NASA JSC's SIMULANT DEVELOPMENT LAB CAPABILITIES AND ARTEMIS TESTING. H.C. O'Brien[1], R.N. Kovtun[1], S.L. Simpson[1], and A.I. Ford[2], [1]Amentum – JETS II Contract, NASA Johnson Space Center (hannah.c.obrien@nasa.gov), [2]NASA Johnson Space Center (Nasa Lyndon B. Johnson Space Center 2101 NASA Parkway Houston, TX 77058, anastasia.i.ford@nasa.gov).

Introduction: The Simulant Development Lab (SDL) is a multifunctional collaborative workspace that supports the development, curation, analysis, testing, and distribution of planetary regolith simulants – including lunar, Martian, asteroidal, and other granular materials. The lab provides a multidisciplinary setting for scientific characterization of simulant physical properties and for engineering evaluations conducted with simulant test beds. To enable this work, the SDL curates and maintains a stock of more than 35 metric tons of simulant material. To evaluate these materials and support testing goals, the lab is equipped with a comprehensive suite of processing tools and analytical instruments. These capabilities enable the SDL's mission at NASA's Johnson Space Center to distribute, develop, process, characterize, and test regolith simulants for mission relevant applications [1].

Through controlled and repeatable testing environments that replicate the physical and compositional properties of lunar regolith, the SDL supports Artemis hardware maturation [1], providing safe, Earth-based analogs for evaluating systems that must withstand regolith dust interactions, physical wear and abrasion, and operational loads [1]. The facility's extensive simulant inventory and integrated geological and engineering test infrastructure accelerate technology readiness for Artemis and future exploration campaigns (e.g., future crewed or robotic missions to Mars) [1].

Methods and Capabilities: The SDL's processing capabilities allow precise control of simulant particle size, distribution, and compositional characteristics. The SDL maintains the following material processing equipment: Gilson BO-350S 7ft³ Stainless Steel Interior Bench Oven (for thermal conditioning and drying of simulants prior to vacuum chamber testing), Gilson LC-37 Bico Badger Jaw Crusher, Pavestone JAC12CE Rock Crusher, Gilson LC-53 Bico Pulverizer, Gilson LCA-91 Dust Enclosure Bench, Gilson LC-91 1 Tier Jar Mill, Gilson SS-15D Gilson 8in Sieve Shaker, Gilson 8in Vibratory Sieve Shaker, Readco Kurimoto RK Labmaster Mixer, and Gilson Mechanical Soil Compactor [1]. Analytical tools in the facility support physical properties evaluation aligned with engineering performance needs. Some of these analytical instruments in the lab include: Microtrac Sync Wet/Dry Multi Laser Diffraction Particle Size Analyzer (Range: 0.01 – 2,000 microns), Keyence VHX-7000 Series Digital Microscope, Bartington MS2B Dual Frequency Sensor + MS3 Meter (Magnetic Susceptibility), and a Gilson Standard Pneumatic Direct Shear Machine. The lab also houses a variety of sieves, tumblers, a shear vane, two cone penetrometers, a density drive tube, and a density sand cone for physical, geotechnical, and mechanical analysis of simulants.

Integrated Testing: The SDL enables integrated testing across a wide range of exploration hardware and mission scenarios [1]. Testbeds support mechanical, thermal, electrical, and operational evaluations of components and systems designed for lunar surface deployment [1]. The facility's high volume simulant inventory, coupled with adaptable processing and workflows, and modifiable testing gloveboxes and testbeds, supports repeatable test campaigns for engineering verification and validation, contributing to improved fidelity in technology maturation pathways [3].

Testing Applications: The SDL supports Artemis relevant activities including dust-mitigation testing [5], geology tools testing (*Image 1*), hardware performance evaluations [6], soft goods abrasion and puncture resistance testing (*Image 2*) [7], human-health dust-exposure research [2], electronics resilience studies (*Image 3*), ISRU technology development [8], astronaut training, sample-return mission planning, environmental testing, and rover-mobility assessments [9]. These applications collectively enable mission critical insights for system design, risk reduction, and operational preparation for Artemis surface missions.

