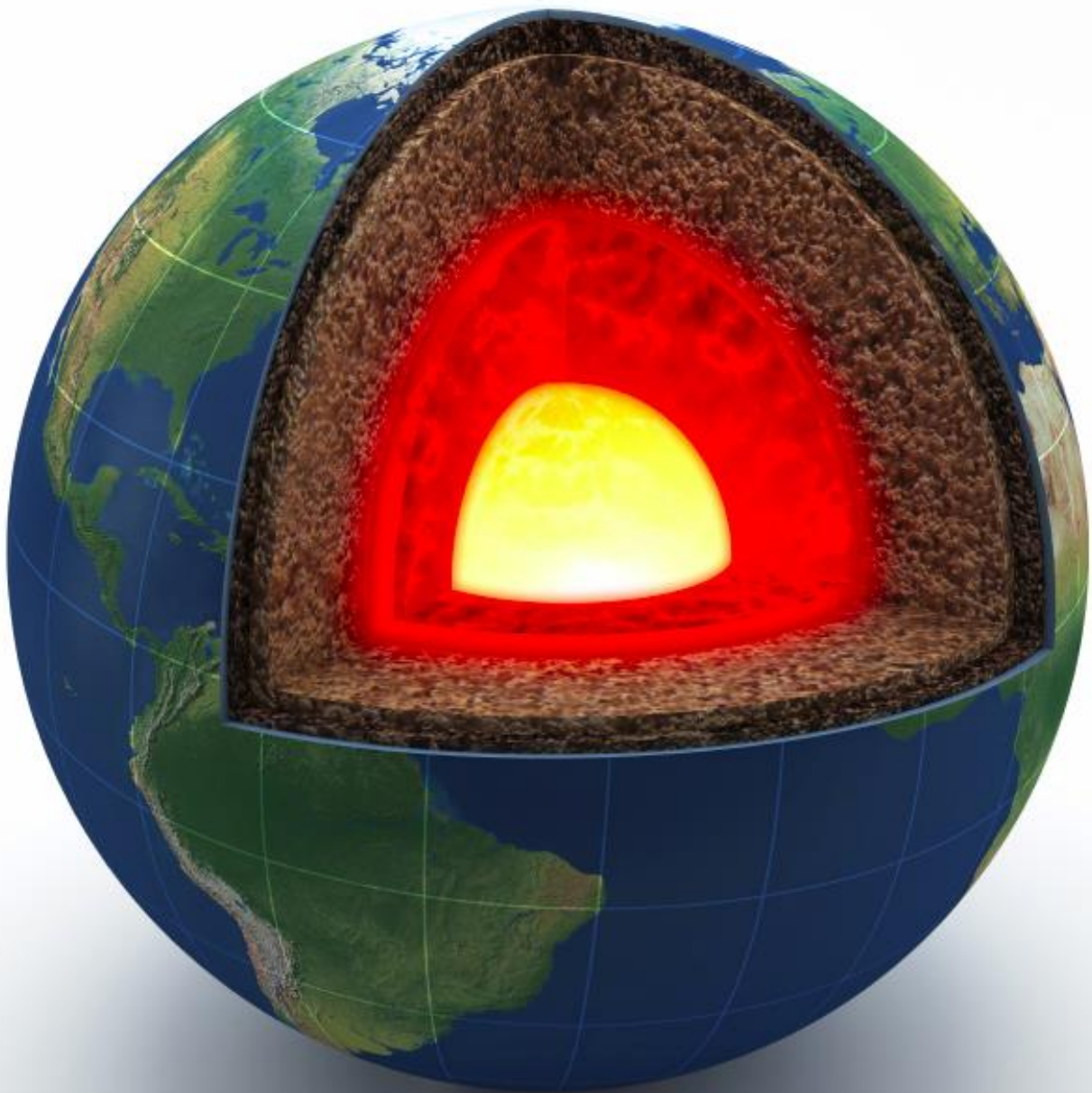


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Solid Earth Evolution

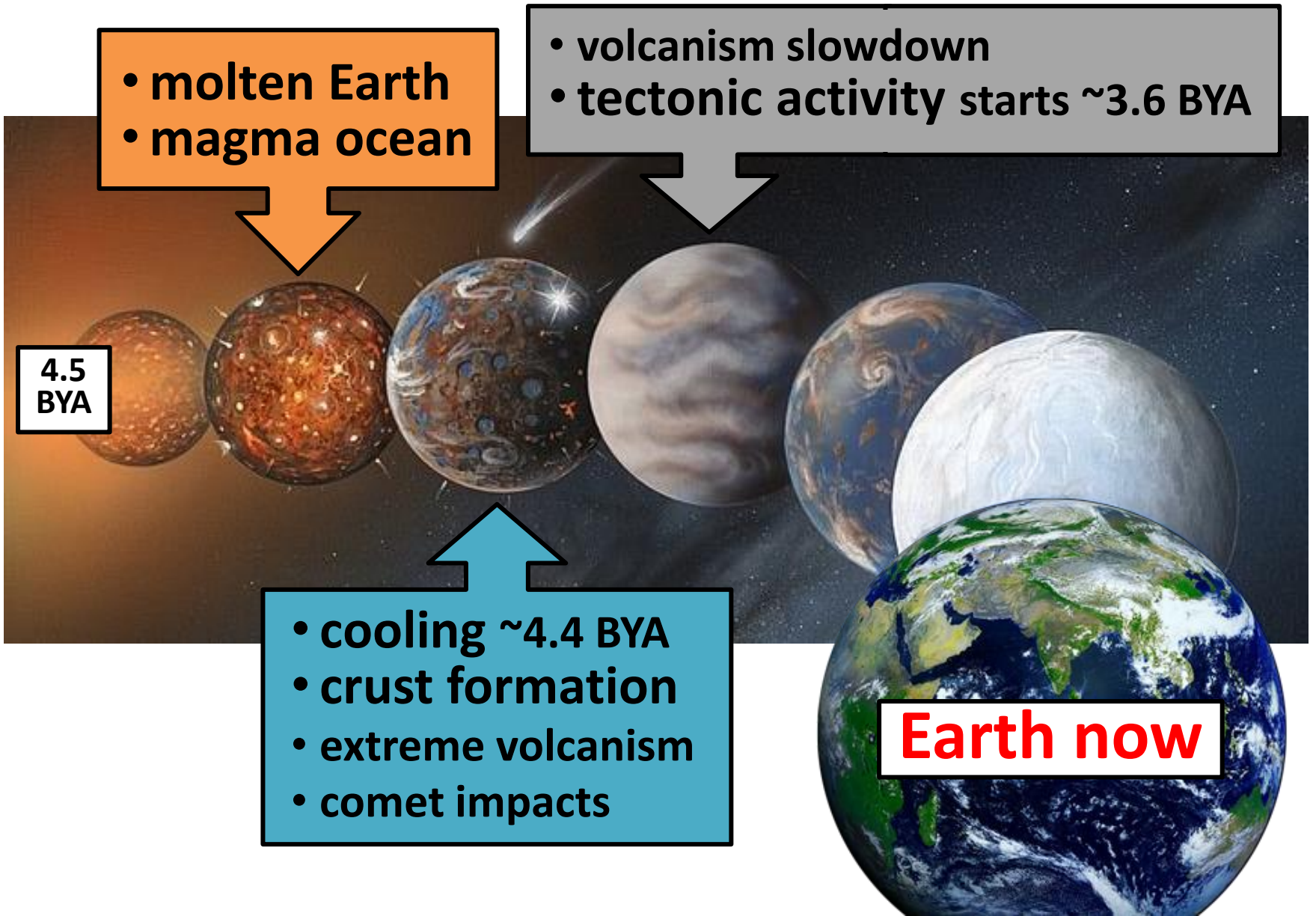
- molten Earth
- magma ocean

- volcanism slowdown
- tectonic activity starts ~3.6 BYA

4.5
BYA

- cooling ~4.4 BYA
- crust formation
- extreme volcanism
- comet impacts

Earth now



Inside Earth: Layers

➤ Inner core

- R = 1300 km
(0-800 mi)

