Paper ID: 76075
student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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LUNAR MINERALOGY: UNLOCKING THE MYSTERIES OF THE EARTH-MOON CO-EVOLUTION THROUGH PANGOLIN-INSPIRED ROBOTICS

Abstract

The co-evolution of the Earth-Moon system can be studied by probing further into the distribution and properties of lunar minerals. At present, the available lunar mineral information falls short of giving us a comprehensive understanding of the history of the Earth-Moon system. It is essential to understand the processes which led to the modification or evolution of the lunar minerals, be it via various geological processes or by meteoritic impacts on the Moon.

In line with the Artemis Science Plan's objective to interpret the impact history of the Earth-Moon system and conduct experimental science in the lunar environment, a robotic mission was proposed as part of Spaceonova's Robotics Internship and Training Program at Mare Nectaris on the Moon. Its primary aim is to conduct extensive research on the mineralogical composition of the lunar surface, with a specific emphasis on the identification and characterization of rare earth elements and other valuable resources.

To achieve this aim, a unique approach was taken, focusing on developing a robot inspired by pangolins to explore the South Pole-Aitken basin, which is on the Moon's far side. The extreme conditions of the lunar surface make it challenging for gathering data or conducting scientific experiments. The pangolins, known as monster "Taunah" (diggers) among the Javanese, with their short limbs and sharp claws, are undoubtedly one of nature's best diggers. The mission incorporated the unique adaptation features of pangolins into the robotic system to mimic the morphology and movement of the animal.

By mobilizing teams in different subsystems, the biomimetic design of the robot was initiated. The gripping and digging mechanism inspired by the pangolin is designed to enable the extraction of rock samples from various depths on the lunar surface. The pangolin-inspired robot is also designed to house advanced scientific instruments, including the Raman spectroscopy system to identify the mineralogical composition of collected samples, the laser-induced breakdown spectroscopy system, and high-resolution cameras.

To assess the performance of the robot, a series of rigorous and comprehensive simulations and tests are designed, to which the robot will be subjected. The development of this nature-inspired robot is hoped to unlock the mysteries of the Earth-Moon co-evolution and contribute to developing new technologies and systems for future lunar missions.