11.3 Plate Boundaries

In this section, you will learn how movement at the boundaries of lithospheric plates affects Earth's surface.

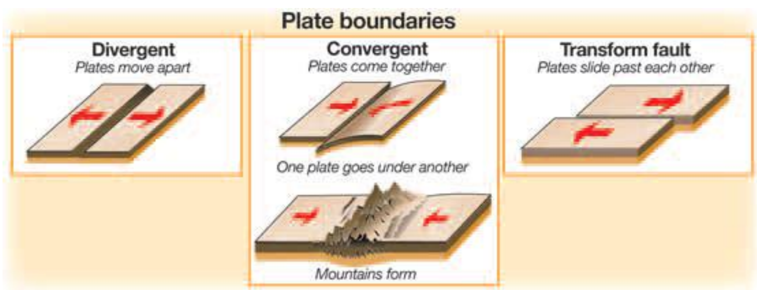
Moving plates

Three types of boundaries

Imagine a single plate, moving in one direction on Earth's surface (Figure 11.7). 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.



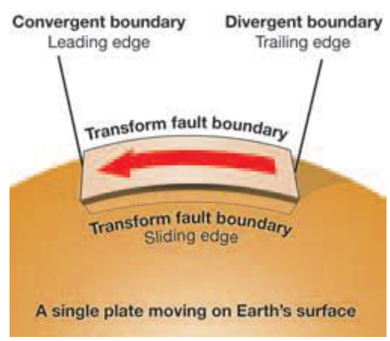
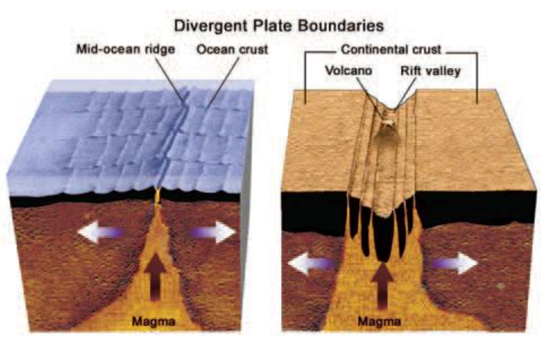


Figure 11.7: *Divergent, convergent, and transform fault boundaries.*

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 may 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. This rift is marked by a series of long lakes that start near the southern end of the Red Sea and move southward toward Mozambique.



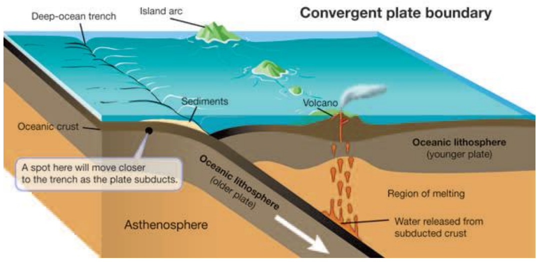
Convergent boundaries

Deep-ocean trenches

A **deep-ocean trench** is a valley on the ocean floor. These trenches are formed when two oceanic plates collide and one plate subducts under the other.

Why does one plate subduct under another?

A denser plate subducts under a less dense one. Older oceanic plates are cooler, and therefore denser than young oceanic plates. So older plates tend to subduct or slide under younger plates.



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. Which plate would subduct? A continental plate is simply too buoyant and too thick to subduct under an oceanic plate. The oceanic plate must subduct under the continental plate. A good example of this is the Nazca Plate off the coast of South America. The Nazca Plate is subducting under the South American Plate (Figure 11.8).

