Topic F4 : Key idea 1 – Earth's concentrically zoned structure

Earth's chemical structure

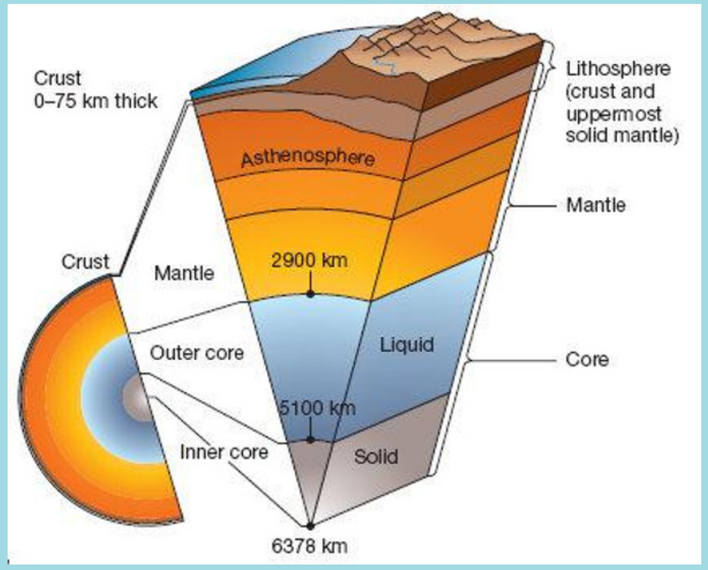
The Earth has a layered structure based on its composition or mechanical/ rheological properties. Chemically, it is divided into layers that become denser with depth.

- **Crust:** divided into older, thicker (35km) continental crust of granitic (silicic) composition and younger, denser oceanic crust of basaltic (mafic) composition (6-7 km thick).
- **Mantle:** a solid, silicate layer extending from the boundary with the crust (traditionally the Mohorovičić disconformity - or Moho) down to ~2900 km and making up about 84% of Earth's volume and 64% of its mass. Composed of a denser, ultra-mafic rock (peridotite).
- **Core:** beneath the mantle and extending down to the Earth's centre at 6378 km. It is divided into a liquid **outer core** and solid **inner core,** both of which consist of iron and nickel. The outer core is hot enough to be molten despite the pressure, but at ~5000 km, the pressure becomes too intense to allow melting and the inner core is therefore solid.

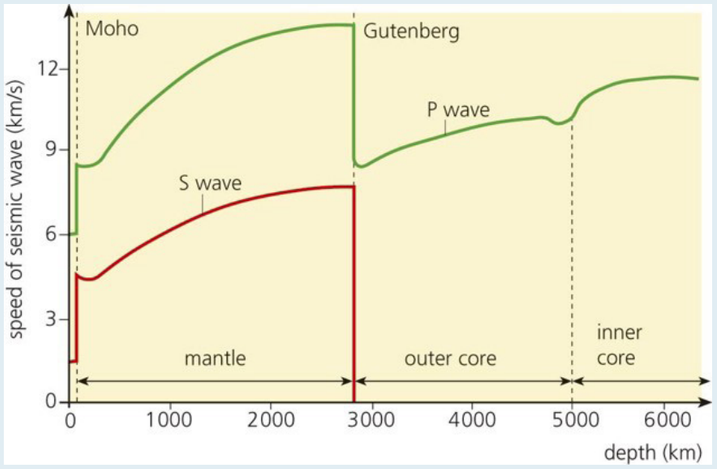
Earth's mechanical-rheological properties

The uppermost part of the mantle and overlying crust form a rigid outer shell called the **lithosphere,** which is underlain by a weaker zone of the upper mantle – the **asthenosphere.** This is evidenced by a seismological low-velocity zone **(LVZ)**. The lithosphere represents a lithospheric (tectonic) **plate.**

Earth's concentric layers



Seismological evidence



A velocity-depth model of the Earth (above) shows that the outer core is molten.

Earth structure: geophysical evidence

Seismological evidence

The velocities of **P-waves** and **S-waves** generally increase through the Earth indicating that incompressibility and rigidity increase at a **faster rate** than the increase in density. Unlike solids, fluids have zero rigidity and S-waves are unable to be transmitted through liquid rock with the liquid core forming an S-wave shadow zone on the surface.

Geomagnetism

The Earth's fluctuating magnetic field, roughly parallel to its axis, is consistent with that induced by a moving (liquid) nickel-iron core.

Gravity

Gravity anomalies suggest variations in elevation and density of rock layers.

Earth structure: rock evidence

- **Meteorites:** thought to share similarities with the Earth's mantle (stony meteorites) and the Earth's core (iron meteorites).
- **Xenoliths:** mantle peridotite often brought up as xenoliths in lava.
- **Density:** the measured densities of rocks from the crust and upper mantle are lower than the mean density calculated for the whole Earth (5.5 gcm^{-1}). Therefore, core densities must be greater than the Earth's estimated mean (at 9.9 – 13 gcm^{-1}).