Atlantic Geology

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Volume 8, numéro 2, september 1972

URI : https://id.erudit.org/iderudit/ageo08_2rep02

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Éditeur(s)

Maritime Sediments Editorial Board

ISSN

0843-5561 (imprimé)
1718-7885 (numérique)

Découvrir la revue

Citer cet article

Owens, E. H. & Harper, J. R. (1972). The Coastal Geomorphology of the Southern Gulf of Saint Lawrence: A Reconnaissance. *Atlantic Geology*, *8*(2), 61–64.

Maritime Sediments, Vol. 8, No. 2, September 1972, pp. 61-64.

The Coastal Geomorphology of the Southern Gulf of Saint Lawrence: A Reconnaissance*

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A method for the rapid reconnaissance of coastal morphology and littoral sediments was applied to the southern Gulf of St. Lawrence during the summer of 1972. The aim of the investigation was to define and analyze the major characteristics of a 2500-km section of coast and to describe and explain variations in form and processes within the region. The reconnaissance provided basic data on the coastal geomorphology and the littoral processes and was used also as a framework for the delineation of particular problems for further detailed studies. Although this type of study is directed towards a descriptive analysis it is possible to discuss littoral processes from direct observations and from the interpretation of geomorphological and sedimentological characteristics.

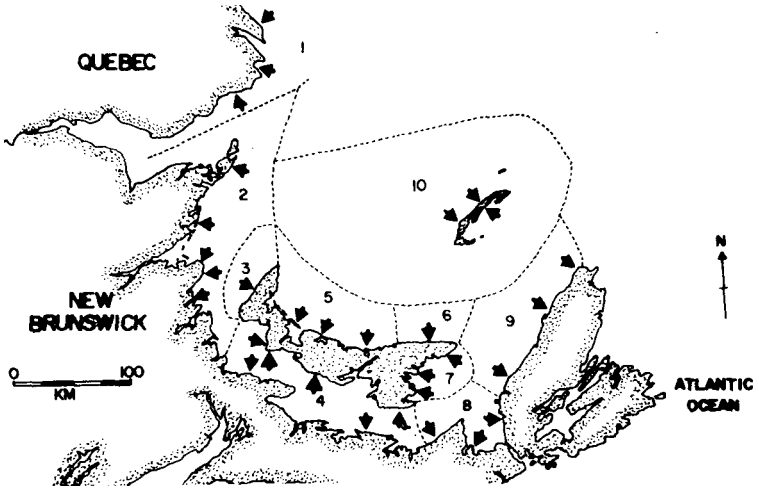

Figure 1: Morphological units defined by zonal method and location of study sites within each unit.

Method

In order to study a large section of coast it is necessary to evolve an approach which will focus on the important characteristics of an area. A reconnaissance method (the zonal study) has been developed (Hayes, Owens, Hubbard and Abele, 1972) which divides a region into major morphological units and which analyses the characteristic features within each of these units. In addition, a systematic sampling program is carried out to determine sediment parameters within the littoral zone. The field work required a 3-man crew over a 10-week period using the zonal method for this study in the southern Gulf. Selected profile and mapping sites were established on a permanent basis so that these locations may be resurveyed in order to provide data on long-term changes.

The southern Gulf was divided into ten morphological units on the basis of geology, relief, coastal landforms, sediment availability, tidal range, and exposure to wave generation (Table I). Within each of the ten units, sites for detailed local studies were selected following an aerial reconnaissance in order that the major characteristics of each unit could be described and analyzed (Fig. 1). The procedures and techniques for data collection used in the field study have been discussed in detail by Hayes et al (1972).

In the case of unit 5, the north shore of Prince Edward Island, detailed zonal study sites were located on a barrier island, a sandstone cliff, and a low eroding dune and moraine shore. These three sites illustrate all the major geomorphological characteristics occurring along that 17-km section of coast. Unit 5 is differentiated from the adjacent units by a change in one or more important coastal parameters. Unit 3 differs on the basis of the orientation of the coast, and therefore fetch and exposure to waves. Unit 6 is defined by the local morphology as this section is a rocky coast with little or no sediment on the wave-cut platform.

