Education and Research: Testing Hypotheses

# Crossing the Pacific—Bathymetry

## Summary

What is really under the salt water in our worldwide oceans? This four-part activity will guide students to explore, investigate, and analyze our mysterious ocean floors. Students will work collaboratively to investigate ocean observing systems around the world to gain understanding of the Earth's oceans and how scientists are studying these ecosystems. Students will also learn to navigate through Google Earth to find and utilize data points, graph them electronically, and produce a 3-D model of the topographical features on the ocean floor from one point to another. Students will use this information to analyze the importance of mapping the ocean floor and the future of ocean technology and conservation.

## Key Concepts

- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.
- Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.
- Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

## Learning Targets/Objectives

Students will be able to:

- ***Observe*** technologies that support ocean research and conduct responsible research online.
- ***Identify*** critical ocean research and the topography of the ocean floor.
- ***Utilize*** accurate data to electronically graph ocean landforms.
- ***Record*** investigative questions, information from ocean observatories, and ocean floor depths.
- ***Demonstrate*** learning from bathymetry data to construct a 3-D model of the ocean floor.
- ***Communicate*** results through a written summary, discussion, and further investigative questions.

## Materials

- Computers with Internet access, Microsoft Word/Excel and Google Earth installed
- Science Notebook/Pencil
- ***Google Earth Bathymetry Methodology*** instructions
- ***Bathymetry Rubric***
- Paper, tape, clay, string, cardboard, foam pieces, etc. for 3-D construction

## Procedure

**Part 1—Student Investigative Questions and Online Research**

2. Students are introduced to the lesson by asking some investigative questions.
   a. Review with the students **why we study oceans** (from previous lessons).
   b. What does the bottom of the ocean look like? **Predict** what a cross-section (review cross-section) looks like on the ocean floor and carefully draw it in your Science Journal.
   c. What kind of **specific landforms** do you think are located on the sea floor (review landforms if needed)?
3. Explain to the students they will begin to investigate what the floor of the ocean looks like. Students will start with exploring different websites to gain a further understanding of what is located on the ocean floor. Use **Cornell Notes** as a guide for student thoughts (http://coe.jmu.edu/LearningToolbox/cornellnotes1.html).
   a. Monterey Bay Aquarium Research Institute (MBARI) http://www.mbari.org/mars/
      i. Explain in complete sentences the MARS project (Monterey Accelerated Research System). What kind of scientific experiments are being done with the science node system? Explain **at least three** of these experiments in depth.
   b. Alaska Ocean Observing System (AOOS) (or other regional Ocean Observing Systems Available; see resources) http://www.aoos.org/
      i. Navigate to the AOOS data portal. Choose a **Layer** (such as Air Temperature) and observe the map. What do you notice about the data and how it relates to Alaska and the surrounding oceans? Look at how it changes closer to shore vs. further out in the Gulf of Alaska. **Explain your observations.**
   c. Ocean Observatories Initiative (OOI) http://www.oceanobservatories.org/
      i. Click on "News and Events." Choose **one article** and briefly describe what is explained about oceanography.
   d. U.S. Integrated Ocean Observing System (IOOS) http://www.ioos.gov/
      i. Click on "Interagency Programs" and "Marine Protected Areas." Watch one of the four main videos and **summarize** the video in a few sentences.
   e. Global Ocean Observing System (GOOS) http://www.ioc-goos.org/
      i. Click on "What is GOOS" and read about this worldwide observing system. **Explain** how GOOS is helping scientists and people learn about oceans around the world. What does it have planned for the future, AND what do ***you*** think we can do to help protect our oceans?

