IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Astrobiology and Exploration (6)

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EXPLORING THE CO-EVOLUTION OF EARTH-MOON SYSTEM THROUGH LUNAR MINERALOGY AND METEORITE IMPACTS

Abstract

The premise of mineral evolution is the co-evolution of the Earth's geosphere and biosphere through a series of stochastic and deterministic events. This has resulted in profound changes in the diversity and distribution of Earth's near-surface minerals across different eras of planetary accretion, crust and mantle reworking, and biologically mediated mineralogy. It is now known that different rocky planets and moons underwent a unique set of mineral evolution processes.

According to previous research, the Moon's mineralogy is limited to anhydrous species and species formed at low pressure and oxygen fugacity due to conditions related to its origin, size, and thermal history. The discovery of Change-site—(Y) by China's Chang'e 5 robotic mission, an anhydrous mineral belonging to the merrillite group of phosphate minerals, further confirms this. However, the current global distribution, composition, and concentrations of lunar minerals still do not provide a complete picture of the co-evolution of the Earth-Moon system.

To better understand the co-evolution of the Earth-Moon system, it is crucial to comprehend the types and quantities of minerals delivered to the Moon through meteoritic bombardment and the processes by which these minerals undergo modification or evolution over time. Meteorite impacts may have played a critical role in the evolution of lunar minerals. A 2021 study suggests that the rare earth element zircon mineral analysis, combined with sophisticated geochronology techniques and imaging, can establish a relationship between dated zircon development and current magmatic conditions or metamorphic events on Earth.

This study looks into identifying a further correlation between the shared co-evolution of the Earth-Moon system, and as such, the role of meteorites and their impacts on the mineral evolution process is explored. Mineralogical data from regions such as Mare Nectaris, Von Kármán crater, and Mare Moscoviense from the Moon have been investigated to better understand the processes of lunar mineralogy.

In this paper, a coordinated effort was undertaken to tabulate and catalog lunar minerals to create a database that can serve as a resource for the lunar, earth, and planetary science community. Statistical techniques and mineralogical databases can be applied to this database to study the mineral diversity-distribution relationship. This lunar mineral database could assist or complement ongoing research efforts among the earth and planetary science community to unlock the co-evolution of the Earth-Moon system.