The Distance Between Us and Them: Sea Floor Spreading in the Atlantic Ocean

Adapted from: http://www.beloit.edu/~SEPM/Earth_Works/Sea_floor_spreading.html

Focus on Inquiry

The student will collect and analyze data on sea floor spreading in the Atlantic Ocean to determine the rate at which the plates are moving.

Lesson Overview

In this activity, students will gain an understanding of how geologists determine rates of sea floor spreading between two tectonic plates. Using a strip map of the North Atlantic seafloor, they will measure distances and note the ages of the strips of seafloor basalt. They will also gain experience applying some basic, useful mathematical concepts such as the calculation and use of velocities and conversion from one set of units to another.

Duration	Setting	Grouping	PTI Inquiry Subskills
50-70 minutes	Classroom with Computer Access	Small cooperative groups	3.2, 3.6, 4.2, 4.3, 4.4, 5.2, 5.3, 7.3

Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
Engage	10min	5.3	Computer with Internet	1	Students watch a video and are engaged in a discussion of sea floor spreading.
Explore	25 min	3.2, 4.2, 4.4	None	3	Students utilize their math skills to determine the rate at which the sea floor is spreading in the Atlantic Ocean.
Explain	20 min	3.6, 4.3, 5.2,	None	3	Students summarize their sea floor spreading data and share their findings with the class.
Expand	10 min	3.2, 3.6, 4.4	None	3	Students use knowledge learned to calculate how far apart the North American and African plates will be in the future.
Evaluate	5 min	7.3	None	3	Worksheet, poster, and discussions will be evaluated for depth of understanding.

Level of Student Engagement

1	Low	Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction
2	Moderate	Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance
3	High	Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered

National Science Education Standards – Inquiry

Use appropriate tools and techniques to gather, analyze, and interpret data.
Develop descriptions, explanations, predictions, and models using evidence.
Think critically and logically to make the relationships between the evidence and explanations.
Use mathematics in all aspects of scientific inquiry.

National Science Education Standards – Earth Science

Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle.

Louisiana Grade Level Expectations – Inquiry

Gr. 8, Inquiry GLE#6 – Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
Gr. 8, Inquiry GLE#9 – Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)
Gr. 8, Inquiry GLE#11 – Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
Gr. 8, Inquiry GLE#12 – Use data and information gathered to develop an explanation of experimental results (SI-M-A4)

Gr. 8, Inquiry GLE#13 – Identify patterns in data to explain natural events (SI-M-A4) Gr. 8, Inquiry GLE#16 – Use evidence to make inferences and predict trends (SI-M-A5) Gr. 8, Inquiry GLE#19 – Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
Louisiana Grade Level Expectations Earth Science Gr. 8, GLE#11 – Illustrate the movements of lithospheric plates as stated in the plate tectonics theory (ESS-M-A2)

Materials List (per group)

- Computers with Internet Access
- Ruler with mm subdivisions or 1/10 inch subdivisions (C-Thru rulers work best)
- Calculator
- Copies of map, worksheets, and geologic time scale (provided in activity)
- 11" x 17" poster paper

Advance Preparation

1. Obtain materials listed in the materials list.
2. Run off the **Blackline Masters #1-3**.
3. Make sure you have the computer software necessary to show the online videos on your computer found in the Procedure section (Engage).
4. Print out a copy of the original lesson from http://www.beloit.edu/~SEPM/Earth_Works/Sea_floor_spreading.html.

Other Information

Learning Objectives

The learner will:

- Determine a map scale based on a known distance between two points.
- Determine velocity with which the Atlantic Ocean opened based on age data from a strip map of the Atlantic Ocean.

Prior Knowledge Needed by the Students

- Determine a map scale based on a known distance between two points.
- Determine velocity with which the Atlantic Ocean opened based on age data from a strip map of the Atlantic Ocean.

Procedure

Engage

1. Earth's crust is a dynamic place. Show students an animation of sea floor spreading. A suggested animation would be Earth Visualization ES0803: Observe how alternating magnetic polarity is recorded in rocks at mid-ocean ridges (http://www.classzone.com/books/earth_science/terc/content/visualizations/es0803/es0803page01.cfm?chapter_no=visualization). Overview of plate tectonics: (http://www.teachersdomain.org/6-8/sci/ess/earthsys/wegener2/index.html).
2. What kinds of questions come to mind about sea floor spreading as you watch this video?

Explore

1. Follow the recommended procedure from the activity website [http://www.beloit.edu/~SEPM/Earth_Works/Sea_floor_spreading.html].
2. Assign each group a particular strip of the sea floor.
2. For convenience, the three worksheets necessary to complete the exploration are provided as **Blackline Masters #1-3**.

Explain

1. In their cooperative groups, have student groups **list three things** they have learned by completing this activity on an 11”x17” poster. Have each group explain what they learned to the class.
2. To guide this discussion of learning, the following questions might be useful:
   a. Has the sea floor spreading rate been constant over time? [No.] What evidence do you have to support your answer? [Different calculated spreading rates for different bands.]
   b. How has the spreading rate changed over time? When was it faster? When was it slower?
   c. How can you explain the geologic evidence you’ve obtained from the map of the Atlantic sea floor?
   d. What implications does sea floor spreading have on other areas of the Earth? Can the Earth just keep expanding at mid ocean ridges without consequences elsewhere?

