SECTION 2

Restless Continents

Have you ever looked at a map of the world and noticed how the coastlines of continents on opposite sides of the oceans appear to fit together like the pieces of a puzzle? Is it just coincidence that the coastlines fit together well? Is it possible that the continents were actually together sometime in the past?

What You Will Learn

- Describe Wegener's hypothesis of continental drift.
- Explain how sea-floor spreading provides a way for continents to move.
- Describe how new oceanic lithosphere forms at mid-ocean ridges.
- Explain how magnetic reversals provide evidence for sea-floor spreading.

Vocabulary

continental drift
sea-floor spreading

READING STRATEGY

Paired Summarizing Read this section silently. In pairs, take turns summarizing the material. Stop to discuss ideas that seem confusing.

Wegener's Continental Drift Hypothesis

One scientist who looked at the pieces of this puzzle was Alfred Wegener (VAY guh nuhr). In the early 1900s, he wrote about his hypothesis of *continental drift*. **Continental drift** is the hypothesis that states that the continents once formed a single landmass, broke up, and drifted to their present locations. This hypothesis seemed to explain a lot of puzzling observations, including the observation of how well continents fit together.

Continental drift also explained why fossils of the same plant and animal species are found on continents that are on different sides of the Atlantic Ocean. Many of these ancient species could not have crossed the Atlantic Ocean. As you can see in **Figure 1,** without continental drift, this pattern of fossils would be hard to explain. In addition to fossils, similar types of rock and evidence of the same ancient climatic conditions were found on several continents.

Reading Check **How did fossils provide evidence for Wegener's hypothesis of continental drift?** (*See the Appendix for answers to Reading Checks.*)

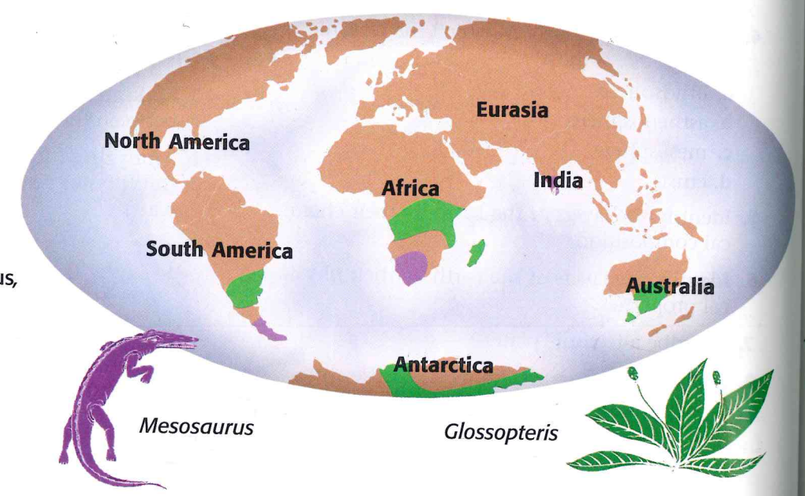
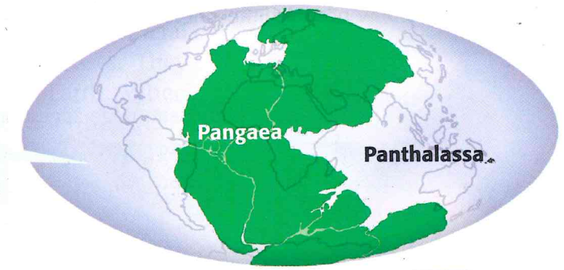


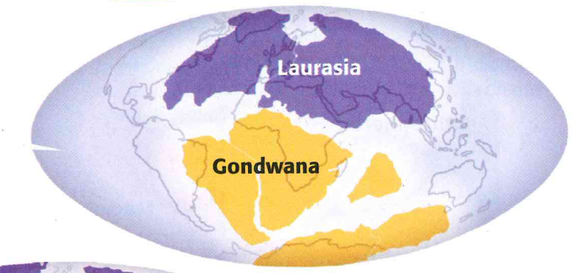
Figure 1 *Fossils of* Mesosaurus, *a small, aquatic reptile, and* Glossopteris, *an ancient plant species, have been found on several continents.*