➤ Outer core

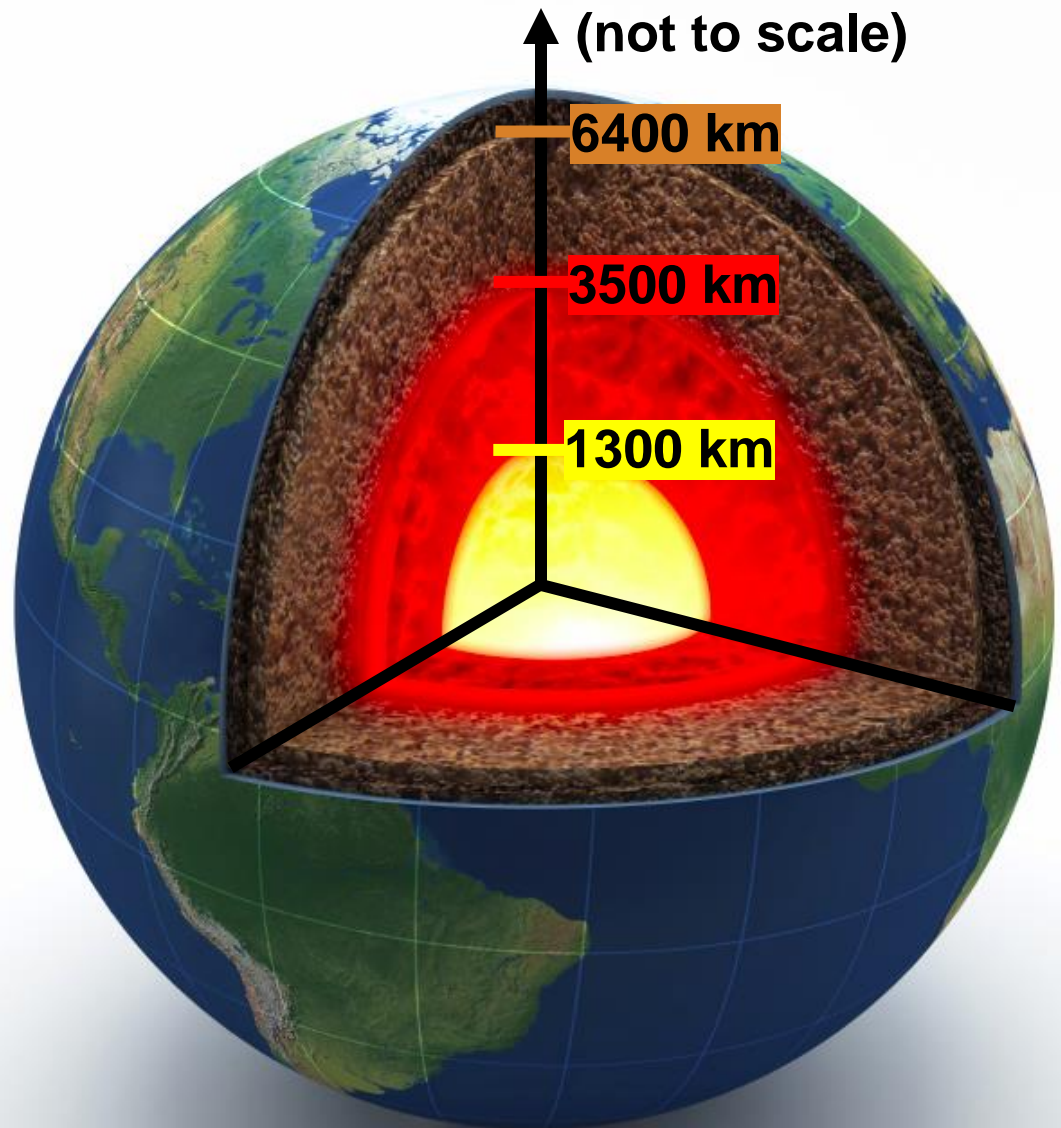
- 1300-3500 km
(800-2200 mi)

➤ Mantle

- 3500-6400 km
(2200-4000 mi)

