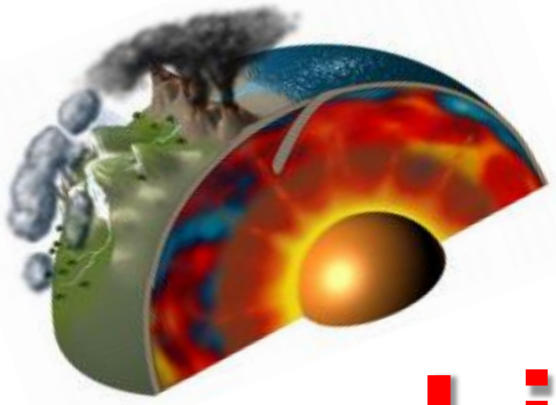
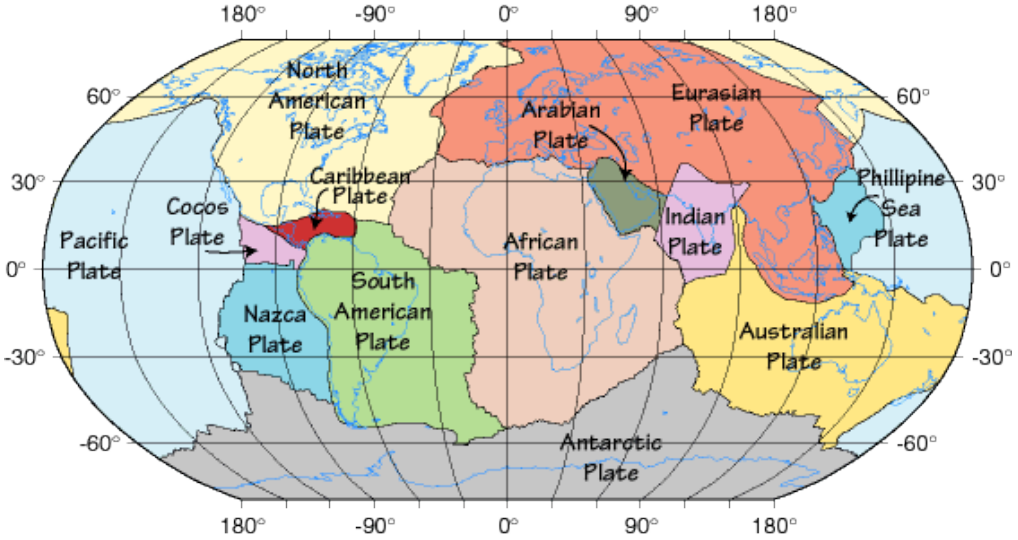
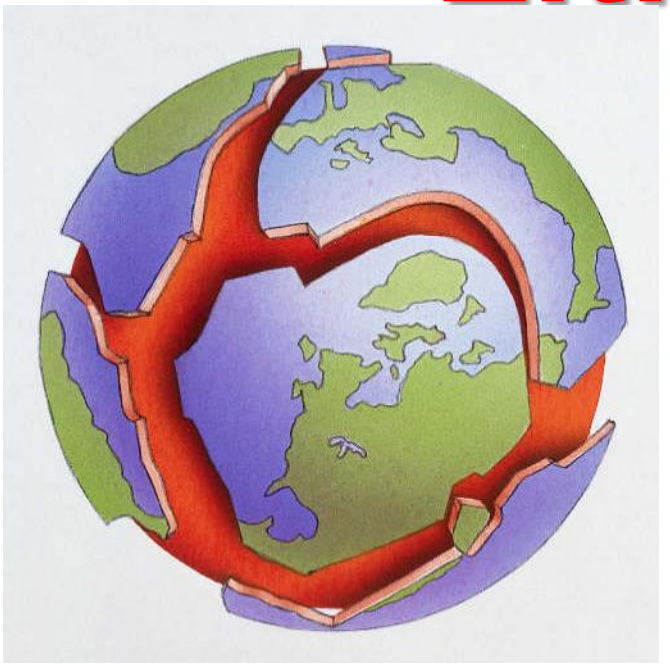
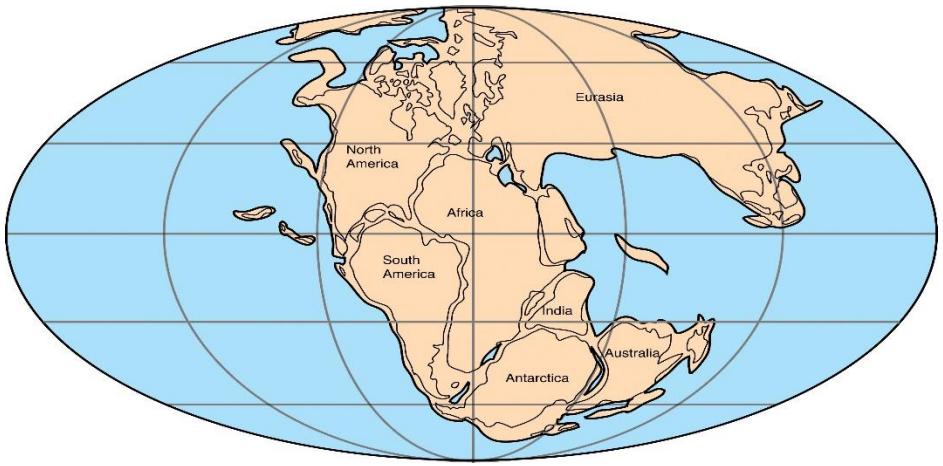
Solid Earth





