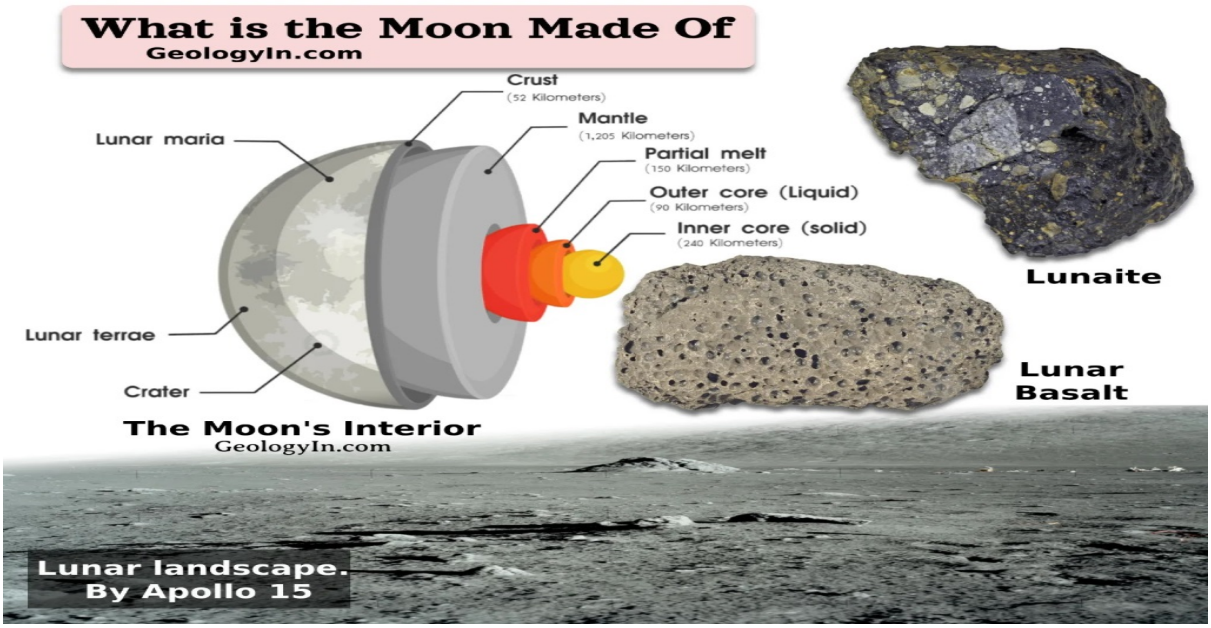
Why the Two Sides of the Moon are So Different

***Prelims**: Current events of national and international importance| Geography*

Why in news?

Recently NASA's Gravity Recovery and Interior Laboratory (GRAIL) mission revealed that moon's two hemispheres look different due to difference in internal composition of Moon.

> *The two sides of the Moon—the **nearside** (facing Earth) characterized by large, dark basaltic plains called Maria and the **farside** (facing away) is marked by rugged, heavily cratered terrain.*



- **GRAIL mission** – It is a NASA mission aimed at ***mapping the Moon's gravitational field*** to enhance our understanding of its *internal structure*.
- It is ***launched in 2011*** with two identical orbiters, GRAIL-A and GRAIL-B, later named **Ebb** and **Flow** through a student contest.
- **Objective** – To create detailed gravitational map of lunar surface and understand the Moon's asymmetric thermal evolution.
- **Method** – By measuring *distance variations between spacecrafts* caused by gravitational anomalies.
- These measurements, accurate to within a micron, allowed scientists to infer the Moon's internal mass distribution.

Reasons for differences in two hemispheres

- **Tidal deformation and gravitational asymmetry –** The nearside (facing Earth) flexes more during its orbit due to Earth's stronger gravitational pull — a process called tidal deformation.
- This suggests that the *nearside is warmer and more geologically active deep* inside compared to the farside, which is more rigid.
- The difference in *internal flexibility* results in creating the Moon's uneven surface features.
- **Crustal thickness and surface composition –** GRAIL data showed that the ***nearside crust is much thinner*** than the ***farside crust***.
- The thinner crust made it easier for ***magma to rise*** and erupt, forming flat lava plains.
- In contrast, the ***farside's thicker crust*** ***blocked magma***, leaving behind a *rugged, cratered highland terrain.*
- This difference in crust thickness also affected how ***heat-producing elements*** were distributed, deepening the contrast between the two sides.
- **Volcanic activity and heat distribution –** The nearside experienced intense volcanic eruptions billions of years ago, which created dark basalt plains called maria.
- These eruptions also build up ***heat-producing elements*** like *thorium and titanium* in the ***nearside's mantle***.
- As a result, the ***nearside is 100–200°C hotter*** than the farside, leading to a long-lasting thermal imbalance.
- The ***farside, with fewer radioactive elements*** and less heat, remained mostly inactive and unchanged.

Significance of these findings

- **Future lunar missions –** It aids in developing lunar positioning, navigation, and timing systems.
- It is essential for success of upcoming crewed moon missions.
- **Broader space exploration –** The gravitational mapping techniques applicable to other moons for advanced search for extra-terrestrial life.

Reference

Times of India| Why the Moon Look So Different on Each Side