INTEGRATING DIVERSE DATASETS TO ASSESS APPROACHES FOR CHARACTERIZING MARE BASALTS.

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Introduction: The Marius Hills Volcanic Complex (MHVC), located on a plateau in central Oceanus Procellarum at 13.4N, 304.6E, is the largest single concentration of volcanic features on the Moon (~35,000 km^2) [1]. The region includes volcanic domes, cones, rilles, and depressions and represents a significant period of lunar magmatism thought to have taken place during the Imbrian (~3.3 Ga) through Eratosthenian (~2.5 Ga) periods [1,2]. Previous studies of the MHVC utilizing the Clementine Ultraviolet/Visible (UVVIS) camera, the Kaguya Multiband Imager (MI), and the Moon Mineralogy Mapper (M^3) aboard the Chandrayaan-1 mission have found that the volcanic domes and surrounding mare basalts are compositionally indistinguishable, indicating similar eruption times [1,2], although it has been suggested that the domes are embayed by younger mare basalts [1]. This research utilizes new Lunar Reconnaissance Orbiter Camera (LROC) data to re-evaluate the composition of the volcanic domes and surrounding mare basalt flows in the MHVC. Through this, the compositions and relative ages of the domes and the surrounding flows can be determined, improving our understanding of the volcanic history of this region.

Data: For this study, the MHVC was studied using datasets from both the LRO and Clementine missions.

LRO Mission Data: This study utilized the LROC WAC 7-band multispectral basemap of [3], which was processed to produce a false color image accentuating the ultraviolet properties of the region (R = 415/689, G = 321/415, B = 321/360) (Fig. 1). The WAC is a seven-band (321, 360, 415, 566, 604, 643, and 689 nm) push-frame imager with resolutions of 400 m in the ultraviolet (321, 360 nm) and 100 m in the visible (415, 566, 604, 643, 689 nm); for the purposes of this investigation the five visible bands were resampled to the same 400 m/pixel resolution of the UV bands. We also employed topography data from the GLD100 [4] and the WAC global morphology base map [5].

Used along with these are high resolution (0.5 m/pixel) Narrow Angle Camera (NAC) featured mosaics (large-scale controlled NAC mosaics with consistent lighting and photometric properties) and individual NAC image pairs as well as NAC Digital Terrain Models (DTMs) from the Planetary Data System to show the morphometry of specific landforms in the MHVC.

Clementine Mission Data: The Clementine data used for this study includes UVVIS color ratio (R = 415 nm, G = 900 nm, B = 1000 nm) [6], TiO_2, FeO [7], and optical maturity (OMAT) [8] data within the MHVC region. The Clementine UVVIS camera was a five-band (415, 750, 900, 950, and 1000 nm) imager aboard the Clementine spacecraft with resolutions ranging from 100-200 m/pixel [9].

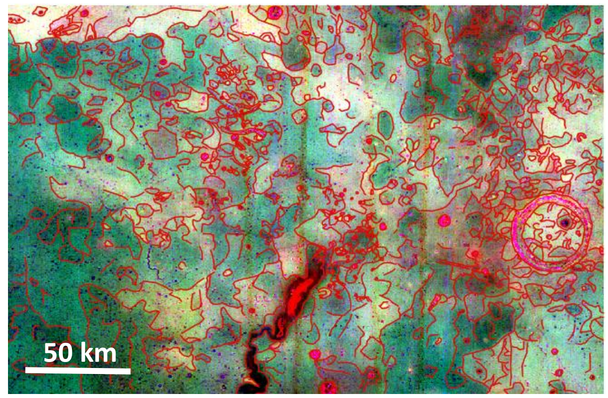

Figure 1. *WAC color unit boundaries (red lines) overlain onto WAC 7-band multispectral basemap.*

Methods: Color unit boundaries were mapped using the LROC Wide Angle Camera (WAC) 7-band multispectral [3] (Fig. 1) and Clementine 5-band color ratio [6] basemaps. The boundaries were iteratively compared to each other to assess any differences between them and were then compared to the WAC hillshade and morphology data to assess the quality of correlations between color unit boundaries and topographic features. Next, five LROC Narrow Angle Camera (NAC) featured mosaics as well as 30 individual NAC image pairs in specific areas of interest were analyzed in order to associate the WAC color unit boundaries with morphologies that are evident in the high resolution NAC frames. The correlated morphologies were mapped and confirmed by taking elevation profiles of NAC DTMs in the LOC and LOD featured mosaic areas (chosen due to optimal DTM overlap). The WAC color unit boundaries were then compared with the Clementine TiO_2, FeO, and OMAT data as well as the mare basalt units mapped by [2] to evaluate the differences between them.

Results: It was discovered that some of the volcanic domes are outlined or crosscut by the WAC color unit boundaries. It can also be seen that a large majority of the color unit boundaries mapped from the WAC basemap correlate with morphologies that are evident in the NAC frames (Fig. 2). Evidence of morphology changes were found to correlate with color unit boundaries in flat areas throughout the MHVC as well as near the flanks of the domes that were observed, showing possible embayment of the mare basalt flows on the flanks (Fig. 3).

The color units derived from the WAC basemap almost exactly parallel units evident in the Clementine TiO_2 map and also matched well with the Clementine FeO map. The color unit boundaries mapped from the WAC also correlated very well with the mare basalt units mapped by [2], but in general are more detailed and complex.

