8-1 What is continental drift?

Objective ▸ Explain continental drift and the evidence that supports the theory.

TechTerm

- **continental** (KAHNT-un-ent-ul) **drift:** idea that states the continents were once a giant landmass, and broke into pieces that moved to the positions they are in today

Continental Drift Most scientists think that millions of years ago there was one giant continent (KAHNT-un-ent). A continent is a large landmass. This giant continent had water all around it. Millions of years ago, the continent began to break apart. The pieces of the continent slowly drifted apart. They became today's seven continents.

The idea that the continents were once part of a giant landmass that split apart was stated by Alfred Wegener. Wegener was a German scientist. Wegener called the giant landmass Pangaea (pan-JEE-uh). He called his idea **continental** (KAHNT-un-ent-ul) **drift.**

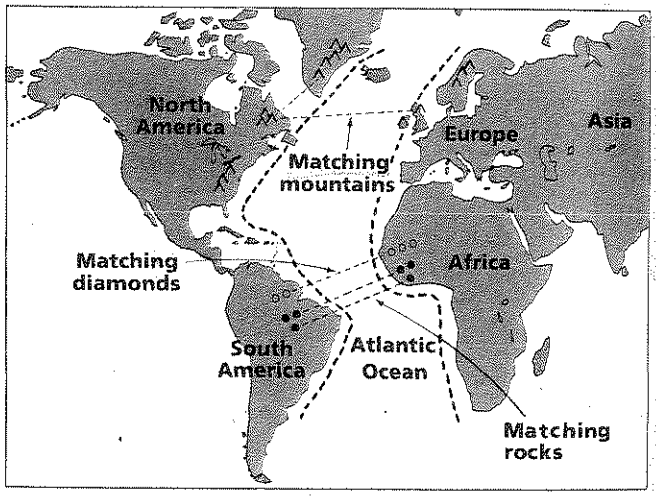
Identify: Who first stated the idea of continental drift?

A Giant Jigsaw Puzzle In the early 1900s, Wegener noticed that the continents seemed to fit together. Look at the shapes of the coastlines of South America and Africa on the map. The coastlines seem to fit together like jigsaw puzzle pieces. Other places can be found that might once have fitted together. The shapes of coastlines are only one clue that supports continental drift.

Describe: How are coastlines on both sides of the Atlantic Ocean alike?

Fossil Evidence Fossils of once-living things provide clues that support continental drift. Some of these fossils have been found in places that are far apart. Wegener studied the fossils of Mesosaurus (meh-soh-SAWR-us). Mesosaurus fossils were found in Africa and in South America. Mesosaurus lived in fresh water. How could it swim across the salty Atlantic Ocean? Wegener concluded that the animal must have lived on one landmass. When the landmass broke apart, some of the animals were trapped on each part.

Identify: What animal fossil is used to support continental drift?



More Evidence Today, most scientists accept the idea of continental drift. Here are some reasons.

- Some mountain ranges on different continents seem to match. A mountain range along the eastern United States and Canada is similar to one in Greenland and northern Europe. On a model of Pangaea, the mountains seem to fit together as one long chain.
- The age and kind of rocks along the edge of one continent match rocks along the edge of another continent. Even the sizes of the diamonds in Brazil and West Africa are the same.

Explain: How are mountain ranges used to support continental drift?

Name _____ Class _____ Date _____

8-1 What is continental drift?

Lesson Review

Part A *Complete the following.*

1. Explain continental drift in your own words. _____

_____

_____

2. Who was Alfred Wegener? _____

_____

Part B *Place a check mark beside each statement that supports continental drift.*

_____ 1. Alfred Wegener named a giant landmass Pangaea.

_____ 2. There are seven continents.

_____ 3. *Mesosaurus* fossils are found in Africa and South America.

_____ 4. Canada, the United States, and northern Europe have similar climates.

_____ 5. Mountain ranges on different continents seem to match.

_____ 6. Rocks along the edges of one continent match those along the edge of another continent.

_____ 7. The continents are surrounded by water.

_____ 8. The coastlines of South America and Africa seem to fit together like jigsaw puzzle pieces.

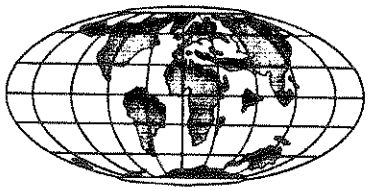
Skill Challenge

Skills: *sequencing, inferring*

Place the drawings of the way the earth looked in the correct order based upon continental drift. Write the number of years ago in the space provided. Use these labels: 250 million years ago, 150 million years ago, 100 million years ago, 50 million years ago, present

