REALISTIC MODELS OF ICE DISTRIBUTION ON THE LUNAR SUB-SURFACE.

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Introduction: In the context of the Lunar Science Institute "Scientific and Exploration of the Moon'" we study models of ice distribution in the lunar sub-surface. The main aim of this research is to constrain such models with state-of-art lunar data and gain a better understanding of water ice dynamics in the lunar sub-surface throughout the lunar history.

Although controversial in its physical form (e.g., crystalline as oppose to amorphous) there is increasing evidence of water ice at the lunar poles "cold traps". Such locales plausibly hold not only water ice but also other volatiles of economic and scientific value. Future lunar missions may include rovers with the ability to sample materials from the top meter of the surface. This requires the identification of regions to explore and sample with the highest likelihood of finding water ice. Cold traps are the most plausible candidates.

To understand the current distribution of water ice in the polar neighborhood one needs to study the dynamics of water in the top layer of regolith throughout lunar history. In a seminal paper [1] investigated the migration of H_2O molecules in the lunar regolith by random hops within the pores. They discussed several scenarios for subsurface accumulation. In the current study, we propose to apply a more realistic diffusion process than the ones used in [1] to regions of the lunar surface where the measured temperatures and the hydrogen maps, as measured by Lunar Prospector, indicate that the presence of water ice has been stable over the last few billion years.

Subsurface water ice migration and stability: Water molecules move through the interstices in a porous regolith. In the Knudsen diffusion regime, the molecules do nor interact with one another, but move in straight lines between points on the pore channel surface. Upon collision with the surface, a molecule adsorbs for some time, *the residence time*, that depends on the local temperature. A general pore with an irregular surface can be mentally constructed by a perturbation on top of a pore with a smooth surface. Along the pore, there are a large number of voids with a power law size distribution within the fractal range which describes the regolith at the Apollo sites [2]. In order to produce more realistic water ice distributions the effects of the all grain surface specifications are included in our novel analysis.

An accurate understanding of the temperature profile in the sub-surface is central to the modelling of the water ice distribution in depth since the molecules' mobility is controlled not only by the pore size and geometry but also by the residence time. We use temperature maps constrained by the latest LRO Diviner measurements (nighttime surface temperatures for the north pole are shown below) [3]. However, besides the physical conditions for ice stability one needs also to consider the locales where there has been a delivery of volatiles over the last two and half billion years. The best candidates are the regions that present the highest hydrogen concentrations as seen by the Lunar Prospector Neutron Spectrometer [4]. Currently, we are considering including weathering and/or gardening in our models [5].

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