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Glacial and Post-Glacial Processes and Topography in the Stellwagen Bank National Marine Sanctuary Region off Boston, Massachusetts

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Summary

THE SURVEY

- A multibeam echo sounder survey mapped 1100 square miles of the sea floor that lies between Cape Cod and Cape Ann, Massachusetts, including the Stellwagen Bank National Marine Sanctuary.
- Water depths range from 20 to 200 m.
- Sun-illuminated topographic and backscatter imagery show many well-preserved glacial and post-glacial features.
- Groundtruthing methods included video and photo imagery, subbottom profiles, and sediment texture analyses.

FORMATION OF SEA FLOOR FEATURES

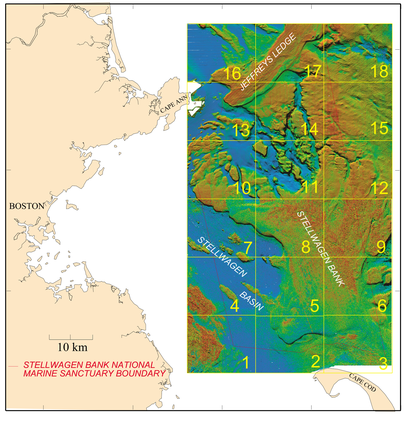
- Regional glaciers moved southeastward across the region, imprinting the seabed with large linear basins,banks, and ridges and smoothing bedrock exposures.
- Melting of regional glaciers produced wide expanses of stationary rotting ice and small valley glaciers andice falls that were active in areas of high topographic relief.
- Features formed during deglaciation include:

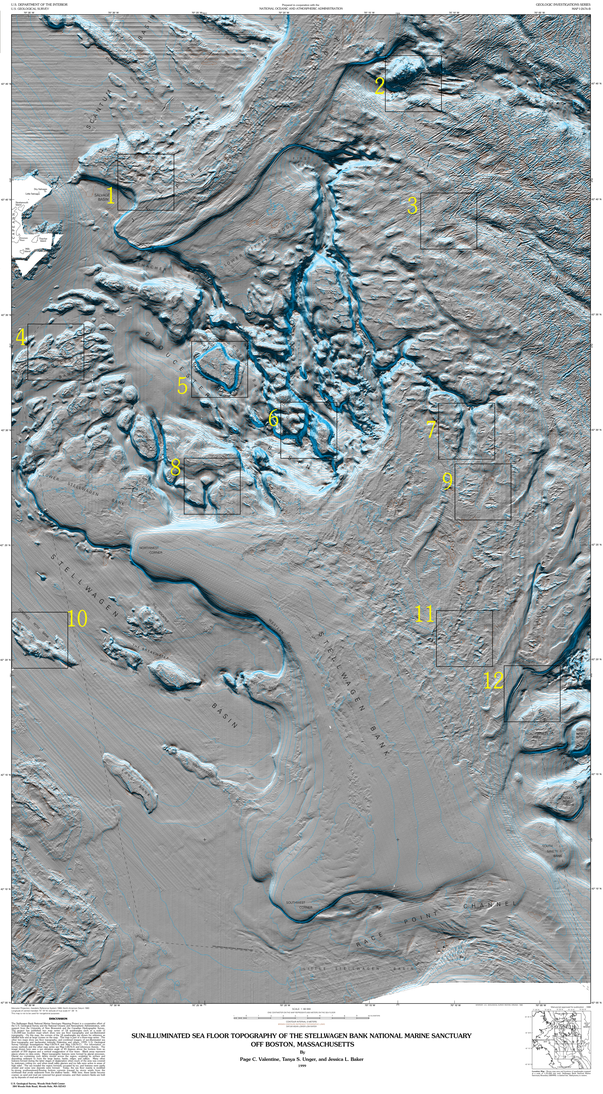
  - ☐ Ice fall deposits
  - ☐ Crevasse fills
  - ☐ Eskers
  - ☐ Hanging valleys
  - ☐ Drumlins
  - ☐ Ice berg gouges
  - ☐ Moraines
  - ☐ Glacial valleys

FORMATION OF POST-GLACIAL SEA FLOOR FEATURES

- Storm currents from the northeast construct bedforms and erode sand and fine sediment from the shallow banks.
- Sandy sediment deposits form on the eastern and northern margins of basins.
- Fine sediment is deposited in the basins.

