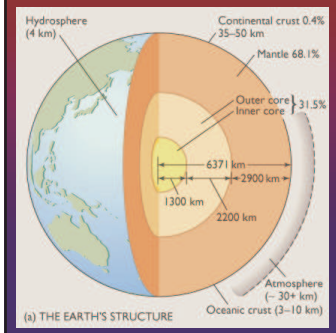
Earth's Structure



Earth consists of a series of concentric layers or spheres which differ in chemistry and physical properties.

The compositional layers of the Earth, differentiated by their chemistry, are the Crust, the Mantle, and the Core. The Core is subdivided into a molten outer core and solid inner core.

Three spheres surround the rocky portion of the Earth.

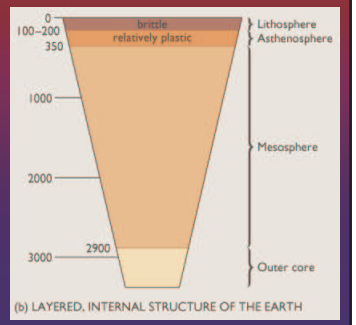
- Hydrosphere includes all of the "free" water of the Earth contained in the ocean, lakes, rivers, snow, ice, water vapor and groundwater.
- Atmosphere is the gaseous envelope that surrounds the Earth and is mainly a mixture of nitrogen and oxygen.
- Biosphere refers to all living and non-living organic matter.

Earth's Structure

Divisions of the Earth based upon physical state are the Lithosphere, Asthenosphere, Mesosphere, Outer core, and Inner core.

- The Lithosphere is rigid, or brittle, and consists of the crust and uppermost mantle.
- The Aesthenosphere is ductile, or plastic, and can flow.
- The Mesosphere is a more rigid zone of the mantle.
- The Outer Core is liquid, and the Inner Core is solid, as increased pressure in the inner core raises the melting point temperature.

The layers are arranged in order of increasing density, from the Crust to the Core. This is known as *density stratification.*



Density

What is density?

- Defined as mass per unit volume
- Determines what floats on top (less dense), sinks to bottom (more dense)
- Delineates the inner layers of Earth
- Denoted by rho (ρ)
- Delicious!

Density Stratification

How did Earth's layers form?

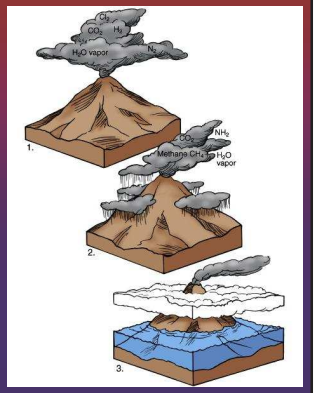
About 5 billion years ago ...

- Solar system (Sun and planets) began to form from solar nebula, including "Proto-Earth"
- Nebular material (gas and dust) in Proto-Earth was very uniform, no stratification
- As Earth began to cool and coalesce, heavier materials, such as iron and nickel, migrated toward center
- Lighter materials, such as silicon, oxygen, aluminum, and potassium remained near the surface

Origin of Oceans

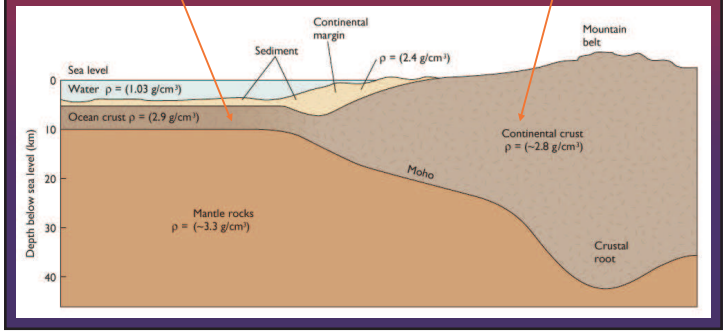
<u>About 4 billion years ago</u> ...

1. Outgassing
   - Volcanic activity released low-density gases from interior
   - Mostly water vapor, carbon dioxide, hydrogen, others
2. Condensation into gaseous clouds
3. Formation of early atmosphere and oceans
   - Atmosphere devoid of oxygen
   - Oceans' chemistry different from today's oceans



Two types of crust

oceanic vs. continental



Two types of crust

Oceanic Crust	Continental Crust
<u>thin, more dense</u> • composed of dark-colored *mafic* rocks like **basalt** (rich in Mg, Fe) • avg. density: **2.9-3.0 g/cm^3** • thickness: **4-10 km**	**<u>thick, less dense</u>** • composed of light-colored *felsic* rocks like **granite** (rich in Si, Al) • avg. density: **2.7-2.8 g/cm^3** • thickness: **30-40 km**
forms ocean basins	"buoyant" continents stand high
subducted at trenches during collision	**preferentially preserved** during collision
ocean basins <200 million years old *(i.e., the present ocean basins are relatively young features)*	continents >3500 million years old *(i.e., the continents are old)*

Isostasy

- the *ductile* (or *plastic*) Asthenosphere supports the *rigid* Lithosphere
- condition of equilibrium is maintained between <u>crustal blocks of different thickness and density</u>
- the Asthenosphere and Lithosphere can accommodate changes in the redistribution of load *(ice sheets, volcanoes, mountains, erosion)*
- the Lithosphere is in <u>isostatic equilibrium</u> with the underlying Asthenosphere, meaning that the pressure at point A is equal to the pressure at point B.