KEY CONCEPT

6.4 Plates converge or scrape past each other.

BEFORE, you learned

- Plates move apart at divergent boundaries
- In the oceans, divergent boundaries mark where the sea floor spreads apart
- On land, continents split apart at divergent boundaries

NOW, you will learn

- What happens when two continental plates converge
- What happens when an oceanic plate converges with another plate
- What happens when one plate scrapes past another plate

VOCABULARY

subduction p. 206
continental-continental collision p. 207
oceanic-oceanic subduction p. 208
oceanic-continental subduction p. 209

EXPLORE Tectonic Plates

What happens when tectonic plates collide?

PROCEDURE

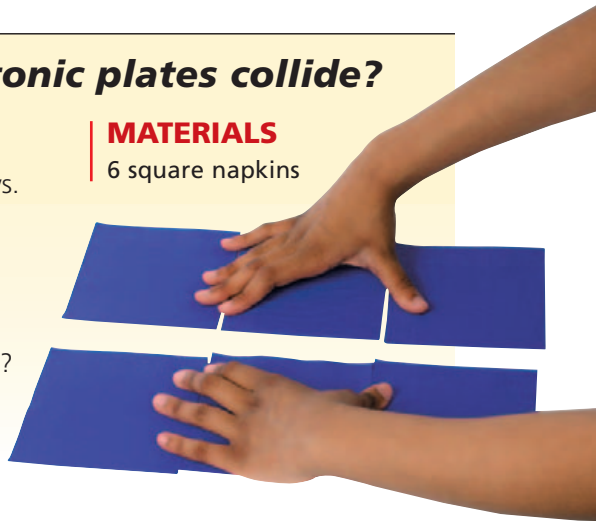
1. Arrange six square napkins in two rows.
2. Slowly push the two rows of napkins together. Observe what happens.

MATERIALS

6 square napkins

WHAT DO YOU THINK?

- In what ways did the napkin edges move?
- How might your observations relate to the movement of tectonic plates?



Tectonic plates push together at convergent boundaries.

You read earlier that new crust forms at divergent boundaries where plates move apart. At convergent boundaries, where plates push together, crust is either folded or destroyed.

When two plates with continental crust collide, they will crumple and fold the rock between them. A plate with older, denser oceanic crust will sink beneath another plate. The crust melts in the asthenosphere and is destroyed. When one plate sinks beneath another, it is called **subduction.** The word is based on the Latin prefix *sub-*, meaning "under," and the Latin *ducere,* meaning "to lead." Therefore, subduction is a process in which one plate is "led under" another.

There are three types of convergent boundaries: where two continental plates meet, where two oceanic plates meet, or where an oceanic plate and a continental plate meet. Major geologic events occur at all three types of boundaries.

VOCABULARY
Remember to make a description wheel for the terms in this section.

Continental-Continental Collision

A **continental-continental collision** occurs where two plates carrying continental crust push together. Because both crusts are the same density, neither plate can sink beneath the other. If the plates keep moving, their edges crumple and fold, as in the diagram below.

You can see the same effect if you put two blocks of clay on a table and push them together. If you push hard enough, one or both of the blocks will buckle. One cannot sink under the other, so the clay folds under the pressure.

In some cases, the folded crust can be pushed up high enough to form mountains. Some of the world's largest mountains appear along continent-continent boundaries. For instance, the European Alps, shown in the photograph at right, are found where the African and European plates are colliding. The tallest mountains in the world, the Himalayas, first formed when the Indian Plate began colliding with the European Plate.

