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DEEPER AND DEEPER: AN INTRODUCTION TO SEAFLOOR GEOLOGY

Amy Nicholson

Virginia Institute of Marine Science

Grade Level

Fourth Grade

Subject Area

General Science

VA SEA is a collaborative project between the Chesapeake Bay National Estuarine Research Reserve, the Virginia Institute of Marine Science's Marine Advisory Program, and Virginia Sea Grant. The VA SEA project is made possible through funding from the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and managed by the University of Michigan Water Center.



Title: Deeper and Deeper: An introduction to seafloor geology

Focus: Identifying seafloor features and reading bathymetric profiles

Grade Level: 4th Grade Science

VA Standards of Learning:

4.1c The student will demonstrate an understanding of scientific and engineering practices by

c) interpreting analyzing and evaluating data

- Organize and represent data in bar graphs and line graphs
- Interpret and analyze data represented in bar graphs and line graphs
- Compare two different representations of the same data (e.g., a set of data displayed on a chart and on a graph)
- Analyze data from tests of an object of tool to determine whether it works as intended

4.7 The student will investigate and understand that the ocean environment has characteristics. Key characteristics include

- a) Geology of the ocean floor;
- b) Physical properties and movement of ocean water; and
- c) Interaction of organisms in the ocean.

Learning Objectives:

- Students will identify features and basic geology of the seafloor by learning and identifying 3 key features of the ocean floor.
- Students will create a bathymetric profile.
- Students will read and create line graphs.

Total length of time required for the lesson: 1hr (1h30m with preparation time)

Vocabulary:

Geology: The science that deals with the dynamics and physical history of the earth, the rocks of which it is composed, and the changes Earth is undergoing. (Adapted from dictionary.com)

Bathymetry: “The measurement of the depths of oceans, seas, or other large bodies of water” (dictionary.com)

Trench: Long depressions in the seafloor that form at the boundary of tectonic plates. (Adapted from whoi.edu)

Ridge: A long elevated landform separated by the terrain with steep sides. (Adapted from wikipedia.com)

Background Information:

Not mapped or explored until the late 1800s, the ocean seafloor is a vast and mysterious part of our planet. However, when you look a little closer at the surface of the seafloor, you realize that it is just as rolling and diverse as our own terrestrial landscapes. The bathymetry, or measurement of the depth of the seafloor, highlights ridges, trenches, volcanoes, plains, slopes, and even more landforms all out of our sight and under the surface.

Just like throughout the rest of Earth, the seafloor is made of plates, called tectonic plates, that have been active for all of Earth’s history that we know of. These plates move at very slow rates, which in turn create the features we see around us such as those trenches, ridges, slopes, volcanoes, mountains, and more. When these plates collide, slide, or move apart, that is when we get the unique features all around us.

In this lesson plan, we will be focusing on three common features: ridges, trenches, and slopes. Ridges are like hills or mountains in the ocean, and they occur when the seafloor plates spread, or move away from each other.

Ridges can look differently depending on the speed of the spreading, but in general they are a large peak on the ocean floor.

Trenches are like valleys or canyons on the ocean floor. These occur when plates collide, or crash with each other. These are where we find the deepest parts of the ocean, and almost alien-like sea life.

Lastly, slopes are like one side of a hill in the ocean. These are less related to tectonic plates moving and more related to sediment, like sand, moving due to the energy of the ocean and building on top of itself. These slopes connect the shallow part of the ocean, where we often swim and snorkel, to the deepest parts where no light reaches.

But how do we even know all of this? Mapping the seafloor first started with what would now be considered pretty rudimentary techniques. On ships out in the open ocean, scientists would cast very long anchors down to the bottom of the ocean and measure how much chain was let out, which would in turn estimate the depth of the ocean. They would do this in certain increments throughout an area to eventually get a comprehensive picture of what the ocean floor would've looked like. Of course, this was incredibly time-consuming and luckily methods improved in the coming decades.

In the midst of World War II, sonar became a much bigger technology that was used to map the seafloor (originally designed to detect submarines) and around this time the study of seafloor geology took off. Now, we have very advanced technologies to map the seafloor and we even have submersibles that can take scientists to it to see it either in person or through a camera! All of this technology has allowed us to gain a comprehensive view of its traits and features.

Understanding the geology that drives the creation of our seafloor's features is a great way to begin to understand the geology that drives the dynamic nature of our whole planet.

