9.3 Theory of Plate Tectonics

Reading Focus

Key Concepts

- What is the theory of plate tectonics?
- What are the three types of plate boundaries?

Vocabulary

- plate
- plate tectonics
- divergent boundary
- convergent boundary
- transform fault boundary
- continental volcanic arc
- volcanic island arc

Reading Strategy

Comparing and Contrasting Copy the table. After you read, compare the three types of plate boundaries by completing the table.

Boundary Type	Relative Plate Motion
convergent	a. ____?____
divergent	b. ____?____
transform fault	c. ____?____

During the 1960s, scientists realized that sea-floor spreading explained part of Alfred Wegener's idea of continental drift. It explained how ocean basins could open and close. Canadian geologist J. Tuzo Wilson combined the evidence for sea-floor spreading with other observations. Wilson and other scientists soon developed a new theory that led to a revolution in geology.

Earth's Moving Plates

Wilson suggested that the lithosphere is broken into several huge pieces, called **plates**. Deep faults, like the cracks in the shell of a hard-boiled egg, separate the different plates. **In the theory of plate tectonics, Earth's lithospheric plates move slowly relative to each other, driven by convection currents in the mantle.** The plates, shown in Figure 15 on pages 262–263, generally are made up of both oceanic lithosphere and continental lithosphere.

Causes of Plate Motion Wegener had failed to explain how the lithosphere could move. The theory of plate tectonics identified a force that could set Earth's outer shell in motion. According to Wilson, convection currents within Earth drive plate motion. Hot material deep in the mantle moves upward by convection. At the same time, cooler, denser slabs of oceanic lithosphere sink into the mantle.

Effects of Plate Motion Plate motion averages about 5 centimeters per year. That's about as fast as your fingernails grow. The results of plate motion include earthquakes, volcanoes, and mountain building.

Facts and Figures

The continents are still moving, and eventually they will probably collide to form a single landmass again. Earth scientists predict that the continents will probably merge again somewhere in the Pacific Ocean. When will this happen? Research suggests that, based on the current rate of plate movements, a single landmass is formed about once every 500 million years. Since it has been about 200 million years since Pangaea broke up, the next supercontinent may form in a few hundred million years.

Section 9.3

1 FOCUS

Section Objectives

9.7 **Explain** the theory of plate tectonics.
9.8 **Describe** lithospheric plates.
9.9 **Identify** the three types of plate boundaries.

Reading Focus

Build Vocabulary L2

Concept Map Have students make a concept map using the term *plate tectonics* as the starting point. All the vocabulary terms in this section should be used.

Reading Strategy L2

a. plates move together
b. plates move apart
c. plates slide past each other

2 INSTRUCT

Earth's Moving Plates

Build Science Skills L2

Using Analogies ACTIVITY
Crack the shell of a hard-boiled egg. Ask students if the egg reminds them of anything. The egg can be seen as a tiny model of Earth. The thin eggshell is analogous to Earth's crust, divided into plates. Within the shell is the firm mantle. Have students move the pieces of shell around. They should notice how the shell buckles in some places and exposes "mantle" in other places. This movement is analogous to the movement of Earth's crust. However, Earth's movement results in the formation of mountains, earthquakes, and new ocean floor.
Kinesthetic, Visual

MAP MASTER Skills Activity

Answer
Locate South American plate. Divergent: Caribbean plate, Mid-Atlantic Ridge; Southeast Indian Ridge, Antarctic plate. Convergent: Nazca plate, South American plate; Australian-Indian plate, Eurasian plate. Transform fault: Antarctic plate, Pacific plate; Caribbean plate, North American plate

Use Visuals
L1

Figure 15 Have students examine the figure. They may need help from an atlas or a globe to locate the features in the questions. Ask: **How do you think the Andes Mountains were formed?** *(The Nazca plate collided with the South American plate.)* **How do you think the Red Sea was formed?** *(The African plate and the Arabian plate moved apart, forming a rift that became the Red Sea.)* **Which plate is the largest? Where is it located?** *(The Pacific plate; it is mostly within the Pacific Ocean.)*
Visual

