A Study about a Lunar Dome near T. Mayer Domes Field: Morphometry and mode of Formation.

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Introduction: Lunar mare domes formed during the later stages of volcanic episode on the Moon, characterized by a decreasing rate of lava extrusion and comparably low eruption temperatures, resulted in the formation of effusive domes [1-3]. Important clusters of lunar domes are observed in the Hortensius/Milichius/T. Mayer region in Mare Insularum and in Mare Tranquillitatis around the craters Arago and Cauchy.

The region west of Copernicus extending from Hortensius to Milichius and to Tobias Mayer contains large numbers of lunar domes and cones, evidence of past volcanism on the lunar surface [1-3]. In this contribution we provide an analysis of another low dome to the east of T. Mayer, termed M21, located at 13.78° N and 29.24° W with a base diameter of 5.75 km (Figs.1-3).

Morphometric properties: For the determination of its morphometric properties, we rely on GLD100 dataset [7]. We found that the average dome height corresponds to 85 m, resulting in an average flank slope of 1.7°. The volume of the dome (0.96 km^3) was computed assuming a parabolic shape. Note that the dome M21 is not reported in the USGS map I-515 [4]. Accordingly, the rheologic model, introduced in [5], yields a moderate lava viscosity of 2.2 x 10^5 Pa s, an effusion rate of E = 100 m³ s^{-1}, and a duration of the effusion process of T = 0.35 years. The magma rise speed amounts to U = 4.3 x 10^{-5} m s^{-1} and the dike width and length to 22 m and 100 km, respectively.

This model relies on the morphometric dome properties and several physical constants such as the lava density, the acceleration due to gravity, and the thermal diffusivity of the lava. In the computation we assume a magma density of 2,800 kg m^{-3}.

Thus, M21 is a typical representative of rheologic group R$_1$ as defined in [3], characterised by lava viscosities of 10^4-10^6 Pa s, magma rise speeds U of 10^{-5}-10^{-3} m s^{-1}, dike widths W around 10-20 m, and dike lengths L between about 30 and 150 km. If it is assumed that the vertical extension of a lunar dike is comparable to its length L [6], the magma which formed M21 originated in the upper lunar mantle, well below the crust.

Spectral properties: The Clementine UVVIS data reveal that M21 appears spectrally red. It has a 750 nm reflectance of R$_{750}$ = 0.1222, a moderate value for the UVVIS colour ratio of R$_{415}$/R$_{750}$ = 0.5746, indicating a low TiO$_2$ content, and a weak mafic absorption with R$_{950}$/R$_{750}$ = 1.0024.
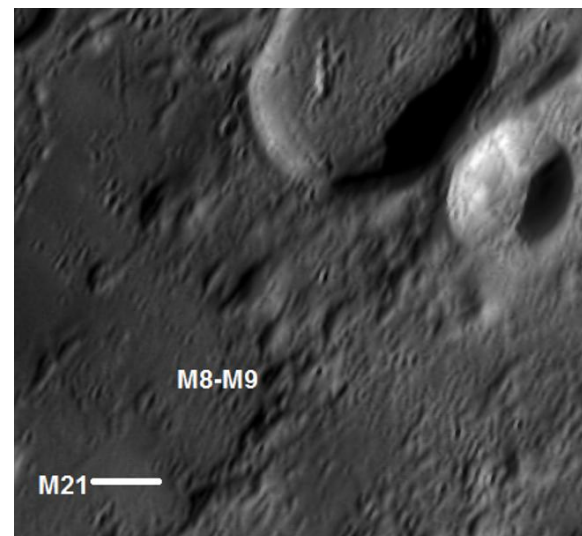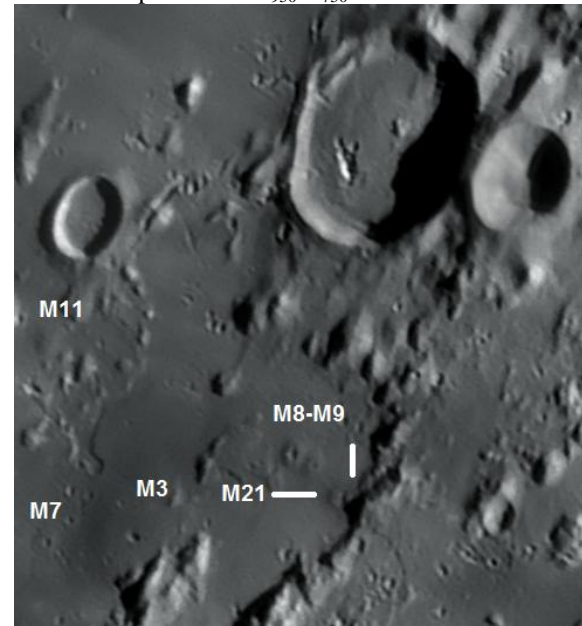

Fig. 1. Telescopic images of the examined region and the dome M21. Top: image taken by Zannelli on May 25, 2018 at 21:36 UT using a Celestron C14 Star Bright (355 mm of diameter); Bottom: image taken by Barzacchi on March 19, 2016 at 22:18 UT using a Canopus 18" (477 mm of diameter).

