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

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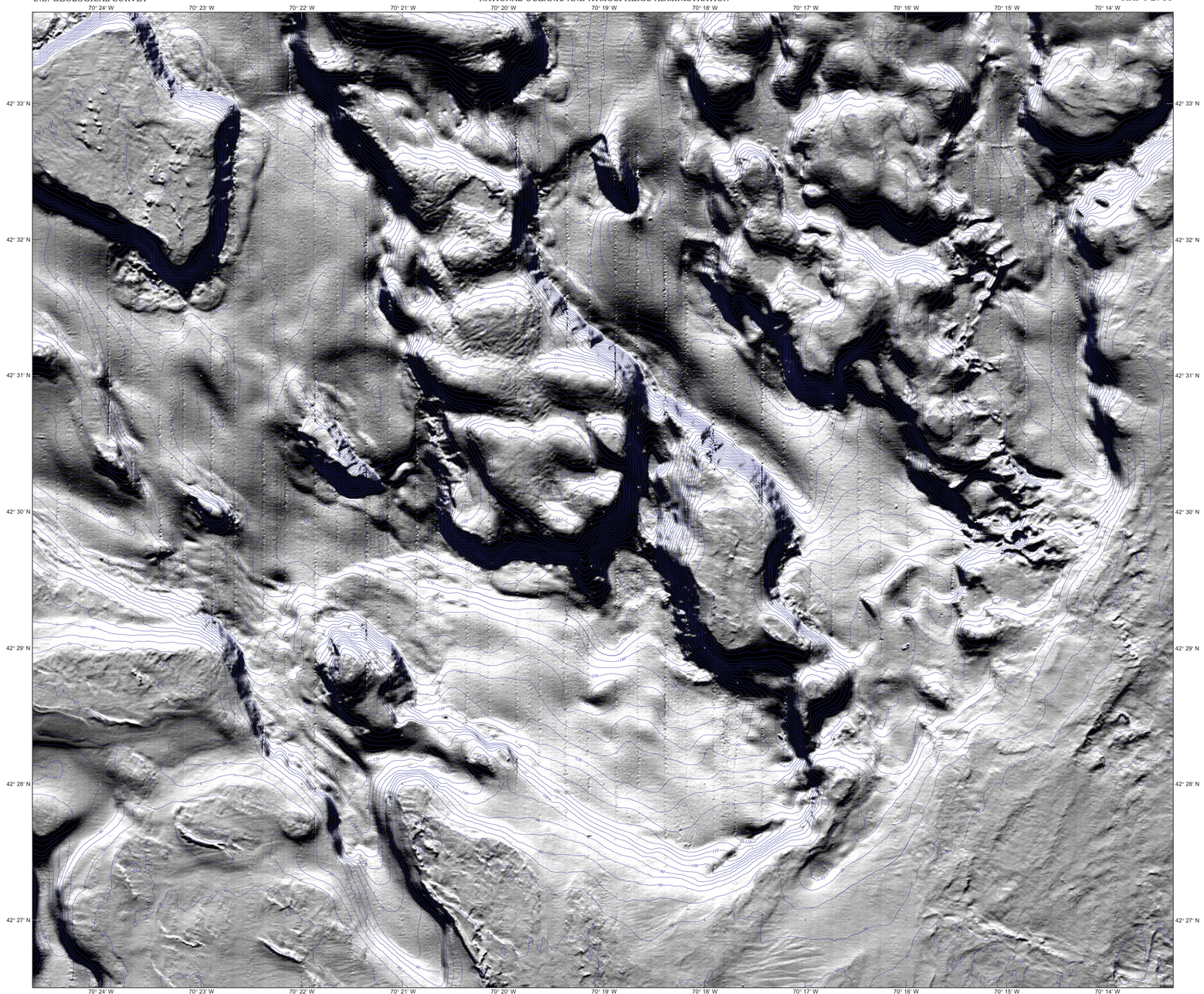
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2711



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 11 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 11 features - Quadrangle 11 covers the northern part of Stellwagen Bank (60 to 75 m water depth) and a topographically varied region to the north of the bank that is characterized by banks and complex ridges (60 to 90 m) separated by deep valleys and basins (125 to 180 m). In the southern part of the quadrangle, Stellwagen Bank is relatively flat except where it is incised by northward-trending glaciated valleys. The bank surface here is chiefly gravel and includes boulder piles and ridges. Some of these linear ridges resemble eskers (sand and gravel deposited by running water in channels within stationary glacial ice) and are located along the southern margin (70° 19'W) and in the southeastern corner of the quadrangle. Other ridges are located along the upper edges of both shallow and deep glaciated valleys in the southwestern part of the quadrangle and are interpreted to be lateral moraines (deposits of rock debris piled up at the edges of moving ice). The northern flank of the bank and the shallow valleys in the southwestern part of the quadrangle are sandy, becoming muddy with increasing depth into the basin to the north. Sand deposits that display east-west-trending bedforms are located along the northern flank between 70° 17'W and 70° 19'W and between 70° 21'W and 70° 22'W. Broad depressions in the seabed along the eastern margin of the quadrangle, extending from the southeastern corner to 42° 30'N, possibly indicate the former locations of large masses of melting ice. The sea floor here is chiefly gravel, in places partly covered by a thin veneer of sand. Two deep valleys that incise the bank in the southwestern part of the quadrangle are floored with muddy sand. The floor of one valley (70° 21'W) is smooth to a depth of 115 m, from where it displays low ridges and mounds that clog the valley as it proceeds northward into a large basin (42° 29.4'N, 70° 22.6'W). The ridges and mounds possibly represent deposits of gravelly glacial debris transported by ice flows down the steep west wall of the valley. These deposits now are covered with muddy sand. The other valley (70° 24.5'W) is shorter and has a relatively smooth floor. The rugged topography of the central and northern parts of the quadrangle displays a regional southeast-trending grain imposed by the direction of movement of a glacial ice sheet. Deep southeast-trending basins separate the banks and ridges. The relatively smooth basin floors are interrupted in some places by small elongate banks (42° 30.4'N, 70° 23.9'W and 42° 32.5'N, 70° 18.9'W) that are alined with the basins. This regional grain has been modified during the late stages of the last glaciation by the movement of small valley glaciers and ice falls and by the melting of masses of stationary ice. Resulting topographic features include well-defined banks with steep flanks and flat tops, and complex ridges, also with relatively steep flanks, but whose surfaces have been dissected by erosion into many small valleys and rounded hills. The flat-topped banks (42° 33'N, 70° 24'W and 42° 29.7'N, 70° 17.7'W) are covered with sandy gravel and gravel, including boulder piles and ridges. Many hummocky, lobe-shaped depositional features extend from the bases of banks and ridges into the adjacent valleys and basins. 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. Several good examples of ice fall deposits lie on the perimeter of a large bank in the northwestern corner of the quadrangle (42° 33'N, 70° 24'W). Two complex ridges trend southward from the northern margin of the quadrangle (70° 17'W and 70° 21'W) and display a wide range of topographic features (hills, valleys, and small basins) and related sediment types. Generally, hills are covered with gravel, valleys are sandy, and small basins are muddy sand. The floors of the large basins in this quadrangle are covered with mud that becomes sandy near the perimeters of banks and ridges.

REFERENCES CITED

Valentine, P.C., Baker, J.L., Unger, T.S., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 11 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-684, 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.

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