Section 5

# The Theory of Plate Tectonics

## Reading Preview

### Key Concepts

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

### Key Terms

- plate
- scientific theory
- plate tectonics
- fault
- divergent boundary
- rift valley
- convergent boundary
- transform boundary

### Target Reading Skill

**Building Vocabulary** A definition states the meaning of a word or phrase by telling about its most important feature or function. After you read the section, reread the paragraphs that contain definitions of Key Terms. Use all the information you have learned to write a definition of each Key Term in your own words.

Lab zone **Discover Activity**

### How Well Do the Continents Fit Together?

1. Using a world map in an atlas, trace the shape of each continent and Madagascar on a sheet of paper. Also trace the shape of India and the Arabian Peninsula.
2. Carefully cut apart the landmasses, leaving Asia and Europe as one piece. Separate India and the Arabian Peninsula from Asia.
3. Piece together the continents as they may have looked before the breakup of Pangaea. Then attach your reconstruction of Pangaea to a sheet of paper.

**Think It Over**

**Drawing Conclusions** How well did the pieces of your continents fit together? Do your observations support the idea that today's landmasses were once joined together? Explain.

Have you ever dropped a hard-boiled egg? If so, you may have noticed that the eggshell cracked in an irregular pattern of pieces. Earth's lithosphere, its solid outer shell, is not one unbroken layer. It is more like that cracked eggshell. It's broken into pieces separated by jagged cracks.

A Canadian scientist, J. Tuzo Wilson, observed that there are cracks in the continents similar to those on the ocean floor. In 1965, Wilson proposed a new way of looking at these cracks. According to Wilson, the lithosphere is broken into separate sections called **plates.** The plates fit together along cracks in the lithosphere. As shown in Figure 22, the plates carry the continents or parts of the ocean floor, or both. Wilson combined what geologists knew about sea-floor spreading, Earth's plates, and continental drift into a single theory. A **scientific theory** is a well-tested concept that explains a wide range of observations.

FIGURE 21
**A Cracked Eggshell**
Earth's lithosphere is broken into plates like the cracked shell of a hard-boiled egg.

## How Plates Move

The theory of **plate tectonics** (tek TAHN iks) states that pieces of Earth's lithosphere are in slow, constant motion, driven by convection currents in the mantle. **The theory of plate tectonics explains the formation, movement, and subduction of Earth's plates.**

How can Earth's plates move? What force is great enough to move the heavy continents? Geologists think that movement of convection currents in the mantle is the major force that causes plate motion. During subduction, gravity pulls one edge of a plate down into the mantle. The rest of the plate also moves. This slow movement is similar to what happens in a pot of soup when gravity causes the cooler, denser soup near the surface to sink.

As the plates move, they collide, pull apart, or grind past each other, producing spectacular changes in Earth's surface. These changes include volcanoes, mountain ranges, and deep-ocean trenches.

