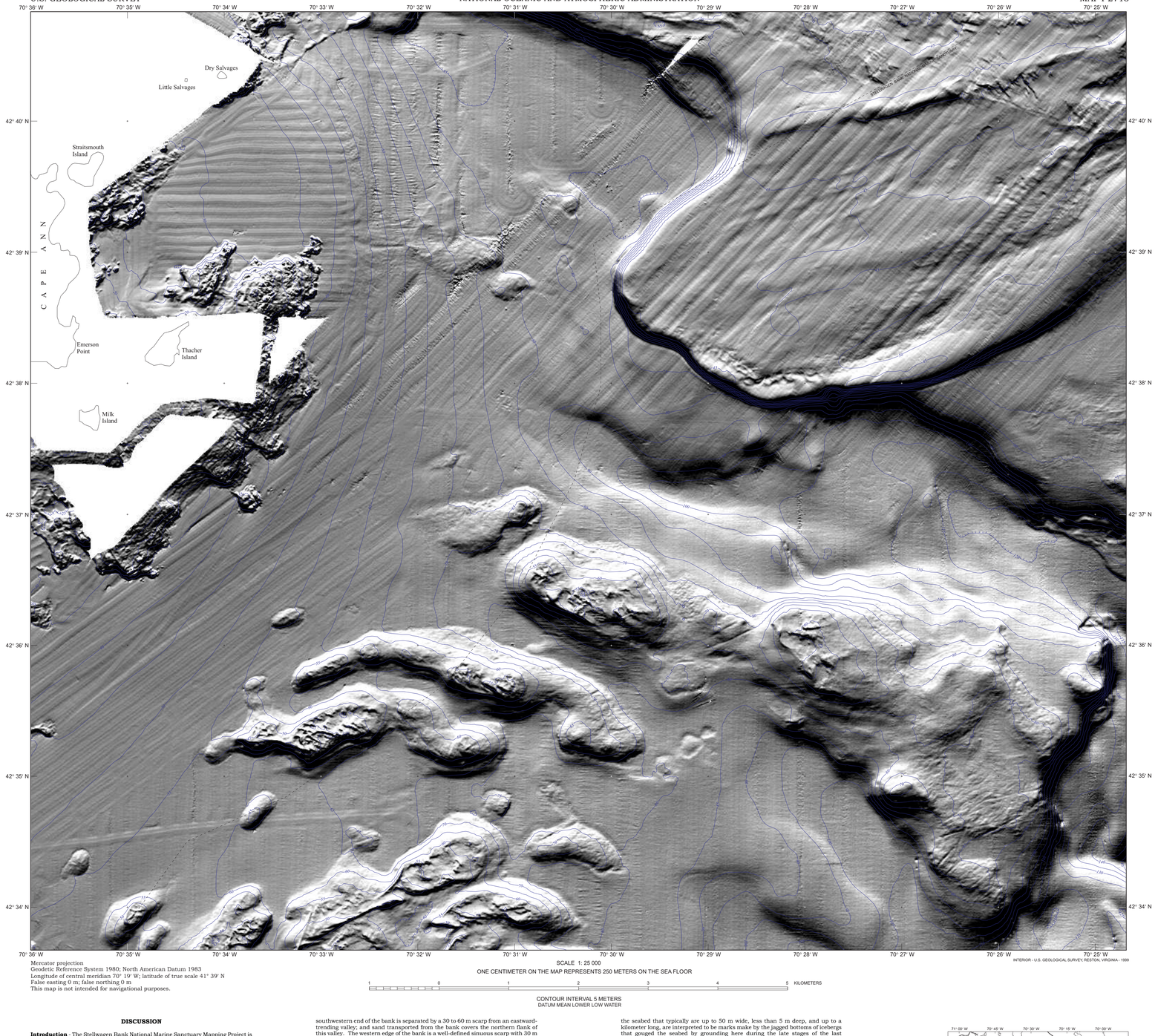
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2713