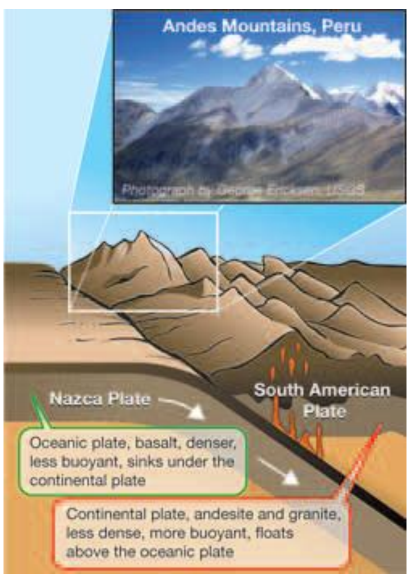
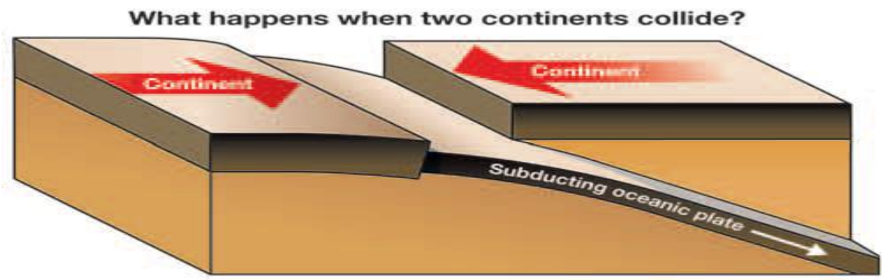


Figure 11.8: *The collision of the Nazca and South American Plates has deformed and pushed up the land to form the high peaks of the Andes Mountains.*

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 sucked 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 South Asia. The Indo-Australian oceanic plate carried the landmass of India toward China as it subducted under the Eurasian continental plate. The Himalayan Mountains are the result of this collision (Figure 11.9). The impact of the collision still causes earthquakes in China today. The formation of mountains is a slow process. The Himalayan Mountains are still growing, millions of years after the collision!

Figure 11.9: *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 like 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 zig-zag (Figure 11.10).

Figure 11.10: *The creek is offset to the right as viewed from bottom to top in the photo.*

Earthquakes are another clue

Another good way to detect transform faults is by the earthquakes they cause. The San Andreas Fault is a well-known fault that causes earthquakes in California (Figure 11.11). The San Andreas Fault is the transform fault boundary between two lithospheric plates—the Pacific Plate and the North American Plate.

Figure 11.11: *This line of students stretches across part of the San Andreas Fault in California.*

Using plate tectonics to understand other events

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

Slickensides, evidence of plate boundaries

What are slickensides?

The photo at the near right shows the effect of rock moving against rock along a fault in the Coronado Heights section of San Francisco. The polished rock surface is called *slickensides*. At one time, the slickensides were below Earth's surface with another mass of rock pressing against it. The other mass has since weathered away.

Motion of the slickensides

Figure 11.12 is a close-up of the slickensides looking to the right. Look at the edge that is sticking out. This edge indicates that the direction that the slickensides moved in the past was away from you. The rock mass that weathered away would have been to the right of the slickensides. The graphic below at the left gives you a bird's eye view of how these plates moved.

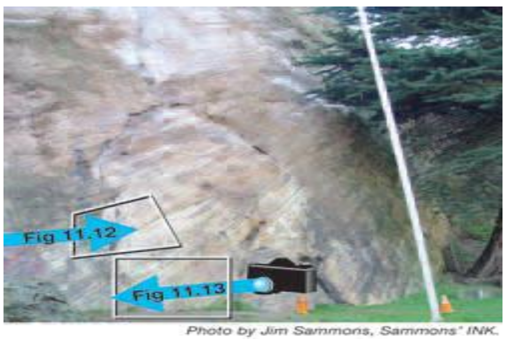


Figure 11.12: *The edge that is sticking out indicates that the slickensides moved away from you.*

Looking at a transform fault boundary

Figure 11.13 is another close-up of thesame slickensides, but looking to the left. From this view we can see part of the rock mass that moved against the slickensides rock mass. The blue pen marks the fault that separates the two rock masses. The rock mass to the left of the fault was part of the Pacific Plate. The slickensides rock mass to the right of the fault was part of the North American Plate. This is the location of a transform fault boundary!

