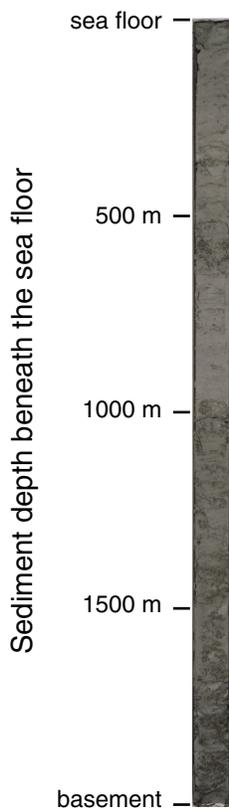


An Expedition to the Seafloor - Student Guide

Using Google Earth and Ocean Cores to Analyze Seafloor Spreading

Background

The goal of the **Deep Sea Drilling Project** was 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 nanofossils, 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 collected by the *Glomar Challenger*. In late 1968, scientists onboard the ship collected sediment core samples at seven sites east and west of the **Mid-Atlantic Ridge**. At each location, they discovered nanofossil oozes that had formed at different time intervals. The age of the sediment in contact with the basement rock at each location was used to date when that basement rock formed.

Learning Objectives

Students will be able to:

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

Notes about Google Earth

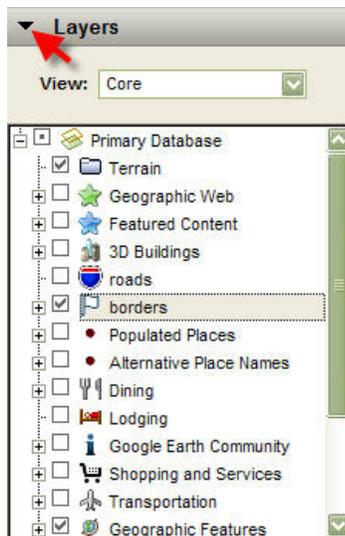
1. The images are generally current to within the past three years.
2. The Google Earth view of the ocean is digitally created so you can see the “look of the seafloor” without water. Of course, a real satellite picture of the ocean would show water.



Glomar Challenger

What To Do

1.  When you see this symbol it means you will need to answer a question on your worksheet.
2. Double click on the Google Earth icon.
3. Along the left side of the screen you should see two lists.



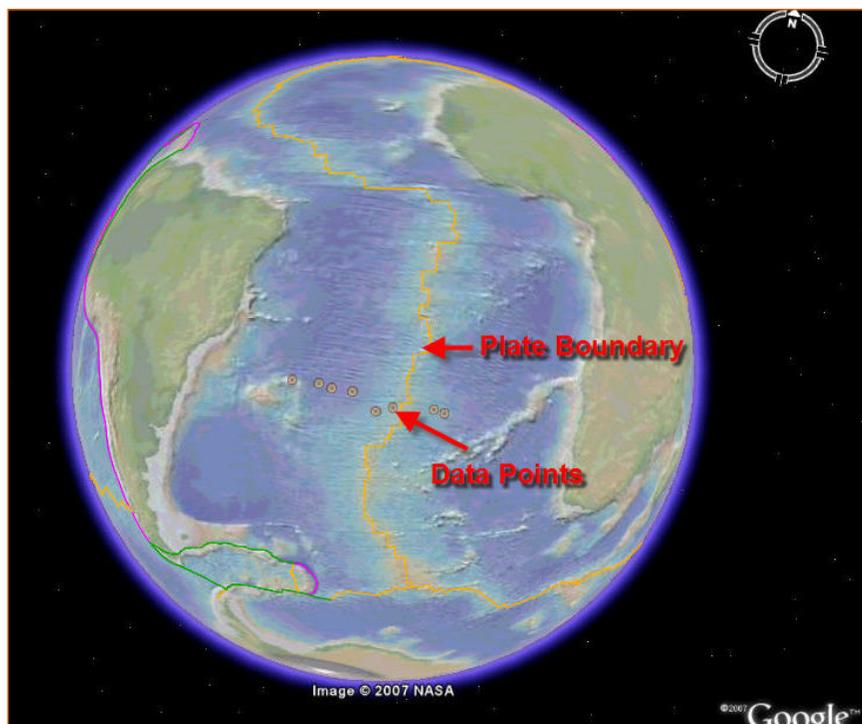
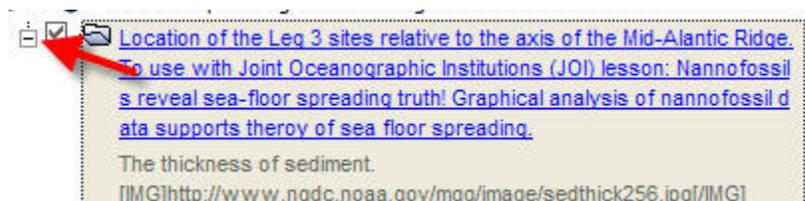
The top list, “Places,” may have a lot of different locations on it. In the lower list, “Layers,” make sure that the only boxes checked are: terrain, geographic features, and borders. Next you will hide this layer by clicking on the triangle shown below.

