8.4 Evidence for a New Theory

After Wegener died on an expedition to Greenland in 1930, his ideas were almost forgotten. It was not until the 1960s that new evidence made scientists reconsider his ideas about Pangaea and continental drift. By then, advances in technology had given scientists new information about the ocean floor.

Mapping the Ocean Floor

The ocean floor is not flat, as was previously believed (**Figure 1**). Scientists mapping the ocean floor were surprised to find deep trenches. These long, narrow trenches usually run parallel to and near the edges of the oceans. Scientists were also surprised to find a huge mountain range that almost encircles the Earth. This ridge of mountains is about 50 000 km long and runs through the middle of the oceans. It is called a **mid-ocean ridge.**

LEARNING TIP

Check for understanding as you read. Turn each subheading into a question and answer it.

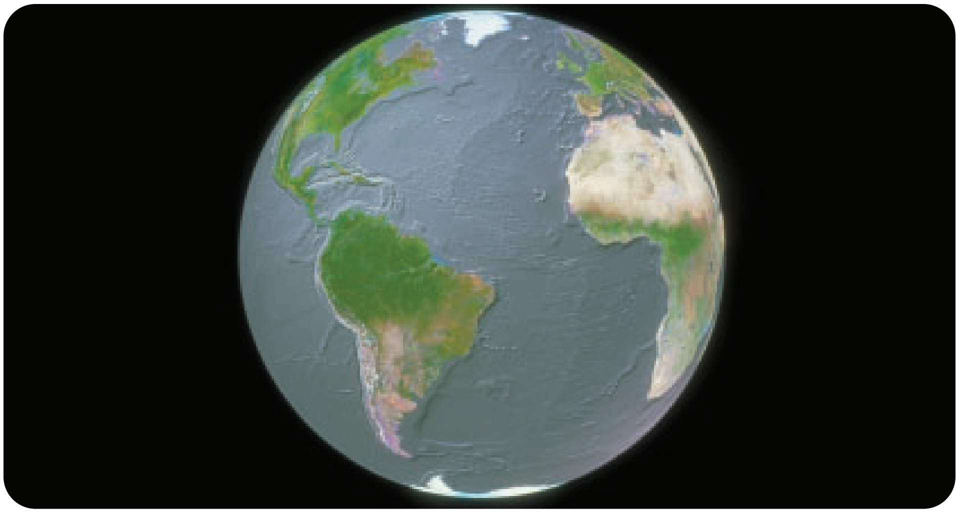

Figure 1

This map shows what the sea floor of the Atlantic Ocean would look like if all the water could be drained away. The ridge of mountains is called the mid-Atlantic ridge.

Ages of Rocks on the Ocean Floor

Scientists discovered that the layers of sediment on the ocean floor in the mid-Atlantic are quite thin. This suggested that the ocean floor is not as old as they had thought. If the ocean floor had remained unchanged for millions of years, the layers of sediment would have been thick.

As well, scientists found very young rocks at the top of mid-ocean ridges. The farther away from the ridge, the older the rocks are. Scientists concluded that the ridge is where the crust is splitting apart. Magma is rising at the ridge to form new crust. The sea floor at the mid-ocean ridge is increasing in size as new crust is formed. A scientist named Harry Hess called this process sea-floor spreading.

Hess suggested that the new ocean crust is constantly moving away from the ridge as if it is on a huge, and very slow, conveyor belt. After millions and millions of years, the crust sinks at a trench. Since Earth does not seem to be getting bigger, Hess concluded that the Atlantic Ocean is expanding and the Pacific Ocean is shrinking.

Magnetic Reversals

Scientists know that Earth's magnetic field has reversed several times over millions and millions of years. The mineral magnetite is magnetic. Grains of magnetite in molten magma line up like little magnets. The north ends of magnetite grains point to Earth's North Pole and the south ends point to Earth's South Pole. These patterns become locked into the rock as magma hardens. When Earth's magnetic field changes, this pattern reverses. Magnetite in solid rock cannot move, so only the magnetite in molten magma moves in the new direction.

The magnetic patterns locked into rock tell scientists about the direction of Earth's magnetic field at the time the rock was formed. Stripes of rock, parallel to the mid-ocean ridge, alternate between normal and reversed magnetic fields. This indicates that new rock is formed at the ridge.

TRY THIS: *CREATE A MODEL OF A MID-OCEAN RIDGE*

Skills Focus: creating models, observing, inferring

Push together two desks or tables. Take two pieces of lined paper. Hold the pieces of paper together beneath the desks, and push them slowly up through the crack as shown in **Figure 2**, about 4 cm at a time. Each time you stop, use a different colour to draw a stripe of rock on each side. Also draw arrows on each side to show the direction of magnetism. Reverse the direction of magnetism each time by reversing the direction of the arrow.

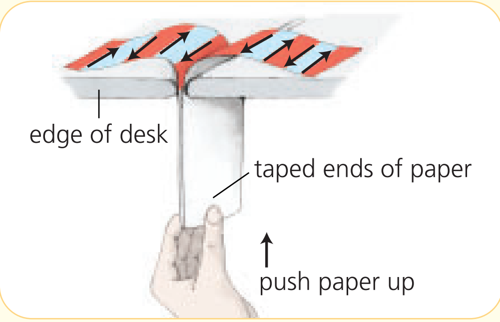

Figure 2

Locations of Earthquakes and Volcanoes

> **LEARNING TIP**
> The term "tectonic" is used to refer to building or construction. It comes from the Greek word *tektonikos*, meaning "carpenter." So "plate tectonics" means "built or constructed of plates."