Lithosphere Part 1





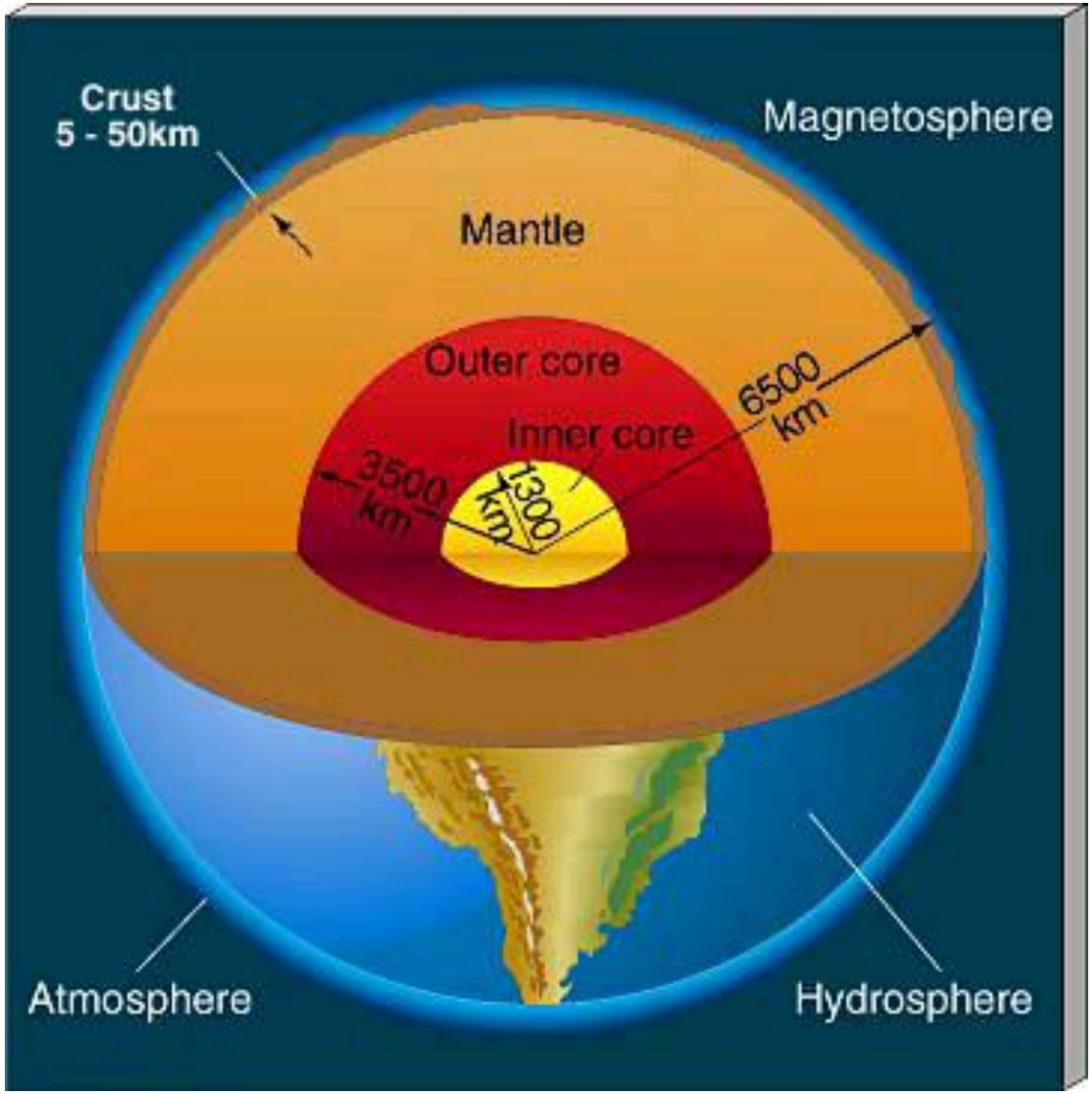
Continental Drift

Earth Evolution

"A planet and its life will co-evolve"

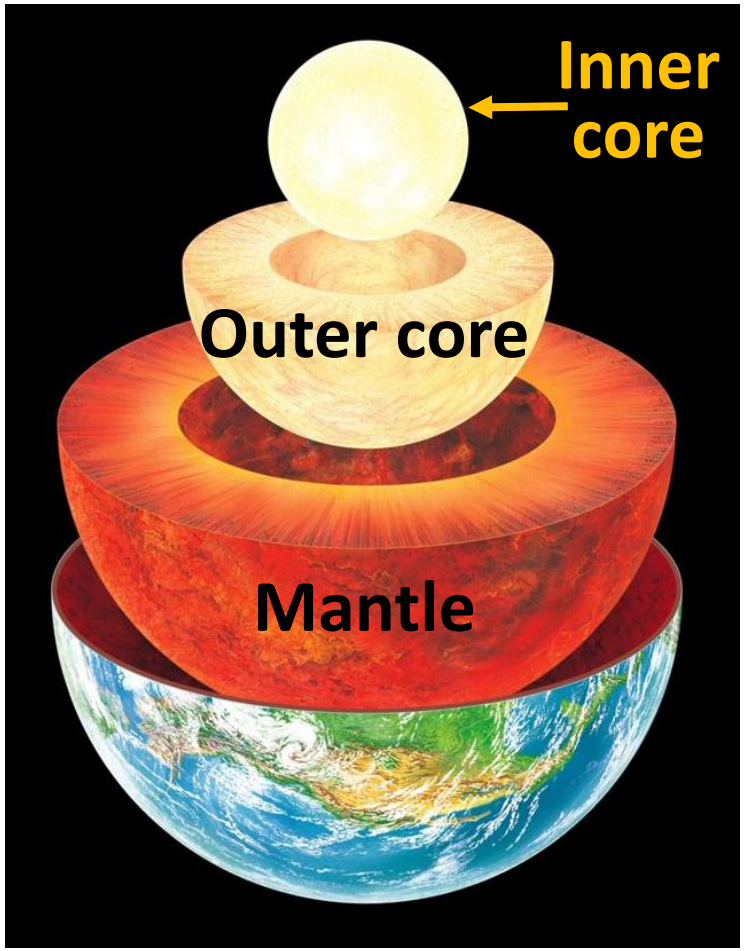
Earth's Layers

- **Inner core**
  - R = 1300 km (0-800 mi)
- **Outer core**
  - 1300-3500 km (800-2200 mi)
- **Mantle**
  - 3500-6400 km (2200-4000 mi)
- **Crust**
  - tops mantle
  - 5-50 km thick (3-25 mi)



