Effusive Lunar Domes Near Aristoteles N, Plana G and Plana F: Morphometry and Mode of formation. P. Lazzarotti.[1] and R. Lena[2] - Geologic Lunar Research (GLR) Group. [1]Via Pernice 71, 54100 Massa, Italy; paolo@lazzarotti-hires.com; [2]Via Cartesio 144, sc. D, 00137 Rome, Italy; r.lena@sanita.it;.

Introduction: Lunar mare domes are smooth low features with gentle convex upward profiles. In this contribution we provide an analysis of three effusive domes located in the eastern lunar regions near crater Aristoteles N, Plana G and Plana F, which have previously not been examined in detail. The first examined dome is located at longitude 25.44º E and latitude 52.24º N with a base diameter of 6.0 km (Fig. 1). It is a previously unreported dome, which we named Aristoteles 1 (Aris1). Another dome, bisected by Rimae Daniell, located at 24.86° E and 38.45° N and having a diameter of 9 km, has been termed Plana G1 (P1). It displays three protrusions which probably are pre-existing non-volcanic hills. The third examined dome is situated to the north of P1 and to the east of Plana F, at longitude 39.32° E and latitude 13.50° N, and has a diameter of 7 km (Fig. 2, dome termed P2).

Spectral properties: For both domes, Clementine UVVIS spectral data indicate a R_{415}/R_{750} ratio of about 0.56-0.57 indicating basalts of low TiO_2 content and furthermore reveal a 750 nm reflectance of R_{750} = 0.13 for P1-P2 and 0.16 for Aris1, and a weak mafic absorption for two domes in Lacus Somniorum with R_{950}/R_{750} = 1.06, suggesting a high soil maturity. The dome Aris1 has a lower R_{950}/R_{750} ratio of 1.01 (Fig. 3).

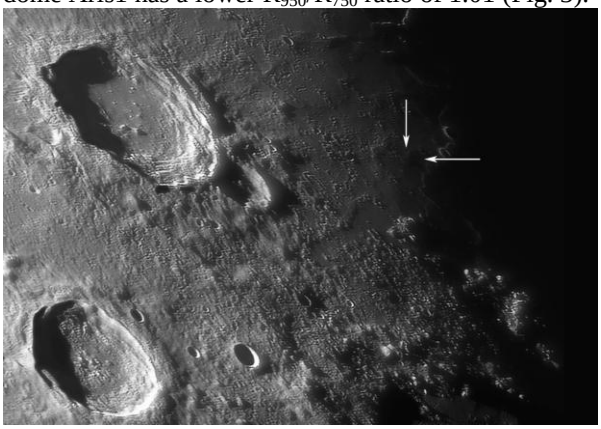

Fig. 1. Aristoteles 1 dome marked with arrows. Image acquired on August 19, 2011 at 03:40 UT (Gladius XLI Cassegrain with aperture of 400 mm f/16 and a Baader Zeiss 2x Barlow lens). North is to the top and west to the left (for all the images).

dome	Slope [°]	D [km]	h [m]	V [km^3]	class	Rheolgic Group
Aris1	1.6	6.0	85	1.2	B_2	R_1
P1	2.3	9.0	185	5.9	C_2	R_3
P2	2.3	7.0	145	2.7	C_2	R_3

Table 1: Morphometric properties of the examined domes.

Morphometric dome properties: Based on the telescopic CCD images we obtained a DEM of the examined domes by applying the combined photoclinometry and shape from shading method described in [1-3].

