

## Formation of Solar System and Earth

- **Nebular hypothesis**
  - Nebula=cloud of gases and space dust
    - Mainly hydrogen and helium
  - Gravity concentrates material at center of cloud (Sun)
  - Protoplanets from smaller concentrations of matter (eddies)

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## Protoearth

- Larger than Earth today
- Homogeneous composition
- Bombarded by meteorites
- Heat from solar radiation
  - Initial atmosphere boiled away
  - Ionized particles (solar wind) swept away nebular gases

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## Earth's internal structure

- Highest density material at center (core)
- Lowest density material at surface (crust)
- **Earth layered**
  - Chemical composition
  - Physical properties

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## Chemical composition

- Crust
  - Low-density, mainly silicate minerals
- Mantle
  - Mainly Fe and Mg silicate minerals
- Core
  - High-density, mainly Fe and Ni

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## Layered Earth

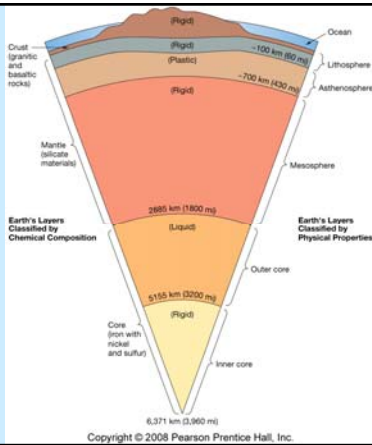


Fig. 1.14

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## Physical properties

- Lithosphere
- Asthenosphere
- Mesosphere
- Outer core
- Inner core

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## Physical properties

- **Lithosphere**
  - Cool, rigid, brittle
  - Surface to about 100 km (62 miles)
- **Asthenosphere**
  - Warm, plastic, able to flow
  - From 100 km to 700 km (430 miles)

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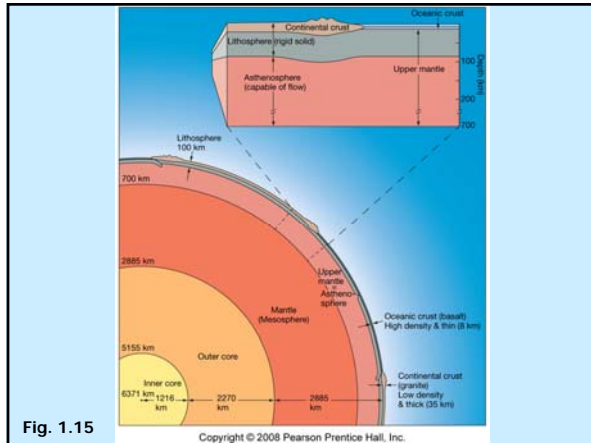


Fig. 1.15

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## Lithosphere

- **Oceanic crust**
  - Underlies ocean basins
  - Igneous rock basalt
  - Average thickness 8 km (5 miles)
  - Relatively high density
    - 3.0 g/cm<sup>3</sup>

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**Lithosphere- *Crust and Uppermost mantle fused together.***

■ **Continental crust**

- Underlies continents
- Igneous rock granite
- Average thickness 35 km (22 miles)
- Lower density
  - 2.7 g/cm<sup>3</sup>

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**Asthenosphere**

- Upper mantle
- Plastic—deforms by flowing
- High viscosity—flows slowly

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**Isostatic adjustment**

- Buoyancy
  - Less dense “floats” higher than more dense
- Continental crust “floats” higher than oceanic crust on plastic asthenosphere

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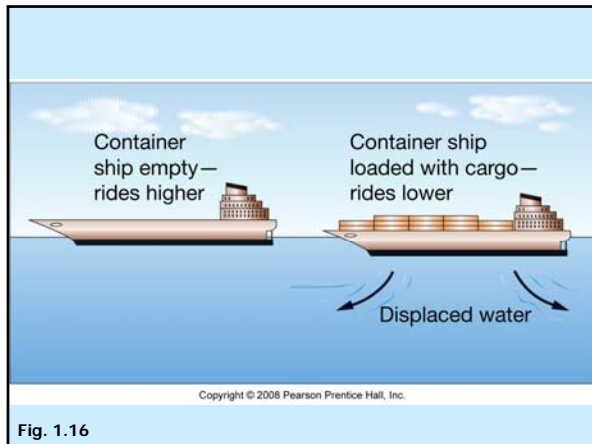
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**Origin of Earth's atmosphere**

- Partial melting resulted in **outgassing** about 4 billion years ago
  - Similar to gases emitted from volcanoes
  - Mainly water vapor
  - Carbon dioxide, hydrogen
  - Other gases such as methane and ammonia

