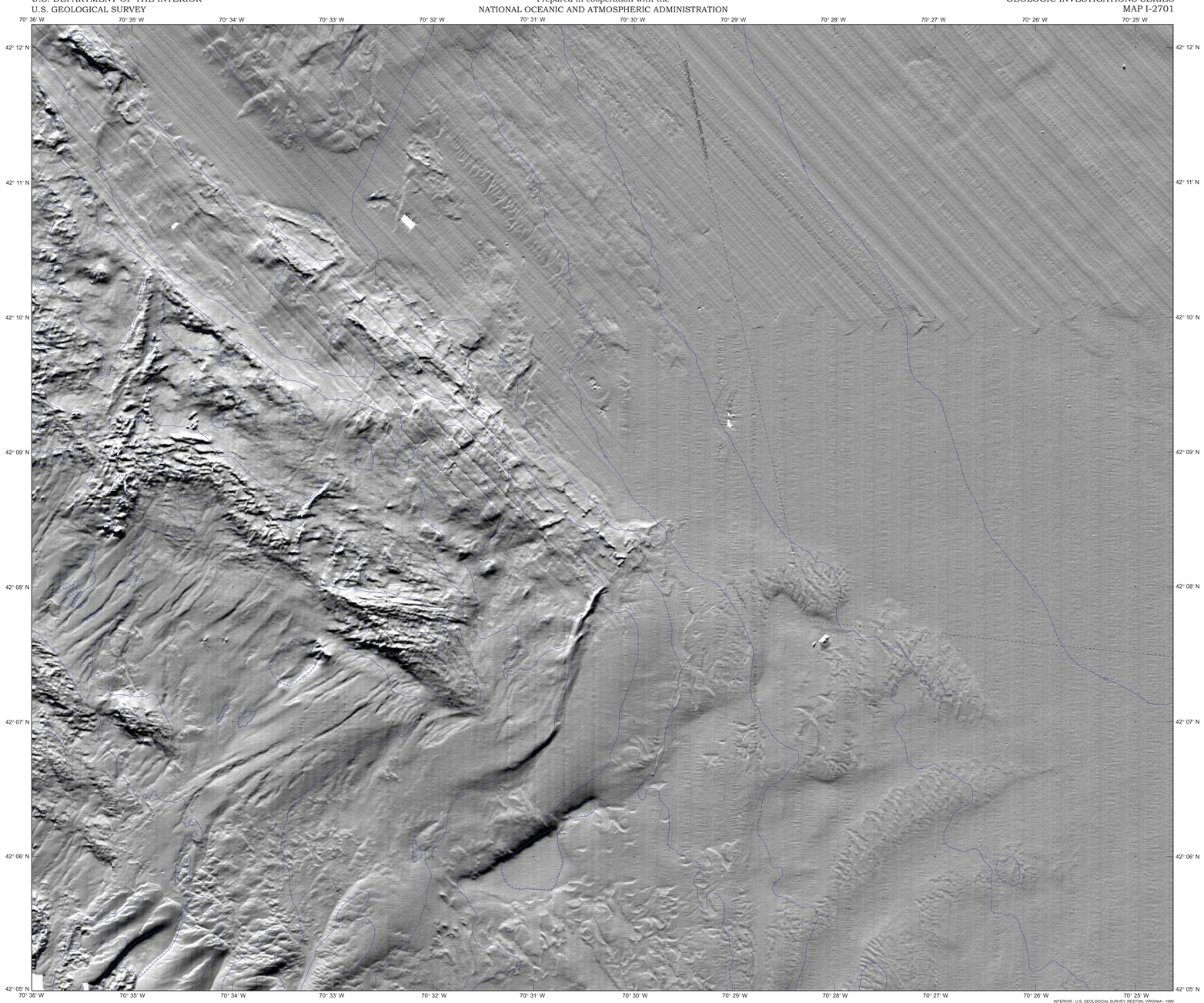
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2701



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 trackline. 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 1 features - The northeastern corner of Quadrangle 1 lies in the southwestern part of Stellwagen Basin. The sea floor here is smooth mud that slopes gently eastward through water depths of approximately 55 to 65 m. The seabed in the remainder of the quadrangle is made up of gravel banks and sandy basins in the west that become increasingly covered with mud as water depth increases toward the basin in the east. In the western and west central part of the quadrangle, the seafloor is southeastward-trending gravel banks that are separated by basins covered with sand and, to a less extent, muddy sand. The orientation of these features parallels the movement of glacial ice. Similar features are present in the adjacent Quadrangle 4 to the north (Valentine and others, 1999). The banks lie at 15 to 30 m water depth and have a relief of 5 to 10 m. Their surfaces are gravel, including boulder piles and ridges that have a relief of up to 5 m. These features resemble eskers (sand and gravel deposited by running water within stationary glacial ice) and end moraines (deposits of rock debris piled up at the forward edges of moving ice). Eskers are present on the bank tops and flanks (42° 8.9'N, 70° 34.4'W; 42° 9.8'N, 70° 35.9'W). Probable end moraines are located on the southeastern ends of the banks and are oriented northeastward, across the regional grain (42° 9.9'N, 70° 34.9'W; 42° 7.8'N, 70° 30.4'W). These gravel features are, in places, partly covered by a thin veneer of sand. Shallow, irregularly-shaped depressions in the sea floor possibly outline the former locations of large masses of melting glacial ice (42° 10.5'N, 70° 33.3'W; 42° 9.8'N, 70° 34.4'W). The basins that lie between the gravel banks are covered with sand and gravelly sand. A deep basin (40 m and deeper) has a smooth floor covered with sand (42° 11.6'N, 70° 34.4'W). A basin of intermediate depth (30 to 40 m) is rougher and is floored with coarser sand and gravel (42° 10.9'N, 70° 34.8'W). Shallow basins (20 to 30 m) are covered with bedforms and sand and gravel deposits that are oriented northeastward, across the grain of the bounding gravel banks (42° 7.9'N, 70° 34.6'W). In the southwestern corner of the quadrangle, sand deposits in the form of elongated ridges (42° 5.5'N, 70° 34.8'W) and rounded features (42° 5.4'N, 70° 33.5'W) in 20 to 30 m water depth are finer-grained than the sand in adjacent areas of the seabed. The sea floor that lies between the basins and gravel banks of the western part of the quadrangle and the mud basin of the eastern part is characterized by shallow basins and gravel banks (42° 6.3'N, 70° 27.2'W; 42° 11.0'N, 70° 31.0'W) of low relief that are partly buried by sand and muddy sand. A low round hill of coarse sediment that is almost covered with mud lies in the northeastern part of the quadrangle at 60 to 65 m water depth (42° 11.8'N, 70° 27.1'W). Within the region of partly-buried banks and basins, there are scattered exposures of coarse-grained sand that are partly covered with deposits of fine-grained sand (42° 5.3'N, 70° 29.8'W; 42° 11.4'N, 70° 32.7'W). The edges of the fine layer, where they bound the coarse exposures, are curved and sharply defined, as if formed by bottom currents. It is possible that the coarse sand deposits have been exposed by bottom currents that have eroded the overlying fine layer. Similar features are present in the adjacent Quadrangle 4 to the north.

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 1 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

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REFERENCES CITED

Valentine, P.C., Baker, J.L., Unger, T.S., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 1 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-502, 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., 1999, Sun-illuminated sea floor topography of Quadrangle 4 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2704, 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.