Figure 2 **The Drifting Continents**

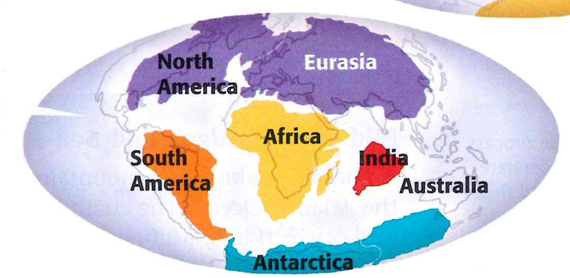
245 Million Years Ago
Pangaea existed when some of the earliest dinosaurs were roaming the Earth. The continent was surrounded by a sea called *Panthalassa*, which means "all sea."



180 Million Years Ago
Gradually, Pangaea broke into two big pieces. The northern piece is called *Laurasia*. The southern piece is called *Gondwana*.



65 Million Years Ago
By the time the dinosaurs became extinct, Laurasia and Gondwana had split into smaller pieces.



The Breakup of Pangaea

Wegener made many observations before proposing his hypothesis of continental drift. He thought that all of the present continents were once joined in a single, huge continent. Wegener called this continent *Pangaea* (pan JEE uh), which is Greek for "all earth." We now know from the hypothesis of plate tectonics that Pangaea existed about 245 million years ago. We also know that Pangaea further split into two huge continents—Laurasia and Gondwana—about 180 million years ago. As shown in **Figure 2,** these two continents split again and formed the continents we know today.

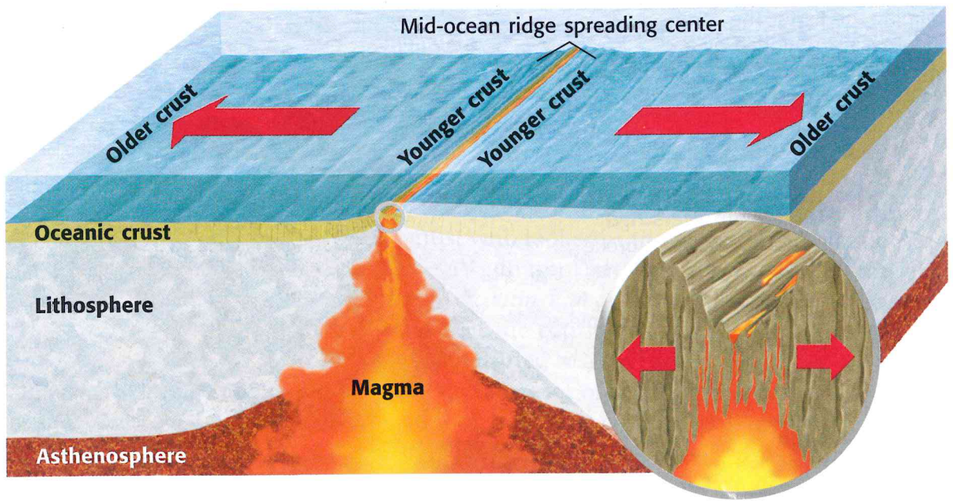
continental drift the hypothesis that states that the continents once formed a single landmass, broke up, and drifted to their present locations

Sea-Floor Spreading

When Wegener put forth his hypothesis of continental drift, many scientists would not accept his hypothesis. From the calculated strength of the rocks, it did not seem possible for the crust to move in this way. During Wegener's life, no one knew the answer. It wasn't until many years later that evidence provided some clues to the forces that moved the continents.

Figure 3 **Sea-Floor Spreading**

Sea-floor spreading creates new oceanic lithosphere at mid-ocean ridges.



sea-floor spreading the process by which new oceanic lithosphere forms as magma rises toward the surface and solidifies

Mid-Ocean Ridges and Sea-Floor Spreading

A chain of submerged mountains runs through the center of the Atlantic Ocean. The chain is part of a worldwide system of mid-ocean ridges. Mid-ocean ridges are underwater mountain chains that run through Earth's ocean basins.

