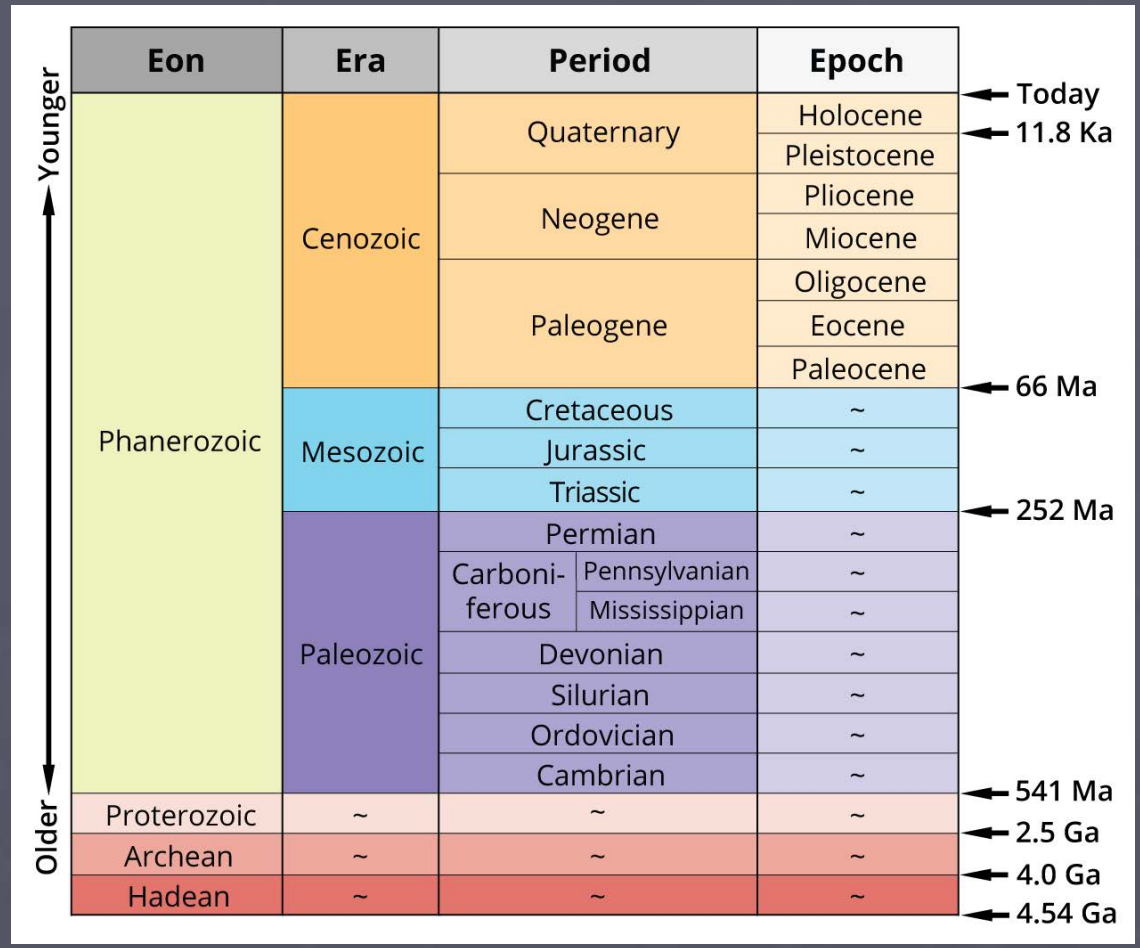
Earth’s Geosphere

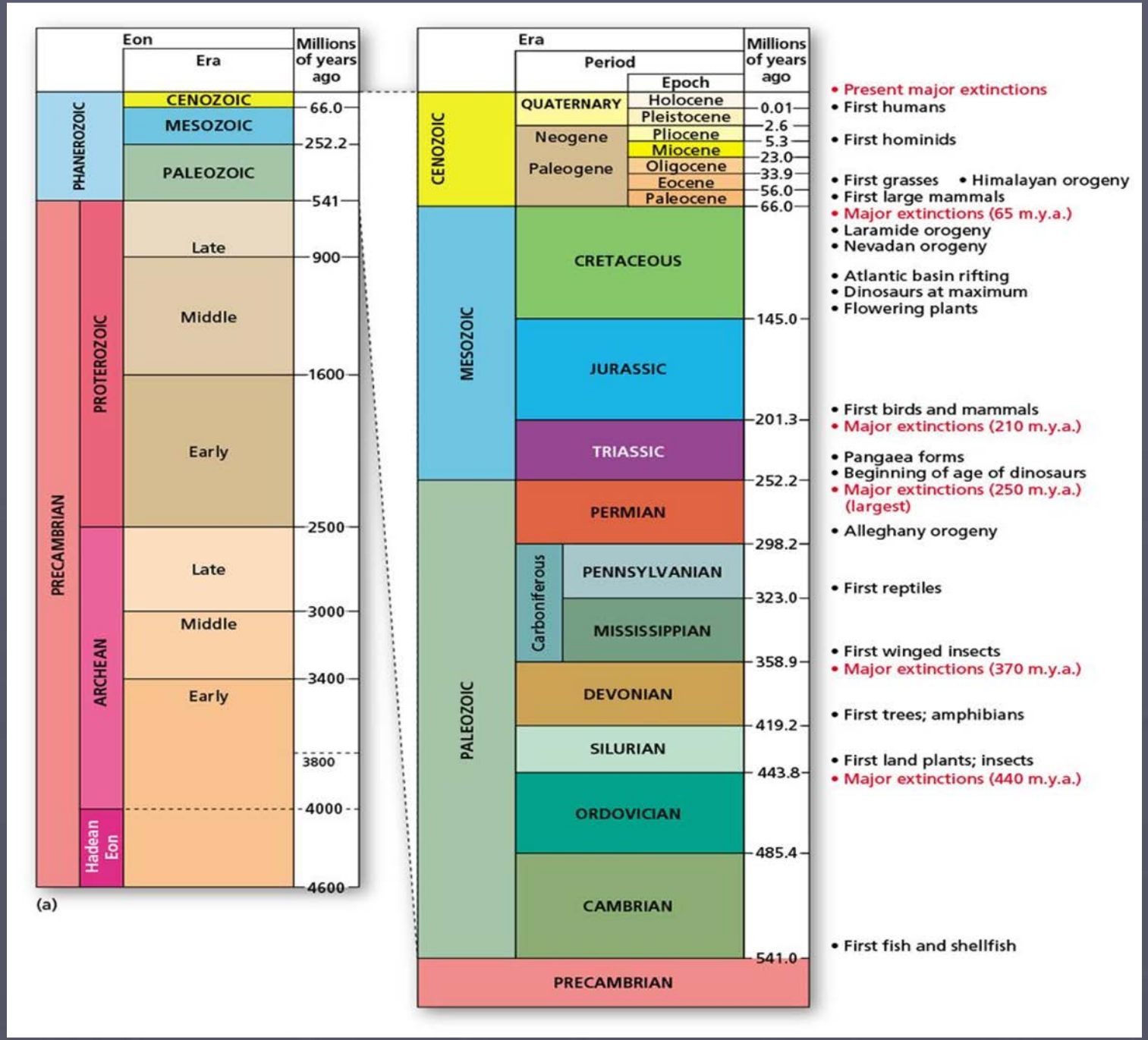
Chapter 11: The Dynamic Planet

Geological Time Periods and Epochs

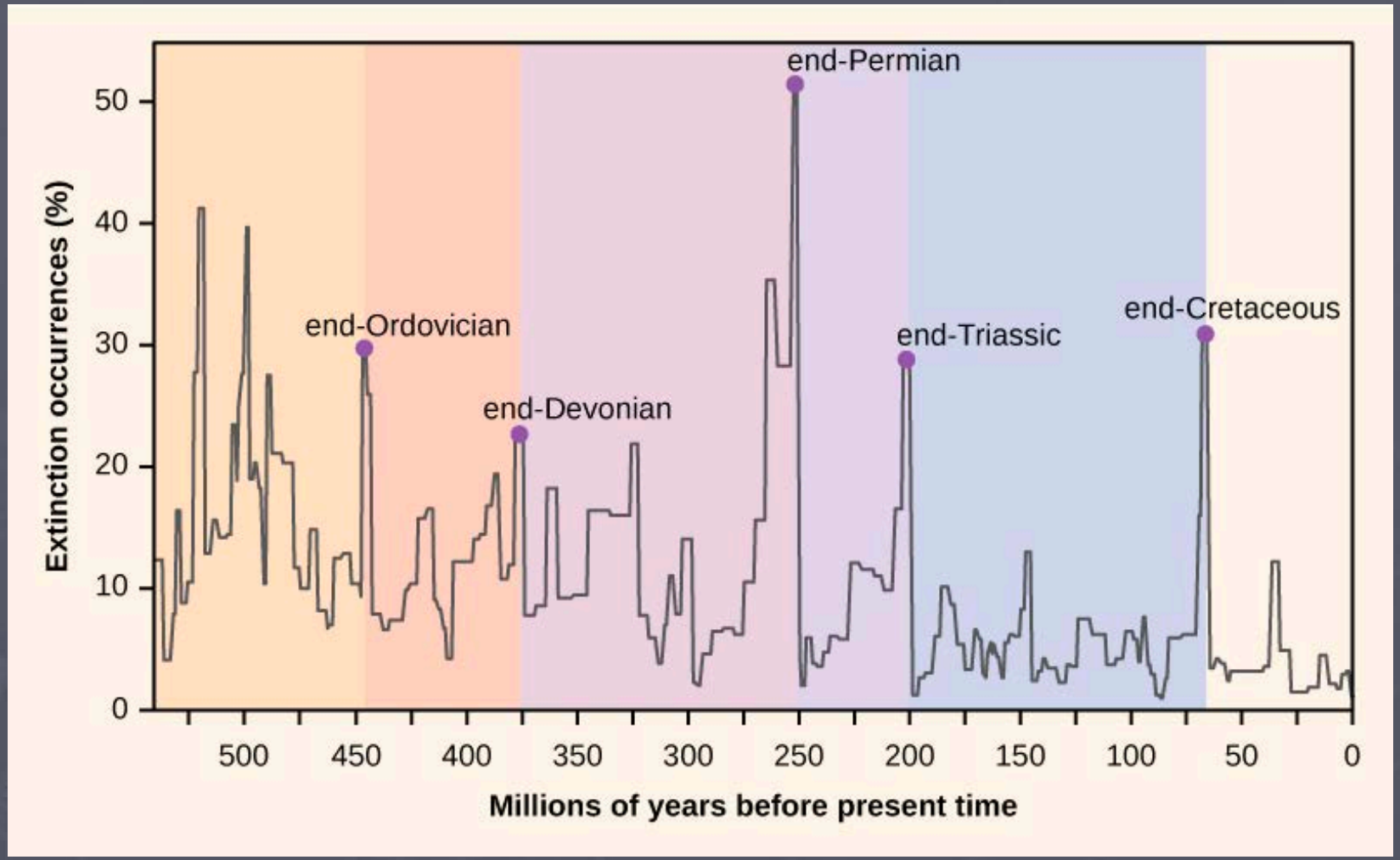
- **Geochronology** - Branch of Geology concerned with the dating of rock formations and the division of pre-historic events
  - Based on history of earth's formation as evident in layers of the earth's crust
  - Best evidence suggest earth about 4.5 billion years old