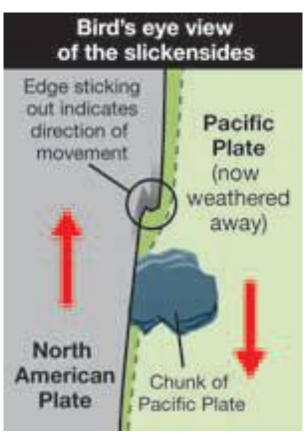
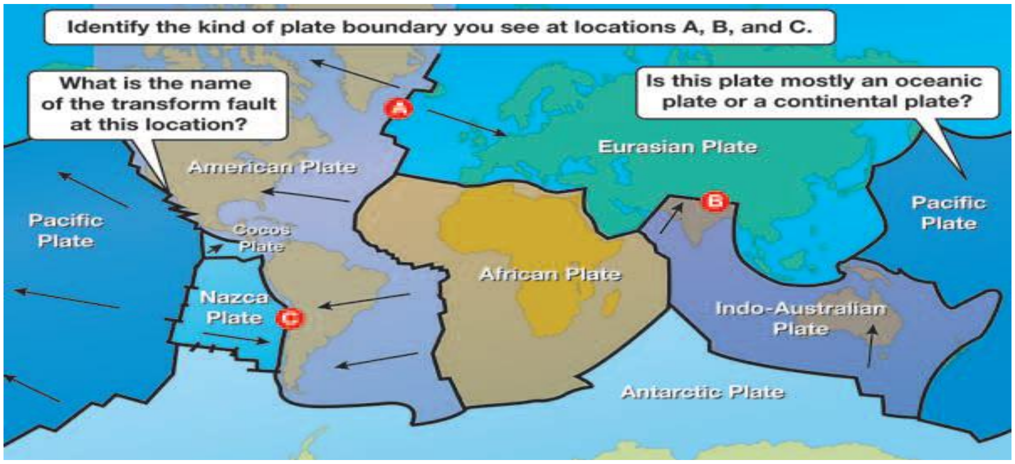


Figure 11.13: *A transform fault boundary between the Pacific Plate to the left and the North American Plate to the right (marked by the photographer's blue pen).*

Earth's lithospheric plates

This map shows the largest lithospheric plates that cover Earth. There are many small plates, but some of these have been combined with the larger ones to simplify the map. Study the map below. Can you identify the three types of plate boundaries labeled A, B, and C? Use the arrows on the map to help you. Remember that the three types of plate boundaries are divergent, convergent, and transform. Then, see if you can answer the questions. A more detailed view of Earth's lithospheric plates is on the next page.



Earth's lithospheric plates

11.3 Section Review

1. What are the three types of plate boundaries and what direction of movement does each have?

2. What kind of plate boundary is a mid-ocean ridge?

3. What is pillow lava and where is it formed?

4. Give an example of a divergent boundary on land.

5. What happens when oceanic plates collide? What surface feature does this plate boundary create?

6. What features of a plate determine whether one plate will subduct under another plate? Pick the two correct features below:
a. the name of the plate b. the age of the plate c. whether the plate is oceanic or continental

d. how fast the plate is traveling e. whether the plate is in the northern or southern hemisphere

f. the density or buoyancy of the plate

7. Which is more buoyant—a continental plate or oceanic plate? Which would subduct if the two were to collide?

8. What happens when two continental plates collide? Give an example of continents colliding today.

9. What are two clues to finding transform faults?

10. The polished surfaces of rock that are a result of rock moving against rock along a fault are known as ____________________.

11. The previous page shows a detailed map of Earth's larger and smaller lithospheric plates. Pick a plate and find out one fact about this plate.

<u>Add these vocabulary works to Journal 3</u>

1. Convergent boundary
2. Divergent boundary
3. Transform boundary
4. Deep ocean trench