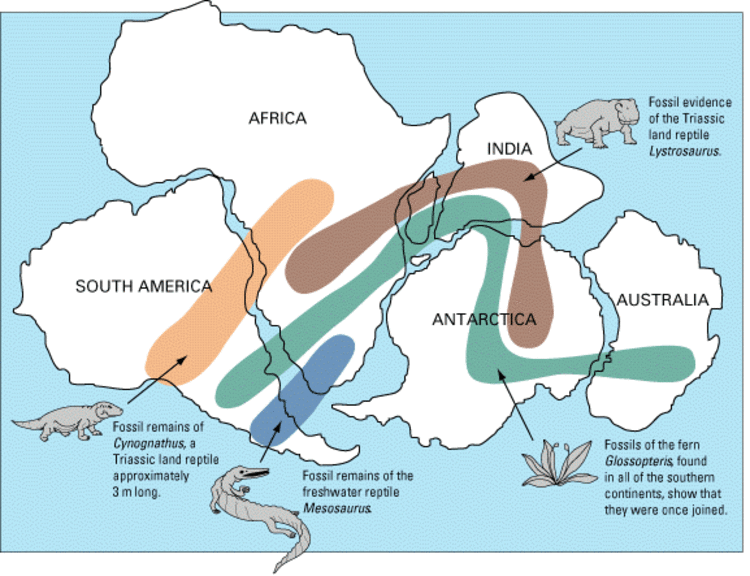
**Inventors and Scientists: Alfred Wegener and Harry Hess (820)**

**Synopsis:** Alfred Wegener showed evidence in 1912 that the continents are moving. But geologists rejected his ideas at first, partly because Wegener was not a geologist. He also could not explain how the continents moved. Almost 50 years later, Wegener's ideas were confirmed. Harry Hess proved Wegener right by using evidence of the ocean floor spreading to explain what moved the continents.

**Balloons and Arctic Air**

Alfred Wegener was born in Berlin, Germany. He received a PhD in astronomy from the University of Berlin in 1904. However, his real love was air balloons. He and his brother, Kurt, set the world's record in 1906 for the longest time spent in a balloon. They floated through the air for 52 hours.

Later that year, Wegener joined an expedition to Greenland. He would use his expertise with air balloons to track polar air circulation. Wegener had always dreamed of polar exploration.

**Continental Drift**

Wegener studied the atmosphere as a meteorologist. Although he was earning respect for his work, his mind kept roaming. By 1910, he had noticed on a map that the east coast of South America fits exactly against the west coast of Africa. It appeared as if they had once been joined. He found evidence that it had and, in 1915, published *The Origin of Continents and Oceans*. In the book, he claimed that about 300 million years ago the continents formed a single mass. He labeled it "Pangaea," a Greek word meaning "whole Earth."

Wegener was not the first to present the idea of "continental drift." But he beat everyone else in putting together evidence from different scientific approaches. For instance, he located ancient tropical plants on the Arctic island of Spitzbergen. This is thousands of miles from where scientists would expect to find them. He also found rocks and mountains on different continents that were similar. He pointed out that the Appalachian Mountains in the United States are similar to the Scottish Highlands. He located rock layers in South Africa that matched those in Brazil.

Geologists mocked Wegener's ideas. Wegener was not even a geologist. Who was he to try to overturn their beliefs?

Besides, he could not explain what caused the continents to plow through the Earth's crust. It would have required immense force.

In 1930, Wegener led another trip to Greenland. He celebrated his 50th birthday there at an isolated weather station. On his return trip back to the coast, he died.

**Seafloor Spreading**

Scientists kept talking about the idea of continental drift. During World War II, sounding gear produced new evidence of what the seafloor looked like. The gear, called sonar, was developed in the 1930s. It worked by bouncing sound waves off the seafloor. Sonar equipment on board received the waves and determined the seafloor's depth and features.

At the time, a geologist from Princeton University named Harry Hess was in charge of a military ship. Hess wanted to continue his scientific studies even while at war. Ship commanders usually only turned on sounding gear to navigate when docking. Hess, however, left his ship's gear on all of the time.

What Hess discovered was a big surprise. The bottom of the sea was not smooth as expected. In fact, it was full of canyons, trenches, and volcanoes.

By the 1950s, other scientists had found that a huge crack ran along the top of the Mid-Atlantic Ridge. The discovery enabled Hess to understand what he had learned about the ocean floor of the Pacific. He now knew that the Earth's crust had been moving away on either side of oceanic ridges. The ridges ran down the Atlantic and Pacific oceans. They were long and volcanically active. He published his theory in 1962. It came to be called "seafloor spreading."

In the early 1960s, samples were taken from deep in the ocean's floor and dated. They showed that the ocean floor was younger at the Mid-Atlantic Ridge and became older and older in either direction. This confirmed that the seafloor was truly spreading.

Unlike Wegener, Hess lived to see his major theory accepted. He helped to plan the U.S. space program. On August 25, 1969, he died of a heart attack. It was just a month after the Apollo 11 mission brought the first humans to the Moon.