**Part 2—Google Earth and Electronically Graphing the Ocean Floor**

1. Students will take information from Google Earth to gather data from the ocean floor depths. Using this data, students will graph the ocean floor from one point to another.
2. Refer to the ***Google Earth Bathymetry Methodology*** instructions to guide you through this activity.
3. Teachers and students are welcome to use Excel to organize the data, or you can use the Google Earth application. The recommendation is to use 50 minutes as an interval to record depths as you fly from one point to another on Google Earth. When major features are encountered (trenches, seamounts, etc.), it is recommended to take multiple readings at higher intervals (see ***Google Earth Bathymetry Methodology*** Instructions). Here is an example of a chart you could use for gathering data:

| **Locations (minutes)** | **Depth (meters)** |
|---|---|
| Staring Point: MBARI | 0 m |
| 50 minutes | |
| 100 minutes | |
| 150 minutes | |
| Etc. | Etc. |

**Part 3—Constructing a 3-D Model of the Ocean Floor**

1. Using the data points from the chart above, students will construct a 3-D model of the ocean floor.
   a. Determine the conversion between computer and 3-D model. How many mm should represent how many km? Construct a chart (see below) in your Science Journal and convert all your data.

| Minutes | Depth (km) | Converted to mm |
|---|---|---|
| | | |
| | | |

   b. The 3-D model must fit the size of two 11 x 17 inch papers taped together end-to-end. Carefully mark and label your x axis (horizontal) and y axis (vertical) with the appropriate intervals. Be careful, and ask for help if needed!
   c. Students will use the data to construct a 3-D model from provided materials: tape, clay, string, cardboard, foam pieces, foam boards, etc. (add other materials as needed). Each group will use their creativity to make their 3-D tactile topographical ocean floor model.
   d. Use vocabulary and images from ***"What's Really Under the Ocean: Sea-Floor Mapping"*** to help teach/review and neatly label features of the ocean floor.
   e. The 3-D version should match their computer version for full credit on this learning target/objective. If not, students can adjust/modify their model for accuracy.

**Part 4—Conclusion**

1. Once all activities are completed, students are instructed to write a one paragraph summary about their learning. This needs to include an introductory sentence, **at least two details** from each part (six details total), and an ending sentence. Refer to your original questions at the beginning to guide your writing from your Cornell Notes. Students are also encouraged to ask **more** questions about the oceans for future studies.
2. After summaries are written, a class discussion will conclude this study of the ocean floor. Images from ***"What's Really Under the Ocean: Sea-Floor Mapping"*** should be shown to further discuss and match with formations from the graph. Each group also needs to share **at least three** concepts they learned and an idea of **future conservation** efforts to help global oceans.
3. Use the attached ***Bathymetry Rubric*** to assess specific learning targets/objectives.

## Assessment

- **Performance—**Student questions, notes, and research gained from web investigations (Cornell Notes).
- **Product—**Students will produce an electronic graph of the ocean floor and a 3-D model from ocean topography. Students will also write a summary paragraph about what they learned regarding the ocean floor once all activities are completed.

## National Science Education Standards

**Understanding About Science and Technology**

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

**Earth Systems**

- Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.
- Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

## Essential Science Skills

- Asks Questions
- Makes and keeps simple records of observations
- Communicates with others
- Organizes data into tables and charts
- Formulates models
- Draws conclusions
- Uses the Internet to find information
- Uses technology to solve problems

## Ocean Literacy Standards

- An ocean basin's size, shape and features (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.
- Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.

## AAAS Benchmarks

**The Nature of Science**

- **The Scientific Worldview:** Scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.
- **Scientific Inquiry:** Scientific investigations usually involve the collection of relevant data, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected data.
- **The Scientific Enterprise:** No matter who does science and mathematics or invents things, or when or where they do it, the knowledge and technology that result can eventually become available to everyone in the world.
- **The Scientific Enterprise:** Computers have become invaluable in science, mathematics, and technology because they speed up and extend people's ability to collect, store, compile, and analyze data; prepare research reports; and share data and ideas with investigators all over the world.

## Additional Resources

Integrated Ocean Observing System Regional Partners—http://www.ioos.gov/partners/regional.html

NOAA Ocean Explorer—http://oceanexplorer.noaa.gov/

Northwest Association of Networked Ocean Observing Systems (NANOOS)—http://www.nanoos.org/

Neptune Canada—http://www.neptunecanada.ca/

Centers for Ocean Sciences Education Excellence (COSEE)—http://www.cosee.net/

Ocean Literacy—http://oceanliteracy.wp2.coexploration.org/

Center for Ocean Solutions—http://www.centerforoceansolutions.org/