Lunar Soil Simulants Cannot Reproduce Apollo Lunar Soils With Many Space Weathering Products.

Lawrence A. Taylor\(^1\) and Carle M. Pieters\(^2\)  
\(^1\)Planetary Geosciences Institute, Earth and Planetary Sciences Dept., The University of Tennessee, Knoxville, TN 37996; lataylor@utk.edu  
\(^2\)SSERVI - SEEED, Department of Geological Sciences, Brown University, Providence, Rhode Island.

Introduction – Since the Apollo Missions first brought back lunar rocks and soils to Earth, scientists and engineers have needed these lunar materials for their experiments. Yet, because they are a “National Treasure”, it has been particularly difficult for the engineering community to obtain samples of suitable size for their studies [1]. The various NASA-sponsored lunar sample committees (LSAPT, LAPST, CAPTEM) over the years have become more accommodating, yet they remain cautious in allocation of the size of samples that the engineers typically need (e.g., kg). This has naturally led to the development of many materials that reportedly simulate one or more of the physical and chemical properties, starting with Minnesota Lunar Simulant (MLS-1), followed some 20 years later by NASA’s versions of lunar soil - JSC-1 and more recently, JSC-1A. Impatient to get their studies accomplished and not always capable or knowledgeable enough to get some of these simulants, the world community, especially since 2004, has produced well over 50 additional simulants, many without the proper duplication of the correct properties. Much of these ineffective efforts have centered round a general lack of sufficient knowledge of the details of lunar soil engineering properties.

NASA has attempted to remedy the problem of lunar soil simulants, both in quality and quantity, with major endeavors since 2004, the magic year the junior President Bush declared that human exploration would extend to the Moon, then Mars, and Beyond. Marshall Space Flight Center established an effective lunar simulant “Clearing House” at MSFC, and began to supervise the production and distribution of lunar simulants, spending $Ms in their development of simulants through SBIR contracts. However, due in part to a deficiency of knowledge of the true lunar soil properties, many of these endeavors have only contributed more inefficiency in the generation of lunar simulants manufactured with the exact properties that duplicate the actual Apollo lunar soils. The properties that have been imposed upon the lunar regolith to produce the soils are all part of the complicated topic of “Space Weathering”, and we have not been able to duplicate several of these unique features.

Space Weathering – The collective processes that form and alter the soils on all airless bodies is called space weathering. Having originally gone to the Moon with our “terrestrial hats on”, it soon became apparent that the airless space on the Moon permitted an entirely different and foreign type of weathering processes to occur – e.g., it took us almost three (3) years to begin to understand the origin of the ferromagnetic properties of the soil – the effects of single-domain (later, nanophase) metallic Fe. Yet, the general scientific understanding of its origin took another 25 years, and we still investigate the details of nanophase Fe formation. It is just these space weathering properties that will be addressed in this talk.