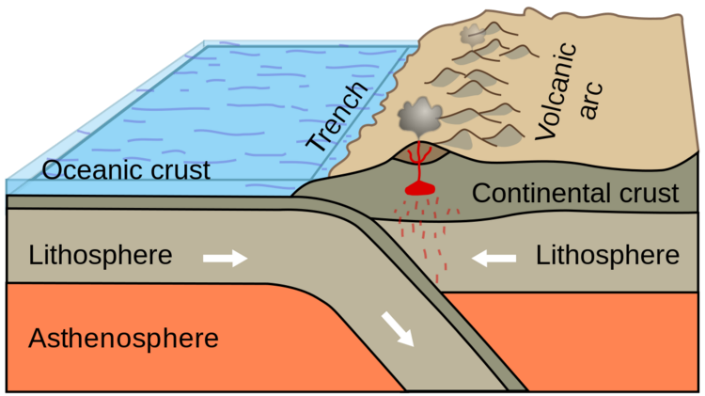
**Plate Tectonics**

By the 1970s, geologists had agreed to use the term "plate tectonics." They already knew that the continents move, but now they had also found evidence that so do whole "plates" of the Earth's crust. A plate might include a continent or parts of a continent. Even portions of the Earths's crust now underwater can form plates. Wegener's idea of continental drift had been taken a step further.

Geologists today understand that the Earth's crust is broken up into eight to 12 large plates and 20 or so smaller ones. These plates move in different directions and at different speeds. Their sizes don't match the landmasses on top of them. For instance, the North American plate is much larger than the North American continent. The plate starts at the western coast of North America and extends into the middle of the Atlantic Ocean. Iceland is split down the middle. It belongs to two different plates.

The continents have come together into one large mass and then split apart again more than once. Over the last 500 million years, this may have happened as many as three times.

The force that moves the plates is thought to be convection currents in the Earth's mantle. The mantle is the area below the Earth's crust, separating the crust from the Earth's core. In the short term, the mantle is solid.

But over longer geologic time, the mantle does flow, though very slowly. And plates float on top of the mantle. Pockets of hot liquid magma in the mantle ooze up along mountain ridges deep under the water, forming volcanoes.

Where the edges of the plates meet, several things may happen. Continents are lighter than the ocean floor. So, if both plates carry continents, they may clash head on. Mountains rise up where they meet. If one plate is heavier, it may go under the other. Or the plates may grind against each other, forming cracks. However, where plate edges meet, earthquakes take place. A global map of earthquake zones shows the outlines of the underlying plates.

The European and North American plates are moving apart at the speed a fingernail grows. In a human lifetime, this amounts to about 2 meters (just over 6 feet). Millions of years in the future, parts of California and Mexico will probably drift off. They will separate from North America and become an island.

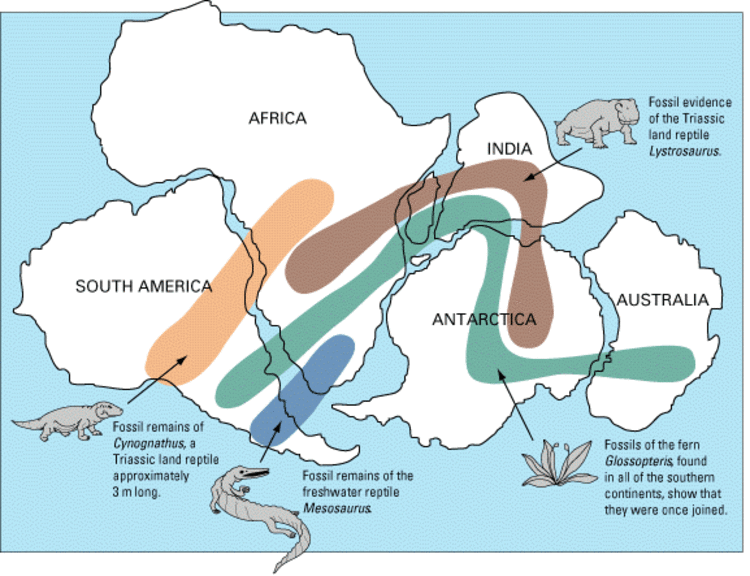
Most of Africa is pushing toward Europe. Eventually, it will squeeze out the Mediterranean Sea and form high mountains along the southern coast of Europe. The eastern side of Africa will split off at the Great Rift Valley and float into the Indian Ocean. In slow geologic time, the Earth's plates are always moving.

**Inventors and Scientists: Alfred Wegener and Harry Hess (670)**

**Synopsis:** Alfred Wegener showed evidence in 1912 that the continents are moving. Scientists rejected his ideas at first. After all, Wegener was not a geologist, a scientist who studies what the Earth is made of. He could not explain the forces causing the continents to move. Almost 50 years later, Wegener's ideas were proved to be right. Harry Hess found evidence of the ocean floor spreading. He used it to explain what moved the continents.