Teacher Demo

A Convergent Model
L2

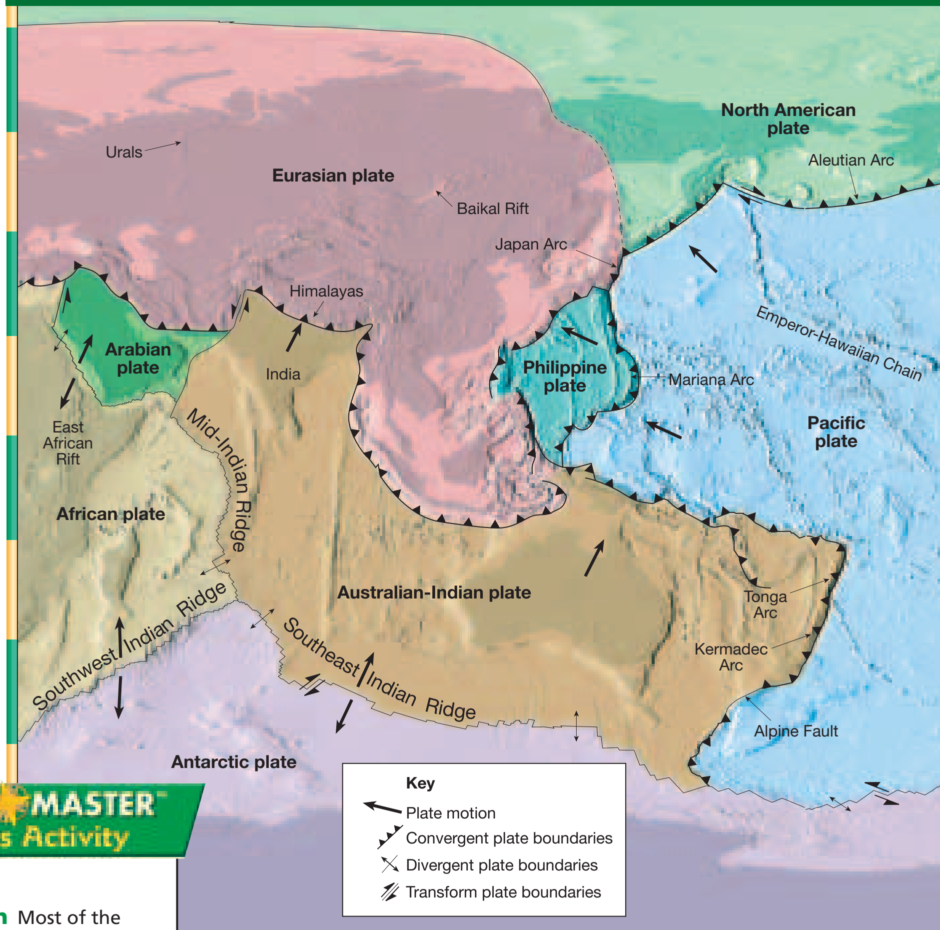
Purpose Students will observe what happens when two plates collide in a model of a convergent boundary.

Materials two slabs of modeling clay, wax paper

Procedure Place the slabs of clay on the wax paper on a table so they will slide easily. Push the two slabs of clay together to model a collision of two plates.

Expected Outcome The clay slabs will buckle up to create folds and breaks that resemble mountains.
Kinesthetic, Visual

Earth's Tectonic Plates



MAP MASTER Skills Activity

Figure 15
Location Most of the Earth's plates are made up of both oceanic and continental lithosphere.
Locate Find a major plate that includes an entire continent plus a large area of seafloor. Locate two examples of a divergent boundary, a convergent boundary, and a transform fault boundary.

Types of Plate Boundaries Interactions among individual plates occur along plate boundaries. The three types of plate boundaries are convergent, divergent, and transform fault boundaries. Each plate contains a combination of each of the three types.

Divergent boundaries are found where two of Earth's plates move apart. Oceanic lithosphere is created at divergent boundaries—think of how sea-floor spreading adds rock to the ocean floor.

Convergent boundaries form where two plates move together. Lithosphere can be destroyed at convergent boundaries—think about how oceanic lithosphere sinks into the mantle during subduction.

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Customize for Inclusion Students

Students who are learning disabled will benefit by having globes in the classroom. You might want to mark the major plates on a globe so students can better visualize how Earth's lithosphere is divided into tectonic plates.

Transform fault boundaries occur where two plates grind past each other. Along transform boundaries, lithosphere is neither created nor destroyed.

Plates may shrink or grow in area, depending on the locations of convergent and divergent boundaries. For example, you can see in Figure 15 that the Philippine plate is subducting beneath Asia, but has no ridges as boundaries to create new lithosphere. As a result, the plate is getting smaller because of subduction.

Reading Checkpoint *What is a transform fault boundary?*

Facts and Figures

Wide Plate Boundaries Earth is always more complicated than a book can describe. The boundaries between plates are rarely the sharp lines that are shown in maps and figures. Significant deformation occurs where two plates interact. For instance, the entire Himalayas and much of southern China is actually part of the India/Asia plate boundary, actively deforming from the collision. Much of the western United States, like the Basin and Range region, is actually a "plate boundary" area and is internally deforming. The San Andreas fault is part of a wide system of faults and deformation many hundreds of kilometers across. In fact, about 15% of Earth's surface can be considered plate boundary areas. This is half as much area as the amount of land at Earth's surface (30%).

