Atlantic Ocean Floor Age Activity

North Carolina Geological Survey

www.deq.nc.gov/geoscience-education

Overview

Supercontinent Pangea began to rift apart around 200-150 million years ago because of diverging tectonic plates. The main rift led to the formation of the Atlantic Ocean. This divergent boundary (the mid-Atlantic ridge) is still active, and the Atlantic Ocean continues to grow and widen.

Targeted Grade Level(s)

6th grade and 8th grade

2023 Science Standard(s)

ESS.6.2.2: Construct an explanation to illustrate how the movement of lithospheric plates can create geologic landforms and cause major geologic events such as earthquakes and volcanic eruptions.

ESS.8.1.1: Analyze and interpret data to conclude the relative age of Earth and relative age of rocks and fossils from index fossils and ordering of rock layers.

Objectives

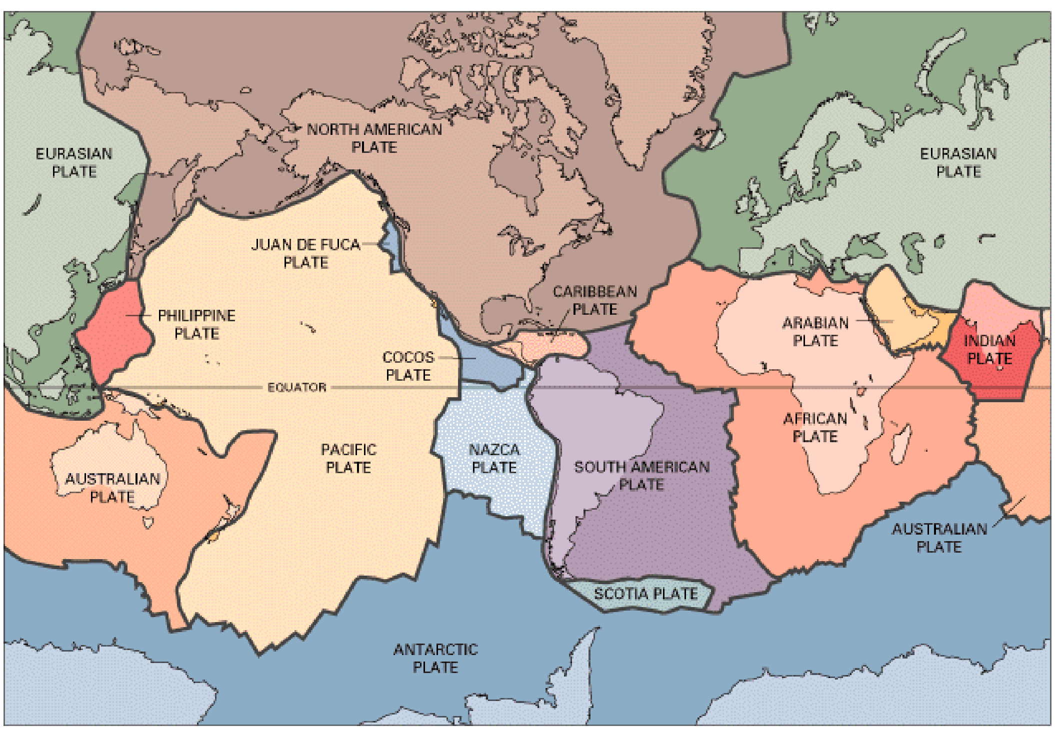
This hands-on activity will allow students to explore and graph the ages of the rocks that make up the Atlantic Ocean floor crust between North America, Europe, and Africa.

Estimated Time

One class period for discussion about plate tectonic boundaries and one class period for activity.

Teacher Prep & Background

Teachers should use the information provided in this activity, along with other resources to teach students about tectonic plate boundaries. This activity is appropriate for divergent boundary discussions and will allow students to create illustrations and to interpret data regarding ocean floor age.



