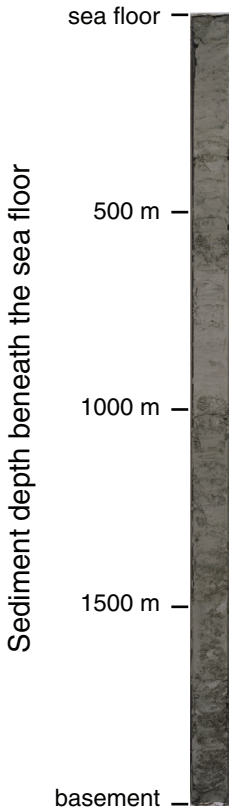
Sediment Deposition Supports Seafloor Spreading - Student Guide

Using Ocean Cores to Analyze Seafloor Spreading

Background

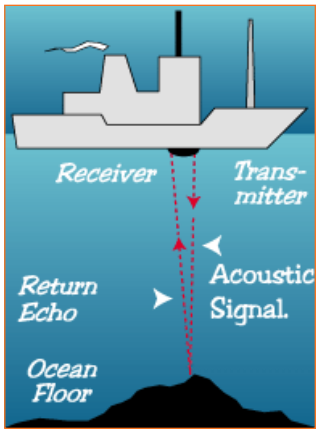
The goal of the scientific ocean drilling program is to investigate the sediments and rocks beneath the deep oceans by drilling and coring. The seafloor is usually made up of a thick layer of sediment. The sediment is composed of sand, silt, clay, and microfossils that drift down through the water. Microfossils 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.

