U.S. DEPARTMENT OF THE INTERIOR
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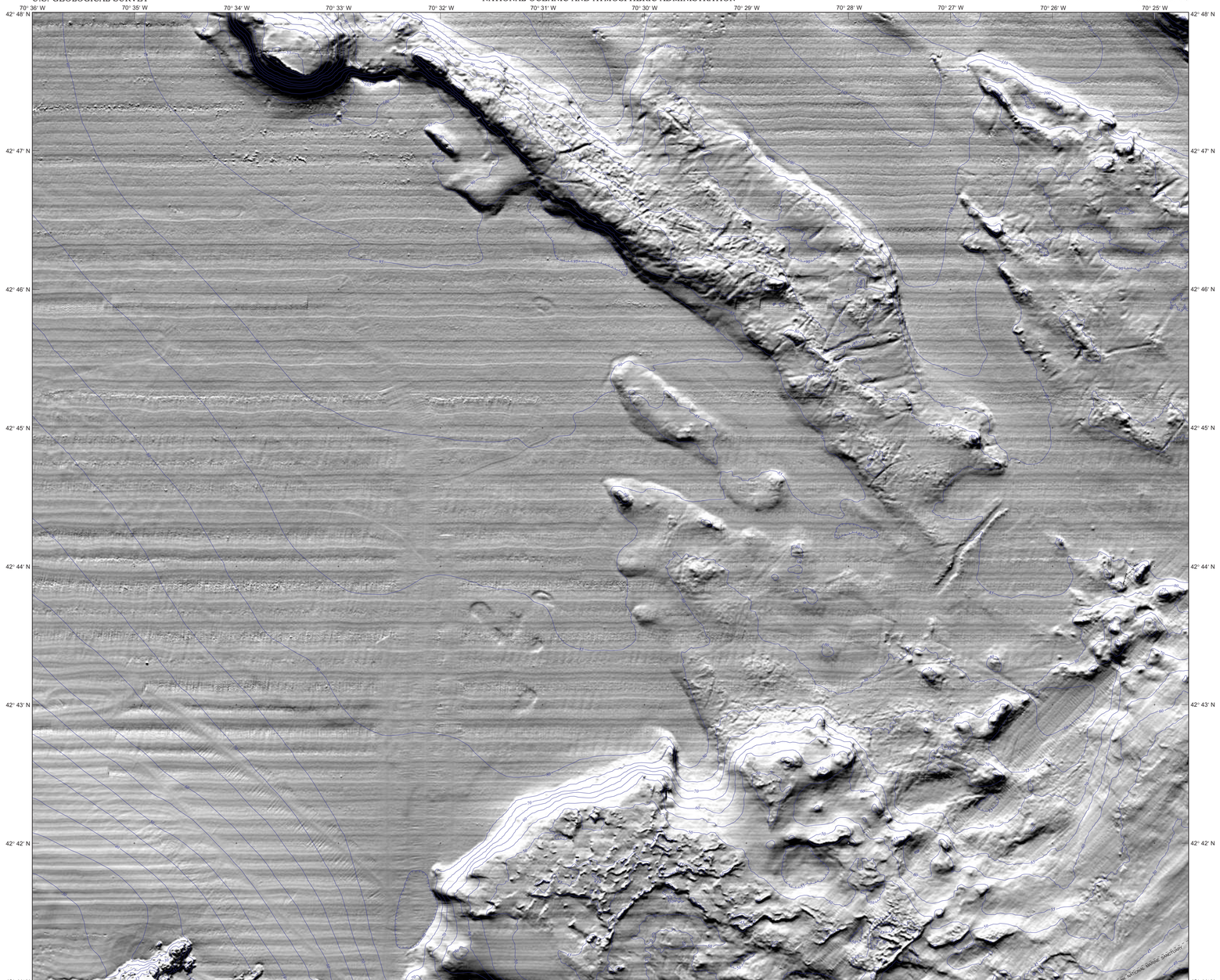
GEOLOGIC INVESTIGATIONS SERIES
MAP I-2716



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

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 16 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

By

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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 16 features - The southern part of this quadrangle is a shallow bank that lies at water depths of 40 to 55 m. It is the westward extension of a large bank that lies mostly in the adjacent Quadrangle 17 to the east (Valentine and others, 1999a). The bank surface is gravel (including boulder piles and ridges) that is covered with a thin veneer of sand in low parts of the bank top. The boulder ridges are a complex of glacial features that resemble lateral and end moraines (deposits of rock debris piled up at the edges of glacial ice) and eskers (sand and gravel deposited by running water in channels within stationary ice). Several large depressions on the bank (42° 41.0'N, 70° 28.4'W and 42° 40.9'N, 70° 27.5'W) possibly mark the former locations of large masses of melting ice. The bank is incised on its northern edge by a north-trending valley (42° 42.5'N, 70° 29.5'W) that is floored by sand in its head and muddy sand where it enters a large basin. The southeastern corner of the quadrangle is part of the western flank of the large bank in Quadrangle 17. The seabed slopes northwestward through water depths of 40 to 75 m. It is gravel to a water depth of approximately 55 m; below this depth, the gravel is covered with a veneer of sand to 75 m. Low hills and elongate ridges extend northwestward from the eastern edge of the quadrangle into a large basin that occupies a major part of the region. The hills and ridges range through water depths of 70 to 100 m. They are covered with gravel, including boulder piles and ridges. The gravel is covered in places with a veneer of sand that is more extensive on the sides of these features than on their tops. A long, broad ridge extends northwestward across the upper part of the quadrangle and past the quadrangle's northern boundary at 42° 48'N, 70° 33.5'W near the northern edge of the quadrangle. The ridge crest is covered with gravel, including boulder piles and ridges, and its flanks are covered with a thin veneer of sand. Long, narrow grooves in the seabed that typically are 50 to 100 m wide, less than 5 m deep, and up to a kilometer or more in length, are interpreted to be marks make by the jagged bottoms of icebergs that gouged the seabed by grounding here during the late stages of the last glaciation. They are present at 70 to 95 m water depth. Similar grooves are also present in the adjacent Quadrangle 17 to the east. Outcrops of bedrock are present in the far southwestern corner of the quadrangle. They lie at 15 to 55 m water depth and are an extension of rocks exposed on the coastline a mile to the west. The remainder of the sea floor in Quadrangle 16 is relatively smooth sandy mud and mud and is part of a basin that ranges in depth from 30 m in the southwest to 110 m in the northeast. Sediment in the basin becomes more muddy with increasing water depth in the transition areas surrounding bedrock outcrops, and gravelly banks, ridges, and hills. In several areas of the basin, the smooth mud seabed is interrupted by shallow depressions (42° 43.05'N, 70° 31.15'W; 42° 43.65'N, 70° 31.60'W; 42° 43.77'N, 70° 31.00'W). The depressions are irregular in outline and up to several hundreds of meters in length, and some of them surround small mounds. Observations of similar features in Quadrangles 7 and 8 (Valentine and others, 1999b, c) have shown them to be patches of gravel, including boulders, that are frequented by groundfish. The depressions in the mud are interpreted to have formed by the scouring actions of groundfish that have exposed the gravel habitat and prevent its burial by basin mud.

REFERENCES CITED

Valentine, P.C., Unger, T.S., Baker, J.L., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 16 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-729, scale 1:25,000.

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Valentine, P.C., Baker, J.L., and Unger, T.S., 1999a, Sun-illuminated sea floor topography of Quadrangle 17 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2717, scale 1:25,000.

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Valentine, P.C., Unger, T.S., and Baker, J.L., 1999c, 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.

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