HIGH-FIDELITY REGOLITH SIMULANTS AT THE CLASS EXOLITH LAB. R. M. Havel\textsuperscript{1} (rhavel@knights.ucf.edu), Z. A. Landsman\textsuperscript{1} (zoe.landsman@ucf.edu), D. T. Brit\textsuperscript{1}, A. D. Metke\textsuperscript{1}, J. M. Long-Fox\textsuperscript{1}, K. Krol\textsuperscript{1}, A. P. Madison\textsuperscript{1}, L. M. Weber\textsuperscript{1}, A.-P. Dovali\textsuperscript{1}, \textsuperscript{1}University of Central Florida (4111 Libra Drive, Physical Sciences Bldg. Suite 430, Orlando, FL 32816)

**Introduction:** The Center for Lunar & Asteroid Surface Science (CLASS) at the University of Central Florida is home to researchers whose goal is to understand the formation and evolution of the surfaces of rocky, airless bodies throughout our Solar System. By integrating interdisciplinary information (regoliths, impacts & dynamics, small-body observations, and physical properties of exploration targets) with educational outreach initiatives, CLASS supports future Solar System exploration initiatives. To support the ambitious goals of CLASS, the Exolith Lab, a non-profit organization, produces custom, high-fidelity Martian, Lunar, and asteroid regolith simulants as a service to the scientific community. With access to CLASS experts, the Exolith Lab production team has been able to produce tens of tons of regolith simulants since 2015. These regolith simulants have been used by researchers and students at government space agencies, the private aerospace sector, and universities across the globe to study plant growth, dust mitigation, water extraction, plume, and mechanical property testing, amongst other in-situ resource utilization (ISRU) related topics.

**Simulant Production:** In order to produce high-fidelity regolith simulants, minerals are sourced, tested, and processed before being mixed to yield the finished product. Once each mineral is sourced from an industrial supplier, its composition is verified using X-ray fluorescence (XRF) and X-ray diffraction (XRD) prior to processing. Processing of the raw materials (Figure 1) involves multiple stages of crushing and sieving to achieve the desired particle size distribution as well as angular particle shapes. Processed minerals are mixed according to simulant-specific recipes. Mixing procedures vary for each simulant and may include custom components such as simulated agglutinate glass. Simulants are regularly tested to ensure proper particle size distribution and shape.

**Simulants Available:** A variety of Martian, Lunar, and asteroid simulants are produced at the Exolith Lab. Regolith simulants and their variants are produced to replicate mineralogy, bulk chemistry, particle size distribution, volatile release, and derivative properties.

**Lunar Simulants:** LMS-1 Lunar Mare Simulant, LMS-1D Lunar Mare Dust Simulant, LHS-1 Lunar Highlands Simulant, LHS-1D Lunar Highland Dust Simulant, LHS-1-25A Lunar Highlands Agglutinated Simulant. Described in Cannon and Brit, 2019 [1].

**Martian Simulants:** MGS-1S Mars Global Simulant, MGS-1S Sulfate ISRU, MGS-1C Clay ISRU, JEZ-1 Jezero Delta Simulant. Described in Cannon et al., 2019 [2].


**Phobos Simulants:** PGI-1 Phobos - Giant Impact, PCA-1 Phobos - Captured Asteroid. Described in Landsman et al., 2021 [4].

**Other Materials:** Highlands-composition Agglutinate Simulant

Recent, notable variations to Exolith Lab regolith simulants include fine-grained lunar dust simulants and agglutinated lunar simulants.

![Figure 1: Examples of mineral processing procedures and equipment. Steel balls used in production of dust simulants (left) and manual crushing used to reduce particle size (right).](image1)

![Figure 2: Exolith simulants CI (a), PGI-1 (b), MGS-1 (c), and LHS-1 (d).](image2)
**Exolith Services:** Customizations can be made to particle size range, mineralogy (e.g., inclusions of minor or trace minerals and organics), and shape (e.g. cobbles or blocks). We can accommodate bulk simulant orders for, e.g., test bed construction. Exolith Science Staff are available to consult on implementation of simulants in research and to develop custom simulants for projects.

**Simulant Characterization:** We are working to characterize the physical and geotechnical properties of Exolith simulants and share these results with the community on our website and in the scientific literature. Ongoing efforts include reflectance spectroscopy, magnetic susceptibility testing, rheology studies, slope forming and failure analyses [5], and direct shear testing [6,7].

**Contact Information:** The Exolith Lab office is located at 12354 Research Parkway, Orlando, FL 32826. The Exolith Lab team can be reached at exolith@ucf.edu. For more information or to request a consultation, please visit the Exolith Lab website (https://exolithsimulants.com/). For more information on CLASS at UCF, please visit (https://sciences.ucf.edu/class/about/).

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