SECTION 3

Drifting Continents

DISCOVER

ACTIVITY

How Are Earth's Continents Linked Together?

1. Find the oceans and the seven continents on a globe showing Earth's physical features.
2. How much of the globe is occupied by the Pacific Ocean? Does most of Earth's "dry" land lie in the Northern or Southern hemisphere?
3. Find the points or areas where most of the continents are connected. Find the points at which several of the continents almost touch, but are not connected.
4. Examine the globe more closely. Find the great belt of mountains running from north to south along the western side of North and South America. Can you find another great belt of mountains on the globe?

Think It Over

Posing Questions What questions can you pose about how oceans, continents, and mountains are distributed on Earth's surface?

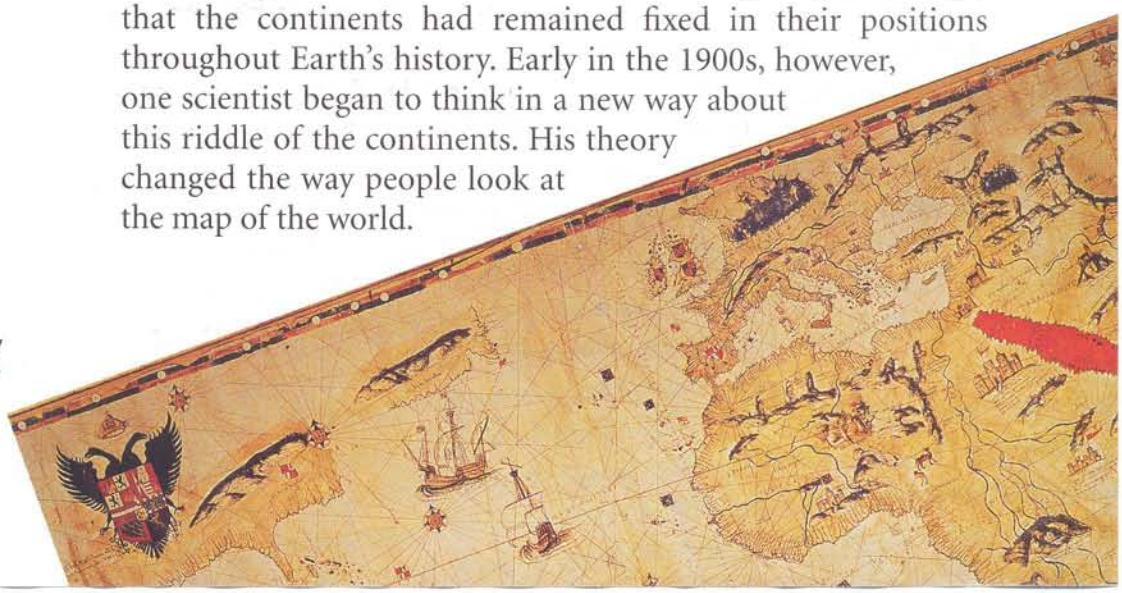
GUIDE FOR READING

- **What is continental drift?**
- **Why was Alfred Wegener's theory rejected by most scientists of his day?**

Reading Tip **As you read, look for evidence that supports the theory of continental drift.**

Five hundred years ago, the sea voyages of Columbus and other explorers changed the map of the world. The continents of Europe, Asia, and Africa were already known to mapmakers. Soon mapmakers were also showing the outlines of the continents of North and South America. Looking at these world maps, many people wondered why the coasts of several continents matched so neatly.

Look at the modern world map in Figure 11. Notice how the coasts of Africa and South America look as if they could fit together like jigsaw-puzzle pieces. Could the continents have once been a single landmass? In the 1700s, the first geologists thought that the continents had remained fixed in their positions throughout Earth's history. Early in the 1900s, however, one scientist began to think in a new way about this riddle of the continents. His theory changed the way people look at the map of the world.