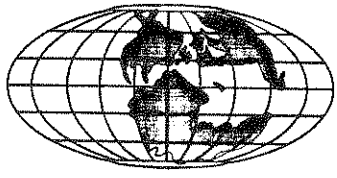
1. _____

2. _____



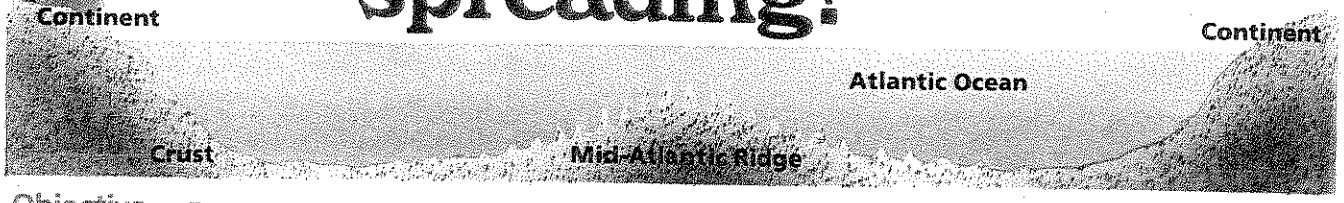
3. _____

4. _____



5. _____

8-2 What is sea-floor spreading?



Objective ▸ Recognize that sea-floor spreading forms new oceanic crust.

TechTerms

- **mid-ocean ridge:** underwater mountain chain
- **rift valley:** deep crack running down the center of the mid-Atlantic ridge
- **sea-floor spreading:** process that forms new sea floor

Kinds of Crust There are two kinds of crust. One kind is oceanic (oh-shee-AN-ik) crust. This crust makes up the ocean floor. The other kind of crust is continental (KAHNT-un-ent-ul) crust. It makes up the earth's continents. Oceanic crust is made of material that is heavier and denser than continental crust.

Name: What are the two kinds of crust?

Mid-ocean Ridges Some of the longest mountain ranges and the tallest mountains are under the ocean. These mountains form a chain 73,600-km long. The mountain chain is called the **mid-ocean ridge.** Some of its peaks are 3048 m above the ocean floor. In a few places, the peaks rise above the surface of the ocean. These peaks form islands. Iceland is a mountain peak of the Mid-Atlantic Ridge. The Mid-Atlantic Ridge runs down the middle of the Atlantic Ocean.

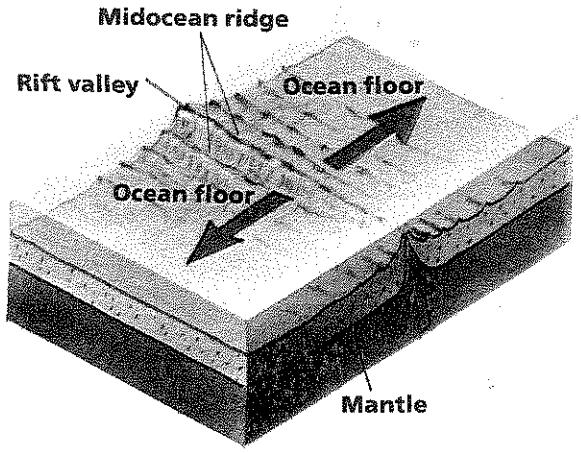
Identify: What are the longest mountain ranges on the earth?

The Rift Valley In the late 1940s, scientists began to map the mid-ocean ridges. Along the Mid-Atlantic Ridge, they discovered a deep crack running down the center of the ridge. This deep crack is called a **rift valley.** Magma pouring out of the rift hardened and formed a broad valley with steep sides. Scientists discovered that a lot of earthquakes and volcanic activity take place along mid-ocean ridges.

Define: What is a rift valley?

Formation of New Sea Floor Deep-sea drills have been used to bring up samples of oceanic crust. Scientists discovered that these samples were younger than samples of continental crust. The crust near a mid-ocean ridge was younger than the crust farther away. The youngest crust was in the center of the ridge.

At the mid-ocean ridges, magma, or molten rock, was rising through the crust. As the magma cooled, it formed new crust on both sides of the ridge. On both sides of the ridge, the sea floor was being pushed away. The sea floor was spreading apart at the ridges. New oceanic crust was being formed at the ridge, and pushing out the older crust next to it. Scientists called this process **sea-floor spreading.** Sea-floor spreading helped to explain continental drift.



Describe: What happens as magma rises through the crust at mid-ocean ridges?

Name _____ Class _____ Date _____

8-2 What is sea-floor spreading?

Lesson Review

Write true if the statement is true. If the statement is false, change the underlined term to make the statement true.