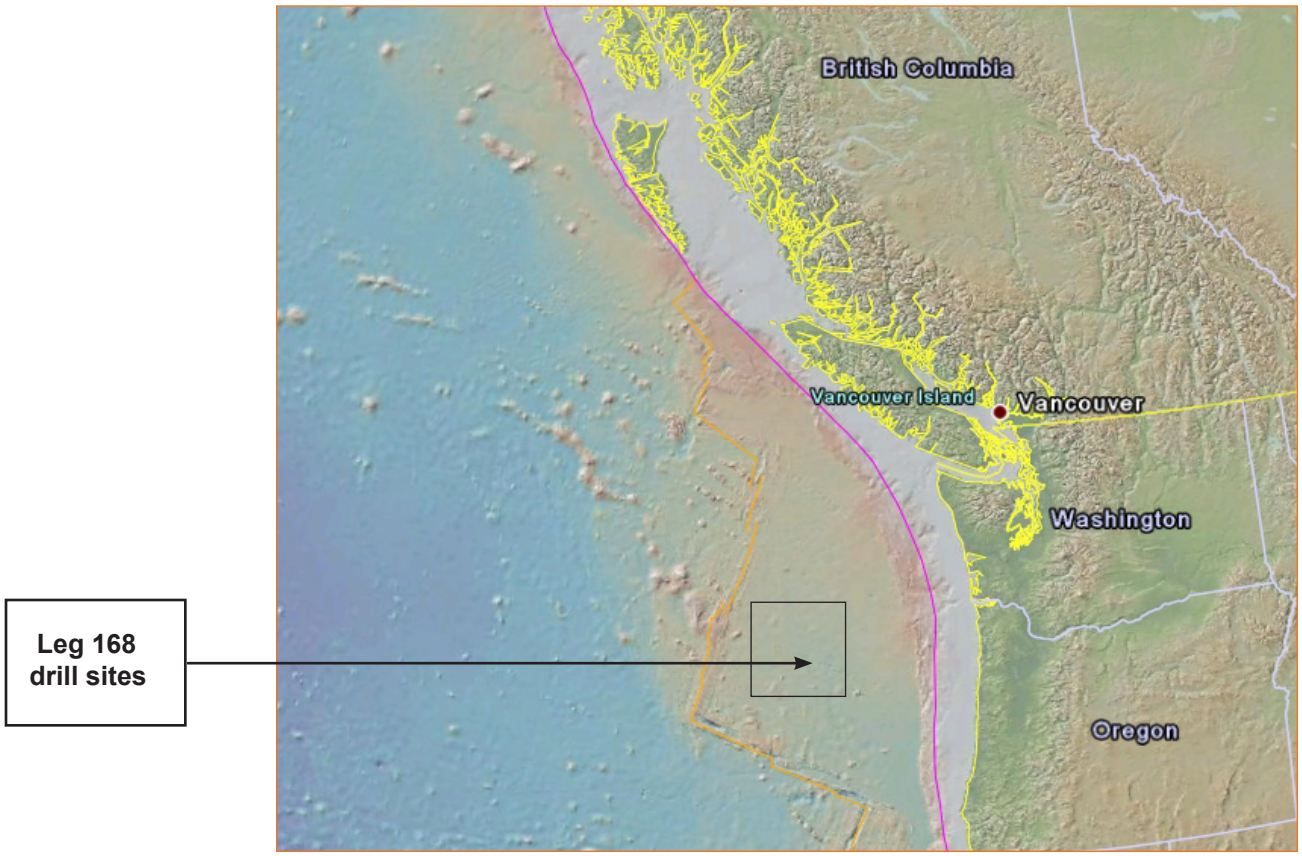
Materials

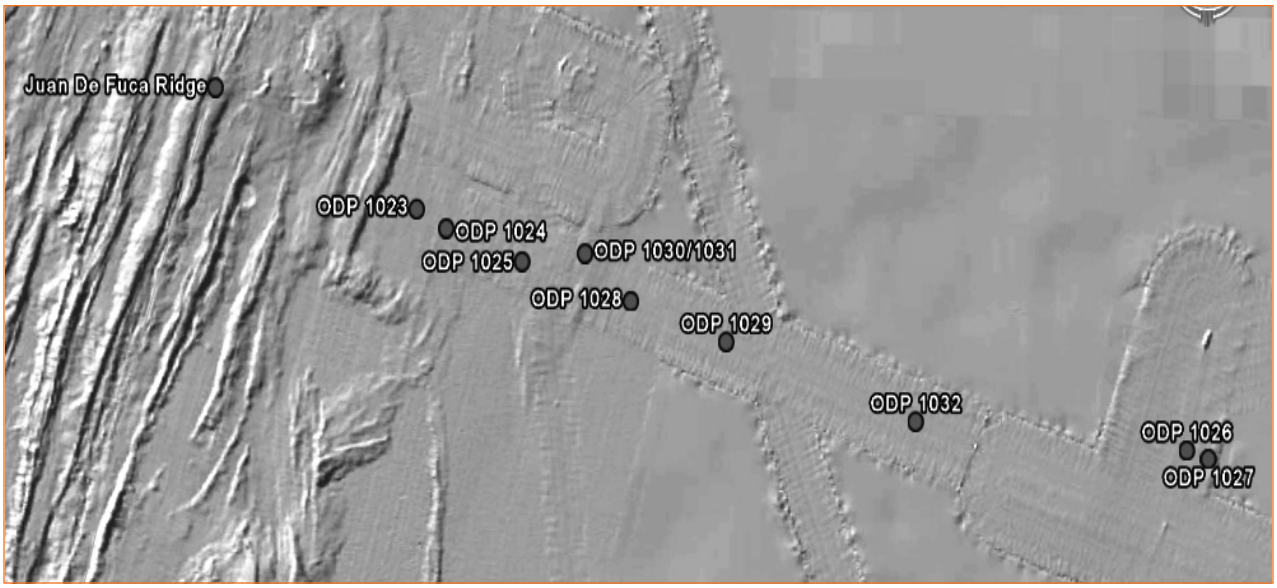
- Student pages
- Rulers
- Colored pencils
- Calculators

Learning Objectives

You will be able to:

1. Evaluate real data collected by the Ocean Drilling Program that support 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.





What To Do

1 The gray circles on the map represent drill sites where the *JOIDES Resolution* collected sediment cores from the ocean floor during Ocean Drilling Program (ODP) expedition 168 in 1996.

2. The data table on the answer page provides the velocity of sound in water. It also provides the length of time it took for the sonar wave to reach the ocean floor and return to the ship. You will use this table to record data and answer questions.

3.  When you see this symbol it means you will need to answer a question, record data, make a graph, or draw a diagram.

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/Data4GoogleEarth.html) 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

