CHEMICAL REACTIVITY OF LUNAR DUST RELEVANT TO HUMANS. E. Tranfield[1], J. C. Rask[1], C. McCrossin[1], W.T. Wallace[2], K. R. Kuhlman[3], L. Taylor[4], A. S. Jeevarajan[2], R. Kerschmann[1], D. J. Loftus[1]. [1]Space Biosciences Division, NASA Ames Research Center, Moffett Field, CA 94035 (erin.tranfield@nasa.gov); [2]Habitability and Environmental Factors Division, NASA Lyndon B. Johnson Space Center, Houston, TX 77058; [3]Planetary Science Institute, Tucson, AZ 81719; [4]Planetary Geosciences Institute, University of Tennessee, Knoxville, TN 37996.

Introduction: Analysis of Apollo era samples has provided a wealth of data about the basic structure and composition of lunar regolith. Diligent study over the last three decades has shown that lunar regolith is a complex material, formed and modified by continuous micrometeorite impacts on the lunar surface. High velocity impacts cause localized vaporization of lunar regolith which quickly re-condenses on surrounding regolith resulting in agglutinates with high surface area, complicated shapes, and sharp jagged edges. The bulk composition of these materials is about 50% SiO_2, 15% Al_2O_3, 10% CaO, 10% MgO and 5-15% iron. The iron component consists of both iron oxide and metallic (fully reduced) iron, in nanoscale deposits ("nanophase iron") a form of iron not present in terrestrial minerals.

Based solely on mineral composition, we expect that lunar regolith will exhibit substantial chemical reactivity. On the Moon's surface the problem is even more complex, since lunar regolith is exposed to intense UV radiation, as well as three different sources of particle radiation. The highest fluence particle radiation is from the solar wind, which consists of low-energy (keV) protons and helium. Also of concern is solar particle event radiation, which consists of a spectrum of MeV-range protons. Lastly, Galactic Cosmic Radiation, which consists of higher energy protons (1GeV) and low fluences of heavy ions (HZE particles), may also have an effect on lunar regolith. Radiation effects undoubtedly alter the chemistry of lunar regolith especially on particle surfaces, and these effects will likely have significant implications for lunar dust (a fine fraction of lunar regolith) interactions with both biological systems and non-biological systems.

The Challenge: While the importance of Apollo era samples cannot be underestimated, it is now clear that specimens in the curation facility at NASA JSC have significant limitations. Some of the Apollo era samples became contaminated with oxygen and water from ambient air due to an imperfect vacuum in the specimen containers. Water and oxygen are expected to interact with surface radicals and other reactive sites on lunar dust, with the result that the chemical reactivity, as it existed on the lunar surface, has been lost. Even in the absence of contamination, the long duration of storage has likely resulted in changes in the surface chemistry of the lunar samples. Since the chemical reactivity of lunar dust may be the most important feature that determines its interaction with biological systems, toxicology experiments must include reactivation of lunar dust. The issue of chemical reactivity is also important for non-human biological systems, such as small rodents, cyanobacteria, and plants.

Strategies for "reactivating" lunar regolith may include exposure to hydrogen and helium plasmas, UV exposure, and proton bombardment (e.g. ion implantation). Work in these areas is ongoing at NASA and the Planetary Science Institute. A difficulty that we face is that critical measurements of the chemical reactivity of lunar dust were never carried out during the Apollo program. As such, it is not possible to compare the reactivation methods we are using with a known measure of the chemical reactivity of pristine lunar dust.

A Potential Solution: At ARC and JSC, we have been using a simple chemical assay to evaluate the chemical reactivity of lunar dust (1). The assay measures the potential for surface radicals on lunar dust to generate hydroxyl radicals upon exposure to water. The assay involves the conversion of terepthalate (non-fluorescent) to hydroxyterepthalate (fluorescent), in the presence of hydroxyl radicals. Hence, simple fluorescence detection systems can be used as an indicator of surface radicals on lunar dust. This assay provides us with a method for evaluating different techniques of lunar dust reactivation, as well as a method for characterizing the decay (passivation) of this reactivated state in a habitat like environment.

To fully validate our reactivation methods, we need to use pristine lunar dust to calibrate the terepthalate assay. To this end, we have designed an instrument, LunaChem, that can be delivered to the lunar surface as a secondary payload, so that an analysis of lunar dust can be performed using the terepthalate assay *in situ*. LunaChem includes a robotic arm for acquisition of lunar regolith, microfluidics for reagent dispensing, and optical components for measuring fluorescence. The results of *in situ* analysis of lunar dust chemical reactivity will clarify critical issues pertinent to lunar dust toxicology, and will provide fundamental understanding of the interaction of biological systems with lunar regolith.

(1) W.T. Wallace, L. Taylor, B. Cooper, and A.S. Jeevarajan, Earth Planet. Sci. Lett. (2008) submitted.