REGOLITH CHARACTERIZATION IN SMALL-SCALE LABORATORY EXPERIMENTS. C. Dreyer[1,2], A. Abbud-Madrid[1,2], R. Dee[2], M. Horanyi[2], S. Kempf[2], T. Munsat[2], Z. Sternovsky[2] ([1]Center for Space Resources, Colorado School of Mines, [2]SSERVI Institute for Modeling Plasma, Atmospheres, and Cosmic Dust, University of Colorado)

Introduction: Motivated by the fact that cohesion between the regolith particles is non-negligible on small asteroids, terrestrial experiments will be developed that control for physical phenomenon of interest through the appropriate design of scaled experiments. Initial experiments have been carried out to probe the relation between gravity, cohesion and electrostatics by utilizing the Dusty Plasma Laboratory setups of SSERVI-IMPACT at the University of Colorado. A key focus of these experiments is the relative strength of cohesion as a function of relative grain size distribution. A recent hypothesis on the strength of rubble pile asteroids links the cohesive properties of fine material to the macroscopic strength of collections of boulders, with the regolith fines acting as a cement matrix that can strengthen otherwise cohesionless bonds between larger boulders. The proposed experiments will clarify the role that fines can have in strengthening aggregates in terms of the quantity and bond number of the smallest grains in the distribution. In addition to the electrostatics experiments, we will also test the mechanical strength of cohesive grains.

Laboratory setup: The ISRU experiments are designed as fundamental physical-science experiments that investigate generalized hardware, which in this discussion is referred to as simply a "probe", in contact with dusty and icy surfaces. Experiments address functionality of ISRU hardware in the operational environments of volatile-rich areas of the SSERVI target bodies. We will conduct experiments with the Regolith References Surfaces with composition varied from dry to icy and with geologically derived simulants (such as JSC-1a) for a select set of conditions. Generic hardware is chosen over hardware designed by specific developers so that results are applicable to a wide range of ISRU hardware and independent of any specific design. Experimental results will be communicated to system level technology developers through conferences and through an ISRU Industrial Partner Group so that findings can be quickly incorporated into mission planning and technology development. We propose to develop the ISRU Experimental Probe (IEP) apparatus shown in Fig.1. Experiments will be conducted in vacuum chambers at IMPACT in dusty plasma environments with mixtures of regolith and ice at cryogenic temperatures. Experiments will include several interchangeable probes attached to a multi-axis load cell on a three-axis translation stage. Probe interaction with surfaces will be recorded by video with diagnostics including force measurements, stage position, chamber pressure, residual gas analysis, dust impact sensors, surface and probe temperature, dispersed dust collectors, and charge mea- surements. Three probe designs will be developed: 1) penetrometer, i.e. a conical tip, 2) wedge, a triangular tip; and 3) a drill.

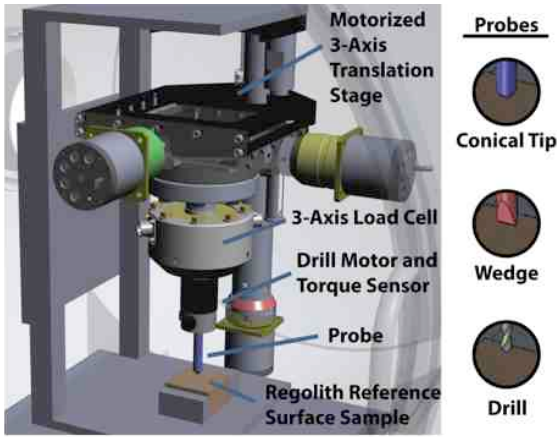

Figure 1. The ISRU Experimental Probe (IEP) sys- tem for study of the interaction of ISRU hardware with icy regolith surfaces. The Probe may be tipped by a cone, wedge, or simple drill. The Regolith Reference Surface will be positioned for UV and simulated solar wind exposure. Measurement of interaction forces dur- ing translation allow physical properties of the sample to be derived. Dust and gas generated by probe contact with the surface will be recorded with video, charged plates, and chamber pressure rise.

The IEP experiments are designed to examine surfaces under compression, sheer, and combined modes (drilling). The probes will be designed to function similarly to well established geotechnical tools such as the cone penetrometer, dynamic cone penetrometer, and shear vane penetrometer for which correlations to geomechanical properties are well established.

The IMPACT IEP work will contribute to the community of researchers developing geotechnical instruments for space exploration and research on extraterrestrial soil mechanics.