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

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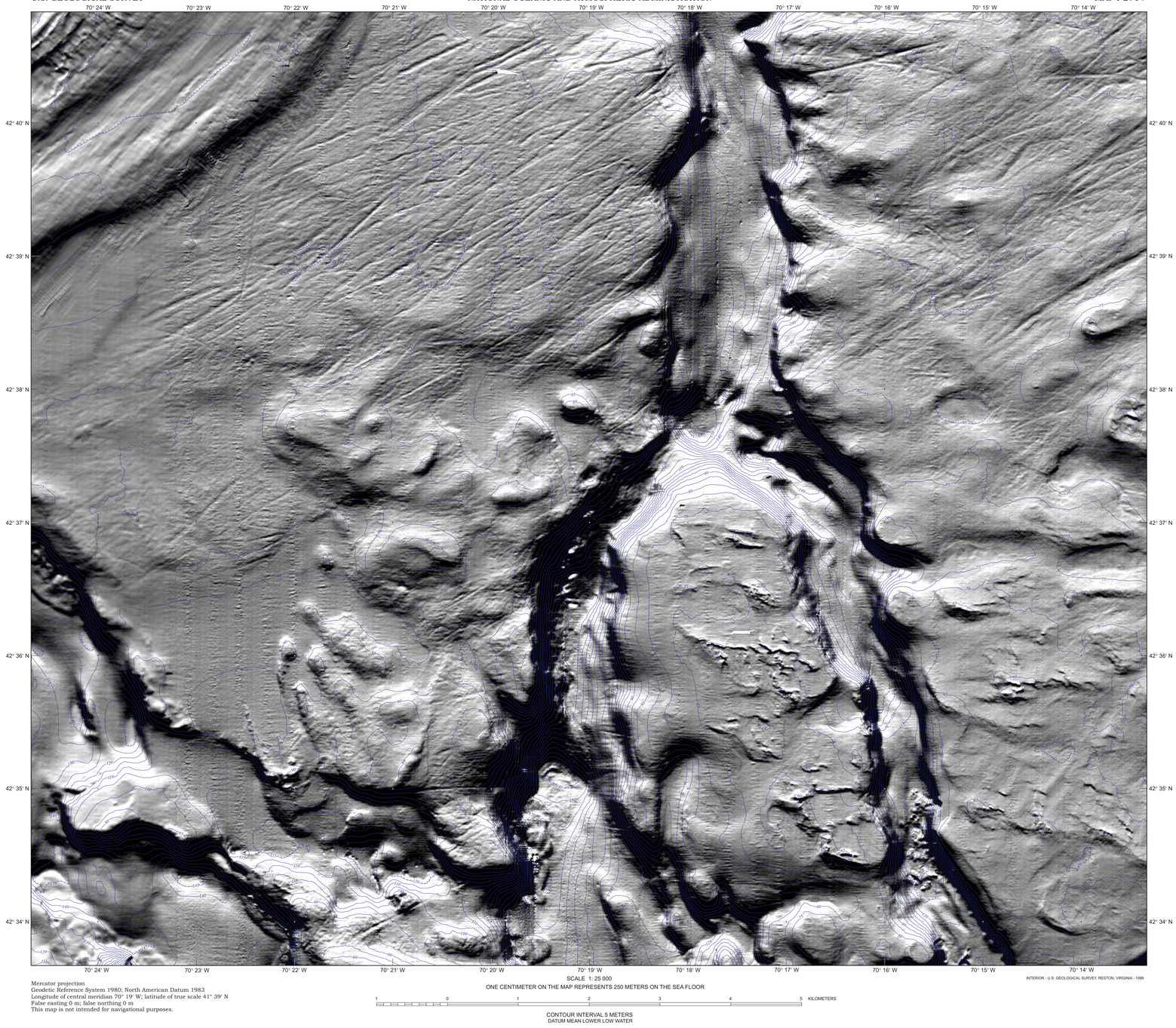
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2714



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 14 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 14 features - The sea floor in Quadrangle 14 is topographically variable and includes banks, shallow and deep basins and valleys. The southeastern part of a shallow bank named Jeffreys Ledge is located in the far northwestern corner of the quadrangle. The seabed of Jeffreys Ledge at water depths of 35 to 50 m is gravel and includes boulder piles and ridges and a large depression (42° 40.3'N, 70° 24.6'W) that possibly marks the former location of a mass of melting ice. Sand and shell deposits cap the edge of Jeffreys Ledge from a depth of 50 m to the base of the bank at 65-70 m, where an adjacent deposit of sand extends southward (42° 38.3'N, 70° 24.4'W). A broad bank that dominates the western part of the quadrangle slopes gently southward from Jeffreys Ledge through water depths of 75 to 90 m. It is bounded on the east and south by valleys and basins that reach depths of 115 to 185 m. The seabed in the northern part of this feature is relatively smooth with some low hills and is covered with gravel (patches of cobbles and boulders are present) that is partly covered with a 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 4 km long 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, 1999a, b), possibly because they have been partly filled by sand transported from the bank that lies to the northwest. The southern part of the feature exhibits low rounded hills and shallow, smooth-floored valleys and basins. The hills are covered with gravel, including boulder piles, and the gravel is covered in places by a thin veneer of sand that is most extensive on the hillsides. The floors of the shallow valleys and basins (42° 37.9'N, 70° 20.1'W; 42° 36.2'N, 70° 22.7'W) are covered with sand and muddy sand. A wide, deep glaciated valley extends from the northern edge of the quadrangle to its center where it divides into two valleys that extend southward around a large, elongated bank. The valley floors (125-185 m) are muddy sediment, except for some areas where sand has been transported into the valleys from neighboring banks. Hummocky, lobe-shaped depositional features extend into the valleys (42° 34.6'N, 70° 19.5'W) and southwestward from the base of the broad bank on the western edge of the quadrangle (42° 36.5'N, 70° 24.5'W). They are interpreted to have been formed by glacial debris (now covered by muddy sand) that was deposited by ice falls that flowed from the elevated surfaces of the banks and ridges. The large central bank bounded by these valleys has a relief of 60 to 100 m, and its surface is covered with sand and gravel, including boulder piles and ridges. Some of the boulder ridges resemble eskers (sand and gravel deposited by running water in channels within stationary glacial ice). Other ridges are located along the upper edges of glaciated valleys and are interpreted to be lateral moraines (deposits of rock debris piled up at the edges of moving ice). The eastern side of the quadrangle is characterized by low hills and shallow valleys, similar to features that occur in the adjacent Quadrangle 15 to the west. The low hills are covered with gravel, including boulder piles and ridges. The gravel is covered in places by a thin veneer of sand that is more extensive on the hillsides than on the hilltops. In the northeastern part of the quadrangle, the seabed displays iceberg scours similar to those described above from the western part of the quadrangle. In the southwestern part of the quadrangle, hills, complex ridges, and deep basins (140-150 m) display a range of sediment types. Generally, the hills are covered with gravel (including some boulder piles and ridges), the shallow valleys and depressions (42° 34.1'N, 70° 20.4'W) are sandy, and the deep valleys (42° 34'N, 70° 23'W) are muddy sand and mud.

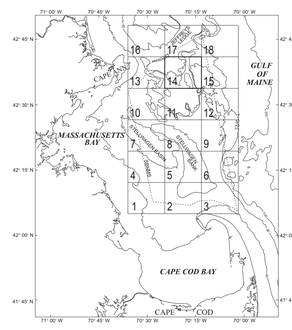
REFERENCES CITED

Valentine, P.C., Unger, T.S., Baker, J.L., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 14 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-727, 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 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.

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



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