_____ 1. The two kinds of crust are oceanic crust and land.

_____ 2. The underwater mountain chain is called the mid-ocean ridge.

_____ 3. Iceland is part of the Mid-Pacific Ridge.

_____ 4. Oceanic crust near the mid-ocean ridge is older than crust farther away.

_____ 5. The deep crack running down the center of an ocean ridge is called a trench.

_____ 6. New continental crust is formed at the mid-ocean ridges.

_____ 7. Sea-floor spreading is a process that forms new oceanic crust.

Skill Challenge

Skills: *modeling, identifying*

Complete the following.

1. Label the lettered parts of Figure A.

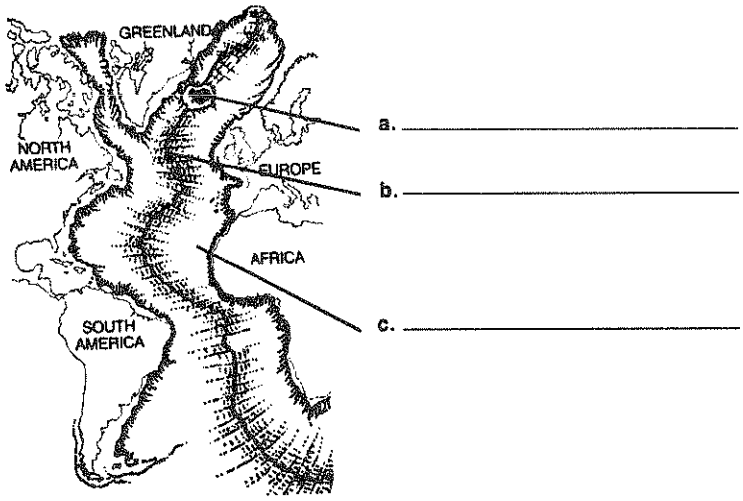


Figure A

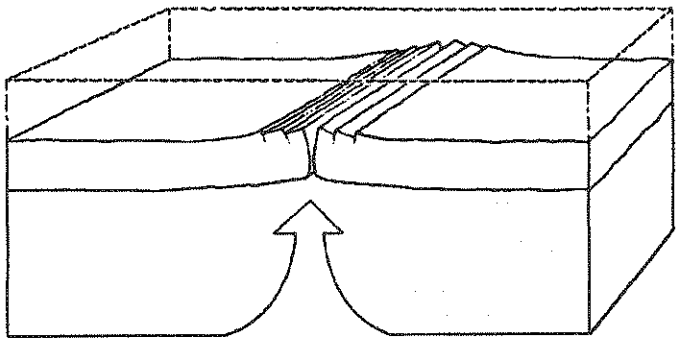


Figure B

2. Label Figure B. Use these terms: **rising magma, ocean crust, mid-ocean ridge,** and **rift valley.**

3. Draw arrows on Figure B to show sea-floor spreading.

8-3 What evidence supports sea-floor spreading?

Objective ▸ Describe some effects of sea-floor spreading.

TechTerms

- **trench:** long, V-shaped valley
- **subduction** (sub-DUKT-shun) **zone:** place where old crust is pushed down into a trench

Trenches On the ocean floor, there are long, V-shaped valleys called **trenches.** Trenches are the deepest parts of the oceans. They may be more than 10,000 meters deep. Most trenches are found in the Pacific Ocean. They are along the coasts of continents and near strings of islands. Many trenches are along the Ring of Fire.

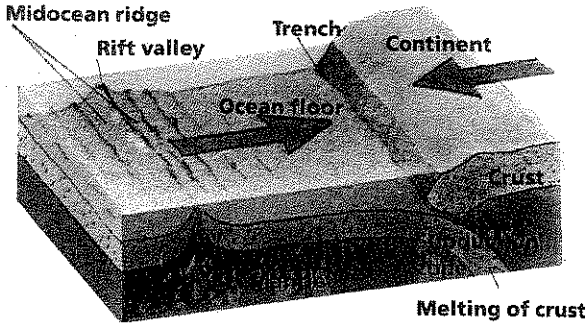
Define: What is a trench?

Disappearing Crust The oldest rocks found on the ocean floor are only 175 million years old. Yet the earth is about 4.5 billion years old. Very old sea-floor rocks have not be found. As new crust is made in one place, it must be destroyed someplace else. If the crust were not being destroyed, the earth would be getting bigger. Scientists think that old crust on the ocean floor is pushed into ocean trenches. When the crust is pushed deep enough, the rocks of the crust melt. They become magma again.

State: About how old is the earth?

Subduction Zones The areas where the oceanic crust is pushed down into ocean trenches are called **subduction** (sub-DUKT-shun) **zones.** In these zones, the older oceanic crust is pushed down into the mantle. There is a lot of volcanic activity near subduction zones. There also are many earthquakes in these areas. The Ring of Fire around the Pacific Ocean has many subduction zones.