Materials & Supplies:

- Play-doh (any color, enough for each student to get a roughly 3x2 slab roughly 1 inch thick)
- Pencils (for the worksheet, per student)
- Laminated bathymetric profiles (per group)

Teacher Preparation:

Students should be in small groups of 2-4 depending on the amount of students. There should be enough room at their station to perform a hands-on activity and write on a worksheet. Most typical seating arrangements should fulfill these needs, but it is something to be cognizant of because this lesson plan will require some play space at their desks.

Procedure:

Activity Set-Up: 30 minutes

- 1) Before starting the activity, print out and laminate bathymetric profile cards to hand out to students. Each pair or group of students should get one bathymetric profile, so print out as many as needed for the classroom. Alternatively, students can work on this activity individually if the classroom is small.
- 2) Additionally, print out one worksheet per student to work on throughout the lesson plan.

PowerPoint: 30 minutes

Activity: 30 minutes

- 1) Hand out the lesson plan worksheets to students along with a tub of Play-Doh.
- 2) Explain that today, they are going to get to make their very own seafloor.
- 3) Students can then be instructed to break up into pairs/small groups and each group will then be distributed a laminated bathymetric profile card.
- 4) Students will then work through the worksheet and use the provided Play-Doh to match the bathymetric profile they received.
- 5) Ask students to raise their hand and show you their work after they complete question two. This will allow you to ensure that they have an understanding of how to read a depth profile before moving on to the last question.
- 6) Give them the go ahead to start the last question on the worksheet. If they'd like, they can use their play-doh to mimic that one as well!
- 7) At the end of the activity, if time allows, you may also have a discussion about what students found and on any questions they may have.

Assessment:

The worksheet given out to students that accompanies the lesson plan can be used as an assessment.

Handouts/Worksheets:

- 1 Appendix 1: Profile cards
- 2 Appendix 2: Activity worksheet
- 3 Appendix 3: Activity worksheet answer key

References:

Bradford E. Prather, Mark E. Deptuck, David Mohrig, Berend Van Hoorn, Russell B. Wynn, 2012. "Application of the Principles of Seismic Geomorphology to Continental-Slope and Base-of-Slope Systems: Case Studies from Seafloor and Near-Seafloor Analogues", Application of the Principles of Seismic Geomorphology to Continental Slope and Base-of-Slope Systems: Case Studies from SeaFloor and Near-Sea Floor Analogues, Bradford E. Prather, Mark E. Deptuck, David Mohrig, Berend Van Hoorn, Russell B. Wynn

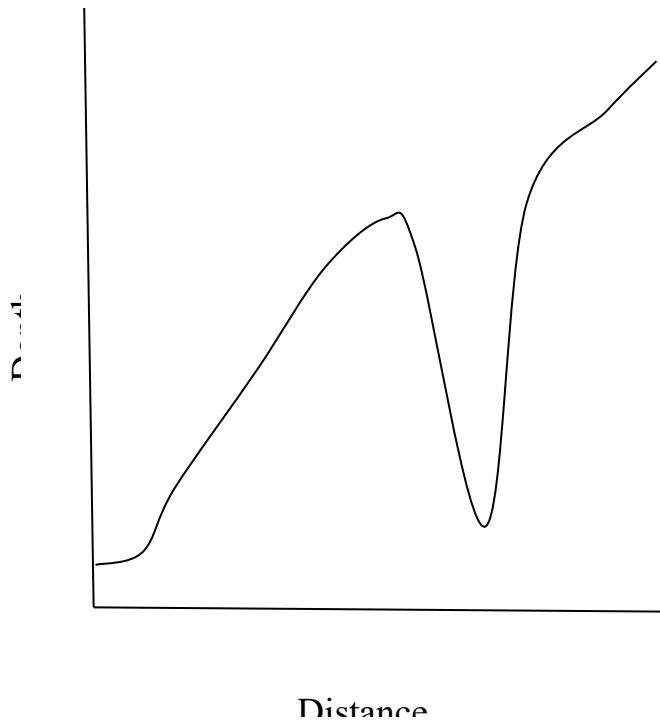
Ocean Trench. *Education*, National Geographic, education.nationalgeographic.org/resource/ocean-trench/.

