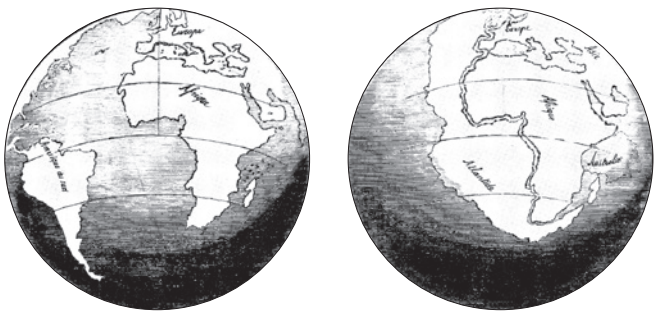
Factsheet Continental Drift and Plate Tectonics

The New Understanding of the Earth System

The history of the formation of the continents was a mystery to people for a long time. Alfred Wegener developed the theory of continental drift in 1912. The detailed depth data obtained by echo sounding revolutionized the understanding of the Earth system in the 1960s and 1970s. American oceanographers Marie Tharp and Bruce Heezen created the first three-dimensional maps of oceanic ridges from these data. Based on these maps, Heezen developed the theory that volcanic material was rising in the apex trenches of the ridges, pushing the ocean floor apart. This theory in turn inspired the American geophysicist Harry Hess to develop his model of plate tectonics. This was the first to explain how oceans and continents are formed, why mountains rise where we find them today, and how natural hazards such as earthquakes, volcanic eruptions, and tsunamis occur.



Source: La Création et ses mystères dévoilés, Antonio Snider-Pellegrini 1858

Continental Drift ▲

First known illustration of the formation of the Atlantic Ocean by geographer Antonio Snider-Pellegrini in 1858. Early on, scientists noticed that the coasts of Europe and Africa fit together with that of the American continent like pieces of a puzzle.

However, scholars struggled for a long time with a well-founded explanation of this coincidence. In 1570, the Flemish cartographer Abraham Ortelius assumed that the American continent had been torn away from the Eurasian continent by earthquakes and floods. Theses in the 19th and early 20th century assumed that the two continents had once been connected by land bridges, which later sank into the sea. Until the 60's of the last century there was the assumption that the drift of the continents was caused by a constant increase of the earth's radius (expansion theory).

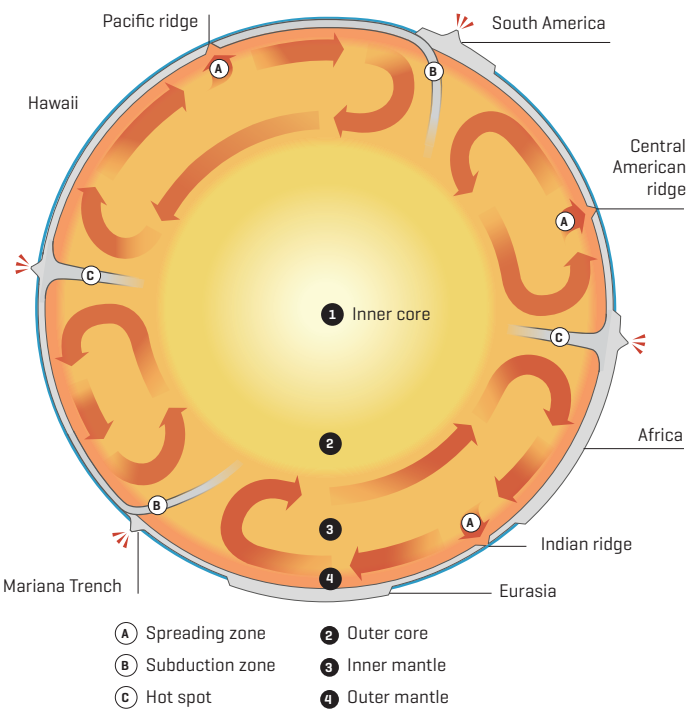


Illustration: Holmer W. Ehrenhauss

Plate Tectonics ▲

In the interior, the hot core of the Earth causes convection currents, whereby parts of the viscous mantle push upward. At the oceanic ridges, this hot mantle rock is partially melted and comes to the surface as magma. New ocean crust is formed, cools slowly and spreads sideways. As if on a conveyor belt, the Earth's plates move across the uppermost mantle, pushing the continents along with them. Volcanic eruptions and earthquakes occur. At hot spots, particularly hot material rising from the Earth's interior forms a locally stable melting zone in the mantle. Due to the movement of the plates above the hot spot, volcanic island chains such as Hawaii or the Canary Islands are formed.

Source: Deutsches Museum

Alfred Wegener

In 1912, the German meteorologist and polar explorer summarized the empirical findings of the past and developed the continental drift theory, which he came up with „under the immediate impression of the congruence of the Atlantic coasts."

