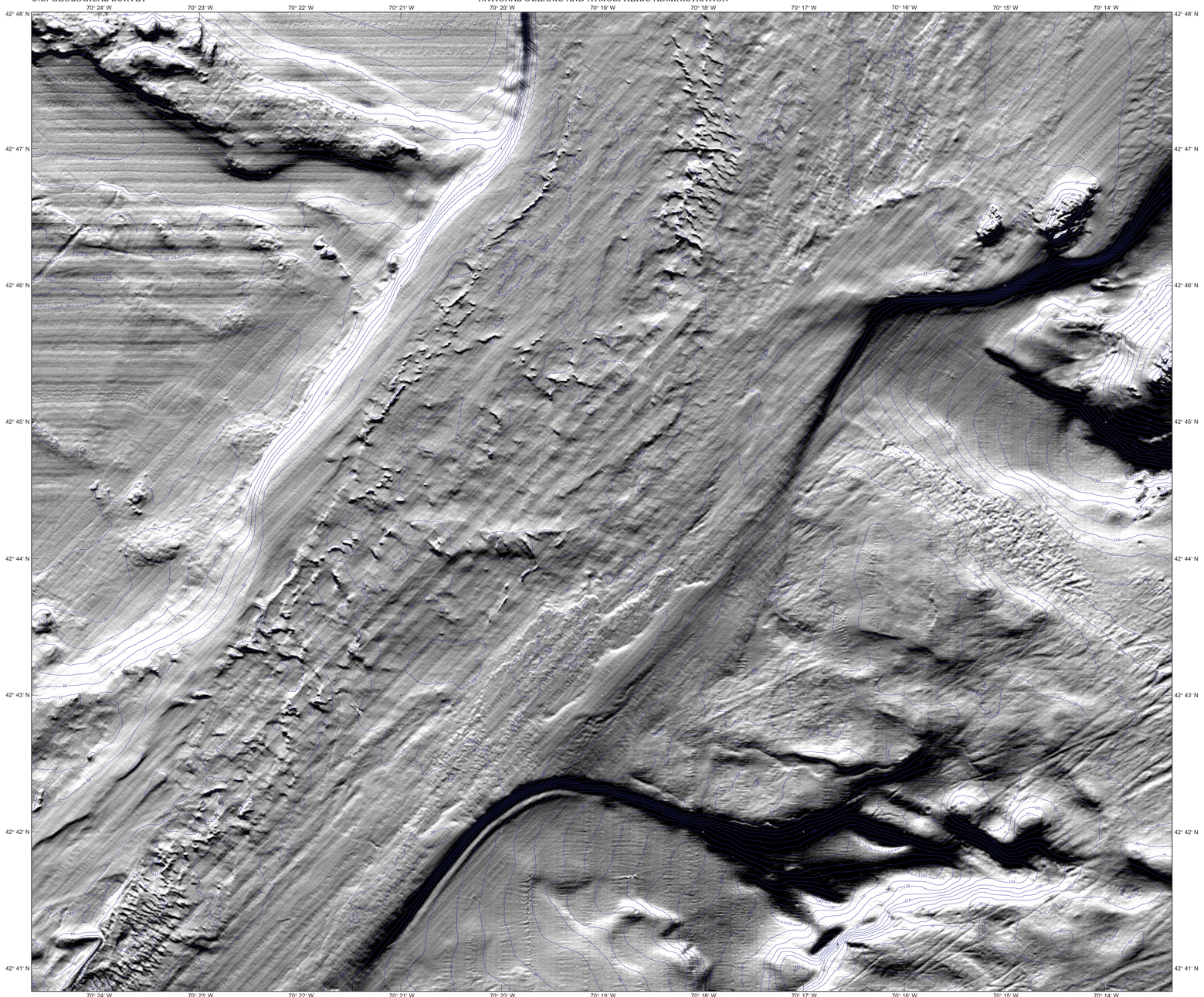
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2717



