Inventors and Scientists: Alfred Wegener and Harry Hess

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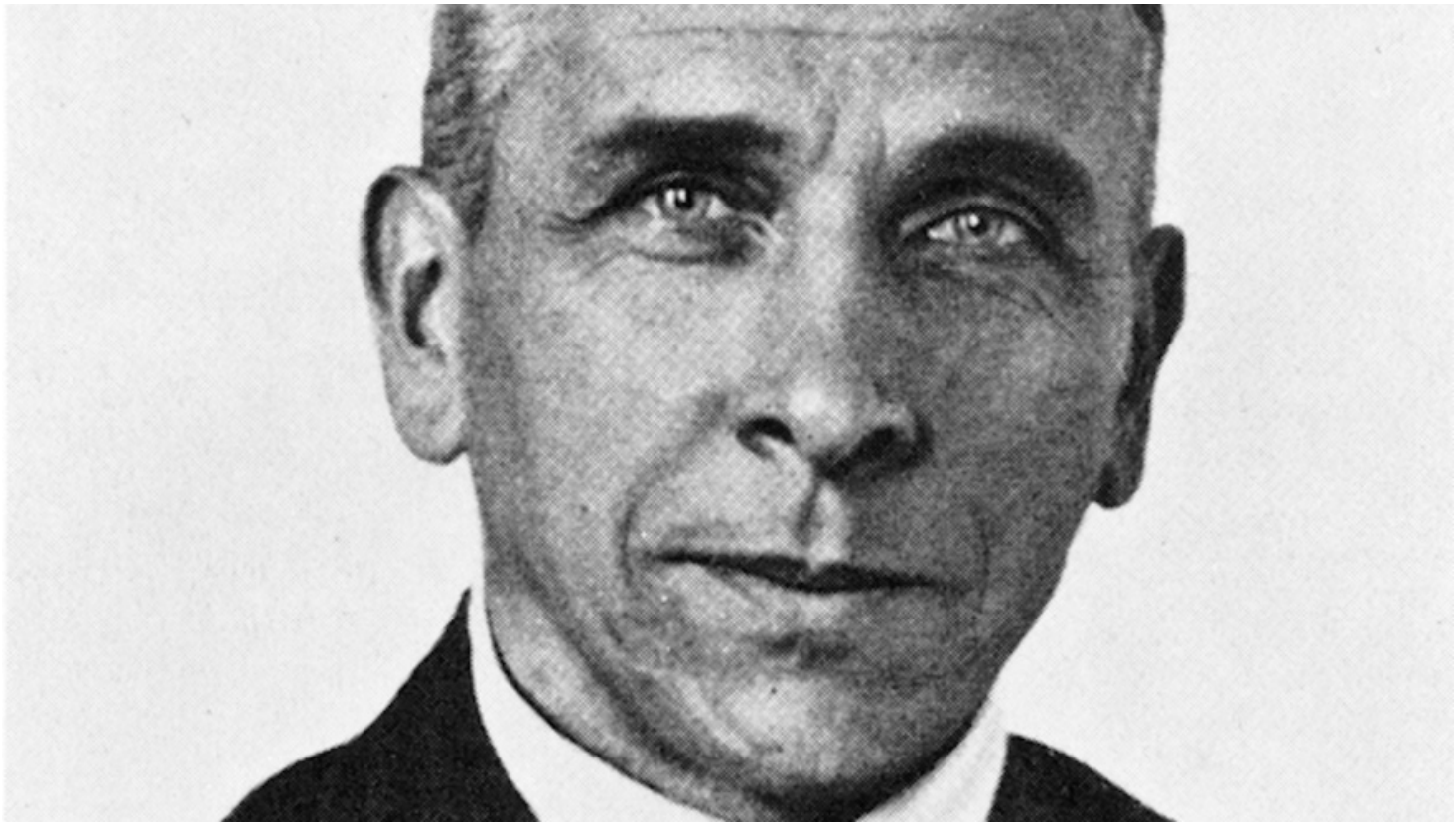


TOP: A map of the tectonic plates of the world, from USGS.gov. MIDDLE: Alfred Wegener, courtesy of the Alfred Wegener Institute for Polar and Marine Research. BELOW: Maps of continental drift and plate tectonics, Wikipedia.

Synopsis: Alfred Wegener produced evidence in 1912 that the continents are in motion. But, because he could not explain what forces could move them, geologists rejected his ideas. Almost 50 years later, Harry Hess confirmed Wegener's ideas by using the evidence of seafloor spreading to explain what moved the continents.

