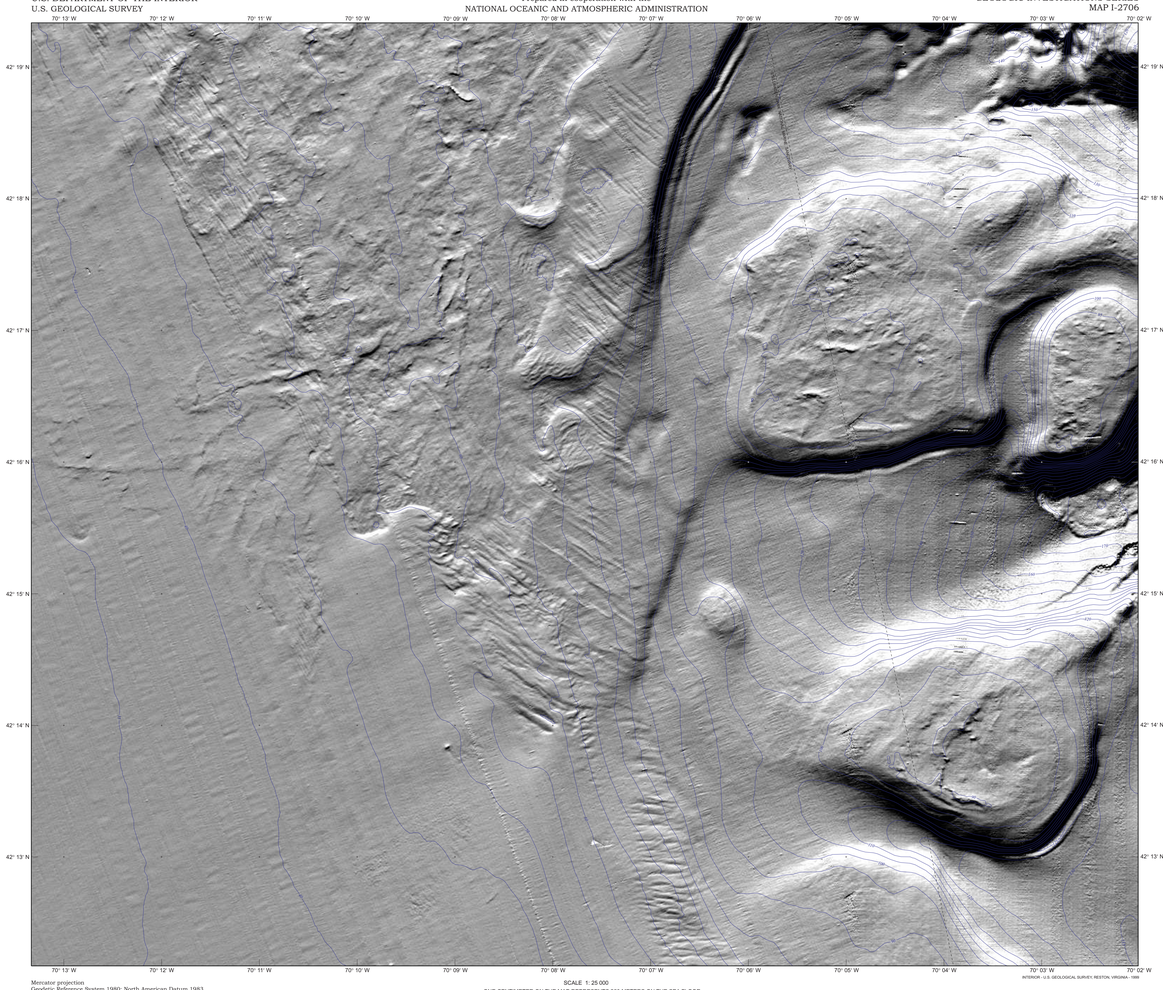
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2706



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

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 6 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

By

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

1999

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 Service. The bathymetric data presented here were 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 areas, such as those underlain by bedrock outcrops, are highly irregular whereas 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 sheet 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 glacial features were partly eroded and some new sedimentary deposits were formed. Today, the sea floor mainly is modified 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 the eastern parts of adjacent basins are built up by deposits of mud and sand.

Quadrangle 6 features - This quadrangle covers the eastern central part of Stellwagen Bank and several banks that lie to the east. The bank surface slopes gently eastward through water depths of 35 to 75 m and is covered with sand and gravel. In the 50- to 75-meter interval, the surface is very rough due to the presence of large depressions and boulder piles and ridges. Many of the boulder ridges resemble eskers (sand and gravel deposited by running water within stationary glacial ice). The ridges commonly are constructed of boulders and cobbles that are now separated by voids from which sand and small gravel presumably were eroded during advance of the sea after the glacial ice melted. The ridges commonly are as much as 10 m high, 50 m wide, and 1 km long and mark former locations of large masses of melting glacial ice. The bank margin is formed by the walls of valleys that extend into deeper water to the east. In the north central part of the quadrangle, the bank edge is capped by a linear north-trending sand bank, that extends into Quadrangle 9 (Valentine and others, 1999a) and is dissected by shallow southeast-trending gullies. The sand bank lies in water depths of 70 to 75 m and is surmounted by arcuate ridges 5 m high that display bedforms on their surfaces. Three prominent flat-topped banks lie at depths of 90 to 95 m in the eastern part of the quadrangle. The bank tops are sandy and gravelly and display shallow depressions and boulder ridges that are similar to features on Stellwagen Bank described above. The northern part of a fourth 90-meter bank lies in the southeastern corner of the quadrangle (see Quadrangle 3 in Quadrangle 3 (Valentine and others, 1999b). It is less well formed than the others, and its surface of sand and gravel is less rough. The banks are separated from Stellwagen Bank and from each other by shallow, smooth-floored valleys that appear to have been deepened by the movement of small glaciers. The valley floors are muddy sand. The valley walls exhibit narrow ridges that parallel topography and are interpreted to be lateral moraines (deposits of rock debris piled up at the edges of moving ice) now covered by muddy sand. A rough-surfaced lobate feature of low relief extends from the base of the southern flank of the easternmost bank (42° 15.7'N). It is interpreted to be rock debris deposited from the lobe of an ice fall that flowed from the top of the bank into the valley below. It retains its distinctive shape beneath a thin layer of muddy sand. A feature of similar origin lies across the valley at the base of the opposing bank to the south (42° 15.1'N). Hummocky topography in the northeastern corner of the quadrangle represents the eroded western flank of another 90-meter bank whose summit lies 800 meters east of the quadrangle boundary.

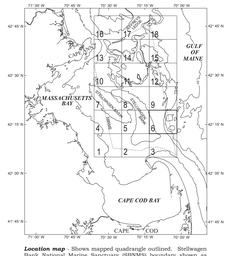
REFERENCES CITED

Valentine, P.C., Unger, T.S., Baker, J.L., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 6 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-507, 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 9 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2709, scale 1:25,000.

Valentine, P.C., Baker, J.L., and Unger, T.S., 1999b, Sun-illuminated sea floor topography of Quadrangle 3 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2703, 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.

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

PRE-PUBLICATION COPY