Lesson Plan 2

A Watered-down Topographic Map

Focus
Bathymetric and topographic contour mapping.

Focus Questions
How can a two-dimensional map be created showing the three-dimensional nature of a landform?

What are topographic maps and bathymetric charts?

Learning Objectives
Students will create a bathymetric map of a model underwater feature.

Students will interpret a simple topographic or bathymetric map.

Students will explain the difference between topographic and bathymetric maps.

Students will create models of some of the undersea geologic features studied in ocean explorations.

Additional Information for Teachers of Deaf Students
The words listed as Key Words are really the focus of the lesson. There are no formal signs in American Sign Language for many of these words and most are difficult to lipread. If some of this information has not already been covered in your class, you may need to introduce it prior to the activity and add additional class periods. Using the "Me" Connection activity first is also a good introduction to this activity.

Materials Per Group Of Four Students
- ❒ A square quart plastic food storage container at least 7 cm deep
- ❒ 500-700 ml of water in measuring cup or bottle
- ❒ Small plastic funnel
- ❒ 10 cm plastic ruler (can be made by photocopying a ruler repeatedly on an overhead acetate)
- ❒ Overhead projector acetate cut to fit food container top
- ❒ Felt tip waterproof marker
- ❒ 12 inches of masking tape
- ❒ Scissors
- ❒ Two sticks of modeling clay – two colors
- ❒ Student Handouts

Audio/visual Materials
- ❒ Overhead projector

Teaching Time
Two 45-minute periods

Seating Arrangement
Cooperative groups of up to four students

Key Words
Topographic
Bathymetric
Contour line
Contour interval
Relief
Elevation
Depth
Submarine canyon

Seamount
Ridge/bank
Rift/mid-ocean ridge
Continental shelf

Background Information

This activity serves two purposes: it introduces your students to contour maps—both bathymetric and topographic—and it introduces them to the geologic features that many explorers study. Bathymetric mapping is a major part of many of the OE expeditions since our understanding of the ocean floor starts with knowing what it looks like. We do not know much at this point.

Topographic maps are tools used by anyone in need of knowing his/her position on Earth in relation to surrounding surface features. A topographic map is a two-dimensional map portraying three-dimensional landforms. Geologists, field biologists, and hikers are just a few who routinely use topographic maps.

Bathymetric maps (also called charts) are topographic maps of the bottom features of a lake, bay or ocean. They are very similar to topographic maps in their terminology and interpretation. The primary difference is that bathymetric maps show depth below sea level while topographic maps show elevation above sea level. Another difference is the limited data available to create a bathymetric map when compared to a topographic map.

The skill needed to see two dimensions on a map and visualize three dimensions can be a difficult for students. Interpreting familiar topographic maps provides practice in this skill. This exercise will build an understanding of the relationship between a two-dimensional representation and a three-dimensional landform.

Both topographic and bathymetric maps use contour lines to show elevation or depth. Contour lines are imaginary lines connecting points of the same elevation or depth. A contour interval is the predetermined difference between any two contour lines. A contour interval of 100 feet means that the slope of the land or sea bottom has risen or declined by 100 feet between two contour lines. A map that shows very close contour lines means the land is very steep. A map that has wide spacing between contour lines has a gentle slope. The smaller the contour interval, the more capable a map is of depicting finer features and details of the land. A contour interval of 100 feet will only pick up details of features larger than 100 feet. It also means that a seamount could be 99 feet higher in elevation than the map depicts.

Because one cannot usually easily see beneath the water, the difference between what is mapped and the reality of what actually exists is greater on bathymetric maps. With the advent of new, more sophisticated ocean floor sensing technology, bathymetric maps are becoming much more detailed, revealing new information about ocean geology.

Learning Procedure

1. Distribute the plastic food storage containers and sticks of clay to each group, along with a card describing an underwater feature (these same features also occur on dry land). Each group should read the card and build a clay model to match the description written on the card. The model may not extend above the top of the container. For ease of construction, they may assemble them on the desk and then install them in the container. Allow them to consult the OE web site or CD or oceanography texts if they need help visualizing the descriptions.