Conclusion: The examined region is characterized by presence of domes with steeper slopes together with domes with lower slopes and volumes [1,3]. Based on the spectral and morphometric data obtained in this study, the dome M21 belongs to class E_1 with a tendency towards class E_2 in the classification scheme of lunar mare domes [3]. The nearby domes M8 and M9 are spectrally red but steeper than M21 and with their higher slopes, corresponding to 3.2°-3.5° and small diameters < 6km, belong to class E_1. During our survey (since 2006) we have identified and characterized a total of twenty-one domes. We have updated the catalogue and the domes maps which are online at the link: http://hortdomes.blogspot.com/

References: [1] Wöhler et al. (2006) *Icarus* 183, 237-264; [2] Wöhler & Lena (2009) *Icarus* 204, 381-398; [3] Lena et al. (2013) Lunar domes: Properties and Fomation Processes. Springer Praxis Books; [4] Schmitt, Trask, Shoemaker.: *Geologic Map of the Copernicus Quadrangle of the Moon. USGS map I-515 (1967).* [5] Wilson & Head (2003) *J. Geophys. Res.* 108(E2), 5012–5018; [6] Jackson et al. (1997) *Lunar Planet. Sci.* XXVIII, abstract #1429; [7] Scholten et al. (2012) *J. Geophys. Res.* 117 (E00H17), doi:10.1029/2011JE003926.
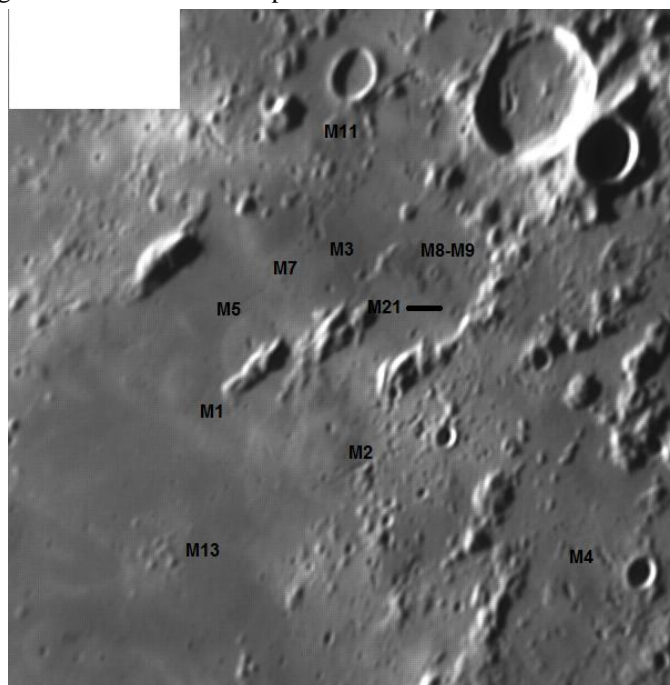

Fig. 2: M21. Image taken by Phillips using a TMB 10" (254 mm) refractor on September 25, 2016.
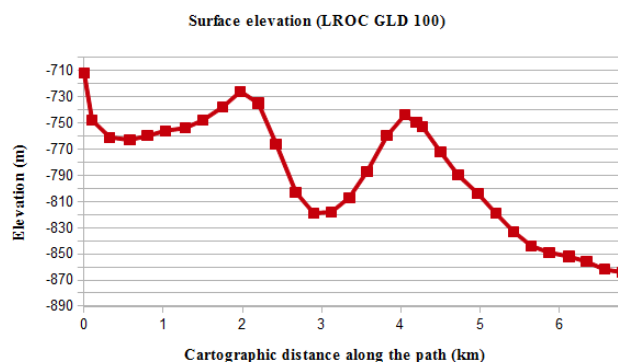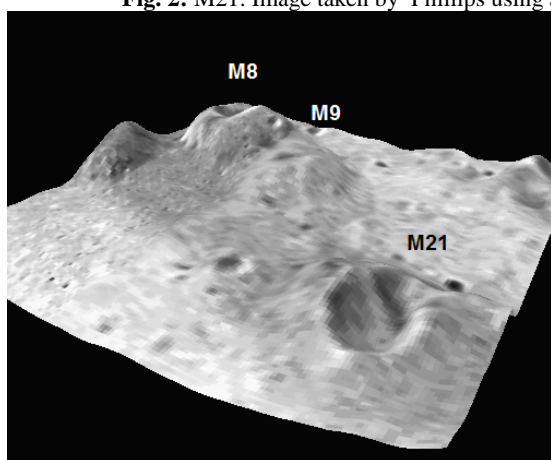

Fig. 3. Right:3D reconstruction based on GLD100 dataset. The vertical axis is 10 times exaggerated. Left: Contour lines for the examined dome based on GLD100 dataset.