17th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Space Resources: Technologies, Systems, Missions and Policies (5)

Author: Mr. Roger X. Lenard
LPS, United States, rxlenard@gmail.com

EXPERIMENTAL RESULTS OF LONG-ROD PENETRATOR INTO SIMULATED LUNAR SURFACE AND SUBSURFACE CONDITIONS ESTIMATED TO BE WITHIN PERMANENTLY SHADOWED REGIONS

Abstract

From May through July 2018, a group of four University of New Mexico National Science Foundation STEP in-coming Juniors and officers of Zodiac Planetary Services conducted a series of analysis and experiments to ascertain issues associated with impacting various Lunar equivalent soil conditions simulating possible conditions on within the permanently shadowed regions (PSRs) of the lunar polar craters. The experimentation was to support the development of a system to be built by Zodiac Planetary Services to "prospect" the PSRs to determine makeup of the region with multiple sample returns [40 from various location] to establish "ground truth" of region's regolith composition. The questions are legendary about the makeup of the regolith for such valuable resources as volatiles, water, and ice. The objective of the local experiments with the students was to evaluate how surface and subsurface conditions (to a depth of 1 m) would effect the ability to gather samples using a gravity accelerated, hollow, long-rod penetrator. Analyses based on empirically derived formulae associated with Sandia National Laboratories' ground penetrator testing were use for initial assessments. These analyses were also used to size accelerometer devices whose data would be transmitted to the orbiting platofrm's command and data handling system to provide an assessment of subsurface strata, and to inform the platform when the penetrator had come to rest. Experimentally, a long rod penetrator was machined from a hollow tube of A500 steel, with a tip taper of 9o and a length of .9 meters. A series of four different lunar soil witness samples were generated representing two different conditions. All samples presumed the hydrogenous material in the PSRs was frozen water of cometary or asteroidal origin impacting the lunar surface under two conditions. One condition presumed that the impact velocity of the ice-bearing celestial object was insufficient to liquefy the entrained ice which subsequently shattered upon impact and mixed with the lunar surface regolith. The other condition presumed that the impactor velocity was sufficient to melt the ice which, when mixed with lunar regolith formed a solid aggregate. Several conclusions were reached by the student - Zodiac team that will lead to an improved approach to gather samples from the PSRs of the Moon.