Virtual Expedition to the Mid-Atlantic Ridge

STUDENT NAME: ....

STUDENT ACTIVITY

SCIENTIFIC OCEAN DRILLING

Objective(s)/Outcome(s)

Students will be able to:

1. use microfossil to determine the age of the seafloor at different locations.
2. use the age of the seafloor and its distance from the midocean ridge to determine the rate of seafloor spreading.

Materials

- A device with access to Google Earth downloaded on it
- Access to the Seafloor Spreading .KML file
- Access to the Dynamic Earth .KMZ file (optional)
- Graph paper or a graphing program
- *Data Log* handout
- *Reference Sheet* handout

Background

The goal of the International Ocean Discovery Program is to investigate sediments and rocks beneath the deep oceans by drilling and coring seafloor sediment. The seafloor is usually made of a thick layer of sediment which can be up to 2,000 meters deep. It is composed of sand, silt, clay, and microorganisms that settle out of the water column. Microfossils form when microscopic organisms are buried and fossilize within the seafloor sediment. Below the sediment is a layer of igneous rock (mostly basalt) which is called the basement layer. This crust is made from hardened lava from Earth's mantle.

The data in this exercise were taken from sediment cores collected by a ship called the *Glomar Challenger*. In late 1968, scientists onboard the ship collected sediment core samples at eight sites located near the Mid-Atlantic Ridge. At each location, they found microfossils throughout the cores. The age of the sediment at each location was used to determine the rate at which each plate is moving as new crust forms within the ridge and pushes the plates on either side of the ridge.

Activity

1. Open Google Earth on your device. Note: this activity requires the downloaded version. The online version will not allow you to view all the features in the .KML file.

2. Along the left side of the screen, near the bottom of the window, you should a section entitled "Layers." Make sure that the only boxes that are checked are the "Borders and Labels" box and the "Terrain" box, as shown in Figure 2.

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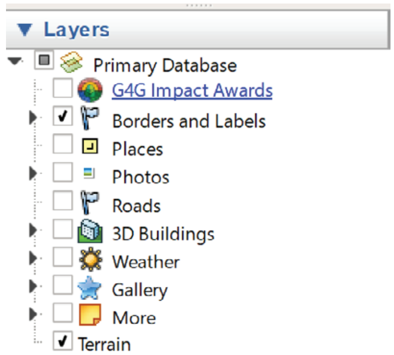
FIGURE 2. "LAYERS" MENU ON GOOGLE EARTH.



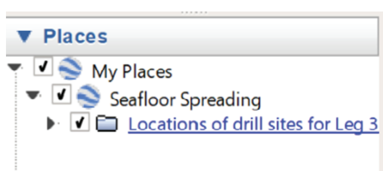
3. Download the .KML file. To open the file:

    a. Go to the saved Sea Floor Spreading file and double-click it. It should automatically open in Google Earth, or

    b. In Google Earth, select "File" from the menu at the top and then choose the "Open" option. Open the file Sea Floor Spreading.KML.

4. In the "Places" section on the left side of the screen, you may need to expand the menu until you see the information under the subheading "Seafloor Spreading." Click on the text that says "Locations of the drill sites for Leg 3…", as shown in Figure 3.

FIGURE 3. "PLACES" MENU ON GOOGLE EARTH.



5. This should cause the map to rotate and a textbox to open. If not, rotate the Earth so it is centered on the southern Atlantic Ocean and zoom in until you see all 8 drilling sites (red and green points).

6. Notice the jagged color line going down the center of your data. This is the place where two tectonic plates meet and form the Mid-Atlantic Ridge.

7. The map in the textbox shows the depth of sediment on the seafloor around the earth. Click on the link in the textbox to see the map larger and to make observations of the thickness of the sediment changes across the ocean.

8. Click "Back to Google Earth" at the top left of the map window.

9. Use the "Show Ruler" tool in the toolbar at the top of the map window. Choose "centimeters" as the unit for distance.

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   a. Measure the distance from each of the drilling sites to the closest spot of the Mid-Atlantic ridge. Record each distance in centimeters in the data table.

   b. To improve accuarcy, zoom in on each feature before clicking on it to be able to get your measurement as close to both the drilling sites and the ridge as possible.

10. Starting with Site 14, click on each of the sites on the map. When you click on a site, a popup window will appear to show you information about that site.