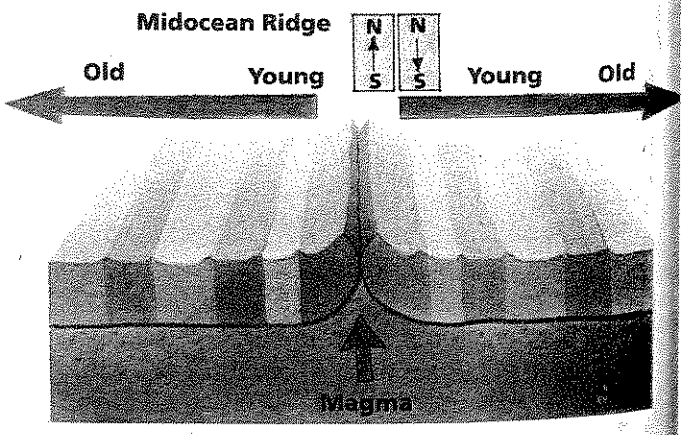
Define: What are subduction zones?



Evidence of Seafloor Spreading The earth is like a giant magnet. It has a magnetic field. If you have ever used a compass, you know that a compass always points north. Some minerals have magnetic properties. When rocks with these minerals form, the magnetic particles are fixed in position. They should point north. Scientists have discovered rocks with magnetic particles that pointed south. The earth's magnetic field changed through its history. North became south; and south became north.

On the sea floor there are stripes of rocks with magnetic particles pointing north and magnetic particles pointing south. Of course, you cannot see the stripes. They are detected by scientific instruments. On either side of the mid-Atlantic ridge, the pattern is the same. This was evidence that the ocean floor was being pushed out from both sides of the mid-Atlantic ridge.

State: What evidence shows the earth's magnetism has changed?



Name _____ Class _____ Date _____

8–3 What evidence supports sea-floor spreading?

Lesson Review

Part A *Place a check mark in the space or spaces provided to show where you would most likely find each place.*

1. Trench:	____ a. mountains	____ b. Pacific Ocean	____ c. valleys
2. Subduction Zone:	____ a. Ring of Fire	____ b. Pacific Ocean	____ c. Mid-ocean ridge
3. Ring of Fire:	____ a. Atlantic Ocean	____ b. Iceland	____ c. Pacific Ocean

Part B *Complete the following.*

1. Explain the relationship between trenches and sea-floor spreading. _____

_____

_____

2. Explain how the changes in the earth's magnetic field is used as evidence to support sea-floor spreading. _____

_____

Skill Challenge

Skills: *modeling*

Use Diagram A to draw arrows to show what happens at subduction zones. Use Diagram B and the KEY to show changes in the earth's magnetic field as found in magnetic particles in rocks on the ocean floor. Draw arrows to show sea-floor spreading.

Diagram A

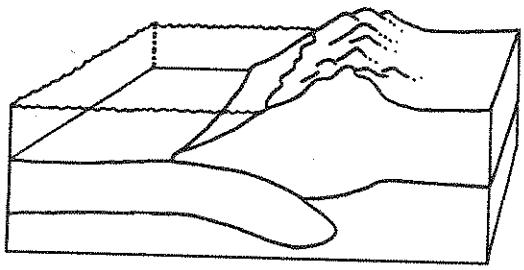
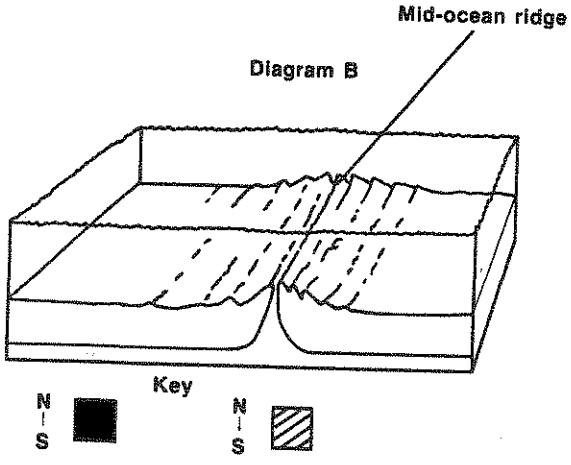


Diagram B



8-4 What is plate tectonics?

Objectives
- Name some crustal plates.
- Describe the theory of plate tectonics.

