

45 Understanding Plate Boundaries



The map below shows the locations of earthquakes and volcanoes on the earth's surface. Today, many of the world's most active volcanoes are located around the edges of the Pacific Ocean, and are often referred to as the "Ring of Fire." You may notice that both volcanoes and earthquakes tend to be concentrated in particular areas. The theory of plate tectonics helps explain this pattern.

CHALLENGE

How does the theory of plate tectonics help to explain the locations of earthquakes, volcanoes, and mountain ranges?

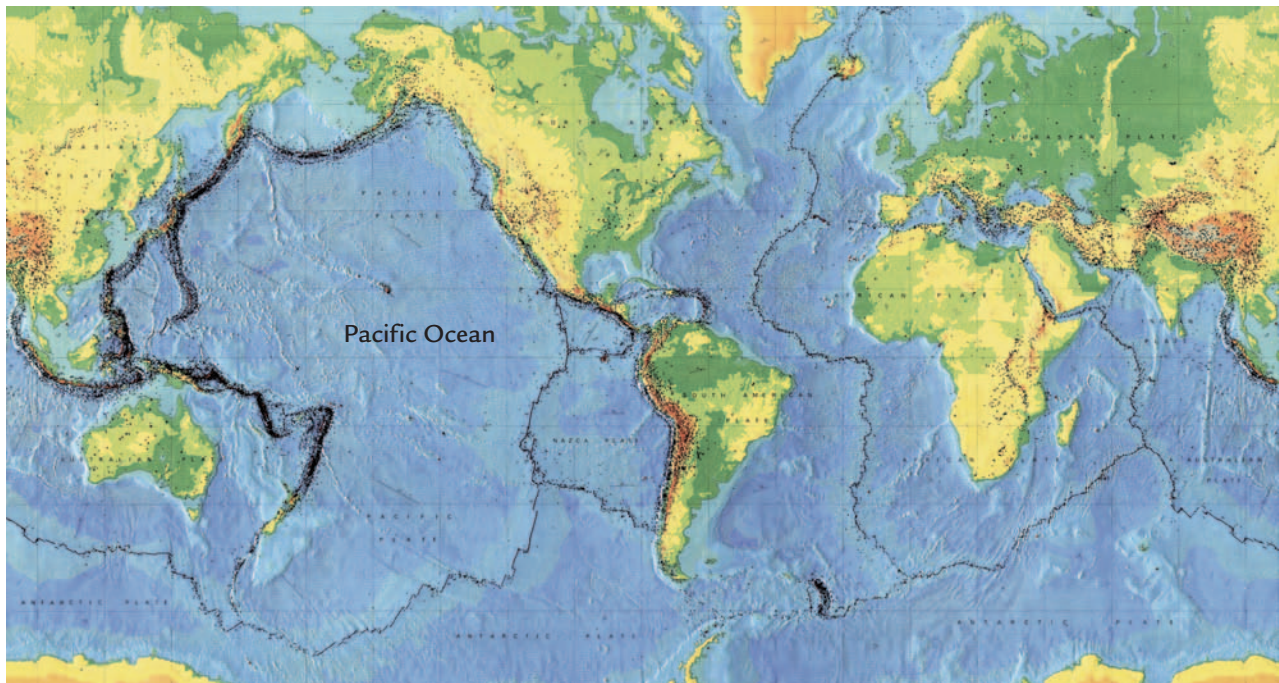


Figure 1: Map of Recent Earthquakes and Volcanoes on Earth
Black dots mark the locations of individual earthquakes and volcanoes.

MATERIALS



For each student

- 1 completed Student Sheet 44.2, “Plate Boundaries”
- 1 Student Sheet 45.1, “Directed Reading Table: Understanding Plate Boundaries”

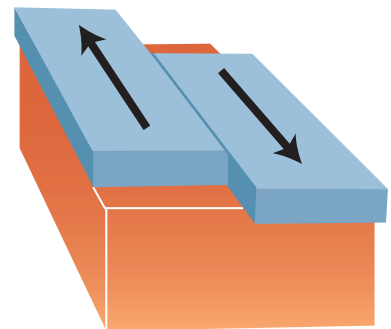
READING

Use Student Sheet 45.1, “Directed Reading Table: Understanding Plate Boundaries,” to guide you through the following reading.