The Stellwagen Bank NMS Region





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

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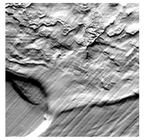
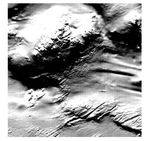


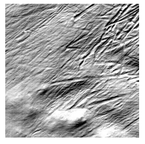
MORAINES - LINEAR, SINUOUS FEATURES 5 m HIGH ON BANK TOP REPRESENT GRAVEL RIDGES DEPOSITED AT THE EDGES OF GLACIAL ICE. TERRACE DEPOSIT AT THE BASE OF BANK WALL MAY BE A DEPOSIT FROM AN ICE FALL.

2



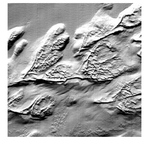
BEDROCK PEAK - SUBCONICAL, RESISTAN OUTCROP EXCAVATED BY REGIONAL GLACIAL EROSION. ICE MOVEMENT STEEPENED THE SOUTH-EASTERN FLANK BY SCOURING AND FORMED EASTWARD-TRENDING GROOVES AND RIDGES (1-2 KM LONG) IN THE ADJACENT BASIN.

3



ICE BERG GOUGES - LONG, NARROW GROOVES ARE 50-100 m WIDE, 5-10 M DEEP, AND UP TO 5 km LONG. THEY REPRESENT GOUGES MADE BY THE JAGGED BOTTOMS OF ICE BERGS THAT GROUNDED. THE GOUGES ARE ORIENTED MAINLY NE-SW AND DO NOT OCCUR SHALLOWER THAN 75-80 m WATER DEPTH.

4



ESKERS - FIELDS OF LINEAR COBBLE AND BOULDER RIDGES 5-10m HIGH REFLECT DRAINAGE PATTERNS WITHIN AND BENEATH STATIONARY GLACIAL ICE.

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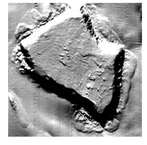
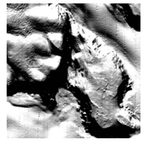


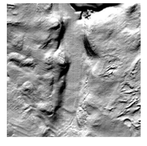
ICE FALL DEPOSITS - HUMMOCKY, LOBATE FEATURES THAT EXTEND FROM THE BASE OF STEEP BANK WALLS ARE 5 - 10 m HIGH. THEY REPRESENT ROCK DEBRIS DEPOSITED FROM LOBES OF ICE THAT FLOWED FROM THE TOP OF THE BANK INTO THE SURROUNDING VALLEYS 60-70 m BELOW. NOW COVERED WITH A FINE VENEER OF SEDIMENT.

6



HANGING VALLEY - NARROW VALLEY DESCENDS SOUTHWARD IN 2 STEPS TO MAIN VALLEY FLOOR. LOW, HUMMOCKY DEBRIS DEPOSIT AT FOOT OF VALLEY PARTLY COVERED WITH FINE SEDIMENT. LOBATE ICE FALL DEPOSIT IS PRESENT AT FOOT OF ADJACENT VALLEY TO THE WEST.

7

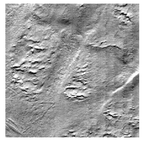


GLACIAL VALLEY - SMALL VALLEY, 4 km LONG, ERODED BY NORTHWARD FLOW OF VALLEY GLACIER. TERMINAL MORAINE LOCATED NEAR VALLEY HEAD. VALLEY COALESCES WITH 2 OTHER GLACIAL VALLEYS.

8

UPPER LATERAL MORAINES - NARROW COBBLE AND BOULDER RIDGES 5 m HIGH ARE SITUATED ON, AND PARALLEL THE UPPER MARGINS OF GLACIATED VALLEYS. THEY REPRESENT GLACIAL DEBRIS PILED UP AT THE EDGES MOVING ICE.

