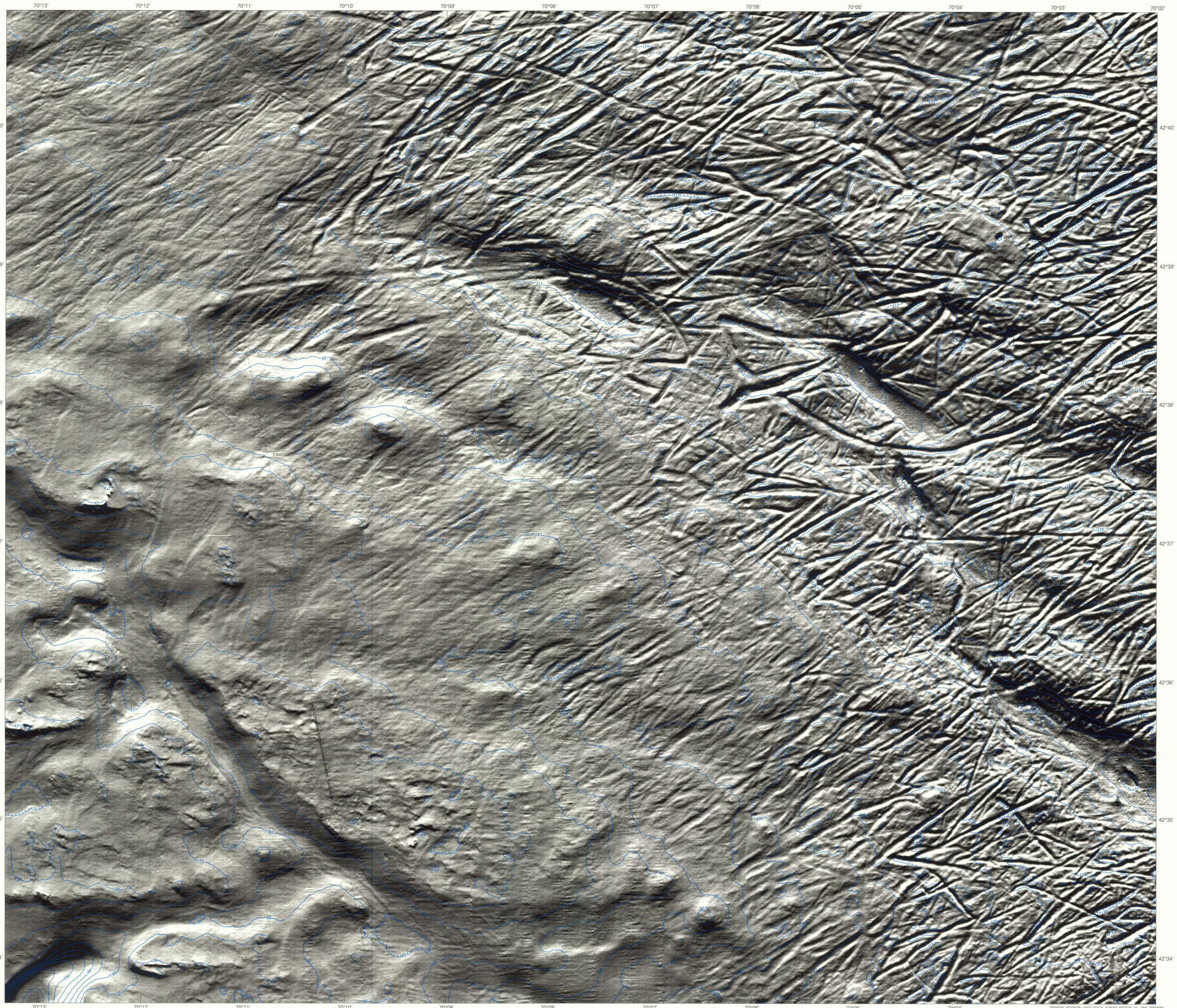
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES
MAP I–2715



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 .5 0 1 2 3 4 KILOMETERS
1 .5 0 1 2 NAUTICAL MILES

CONTOUR INTERVAL 5 METERS
DATUM MEAN LOWER LOW WATER

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 Service. 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 they 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 of all 18 quadrangles in 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 is modified mainly 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 and gravel remains; and the western flanks of the banks, as well as adjacent basins, are built up by deposits of mud and sand.