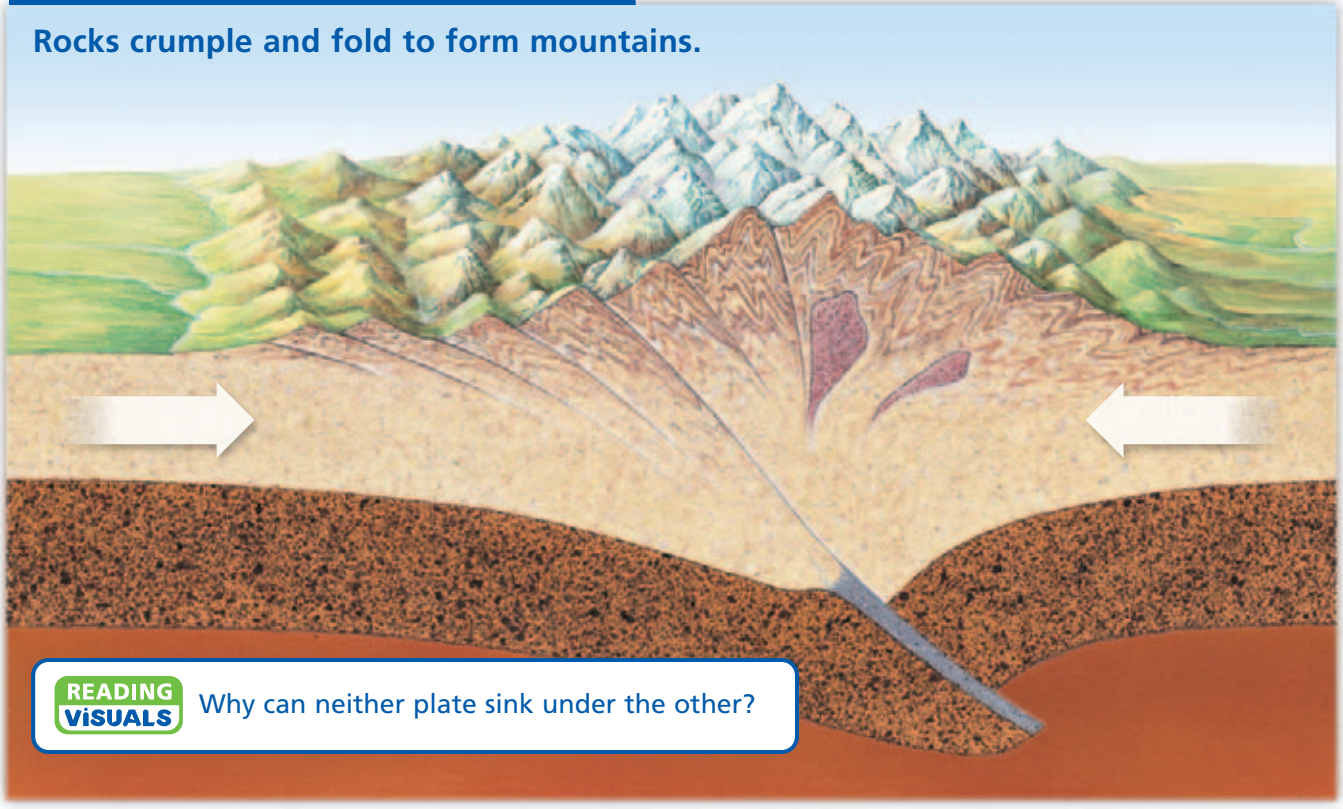
The Himalayas and the Alps are still forming today. As long as the plates keep moving, these mountains will keep rising higher.

The European Alps began rising nearly 40 million years ago as a section of the African Plate collided with the European Plate.

CHECK YOUR READING Explain how colliding plates form mountain ranges.

Convergent Boundary—Collision

Rocks crumple and fold to form mountains.



READING VISUALS Why can neither plate sink under the other?