* Manuscript received December 12, 1972.
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Table 1: Definition of major zonal units in the southern Gulf of St. Lawrence (physiographic regions after bostock, 1970).

UNIT	PHYSIOGRAPHIC REGION	GEOLOGICAL CHARACTER	COASTAL ZONE		FETCH & WAVE EXPOSURE	MEAN TIDAL RANGE	SEDIMENT AVAILABILITY
			BACKSHORE RELIEF	BEACH CHARACTER			
1. Gaspe	a. Notre Dame Mountains b. Chaleur Uplands	deformed metased, and sed. rocks: structure perpendicular to coast	resistant rocky cliffed upland coast (5-100 m)	narrow, or pocket gravel beaches: some sandy mid-bay bars	>300 km very exposed	>1 m	very sparse
2. North and Central Eastern New Brunswick	Maritime Plain	ss/sh	unresistant low relief: till, rock cliffs (3-10 m)	sandy barrier islands and spits: mixed sand-gravel near cliffs	>300 km exposed	<1 m	abundant
3. West Prince Edward Island	Maritime Plain	ss/sh; structure parallels coast	unresistant low relief: rock cliffs (3-10 m)	narrow, or pocket beaches: mixed sand-gravel	50 km sheltered	<1 m	sparse
4. Northumberland Strait	Maritime Plain	ss/sh	unresistant low relief: till, rock cliffs (3-10 km)	barriers, spits, and intertidal bars: mixed or fine-grained sediments	<50 km very sheltered	>1 m	sparse
5. North Prince Edward Island	Maritime Plain	ss/sh	unresistant low relief: till, rock cliffs (3-10 m)	sandy barrier islands and barrier spits: gravel near cliffs	>300 km exposed	<1 m	abundant
6. Northeast Prince Edward Island	Maritime Plain	ss/sh: structure parallels coast	unresistant low relief: till, rock cliffs (2-6 m)	absent, or narrow mixed sand-gravel beaches	>300 km exposed	<1 m	sparse
7. East Prince Island	Maritime Plain	ss/sh: structure perpendicular to coast	unresistant low relief: rock cliffs (3-10 m)	narrow, or sandy barriers and mid-bay bars	50 km sheltered	>1 m	sparse
8. Antigonish - St. Georges Bay	Nova Scotia Highlands	metased. and sed. rocks	low relief: till, rock cliffs (2-10 m)	narrow, or spits and barriers: mixed sand-gravel seds.	50 km sheltered	c. 1 m	sparse
9. West Cape Breton Island	Nova Scotia Highlands	deformed sed., metased. and igneous rocks	resistant rocky upland cliffed coast (5-100 m)	absent, or narrow gravel-boulder beaches	>300 km very exposed	<1 m	very sparse
10. Magdalen Islands	Maritime Plain	ss/sh	unresistant low relief: rock cliffs (5-15 m)	sandy barrier beaches: narrow gravel beaches near cliffs	>200 km very exposed	<1 m	abundant

The systematic sampling program was undertaken at a 10-km interval, giving 176 stations. This program is valuable as it provides systematically collected data on coastal zone sediments and involves work at regular intervals along the shore, so that all sections of the coast are visited. An example of the location of the sample stations for one area is given in Figure 2.

Coastal Geomorphology

In general terms the southern Gulf may be divided into three broad shoreline types as follows: (1) resistant upland cliffed coasts, (2) barrier beaches, and (3) rapidly eroding low sandstone cliffs. The first type is restricted to units 1 and 9 (Fig. 1 and Table I) where resistant lower Paleozoic rocks have given coasts of high relief and little sediment. Beaches are usually narrow, often reworked talus deposits, or pocket beaches located in areas where erosion has followed lines of structural weakness. The sediments are generally coarse with only occasional sand accumulations. Units 1 and 9 differ from each other by the character of the geological structure. In the Gaspé the structural patterns are nearly perpendicular to the trend of the coast giving a series of large embayments partially closed by mid-bay bars. On Cape Breton Island the structure parallels the coast and the shore is straight with local irregularities resulting from secondary structural features.

