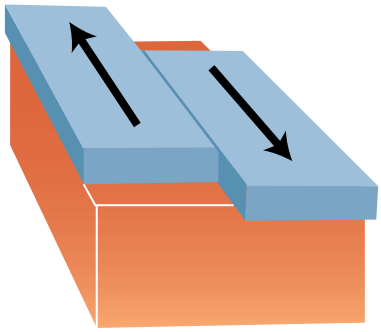
# READING

*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.

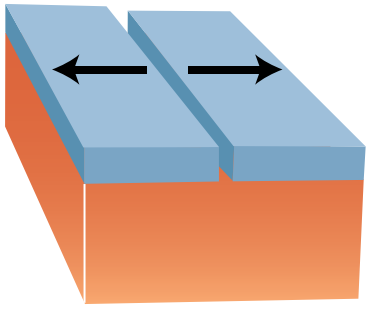
## Sliding Plates



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 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, on the next page). Over time, the lava from these volcanoes can build

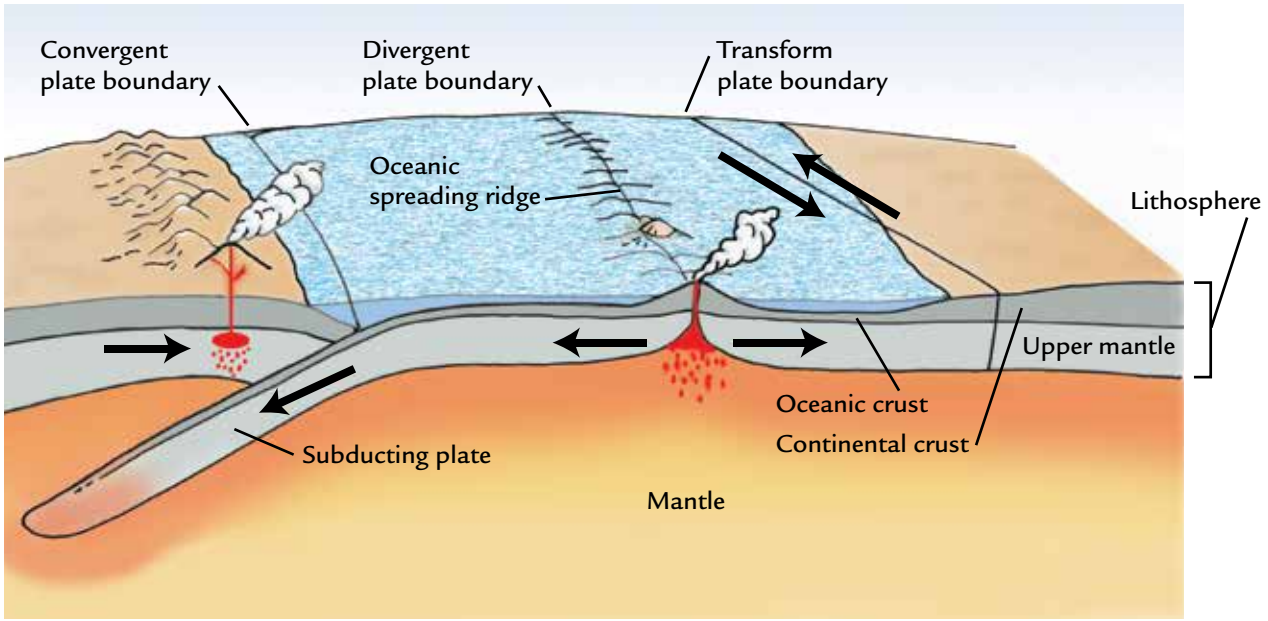



FIGURE 2:
TYPES OF PLATE BOUNDARIES

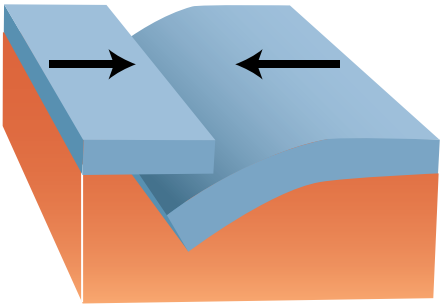
up and form volcanic mountains. You read about such mountains in Activity 38, "Beneath the Earth's Surface."

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.

## 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, above.)



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, "Mapping Plates," are a result of the oceanic lithosphere of the Pacific plate being subducted below the continental lithosphere of the South American plate. The March, 2011 earthquake off the coast of Japan was also a result of the subduction of the oceanic Pacific plate beneath a continental plate. This is also happening in the Pacific northwest as the Juan de Fuca plate is moving under the North 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.

