Searching lunar domes in Sinus Iridum region: A dome in Promontorium Laplace

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Detailed study of lunar domes is based on lunar images obtained under oblique illumination conditions for their measurements and for maximum detail.

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].

Maximilian Teodorescu, from Romania, has reported a possible dome, with a vent on the summit, located near Promontorium Laplace (Fig. 1). We term provisionally this volcanic construct as L1, to be consistent with previous classification regarding Sinus Iridum region. It lies at coordinates of 48.57°N and 26.37°W.

In Fig. 1 the dome displays a curved edge with the shadow bending around it, showing that the centre of the structure is higher than the edges.

Teodorescu has imaged this region with higher solar illumination angle as shown in Figs. 2 and 3.

Another image of this region, made by Phillips, is shown in Fig. 4.

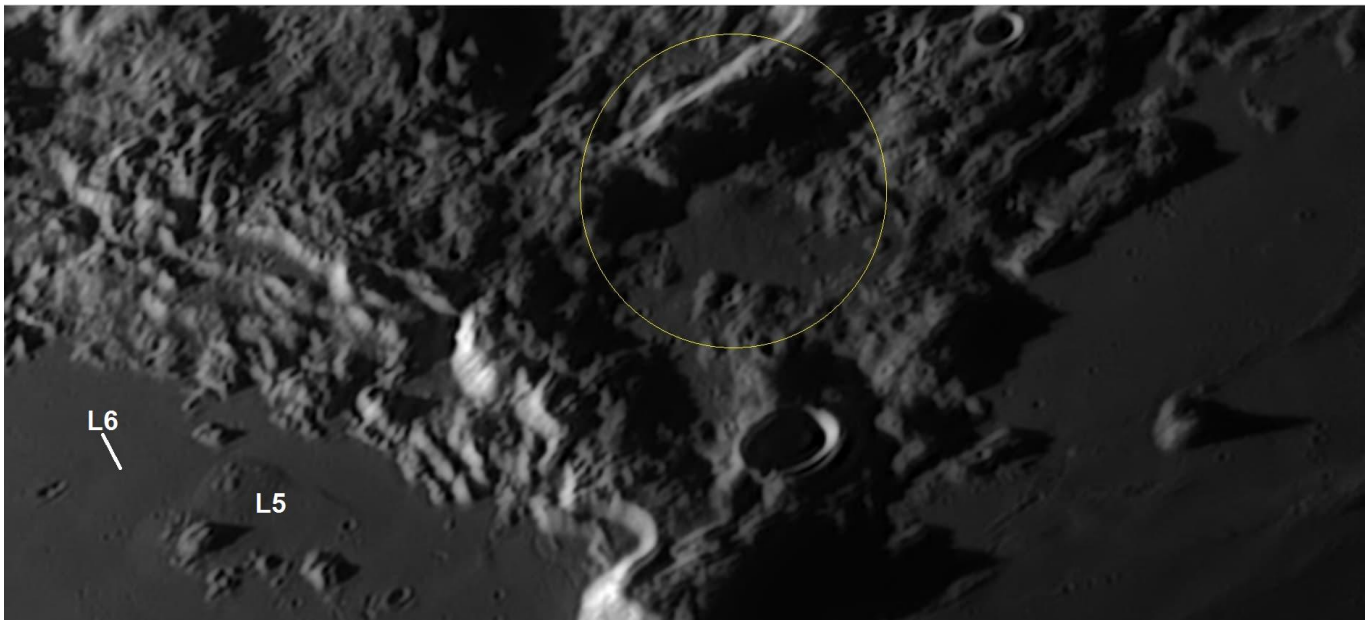

Figure 1. Image by Teodorescu taken on September 23, 2019 at 02:30 UT using a 355mm Newtonian telescope and ASI 174MM CCD camera. The examined lunar dome-termed L1- is marked with a circle. Two domes, termed L5 and L6, have been previously described by Lena et al. [3].

As shown in Figs. 1-4, slightly different solar elevation angles may result in strong differences and appearance of the dome.

A possible vent of about 1 km diameter is present on the summit. According to the LOLA DEM the vent has a depth of 90 ± 10m. The dome has a diameter of 7.6 ± 0.2 km and a height of 100 ± 10 m determined in E-W direction, resulting in an average flank slope of 1.5° ± 0.1°. Note that the most elevated part of the surface section covered by the DEM (in N-S direction) has a height of 230 ± 20 m, resulting in a slope of 3.4° ± 0.3°.

The 3D reconstruction of the examined dome, obtained using WAC mosaic draped on top of the global WAC-derived elevation model GLD100, is shown in Fig. 5.