Quadrangle 15 features

The sea floor in Quadrangle 15 slopes from approximately 70 m water depth in the southwest to 110 m in the northeast and 130 m in the southeast. The shallow and deep parts of the seabed in this quadrangle are very different in character. The southwestern part of the quadrangle is characterized by low hills and shallow valleys (and one deep valley in the southwest corner) that are related topographically to the well-defined banks and deep valleys that occur in the adjacent Quadrangle 14 to the west (Valentine and others, 2001). The low hills are covered with gravel, including boulder piles and ridges. The gravel is covered in places by a thin veneer of sand that is more extensive on the hillsides than on the hilltops. Some of the linear boulder ridges (42°33.95′ N., 70°11.4′ W. and 42°35.16′ N., 70°09.2′ W.) resemble eskers (sand and gravel deposited by running water in channels within stationary glacial ice). Other ridges are located along the upper edges of shallow glaciated valleys (42°33.9′ N., 70°11.9′ W. and 42°35.65′ N., 70°13.15′ W.) and are interpreted to be lateral moraines (linear deposits of rock debris formed at the edges of moving ice). The valleys are floored with sand. Lateral moraines also are present lower on the valley walls (42°36.9′ N., 70°12.5′ W. and 42°34.35′ N., 70°11.3′ W.). Broad depressions in the tops of some hills possibly indicate the former locations of large masses of melting glacial ice (42°34.8′ N., 70°09.0′ W.). The sea floor in the remainder of the quadrangle exhibits a southeast-trending grain of small hills and basins that probably reflect the movement of a regional ice sheet. The hills are low and rounded and typically have 5 to 10 m of relief. They are covered with gravel (although patches of boulders and cobbles are common) 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, southeast-trending basins is present in the central and eastern parts of the quadrangle. Some of the basins reach water depths of 120 m to more than 150 m, and their floors are 15 to 20 m below the surrounding seabed. The floors of the deepest basins are relatively smooth and are covered with fine-grained sand and mud.

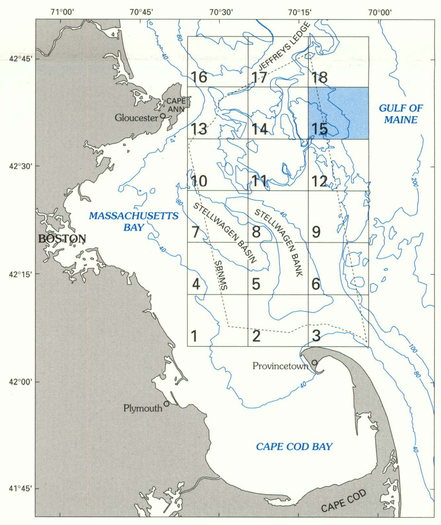
The most striking topographic features in Quadrangle 15 are the many long, narrow grooves that dominate all but the southwestern part of the map area. They typically are 50 to 100 m wide, up to 5 to 10 m deep, and up to several kilometers long. A wide, curved groove extends westward for 7 km from the eastern margin of the quadrangle at 42°38.7′ N. It is truncated by a very wide and deep groove at 42°38.1′ N., 70°05.85′ W. A relatively shallow but very long groove extends west-northwestward for 11.7 km, from 42°39′ N. on the eastern margin of the quadrangle to 70°10′ W. on the northern margin of the quadrangle. 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. There is clear indication that grounded icebergs drifted southwestward, gouged grooves in the seabed, and pushed up mounds of sediment where their drifting terminated (42°39.25′ N., 70°03.15′ W. and 42°39.95′ N., 70°10.45′ W.). The iceberg grooves are most common in the deeper eastern part of the quadrangle, and they disappear in the 75- to 80-meter depth interval in the shallow southwestern part of the quadrangle. The grooves appear to have a dominant northeast-southwest orientation. They become less distinct toward the southwest, where they appear to be partly filled with sandy sediment that most likely was transported from shallow areas in the western part of this quadrangle and the eastern part of Quadrangle 14.

REFERENCES CITED

Valentine, P.C., Baker, J.L., Unger, T.S., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 15 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97–728, 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., 2001, Sun-illuminated sea floor topography of Quadrangle 14 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I–2714, scale 1:25,000.



Location map outlining the 18 quadrangles in this series. Quadrangle 15 shown in blue. Boundary of Stellwagen Bank National Marine Sanctuary (SBNMS) indicated by dashed line. Bathymetric contours in meters.

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 15 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

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