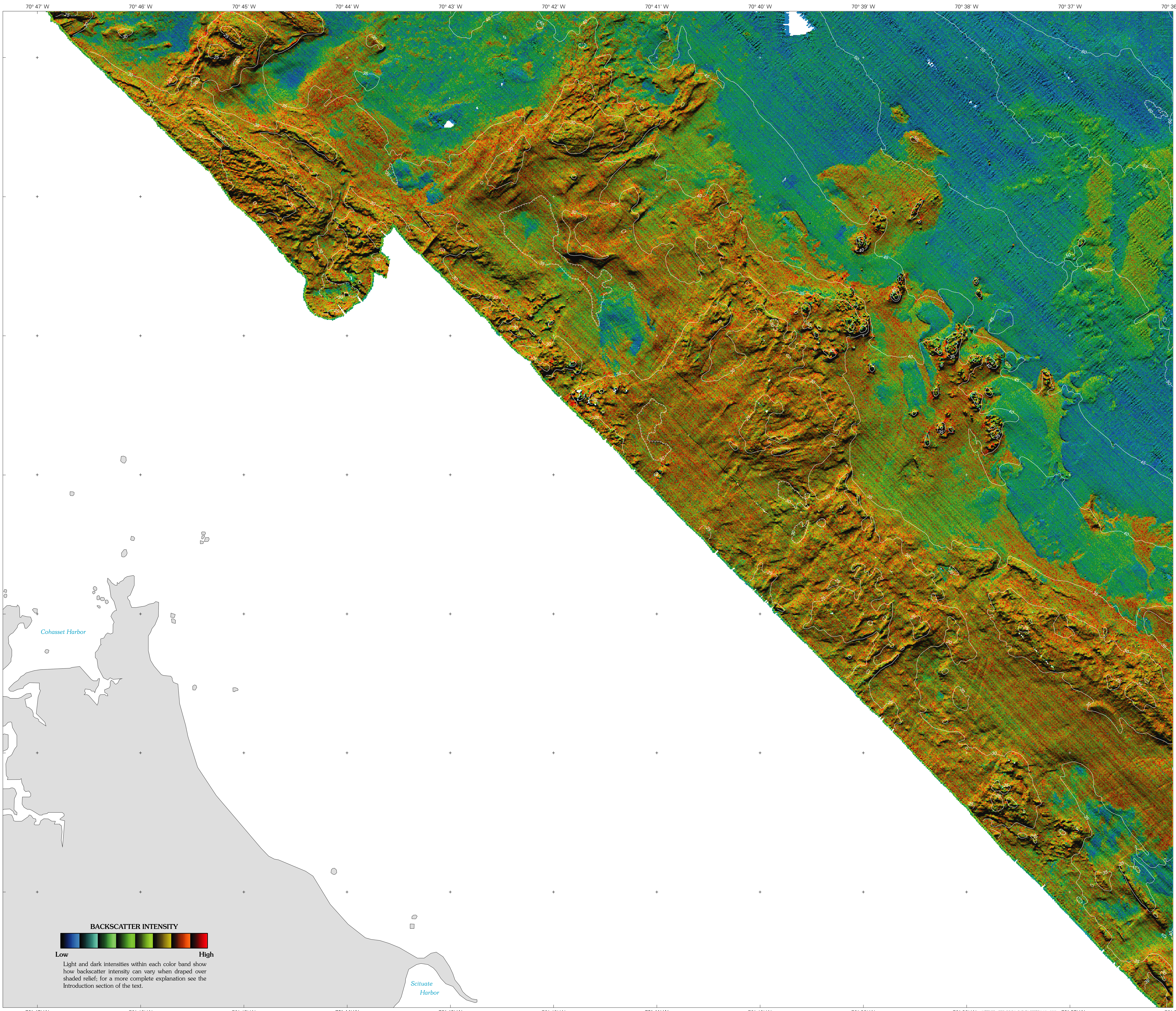

Mercator projection

Geodetic Reference System 1980; North American Datum 1983
Longitude of central meridian 70°19' W.; latitude of true scale 41°39' N.
False easting 0 m; false northing 0 m

This map is not intended for navigational purposes.

SCALE 1:25 000
ONE CENTIMETER ON THE MAP REPRESENTS 250 METERS ON THE SEA FLOOR

1 .5 0 1 2 3 4 5 KILOMETERS

1 .5 0 1 2 NAUTICAL MILES

CONTOUR INTERVAL 5 METERS
DATUM MEAN LOWER LOW WATER

Shoreline data were extracted from the National Oceanic and Atmospheric Administration Medium Resolution Digital Vector Shoreline (see text).

DISCUSSION

Introduction

This map shows backscatter intensity of the sea floor draped over shaded relief, with sea floor depth as topographic contours overprinted in white, at a scale of 1:25,000. It is based on multibeam echo-sounder data collected using a Simrad Subsea EM 1000 Multibeam Echo Sounder (95 kHz) during four cruises conducted between the fall of 1994 and the fall of 1998 aboard the vessel *Frederick G. Creed*. The map is part of a 3-quadrangle map series showing the area offshore of Boston, Mass., that is companion to the Stellwagen Bank National Marine Sanctuary map series (Valentine and others, 2001, 2003a–c; also see location map). Other maps of Quadrangle 1 depict topographic contours (Butman and others, 2003a), and shaded relief and topographic contours (Butman and others, 2003b).