Oceanic-Oceanic Subduction

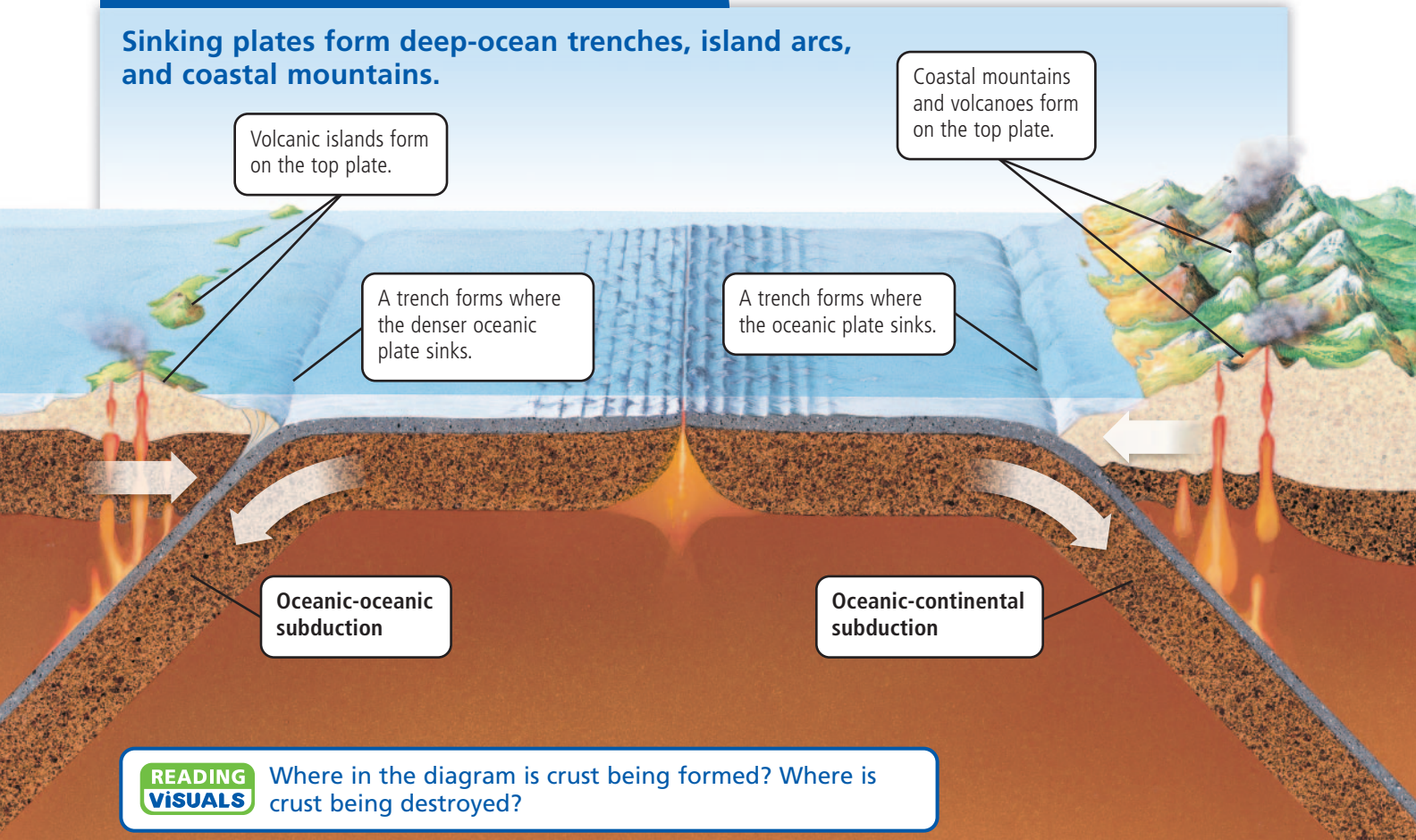
An **oceanic-oceanic subduction** occurs where one plate with oceanic crust sinks, or subducts, under another plate with oceanic crust. The older plate sinks because it is colder and denser than the younger plate. When the older crust reaches the asthenosphere, it melts in the intense heat. Two main features form at oceanic-oceanic subductions: deep-ocean trenches and island arcs.

Deep-Ocean Trenches These trenches are like deep canyons that form in the ocean floor as a plate sinks. Most deep-ocean trenches are found in the Pacific Ocean. For example, at the Mariana Trench, the Pacific Plate is sinking under the Philippine Plate. This trench is the deepest place in the world's oceans, extending nearly 11,000 meters (36,000 ft) into the sea floor.

Island Arcs There are chains of volcanic islands that form on the top plate, parallel to a deep-ocean trench. As oceanic crust of the sinking plate melts, magma rises through the top plate. Over time, the flows build up a series of islands. Island arcs include the Philippine Islands, the Aleutian Islands of Alaska, and the islands of Japan.

