Name _____ Class _____ Date _____

CHAPTER 10 Plate Tectonics

SECTION 2

The Theory of Plate Tectonics

KEY IDEAS

As you read this section, keep these questions in mind:

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

What Is Plate Tectonics?

After Harry Hess described the idea of sea-floor spreading, scientists found more evidence that continents can move. They used the evidence to develop a new theory: the theory of plate tectonics. The theory of **plate tectonics** explains how continents move and change shape.

READING TOOLBOX

Summarize After you read this section, create a concept map that uses all the vocabulary terms.

THE LITHOSPHERE AND ASTHENOSPHERE

Remember that Earth's outer layer is called the *crust*. The layer underneath the crust is called the *mantle*. The top part of the mantle is very stiff and brittle. Together, the crust and this upper, stiff part of the mantle form the **lithosphere**. ☑

READING CHECK

1. Identify What are the parts of the lithosphere?

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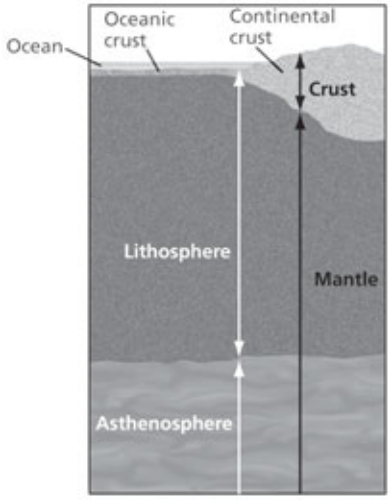
The lithosphere includes only the very top part of the mantle. The layer of the mantle below the lithosphere is called the **asthenosphere**. Unlike the rock in the lithosphere, the rock in the asthenosphere is soft. It is solid, but it is so hot and soft that it can flow, like chewing gum. Scientists say that the asthenosphere is made of plastic rock. *Plastic* means "flexible and able to flow."



The lithosphere is hard. It includes the crust and the top part of the mantle. The asthenosphere is soft. It can move slowly.

LOOKING CLOSER

2. Describe Which is thicker, the lithosphere or the crust?

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TECTONIC PLATES

The lithosphere is broken up into large pieces called tectonic plates. The tectonic plates move slowly over the asthenosphere. As the tectonic plates move, they carry the continents with them. Therefore, the movement of tectonic plates explains the movement of continents. ☑

READING CHECK

3. Describe What is a tectonic plate?

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What Happens Where Tectonic Plates Touch?

Tectonic plates are like puzzle pieces. The places where they touch are called plate boundaries. Earthquakes and volcanoes are more common at plate boundaries than anywhere else.

EARTHQUAKES AND VOLCANOES

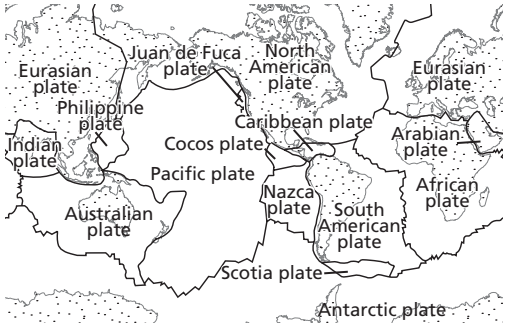
At plate boundaries, tectonic plates rub together. The plates do not rub together smoothly, though. Instead, they stick together, like two pieces of sandpaper. The movements of the plates cause pressure on the plate boundaries. When the pressure gets too high, the rock breaks. The breaking rock releases energy that makes the ground shake. The shaking is an earthquake.

Almost all earthquakes happen at plate boundaries. Scientists have special tools that can record where earthquakes happen. They can draw those locations on a map. When they draw the locations on a map, they see that most earthquakes happen in certain areas. These areas are the same as the plate boundaries.

Volcanoes are also more common on plate boundaries. Like earthquakes, volcanoes are most common in certain areas. The areas where earthquakes and volcanoes are most likely show where the plate boundaries are.

Talk About It

Model Make a model of how an earthquake happens. Discuss your model with a partner. Describe how your model shows what happens during an earthquake.



There are about 15 large tectonic plates on Earth. There are also many smaller plates. This map shows many of the tectonic plates on Earth.

