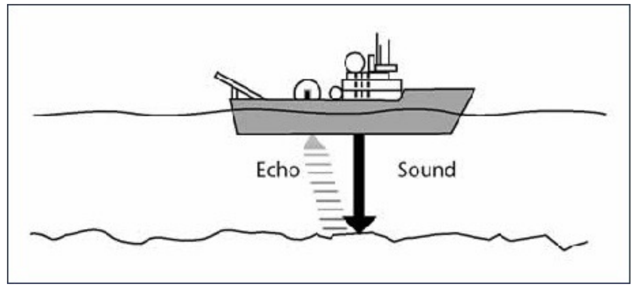
# Lesson Plan: Pings!



http://www.oicinc.com/single-beam-echosounder-samples.html

Focus: The ocean is vast and largely unexplored. Although satellite data gives us a rough idea of large features on the ocean floor, detailed mapping can help scientists better understand the geologic history and biological potential of submarine areas. Mapping the ocean floors provides the groundwork for future studies as the scientific world strives to better understand deep sea geology and biology and how climate change and deep sea mining will affect these unique ecosystems.

Learning Objectives: This classroom task is intended to give students a better idea of the process used to map deep ocean floors. Students will create their own cross-section of the ocean floor including common seafloor features. Students will simulate transmitting and receiving sonar signals in order to blindly "map" a partner's unknown cross-section of the ocean floor.

Grade Level: 7-8 (Earth Science/Life Science) or 9-12 (Oceanography/Marine Science), depending on concept focus and depth of research

**Next Generation Science Standards:**

HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] [Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.]

**National Science Standards:**

**Content Standard D: Earth and Space Science** • Structure of the Earth system

**Content Standard F: Science in Personal and Social Perspectives** • Populations, resources, and environments

**Ocean Literacy**

**Essential Principle: The Earth has one big ocean with many features.** *Fundamental Concept b.* An ocean basin's size, shape and features (such as islands, trenches, mid-ocean ridges, rift valleys) vary due to the movement of Earth's lithospheric plates. Earth's highest peaks, deepest valleys and flattest vast plains are all in the ocean.

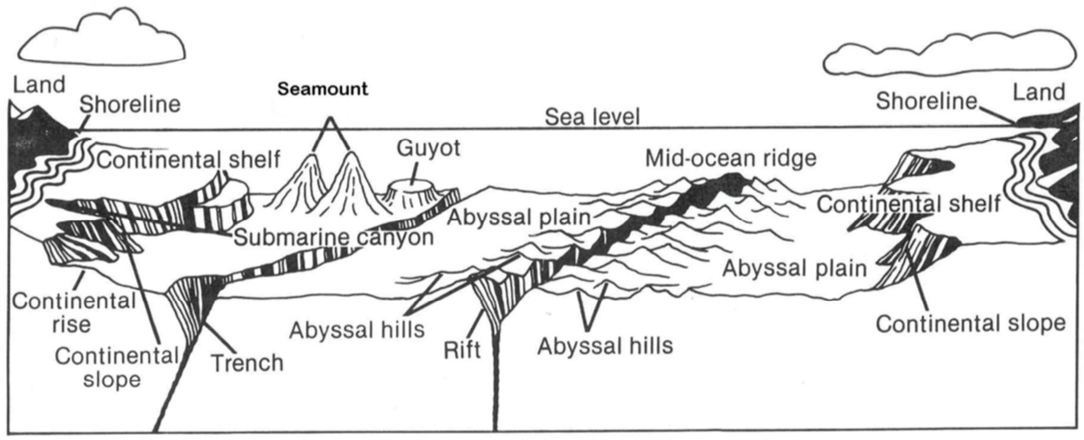
**Essential Principle: The ocean and life in the ocean shape the features of the Earth.** *Fundamental Concept e.* Tectonic activity, sea level changes, and force of waves influence the physical structure and landforms of the coast.

**Essential Principle: The ocean is largely unexplored.** *Fundamental Concepts: a. The ocean is the last and largest unexplored place on Earth—less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation; b. Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes; d. New technologies, sensors and tools are expanding our ability to* *explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles; f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.*

Materials: Student Data Sheet, stopwatch

Teaching Time: 1 class period (45-55 minutes).

This lesson should follow an introduction to common features on the ocean floor, for example a plate tectonics unit. Relevant keywords are: seamount, guyot, ridge, rift, trench, submarine canyon, abyssal plain, continental shelf, continental slope. We will use a sonar activity in order to better understand how these features are mapped in detail.




http://aswc.seagrant.uaf.edu/images/stories/grade6/oceanfeatures.pdf

Introductory Resources:
http://www.noaa.gov/resource-collections/ocean-floor-features
http://www.cosee-se.org/files/southeast/Introduction%20to%20the%20Seafloor%20Teacher.pdf
https://manoa.hawaii.edu/exploringourfluidearth/physical/ocean-floor/seafloor-features

Learning Procedure:

1. Use the graph paper provided to make a sketch of a cross-section of your ocean floor. Your ocean floor should include at least three underwater features, examples are listed in the keywords. Label them. Do not show your cross-section to your classmates, but do get it checked by your teacher.
2. Keeping your cross-section a secret, find a partner with whom you will perform your sonar experiment. One person will start as the transmitter and the other as the receiver.
3. Start by calibrating your measurements. In the field, this is done with an expendable bathythermograph (XBT) to see how sound velocity varies with depth. In this experiment, we will calibrate the ping time from the surface of the ocean to the bottom of the deepest part of the ocean floor (no features) and back. In order to calibrate (and for future data points), the transmitter says "ping" loudly and starts a stopwatch that is visible to both the transmitter and the receiver. The receiver will "ping" back (more quietly, if we're getting technical) in the amount of time it would take the signal to travel to the deepest part of the ocean floor AND BACK. Use the depth grids as a unit of measure (hint: the sound velocity in the ocean is around 1500 meters per second).
4. To start mapping their partner's cross-section, the transmitter announces position number 1. The receiver should find position 1 on their cross-section and prepare to return the ping (noting the time delay carefully based on the calibration). For example, if the calibration is 3 gridlines (1500 meters) per second and the

ocean feature at position 1 is 6 gridlines below the ocean surface, then the receiver would wait 4 seconds to ping back.

5. Once the receiver is ready, the transmitter says "ping" loudly, starts the stopwatch, and waits for a response "ping" from the receiver (who is also watching the stopwatch). The receiver should note the time delay in the table and use that along with the calibration to find the depth of the feature below the surface. Repeat the process for all positions along the cross-section.
6. The transmitter should then be able to sketch a prediction of the receiver's ocean floor. If the transmitter is unsure of a data point or would like additional points for accuracy, they can choose to add points between positions.
7. Switch roles and repeat the experiment so that each student has had a chance to be the transmitter and receiver.
8. Compare the transmitter's predicted sketch with the receiver's original sketch.
9. Follow up questions:

    a) How did your transmitter's prediction compare with your partner's (receiver) original drawing of the ocean floor?

    b) What were some challenges you encountered and what strategies did you try in order to work past them?

    c) How would this procedure need to be changed if we were actually trying to map the ocean floor?

10. Watch the short video clip (https://www.youtube.com/watch?v=-mYdhe4fAGI) to learn more about how R/V *Falkor* uses multibeam mapping to get a detailed picture of the ocean floor.
11. Follow up questions:

    a) List at least three ways that the mapping procedure the R/V Falkor uses is different from the procedures in this lab activity?

    b) What are some difficulties in mapping the ocean floor and how are they addressed?

    c) What can we learn from mapping the ocean floor? Why is this kind of science important?