19.3 Plate Boundaries

In this section, you will learn how the movement of lithospheric plates affects Earth's surface. In particular, many events, such as earthquakes and volcanic activity, occur on Earth's surface at plate boundaries. Why do you think that is? Read on to find out.

VOCABULARY

divergent boundary - a lithospheric plate boundary where two plates move apart.

convergent boundary - a lithospheric plate boundary where two plates come together.

transform fault boundary - a lithospheric plate boundary where two plates slide by each other.

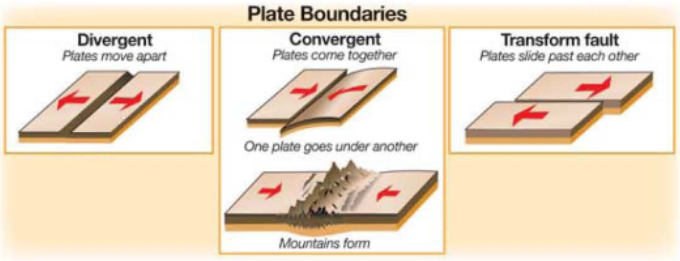
Moving plates

Three types of boundaries

Imagine a single plate moving in one direction on Earth's surface (Figure 19.11). One edge of the plate—the trailing edge—moves away from other plates. This edge is called a **divergent boundary**. The opposite edge—called the leading edge—bumps into any plates in the way. This edge is called a **convergent boundary**. The sides of our imaginary plate slide by other plates. An edge of a lithospheric plate that slides by another plate is called a **transform fault boundary**.

How plates move relative to each other

Earth's surface is covered with lithospheric plates. Unlike our single imaginary plate, the boundaries of real plates touch each other. Plates move apart at divergent boundaries, collide at convergent boundaries, and slide by each other at transform fault boundaries.



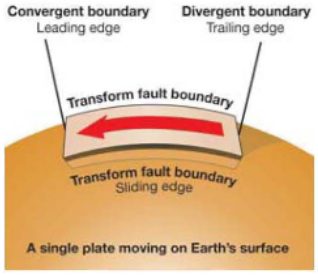


Figure 19.11: *This single plate on Earth's surface illustrates the difference between divergent, convergent, and transform fault boundaries.*

Divergent boundaries

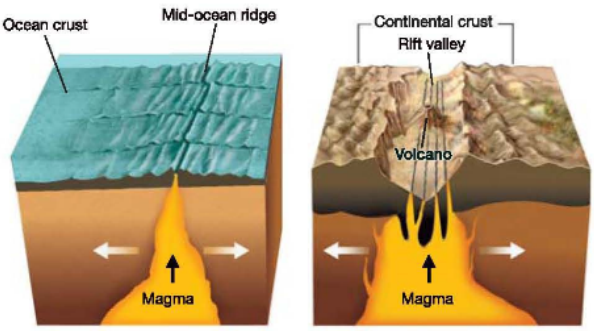
New sea-floor at mid-ocean ridges

Mid-ocean ridges in the oceans are divergent boundaries, where two plates are moving apart. This type of boundary is found over the rising part of a mantle convection cell. Convection causes the two plates to move away from each other. As they move, molten rock fills the space created by their motion. The molten rock cools and becomes new ocean floor.

Rift valleys

Divergent boundaries can also be found on continents as rift valleys. When a rift valley forms on land, it might eventually split the landmass wide enough so that the sea flows into the valley. When this happens, the rift valley becomes a mid-ocean ridge. The East African Rift Valley is an example of rifting in progress that began about 20 million years ago, when Arabia split from Africa. This rift is marked by a series of long lakes that start near the southern end of the Red Sea and extend southward toward Mozambique.

Divergent Plate Boundaries



JOURNAL

Using Clues to Make Discoveries

On the ocean floor, special lava formations called pillow lava are clues to the location of ancient mid-ocean ridges.

The pillow lava forms when basaltic lava flows out under water. The water cools the surface of the lava, forming a crust. This crust stops the flow of lava for a moment. Then the crust cracks and a new jet of lava flows out. This process causes the lava to form what looks like a pile of pillows. Ancient mid-ocean ridges existed near pillow lava formations.

Write a paragraph describing a recent experience where you used a clue to discover something about a place or an object.

Convergent boundaries

Deep-ocean trenches

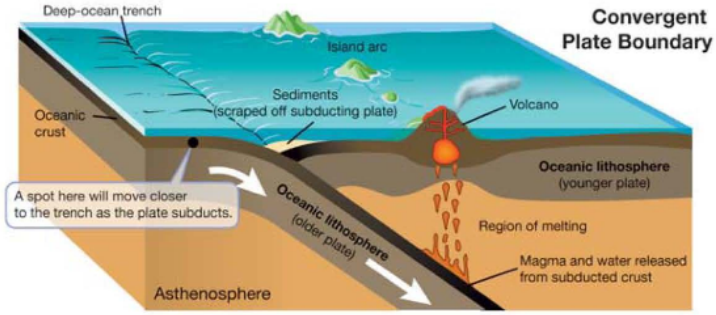
A **deep-ocean trench** is a valley on the ocean floor. These trenches are formed when two oceanic plates or when oceanic and continental plates collide and one plate subducts under the other. The deepest trench on Earth, the Mariana Trench, has a maximum depth of 11 kilometers and is located in the western North Pacific Ocean.

