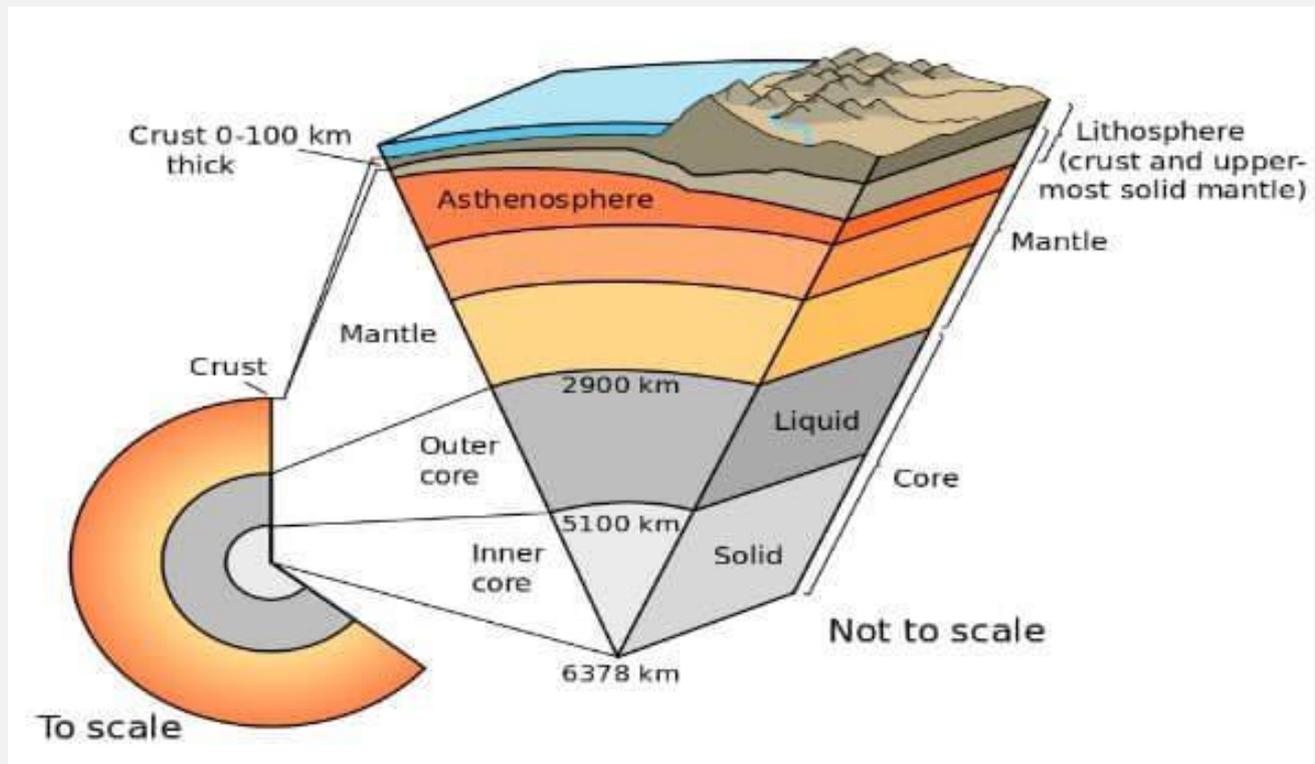


### Earth's Layers: Internal Structure of the Earth

The Earth is composed of **concentric layers** with distinct **physical and chemical properties**. These layers are studied using **seismic waves** generated during earthquakes.