Then it should look like this:

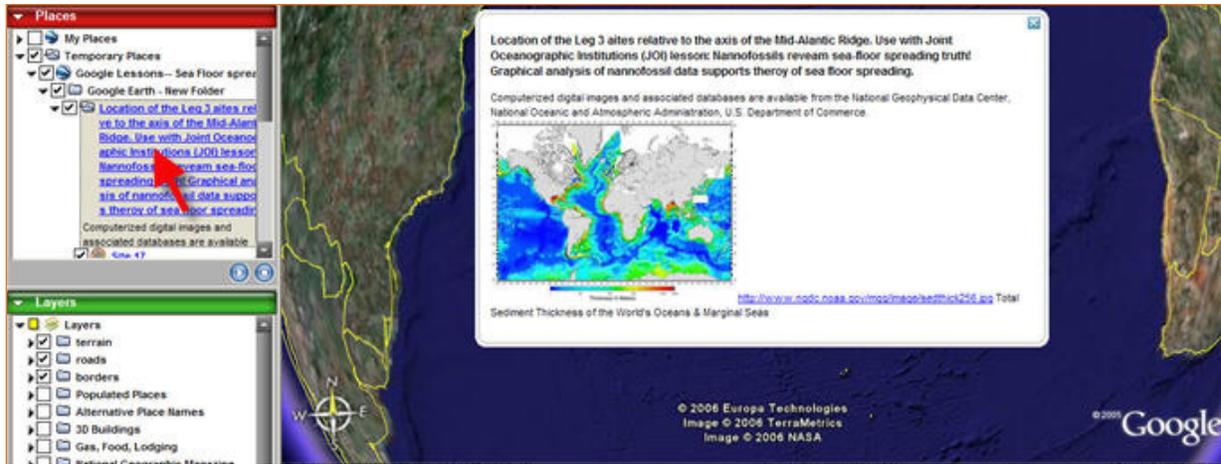


Note: On Macintosh icons vary slightly. For example (+) (-) signs may be replaced with triangles. Click on the triangle to expand the file as needed.

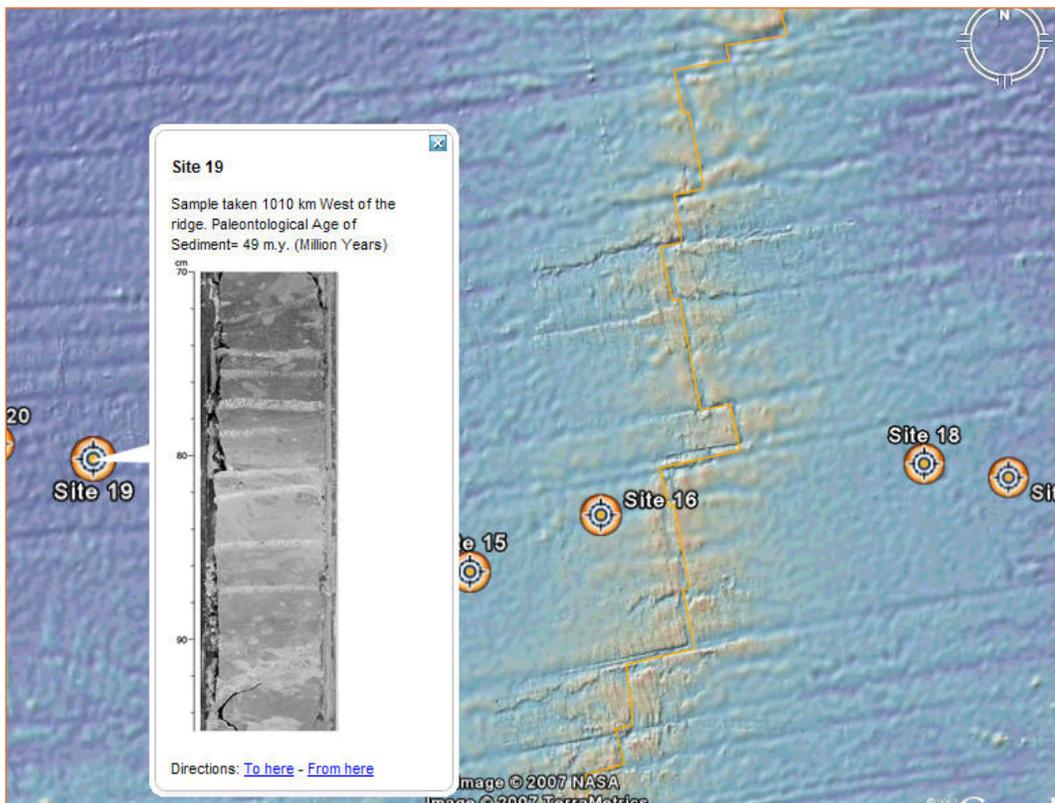
4. Open the Google Earth file. Choose the File > Open menu, and select the file “Seafloor_Spreading” from the Desktop.
5. Next double click on the plus sign next as shown below. It will change into a minus sign after you click on it.
6. Use the left button and the mouse (or the controls at the bottom of the screen) to “move the Earth around” so that the screen shows several data points (yellow circles) in the Southern Atlantic Ocean. You can also click on the plus sign at the bottom to zoom in on the points.
7. The yellow data points you see on the screen are drilling sites where the *Glomar Challenger* collected sediment cores during the 1968 expedition. You will also notice that a high-resolution image has been added to the seafloor. This image shows high levels of detail as you zoom in, and needs to refresh between zooming. Note: If you see a large white arrow be patient, the image will load soon.



