What is the process of sea-floor spreading?

- What is the evidence for sea-floor spreading?
- What happens at deep-ocean trenches?

Sea-Floor Spreading

Key Concepts

The longest chain of mountains in the world is the system of mid-ocean ridges. In the mid-1900s, scientists mapped the mid-ocean ridges using sonar. Sonar is a device that bounces sound waves off underwater objects and then records the echoes of these sound waves. The mid-ocean ridges curve along the sea floor, extending into all of Earth's oceans. Most of the mountains in the mid-ocean ridges lie hidden under hundreds of meters of water. A steep-sided valley splits the top of some mid-ocean ridges.

Earth's ocean floors move like conveyor belts, carrying the continents along with them. This movement begins at a mid-ocean ridge. A ridge forms along a crack in the oceanic crust. At a mid-ocean ridge, molten material rises from the mantle and erupts. The molten material then spreads out, pushing older rock to both sides of the ridge. As the molten material cools, it forms a strip of solid rock in the center of the ridge. Then more molten material splits apart the strip of solid rock that formed before, pushing it aside. This process, called sea-floor spreading, continually adds new material to the ocean floor.

Scientists have found strange rocks shaped like pillows in the central valley of mid-ocean ridges. Such rocks can form only if molten material hardens quickly after erupting under water. The presence of these rocks supports the theory of sea-floor spreading. More support came when scientists discovered that the rock that makes up the ocean floor lies in a pattern of magnetized "stripes." The pattern is the same on both sides of the ridge. These stripes hold a record of reversals in Earth's magnetic field. The final proof of sea-floor spreading came from rock samples obtained by drilling into the ocean floor. Scientists found that the farther from a ridge the

rocks were taken, the older they were.

The ocean floor does not just keep spreading. Instead, it sinks beneath deep underwater canyons called deep-ocean trenches. Where there are trenches, subduction takes place. Subduction is the process by which the ocean floor sinks beneath a deep-ocean trench and back into the mantle. At deep-ocean trenches, subduction allows part of the ocean floor to sink back into the mantle, over tens of millions of years.

The processes of subduction and sea-floor spreading can change the size and shape of the oceans. Because of these processes, the ocean floor is renewed about every 200 million years. The Pacific Ocean is shrinking. Its many trenches are swallowing more ocean crust than the mid-ocean ridge is producing. The Atlantic Ocean is expanding. In most places, the oceanic crust of the Atlantic Ocean is attached to continental crust. As the Atlantic's floor spreads, the continents along its edges also move.

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Sea-Floor Spreading

This section explains sea-floor spreading and describes evidence that it happens. The section also explains subduction and describes how subduction affects Earth's oceans.

Use Target Reading Skills

As you read about sea-floor spreading, fill in the flowchart to show the sequence of events.

Magma erupts along mid-ocean ridge

Magma a._____ to form new b._____

c,_____ spreads away from d._____

Mid-Ocea·n Ridges

1. Circle the letter of each sentence that is true about mid-ocean ridges.
   a. The mid-ocean ridges were mapped using sonar.
   b. The mid-ocean ridges are found only below the Pacific Ocean.
   c. The mid-ocean ridges are completely under water.
   d. The tops of some mid-ocean ridges are split by a steep-sided valley.
2. A device that bounces sound waves off underwater objects is called _____
3. What is sonar used for? _____

What Is Sea-Floor Spreading?

4. The process that continually adds new material to the ocean floor is called _____
5. In sea-floor spreading, where does new crust come from? _____

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Evidence for Sea-Floor Spreading

6. List three types of evidence for sea-floor spreading.

   a. ----------

   b. ----------

   c. _____

7. Circle the letter of each sentence that is true about Earth's magnetism.

   a. At times in the past; a compass needle on Earth would have pointed south.

   b. Rock that makes up the ocean floor lies in a pattern of magnetized stripes.

   c. The pattern of stripes is different on both sides of mid-ocean ridges.

   d. The magnetic memory of rock on the ocean floor changes over time.

8. How did drilling samples show that sea-floor spreading really has taken place?

_____

_____

Subduction at Trenches

9. A long, narrow and very deep canyon where the ocean floor bends down toward the mantle is called a ----------

10. What is subduction? ---------- ----------

_____

Sea Fioor Spreading *(continued)*

11. Complete the cause, events, and effect graphic organizer to show the relationships among the processes of convection currents, subduction, and sea-floor spreading.

a. _____ in Earth's mantle

cause

Subduction

b. _____

results in

The ocean is changed in c. _____

d. What process in Earth's interior causes subduction and sea-floor spreadlng? _____

e. What effect do those two events have on Earth's surface? _____

12. Is the following sentence true or false? At deep-ocean trenches, conduction allows oceanic crust to sink back into the mantle.

