Sea Floor Image Maps Showing Topography, Sun-Illuminated Topography, Backscatter Intensity, Ruggedness, Slope, and the Distribution of Boulder Ridges and Bedrock Outcrops in the Stellwagen Bank National Marine Sanctuary Region off Boston, Massachusetts

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MAP C.—BACKSCATTER INTENSITY AND SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY REGION

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DISCUSSION

Introduction

Sea floor mapping in the Stellwagen Bank National Marine Sanctuary (NMS) is a cooperative effort of the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration, with technical support from the University of New Brunswick and the Canadian Hydrographic Service. The maps generated from this undertaking are based on a 1994–96 survey that used a multibeam echo sounder to map 1,100 square nautical miles of the sea floor (fig. 1). The technology and methods of image acquisition and topographic contouring that were used are described in publication 4 in the References section. USGS Scientific Investigations Maps (SIM) 2840–A to –F constitute a six-map (twelve-sheet) series in digital (DVD-ROM) format. The first three maps, SIM 2840–A, –B, and –C, were previously published on paper as USGS Geologic Investigations Series Maps I–2676–A, –B, and –C (publications 43–45 in the References). Preliminary versions of those three maps also had been released earlier on a CD-ROM as USGS Open-File Report 00–410 (publication 42).

The map area shown here is a composite of 18 individual quadrangle maps (fig. 1). Two map series of the 18 quadrangles have been published at a scale of 1:25,000 and show sea floor topography (publications 4–22) and sun-illuminated sea floor topography (fig. 2; see publications 23–41). Selected sea floor maps, photographs, CD-ROMs, fact sheets, posters, and geographic names related to research conducted in the Stellwagen Bank NMS region are available online at USGS Web site http://woodshole.er.usgs.gov/project-pages/stellwagen/index.html. See the References section for a complete numbered list of publications.

On the maps presented in this series, the locations of the corners of the 18 quadrangles are shown for reference as ticks labeled outside the map edges, and (on maps C and E) as large crossticks within the map area. Maps A, B, D, and F show the boundaries of the individual quadrangles. On the maps that show sun-illuminated sea floor topography, blank spaces represent areas of no data.

Backscatter intensity

This map combines contoured and sun-illuminated topography with backscatter intensity of the sea floor. Backscatter intensity is an indicator of sea floor hardness and roughness as determined by the strength of the sound waves reflected from the seabed during the survey. It is depicted here by a suite of eight colors (fig. 3) ranging from blue, which represents low intensity (soft bottom), to red, which represents high intensity (hard bottom). The mapped backscatter intensity data are draped over a shaded relief image created by vertically exaggerating the topography four times and artificially illuminating the relief by a light source positioned 45 degrees above the horizon from an azimuth of 350 degrees. The resulting image displays light and dark tones within each color band that are determined by a feature's position with respect to the light source. For example, north-facing slopes, receiving strong illumination, show as light tones within a color band, whereas south-facing slopes, being in shadow, show as dark tones within a color band.

The interpretation of backscatter intensity is based on numerous sediment texture analyses and video and photographic imagery of the sea floor in the mapped area (see Map F, Sheet 3 of this series for location of stations). High backscatter values (6-7-8, yellow-orange-red) represent coarse sand, gravelly sand, sandy gravel, gravel (including ridges and piles of boulders), and rock outcrops. Moderate backscatter values (3-4-5, green-yellow) represent sand and muddy sand, and low backscatter values (1-2, blue) represent sandy mud and mud.

These interpretations are most accurate in regions of relatively low relief, because steep slopes can divert the paths of some of the reflected sound waves away from the survey vessel. Thus, seabed that slopes steeply away from the survey track can produce a lower backscatter intensity than if the seabed were level. For example, the conical crest of Sanctuary Hill (Quadrangles 17 and 18) is a bedrock outcrop that should display high backscatter values (6-7-8) but here displays moderate values (3-4-5), presumably because its flanks reflect sound waves in many directions, reducing the sound energy returned to the receiver. Conversely, seabed that slopes steeply toward the survey track can produce a higher backscatter intensity.

