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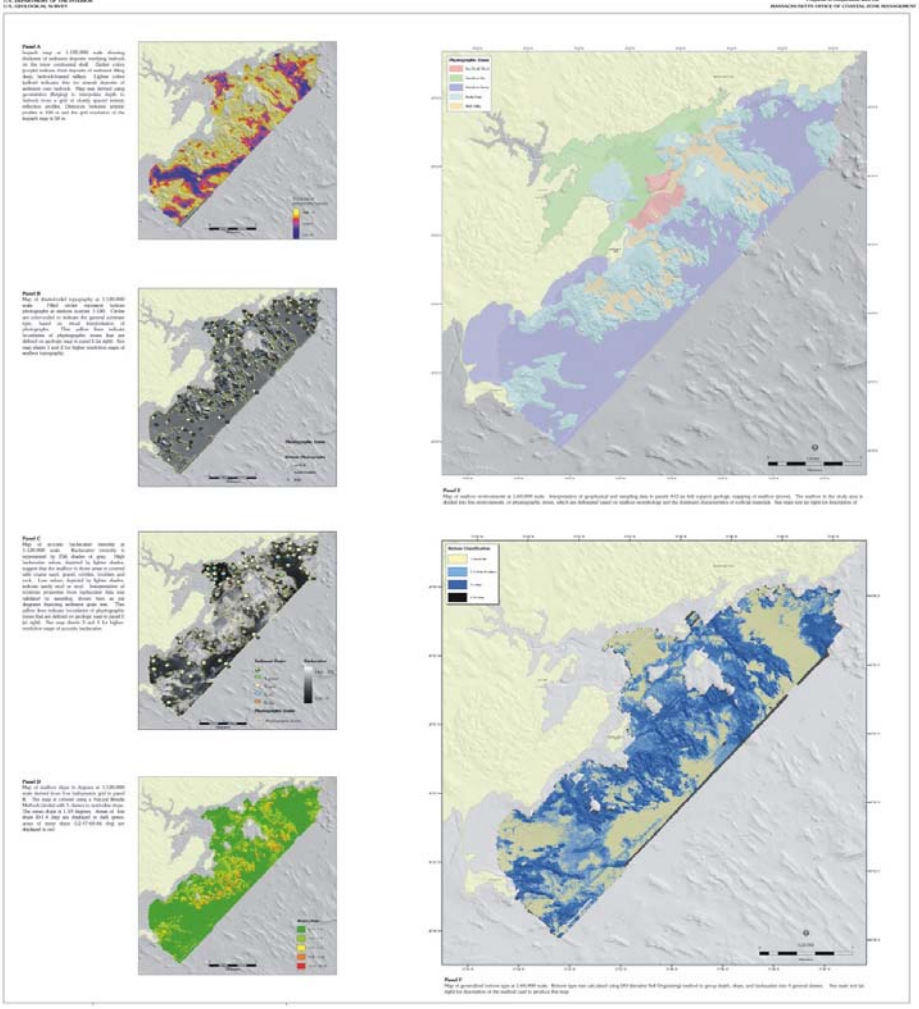
Sheet 5 of 5



HIGH-RESOLUTION GEOLOGIC MAPPING OF THE INNER CONTINENTAL SHELF: NAHANT TO GLOUCESTER MASSACHUSETTS

Sheet 5: Geologic maps of seafloor

By

Walter A. Barnhardt, Brian D. Andrews, and Bradford Butman

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Map Sheet 5: Geologic maps of the seafloor

Introduction

A series of four map sheets shows the seafloor topography and geology of the inner continental shelf between Nahant and Gloucester, Massachusetts including Salem Sound and parts of eastern Massachusetts Bay. The maps detail the basic geologic maps of the seafloor and environments from data were produced. Sheet 1 shows shaded-relief topography in color, sheet 2 shows shaded-relief topography in grayscale, sheet 3 shows grayscale backscatter intensity, and sheet 4 shows shaded-relief topography overlain by backscatter intensity. These maps are based on high-resolution geophysical data collected in 2001 and 2002 as part of a cooperative mapping project between the U.S. Geological Survey Massachusetts (USGS) to systematically map the seafloor geology offshore of Massachusetts. The maps shown is accompanied by a text summary report (USGS-0000) that presents a description of the data collection, processing, and analysis procedures used to create these maps. The USGS-0000 also includes copies of all data layers in GIS format, and the original data used to produce the seafloor interpretations.

