Name _____ Class _____ Date _____

CHAPTER 4 Plate Tectonics

SECTION 3

The Theory of Plate Tectonics

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

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

National Science Education Standards

ES 1b, 2a

What Is the Theory of Plate Tectonics?

As scientists learned more about sea-floor spreading and magnetic reversals, they formed a theory to explain how continents move. The theory of **plate tectonics** states that Earth's lithosphere is broken into many pieces—tectonic plates—that move slowly over the asthenosphere.

Tectonic plates move very slowly—only a few centimeters per year. Scientists can detect this motion only by using special equipment, such as global positioning systems (GPS). This equipment is sensitive enough to pick up even small changes in a continent's location. ☑

STUDY TIP

Compare As you read, make a table showing the features of the three kinds of plate boundaries.

READING CHECK

1. Explain How do scientists detect tectonic plate motions?

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What Happens Where Tectonic Plates Touch?

The places where tectonic plates meet are called *boundaries*. Some features, such as earthquakes and volcanoes, are more common at tectonic plate boundaries than at other places on Earth. Other features, such as mid-ocean ridges and ocean trenches, form only at plate boundaries.

There are three types of plate boundaries:

- divergent boundaries, where plates move apart;
- convergent boundaries, where plates move together; and
- transform boundaries, where plates slide past each other.

The features that form at a plate boundary depend on what kind of plate boundary it is.

DIVERGENT BOUNDARIES

A **divergent boundary** forms where plates are moving apart. Most divergent boundaries are found beneath the oceans. Mid-ocean ridges form at these divergent boundaries. Because the plates are pulling away from each other, cracks form in the lithosphere. Melted rock can rise through these cracks. When the melted rock cools and hardens, it becomes new lithosphere. ☑

READING CHECK

2. Describe What features are found at most divergent boundaries?

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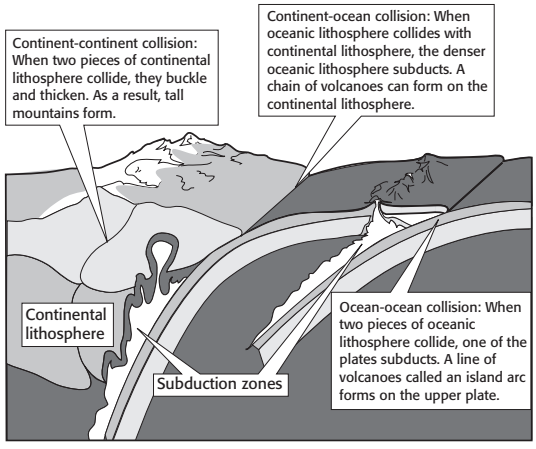
CONVERGENT BOUNDARIES

A **convergent boundary** forms where plates are moving together. There are three different types of convergent boundaries:

- **Continent-Continent Boundaries** These form when continental lithosphere on one plate collides with continental lithosphere on another plate. Continent-continent convergent boundaries can produce very tall mountain ranges, such as the Himalayas.
- **Continent-Ocean Boundaries** These form when continental lithosphere on one plate collides with oceanic lithosphere on another plate. The denser oceanic lithosphere sinks underneath the continental lithosphere in a process called *subduction*. Subduction can cause a chain of mountains, such as the Andes, to form along the plate boundary.
- **Ocean-Ocean Boundaries** These form when oceanic lithosphere on one plate collides with oceanic lithosphere on another plate. One of the plates subducts beneath the other. A series of volcanic islands, called an *island arc*, can form along the plate boundary.



TRANSFORM BOUNDARIES

A **transform boundary** forms where plates slide past each other horizontally. Most transform boundaries are found near mid-ocean ridges. The ridges are broken into *segments*, or pieces. Transform boundaries separate the segments from one another.

One well-known transform boundary is the San Andreas fault system in California. It is located where the Pacific and North American plates slide past each other.

Critical Thinking

3. Infer Why do continent-continent convergent boundaries produce very tall mountain ranges?

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STANDARDS CHECK

ES 1b Lithospheric plates on the scales of continents and oceans constantly move in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building result from these plate motions.

Word Help: response
an action brought on by another action; a reaction

Word Help: major
of great importance or large scale

4. Identify Name two structures that can form at convergent plate boundaries.

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Why Do Tectonic Plates Move?

Scientists do not know for sure what causes tectonic plates to move. They have three main hypotheses to explain plate movements: convection, slab pull, and ridge push.

Scientists used to think that convection in the mantle was the main force that caused plate motions. Remember that *convection* happens when matter carries heat from one place to another. Convection happens in the mantle as rock heats up and expands. As it expands, it becomes less dense and rises toward Earth's surface. ☑

READING CHECK

5. Define What is convection?

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As the hot material rises, cold, dense lithosphere sinks into the mantle at subduction zones. The rising hot material and the sinking cold material form *convection currents*. Until the 1990s, many scientists thought that these convection currents pulled the tectonic plates over Earth's surface.