Nakanishi, M., Hashimoto, J. A precise bathymetric map of the world's deepest seafloor, Challenger Deep in the Mariana Trench. *Mar Geophys Res* **32**, 455–463 (2011).
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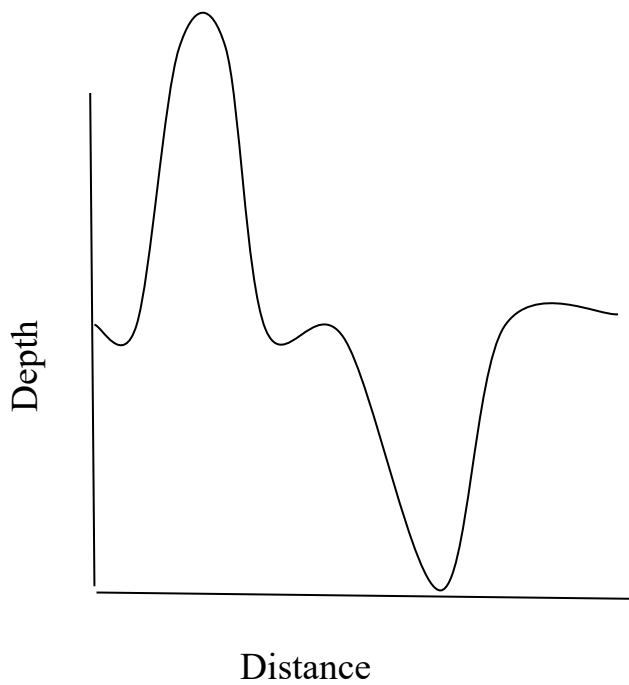
US Department of Commerce, National Oceanic and Atmospheric Administration. "What Is the Mid-Ocean Ridge?" *Ocean Exploration Facts: NOAA Ocean Exploration*, NOAA, 8 July 2014, oceanexplorer.noaa.gov/facts/mid-ocean-ridge.html.

Wang, W. Geological structures of ridges with relation to the definition of three types of seafloor highs stipulated in Article 76. *Acta Oceanol. Sin.* **30**, 125–140 (2011).
<https://doi.org/10.1007/s13131-011-0154-z>

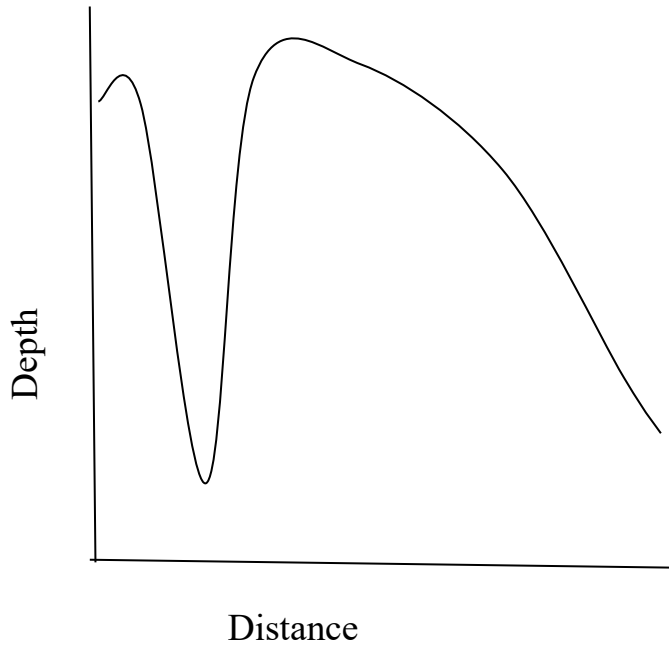
Appendix 1: Profile cards



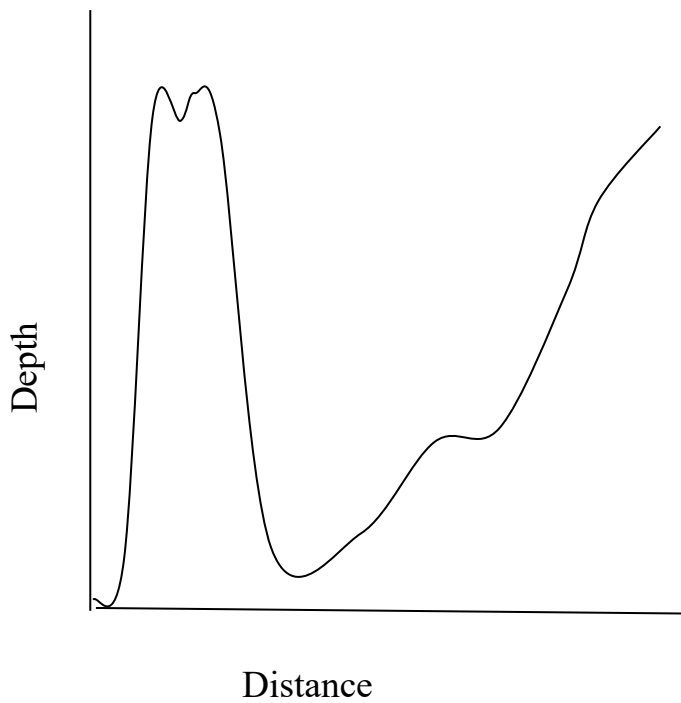
Bathymetric Profile 1 - Slope and Trench



