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Discovering the Bay of Fundy's Seafloor

The Bay of Fundy, famous for the highest recorded tides in the world (17 metres), is home to rich fisheries and significant tidal power potential. There are currently plans to utilize this renewable tidal energy source, but a better understanding of the bay's underwater geography is needed to identify safe and suitable turbine locations. Natural Resources Canada's Geological Survey of Canada (GSC) has responded to this need by mapping the Bay of Fundy seabed, providing geological maps and knowledge to guide tidal power generation decisions and aid efforts to manage the bay's biological resources.

Mapping the bottom of the bay

GSC researchers collaborated with Fisheries and Oceans Canada's Canadian Hydrographic Service, as well as several universities, to map the topography and geology of the ocean bottom and the character and thickness of seabed sediments. This was achieved using a suite of sophisticated survey tools and techniques, including shipboard and aircraft-based devices.

Multibeam sonar (**SO**und **N**avigation **A**nd **R**anging) is a device mounted under a survey vessel that rapidly sends out beams of high frequency sound signals or "pings". The sonar listens for the echoes of the pings from the seabed and then calculates the water depth based on the time taken for the echoes to return (this type of surveying is known as multibeam bathymetry). The GSC and its partners collected millions of these depth determinations and used them to construct an accurate relief map of the Bay of Fundy seabed. The resulting map is similar to how an aerial photograph would show the Bay of Fundy with all of its water removed (Figure 1).

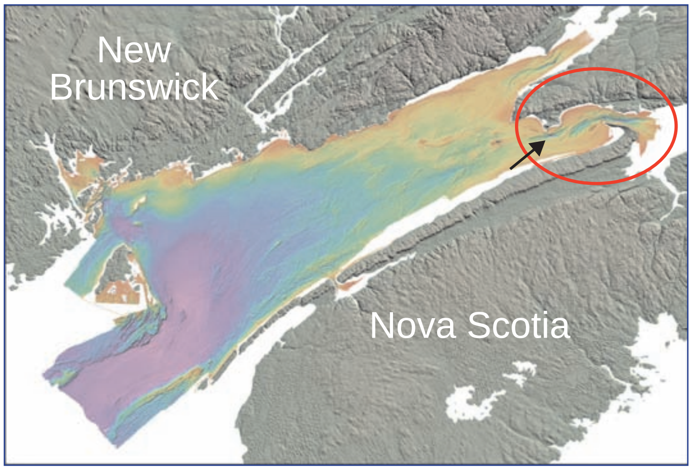

Figure 1. *Bathymetric map of the Bay of Fundy. Red-to-orange colours indicate shallow water and blue-to-violet colours denote deeper water. Much of the bay is less than 100 m deep but the southwest part of the bay reaches 240 m water depth. The black arrow shows direction of oblique view in Figure 2.*

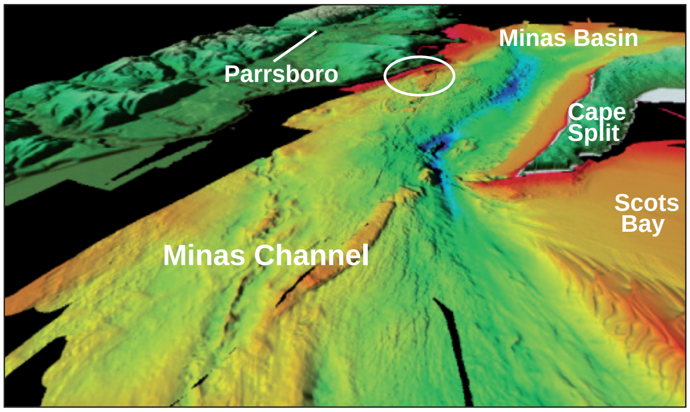

Figure 2. *This oblique view of Minas Channel is the focus of tidal power studies. A device was installed in late 2009 on the seafloor in the area circled. The seabed was imaged using multibeam sonar and the adjacent land was imaged using LiDAR.*

