

DISCUSSION

Introduction

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 geological 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 glaciation. 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 formed by meltwater flowing from the ice.

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 9 features
This quadrangle covers the northeastern flank of Stillwater Bank. The bank surface slopes gently northward with elevations of 45 to 100 m and is covered with sand and gravel. In the central and eastern parts of the quadrangle, the sea floor is well exposed, showing a series of broad, low-lying, sandy ridges and large depressions. Some of the broader ridges, reaching sea level, are probably denuded by running water within stationary glacial troughs; see example at 42° 24' N., 70° 06' W. Other prominent boulder ridges are located along the upper margins of small valleys (for example, the ridge at 42° 23' N., 70° 04' W., which lies along the upper margin of a small valley). The ridges are composed of glaciogenic moraines (deposits of rock debris piled up at the edges of moving ice) formed by small valley glaciers. The boulder ridges commonly are constructed of boulders and cobble sizes that are separated by voids from sand and small gravel particles.

Several large coarse-grained sand deposits are present in this quadrangle. In the northeast part, the sea floor is dominated by a northeast-trending band of sand that is at 70 m water depth and that is imbricated with northwest-trending gravel and boulders. In the eastern part of the quadrangle, a coarse-grained sand deposit is located at 70 m water depth. This deposit is imbricated with a gravel and boulders deposit at 75 to 80 m water depth. In the southwest part of the quadrangle, a coarse-grained sand deposit is at 70 m water depth. This deposit is imbricated with a layer of coarse sand banks that extends southwestward into Quadrangle 9 (Mandalay and others, 1999). In the southeast corner of Quadrangle 9 the edge of Stellwagen Bank forms a sharp corner that is capped at 85 m by sand banks which sediment becomes fine-grained and muddy with increasing water depth. Hummocky topography in the northeast part of the quadrangle is imbricated with a coarse-grained sand deposit. In the northwest part of the quadrangle, a coarse-grained sand deposit is imbricated with a bouldered rock deposit and is situated west of a 90-m-deep sand bank which summit lies 90 m or greater than the seabed elevation. The bouldered rock deposit is west of the sandbank which is 90 m deep.

Hummocky areas display multiple narrow ridges that parallel topography and that are interpreted to be lateral moraines. The moraines, now covered with muddy sand, were piled up at the edge of moving ice that flowed northward down a valley that begins in Quadrangle 6 and ends in the south (Vale and others, 1999). Another lateral moraine, the Kinnikinnick lateral moraine, is located in the south-central part of the valley bank in the northeast corner of Quadrangle 9. The seabed of muddy sand to the east of the feature displays northeast-trending grooves caused by the glacio-acting of dredgers that ground them down during the late stages of the last glaciation. The grooves are approximately 1 km apart and 10 m deep. The valley floor is 10 m above sea level, extending about 1.5 km southwest from 42° 24' W. on the eastern edge of the quadrangle. Numerous low ridges which distinguish the valley floor pattern resemble that of crevassed ground in the northern part of the quadrangle (see below). A glacial pattern is present near the northern edge of the quadrangle between 49° and 70° 10' W. and in the adjacent Quadrangle 12 to the north (Vale and others, 2000). Short, dark angled lines located along 42° 20' N. are sea floor features that

words that mark the ends

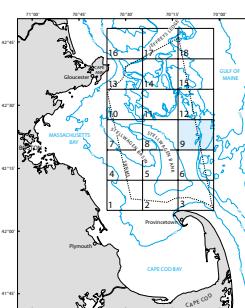
REFERENCES CITED

scale 1:250,000.

Valentine, P.C., Baker, J.L., Unger, T.S., and Pollard, C., 1998, Sea floor topographic map and perspective-view imagery of Quadrangle 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., 1999, Sun-illuminated sea floor topography of Quadrangle 6 in the Stellwagen Bank National Marine Sanctuary of Boston, Massachusetts: U.S. Geological Survey Geographic Investigations Series Map 1-2706, scale 1:250,000.

2000, 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 1-2712, scale 1:250,000.



Location map outlining the 18 quadrangles in this series. Quadrangle 9 shown in blue. Stellwagen Bank National Marine Sanctuary (SBNMS) boundary indicated by dashed line. Bathymetric contours in meters.

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 9 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

By

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