The Core

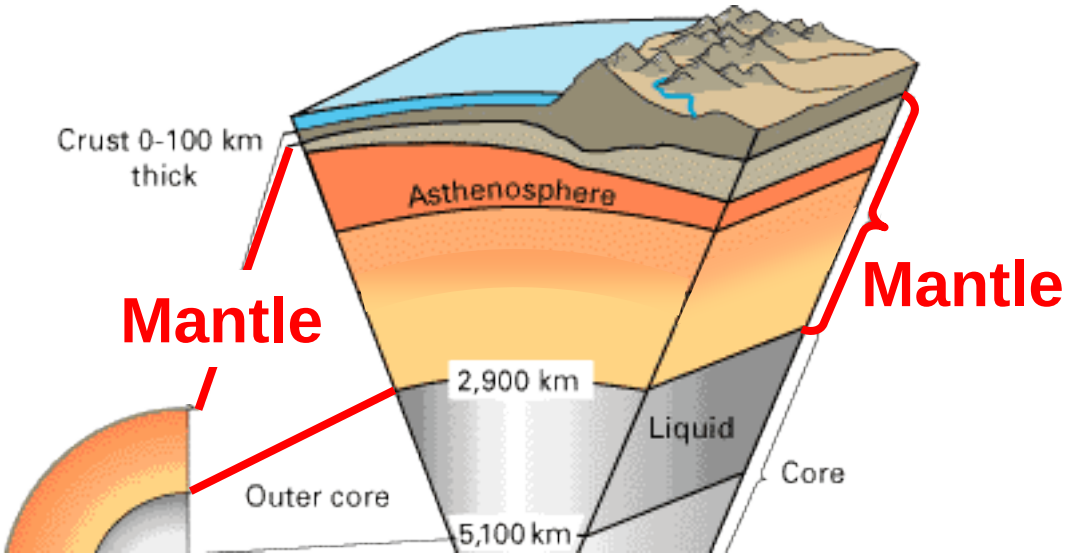
- **16% of Earth's volume**
- **Two sections:**



  - **inner core**
    - **total diameter ~2600 km (larger than Mercury!)**
    - **T ~ 6,000-7,000 K (>10,000°F)**
    - **solid, very dense**
    - **nickel-iron alloy**
    - **grows ~1 mm per year**
  - **outer core**
    - **~2250 km thick**
    - **liquid**
    - **T ~ 4,000-6,000 K (~6,700-10,300°F)**
    - **primarily iron with some nickel and sulfur**
    - **convection of liquid metals creates the Earth's magnetic field**

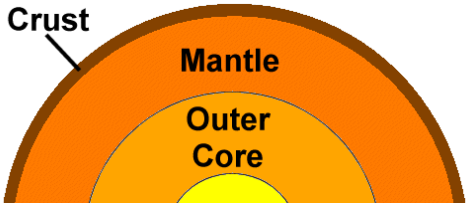
The Mantle

- **2900 km thick**
- **~84% of Earth's volume**

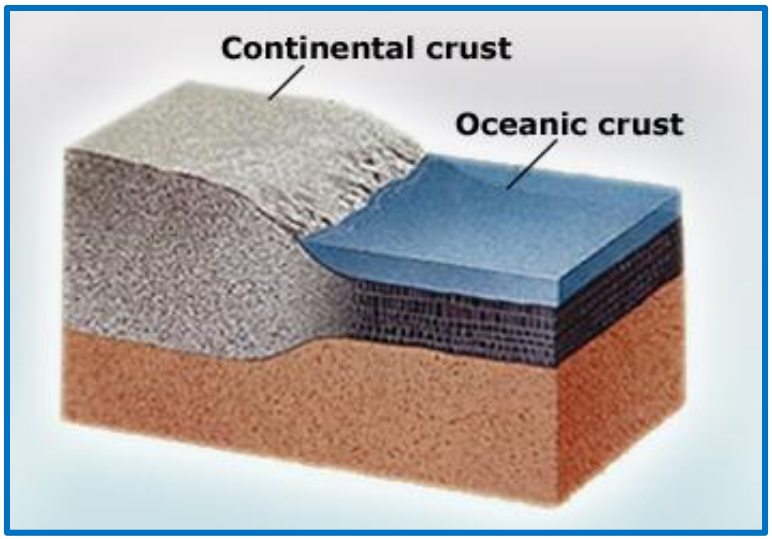


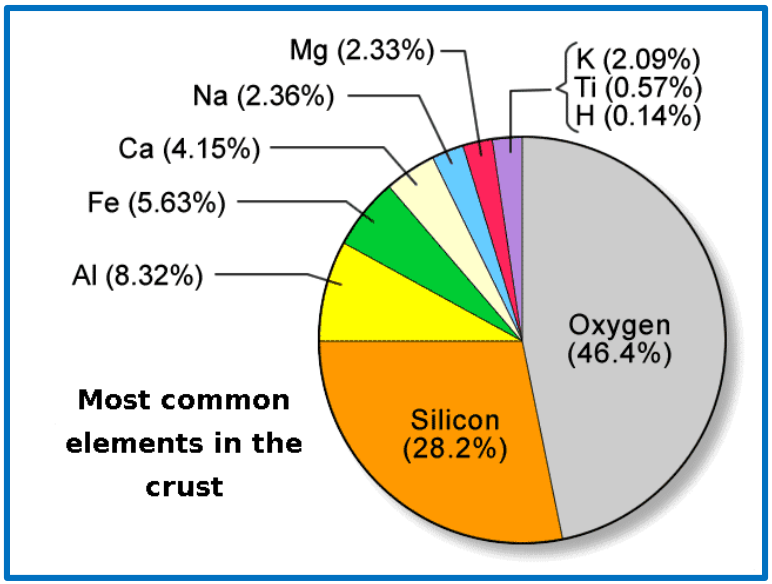
- **Three regions:**
  - ➢ **lower region**
    - — dense, solid (due to *enormous pressure*!)
    - — temperatures between ~2000-3,500 K (~3,100-5,800°F)
  - ➢ **upper region (*asthenosphere*, *"weak" sphere*)**
    - — has reduced pressures and rock strength
    - — plastic rock (at pressures and temperatures found in this region, mantle rock can deform and flow slowly).
  - ➢ **uppermost region**
    - — solid; temperatures between 750-1200 K (~900-1,700°F)