Discussion: The morphologies seen in the NAC frames that parallel the color unit boundaries indicates that WAC color has great potential for identifying mare basalt units. When confirmed with elevation profiles from the NAC DTMs, the morphologies show embayment of the observed domes, indicating that the mare basalts were erupted after dome formation. This implies that the domes are older than the flows and the volcanic activity on the plateau was a complex process, as described by [1].

Conclusions: Color unit boundaries derived from WAC data correlate well with morphologies that are seen in the high resolution NAC frames and elevation profiles from NAC DTMs. These results tend to support the hypothesis that the domes are embayed by the surrounding mare basalt flows. The techniques used in this study are not only useful for mapping distinct mare basalt units with the LROC WAC data, but will also be helpful in determining the relative stratigraphy and relative ages of the volcanic domes and surrounding mare basalts in the MHVC.

References: [1] Lawrence S. J. et al. (2013) *JGR, 118,* 615-634. [2] Heather D. J. et al. (203) *JGR, 108,* E3, 5017. [3] Sato H. et al. (2014) *JGR, 119,* 1775-1805. [4] Scholten et al. (2012) *JGR, 117,* E00H17. [5] Speyerer et al. (2011) *LPSC XXXXII,* Abstract #2387. [6] Eliason et al. (1999) *LPSC XXX.* [7] Lucey P. G. et al. (2000) *JGR, 105,* 20,297-20,305. [8] Lucey P. G. et al. (2000) *JGR, 105,* 20,377-20,386. [9] Kramer et al. (2011) *JGR, 116,* E00G04.

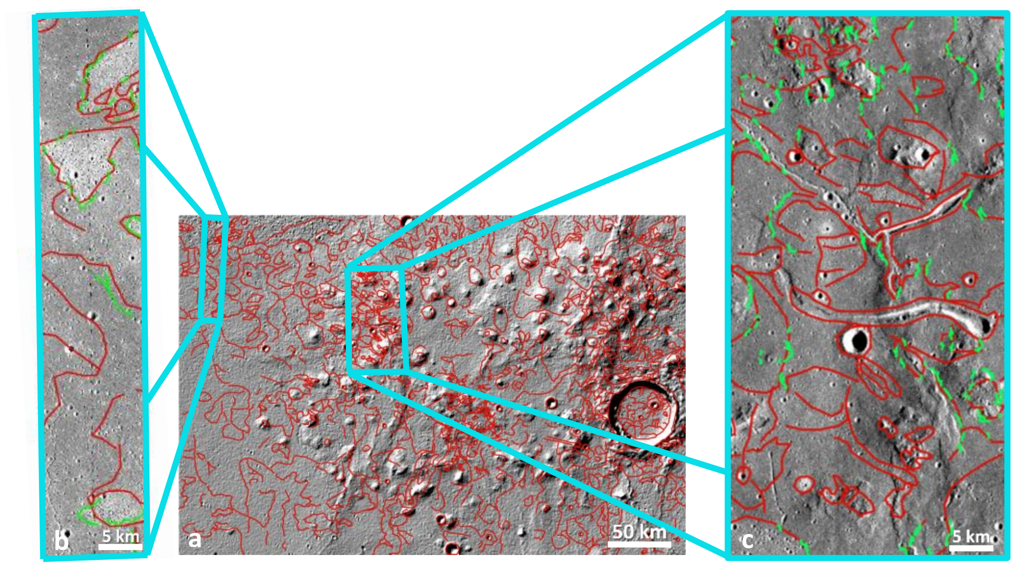

Figure 2. *a) WAC color unit boundaries (red) overlain onto WAC synthetic hillshade data to highlight boundary/topography correlation. b) and c) WAC color unit boundaries (red) and correlated NAC morphology lines (green) overlain onto NAC frames with volcanic domes of interest labeled with arrows.*

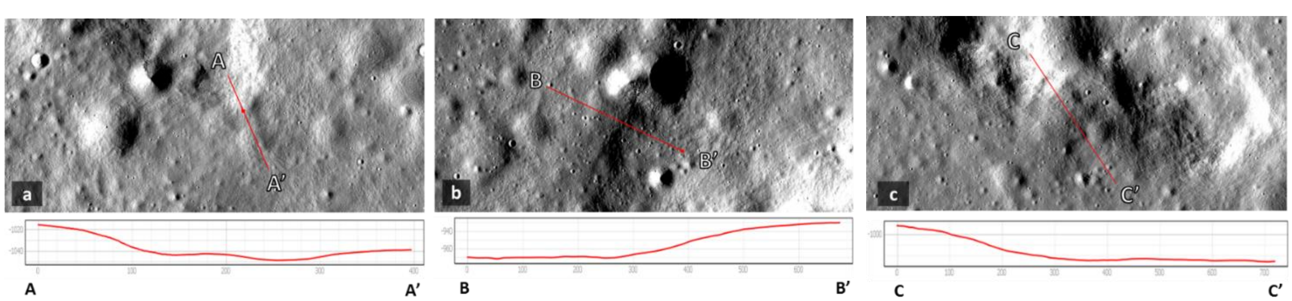

Figure 3. *a) Elevation profile of trough at the base of the southeastern flank of dome A. b) Elevation profile of trough at the base of the southwestern flank of dome B. c) Elevation profile of talus slope on southeastern flank of dome B. Elevation profiles were extracted from NAC DTMs. All units are in meters.*