VOCABULARY

deep-ocean trench - a valley in the ocean created when one lithospheric plate subducts under another.

Why does one plate subduct under another?

Density drives how plates interact, and a denser plate will subduct under a less dense one. Since older oceanic plates are cooler, and therefore denser, they tend to subduct under younger oceanic plates. Magma formed at the older, subducting plate rises toward the younger plate and eventually forms an *island arc*, a row of volcanic islands.



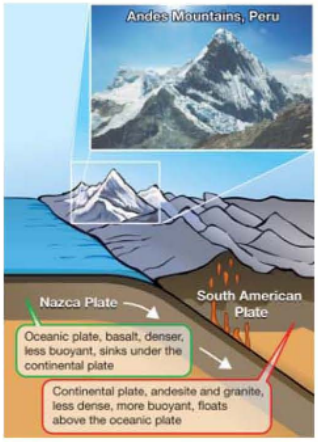


Figure 19.12: *The collision of the Nazca and South American plates has deformed and pushed up the land to form the high peaks of the Andes Mountains.*

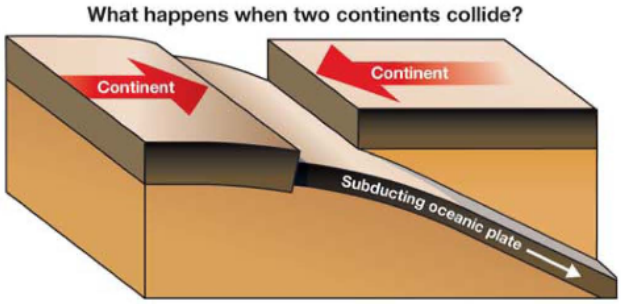
Oceanic and continental plate subduction

What happens if an oceanic plate and a continental plate collide? Continental plates are largely made of andesite and granite. Andesite and granite are much less dense than the basalt of oceanic plates. Additionally, a continental plate is too buoyant and too thick to subduct under an oceanic plate. So, the oceanic plate subducts under the continental plate. For example, the oceanic Nazca Plate off the west coast of South America is subducting under the continental South American Plate (Figure 19.12).

Mountains and convergent boundaries

What happens when two continents collide?

What happens if an oceanic plate with a continental plate attached is subducted under another continental plate? Eventually all of the oceanic crust is subducted and the continental plates collide! The continent on the oceanic plate cannot be pushed down into the trench because its granite rocks are too buoyant to be subducted.



Colliding continents form mountains

Vast mountain ranges are formed when continents collide. Millions of years ago, India was a separate continent and not attached to southern Asia. The Indo-Australian oceanic plate carried the landmass of India toward China as it subducted under the Eurasian continental plate. The Himalaya Mountains are the result of this collision (Figure 19.13). The impact of the collision still causes earthquakes in China today. The formation of mountains is a slow process. The Himalaya Mountains are still growing, millions of years after the collision!

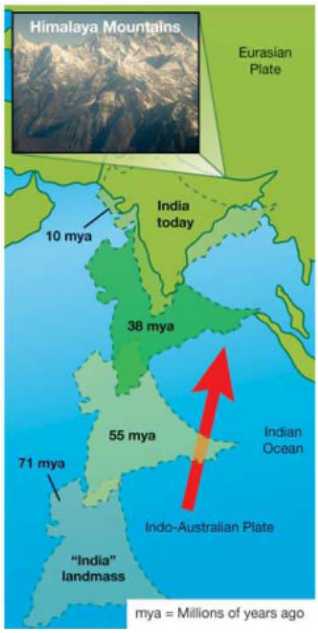


Figure 19.13: *The Himalaya Mountains are the result of the slow but powerful collision between India on the Indo-Australian Plate and China on the Eurasian Plate.*

Transform fault boundaries

Finding boundaries Once scientists began to understand lithospheric plate boundaries, finding divergent and convergent boundaries was easy. Mid-ocean ridges and continental rift valleys are divergent boundaries. Deep-ocean trenches and mountain ranges occur at the locations of convergent boundaries. Finding transform fault boundaries is more difficult. Transform faults leave few clues to indicate their presence.

Zig-zags are clues Sometimes the action of a transform fault will form a small valley along its line of movement. Often there will be ponds along the line. A good clue for locating transform faults is offsetting. If a feature, such as a creek or a highway, crosses a transform fault, the movement of the fault will break, or offset, the feature. When seen from above, the feature will appear to make a zigzag pattern (Figure 19.14).

Earthquakes are another clue Another good way to detect transform fault boundaries is by the earthquakes they cause. The San Andreas Fault is a well-known fault that causes earthquakes in California (Figure 19.15). The San Andreas Fault is the transform fault boundary between two lithospheric plates—the Pacific Plate and the North American Plate.

