

INCORPORATED RESEARCH INSTITUTIONS FOR SEISMOLOGY

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Timecodes:

0:00 Introduction

0:36 1600s–1800s

1:11 Bathymetry reveals ridges

1:30 Wegner's Continental Drift

2:11 Radioactive decay 2:50 Nuclear bomb testing

3:13 Marie Tharpe/ocean ridges

3:46 Harry Hess/seafloor spreading 4:02 Seafloor magnetic stripes

4:17 Hot-spot formation

4:35 Three Boundary types

4:52 Mantle convection and gravity

Plate tectonics theory was not accepted for centuries because no one could adequately answer the question, “*What is the mechanism that drives the plates*?”

In the late sixteenth century. Abraham Ortelius, in compiling New World explorer maps noted that by carefully considering the coasts lines of the Atlantic Ocean it appeared that the Americas had been torn away from Europe and Africa by, he theorized, earthquakes and floods".

Over the next three centuries other proponents of an original single continent included:

* Francois Paget who invoked the sinking of the land between the continents to create the Atlantic Ocean;
* Georges-Louis Leclerk who resurrected Ortelius’s theory of a great earthquake and floods pushing the land apart, and finally
* Antonio Snider Pellegrini who proposed that the shape of the continents, supported by fossil evidence argued for the origin of a single continent which not only joined the continents across the Atlantic Ocean but also included Australia.

No one, however, could explain how the continents moved.

Bathymetric surveys in the following decades unveiled an extensive submarine mountain ridge the length of the Atlantic Ocean, between the continents.

Meanwhile, seismic data began to reveal Earth’s layers, a core, a crust-mantle boundary, and a thick outer layer called the lithosphere that lay above a less-dense asthenosphere.

In 1912 German meteorologist Alfred Wegener, also intrigued by the fit of the edges of the continents, championed the concept of “Continental Drift” based on his study of similar rock type, geological structures and fossils on both sides of the Atlantic. To make it work, he hypothesized that the mechanisms causing the drift might be the centrifugal force of the Earth's rotation or the change in its axis of rotation. Wegener also speculated that “*the Mid-Atlantic Ridge, is continuously tearing open and making space for fresh, relatively fluid and hot material from depth*.”

His views were considered preposterous and improbable, and rejected by most Earth scientists.

Following the discovery of radioactivity in 1896, it became clear that Earth's interior was heated by radioactive decay, and the insides would be largely molten.  Indeed, by 1926 a liquid core was determined.

In 1927 geologist Arthur Holmes, studying radioactive decay, proclaimed that ***mantle*** convection, was the answer to Wegener’s missing power source to drive Continental Drift.  He based it on the fact that as a substance is heated, its density decreases and rises to the surface until it cools, then sinks again.

But convection of the solid mantle alone was still unpalatable to most geoscientists.

Nuclear bomb testing in the 50’s motivated the establishment of the Worldwide Standardized Seismograph Network to monitor explosions, prompting a greater concentration of seismograph stations. The increased data allowed seismologists to precisely locate far more earthquakes revealing that most occur in discrete areas: near trenches and along mid-ocean ridges.

Decades after Wegener’s death, geologist Marie Tharpe, left in the lab to examine data from ocean-floor field surveys, theorized that the mid-ocean ridges appeared to be extensional rift valleys formed by plate motion paving the way for Wegener’s continental drift theory. Her colleague Bruce Heezen, initially skeptical, published her work in 1956 under his own name, but ascribed the extension to an expanding Earth theory. It wouldn’t be until the mid-sixties that he would accept Tharp’s interpretation of plate motion.

Curiously, it was Harry Hess who, in 1962 was credited for recognizing that oceans did grow from spreading ridges where new seafloor was created, and then moved away in both directions. He also defined ocean trenches as locations where ocean floor was destroyed and recycled. But he, too, lacked geophysical evidence to confirm this theory.

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While pondering the mystery of how volcanoes, such as the Hawaiian chain, could be so far from spreading ridges or subduction zones, Tuzo-Wilson proposed the plates moved over hotspots, and followed this breakthrough with the discovery that ocean ridges were connected with transform faults. The science rapidly blossomed with the definition of the three main plate boundary types: Divergent margins where plates move apart, Convergent margins where plates push together at subduction zones or mountain ranges, and Transform margins where plates move horizontally past each other).

As geophysical evidence supporting plate tectonics accumulated during the 1960s scientists revived Holmes’s theory of mantle convection as a driving force for moving the plates.

Mantle convection, assuredly plays a role, but doesn’t explain how some plates creep along faster than the convective currents beneath them. This led scientists to a fundamental force: Gravity. Gravity acts on the tectonic plates resulting in what are now referred to as "ridge push" at the spreading ridges and "slab pull" beneath subduction zones.  This is an evolving science that not only includes these three forces, but involves friction and much more, leaving scientists to ponder:

What will be the next tool that helps reveal new facets of plate tectonics?