Convergent Boundaries—Subduction

Sinking plates form deep-ocean trenches, island arcs, and coastal mountains.



READING VISUALS Where in the diagram is crust being formed? Where is crust being destroyed?

Oceanic-Continental Subduction

An **oceanic-continental subduction** occurs when ocean crust sinks under continental crust, as shown in the diagram on page 208. The oceanic crust sinks because it is colder and denser than the continental crust. At these sites, deep-ocean trenches also form, along with coastal mountains.

Deep-Ocean Trenches Some of the world's youngest trenches are in the eastern Pacific Ocean. Here, for example, the Pacific Plate is sinking under the North American Plate. As the oceanic crust moves, it often causes underwater earthquakes.

Coastal Mountains As oceanic crust sinks under a continent, the continental crust buckles to form a range of mountains. These mountains, like island arcs, parallel a deep-ocean trench. As the diagram on page 208 shows, some of these mountains are volcanoes, which form as melted oceanic crust rises through the top plate.

The Cascade Mountains in Oregon and Washington are an example of coastal mountains. They began forming as the Juan de Fuca Plate began sinking under the North American Plate. Some of these peaks, such as Mount St. Helens in Washington, are active volcanoes.

VISUALIZATION CLASSZONE.COM
Explore what happens along plate boundaries.

CHECK YOUR READING Why do deep-ocean trenches form at both types of subduction?

INVESTIGATE Convergent Boundaries

How can you model converging plates?

Tectonic plates move so slowly and are so large that it may be hard to visualize exactly how they move. Use what you know to design models showing how converging plates collide and subduct.

SKILL FOCUS
Designing models

MATERIALS
- clay in three or more colors
- poster board
- marker pens

TIME
30 minutes

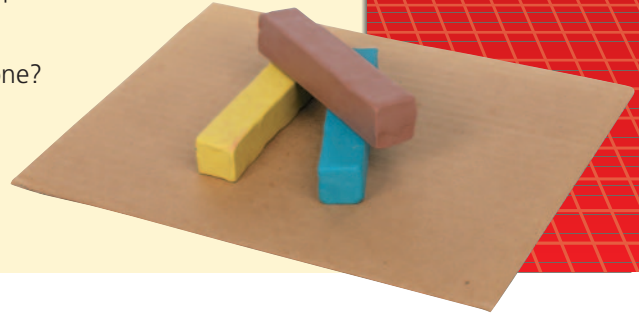
DESIGN YOUR OWN

PROCEDURE

1. Design your models using the materials listed. You can use the diagrams on pages 207–208 as a guide.
2. Add more clay to your models if you need it.

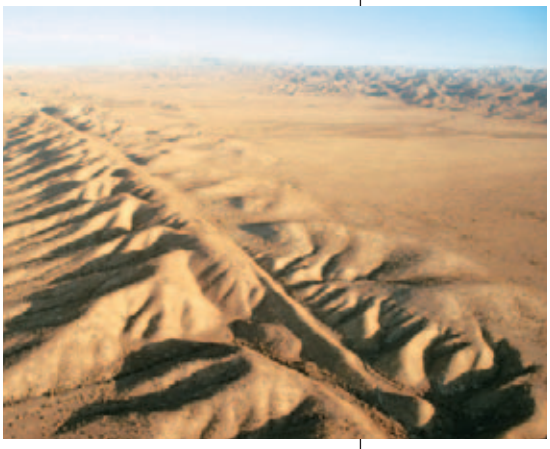
WHAT DO YOU THINK?

- Describe how your models worked. You can draw a picture of each model to go along with your description.
- How well did your models represent each type of zone? Did each model work? Why or why not?
- How would you modify your designs now that you have seen the results?



Tectonic plates scrape past each other at transform boundaries.

You learned that crust is formed at a divergent boundary and folded or destroyed at a convergent boundary. However, at a transform boundary, crust is neither formed nor destroyed. Here, two plates move past each other in opposite directions, as shown in the diagram below. As the plates move, their edges scrape and grind against each other.