Background

Earth's crust is divided into tectonic plates. These plates fit together like a puzzle and interact with each other at their boundaries. There's debate about how many tectonic plates exist, but there are at least 7 major plates and 8 minor plates, based on size. The 7 larger plates cover about 95% of Earth's surface. Plates are, on average, about 78 miles thick and continental plates are thicker than oceanic plates. Tectonic plate boundaries can be one of three types – convergent, divergent, or transform. Some plates interact with other plates more than one way, especially if the plates are large. Tectonic plates move, on average, an inch or two each year but can move much larger distances if there is a large earthquake associated with plate movement. Plate movement is driven by convection currents in Earth's mantle, a process which causes hot, buoyant magma to rise from the mantle towards Earth's surface.

Convergent plate boundaries occur when one or more tectonic plates converge or come together. One tectonic plate (the older, denser plate) will be pushed beneath the younger, less dense plate in a process called subduction. Convergent plate boundaries produce a wide range of geological landforms and hazards including mountain ranges (Appalachians, Himalayans, Andes), volcanoes, large, deep earthquakes, and tsunamis.

Divergent plate boundaries occur when tectonic plates move away from each other. Magma from deep in the mantle rises towards the surface and thins the crust, which then begins to separate. New crust is formed in the process. Small, shallow earthquakes are common at divergent plate boundaries as are long mountain ranges, such as the mid-ocean ridge in the Atlantic Ocean. Rift valleys can form parallel to the main divergent boundary and hydrothermal vents can carry gasses and minerals to the ocean floor along ocean floor divergent boundaries. Examples of divergent boundaries include the mid-Atlantic ridge, the Great Rift Valley in Africa, the Red Sea, and the Gulf of Aden.

Transform plate boundaries occur when two or more plates slide past each other horizontally. No crust is created or destroyed in this type of interaction, but large pieces of crust are cracked and broken (faults). Shallow earthquakes occur at these boundaries and the land on either side of the fault can be offset and deformed. Examples of transform boundaries include the San Andreas Fault and the large Alpine Fault in New Zealand.

Divergent Boundaries and Seafloor Spreading

When two tectonic plates move apart in a process called rifting, new crust is created, and sometimes new oceans are formed in a process called seafloor spreading. As the plates rift apart, magma rises up and exits the crust at the spreading center, creating new ocean crust. As the magma cools into igneous rocks, it's pushed away from the spreading center and creates successively younger ocean floor. This means that the youngest ocean floor crust is next to the divergent spreading center and it gets successively older the further away it is.

The divergent plate boundary in the middle of the Atlantic Ocean is called the Mid-Atlantic Ridge because the cooled magma has formed a 10,000-mile-long mountain chain/ridge at the bottom of the ocean. This divergent plate boundary began to separate around 200-150 million years ago, as Pangea split apart. Since that time, the Atlantic Ocean has continued to get wider as it spreads to the east and west at a rate of 0.8 to 2 inches each year. The rift, or opening, that is being created by the diverging plates is about the width and height of the Grand Canyon.

Atlantic Ocean Age Activity

Using data techniques, scientists have been able to determine the age of the rocks on the Atlantic Ocean floor. The illustration on the next page shows the location of the mid-ocean ridge (dashed line) and lines that separate rocks of different ages on the ocean floor. The rock ages are given in millions of years next to the lines.

1. Highlight the United States, Africa, and western Europe on the illustration. Then color the mid-ocean ridge (dashed line) a bright red.

