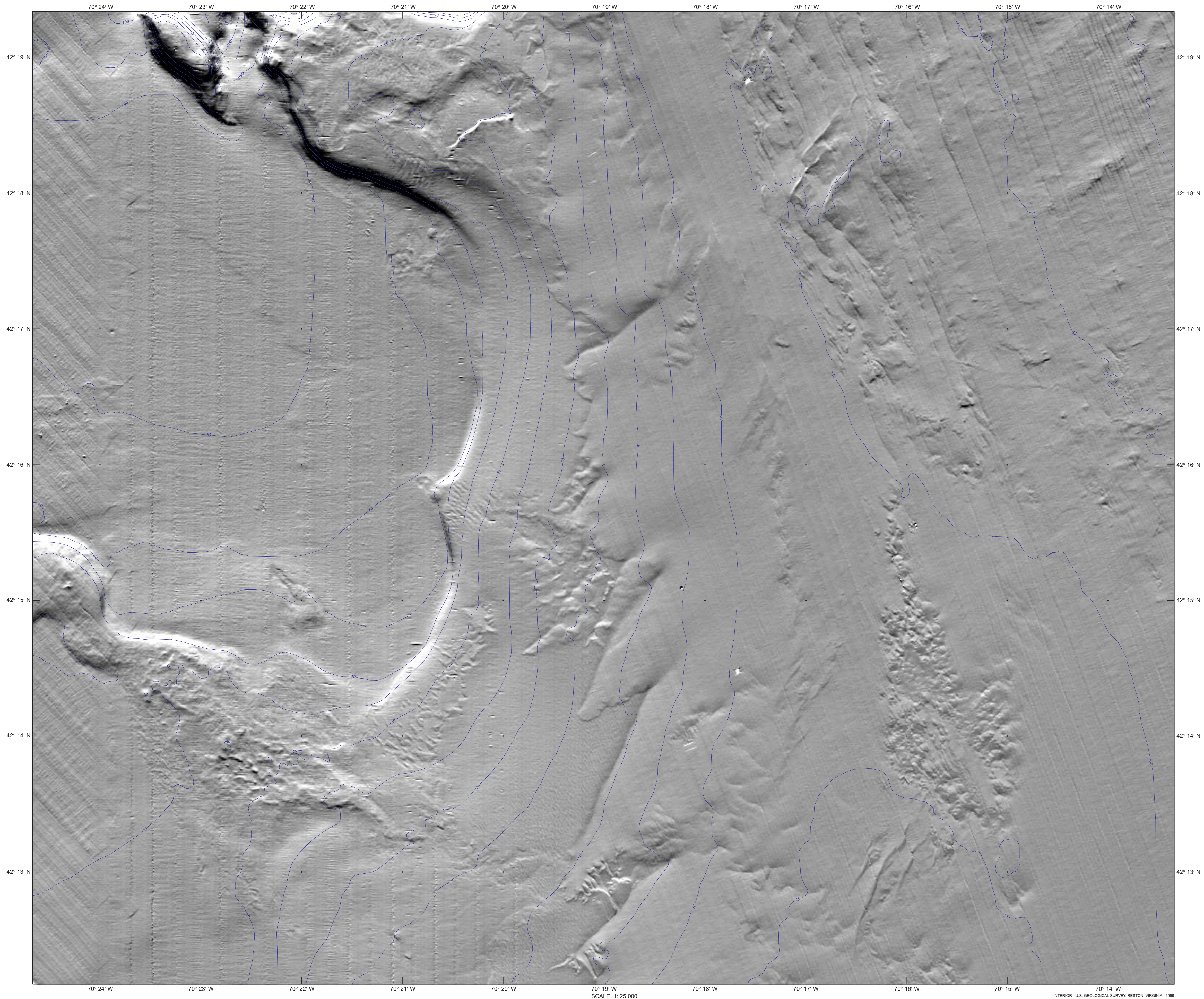
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2705



INTERIOR - U.S. GEOLOGICAL SURVEY, RESTON, VIRGINIA - 1999

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 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 5 METERS
DATUM MEAN LOWER LOW WATER