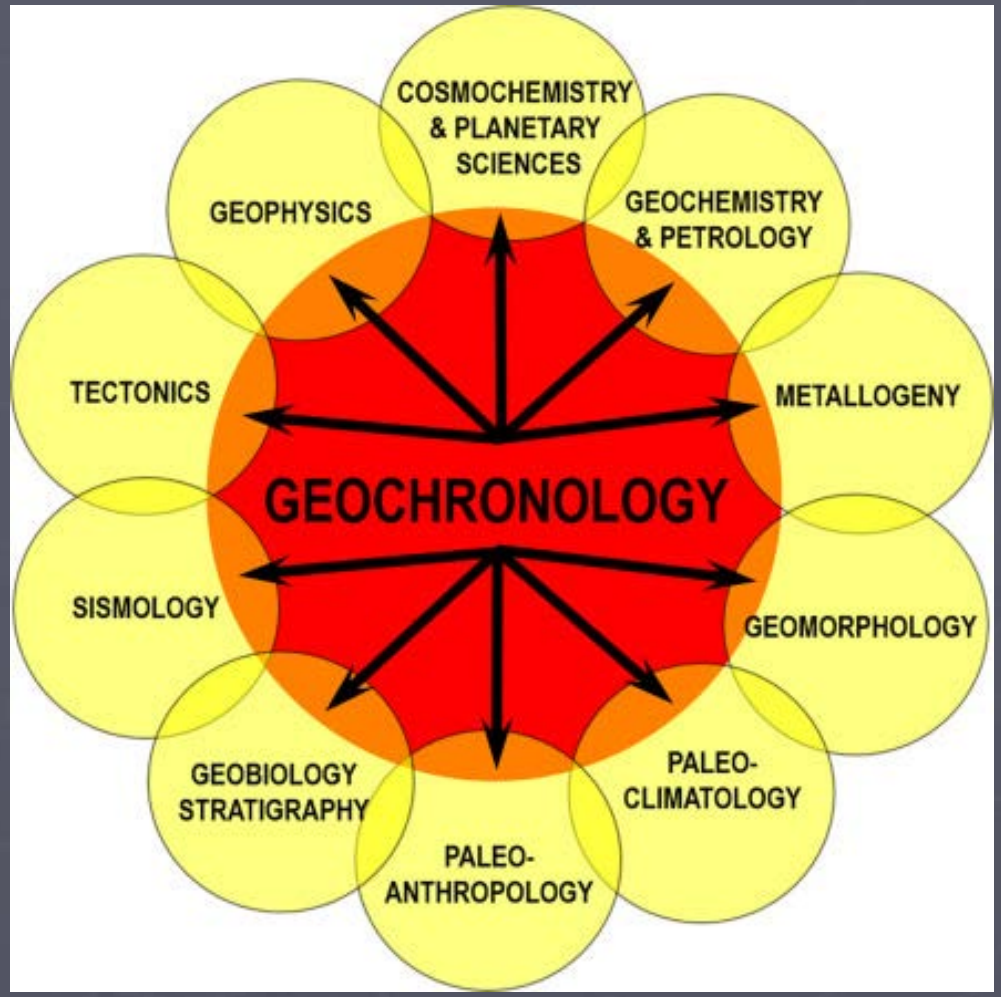
The Phanerozoic Eon



Ends of Periods and Mass Extinction Events

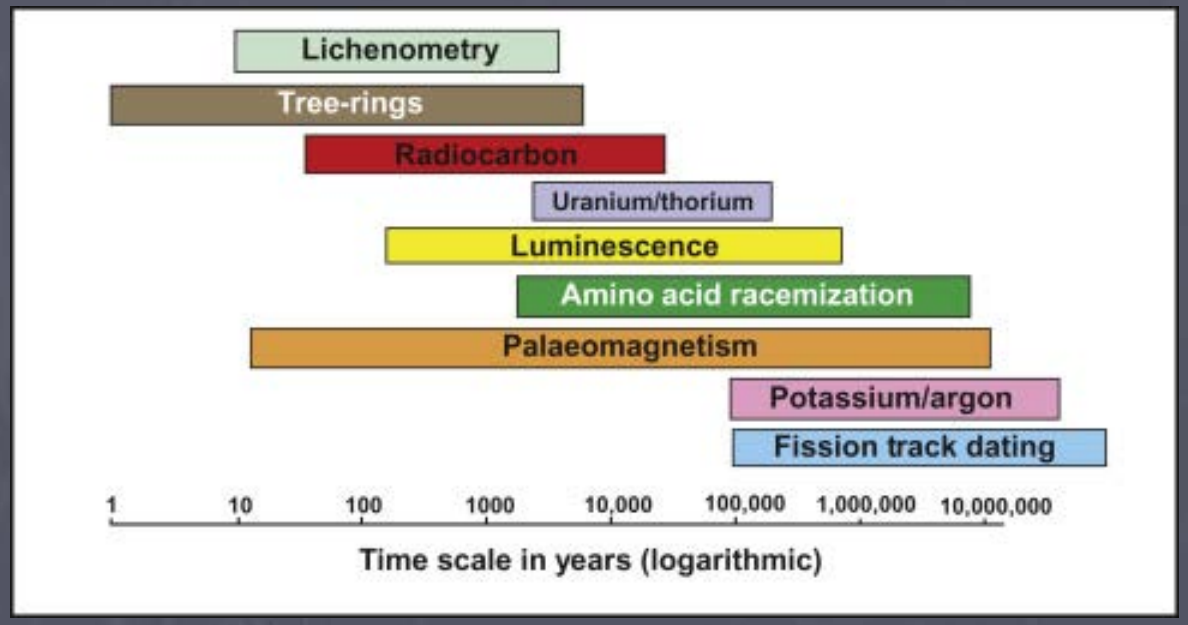


Disciplines of Geochronology



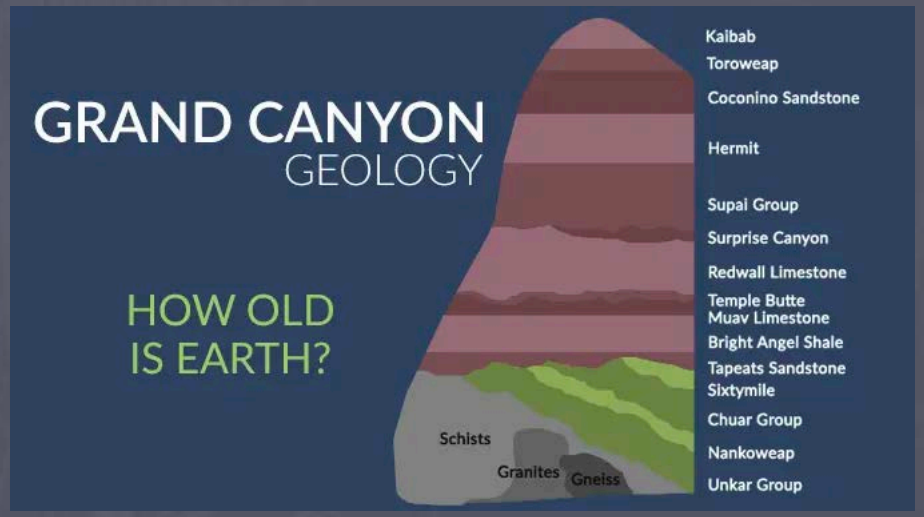
Geochronological Dating

- Geoscientist study strata of earth's layers and use dating methods to determine ages and characteristics of different geological eras

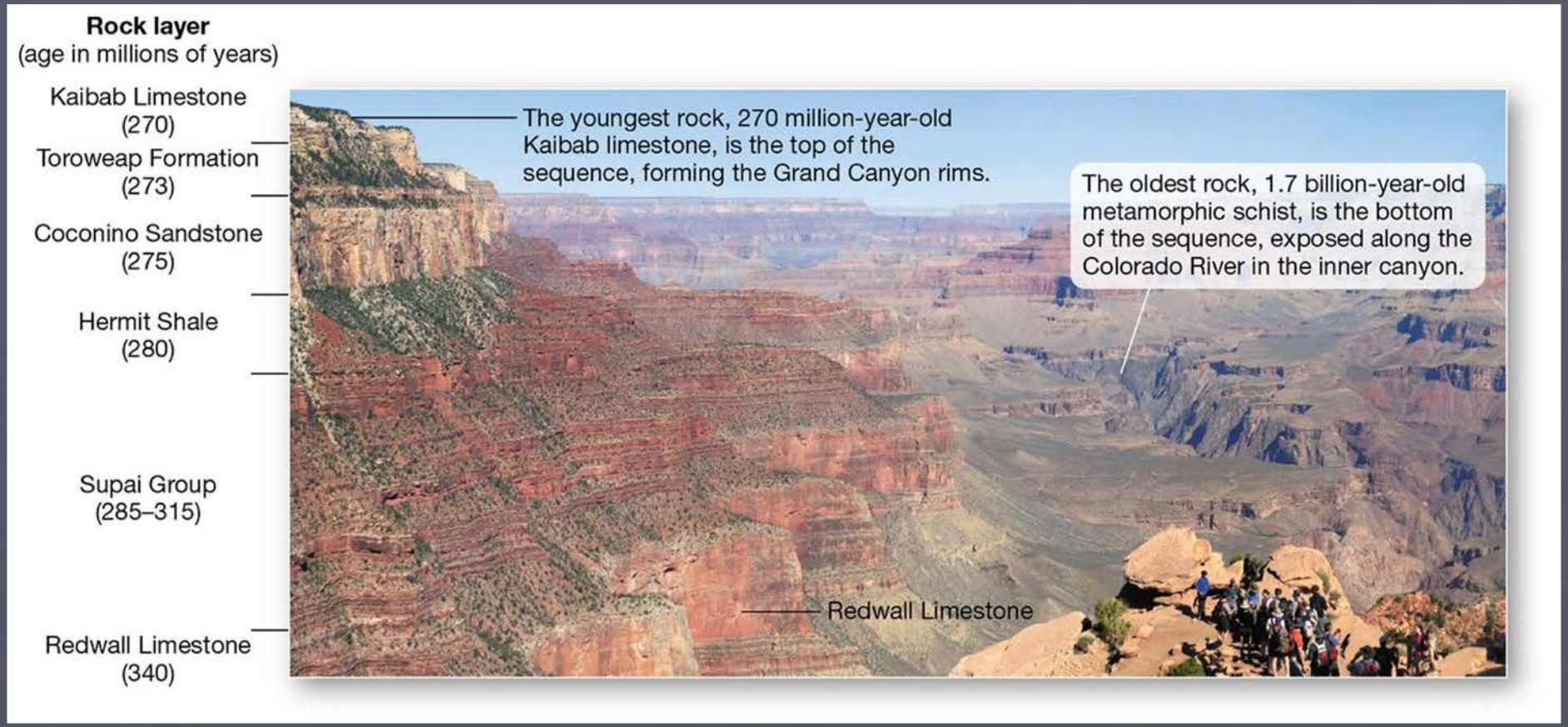


Superposition

- Basic principle that newer rock layers are on top of older rock layers
  - Unless there has been some sort of disturbance