The Crust



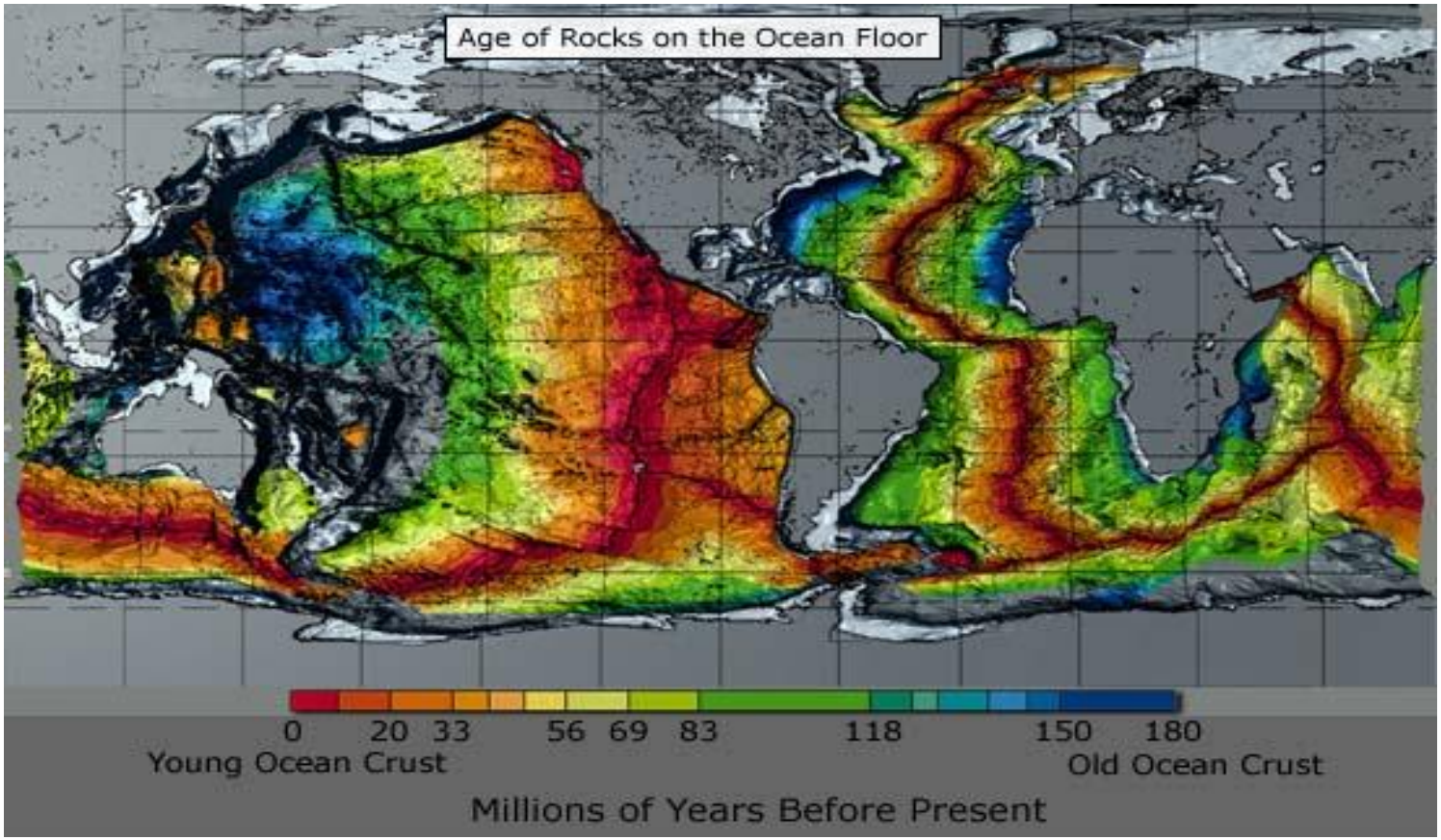
- **<1% of Earth's mass**
- **Solid**
- **Two types:**
  - **oceanic crust**
    - **55% of the surface**
    - **6 to 10 km thick**
    - **composed of basalts**
    - **relatively young (*<200 MYO*)**
  - **continental crust**
    - **45% of the surface**
    - **70% by volume**
    - **25 to 70 km thick**
    - **granites *(less dense)***
    - **mostly old (*up to 3.5-4 BYO*)**





