

Outline 20: Origin of the Earth: solids, liquids, and gases

The Early Archean Earth

Origin of Earth's Matter

- The earth is made of recycled elements formed in stars that existed prior to our Sun.
- Supernova explosions produced nebular dust clouds of various elements.
- Our solar system formed from a nebular dust cloud.

Formation of Earth

- Our planet formed along with all the other planets when our solar system formed 4.6 BY ago.
- The planets formed by planetary accretion.
- Gravity slowly brought solids and gases together.

Formation of Earth

- All the planets had rocky cores and gaseous outer layers, just like modern Jupiter or Saturn.
- Earth was 1200 times more massive.
- Ignition of the sun stripped the inner planets of their gaseous outer layers.

Formation of Earth

- The early earth formed from meteorites, asteroids, and planetismals was cold and lumpy.
- It heated up and completely melted.

The Early Molten Earth

Heat sources:

1. Gravitational compaction
2. Impact energy converted to heat
3. Heat from radioactive decay

The Early Molten Earth

Earth became layered according to density.

Core, 14% of volume; iron

Mantle, 84% of volume; ultramafic

Crust, 2% of volume; mafic

Origin of Oceans and Atmosphere

- Formed by degassing of the mantle.
- Modern oceanic (mafic) volcanic gases:

H₂O, 79%

CO₂, 12%

SO₂, 7%

N₂, 1%

Cl, <1%

Water from Rocks?

- Meteorites are 0.5% water.
- An equivalent amount of water in the mantle would fill the ocean basins 20 times!
- Volcanoes today release enough water to have filled the ocean basins 100 times during earth history!

The First Atmosphere

- Order of abundance after water vapor, H₂O :

Carbon dioxide, CO₂

Sulfuric acid, H₂SO₄

Ammonia, NH₃

Methane, CH₄

The First Atmosphere

- Poisonous to modern life.
- No free oxygen.
- Contained the basic elements of life: carbon, oxygen, nitrogen, sulfur, and hydrogen.

The Modern Atmosphere

- 78% nitrogen
- 21% oxygen
- 1% argon
- 0.03% carbon dioxide
- What happened to all the CO₂? Photosynthesis

The Modern Atmosphere

- Created by biological processes. The only planet with free oxygen.
- Photosynthetic bacteria used water and carbon dioxide to make sugar and the by product oxygen.