

GENERAL SCIENCE LABORATORY 181

Sea Floor Spreading

According to the theory of plate tectonics (from the Greek, *tekto*, “builder”), the Earth’s crust is broken into many slowly moving plates. *Sea floor spreading* occurs at the mid-ocean ridge where two plates are moving away from each other. Magma (hot, molten, underground rock material) rises up into the gap from below and cools to form new seafloor rock. Thus the sea floor spreads out to either side as shown in Figure 1. This spreading occurs at about the same rate as your fingernails grow. In Figure 1 lithosphere is the outermost solid portion of the Earth, which includes the crust and part of the upper mantle and asthenosphere is the rocky substratum below the lithosphere that is hot enough to be deformed and is capable of internal flow.

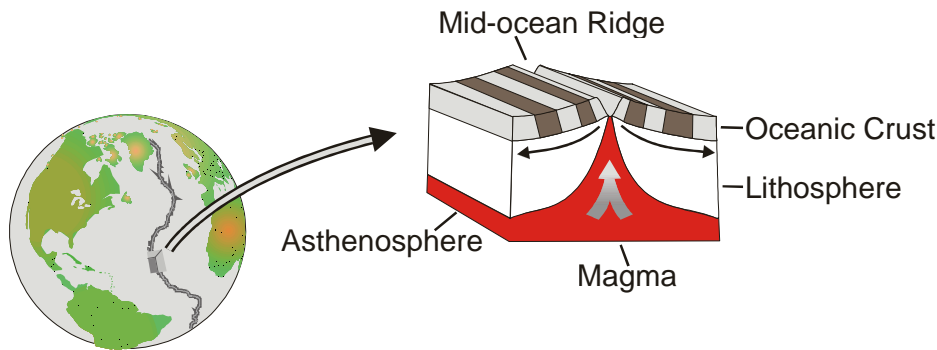


FIGURE 1

The pattern of sea floor spreading can be observed by studying the magnetic field of the rock on the sea floor. At the mid-ocean ridge, magma rises up from the mantle below and cools. As it continues to cool, iron in the rock aligns itself with the magnetic field of the Earth, much like the needle in a compass. When the rock solidifies, this magnetic “signature” is locked in place.

Throughout history, the orientation of the Earth’s magnetic field has varied greatly. At times, the magnetic pole in the north has reversed completely and was located near the south geographic pole. Because new ocean floor is constantly moving away from the mid-ocean ridge, these reversals appear as bands of alternating magnetic fields as shown in Figure 1. On average, the Earth’s magnetic field reverses every several hundred thousand years with the most recent reversal occurring about 780,000 years ago.

In this experiment, you will use a model of a sea floor spreading zone. The mid-ocean ridge is running north to south down the center of the model. You will use a Magnetic

Field Sensor to map the magnetic field of your model and use it to explain how this is evidence of sea floor spreading.



FIGURE 2

OBJECTIVES

In this experiment, you will

- Use a Magnetic Field Sensor to measure magnetic field.
- Map sea floor spreading.
- Interpret your results.

MATERIALS

Computer
Vernier computer ULI interface
LoggerPro 2.2.1

Magnetic Field Sensor
model sea floor spreading zone
Ruler, metal rod with clamp

PROCEDURE

1. Connect the Magnetic Field Sensor to DIN 1 of the Vernier computer interface. The switch on the sensor should be set on the $LOW \times 10$ amplification setting.
2. Click on Logger Pro (2.2.1). Prepare the computer for data collection by opening the file "05 Sea Floor Spreading" in the *Earth Science with Computers* folder. A graph of

magnetic field vs. distance will be displaced along with a table. Magnetic field is shown in the unit of mT (milli-Tesla) and distance is in cm.

3. Zero the Magnetic Field Sensor by doing the following. This step removes the effects of the Earth's magnetic field and any local magnetism from the results.
 - a. Remove anything magnetic from the area where data collection will take place. This includes moving the model sea floor spreading zone.
 - b. Clamp the sensor in place vertically with bent tip closer to the table. The white circle near the tip of the sensor should face upward.
 - c. When the magnetic field readings on the screen have stabilized, click .
4. Prepare the model sea floor spreading zone for data collection
 - a. Place the model sea floor spreading zone on your table under the sensor. Consider the long side of the pan as East and West, so the mid-ocean ridge is running north-south down the center of the model as in Figure 2 and 3.
 - b. Position the ruler so that it is lined up with the East and West marks on the sides of the pan. Align the 0 cm mark with the left edge of the pan as shown in Figure 2.
5. Click to begin data collection.
6. Position the tip of the Magnetic Field Sensor at the 0 cm mark. **Important:** For each reading, make sure the probe at the same height as the ruler and the white circle is facing up.
7. When the reading has stabilized, click .
8. Type "0" in the edit box (for 0 cm) and press the ENTER key. The first data pair has now been saved.
9. Move the pan so that the sensor is above the 1 cm mark. When the reading has stabilized, click . Type "1" in the edit box and press the ENTER key.
10. Repeat the Step 9 procedure at 1 cm intervals until you reach the other side of the pan (30 cm mark).
11. When data collection is complete, click to end data collection.
12. Print a copy of your graph or make a sketch of it as directed by your instructor.

PROCESSING THE DATA

1. Study your graph. The mid-ocean ridge runs north to south down the center of your model. Use a ruler or straight-edge to draw a line on your graph representing the mid-ocean ridge. Label the line "Mid-Ocean Ridge".
2. Draw the bands of magnetic reversal on your graph.
 - a. Study your graph. A change between normal magnetic field ("normal" meaning the north magnetic pole is aligned with the north geographic pole) and reverse magnetic field ("reverse" meaning the north magnetic pole is aligned with the south geographic pole) occurred each time the line crosses zero. Using a straight-

- edge or ruler, draw a vertical line on your graph at each point where the line crosses zero.
- b. In locations where the magnetic field values are positive, the magnetic field of the Earth was normal. In locations where the magnetic field values are negative, the magnetic field of the Earth was reversed. Lightly shade the bands of ocean floor where the Earth's magnetic field was reversed with a colored pencil.
 - c. Across the top of your graph, label each band either "Normal" or "Reverse".
3. Toward the bottom of your graph, draw two arrows indicating the direction of movement of the ocean floor. Remember from Figure 1 that the ocean floor is moving away from the mid-ocean ridge.
 4. What is sea floor spreading?
 5. Explain how the Earth's magnetic reversals provide evidence of sea floor spreading.



FIGURE 3

EXTENSIONS

1. If the last magnetic reversal occurred about 780,000 years ago, approximately how long ago did it take for the ocean floor at the center of your model to reach the outside edge of your model?