TechTerms
- **crustal plates:** large pieces of the solid part of the earth
- **theory** (THEE-uh-ree): statement of an idea supported by evidence over a period of time
- **theory of plate tectonics** (tek-TAHN-iks): theory that states the earth's crust is broken into plates that float on the lower mantle

Crustal Plates Most scientists think that the crust of the earth and solid part of the mantle are broken into **crustal plates.** The mantle is the layer of the earth below the crust. These plates are made up of the solid part of the earth. Most plates are made up of oceanic and continental crust. There are seven main plates and about 13 smaller ones. The largest plate is the Pacific plate. The map shows the crustal plates.

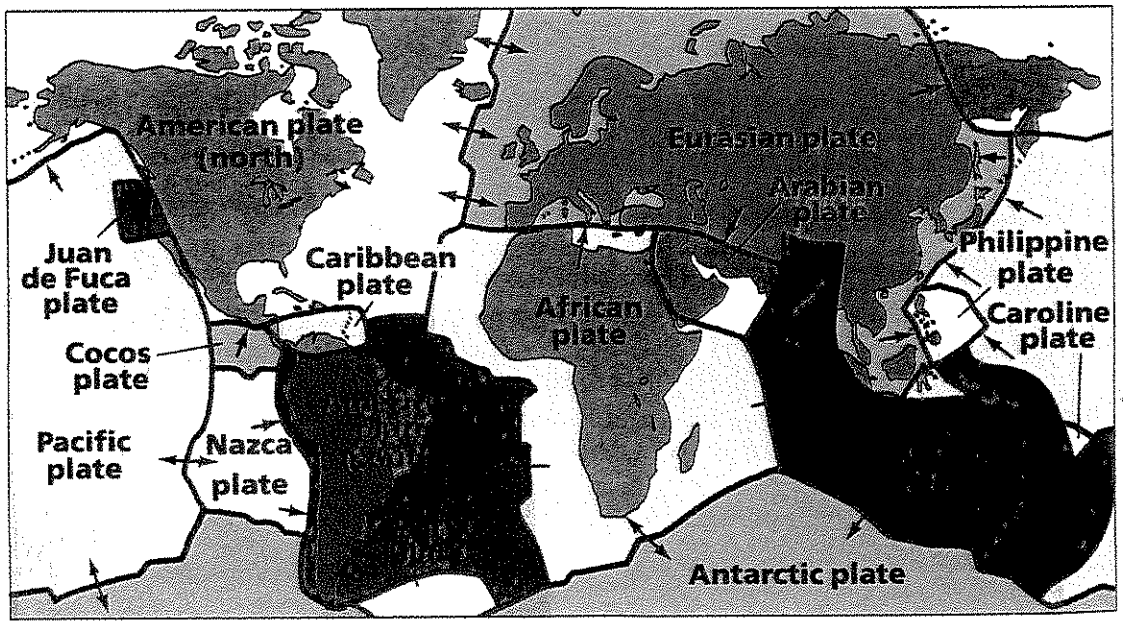
Calculate: About how many crustal plates have been identified?

Floating Plates Crustal plates float on the lower part of the mantle. This part of the mantle is made up of rock that flows like a thick liquid. The crustal plates float like rafts on a lake. The continents and oceans are carried on the plates like the passengers on a raft.

Name: On which part of the earth do crustal plates float?

Theory of Plate Tectonics Today, scientists have a **theory** (THEE-uh-ree) to explain how the continents are drifting apart. A theory is a statement of an idea that has been supported by evidence over a period of time. Using information that supports seafloor spreading and continental drift, scientists stated the **theory of plate tectonics** (tek-TAHN-iks). The theory of plate tectonics combines the theories of continental drift and seafloor spreading. The theory of plate tectonics states how and why the continents move. It states that the earth's crust is broken into crustal plates. The continents move because they are carried along on the moving plates.

Name: What two theories does plate tectonics combine?



Name _____ Class _____ Date _____

8–4 What is plate tectonics?

Lesson Review

Part A *Complete the following.*

1. What are crustal plates? _____
2. What two layers of the earth make up crustal plates? _____
3. About how many crustal plates have been identified? _____
4. On what part of the earth do the crustal plates float? _____
5. State the theory of plate tectonics in your own words. _____

_____

Part B *Read each statement. If the statement refers to continental drift, write a "C" in the space provided. If the statement refers to sea-floor spreading, write an "S" in the space provided.*

_____ 1. The earth's crust is broken into plates.

_____ 2. The continents have moved during the earth's history.

_____ 3. New ocean floor is formed at the mid-ocean ridges.

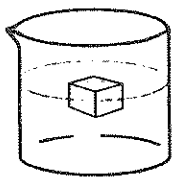
_____ 4. The continents were once part of one giant landmass.