World map drawn by Juan Vespucci in 1526. ▶

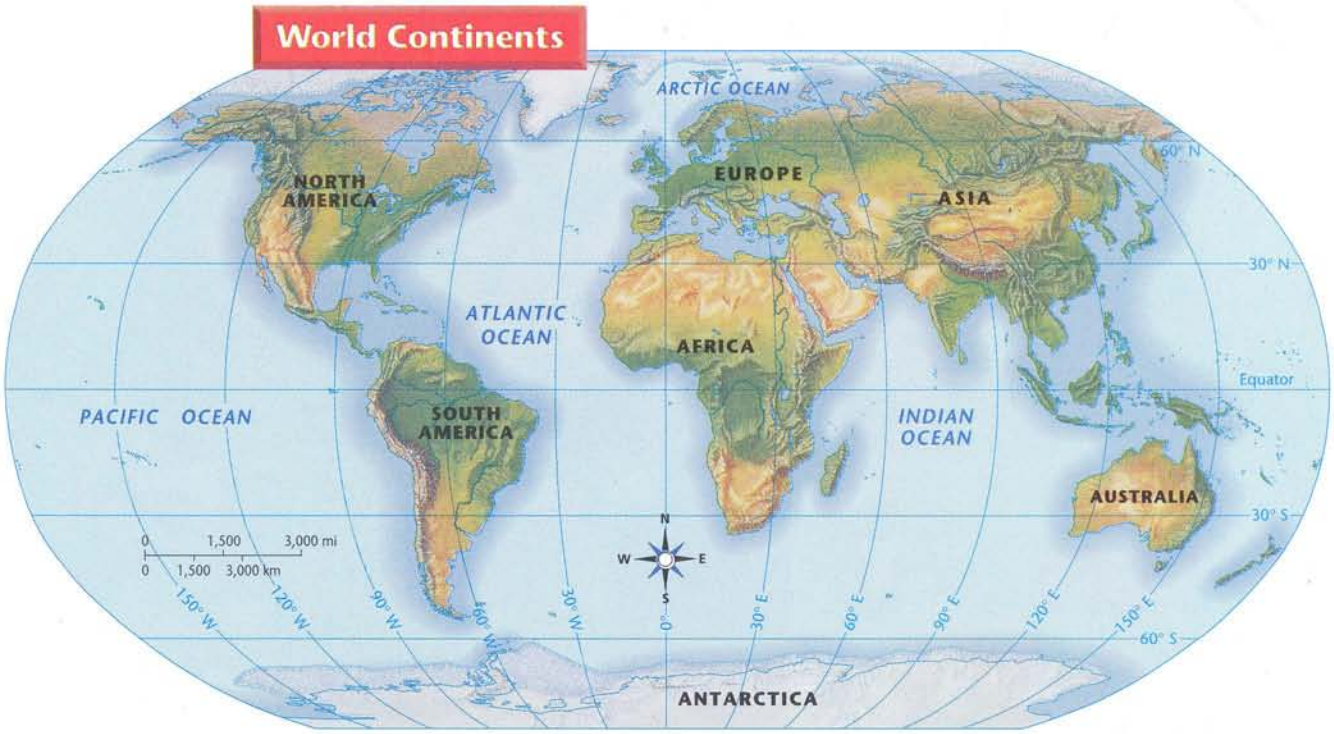


Figure 11 Today's continents provide clues about Earth's history. *Observing* *Which coastlines of continents seem to match up like jigsaw-puzzle pieces?*

The Theory of Continental Drift

In 1910, a young German scientist named Alfred Wegener (VAY guh nur) became curious about the relationship of the continents. He formed a hypothesis that Earth's continents had moved! **Wegener's hypothesis was that all the continents had once been joined together in a single landmass and have since drifted apart.**

Wegener named this supercontinent **Pangaea** (pan JEE uh), meaning "all lands." According to Wegener, Pangaea existed about 300 million years ago. This was the time when reptiles and winged insects first appeared. Great tropical forests, which later formed coal deposits, covered large parts of Earth's surface.

Over tens of millions of years, Pangaea began to break apart. The pieces of Pangaea slowly moved toward their present-day locations, becoming the continents as they are today. Wegener's idea that the continents slowly moved over Earth's surface became known as **continental drift**.

Have you ever tried to persuade a friend to accept a new idea? Your friend's opinion probably won't change unless you provide some convincing evidence. Wegener gathered evidence from different scientific fields to support his ideas about continental drift. In particular, he studied landforms, fossils, and evidence that showed how Earth's climate had changed over many millions of years. Wegener published all his evidence for continental drift in a book called *The Origin of Continents and Oceans*, first published in 1915.