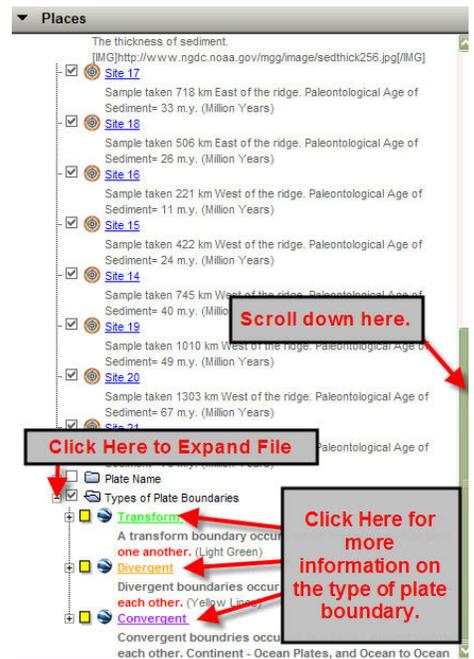
8. Move your cursor over the blue text shown below. Click on it and a box will pop up describing the lesson. Included in the box is an image of the sediment thickness in the world's oceans. By clicking on the blue hyperlink below the map you will link to a larger version of the image. Notice the thickness of the sediment as you traverse (move across) the ocean. Notice how the thickness of the sediment changes across the ocean.