2. Use different colors to shade in the age bands as listed here:

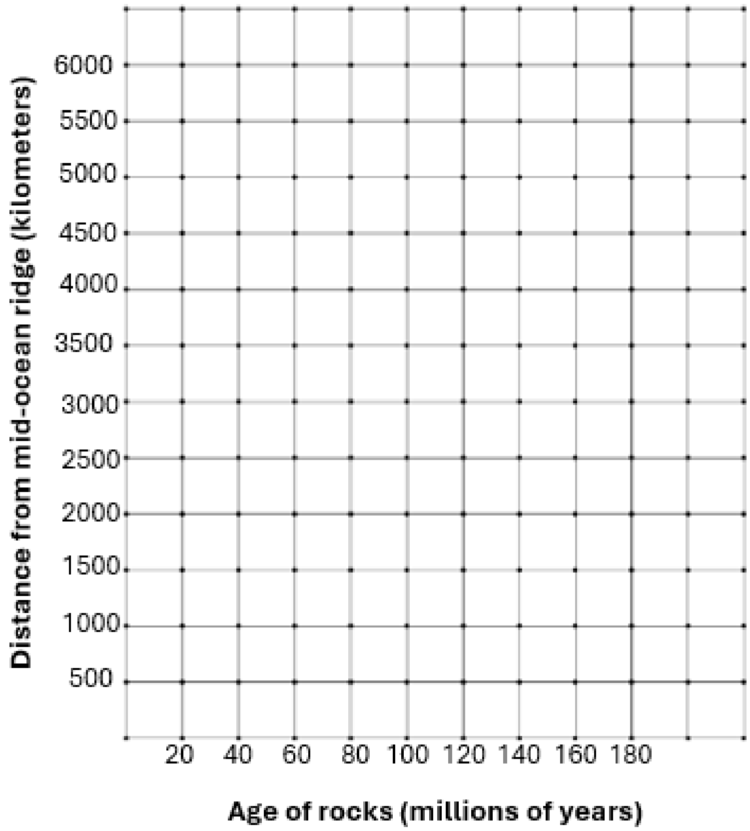
    a. 9-38 million years: dark green
    b. 38-53 million years: light blue
    c. 53-63 million years: yellow
    d. 63-81 million years: purple
    e. 81-135 million years: orange
    f. 135-155 million years: dark blue
    g. 155-180 million years: light green

3. Using a ruler, measure the distance in centimeters from the mid-ocean ridge to the center of each of the dots on the lines. Round to the nearest tenth of a centimeter. Record your answers in this table:

<table>
<tr><th>Age of Sea Floor (millions of years)</th><th>Distance from the mid-ocean ridge to the dot (centimeters)</th><td rowspan="8">Multiply the dot distance (cm) by 700 to get the distance in kilometers</td><th>Actual distance from the mid-ocean ridge (kilometers)</th></tr>
<tr><td>9</td><td></td><td></td></tr>
<tr><td>38</td><td></td><td></td></tr>
<tr><td>53</td><td></td><td></td></tr>
<tr><td>63</td><td></td><td></td></tr>
<tr><td>81</td><td></td><td></td></tr>
<tr><td>135</td><td></td><td></td></tr>
<tr><td>155</td><td></td><td></td></tr>
</table>

4. Calculate the distance of the ocean floor crust from the mid-Atlantic Ridge by multiplying the distance to the dot (cm) by 700 to get the distance in kilometers. Record your answers in the table.

5. Graph the data from the table to show the relationship between the age of the sea floor in millions of years (first column) and distance from the mid-ocean ridge in kilometers (last column) on the graph that follows.



Discussion Questions:

1. What does this graph tell us about the age of Atlantic Ocean rocks as they get further away from the mid-ocean ridge?

2. Where are the youngest rocks on the Atlantic Ocean floor? Explain your answer.

3. What do you notice about the ages of the rocks on both sides of the mid-ocean ridge? How are they similar and how does this information provide evidence of a divergent boundary and seafloor spreading?

4. How would you convert the distances in this activity from kilometers to miles?

Atlantic Ocean Age Activity – Answer Key

Using data techniques, scientists have been able to determine the age of the rocks on the Atlantic Ocean floor. The illustration on the next page shows the location of the mid-ocean ridge (dashed line) and lines that separate rocks of different ages on the ocean floor. The rock ages are given in millions of years next to the lines.

6. Highlight the United States, Africa, and western Europe on the illustration. Then color the mid-ocean ridge (dashed line) a bright red.

