

DAYTIME DEPENDENCE OF THE NEAR-INFRARED LUNAR WATER/HYDROXYL ABSORPTION

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Introduction: Analysis of the absorption band at wavelengths around 2.8-3.0 μm apparent in near-infrared spectral reflectance data of the Moon Mineralogy Mapper (M³) instrument [1, 2] has revealed the occurrence of lunar surficial water and/or hydroxyl (OH) [2]. Adsorption of protons from the solar wind and subsequent chemical reactions with oxygen atoms in the lunar surface material as proposed e.g. in [3, 4] are a widely accepted explanation of the origin of this surficial water/OH. An early description of daytime dependent variations of the water/OH absorption depth has been provided in [4].

In this study we analyze the daytime dependent behavior of the OH absorption depth for a set of lunar highland regions for which M³ data acquired at 4-8 different local daytimes are available. These regions are located both near the equator and at high latitudes. In particular, the latitude dependence of the pattern of the OH absorption depth variations during the lunar day is examined.

Data and Method: Based on the M³ level-1B spectral radiance data published on the PDS (pds-imaging.jpl.nasa.gov/volumes/m3.html) we constructed maps of the spectral reflectance for our study regions using the framework of [5].

The spectral radiances in the wavelength range covered by the lunar water/OH absorption are strongly affected by a thermal emission component, which needs to be removed based on an accurate estimation of the surface temperature. Since the thermal removal of the M³ level-2 spectral radiance data on the PDS, for which the well-known approach of [6] has been used [7], is meanwhile considered to be inaccurate (e.g. [8]), we applied the method introduced in [5]. This method extends the thermal equilibrium based approach of [9] by iteratively adjusting the surface temperature and spectral reflectance, and by providing a correction for the surface roughness similar to [10].

Based on the obtained normalized reflectance spectra, the OH band depth integrated over M³ channels 78-84 between 2697 and 2936 nm (here termed OHIBD) is computed [5]. For each study area we constructed a set of OHIBD maps for all daytimes with available corresponding M³ data.

Results and discussion: In highland regions located at moderate and high latitudes $>45^\circ$, the maximal OHIBD is observed in the early morning around

06:00-08:00 local time. Already within the next 1-2 lunar hours the OHIBD decreases and reaches its minimum value around midday. Typically, the minimum OHIBD value amounts to less than 50% of the maximum value. In the afternoon the OHIBD tends to increase again, but since for only a few of our study regions M³ data acquired under local evening conditions are available, there is no clear evidence for the typical OHIBD level reached in the evening. A mechanism that might explain the observed behavior is the adsorption of solar wind protons [3, 4] reacting with oxygen atoms in the lunar surface minerals [3], counteracted by diffusion [3] and photolysis [5, 11] of the formed OH/water.

In contrast to e.g. [2], we observe also in highland regions located near the equator at low latitudes $<20^\circ$ a significant OHIBD level, in consistence with [8]. In this latitude range the OHIBD shows only insignificant variations with local time, where the OHIBD level is not far below the level observed at high latitudes.

Our observation that the OHIBD level never drops down to zero independent of the latitude suggests the presence of a spectrally detectable strongly bounded water/OH component as proposed e.g. in [8], which might add up with the variable, daytime-dependent component to generate the observed OHIBD behavior.

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