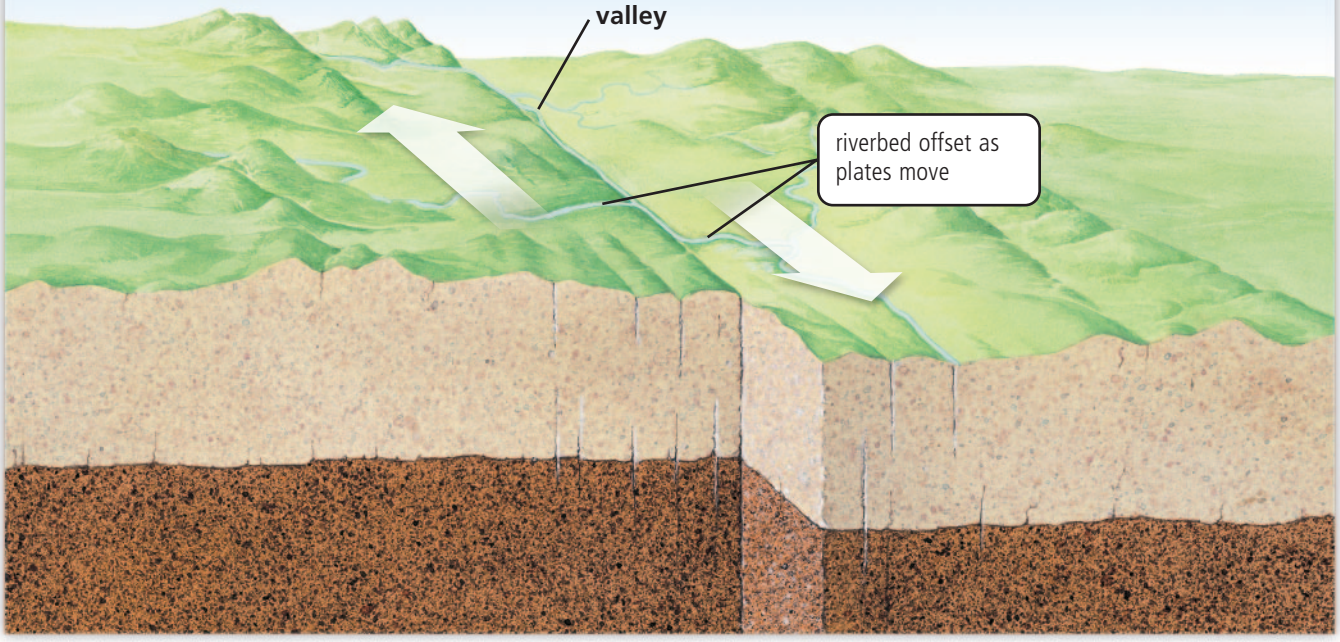
This long crack in the earth reveals the transform boundary known as the San Andreas Fault.

Transform boundaries occur mostly on the sea floor near mid-ocean ridges. They also occur on land, where some are clearly visible as long cracks in Earth's surface. The San Andreas Fault in California is a transform boundary that runs from the Gulf of California through the San Francisco area. It marks where the Pacific Plate and part of the North American Plate are moving in opposite directions. If the plates keep moving at their present rate, Los Angeles will be a suburb of San Francisco in about 10 million years.

CHECK YOUR READING What makes the San Andreas Fault a transform boundary?

