EARTH’S INTERNAL STRUCTURE: GEOGRAPHY

NEWS: *Earth’s inner core isn’t just slowing down — it may be changing shape*

WHAT’S IN THE NEWS?

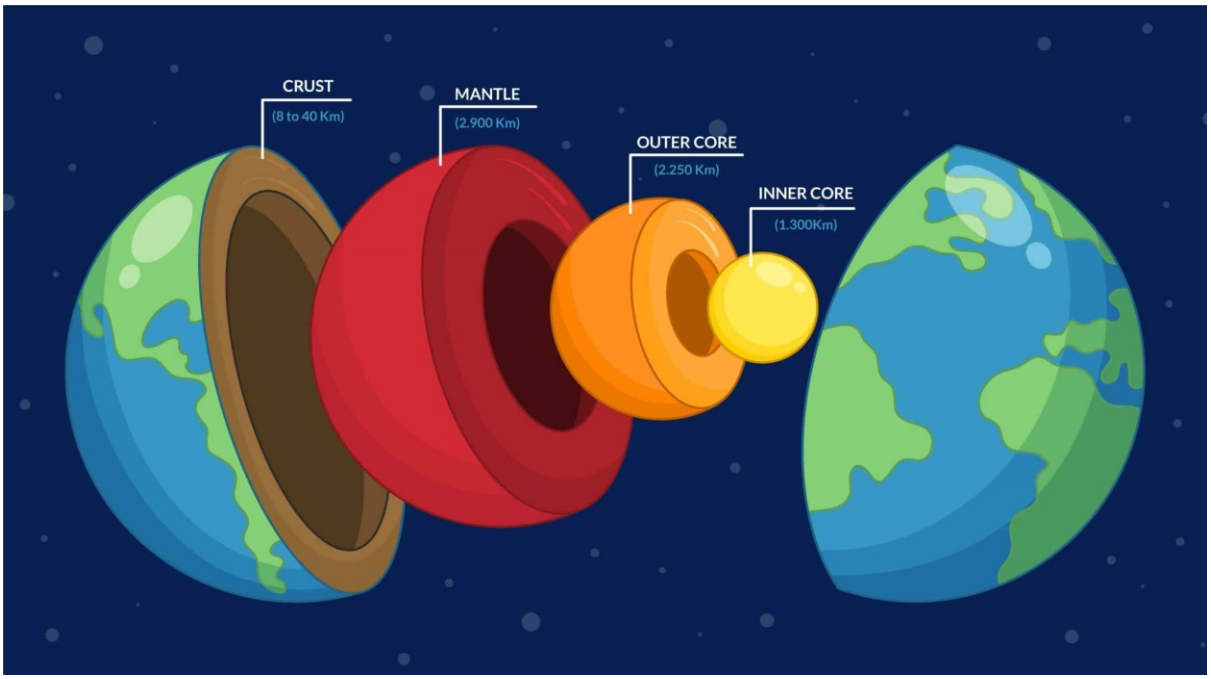
The Earth's internal structure consists of the crust, mantle, and core, with new research suggesting deformation in the inner core. This finding, based on seismic wave analysis, challenges the previous belief that the inner core is a perfect sphere.

OVERVIEW:

The Earth's internal structure is divided into four layers: **Crust, Mantle, Outer Core, and Inner Core**. Each layer has distinct **chemical composition, physical properties, and geodynamic significance**. A recent study published in *Nature Geoscience* suggests that the Earth's inner core may be deforming and slowing in rotation, which could impact our understanding of Earth's geophysical processes.

1. Structure of the Earth

The Earth is divided into **four major layers**, each with different characteristics:

