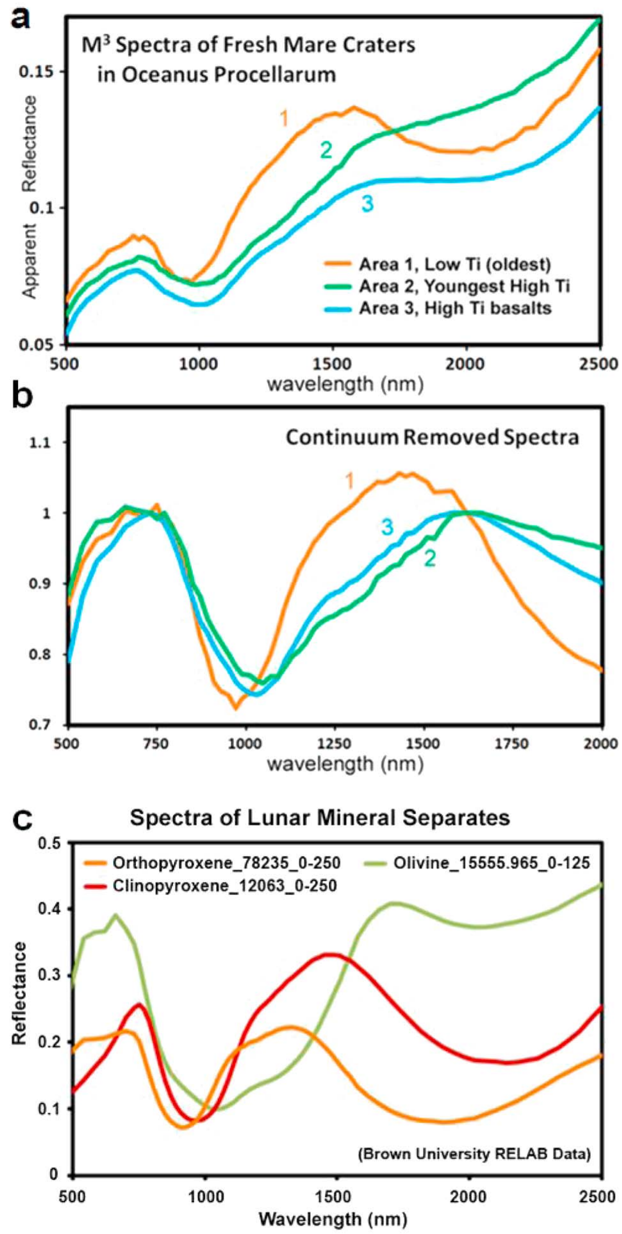

Figure 4. (a and b) Spectra of fresh mare craters associated with the three distinct spectral groups identified in Figures 2 and 3. Low-Ti basalts that predate higher-Ti flows (e.g., area 1) are dominated by 1 and 2 μm pyroxene absorptions typical of most pre-Eratosthenian lunar basalts. The reflectance properties of craters within the younger high-titanium basalts (areas 2 and 3) have strong but longer-wavelength 1 μm absorptions and relatively weak 2 μm bands, consistent with abundant olivine within these basalts. (c) Laboratory reflectance spectra of lunar pyroxenes and olivine mineral separates (Brown University, NASA RELAB facility) [*Pieters*, 1993; *Isaacson and Pieters*, 2010].

2 μm is consistent with typical high-Ca pyroxene compositions (Figure 4c) [*Adams*, 1974; *Cloutis and Gaffey*, 1991]. The specific band center of the 2 μm ferrous absorption in these and other global mode spectra presented in Figure 4 is less reliable than positions at 1 μm, due to a lack of thermal corrections in these data. Previous studies of Clementine data have shown that fresh mare craters retain spectral slope differences related to titanium content [*Staid and Pieters*, 2000] that have been demonstrated in laboratory studies of mature mare soils [*Charette et al.*, 1974]. The UV/VIS properties of the older low-Ti units observed in area 1 are redder than craters sampled in areas 2 and 3, consistent with lower-Ti contents. The mare crater spectrum from area 1 is also brighter than areas 2 and 3, consistent with a lack of abundant opaques such as the Ti-rich phase ilmenite. However, since only a small number of craters were averaged from each unit, absolute albedos and band strengths cannot be reliably compared across study areas due to potential differences in the optical maturity of the craters sampled.

[28] M^3 spectra collected from craters within the younger high-Ti basalts (areas 2 and 3) have strong, but longer wavelength 1 μm absorptions and relatively weak 2 μm bands. Olivine reflectance spectra display a broad and asymmetric composite absorption near 1 μm and lack a 2 μm absorption that is present in pyroxenes (Figure 4c) [*Adams*, 1975; *Singer*, 1981; *Burns*, 1993], and the M^3 global mode spectra are consistent with previous observations that have attributed these spectral properties to the likely presence of olivine within these basalts [*Pieters et al.*, 1980; *Staid and Pieters*, 2001; *Lucey*, 2004]. The UV/VIS ratio of these deposits are also relatively blue and dark compared to the older low-Ti deposits of area 1, consistent with their derivation from materials associated with the upper high-Ti rather than underlying low-Ti units. Area 3 also lies within the high-Ti western basalts but appears to be stratigraphically older than basalts to the north associated with area 2. Basalts in this region also have significantly older crater age estimates (~2.8 Ga compared to 1.2 to 2.1 Ga for the spectral unit to the north sampled by area 2 [*Hiesinger et al.*, 2003]). Mare soils in this region appear as light red in the M^3 IBD color composites (e.g., Figures 1c and 2), with strong 1 μm ferrous bands and weaker 2 μm bands that are intermediate in strength between the youngest high-Ti basalts and pre-Eratosthenian low-Ti basalts. On average, craters sampled in this region lack 1 to 2 μm band strength differences as strong as for area 2 but still display weaker 2 μm bands than typical pyroxene-rich basalts. However, the spectral properties of craters in area 3 were observed to vary significantly from those with more typical pyroxene absorptions to craters with properties similar to those in area 2 (strong 1 μm but weak 2 μm absorption). Differences between the band positions and strength of the area 2 and area 3 basalts are further compared in the continuum-removed spectra presented in Figure 4b. In Figure 4b, area 2 basalts have a band center that lies beyond 1 μm and is intermediate in position between the pyroxene-rich basalts in area 1 and the olivine-rich basalts in area 2. Similarly, the 2 μm band is slightly stronger than it is for the area 2 basalts while the 1 μm bands have similar strengths in this continuum-removed plot.

4.3. M^3 Targeted Data

[29] Targeted data of several areas of the western high-Ti basalts were acquired prior to loss of communication with Chandrayaan-1 satellite. These data have approximately 3 times the spectral and twice the spatial resolution of the global mode M^3 data. Because these basalts are known to be