A study about a lunar dome near Hortensius: Morphometry and mode of formation. M. Wirths¹, R. Lena², A. Mallama³. Geologic Lunar Research (GLR) Group. ¹km 67 Camino Observatorio, Baja California, Mexico; mwright@starband.net; ² Via Cartesio 144, sc. D, 00137 Rome, Italy; gibbidomine@libero.it; ³14012 Lancaster Lane, Bowie, MD, 20715, USA, anthony.mallama@gmail.com

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. Important clusters of lunar domes are observed in the Hortensius/Milichius/T. Mayer region in Mare Insularum and in Mare Tranquilitatis 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]. A comprehensive map of the area was produced by GLR group, including the six lunar domes north of Hortensius and three lower domes to the south of Hortensius [4].

In this contribution we provide an analysis of another low dome to the east of Hortensius, termed H11, located at 26.87° W and 6.88° N and with a prominent lunar impact crater on the summit (Fig.1).

Morphometric properties: For the determination of its morphometric properties, we rely on telescopic CCD image acquired at oblique solar illumination (cf. Fig. 1), applying the combined photoclinometry and shape from shading technique described in [1-3] to generate the local DEM shown in Fig. 2. We found that the dome diameter corresponds to 8.3 km and its height to 60 m, resulting in an average flank slope of 0.83°. The volume of the dome (0.959 km³) was computed by the LOLA DEM. Accordingly, the rheologic model introduced in [5] yields a magma viscosity of 1.7 x 10⁵ Pa s, an effusion rate of 200 m³ s⁻¹, and a duration of the effusion process of 0.16 years.

LOLA DEM dataset: The Lunar Orbiter Laser Altimeter (LOLA), a science instrument on the Lunar Reconnaissance Orbiter (LRO) spacecraft, has been introduced in [6]. The precision of topographic data is estimated to be about 10 cm and the LOLA dataset was used as the reference for evaluating the quality of the GLD100 dataset [7]. For this research we used the dataset of LOLA Gridded Data Records (GDR) at a resolution of 512 pixels per degree to generate a set of geometric measurements including the diameter, height, slope and volume. The terrain around H11 tilts upward from west to east (Fig. 3), so the last three quantities were measured from the average elevation in the immediate vicinity of the dome (diameter 8.23 km). Mathematically, these results are equivalent to measuring the height (64 m), slope (0.89°) and volume above the average of a uniformly tilted terrain.

Fig. 1. Telescopic image acquired on May 1, 2012, at 03:44 UT with a 450 mm aperture Starmaster driven Dobsonian (M. Wirths). Morphometric properties of the domes H1-H7 have been examined in previous studies [1, 3].

Fig. 2. Cross-sectional profile in east-west direction derived from the telescopic image for H11 (half surface). The vertical axis is 10 times exaggerated.

Fig. 3. 3D reconstruction based on GLD100 dataset. The vertical axis is 10 times exaggerated.

Volume was computed by direct integration of height over the footprint of the dome using numerical integral calculus. However, the presence of the large crater in the middle of the dome reduced the resulting volume
integral to 0.155 km$^3$. Therefore, we separately integrated the empty volume inside the crater (0.804 km$^3$) and added that to the original integral over the footprint of the dome. The sum, 0.959 km$^3$, represents the volume of the dome before the crater impact. The depth of the impact crater is determined to about 400 m. The traverse plot of elevation (Fig. 4 and 5) shows that the terrain east of the dome is tens of meters higher than that to the west. Most of the west-to-east rise occurs on the western flank of the dome. The terrain to its east is flatter and it is at about the same height as the peak of the dome itself.

**Fig. 4.** Contour lines for the dome H11 (top) and summit crater (bottom) based on LOLA dataset

**Spectral properties:** The lava of the examined mare dome is characterized by moderate $R_{410}/R_{750}$ of 0.6102 indicating a moderate TiO$_2$ content and a $R_{950}/R_{250}$ of 1.009.

**Rheologic properties:** Based on the viscoelastic dike model proposed in [8], a magma rise speed of $7.3 \times 10^4$ m s$^{-1}$, a width of the feeder dike of 8 m and a length of 35 km can be inferred. According to its morphometric properties, the viscosity of the dome-forming magma and the dike geometry, H11 belongs to class C$_1$ with a tendency toward class C$_2$ due to smaller diameter and edifice volume. Thus, H11 is a typical representative of rheologic group R$_1$ as defined in [1, 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.

**Fig. 5.** Top: Cross-sectional profile in east-west direction. Bottom: 3D reconstruction of H11 (left) and its summit crater (right) based on LOLA DEM.

**Conclusion:** The examined region near Hortensius is characterised by presence of domes with steeper slopes and moderate to high volumes (e.g. H2–H6 of class B$_2$) together with domes (e.g. H1 and H7 of class B$_1$) with lower slopes and volumes [1,3]. Class B$_2$ domes formed during shorter periods of time than those of class B$_1$ resulting in shallower flanks (1.3–1.9°) than domes H2–H6 (2.0°–5.6°). H11 is similar to some domes in Milichius region (e.g. M15, M1, M3, and M5) described in [1, 3]. The conditions under which domes of classes B$_2$ and H11 formed were very similar, while for H11 the effusion rate was much higher. In this scenario, the influence of the impact-induced stress fields was such that the magma flow through the crust likely experienced less resistance for the class C$_1$ domes, while the magma properties themselves were not perceivably different.