rim of the rille is darker than the northern, but this is mainly an effect of temperature. The sun is coming from the southwest and, given the inclination of the rims, the temperature of the south rim is lower than the north and thus explains the dark and bright sides of the rille in the albedo image at 2976 nm. The northern part of the dome (Figure 10a) appears darker in that image, which is also a temperature effect (as shadow can contribute to only half a M^3 pixel maximum). When we look at Figure 10c, both rims of the rille have the same color, confirming that temperature effect is removed when we use wavelengths lower than 2.2 μm (the same effect can be seen with craters). However, part of the domes and cones still appear dark in Figures 10c, 10g, and 10k.

[36] *Weitz and Head* [1999] and *Heather et al.* [2003] have proposed glassy particles coming from explosive eruptions of the cones as the particles responsible for the dark signature. As described previously, the presence of these particles agrees with the lower absorption band of these features in the IBD1000 and thus can explain the lower albedo when we come close to the source of the cones. In our analysis, using a larger spectral range, we see that the dark spots are correlated with the presence of cones and domes. The mechanism responsible for these dark spots might be more complicated and the variations with phase angle are puzzling. It is possible that the grain size could be partially responsible for these changes in reflectance. The behavior of opaque minerals may also produce these dark spots. In order to assess the properties of the dark spots, thermal and photometric corrections are needed. Because the phenomenon is associated with volcanic features and localized topography, both corrections are required at a pixel level with a topographic model for the photometric correction to insure that we adequately correct for any thermal effect. These corrections are an ongoing process that will allow us in the future to evaluate the properties of these dark spots.

5. Spectral Analysis of Marius Crater

5.1. Distinctive Composition From the Rest of the MHC

[37] We have briefly described in section 3 the unusual nature of Marius crater. Based only on the IBD1000 parameter presented in Figure 5, the crater does not appear to be particularly different from the rest of the plateau. Its strength in the 1 μm region seems to be intermediate between the two mare units (i.e., strong and weaker IBD1000). In Figure 11, ejecta blankets can be seen around the crater. In Figures 5 and 6, these ejecta blankets have a spectral signature that is consistent with the weaker IBD1000 mare units.

[38] Figure 6 addresses the compositional differences of the 1 μm absorption by separating the olivine-rich compositions (more blue) and the high-calcium pyroxene-rich compositions (more red). Figure 6 clearly addresses the uniqueness of Marius crater, which exhibits the strongest olivine-rich composition on the MHC, similar to deposits located northeast of the plateau and south of the crater. These other blue areas are located at the edge of the MHC and may reflect the composition of the surrounding maria. This olivine-rich composition appears to be far more olivine-rich than the strong IBD1000 of the MHC mare units described in section 3. In their mapping of the mare units, *Heather et al.* [2003] defined the m20 Flamsteed basalt unit that contains Marius crater. This unit extends to the south part of the crater and the central part of the plateau. However, the characteristics of Marius crater are so different that the present analysis suggests that this region should be unique. The spectral characteristics of the floor of Marius crater are presented in Figures 7c and 7d. The purple curve that sampled the floor of the crater exhibits the characteristic olivine signature; the presence of the absorption at 1.3 μm and the center of the band shifted to longer wavelengths (greater than 1 μm) is typical of an olivine-rich composition. These results suggests that either the olivine is abundant relative to pyroxene or that factors such as grain size and mineral associations within the basalts allow light to reflect more easily within the olivine-rich component.

[39] The modeling of band positions of basalts containing both olivine and pyroxene is a complex problem. An attempt at modeling the Marius olivine is presented by *Isaacson et al.* [2011]. However, the spectrum of Marius crater does not represent pure olivine and includes substantial pyroxene. In addition, as described previously, thermal and photometric corrections have not been applied and it is thus not possible to use the 2 μm band to constrain modeling. Therefore, a more detailed compositional modeling is not possible at this time.

[40] Images from Lunar Orbiter suggest that the rim of Marius has not been breeched (Figure 11). Therefore, the floor of Marius crater was likely filled from the bottom with the magma likely reaching the surface through the numerous fractures and faults created by the impact.

5.2. Comparison With Surrounding Basalts

[41] Figures 7c and 7d present the spectra of Marius crater and characteristic spectra of previously described mare units. These spectra are good examples of the diversity of the lava flows and volcanic episodes that occurred on the MHC. The floor of Marius clearly has the strongest olivine shoulder at 1.3 μm and the weakest 2 μm band. The blue crosses of Figure 7 correspond to basalts of Oceanus Procellarum outside of the plateau and exhibit similar characteristic with Marius crater (e.g., position of the 1 μm band, weaker absorption at 2 μm and stronger absorption at 1.3 μm).

[42] Absolute albedos and band strengths cannot be reliably compared due to potential differences in the optical maturity of the craters sampled and the lack of a reliable photometric correction. However, the craters selected for these spectra were carefully chosen following these criteria: (1) approximately the same size, (2) no ejecta rays, and (3) as close to the same albedo as possible, suggesting relatively similar maturity levels. We then can argue that the band depth can be compared between the different regions of the MHC. These relative band strengths suggest a greater olivine content for the basalts in Marius crater. However, the relative difference in strength between the olivine-rich unit and the high-calcium pyroxene unit is very slight for the 2 μm band. The full characterization of the 2 μm band can only be made by studying that part of the absorption that is potentially contaminated by thermal emission, which requires a thermal correction of the spectrum. The red diamonds of Figures 7c and 7d correspond to the mare unit with a weaker IBD1000. After continuum removal, the 1 μm absorption band appears