Until recently, shallow areas adjacent to the coast (the intertidal zone) had not been bathymetrically surveyed due to the danger of operating a vessel there. To overcome this challenge, researchers used an aircraft-mounted device known as LiDAR (**Li**ght **D**etection **A**nd **R**anging). During low tide, the aircraft flew along the Bay of Fundy coast while the LiDAR emitted pulses of laser light. Similar to the sonar technique, the light pulses were reflected from the land and recorded by the aircraft's device. Millions of these measurements provided an accurate map of the intertidal zone. The combination of the multibeam sonar and LiDAR results provided the first detailed and "seamless" map from the bottom of the Bay of Fundy across the shoreline and onto land (Figure 2).

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Once the ocean bottom topography was mapped, seismic profiling techniques were used to determine the types of rock and sediment that lay beneath the seafloor. Sound energy was used once more, this time to produce echoes from layers of sediment up to 100 m beneath the seabed. The result was a series of sub-surface profiles of sediment thickness produced as the survey ship completed transects of the bay (Figure 3).

Finally, the GSC and its partners verified predictions from the acoustic methods by collecting and analyzing seabed samples, cores, and photographs.

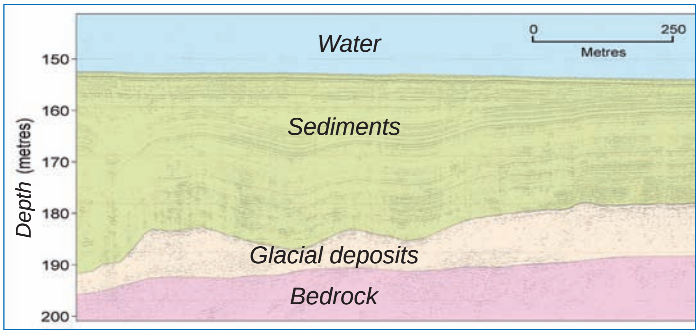

Figure 3. *Interpreted seismic cross-section showing bedrock and sediment layers in the Bay of Fundy. Up to 40 m of mud overlies material deposited by the retreating ice sheet during the last glaciation of North America.*

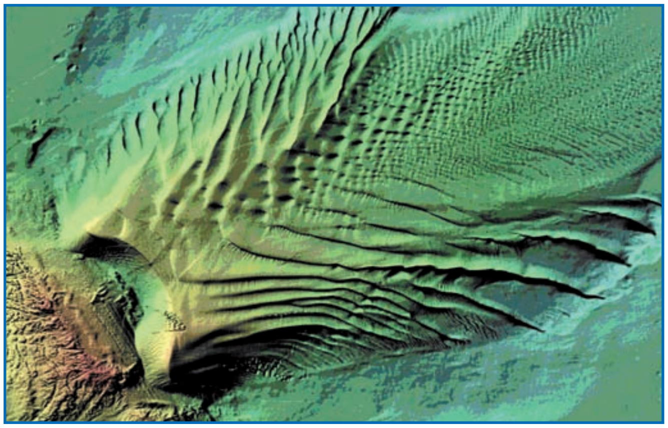

Figure 4. *Complex pattern of intersecting sand waves in the Bay of Fundy. The area of seafloor is 2.2 km^2. Image by John Hughes Clarke, Ocean Mapping Group, University of New Brunswick.*

Key Findings

1. The Bay of Fundy's seafloor is covered with glacial landforms created by a continental ice sheet that once covered the entire area and retreated about 14,000 years ago. The glaciers created complex and highly variable seafloor geology within the bay.

2. Fields of sand waves, up to 20 m high, move and change with each tidal cycle (Figure 4). How much and how often the bedforms move is important for designing and locating future tidal energy installations.

Making a Difference

The GSC completed the three-year bathymetry and topography mapping program of the Bay of Fundy in late 2009. The combined multibeam, LiDAR, geophysical, and geological data were used to produce a new series of integrated geological maps. The methods and products developed under this project will be used to assist ocean sector industries, such as hydrocarbon, tidal power, and telecommunications companies, when trying to locate safe and appropriate places to install equipment on the seabed.

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