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LUNAR VITALIS: UNLOCKING RESOURCES FOR SUSTAINED EXPLORATION

Abstract

Humans are closer than ever to establishing a permanent presence on the Moon, with upcoming missions like NASA's Artemis program paving the way for sustainable lunar exploration. The lunar south pole has drawn significant global interest, with its permanently shadowed regions (PSRs) believed to contain substantial water ice deposits. Water is a vital resource for supporting human life, producing oxygen, and serving as a key component for fuel generation, reducing dependence on Earth.

Recent studies suggest that two secondary craters within the Shoemaker Crater, located in the lunar south pole, hold the greatest potential for water ice deposits within the top meter of the surface. These PSRs exhibit both high circular polarization ratio (CPR) values, suggesting potential ice deposits, and high weight-equivalent hydrogen (WEH) concentrations, indicating the presence of hydrogen, likely in the form of water ice. These characteristics make them ideal sites for future sampling missions.

To explore these regions, this paper proposes a hopper/lander mission 'Lunar Vitalis' designed to drill into the lunar regolith, analyze its composition using spectrometers, and utilize microwave heating to extract water. Microwave heating is an efficient method for extracting subsurface ice, particularly in the

Moon's vacuum environment, where conventional heat transfer is slow and the regolith acts as a strong thermal insulator. A microwave source will be placed inside a drilled hole, where it will sublimate subsurface ice into water vapor, which will then be collected, condensed, and stored in a cold trap system, eliminating the need for large-scale excavation.

This mission will provide essential ground-truth data on the lunar regolith's composition and water abundance in the Shoemaker Crater, validating orbital observations and advancing in-situ resource utilization (ISRU) technologies. By demonstrating an efficient and scalable water extraction technique, it will play a key role in enabling long-term lunar habitation and supporting future deep-space missions. The insights gained will not only inform upcoming lunar exploration efforts but also serve as a foundation for sustaining human presence on the Moon and beyond.