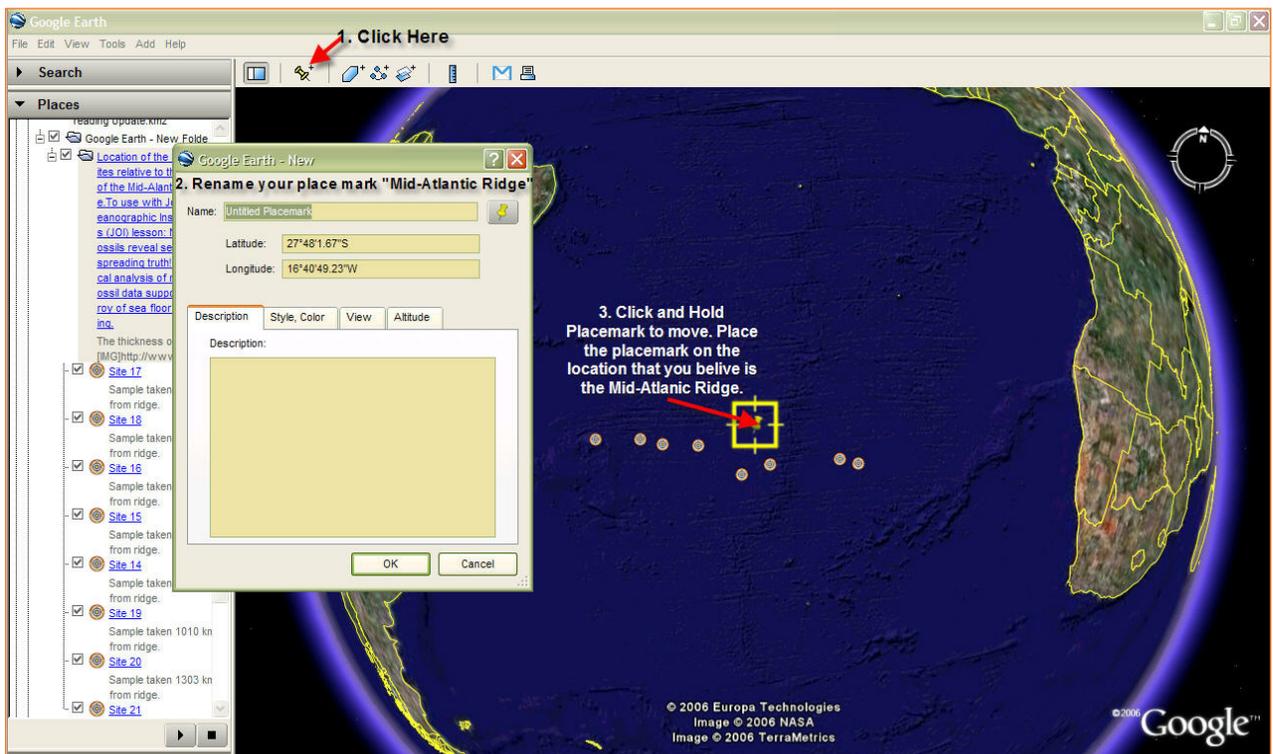
9.  Return to your data points. Fill in the data table on your worksheet with the paleontologic age of the sediments at the basement rock interface and the distance from the ridge and plot your graph. Draw a line of best fit for your points that passes through (0,0).



10.  Notice the color line going down the center of your data points. This is the place where two plates meet and form the Mid-Atlantic Ridge. The color indicates the type of movement of the plates along the boundary. Click the plus sign, as shown to the left, to read more information on the type of plate boundary, and the direction of plate movement along this mid-ocean ridge. As you observe the Mid-Atlantic ridge, record observations on your worksheet and answer questions 2–5.



11. Click the picture of the push pin at the top of your screen. “Add a new placemark” will pop up. Click and hold as you move the placemark to the Mid-Atlantic Ridge.



12.  In the “Google Earth - New” placemark box that popped up to the left of the viewing window, rename the placemark Mid-Atlantic Ridge. Ask your teacher to verify that you have identified a reasonable location. You are required to get your teacher’s initials on your student worksheet (question 6) before continuing.

13.  After your teacher has initialed question 6 remove the placemark. To do so right-click (on a Macintosh hold the control key and click at the same time) on the place mark and select delete. Then answer questions 7–10.

14. **STOP HERE!!!** Before you continue, make sure you have answered ALL but question 12.

VOCABULARY

Deep Sea Drilling Project	<i>Glomar Challenger</i>	Mid-Atlantic Ridge	plate boundary
sediment	basement rock	nannofossils	ooze

BONUS

seafloor spreading	divergent	convergent	transform
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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

Adapted by Tavia Prouhet (2007) from “Nannofossils reveal seafloor spreading truth” (<http://www.oceanleadership.org/education/deep-earth-academy/educators/classroom-activities/nannofossils-reveal-seafloor-spreading-truth/>), written by Jerry Cook and Virginia Jones. Some overlay files were modified from Lamont-Doherty Earth Observatory data sets (<http://www.marine-geo.org/tools/kmls.php>). This material is based on work supported by the National Science Foundation under grant no. 0083336. The author thanks Sheryl Schickedanz, Brigitte Berry, and Jerry Cook for providing comments. Edited by Katerina Petronotis (IODP-USIO) and Leslie Peart (Consortium for Ocean Leadership), 1/2007.

