COMPARING THERMALLY CORRECTED SPECTRA FROM THE MOON MINERALOGY MAPPER (M³). A.M. Dapremont1, J.L. Bishop2, C. Wöhler3, K.S. Wohlfarth3, M. Parente4, R. Klima4, and J. Flahaut5. 1The Johns Hopkins Applied Physics Laboratory, Laurel, MD, USA (Angela.Dapremont@jhuapl.edu). 2SETI Institute, Mountain View, CA, USA. 3 TU Dortmund University, Dortmund, Germany. 4University of Massachusetts, Amherst, MA, USA. 5CRPG-CNRS, Vandœuvre-lès-Nancy, France.

Introduction: Investigating the presence and characteristics of lunar volatiles is important for understanding the geologic history of the Moon, and has implications for determining future resource utilization locations. An absorption band near 3 microns (~2.7-3 μm) indicating the presence of hydroxyl (OH) and/or H2O-bearing materials on the lunar surface has been identified using several spectral datasets (e.g., Deep Impact, Cassini, and M³) [1-3]. M³ detected hydrated materials across the Moon and revealed a latitudinal dependence on the ~3 μm absorption feature, with strengthening toward higher lunar latitudes [2]. Additional studies supported the ubiquitous presence of ~3 μm region absorption(s) due to adsorbed OH⁻ or adsorbed H2O produced via solar wind H⁺ interaction with oxygen in lunar regolith silicates [e.g., 4]. Local enhancements of potentially endogenous lunar water based on ~3 μm region absorptions have also been detected; for example, a broad absorption near 2.8 μm attributed to OH⁻ at Bullialdus crater [5] and a OH⁻/H₂O anomaly associated with farside presumed pyroclastic deposits [e.g., 6].

Thermal emission challenges interpretations of the ~3 μm region band absorption positions and shapes. Recent efforts [7-9] have refined the thermal correction approach initially applied to M³ data [10], with the objective of investigating time of day changes on the lunar surface both locally [8] and globally [9].

Here, we present a comparison of thermally corrected M³ visible/near-infrared (VNIR; 0.46 – 3.0 μm) spectra at a lunar highlands study region (Figs. 1-3). The standard M³-derived empirical approximation [10] and a refined correction technique [7,9] were applied to study region images to assess correction influence on >2.5 μm region observations with implications for interpreting hydrated mineral presence on the lunar surface.

Methods: The M³ imaging spectrometer operated in two modes: global (140 m/pixel, 85 spectral channels, 20-40 nm spectral sampling) and targeted (70 m/pixel, 260 spectral channels, 10 nm spectral sampling) [11]. M³ global and targeted data strips with the applied thermal correction of [10] were acquired from NASA’s Planetary Data System (PDS). Gaofen-4, Lunar Reconnaissance Orbiter (LRO) Diviner, and BepiColombo Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS) mission data [7,9] were used to produce refined thermal correction global images (100 m/pixel) of the study region. Spectral radiances were multiplied by scaling factors of 1.5 (1a) and 2.0 (1b) to produce reprocessed refined thermal correction global images to assess ~3 μm band changes based on modification of M³ radiances to additional mission data (e.g., Kaguya Spectral Profiler, Clementine). Spectra were acquired from regions of interest (ROIs) at crater rim and wall materials from similar sites in 5 differently prepared images using ENVI software to compare correction techniques (Fig. 2). ROIs were drawn at five separate sites within the highlands study region (Fig. 3) from which VNIR spectra were acquired.

Results and Discussion: While the initial, refined, and reprocessed thermally corrected images exhibited similar absorption features near 1 and 2 μm, consistent with the presence of pyroxene, differences were observed in absolute reflectance and at longer wavelengths, especially near the ~3 μm region. The spectra of M³ targeted and global data strips exhibited a consistent red slope from 0.5 to 3 μm, in contrast to a blue slope from ~2.7-3 μm that characterized the refined and reprocessed thermal correction global images (Fig. 1b). Spectra acquired from the M³ global data strip, refined thermal correction global data, and reprocessed thermal correction global data revealed a consistent narrow absorption dip at 2.8 μm not observed in the M³ targeted data strip. However, this 2.8 μm feature is likely an artifact of binning. ROI size differences among targeted and global images (Fig. 2) could contribute to observed compositional differences (e.g., shifts in band position near 2 μm in Fig 1c).

Refined thermal correction global images provide the ability to document variations in the hydration components in the ~2.7-3 μm region (Fig. 3). The purple spectrum includes stronger pyroxene bands and no band near 3 μm, while spectra of the other locations exhibit stronger bands near 3 μm.

Figure 1. (a) Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) global 100m/pixel basemap of lunar maria and highlands with latitude and longitude coordinate grid. North is up. Red strip denotes location of M^3 global data strip M3G20090212T103632 and overlapping blue strip denotes location of M^3 targeted data strip m3t20090421t183929. (b) and (c) Lunar highlands study region VNIR spectral plots of ROI average spectra. (b) spectra from top to bottom are as follows: reprocessed 1b, reprocessed 1a, M^3 targeted, M^3 global, refined. (c) continuum removed spectra from top to bottom are as follows: reprocessed 1b, reprocessed 1a, refined, M^3 global, M^3 targeted.

Figure 2. ROI location examples over each image type used in this study. (a) corresponds to spectra in Fig. 1b. (b) corresponds to spectra in Fig. 1c. The thermal correction of [10] was applied to M^3 targeted and M^3 global images. The thermal correction of [7,9] was applied to refined, reprocessed 1a, and reprocessed 1b global images.

Figure 3. Highlands study region. (a) Map projected M^3 targeted data strip m3t20090421t183929. Optical period 2A (afternoon). (b) Map projected M^3 global data strip M3G20090212T103632. Optical period 1B (morning). (a) and (b) scale bars are 1 meter. (c) Map projected refined thermally corrected image for subset of image (b). Scale bar is 100 km. North is up in all images. Colored boxes (not to scale) denote five sites from which VNIR spectra were acquired. (d) Reprocessed 1b global image spectra of five study sites (c) showing differences near 3 µm region.

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