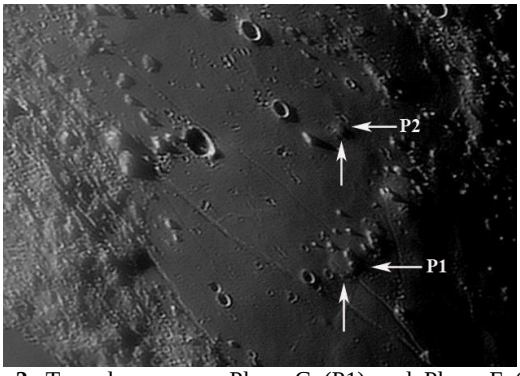

Fig. 2. Two domes near Plana G (P1) and Plana F (P2) marked with arrows. Image acquired on August 19, 2011 at 03:40 UT (Gladius XLI Cassegrain with aperture of 400 mm f/16 and a Baader Zeiss 2x Barlow lens).

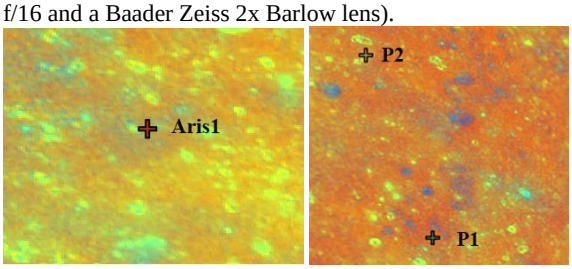

Fig. 3. Clementine colour ratio image of the examined regions with the domes Aris1, P1 and P2.

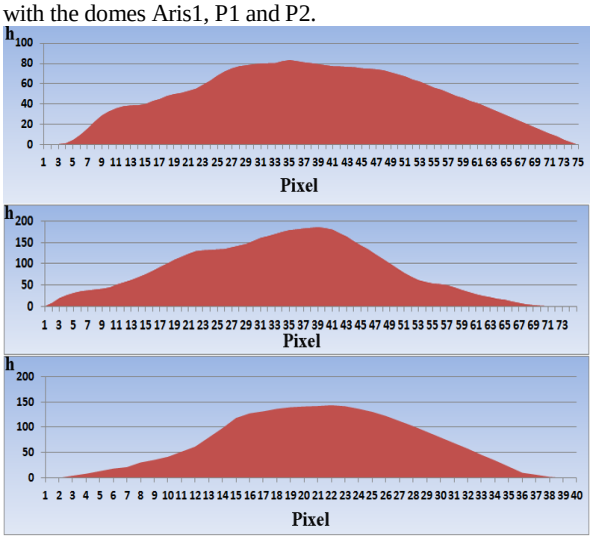

Fig. 4. Cross-sectional profile in east-west direction derived from the telescopic images for the domes Aris1(top), P1 (middle) and P2 (bottom). The vertical axis is 10 times exaggerated.

The flank slopes, diameters, heights, and edifice volumes of these domes were extracted from the DEMs (Table 1). The dome Aris1 belongs to class B_2, while the domes P1 and P2 are of subclass C_2, as introduced in [1, 3]. ACT-REACT Quick Map tool

was used to access to the GLD100 dataset [4], allowing to obtain the cross-sectional profiles and the corresponding 3D view (Fig. 5), in agreement with the results obtained with photoclinometry and sfs applied to telescopic image.

dome	η [Pa s]	E [m^3 s^{-1}]	Te [years]	U [m s^{-1}]	W [m]	L [km]
Aris1	1.5 x 10^5	75	0.6	2.0 x 10^{-5}	20	90
P1	3.0 x 10^6	75	2.5	5.9 x 10^{-6}	65	180
P2	1.5 x 10^6	61	1.4	6.8 x 10^{-6}	60	180

Table 2: Rheologic properties and dike geometries inferred for the examined domes.