LOOKING CLOSER

4. Infer Circle two areas on the map that probably have a lot of earthquakes or volcanoes.

TYPES OF PLATE BOUNDARIES

Not all plate boundaries are the same. There are three types of plate boundaries:

- divergent boundaries, where plates move apart
- convergent boundaries, where plates move together
- transform boundaries, where plates slide past each other ☑

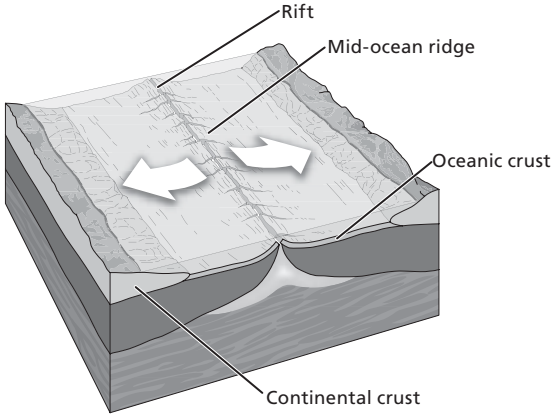
READING CHECK

5. Identify What are the three types of plate boundaries?

What Happens at a Divergent Boundary?

To *diverge* means "to move apart." At a **divergent boundary**, two plates move away from each other. Mid-ocean ridges are divergent boundaries. However, divergent boundaries can also form on land.

Divergent boundaries are places where new lithosphere forms. At a mid-ocean ridge, melted rock, or magma, rises up from the asthenosphere. It flows into the rift between the plates. When the magma cools and hardens, it forms new lithosphere.



New lithosphere forms at divergent boundaries. Most divergent boundaries are under the oceans.

Critical Thinking

6. Apply Concepts If one plate at a divergent boundary is moving north, in which direction is the other plate probably moving?

What Happens at a Convergent Boundary?

To *converge* means "to come together." At a **convergent boundary**, two plates move toward each other. In other words, the plates collide. The collision of the plates can have different effects.

The effects of the collision depend on what kinds of lithosphere are colliding. There are two main types of lithosphere: oceanic lithosphere and continental lithosphere. Oceanic lithosphere is thin and dense. Continental lithosphere is thick and not very dense. ☑

READING CHECK

7. Compare Name two ways continental lithosphere is different from oceanic lithosphere.

OCEANIC-CONTINENTAL COLLISIONS

At some convergent boundaries, oceanic lithosphere meets continental lithosphere. The oceanic lithosphere is denser than the continental lithosphere. Therefore, the oceanic lithosphere sinks beneath the continental lithosphere. The oceanic lithosphere sinks into the asthenosphere. The sinking of the lithosphere into the asthenosphere is called *subduction*. ☑

READING CHECK

8. Define What is subduction?

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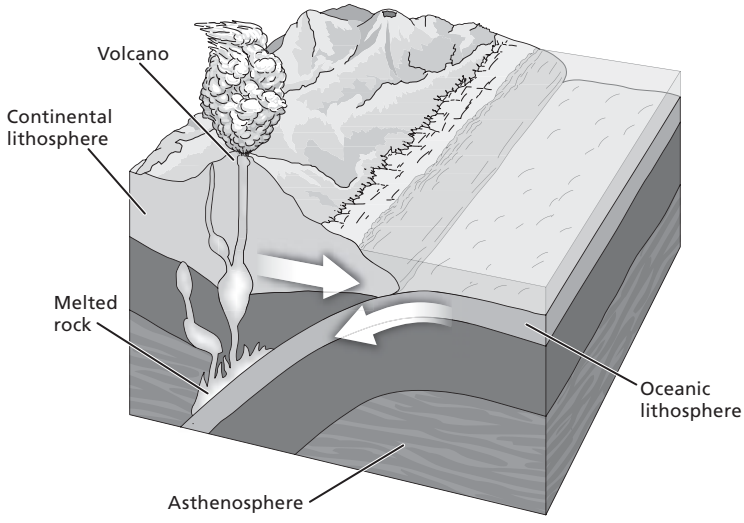
As part of the lithosphere sinks into the asthenosphere, the heat and pressure on the lithosphere become greater. The high heat and pressure squeeze water out of the sinking lithosphere. The water mixes with the rock in the asthenosphere and makes the rock melt. The melted rock rises through the crust and erupts. Thus, volcanoes are common at plate boundaries where oceanic lithosphere sinks beneath continental lithosphere.



When oceanic lithosphere meets continental lithosphere, the oceanic lithosphere sinks into the asthenosphere. The Andes Mountains in South America are an example of this kind of convergent boundary.

LOOKING CLOSER

9. Identify Where does the magma that is erupting at this convergent boundary come from?

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As the oceanic lithosphere sinks, it rubs against the continental lithosphere on the other plate. The rubbing produces pressure that can make the rock slip and break, causing earthquakes. Thus, large earthquakes are common at plate boundaries where oceanic lithosphere collides with continental lithosphere.

