14 | Plate Tectonics

Part III—Earth’s Changing Landscapes

Geography 101
Physical Geography: Earth’s Surface Landscapes
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Today

- A Brief History
- Pangaea
- Sea-Floor Spreading & Production of New Crust
- Plate Boundaries

Chile

- Sept 16, 2015
  - M. 8.3
- April 1, 2014
  - M. 8.2
- February 27, 2010
  - M. 8.8
- May 22, 1960
  - M. 9.5
- May 21, 1960
  - M. 7.9

Ring of Fire

Active Volcanoes, Plate Tectonics, and the ‘Ring of Fire’

Earthquakes, Active Volcanoes, and Plate Tectonics
Plate Tectonics

- The Earth's surface is covered by a series of crustal plates
- The seafloor is constantly moving and being regenerated
- The movement results from convection
- The convection results from radioactive decay

Mesosaurus

Alfred Wegener

- *Origin of the Continents and Oceans*, 1915
- Proposed **Continental Drift**
- Many rejected it
Pangaea

- A supercontinent in the Triassic Period
  - Keep in mind this was only about 300-250 million years ago
  - New research is exploring other supercontinents that existed before this

Continental Drift

- Wegener had some stuff wrong, but had a sound theoretical concept
  - Wrong about timeline and what moved the continents
    - Thought centrifugal force moved continents

Evidence

- Continental fit
- Strata
- Mountains
- Fossils

Continental Fit

- It just looks right!
  - Below current sea level

Geologic Strata

Mountains

The Appalachians
Alleghenian Orogeny

American Association of Petroleum Geologists Symposium, 1928
- More people disputed the idea even though the evidence was solid
  - One problem was the lack of proof for a driving force behind the continents moving.
  - It's hard to grasp the concept
  - Majority of evidence in the Southern Hemisphere

Fossils

Modeling
Not used by Wegener, but pretty cool…
- Animation 1
- Animation 2

Dismissal
Resurgence

- WWII!
- Research on seafloor spreading gave more proof of continental drift (1950s-1960s)

Harry Hammond Hess
- A Geology Professor & Naval Officer
- Echo-sounding
- Published History in 1962

Still not enough data for everyone to buy it
- Magnetic reversals

The Magnetic Poles

Magnetic field exhibits polarity

Polar wandering
- Prior to reversal
- Declination
- Weakens, then sudden reverse

Geomagnetic reversal
- 9 times in Earth's history
- No real explanation as to why
Isn’t North, North?

Three types of north
1. True north
2. Grid north
3. Magnetic north

Magnetic Reversals

When basalt is formed, iron orients with the magnetic field
- Records wandering

Magnetic Polarity

- Seafloor reveals a constant record of the magnetic polarity of the Earth for the last 200 million years

Magnetic Polarity

- Continental records of past magnetic polarity didn’t match the sea-floor
  - Either means the Earth has had two sets of poles...
  - Or the continents used to be in different places
Deep-Sea Drilling Project
- International effort 1968-1983
- Enough proof for sea-floor spreading & continental drift

Sea-Floor Spreading
- The driving force behind continental drift
- Cause of undersea mountain range
  - Mid-ocean ridge caused by magma upwelling
  - Cools & creates new sea-floor
  - Older sea-floor subducted, returned to magma
- This cycle is known as a thermal convection cell

Iceland
Caught in between the North American Plate and the Eurasian Plate

The Theory of Plate Tectonics
Incorporates:
- Upwelling of magma
- Seafloor spreading
- Continental drift
- Earthquakes
- Volcanoes
- Orogenesis
Plate Boundaries

- Spreading (Divergent) boundaries
- Converging boundaries
- Transform boundaries

Oceanic Spreading Boundary
Example: Mid-Atlantic Ridge

Rift Valley

The Rift African Valley
Converging Boundaries

**Collision zones**
- Where plates (both continental and oceanic crust) collide

**Compression**

Middle East & Oil

Zagros Mountains

Figure 30.7 When continental plate A moving eastward meets oceanic plate B moving westward, the process of subduction carries the heavier oceanic plate downward beneath the thinner but lighter continental plate. In this process, high relief develops along the coastline, and the continental crust is heavily deformed. Melting occurs above the sinking oceanic plate, and the magma then rises through the continental crust to form a chain of volcanoes.
Figure 30.9 Simplified cross-section of a collision between two continental landmasses. Earlier, oceanic lithosphere of the plate on the left was being subducted below continental lithosphere of the right plate. The left plate carried a continent. However, when it arrived at the subduction zone, its low-density rocks would not sink into the asthenosphere, so subduction came to an end. There was then much compression and deformation of the crust through faulting and folding, and high mountains developed above the now-inactive subduction zone.

The Himalaya Mtns.
Transform Boundaries
- Where plates slide past each other
- No diverging, no converging
- Usually no volcanic activity

San Andreas Fault

Hot Spots
- Magma upwelling from stationary sites in the mantle
- Not necessarily at plate boundaries
- Can be useful in tracking movement of plates

Next Time
Earthquakes & Volcanoes