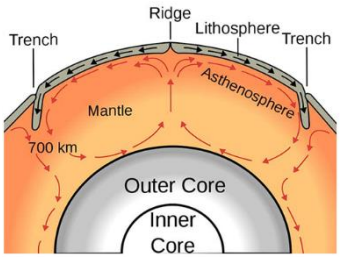
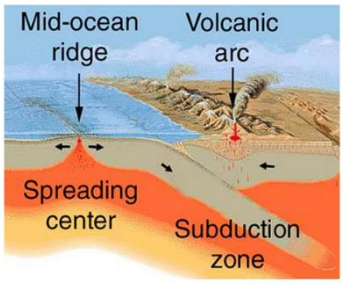
Riding the Ridge: Studies in Seafloor Spreading

Modified from "Life on an Ocean Planet" and National Science Teachers Association

Part One: Background Information



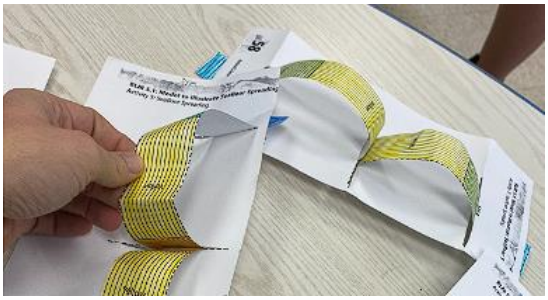


The creation of new seafloor at mid-ocean ridges (aka spreading centers) is one of many cycles that cause the Earth to experience constant change. Spreading centers occur where two tectonic plates of the Earth's crust are moving away from each other. For this reason, they are also known as divergent plate boundaries, and they result in deep cracks in the crust. Mid-ocean ridges are found in all the planet's oceans and on a map resemble the seams of a baseball. Seafloor is constantly destroyed in subduction zones (aka convergent plate boundaries). The new seafloor is made from magma (liquid rock) that rises from the mantle and cools to form solid igneous rocks. In the Atlantic, the mid-ocean ridge mirrors the adjacent continents. Scientists initially expected the ridge to be about the same age as continental crust. Instead, the use of radiometric data found that oceanic crust is generally younger than 200 million years old, which is only about five percent of Earth's estimated age. Furthermore, based on dating methods, scientists determined that the ocean's crust gets older the farther you get from the ridge. Seismic data accumulated over many decades also indicate that the ridges are very active both seismically and volcanically. Magnetometers towed behind ships picked up natural magnetic properties of the ocean floor beneath. They found banded patterns that border the mid-ocean ridge and mirror image, stripe for stripe, the contours of the mid-ocean ridge. This is because the Earth's magnetism flips every million to two million years and then flips back, leaving a record in the rocks formed during that time. This information can be used to create a model of seafloor spreading, as you will do today!

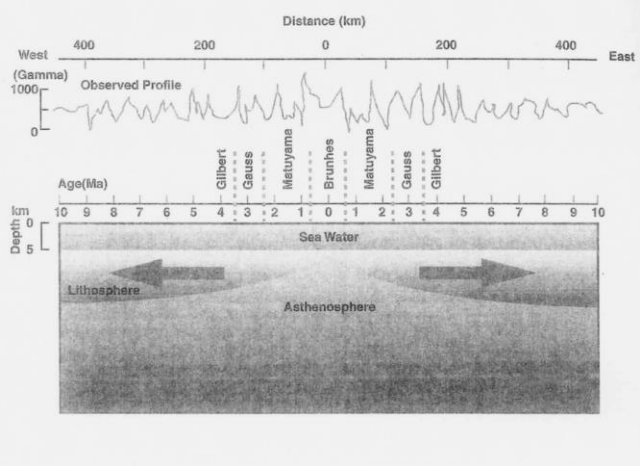
Part One Analysis Questions

1. Explain the difference between convergent and divergent plate boundaries.
2. Why is oceanic crust younger in age than continental crust? (not explicitly given, use the images too)
3. What causes banding patterns in rocks as you move away from a seafloor spreading center?

