

## 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.

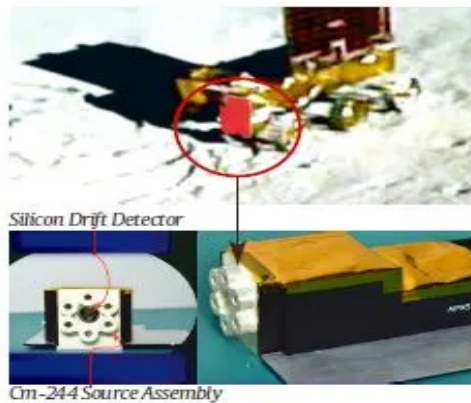


**APXS IS** a mobile chemical lab used to detect elemental compositions. It is small and lightweight; ideal for space missions to study the composition of rocks and soils of celestial bodies.

**IT BOMBARDS** a sample with alpha particles (helium nuclei stripped of electrons), and the energy briefly 'excites' atoms of the sample. The atoms return to stable state by emitting x-rays.

**X-RAYS** emitted from the sample carry a specific amount of energy that is unique to the element it originated from. APXS reads these characteristic emission signatures to determine the composition of the sample.

**EMISSION RATE** of x-rays provides clues about the concentration of a particular element in the sample. Computers on APXS process the data



(Top) Chandrayaan lander as seen by rover; the APXS instrument. ISRO

from the sample (which most often contains multiple elements) to identify the elements present and to quantify their concentration.

- **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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