



Structural Changes in Earth's Inner Core

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Why in News?

- A study published in **Nature Geoscience** reveals that [Earth's inner core](#) is undergoing **structural changes**.

What are the Key Findings of the Study?

- **Methodology:** Researchers analyzed [seismic waves](#) near Antarctica's South Sandwich Islands from 1991 to 2024. Repeating earthquakes revealed subtle changes in seismic waves, offering insights into Earth's inner structures.
- **Structural Changes in Inner Core:** The **near surface of Earth's inner core** is undergoing **structural changes**, challenging the earlier belief that **it is rigid and stable**.
 - The **inner core's rotation** appears to be **slowing down**, which could subtly **alter the length of a day** on Earth.
 - Researchers suggest **viscous deformation in the inner core** is caused by dynamic interactions between the **turbulent, molten outer core and the solid inner core**, similar to how [magma](#) flows under stress.

What are the Key Facts About Earth's Inner Core?

- **Structure:** The **inner core** is a **hot, dense ball** primarily made of **iron and nickel**. Unlike the **liquid outer core**, the inner core remains **solid due to immense pressure** from Earth's upper layers.
- **Depth and Size:** Located **5,150 km beneath** the surface, at Earth's center. It has a **radius of about 1,220 km**.
 - The boundary between the inner and outer core is called the **Lehmann Discontinuity**.
- **Magnetism:** The inner core influences [Earth's magnetic field](#), while the outer core's swirling liquid iron generates it through the **geodynamo effect** (magnetic field generation).
 - The inner core has **high thermal and electrical conductivity**.
- **Rotation:** The inner core rotates eastward slightly **faster than the Earth's surface**, completing an extra rotation every 1,000 years.
- **Growth:** The inner core grows by about **1 mm per year** as the liquid outer core solidifies.
 - Growth is uneven, occurring more around subduction zones and less near superplumes.
 - The core will never fully solidify due to slow crystallization and continuous radioactive decay.

Earth's Interior

- The Earth's interior is structured in concentric layers, similar to an onion. These layers are:
 - **Crust (Outermost Layer):** The **thinnest** layer, varying in thickness:
 - **Continental crust:** ~35 km thick, composed mainly of **silica (Si) and alumina (Al)**, referred to as "**sial**" for the continental crust.
 - **Oceanic crust:** ~5 km thick, oceanic crust contains **silica (Si) and magnesium**

(Mg), called "sima".

- **Mantle (Thickest Layer):** Extends up to **2900 km** below the crust. Composed of silicate minerals rich in **iron and magnesium**.
 - The upper part contains the **asthenosphere**, a semi-molten layer responsible for **plate movements**.
- **Core (Innermost Layer):** Extends up to **3500 km** in radius. Composed of **nickel (Ni) and iron (Fe)**, called "nife".
 - **Divided into Outer Core** (liquid state, generates Earth's magnetic field) and **Inner Core**.

INTERIOR OF THE EARTH

1 THE CRUST

- Thin, outermost layer
- Oceanic crust – thinner
 - Mean thickness - 5 km
 - Made up of Silica and Magnesium (SiMa)
- Continental crust – thicker
 - Mean thickness - 30 km
 - Made up of Silica and Aluminum (SiAl)
 - Thicker in the areas of major mountain systems.
 - Around 70 km thick in the Himalayan region.
- Temperature increases with depth (rises by up to 30° C for every km)

Lithosphere

- Rigid outer layer, thickness: 100 km
- Consists of the crust and the upper mantle
- Divided into tectonic plates responsible for large-scale changes in the earth's geological structure (folding, faulting)

3 THE CORE

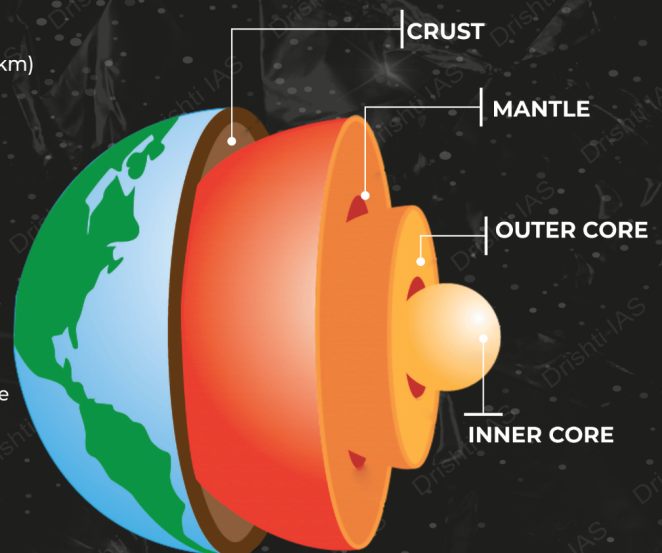
- Lies between 2900-6370 km below the earth's surface
- Made up of heavy materials, primarily nickel (Ni) and iron (Fe) - NiFe
- Outer core –
 - Between 2900-5100 kms
 - **Liquid** because of not enough pressure to solidify
- Inner core –
 - Between 5100-6370 kms
 - **Solid** – it can transmit **secondary waves** (earthquake) which outer core can't
- **Denser than Mantle**

Boundaries/discontinuities between Earth's layers

1. **Conorod Discontinuity**– between upper and lower crust
2. **Mohorovicic Discontinuity (Moho)** – separates the crust from the mantle, its average depth being about 35 km.
3. **Repiti Discontinuity** – between the upper and lower mantle
4. **Cutenberg Discontinuity** – lies between the mantle and the outer core.
5. **Lehman Discontinuity**- between inner and outer core

2 THE MANTLE

- Extends from Moho's discontinuity to a depth of 2,900 km
- Upper portion is called **asthenosphere**
 - Zone of weak rocks; in semi molten or jelly like state
 - Extends upto 400 kms
 - **Main source of magma** that comes out of volcanic eruptions



UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. In the structure of planet Earth, below the mantle, the core is mainly made up of which one of the following? (2009)

- (a) Aluminium
- (b) Chromium
- (c) Iron
- (d) Silicon

Ans: (c)

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