Address Misconceptions L2

Students may think that the movement of lithospheric plates causes Earth's surface area to become either larger or smaller (depending on which way the plates move). Explain that individual plates can become larger or smaller, but Earth's total surface area cannot change. Give students a basketball or soccer ball and ask them to imagine what will happen to the interior of the ball if the surface area changed. *(If surface area decreased, the interior would become compressed and internal pressure would increase. If surface area increased, either the interior would expand or the lithosphere would separate from the mantle.)*
Visual, Logical

Use Community Resources L2

Invite a geologist or physicist in your community to talk to the class about global positioning systems (GPS), how they work, and what they are used for. Encourage students to think about and ask questions about how GPS can be used to measure the movements of landmasses.
Verbal, Interpersonal

Answer to . . .

Figure 15 *Several plates, including the African, South American, and Antarctic, include a continent plus a large area of ocean floor. Check to determine if students can correctly identify divergent, convergent, and transform boundaries on the map.*

Reading Checkpoint *Plate boundary where two plates slide past each other and lithosphere is not created or destroyed*

Teacher Demo

Creating a Continental Rift L2

Purpose Students will observe how fractures grow to create a continental rift as a result of the stretching of the lithosphere.

Materials 2 slices of individually wrapped American cheese, dull knife or fingernail, metric ruler

Procedure Using your fingernail or a dull knife, make a small cut in the center of a cheese slice parallel to one edge. Pull on the two cheese edges parallel to the cut. You will be pulling perpendicular to the direction of the cut. Observe how the small defect (the cut) concentrates the tearing. Observe the shape of the fracture that forms, especially the pointed tips where the tearing is taking place, and how the fracture tips move faster as the fracture gets bigger.

Now, make a cut near the center of the second piece of cheese. Make a second parallel cut about 2 cm below and 2 cm to the right of the first cut. Pull on the cheese as before. Fractures will begin to form from each of the cuts. As the tips of these fractures begin to move past each other, they will begin to curve toward each other and eventually link up into a single fracture.

Safety Do not allow students to eat the cheese.

Expected Outcome Students should infer that the fractures in the cheese are analogous to the formation of faults that result in the development of a rift valley.
Visual, Logical

Formation of a Rift Valley

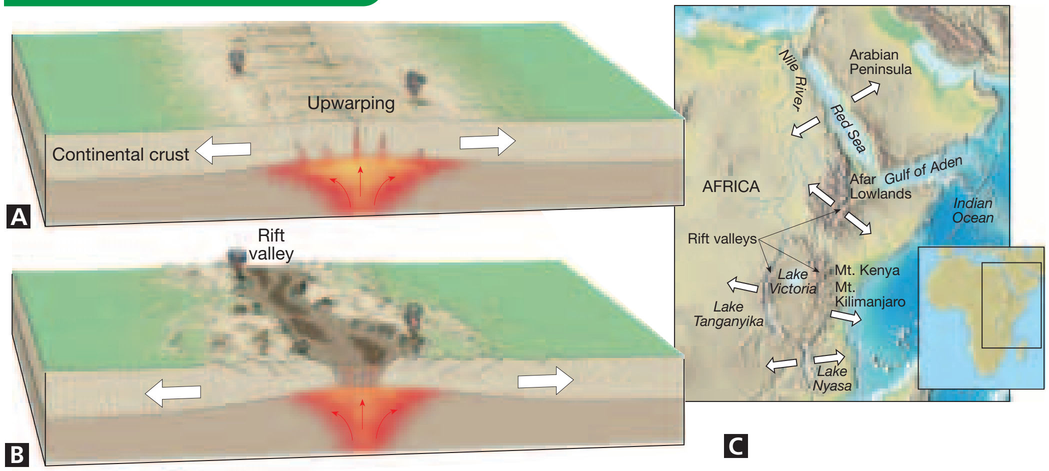


Figure 16 The East African rift valleys may represent the initial stages of the breakup of a continent along a spreading center. **A** Rising hot rock forces the crust upward, causing numerous cracks in the rigid lithosphere. **B** As the crust is pulled apart, large slabs of rock sink, causing a rift zone. **C** Further spreading causes a narrow sea like the Red Sea.
Relating Cause and Effect ***What causes the continental crust to stretch and break?***

Divergent Boundaries

Along divergent boundaries, plates move apart. Because they are the areas where sea-floor spreading begins, divergent boundaries are also called spreading centers. **Most divergent boundaries are spreading centers located along the crests of mid-ocean ridges. Some spreading centers, however, occur on the continents.** You can think of these plate boundaries as *constructive* plate margins because this is where new oceanic lithosphere is produced.

