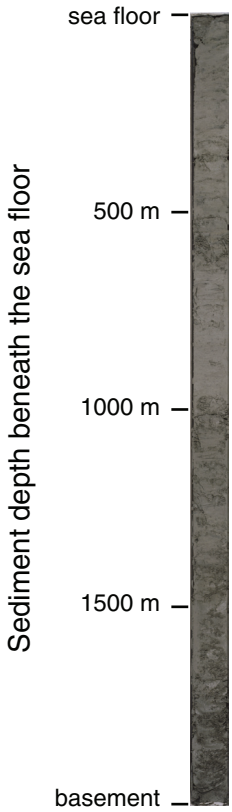
Sediment Deposition Supports Seafloor Spreading - Student Guide

Using Google Earth and Ocean Cores to Analyze Seafloor Spreading

Background

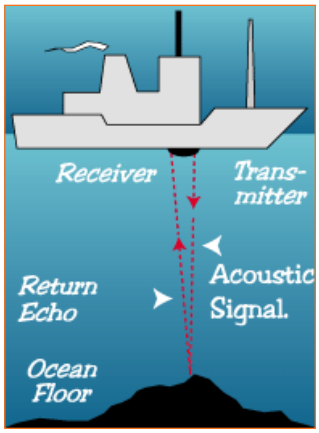
The goal of the scientific ocean drilling program is to investigate the sediments and rocks beneath the deep oceans by drilling and coring. The seafloor is usually made up of a thick layer of sediment. The sediment is composed of sand, silt, clay, and microfossils that drift down through the water. Microfossils are fossilized microscopic organisms. Common types include nannofossils, foraminifers, and diatoms. When microfossils are the major component of the sediment, then that sediment can be called an ooze. The sediment layer can be up to 2000 meters thick! Below the sediment is a layer of igneous rock, basalt, also called basement rock.



The data in this exercise were taken from sediment cores and sonar data collected by the *JOIDES Resolution*.

The scientific drilling vessel, JOIDES Resolution

In the summer of 1996, scientists onboard the ship collected sediment core samples at 10 sites east of the Juan de Fuca Ridge.



First, scientists used sonar to determine the depth to the ocean floor. To use sonar, scientists send sound waves from the ship to the ocean floor and time how long it takes for each sound wave to bounce back to the ocean's surface (image courtesy of Naval Meteorology and Oceanography Command). This time measurement is used to calculate the depth to the ocean floor with the following equation:

$$D = (V \times T)/2,$$

where

D = the depth to the ocean floor,

V = the velocity of sound in sea water, and

T = round-trip traveltime.

Time is divided by two in the equation to obtain the distance from sea level to the ocean floor and not the distance back to the surface.

Second, scientists used data from core samples to determine the sediment thickness at each site.