Plate tectonics is the theory that the earth’s lithosphere is broken into plates that are in constant motion. The edges of these plates may be sliding past each other, spreading apart, or colliding. Over geological time, important processes—such as the formation of mountain ranges, earthquakes, and volcanoes—take place along the boundaries where these plates meet.

Sliding Plates

Geologists call the region where two plates are sliding past each other a **transform** boundary. Earthquakes are common along transform boundaries. There is a lot of pressure between the plates as they try to move past each other, and this pressure is only released when large pieces of rock along the boundary crack or shift their position. People can sometimes feel the vibrations caused by these movements and call them earthquakes.



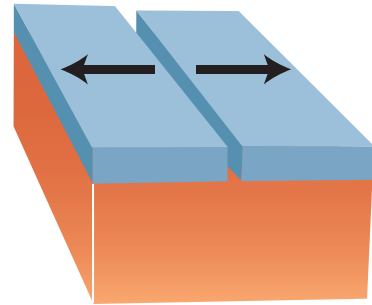
In Activity 44, “Mapping Plates,” you recorded the overall movement of several large plates. Each plate may have different types of boundaries along different parts of its edge. A transform boundary is located between a part of the Pacific plate and a part of the North American plate, along the western edge of California. This is an area known for

Activity 45 • Understanding Plate Boundaries

its many earthquakes, as you can see in Figure 1, “Map of Recent Earthquakes and Volcanoes on Earth.” On its eastern edge, the North American Plate has a divergent boundary.

Spreading Plates

The place where plates are spreading apart is called a **divergent** (dy-VER-junt) boundary. Volcanoes as well as earthquakes are common along divergent boundaries. As the plates pull apart, the lithosphere thins and molten magma from the earth’s mantle erupts onto the surface, forming new lithosphere (See Figure 2, below). Over time, the lava from these volcanoes can build up and form volcanic mountains. You read about such mountains in Activity 38, “Beneath the Earth’s Surface.”



Sometimes, divergent boundaries are located under the ocean, and large underwater volcanic mountains can form. The plate boundaries seen along the middle of the Atlantic Ocean are an example of an underwater divergent boundary.

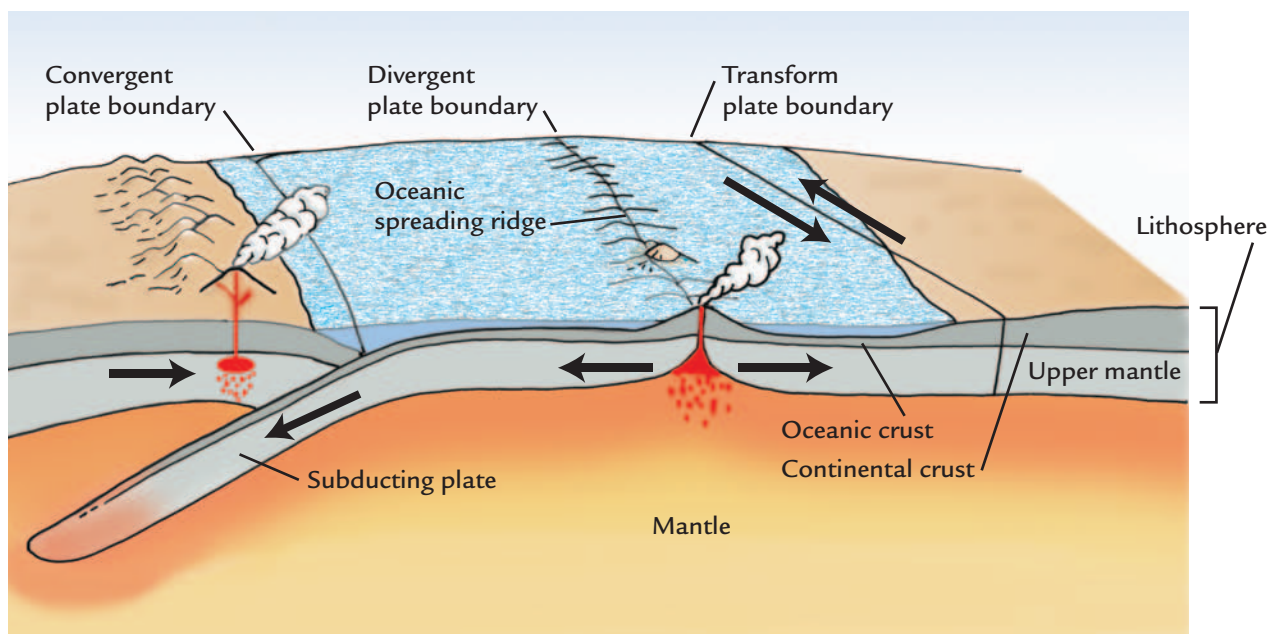
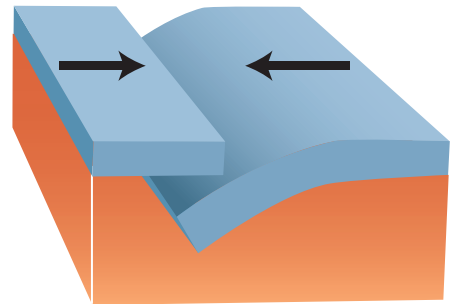