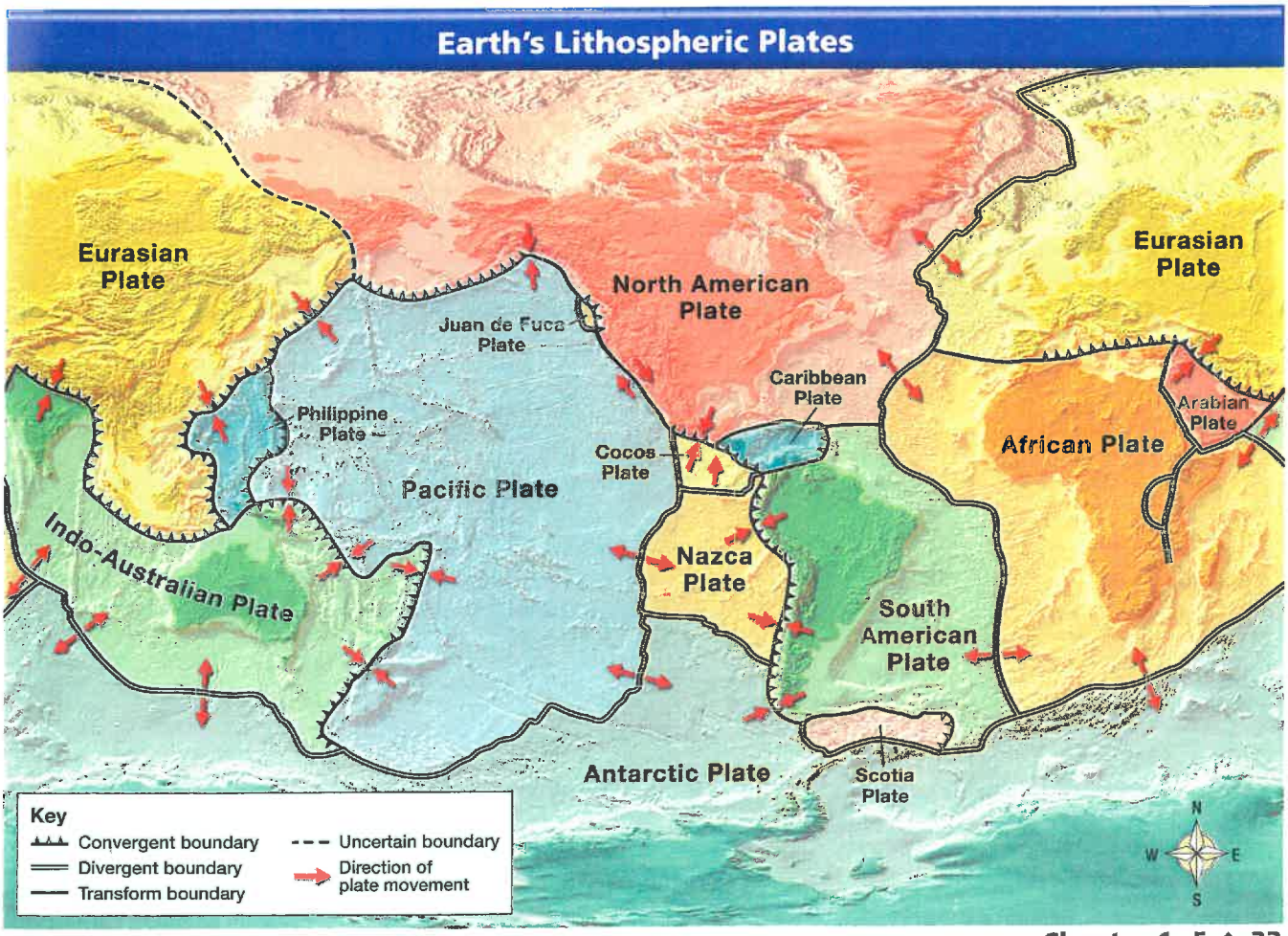
**Lab zone Skills Activity**

### Predicting

Study the map of Earth's plates in Figure 22. Notice the arrows that show the direction of plate movement. Now find the Nazca plate on the map. Which direction is it moving? Find the South American plate and describe its movement. What do you think will happen as these plates continue to move?

**FIGURE 22**

Plate boundaries divide the lithosphere into large plates.
**Interpreting Maps** *Which plates include only ocean floor? Which plates include both continents and ocean floor?*



# Plate Boundaries

The edges of Earth's plates meet at plate boundaries. Plate boundaries extend deep into the lithosphere. **Faults**—breaks in Earth's crust where rocks have slipped past each other—form along these boundaries. **As shown in Figure 23, there are three kinds of plate boundaries: divergent boundaries, convergent boundaries, and transform boundaries. A different type of plate movement occurs along each type of boundary.**

Scientists have used instruments on satellites to measure plate motion very precisely. The plates move at amazingly slow rates: from about 1 to 24 centimeters per year. The North American and Eurasian plates are moving apart at a rate of 2.5 centimeters per year. That's about as fast as your fingernails grow. This may not seem like much, but these plates have been moving apart for tens of millions of years.

**Divergent Boundaries** The place where two plates move apart, or diverge, is called a **divergent boundary** (dy VUR junt). Most divergent boundaries occur along the mid-ocean ridges where sea-floor spreading occurs.