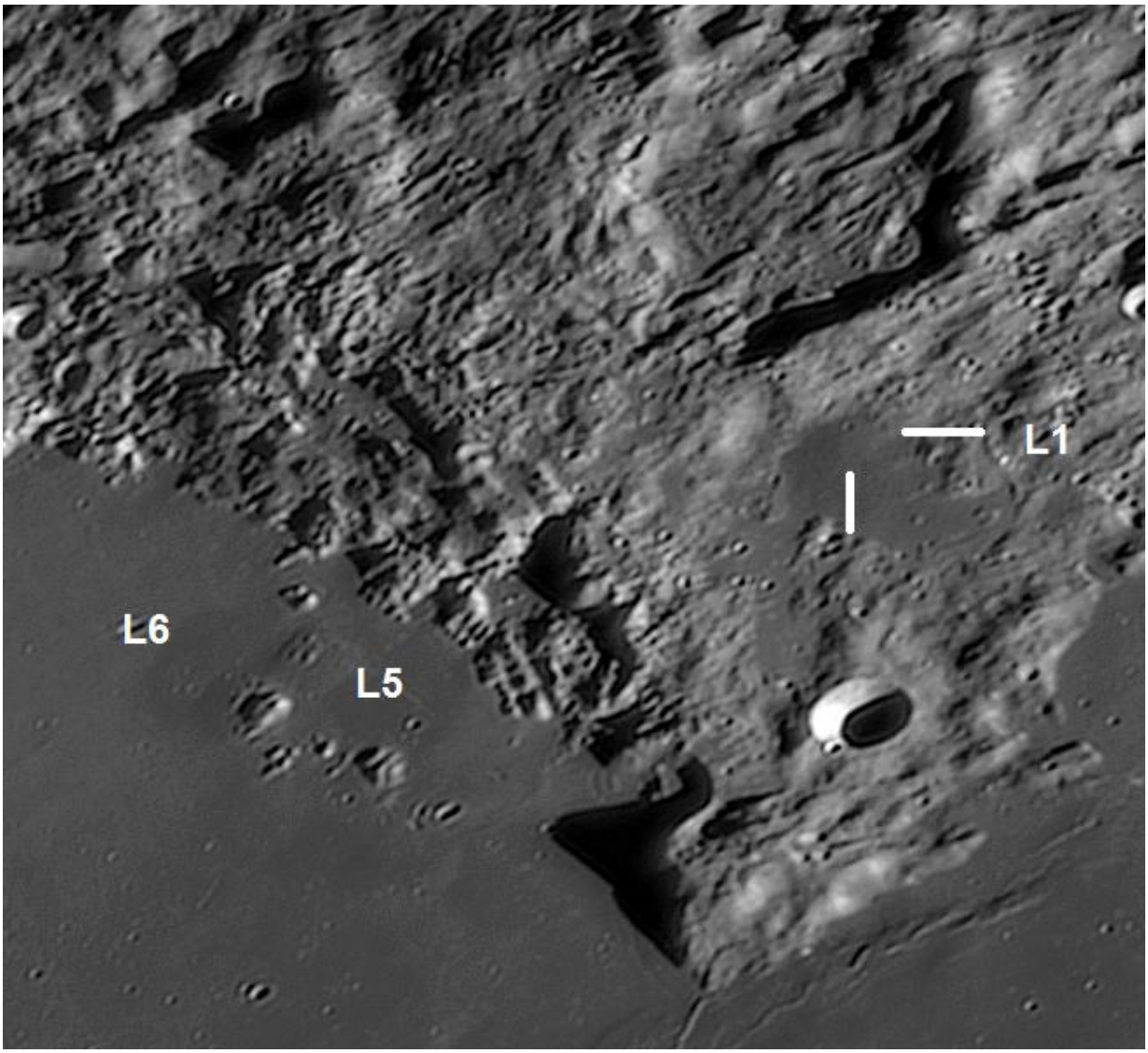

Figure 2. Another Image made by Teodorescu from Romania showing the dome L1. Two domes, termed L5 and L6, have been previously described by Lena et al. [3].