Using plate tectonics to understand other events Before plate tectonics was understood, scientists knew where earthquakes commonly occurred, but they didn't know why they happened. This is an example of how understanding plate tectonics led to other new discoveries. Today we know that earthquakes occur at all three types of plate boundaries, whereas volcanic activity only occurs at convergent and divergent boundaries. You will learn more about earthquakes and volcanoes in the next chapter.

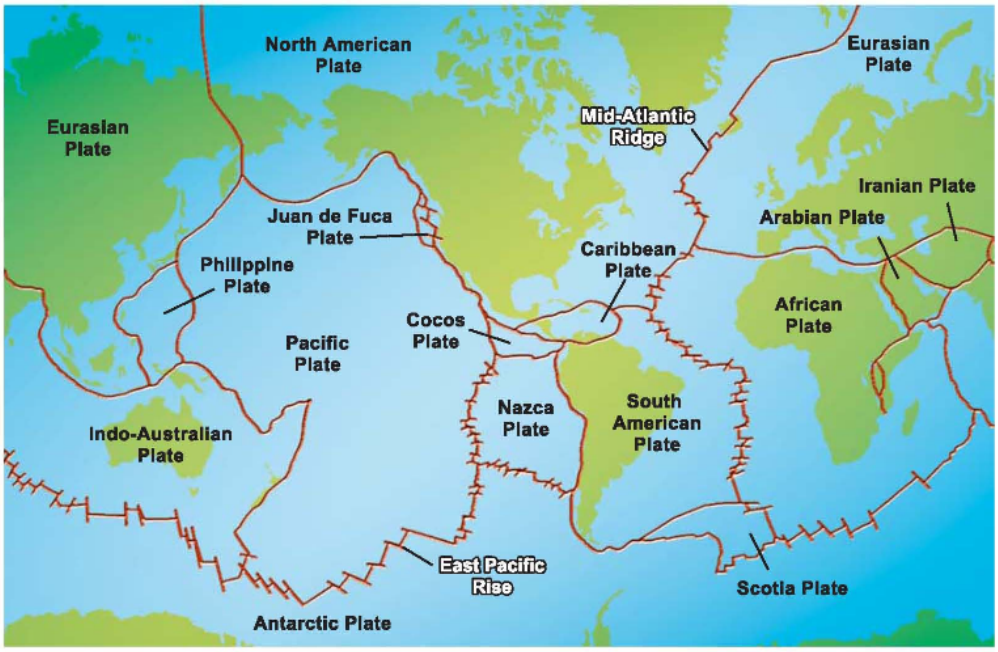
Source: U.S. Geological Survey Photo Library

Figure 19.14: *The creek is offset to the right as viewed from bottom to top in the photo.*


Photo courtesy of Dr. John B. Reid

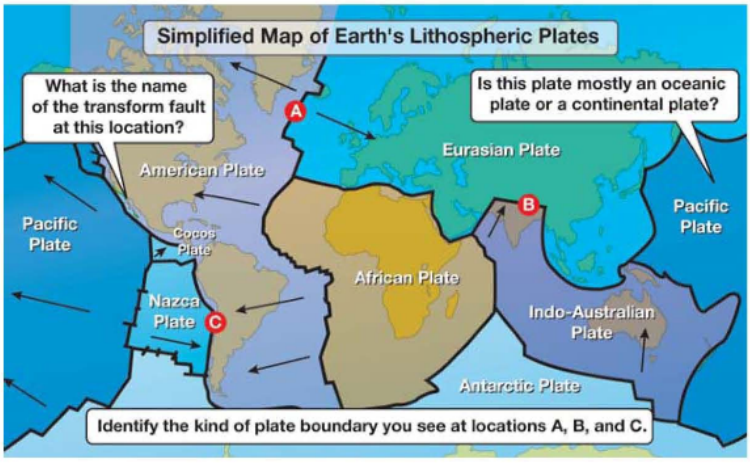
Figure 19.15: *This line of students stretches across part of the San Andreas Fault in California.*

Earth's lithospheric plates



Section 19.3 Review

1. What kind of plate boundary is a mid-ocean ridge?
2. What is pillow lava and where is it formed?
3. Give an example of a divergent plate boundary on land.
4. What happens when oceanic plates collide? What surface feature of Earth occurs when oceanic plates collide?
5. What feature of a plate determines whether one plate will subduct under another plate?
6. Which is more buoyant—a continental plate or oceanic plate? Which would subduct if the two were to collide?
7. What happens when two continental plates collide? Give an example of continents colliding today.
8. What are two clues to finding transform faults?



CHALLENGE

Earth's Lithospheric Plates

The map at the bottom of this page shows the largest lithospheric plates that cover Earth (smaller plates have been combined with the larger ones to simplify the map).

The map also shows the direction that some plates move. You can use this information to identify the type of plate boundary at a certain location.

Identify the types of plate boundaries labeled A, B, and C. Then, see if you can answer the questions on the map.

SCIENCE FACT

Look at the large, detailed map of Earth's larger and smaller lithospheric plates on the previous page.

Choose a plate and find out one fact about it.