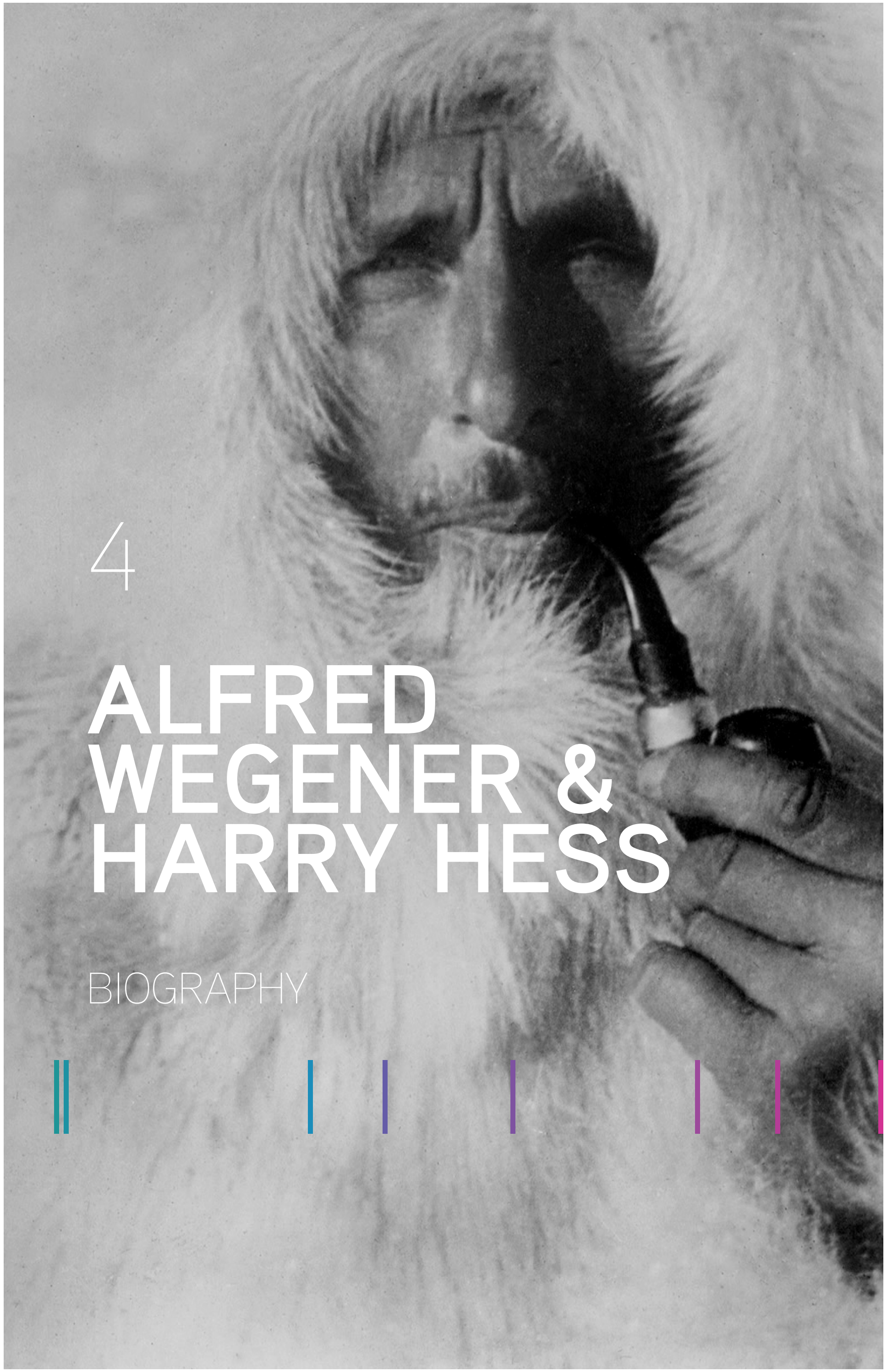

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ALFRED WEGENER & HARRY HESS

BIOGRAPHY

BIG HISTORY PROJECT

Alfred Wegner

Born
November 1, 1880
Berlin, Germany

Died
November 1930
Clarinetania, Greenland

Harry Hammond Hess

Born
May 24, 1906
New York, New York

Died
August 25, 1969
Woods Hole, Massachusetts

ALFRED WEGENER & HARRY HESS

A METEOROLOGIST, A GEOLOGIST, AND THE THEORY OF PLATE TECTONICS

By Cynthia Stokes Brown

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 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, but 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. (As well, he had always dreamed of polar exploration.) In 1908 he began to teach at the University of Marburg, and in 1911 he co-wrote *The Thermodynamics of the Atmosphere*, a textbook that became popular; his fellow author, Vladimir Köppen, was a famous climatologist. Wegener married Köppen's daughter Else two years later.

Continental drift

Wegener was making his mark as a meteorologist, or weatherman. Yet his mind seemed indifferent to the boundaries of academic disciplines. By 1910 he had noticed on a world map that the east coast of South America fits exactly against the west coat of Africa, 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 was the first to put 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, as well as rock strata in South Africa that matched those in Brazil. He argued against the claim that earlier land bridges between the continents had sunk. He also disputed the theory

Alfred Wegener considers weather data at his desk in Greenland, 1930

that mountains formed like wrinkles on the skin of a drying apple, claiming instead 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 accurate, would shake the foundations of their discipline. Wegener was not even a geologist — who was he to overturn their field?

Besides, he couldn't 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. 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 of meteorology and geophysics at the University of Graz in Austria. Six years later he led another expedition to Greenland, this time with government backing, where he would 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 colleagues at the isolated inland station, which was under-provisioned. 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.