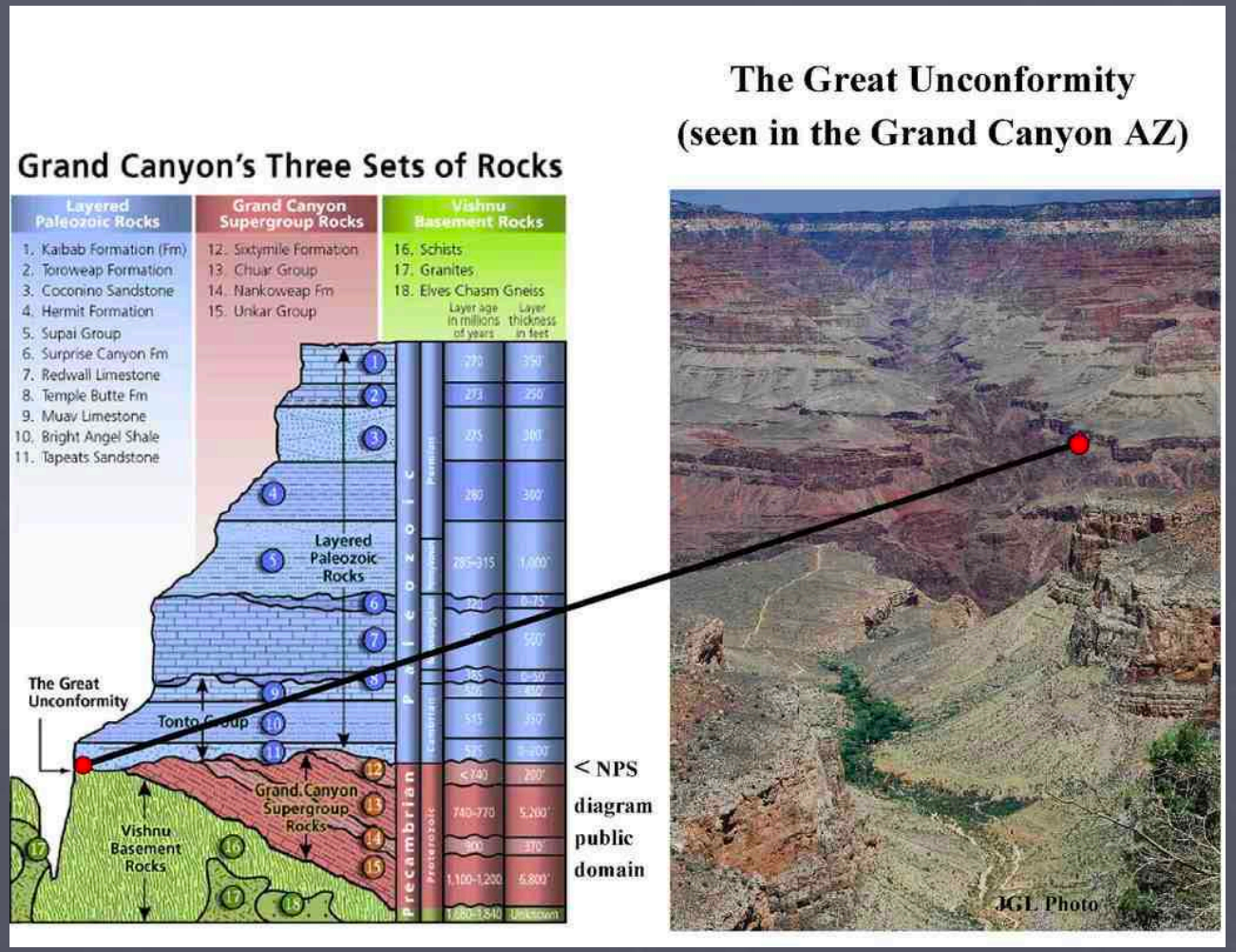


Superposition of the Grand Canyon

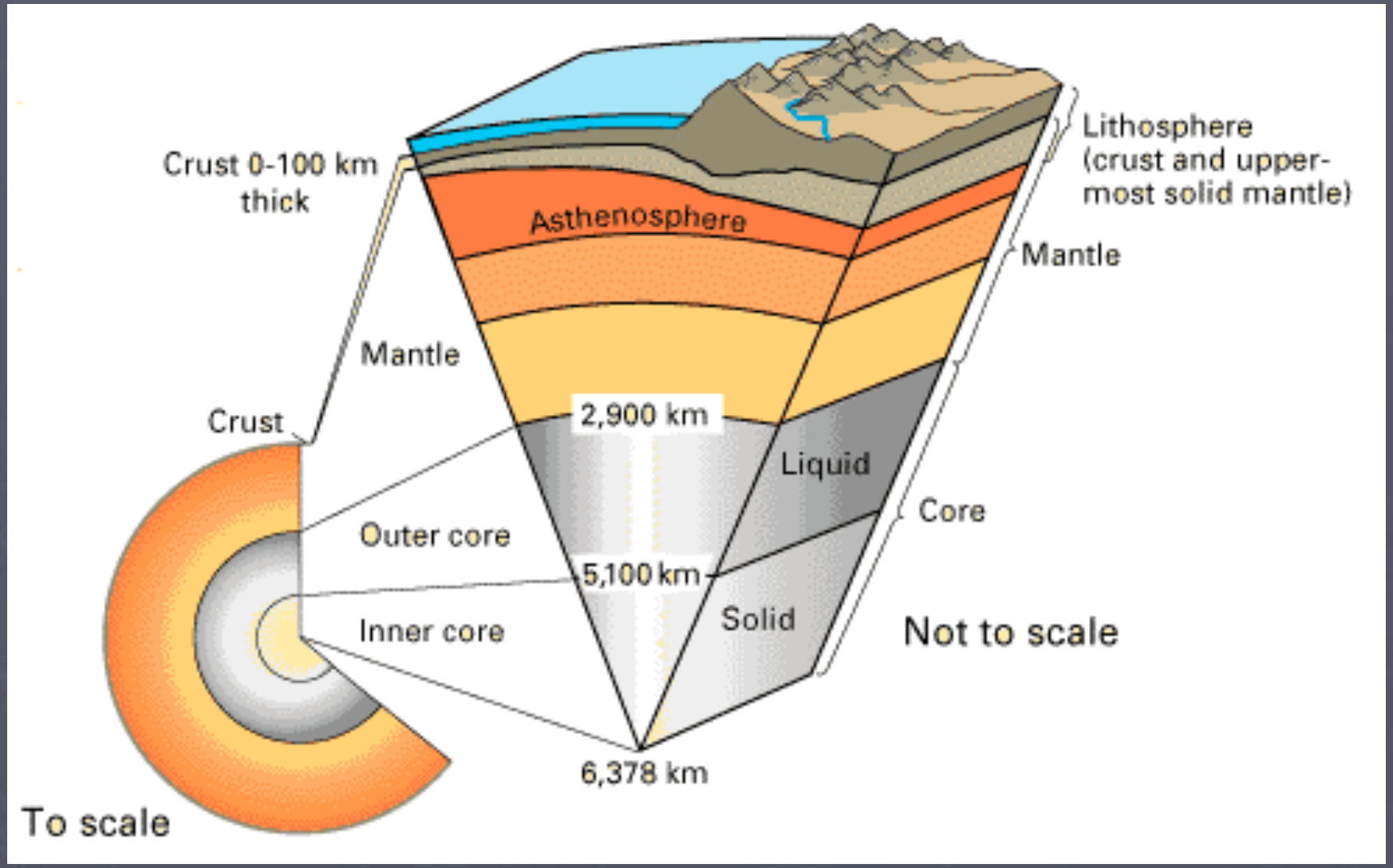


Disturbances in Superposition

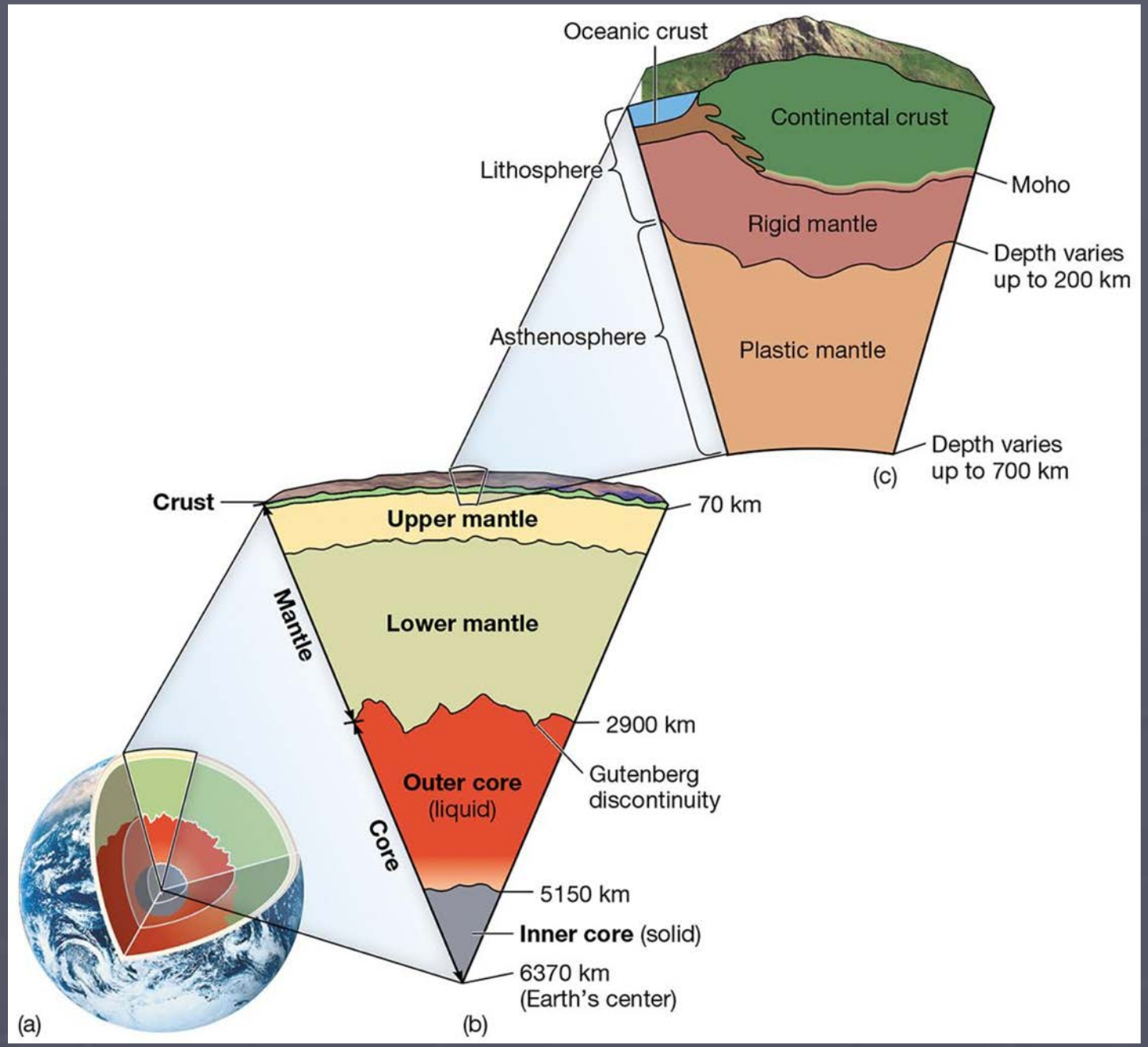
- The Great Unconformity – Rapid change in geological age of different levels
  - Thought to be result of breakup of super continent Rodinia