When a spreading center forms on land, the process can literally split a continent apart. As shown in Figure 16A, the process begins when the forces of plate motion begin to stretch part of the lithosphere. At the same time, plumes of hot rock rise from the mantle. The rising plumes bend the crust upward, weakening and fracturing it. The fractures allow magma to reach the surface. The result is the floor of a new rift valley, as shown in Figure 16B.

Examples of active rift valleys include the Rhine Valley in northwestern Europe and the Great Rift Valley in East Africa. The Great Rift Valley, shown in Figure 16C, may represent the first stage in the breakup of the African continent. If the sides of the rift valley continue to move apart, the rift could eventually become a narrow sea similar to the Red Sea.

Reading Checkpoint *How do rift valleys begin to form?*

Facts and Figures

The first rift that developed as Pangaea began to break apart 200 million years ago resulted in the separation of North America and Africa. Large quantities of basalts were produced. These basalts can be found today as weathered rock beds along the eastern seaboard of the United States. They are buried beneath rocks that form the continental shelf and have been radiometrically dated as being between 200 million and 165 million years old. The rifting eventually formed the Atlantic Ocean basin.

Convergent Boundaries

At convergent boundaries, plates collide and interact, producing features including trenches, volcanoes, and mountain ranges. Along convergent boundaries, older portions of oceanic plates return to the mantle. As a result, Earth's total surface area can remain the same, even though new lithosphere is constantly being added at mid-ocean ridges.

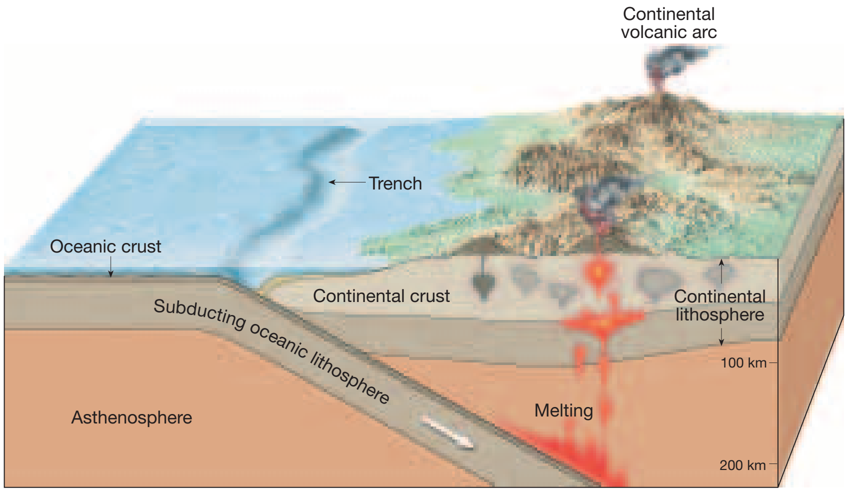
Because lithosphere is "destroyed" at convergent boundaries, they are also called *destructive* plate margins. As two plates slowly converge, the leading edge of one is bent downward, allowing it to slide beneath the other. At destructive plate margins, oceanic crust is subducted into the mantle.

The type of lithosphere involved and the forces acting on it determine what happens at convergent boundaries. Convergent boundaries can form between two pieces of oceanic lithosphere, between oceanic lithosphere and continental lithosphere, or between two pieces of continental lithosphere.

Oceanic-Continental When the leading edge of continental lithosphere converges with oceanic lithosphere, the less dense continental lithosphere remains floating. The denser oceanic slab sinks into the asthenosphere. When a descending plate reaches a depth of about 100 to 150 kilometers, some of the asthenosphere above the descending plate melts. The newly formed magma, being less dense than the rocks of the mantle, rises. Eventually, some of this magma may reach the surface and cause volcanic eruptions.

A **continental volcanic arc** is a range of volcanic mountains produced in part by the subduction of oceanic lithosphere. As shown in Figure 17, the volcanoes of the Andes in South America are the product of magma formed during subduction of the Nazca plate.

Figure 17 Oceanic-Continental Convergent Boundary Oceanic lithosphere is subducted beneath a continental plate.
Inferring ***Why doesn't volcanic activity occur closer to the trench?***



Convergent Boundaries

Build Reading Literacy L1

Refer to **p. 420D** in **Chapter 15**, which provides the guidelines for this predicting strategy.