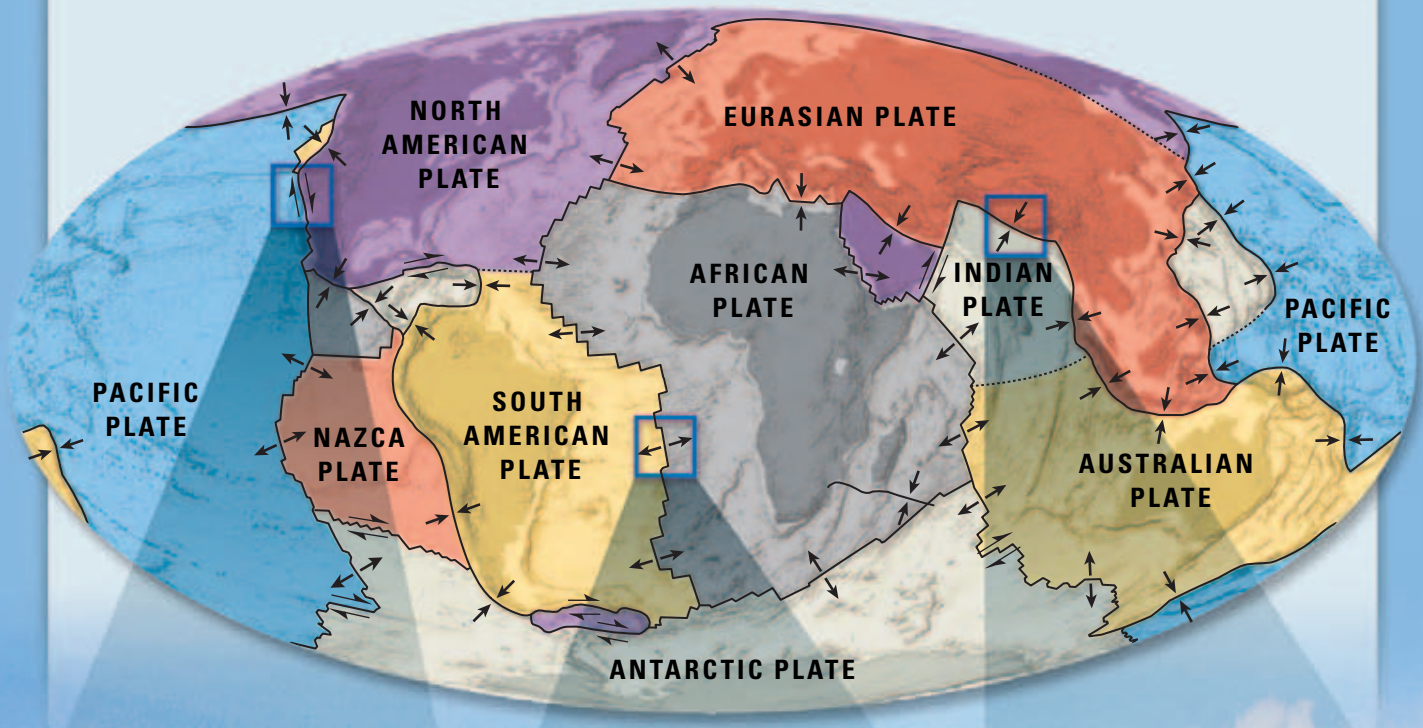
Transform Boundary

Plate edges grind and scrape past each other. Crust is neither formed nor destroyed.

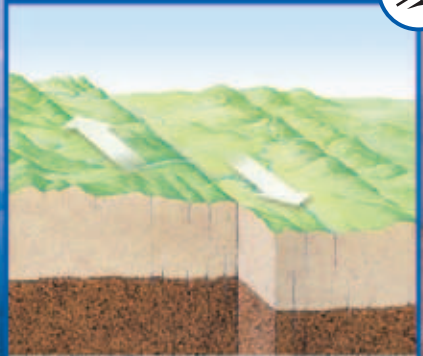


Tectonic Plate Boundaries

There are three types of plate boundaries: transform, divergent, and convergent. Major geologic events occur at all three types.

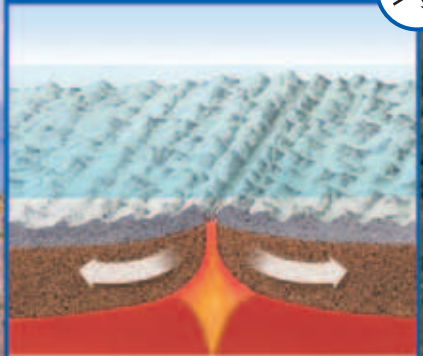


Transform Boundaries



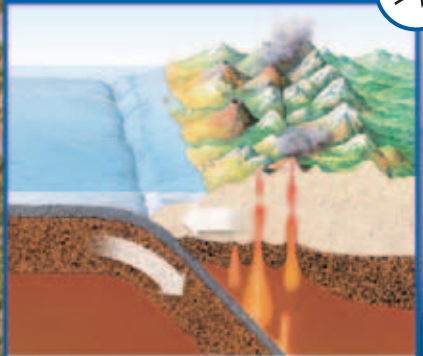
Plates scrape horizontally past each other. Crust is neither formed nor destroyed.

