Origin of the Universe

Most accepted : Big Bang

- **~14 billion years ago (bya). All mass in universe compressed to single point 10^9 kg m^{-3} density, $T=10^{12}$ K**

- **Aggregates of ejected material collapsed gravitationally to form earliest stars.**

Temperatures in cores increased due to compressional heating

When temperatures reached 10 million K, nuclear fusion of H into He and other elements began, releasing energy to power the stars.

As early stars aged, they ultimately exploded, ejecting elements to the universe around

Origin of the Sun

4.6 billion years interstellar material aggregated to form cloudy mass, the solar nebula

Sun formed from gravitational collapse of solar nebula

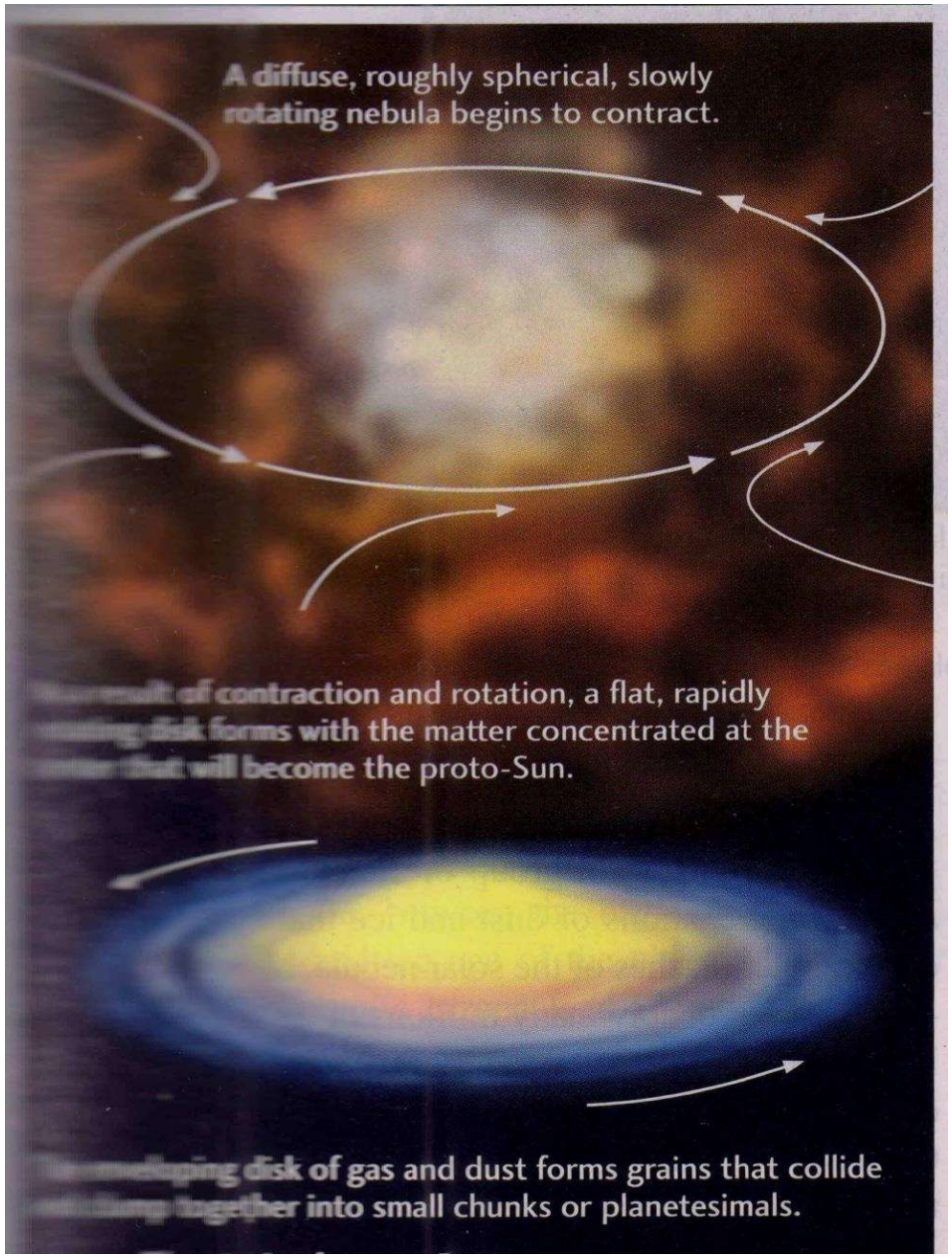
Origin of the Earth

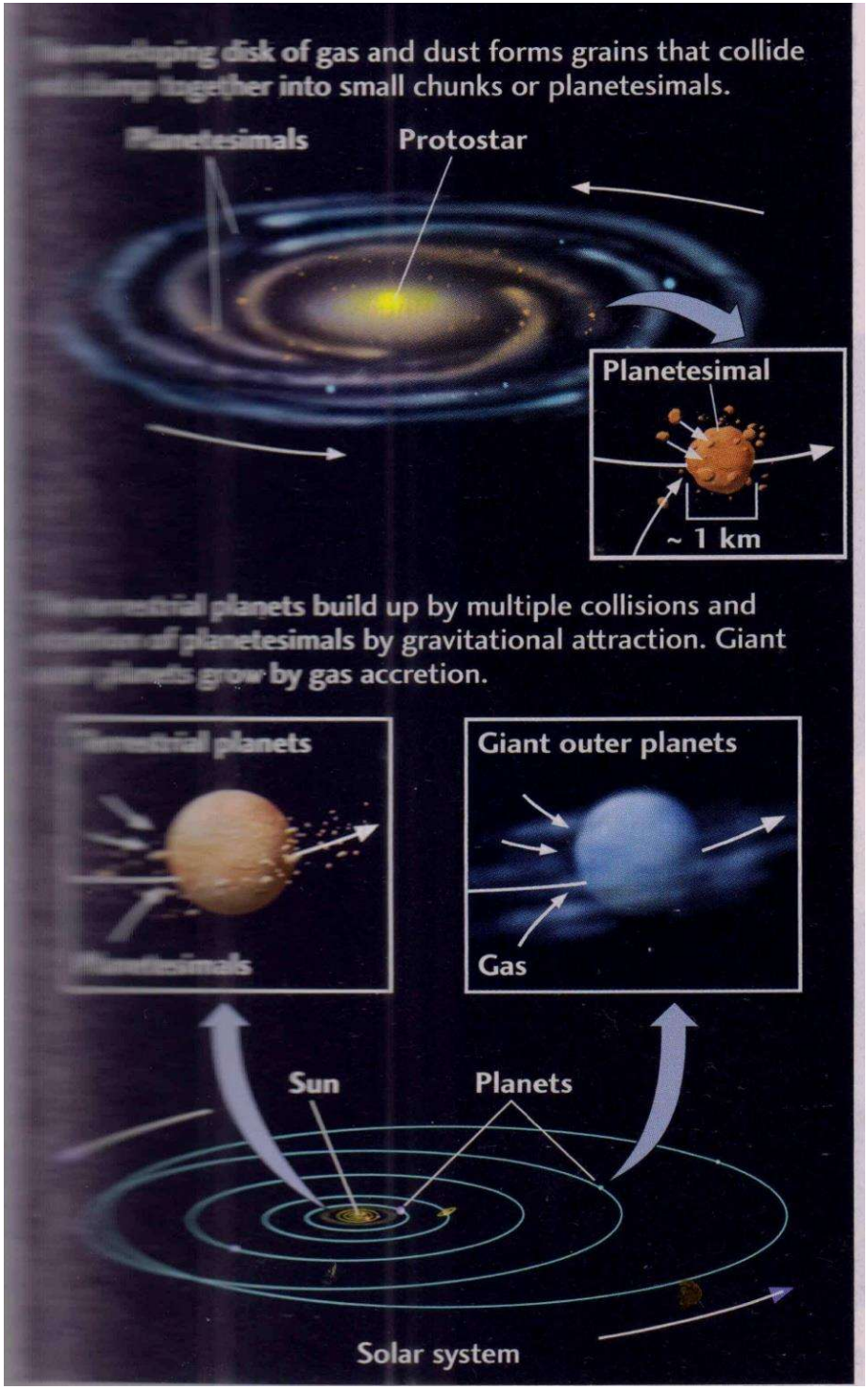
~4.6 billion years ago, rock-forming elements, which were gases at high temperature in solar nebula, condensed into small solid grains as nebula cooled.

Grains accreted to planetesimals, such as asteroids and comets.

Planetesimals accreted to form the Earth and other planets

Origin of our solar system





The Planets

Inner Planets: Mercury, Venus, Earth, Mars

Characteristics: Lost much of the volatiles

Smaller in size

Rocky and metallic (Fe-Ni)

Outer Planets: Jupiter, Saturn, Uranus, Neptune

Characteristics: Larger

Icy

Gaseous

Asteroidal Belt between the Mars and Jupiter;
Meteorites ; intermediate in characteristics

Kuiper Belt in the outer solar system- beyond Neptune- Comets are thought to come from here

What happened right after the Earth formed ?