Predict Have students read the section on p. 264 about divergent boundaries. Ask: **Predict what a rift valley might look like if it stopped developing.** *(The valley would probably be filled with ancient volcanic rocks that formed from the magma that rose to the surface.)*
Logical

Use Visuals L1

Figure 17 Have students study the diagram showing an oceanic-continental convergent boundary. Ask: **Which plate is subducted? Which plate floats?** *(The oceanic plate is subducted. The continental plate floats.)* **Why do the two plates in the diagram always move the way they do?** *(The oceanic plate is denser than the continental plate, so it slides under the continental plate and sinks into the asthenosphere.)*
Visual, Logical

Customize for English Language Learners

Encourage students to work in groups to brainstorm different types of boundaries. Their types of boundaries can come from other sciences, such as cell membranes, or from everyday life, such as the boundary between a sidewalk and the strip of grass between the sidewalk and the curb. Ask students what all these boundaries have in common and how they are different.

Answer to . . .

Figure 16 *The continental crust is stretched and broken by the upwarping of the crust, caused by rising magma.*

Figure 17 *The plate doesn't get deep enough for melting to occur until farther from the trench.*

Reading Checkpoint *Rifts begin when the lithosphere is stretched and a plume of hot rock from the mantle weakens and then splits the lithosphere.*

Address Misconceptions

L2

A commonly held misconception is that the volcanoes in a volcanic island arc are interconnected and that an eruption of one volcano in the arc will trigger eruptions in all the volcanoes. Draw a cross-sectional diagram similar to Figure 18. Show a separate magma chamber for each volcano in the arc.
Visual

Use Visuals

L1

Figure 18 Have students study the diagram showing an oceanic-oceanic convergent boundary. Ask: **How is an oceanic-oceanic convergent boundary different from an oceanic-continental convergent boundary?** *(Volcanoes form on the ocean floor in an oceanic-oceanic boundary rather than on Earth's surface.)* **What is formed by sustained volcanic activity at an oceanic-oceanic convergent boundary?** *(an island chain, called a volcanic island arc)*
Visual, Verbal

Use Visuals

L1

Figure 19 Have students study the diagram showing a continental-continental convergent boundary. Ask: **Why isn't the continental lithosphere subducted far into the asthenosphere in this diagram?** *(The continental lithosphere is buoyant and does not sink into the asthenosphere to a great depth.)* **Why aren't volcanoes formed in a continental-continental convergent boundary?** *(Because molten magma that forms down deep is unable to rise all the way to the tops of the mountains. The magma cools within the cores of the mountains to form large granitic plutons.)*
Visual, Verbal

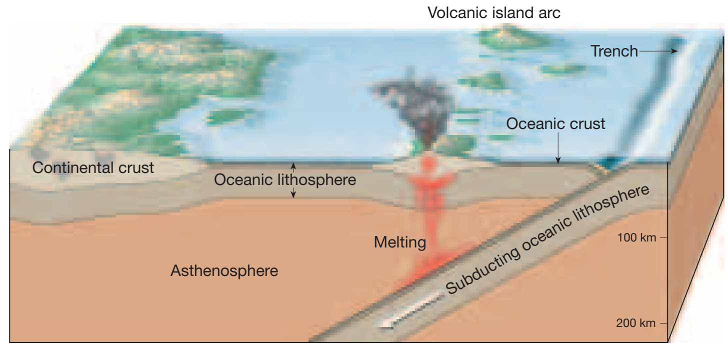


Figure 18 Oceanic-Oceanic Convergent Boundary One oceanic plate is subducted beneath another oceanic plate, forming a volcanic island arc. **Predicting** ***What would happen to the volcanic activity if the subduction stopped?***

Oceanic-Oceanic When two oceanic slabs converge, one descends beneath the other. This causes volcanic activity similar to what occurs at an oceanic-continental boundary. However, the volcanoes form on the ocean floor instead of on a continent, as shown in Figure 18. If this activity continues, it will eventually build a chain of volcanic structures that become islands. This newly formed land consisting of an arc-shaped chain of small volcanic islands is called a **volcanic island arc.** The islands of Java and Sumatra in the Indian Ocean are an example of a volcanic island arc. Next to these islands is the Java trench, where one of the most powerful earthquakes ever recorded occurred in 2004.

Continental-Continental When oceanic lithosphere is subducted beneath continental lithosphere, a continental volcanic arc develops along the margin of the continent. However, if the subducting plate also contains continental lithosphere, the subduction eventually brings the two continents together, as shown in Figure 19. Because continental lithosphere is less dense than oceanic lithosphere, it is not subducted. Instead, the result is a collision between the two continents and the formation of complex mountains.

