PRABANDH

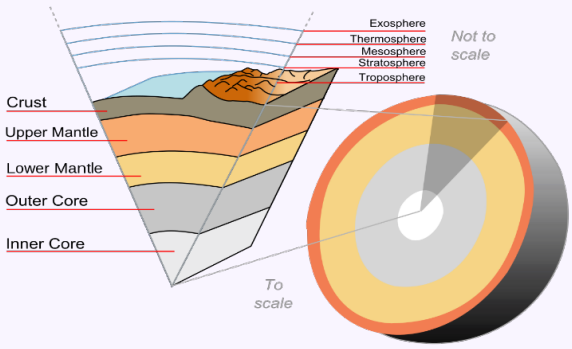
The Ultimate Cheat Sheet: Interior of The Earth

Earth’s Interior for UPSC Prelims 2025

1. Formation & Differentiation of Earth

The Earth’s interior formed through **planetary differentiation**, a process where denser materials like iron and nickel sank to form the core, while lighter silicates rose to form the mantle and crust. During cooling, **outgassing** released water vapor and gases (e.g., nitrogen, sulfur compounds) from the molten mantle, contributing to the early atmosphere. Materials that remained liquid during this phase, termed **incompatible elements**, solidified later to form the brittle crust (e.g., granite, basalt).

2. Layers of the Earth



(A) Crust

- **Oceanic Crust (SiMa)**:
  - Thickness: 5–10 km.
  - Composition: Basalt rich in **silicate and magnesium**.
  - Formation: Created at **mid-ocean ridges** and destroyed in **subduction zones** due to plate tectonics.
  - Age: Younger (rarely exceeding 200 million years).
- **Continental Crust (SiAl)**:
  - Thickness: Up to 70 km under mountain ranges.
  - Composition: Granite rich in **silicate and aluminium**.
  - Age: Older (up to 4 billion years) due to minimal recycling.

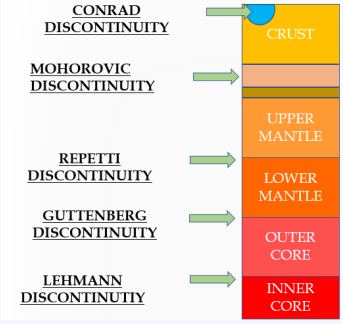
(B) Mantle

- **Lithosphere**:
  - Includes the crust and rigid upper mantle (up to 100 km depth).
  - Divided into **oceanic** (denser) and **continental** lithosphere.
- **Asthenosphere**:
  - Semi-fluid layer (100–700 km depth) enabling **plate tectonics**.

- Source of magma for volcanic eruptions.

(C) Core

- **Outer Core**: Liquid layer (2,900–5,150 km depth) composed of **nickel-iron (NiFe)**; generates Earth's magnetic field via convection currents.
- **Inner Core**: Solid (5,150–6,371 km) with extreme density (~13 g/cm³) due to immense pressure.



3. Key Discontinuities

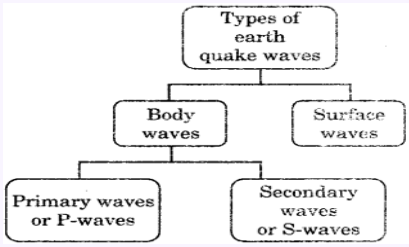
- **Mohorovičić (Moho) Discontinuity**:
  - Separates the crust from the mantle (5–70 km depth).
  - Seismic waves accelerate here due to denser mantle rocks.
- **Gutenberg Discontinuity**:
  - Core-mantle boundary (2,900 km depth).
  - P-waves slow down, and S-waves disappear, confirming the outer core's liquid state.

4. Earthquakes & Seismic Waves

(A) Basics

- **Focus**: Subsurface origin of earthquakes.
- **Epicenter**: Surface point directly above the focus.

(B) Wave Types

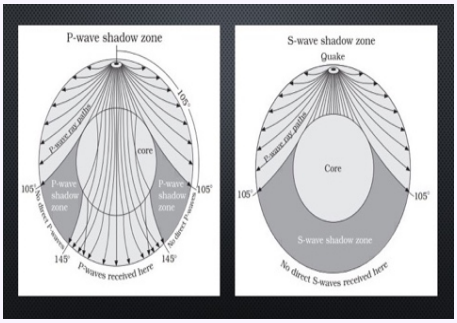


1. **Body Waves**:
   - **P-waves (Primary)**:
     - Longitudinal waves traveling through solids and liquids.
     - Speed: 5–8 km/s.
   - **S-waves (Secondary)**:
     - Transverse waves restricted to solids.

- Speed: 3–4 km/s.

2. **Surface Waves**:
    - **Love Waves**: Horizontal ground movement.
    - **Rayleigh Waves**: Rolling motion causing maximum structural damage.

(C) Shadow Zone

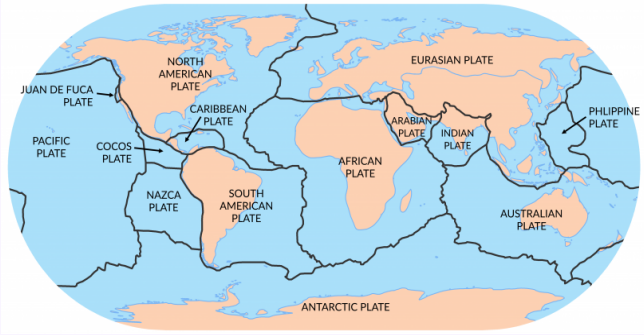


- Region (105°–145° from the epicenter) where **S-waves** are absent, and **P-waves** refract due to the liquid outer core.

5. Earthquake Measurement

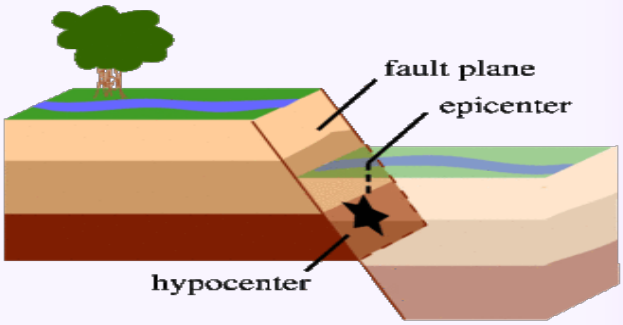
- **Richter Scale**: Logarithmic scale quantifying energy released (magnitude).
- **Mercalli Scale**: Qualitative assessment of shaking intensity (I–XII).

6. Types of Earthquakes



1. **Tectonic**: Caused by plate movements (e.g., subduction, rifting).
2. **Volcanic**: Linked to magma movement and eruptions.
3. **Collapse**: Due to cave/mine collapses.
4. **Explosion**: Human-induced (e.g., nuclear tests).

7. Relevance of Studying Earth's Interior



- **Resource Distribution**: Mantle dynamics influence mineral and fossil fuel deposits.
- **Hazard Mitigation**: Insights into earthquakes and volcanoes improve early warning systems.
- **Planetary Evolution**: Clues about Earth's formation and comparative planetology.