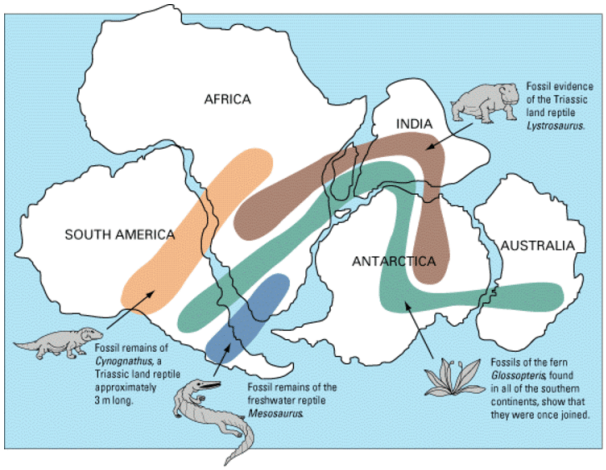
Balloons And Arctic Air

Alfred Lothar Wegener was born in Berlin, the son of a Protestant pastor. 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 April 1906 for the longest time spent aloft in a balloon — 52 hours.

Later that year, Wegener joined an expedition to Greenland to track polar air circulation, which could be done with the help of air balloons. He had always dreamed of polar exploration too. In 1908, he began to

teach at the University of Marburg. In 1911, he co-wrote *The Thermodynamics of the Atmosphere*, a textbook that became popular.

Continental Drift



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

Wegener was not the first to present the idea of continental drift, as he called it. But he beat everyone else in putting together extensive evidence from several different scientific approaches. He used fossil evidence, such as that of tropical plants found on the Arctic island of Spitzbergen. He found large-scale geographic features that matched, like the Appalachian Mountains in the United States and the Scottish Highlands. He located layers of rock called strata in South Africa that matched those in Brazil.

Wegener argued against the claim that earlier land bridges between the continents had sunk. He also disputed the theory that mountains formed like wrinkles on the skin of a drying apple. Instead, he claimed that mountains formed when the edges of drifting continents crumpled and folded.

Geologists reacted to Wegener's ideas with widespread scorn. They knew that his ideas, if correct, would shake the foundations of geology. Wegener was not even a geologist — who was he to overturn their field?

Besides, he could not explain what force could be immense enough to cause the continents to plow through the Earth's crust like an icebreaker cutting through frozen sheets of ice. At a 1926 international conference in New York, many speakers were sarcastic to the point of insult; Wegener sat smoking his pipe, listening.

In 1924, Wegener accepted a professorship at the University of Graz in Austria. Six years later, he led another expedition to Greenland. This time, he had government backing, and set up yearlong weather-monitoring equipment at three stations on the glacier.

Drifting ice delayed the expedition and the Arctic weather proved a great hardship. In November 1930, Wegener led several dogsled teams carrying supplies to his partners working at the isolated inland station. After celebrating his 50th birthday at the remote weather station, Wegener and his companion, Rasmus Villumsen, died on their return trip west to the coast.

Seafloor Spreading

The idea of continental drift continued to circulate in scientific circles. During World War II, sounding gear produced new evidence of what the seafloor looked like. The gear, developed in the 1930s, bounced sound waves off the seafloor to determine its depth and features.

It happened that the command of an attack transport ship was given to Harry Hess, a geologist from Princeton University. Hess, then in his late thirties, wanted to continue his scientific investigations even while at war. So he left his ship's sounding gear on all of the time, not just when approaching port or navigating a difficult landing.

What Hess discovered was a big surprise. The bottom of the sea was not smooth as expected. It was, in fact, full of canyons, trenches, and volcanic sea mountains. Ocean floor exploration continued. By the 1950s, other researchers had found that a huge rift ran along the top of the Mid-Atlantic Ridge. That enabled Hess to understand his ocean floor profiles in the Pacific. He realized that the Earth's crust had been moving away on each side of oceanic ridges, down the Atlantic and Pacific oceans, that were long and volcanically active. He published his theory in *History of Ocean Basins* (1962), and it came to be called "seafloor spreading."

In the early 1960s, dating of ocean-core samples showed that the ocean floor was younger at the Mid-Atlantic Ridge. It became progressively older in either direction. This confirmed that the seafloor was truly spreading. Further evidence came along by 1963, as geophysicists realized that Earth's magnetic field had reversed polarity many times. Each reversal lasted fewer than 200,000 years.

Rocks of the same age in the seafloor crust would have taken on the magnetic polarity that was common at the time that that part of the crust formed. Sure enough, surveys of either side of the Mid-Atlantic Ridge found rocks with a symmetrical pattern of alternating polarity stripes. That clinched the argument for most geologists.

Unlike Wegener, Hess lived to see his major theory confirmed and accepted. He helped to plan the U.S. space program. On August 25, 1969, he died of a heart attack, just a month after Apollo 11's successful mission to bring the first humans to the surface of the Moon.

Plate Tectonics

By the 1970s, geologists had agreed to use the term "plate tectonics." They used the term "plates" because they had found evidence that not just continents move, but so do whole plates of the Earth's crust. A plate might include a continent, parts of a continent, or undersea portions of the crust. Wegener's idea of continental drift had been developed and refined.

