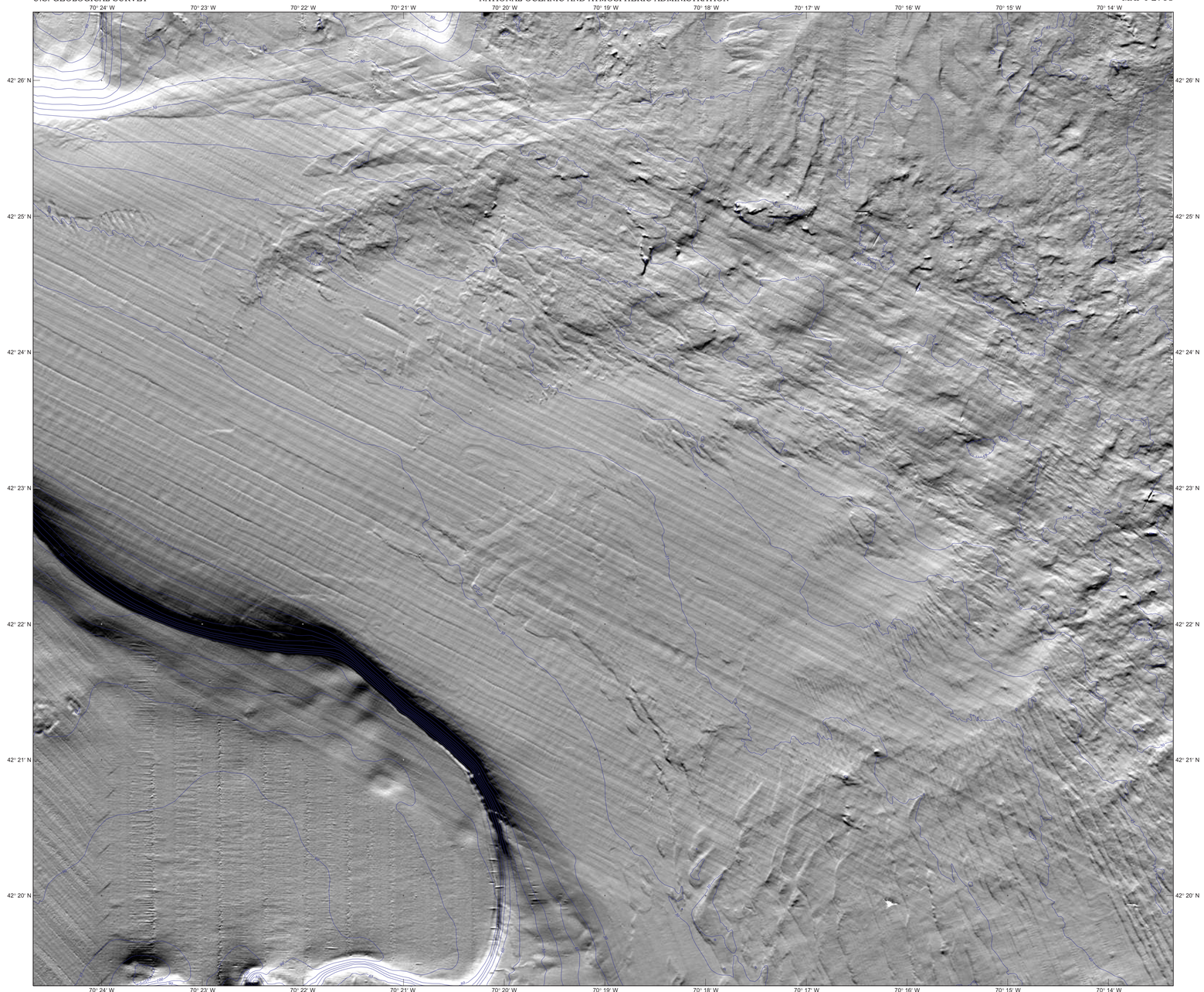
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I-2708



