8B Bathymetry of the Sea Floor

How can we tell what kinds of features are on the sea floor?

Did you know that about three quarters of the surface of Earth is covered by water? People have used boats and ships to travel all over the oceans for hundreds, if not thousands of years. During most of this time nobody really knew what was beneath the surface of the ocean. Today we have detailed maps of the ocean bottom. *Bathymetry* is the mapping of the ocean bottom. In this investigation, you will learn how scientists have been able to find out what kinds of features are deep down on the sea floor.

Materials

- Blindfold
- Graph paper
- Colored pencils (red, orange, yellow, green, blue, purple, brown, and black)
- Pencil sharpener
- Side-view depth diagrams A-H

Dolphins use sound waves to navigate, hunt, and visualize their surroundings. They make a series of clicking sounds and wait for the echoes of those sounds to return. This is called echolocation. The direction and volume of the echoes gives the dolphin an idea of what is in their general area. Let's find out what it might be like to be a dolphin and use echolocation.

1 Setting up

1. Clear an area in your classroom that is big enough for everyone in your class to stand in a large circle. You could also use a large open space like a gym, or even a field outside as well.
2. Your teacher will select one person to be the dolphin.
3. Your teacher will select three people to be fish.
4. Your teacher will select two people to be squid.
5. Your teacher will select one person to be a shark.
6. The remaining students will stand in a circle, and gently guide the dolphin back to the middle of the circle if he or she gets to the edge.

2 Doing the activity

1. The dolphin in this activity will wear a blindfold.
2. The dolphin will say "click!" every few seconds. When the dolphin says "click", the fish have to respond by saying "fish", the squid reply by saying "squid", and the shark responds by saying "shark." The replies represent the dolphin's clicks echoing back to the dolphin.
3. The shark swims randomly around the circle. The fish must stay together in a school as they swim around in the circle, by walking together with baby steps. The fishes and the shark must always swim forward at all times. They may not move backwards or stop. The squid can swim around in any direction, stop, and move backwards. The squid and the shark should move at a regular walking speed as they swim around.
4. The dolphin tries to capture his prey, the fish and the squid, and avoid his predator, the shark. The dolphin can stop swimming, but not move backwards.

5. The dolphin captures his prey by tagging them lightly when it sounds like they are near, using echolocation.
6. The dolphin must avoid the shark. If the dolphin bumps into the shark, someone else gets to be the dolphin.
7. The game is over when the dolphin catches all the fishes and both squid.

3 Thinking about what you observed

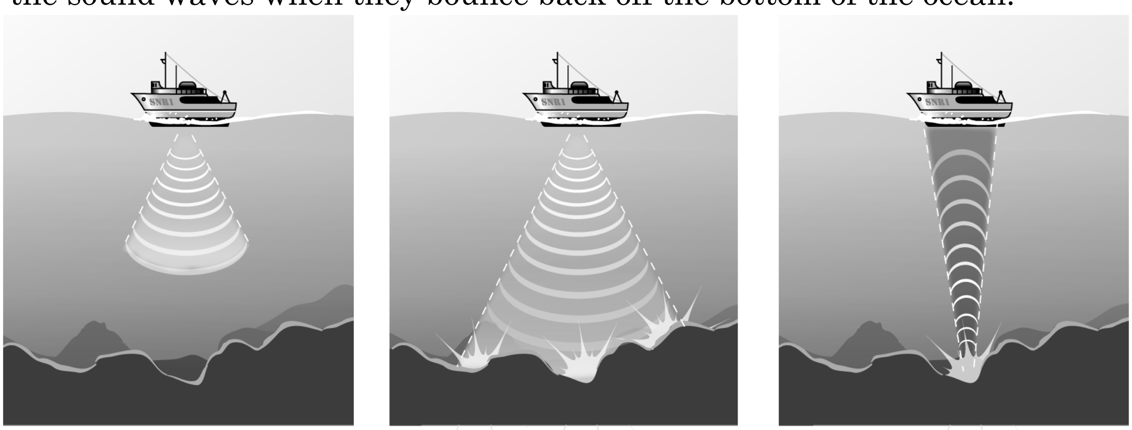
a. How did the dolphin know where the fishes, squid, and shark were?

b. When a dolphin makes clicking noises under water, how do you think it can tell the difference between a fish and a shark?

c. Why do you think scientists call this process echolocation?

