MINERAL INVESTIGATION THROUGH THE COMBINED ANALYSIS OF NIR AND IMAGE-BASED 3D SHAPE RECONSTRUCTED TOPOGRAPHIC DATA. U. Mall[1], R. Bugiolacchi[1], C. Woehler[2] and A. Grumpe[2], [1]Max-Planck-Institute for Solar System Science, Max-Planck-Str. 2, 37191 Katlenburg-Lindau,Germany, mall@mps.mpg.de, [2] TU Dortmund University, Otto-Hahn-Str. 4, 44227 Dortmund, Germany.

Introduction: One of the most important objectives of lunar remote sensing remains the investigation of the abundance and distribution of the major minerals across the Moon's surface. Reflectance spectroscopy makes use of the fact that absorption bands in the reflectance spectra of planetary surfaces contain information on the mineralogy and petrology of the remotely sensed surface areas.The most prominent spectral variations that characterize lunar soils occur in the VIS-NIR part of the spectrum, and in particular, in the near-infrared. The strength and shape of measured infrared absorption bands of an irradiated mineral compound are a function of several variables, among them the abundance of the absorbing minerals. The precise measurements of the spectra allow an estimation of the quantitative mineralogical composition of the observed material.

Mineralogical Maps: Among the lunar minerals, pyroxenes' prominent spectral absorption features at one and two microns in the near-infrared (NIR) spectral region make them ideal targets for remote sensing investigations (i.e. [1], [2]). A variety of quantitative lunar pyroxenes maps have been produced in the past (among them, maps by [3], or more recently, by [4]).However, until recently, all those maps resulted from the measurements of absorption bands at very few selected wavelengths, always assuming a flat lunar surface.

Data Sets: By combining data measured withinstruments on more recent missions like Chandrayaan-1 and LRO, a more precise analysis of absorption spectra and the reflecting topography is becoming a reality.Within this paper, we use hyperspectral data from the SIR-2 and M3 instruments on Chandrayaan-1 to analyze and interpret the mineralogical composition of selected lunar areas with unprecedented high spectral and spatial resolution. The SIR-2 Near InfraRed (NIR) point spectrometer that orbited the Moon on board the Chandrayaan-1 mission in 2008 and 2009 [5], delivered spectra in the 0.9-2.4 µm spectral range with approx. 6 nm spectral resolution at an absolute constant temperature of ±0.1 degree K with a single detector, thus providing NIR reflectance measurements of slightly elliptical footprints of approximately 220 m diameter. The topographic information is obtained by the fusion of the GLD 100, which is derived from LROC WAC imagery and the photometric information from the analysis of M3 images. The GLD 100 is accurate at scales of about 1.5 km/px and lacks topographic features with extents less than 1.5 km[6] while the M3 data features a resolution of 140 m/px. The fusion results in topographic maps of the same lateral resolution as the M3 imagery and, more important, topographic maps which share the same pixel coordinates as the M3 images and are aligned to SIR-2 spectra taken simultaneously, thus allowing one to reference the spectra with absolute precision.

Methods: In order to improve the lateral resolution of the GLD 100, an extended photoclinometry and shape from shading algorithm is applied as proposed in [7]. The method can be described as the search for the surface that best matches the observed images if illuminated using the same light source and viewer positions and is still close to the original shape model. Furthermore, the shape reconstruction method is used to register M3 images from different orbits as proposed in [7]. The aligned images contain different photometric information and thus allow a better estimation of the reflectance behavior, such as the single-scattering albedo and single-scattering phase functions. Since the spectral range of the M3 reaches up to 3 µm the thermal emission is important. We estimate the surface temperature by the superposition of a linear extrapolation to the norm reflectance spectrum R62231 and a black body emission spectrum, as presented in [8]. Radiance values of the SIR-2 and M3 data are used to align the two data sets. Finally, the information derived from the M3 images, such as surface temperature and continuum slope of the absorption at 2 microns, can be applied to the SIR-2 spectra, resulting in high precision NIR reflectance measurements.

We report on the identification and abundance measurements of lunar minerals through the combined analysis and interpretation of NIR and image-based 3D shape reconstructed topographic data.

References:

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