Geologic Mapping

The maps shown interpretations and analyses in mapping the seafloor geology offshore of Massachusetts. The datasets used to construct the geologic maps are shown in four small panels (A-D) along the left margin of this sheet. Panel A is an imagery map which shows the bathymetry of the seafloor. Panel B is a shaded-relief topography map which shows the seafloor topography. Panel C is a backscatter intensity map which shows the acoustic reflectivity of the seafloor. Panel D is a composite map that combines topography and backscatter intensity. Panel E is a map of seafloor environments at 1:100,000 scale. Interpretations of geophysical and sampling data to provide the geologic mapping of seafloor sediments, and the distribution characteristics of surficial materials. Panel F is a map of generalized bottom type at 1:40,000 scale. Bottom type was calculated using ESI Benthic Terrain Modeler (BTM) software to group depth, slope, and backscatter into 4 general classes. See main text for explanation of the seafloor sediment classification.

The coast is shaped by a succession of glacial and postglacial processes. The last glaciation of the region occurred during the Wisconsinan Stage, which ended about 18,000 years ago. At that time, the Laurentide Ice Sheet covered much of New England and eastern Canada. As the ice sheet melted, it deposited sediments that form the bedrock and surficial deposits of the region. Sea level rose rapidly as the ice melted, flooding the coastal lowlands and creating the present coastline. The seafloor in the study area is characterized by a variety of sediment types, including bedrock, glacial till, sand, gravel, and mud. The distribution of these sediments is controlled by the underlying geology, the processes that have shaped the coast, and the modern oceanographic conditions.

Nearshore Zones are zones of shallow, low-relief seafloor adjacent to the mainland and associated bays, offshore zones by islands and peninsulas. The nearshore zone is characterized by a mixture of sediment types, including sand, gravel, and mud. The nearshore zone is typically subject to the strongest wave and current action. The nearshore zone extends from the shoreline to a depth of about 10 m (33 ft).

Bedrock Zones are mapped where bedrock crops out at the seafloor or is covered by a thin veneer of sediment. Bedrock zones are typically characterized by high backscatter intensity and rough topography. The bedrock zones in the study area are composed of a variety of rock types, including granite, gneiss, and schist. The bedrock zones are typically subject to the strongest wave and current action. The bedrock zones extend from the shoreline to a depth of about 10 m (33 ft).

Shoal Zones are mapped where sediment is thicker than the surrounding seafloor and forms a shallow, elongated ridge or mound. The shoal zones are typically composed of sand and gravel. The shoal zones are typically subject to strong wave and current action. The shoal zones extend from the shoreline to a depth of about 10 m (33 ft).

Basin Zones are mapped where sediment is thicker than the surrounding seafloor and forms a deep, elongated depression. The basin zones are typically composed of mud and fine sand. The basin zones are typically subject to weak wave and current action. The basin zones extend from the shoreline to a depth of about 10 m (33 ft).

Boulder Zones are mapped where boulders are abundant on the seafloor. The boulder zones are typically composed of granite, gneiss, and schist. The boulder zones are typically subject to strong wave and current action. The boulder zones extend from the shoreline to a depth of about 10 m (33 ft).

Gravel Zones are mapped where gravel is abundant on the seafloor. The gravel zones are typically composed of granite, gneiss, and schist. The gravel zones are typically subject to strong wave and current action. The gravel zones extend from the shoreline to a depth of about 10 m (33 ft).