CONTINENTAL-CONTINENTAL COLLISIONS

At some convergent boundaries, two pieces of continental lithosphere collide. Because continental lithosphere is not very dense, it does not easily sink into the asthenosphere. Therefore, when two pieces of continental lithosphere collide, both pieces crumple up and form very tall mountains. The tallest mountains in the world, the Himalaya Mountains, are found at this kind of convergent boundary. ☑

Volcanoes are not very common at this type of convergent boundary. Earthquakes are common. However, the earthquakes are not as large as those at continental-oceanic boundaries.

READING CHECK

10. Explain Why doesn't continental lithosphere sink into the asthenosphere?

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OCEANIC-OCEANIC COLLISIONS

At some convergent boundaries, oceanic lithosphere meets oceanic lithosphere. Subduction happens at these convergent boundaries. One of the pieces of oceanic lithosphere sinks beneath the other one. The sinking lithosphere gives off water, just like at a continental-oceanic convergent boundary.

The water causes the asthenosphere to melt and form magma. The magma rises through the lithosphere and erupts. Therefore, volcanoes are common at oceanic-oceanic convergent boundaries. Earthquakes are also common, because of the pressure produced when the sinking lithosphere rubs against the other lithosphere.

An *island arc* is a chain of volcanic islands. Island arcs are common at this kind of convergent boundary. Japan is an example of an island arc.

Type of Convergent Boundary	Description	Example
Continental-oceanic	continental lithosphere collides with oceanic lithosphere; volcanoes and earthquakes common; mountains form	Andes Mountains
Oceanic-oceanic	oceanic lithosphere collides with oceanic lithosphere; volcanoes and earthquakes common; chain of islands forms	Japan
Continental-continental	continental lithosphere collides with continental lithosphere; earthquakes common; very tall mountains form	Himalaya Mountains

LOOKING CLOSER

11. Compare At what two types of convergent boundaries are you likely to find volcanoes?

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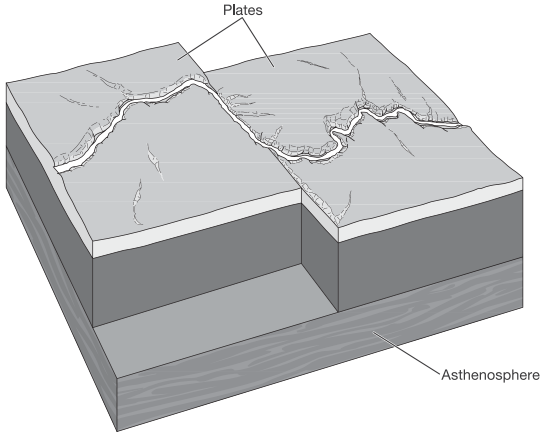
What Happens at a Transform Boundary?

At a **transform boundary**, two tectonic plates slide past each other. As the plates slide past each other, they stick and press together. When the pressure gets too high, the rock breaks and causes an earthquake. Therefore, earthquakes are common at transform boundaries. Volcanoes are not common at transform boundaries.

The San Andreas fault in California is an example of a transform boundary. Transform boundaries are also common along mid-ocean ridges. Transform boundaries break most mid-ocean ridges into short segments.



At a transform boundary, plates slide past each other. They do not move apart or together.

LOOKING CLOSER

12. Describe Draw arrows on the diagram to show the directions the plates are moving.

What Makes Tectonic Plates Move?

Scientists are still not sure why the tectonic plates move. However, they think that three main factors cause the plates to move. Those three factors are mantle convection, ridge push, and slab pull.

MANTLE CONVECTION

Suppose you put a pot of water on a hot stove. The water at the bottom of the pot will heat up first. As it heats up, it becomes less dense. The less dense water rises to the top of the pot. Cooler, denser water sinks toward the bottom to replace the rising water. The movement of the water is an example of convection. During *convection*, denser material sinks, and less dense material rises. ☑

Scientists think the rock in Earth's mantle can convect, just like the water in the pot. Hot rock rises toward the surface, and colder rock sinks. Scientists think the movement of the mantle might be one of the reasons the plates move. As the mantle moves, it may carry the plates along.

☑ *READING CHECK*

13. Define What is convection?

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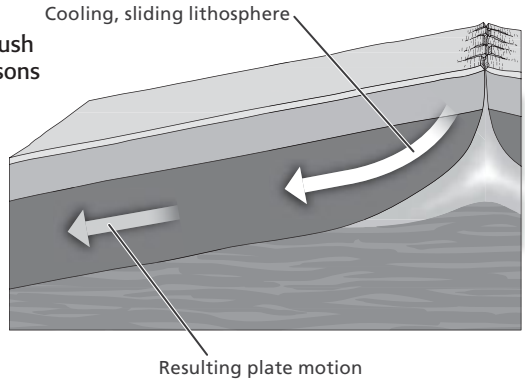
RIDGE PUSH

Convection in the mantle is not the only reason the plates move. At mid-ocean ridges, new crust forms. The new crust pushes the older crust away from the ridge. This process is called *ridge push*. Scientists think ridge push might also cause plates to move.



