Mapping the Bank

FOCUS
Bathymetry of the *Oculina* Bank

GRADE LEVEL
9 – 12 (Earth Sciences and Technology)

FOCUS QUESTION
What are the differences between bathymetric maps and topographic maps?

LEARNING OBJECTIVES
- ✂ Students will be able to compare and contrast a topographic map to a bathymetric map.
- ✂ Students will investigate the various ways in which bathymetric maps are made.
- ✂ Students will learn how to interpret a bathymetric map.

MATERIALS
Part I:
- ☐ 1 *Oculina* Bank Bathymetry map transparency
- ☐ 1 local topographic map

Part II:
- ☐ 1 local topographic map per group
- ☐ 1 *Oculina* Bank Bathymetry map per group
- ☐ 1 *Oculina* Bank Bathymetry map transparency
- ☐ Contour Analysis Worksheet

Part III:
- ☐ Library Books and Resources

AUDIO/VISUAL EQUIPMENT
Overhead Projector

TEACHING TIME
Two 45-minute periods

SEATING ARRANGEMENT
Cooperative groups of 2 to 4

MAXIMUM NUMBER OF STUDENTS
30

KEY WORDS
Topography
Bathymetry
Map
Bank
Contour lines
SONAR
Side-scan sonar
Multi-beam echo sounder
Fathometer

BACKGROUND INFORMATION
A map is a flat representation of all or part of Earth's surface drawn to a specific scale (Tarbuck & Lutgens, 1999). Topographic maps show elevation of landforms above sea level, and bathymetric maps show depths of landforms below sea level. The topographic elevations and the bathymetric depths are shown with contour lines. A contour line is a line on a map representing a corresponding imaginary line on the ground that has the same elevation or depth along its entire length (Tarbuck & Lutgens, 1999).

Since the ocean floor is not visible to us, it is difficult to map. Scientists use various techniques to gather data for a bathymetric map. In the early 1800's, mariners took depth records in shallow waters with a weight on a line. Then in 1854, a depth-sounding device was attached to the line instead of the weight. This made determining when the line hit the bottom of the ocean easier; however, recording a small section of the ocean was time-consuming.

During World War II, when submarine warfare was at its height in the Atlantic and Pacific Oceans, sonar developed rapidly. Sonar devices use sound echoes to determine the distance to or size of objects underwater, or to measure ocean depth (Metzger, 1999). The frequency of the return signal also can reveal information about the hardness of the seafloor (e.g. soft-bottom vs. hard bottom). After World War II, with the increased use of sonar, suspicions of a featureless seafloor where dispelled. Scientists were able to map ocean trenches, ridges, plains, and submerged islands. These maps were the critical first steps in the ocean age of discovery in the 1960s and 1970s, when the theory of plate tectonics was developed and proven.

Today, scientists are working on advances to make sonar more efficient and accurate. The first fathometers sent a single beam of sound to the seafloor and measured the depth at that one point – surveys with high resolution took many passes of the platform across the bottom. Side-scan sonar sends out a few wide beams of sound that scan a swath of bottom beneath and to the sides of the support platform, and although the depth measurements are less accurate, a high-resolution picture of the bottom structure and hardness can be done relatively quickly. Multi-beam echo sounders are essentially an array of over 100 fathometer beams that ping a swath across the bottom, providing accurate depths and information on bottom hardness. Even with all of these new advances in bathymetric mapping, only a limited portion of the vast seafloor actually has been mapped.

LEARNING PROCEDURE

Part I:

1. Introduce topographic maps and bathymetric maps to the students.

Part II:

1. Have student groups gather the following materials:
   a. 1 local topographic map per group
   b. 1 *Oculina* Bank bathymetry map per group
   c. 1 Contour Analysis Worksheet per student
2. Have students observe and analyze the two different maps using the Contour Analysis Worksheet.

Part III:

1. Have student groups research and give presentations on the different techniques used to collect depth data for bathymetric mapping.
2. Topics could include:
   a. Fathometer echo sounder
   b. Seismic reflection profiles
   c. Multi-beam echo sounder
   d. Sounding lines and weighted wires
   e. Sonar
   f. World War II and sonar

CONNECTION TO OTHER SUBJECTS
Mathematics, Language Arts, History

EVALUATIONS

- Students will write a paragraph summarizing what they learned about the bathymetry of the *Oculina* Bank.
- Teacher will review each student's Contour Analysis Worksheet.
- Teacher will review presentations given by students on the various techniques used to map the bottom of the ocean floor.