Age of Oceanic Crust

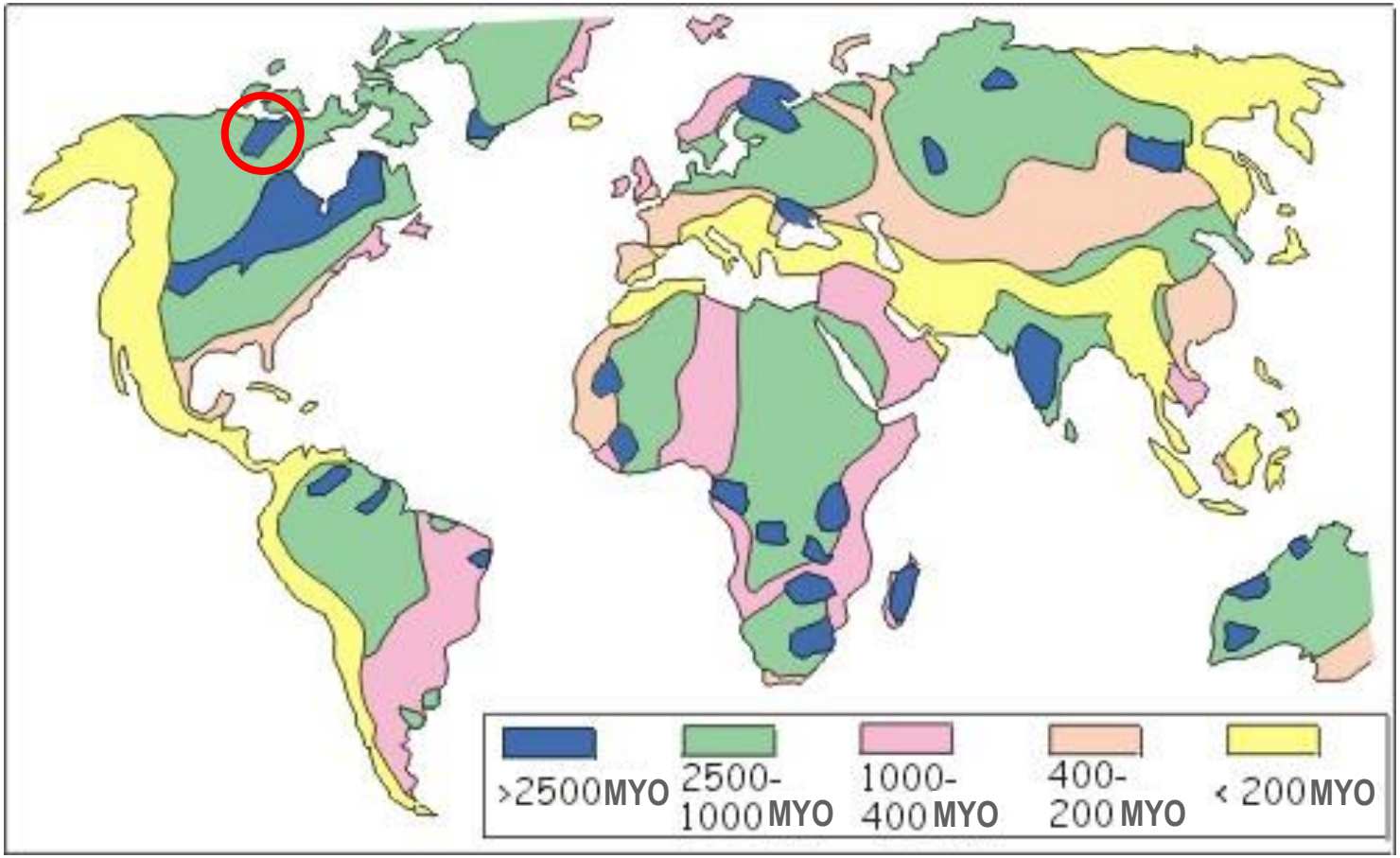
By analyzing radioactive minerals in igneous rocks (*those formed through the cooling and solidification of magma or lava*), scientists can tell how much time has passed since rocks solidified from lava - the age of a rock.



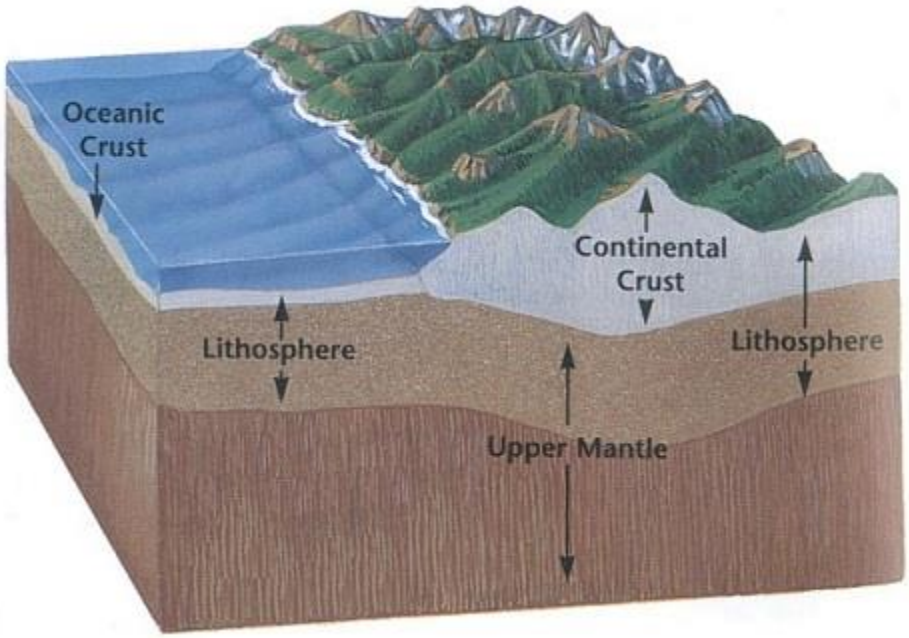
Oceanic crust is seldom more than 200 million years old.

Age of Continental Crust

The oldest rocks on Earth are found within the stable cores of the continents. The oldest known intact crustal fragment on Earth, Acasta Gneiss (located in Northwest Territories, Canada), is believed to be ~4 billion years old.