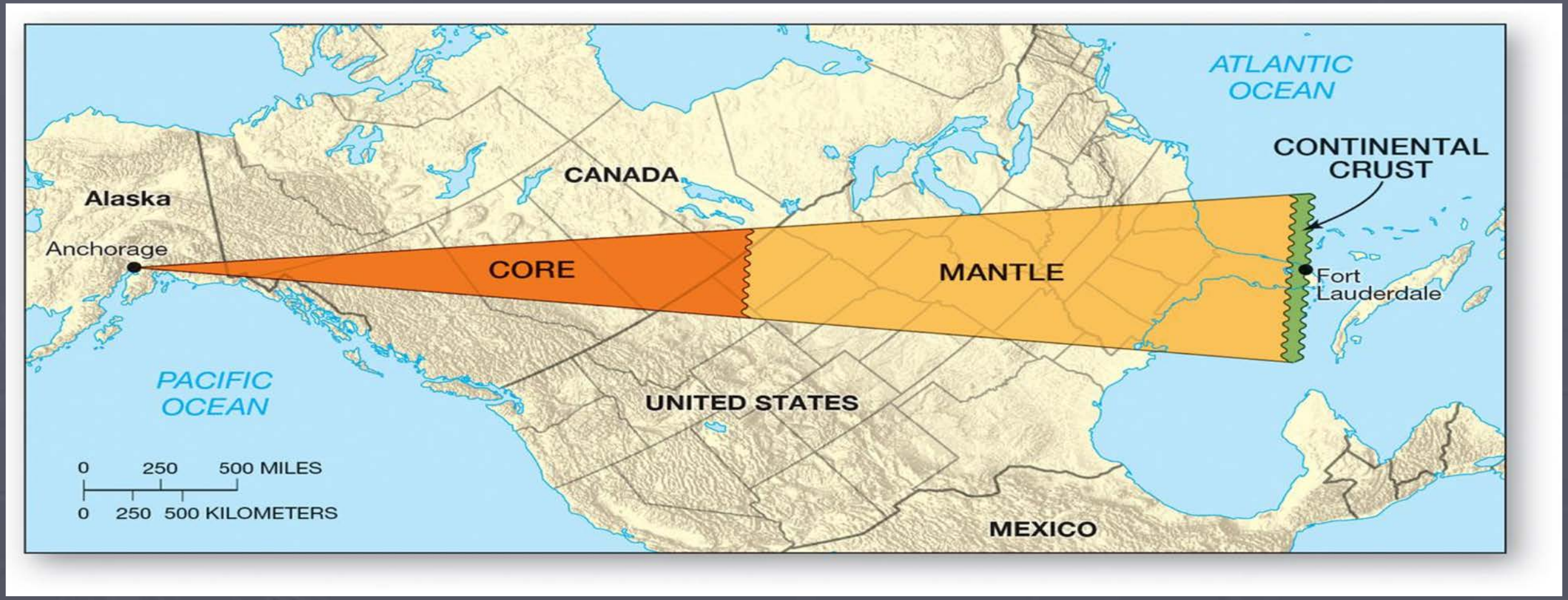
Layers of the Earth



Structure of the Earth



Core to Crust

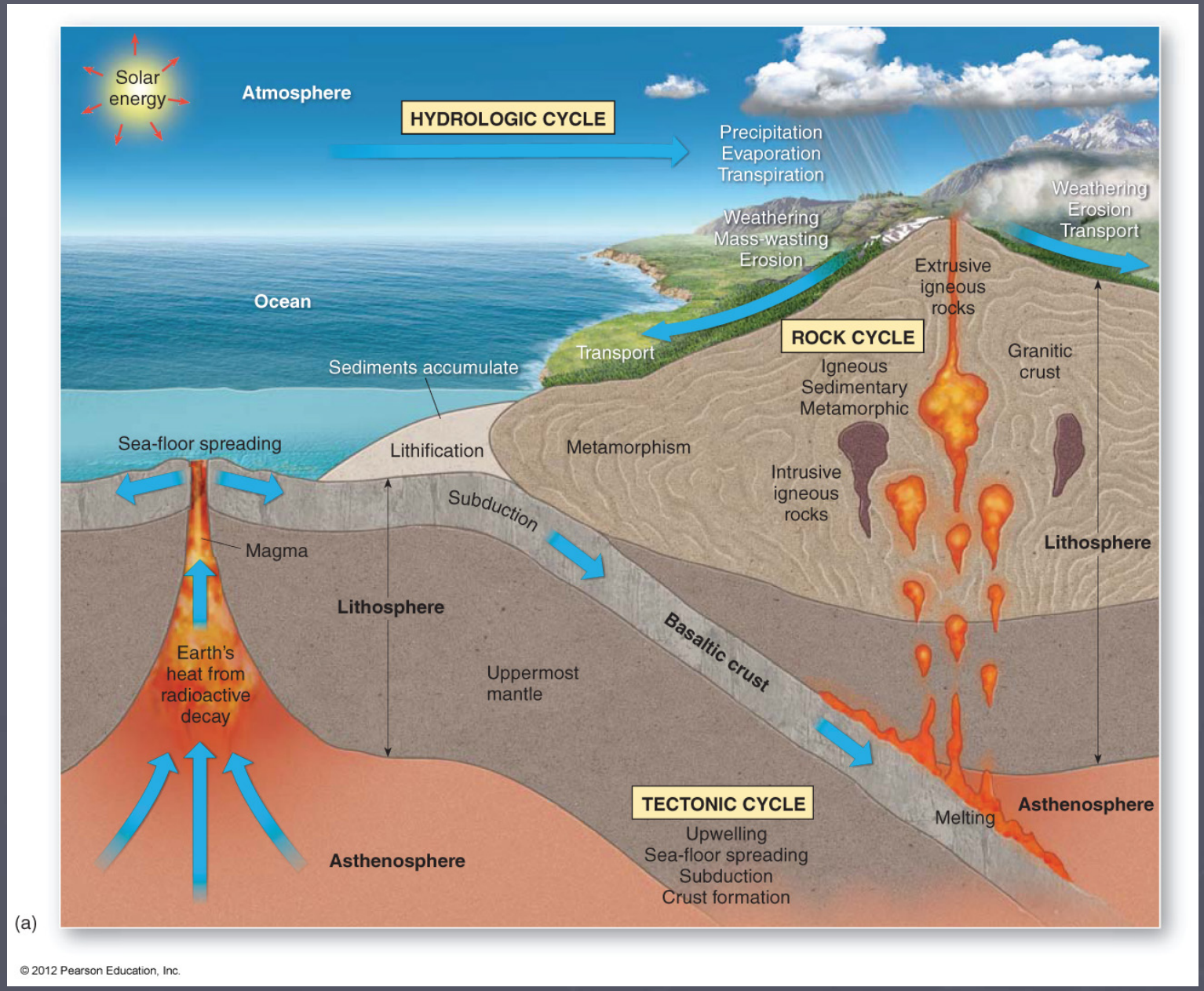


Roughly distance of 3,977 miles

Understanding Earth's Composition

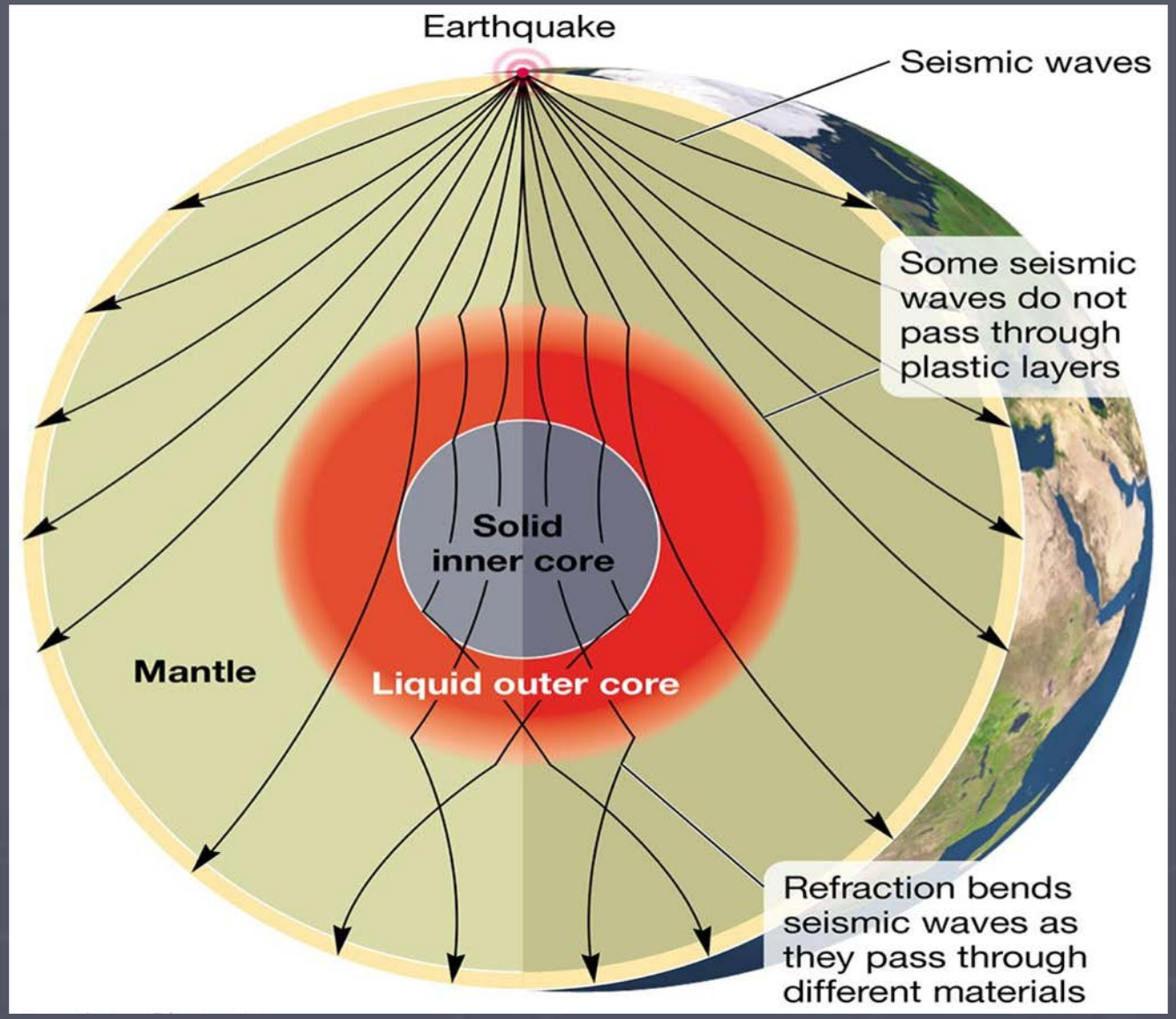
- Scientists have only reached a depth of about 7.6 miles
- Most of our knowledge is based on indirect evidence
  - Seismic waves studied to understand Earth's interior