Improvements in technology allowed scientists to record earthquakes and volcanoes under the oceans as well as on land. These new observations gave scientists a clearer pattern from which to draw conclusions about the movement of the continents and about Earth's crust in general. (You will learn more about the locations of earthquakes and volcanoes in Investigation 8.5.)

From these new observations, and the previous observations made by Wegener, the theory of **plate tectonics** [tek-TON-iks] was developed. According to this theory, the surface of Earth consists of about a dozen large plates that are continually moving (**Figure 3**).

spreading apart

coming together (teeth on the side of the top plate)

direction of plate motion

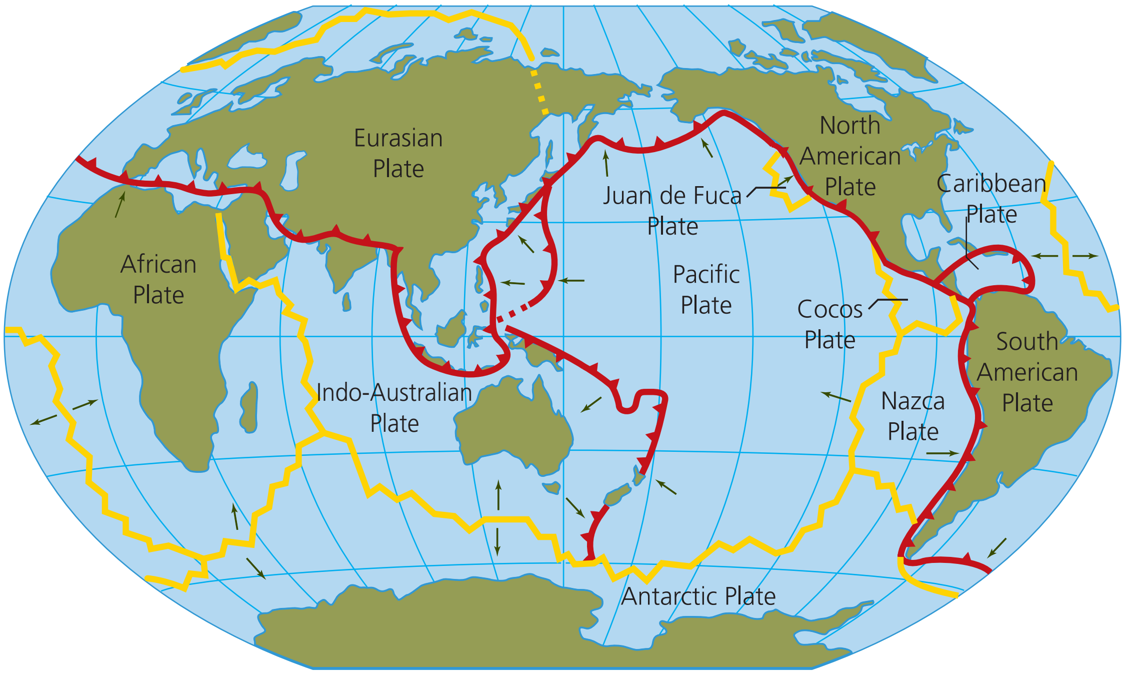

Figure 3
The major plates of Earth's crust: One small plate that is very important to British Columbia is the Juan de Fuca Plate. This plate is sandwiched between the North American Plate and the Pacific Plate.

The parts of Earth's crust that have continents on them are called **continental crust.** The parts that have only ocean floor on them are called **oceanic crust.** Plates can be made up of continental crust, oceanic crust, or both. Wegener's theory of continental drift was wrong in one way: not only the continents are moving. Both the continents and the ocean floor form plates that move.

The plates move at different rates. The fastest plate movement, about 15 cm per year, is at the East Pacific Rise near Easter Island in the South Pacific Ocean. The Australian Plate moves about 6 cm per year. The slowest plate movement, about 2.5 cm per year, is at the Arctic Ridge.

Scientists are still working on the question that was such a problem for Wegener: What makes the plates move? Scientists generally agree with Hess's theory that the slow movement of the hot mantle below the plates moves the plates. However, the details about what causes this movement are still being discussed. Hess thought that the movement commonly seen in boiling water or soup played a role. Now scientists think that the sinking of oceanic crust into trenches, which pulls the rest of the plate behind it, is an important cause of plate motion. Unfortunately, none of the current theories fully explain all the observations about plate movement.

CHECK YOUR UNDERSTANDING

1. What is the theory of plate tectonics? How is it different from Wegener's theory of continental drift?
2. What new scientific evidence was added to Wegener's evidence to develop the theory of plate tectonics?
3. Why are we not able to observe with our senses that Earth's plates are moving?
4. In section 8.1, you used an orange, a peach, and a hard-boiled egg as models of Earth. Which one could you use to show plate movement? Explain how you would do this.