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**Origin of Earth's oceans**

- Water vapor released by outgassing
- Condensed as rain
- Accumulated in ocean basins
- About 4 billion years ago
- *Ice Comets were also important to adding water to the Earth system*

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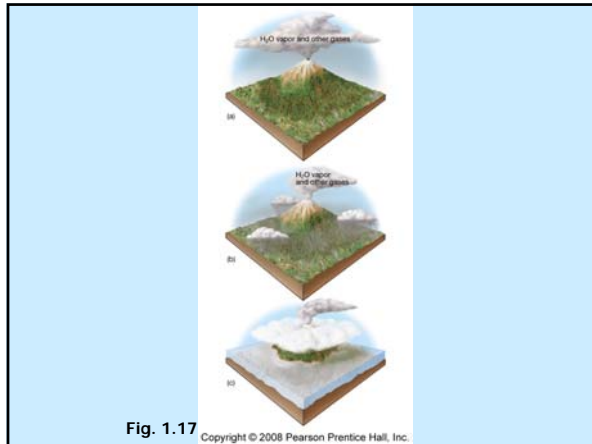
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**Ocean salinity**

- Rain dissolves rocks
- Dissolved compounds (ions) accumulate in ocean basins
- Ocean salinity based on balance between input and output of ions
- Ocean salinity nearly constant over past 4 billion years

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**Life in oceans**

- Earliest life forms fossilized bacteria in rocks about 3.5 billion years old
- Marine rocks
- Life originated in oceans?

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## Stanley Miller's experiment

- Organic molecules formed by ultraviolet light, electrical spark (lightning), and mixture of water, carbon dioxide, hydrogen, methane, and ammonia

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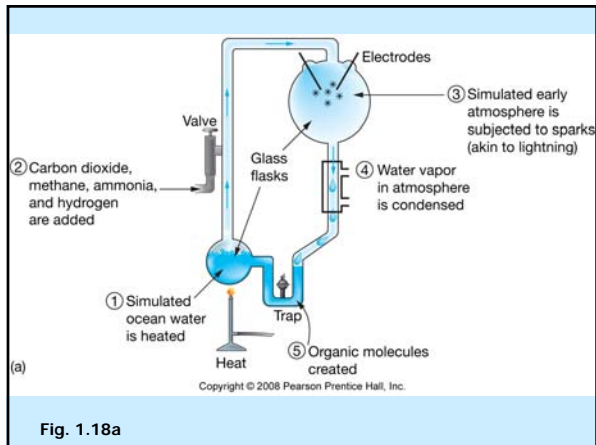
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## Age of Earth

- Radiometric age dating
  - Spontaneous change/decay
  - Half-life
- Earth is about 4.6 billion years old

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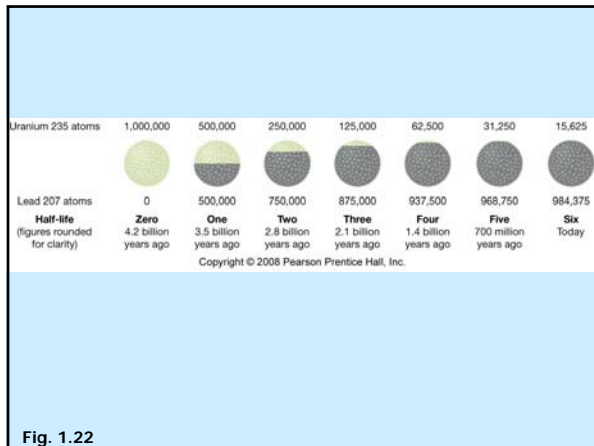


Fig. 1.22

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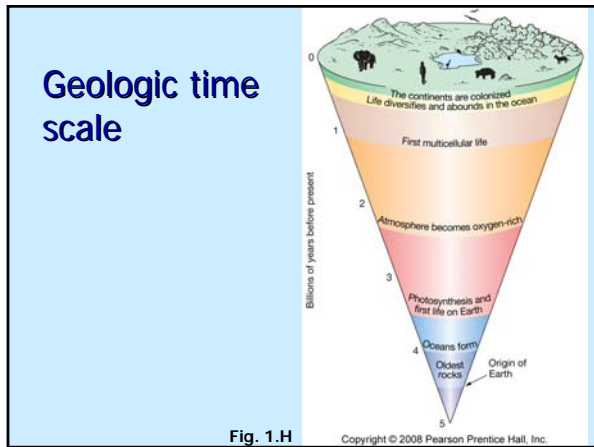


Fig. 1.H

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