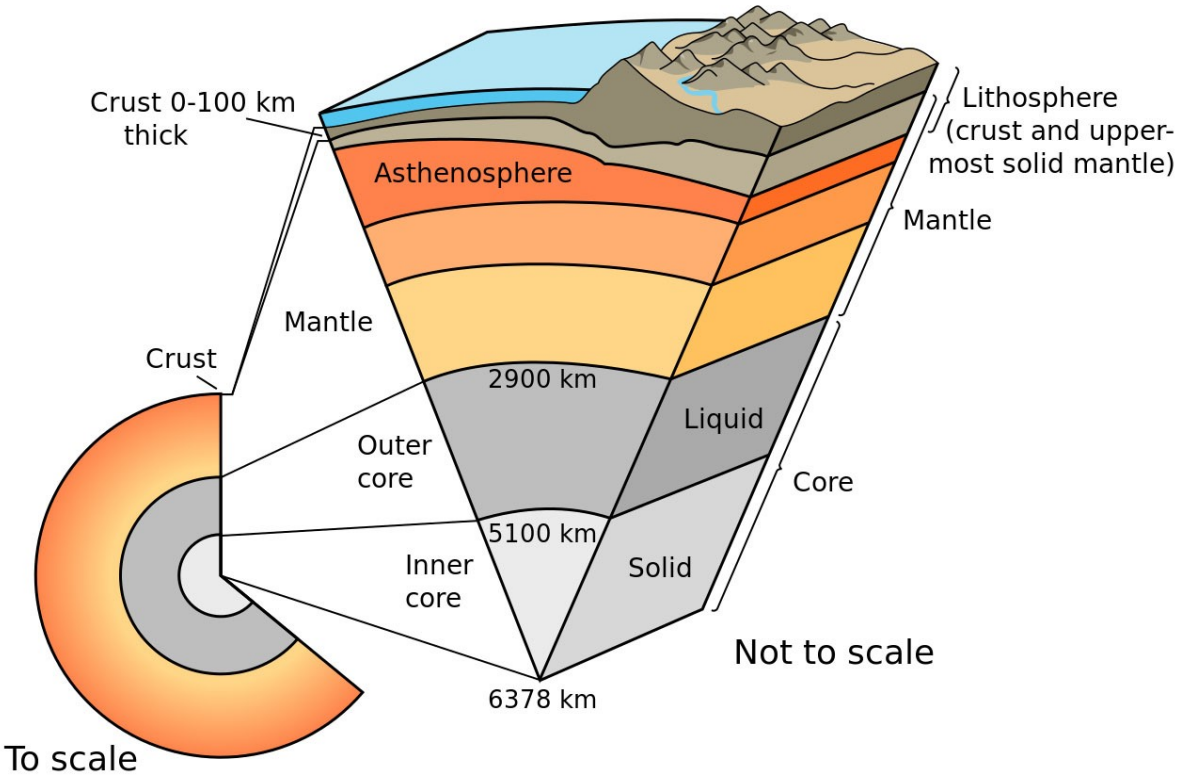


(A) Crust – The Outermost Layer

- The **crust is the outermost solid layer** of Earth, composed primarily of **silica and alumina (SIAL in continental crust) and silica and magnesium (SIMA in oceanic crust)**.
- **Thickness Variations:**
  - **Continental Crust:** 30–70 km (thicker in mountain ranges like the Himalayas).
  - **Oceanic Crust:** 5 km (denser but thinner).
- **Density:**
  - **Upper crust:** ~2.7 g/cm³
  - **Lower crust:** ~3.0 g/cm³

(B) Mantle – The Largest Layer

- Extends from **Moho's Discontinuity (~35 km) to a depth of 2,900 km**.
- **Upper Mantle:** Contains the **Asthenosphere** (partially molten, extends to ~400 km).
- **Lower Mantle:** Extends beyond 700 km, remains solid due to high pressure.



- **Composition:** Rich in **silicates, iron, and magnesium**.

Divisions of the Mantle Based on Recent Research

The **International Union of Geodesy and Geophysics (IUGG)** classified the mantle into three zones:

- **Zone 1:** Moho's Discontinuity to 200 km depth.
- **Zone 2:** 200 km to 700 km depth.

- **Zone 3:** 700 km to 2,900 km depth.

(C) Core – The Innermost Layer

- Extends from **2,900 km to the center (~6,371 km)**.
- **Outer Core:**
  - **Liquid in state**, composed of **Nickel and Iron (NiFe)**.
  - **Generates Earth's Magnetic Field** via the **geodynamo effect**.
- **Inner Core:**
  - **Solid in state**, despite extreme heat (~5,200°C) due to immense pressure.
  - Rotates **independently from the rest of the Earth**.

Significance of the Core

- **Maintains Earth's Magnetic Field**: Protects life from **solar wind and cosmic radiation**.
- **Influences Geological Activity**: Inner core interactions affect **mantle convection and plate tectonics**.

2. Findings of the Recent Study on Inner Core Deformation

A **2023 research paper** titled *"Annual Scale Variability in Both the Rotation Rate and Near Surface of Earth's Inner Core"*, published in *Nature Geoscience*, provides **new insights into the inner core's behavior**.

Key Discoveries

1. **Inner Core Deformation**
   - The **inner core is not a perfect sphere** as previously believed.
   - **Deformations of up to 100 meters** have been detected at the inner core's outer boundary.
2. **Slowdown of Inner Core Rotation**
   - Previous studies suggested that the **inner core spins slightly faster** than the rest of the planet.
   - However, **new evidence suggests that its rotation is slowing down** over time.
3. **Possible Causes of Deformation**
   - **Uneven gravitational forces** acting on the inner core.
   - **Dynamic motion of the liquid outer core** affecting inner core stability.

3. Methodology of the Study

Scientists used **seismic wave analysis** to examine changes in the Earth's inner core over time.

Seismic Wave Observations

- **Earthquakes generate seismic waves**, which travel through Earth's interior.
- **Changes in wave speed and direction** provide insights into **density and composition variations**.
- This study **focused on seismic wave patterns from repeated earthquakes** near **South Sandwich Islands (Southern Atlantic Ocean)** from **1991 to 2023**.

4. Significance of the Research

While the findings **do not have immediate practical implications** for daily life, they are **crucial for understanding Earth's internal processes**.

Scientific Importance

- **Refines knowledge of Earth's geodynamics.**
- Helps in **predicting long-term changes in Earth's magnetic field.**
- Enhances understanding of **core-mantle interactions and their effects on plate tectonics.**

Potential Future Applications

- Could influence models related to **seismic risk assessment and earthquake prediction.**
- May improve insights into **planetary evolution and magnetic field sustainability.**

Source: **https://www.downtoearth.org.in/science-technology/earths-inner-core-isnt-just-slowing-down-it-may-be-changing-shape**