Records in the Rock: Paleomagnetism and Plate Tectonics

Geology Mr. Traeger

Name: _____ Period: ____ Date: _____

Purpose

The purpose of this activity is to understand the magnetic field of the earth. Understanding the earthôs magnetic field has allowed us to verify the theory of plate tectonics.

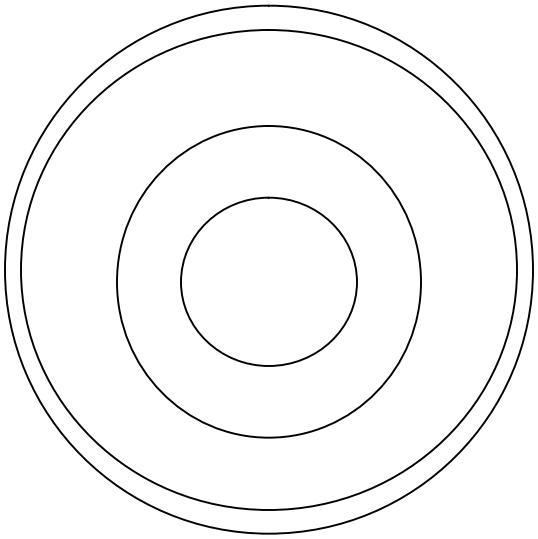
Materials

- Bar magnet
- manila folder
- metric ruler
- compass
- scissors
- seismic sleuths worksheets
- iron filings
- glue

Part 1: What *is* a Magnetic Field?

It is thought that the earthôs magnetic field is created by fluid circulating in the outer core. An electric current is created by the circulating core fluid. Through a series of more complex steps, this changing electric current will create earthôs magnetic field. This is the principle behind electric motors, doorbells, and stereo speakers. See page 74 for details.

1. Before we can move on, you must know the different layers inside of the earth. On the diagram below, do the following: a) label the name of each layer. b) State whether each layer is a solid or liquid. c) Give the depth from the surface in km. d) give the temperature range of each layer in degrees Kelvin. See page 72-73 of your book.



2. What generates the heat in the core of our earth?

3. We can simulate the magnetic field of the earth by assuming that there is a bar magnet running through the center of our planet from the North Pole to the South Pole. Obtain a bar magnet, iron filings (salt shakers), a compass, and a manila folder.

4. Place the magnet below the manila folder. Pour some iron filings on to the manila folder. **Do not pour iron filings directly on to the magnet!** Gently tap or shake the manila folder so that the iron filings align with the magnetic field of the bar magnet.

5. ***Draw*** the pattern that you see around the bar magnet in the space below. Also draw the direction that the magnetic field is going in. You could find this by noting which way the north side of the compass needle points to. You could also find this by using a Vernier magnetic field sensor. I can show you how. This model that you drew below is very similar to the magnetic field of the earth.

6. Now, take a compass and move it near the bar magnet. Describe what happens to the compass needle when you move the compass in a complete circle around the bar magnet.

7. Why do you think the compass behaves the way it does? What causes the compass needle to change direction?

8. Now, place a compass in your hand far *away* from the bar magnet. Describe its behavior. Which way does the compass needle point?

9. What could be causing the compass needle to point in the direction that it does?

10. Imagine for a moment that the direction of earth's magnetic field switched 180°. Which way would your compass be pointing now?

Part 2: Magnetic Reversals and Sea Floor Spreading

The oceanographic research of Vine and Matthews in the 1960ûs found that the Earthûs magnetic field has undergone many reversals in the geologic past. To demonstrate this idea, you will now complete Vernier Experiment #5. Please refer now to the separate set of instructions for how to do this part of the lab.

Questions from *Processing the Data* part of the lab instructions for Vernier Experiment 5

1. Follow lab instructions for drawing the mid-ocean ridge on your graph.
2. a. through c. Follow instructions for drawing bands of magnetic reversal on your graph.
3. Follow instructions for drawing arrows on your graph.
4. What is sea floor spreading?

5. Explain how the Earthûs magnetic reversals provide evidence of sea floor spreading.

6. Extension Question 1: What could cause magnetic field reversals?

7. Extension Question 2: If the last magnetic reversal occurred about 780,000 years ago and each subsequent reversal occurred every 200,000 years, 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? Show your calculations!

8. What happens to the age of the rock the farther away you get from the Mid-Atlantic Ridge?

9. Are the plates moving away from each other (divergent), toward each other (convergent), or alongside each other (transform) at the Mid-Atlantic Ridge? How do you know?

10. What is the *current* magnetic orientation along the Mid-Atlantic Ridge right now in real life?

11. What was the *last* magnetic orientation along the Mid-Atlantic Ridge in geologic time?

12. What will be the *next* magnetic orientation along the Mid-Atlantic Ridge in future geologic time?

13. How does this model of sea floor spreading give support to the theory of plate tectonics?

Part 3: Using Paleomagnetism to Reconstruct the Continents 120 Million Years Ago

This section shows the application of Paleomagnetism (Ancient Magnetism) to estimating the position of the continental plates 120 Million Years Ago. We will use the idea that rocks store the magnetic orientation of the earth at the time they solidify from magma/lava.

1. Obtain 2 copies of Master 2.2d (Continental Pieces), one copy of Master 2.2e (World Map Grid), and one copy of Master 2.2f (World Map Grid, 120 MYA).
2. Label each continent on the Continental Pieces sheet.
3. Cut out the continents on one copy of Master 2.2d along the dotted continental outlines.
4. Notice that each continent has an arrow with G/N and G/PN. **G means Grid north**. This is aligned with the longitude lines on the map. **N means magnetic North today**. **PN means magnetic Paleo North 120 Million Years Ago**. Both N and PN will always point towards the North at the top of the page.
5. Working with the present day map, arrange the cut out continents on the map. Use your ruler to measure the distance from the **intersection** of the G and N lines to the **North** at the top of the map. Make sure that the **N** arrow is pointing directly towards the **North** at the top of the map. Once your continent is in position, glue it or tape it to the page.
6. Repeat steps 2 through 5 for Master 2.2f (World Map Grid, 120 MYA). Substitute PN (Paleo North) for N (Present Day North).

7. Compare your map of the Present Day to the map 120 Million Years Ago. Describe the changes that you see in the world between 120 Million Years Ago and today.

8. Alfred Wegener proposed the idea of continental drift based upon his observations. He was never able to publish the theory of plate tectonics until Paleomagnetism gave substantial evidence for his ideas. Why do you think that Paleomagnetism was needed to establish the theory of plate tectonics?

9. Based on what you saw in this lab, what do you predict the world will look like in the future 120 million years from now?

Conclusion

What are your overall thoughts on this lab? Did you learn anything about how the theory of plate tectonics was formed?

Make sure to staple your Vernier lab printout and your two maps to this lab!