Part Two: Creating a model of Seafloor Spreading



a. Color the areas indicated on the two strips of the seafloor spreading model provided, then cut along the dotted lines.
b. Tape together the orange ends of the strips with the colored sides facing each other.
c. Thread the two strips, leading with the blue end, through the underside of Slit B of the larger sheet. Pull one side down through Slit A and the other through Slit C.
d. Pull the strips through the slits so that the same colors on both strips emerge from Slit B and disappear into Slits A and C at the same time.



The colors on your model represent different magnetic epochs, named Gilbert (orange), Gauss (yellow), Matuyama (green) and Brunhes (blue) after four scientists who pioneered the study of Earth's magnetism. It was at the boundary between each of these epochs that the Earth's magnetism flipped.

As magma cools into igneous rock, the iron-containing minerals align to the magnetic field and "lock in" that orientation when the rock solidifies, thus leaving a record of the Earth's magnetism (measured by gamma in the image to the left).

Part Two Analysis Questions

4. What is happening at Slit B of your model? What geologic feature occurs at the corresponding location on the seafloor?
5. What is happening at Slits A and C of your model? What geologic features occur at corresponding locations on the seafloor?
6. If you were to date the rocks along the colored strip starting at Slit B and moving toward Slit A, what change if any would you see in the age of the rocks?
7. Why would rocks in opposite directions from the mid ocean ridge, yet equidistant from the center, have similar characteristics?
8. If new ocean floor is constantly being produced at mid-ocean ridge systems, then how is it that our planet's crust is not getting larger and magma in the aesthenosphere is not being emptied as time progresses? Why is the planet not getting bigger?

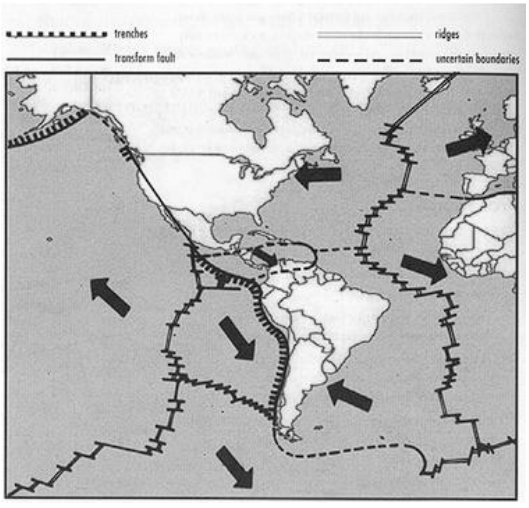
Part Three: Comparing Seafloor Data from the Pacific and Atlantic Oceans