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 13 features - The northeastern corner of this quadrangle is occupied by the southern end of a large bank that extends northeastward through Quadrangle 17 (Valentine and others, 1999a). The bank lies at a water depth of 40 to 50 m, and its surface is mainly gravel that includes boulder piles and ridges. A long rounded ridge that is less than 5 m high and is outlined by the 40 m depth contour trends northeastward for 5.5 km to the eastern edge of the quadrangle. South of this ridge, several other smaller ridges also trend northeastward along the bank (42° 39.7'N, 70° 27.2'W). These parallel ridges possibly represent a recessional series of end moraines (rock debris deposited at the forward edge of glacial ice). The large ridge at 40 m water depth is poorly developed where smaller gravel ridges that trend southeastward are superimposed on it (42° 40.3'N, 70° 26.0'W). The small ridges resemble eskers (sand and gravel deposited by running water within stationary glacial ice). North of the ridge at 40 m, the sea floor is a complex of gravel ridges (eskers and moraines) associated with large shallow depressions that possibly mark the former locations of masses of melting glacial ice (42° 40.7'N, 70° 26.5'W). A steep scarp of varying height (15 to 60 m) delineates the bank from adjacent basins and banks that lie to the east and south. The southeastern edge of the bank is capped by a sand deposit that is, in part, elevated above the gravel surface immediately to the north. At the base of the bank's southeastern margin, there is an apron of sand that has been transported onto the gravelly surface of the deeper adjacent bank (60-75 m). South of the sand apron, the slightly undulating surface of the lower bank is gravel that is partly covered with sand that is most extensive in low areas. The southwestern end of the bank is separated by a 30 to 60 m scarp from an eastward-trending valley; and sand transported from the bank covers the northern flank of this valley. The western edge of the bank is a well-defined sinuous scarp with 30 m of relief that extends from water depths of 45 to 70 m to meet the nearly flat surface of a basin. A hummocky feature of low relief extends into the basin from the base of the scarp (42° 40.3'N, 70° 29.2'W). It is interpreted to have been formed by glacial rock debris (now covered in part with sand) that was deposited by an ice fall that flowed from the bank surface above. Outcrops of bedrock are present in the northwestern part of the quadrangle. They are extensions of rocks exposed on the nearby islands and coast. A large basin in the northern part of the quadrangle is bounded by these bedrock outcrops and the bank to the east. The basin floor slopes eastward and ranges in depth from 25 to 85 m. It is relatively smooth and is covered with mud except where sandy mud is present along its margins near the bedrock outcrops and the bank. Several rounded hills on the basin floor (42° 39.0'N, 70° 31.4'W) are gravel partly covered with a veneer of mud. South of approximately 42° 38'N, the quadrangle is a complex of banks and rounded hills that lie at 45 to 75 m water depth and that are surrounded by a relatively smooth seabed that slopes eastward to form several valleys in the eastern part of the quadrangle. The banks and hills are elongate, low (5 to 20 m of relief) and are rounded in outline. They range from 400 m to 5.5 km in length. Their surfaces are gravel, including boulder piles and ridges; and the gravel is covered in places with a thin veneer of sand that is most extensive on the hillsides. These features resemble drumlins and drumlinoid ridges composed of glacial debris that were formed by deposition during ice movement. The surfaces of some of these features are covered with networks of sinuous sharp-gravel ridges (42° 34.2'N, 70° 32.2'W; 42° 35.3'N, 70° 33.0'W) that are interpreted to be eskers. The ridges commonly are constructed of boulders and cobbles that are now separated by voids from which sand and small gravel presumably were eroded during advance of the sea after the glacial ice melted. A triangular bank is present (42° 35.5'N, 70° 26.5'W) in the southeastern part of the quadrangle. Its surface is rounded hills of gravel separated by shallow depressions and small valleys. The gravel hills are covered in part by a thin veneer of sand that is more common on hillsides that on hilltops, and the depressions are covered with sand. This bank is bounded on the north and east by a valley that extends eastward through water depths of 85 to 135 m and then continues southward along the eastern side of the bank to a depth of 145 m. The valley floor is covered with sandy mud, the sand having been transported into the valley from the bounding banks. Within the valley, at the base of the north wall (42° 36.8'N, 70° 25.0'W), a hummocky feature of low relief is interpreted to be rock debris deposited by an ice fall that flowed from the bank above. This feature lies partly in Quadrangle 14 to the east (Valentine and others, 1999b). Smaller features of similar origin lie along the base of the south wall of the valley (42° 36.2'N, 70° 24.9'W; 42° 35.5'N, 70° 24.9'W). Two parallel valleys (42° 34'N, 70° 29'W; 42° 35'N, 70° 28'W) are present south of the triangular bank. Their smooth floors are covered with sandy mud and extend from 85 to 90 m water depth southeastward to approximately 105 m at the southern edge of this quadrangle. On the banks in the southern part of the quadrangle, narrow grooves in the seabed that typically are up to 50 m wide, less than 5 m deep, and up to a kilometer long, 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 85 m water depth. Similar grooves are also present in the adjacent Quadrangle 14 to the east. In several areas of the basin, the smooth mud seabed is interrupted by shallow depressions (42° 34.9'N, 70° 30.6'W; 42° 35.2'N, 70° 29.2'W; 42° 36.26'N, 70° 32.65'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, 1999c, d) 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. The long, narrow, evenly-spaced stripes displayed in the sea floor image (they trend northeastward on the large bank and in other directions elsewhere in the quadrangle) are artifacts of the survey and do no represent seabed features.

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SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 13 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

By

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1999

REFERENCES CITED

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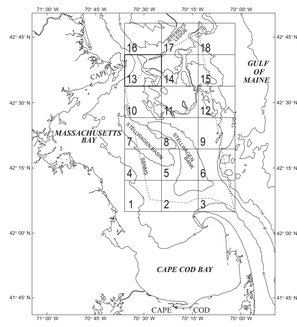
Valentine, P.C., Unger, T.S., and Baker, J.L., 1999d, Sun-illuminated sea floor topography of Quadrangle 8 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2708, scale 1:25,000.



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

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