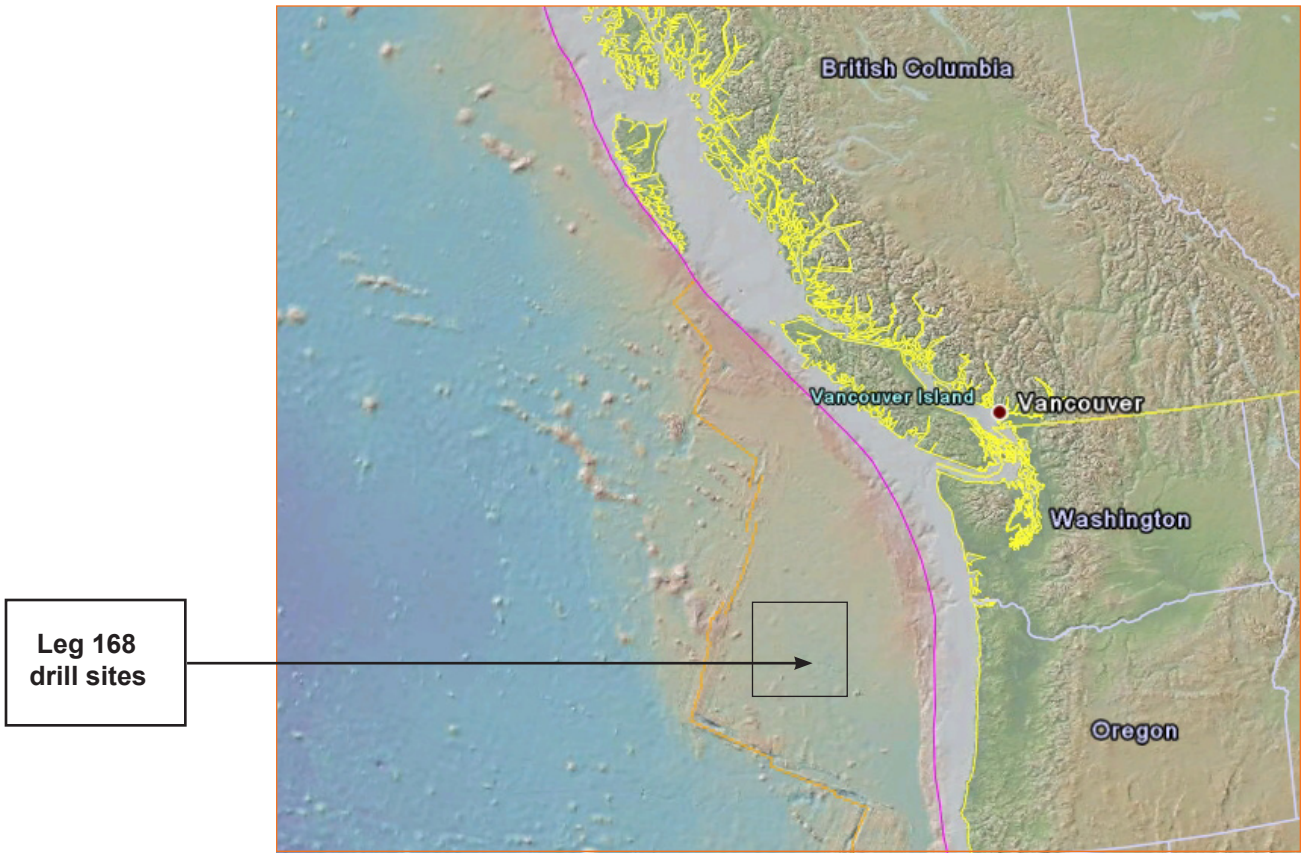
Materials

- Student pages
- Rulers
- Colored pencils
- Calculators

Learning Objectives

You will be able to:

1. Use Google Earth to evaluate real data collected by the Ocean Drilling Program to discover evidence of seafloor spreading.
2. Use the data you collect to create a graph showing the relationship between thickness of the sediments and distance from the spreading center (Thickness vs. Distance).
3 Explain a historical perspective on science research.



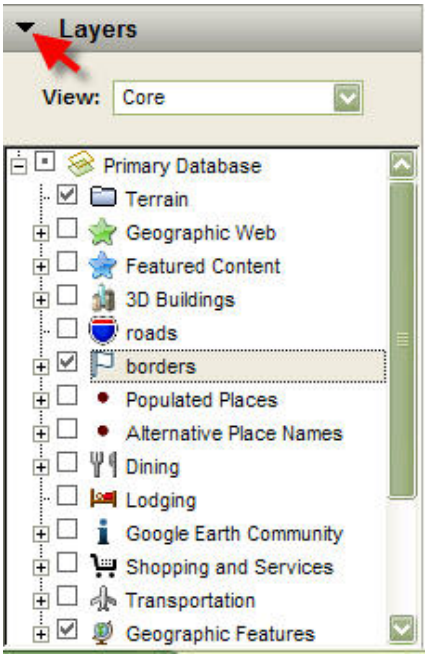
Notes about Google Earth

1. The images are generally current to within the past three years.
2. The Google Earth view of the ocean is digitally created so you can see the "look of the seafloor" without water. Of course, a real satellite picture of the ocean would show water.

Student Instructions

1. When you see this symbol it means you will need to answer a question, record data, make a graph, or draw a diagram on your answer page.
2. Double click on the "Expedition 168 Ooze Evidence" icon located on your desktop. This will open Google Earth.