Backscatter intensity is a measure of surficial sediment texture and bottom roughness. Generally, high backscatter intensity is associated with rock or coarse-grained sediment, and low backscatter intensity characterizes finer grained sediments. Direct observations, using bottom photography or video and sampling techniques such as grab sampling or coring, are needed to verify interpretations of the backscatter intensity. In the image shown here, the backscatter intensity is represented by a suite of eight colors ranging from blue, which represents low intensity (fine-grained sediments), to red, which represents high intensity (rock outcrops and coarse-grained sediments). These data are draped over a shaded relief image created by vertically exaggerating the topography four times and then 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 intensities within each color band that result from a feature's position with respect to the light source. For example, north-facing slopes, receiving strong illumination, show as light intensity within a color band, whereas south-facing slopes, being in shadow, show as dark intensity within a color band. The shaded relief image accentuates small features that could not be effectively shown by contours alone at this scale. The bathymetric soundings were gridded at 6 m/pixel resolution and smoothed using a 9-cell by 9-cell median filter; contours having a 5-meter interval were generated from the resulting grid. Blank areas in the image represent places where no data exists; data coverage begins 6 to 7 km offshore. Most areas of no data in this backscatter intensity image are smaller than in the shaded relief image (Butman and others, 2003b) because depth measurements at the outer edge of the swath were sometimes removed as bad data; in many of these cases, the backscatter intensity data were still useable, resulting in greater spatial coverage for backscatter intensity. The shoreline was extracted from the National Oceanic and Atmospheric Administration Medium Resolution Digital Vector Shoreline (data downloaded from http://seaserver.nos.noaa.gov/projects/shoreline/shoreline.html, Segment EC80_05, digitized from Chart 13267 (National Ocean Service, 1997)). Topographic lows are identified by hachured contours (hachures face deeper water).

Some features in the image are artifacts of data collection and environmental conditions. They include small highs and lows and unnatural-looking features, and patterns oriented parallel or perpendicular to survey tracklines (tracklines run northwest-southeast). For example, wrinkle-like features in the northeastern part of the quadrangle, which are about 100 to 150 m long and are oriented northeast-southwest and perpendicular to the ship's track, are a result of heave of the vessel during data collection caused by large surface waves. The northwest-southeast-trending dark lines, especially apparent in the high-backscatter areas of the image, are a result of noisy backscatter return directly beneath the ship. Other northwest-southeast-trending lines, especially noticeable along the shallow southwestern part of the mapped area of the quadrangle (for example, the linear feature extending between 42°16.37' N., 70°40.79' W. and 42°15.63' N., 70°39.80' W.), are a result of marginal data overlap between swaths where survey lines were spaced too far apart.

Geologic history

The major topographic features shown in this map series were formed by glacial processes that occurred in several stages. Ice containing rock debris moved across the region, sculpting its surface and depositing sediment, forming the ridges and valleys that characterize the region. Other features are the result of processes at work when much of the area was covered with rotting ice, and when at the same time small valley glaciers and ice falls were active. Ice retreat and marine submergence occurred between 18 and 14 ka, resulting in a highstand of sea level approximately 33 m above modern sea level about 14 ka (Oldale and others, 1993). A lowstand of sea level approximately 45 m below modern sea level occurred about 12 ka as the earth's crust rebounded from ice loading. Thus, the sea floor of Massachusetts Bay in water depths shallower than about 45 m was reworked during the marine transgression between 18 and 14 ka, again during a relatively rapid sea-level regression between 14 and 12 ka, and finally during the transgression between 12 ka and the present. Today, the surficial sediments and features are reworked and shaped by tidal and storm-generated currents that erode and transport sediments from the shallow areas into the deeper basins. Over time, the shallow areas affected by these processes have become coarser as sand and mud are removed and gravel remains, and the deeper basins have been built up as they receive the sand and mud. Knebel and Circé (1995) have identified areas of erosion, sediment reworking, and deposition in this region.

Quadrangle 1 features

One of the most striking aspects of the sea floor shown by this survey is the variability in bottom morphology and texture over scales of a few kilometers or less, caused by both natural and anthropogenic processes. The topography, surface features, and surficial sediment texture are the result of glacial processes, reworking during the last rise in sea level, reworking by modern processes, and the disposal of dredged and other material in this region over the last century.