Mid-ocean ridges are places where sea-floor spreading takes place. **Sea-floor spreading** is the process by which new oceanic lithosphere forms as magma rises toward the surface and solidifies. As the tectonic plates move away from each other, the sea floor spreads apart and magma fills in the gap. As this new crust forms, the older crust gets pushed away from the mid-ocean ridge. As **Figure 3** shows, the older crust is farther away from the mid-ocean ridge than the younger crust is.

Evidence for Sea-Floor Spreading: Magnetic Reversals

Some of the most important evidence of sea-floor spreading comes from magnetic reversals recorded in the ocean floor. Throughout Earth's history, the north and south magnetic poles have changed places many times. When the poles change places, the polarity of Earth's magnetic poles changes, as shown in **Figure 4.** When Earth's magnetic poles change places, this change is called a *magnetic reversal.*

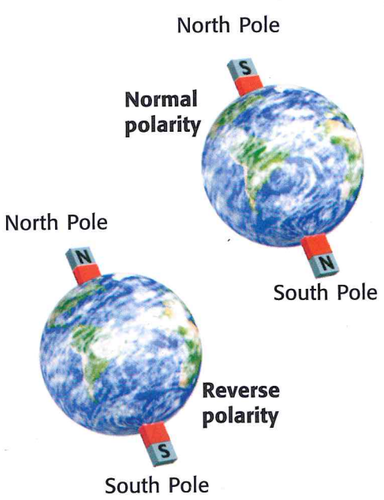


Figure 4 *The polarity of Earth's magnetic field changes over time.*

Magnetic Reversals and Sea-Floor Spreading

The molten rock at the mid-ocean ridges contains tiny grains of magnetic minerals. These mineral grains contain iron and are like compasses. They align with the magnetic field of the Earth. When the molten rock cools, the record of these tiny compasses remains in the rock. This record is then carried slowly away from the spreading center of the ridge as sea-floor spreading occurs.

As you can see in **Figure 5,** when the Earth's magnetic field reverses, the magnetic mineral grains align in the opposite direction. The new rock records the direction of the Earth's magnetic field. As the sea floor spreads away from a mid-ocean ridge, it carries with it a record of magnetic reversals. This record of magnetic reversals was the final proof that sea-floor spreading does occur.

Reading Check **How is a record of magnetic reversals recorded in molten rock at mid-ocean ridges?**

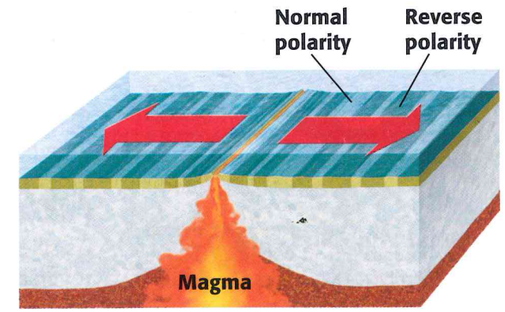


Figure 5 *Magnetic reversals in oceanic crust are shown as bands of light blue and dark blue oceanic crust. Light blue bands indicate normal polarity, and dark blue bands indicate reverse polarity.*

SECTION Review

Summary

- Wegener hypothesized that continents drift apart from one another and have done so in the past.
- The process by which new oceanic lithosphere forms at mid-ocean ridges is called sea-floor spreading.
- As tectonic plates separate, the sea floor spreads apart and magma fills in the gap.
- Magnetic reversals are recorded over time in oceanic crust.

Using Key Terms

1. In your own words, write a definition for each of the following terms: *continental drift* and *sea-floor spreading.*

Understanding Key Ideas

2. At mid-ocean ridges,
   a. the crust is older.
   b. sea-floor spreading occurs.
   c. oceanic lithosphere is destroyed.
   d. tectonic plates are colliding.
3. Explain how oceanic lithosphere forms at mid-ocean ridges.
4. What is magnetic reversal?

Math Skills

5. If a piece of sea floor has moved 50 km in 5 million years, what is the yearly rate of sea-floor motion?

Critical Thinking

6. **Identifying Relationships** Explain how magnetic reversals provide evidence for sea-floor spreading.
7. **Applying Concepts** Why do bands indicating magnetic reversals appear to be of similar width on both sides of a mid-ocean ridge?
8. **Applying Concepts** Why do you think that old rocks are rare on the ocean floor?

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Topic: Tectonic Plates

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