Geological Discoveries about the Moon

Why in news?

Recently, ISRO announced the significant discoveries about the moon based on the data from Chandrayan 3 Mission.

What are the characteristics of Moon?

- **Moon** – It is *Earth's only natural satellite* that orbits around the Earth at an average distance of 384,400 km (238,900 mi).
- **Formation** – It was formed about 4.51 billion years ago.
- It formed out of the debris from a giant impact between Earth and a hypothesized Mars-sized body called Theia.
- **Physical parameters**
  - Mass – 1.2% of the Earth
  - Diameter – 3,474 km.
- **Physiography** – It is marked by rocky surface, mountains, impact craters, their ejecta, ray-like streaks, rilles.
- **Atmospheres** – It has a very thin atmosphere.
- **Rocky surface** – Moon was initially molten and the minerals in there slowly crystallised as the lava cooled to form rocks of various kinds and is now covered in lunar dust.
- Rocks in moon are of two types
  - The dark volcanic rock
  - The brighter highland rock
- The brightness difference between these two gives the familiar *"man in the moon" face* or *"rabbit picking rice" image* to the naked eye.
- Since Moon has a thin atmosphere and lacks volcanic activity, all meteors reach its surface preventing their replenishment with new rocks over time.
- **Moon dust** – Meteorites raining down on the moon beat the moon rocks down to fine dust over many centuries.
- **Mineral compositions**
  - **Outer layer** – Lighter minerals, with Calcium and Sodium
  - **Inner layer** – As it cooled down over millions of years, heavier silicon and magnesium rich minerals like Olivine and Pyroxene sank and formed the inner layers of the Moon.

What are geological discoveries of moon by Chandrayan-3?

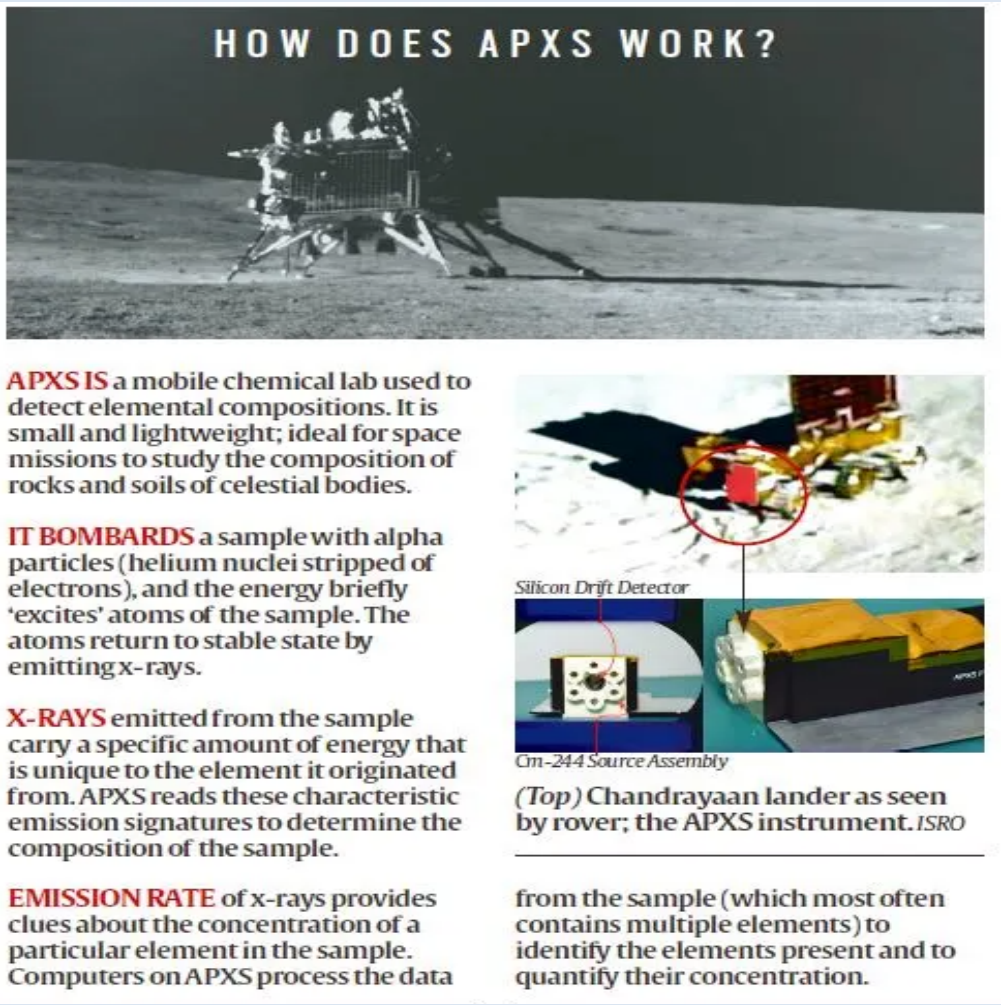
> *Chandrayaan-3 made a successful landing on lunar surface near the south pole of the moon in 2023 with the rover 'Pragyan' that collected data of temperature to*