Figure 2: Types of Plate Boundaries

Colliding Plates

Colliding plates create **convergent** (kun-VER-junt) boundaries. What happens along a convergent boundary depends on the type of lithosphere at the edge of each of the colliding plates. The earth's lithosphere—which includes the crust and solid upper mantle—varies over the surface of the earth. This is partly due to differences in the thickness of the earth's crust. The crust that makes up the oceans is generally thinner than the crust that makes up the continents. Oceanic crust is usually about 10 kilometers (km) thick, while continental crust ranges from 20 to 80 km thick. For this reason, the lithosphere is about 100–150 km thick under the ocean, and up to 300 km thick at some continents. Despite being thinner, oceanic lithosphere is denser than continental lithosphere because its crust is made up of denser rocks, such as basalt.

When continental and oceanic lithosphere collide, the less dense continental lithosphere usually rides up over the oceanic lithosphere, which goes down into the mantle and is destroyed. (See Figure 2.) The process of one plate moving below another plate is known as **subduction** (sub-DUK-shun). Both earthquakes and volcanoes are common along subduction zones. The volcanic mountains that you plotted along the western coast of South America in Activity 44 are a result of the oceanic lithosphere of the Pacific plate being subducted below the continental lithosphere of the South American plate. Subduction also occurs when two sections of oceanic lithosphere collide.



When two sections of continental lithosphere collide, the lithosphere tends to crumple and be pushed upward, forming mountains as well as causing earthquakes. The Himalayan mountains found along the northern border of India were formed when the Indian plate collided with the Eurasian plate. Several of the world's highest mountains, including Mount Everest, are part of the Himalayas and were formed from this collision.

Hot Spots

Most earthquakes and volcanoes occur along plate boundaries, but there are some exceptions. For example, the Hawaiian Islands are located in the middle of the Pacific plate. Yet each Hawaiian island was formed by a volcano, as lava from ongoing eruptions built up into an island.

A **hot spot** is a fixed area of the mantle that is so hot that magma rises through the lithosphere above it. As plates move, the location of the hot spot remains the same. In time, the movement of the plate can result in a chain of volcanic mountains or islands, like the Hawaiian Islands. (See Figure 3 below.) Scientists use this information to help determine the direction of plate movement.

Today, only the island of Hawaii (also called the “Big Island”) has an active volcano. At its southeastern corner, the next Hawaiian island, called Loihi, is already forming. It is still completely covered with seawater, but its top is almost 2 km high above the ocean floor. Scientists predict that it will build up enough to rise above the ocean’s surface in about one million years.