The Geological Cycle



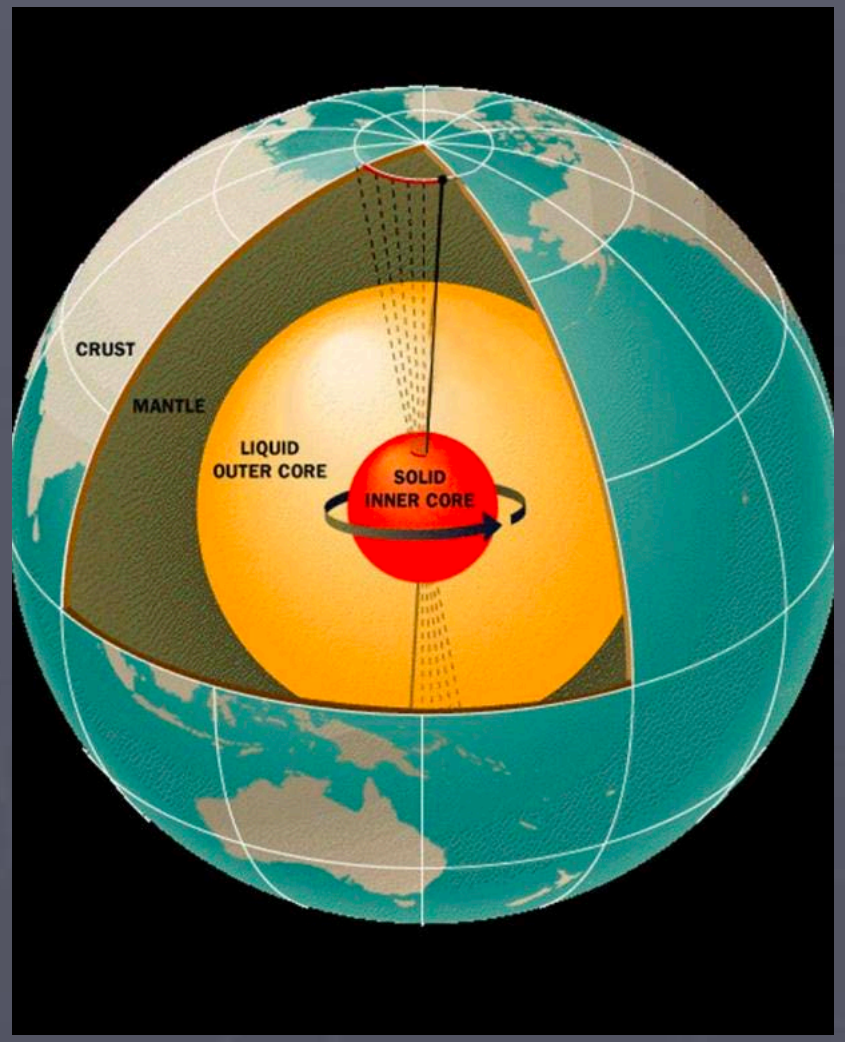
Seismic Waves

- Passage of seismic waves help us understand structure better
  - Seismic waves speed up in cold, rigid regions and slow down in hotter, more plastic or fluid regions.
  - Core is hottest, surface is coolest



General Characteristics - Core

- 1/3rd of Earth's mass
  - 1/6th of volume
- Highly compressed iron at about 10,800°F (Outer core is liquid Iron)
  - Inner core also comprised of us to 5% silicon

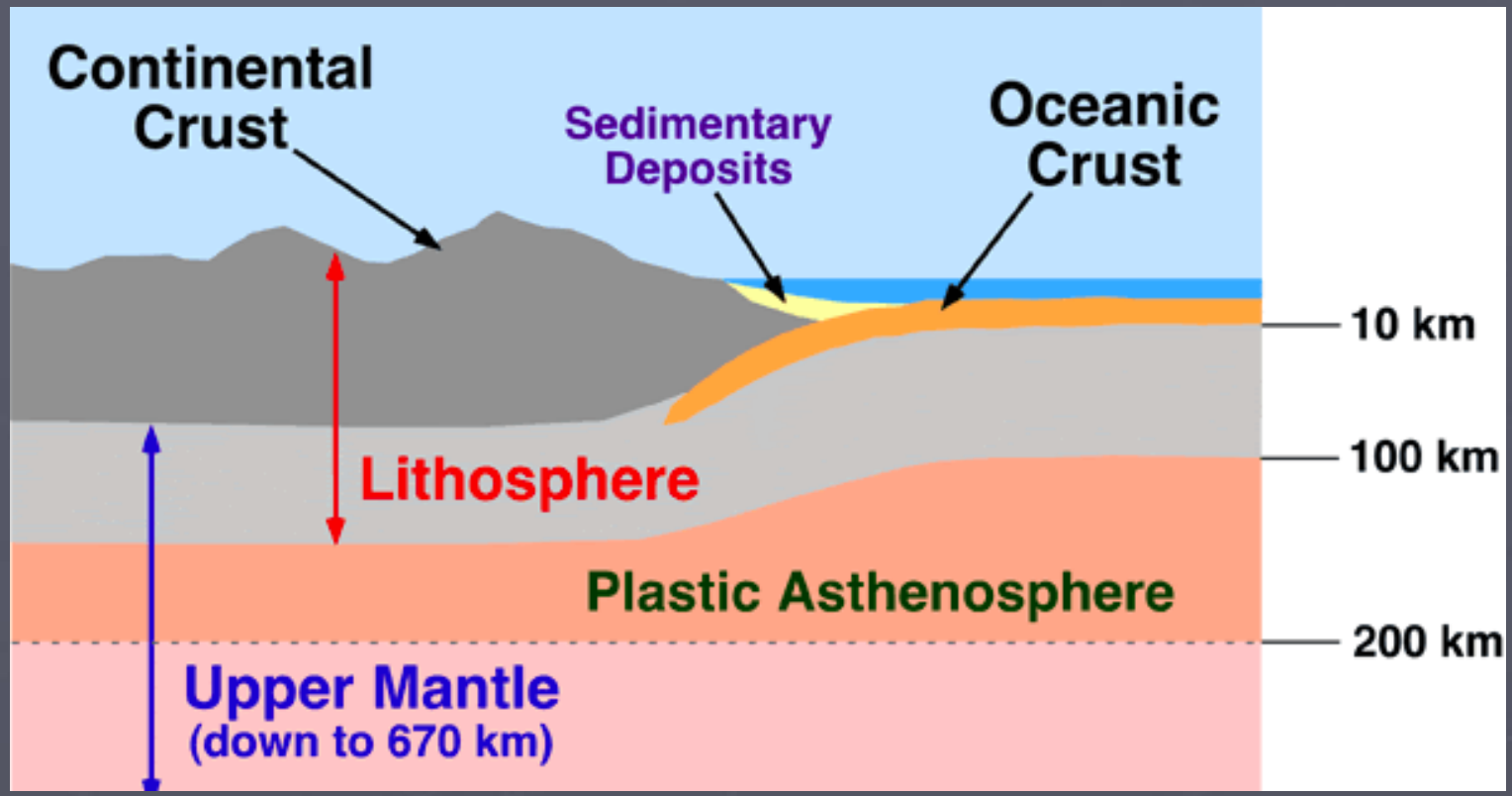


General Characteristics - Mantle

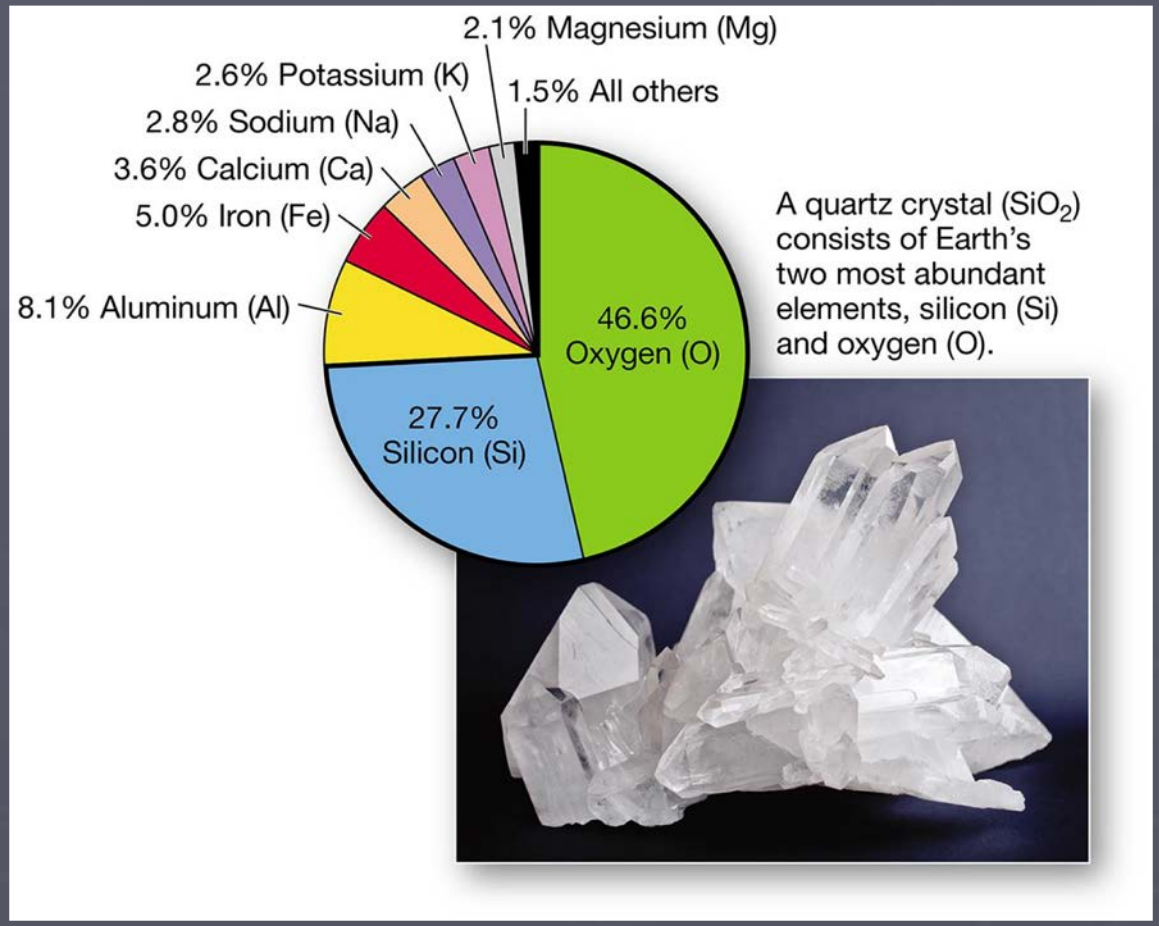
- At roughly 1,800 miles thick, mantle is most of Earth's volume
- Made mostly of iron, magnesium and silicon, it is dense, hot and semi-solid
- Circulates, but not as fast as core
- Top part of Mantle – asthenosphere – is what tectonic plates sit on