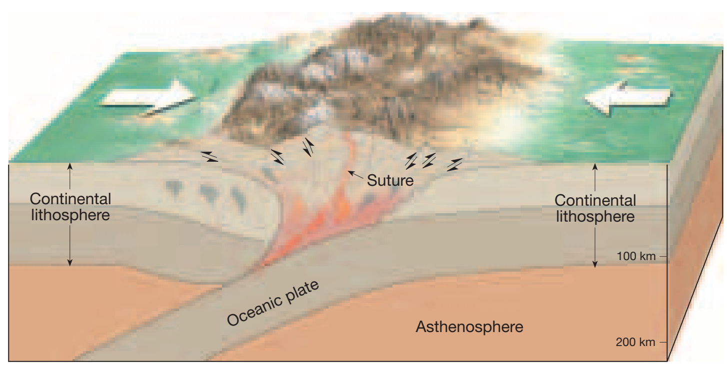


Figure 19 Continental-Continental Convergent Boundary Continental lithosphere cannot be subducted, because it floats. The collision of two continental plates forms mountain ranges. The suture (red line) represents the zone where the two plates meet.

Facts and Figures

Only two volcanic island arcs are located in the Atlantic Ocean—the Lesser Antilles adjacent to the Caribbean Sea and the Sandwich Islands in the South Atlantic. There have been many volcanic eruptions in the Lesser Antilles. In 1902 on the island of Martinique, Mount Pelé erupted, killing 28,000 people and destroying the town of St. Pierre. More recently, the Soufriere Hills Volcano on the island of Montserrat erupted from 1995 until 1997. Although volcanic activity has since decreased, seismic activity has increased. There were several earthquakes on Montserrat in early 2004.

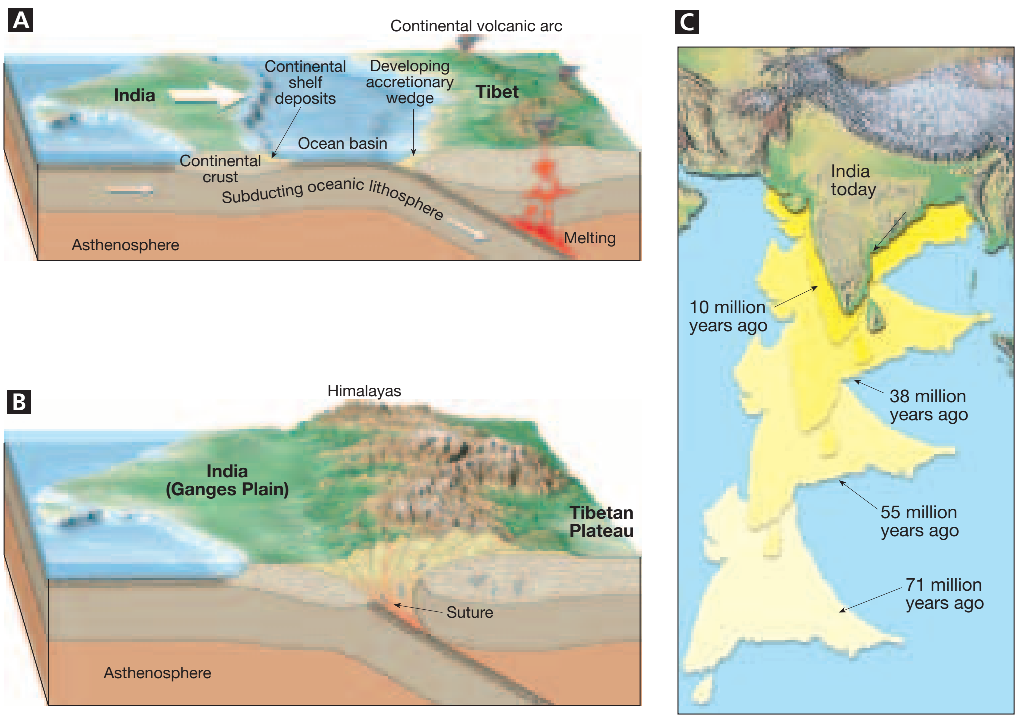
Before continents collide, they are separated by an ocean basin. As the continents move toward each other, the seafloor between them is subducted beneath one of the plates. When the continents collide, the collision folds and deforms the sediments along the margin as if they were placed in a giant vise. A new mountain range forms that is composed of deformed and metamorphosed sedimentary rocks, fragments of the volcanic arc, and possibly slivers of oceanic crust.

This kind of collision occurred when the subcontinent of India rammed into Asia and produced the Himalayas, as shown in Figure 20. During this collision, the continental crust buckled and fractured. Several other major mountain systems, including the Alps, Appalachians, and Urals, were also formed by this process.

Reading Checkpoint *What caused the Himalayas to form?*

Figure 20 **A** The leading edge of the plate carrying India is subducted beneath the Eurasian plate. **B** The landmasses collide and push up the crust. **C** India's collision with Asia continues today.

Collision of India and Asia



Facts and Figures

The Himalayas include the highest mountains on Earth. When India and Asia collided, the leading edge of the Indian plate was forced partially under Asia, generating an unusually great thickness of continental lithosphere. This accumulation accounts in part for the high elevation of the Himalayas and may also explain the elevated Tibetan Plateau to the north.