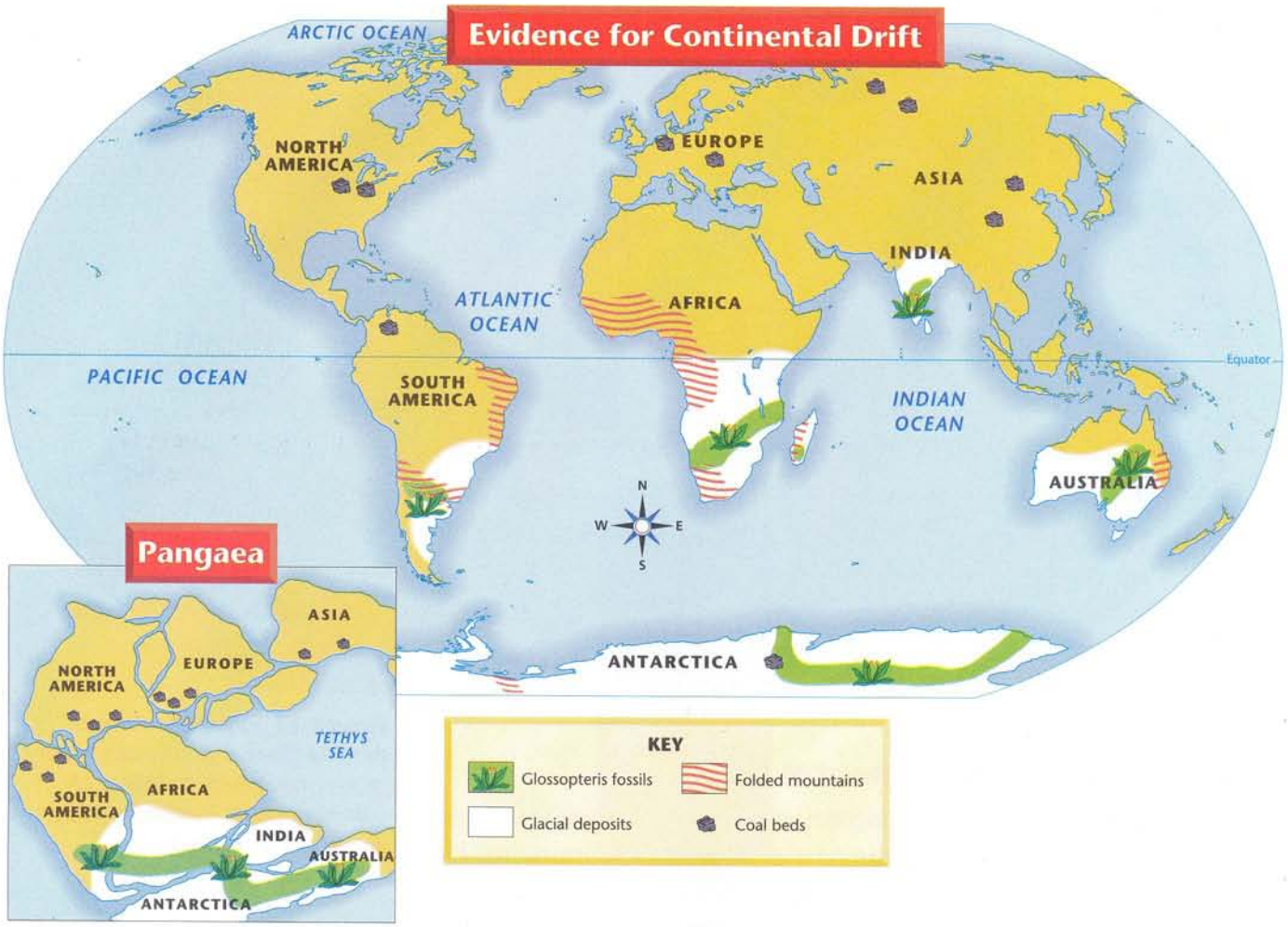


Figure 12 Wegener used several types of evidence to support his idea that the continents were once joined in a single landmass called Pangaea. *Inferring* *According to Wegener's theory, what does the presence of similar mountain ranges in Africa and South America indicate?*

Evidence from Landforms Mountain ranges and other features on the continents provided evidence for continental drift. For example, when Wegener pieced together maps of Africa and South America, he noticed some remarkable things. A mountain range running from east to west in South Africa lines up with a mountain range in Argentina. European coal fields match up with similar coal fields in North America. Wegener compared matching these features to reassembling a torn-up newspaper. If the pieces could be put back together, the "words" would match.

Evidence From Fossils Wegener also used fossils to support his argument for continental drift. A **fossil** is any trace of an ancient organism that has been preserved in rock. *Glossopteris* (glaw SAHP tuh ris) was a fernlike plant that flourished 250 million years ago. As shown in Figure 13, *Glossopteris* fossils have been found in rocks in Africa, South America, Australia, India, and Antarctica. The occurrence of *Glossopteris* on these widely separated landmasses convinced Wegener that the continents had once been united.

