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Space Resources, the Enabler of the Earth-Moon Econosphere (5)

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GEOMECHANICS ON THE MOON. A PROSPECTING MISSION ARCHITECTURE CONCEPT

Abstract

Humanity will soon have a long-term presence on the surface of the Moon. To successfully execute this enormous challenge, we will need to produce our commodities through in-situ resource utilization (ISRU). ISRU technologies are critical to keep the mission financially viable; however, the Moon still presents a significant challenge as much of the surface is still uncharacterized. The lunar crust is of outstanding interest as it is covered with a layer of fine particles and unconsolidated regolith debris with potential candidate materials for extraction, including volatiles, metals, water and important quantities of Iron, Titanium, and Helium-3, concentrated in the Mares regions. Additionally, both poles are confirmed to have deposits of ice-water. Nevertheless, many technical gaps and severe uncertainty needs to be addressed before establishing mining operations. This work sheds light on the main geomechanical parameters relevant for the exploration, extraction and processing of critical resources. We identify key variables that define the soil response including compressive and tensile strength, porosity, bulk density, differential consolidation, degree of weathering, water ice content, temperature, and particle size distribution. The influence of these parameters is correlated with respect to excavation rate and haul operations, applied for water ice excavation on the poles. The calculations presented are based on experiments with analogue simulants. The overview and findings are presented under a suitable mission architecture, named Hyperion, which consists of a rover vehicle with a payload onboard for geomechanical prospecting. This research would serve as a mission template that can be updated, enhanced and enriched once new data becomes available opening a wide gate of possibilities to further develop the geomechanical knowledge of the Moon.