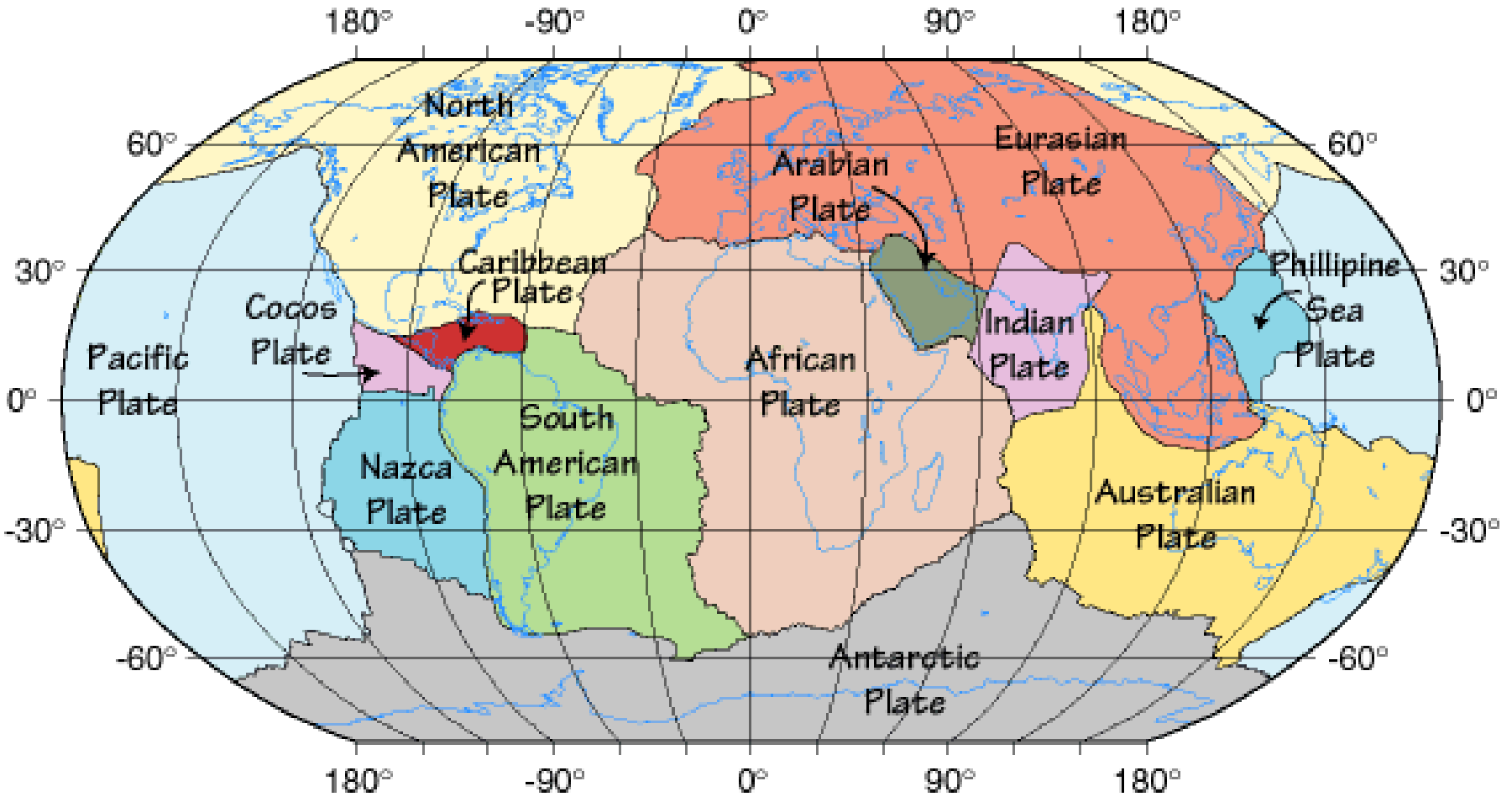


Lithosphere: Sphere of Rock



- rigid <u>outer layer</u>
- made of **crust** and the uppermost part of the **mantle**
- broken into pieces called **tectonic plates**
- eight major tectonic plates (plus several minor)