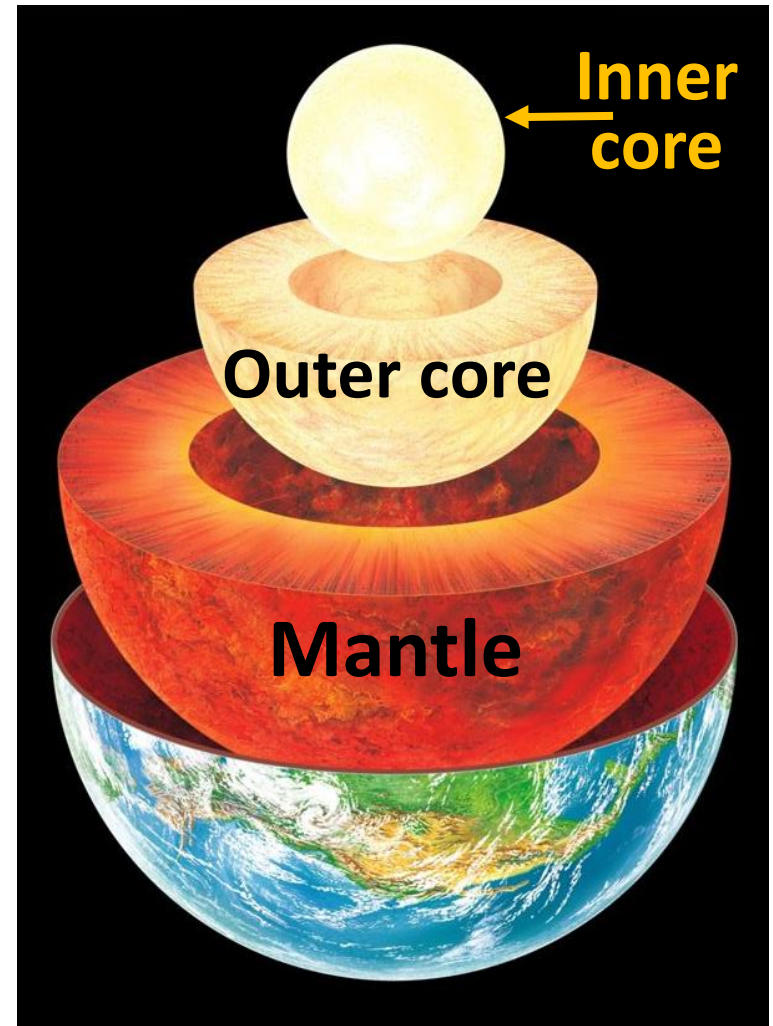
➤ Crust

- tops mantle
- 5-50 km thick
(3-25 mi)



The Core

- 16% of Earth's volume
- Two sections:
 - inner core
 - total diameter ~2600 km
 - $T \sim 6,000\text{-}7,000\text{ K}$ ($>10,000^\circ\text{F}$)
 - solid, very dense
 - nickel-iron alloy
 - grows ~1 mm per year
 - outer core
 - ~2200 km thick
 - liquid
 - $T \sim 4,000\text{-}6,000\text{ K}$ ($\sim 6,700\text{-}10,300^\circ\text{F}$)
 - 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