Sand Zones are mapped where sand is abundant on the seafloor. The sand zones are typically composed of quartz and feldspar. The sand zones are typically subject to moderate wave and current action. The sand zones extend from the shoreline to a depth of about 10 m (33 ft).

Mud Zones are mapped where mud is abundant on the seafloor. The mud zones are typically composed of clay and silt. The mud zones are typically subject to weak wave and current action. The mud zones extend from the shoreline to a depth of about 10 m (33 ft).

Data and Methods

Mapping of the seafloor was carried out by the interpretation of high-resolution geophysical data collected in 2001 and 2002 as part of a cooperative mapping project between the U.S. Geological Survey Massachusetts (USGS) to systematically map the seafloor geology offshore of Massachusetts. The data used to construct the geologic maps are shown in four small panels (A-D) along the left margin of this sheet. Panel A is an imagery map which shows the bathymetry of the seafloor. Panel B is a shaded-relief topography map which shows the seafloor topography. Panel C is a backscatter intensity map which shows the acoustic reflectivity of the seafloor. Panel D is a composite map that combines topography and backscatter intensity. Panel E is a map of seafloor environments at 1:100,000 scale. Interpretations of geophysical and sampling data to provide the geologic mapping of seafloor sediments, and the distribution characteristics of surficial materials. Panel F is a map of generalized bottom type at 1:40,000 scale. Bottom type was calculated using ESI Benthic Terrain Modeler (BTM) software to group depth, slope, and backscatter into 4 general classes. See main text for explanation of the seafloor sediment classification.

Sources

Many shoreline interpretations and surficial materials on the inner continental shelf data are important tools in understanding the region's geologic history. Previous studies of the region's geology include the work of Oldale and others (1982) who mapped the surficial sediments of much of North Atlantic Ocean, the overall geometry of the coast and inner continental shelf (Uchupi et al., 1996). Previous studies include those by Barnhardt and others (1997) who mapped the seafloor sediments of the Massachusetts Bay and Boston Harbor areas, and Knebel and others (1999) who mapped the seafloor sediments of the Gulf of Maine and Georges Bank. These studies provided a regional framework for understanding the geology of the study area.

Most sources and source material utilized and from this mapped, notably comprising data characterizes the seafloor in terms of the study area. Sources of physical fill and mineral materials, notably fine-grain silts, a wide range of particle sizes from unconsolidated mud to large boulders. Glacial sediments dominate some of boulder-covered tills or moraines and areas of Multibeam Data, to shallow water but provide the evidence to Salem Sound. These hills features are erosion and current-resistant to glacial till, while more resistant bedding is formed from the till and the bedrock. A systematically mapped across the region at the end of the last ice age. Sand, sediment fills the basins and valleys between the bedrock hills and glacial till ridges. Sediments in the basins are typically fine-grained and have been modified by erosion. An erosion valley runs across the study area between Salem Sound, passing between some islands and Marblehead. The valley widens in sections of reflection and a more channel has been probably eroded by the ancestral Merrimack River when valleys formed as Ice Age melt.

Ice-margin moraines generally deliver significant amounts of sediment to the area, so mapping of varying deposits can largely determined the physical distribution of bottom sediment. Modern processes impose other features and physical deposits to create the shoals, beaches and other coastal landforms visited along the coastal boundary. Sandy sediment, derived from reworked glacial sediment, has also accumulated on the surface of broad, gently sloping areas of seafloor in Salem Bay to the southwestern part of the map, and offshore of Marblehead to the northeastern part of the map. Some deposits of muddy sediment primarily occur in Salem Sound, coastal islands and islands to the southwest of the study area. Muddy sediment is also found in the deeper parts of the Gulf of Maine Continental Shelf Research, v. 11, p. 1283–1305).

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Map of the seafloor and their imaging systems. Area is the panel for Gloucester Harbor and separated from its primary area offshore of light data in Salem to Nahant. Nahant marks the Nahant and Gloucester area shown (below).

Projection: UTM
Zone: 19
Datum: NAD83

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