Fathometer in a Box

Overview

Students will explore depth sounding by constructing and mapping "ocean" *topography* in a closed box. This will help them to understand how scientists measure *ocean floor topography* with a fathometer and sea surface topography with an altimeter. A *fathometer* uses *sonar* or *sound waves* to measure the depth of the seafloor.. *Altimeters*, such as those on the TOPEX/Poseidon satellite, use *radar* or *radio waves* to bounce signals off of the sea surface and record the time that it takes for each signal to return.

Concepts

- Sound energy traveling through the water is used to measure the depth of the water. From this you can determine ocean floor topography.
- TOPEX/Poseidon uses radar to measure the height of the satellite above the sea. From this you can determine sea surface topography. The radar signal also measures wind speed and wave height.

Materials (for group of four students)

- Shoe box with lid
- Stiff wire or 1/4" wooden dowels
- Ruler
- Newspaper, clay, plaster, or rocks to use for the simulated ocean bottom (or you can use wood scraps of varying thickness and shapes and glue them to the bottom of the box).
- 2 sheets of graph paper
- Ice pick (or other tool to punch holes in the top of a shoe box)

Preparation

Set up one work station for each group. Use an ice pick to punch holes in the top of the box every two centimeters (about 1 in) along one or more lines running from one end of the box to the other. Having only one line of holes simplifies the activity, but produces only one profile across the simulated sea floor. Label holes from one end of the box to the other as 0 cm, 2 cm, 4 cm, etc. Label them with 2 coordinates if you have more than one row of holes.

For a more elaborate project, use plaster of Paris to form the simulated sea floor.

Procedure

Engagement

How is ocean depth measured? What different instruments can we use? In this activity you will see how a fathometer uses sound to measure ocean depth and helps to provide a picture of ocean floor topography. When you are finished, you can use the information you learned about a fathometer to understand how scientists use an altimeter to measure sea surface topography.

Activity

1. Gather materials to create a model of the ocean floor. Open the shoe box and use the materials provided to shape an ocean bottom in your box. You might stack rocks, wad wet newspaper, or layer clay. Make sure that there are at least two different major topographic features (mountains, slopes, shelves, trenches) in your design. Label one end of the box "X" and the other "Y".
2. When finished, sketch an approximate side view picture of the ocean bottom on graph paper starting at "X" and ending at "Y". Tape this picture on the underside of the lid, and write your group number on your box.
3. The teacher will collect and redistribute all of the boxes. Each group should get a box other than the one that they built.
4. The wire or wooden dowel represents the sound wave that is bounced off the ocean floor. Slide the wire or wooden dowel vertically into each hole in the box. Keep track of the length that fit into the box with either a pencil mark or your fingers. Use the ruler to measure how deep the "sound wave" penetrated the box at each hole.
5. On the graph paper, plot depth versus location for each row of holes. The graph should be a fairly accurate representation of the underwater features along that row of holes.
6. After the graph (or graphs) have been made, open the box and compare your graph to the "ocean floor" in the box and to the drawing on the lid of the box.
7. Compare results with the class.
8. You may want to repeat the procedure after redistributing boxes again.

Explanation

Sailors have long used ropes with weights on the end to measure depths in shallow water. Often they tied knots 6 feet (1 *fathom*) apart in the rope for ease of measurement. The number of knots let out gave the depth in fathoms once the weight hit the bottom.

The first accurate physical measurements of the deep ocean bottom were made by Sir J. Clark Ross in 1840 who measured a depth of 4435 meters off Antarctica. Later, extensive depth recordings were taken by scientists on the *H.M.S. Challenger* using steam-driven winches with one inch hemp rope that did not tangle. Scientists lowered the rope until it hit the bottom, recorded how much rope had been let out, and pulled the rope back. Letting out 3,000 meters of rope and reeling it back in could take as long as twelve hours.

Today, scientists can use sonar to make the same measurement. First, a sound or "ping" is sent toward the bottom. The "ping" reflects off the bottom, and an instrument (called a transducer) mounted in the ship's hull receives the reflected ping. A timer records the time from transmission to reception. The depth of the water is calculated by multiplying the time by the speed of sound through water. The distance traveled by the ping is twice the depth from the vessel to the bottom.

EXTENSION

The TOPEX/Poseidon satellite's primary instrument for measuring ocean topography is a radar altimeter. The altimeter bounces a microwave pulse off the sea surface. By measuring how long the signal takes to return, the altimeter determines the distance between the satellite and the sea surface.

Water vapor in the atmosphere slows down the return of the microwave signal. So an instrument called a radiometer is used to adjust for the influence of water in the atmosphere.

Altimeter and radiometer data, combined with precise knowledge of the satellite's position, are used to

obtain a detailed map of sea surface topography. From this, scientists calculate ocean current patterns and speeds.

Radar altimeters have also been used to determine the topography of Venus, most notably from the Magellan spacecraft. Its radio waves were able to penetrate Venus' thick cloud cover.

Have the students research methods and uses of altimeters on Earth and other planets. If you were planning a mission to Mars or Jupiter's moon, Europa, would you explore using sound waves or radio waves? Why? What type of scientific studies are aided by topography data?

Links to Related CD Activities, Images, and Movies

Image of *TOPEX/Poseidon method of measurements*

Movie of *How TOPEX/Poseidon measurement system works*

Vocabulary

altimeter
fathom
fathometer
ocean floor topography
radar
radio wave
sea surface topography
sonar
sound wave
topography

Source

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