Scientists think ridge push may be one of the reasons the plates move.

LOOKING CLOSER

14. Explain What causes ridge push?

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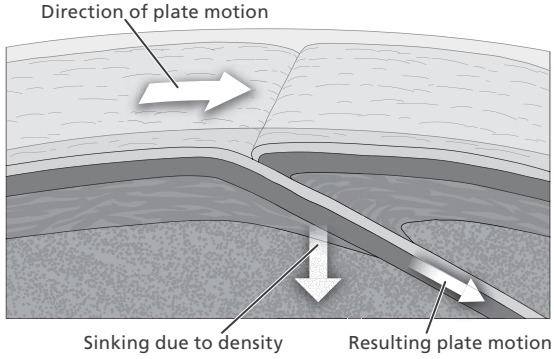
SLAB PULL

Most scientists think that mantle convection and ridge push cause only a little bit of plate motion. They think pulling forces where plates converge are the main forces that make the plates move. Subduction happens at most convergent boundaries. Remember that during subduction, one plate sinks into the asthenosphere. Scientists think that, as the edge of the plate sinks, it pulls the rest of the plate along with it. This process is called *slab pull*.



Scientists think that slab pull is the main reason the plates move.

LOOKING CLOSER

15. Explain Why does the edge of the plate sink?

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Section 2 Review

SECTION VOCABULARY

asthenosphere the solid, plastic layer of the mantle beneath the lithosphere

convergent boundary the boundary between tectonic plates that are colliding

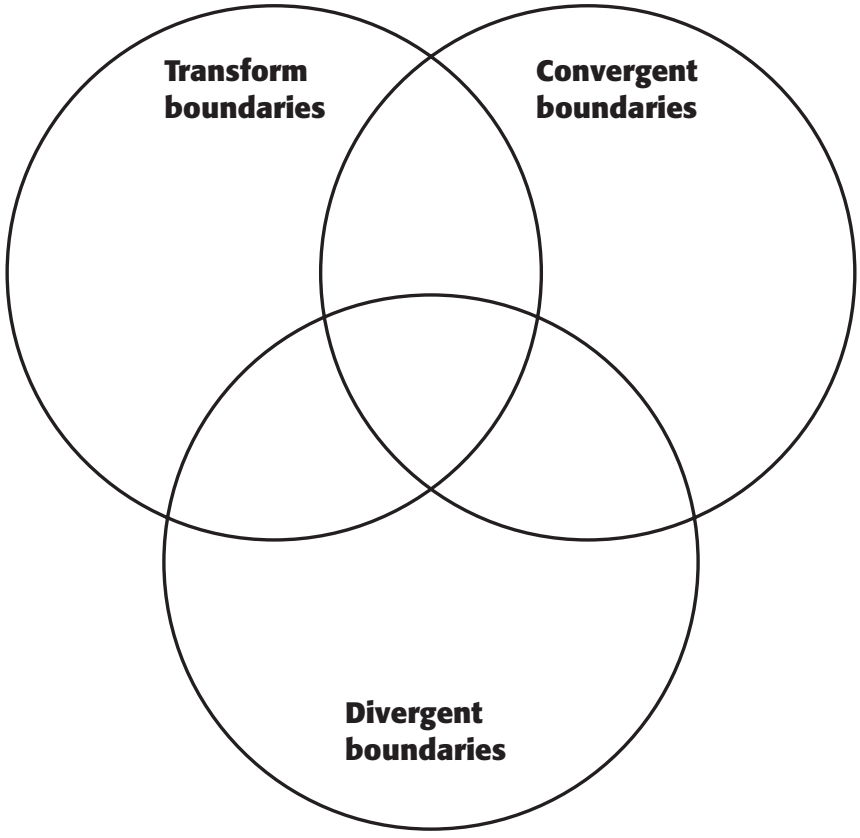
divergent boundary the boundary between tectonic plates that are moving away from each other

lithosphere the solid, outer layer of Earth that consists of the crust and the rigid upper part of the mantle

plate tectonics the theory that explains how large pieces of the lithosphere, called *plates,* move and change shape

transform boundary the boundary between tectonic plates that are sliding past each other horizontally

1. Compare Complete the Venn diagram to compare the three types of plate boundaries.



2. Describe Relationships How are subduction and sea-floor spreading related to ridge push and slab pull?