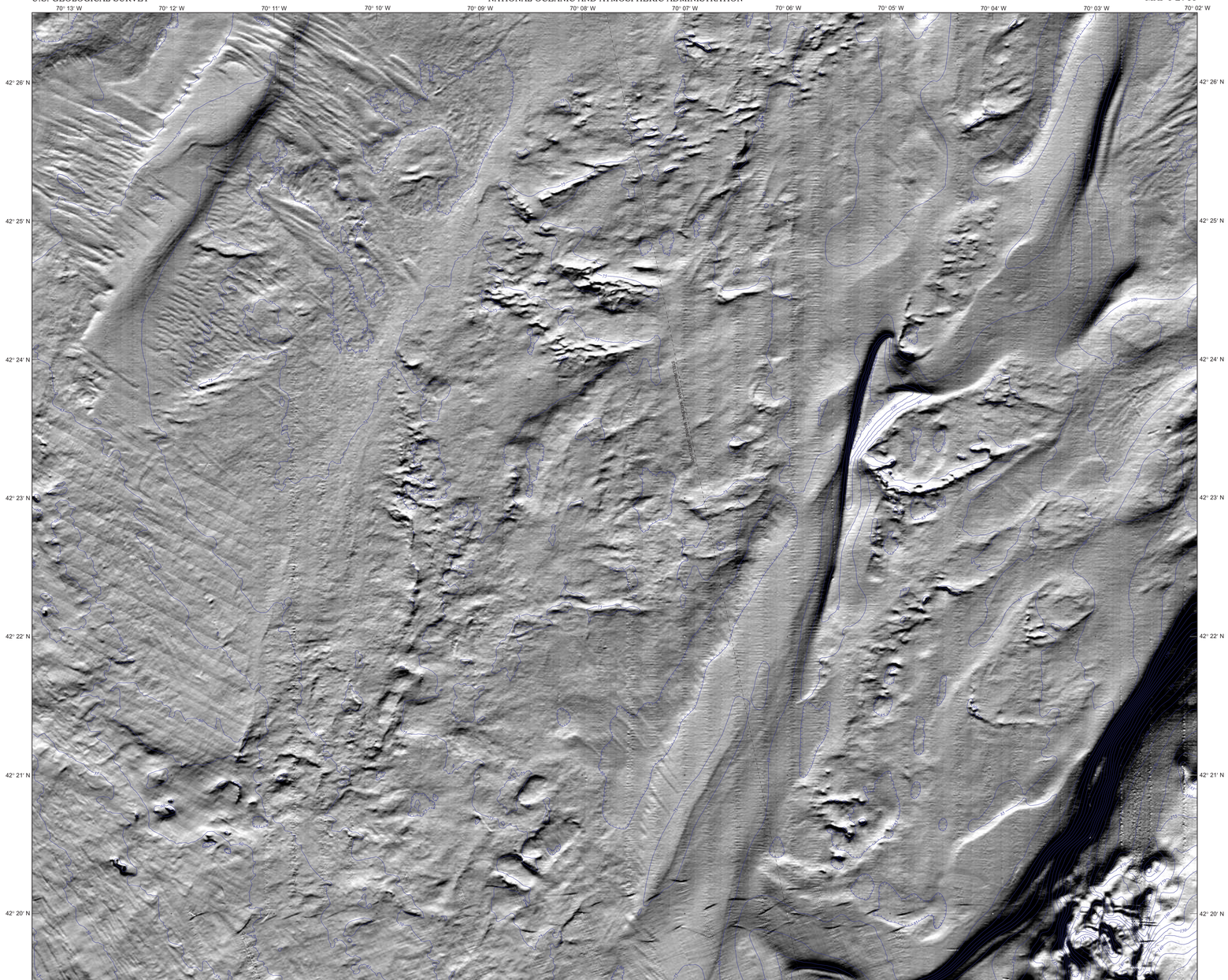
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2709



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

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.

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 9 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

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 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, knolls, 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 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 adjacent basins, are built up by deposits of mud and sand.

Quadrangle 9 features - This quadrangle covers the northeastern flank of Stellwagen Bank. The bank surface slopes gently northeastward through water depths of 50 to 100 m and is covered with sand and gravel. In the central and eastern parts of the quadrangle, the gravelly sea floor is very rough due to the presence of boulder piles and ridges and large depressions. Many of the boulder ridges resemble eskers (sand and gravel deposited by running water within stationary glacial ice). Other prominent boulder ridges are located along the upper margins of small valleys (42° 21.4'N, 70° 04.1' W). They appear to be lateral moraines (deposits of rock debris piled up at the edges of moving ice) formed by small valley glaciers. The boulder ridges commonly are constructed of boulders and cobbles that now are separated by voids from which sand and small gravel presumably were eroded during advance of the sea after the glacial ice melted. The depressions (42° 20.5'N, 70° 08.5'W) possibly outline the former locations of large masses of melting glacial ice. Several large coarse-grained sand deposits are present in this quadrangle. In the northwestern part, the sea floor is dominated by a northeast-trending sand bank that lies at 70 m and is imprinted with northwest-trending gullies and bedforms. In the east central part, a series of northeast-trending sand banks (interrupted by a deep narrow valley at 42° 23'N) are present at depths of 75 to 85 m; these features are part of a larger system of sand banks that extends southwestward into Quadrangle 6 (Valentine and others, 1999a). In the southeastern corner of Quadrangle 9, the bank edge is capped at 85 m by linear sand banks below which sediment becomes finer-grained and muddy with increasing water depth. Hummocky topography in the southeastern corner of the quadrangle in water depths of 130 to 180 m represents buried rock debris and the eroded western flank of a 90-meter bank whose summit lies 900 meters southeast of the quadrangle corner. The bank margin here displays multiple narrow ridges that parallel topography and are interpreted to be lateral moraines. These are deposits of rock debris, now covered with muddy sand, that were piled up at the edge of moving ice that flowed northeastward down a valley that begins in Quadrangle 6 to the south (Valentine and others, 1999a). Another lateral moraine partly buried by sand is present in the northeast corner of Quadrangle 9. The seabed to the east of this feature is muddy sand and displays northeast-trending grooves caused by the gouging of icebergs that grounded here during the late stages of the last glaciation. The grooves are approximately 5 m deep and up to 100 m wide. The floor of a shallow valley at 42° 24'N on the eastern edge of this quadrangle displays low gravelly ridges whose distinctive mesh-like pattern resembles that of crevasse fills (sediment deposited in large cracks in glacial ice). Similar patterns are present near the northern edge of the quadrangle between 70° 09'W and 70° 10'W and in the adjacent Quadrangle 12 to the north (Valentine and others, 1999b). Short, dark angled lines located along 42° 20.7'N latitude are not features but are artifacts in the sonar records that mark the ends of survey lines.

REFERENCES CITED

Valentine, P.C., Baker, J.L., Unger, T.S., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 9 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-682, 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., Unger, T.S., and Baker, J.L., 1999a, Sun-illuminated sea floor topography of Quadrangle 6 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2706, scale 1:25,000.

Valentine, P.C., Unger, T.S., and Baker, J.L., 1999b, Sun-illuminated sea floor topography of Quadrangle 12 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2712, 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.

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