_____

13. Is the following statement true or false? The Pacific Ocean is shrinking.

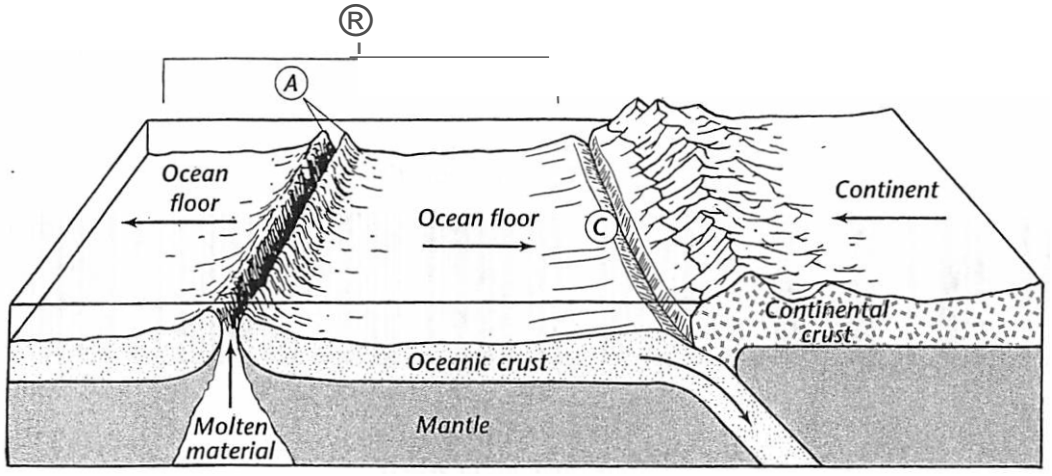
_____

14. Why is the Atlantic Ocean expanding? _____

Sea-Floor Spreading

Understanding Main Ideas

Use the figure below to answer the questions that follow. Answer the questions on a separate sheet of paper.



1. Name and describe the feature of the ocean floor shown at A.
2. Describe the process shown occurring at B, and explain what results from this.
3. What happens to old oceanic crust as new molten material rises from the mantle?
4. The arrows on the figure show the ocean floor spreading from the ridge. What are three kinds of evidence scientists have found to support this idea?
5. What process is shown occurring at C, and why does it occur?

Building Vocabulary

Fill in the blank to complete each statement.

6. A device that scientists use to map the ocean floor is _____,_____
7. The feature on the ocean floor at C is called a(n) _____
8. The process that continually adds new material to the ocean floor is called _____
9. The process by which the ocean floor sinks into the mantle is called _____
10. A chain of underwater mountains along which sea-floor spreading occurs is a _____

Magnetic Reversals Through the Ages

How often does Earth's magnetic field reverse itself? The graph below shows the record geologists have put together for the last 65 million years. As you might know, the last of the dinosaurs died about 65 million years ago. So you can think of this graph as the record of Earth's reversals since the dinosaurs became extinct.

In this graph, each dark band represents a "normal" magnetic field, as it is today. Each light band represents a reversed magnetic field. Use the graph to answer the questions that follow.

Reversals in Earth's Magnetic Field

Time (millions of years)

Answer the following questions on a separate sheet of paper.

1. Was Earth's magnetic field "normal" or reversed *65* million years ago?
2. About how long ago was the last time Earth's magnetic field reversed?
3. Can you see any pattern in how often Earth's magnetic field reverses? Give reasons for your answer.
4. How would this history of reversals show itself on the ocean floor?
5. From this graph, when would you predict the next reversal would occur? Give reasons for your answer.

Name _____ Date _____ Class _____

Modeling Sea-Floor Spreading

Problem

How does sea-floor spreading add material to the ocean floor?