## Volcanoes and Plates

Most earthquakes and volcanoes occur along plate boundaries, but there are exceptions. For example, volcanoes formed each of the Hawaiian Islands. Lava from eruptions over hundreds of thousands of years built up the islands. Yet the Hawaiian Islands are located far from any plate boundaries. Hawaii, the "Big Island" at the southwestern end of the island chain, is the only one of those islands that still has an active volcano. A new island called Loihi has begun to form beneath the ocean southwest of the Big Island. But don't start making vacation plans to visit Loihi. Scientists predict it will rise above the ocean's surface in about one million years.

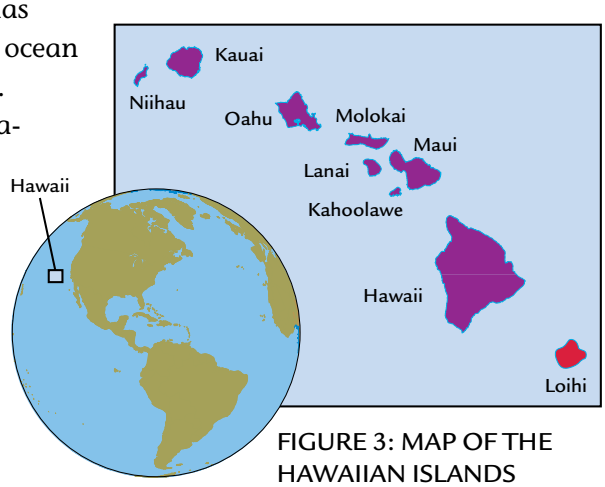



FIGURE 3: MAP OF THE HAWAIIAN ISLANDS

The explanation for the formation of the

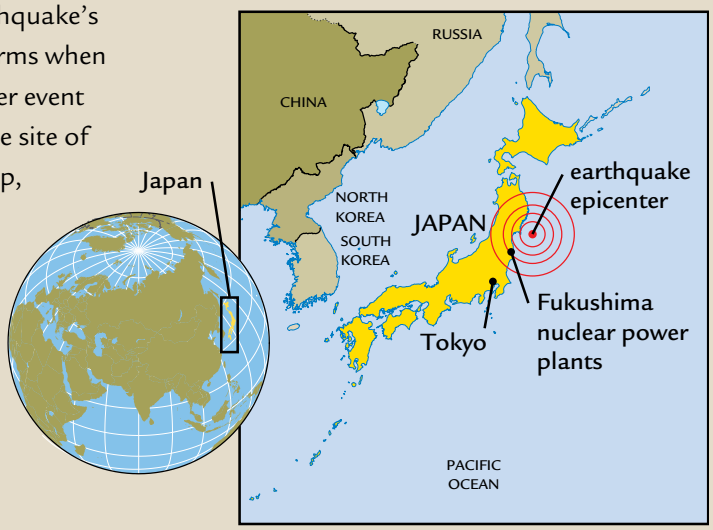
# The 2011 Earthquake and Fukushima Nuclear Accident in Japan

ON MARCH 11, 2011, a huge earthquake rocked Japan. This earthquake had a magnitude of 9.0 and was centered 70 km (43 mi) off the coast of the largest Japanese island, Honshu. More than 15,000 people were killed, more than 5,000 were injured, and more than 330,000 structures, including buildings, roads, bridges, and railways, were destroyed. The cost of this earthquake is estimated at hundreds of billions of U.S. dollars.

Most of the deaths, injuries, and damage were caused by a tsunami, rather than the earthquake's shaking. A tsunami is a large wave that forms when an earthquake, volcano, landslide, or other event moves a very large amount of water. At the site of an earthquake where the water is very deep, the wave might be only a few inches high. But as the wave moves into shallower areas closer to shore, the very large amount of water forms a high wave. At its highest, the height of the wave from the Japanese earthquake reached nearly 38 m (125 ft).

The earthquake led to a serious accident at a nuclear power plant located in Fukushima, on Honshu. Three of the six nuclear reactors in the plant overheated when the cooling system failed. This caused a nuclear fuel meltdown and explosions. Several workers were killed, and more were exposed to radiation. Of concern to people outside the plant, radioactive material was released into the air and water. The long-term effects of radiation released to the environment by the accident are not yet known. The greatest fear is that exposure to radiation will lead to increased deaths from cancer.

Although nuclear waste does not explode, the accident in Japan has increased concern in the United States and elsewhere about all aspects of nuclear safety.




*This damaged building at the Fukushima Daiichi nuclear power plant was photographed one year after the earthquake and tsunami.*

Hawaiian island chain is still a subject of active research. One theory suggests that extremely hot material in a region called a hot spot rose to the surface from the deep mantle. According to this theory, movement of the Pacific plate carried each of the islands toward the northwest, away from the hot spot. Other ideas are based on the properties of plates. For example, volcanoes might form when thin or cracked areas of the lithosphere allow hot material from the upper mantle to break through.

## 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. Of the three different types of rocks—igneous, metamorphic, and sedimentary—which type of rock would you expect to find along a divergent plate boundary? Explain.