EXTENSIONS

- Ask students to write a short essay comparing the Appalachian Mountains to the *Oculina* Bank.
- Make a clay model of the *Oculina* Bank.
- Ask students to identify all of the deep water coral banks and seamounts found along the Atlantic Coast.
- Visit the @Sea Web Site at http://www.at-sea.org/ for more information on the 2005 *Ivory Tree Coral Expedition*.
- Visit the Ocean Exploration Web Site at www.oceanexplorer.noaa.gov
- Visit the joint NOAA and USGS demonstration project web-page for a GIS fly-through of Tampa Bay, FL at http://nauticalcharts.noaa.gov/bathytopo/spatialvis.html

RESOURCES:

http://pubs.usgs.gov/of/1999/of99-010/ - Kathryn M. Scanlon, Peter R. Briere, Christopher C. Koenig. 1999. Oculina Bank: Sidescan Sonar and Sediment Data from a Deep-Water Coral Reef Habitat off East-Central Florida

http://www.uncw.edu/oculina - *Oculina* Bank Geographic Information System (GIS)

http://erg.usgs.gov/isb/pubs/booklets/topo/topo.html - USGS topographic mapping page

http://chartmaker.ncd.noaa.gov/staff/faq.htm - NOAA coast survey FAQs on navigational charting

http://mrib.usgs.gov/ - USGS Marine Realms Information Bank

http://www.gis.com/whatisgis/ - What is a Geographic Information System?

http://www.ccom.unh.edu/education.html - opportunity/curriculum for graduate degree in Ocean Mapping

http://pubs.usgs.gov/fs/fs039-02/fs039-02.html - USGS Fact Sheet: Mapping the Sea Floor

http://woodshole.er.usgs.gov/operations/sfmapping/default.htm - general information on how USGS maps the seafloor

REFERENCES:

Maddocks, Rosalie F., 2000, Introductory Oceanography Lecture 4A: The Ocean Floor. Department of Geosciences, University of Houston.

Metzger, Ellen P., 1999, "Submarine Mountains Teachers Guide." (www.ucmp.berkeley.edu/fosrec/Metzger2.html)

Tarbuck, E.J., and Lutgens, F.K., 1999, EARTH *An Introduction to Physical Geology* (6th ed.): Prentice Hall, Inc., Upper Saddle River, New Jersey, p. 450-452

SUNSHINE STATE STANDARDS

Earth and Space:

- (SC.E.1.4)

The Nature of Science:

- (SC.H.1.4)
- (SC.H.2.4)
- (SC.H.3.4)

ACKNOWLEDGEMENTS

This lesson plan is a modified version of the one available at http://oceanexplorer.noaa.gov

CONTOUR ANALYSIS WORKSHEET

1. Collect the following materials from your teacher:
   a. 1 local topographic map
   b. 1 bathymetric map of *Oculina* Bank
   c. 2 rulers
   d. 1 compass/protractor

2. Distance on the topographic map:
   a. How far in statute miles is an inch?
   b. What is the scale to nearest 10,000 (expressed as ratio-- 1" on map: # actual inches)?
   c. How many statute miles is a minute of latitude (nearest tenth)?

3. Distance on the bathymetric map?
   a. How far in nautical miles is an inch?
   b. What is the scale (expressed as ratio-- 1" on map: # actual inches)?
   c. How many nautical miles is a minute of latitude?

4. Why is the mileage scale on the topo map based on statute miles?

5. What do the colors represent on the topographic map?

6. What do the colors represent on the bathymetric map?

7. Locate Seminole Forest State Park on the topo map:
   a. What is the highest marked elevation within 2 miles of the park symbol?
   b. What is the latitude/longitude (nearest minute) position of this location?
   c. What general compass direction would you drive to get to Cassia?

8. Locate the Oculina Bank on the bathy map:
   a. What is the deepest <u>marked</u> depth (in ft and meters)?
   b. What is the latitude/longitude position (nearest minute) of the southwest corner of the closed area?
   c. What is the distance and bearing in nearest degree should we take to get to Fort Pierce?

9. Why doesn't the topo map have a compass rose?

10. What land-based features are common to the two maps?

11. Write a two-paragraph summary comparing and contrasting topographic maps to bathymetric maps.