Morphologic and spectral characterization of regolith breakdown due to water ice

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Abstract. The low abundance and distribution of surface-exposed water ice on the Moon is unique among Solar System airless bodies and may be directly linked to its formation, evolution, and current geomorphological processes[1]. The need to study the presence of water on the Moon and how it interacts with the regolith is then necessary in understanding the formation and evolution of the Moon. This project aims to characterize the morphologic and spectral changes of lunar regolith simulants when exposed to varying concentrations of liquid water and freezing temperatures in order to better understand how water ice exists in and interacts with the lunar regolith environment. This motivation for this work is again obvious in the face of NASA's goal to establish a human presence there by the 2030s[2]. Three lunar regolith simulants will be mixed with increasing concentrations of liquid water in small batches of simulant. The samples will be sealed and placed in a freezer where temperature and humidity will be monitored. After freezing, the samples will be characterized and compared with their unaltered counterparts to assess the morphologic and spectral changes within the lunar simulants, and the nature in which these modifications present themselves over time. A sample mass of at least 2 g of simulant is necessary to obtain thermal infrared spectral characterizations. In accordance with what is necessary for spectral characterization of the samples, we will introduce 3-4 different concentrations of water between 0.02 g and 0.6 g[1] per 2 g increment of simulant. Once mixed, the samples will be placed into freezer storage. The environment in which the water-mixed samples are placed will be consistently monitored for any changes in temperature and relative humidity and left to freeze for at least a month and up to 12 months before any sample characterizations are performed. The unaltered and frozen simulants will be analyzed using a Cilas laser particle size analyzer, which will capture images of the assembly of particles. These images will be analyzed by the ExpertShape image analysis software included with the Cilas system, which will provide statistical analysis on multiple particle size and shape parameters to characterize any changes in the particle size distribution. Thermal infrared spectral measurements will be made under ambient and simulated lunar conditions through the use of the Planetary Analogue Surface Chamber for Asteroid and Lunar Environments (PASCALE) vacuum environment chamber, which has the capability to simulate the desired near-surface environments[3]. In the future, any differences in the measured size and/or shape parameters will be presented for each type of simulant and the respective concentrations of water added to them. These changes will then be related to changes in their thermal infrared signatures for further analysis.

[1] S. Li, et al., *Proceedings of the National Academy of Sciences, 115*, no. 36, 8907–8912, (2018).
[2] NASA, www.nasa.gov/sites/default/files/atoms/files/fy2021_ssssumm_budget_brief.pdf., (2020).
[3] K. L. Donaldson Hanna, et. al., *Journal of Geophysical Research Planets, 126,* no. 2, (2021).