Those areas that show relatively uniform backscatter intensity imply homogeneity of bottom sediment. However, in other places variable backscatter intensity implies a more heterogeneous composition of bottom sediment. Unnatural-looking stripes and patterns oriented parallel or perpendicular to survey tracklines are artifacts of data collection.

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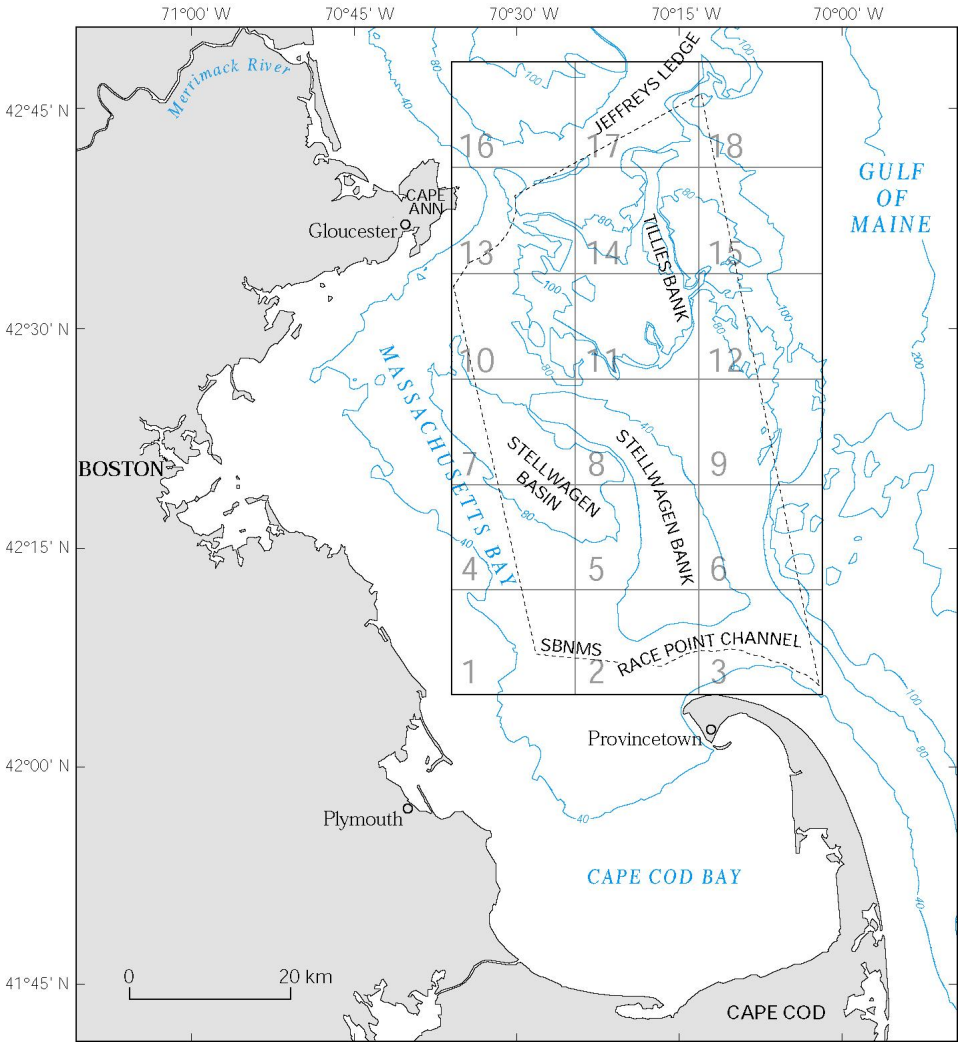

Figure 1. Regional setting of the map area (outlined in black). Publications specific to the entire map area or to individual quadrangles 1–18 (outlined in gray) are listed in the References section. Stellwagen Bank National Marine Sanctuary (SBNMS) boundary is shown as a dashed line. Bathymetric contours are labeled in meters.

