Isotope Revolution:
Magnetic Reversal and Radiometric Dating

Teacher Instructions

Getting Started

1. Explain to students that previous studies of the Atlantic Ocean floor indicate that there is a tall mountain range in the middle of the Atlantic Ocean. It extends from Iceland southward for thousands of miles into the Southern Hemisphere.
2. Show the students the spreading center models side by side. Explain that this model represents the ocean floor near this long mountain range called the Mid Atlantic Ridge.
3. Explain that where the two pieces of the model meet represents the ridge. The side labeled "West of Ridge" is the section of the ocean floor located between the ridge and North America. The side labeled "East of Ridge" is the section of the ocean floor located between the ridge and Africa.
4. Demonstrate how to use a compass to measure the magnetic polarity of the sea-floor model:
    a. Place the two sections of the model together so the arrows meet.
    b. Place the Survey Sheet A and Survey Sheet B on top of the appropriate side of the model, with the sides labeled "Ridge Crest" together in the middle.
    c. Tape the sheets to the spreading center model.
    d. Display the overhead transparency of Survey Sheets A and B.
    e. Place a compass on the top dashed line, on the far western edge of the transparency. Rotate the compass so that "north" is toward the top of the model. Demonstrate how to slowly move the compass along the dashed line as you move it and that "north" always faces the top of the model.
    f. Tell the students they should stop when the needle points directly north-south.
5. Demonstrate how to record data:
    a. Explain that students will stop and mark any spots along the dashed line where the needle is perfectly aligned in the north-south direction. Have them mark a + sign or a – sign to show polarity.
    b. Demonstrate by stopping at some point and making a small mark (+ or -) at the top and bottom of the compass to mark the spot where you stopped.
    c. Explain that the rock being formed along the mid ocean ridge presently records the earth's magnetic field as it stands today. We refer to the polarity closest to the ridge as "normal" because that is what it is like right now. As you move away from the ridge, you will come to a point where the needle flips. This point represents an area where the magnetic polarity of the earth flips. From this point until the point where the needle flips again, we refer to the area as "reverse" polarity because it is opposite of

what the polarity is like currently on the earth. Label the sections of the model in both directions from the ridge as either normal or reverse.

d. Repeat this procedure along both the top and bottom dashed lines.

Working with the Survey Data

1. Ask students to discuss patterns they recorded on their survey sheets.
2. Ask how the patterns on the top of the models matched those patterns on the bottoms of the models, as well as "East of Ridge" sections and "West of Ridge" sections.
3. Explain that, like scientists, students have discovered a pattern of sections of different polarities of rock near the ridge. What does it mean?
4. Have students use rulers to draw vertical lines through the marks (+ and -) on the top and bottom dashed lines. They should end up with three distinct sections on each survey sheet for a total of six.
5. Have them label the sections A – F beginning with the far western edge of the model.
6. Have students label the sections as either Normal or Reverse based on their data from the activity.
7. Have students use two colored pencils to shade in the sections. Shade the "Normal" sections one color and the "Reverse" sections another color. Do not use markers.
8. Circles will appear on the sea floor survey as the sections are shaded in. Tell students that these circles represent locations where core samples were collected by scientists. Have the students label the drilling locations A – F to correspond with the sections they are located in.
9. Explain to students that scientists examine the minerals within these core samples. For this type of work, they examine the minerals found in basalt, the type of igneous rock that makes up the sea floor. Within these minerals scientists focus their attention on certain elements and isotopes. They look to see how much of the original material (elements or isotopes), present when the basalt formed, still remains. This, in conjunction with knowing the decay rate of the material, allows them to calculate the age of the sample.
10. Students will now examine models of core samples (bags of beads) to determine the age of each of the core samples. This information will add meaning to the magnetic reversals they have already discovered.
11. Provide each group of students with six bags. Each bag represents a core sample and contains beads that represent elements present when the rock formed as well new elements formed from the radioactive decay of the original elements. The original elements are referred to as "Parent" material and the decay products are referred to as "Daughter" material.
12. The blue beads represent "Parent" material and the red beads represent " Daughter" material. See the activity "Isotope Revolution" in this packet for instructions on radiometric dating. This process should also be illustrated in all middle school and high school Earth Science textbooks

13. **The half-life of this hypothetical element is 2.4 million years.** Students will need this value to calculate the age of the sea floor.
14. Have the students fill out the data table: polarity, parent, daughter, ratio, half-lives.
15. After the first three columns of data have been determined, have students calculate the age of the drilling sites and enter the data in the "Age of Sample" column using the following formula.

Age = # of half-lives elapsed x length of half-life (2.4million years)

16. Have students measure the distance from the ridge (edge of model) to each drill site (center of site). Fill in the "Distance from Ridge" column using the conversion 1cm = 10km.

17. Students can now calculate the spreading rate using the following formula:

Rate = Distance from Ridge / Age

The "Magnetic Reversals and Radiometric Dating" activity is a modified version of the "Field Work in Iceland" activity from the Great Explorations in Math and Science (GEMS) teacher's guide entitled *Plate Tectonics,* copyright by The Regents of the University of California, and used with permission. The GEMS series includes more than 70 teacher's guides and handbooks for preschool through eighth grade, available from LHS GEMS, Lawrence Hall of Science, University of California, Berkeley, CA 94720-5200; (510) 642-7771. For more information, visit the website at www.lhsgems.org.

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Student Instructions

The circles that appeared on your sea floor model survey papers represent sites on the ocean floor where core samples were drilled. Scientists examine the minerals within these core samples. They look for certain elements within the minerals. They can calculate the age of the sea floor by determining how much of the original element (parent material) has decayed into another element (daughter material).

1. List the polarity of the drilling sites (A – F) in the table below. *You have already recorded this data on your survey sheet.*

2. Count the number of blue beads (parent material) and red beads (daughter material) present in each bag. Record the results in the column named "Parent/Daughter/Ratio" on the table below. *Remember, these bags represent minerals found in rock samples in the sea floor. The beads represent elements and isotopes that scientists examine to determine the age of rocks.*

3. Record the number of half-lives each sample has gone through in the "Half-Lives" column.

3. Record the age of each sample in the "Age of Sample" column of the table below.

age = # of half-lives elapsed x length of half life

5. Use a ruler to measure the distance from the ridge on the model to the drilling site. Measure in centimeters. Record the data in the "Distance from ridge" column. *Remember, 1cm = 10km in this model.*

6. Use the distance and age data to record the spreading rates for sections A – F in the table below.

spreading rate = distance / age

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Student Worksheet

Sea-Floor Survey Table

Drilling Site	Polarity (N or R)	Parent/Daughter/ Ratio P	D	R	Half-Lives	Age of Sample	Distance from ridge (1cm =10km)	Spreading Rate (distance/age)
A								
B								
C								
D								
E								
F								

1. Describe patterns you see in the magnetic polarity of the sea floor as well as the age of the sea floor.

2. What is the relationship between age of sea-floor and distance from mid-ocean ridge?

3. How does this evidence support the theory of plate tectonics?

4. Create a graph plotting the age of sea floor against the distance from the ridge.

5. Why is it important to travel perpendicular from the ridge as you take core samples of the sea floor to determine age?

6. How would you expect fossils of marine life from sections to A and F to compare? Explain.