Rheologic properties: The rheologic model developed in [5], which depends on the morphometric dome properties, yields estimates of the lava viscosity η, the effusion rate E, and the duration T of the effusion process for a monogenetic lava dome. Using the morphometric values listed in Table 1, we obtained lava viscosities between 8.8 x 10^4 and 3.0 x 10^6 Pa s, effusion rates between 60 and 75 m^3 s^{-1}, and durations of the effusion process between 0.6 and 2.5 years (Table 2). Furthermore, we estimated the magma rise speed U and the dike geometry (width W and length L) according to the model developed in [6]. We found that the magma ascended at speeds between 2.0 x 10^{-5} and 6.8 x 10^{-6} m s^{-1} through dikes of widths between about 20 and 65 m (Table 2). The dome Aris1 is a typical representative of rheologic group R_1 as defined in [1], 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. Rheologic group R_2 is characterised by low lava viscosities between 10^2 and 10^4 Pa s, fast magma ascent (U > 10^{-3} m s^{-1}), narrow (W = 1-4 m) and short (L = 7-20 km) feeder dikes. The third group, R_3, is made up of domes which formed from highly viscous lavas of 10^6-10^8 Pa s, ascending at very low speeds of 10^{-6}-10^{-5} m s^{-1} through broad dikes of several tens to 200 m width and 100-200 km length. The domes P1 and P2 are typical representatives of rheologic group R_3. Hence, for three examined domes the magma reservoirs are located well below the lunar crust regarding the thicknesses of the total crust of about 55 km [7].

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] Scholten et al. (2012) J. *Geophys. Res.* 117 (E00H17), doi:10.1029/2011JE003926; [5] Wilson & Head (2003) *J. Geophys. Res.* 108(E2), 5012–5018; [6] Rubin (1993) *J. Geophys. Res.* 98, 15919-15935; [7] Wieczorek et al (2006) *Rev. Mineral. Geochem.* 60,221-264;

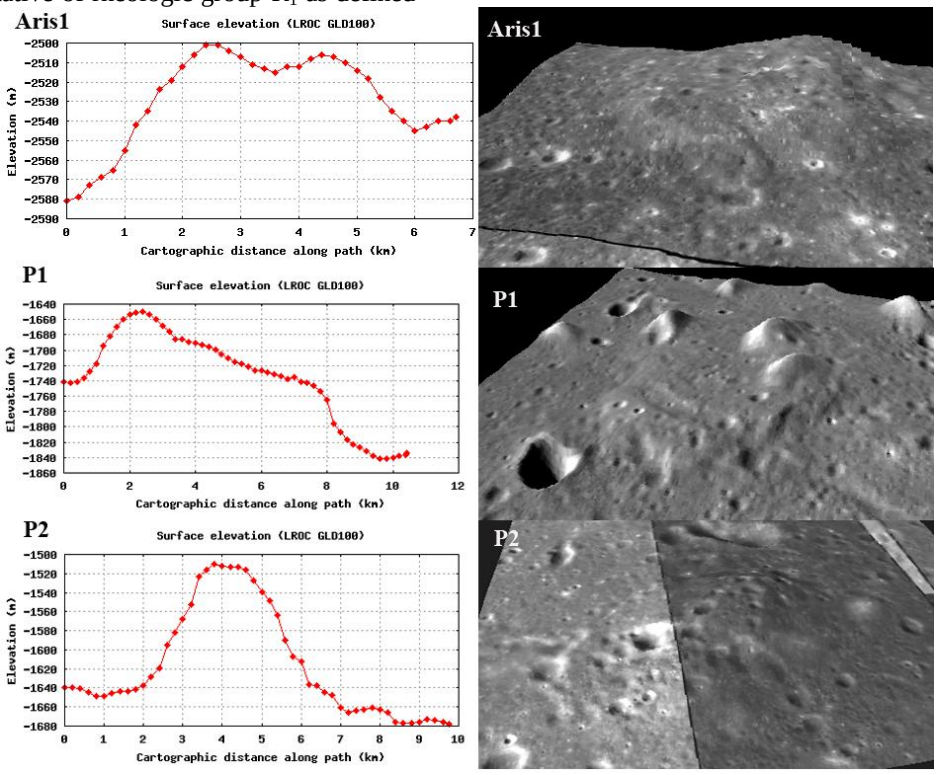

Fig. 5. Cross-sectional profile in east-west direction derived for three examined domes based on GLD100 dataset and 3D reconstruction. The vertical axis is 7 times exaggerated.