrupt. Here, also, is the site of one of the first (if not the first) serious mining ventures in Canada (Plates VI and XXII). Father Balloquet of the Jesuit mission group in Québec City examined this prospect in 1665, but was not encouraged. Nevertheless, and also in 1665, the Intendant Talon sent 40 miners down from Québec City to get the "mine" going, and probably this was when the first prospect pits were dug — these can still be seen, some of them having been deepened by later prospectors. Nicholas Denys knew of this prospect around the year 1650, but was not too impressed by it. In Sir William Logan's famous "1863" report on the "Geology of Canada" mention is made of serious work having been done here "lately" by two prospectors. As seen by Logan, "the lode" was about 18 inches wide and was composed of calcite "holding masses of galena, together with small portions of blende (sphalerite — zinc mineral) and copper ore". At the present time (1966) a pit about 6 feet deep at its inland edge and 12 feet in diameter is seen just above the high tide mark, and a trench 4-6 feet wide and 40 feet long is cut at right angles to the shore just above the pit (Plate XXII). Veinlets of calcite across a 15-foot width carry scattered grains and nodules of galena. Fossils (mainly brachiopods and worm markings) are scattered in the limestone, and small, black fragments of plants occur in the Gaspé Sandstone (at the west end of the cove). North of the beach and 50 feet north of the road paralleling the beach a shaft or pit 6 X 8 feet across and 25 feet deep was dug on the main vein about 1850. It is stated locally that a tunnel extends from the bottom of this shaft under the road and out to the beach, where its mouth may be seen at low tide. More recently (but just when is not known to the writer) a trench cut in rock 50 feet to the northwest of the shaft followed the vein for about 40 feet. Remnants of the vein up to 6 inches thick with some galena may be seen on the south wall of the trench. The vein follows a northwest-trending joint.

Geologic terms used in this description

Geology

A science concerned with the study of the planet Earth, and particularly with the rocks at or near Earth's surface. This science has so many branches or facets that the terms "Earth Sciences" or "Geologic Sciences" are used by many universities as the title of the Department concerned rather than the term "Department of Geology". This science involves most of the other physical sciences (particularly mathematics, physics, chemistry, geography, astronomy) as well as botany, zoology, and philosophy. There is much in the geologic sciences for most who incline towards science and also for many who incline towards philosophy. The study of the geologic sciences begins logically with a study of rocks and minerals, proceeds to a consideration of the tremendous Earth forces and particularly to those



Plate XVII — Same rocks and general location as Plate XV. Small fault in middle of photo. "Drags" or bends in the layers on the two sides of the fault show that the left side moved down relative to the right side. The white streaks are calcite veins; one vein follows the fault.

Plate XVIII — Vertical diabase dike up to 8 feet wide cutting (intruding) rocks of the Cape Bon Ami Formation in shore cliff 1,600 feet north of Le Quai.



that affect the rocks in the crust (outer "skin") of our planet Earth, and then uses the evidence so gained to explore the record of Earth's history as contained in its rocky crust. And, although no one should choose a scientific profession for any reason other than personal and professional interest, the geologic sciences provide many opportunities to earn well and even to become wealthy.

Anticline and Syncline

The two basic types of folds in the rocks of Earth's crust. Both are canoe-shaped in general. In a syncline (down-fold) the axis of the fold (keel of the canoe) is down, and the strata (layers; beds) on the two sides or limbs of the fold dip toward each other. In an **anticline** (up-fold) the keel or axis of the fold is at the top (the "canoe" is upside down) and the two sides of the fold dip away from each other. Such folds vary in size

