Bay of Fundy: Reconnaissance by Sub-Bottom Profiler *

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Introduction

In March of 1966, over 1,110 kilometers of sub-bottom profiles were collected in the Bay of Fundy. Preliminary examination indicates that the records provide abundant information on the bedrock geology, Pleistocene history, and Holocene sedimentation in the bay. These topics will be described in detail in later publications. The purpose of this note is to present a preliminary report on the more readily processed portion of the data.

The profiles were obtained with a Huntec Mark 2A Hydrosonde profiling system. The system was programmed to provide four sparks per second with a sweep time of 250 milliseconds. Filters were set at 152 to 2329 CPS, providing a band free from interference by the ship's electrical system. Spark tip and hydrophones were towed at five knots behind the CNAV SACKVILLE. Fiducial lines were drawn across the record every 15 minutes to coincide with fixes on the ship's position. The cross-sections constructed from these profiles were based on velocities of 1.5 kilometers per second for sea water and 2.0 kilometers per second for sediment cover. Tidal corrections for fiducial points were determined from the Atlantic Coast Tidal and Current Tables, published by the Canadian Hydrographic Service.

Bedrock Geology

The sub-bottom profiles permit the resolution of three generalized bedrock units in the Bay of Fundy. These units are defined on the basis of their destinctive patterns on the profiles, and were identified by tracing these units towards seacliffs whose stratigraphy is known.

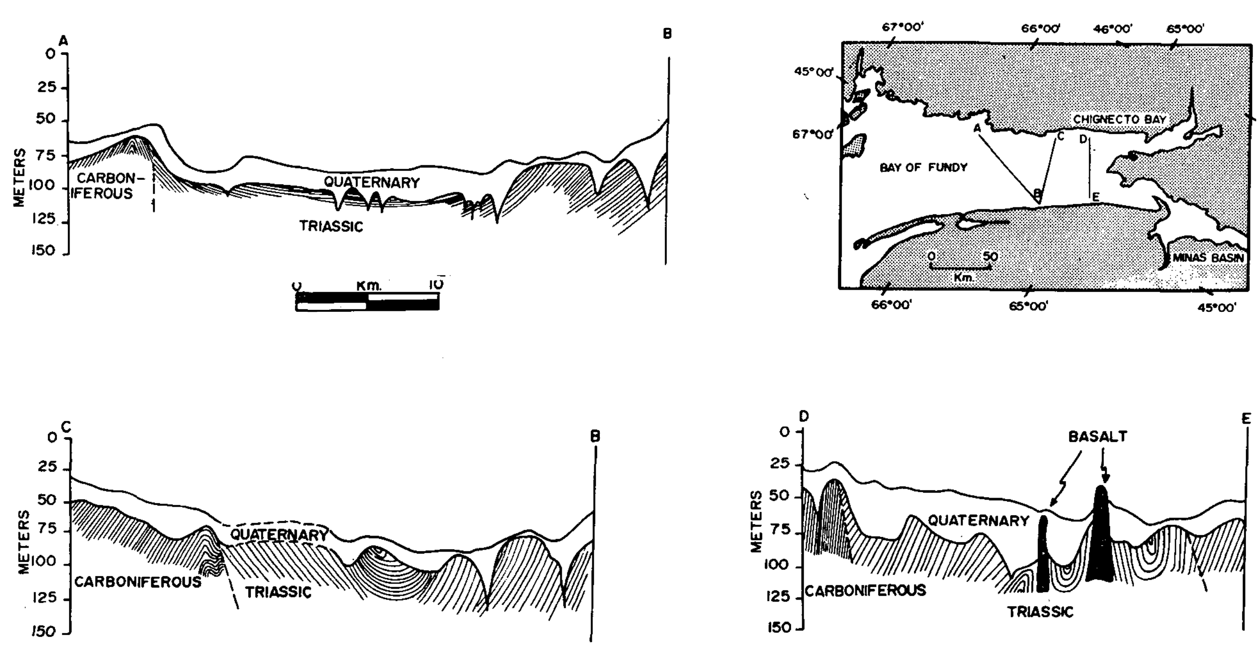

Figure 1. Index map and cross-sections, Bay of Fundy.