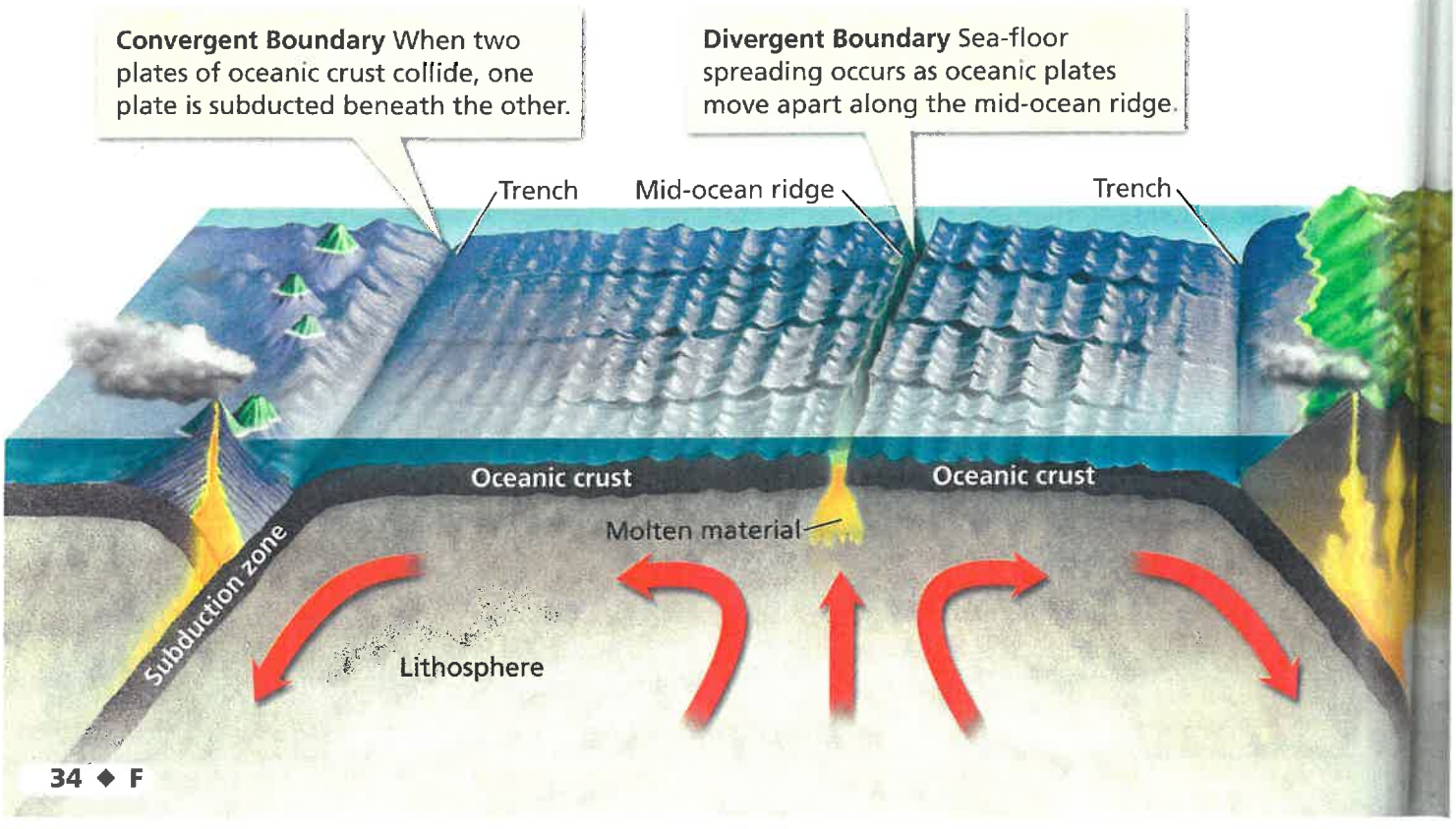
Divergent boundaries also occur on land. When a divergent boundary develops on land, two of Earth's plates slide apart. A deep valley called a **rift valley** forms along the divergent boundary. For example, the Great Rift Valley in East Africa marks a deep crack in the African continent.

FIGURE 23

## Plate Tectonics

Plate movements have built many of the features of Earth's land surfaces and ocean floors.

**Predicting** *What will eventually happen if a rift valley continues to pull apart?*



**Convergent Boundaries** The place where two plates come together, or converge, is called a **convergent boundary** (kun VUR junt). When two plates converge, the result is called a collision. When two plates collide, the density of the plates determines which one comes out on top.

Oceanic crust becomes cooler and denser as it spreads away from the mid-ocean ridge. Where two plates carrying oceanic crust meet at a trench, the plate that is more dense sinks under the other plate.

Sometimes a plate carrying oceanic crust collides with a plate carrying continental crust. Oceanic crust is more dense than continental crust. The less dense continental crust can't sink under the more dense oceanic crust. Instead, subduction occurs as the oceanic plate sinks beneath the continental plate.

When two plates carrying continental crust collide, subduction does not take place. Neither piece of crust is dense enough to sink very far into the mantle. Instead, the collision squeezes the crust into mighty mountain ranges.

**Transform Boundaries** A **transform boundary** is a place where two plates slip past each other, moving in opposite directions. Earthquakes often occur along transform boundaries, but crust is neither created nor destroyed.

**Reading Checkpoint** **What features form where two continental plates come together?**

**Math Skills**

## Calculating a Rate

To calculate the rate of plate motion, divide the distance the plate moves by the time it takes to move that distance.

$$\text{Rate} = \frac{\text{Distance}}{\text{Time}}$$

For example, a plate takes 2 million years to move 156 km. Calculate its rate of motion.

$$\frac{156 \text{ km}}{2{,}000{,}000 \text{ years}} = 7.8 \text{ cm per year}$$

**Practice Problem** The Pacific plate is sliding past the North American plate. It has taken 10 million years for the plate to move 600 km. What is the Pacific plate's rate of motion?