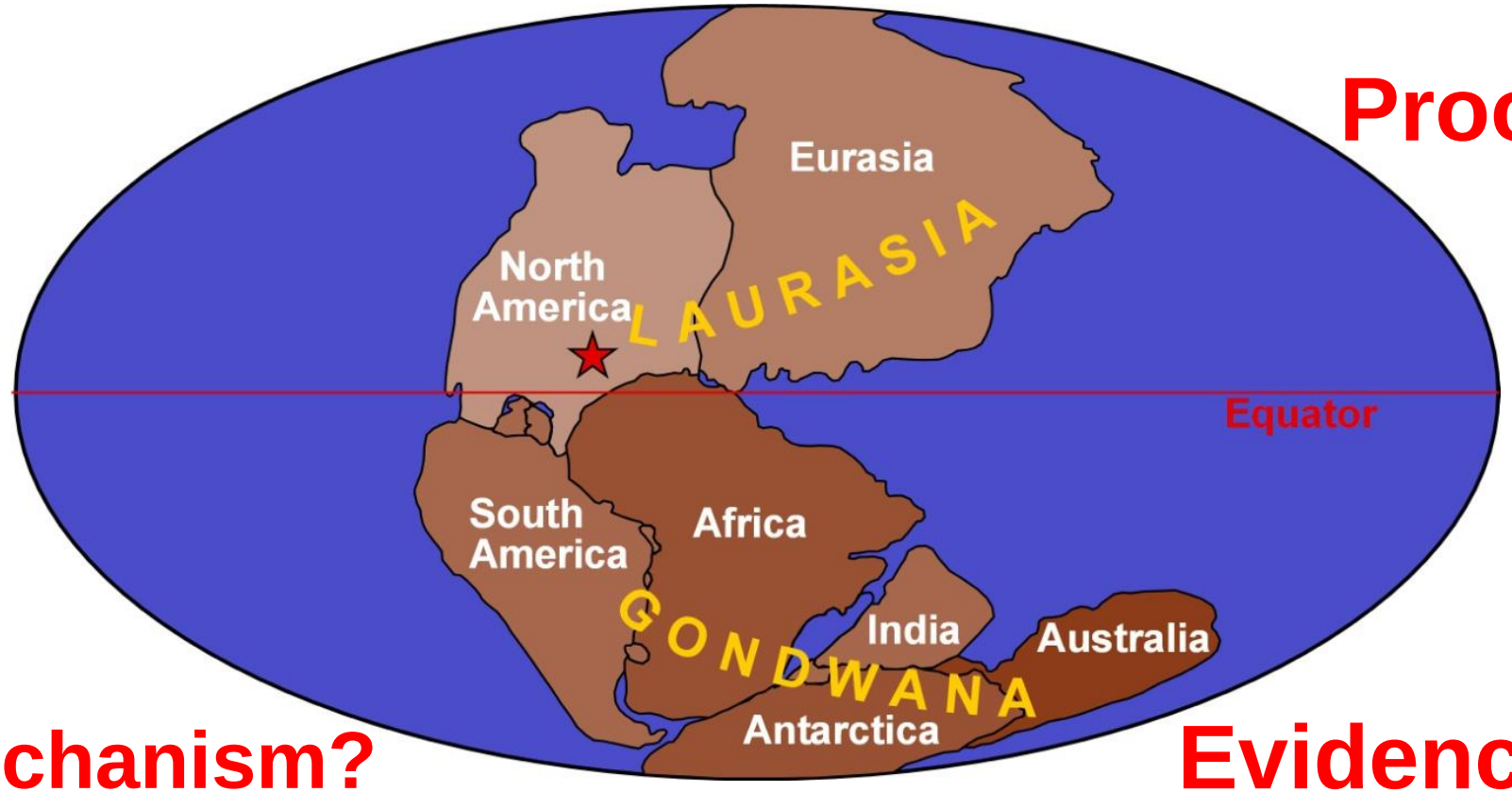
Tectonic Plates



The tectonic plates of the World were mapped in the second half of the 20th century.

Continental Drift

- **In the late 19th and early 20th centuries, geologists assumed that the Earth's major features were fixed.**
- **<u>In 1912</u>, Alfred Wegener proposed that up until about 200 million years ago, all of the present continents were joined together into a single super-continent later called Pangea.**

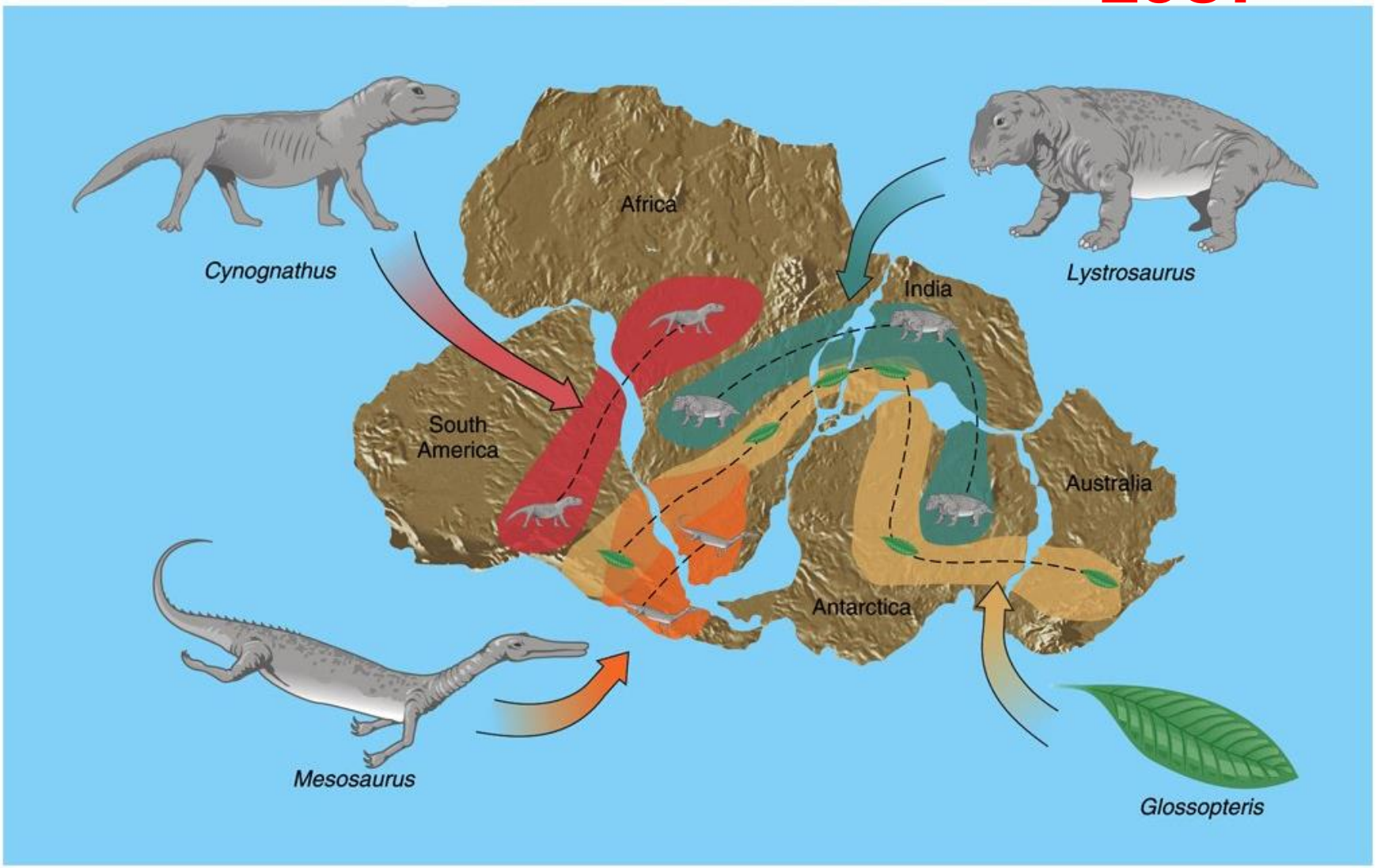


Proof?

