



Distribution of Argon-40 on Moon

For Prelims: Chandra's Atmospheric Composition Explorer-2 (CHACE 2), Chandrayaan 1 and 2, Noble gases Argon-40, Periodic table,

For Mains: Achievements of Indians in Science & Technology, Space Technology, Chandrayaan-2.

Why in News?

Recently, **Chandra's Atmospheric Composition Explorer-2 (CHACE-2)**, a payload onboard [Chandrayaan-2](#), has made the first-of-its-kind discovery on the **distribution of one of the noble gases, Argon-40**.

- India launched Chandrayaan-2, its **second lunar exploration mission after [Chandrayaan-1](#)**, from Satish Dhawan Space Centre, Sriharikota in **July 2019**.

What is the Chandrayaan-2 Mission?

- Chandrayaan-2 is an **integrated 3-in-1 spacecraft** consisting of an **Orbiter of the Moon, Vikram (after Vikram Sarabhai) the lander** and **Pragyan (wisdom) the rover**, all equipped with scientific instruments to study the moon.
- Failure of Lander:** Vikram lander's descent was as planned and normal performance was observed up to an altitude of 2.1 km from Lunar surface in September, 2019.
 - A successful soft-landing would have made India the **fourth country after the erstwhile Soviet Union, the United States, and China to do so**.
- Orbiter:** It is equipped with different kinds of **cameras to create high-resolution three-dimensional maps of the surface**.
 - It will study the mineral composition on the moon and the lunar atmosphere, and also to assess the abundance of water.
- Objective:** The mission sequence **involves meticulous planning of a series of Earthbound manoeuvres, trans-lunar injections, series of lunar burns, lander separation, lander descent, and touchdown** and subsequent rover rolling out of the lander on the Moon surface.

What are the major Findings?

- The gas found in the lunar exosphere is **believed to have escaped from the lunar surface**.
- The CHACE-2 observations reveal that the distribution in **Ar-40 has significant spatial heterogeneity**.
- There are localised enhancements (termed as **Argon bulge**) over several regions including the **KREEP** [potassium (**K**), **Rare-Earth Elements**, and **Phosphorus (P)**] on South Pole Aitken terrain (impact crater on the far side of the Moon).

What is the Lunar Exosphere?

- 'Exosphere' is the **outermost region of the upper atmosphere** of a celestial body where the constituent atoms and molecules rarely collide with each other and can escape into space.
- Earth's Moon features a **surface-boundary-exosphere**. For Moon, different constituents in the exosphere are fed from the surface by a variety of processes such as:
 - **Thermal Desorption:** The exospheric atoms may be lost to space by the thermal escape (also known as the Jean's escape).
 - **Photo-Stimulated Desorption:** The atoms get ionised by photo-ionisation and charge exchange with the solar wind ions.
 - **Solar wind Sputtering:** The atoms can be swept away by the convective electric field of the solar wind.
 - **Micrometeorite Impact Vaporisation:** The impact of **micrometeoroid** is usually sufficiently energetic to cause vaporisation of the impacting particle as well as produce an impact crater of volume an order of magnitude greater than the impacting particle.
 - A micrometeoroid is **orbital debris** which is **smaller than a grain of sand**.
- Thus, the lunar exosphere exists as a result of a **dynamic equilibrium between several source and sink processes**.

What is the Significance of the Discovery?

- Noble gases serve as important tracers to understand the processes of **surface-exosphere interaction**, and **Argon-40 (Ar-40) is such an important tracer atom** to study the dynamics of the lunar exospheric species.
- It will also help decipher **radiogenic activities** in the first few tens of metres below the lunar surface.
 - Ar-40 originates from the **radioactive disintegration of Potassium-40 (K-40) present below the lunar surface**.
 - Once formed, it diffuses through the **inter-granular space** and makes its way up to the lunar exosphere through seepages and faults.
- The CHACE-2 observations provide the **diurnal and spatial variation of Ar-40 covering the equatorial and mid latitude regions of the Moon**.
 - The uniqueness of this result from Chandrayaan-2 mission lies in the fact that although **Apollo-17(1972) and Lunar Atmosphere and Dust Environment Explorer (LADEE Mission 2014)** have detected the presence of Ar-40 in the lunar exosphere, the measurements were confined to the near-equatorial region of the Moon.
- The observations of Argon bulge by CHACE-2 are indicative of unknown or **additional loss processes**.

What are Noble Gases?

- Noble gases are a group of the seven chemical elements that make up Group 18 (VIIIa) of the [periodic table](#).
- The elements are **helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), radon (Rn), and oganesson (Og)**.
- The noble gases are **colourless, odourless, tasteless, nonflammable gases**.
 - However, recent studies have shown reactive compounds of **xenon, krypton, and radon**.
- The abundances of the noble gases **decrease as their atomic numbers increase**.
- **Helium is the most plentiful** element in the universe after hydrogen.\

PYQ

Q. Which of the following pairs is/are correctly matched? (2014)

Spacecraft

Purpose

1. Cassini-Huygens : Orbiting the Venus and transmitting data to the Earth
2. Messenger : Mapping and investigating the Mercury
3. Voyager 1 and 2 : Exploring the outer solar system

Select the correct answer using the code given below:

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

Ans: (b)

Source: TH

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