_____ 5. Old crust is pushed into the mantle at subduction zones.

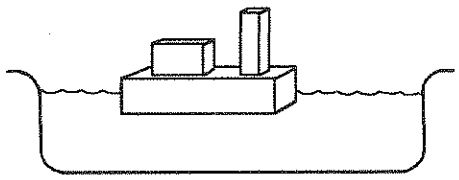
Skill Challenge

Skills: *interpreting a model, synthesizing information*

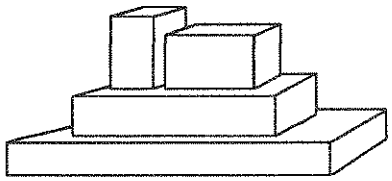
Place a check mark beneath the diagram that would be best to use to help explain plate tectonics to someone.



a. _____



b. _____



c. _____

Explain your choice. _____

_____

_____

_____

8-5 What causes plate tectonics?

Objective ▸ Describe how convection currents cause plate tectonics.

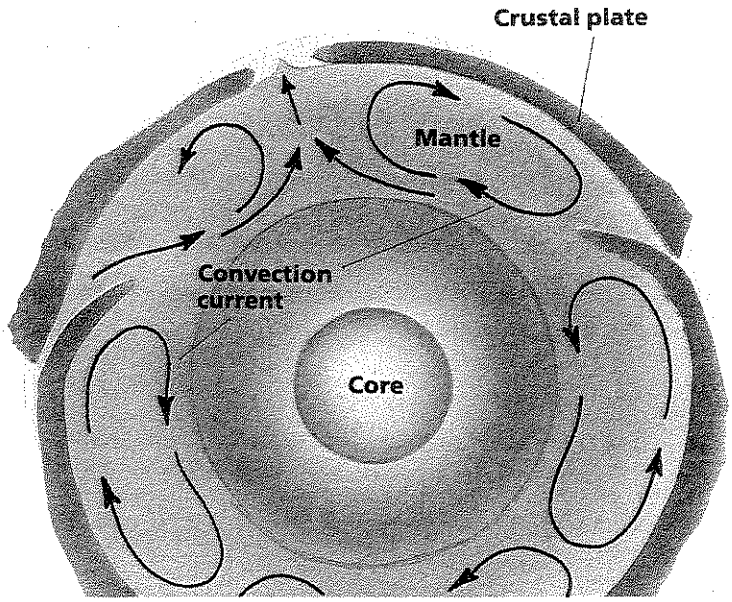
TechTerm

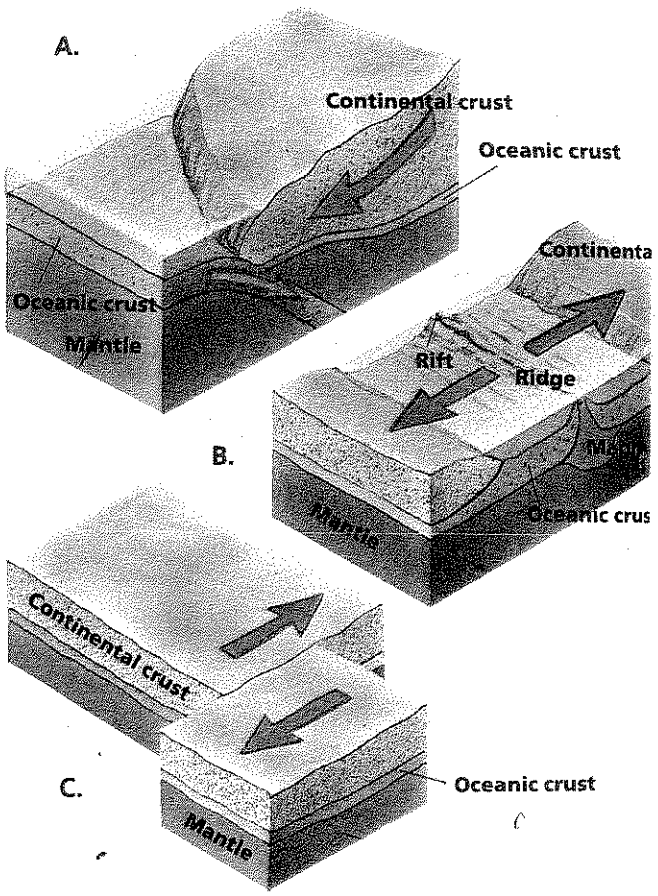
▸ **convection** (kuhn-VEK-shun) **current:** movement of a gas or liquid caused by changes in temperature

Convection Currents A **convection** (kuhn-VEK-shun) **current** is the movement of a gas or a liquid caused by differences in temperature. For example, warm air rises and cool air sinks to take its place. When you put a pan of water on the stove to boil, the water is heated by convection. The water at the bottom of the pan gets hot first. The hot water rises. Cool water at the top of the pan sinks.