Answer Page

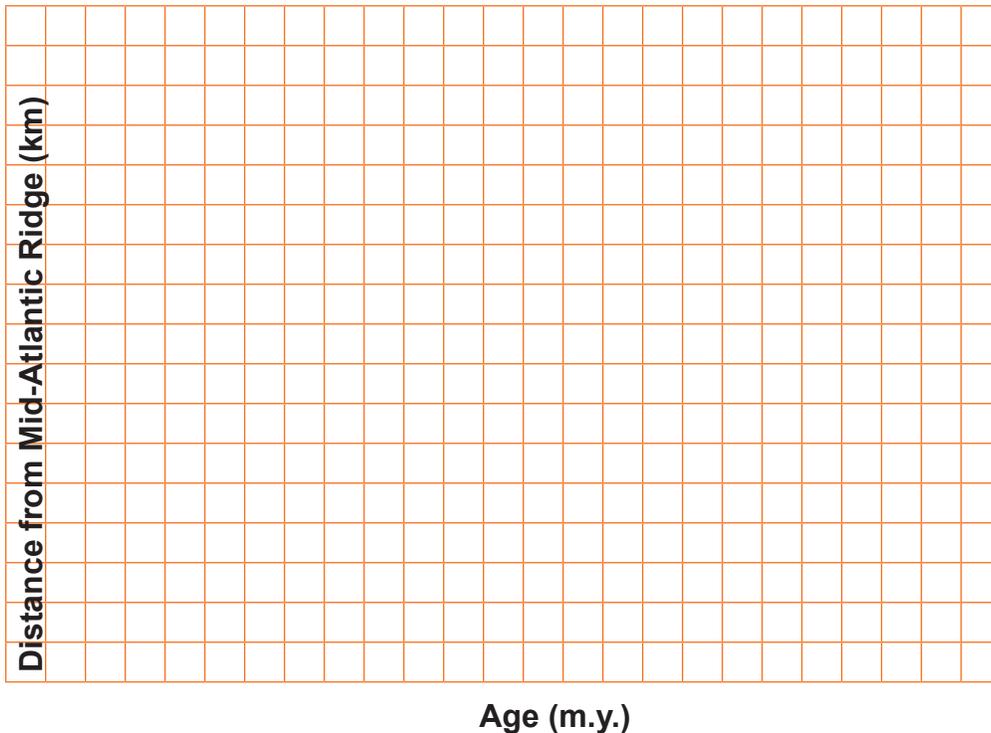
Name _____

Date _____

1. Record your information in the table. Then create a line graph showing the relationship of the distance (km) from the Mid-Atlantic Ridge against the age of the sediment (m.y.) in the grid provided.

Site #	Distance from Ridge in kilometers (km)	Age of sediment in millions of years (m.y.)	Direction from Ridge (Circle One)
21			West East
20			West East
19			West East
14			West East
15			West East
16			West East
18			West East
17			West East

Directions: You may sketch your graph below.



In this box write one sentence that explains what this graph means:

2. What ocean were the cores taken from?
3. What feature do you notice that runs between Site 16 and Site 18?
4. Examine the Google Earth screen showing the core sites and describe the location of the youngest and oldest samples. What is the relationship between the age of the samples and sediment thickness. (You may return to the sediment thickness map if needed.)
5. Why do the samples get older as you move east or west of the Mid-Atlantic Ridge?
6. Push Pin Placement: _____ Teacher initials
7. How did these data provide proof for the theory of seafloor spreading?
8. Zoom in on the area that seems to be the Mid-Atlantic Ridge. Describe or draw what you see. To the best of your ability explain the process that may have created the features you see on the seafloor. Explain your conclusions based on the Google Earth data. You may draw pictures or explain your answer in words.
9. Follow the area you have identified in Google Earth to be the Mid-Atlantic Ridge in both North and South directions. Describe the end points of the Mid-Atlantic Ridge; what are the nearest land masses to the northern and southern end points?
10. Pretend you are a scientist participating in the *Glomar Challenger* expedition. What different data or more data would you collect to support the seafloor spreading hypothesis? Explain how these data would be useful.
11. If the Atlantic Ocean is getting larger what must be happening to the Pacific Ocean on the other side of the world? Traverse over to Indonesia; what color are most of these plate boundaries and what does this mean?

12. To calculate the rate of seafloor spreading in kilometers per million years, use the equation below:

$$\text{Seafloor spreading rate} = \frac{\text{Distance in kilometers (km)}}{\text{Age in million years (m.y.)}} \quad (\text{Round to the nearest 10th})$$

Site #	Rate of Seafloor Spreading (km/m.y.)
21	1686 km / 76 m.y. = 22.2 km/m.y.
20	km/m.y.
19	km/m.y.
14	km/m.y.
15	km/m.y.
16	km/m.y.
18	km/m.y.
17	km/m.y.

Now, convert the spreading rate into centimeters per year.

(To do so, multiply by 100,000 cm / 1,000,000 yr)

Site #	Rate of Seafloor Spreading (cm/yr)
21	22.2 km/m.y. (100,000 cm / 1,000,000 yr) = 2.2 cm/yr
20	cm/yr
19	cm/yr
14	cm/yr
15	cm/yr
16	cm/yr
18	cm/yr
17	cm/yr