**Balloons and Arctic Air**

Alfred Wegener was born in Germany. He studied the planets and space in college. However, his real love was air balloons. He and his brother set the world's record in 1906 for the longest time spent in a balloon. They floated through the air for 52 hours.

Later that year, Wegener joined a trip to Greenland. Greenland is a large island near the North Pole. Wegener would use his experience with air balloons to study the polar air. He had always dreamed of exploring the Arctic.

**Continental Drift**

Wegener worked as a meteorologist, a scientist who studies the atmosphere. We might call him a weatherman. He was very respected for his work. Yet his mind kept roaming. Looking at a map, he noticed that the east coast of South America fit exactly against the west coast of Africa. It looked like they had once been joined. In 1915, Wegener published *The Origin of Continents and Oceans*. In the book, he said that millions of years ago the continents all formed a single mass. He called this super-continent "Pangaea," a Greek word that means "whole Earth."

Wegener was not the first to present the idea of "continental drift." But he was the first to pull together evidence from different scientific approaches. For example, he found ancient tropical plants on an Arctic island. These plants were thousands of miles from where scientists would expect to find them. Wegener also found rocks on different continents that were alike. He found some in South Africa that matched those in Brazil. He believed this was proof that the continents had drifted apart over time.

Geologists made fun of Wegener's ideas. Wegener was not even a geologist. Who was he to challenge their ideas?

In 1930, Wegener led another trip to Greenland. He celebrated his 50th birthday there at an isolated weather station. Tragically, on his return trip back to the coast, he died.

**Seafloor Spreading**

Scientists kept talking about the idea of continental drift. During World War II, sonar technology produced new evidence of what the ocean floor looked like. Sonar works by bouncing sound waves off the seafloor. When the sound waves come back to the ship, objects in the water can be heard.

At the time, Harry Hess was in charge of a military ship. He was a geologist. He wanted to continue his scientific studies even while at war. Ship commanders usually only used sonar when docking a ship. However, Hess left the technology on all the time.

What he discovered was a big surprise. The bottom of the sea was not as smooth as expected. In fact, it was full of canyons, valleys, and volcanoes.

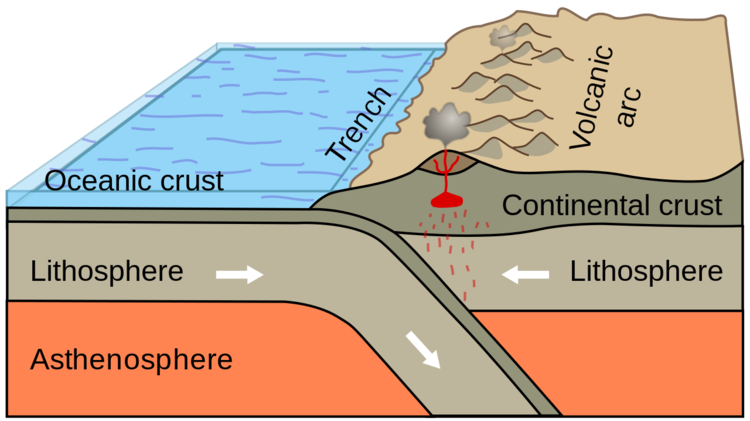
By the 1950s, scientists knew much more about the ocean floor. They had discovered an underwater mountain range called the Mid-Atlantic Ridge. The ridge had a valley down the middle. Each side of the valley was moving away from the other. This discovery helped Hess. He now knew that Earth's crust had been moving away on either side of the ridge. Hess published his theory in 1962. It came to be called "seafloor spreading."

Hess went on to help plan the U.S. space program. On August 25, 1969, he died of a heart attack. It was just a month after the first humans landed on the Moon.

**Plate Tectonics**

Geologists today understand that the Earth's crust is broken up into different sections, or "plates." There are eight to 12 large plates and 20 or so smaller ones. The plates move in different directions and at different speeds. Their sizes do not match the land masses on top of them. For example, the North American plate is much larger than the North American continent. The plate starts at the western coast of North America. Yet it extends into the middle of the Atlantic Ocean. Iceland is split down the middle. It belongs to two different plates.

The force that moves the plates is thought to be currents in the Earth's mantle. The mantle is the area below the crust. Part of the mantle is hot liquid from melted rock (magma). Over long periods of time, the mantle flows very slowly. Plates float along on top of it. Along mountain ridges deep under the water, hot liquid magma escapes from the mantle. It bubbles up and then cools into rock.

Where the edges of the plates meet, several things may happen. Continents are lighter than the ocean floor. If two plates both carry continents, they might crash together. Mountains rise up where they meet. If one plate is heavier, it might go under the other. Or the plates may grind against each other, forming cracks. When plate edges meet, earthquakes take place.

The European and North American plates are moving apart very slowly. They are moving at the speed that a fingernail grows. Millions of years in the future, parts of California and Mexico will probably drift off. They will become their own islands. Over time, the Earth's plates are always moving