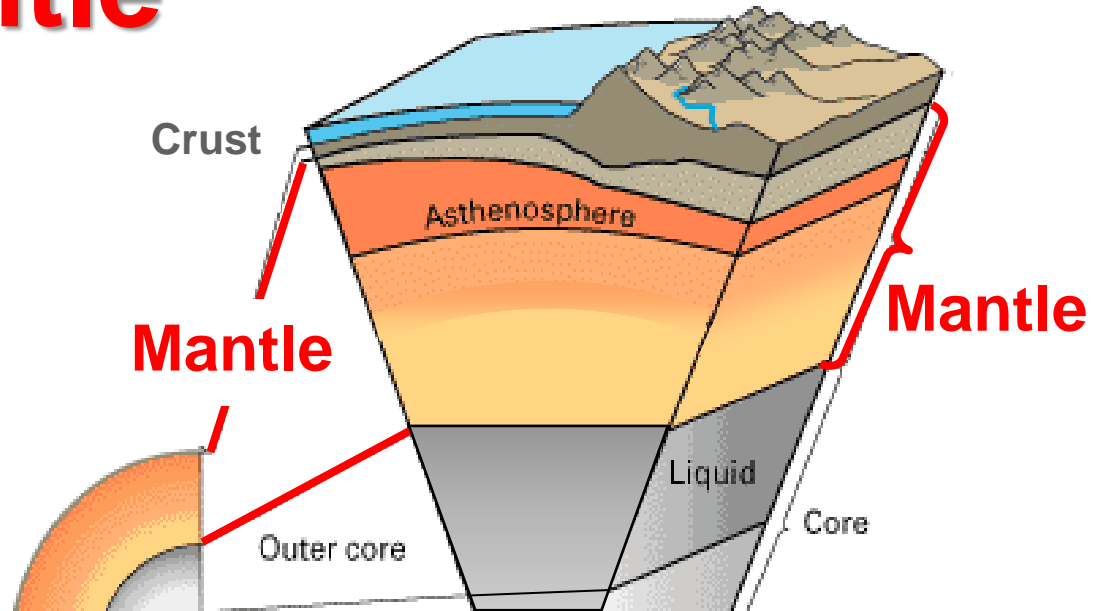
- dense, **solid** (due to *enormous pressure!*)
- temperatures between ~2000-3,500 K (~3,100-5,800°F)

- 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**).

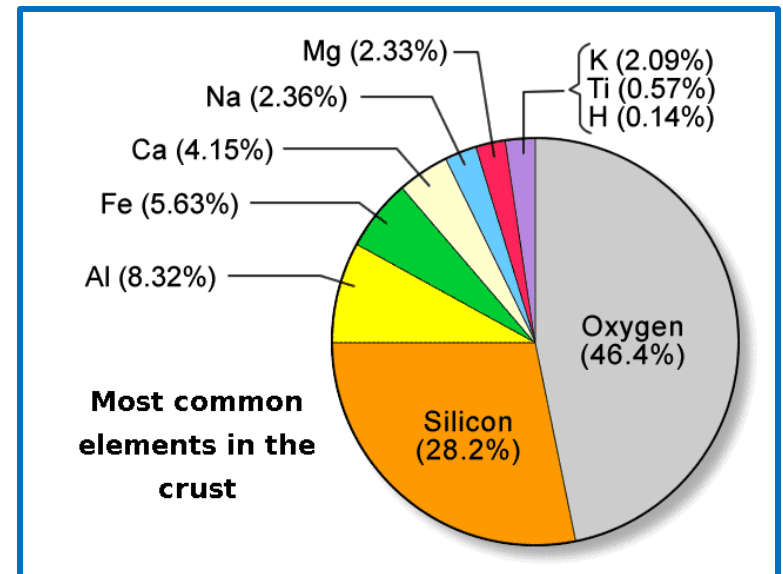
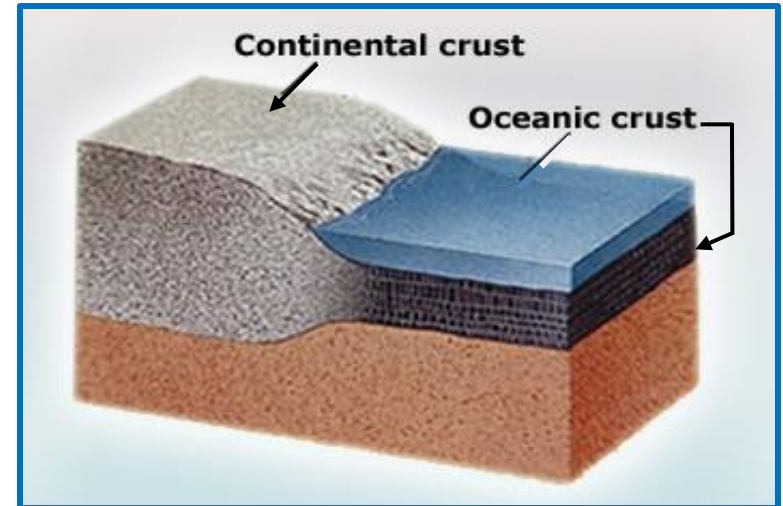
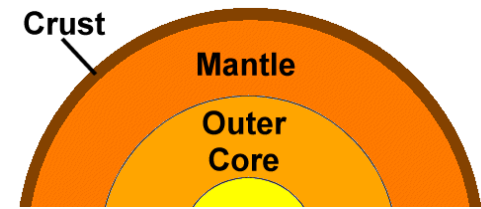
- uppermost region