3. Along the left side of the screen you should see two lists.



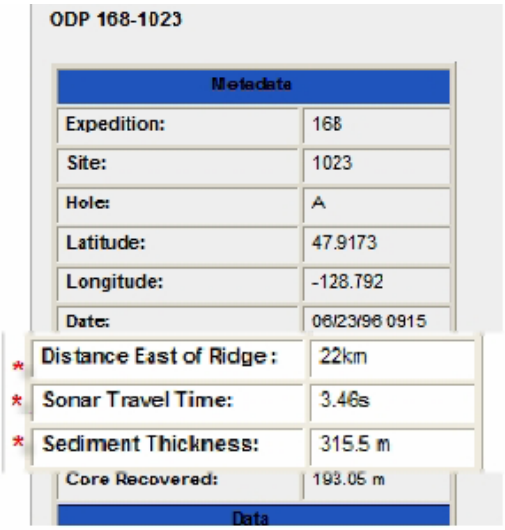
The top list, "Places," may have a lot of different locations on it. In the lower list, "Layers," make sure that the only boxes checked are: **Terrain**, **Borders**, and **Geographic Features**. Next you will hide this layer by clicking on the triangle to the left of the word "**Layers**."

Then it should look like this:

Note: On Macintosh icons vary slightly. For example (+) (-) signs may be replaced with triangles. Click on the triangle to expand the file as needed.

4. The yellow data points you see on the screen are drill sites where the *JOIDES Resolution* collected sediment cores from the ocean floor during Ocean Drilling Program (ODP) expedition 168 in 1996.

5. Zoom in on the drill sites. As you click on each site you will be given some important information as shown on the right. Use this information to fill in the columns labeled “Sonar Travel Time,” “Sediment Thickness,” and “Distance East of Ridge” in the data table on the answer page.



VOCABULARY

Ocean Drilling Program	*JOIDES Resolution*	Juan de Fuca Ridge	plate boundary
sediment	basement rock	ooze	sonar

CHALLENGE

seafloor spreading	divergent	convergent	transform

LINKS

Deep Earth Academy	www.deepearthacademy.org
Consortium for Ocean Leadership	www.oceanleadership.org
Integrated Ocean Drilling Program (IODP)	www.iodp.org
IODP U.S. Implementing Org. (IODP-USIO)	www.iodp-usio.org
Photo gallery	iodp.tamu.edu/publicinfo/gallery.html
Request core samples	iodp.tamu.edu/curation
Download data	iodp.tamu.edu/database

Acknowledgments

Written by Jerry Cook, Tavia Prouhet, and Ramona Smith (2007). Some overlay files were modified from Lamont-Doherty Earth Observatory data sets (http://www.marine-geo.org/tools/kmls.php) and ocean drilling data provided by Bernard Miville. This material is an outcome of the School of Rock Expedition organized by IODP-USIO in December 2005. The authors thank Lisa Crowder for providing comments. Edited by Katerina Petronotis (IODP-USIO) and Leslie Peart (Ocean Leadership Consortium), 3/2007.

