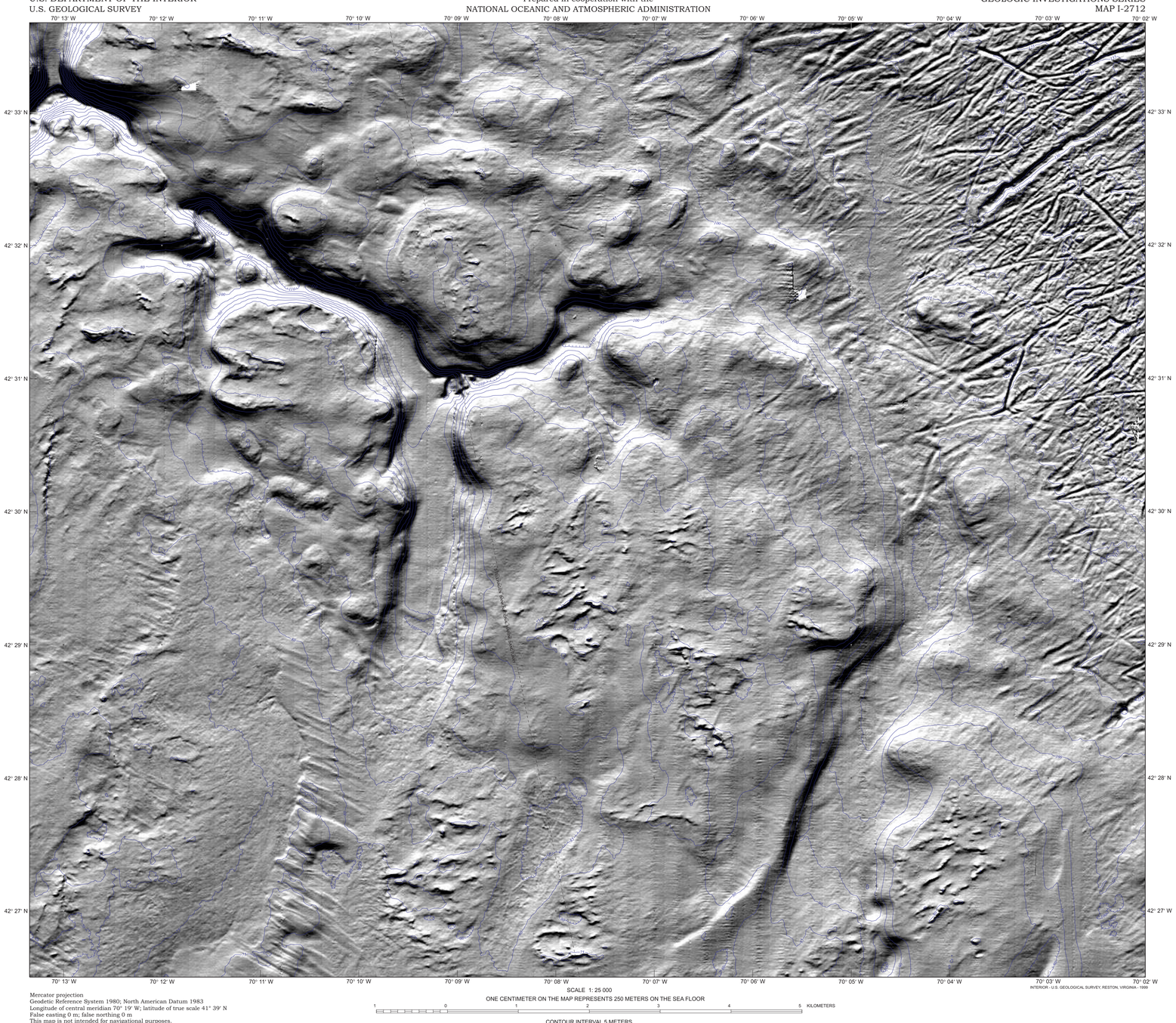
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2712



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.

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 echosounder 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 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 12 features - This quadrangle covers the deep part of the northeastern flank of Stellwagen Bank. The bank surface is uneven and displays a variety of sediment types and features, but the regional slope is northeastward through water depths of 70 to 140 m. Some of the seabed features extend into this quadrangle from Quadrangle 9 to the south (Valentine and others, 1999a). Much of the quadrangle is characterized by rounded hills of low relief (5-10 m), but some shallow depressions in the sea floor (42° 27.5'N, 70° 12.7'W) possibly outline the former locations of large masses of melting glacial ice. The seabed is chiefly gravel, including boulder piles and ridges. In some places, the gravel is partly covered with a discontinuous thin veneer of sand. The sea floor in the northeastern part of the quadrangle exhibits a highly grooved surface. The grooves are approximately 5 m deep and up to 100 m wide and have primarily a northeast-southwest orientation. They are interpreted to have formed by the plowing action of grounded icebergs during the late stages of the last glaciation. In the north central part of the quadrangle, the low elongated and rounded mounds resemble drumlinoid ridges characteristic of glaciated terrain. The surfaces of many of the hills display elongate, sinuous boulder ridges that resemble eskers (sand and gravel deposited by running water within stationary glacial ice). The eskers are common in the south central part of the quadrangle. Other prominent boulder ridges are located along the upper margins of small valleys (42° 31'N, 70° 11'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. Three glaciated valleys converge near the center of the quadrangle (42° 31'N, 70° 09'W). They are 20 to 25 m deep and are floored with slightly muddy sand. Mounds of glacial debris are present at the intersection of the valleys. The north-trending valley displays a low transverse ridge (42° 29.2'N, 70° 09.41'W) that may represent a moraine deposited at the northern terminus of a small valley glacier that occupied the southern part of the valley. Two glaciated valleys intersect in the northwest corner of the quadrangle. They have a relief of 30 to 40 m and are floored with slightly muddy sand. One valley trends northwest and then bends to the southwest and continues into a deep basin in Quadrangle 11 (Valentine and others, 1999b). The floor of this valley displays a small basin where it intersects with a south-trending hanging valley whose floor is shallower by approximately 5 m (42° 33.2'N, 70° 13.1'W). The floor of a shallow valley near the southern margin of the quadrangle (42° 27.5'N, 70° 08.2'W) displays low gravelly ridges whose distinctive mesh-like pattern resembles that of crevasse fills (sediment deposited in large cracks in glacial ice). Somewhat similar patterns are present near the head of a glaciated valley (42° 28.5'N, 70° 09.5'W) and in the adjacent Quadrangle 9 to the south (Valentine and others, 1999a). Two large sand features are present in this quadrangle. A large northeast-trending sand bank extends into the southwestern part of the quadrangle(70° 11'W) from Quadrangle 9 to the south. The bank is imprinted by northwest-trending gullies and bedforms. A long low sand bank, also trending northeastward, lies along the western margin of a shallow valley whose head is located at the southern margin of the quadrangle (70° 06'W). The valley separates elevated areas topped by boulder ridges (eskers), and its floor displays low ridges that possibly are crevasse fills.

REFERENCES CITED

Valentine, P.C., Unger, T.S., Baker, J.L., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 12 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-685, 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 11 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2711, 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 12 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

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