GENERATING CRYOGENIC LUNAR SIMULANTS WITHIN THE PLANETARY EXPLORATION & ASTROMATERIALS RESEARCH LABORATORY Ernest K. Lewis[1], Cecilia L. Amick[2], Christopher L. Harris[2], Saunab Ghosh[2], Amber A. Turner[2], Crystal A. Mantilla[2], Kimberly K. Allums[3], Jeremy W. Boyce[4]

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Introduction: The Planetary Exploration & Astromaterials Research Laboratory (PEARL) aims to provides capabilities for the creation of—and research on—cryogenic lunar regolith simulants (CRS) containing surface volatile analytes. CRS represent regolith samples that might be collected from lunar Permanently Shadowed Regions (PSRs) during future missions. Handling CRS requires procedural and engineering development due to extremely cold (i.e. ≤ -196°C) working temperatures. However, there is an imperative to understand the physical and chemical alteration of samples during collection, transport, and curation processes throughout the Artemis missions [1]. The chemistries that will be encountered within the PSRs need to be understood based upon prior mission data analysis [2]. The ability to utilize these techniques provides future tests that could be relevant to planetary protection applications regarding future robotic sample return [3].

Simulated PSR samples—and CRS—are complex mixtures at cryogenic temperatures that require specific handling techniques to enable advanced curation and research efforts [4-11]. Several projects utilizing cryogenic simulant are in progress, including storage testing capabilities and a bank of analytical equipment for analysis of solid and gas species. Inert negative pressure glove boxes and chemical hoods provide capabilities for making the simulants under extremely cold and/or atmospherically controlled conditions.

Setup: The lunar highlands simulant, NU-LHT-4M, was used in these preliminary tests [14]. The regolith temperature was lowered to -196 °C using liquid nitrogen. The cold regolith was then combined with dry ice snow and spray deposited subsets of volatiles reported by Colaprete, et al. [2] to represent material that could be found within PSRs. Controlling the temperature of the materials while remaining in a nearly dry-nitrogen environment was done to attempt to limit the addition of condensed water from the atmosphere.

Results: Figure 1 shows a successful CRS sample produced in the PEARL. Developing the ability to generate icy regolith simulant and perform gas retention studies via universal gas analyzer (UGA) is underway.

***Figure 1**. Closeup (field of view ~ 10 cm by 10 cm) view of volatile-bearing cryogenic regolith simulant prepared using NU-LHT-4M. The regolith is combined with LCROSS surface volatile analogs. Adsorbed water crystals (white) can be seen on the outer surfaces of the regolith (grey)..*

Discussion: The ability to generate high-fidelity small volume samples has many advantages: For example, with one cm^3 of simulant, one can acquire: (1) surface morphology or spectroscopy data via SEM-EDS, TEM, or FTIR-ATR; or (2) volatile abundances and isotope ratios via UGA, GC-MS, etc. This will lead to insights into the alterations of icy regolith prior to PSR sample return. Essential sample collection, transportation, and handling procedures can be developed for successful collection and curation of these materials.

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