The topographic contours in this region of western Massachusetts Bay run approximately northwest-southeast. Northeastward of about the 45-meter contour, the sea floor slopes steadily toward Stellwagen Basin (see location map) and is characterized by sediment having low backscatter intensity. Shoreward, between 45 and 35 m water depth, the sea floor grades to higher backscatter intensity. Between 42°16' N., 70°37' W. and 42°18' N., 70°39' W., in water depths between 35 and 45 m, rock pinnacles rise 5 to 10 m above the surrounding sea floor. These rugged features are 100 to 300 m in horizontal extent, are characterized by high to medium backscatter intensity, and are surrounded by high-backscatter-intensity sediment on the adjacent sea floor. A series of depressions less than 1 m deep and characterized by extremely sharp boundaries occurs between 42°15' N., 70°36' W. and 42°18' N., 70°40' W. Examples of these features are centered near (1) 42°17.26' N., 70°38.29' W.; (2) 42°17.0' N., 70°37.80' W.; (3) 42°16.75' N., 70°38.40' W.; (4) 42°16.40' N., 70°37.17' W.; and (5) 42°15.5' N., 70°36.27' W., and they suggest sediment movement and sorting of bottom sediments. These features are floored with high-backscatter material composed of gravel and sand; bottom photographs show large bedforms (Gutierrez and others, 2001). The transition from the high-backscatter gravel in the depressions to low-backscatter sand outside the depressions occurs over a few meters.

Between 35 and 30 m water depth, there is a shoreward transition from smooth to rough sea floor. Relative lows in this depth range, for example the regions centered near 42°14.35' N., 70°37.5' W. and 42°17.1' N., 70°41.4' W., are still relatively smooth, but they are floored with high-backscatter-intensity sand and gravel as well as with low-backscatter-intensity material. At depths shallower than about 30 m the sea floor is rougher and has uniformly high backscatter intensity. There is a suggestion of northeast-southwest-trending ridges having steep faces toward the southeast; the ridges are particularly noticeable in the area between 42°14.6' N., 70°38.6' W. and 42°15.5' N., 70°39.5' W. The shallowest areas on this map (less than 25 m deep and in a few places less than 20 m deep) are characterized by uniformly high backscatter intensity caused by cobbles and boulders.

Ribbon-like features (for example, near 42°16.88' N., 70°40.46' W. and 42°14.57' N., 70°37.91' W.) typically are 0.5 to 1 km long and less than 40 m wide, and are suggestive of downslope sediment transport. The relief across these features is about 25 cm or less. Bottom photographs show that the northern feature is floored with coarse sand shaped into large bedforms (Gutierrez and others, 2001). No photographs are available of the southern feature.

Between 70°40' W. and 70°44' W. and northward from about 42°18.5' N., and northward of 42°19' N. near 70°46' W., numerous dumps of anthropogenic material are visible as high-backscatter-intensity features less than 100 m in diameter. These individual dumps are most apparent in areas where the surrounding sediment has low backscatter intensity. Similar features are found to the north in Quadrangle 2 (Butman and others, 2003c).

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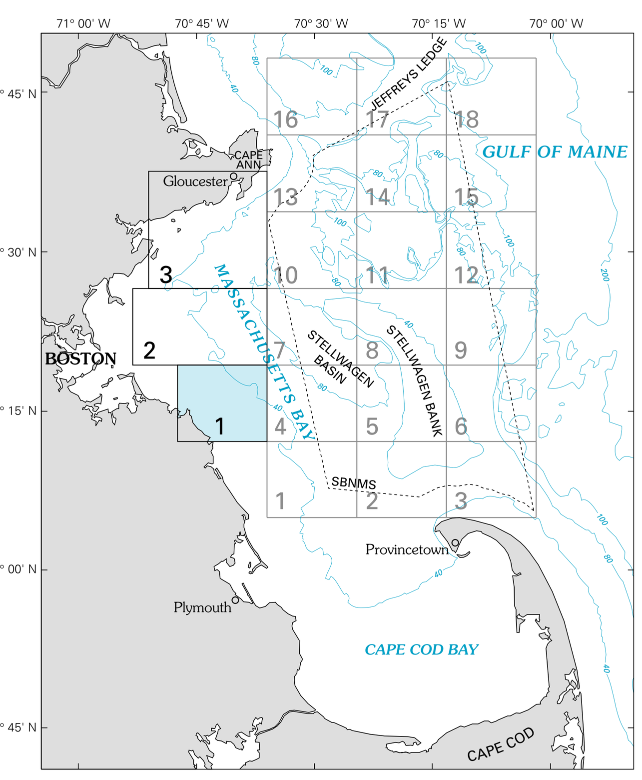

Location map showing mapped Quadrangle 1 shaded in blue. The western Massachusetts Bay map series comprises quadrangles 1–3 (outlined in black); the maps for Quadrangle 1 include this map and Butman and others (2003a,b). Backscatter intensity, shaded relief, and sea floor topography of Quadrangle 2 are shown at scale 1:25,000 in Butman and others (2003c). Quadrangles 1–18 (outlined in gray) compose the companion Stellwagen Bank National Marine Sanctuary (SBNMS) map series. The backscatter intensity, shaded relief, and sea floor topography of the entire area of quadrangles 1–18 are shown at scale 1:60,000 in Valentine and others (2001, 2003c). The SBNMS boundary is shown as a dashed line. Selected bathymetric contours are labeled in meters.

BACKSCATTER INTENSITY, SHADED RELIEF, AND SEA FLOOR TOPOGRAPHY OF QUADRANGLE 1 IN WESTERN MASSACHUSETTS BAY OFFSHORE OF BOSTON, MASSACHUSETTS

By

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2003

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