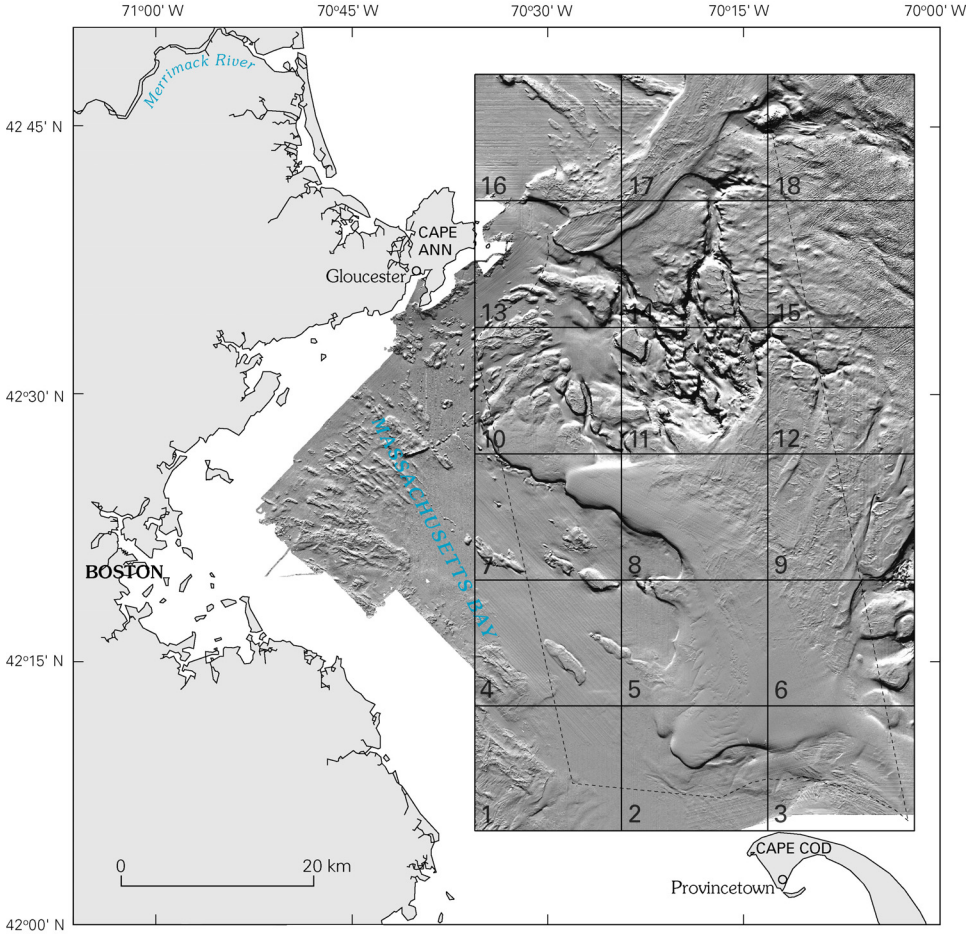

Figure 2. Sun-illuminated sea floor topographic imagery of the Stellwagen Bank National Marine Sanctuary and Massachusetts Bay region, and the 18 quadrangles of the map area. Dashed line is the sanctuary boundary.

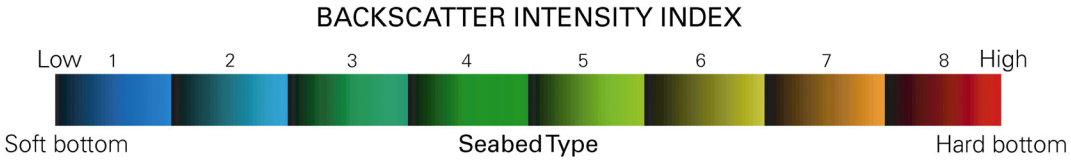

Figure 3. Backscatter intensity index. Interpretation of seabed type applies best in areas of low topographic relief.