The second type, barrier beach systems, occurs on the exposed coasts of eastern New Brunswick, northern Prince Edward Island, and the Magdalen Islands, (units 2, 5 and 10) where large embayments have been closed off by the growth of depositional formations. These areas have

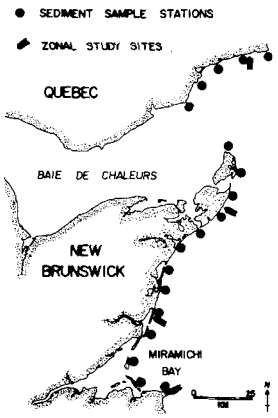

Figure 2: Location of sample stations and zonal study sites in parts of units 1 and 2.

a relatively low relief (less than 20 m on the coast) and a low offshore gradient. The sandy sediments are abundant, and exposure to storm waves leads to rapid longshore dispersal of beach material. These sediments appear to be derived mainly from the erosion of adjacent unresistant sandstone cliffs and glacial deposits. The movement of material landward from the shallow offshore areas during periods of storm waves may also be an important source of sediment. On the New Brunswick coast, north of the Miramichi estuary, the complex barriers are low, generally less than 1 metre above mean high water, and appear to owe their form and character to the results of storm-wave action which moves large volumes of sediment in short periods of time. The locations of inlets and recurved ridges are constantly changing as large waves are able to redistribute sediments easily due to the lack of dunes on the upper parts of the beach. In units 2 and 5 an important aspect of the sediment dispersal pattern is the action of the prevailing southwest winds which transport fine-grained sediments from the backshore areas to the littoral and nearshore zones. The form of the barriers appears to be related to the combined effects of storm waves from the northeast and the prevailing southwest winds.

South of the Miramichi estuary, and on the north shore of Prince Edward Island, the barriers are more stable with well-developed dune complexes. This is a reflection of the greater availability of sediments in these areas which may result from a lower rate of uplift, due to isostatic readjustment since the Pleistocene.

The Magdalen Islands may be considered separately from other barrier systems in the Gulf as the large barriers have developed in response to the prevailing westerly winds. The windward beaches of this tombolo complex are stable beach-dune systems which are in marked contrast to the lower, prograding barriers on the leeward, east-facing shore.

The remaining units in this region represent areas of low-lying, unresistant coasts characterized by low cliffs, rock platforms, narrow or pocket beaches and occasional spits or barriers. Exposure to waves is more limited due to smaller fetches and sediments are comparatively scarce. Local variation between units is based upon different orientations of the shore in relation to broad structural trends (compare units 3, 6, and 7). The shorelines of Northumberland Strait are a separate and distinct unit due to the very short fetches and the higher tidal range. The unit is characterized by unresistant cliffs, rock platforms, spits and intertidal swash bars.

Future Studies

The results of this reconnaissance survey will be synthesized in relation to the sediment dispersal patterns, in order to provide a basic framework for a discussion of the major elemental characteristics of this region. This type of approach can only aim at presenting a discussion of the form and processes in general terms but is useful in an initial study as it defines specific aspects of the littoral zone for further detailed research. In order to provide greater explanation of some of the morphologic-process relationships a study of the coastal geomorphology of the Magdalen Islands will be undertaken. The aims of this detailed investigation are: (1) the discussion of the geomorphic history of the Islands and of the development of depositional features; (2) the explanation of the orientation of the barrier beaches, using wave-refraction diagrams, and the explanation of sediment dispersal in relation to wave-and tide-induced currents; (3) the analysis of storm effects on the barrier-dune systems, and (4) the measurement of process variables (waves, wind, ice) in relation to geomorphic features at the local level.

The Magdalen Islands present a variety of coastal features, many of which are characteristic of other areas of the southern Gulf, and it is hoped that the results will be applicable to other locations in the region as well as other barrier systems throughout the world. The Islands are unique in North America as they are west-facing barriers on the eastern margin of the continent. Other major east-coast barriers are usually influenced by prevailing southwest winds but dominated by northeast storm winds. In contrast, this location faces the prevailing westerlies yet is also exposed to northeast storm winds.

Acknowledgements

The project is part of a longer term program of geomorphological studies undertaken by the Geological Survey of Canada in the Gulf of St. Lawrence. Mr. L.M. Zimlicki assisted in the field work and additional support for this study was provided by Dr. M.O. Hayes, University of South Carolina.

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