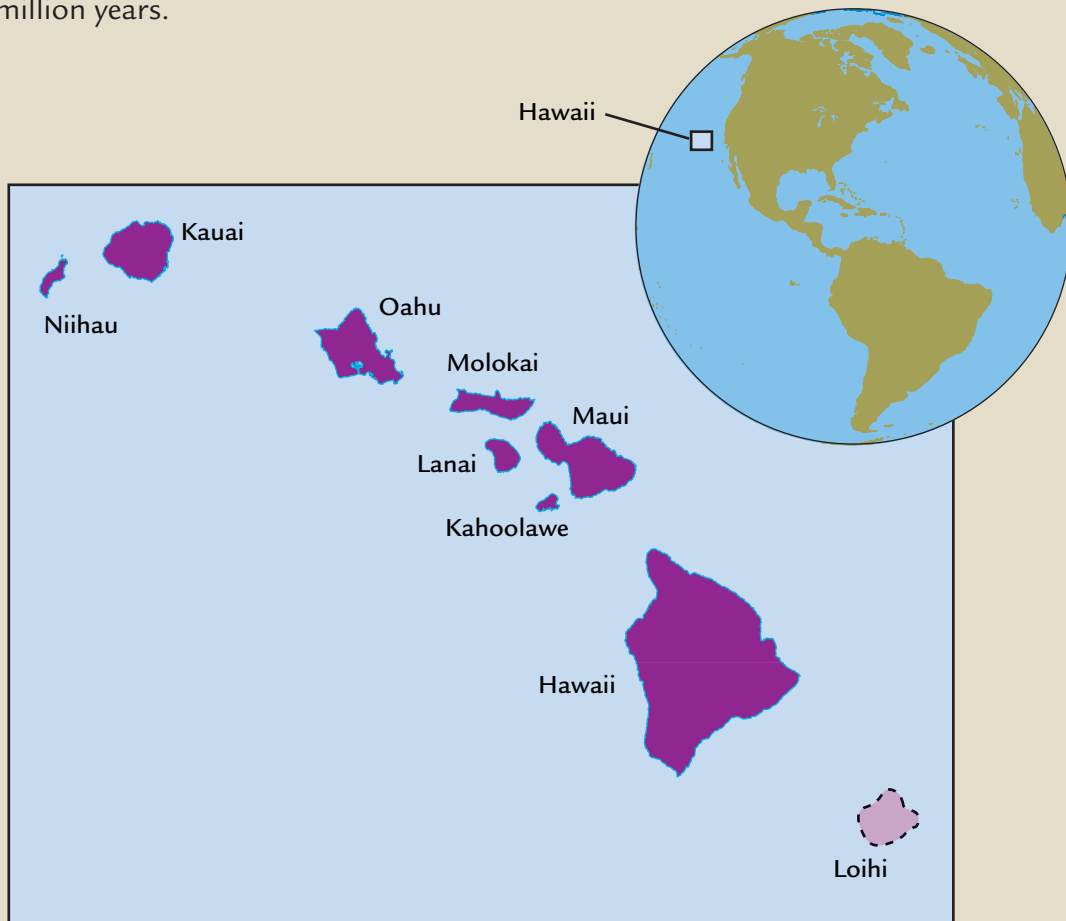


Figure 3: Map of the Hawaiian Islands

ANALYSIS



1. Describe two ways in which the movement of lithospheric plates can result in the formation of mountains.
2. On Student Sheet 44.2, “Plate Boundaries,” you drew the boundaries of large, lithospheric plates. Use information from this reading to identify and label:
 - a. a transform boundary
 - b. a divergent boundary
 - c. a convergent boundary
3. Yucca Mountain is located close to H6 on Student Sheet 44.2. Which type of boundary is closest to it?
4. In Unit B, “Rocks and Minerals,” you learned about three different types of rocks: igneous, metamorphic, and sedimentary. Which type of rock would you expect to find along a divergent plate boundary? Explain.