General Characteristics - Crust

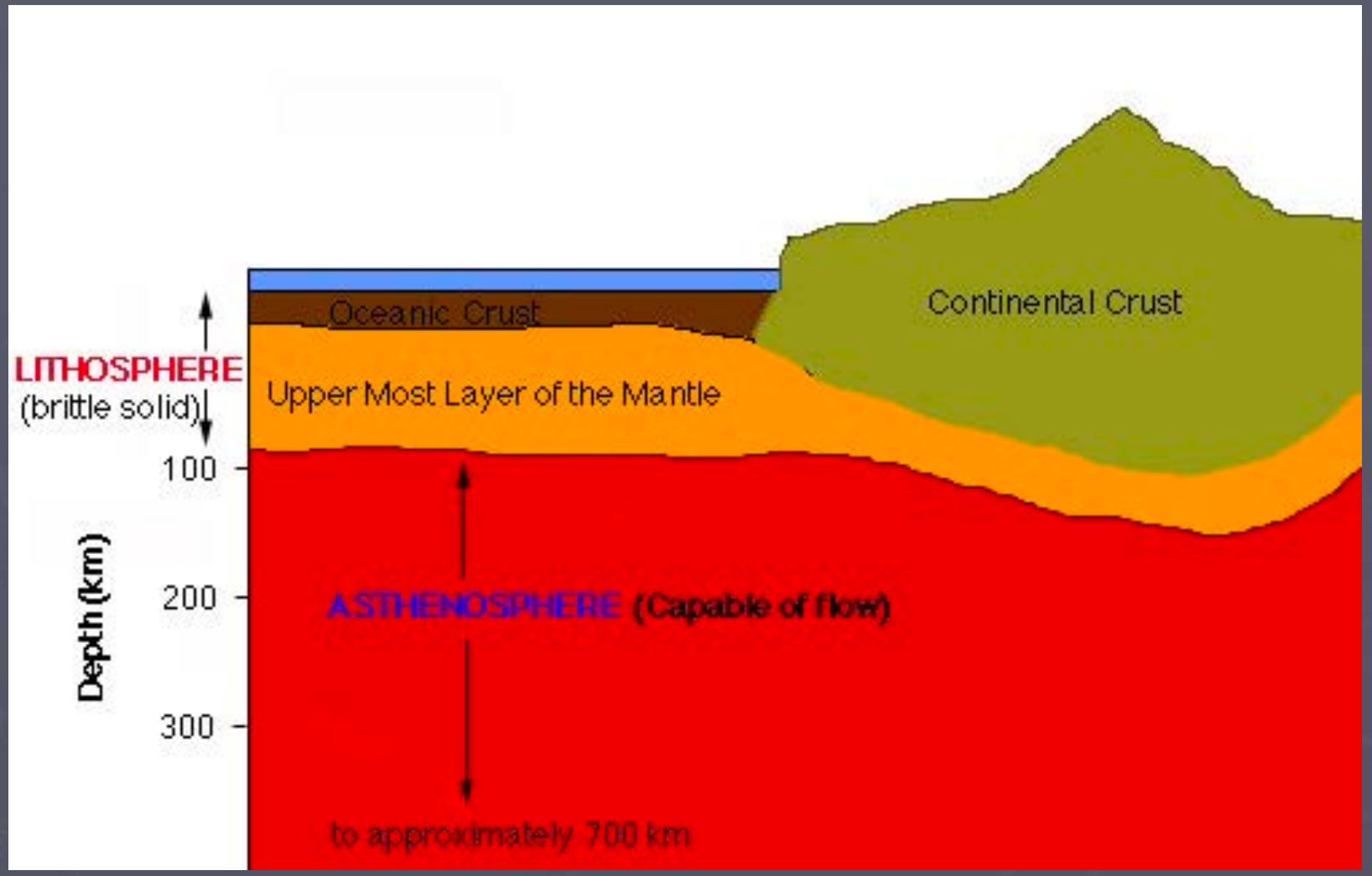
- Eight elements make up 98% of crust by weight.
  - Almost half is oxygen (46%).
- Continental crust lower in density than oceanic crust
  - Continental crust also thicker



