MODELING THE STABILITY OF VOLATILE DEPOSITS IN LUNAR COLD TRAPS.

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Introduction: There are several mechanisms acting at the cold traps that can alter the inventory of volatiles there. Primarily, the lunar surface is bombarded by meteoroids which impact, melt, process, and redistribute the regolith [1]. Further, solar wind and magnetospheric ion fluxes are allowed limited access onto the regions in permanent shadow. Also, although cold traps are in the permanent shadow of the Sun, there is a small flux of radiation incident on the regions from interstellar sources. We investigate the effects of these space weathering processes on a de-posit of volatiles in a lunar cold trap through simulations.

Like Arnold [2], we simulate the development of a column of material near the surface of the Moon resulting from space weathering. This simulation treats a column of material at a lunar cold trap and focuses on the hydrogen content of the column. We model space weathering processes on several time and spatial scales to simulate the constant rain of micrometeoroids as well as sporadic larger impactors occurring near the cold traps to determine the retention efficiency of the cold traps. We perform the Monte Carlo simulation over many columns of material to determine the expectation value for hydrogen content of the top few meters of soil for comparison with Lunar Prospector neutron data.

Each column is initialized with a random starting depth profile of hydrogen content assuming very immature soil. Time is allowed to run for 1 billion years and all changes to the column are calculated. An impactor flux from Gault et al. [3] is imposed to determine the timing and location of all nearby impacts. Nearby impacts excavate material from the column, exposing material from depth. More distant impacts cover the column with an ejecta blanket with a size and time dependent maturity value. In between impacts, the competing effects of sublimation, new deposition, and churning are simulated.

The constant modification of the lunar regolith from space weathering churns the lunar soil. As a result, continuous strata are not expected to be found if one were to take core samples in a cold trap. Space weathering processes act on several scale lengths in a non-unique way. However, we show how the hydrogen content would vary with depth following certain events. In the future event of core samples taken from lunar cold traps, this information is useful in determining the possible history of those columns.

Using the steady state delivery rate of water vapor to the lunar cold traps from Crider and Vondrak [4], we find that the removal rate from space weathering processes does not exceed the rate at which volatiles are delivered to the cold traps on average. Together with the steady migration of hydrogen released from the soil elsewhere on the Moon, the predicted hydrogen content of the topmost meter of regolith in cold traps is within a factor of 2 of the value measured by the LP Neutron Spectrometer [5]. Therefore, release of implanted solar wind hydrogen by sputtering and micrometeoroid bombardment is a sufficient source for the hydrogen at the lunar poles.

That the solar wind is a sufficient source for the cold trap hydrogen is puzzling because comets have impacted the Moon in its history and, thereby, delivered additional water to the Moon. However, this additional source of water is not required based on the current estimate. It is possible that cometary impacts produce a hot enough plume that the water quickly escapes from the system.

References: [1] Watson K. et al. (1961) *JGR 66,* 3033; Arnold J. R. (1979) *JGR 84*, 5659. [2] Arnold, JR (1975) *Proc. Lun. Sci Conf. 6th,* 2375. [3] Gault D. E. et al. (1972) *Geochim. Cosmochim. Act. 3*, 2713 [4] Crider D. H. and Vondrak R. R. (2002) *Adv. Space. Res.* in press [5] Feldman W. C. et al. (2001) *JGR 106,* 23231.