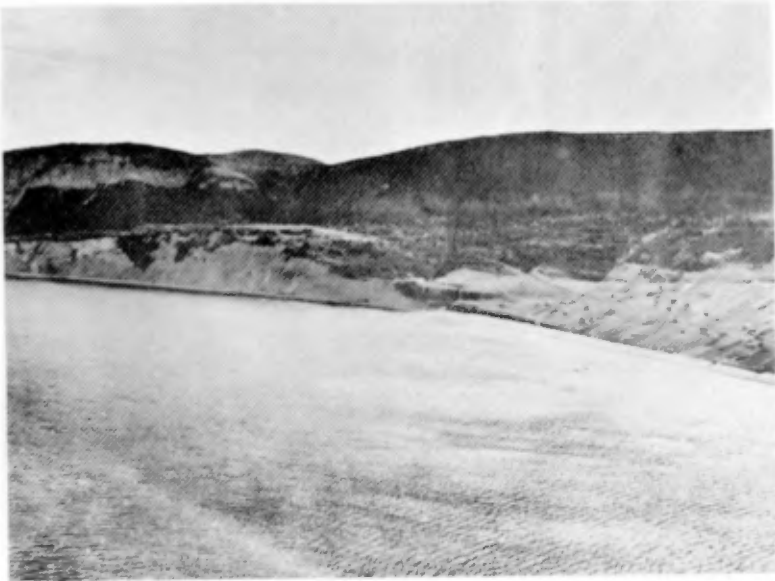


Plate XIX — Cape Rosiers Cove showing higher cliffs on east flank of St. Alban mountain, lower cliffs rising from present sea-level, and the intervening terrace at 325 feet above the sea. (Photo by La Cie Aérienne Franco-Canadienne for Québec Dept. of Roads, 1927).

from smaller than those in Plate XV to many miles across and hundreds of miles long.

“Overturned” folds are not necessarily turned completely over, although such extremes do occur. Generally this term implies only that one limb of a fold has been tilted past the vertical, or that the two limbs are parallel and inclined. Several examples of this “overturning” may be seen in the folds at Cape Rosiers (Plate XV).

Diabase dike

A dike is a book-shaped mass of igneous rock that cuts across the structure of the rock it intrudes. The dike in the Cape Bon Ami shaly limestones (Plate XVIII) probably extends to the east along the sea floor and to the west into the cliff, but how far is not known. Diabase is composed of small laths of gray feldspar in a dark, fine mass of other minerals.

Formation

A mappable succession of rock strata (beds or layers) usually with common characteristics and of the same general age throughout; the usual unit of geologic mapping.

Fossil

The actual remains (usually shells or bones) or the traces of existence (tracks, trails, borings, impressions) of animals or plants that lived in prehistoric time.

Fault

A fracture (Plate XVII) in the rocks of Earth's crust along which the mass of rocks on one side of the fracture has moved or slipped relative to the mass on the other side.



Plate XX — Looking north from the summit on the old "Cape Road" (Chemin du Cap). Some of Cape Bon Ami Park buildings (as seen in 1942) are shown; the white one is just inland from Le Quai. Beyond the buildings is the sea-cliff developed on the St.Alban Formation and beyond this is the lowland developed on Ordovician rocks. Cap des Rosiers lighthouse is 4 miles distant, at the end of the far finger of land.



Plate XXI — View from the same location as XX The higher cliffs inland from the Cape Bon Ami Park are shown (1942).

Faults that result from compression are commonly thrust or push faults. Other faults are the result of stretching or settling, where one side of the fault drops down against the other side. Both types range from fractions of an inch to hundreds of miles long. Movement along faults is the prime cause of earthquakes. Thrusts were common in regions of strong folding, as along the north side of Gaspé peninsula. Although many faults of various types are known in Gaspé peninsula none are now active.

Joint

A fracture in rocks along which no, or very slight, movement takes place. They may be produced by tension or by compression. (Plate X).

Unconformity

Usually a surface of erosion on older rocks and upon which younger rocks have been deposited (Plate XII).

Vein

Rock crack or fracture filled with mineral matter (Plate XVII). Calcite (lime) and quartz veins are common in many formations and may carry ore minerals. Some veins are made up of ore-bearing minerals. Veins range from fractions of an inch wide and long to many yards wide and several miles long, and some have been followed downward several thousand feet in mines.

SEDIMENTARY ROCKS

Most sedimentary rocks are formed by the consolidation or hardening of sediments (muds, silts, sands, gravels). Sediments, along with chemical material, are produced by the breaking down through weathering and erosion of pre-existing rocks of every kind, — including sedimentary rocks. Transportation of most of the rock waste is done by streams, and most sediments eventually reach the seas. Here the selective settling out of the sediments (coarser material near the shore and finer material farther out) and sinking of the sea floor set the stage for the development of sequences of sedimentary



Plate XXII — Part of circular pit (lower left corner) and outer end of trench (top center) cut in Grande Grève Formation in search of lead. Base of Petit Gaspé cove, Gaspé Bay side of Farillon peninsula.

material up to several miles thick. During and after deposition of the sediments packing takes place and chemical material (lime, silica, iron, etc.) works in among the grains of sediment to act as a binder or cement.