Expand

1. This lesson explored the spreading rates of the North American and African plates in the past. Let’s turn things around and figure how far apart North America and Africa will be at a specific time in the future. Let’s figure out how much further apart North America and Africa will be 1 million years in the future if we consider the plates to be diverging at a rate of 2 cm/year. [1million years x 2 cm/yr = 2,000,000 cm; 2,000,000 cm = 200 km]

Evaluate

1. Worksheet answers.
2. Student participation in the explanation of their findings.
3. Fullness in explanations offered for their findings.

Blackline Master

1. Sea Floor Spreading Research Group Data Worksheet
2. Strip Map of the Atlantic Ocean
3. The Geologic Time Scale

Supplementary Resources

None

SEA FLOOR SPREADING RESEARCH GROUP
DATA WORKSHEET

Date_____ Investigators_____

1. Study area: **North Atlantic Ocean**

   Select one strip of sea floor rock. Record its age below and carefully measure the distance it has moved from the mid-ocean ridge where it formed.
2. Sea floor age: _____million years (My)

3. Distance to the Mid-Atlantic Ridge
   (Distance measured on map X map scale): _____kilometers (km)
   Using the age of the rock you have chosen and its distance from the MAR, calculate the half-rate of sea floor spreading, the velocity at which one strip of this rock has spread away from the MAR.
4. Calculated half-rate (velocity) of sea floor spreading
   (Distance / time = velocity in cm/year): _____km per My

5. Calculated total rate (velocity) of sea floor spreading
   (2 X half-rate = total spreading rate): _____km per My

6. Total present day distance between North America and Africa
   (Measured between points A and B): 4550 km
7. Calculated age of the North Atlantic Ocean
   (Total distance / total velocity = time): _____My

8. Geologic Period during which the North Atlantic began to open:

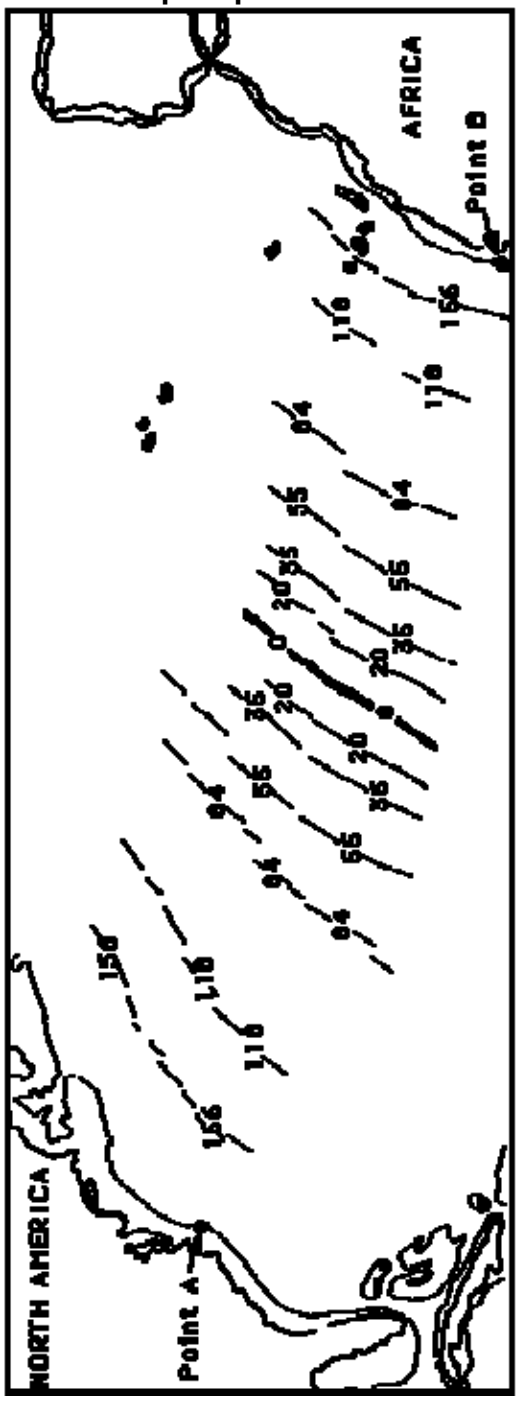
9. Convert the total sea floor spreading rate from step #5 above to units that are easier to "imagine". This can be done simply by filling in the spaces below and performing the multiplication. Check this calculation by making sure that units "cancel out" to correctly yield the units desired (this procedure is known as dimensional analysis).

   (____km/My) X (____mi/km) X (____ft/mi) X (____in/ft) X (____My/yr) = _____in/yr

   How much has the distance (in inches) between North America and Africa increased since you were born?

   How much does the distance (in feet) increase during the average lifetime of an American (~82 years)?
   How much closer (in feet) were these two continents when Columbus made his voyages?

Strip Map of the Atlantic Ocean



Strip map of a portion of the North Atlantic region showing the coastlines and continental shelf edges of North America and Africa. The bold line labelled "0" is the Mid-Atlantic Ridge. Selected strips of sea floor basalt on either side of the ridge are labelled with their ages in millions of years. The approximate distance between Point A and Point B is 4,550 kilometres.

THE GEOLOGIC TIME SCALE			
ERA	PERIOD	EPOCH	APPROXIMATE AGES (in millions of years)
CENOZOIC	Quaternary	Recent Pleistocene	1.6
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene	65
MESOZOIC	Cretaceous		144
	Jurassic		208
	Triassic		245
PALEOZOIC	Permian		285
	Pennsylvanian		320
	Mississippian		360
	Devonian		408
	Silurian		438
	Ordovician		505
	Cambrian		540
PRECAMBRIAN			>4550

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