

Description of Quadrangle 5 topography excerpted from:

Valentine, P.C., Baker, J.L., and Unger, T.S., 1999, 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.

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 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 5 features

This quadrangle covers the western central part of Stellwagen Bank and an embayment of Stellwagen Basin into the western flank of the bank. The bank surface slopes eastward and westward from a broad central crest delineated by the 25- and 30-meter contours. Eastward of

the crest, extending to a depth of 40 m, the gently sloping sea floor is sand and gravel, including boulder piles and ridges. The central bank crest and the western flank (to a water depth of 70 m) are composed of somewhat finer grained sand and gravelly sand. Both the eastern and western flanks exhibit a variety of sand deposits and bedforms that indicate movement of sand from northeast to southwest by storm-wave currents. These deposits typically are a series of coarse- and fine-grained sand bodies that have segregated during transport. In the northeastern part of the quadrangle, the deposits are long, linear, and north-northwest trending; they surround three large parallel boulder ridges that have relief of several meters (42° 18' N., 70° 17' W.) and that trend northeast. On the bank crest, in the southeastern part of the quadrangle, migrating sediment has been formed into rounded deposits of varying textures, extending north-northwest from 42° 13.3' N., 70° 15.0' W. to 42° 15.8' N., 70° 16.2' W. On the western flank of the bank, sand gradually becomes finer grained with increasing water depth. From the southern edge of the quadrangle northward, between 70° 18' and 70° 20' W., the seabed is composed of large sheets of fine-grained sand waves (to the west) interfingering with and overlying coarse sand (to the east).

The western flank gives way at 70 to 75 m water depth to the smooth muddy floor of Stellwagen Basin. In several areas of the basin, the almost flat sea floor is interrupted by shallow irregular depressions that contain low mounds and that are similar to features observed in Quadrangles 7 and 8 (Valentine and others, 1999a,b). These features range up to several hundred meters in length (42° 15.0' N., 70° 22.0' W.; 42° 17.6' N., 70° 20.9' W.). Observations have shown the mounds, in some places, to be patches of gravel, including boulders, that are frequented by groundfish. Boulders and smaller gravel have been observed in the bottom of pits in the mud in which fish are present. The depressions are interpreted to have been formed by the scouring actions of groundfish that have exposed the gravel habitat and prevented its burial by basin mud.

Two spurs extend northwestward from Stellwagen Bank into Stellwagen Basin. The southern spur (Southwestern Spur) is a rough-surfaced low boulder ridge, partly buried by muddy sand, and a connected bank of low relief that extends into Quadrangle 4 (Valentine and others, 2000). The northern spur (Western Spur) and an adjacent small bank (Fifteen Bank) lie in water depths of 65 m and 70 m, respectively, and have a relief of 25 to 30 m. Their surfaces are dominantly sand and gravel, including boulders. The surface of this spur exhibits several irregular depressions that possibly outline the former locations of large masses of melting glacial ice. Together, the spur and small bank extend northwestward into Stellwagen Basin and are aligned with three elongate banks (East Breakwater Bank, West Breakwater Bank, Compass Rose Bank) located in Quadrangles 4 and 7 (Valentine and others, 2000, 1999a). The surfaces of the banks are sand and gravel, including boulder piles and ridges, with a thin veneer of mud. The internal composition of the banks and spur is unknown. Their elongate shape suggests formation by glacial processes, chiefly by erosion of surrounding less-resistant sediment and rock. The northern spur in this quadrangle (Western Spur) resembles a bank that has partly emerged from Stellwagen Bank proper through erosion of the surrounding rock materials by glacial ice.

REFERENCES CITED

Valentine, P.C., Baker, J.L., Unger, T.S., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 5 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-506, scale 1:25,000.

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Valentine, P.C., Baker, J.L., and Unger, T.S., 1999a, 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., 1999b, 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.

—2000, 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.