Today, most scientists think that slab pull is the main force that causes plate motions. During subduction, oceanic lithosphere at the edge of a plate sinks into the mantle. The oceanic lithosphere sinks because it is colder and denser than the mantle. As the lithosphere at the edge of the plate sinks, it pulls the rest of the plate along with it. This process is called *slab pull*.

Another possible cause of plate motions is ridge push. At mid-ocean ridges, new oceanic lithosphere forms. This new lithosphere is warmer and less dense than the older lithosphere farther from the ridge. Therefore, it floats higher on the asthenosphere than the older lithosphere. As gravity pulls the new lithosphere down, the plate slides away from the mid-ocean ridge. This process is called *ridge push*.

Critical Thinking

6. Compare How is slab pull different from ridge push?

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Driving Force	Description
Slab pull	Cold, sinking lithosphere at the edges of a tectonic plate pulls the rest of the plate across Earth's surface.
Ridge push	Gravity pulls newly formed lithosphere downward and away from the mid-ocean ridge. The rest of the plate moves because of this force.
Convection currents	Convection currents are produced when hot material in the mantle rises toward the surface and colder material sinks. The currents pull the plates over Earth's surface.

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Section 3 Review

NSES **ES 1b, 2a**

SECTION VOCABULARY

convergent boundary the boundary between tectonic plates that are colliding

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

plate tectonics the theory that explains how large pieces of the Earth's outermost layer, called tectonic plates, move and change shape

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

1. Define Write your own definition for plate tectonics.

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

3. List Name three processes that may cause tectonic plates to move.

4. Describe How fast do tectonic plates move?

5. Identify Give two features that are found only at plate boundaries, and two features that are found most commonly at plate boundaries.

6. Explain Why does oceanic lithosphere sink beneath continental lithosphere at convergent boundaries?

2. Magma rises toward the surface at mid-ocean ridges. As the tectonic plates move away from each other, the sea floor spreads apart, and magma fills the gap. Then the magma solidifies.
3. younger
4. When oceanic lithosphere forms, magnetic minerals in the magma align with Earth's magnetic field. They are frozen in place when the magma cools and hardens. As sea-floor spreading continues, that part of the lithosphere moves away from the ridge. If Earth's magnetic field reverses, then minerals will align in the opposite direction in the new lithosphere forming at the ridge. Since lithosphere is produced on both sides of the ridge, the normal and reversed magnetic stripes form parallel patterns.
5. The Earth is not getting bigger, new sea floor is being created, and the oldest sea floor is only 180 million years old. If those three things are true, then oceanic crust must be being destroyed somewhere on Earth at the same rate that it is being produced.

SECTION 3 THE THEORY OF PLATE TECTONICS

1. using GPS equipment
2. mid-ocean ridges
3. The lithosphere on each plate is very thick. When the plates collide, the lithosphere is piled up to form tall mountains.
4. mountains, volcanoes
5. when matter carries heat from place to place
6. In slab pull, the driving force comes from subducting slabs. In ridge push, the driving force comes from the formation of new sea floor.

Review

1. a theory that describes how tectonic plates move and change shape as part of Earth's outermost layer
2. convergent, divergent, transform
3. slab pull, ridge push, convection
4. a few centimeters per year
5. Mid-ocean ridges and ocean trenches are found only at plate boundaries. Earthquakes and volcanoes are found mainly at plate boundaries.
6. Oceanic lithosphere is colder and denser than continental lithosphere.

SECTION 4 DEFORMING THE EARTH'S CRUST

1. The image on the right should be circled.
2. the amount of force per unit area on an object
3. Most rock layers are horizontal when they form. They can show folded shapes only if they have been deformed.
4. The oldest rock layers should be blue, and the youngest should be red.
5. The hanging wall is found above the fault.
6. A lot of tension is produced at divergent boundaries.
7. The wall above the fault plane should be labeled "hanging wall"; the wall below the fault plane should be labeled "footwall."
8. when fault blocks slide past each other horizontally
9. The hanging wall has moved down relative to the footwall.
10. Most mountains are the result of plate movements. Since plates move very slowly, mountains form very slowly.
11. tension
12. continent-ocean
13.

Type of mountain	Description
Folded	formed at convergent boundaries; made of folded and crumpled rock
Fault-block	formed where the crust is under tension; made of faulted rock
Volcanic	formed where volcanoes erupt above Earth's surface; made of igneous rock

14. As it cools, it becomes denser and sinks.
15. the weight of the glacier

Review

1. Folding and faulting are both responses to stress. During folding, rocks bend under stress. During faulting, rocks break under stress.
2.

Kind of fault	Description	Kind of stress that produces it
Normal	Hanging wall moves down; footwall moves up.	tension
Reverse	Hanging wall moves up; footwall moves down.	compression
Strike-slip	Fault blocks move past each other horizontally.	shear stress