The most common of the mechanical sedimentary rocks are:

Shales — consolidated muds; very fine in grain.

Siltstones — consolidated silts; between shales and sandstones in grain size.

Sandstones — consolidated sands; grains readily seen without a lens or a microscope.

Conglomerates — these grade from very small pebble-size to beds (layers) of boulders; the pebbles and boulders are "packed" in sandstone (commonly) or in shale or in limestone.

Among the chemical rocks are limestones, chert (very hard, flinty rock), salt, gypsum, and potash.

The four mechanical types plus limestones make up the great bulk of sedimentary rocks. All of these are common in Gaspé peninsula, and chert is present in the Grande Grève Formation along Forillon peninsula and as pebbles in some conglomerates.

FOSSILS

Forms of life preserved in sediments (later to become sedimentary rocks) and mentioned in the text above:

1. **Brachiopods** — Also called "lamp shells" from the general resemblance in shape of the common form living in present day seas to Biblical lamps. However, most fossil brachiopods are not of this type. They all

GEOLOGIC TIME TABLE
(after Arthur Holmes, 1960)

Era	Period	(numbers in parentheses refer to millions of years)
Cenozoic (70) Age of Mammals, Birds, and Modern Plants	Recent	Post last great glaciation — 10,000 years to Present
	Pleistocene	Ice Age (1) — 1,000,000 years to Present
	Pliocene (10) Miocene (14)	
	Oligocene (15) Eocene (30)	
Mesozoic (155) Age of Reptiles (dinosaurs, etc.)	Cretaceous (65)	Age of reptiles (dinosaurs, e.g.)
	Jurassic (45)	First flowering plants
	Triassic (45)	
Age of Vertebrates and Land Plants ----- Paleozoic (375) ----- Age of Invertebrates and Marine Plants	Permian (45)	Extinction of trilobites and certain corals.
	Carboniferous (80)	Age of Amphibians Age of Plants
	Devonian (50)	Age of Fishes
	Silurian (40)	Corals, brachiopods (now rel. rare), cephalopods.
	Ordovician (60)	Graptolites (now extinct), trilobites, brachiopods, cephalopods.
Cambrian (100)	Fossils common; most invertebrate classes present. Trilobites were the dominant animals.	
Precambrian (4,000 to 600)	Beginning of life. — Single celled forms found as well as algal remains (seaweeds), worm burrows, rare shelled invertebrates, sponge spicules, jelly fish? — All evidences of life are very scarce.	
Pre-Precambrian (?5,000 to 4,000)	Development of the Planet Earth and of its geologic crust.	

}

Age of Man

have two shells ("valves"), one closing against the other as in clams (a pelecypod); however, unlike clams, the two shells are not mirror images. Brachiopods were much more common in ancient seas than in the present seas.

2. **Cephalopods** — The octopus, squid, and cuttle-fish belong here. Most of the fossil forms possessed straight or coiled shells, and they are common in rocks of Paleozoic and Mesozoic age.

3. **Graptolites** — Forms of life that lived only in Paleozoic seas. Like many corals, the graptolites were colonial animals; each individual lived in a tiny cup, and the cups were arranged regularly along a slender stem. Most species floated in the sea, attached either to a float or to other colonies, and so they became widely scattered. Most fossils of this class look like black lines with sawtooth edges (a thin film that resembles a pencil mark — hence the name, **graptos lithos** = writing on rock).

4. **Gastropods** — Snails, commonly with a coiled shell.

5. **Trilobites** — A class of crustacean that lived in Paleozoic seas. Related to the lobster and crayfish. The name derives from the fact that the body shield is divided lengthwise into three lobes. Also, most are divided into a head area (cephalon), body area (thorax), and tail area (pygidium); it is relatively rare to find all three of these parts in one fossil specimen.