11. Use the “Microfossil Identification Guide” and “Geologic Time Scale with Corresponding Microfossils” to determine the age of the seafloor at each site.

   a. Enter this information in the data table (in years).

   b. Not all forams on the identification chart were found at drill sites 14–20. Keep in mind that there are many more species of forams than are shown.

12. Once you have the age of the seafloor at each site recorded, close any popup windows that are open.

Analysis

1. What ocean were the cores taken from?

2. On what plate are sites 17 and 18?

3. On what plate are sites 14–16, and 19–21?

4. What feature runs between Site 16 and Site 18?

5. Examine the Google Earth screen showing the core sites and describe the location of the youngest and oldest samples.

6. What is the relationship between the age of the samples and sediment thickness. You may return to the sediment thickness map if needed.

7. Graph "Distance from the nearest point on the Ridge" versus "Age of the Seafloor".

   a. Summarize the data in your graph.

8. Why do the samples get older as you move east or west of the Mid-Atlantic Ridge?

9. How did the data you collected provide evidence to support the theory of seafloor spreading?

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10. 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 data you collected. You may draw pictures or explain your answer in words.

11. 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?

12. Pretend you are a scientist participating in the Glomar Challenger expedition. What different data or more data would you collect to support the theory of seafloor spreading? Explain how this data would be useful.

13. If the Atlantic Ocean is getting larger what must be happening to the Pacific Ocean on the other side of the world?

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

$$\text{Rate of Seafloor Spreading}\left(\frac{\text{cm}}{\text{yr}}\right)=\frac{\text{Distance from the Ridge (cm)}}{\text{Age of the seafloor (yr)}}$$

    b. Use the data from your data table and the formula above to calculate the Rate of Seafloor Spreading at each of the drill sites. Round your answer to the nearest tenth and record your answers in the data table below.

14. Did the Rate of Seafloor Spreading change from drill site to drill site. Explain.

Synthesis

1. Plot two additional locations (one east and one west of the Mid-Atlantic ridge) to show additional sites from which sediment cores could be drilled. Determine their distance from the Mid-Atlantic Ridge, then use the graph to estimate the age of the sediment at this site.

2. If a core could be taken directly in the middle of the Mid-Atlantic ridge, how do you think it would differ from the cores taken on either side of the ridge? Hypothesize the rock type(s) you would expect to find and why.

3. Iceland is the only terrestrial landform on the Mid-Atlantic ridge. How would you expect Iceland to change over time?

Extensions

1. Draw a sketch of where you think the fossils found at these sites will be located in 3 million years. Include a description of your calculations to determine their new locations.

2. Study a **map showing the age of oceanic crust** around the world.

3. How can you use this map to determine other areas where seafloor spreading is occurring?

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a. Do you think all divergent boundaries move at the same rate? Why or why not?

b. Where is the oldest oceanic crust on Earth? What type of plate boundary is in this region? Predict what will happen to the crust in this area.

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HANDOUTS

DATA LOG

Site #	Distance from the nearest point on the Ridge (centimeters)	Age of the Seafloor (years)	Direction from the Ridge (Circle One)
14			West East
15			West East
16			West East
17			West East
18			West East
19			West East
20			West East
21			West East