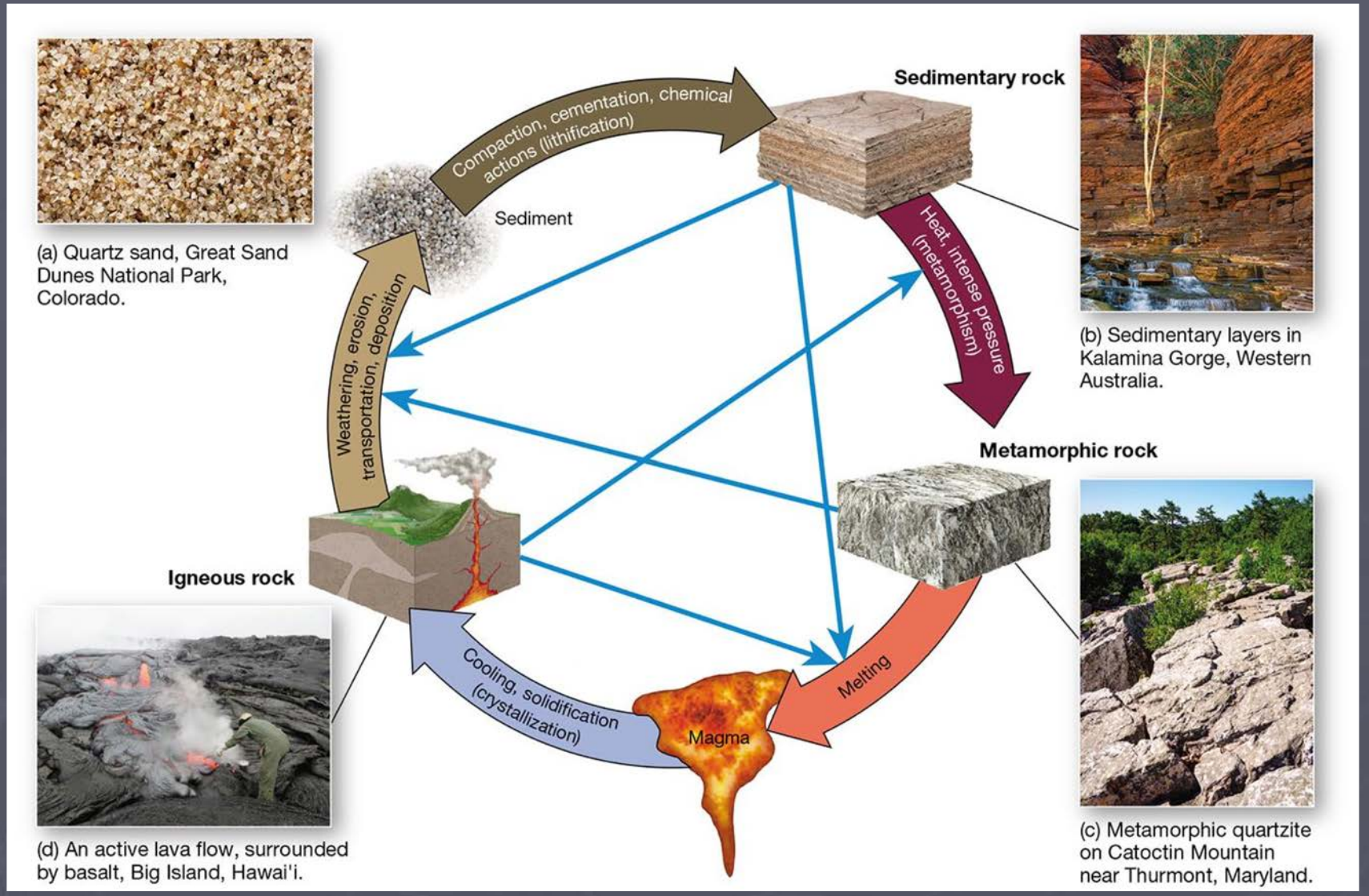
Composition of Earth's Crust



Lithosphere and Asthenosphere



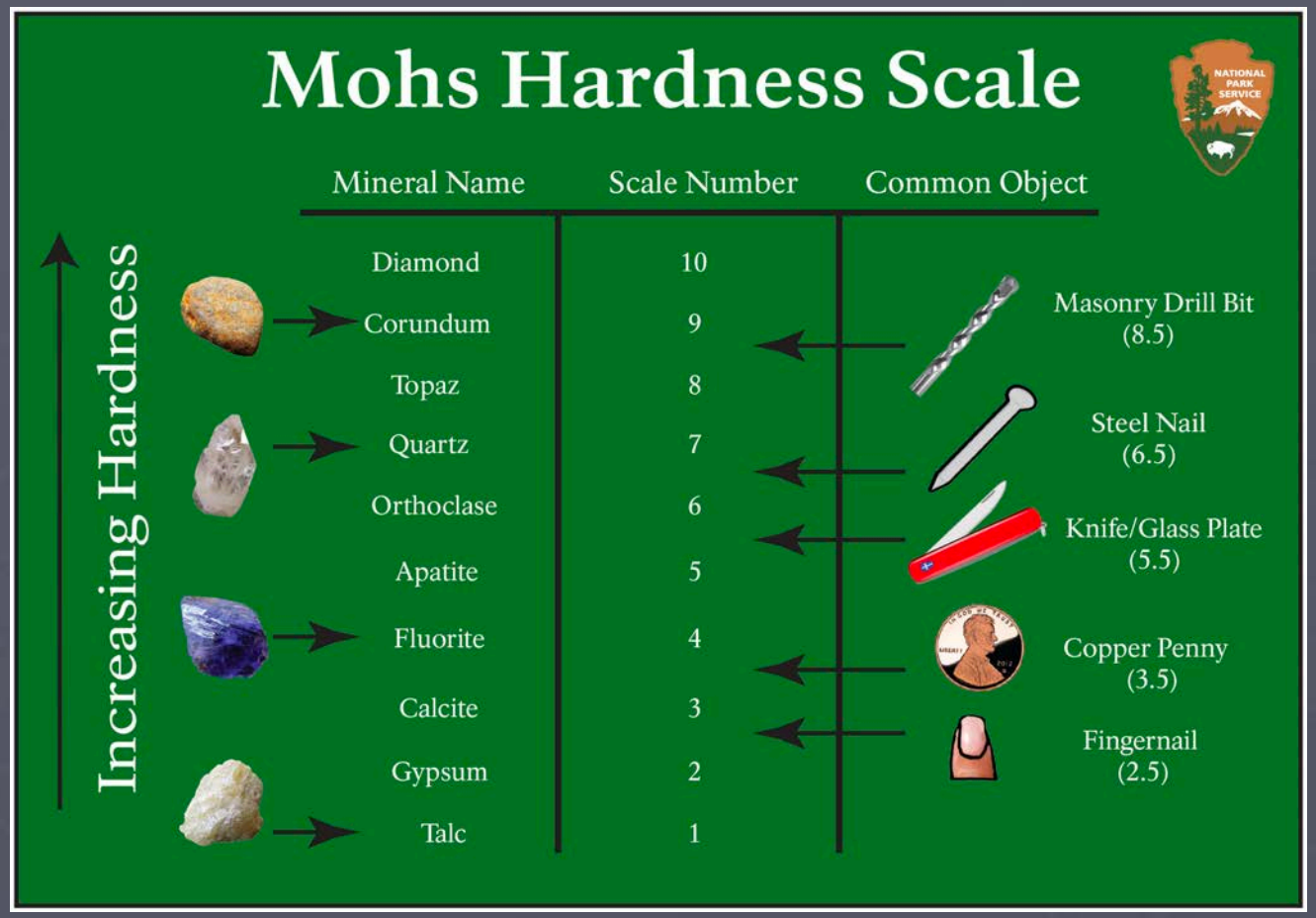
The Rock Cycle and Types of Rock



Rocks and Minerals Defined

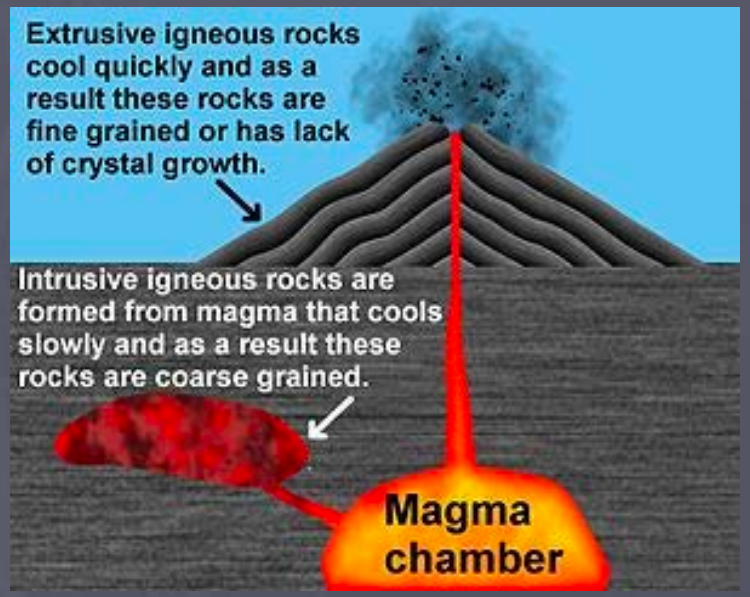
- **Mineral:** An abiotic natural compound having a specific chemical formula and possessing a crystalline structure.
- Rock: Assemblage of undifferentiated minerals/materials, or mass of a single mineral, or even solid organic material (coal)
- Three types of Rocks
  - Igneous (was molten)
  - Sedimentary (from sediment)
  - Metamorphic (changed by heat/pressure)

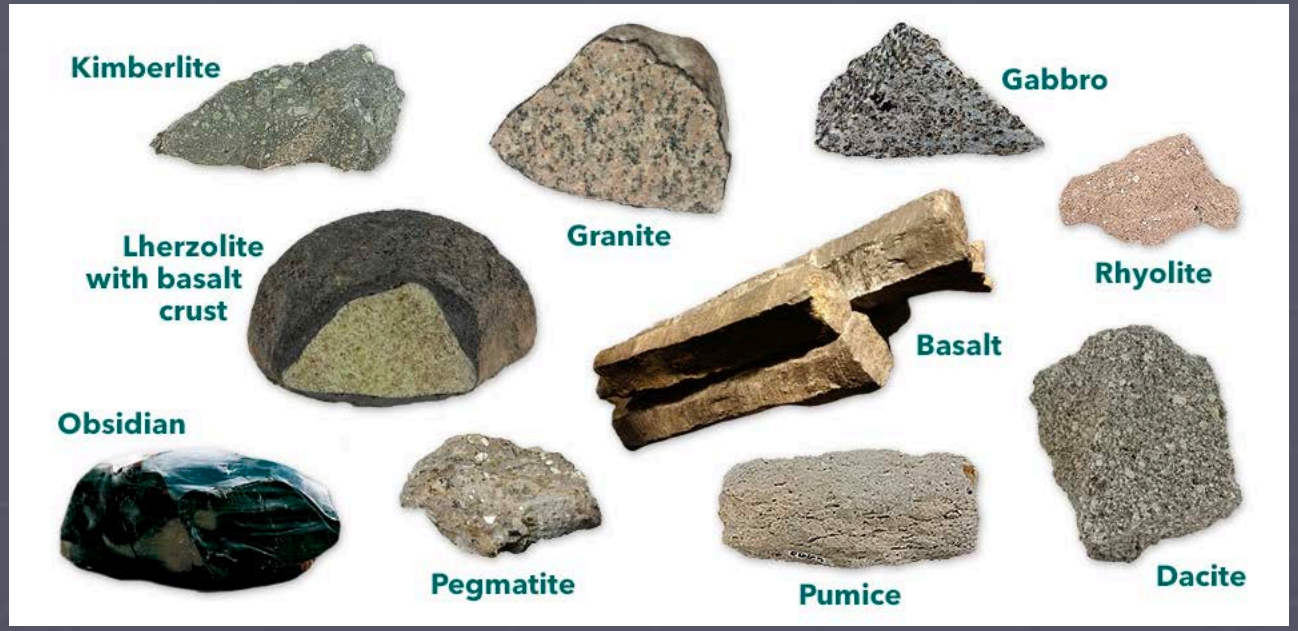
Composition and Processes



Igneous Rock

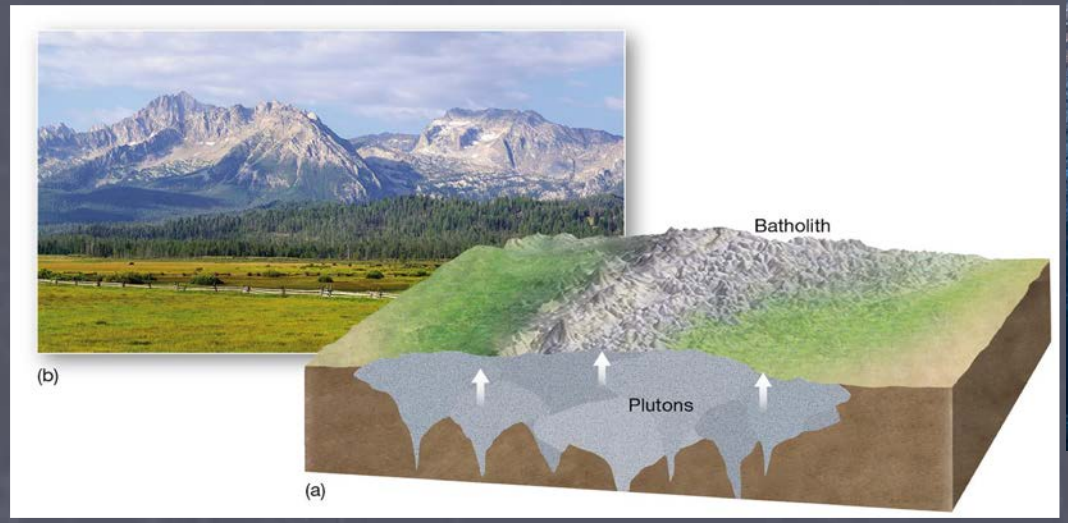
- Rocks formed by volcanic processes (magma is molten rock below surface, and lava is molten rock above the surface)
  - Intrusive (Plutonic) igneous rocks cool below the surface
  - Extrusive (volcanic) igneous rocks cool above the surface





Batholiths

- Large structures of intrusive igneous rock
  - larger than 40 square miles
  - Often formed by collection of many smaller Plutons



Igneous Neck

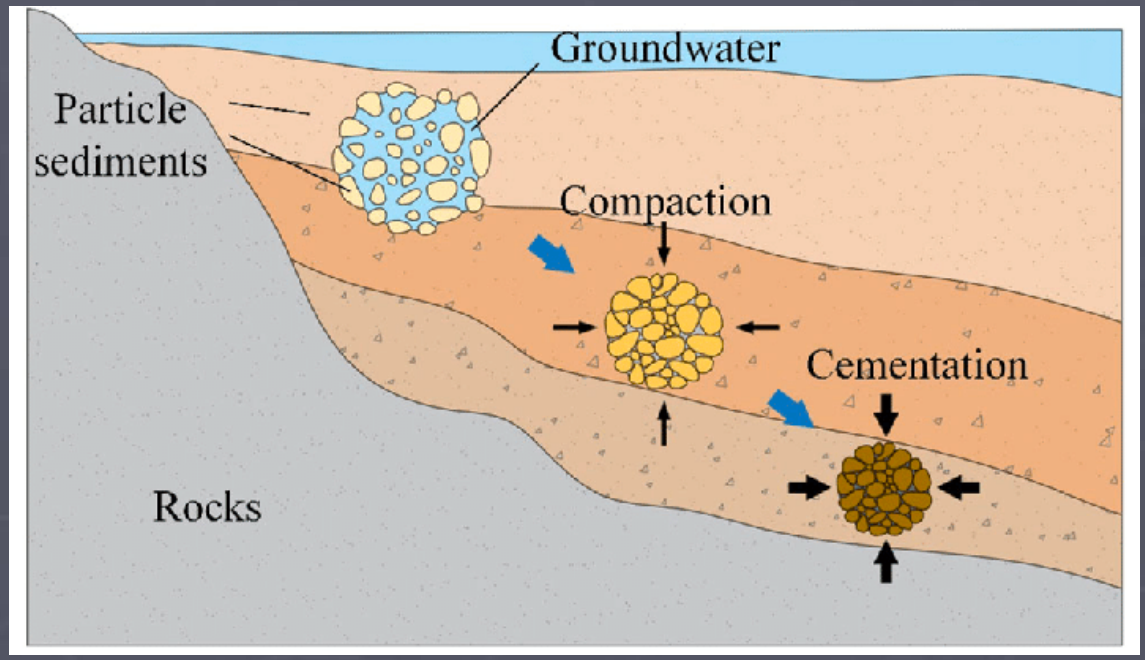
- Internal structure of a volcano that has since cooled and exterior has eroded

