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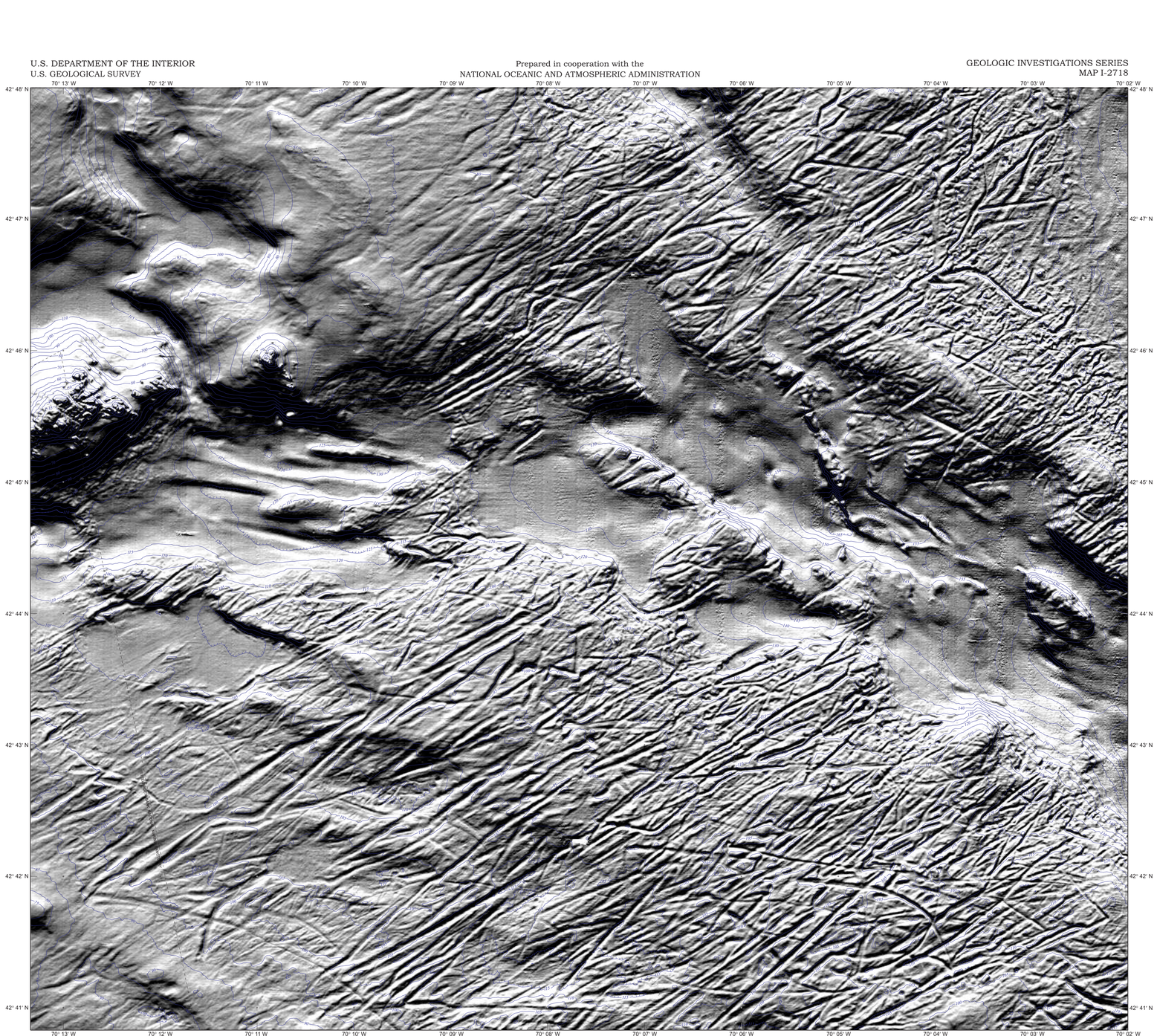
GEOLOGIC INVESTIGATIONS SERIES
MAP I-2718



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 18 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 18 features - In Quadrangle 18, the sea floor slopes regionally from approximately 85 m water depth in the southwest to 155 m in the northeast. Within this regional setting, the seabed is topographically variable and includes valleys, basins, hills, and a prominent hill that reaches a water depth of less than 35 m. The seabed in the southern and northeastern parts of the quadrangle exhibits a southeast-trending grain of small hills and basins that probably reflect the movement of a regional ice sheet. This is similar to the bottom type observed in the adjacent Quadrangle 15 to the south (Valentine and others, 1999a). These hills are low, rounded, typically have 5 to 10 m of relief, and are covered with gravel (including patches of boulders and cobbles) that is partly covered with a thin veneer of sand. Between the hills, the seabed is chiefly sand with patches of gravel and scattered cobbles and boulders. A series of elongate, shallow, east- and southeast-trending basins is present in the central and eastern parts of the quadrangle. The basins deepen from west to east. They reach water depths of 110 to 175 m and their floors are 10 to 35 m below the surrounding seabed. The basin floors are relatively smooth and are covered with fine-grained sand and mud; the percentage of mud increases from west to east with increasing water depth. The most striking topographic features in Quadrangle 18 are many long, narrow grooves that dominate all but the northwestern part of the map area. They typically are 50 to 100 m wide, up to 5 to 10 m deep, and some are 5 kilometers long. These grooves 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. The iceberg gouges are first observed at 145 m water depth in the northeast corner of the quadrangle, and they disappear in the 70- to 75- m depth interval in the shallow northwestern part of the map area. The floors of many of the deeper basins (below 120 to 125 m) are too deep to have been marked by the grounded icebergs. The iceberg grooves have a dominant northeast-southwest orientation. They become less distinct toward the northwestern and southwestern corners of the quadrangle. A large, conical hill is located along the western margin of the quadrangle (42° 45.5'N) that has a relief of 100 m (35 to 135 m) on its southwestern flank. This feature is an outcrop of resistant bedrock whose shape has been modified by the scouring of glacial ice. The ice apparently moved from west to east, removing material from the eastern (or lee) side of the peak and forming eastward-trending grooves and ridges (1 to 2 km long) in the adjacent basin. The flanks and base of the peak are covered with coarse sandy and gravelly sediments. A similar, but smaller, bedrock hill is located approximately 3 km to the northeast (42° 45.9'N, 70° 10.9'W) of the large hill. It reaches a water depth of 50 m and has a relief of 75 m (50 to 125 m) on its southern flank. These features are similar in character to two small hills on Jeffreys Ledge in the adjacent Quadrangle 17 to the west (Valentine and others, 1999b). North of the large hill, a sinuous basin floored with sand is bounded on the east and west by gravelly seabed (patches of cobbles and boulders are common) that is partly covered by a thin veneer of sand.

REFERENCES CITED

Valentine, P.C., Unger, T.S., Baker, J.L., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 18 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-731, 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., Baker, J.L., and Unger, T.S., 1999b, Sun-illuminated sea floor topography of Quadrangle 17 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2717, 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.