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 echo sounder 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 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 8 features - This quadrangle covers the north central part of Stellwagen Bank, part of the northeastern flank of the bank, and an embayment of Stellwagen Basin into the western flank of the bank. The bank crest is relatively flat and lies at a water depth of less than 30 meters where it is covered with sand and gravelly sand. The bank slopes gently northeastward through water depths of 35 to 70 m. From 35 to 50 m it is covered with sand and gravel, including some boulder piles and ridges. In the 50- to 70-meter interval, the surface generally is very rough due to the presence of boulder ridges and some depressions. The depressions possibly outline the former locations of masses of melting glacial ice. In the east central part of the quadrangle, the northeastern flank, at depths of 60 m and shallower, exhibits a variety of sand deposits and bedforms that indicate movement of sand from northeast to southwest by storm wave currents. These deposits are a series of coarse- and fine-grained sand bodies that have segregated during transport. In much of the area, the deposits are long and linear and trend northwest. In the southern part of the quadrangle, parallel boulder ridges having a relief of several meters (42° 20.5'N, 70° 17.5'W), trend northeast and temporarily anchor migrating deposits of coarse and fine sand. Similar boulder ridges are present on the bank crest to the south in Quadrangle 5 (Valentine and others, 1999a). In the northwestern corner of the quadrangle at water depths of 35 to 50 m, the bank margin is capped by a sand sheet. The bank's northern flank slopes steeply through water depths of 50 to 90 m to form the eastern part of the head of a north-trending glacial valley that extends into Quadrangles 7, 10, and 11 (Valentine and others 1999b, c, d). The valley head is covered with fine-grained sand that becomes muddy with depth. The head of an adjacent, parallel valley to the east incises the northern flank at 70° 21'W in water depths of 65 to 80 m and extends northward into Quadrangle 11. The bank is separated from Stellwagen Basin to the southwest by a northwest-trending escarpment that varies from 20 to 30 m in height. The bank edge is sand and gravelly sand except where it is armored by a gravel pavement in the area lying between 42° 21'N and 42° 22'N. A band of irregular seabed along the base of the escarpment (north of 42° 21'N) that is characterized by small mounds and depressions is interpreted to be glacial debris deposited by ice that flowed off the bank. This deposit is lightly veneered with mud in its southeastern part; but to the northwest, and extending into Quadrangle 7 (Valentine and others 1999b), it is covered with sand and mud that has been transported off the bank. The foot of the escarpment in the southern part of the quadrangle is marked by a narrow ridge that parallels topography and is interpreted to be a lateral moraine (deposit of rock debris piled up at the edge of moving ice) now covered by muddy sand. The relatively smooth basin floor ranges in depth from 75 to 105 m; it is covered with muddy sand below the bank escarpment and with mud farther west. The southern margin of the basin here is bounded by a spur of Stellwagen Bank and a small adjacent bank that have a relief of 25 to 30 m and are covered with sand and gravel, including boulders (see adjacent Quadrangle 5 map; Valentine and others, 1999a). On the western edge of the quadrangle, between 42° 21'N and 42° 22'N, the smooth, almost flat mud floor is interrupted by shallow irregular depressions and low mounds that lie near similar features in Quadrangle 7 to the west (Valentine and others, 1999c). These features range up to several hundreds of meters in length, and observations have shown the mounds to be patches of gravel, including boulders, that are frequented by groundfish. Some boulders and smaller gravel are exposed in the bottoms of pits in the mud in which fish are present. The depressions 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 8 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-509, 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 5 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2705, scale 1:25,000.

Valentine, P.C., Baker, J.L., and Unger, T.S., 1999b, Sun-illuminated sea floor topography of Quadrangle 7 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2707, scale 1:25,000.

Valentine, P.C., Unger, T.S., and Baker, J.L., 1999c, Sun-illuminated sea floor topography of Quadrangle 10 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2710, scale 1:25,000.

Valentine, P.C., Baker, J.L., and Unger, T.S., 1999d, Sun-illuminated sea floor topography of Quadrangle 11 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2711, 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.

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 8 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

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