Figure 13 Fossils of *Glossopteris* are found on continents in the Southern Hemisphere and in India.

INTEGRATING LIFE SCIENCE The seedlike structures of *Glossopteris* could not have traveled the great distances that separate the continents today. The "seeds" were too large to have been carried by the wind and too fragile to have survived a trip by ocean waves. How did *Glossopteris* develop on such widely separated continents? Wegener inferred that the continents at that time were joined as the supercontinent Pangaea.

Evidence From Climate Wegener used evidence of climate change to support his theory—for example, from the island of Spitsbergen. Spitsbergen lies in the Arctic Ocean north of Norway. This island is ice-covered and has a harsh polar climate. But fossils of tropical plants are found on Spitsbergen. When these plants lived about 300 million years ago, the island must have had a warm and mild climate. According to Wegener, Spitsbergen must have been located closer to the equator.

Thousands of kilometers to the south, geologists found evidence that at the same time it was warm in Spitsbergen, the climate was much colder in South Africa. Deep scratches in rocks showed that continental glaciers once covered South Africa. Continental glaciers are thick layers of ice that cover hundreds of thousands of square kilometers. But the climate of South Africa is too mild today for continental glaciers to form. Wegener concluded that, when Pangaea existed, South Africa was much closer to the South Pole.

According to Wegener's theory, Earth's climate has not changed. Instead, the positions of the continents have changed. As a continent moves toward the equator, its climate becomes warmer. As a continent moves toward the poles, its climate becomes colder. But the continent carries with it the fossils and rocks that formed at its previous location. These clues provide evidence that continental drift really happened.

Checkpoint *What were the three types of evidence Wegener used to support his theory of continental drift?*

Figure 14 As evidence of continental drift, Wegener pointed to scratches on rocks made by glaciers. These scratches showed that places with mild climates today once had climates cold enough for glaciers to form.

TRY THIS

Reassembling the Pieces

ACTIVITY

Assembling a puzzle can reveal a hidden meaning.

1. Working with a partner, obtain one sheet of newspaper per person.
2. Tear your sheet of newspaper into six to eight large pieces. Trade your pieces with your partner.
3. Try to fit the pieces of newspaper together.

Making Models What evidence did you use to put the pieces together? How do your pieces of newspaper serve as a model of the theory of continental drift?

Figure 15 Although scientists rejected his theory, Wegener continued to collect evidence on continental drift and to update his book. He died in 1930 on an expedition to explore Greenland's continental glacier.

Scientists Reject Wegener's Theory

Wegener did more than provide a theory to answer the riddle of continental drift. He attempted to explain how drift took place. He even offered a new explanation for how mountains form. Wegener thought that when drifting continents collide, their edges crumple and fold. The folding continents slowly push up huge chunks of rock to form great mountains.

Unfortunately, Wegener could not provide a satisfactory explanation for the force that pushes or pulls the continents. Because Wegener could not identify the cause of continental drift, most geologists rejected his idea. In addition, for geologists to accept Wegener's idea, they would need new explanations of what caused continents and mountains to form.

Many geologists in the early 1900s thought that Earth was slowly cooling and shrinking. According to this theory, mountains formed when the crust wrinkled like the skin of a dried-up apple. Wegener said that if the apple theory were correct, then mountains should be found all over Earth's surface. But mountains usually occur in narrow bands along the edges of continents. Wegener thought that his own theory better explained where mountains occur and how they form.

For nearly half a century, from the 1920s to the 1960s, most scientists paid little attention to the idea of continental drift. Then new evidence about Earth's structure led scientists to reconsider Wegener's bold theory.

Section 3 Review

1. What was Wegener's theory of continental drift?
2. How did Wegener use evidence based on fossils to support his theory that the continents had moved?
3. What was the main reason scientists rejected Wegener's theory of continental drift?
4. **Thinking Critically** **Inferring** Coal deposits have also been found beneath the ice of Antarctica. But coal only forms in warm swamps. Use Wegener's theory to explain how coal could be found so near the poles.

Science at Home

You can demonstrate Wegener's idea of continental drift. Use the map of the world in Figure 11. On a sheet of tracing paper, trace the outlines of the continents bordering the Atlantic Ocean. Label the continents. Then use scissors to carefully cut the map along the eastern edge of South America, North America, and Greenland. Next, cut along the western edge of Africa and Europe (including the British Isles). Throw away the Atlantic Ocean. Place the two cut-out pieces on a dark surface and ask family members to try to fit the two halves together. Explain to them about the supercontinent Pangaea and its history.