Mechanism?

Evidence?

Continental Drift: Fossil Evidence 1937



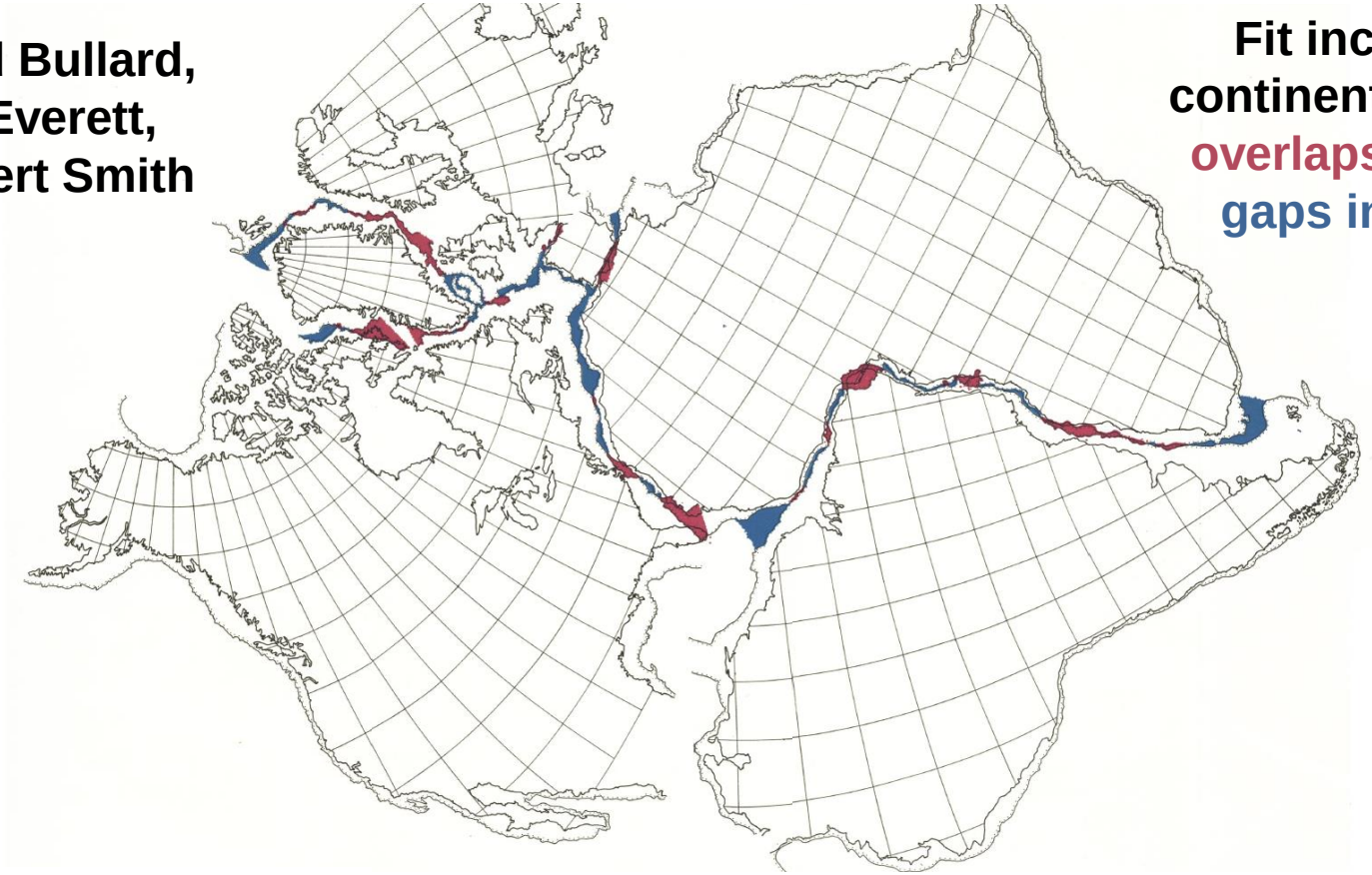
Continental Drift: Debate

- **Fifty years long lively debate started between "drifters" or "mobilists" (proponents of the theory) and "fixists" (opponents), during which the theory of plate tectonics was born.**

- **Early "weak" evidence:**
  - **Parts of Scotland and Ireland contain rocks very similar to those found in Newfoundland and New Brunswick.**
  - **The Caledonian Mountains of Europe and parts of the Appalachian Mountains of North America are very similar in structure and composition.**
- **Strong geophysical evidence:**
  - **Paleomagnetism, the rocks of different ages show a variable magnetic field direction consistent with continents movement.**
  - **Late 1950s and early 60s data on the bathymetry of the deep ocean floors and the nature of the oceanic crust; evidence of seafloor spreading along the *mid-oceanic ridges*.**

Continental Drift: Recognition

**Edward Bullard,
J. E. Everett,
A. Gilbert Smith**



Fit includes continental shelf; overlaps in red, gaps in blue.

- **Royal Society of London, 1965: a symposium on Continental Drift was held where a computer calculation was presented how the continents along both sides of the Atlantic would best fit to close the ocean - the famous "Bullard's Fit".**

Continental Drift Video

The Past

https://www.youtube.com/watch?v=UwWWuttntio

The Future

https://www.youtube.com/watch?v=bQywDr-btz4