Divergent Boundaries



As plates move apart, new crust is built, forming mid-ocean ridges and rift valleys.

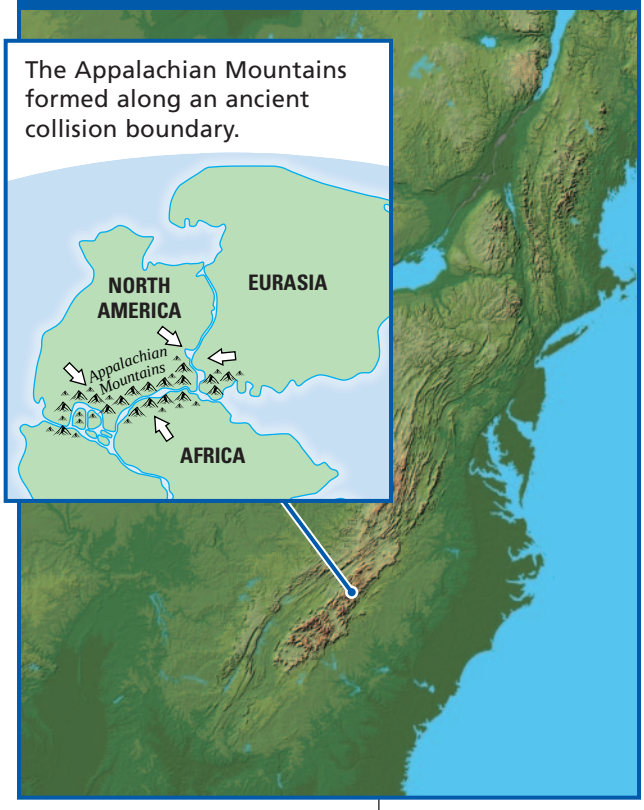
Convergent Boundaries



Crust is destroyed where plates subduct. It is folded where plates collide.

READING VISUALS Where else on the map above can you find a transform, divergent, and convergent boundary?

Current U. S. Eastern Coastline



The theory of plate tectonics helps geologists today.

The theory of plate tectonics changed the way that scientists view Earth. They learned that the planet's lithosphere has been in motion for millions of years. Today, the theory helps them to explain Earth's past and to predict what might happen along plate boundaries in the future.

By studying rock layers and using the theory, geologists can uncover the history of any region on Earth. For example, in the eastern United States, the deformed and folded rocks in the Appalachian Mountains are evidence of an ancient convergent boundary. Geologists discovered that these rocks are the same type and age as rocks in northwest Africa. These facts reveal that the mountains formed when North America collided with Africa and Eurasia as part of Pangaea. Where the plates eventually pulled apart, the rift valleys formed part of the current U. S. eastern coastline.

The theory of plate tectonics also gives scientists a way to study and predict geologic events. Scientists can predict, for example, that there are likely to be more earthquakes where plates slide past each other. They can look for volcanic activity where plates are sinking beneath other plates. And they can predict that mountains will continue to rise where plates push together.

CHECK YOUR READING What future events can scientists predict using the theory of plate tectonics? Give two examples.

6.4 Review

KEY CONCEPTS

1. What are the three types of convergent boundaries?
2. Describe what happens at a transform boundary.
3. Why is the theory of plate tectonics so important to geologists?

CRITICAL THINKING

4. **Compare and Contrast** Use a Venn diagram to compare and contrast oceanic-oceanic and oceanic-continental subduction boundaries.
5. **Interpreting Visuals** Look again at the map on page 211. Identify the plates and type of boundary that formed the Andes Mountains on the west coast of South America.

CHALLENGE

6. **Synthesize** Sketch a diagram of the following landscape and label all the features. A plate with oceanic crust is sinking beneath a plate with continental crust. Further inland on the continent, a transform boundary can be seen in Earth's crust.