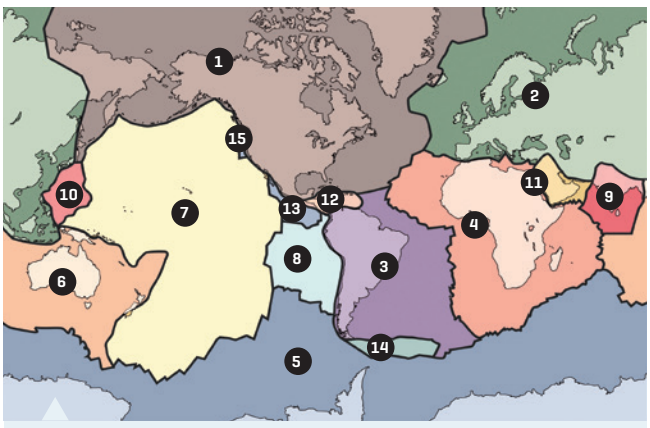
Alfred Wegener suspected that the individual continents had once formed a coherent land mass that drifted apart over millions of years. He assumed centrifugal and tidal forces as the driving energy. Wegener's theory caused heated discussions among experts, but was rejected by geoscientists at the time. Today, however, systematic research of the deep-sea floor shows that Wegener was largely right.

Photo: Marie Tharp Maps (CC BY 2.0)

Marie Tharp

Marie Tharp was an American geologist and cartographer. Her particular achievement was the discovery of the trench structure in the center of the Mid-Atlantic Ridge in 1952 with marine geologist Bruce Heezen.

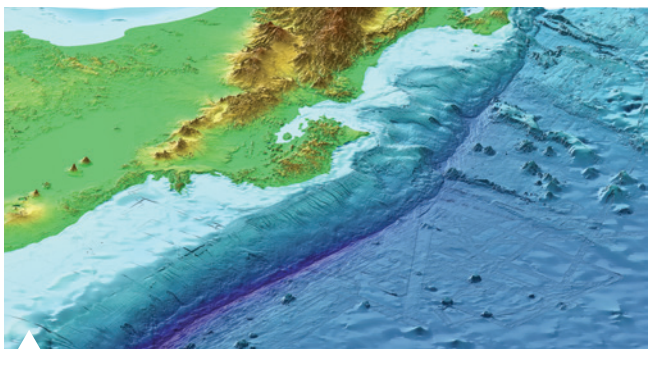
Later, both recognized identical structures when mapping the other oceanic ridges. This discovery was central to the further development and confirmation of the theories of continental drift and plate tectonics.



Continental Plates

Structure of the Earth's outer shell into tectonic plates that rest on the Earth's mantle. The plates, which are about 100 kilometers thick, „float" on the viscoplastic outer mantle.

1 North American Plate
2 Eurasian Plate
3 South American Plate
4 African Plate
5 Antarctic Plate
6 Australian Plate
7 Pacific Plate
8 Nazca Plate
9 Indian Plate
10 Filipino Plate
11 Arabic Plate
12 Karibean Plate
13 Cocos Plate
14 Scotia Plate
15 Juan de Fuca Plate

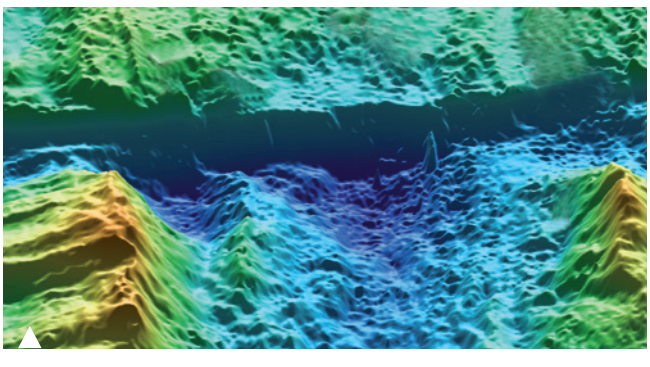


Visualization: GEOMAR

Subduction Zones in the Deep-sea Trenches

Section of the deep-sea trench off the Pacific coast of Costa Rica. Here the Nazca Plate sinks under the South American Plate.

A subduction zone is an area on Earth where an oceanic plate slides under a continental plate. Rocks from the subducting plate return to the Earth's interior, while mountains and island arcs form on the upper plate. In the process, deep-sea trenches form that can reach down about 11,000 meters.



Visualization: GEOMAR

Spreading Zones in the Oceanic Ridges

Section of the apex trench in the Mid-Atlantic Ridge at 5 degrees south in the central Atlantic. Lava rises here and constantly forms new ocean floor.

At this point, the ridge is displaced several kilometers to the west. At a rate of 2 to 13 centimeters per year, the ocean floor slides sideways away from the oceanic ridge. When Columbus sailed across the Atlantic in 1492, this ocean area was still about 20 meters narrower than it is today.