- **solid**; temperatures between 750-1200 K (~900-1,700°F)

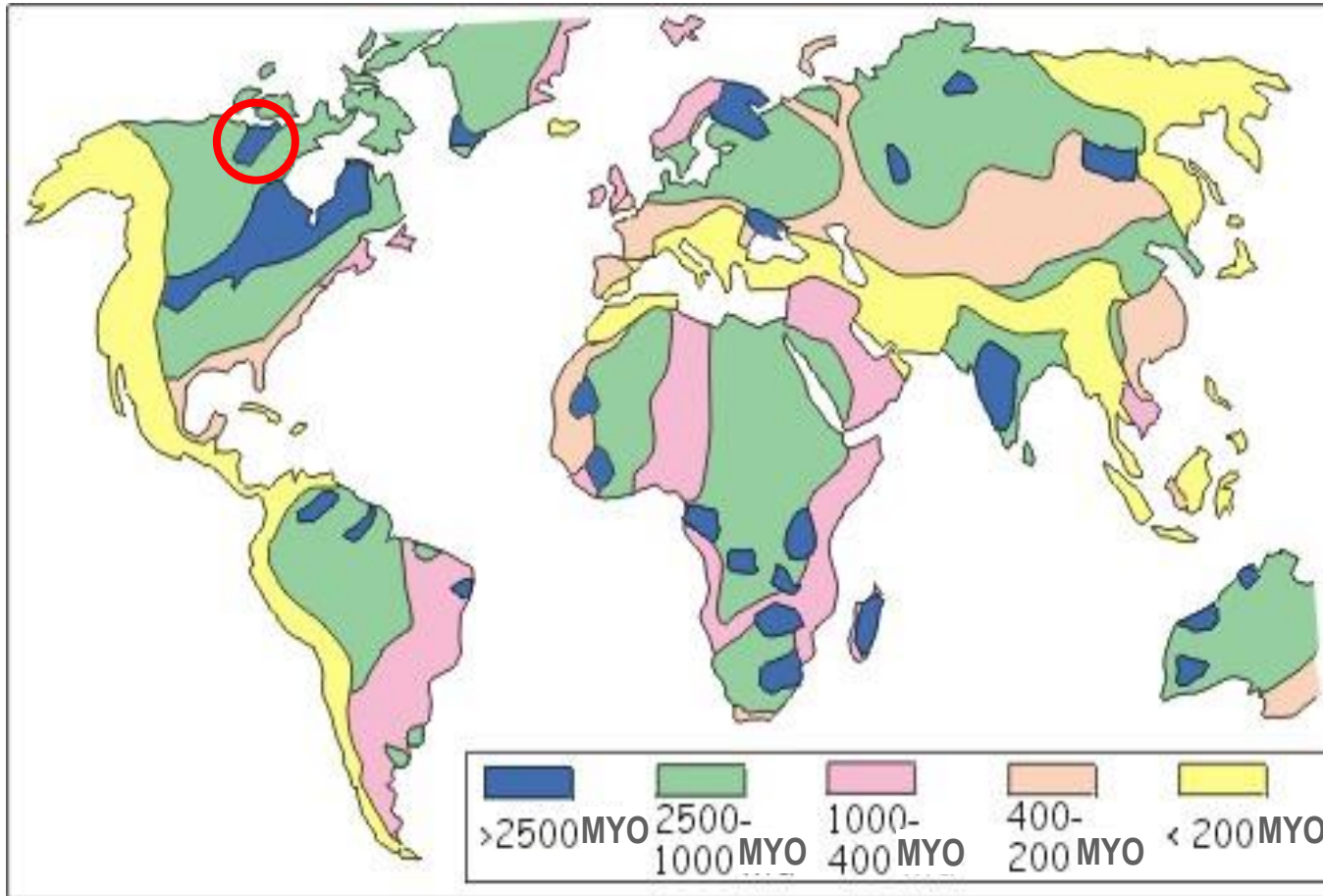


The Crust

- <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 Continental Crust



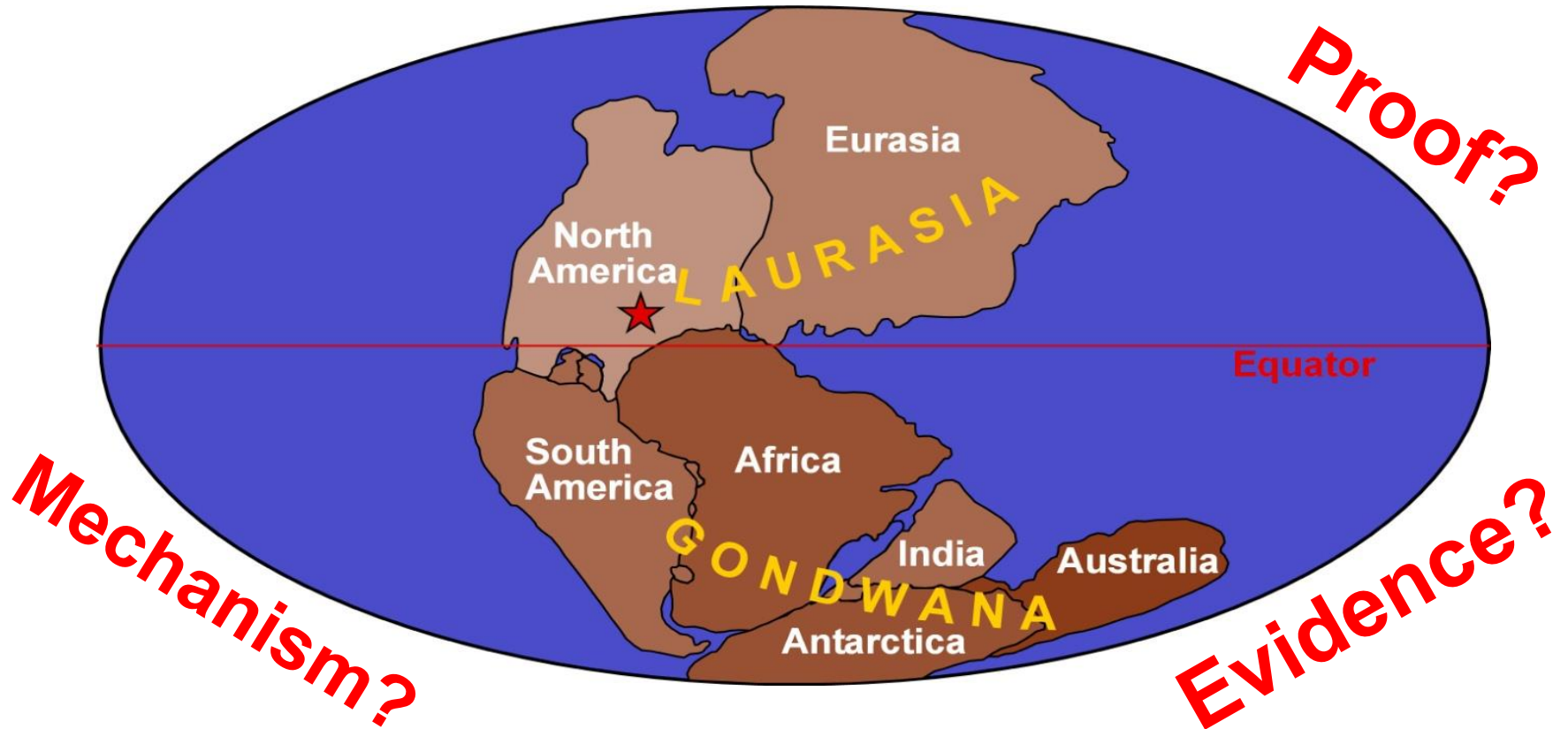
How old is that rock?

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.

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

Continental Drift

- In the late 19th and early 20th centuries, geologists assumed that the Earth's major features were fixed.
- In 1912, **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**.



Continental Drift Simulation

The Past

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

The Future

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