2. Challenge the students to create a two-dimensional map of their three-dimensional underwater feature that would visually interpret it for other groups of students.

3. Help them think this through as a group. Draw a large circular shape on the board. Ask the

students what they think the drawing represents. Guide the answers, if necessary, toward maps of landforms, such as a pond, an island, a race track circuit, and so on. Could it be the base of an underwater mountain? Draw a side view of an undulating mountain directly below and matching the horizontal margins of the circle. Tell the students the two drawings represent the same thing, but from a different perspective. Ask the students again what they think the circular shape and the new side view of the circular shape represents. A mountain should be one of the obvious answers. How can we combine the two dimensions of the circle with the third dimension—height—in the second drawing on a flat map?

4. Hand out the *Student Handouts* and ask them to follow the instructions. When the equipment is ready, have the students check with you to make sure they set up correctly. Depending on your students' abilities you may have all setups complete and proceed as a class through drawing of the contour line. Some classes will take off and do this very well on their own. Having completed the first contour line, have the class add water to the first centimeter mark on the ruler, reminding them to take care when pouring the water into the funnel. Remind them about accuracy in measurement also. Once they draw the second contour line they may work at their own speed.

5. When the "maps" are completed, introduce the terms topographic and bathymetric maps and discuss contour lines to make sure the concept is clear.

6. Have the students remove the water from their models and display the models with the maps. Pass around a model and challenge the students to pick the map that represents it from the maps displayed on the overhead projector.

7. During this oral assessment of understanding, show an overhead projection which is 180 degrees opposite in perspective to the view the students have of the respective feature. This not only tests the students understanding of topography with respect to the orientation but also reinforces the value of compass directions on maps.

8. Have students use the Ocean Exploration CD or web site to find and list the expeditions that explore each of the geologic features listed here: ridge/bank, submarine canyon, seamount or mid-ocean ridge/rift. Have them finds maps and/or illustrations of the features in this exercise, print them out, label them and put them up in the bulletin board. Also look for bathymetric maps that show the same features.

The BRIDGE Connection

www.vims.edu/bridge

The "Me" Connection

Have you ever been lost? What is it that helps you find your way? A familiar landmark is what most people need to find. A topographic map is all about finding landmarks even if you have never seen the landmark before.

Connections To Other Subjects

Mathematics, Geography

Evaluation

Teacher reviews maps created by students for accuracy and understanding. Teacher performs summative assessment by showing mapped objects and topographic map representations for class to relate to each other. Teacher performs formative assessment test questioning on key terms and topographic/bathymetric interpretations.

Extensions

Have students find landmarks and important features on a topographic map of their own area. "Topo" maps are sold at places that sell hiking and camping gear. Take a topographic map on the next field trip. Have students locate where they are on the map, what elevation they are at, and what distance they are from a prominent landmark.

Resources

http://www.topozone.com
: Interactive USGS topographic maps of the entire U.S.

http://erg.usgs.gov.isb/pubs/booklets/symbols
: Topographic mapping and map symbols information

National Science Education Standards

Content Standard A – Science as Inquiry

- Ability necessary to do scientific inquiry

Content Standard D – Earth and Space Science

- Structure of the Earth system

Content Standard E – Science and Technology

- Abilities of technological design

Content Standard G – History and Nature of Science

- Nature of science

Activity developed by Bob Pearson, Eddyville School, Philomath, Oregon

Additional information for teachers of deaf students developed by Denise Monte, Teacher of the Deaf and Audiologist, American School for the Deaf, West Hartford, Connecticut

Student Handout

Read ALL of the instructions first!

Materials:

- Model in quart plastic container: follow the instructions on the Underwater Feature cards to build the clay model in a square plastic food storage box using modeling clay
- Measuring cup or liter beaker of water
- Plastic funnel
- Centimeter ruler
- Overhead projector acetate
- Waterproof felt tip marker
- Masking tape
- Scissors

Procedure:

Read these instructions carefully. They contain new terms you will need for the Student Analysis Worksheet.