4 Man-made echolocation

In the early 1900's, scientists and engineers tried to use sound waves to measure the depth of the ocean. Sound travels about 340 m/sec in air. That's pretty fast! But in saltwater it travels even faster, about 1,500 m/sec. Ships carry devices that use sound waves and echoes in a system called SONAR. SONAR devices send out bursts of sound waves, and then listen for the echoes of the sound waves when they bounce back off the bottom of the ocean.



Sound waves sent down from ship | Sound waves bounce off ocean floor | Sound wave echo returns to ship

5 Stop and think

a. How fast does sound travel through saltwater?

b. In saltwater, how far would a sound wave travel in 1 second? In 2 seconds? In 3 seconds? How about 10 seconds?

c. What is the relationship of the depth of the water to the total distance the sound wave travels?

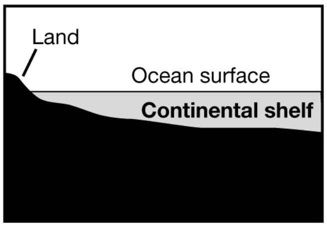
d. When you find out how far a sound wave has traveled, how can you tell how deep the water is?

6 What's down there?

The use of SONAR has helped identify many different features and regions of the ocean bottom that cannot be seen from the surface. These features have distinctive variations in their shapes and locations.

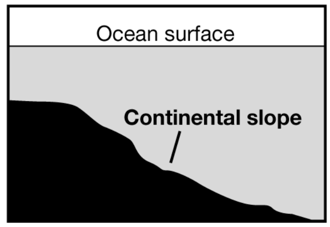
Table 1: Features and regions of the ocean bottom

Continental shelf



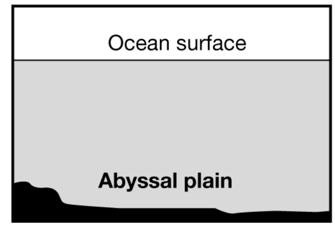
A submerged border of a continent that slopes gradually and extends to a point of steeper descent.

Continental slope



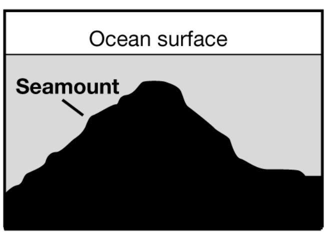
The transitional area between the continental shelf and abyssal plain.

Abyssal plain



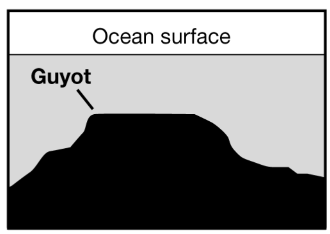
The flat, deep ocean floor. It is almost featureless because a thick layer of sediment covers the hills and valleys.

Seamount



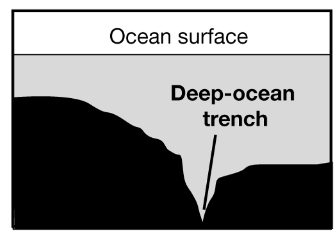
A mountain rising from the ocean seafloor that does not reach to the water's surface.

Guyot



A flat topped seamount that shows signs of being above the water's surface in the past.

Deep-ocean trench



A long, narrow depression of the sea floor having steep sides. The deepest part of the ocean.

7 Stop and think

a. How could you use the information a SONAR system provides to identify the kinds of ocean bottom features and regions in Table 1?

b. What is a seamount that rises above the surface of the ocean called?

c. What do you think causes the flattened top of a guyot?

d. If you were taking SONAR measurements, how would you know that there was a deep-sea trench beneath your ship on the ocean bottom?

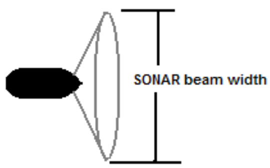
e. How would you know you were going over a seamount?

f. What would happen to your SONAR readings as your ship went from the continental shelf into the continental slope?

