

NEW OBSERVATIONS OF THE MARIUS HILLS COMPLEX FROM MOON MINERALOGY MAPPER (M³). Sébastien Besse¹, J. M. Sunshine¹, C. M. Pieters², N. E. Petro³, M. Staid⁴, D. Deepak², J. W. Head², P. J. Isaacson² and the M3 Team, ¹University of Maryland, College Park, MD, USA, sbesse@astro.umd.edu, ²Brown University, Providence, RI, USA, ³NASA Goddard Space Flight Center, Greenbelt, MD, USA, ⁴PSI, Tucson, AZ, USA

Introduction: The 35,000 km² Marius Hills (MH) complex located in Oceanus Procellarum is one of the highest concentrations of volcanic features (domes and cones) on the surface of the Moon [1]. Domes are 200-500m in height and have a different morphology from the surrounding mare units [2]. The domes are found within all the different lava flows as previously mapped from spectral [3,4] and/or brightness differences [5]. The wide variation in titanium content and strength of the 1 μ m band argues for multiple source regions and eruption characteristics. Previous studies also suggest that the domes are spectrally (and thus compositionally) indistinguishable from the local mare [3,4]. In this study, we investigate the properties of the MH plateau over a more extended spectral range and at higher spectral resolution than previously available.

Data: The Moon Mineralogy Mapper (M³), a guest instrument onboard India's Chandrayaan-1 mission to the Moon, is a 0.43 to 3.0 μ m imaging spectrometer, which has mapped more than 95% of the Moon. The data over the MH complex presented here were obtained with a spatial resolution of 280 meter per pixel. At the time of acquisition, the detector was 6K above nominal temperature. This results in additional noise that leads to the vertical strips visible in Figures 1-3. All data have been processed through the M³ calibration pipeline to apparent reflectance (flat, dark, solar, photometric, and geometric corrections). Thermal corrections have not yet been applied, thus we focus on relative spectral comparisons. Cross-track photometric corrections were also applied to each individual data strip prior to mosaicing (Figure 1).

Results: This preliminary study reveals two different aspects of MH: (1) the uniqueness of the plateau and the domes and (2) a strong enrichment of olivine within the crater Marius.

Plateau and domes: As can be seen on Figure 2, the plateau can be distinguished from its surrounding by a weak 1 μ m band (the plateau is greener, however the northern boundary is more evident than the southern). In Figure 3, the 1 μ m integrated band depth (IBD), the plateau appears darker. However, the weakest 1 μ m IBD are associated with the domes. In addition, different mare units can be distinguished based on the

depth and position of the 1 μ m absorption. These differences are consistent with units mapped from Clementine UVVIS data [4]. However, the spectral resolution of M³ allows us to identify additional units with different spectral properties within those previously mapped.

Olivine signatures: Investigation inside Marius crater revealed presence of olivine in the freshest craters as shown on Figure 4. The 2 μ m absorptions for the craters inside Marius are weaker than other nearby fresh craters (on and off the plateau) and contain only thermal signatures. Thermal removal is an on-going issue and will further constrain the differences between olivine and pyroxene at 2 μ m. To examine the 1 μ m region a straight-line continuum between 0.75 and 1.65 μ m was removed from the apparent reflectance spectra revealing that the units inside of Marius include the characteristic shoulder of olivine near 1.3 μ m. In contrast, many fresh craters on the plateau have a pyroxene signature (high Ca-pyroxene), while fresh craters outside MH are intermediate between those inside Marius and the craters on the plateau. Relative to craters on the plateau, the craters outside MH have longer and wider 1 μ m bands and weaker 2 μ m features. These results agree with the study of large western mare basalt by Staid et al. [6].

Different volcanic types within the Marius Hills complex: The extended spectral range of M³ allows us to distinguish a variety of volcanic deposits within the MH complex. The domes appear to be spectrally distinguished from their surroundings, with a weaker 1 μ m signature that may reflect compositional differences associated with their increased viscosity. Most of the effusive mare flows on the plateau have a stronger 1 μ m bands than the domes, but lack the strong olivine signature seen in the mare deposits that surround the MH complex and some other units within the plateau. These olivine-rich maria are typical of the high-Ti basalts of nearby Oceanus Procellarum [6, 7]. The MH complex thus includes at least three different volcanic episodes: olivine-rich Procellarum mare basalts, MH domes, and the regionally distinct MH lava flows. More detailed study of these various volcanic units and their relationships will continue as we further our understanding of this unique lunar volcanic complex.