Site #	Rate of Seafloor Spreading (cm/yr)
14	
15	
16	
17	
18	
19	
20	
21	

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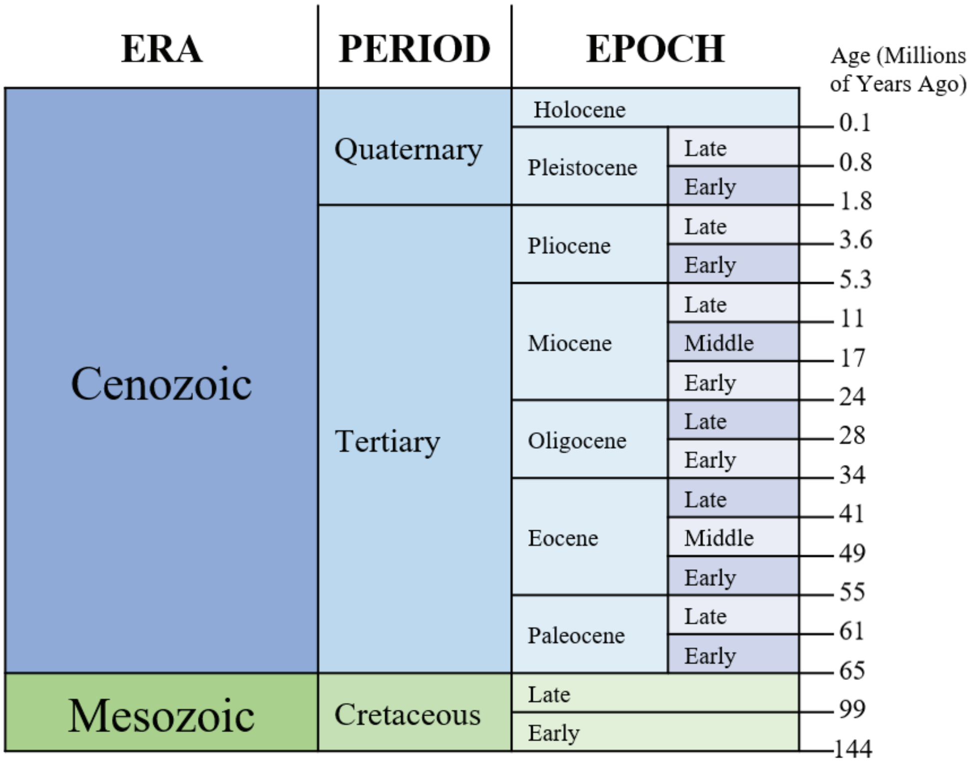
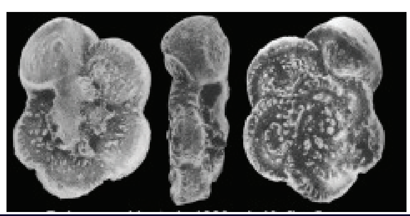
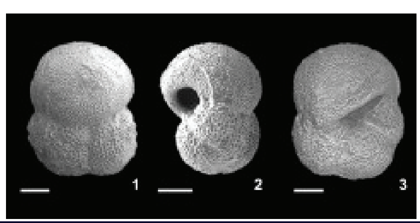
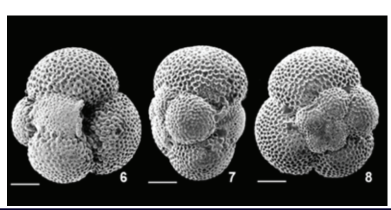
Geologic Time Scale



Microfossil Identification

Microfossil	Image* *Image sources located in references	Corresponding Time Period The age of the sediment layer is equal to the start of this epoch.
Abathomphalus mayaroensis		near the end of the late Cretaceous period
Globigerita ampliapertura		early Oligocene epoch
Globigerinita dissimilis		early Miocene epoch

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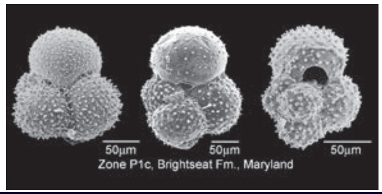
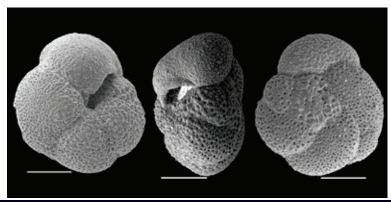
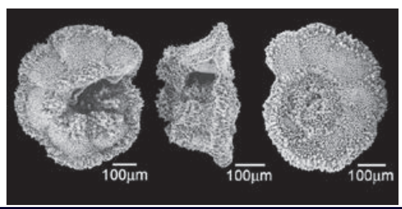
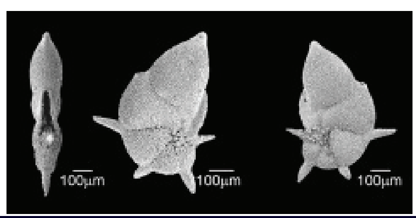
Globigerina deubjergensis		late Paleocene epoch
Globorotalia kugleri		halfway through the late Oligocene epoch
Globorotalia peripheroranda		middle Miocene epoch
Globorotalia velascoensis		early Eocene epoch
Hantkenina dumblei		middle Eocene epoch
Helicopontosphaera reticulata		late Eocene epoch