Answer Page

Name _____ Date _____

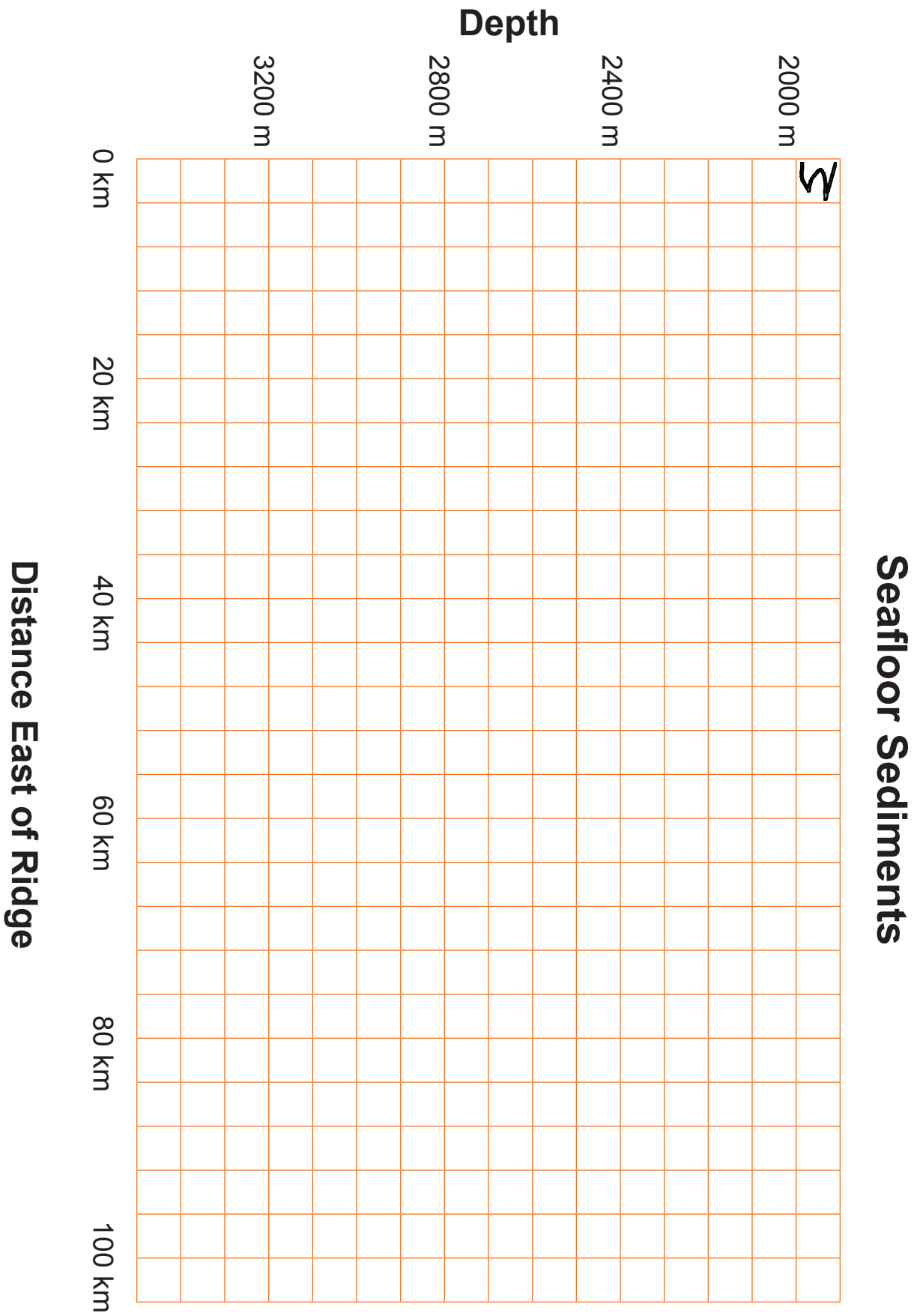
Data Collection

1. Record the information from insrtuction #5 in the table.

ODP Expedition 168 Site	Velocity of Sound in Water	Sonar Travel Time	Depth to Ocean Floor	Sediment Thickness	Depth to Basalt	Distance East of Ridge
Spreading center	1500 m/s					
1023	1500 m/s					
1024	1500 m/s					
1025	1500 m/s					
1030/1031	1500 m/s					
1028	1500 m/s					
1029	1500 m/s					
1032	1500 m/s					
1026	1500 m/s					
1027	1500 m/s					

2. Calculate the "Depth to Ocean Floor" using the formula D = (V × T)/2, where D = the depth to the ocean floor, V = the velocity of sound in water, and T = round-trip traveltime. Record your answers in the data table.
3. Calculate "Depth to Basalt" by adding "Depth to Ocean Floor" to "Sediment Thickness." Record your answers in the data table.
4. Using the data table, plot two lines on your graph. One line will be "Depth to Ocean Floor" against "Distance East of Ridge." The other line will be "Depth to Basalt" against "Distance East of Ridge." The area between the two lines is the sediment!
5. Using colored pencils, color the water blue, the sediment gray, and the basalt black. Label the Juan De Fuca Ridge. Show waves and the *JOIDES Resolution* at the top!

Answer Page


Depth
2000 m
2400 m
2800 m
3200 m
W
0 km
20 km
40 km
60 km
80 km
100 km
Distance East of Ridge
Seafloor Sediments

Answer Page

Analysis

1. Assuming a constant rate of sedimentation throughout the study area, what would cause sediment to be thinner near the Juan De Fuca ridge and thicker as you move away?

2 Circle the area where the oldest sediments are. Why did you choose this location?

3 Where do you think the newest crust is? Where is the oldest crust? Why?

4. Draw a diagram that shows how the depth of the ooze changes as you travel east across the study area. Describe the shape of the ooze. How does the shape of the ooze support the theory of seafloor spreading?

5. Draw a bold arrow beneath the graph showing the direction the ocean floor is moving.

6. Is this map a true representation of the ocean floor? Why or why not?Text.