The Geologic Time Table given here is very generalized, — a skeleton. However, it gives the larger units of geologic time back to the Precambrian. Although the Precambrian represents much the greater part of geologic time, correlation of the succession of events and of rock units (formations) between regions is very difficult owing to the practical lack of fossils in Precambrian rocks, — some fossils are found but they are too few for correlation purposes. Fossils are common

in Cambrian and younger rocks and they permit region to region and even continent to continent correlations of rock units. The fossils present in Eocene or Triassic or Cambrian rocks in China, for example, represent forms of life at least generally similar to those that lived in North America in those periods, and the general succession of life as represented by fossils is strikingly similar throughout the world. In many cases, correlations have been made between Europe and North America on the bases of **identical species**, — particularly species of graptolites, cephalopods, and trilobites, because these were types that could be, and were, widely distributed by ocean currents.

A question that may well be asked is: If age determinations can be made by physical (radioactive) methods in terms of years why bother with the relative ages supplied by biology (fossils)? The answer to this has several parts, some of which are: — (1) Radioactive dating has been developed only recently, and is still being perfected. Also, costs are high and “geochronology” (time-measuring) laboratories are few.

(2) Relatively few age determinations have been made on sedimentary rocks, and rarely on those that carry fossils.

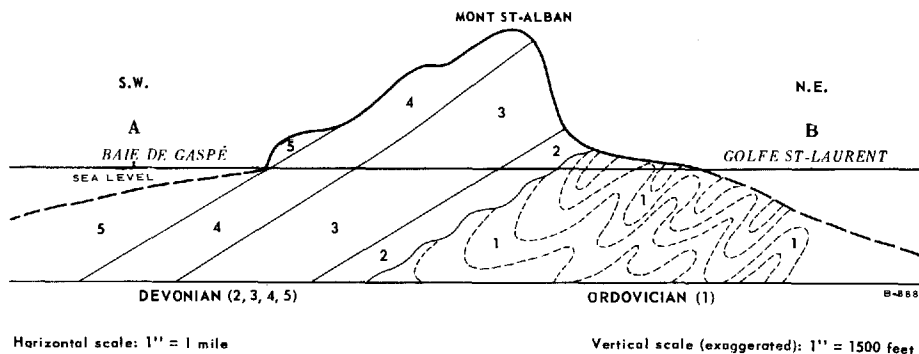
(3) Radioactive datings up to now have been based for the most part on granitic igneous rocks or on rocks altered by granitic, or other, igneous intrusions; in some cases they have been based on rocks altered by mountain-building forces. Such datings give the age of the intrusions but not necessarily of the intruded rock; or, they give the age of the mountain-building movements and only the minimum age of the rocks involved.

Nevertheless, the fact remains that the radioactive determinations of age (the “absolute ages”) that have been made agree very well in general with the relative ages established on the basis of fossils.

Getting back to the Time Table. — The names of the eras are descriptive and reflect the progressive development of life: **Paleozoic** or ancient life, **Mesozoic** or middle life, **Ceno-**

zoic or recent life. The names of the **periods** are based mainly on rock successions in areas where early field studies were made: **Cambrian** from the old name for Wales; **Ordovician** and **Silurian** for ancient Welsh tribes; **Devonian** from Devon in England; **Jurassic** from the Jura mountains, shared by France and Switzerland; **Permian**, from the province of Perm in eastern Russia; **Triassic** from its threefold division in Germany. Two period names are based on a characteristic content: — **Carboniferous** from its coal-bearing (carbon) content in Europe, and **Cretaceous** from its chalk (creta) content in England. And finally **Eocene**, **Miocene**, **Pliocene**, and **Pleistocene** refer to **early recent**, **middle recent**, **more recent**, and **most recent**, respectively. The youngest term (**Recent**) in the Time Table is not disguised and refers to the present time and back for 10,000 years.





H.W. McGerrigle, 23 Nov. 1966

Cross-section along the line A-B (drawn on the accompanying map) to indicate what the succession of the Forillon rocks would look like if a cut were made across them at right angles to their trend and all the hills and rocks southeast of the cut were removed. The face of such a cut would be a vertical cliff at right angles to the trend of the rocks. The section is extended below sea-level so that the Ordovician rocks and the unconformity between the sharply folded Ordovician and the tilted Devonian rocks could be represented.

(For those interested in more technical aspects it should be noted that the Cape Bon Ami - Grande Grève contact shown on both the present map and cross-section is farther north than some recent workers show it; as so placed the contact is more in keeping with mapping in interior Gaspé. Also, as the dips in the cross-section are not steepened to compensate for the exaggerated vertical scale the relative thicknesses of the Grande Grève and Cape Bon Ami formations are not in proportion.)