9



CREVASSE FILLS - LOW, NARROW, INTERSECTING GRAVEL RIDGES A FEW METERS HIGH REPRESENT SEDIMENT DEPOSITED IN CREVASSES IN GLACIAL ICE. DEPOSITS ARE SITUATED IN A SHALLOW, ELONGATE DEPRESSION BETWEEN ELEVATED AREAS THAT DISPLAY LINEAR BOULDER RIDGES.

10

ICE DEPOSIT DEPRESSIONS - BROAD SUBRECTANGULAR DEPRESSIONS IN THE SEABED, UP TO 700 m LONG, REPRESENT FORMER LOCATIONS OF MELTING GLACIAL ICE. BOUNDED BY BOULDER PILES AND RIDGES.

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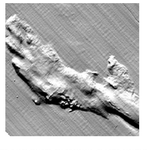
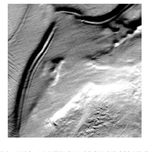
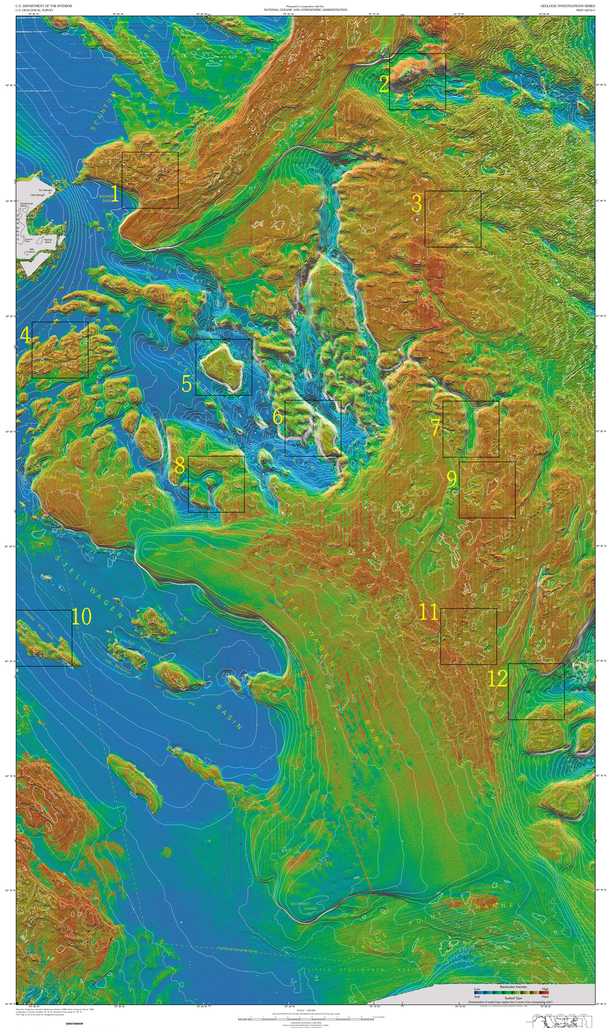


LINEAR BANK - ELONGATED BANK SHAPED BY REGIONAL GLACIER MOVEMENT TO THE SOUTHEAST THAT REMOVED SURROUNDING, LESS RESISTANT MATERIALS. BANK SURFACE FURTHER MODIFIED DURING MELTING OF ICE, NOW COVERED WITH SAND AND GRAVEL, INCLUDING BOULDER PILES AND RIDGES.

12



LOWER LATERAL MORAINES - MULTIPLE NARROW RIDGES UP TO 5 m HIGH ARE SITUATED ON, AND PARALLEL THE LOWER MARGINS OF GLACIATED VALLEY. THEY REPRESENT GLACIAL DEBRIS PILED UP AT THE EDGES OF MOVING ICE. NOW COVERED WITH VENEER OF FINE SEDIMENT.



SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY AND BACKSCATTER INTENSITY OF THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

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