seismological measurements over 10 days.

- The rover stopped and deployed an instrument called an alpha-particle X-ray spectrometer (APXS) 23 times which gives evidences about geological evolution of moon.

APXS Spectrometer

• **Working** – It excites atoms by firing X-rays and alpha particles at it produced from a radioactive mass of curium and analyses the energy produced in order to identify the minerals in the Moon's soil.



- **Evidence of ferroan anorthosite** - They are one of the major lunar rock types and are thought to be pieces of the original lunar crust.

Anorthosite, type of intrusive igneous rock composed predominantly of calcium-rich plagioclase feldspar.

- **Uniformity in soil composition** – *All 23 samples comprised mainly ferroan anorthosite*, a mineral that is common on the Moon.
- It suggests that the topsoil near the landing site is fairly uniform.
- **Presence of Magma Ocean** – The presence of ferroan anorthosite, a remnants of the ocean of liquid molten rock.

- **Evidence of meteorite crash** – It might have occurred in the region four billion years ago.
- It is thought to have *made the South Pole–Aitken basin*, about 350km from the site India's Praygam rover explored.

Aitken basin is one of the largest craters in the solar system, measuring 2,500 km across and 8 km deep.

- **Presence of minerals** – Traces of Magnesium and Sulphur on the lunar surface.
- Magnesium might have thrown up to surface from deep inside the Moon due to meteorite crash.

To know about discovery by RAMBHA-LP of Chandrayaan-3, click here

What are the significance of the findings?

- These findings are the *first of its kind about the southern hemisphere* of Moon.
- **Supports LMO hypothesis** - Lunar Magma Ocean theory states that when Moon was formed 4.5 billion years ago, it began to cool and a lighter mineral called ferroan anorthosite floated to the surface.

*The **lunar magma ocean theory** was first proposed by two independent groups in 1970, after rock collected during the 1969 Apollo 11 landing was analysed.*

- Ferroan anorthosite rocks are very common on the earth and the earth contributed all the anorthosite found on the moon today.
- **Informs about Moon geological evolution** - APXS measurements will serve as the "*first ground truth in the south polar* highlands and play a key role in the overall understanding of the origin and evolution of the Moon.
- **Confirms earlier findings** - It confirms the earlier findings of U.S. Apollo missions and the erstwhile Soviet Union's Luna missions from the lunar equator in the 1960s.
    - Before Chandrayaan-3, the main evidence of *magma oceans was found in the mid-latitudes* of the Moon as part of the Apollo programme.
- **Supports future Missions** – The presence uniform composition on the lunar surface implies that the region can be *used as a calibration point* for remote sensing operations, and can thus be used for planning future missions.
- This would be a game-changer for space agencies' dreams of building a human base on the Moon.

References

1. The Hindu | Chandrayaan's finds magma ocean on early moon
2. BBC | Ancient ocean of magma found on Moon south pole

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