A LUNAR GEOMECHANICAL PROSPECTING MISSION CONCEPT

Clairet Guerra[a], Gustavo Jamanca-Lino[a], Erin Rezich[a], Isabel Casasbuenas [a]

[a] *Space Resources Program, Colorado School of Mines, Golden CO.*
guerraguevara@mymail.mines.edu/clairetg18@gmail.com

Abstract. The age of *in-space* mining is right around the corner and 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 own commodities through in-situ resource utilization (ISRU) which includes mining. The known contents of lunar surface are potential candidates for extraction including volatiles, metals, and water. ISRU technologies are critical to keeping the mission financially viable; however, the Moon still presents a significant challenge as much of the surface is still uncharacterized and many technical gaps need to be filled prior to establishing mining operations [1].

To select the mining methods, many assumptions about the geomechanical properties of the icy regolith are made acknowledging severe uncertainty. In a terrestrial scenario, assuming poorly constrained soil properties in a mining project can lead to an incorrect selection of the mining method and improper sizing of the mining equipment. Both mistakes can lead to an economically unfeasible excavation project. This effect is hyperbolized in a lunar mining scenario where it is difficult or impossible to adapt the mission architecture. Geomechanical properties are therefore critical for tool and process optimization[2, 3].

This research presents a mission concept to obtain geomechanical information of the lunar regolith required by the space mining industry. Conceived as Hyperion, the mission proposes a streamlined method for measuring the specific penetration and soil strength *in-situ* on the craters of interest to NASA to provide the information necessary to mine water-ice on the Moon. The authors propose the application of indirect measurements of a penetration test using indentation load, compression strength through plasma blasting tests in-situ, in addition to acoustic surveying for spatial mechanical description. The technology and instruments are already available and applied on Earth for oil and gas extraction and are hereby extrapolated into the lunar context[4].

---

[1] Jamanca-Lino, G. (2021). Space Resources Engineering: Ilmenite Deposits for Oxygen Production on the Moon. American Journal of Mining and Metallurgy, 6(1), 6-11.
[2] J. J. Papike, S. B. Simon "The lunar regolith: Chemistry, mineralogy, and petrology," Reviews of Geophysics. 1982.[2]A. Pio Rossi and S. van Gasselt, Planetary geology, vol. 47, no. 7. 2002.
[3] C. Guerra, "Stress and fracture prediction using geomechanical reservoir models - A case study from the Lower Magdalena Valley Basin, Colombia," 2019
[4] K. Seweryn et al., "Determining the geotechnical properties of planetary regolith using Low Velocity Penetrometers," Planet. Space Sci., vol. 99, pp. 70–83, 2014, doi: 10.1016/j.pss.2014.05.004.