Build Science Skills L2

Using Analogies The discussion on this page uses an analogy of a giant vise to help students visualize and understand what happens to the lithosphere during a continental-continental collision. Be sure students understand what a vise is. *(a tool that holds an object by squeezing two plates together, usually by turning a large screw)* If they are not familiar with the term, have them look it up in a dictionary, or have another student describe it. Revisit the text and discuss why the analogy is useful. *(A squeezing vise could fold and deform material as colliding continents fold and deform rock)* Ask: **What other analogies might be used to describe continental-continental collisions?** *(Sample answers: small entry rug crumpling as it gets caught between an opening door and a wall, two cars colliding)*
Intrapersonal, Logical

Answer to . . .

Figure 18 *If the subduction stopped, the volcanic activity would probably also soon stop because the source of new magma is the continuing subduction of the oceanic plate.*

Reading Checkpoint *The collision of two continental plates*

Transform Fault Boundaries

Build Science Skills L2

Relating Cause and Effect Remind students that plates in a transform fault boundary move past each other without production or destruction of lithosphere. Ask: **Why does this movement cause earthquakes?** *(The tremendous friction caused by two plates grinding past each other causes earthquakes.)*
Logical

3 ASSESS

Evaluate Understanding L2

To assess students' knowledge of section content, have them write three short paragraphs describing the three convergent boundaries and what results when they converge.

Reteach L1

Have students demonstrate the action of the three convergent boundaries by using their hands to represent the converging plates.

Writing in Science

Students' paragraphs should make the point that the Pacific Ocean should get smaller as ocean floor is subducted beneath the trenches around the margins of the ocean.

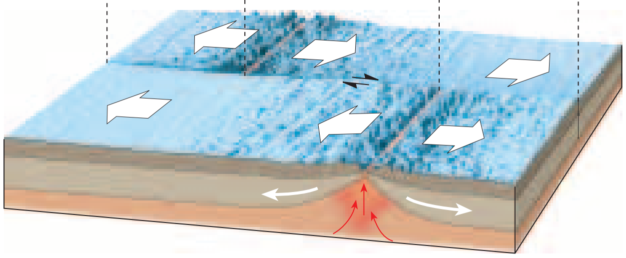


Figure 21 A transform fault boundary offsets segments of a divergent boundary at an oceanic ridge.

Transform Fault Boundaries

The third type of plate boundary is the transform fault boundary. Pieces of lithosphere move past each other horizontally along a transform fault boundary. (*Transform fault* is another term for a strike-slip fault). **At a transform fault boundary, plates grind past each other without destroying the lithosphere.** Most transform faults join two segments of a mid-ocean ridge, as shown in Figure 21. These faults occur about every 100 kilometers along the ridge axis. Active transform faults lie between the two offset ridge segments. The seafloor produced at one ridge axis moves in a direction opposite to that of seafloor produced at the next ridge segment. Between the ridge segments, these slabs of oceanic crust are grinding past each other along a transform fault.

Although most transform faults are located within the ocean basins, a few cut through continental lithosphere. One example is the San Andreas fault in California, where the Pacific plate is moving past the North American plate. If this movement continues, that part of California west of the fault zone will become an island off the west coast of the United States and Canada. It could eventually reach Alaska. However, a more immediate concern is the earthquake activity triggered by movements along this fault system.

Section 9.3 Assessment

Reviewing Concepts

1. In your own words, briefly explain the theory of plate tectonics.
2. List the three types of plate boundaries.
3. Why is a divergent boundary considered a constructive plate margin?

Critical Thinking

4. **Calculating** If a plate moves at a rate of 10 cm per year, how far will the plate move in 20,000,000 years?
5. **Predicting** Suppose you could view the Great Rift Valley in Africa millions of years from now. How might the region have changed?
6. **Relating Cause and Effect** What forms when oceanic lithosphere collides with continental lithosphere at a convergent boundary? Explain.

Writing in Science

Descriptive Paragraph A series of deep-ocean trenches rings the Pacific Ocean. Write a paragraph that describes how the Pacific Ocean might change over millions of years, based on the theory of plate tectonics.

