SOUTH POLE HYDROGEN DISTRIBUTIONS FOR PRESENT LUNAR CONDITIONS.

R. C. Elphic[1], D. A. Paige[2], M. A. Siegler[2], V. R. Eke[3], L. F. A. Teodoro[4], and D. J. Lawrence[5], [1]Planetary Systems Branch, NASA Ames Research Center, MS 245-3, Moffett Field, CA, 94035-1000, [2]Earth and Space Sciences Dept, University of California, Los Angeles, CA 90024, [3]Institute for Computational Cosmology, Physics Department, Durham University, Science Laboratories, South Road, Durham DH1 3LE, UK, [4]ELORET Corp., Planetary Systems Branch, Space Sciences and Astrobiology Division, MS 245-3, NASA Ames Research Center, Moffett Field, CA 94035-1000, [5]Johns Hopkins University Applied Physics Laboratory, MP3-E104, 11100 Johns Hopkins Road, Laurel, MD 20723.

Introduction: The poles of the Moon evidently harbor enhanced concentrations of hydrogen [1,2]. The hydrogen could be in several chemical and physical forms. In addition to solar wind implanted hydrogen, seen in returned samples, there may be stably cold-trapped ice in locations of sufficiently low subsurface temperatures. The lack of polar topography data prevented the accurate estimation of lighting conditions and hence annualized near-surface regolith temperatures. Nevertheless, using imagery from Clementine it was possible to roughly estimate permanently-shadowed regions (PSRs), and to perform image reconstructions of the Lunar Prospector epithermal neutron flux maps [3,4].

A key assumption in the image reconstruction analyses was that any location that was *not* a PSR could only have solar wind hydrogen abundances (<200 ppm), whereas PSRs themselves could have any amount of hydrogen that the fit required, from 100% to zero. Preliminary Kaguya/LALT topography data provided greatly improved estimates of PSR locations [5], and additional reconstructions were performed under the same assumptions. Several PSRs were identified as containing > 1 wt% water-equivalent hydrogen (WEH). These reconstructions are excellent, statistically consistent fits to the model. In fact, reconstructions that did not treat the PSRs at all were statistically inferior to those that decoupled PSRs from non-PSRs. Nevertheless, models are only as good as their assumptions.

New Measurements: New results from Chandrayaan and NASA's Lunar Reconnaissance Orbiter are revising our picture of conditions at the lunar poles. Data from the Diviner Lunar Radiometer Experiment indicate extensive areas of very low temperatures (<100K) in the south polar region, and these areas are not limited to locations of permanent shadow [6]. Such cold terrain has subsurface temperatures low enough to keep shallow buried ice stable for 1 Ga or longer [7]. Moreover, Earth-based telescopic spectral reflectance observations [8] have suggested the possible presence of phyllosilicates in the near-polar regions. Both of these results indicate that the confinement of potentially high hydrogen concentrations to permanent shadow is overly restrictive. The Lunar Prospector epithermal data can now be used to fit a model that includes these three possible hydrogen repositories.

Modeling: Permanently-shadowed regions comprise a subset of the more areally extensive terrains that have annualized subsurface temperatures low enough to permit stable water ice. For that reason, reconstructions are likely to have lower average hydrogen abundance than in the PSR-only reconstructions. In effect, the same amount of hydrogen is placed into a larger area, resulting in lower average abundances.

We will present the results of performing pixon reconstructions using new spatial constraints, such as regions of near-subsurface ice stability, and compare these with our previous results. Also under investigation are topographic effects on neutron leakage flux and the expected signatures of present-day relict ice resulting from the emplacement of abundant polar ice following a cometary impact in the distant past.

References: [1] Feldman, W.C., et al. (1998) *Science* 281:1496–1500. [2] Feldman, W.C. et al. (2000) *J. Geophys. Res.* 105:4175–4196. [3] Elphic R. C. et al. (2007) *Geophys. Res. Lett.,* 34, L13204, doi:10.1029/2007GL029954. [4] Eke, V. R. et al. (2009) *Icarus, 200,* 12-18, ISSN 0019-1035, doi: 10.1016/j.icarus.2008.10.013. [5] Noda, H. et al. (2008) *Geophys. Res. Lett., 35*, L24203, doi:10.1029/ 2008GL035692. [6] Paige, D. A. et al. (2009) http://www.diviner.ucla.edu/blog/?p=123 [7] Andreas, E. (2006) doi:10.1016/ j.icarus.2006.08.024. [8] Vilas, F. et al. (2008) *Earth, Planets, and Space, 60*, 67-74.