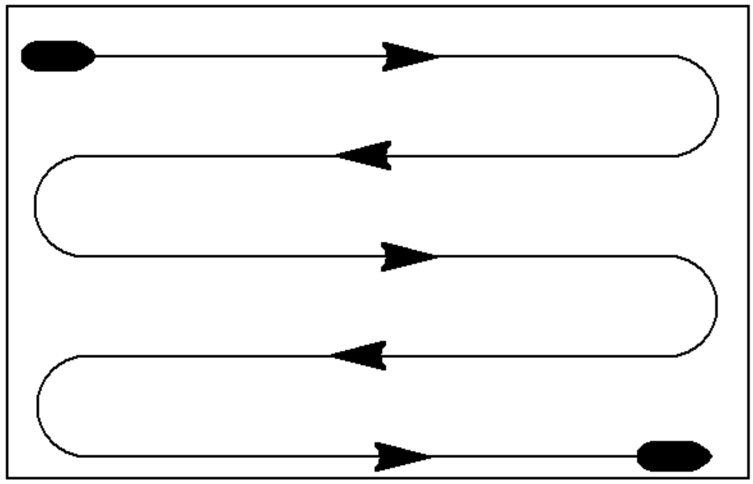
8 Mapping the ocean bottom

To make a map of the ocean bottom, ships have to travel back and forth in a zig-zag pattern over large areas and take readings from their SONAR equipment all along the way. The sound waves spread out to the side of the boat, so each pass the boat makes can measure depth and indicate features in a wide swath. The beam's width depends on the kind of SONAR equipment the ship has and the depth of the water.

Table 2: Beam width and a zig-zag mapping pattern



View of ship from above of SONAR beam width



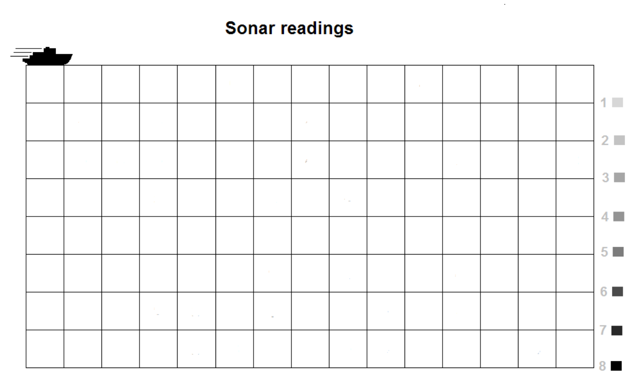
Ship's zig zag pattern for mapping

a. Why do you think a ship follows a zig-zag pattern?

b. How does the width of a ship's SONAR beam affect how many zigs and zags the ship needs to make to get a complete map of an area of the ocean bottom?

9 Readings and depth

1. Your group will be in charge of one set of readings made on a SONAR mapping expedition. You will be given one part (a zig or a zag) of the entire map.
2. The readings indicate how many seconds a SONAR reading took to return to the ship.
3. Your group's task is to create a side view of the terrain under your ship based on the data collected on one pass over part of the whole area.
4. Your teacher will give you a side view depth diagram for your group. Each SONAR reading tells you how long the sound took to return to the ship at that location.
5. Mark the depth of the water based on how many seconds the SONAR sound wave took to return to the ship.
6. The depth will be color coded. Mark each depth according to the color indicated on the depth readout diagram.



10 Making a bathymetric map from your readings

1. Each group will have a completed color coded side view depth diagram.
2. Your class will make a color coded bathymetric map based on the diagrams produced by all groups.
3. Each group will transfer their color coded depth information, from their side view diagram onto the bathymetric map grid, an overhead view of the area.
4. Once all the groups have transferred their color coded depth information, the bathymetric map is complete.

11 Thinking about your observations

a. What kind of information does your color coded bathymetric map tell you?

b. The readings on your side view depth diagram indicated how many seconds the SONAR signal took to return to the ship. How would you turn this information into actual depth readings?

c. Convert each color into the actual depth it represents on your bathymetric map.

Table 3: Finding the depth of water based on sound travel time

Color	Time sound took to echo off ocean bottom (seconds)	Speed of sound in salt water (m/sec)	Total distance sound traveled (m)	Depth of water (m)
red	1	1500		
orange	2	1500		
yellow	3	1500		
green	4	1500		
blue	5	1500		
purple	6	1500		
brown	7	1500		
black	8	1500		

d. Using information from part 6 of this investigation, what kind of features can you identify on your color coded bathymetric map?

e. Use a piece of graph paper to make your own small color coded bathymetric map that shows a seamount, a guyot, and a deep-ocean trench.

f. **Challenge**: How could you use the information represented by different colors to add contour lines to your bathymetric map?

12 Exploring on your own

a. What does SONAR actually stand for?

b. Near the coast we sometimes see the bottom of the ocean. In deep water, how far does visible light penetrate down into the water? What are the different zones associated with light in the ocean?

c. Research: Who was Marie Tharp and what major project did she help accomplish before anyone else?

d. Research: What other animals use echolocation?