Define: What is a convection current?

Inside the Mantle Scientists think that giant convection currents in the earth's mantle cause the movement of crustal plates. The mantle rock close to the core, or center of the earth, is hot. The mantle rock farther from the core is cooler. The hot mantle rock rises. The cooler mantle rock sinks deeper into the mantle. As the cooler rock gets closer to the core, it heats up. The hot rock rises. This process repeats in an endless cycle. The crustal plates are carried along like packages on a moving conveyor belt.





State: What causes the movement of crustal plates?

The Restless Earth The crustal plates move in different ways. Some plates are moving toward each other. At these places, two plates hit each other. Sometimes the oceanic crust is pushed under continental crust. The oceanic crust is pushed into the mantle. Sometimes the plates crumple up. Other plates are moving apart. These plates are mostly in the oceans along rift valleys. In some places, two plates slide past each other. They do not move smoothly.

List: What are three ways plates move?

Name _____ Class _____ Date _____

8–5 What causes plate tectonics?

Lesson Review

Part A *In the space provided, write the letter of the term that best completes each statement..*

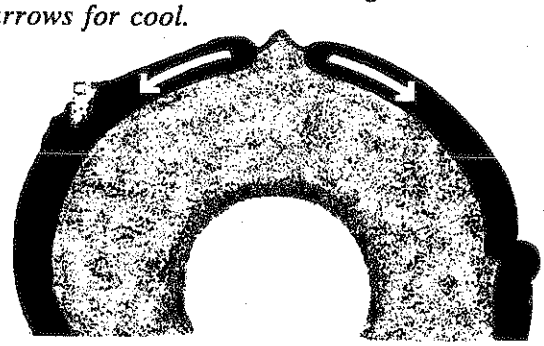
_____ 1. A convection current is caused by differences in
a. temperature. **b.** air pressure. **c.** mass. **d.** color.

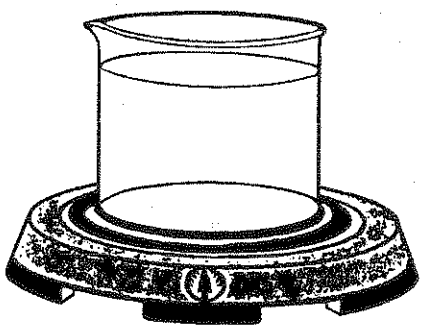
_____ 2. Scientists think that the movement of crustal plates is caused by
a. conveyor belts **b.** heat in the earth's core. **c.** convection currents.
d. pressure in the earth's crust.

_____ 3. Crustal plates that move apart most likely are located along
a. mountains. **b.** continents. **c.** islands. **d.** rift valleys.

_____ 4. In the earth, hot melted rock, rises from the
a. core. **b.** crust. **c.** inner core. **d.** mantle.

Part B *Draw arrows on each diagram to show a convection current. Use red arrows for hot and blue arrows for cool.*



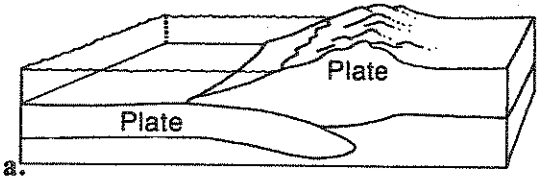


Skill Challenge

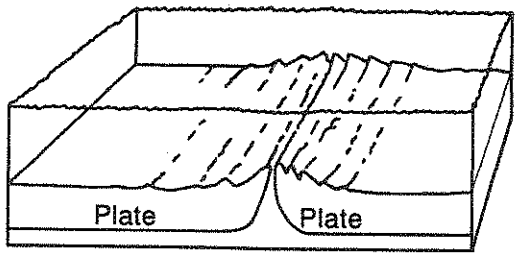
Skills: *modeling, analyzing*

On each diagram, draw arrows to show the different ways in which crustal plates move.

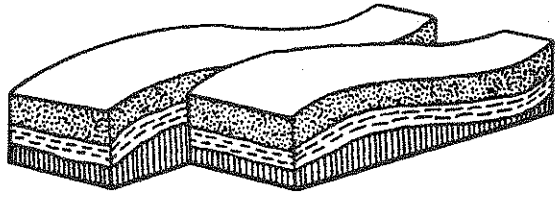
a.



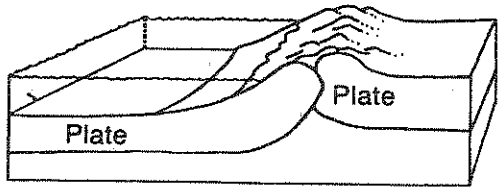
b.



c.



d.



