MINERALOGICALLY ACCURATE SIMULANTS FOR LUNAR ISRU, AND STRATEGIC REGOLITH PROCESSING. K. M. Cannon[1] and D. T. Britt[1], University of Central Florida, Department of Physics. 4111 Libra Drive, Physical Sciences Building 430, Orlando FL 32816. Email: cannon@ucf.edu.

Introduction: Regolith simulants have been in wide use since the run-up to the Apollo missions [1-3]. These materials are never perfect replicas of lunar soil, but serve as stand-ins to do basic science and to mature technologies for future exploration, especially ISRU.

Historically, the vast majority of lunar simulants (http://sciences.ucf.edu/class/planetary-simulant-database/) consisted of basalt ground into a powder. Almost all focus was put on the particle size and bulk chemistry. In a survey conducted of simulant users, only 14% stated modal mineralogy was an important property of a simulant [4]. Here, we argue that mineralogically accurate simulants are necessary to properly test ISRU technologies, particularly for high-energy processes to melt regolith, extract oxygen, and to create metals, ceramics, and composites.

Mineralogy and ISRU: The first stages of lunar ISRU will likely consist of moving regolith for radiation shielding, compacting it to construct landing pads/roads, and extracting ice from polar regions. In most of these cases the granular mechanics of regolith are paramount, and low-fidelity simulants made from crushed basalt and anorthosite may be suitable in these cases. However, the next stages of ISRU will involve higher energy inputs and intensive processing to drive useful chemical reactions. Because minerals are the basic building blocks of planetary materials, the unique combination of minerals present in lunar materials will dictate their properties and behavior: this includes optical, magnetic, thermophysical, and chemical reactivity. Only mineralogically accurate simulants will be useful to properly develop, test, and validate technologies needed for advanced ISRU processes.

Mineral-based Simulants: The Center for Lunar and Asteroid Surface Science (CLASS) at UCF has absorbed the former Deep Space Industries regolith simulant operation and rebranded it as the Exolith Lab. The lab consists of a warehouse facility in Orlando where we are producing and distributing bulk quantities of regolith simulants as a not-for-profit effort. We have developed two root mineral-based simulants (Fig. 1), the Lunar Highlands Simulant (LHS-1) and the Lunar Mare Simulant (LMS-1). These are based respectively on the clean highlands soil 67461, and the clean mare soil 24999. We have also created a frozen volatile-bearing highlands simulant (FROST-Y) and a non-mineralogical silicate dust simulant (DUST-Y).

Fig. 1. LHS-1 and LMS-1 Lunar simulants.

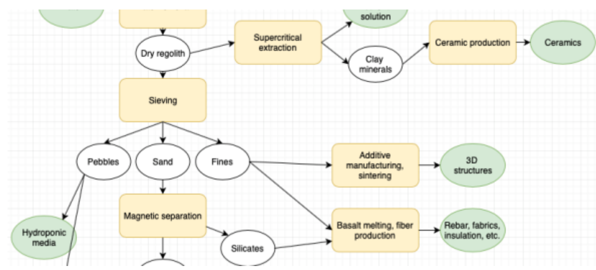

Fig. 2. Portion of the regolith processing framework.

Strategic Regolith Processing: Most ISRU processes will require filtering bulk regolith to separate out a particular particle size fraction or compositional component. What will be done with the unused parts? In addition to useful outputs, waste products are also produced: where will they go? We are developing a conceptual framework (Fig. 2) to chain ISRU processed together to extract the most value out of bulk regolith on the Moon, and are using our mineral-based simulants to test out segments of these processing chains with a series of experiments.

References: [1] Salisbury J. W. (1964) *Air Force Spec. Rep.*, *20*. [2] McKay D. S. et al. (1994) *ASCE*, 857-866. [3] Battler M. M. and Spray J. G. (2009) *PSS*, *57*, 2128-2131. [4] McLemore C. (2009) *LEAG*.