DISCUSSION

Introduction - The Stellwagen Bank National Marine Sanctuary Mapping Project is a cooperative effort of the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, with support from the University of New Brunswick and the Canadian Hydrographic Survey. The multibeam echo sounder survey was conducted on four cruises over a two-year period from the fall of 1994 to the fall of 1996. This map shows one of a series of 18 quadrangles (see location map) in which sea floor depth information is depicted in sun-illuminated (or shaded relief) view at a scale of 1:25,000, with topographic contours overprinted in blue. The image shown here uses a sun elevation angle of 45 degrees above the horizon from an azimuth of 350 degrees and a vertical exaggeration of four times. In effect, topographic relief is enhanced by having the sun illuminate the sea floor from a position 10 degrees west of north so that shadows are cast on the southern flanks of seabed features. Some features in the images are artifacts of data collection. They are especially noticeable where the seabed is smooth and include small highs and lows and unnatural-looking features and patterns that are oriented parallel or perpendicular to survey tracklines. For a depiction of the topographic contours alone, and for an explanation of survey and topographic data processing methods, see the companion map by Valentine and others (1997). Topographic contour maps for all 18 quadrangles of the map series are available on a CD-ROM in EPS, PS, Arc export, and PDF file formats (Valentine and others, 1998). Blank areas represent places where no data exists.

Regional seabed features - The major topographic features depicted in the map series were formed by glacial processes. In broad terms, these features are interpreted here to represent a geologic history that developed in several stages. Ice containing rock debris moved across the region, sculpting its surface and depositing sediment to form the large basins, banks, ridges, and valleys. Many other features observed here represent the latter stages of deglaciation. They are the result of processes at work when much of the area was covered by stationary rotting ice, and when at the same time small valley glaciers and ice falls were active in and near areas of high topographic relief. The sea invaded the region formerly occupied by ice, and seabed features were partly eroded and some new sedimentary deposits were formed. Today, the sea floor is modified mainly by strong southwestward-flowing bottom currents caused by storm winds from the northeast. These currents erode sediments from the shallow banks and transport them into the basins. With time, the banks affected by these currents become coarser, as sand and mud are removed but gravel remains; and the western flanks of the banks, and adjacent basins, are built up by deposits of mud and sand.

Quadrangle 5 features - This quadrangle covers the western central part of Stellwagen Bank and an embayment of Stellwagen Basin into the western flank of the bank. The bank surface slopes eastward and westward from a broad central crest delineated by the 25- and 30-meter contours. Eastward of the crest, extending to a depth of 40 m, the gently-sloping sea floor is sand and gravel, including boulder piles and ridges. The central bank crest and western flank are somewhat finer-grained sand and gravelly sand to a depth of 65 m. Both the eastern and western flanks exhibit a variety of sand deposits and bedforms that indicate movement of sand from northeast to southwest by storm wave currents. These deposits typically are a series of coarse and fine sand bodies that have segregated during transport. In the northeastern part of the quadrangle, the deposits are long and linear and trend northwest; they surround three large parallel boulder ridges with relief of several meters (42º 18'N, 70º 17'W) that trend northeast. On the bank crest, in the southeastern part of the quadrangle, migrating sediment has been formed into rounded deposits of varying textures. On the western flank of the bank, sand becomes gradually finer-grained with increasing water depth; but in some areas, the seabed is composed of large sheets of fine-grained sand waves interfingering with and overlying coarse sand (lower central part of the quadrangle, along 70º 19'W). The western flank gives way at 70 to 75 m to the smooth muddy floor of Stellwagen Basin. In several areas of the basin, the almost flat sea floor is interrupted by shallow irregular depressions that surround low mounds and that are similar to features observed in Quadrangles 7 and 8 (Valentine and others, 1999a, b). The features range up to several hundreds of meters in length (42º 15.0'N, 70º 22.0'W; 42º 17.6'N, 70º 20.9'W). Observations have shown the mounds to be patches of gravel, including boulders, that are frequented by groundfish. Some boulders and smaller gravel are exposed in the bottoms of pits in the mud in which fish are present. The depressions are interpreted to have formed by the scouring actions of groundfish that have exposed the gravel habitat and prevent its burial by basin mud. Two spurs extend northwestward from the bank into Stellwagen Basin. The southernmost spur is a rough-surfaced low boulder ridge, partly buried by muddy sand, and a connected bank of low relief that extends into Quadrangle 4 (Valentine and others, 1999c). The northernmost spur and an adjacent small bank lie at 65 m and 70 m, respectively, and have a relief of 25 to 30 m. Their surfaces are dominantly sand and gravel, including boulders. The surface of this spur exhibits several irregular depressions that possibly outline the former locations of large masses of melting glacial ice. Together, the spur and small bank extend northwestward into the basin and are alined with three elongate banks located in Quadrangles 4 and 7 (Valentine and others, 1999c, a). The surfaces of the banks are sand and gravel, including boulder piles and ridges, with a thin veneer of mud. The internal composition of the banks and spur are unknown. Their elongate shape suggests formation by glacial processes, chiefly by erosion of surrounding less-resistant sediment and rock. The northernmost spur in this quadrangle resembles a “bank” that has partly emerged from Stellwagen Bank proper through erosion of the surrounding rock materials by glacial ice.