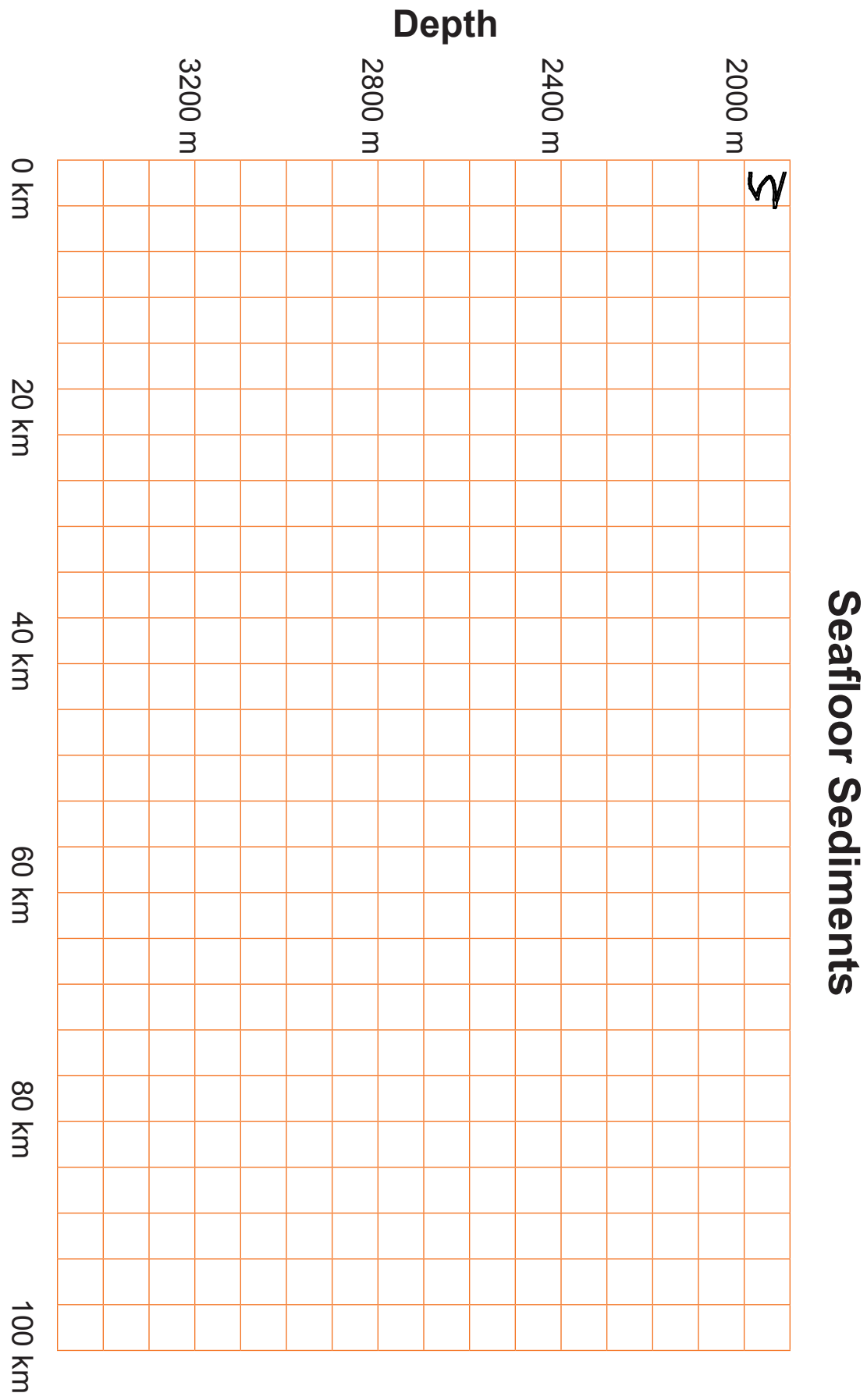
Name _____ Date _____

Data Collection

ODP Expedition 168 Site	Velocity of Sound in Water (m/s)	Sonar Travel Time (s)	Depth to Ocean Floor (m)	Sediment Thickness (m)	Depth to Basalt (m)	Distance East of Ridge (km)
Spreading center	1500	2.80		0		0
1023	1500	3.51		315		22
1024	1500	3.53		342		27
1025	1500	3.55		268		34
1030/1031	1500	3.54		194		41
1028	1500	3.65		139		46
1029	1500	3.65		259		56
1032	1500	3.65		416		76
1026	1500	3.67		324		99
1027	1500	3.67		537		102

1. Using the equation D = (V × T)/2, where D = the depth to the ocean floor, V = the velocity of sound in water, and T = round-trip traveltime, you need to calculate the depth to the ocean floor and record your calculations in the column labeled “Depth to Ocean Floor.”
2. Use the “Depth to Ocean Floor” and “Distance East of Ridge” data to graph the depth to the ocean floor. Then, connect the dots to make a line.
3. Add the “Sediment Thickness” and “Depth to Ocean Floor” data and record your answers in the column labeled “Depth to Basalt.” (Use the equation Sediment Thickness + Depth to Ocean Floor = Depth to Basalt.)
4. Use the “Depth to Basalt” and “Distance East of Ridge” data to graph the depth to basalt. Then, connect the dots to make a line. 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.