Bathymetric Profile 2 - Ridge and Trench



Bathymetric Profile 3 - Slope and a trench



Bathymetric Profile 4 - Ridge and a slope

Appendix 2: Activity Worksheet

Name:

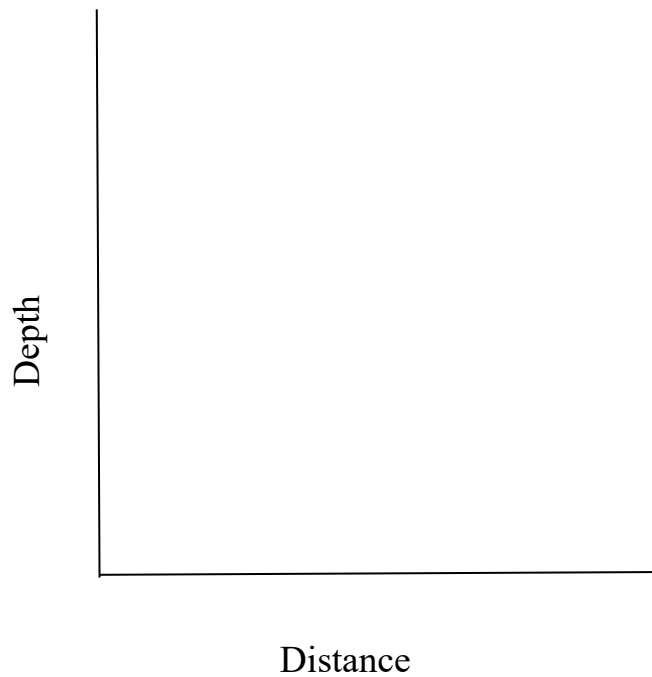
Date:

Seafloor Geology Worksheet

1. Re-draw your seafloor profile in the space below and label any key features (ridges, trenches, slopes)

2. Now take your play-doh and mold it into the bathymetric profile that you received!

3. Taking what you've learned, draw your own bathymetric profile including and labeling two or more key features that we learned about.



Appendix 3: Activity Worksheet Answer Key

Name:

Date:

Seafloor Geology Worksheet

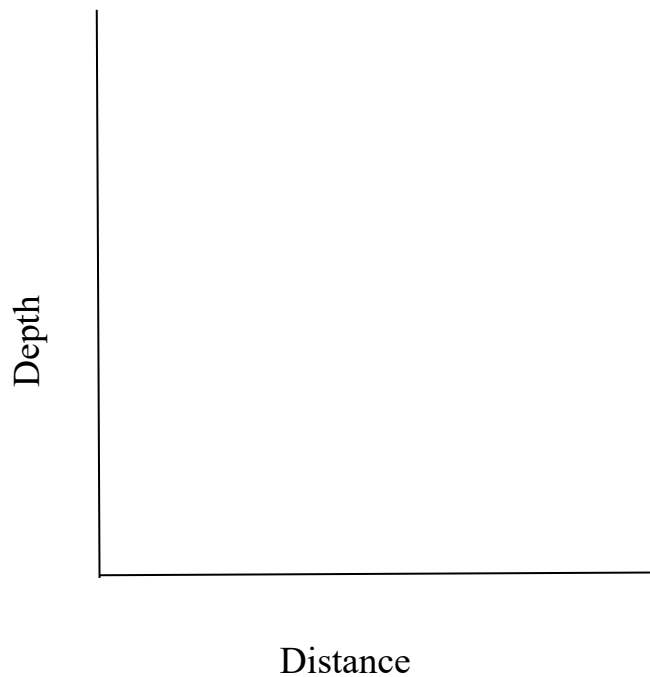
1. Re-draw your seafloor profile in the space below and label any key features (ridges, trenches, slopes)

Students should have a graph with x-axis distance and y-axis depth with a drawing of their own profile that they received.

2. Now take your play-doh and mold it into the bathymetric profile that you received!

Teachers will need to go around the classroom and check for completion for this portion. Have students raise their hand once they are done with this part before they move on.

3. Taking what you've learned, draw your own bathymetric profile below including and labeling two or more key features that we learned about.



Students can have many different creative profiles here. Most importantly, they must include two of the three features they learned about and label them.