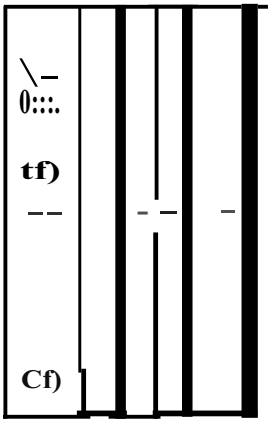
Materials

scissors
metric ruler
2 sheets of unlined paper
colored marker

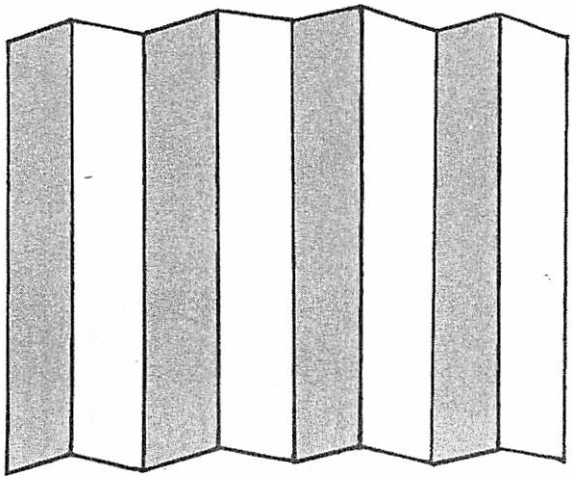
Procedure

Review the safety guidelines in Appendix A

1. Draw stripes across one sheet of the paper. The stripes should vary in

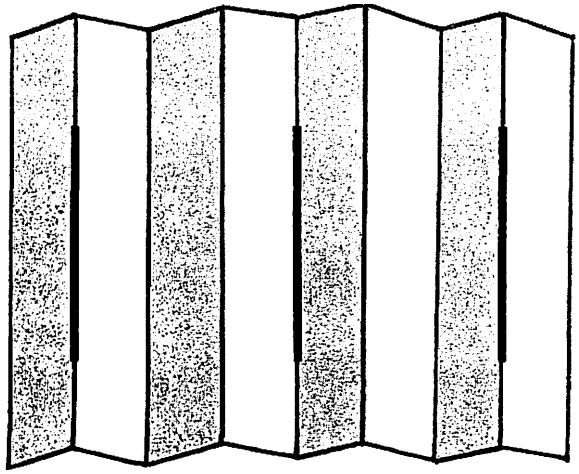


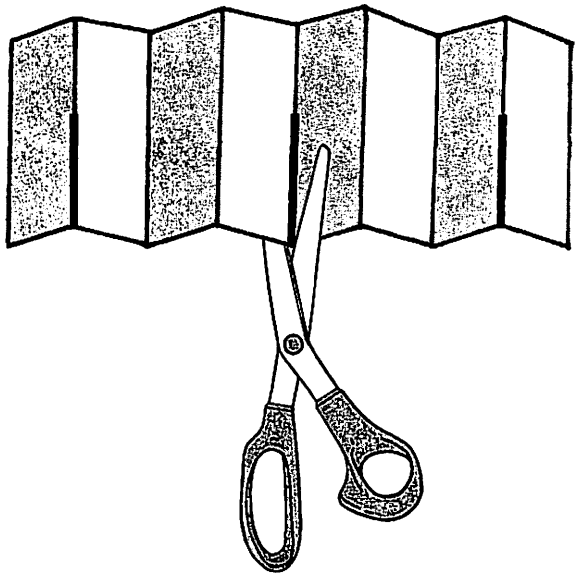
2. Fold the paper in half lengthwise and write the word "Start" at the top of both halves of the paper. Using the scissors, carefully cut the paper in strips.
3. Lightly fold the second sheet of paper into eighths. Then unfold it, leaving creases in the paper. Fold this sheet in half lengthwise.

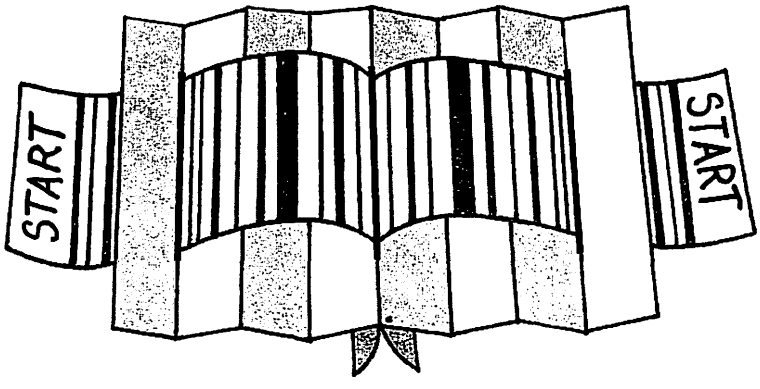


Modeling Sea-Floor Spreading *(continued)*

4. Starting at the fold, draw lines 5.5 em long on the middle crease and the two creases closest to the ends of. the paper.
5. Now carefully cut along the lines you drew. Unfold the paper. There should be three slits in the center of the paper.
6. Put the two striped strips of paper together so their Start labels touch one another. Insert the Start ends of the str ps up through the center slit, and then pull them toward the side slits.
7. Insert the ends of the strips into the side slits. Pull the ends of the strips, and watch what happens at the center slit.
8. Practice pulling the strips through the slits until you can make the two strips come up and go.down at the same time.







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Analyze and Conclude

Write your answers in the spaces provided.

1. What feature of the ocean floor does the center slit stand for? What prominent feature of the ocean floor is missing from the model at this point?

2. What do the side slits stand for? What does the space under the paper stand for?

3. How does the ocean floor as shown by the part of the strip close to the center slit differ from the ocean floor as shown by the part near a side slit? How does this difference affect the depth of the ocean?

4. What do the stripes on the strips stand for? Why is it important that your model have an identical pattern of stripes on both sides of the center slit?

Modeling Sea-Floor Spreading *(continued)*

5. Explain how differences in density and temperature provide some of the force needed to move the strips in your model.

_____

_____

_____

6. Think About It Use your own words to describe the process of sea-floor spreading. What parts of the process were not shown by your model?

_____

_____

_____

_____

More to Explore

Imagine that so much molten rock erupted from the mid-ocean ridge that an island formed there. How could you modify your model to show this island? How could you show what would happen to it over a long period of time?