1. Build and install your model underwater feature in your plastic container.

2. Place the centimeter ruler inside the container against a side wall near a corner. Make sure that the highest number mark is at the BOTTOM. Use the tape to attach the centimeter ruler to the container side, taking care not to make the measurement lines unreadable.

3. Cut the overhead acetate to a size that completely covers the container. On one corner of the acetate, cut away enough material so that the funnel spout can just fit through.

4. Tape the acetate to the top of the container. Attach the tape only at a few edges of the overhead and not completely across the container opening. You will need to remove the acetate later so use only enough tape to hold it firmly.

5. Insert the funnel into the opening and tape it so it is securely in place.

6. Check your setup for approval by your teacher.

Student Handout

7. Draw a line on the acetate that correlates with the place the feature meets the bottom of the container. If it meets the side, do NOT draw a line.

8. Take the beaker of water and carefully add water through the funnel until the water level rises to 1 centimeter or 0.5 centimeters on the ruler.

Note: If you have a feature with high relief like a tall seamount, use 1 cm intervals. If you have a flat feature like a bank, use 0.5 cm intervals.

9. View the model by placing your eyes directly above it, looking downward. Focus on the outline of where the model and the water meet. Using the felt tip pen, very carefully draw this outline on the acetate. Label it with the cm shown at that depth on the ruler. The line that you draw is called a "contour line." Do not draw a line where the water meets the sides of the container.

10. Add another 1.0 or 0.5 centimeters of water. Again, look directly downward at the feature. Focus on where the feature and water line meet. Draw this contour line in the same way you drew the first one, following the line where the water meets the feature. You now have two contour lines which represent a 1.0 or 0.5 centimeter change in depth. Label it from the ruler measurement.

11. Continue adding water at centimeter intervals and drawing the contour lines at each 1.0 or 0.5 rise until the model is completely covered with water. You have created a bathymetric map of the model.

Student Handout

Underwater Feature Cards

Seamount

Volcanoes occur in the ocean too. If they build high enough above the ocean floor, they may form islands. The islands may weigh so much they eventually sink into the Earth's crust. Or they may not ever break the surface of the water. Either way, they may become seamounts—mountains under the ocean. Use your clay to make a volcano-shaped model mountain that is 6 cm high and not wide enough at the base to touch the sides of the plastic container.

Bank

Hard bottom features may rise above the continental shelf. Since many organisms need a hard surface to attach and grow, ridges or banks may be unusually rich areas. They may be large or small and may be quite irregular in shape. Use your clay to make a low mound that ranges from 0.5 to 2 cm high, covers about two thirds of the container bottom and has an irregular shape.

Submarine Canyon

Along the edges of the North American continent, the sea floor is shallow—forming an underwater plain that is very wide in some places and less so in others. Where rivers empty into the sea, canyons were cut into this plain when sea level was much lower during the Ice Ages. As sea level rose, the canyons became flooded. Use your clay to make a shallow sloping platform 4 cm high filling two sides of the container with the third side diagonal across the middle—the continental shelf. From the middle of the two sides, create a slope down to the bottom. Use a tool (dissecting needle or pencil) to cut a canyon that starts at the highest point in the corner between the two high sides and gradually gets deeper as it crosses the shelf. At the slope it should reach all the way to the bottom.

Mid-Oceanic Ridge/Rift

Make a flat bottom of clay about 1 cm deep from one color of clay. Make a thin rope about 1 cm in diameter of the same clay, rolling it in your hands. Lay a strip of the rope across the middle of the clay floor in the model ocean container. It should be about 1 cm higher than the floor. Use the second color of clay to make two flat sheets a little less than ½ the area of the container floor. Place one sheet down each side of the central "ridge" coming up to the middle but not touching so that the clay below shows through the middle. If the lower layer is red, you can think of it as glowing volcanic magma that flows up through the rift in the Earth's crust. In cross-section, there will be a small valley at the top of the ridge.