References

[1] Whitford-Stark J.L., Head J.W., (1977), PLPSC, 8, 2705-2724, [2] Campbell et al. (2009), JGR, 114, [3] Weitz C., Head J.W. (1999), JGR, 104, 18933-18956, [4] Heathler D.J et al., (2003), JGR, 108, 5017, [5] Sunshine J.M., Pieters C.M., Head J.W., (1992), LPSC, XXIII, 1387-1388, [6] Staid et al., (2010) LPSC XXXI, [7] Staid et al., (2001), JGR, 106, 27887-27900, [8] Pieters et al. (1980), JGR, 85, 3913-3938

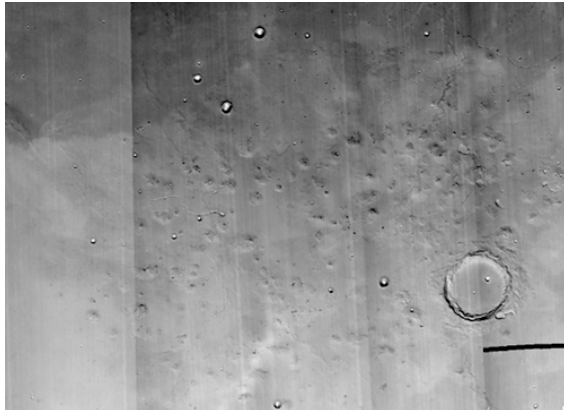


Figure 1: A 3.0 μm mosaic of the MH plateau. This wavelength measures the thermal response of the surface and is thus sensitive to local slopes. The 41 km crater Marius is located in the lower right. A 3X3 median filter was applied.

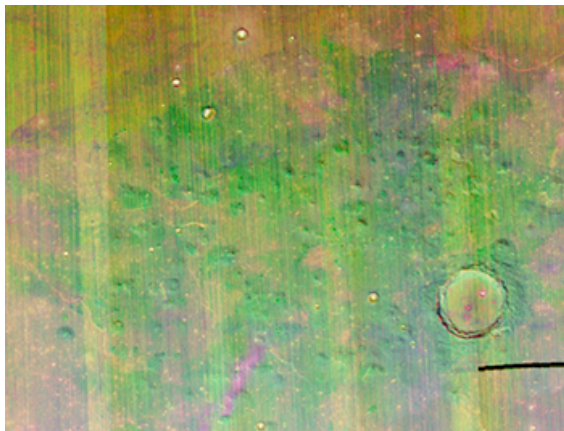


Figure 2: Color composite (R=1 μm integrated band depth [IBD], G= 2 μm IBD, B=reflectance at 1.58 μm). The color map is overlain on Figure 1. Domes correspond to the darkest green; they have the weakest 1 μm IBD. A 3X3 median filter was applied.

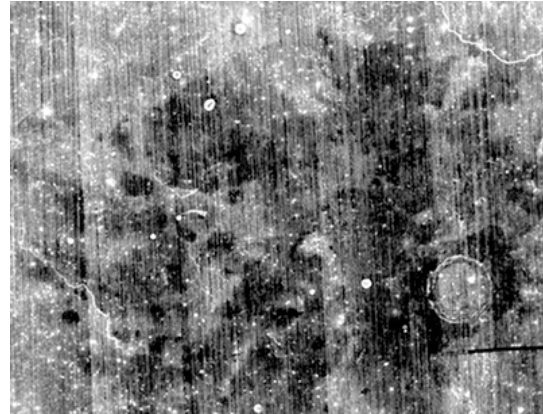


Figure 3: 1 μm IBD of the MH complex. Darker units have a weaker 1 μm band depth. Note that the plateau as a whole has a weak 1 μm band depth and that weakest bands are associated with the domes. A 3X3 median filter was applied.

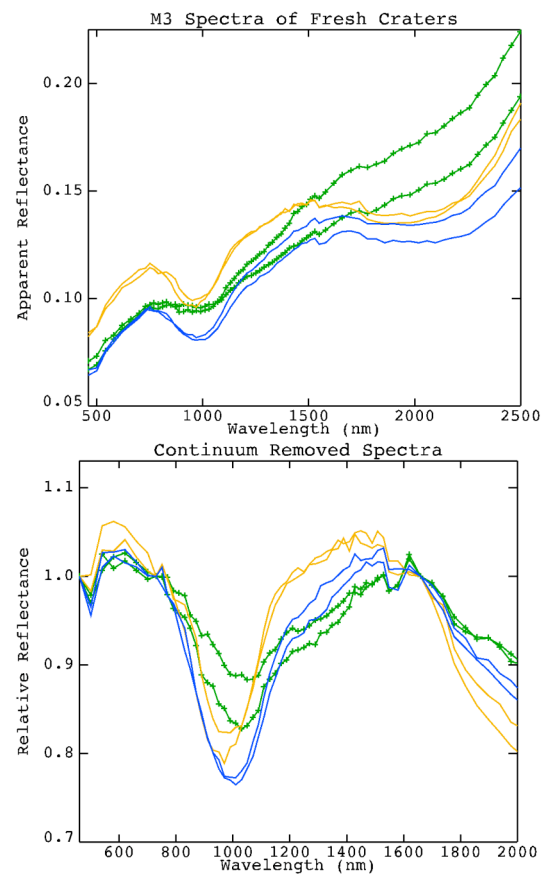


Figure 4: Spectra (3x3 averages) of fresh craters located inside Marius crater (green), on the MH plateau (red), and off the MH plateau in the surrounding maria to the north (blue). Top: Apparent reflectance spectra from 0.43 to 2.5 μm . Bottom: Same spectrum with a continuum removed.