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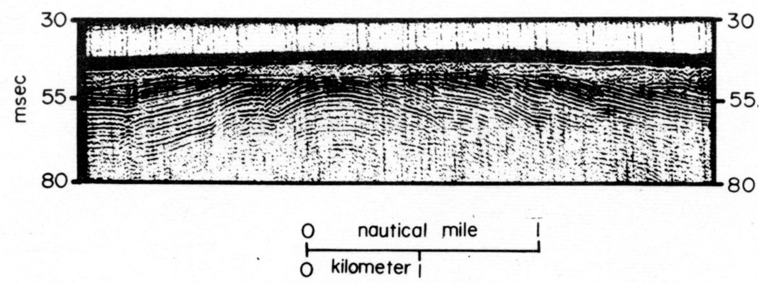
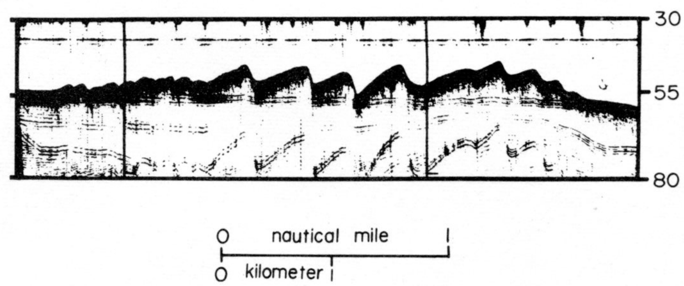


Figure 2. Sub-bottom profile from central Fundy showing glacial pavement overlain by glacial drift.

Figure 3. South end of Cape Split Sand Body in the Minas Channel, Bay of Fundy. Section is normal to sand waves whose steep sides slope north.



The profiles (Figures 1 and 2) show that the bay is floored by the gently dipping Triassic sedimentary rocks of the Acadian Triassic Basin (Powers, 1916). The regular, well-defined, and continuous stratification of this unit suggests that the lithosomes in question are identical with, or related to, Klein's (1961, 1962) lacustrine Scots Bay and Blomidon Formations. A more massive, lenticular stratification occasionally encountered near the margin of the bay is probably Klein's Wolfville sandstone and related alluvial lithosomes.

The Triassic North Mountain Basalt (Klein, 1961, 1962) is recognized by a sharkskin pattern resulting from the intersection of numerous parabolic echoes from point sources on the rough upper surface of the basalt. The profiles reveal that a submarine basalt cuesta extends from the basalt seacliffs at the mouth of the Minas Basin out towards the center of the bay, forming the north limb of the Fundy Syncline.

Carboniferous sedimentary rocks subcrop in Chignecto Bay, along the North side of the Bay of Fundy, and along the north side of the Minas Basin. The Carboniferous pattern consists of weakly-defined stratification, with generally less penetration than in the case of the Triassic sedimentary rock. Dips may be so steep that stratification is no longer resolved by the profiler (over 40 degrees).

The Bay of Fundy is dominated by the Fundy Syncline which can be traced from the mouth of the Bay of Fundy to the great hook-shaped basalt cuesta separating the bay from the Minas Basin (Fig. 1). Of nearly equal importance is the zone of normal faults on the northwest shore which separates Triassic from pre-Triassic rocks. A preliminary study of the records suggests that border faults are both parallel and oblique to the structural axis of the basin. Klein (1961, p. 154) has suggested that similar border faults on the North Shore of the Minas Basin have displacements of up to 1, 700 meters. Smaller oblique and transverse faults are abundant in the Triassic rocks beneath the Bay of Fundy. Displacement of marker beds on sub-bottom profiles indicates throws of tens of meters. Folds with wavelengths of two kilometers or less are abundant near some of the larger faults.