7. Use different colors to shade in the age bands as listed here:

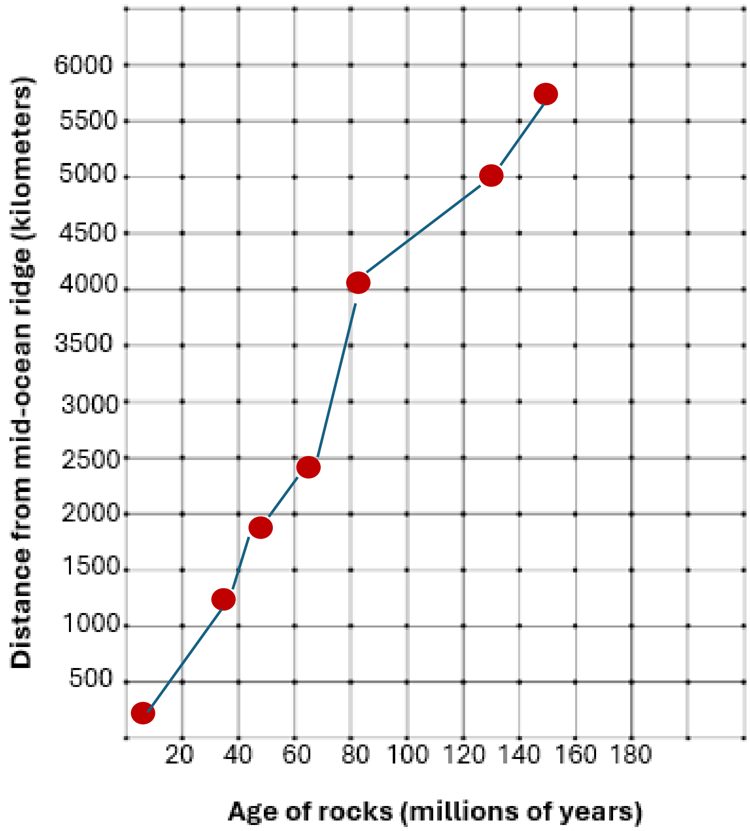
    a. 9-38 million years: dark green
    b. 38-53 million years: light blue
    c. 53-63 million years: yellow
    d. 63-81 million years: purple
    e. 81-135 million years: orange
    f. 135-155 million years: dark blue
    g. 155-180 million years: light green

8. Using a ruler, measure the distance in centimeters from the mid-ocean ridge to the center of each of the dots on the lines. Round to the nearest tenth of a centimeter. Record your answers in this table:

<table>
<tr><th>Age of Sea Floor (millions of years)</th><th>Distance from the mid-ocean ridge to the dot (centimeters)</th><td rowspan="8">Multiply the dot distance (cm) by 700 to get the distance in kilometers</td><th>Actual distance from the mid-ocean ridge (kilometers)</th></tr>
<tr><td>9</td><td>0.5</td><td>350</td></tr>
<tr><td>38</td><td>1.8</td><td>1,260</td></tr>
<tr><td>53</td><td>2.8</td><td>1,960</td></tr>
<tr><td>63</td><td>3.5</td><td>2,450</td></tr>
<tr><td>81</td><td>5.8</td><td>4,060</td></tr>
<tr><td>135</td><td>7.3</td><td>5,110</td></tr>
<tr><td>155</td><td>8.3</td><td>5,810</td></tr>
</table>

9. Calculate the distance of the ocean floor crust from the mid-Atlantic Ridge by multiplying the distance to the dot (cm) by 700 to get the distance in kilometers. Record your answers in the table.

10. Graph the data from the table to show the relationship between the age of the sea floor in millions of years (first column) and distance from the mid-ocean ridge in kilometers (last column) on the graph that follows.



Discussion Questions:

5. What does this graph tell us about the age of Atlantic Ocean crust as it gets further away from the mid-ocean ridge?

   The further the crust is from the mid-Atlantic ridge, the older it is.