Giant Impact

After the formation of the Earth, a period of intense bombardment by asteroids happened

The Moon probably formed by Giant Impact

Age of the Earth

Bracketed by the age of the oldest known meteorite 4.56 b.y and the oldest Apollo Moon Rock 4.46 b.y as ~4.53 by

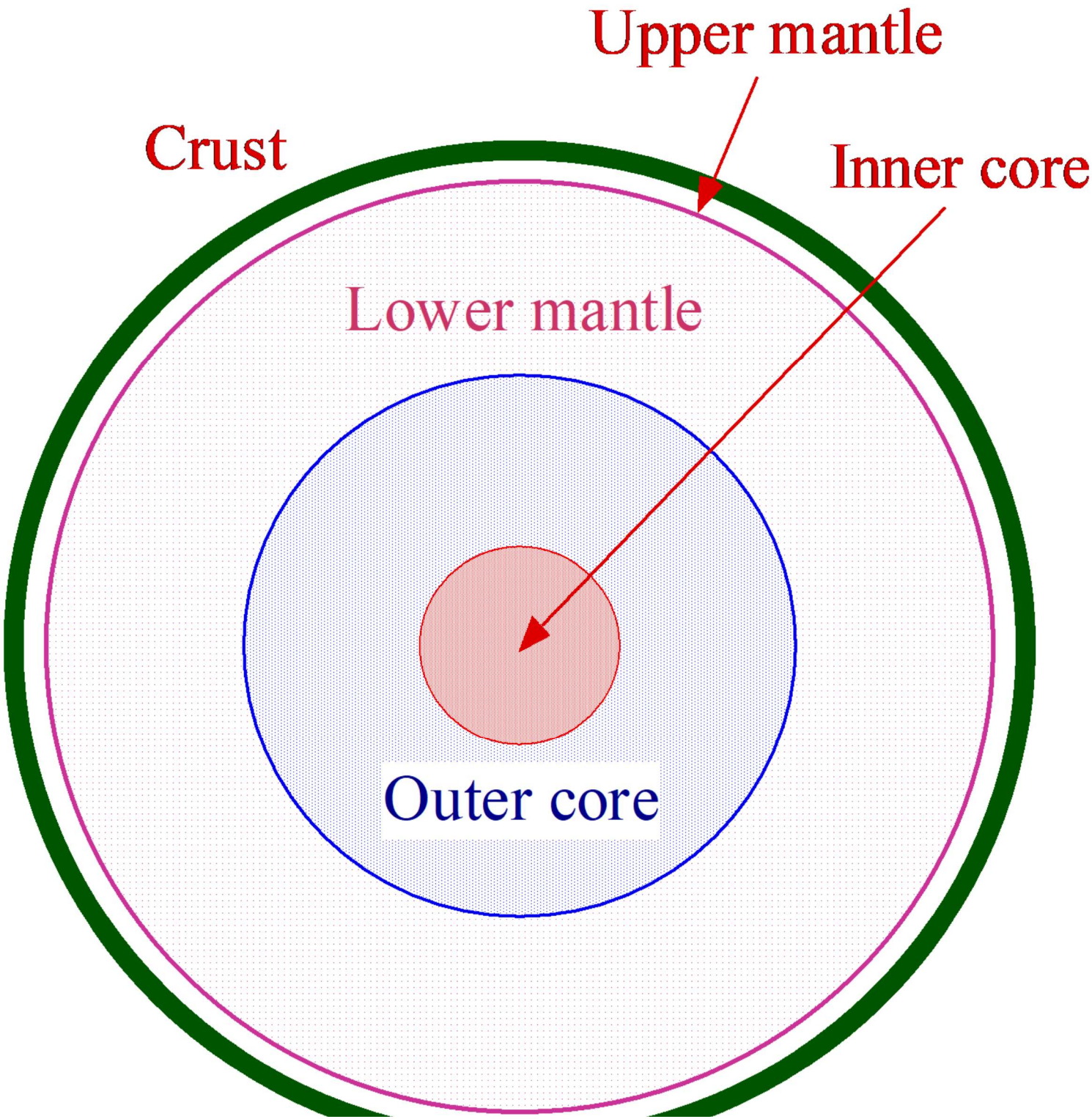
Differentiation of the Earth

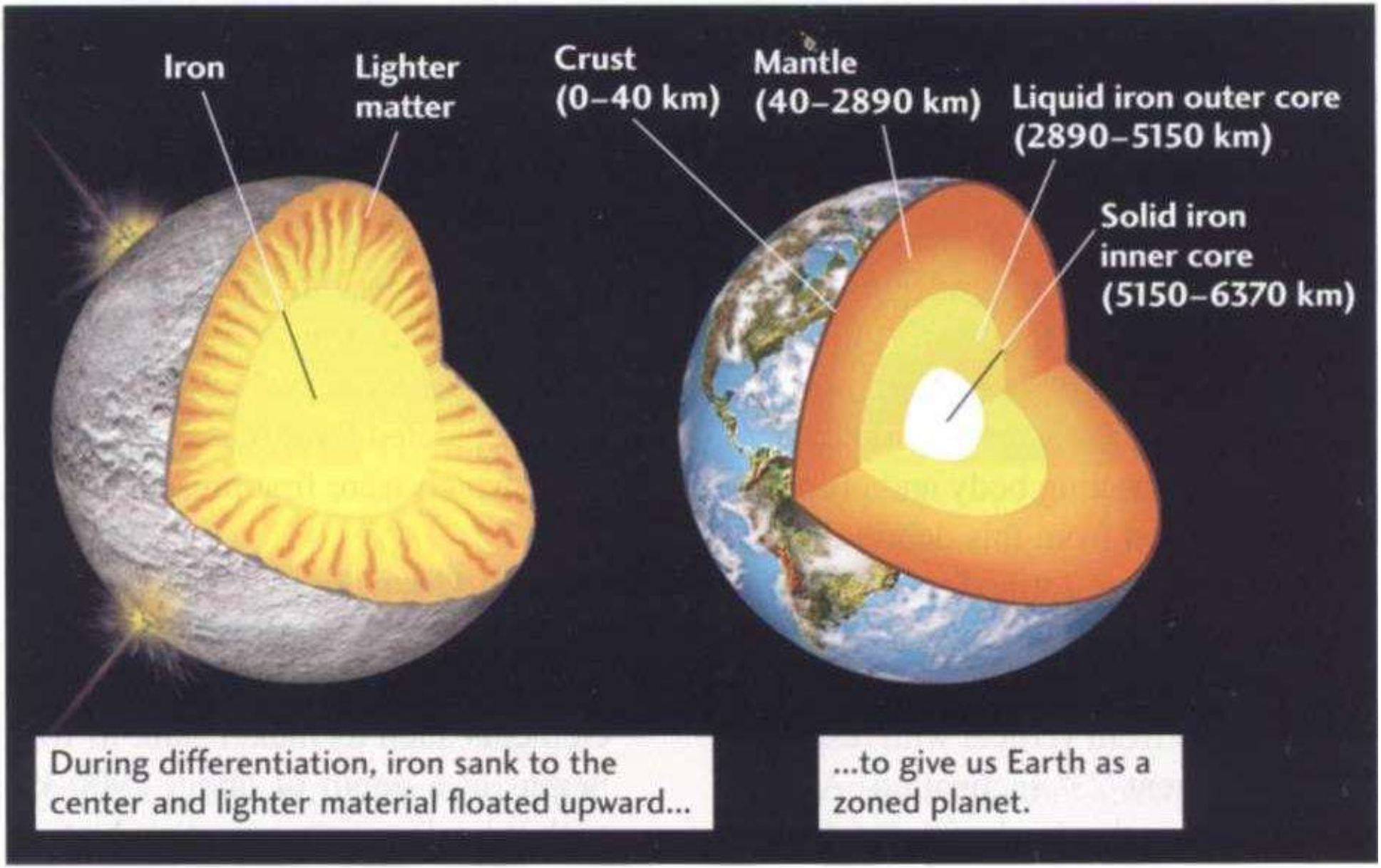
Due to Giant Impact and internal heating (radioactivity) it is estimated that about 70% of the Earth got molten after its formation

Differentiation produced core and mantle

Further melting and differentiation of the Mantle produced the Crust

The Crust also formed very early as we have rocks in the crust as old as ~4.4 by


Upper mantle
Crust
Inner core
Lower mantle
Outer core


Iron
Lighter matter
Crust (0–40 km)
Mantle (40–2890 km)
Liquid iron outer core (2890–5150 km)
Solid iron inner core (5150–6370 km)
During differentiation, iron sank to the center and lighter material floated upward...
...to give us Earth as a zoned planet.

Abundance of elements in different parts of the Earth