8-6 What are some effects of plate tectonics?

Objective ▸ Explain how plate tectonics causes changes on the earth's surface.

TechTerms

- **hot spot:** place where magma reaches the surface within a crustal plate
- **magma chamber:** underground pocket of molten rock

Earthquakes In some areas, two crustal plates slide past each other. The San Andreas fault, in California, is one place where two plates are sliding past each other. Many earthquakes are caused by the movement of plates at a fault. The San Francisco earthquakes of 1906 and 1989 were caused by the movement of crustal plates at the San Andreas fault.

Name: What is caused by two plates sliding past each other at a fault?

Mountain Building When two plates collide, oceanic crust may be pushed down under continental crust. When this happens, the continental crust crumples. It is pushed upward to form new mountains. Mountains along the western coasts of North and South America were formed in this way. They are young mountains and are still rising.

Two crustal plates carrying continents may collide without one plate being pushed down under the other. The Himalaya Mountains were formed in this way. The plate carrying India collided with the Eurasian plate. The edges of the two plates buckled upward, forming the Himalayas.

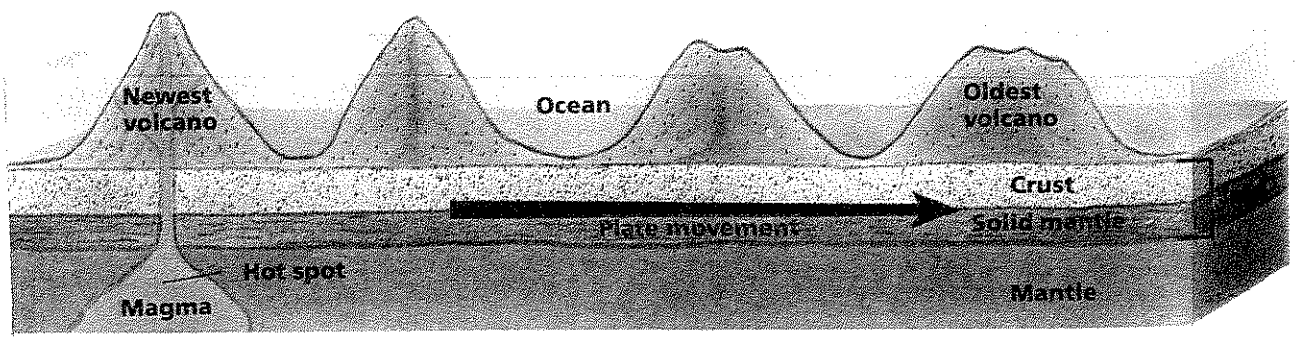
Identify: What mountain range was formed by the collision of two continents?

Volcanoes At subduction zones, friction between the oceanic crust and the continental crust produces a great deal of heat. The heat melts the rocks in the crust, forming magma. The magma collects in underground pockets called **magma chambers.** The magma is hotter than the surrounding rock. It works its way to the surface by melting the solid rock around it. Magma also moves through cracks in the rock. When the magma reaches the surface, a volcano forms. Mt. St. Helens and Mt. Hood are volcanoes that formed in this way.

Describe: How does magma reach the surface?

Islands Some islands are formed by plate tectonics. The Hawaiian Islands are a chain of volcanic islands in the Pacific Ocean. The islands formed one after the other as the Pacific plate moved over a **hot spot.** A hot spot is a place where magma works its way to the surface within a crustal plate. The islands that are farthest west are the oldest. The islands to the east are the youngest. The big island of Hawaii is now over the hot spot. It is still being formed.

Describe: How were the Hawaiian Islands formed?



Name _____ Class _____ Date _____

8–6 What are some effects of plate tectonics?

Lesson Review

Part A *Complete the following.*

1. What is the name of the large fault in California? _____
2. What is a hot spot? _____
3. What is a magma chamber? _____
4. Name three features on the earth's surface formed by plate tectonics activity. _____

_____

Part B *Match the event or feature of the earth to how it was formed.*

_____ 1. Two crustal plates slide past each other.

_____ 2. Two crustal plates carrying continents collide.

_____ 3. Underground magma chambers form at subduction zones.

_____ 4. Hot spots form in a crustal plate.

a. Eruption of Mount St. Helens

b. San Francisco earthquake — 1906

c. The Hawaiian Islands

d. The Himalayas

Skill Challenge

Skills: *modeling, analyzing*

Study the diagram. Answer the questions.

1. What do you think an island arc is? _____

_____

2. Where do island arcs form? _____
3. Which volcano is the oldest — A, B, C, D, or E? _____
4. a. Which volcano is active? _____

   b. Which volcanoes are inactive? _____
5. Label the place where magma is melting.