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

INTERIOR - U.S. GEOLOGICAL SURVEY, RESTON, VIRGINIA - 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 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 17 features - This quadrangle is bisected by a broad, northeastward-trending bank that lies at water depths of 35 to 65 m. The bank's surface is primarily gravel and includes numerous boulder piles and ridges. Boulder ridges oriented northeastward, parallel to the trend of the bank, are located mainly along the western side of the bank. They resemble end moraines (deposits of rock debris piled up at the forward edge of glacial ice). Boulder ridges that trend southeastward, across the bank, resemble eskers (sand and gravel deposited by running water in channels within stationary glacial ice). The bank's western margin is a well-defined scarp (25 to 35 m of relief) that extends from water depths of 55 to 90 m in the north and from 50 to 75 m in the south. This margin is covered with sand and separates the bank from a basin of variable depth and seabed type. The basin is subdivided by a narrow ridge that extends northwestward from the bank. The ridge has a relief of 20 to 25 m and its surface lies at water depths of 75 to 80 m. It is covered with gravel (including boulder piles and ridges), and the gravel is covered in places with a thin veneer of sand. The ridge is bounded on the north and south by the deep parts of the basin (100-110 m) where the seabed is sandy mud. The basin shallows to the south along the western edge of the quadrangle where water depths range from 75 to 90 m. The basin floor here exhibits scattered small hills of gravel, in part with a veneer of sand, that are separated by a relatively smooth sea floor of muddy sand. The eastern edge of the bank south of approximately 42° 44'N is covered with sand intermixed with shell accumulations. The remainder of the eastern edge of the bank is mainly gravel except for a narrow band of sand that extends northward from a hill located at 42° 46.5'N, 70° 14.4'W. This hill has a relief of 25 m (30 to 55 m water depth). It is the easternmost and larger of a pair of distinctive conical hills that are outcrops of bedrock surrounded by sand and gravel of the bank surface. Approximately 2.7 km southeast of these two hills, a larger, conical hill is present along the eastern margin of the quadrangle (42° 45.3'N). This hill also is a bedrock outcrop. It has a relief of 100 m (35 to 135 m water depth) and lies mostly in the adjacent Quadrangle 18 to the west (Valentine and others, 1999a). The flanks and base of the hill are covered with coarse sandy and gravelly sediments. The southeastern part of the quadrangle is topographically complex. Two relatively deep basins are separated by a bank that slopes eastward from the central bank through water depths of 70 to 85 m. Along the bank's northwestern margin, there is an apron of coarse sand (at depths of 65 to 75 m) that was transported from the larger, shallower bank to the west. The bank surface exhibits low, rounded hills and small, shallow basins. The hills are covered with gravel, including boulder piles. The gravel is covered in places with a thin veneer of sand that is most extensive on the hillsides and in the shallow basins. Somewhat deeper basins and valleys on the southern margin of this ank are covered with muddy sand. Long, narrow grooves in the seabed that typically are 50 to 100 m wide and less than 5 m deep are interpreted to be marks made by the jagged bottoms of icebergs that gouged the seabed by grounding here during the late stages of the last glaciation. These grooves are shallower and less pronounced than similar features that occur in Quadrangles 15 and 18 (Valentine and others, 1999b, a), possibly because they have been partly filled by sand transported from the large bank that lies to the northwest. The two deep basins that are bounded to the west by the large central bank deepen eastward and are floored by muddy sand. The southern basin ranges in depth from 70 to 145 m, and the northern basin ranges from 70 to 135 m. A narrow, low ridge that parallels topography exends along the western margins of both basins, at the base of the central bank. These ridges are interpreted to be lateral moraines (deposits of rock debris piled up at the edge of moving ice) now covered by sand transported from the bank.

REFERENCES CITED

Valentine, P.C., Baker, J.L., Unger, T.S., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 17 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-730, 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 18 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2718, scale 1:25,000.

Valentine, P.C., Baker, J.L., and Unger, T.S., 1999b, Sun-illuminated sea floor topography of Quadrangle 15 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2715, 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 17 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

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