Plesitocene Glaciation and the Origin of the Bay of Fundy

Johnson (1915) and Koons (1941, 1942) maintained that the Bay of Fundy was formed by pre-Quaternary fluvial erosion of the Acadian Triassic Basin, and that in the northeastern Gulf of Maine the basin is bounded by a system of prominent submarine fault scarps. Shepard (1930, 1942) maintained that the scarps and the Bay of Fundy were the result of Pleistocene glaciation. Klein (1961) found no scarps within the Bay of Fundy, but supported the hypothesis of pre-Quaternary fluvial erosion. Uchupi (1966), and Tagg and Uchuppi (1966) reported no visible boundary faults on sub-bottom profiles of the southwestern portion of the Acadian Triassic Basin. They found basin margin gradients of two degrees or less. They believe that the bay took its present shape in the Pleistocene.

Our sub-bottom profiles show that Triassic rocks do not extend further than 2 to 5 kilometers seaward of the New Brunswick Coast, where they are replaced by Carboniferous rocks. The contact of the Triassic and pre-Triassic systems is generally a normal fault, and Johnson's Fundian Fault Zone is a reality in this area. However, fault scarps are low (10 meters or less) and are concealed by Quaternary drift.

The floor of the Bay of Fundy is everywhere mantled with 10 meters or less of surficial material (Fig. 2); often recognizable as till (isotropic pattern) and locally traceable to outwash deposits on shore. The underlying bedrock surface is extremely smooth (Fig. 2). Where recently exposed by tidal scour on the tide flats, this surface appears as a striated glacial pavement. Bedrock channels are locally apparent, but they are sharply defined features whose positions seem unrelated to the regional gradients of the Bay. Some may have been incised by subglacial streams. A coherent system along the southeastern side is displaced south of the bathymetric axis of the bay and appears to be an ice margin feature, perhaps superimposed into bedrock during glacial rebound. Boulder fields and hummocky topography on the southeast side of the bay are believed to represent the fragments of a morainal system. The records show that while the Bay of Fundy may have been initiated by earlier fluvial erosion all evidence for it has been obliterated by Pleistocene glaciation, and that the bay in its modern form is the product of glacial erosion.

Holocene Sedimentation

The bulk of the surficial deposits of the bay appears to be relict from the Pleistocene. Locally, however, equilibrium deposits have developed in response to the modern high energy tidal regime. Along the southeastern shore, bedforms occur with amplitudes up to 5 meters, and with form ratios of 30:1 to 60:1. They are solitary and are commonly perched on slight rises and knolls on the bay floor. Their tendency toward a poorly defined flood asymmetry and their greater abundance on the southwestern shore reflects the stronger currents and flood residual components induced on this coast by the Coriolis effect.

As the Minas Channel and Basin are approached, the friable Wolfville sandstone and tills developed from it become an important part of the substrate. The sand supply increases and sand bodies become more abundant. The bay narrows in this region and submarine relief increases. As the tidal regime becomes increasingly complex in response to these factors, the sand bodies become better defined, and their geometry more complicated (Fig. 3) also Swift, Cok, and Lyall (1966) and Swift, McMullen, and Lyall (1967).

On the northeast side of the bay, Pleistocene drift is overlain by acoustically transparent Holocene mud. The tidal range and the velocity of the associated tidal currents are less on this shore due to the Coriolis effect. This area seems to be a terminus for suspended sediment introduced into the counterclockwise residual current system of the bay by coastal and submarine erosion, and by the rivers of New Brunswick whose total discharge is greater than that of Nova Scotian rivers.

It is clear that unmixing of the relict glacial sediments has begun in response to the post-Pleistocene rise in sea level, and the development of the modern high energy tidal regime.

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