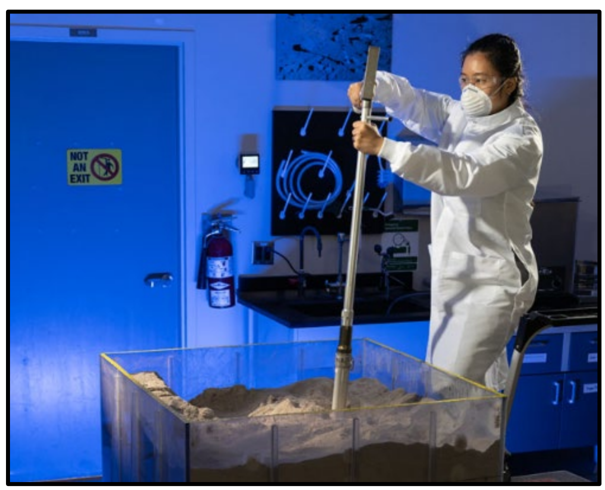

Image 1: Tools Engineer Yisha Ng hammers a Drive Tube into a densified lunar simulant testing bin, collecting a core sample of simulant material. (tools used: Hammer, Extension Handle, Drive Tube from government reference design tool kit).

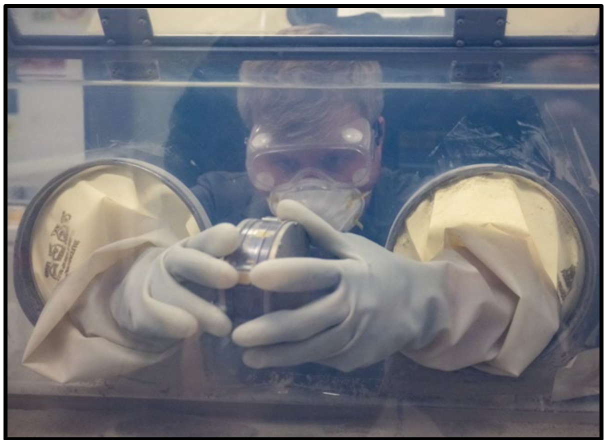

Image 2: Test Engineer James O'Hara examines an astronaut glove wrist connector seal in a dusty lunar simulant environment in a glovebox in the SDL.

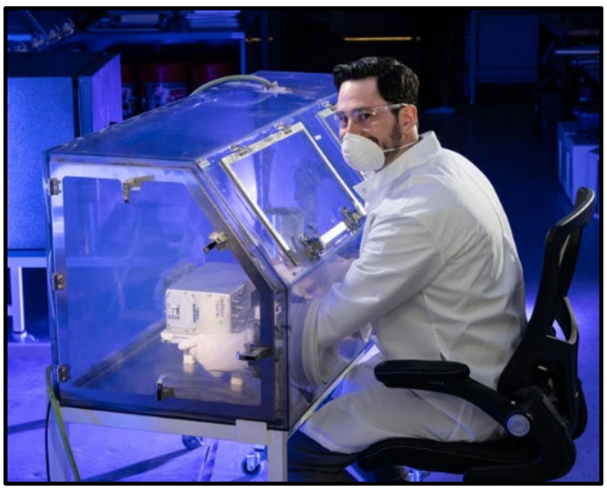

Image 3: Test Engineer Jason Miller operates an Anomaly Gas Analyzer to discover how aerosolized lunar simulant affects the internal sensors and electronics. Lunar simulant is aerosolized via a TOPAS dust disperser within the glove box.

Safety and Compliance: The SDL implements strict engineering controls, personal protective equipment, and facility protocols to manage dust hazards, especially crystalline silica [2]. Specialized dust handling and environmental controls ensure safe processing and testing of crystalline silica-bearing materials, following NASA's implementation of the NIOSH Hierarchy of Controls for exposure mitigation [2]. Ventilation, containment systems, and procedural controls align with OSHA standards and NASA health guidance [4].

Simulant User's Guide and the Simulant Advisory Committee: Guidance for simulant fidelity and standardization aligns with the Lunar Regolith Simulant User's Guide [3], which was published in collaboration with the SDL. The LSII Simulant Advisory Committee (SAC) [4] provides an agency-wide forum for researchers, vendors, and testing teams to engage subject-matter experts and coordinate simulant-related needs.

Recommendations and Ongoing Work: The SDL supports a structured approach to simulant selection based on test purpose and TRL informed by the Lunar Simulant User's Guide [3] and LSII Simulant Advisory Committee updates [4]. Continued collaborative development, support, and testing is focused on high fidelity simulants matched to Artemis surface environments, and future exploration campaigns to Mars [10]. For groups or individuals interested in further discussing how the SDL can support your testing needs and questions, please reach out to the authors.

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