### Broad Classification

#### Mechanical basis

- Lithosphere
- Asthenosphere
- Mesospheric mantle
- Outer core
- Inner core

#### Chemical basis

- Crust
- Upper mantle
- Lower mantle
- Outer core
- Inner core

## The Crust

- Outermost solid layer of the Earth
- Accounts for **0.5–1% of Earth's volume** and **less than 1% of its mass**
- Average density: **~2.7 g/cm<sup>3</sup>**
- Thickness:
  - Oceanic crust: **5–30 km**
  - Continental crust: **30–70 km**
  - Mountain regions (Himalayas): **70–100 km**

## Composition

- Upper crust: sedimentary rocks over crystalline igneous and metamorphic rocks
- Lower crust: basaltic and ultrabasic rocks
- Continental crust: **felsic rocks** (rich in silica, aluminium, sodium, potassium) – granite
- Oceanic crust: **mafic rocks** (rich in iron and magnesium) – basalt

## Temperature

- Increases with depth
- About **200–400°C** at the crust–mantle boundary
- Average geothermal gradient: **~30°C per km** in upper crust

## Most Abundant Elements in Earth's Crust

- Oxygen
- Silicon
- Aluminium
- Iron
- Calcium
- Sodium
- Potassium
- Magnesium

Mnemonic: **OS CIA Na K Mg**

## Mohorovicc Discontinuity (Moho)

- The boundary between the **crust and the mantle**
- Identified by a sudden increase in seismic wave velocity
- Depth:
  - Under oceans: **~8 km**
  - Under continents: **~30 km**
- Caused by a change in rock composition from **feldspar-rich rocks to feldspar-free rocks**

## Lithosphere

- Rigid outer layer of Earth
- Includes **crust + uppermost mantle**

- Thickness: **10–200 km**
- Broken into **tectonic plates**
- Plate movements cause:
  - Earthquakes
  - Volcanism
  - Folding and faulting
- Heat source for plate movement:
  - Primordial heat
  - Radioactive decay of uranium, thorium, and potassium

### Mantle

- Extends from Moho to **2900 km depth**
- Accounts for:
  - **83% of Earth's volume**
  - **67% of Earth's mass**
- Composition: silicate rocks rich in **iron and magnesium**

### Upper Mantle

- Density: **2.9–3.3 g/cm<sup>3</sup>**
- Includes asthenosphere

### Lower Mantle

- Solid state
- Density: **3.3–5.7 g/cm<sup>3</sup>**

### Temperature

- From **~200°C** near crust to **~4000°C** near core
- Heat causes **mantle convection**, driving plate tectonics

### Seismicity

- Earthquakes observed up to **670 km depth** in subduction zones

### Asthenosphere

- Weak, ductile layer of the upper mantle
- Lies below the lithosphere
- Depth: **~80–200 km**
- Highly viscous and partially molten
- Functions:
  - Facilitates plate movement
  - Source of magma

- Enables isostatic adjustment

### Outer Core

- Lies between **2900 km and 5100 km**
- Composition: **iron + nickel (NiFe)** with lighter elements
- State: **liquid**
- Density: **9.9–12.2 g/cm<sup>3</sup>**
- Temperature: **4400–6000°C**

### Importance

- Convection currents + Coriolis force generate **Earth's magnetic field**
- Explained by **Dynamo Theory**

### Inner Core

- Extends from **5100 km to Earth's centre**
- Composition: **~80% iron, some nickel**
- State: **solid** due to immense pressure
- Density: **12.6–13 g/cm<sup>3</sup>**
- Temperature: **~6000°C**
- Can transmit **S-waves**, unlike the outer core
- Rotates slightly faster than Earth's surface
- Does not hold a permanent magnetic field