Section 9.3 Assessment

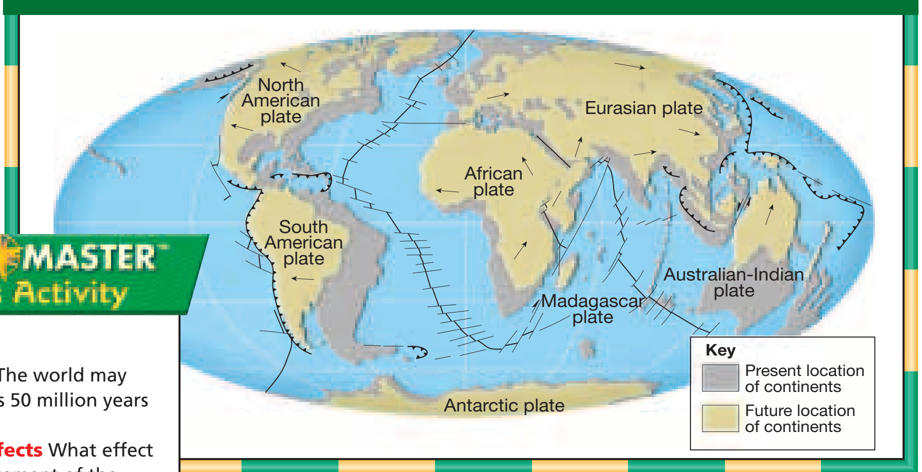
1. According to the theory of plate tectonics, large pieces of Earth's lithosphere, called plates, move slowly over Earth's surface driven by convection currents in the mantle. Plates can include oceanic and/or continental lithosphere. Plate interactions help cause earthquakes, volcanoes, and mountain building.
2. convergent boundaries, divergent boundaries, and transform boundaries
3. because volcanic activity along divergent boundaries produces new oceanic lithosphere
4. 2000 km
5. After millions of years, the Great Rift Valley could widen and form a new ocean basin similar to the Red Sea.
6. Because the oceanic lithosphere is denser than the continental lithosphere, a trench forms, and the oceanic lithosphere is subducted beneath the less dense continental lithosphere.

understanding EARTH

Plate Tectonics into the Future

Two geologists, Robert Dietz and John Holden, used present-day plate movements to predict the locations of landmasses in the future. The map below shows where they predict Earth's landmasses will be 50 million years from now if plate movements remain at their present rates.

Future Continent Positions



MAP MASTER Skills Activity

Figure 22

Location The world may look like this 50 million years from now.
Identify Effects What effect will the movement of the North American and South American plates have on the Atlantic Ocean?

L.A. on the Move

In North America, the Baja Peninsula and the portion of southern California that lies west of the San Andreas Fault will have slid past the North American plate. If this northward motion takes place, Los Angeles and San Francisco will pass each other in about 12 million years.

New Sea in Africa

Major changes are seen in Africa, where a new sea will emerge as East Africa is ripped away from the mainland. In addition, the African plate will collide with the Eurasian plate, perhaps creating the next major mountain-building stage on Earth. Meanwhile, the Arabian Peninsula will move away from Africa, allowing the Red Sea to widen.

Atlantic Ocean Grows

In other parts of the world, Australia will be located across the equator and, along with New Guinea, will be on a collision course with Asia. Meanwhile, North and South America will begin to separate, while the Atlantic and Indian oceans will continue to grow as the Pacific Ocean shrinks.

These projections, although interesting, must be viewed critically. Many assumptions must be correct for these events to occur. We can be sure that large changes in the shapes and positions of continents will occur for millions of years to come.

Facts and Figures

Slab Suction Though subducting lithosphere often goes into the mantle at an angle close to 45°, gravity is pulling it straight down, with the result that the location of the trench often moves away from the overlying plate in a process called trench roll-back. This trench roll-back creates a large force called *slab suction* that pulls the overlying plate toward the trench. Slab suction is a large force and has important consequences. Slab suction is responsible for the formation of back-arc basins that are rifting and opening up behind volcanic arcs, as the arcs are pulled away from the rest of the continent. The Japan Sea, between Japan and China, formed this way. Slab suction may also be the cause of the breakup of supercontinents like Pangaea. A supercontinent has subduction occurring all around its edges. The combined slab suction forces from all this subduction may be what finally pulls the supercontinent apart.

understanding EARTH

Plate Tectonics into the Future

L2

MAP MASTER Skills Activity

Answer
Identify Effects As the North American and South American plates move west, the Atlantic Ocean will grow wider.

Background
Robert Dietz began his career as a marine geologist. He was an early proponent of continental drift and of sea-floor spreading, which he named. Much of his early work was conducted in submersibles off the coast of California. John Holden was Dietz's colleague and his illustrator.

Teaching Tip
Have students cut out outlines of the continents and place them on a piece of white poster paper in their current locations. As students read each paragraph of the feature, they should move the continents to their predicted location. When they finish reading the feature, ask students to write a short paragraph describing how plant and animal life would be different on the continents in their new positions. For example, tropical vegetation in southern California would be replaced with plant life that could exist in an Arctic climate.
Verbal, Kinesthetic

Answer to . . .

Figure 22 *The map shows that the Atlantic Ocean will be wider 50 million years from now.*