REFERENCES CITED

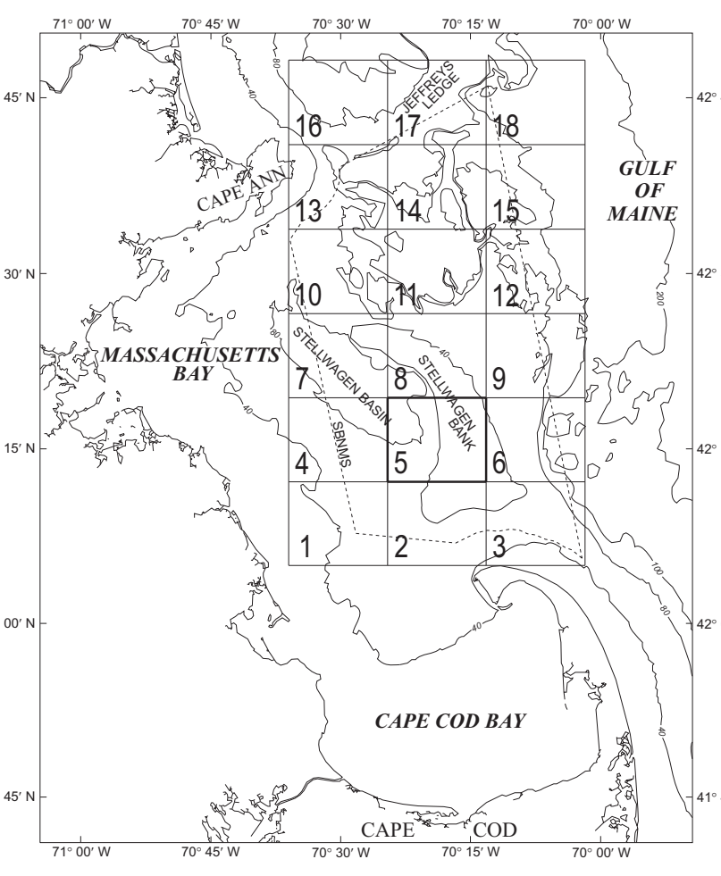
Valentine, P.C., Baker, J.L., Unger, T.S., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 5 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-506, scale 1:25,000..

Valentine, P.C., Baker, J.L., Unger, T.S., and Polloni, C., 1998, Sea floor topographic map and perspective-view imagery of Quadrangles 1-18, Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 98-138, 1 CD-ROM.

Valentine, P.C., Baker, J.L., and Unger, T.S., 1999a, Sun-illuminated sea floor topography of Quadrangle 7 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2707, scale 1:25,000.

Valentine, P.C., Unger, T.S., and Baker, J.L., 1999b, Sun-illuminated sea floor topography of Quadrangle 8 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2708, scale 1:25,000.

Valentine, P.C., Unger, T.S., and Baker, J.L., 1999c, Sun-illuminated sea floor topography of Quadrangle 4 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2704, scale 1:25,000.



Location map - Shows mapped quadrangle outlined. Stellwagen Bank National Marine Sanctuary (SBNMS) boundary shown as dashed line. Bathymetric contours in meters.

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 5 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

By

Page C. Valentine, Jessica L. Baker, and Tanya S. Unger

1999

AUTHOR AFFILIATIONS
U.S. Geological Survey, Woods Hole Field Center
384 Woods Hole Road, Woods Hole, MA 02543

PRE-PUBLICATION COPY