6. Where are the youngest rocks on the Atlantic Ocean floor? Explain your answer.

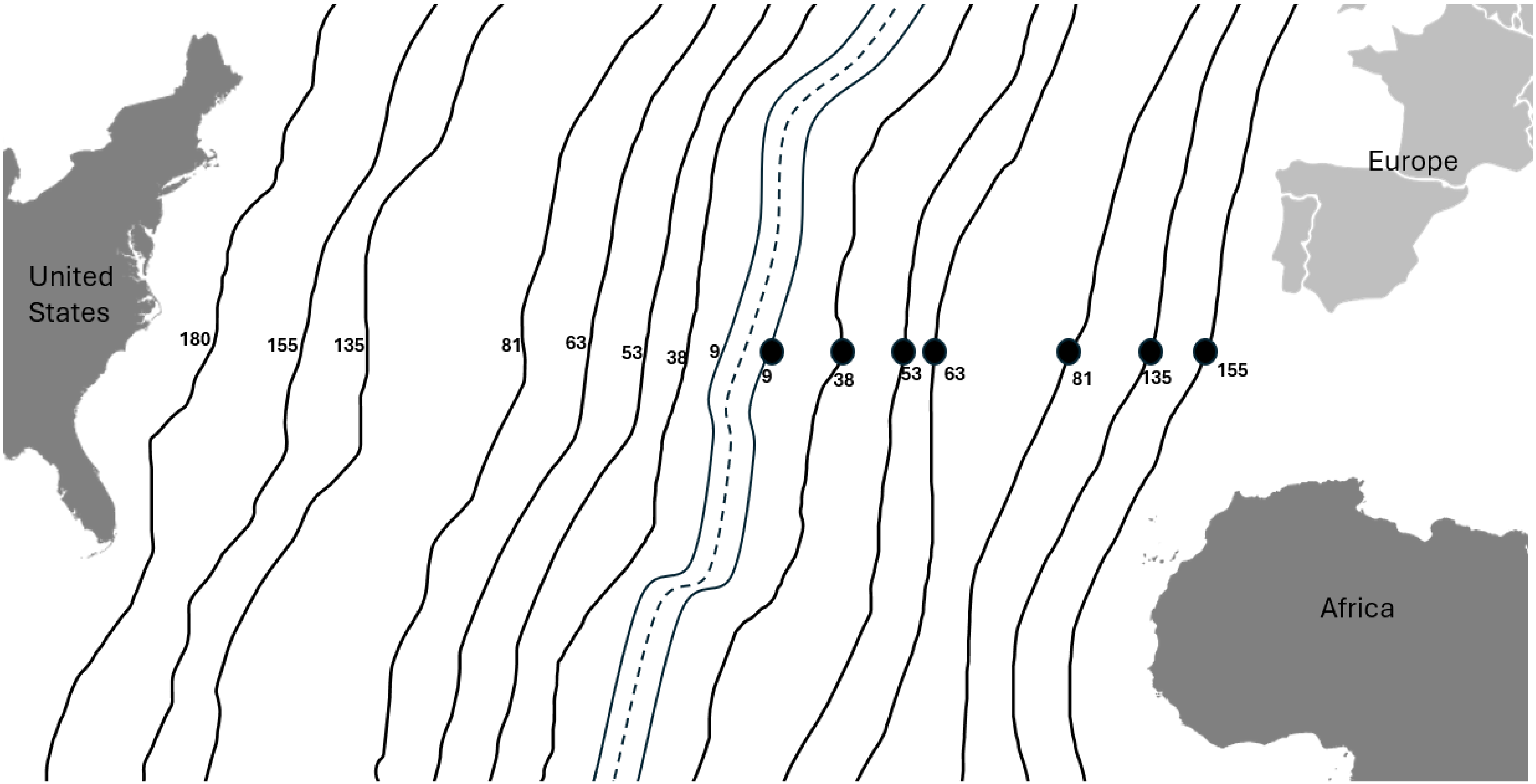
   The youngest rocks are at the spreading center because this is where the magma is coming out onto the ocean floor, creating new rocks/crust.

7. What do you notice about the ages of the rocks on both sides of the mid-ocean ridge? How are they similar and how does this information provide evidence of a divergent boundary and seafloor spreading?

   The ages of the rocks/crust on either side of the spreading center are the same. This information tells us that the new crust that's being formed is being pushed away from the spreading center at the same rate on both sides, which tells us that the ridge is a divergent plate boundary.

8. How would you convert the distances in this activity from kilometers to miles?

   One kilometer is equal to 0.62 miles. To convert kilometers to miles, multiply the number of kilometers by 0.62. Example: 9 million years distance is 350 km. 350 km x 0.62 = 217 miles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