**SPACE MINING AND IN-SITU MINERAL RESOURCE UTILIZATION.** G. Zhou[1] and A. A. Mardon[2], [1]University of California, Los Angeles (School of Engineering and Applied Science, Los Angeles, California, USA, gordzhou@ucla.edu) [2]Antarctic Institute of Canada (Suite 103, 11919-82 Street NW, Edmonton, Alberta, Canada, aamardon@yahoo.ca).

**Introduction:** Like many space exploration missions, cost is a determining factor. Transportation alone imposes a cost of $10,000 per kilogram for the entire mission making it simply not profitable or attractive to potential investors. A potential near-instantaneous solution would be to develop an asteroid mining economy developing of a human-commercial market. It is suggested that this scenario will create the economical and technological opportunities not available today. Future manned missions would require the use of native material and energy on celestial objects to support future human and robotic explorations. The process of collecting and processing usable native material is known as In-situ resource utilization (ISRU). Currently, space travelling require missions to carry life necessities such as air, food, water and habitable volume and shielding needed to sustain crew trips from Earth to interplanetary destinations. [1] The possibility of a mission depends on the deduced market value from commercial sale of the product. Engineering choices are identified; a matrix of mineralogy, product and process choices can be developed. [2] One major consideration in the process of obtaining energy and life supporting materials from the lunar surface is the identification and excavation of raw material. [3] Lunar soil is produced primarily by meteorite impacts on the surface. This process caused for mineral fragmentation with composition consisting of miscellaneous glasses, agglutinates and basaltic and brecciated lithic fragments. The natural specific gravity of lunar soil is said to be between the values of 2.90 and 3.24. [4]

Professor Xiangwu Zeng and his team at the NASA Glenn Research Center have developed a design calculation model to determine the excavation force based on basic principles of soil mechanics. Simulants with the properties of Apollo Regolith were used: the JSC1a fines, JSC1a very fines and the JSC1a. A hydrometer test was used to determine particle size. This test is based on Stoke's Equation.

Unlike traditional models, the Zeng model takes into account the ability to handle acceleration of the tool blade while other models assume constant velocity. It is also able to calculate passive earth pressure. [6] The model is based on the principles of basic soil mechanics and the parameters can be determined by soil tests. These include horizontal and vertical acceleration, soil blade friction angel and external friction angel. A relationship between the total excavation force, the passive earth pressure components and the side friction and the above variables are drawn.

**Conclusion:** The results find the Zeng model have high dependence on soil cohesion and therefore forms a linear relationship with the amount of excavation force needed for ISRU. The results will deviate from the actual lunar specimen as simulants were used for the experiments. The use of real samples may give a more accurate understanding of soil properties and experimental results.

**References:**

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