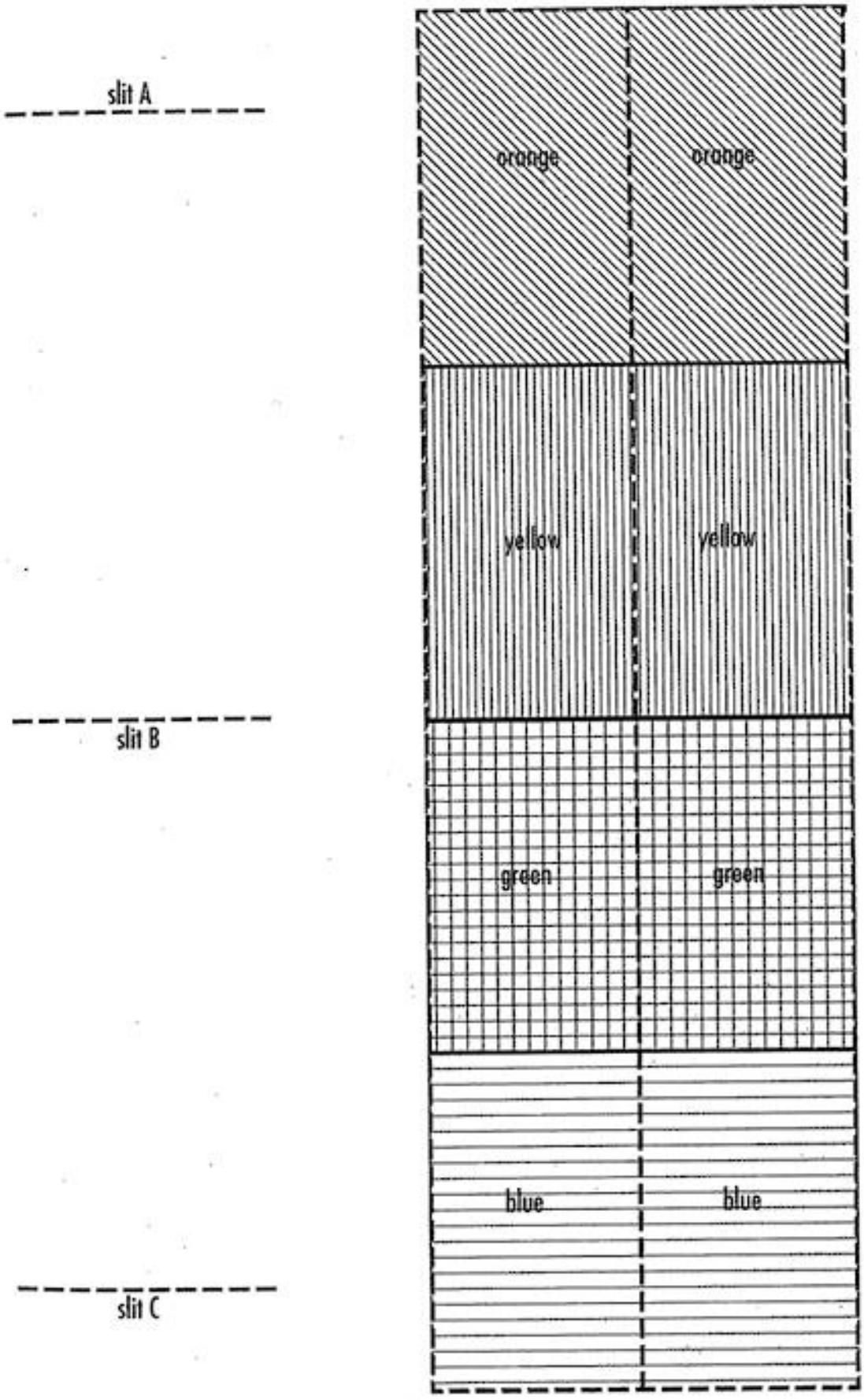
Use the transect data below to answer the following questions.

Table 1: Pacific Ocean Transect Data				Table 2: Atlantic Ocean Transect Data		
Distance from Ridge (km)	**Depth (m)**	**Seafloor Age (million years)**		**Distance from Ridge (km)**	**Depth (m)**	**Seafloor Age (million years)**
0	2870	0.056		0	2740	1.27
163	3120	2.32		79.9	3310	8.08
326	3440	4.63		160	3120	13.9
489	3550	6.94		240	4230	19.8
652	3750	9.24		320	3740	24.5
815	3650	11.6		400	4590	29.3
978	3950	14.1		479	4910	34.0
1140	3900	16.7		559	4620	38.2
1340	3700	19.8		655	5170	43.7
1500	3750	22.1		735	5130	50.9

Part Three Analysis Questions

9. Compare and contrast the change in depth as you move away from the ridge for the Pacific and Atlantic oceans.
10. Why is the mid ocean *ridge* at a lower depth, geologically speaking?
11. Why does seafloor depth tend to level out at great distances away from the ridge?
12. The depth of sediment increases as you get further from the mid ocean ridge. Why do you think this happens? (hint: where does deep ocean sediment come from?)
13. What happens to the seafloor age as you get further from the mid ocean ridge? Does this align with your answer to question 6?
14. Calculate the rate of seafloor spreading for both the Pacific and Atlantic in cm/year. (hint: use the oldest data set)
15. Provide a possible cause for the difference in spreading rates between the Pacific and Atlantic mid-ocean ridges.
16. Look at the map to the right showing some of Earth's plates and the direction of their motion. What is happening to the Atlantic and Pacific Oceans?
17. Relate your answer to question 16 to your previous knowledge of the supercontinent Pangaea.
18. Subductions zones are known for increased instances of geologic activity, including earthquakes and volcanoes. Based on the map to the right, identify three countries or U.S. states where you anticipate seeing more earthquakes and volcanoes?
19. You may see at the top right of the map that the mid ocean ridge extends through Iceland. What does this mean for the country?
20. Recently magnetic banding patterns have been found on the surface of Mars. What conclusions could be made by this discovery?




slit A
orange
orange
yellow
yellow
slit B
green
green
blue
blue
slit C