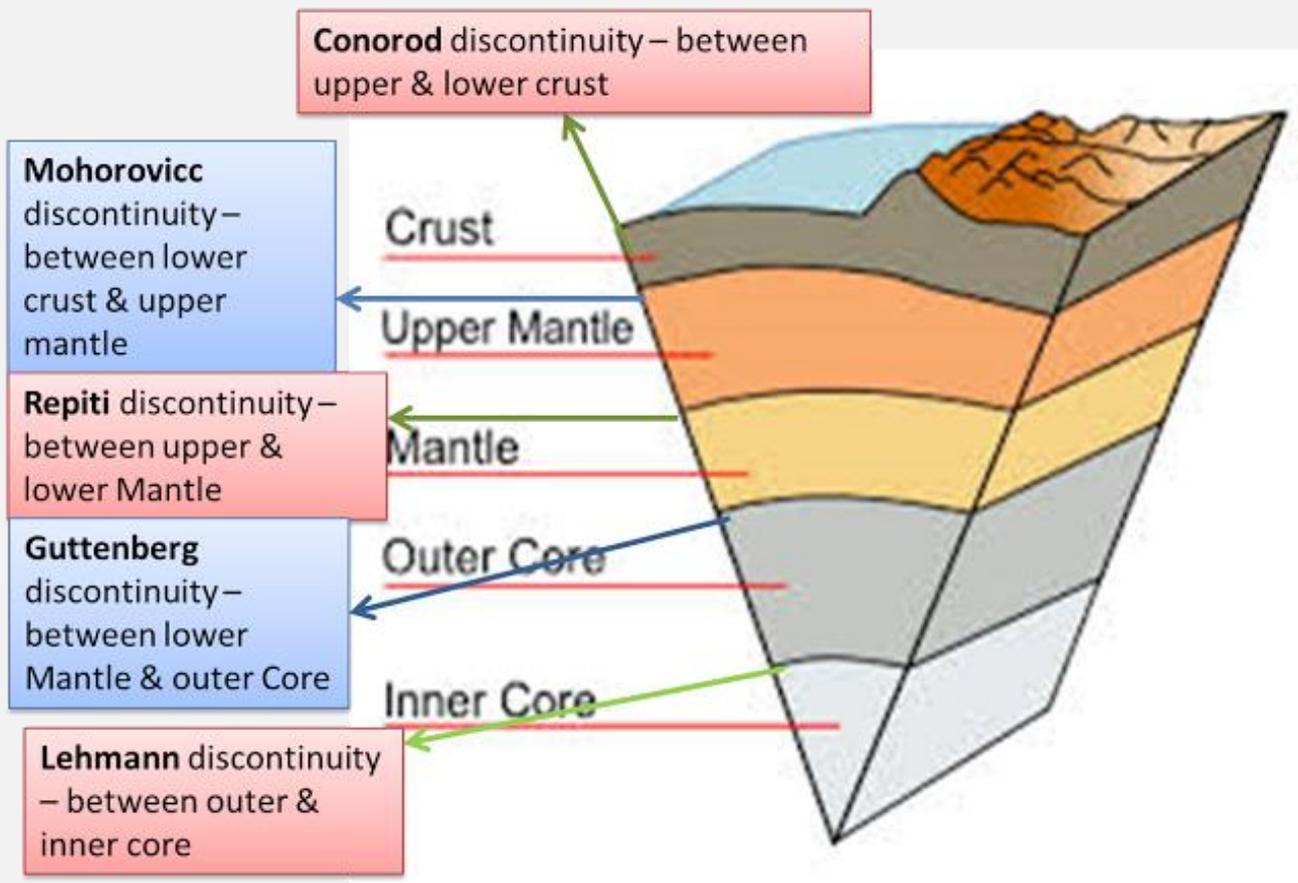
### Core Contribution

- Volume: **~16% of Earth**
- Mass: **~33% of Earth**

### Seismic Discontinuities

Seismic discontinuities are zones where **seismic wave velocity changes abruptly** due to a change in composition or state.

### Major Discontinuities



- **Mohorovicic Discontinuity** – crust–mantle boundary
- **Gutenberg Discontinuity** – mantle–outer core boundary
- **Lehmann Discontinuity** – outer core–inner core boundary

### Pointers

- S-waves cannot travel through liquids
- The outer core is responsible for the magnetic field
- Continental crust is thicker but lighter than oceanic crust
- Mantle convection drives plate tectonics
- An increase in pressure generally increases the melting point, except for ice