A REVIEW OF DIURNALLY-VARYING LUNAR HYDRATION SIGNATURES. Amanda R. Hendrix[1], [1]Planetary Science Institute, Tucson, AZ; arh@psi.edu.

Introduction & Background: Since the initial detections of surficial non-polar lunar hydration [1, 2, 3, 4], several sets of observations indicate a diurnally-varying nature to the hydration. In this review, I summarize what is currently understood about these results and their implications for the lunar water cycle.

Several datasets in the last 1-2 decades point to water and hydrated species on the Moon. Galileo Solid State Imager (SSI) broad band spectra [1, 5] first suggested the presence of water-bearing minerals (indicated by the presence of the broad 0.7 μm charge transfer band in oxidized iron) near the lunar South Pole. The Moon Mineralogy Mapper (M3) on Chandrayaan-1 [2] measured the spectral signatures of adsorbed water (near 3 μm) and hydroxyl (near 2.8 μm), finding them to be strongest at high latitudes and at several fresh craters. Initially, thermal emission precluded the detection of OH/H_2O at low latitudes; a re-processing of the M3 data [6] showed that the water-related absorptions appear also at lower latitudes and may vary with time of day [7]. The M3 detections were verified using Cassini Visual and Infrared Mapping Spectrometer (VIMS) data [4] and Deep Impact data [3], which showed the OH and H_2O absorptions to vary with temperature (related to time of day).

A likely scenario for the production of surficial lunar hydration [e.g. 16, 17, 5] is that solar wind protons interact with the lunar regolith, reacting with iron oxide (FeO) to form H_2O and/or OH. Studies with lunar samples [e.g. 18] indicate that activation energy of lunar regolith grain sites is important in allowing the adsorption of OH, and the activation energy may be related to the amount of weathering experienced by the surface.

Since these initial results, newer analyses have been performed, though a consensus on extent of diurnal effect, as well as hydration abundance, type and depth has yet to be reached.

More Recent Analyses: *Moon Mineralogy Mapper (M3):* The M3 data have been further studied, applying new versions of thermal corrections, with varying results regarding diurnal effects. OH and H_2O abundances have been shown to increase with latitude [8], with water abundance varying by ~200 ppm over a lunar day. In contrast, use of a different thermal correction [9] results in the indication of widespread OH/H_2O across the surface with no diurnal effect.

Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP): Besides the OH/H_2O features near 3 μm, the far-ultraviolet (FUV) hosts a strong H_2O absorption edge near 165 nm, which could be observed at the Moon if H_2O (and possibly OH) were mixed with (or perhaps bound to) lunar regolith grains [10], in the top layer of the regolith, due to the shallow sensing depths of the FUV. Observing in the 165 nm region, LRO LAMP data have been reported to indicate a diurnally-varying effect [10, 11]; this remains under investigation.

LRO Lunar Exploration Neutron Detector (LEND): The LEND instrument measures epithermal neutrons and has detected suppressions associated with permanently shadowed regions near the South Pole, indicating elevated hydrogenation in the regolith down to ~50 cm and below. Such suppressions have also been observed, consistent with the presence of diurnally varying hydrogen in the regolith near the equator [19]; the signature could also be related to variations in regolith temperature.

LRO Cosmic Ray Telescope for the Effects of Radiation (CRaTER): CRaTER data have been used to relate the yield of energetic proton radiation ("albedo") coming from the lunar regolith due to bombardment by galactic cosmic rays (GCRs) to hydrogenation of the lunar regolith. Initial studies [12] indicate increased amounts of hydrogenation (in the upper 1-10 cm of the regolith) at high latitudes. More recent work [13] may indicate a diurnal component to the signature, by observing toward the horizon as compared with the nadir direction. A potential enhancement in proton albedo is seen toward the morning terminator as compared with the evening terminator, consistent with models [14].

Transport to the Polar Regions: The diurnally-varying signatures discussed above occur largely at lower latitudes – but the apparent movement of the OH/H_2O (through the regolith and/or through the exosphere [15]) allows for hydrating species to eventually wind up in the polar regions where they are more stable due to the lower temperatures.

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