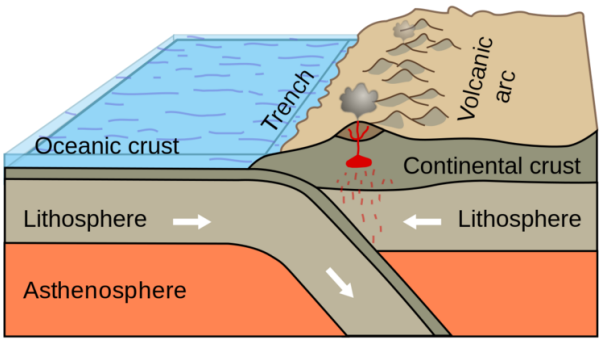
Geologists today understand that the Earth's surface, or crust, is broken up into eight to 12 large plates and 20 or so smaller ones. These plates move in different directions and at different speeds. Their sizes don't correspond to the landmasses on top of them. For instance, the North American plate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

The continents have come together into one large mass, and then split apart again. Over the last 500 million years, this may have happened as many as three times. Scientists can only guess when the first plates formed and how they behaved further back than that.

The force that moves the plates is thought to be convection currents in the mantle under the Earth's crust. The mantle is solid in the short term. But over longer geologic time, it does flow, though very slowly. Pockets of hot liquid magma ooze up along extensive mountain ridges deep under the water, one running roughly north-south in the mid-Atlantic and another in the mid-Pacific. Along these ridges are found active volcanoes and hydrothermal (hot-water) vents, also known as "black smokers." Through these vents pours very hot, mineral-rich water that supports astonishing scenes of life. These ecosystems are the only ones on

Earth whose immediate energy source is not sunlight. It's possible that these "vent communities" are where the first living organisms on Earth developed.

Where the edges of the plates meet, several things may happen. If both plates carry continents, which are lighter than the ocean floor, they may clash head on, causing high mountains to rise. If one plate is heavier, it may go under the other, a process known as "subduction." The material of the subducted plate returns to the mantle, recycling the Earth's crust. Or the plates may move sideways, grinding against each other. This grinding produces cracks, or faults, in the plates, as along the California coast. In whatever form the plate edges meet, earthquakes take place; on a global map of earthquake zones, the outlines of the plates are clearly visible.



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 to become an island. Most of Africa is pushing northward toward Europe and will eventually squeeze out the Mediterranean Sea and cause high mountains to emerge along the whole southern coast of Europe. The eastern portion of Africa will split off at the Great Rift Valley and float off into the Indian Ocean. In geologic time, the Earth's plates are always moving.

Quiz

1 Which sentence BEST summarizes the section "Seafloor spreading"?

(A) After leaving on a ship's sounding gear, Harry Hess discovered that canyons and mountains on the ocean floor caused seafloor spreading.

(B) After being given command of an attack transport ship, Harry Hess was able to take samples of the ocean floor that challenged the idea of seafloor spreading.

(C) While at sea, Harry Hess discovered that the bottom of the ocean was not smooth, and he published his findings in a book titled "Seafloor spreading."

(D) While using a ship's sounding gear to explore the geography of the ocean floor, Harry Hess discovered evidence of the process called seafloor spreading.

2 Read the sentence below from the section "Continental drift".

(Wegener) located layers of rock called strata in South Africa that matched those in Brazil.

How does the sentence help to convey a CENTRAL idea of the article?

(A) It indicates that two different places such as South Africa and Brazil can have more than one layer of strata rock.

(B) It provides evidence that a land bridge once existed between South Africa and Brazil.

(C) It provides evidence that shows South Africa was once part of the same landmass as Brazil.

(D) It indicates that the rock layers of South Africa and Brazil are found on every continent.

3 What is the MOST likely reason the author included the paragraphs in the section "Balloons and Arctic Air"?

(A) to reveal that Wegener was more interested in air balloons than continental drift

(B) to show that Wegener was an accomplished scientist before he began to study continental drift

(C) to establish that Wegener was an avid traveler before he started investigating continental drift

(D) to describe where Wegener first began looking for evidence of continental drift

4 Read the paragraphs below from the section "Continental drift".

Geologists reacted to Wegener’s ideas with widespread scorn. They knew that his ideas, if correct, would shake the foundations of geology. Wegener was not even a geologist — who was he to overturn their field?

Besides, he could not explain what force could be immense enough to cause the continents to plow through the Earth’s crust like an icebreaker cutting through frozen sheets of ice. At a 1926 international conference in New York, many speakers were sarcastic to the point of insult; Wegener sat smoking his pipe, listening.

Which answer choice ACCURATELY characterizes Wegener's reaction to the other scientists' rejection of his ideas?

(A) Wegener thought their rejection was absurd.

(B) Wegener was stunned by their rejection.

(C) Wegener seemed unaffected by their rejection.

(D) Wegener seemed discouraged by their rejection.