Sedimentary Rock

- Sedimentary rocks form when settled by water
  - Clasts – Pieces of rock broken apart to form sediment
- Clastic sedimentary rock forms by compaction or cementation
- Chemical sedimentary rock forms by chemical precipitation of minerals
- Organic sedimentary rock form by the compression of organic material (like coal)

Lithification

- Three Steps
  1. Burial – when additional sediment accumulates on top
  2. Compaction – reduction of the amount of pore space between particles because of the weight of overlying sediment
  3. Cementation – precipitation of minerals within pores that effectively binds sediment together



Sedimentary Clasts

TABLE 11.2 Clast Sizes and Related Sedimentary Rocks

Clast Size	Sediment Type	Rock Type
80 mm (very coarse)	Boulders, cobbles	Conglomerate (breccia, if pieces are angular)
>2 mm (coarse)	Pebbles, gravel	Conglomerate
0.5–2.0 mm (medium to coarse)	Sand	Sandstone
0.062–0.5 mm (fine to medium)	Sand	Sandstone
0.004–0.062 mm (fine)	Silt	Siltstone (mudstone)
<0.004 mm (very fine)	Clay	Shale (mudstone)

Conglomerate

Sandstone

Cobbles

Gravel

Coarse sand

Fine sand

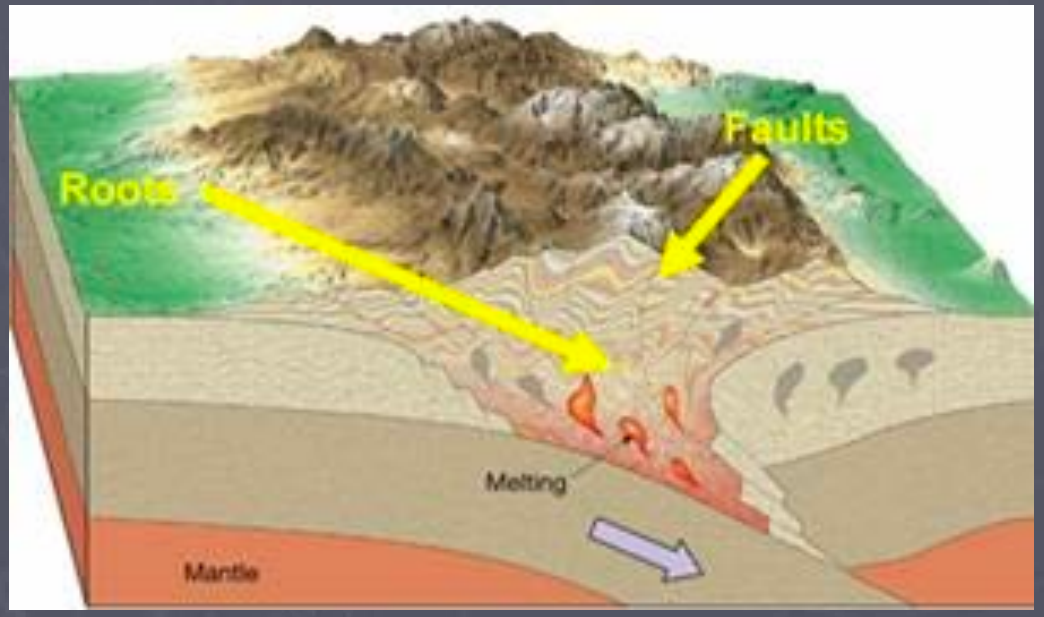
Silt

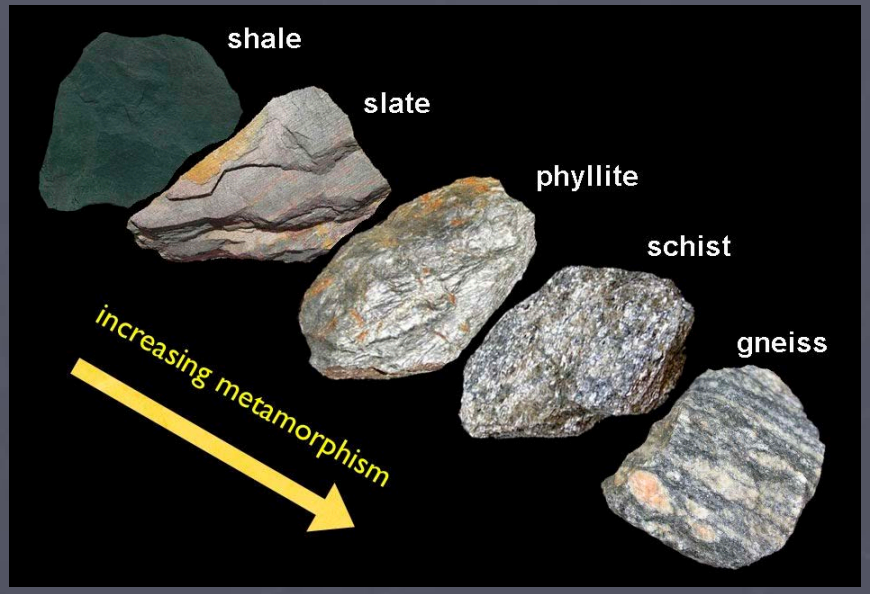
Sedimentary Layers – Pipestone National Monument

Sedimentary Layers – Zion National Park

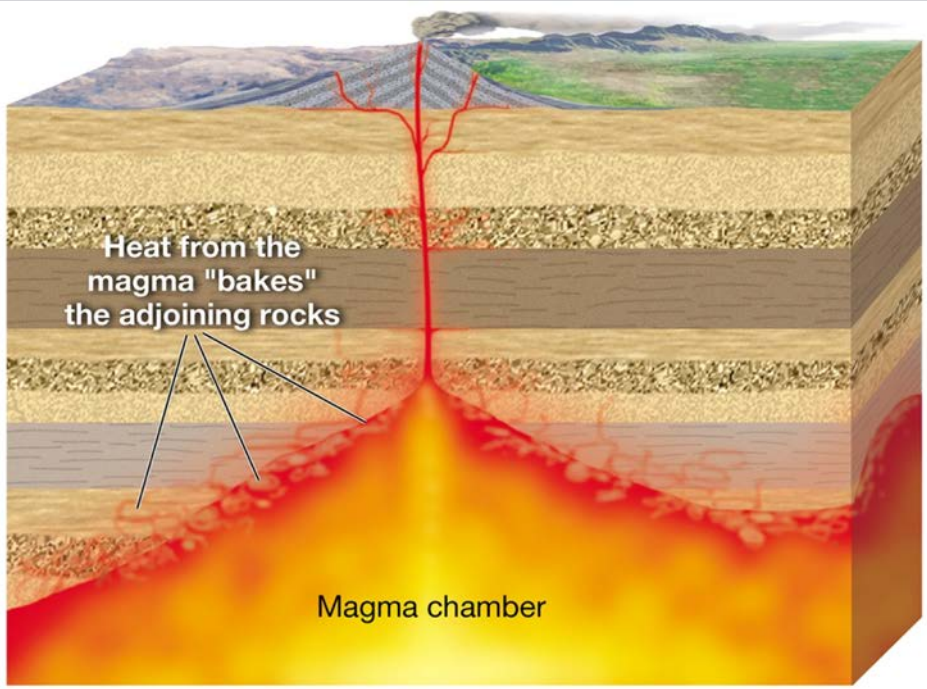
Metamorphic Rock

- Process of changing igneous or sedimentary rocks through heat and pressure
  - Contact metamorphism occurs along fringes of molten magma
  - Regional metamorphism occurs over a large area, especially along faults

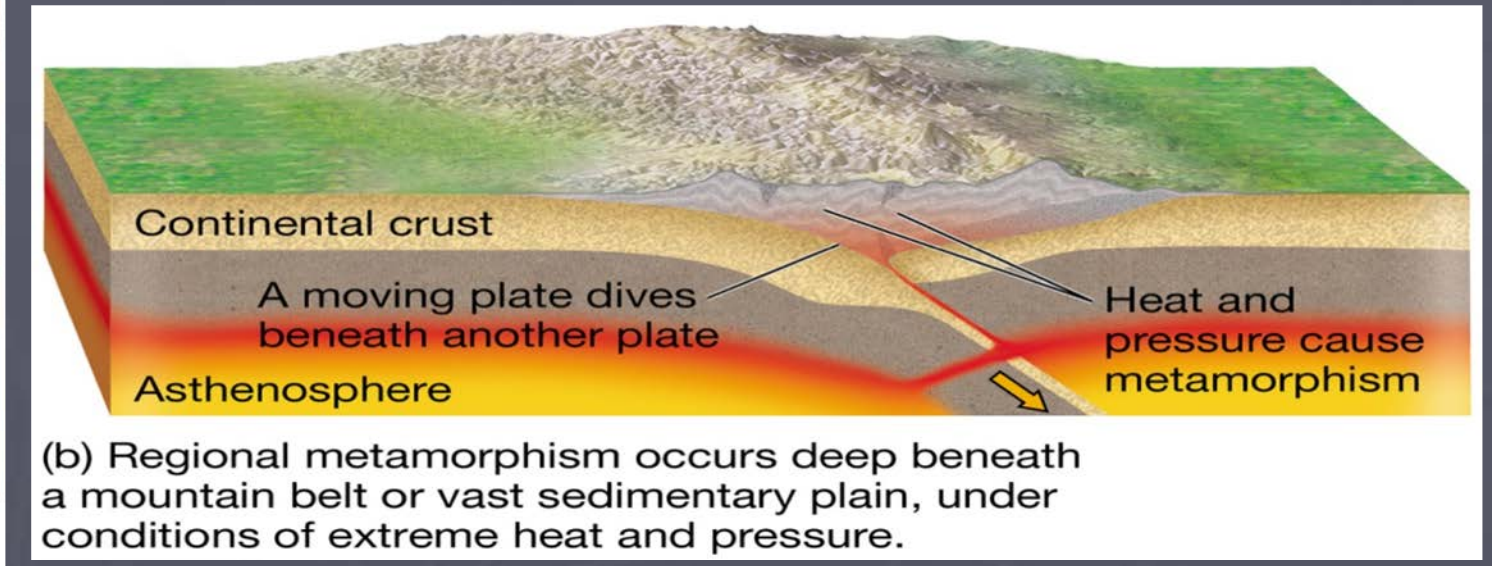




Metamorphic Processes



(a) Contact metamorphism occurs in the upper crust where heat from a magma body is intense.



(b) Regional metamorphism occurs deep beneath a mountain belt or vast sedimentary plain, under conditions of extreme heat and pressure.

Metamorphic Rocks

TABLE 11.3 Metamorphic Rocks

Parent Rock	Metamorphic Equivalent	Texture
Shale (clay minerals)	Slate	Foliated
Granite, slate, shale	Gneiss	Foliated
Basalt, shale, peridotite	Schist	Foliated
Limestone, dolomite	Marble	Nonfoliated
Sandstone	Quartzite	Nonfoliated

Slate

Gneiss

Marble