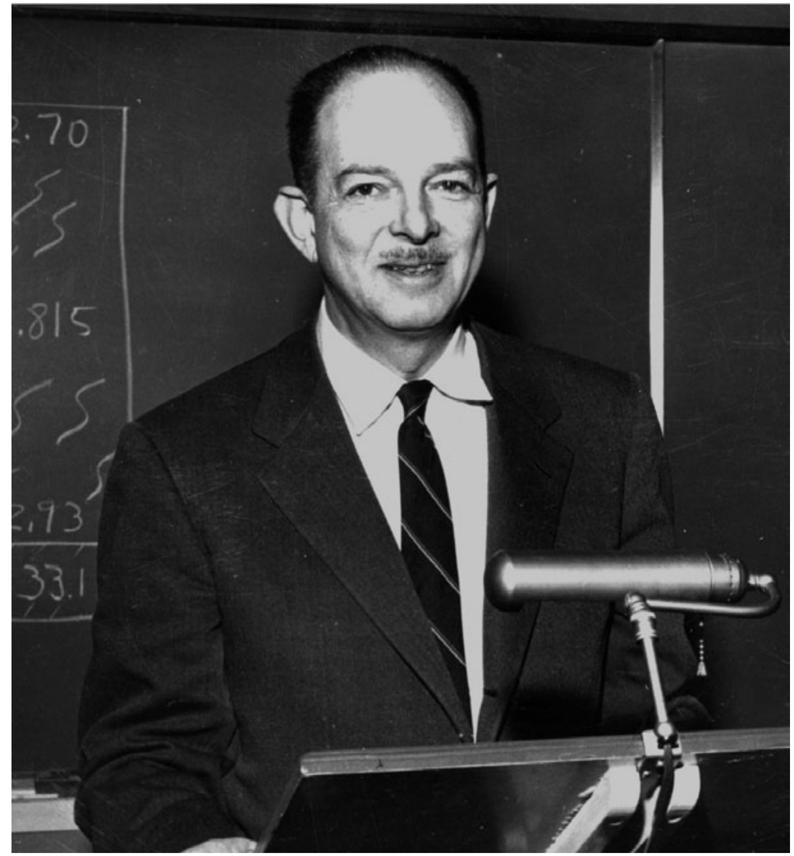
Seafloor spreading

The idea of continental drift circulated in scientific circles until World War II, when 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 one attack transport ship, the USS *Cape Johnson*, was given to Harry Hammond 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, but full of canyons, trenches, and volcanic sea mountains. Ocean floor exploration continued, and 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 but progressively older in either direction, confirming the reality of seafloor spreading. Further evidence came along by 1963, as geophysicists realized that Earth's magnetic field had reversed polarity many times, with each reversal lasting less than



Harry Hammond Hess

200,000 years. Rocks of the same age in the seafloor crust would have taken on the magnetic polarity prevalent at the time that that part of the crust formed. Sure enough, surveys of either side of the Mid-Atlantic Ridge showed a symmetrical pattern of alternating polarity stripes. That clinched the argument for most geologists.

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

Plate tectonics

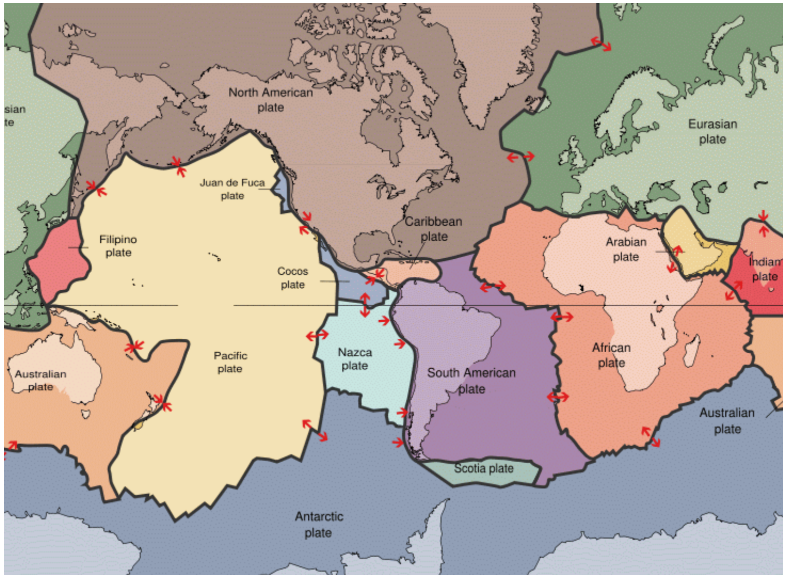
By the 1970s geologists had agreed to use the term “plate tectonics” for what has become the core paradigm of their discipline. They used the term “plates” because they had found evidence that not just continents move, but so do whole plates of the Earth’s crust. A plate might include a continent, parts of a continent, and/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 8 to 12 large plates and 20 or so smaller ones. These plates move in different directions and at different speeds and are not directly related to the landmasses on 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.

Over the last 500 million years the continents have come together into one large mass, and then split apart again – possibly 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 flows very slowly over geologic timescales. 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 ecosystems, 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



A map of the tectonic plates of the world

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; these fractures are called “transform plate boundaries.” 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, about two meters (just over six feet) in a human lifetime. 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.

Sources

Bryson, Bill. *A Short History of Nearly Everything*. New York: Broadway Books, 2003.

Image credits

Alfred Wegener,
courtesy of the Alfred Wegener Institute for Polar and Marine Research

Alfred Wegener considers weather data at his desk in Greenland, 1930,
courtesy of the Alfred Wegener Institute for Polar and Marine Research

Harry Hess,
courtesy of Princeton University Archives

Plate tectonics map,
United States Geologic Survey (USGS)