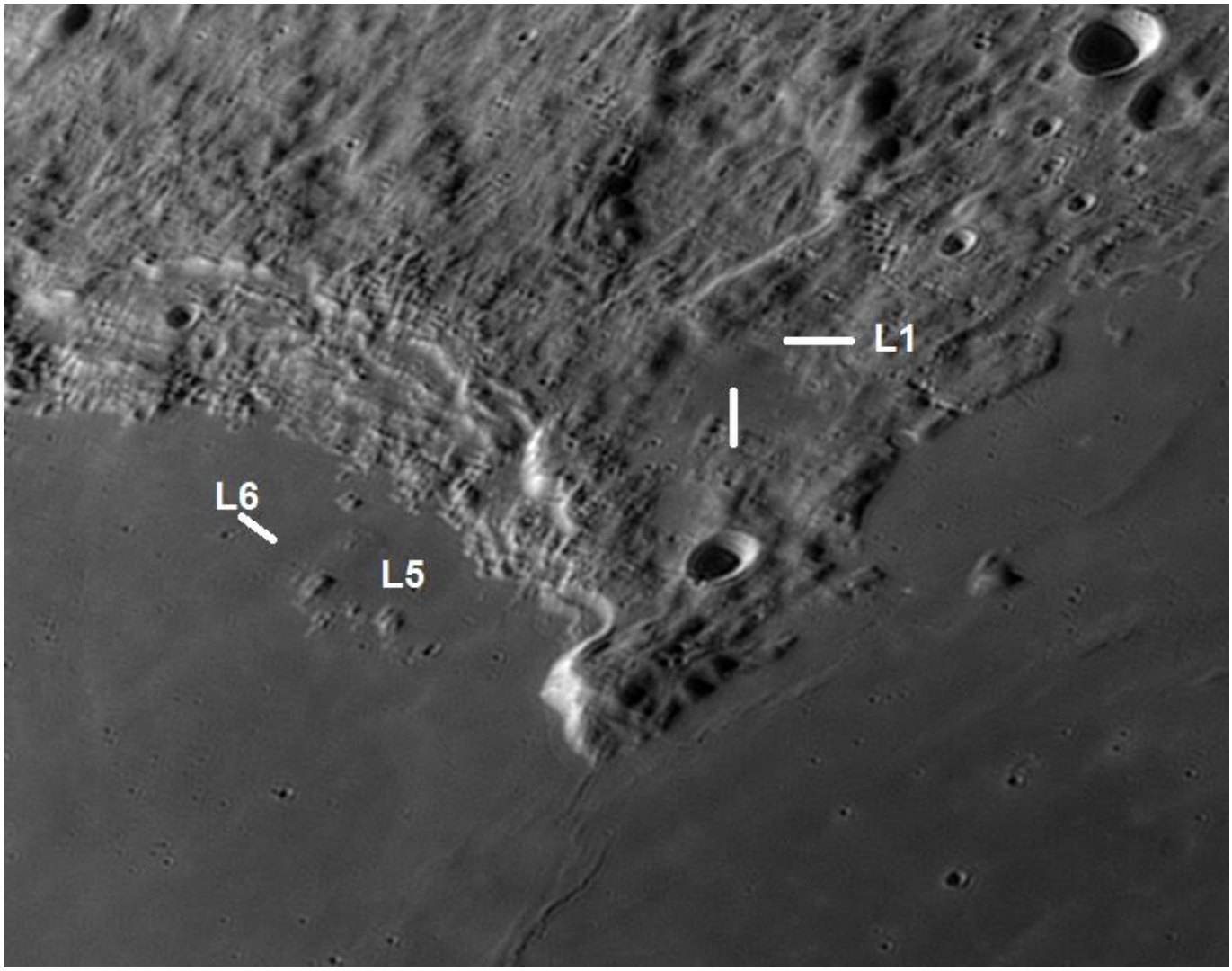

Figure 3. Another Image made by Teodorescu from Romania showing the dome L1. Two domes, termed L5 and L6, have been previously described by Lena et al. [3].

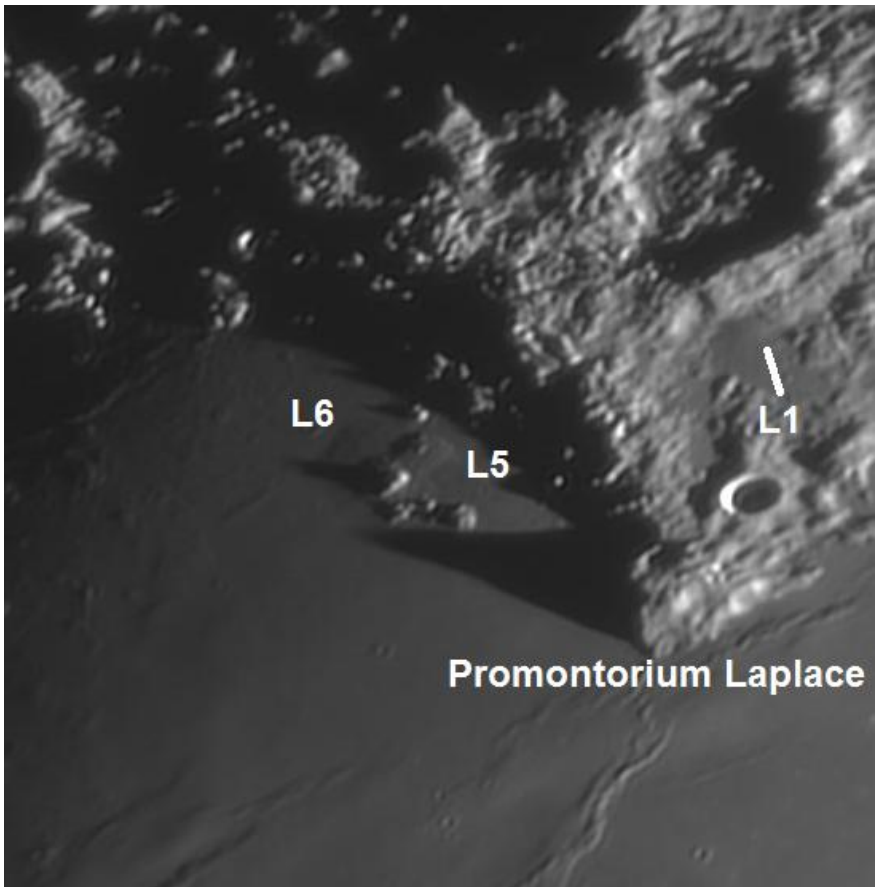

Figure 4. Image by Phillips taken on November 17, 2018 with a 254 mm Maksutov telescope.

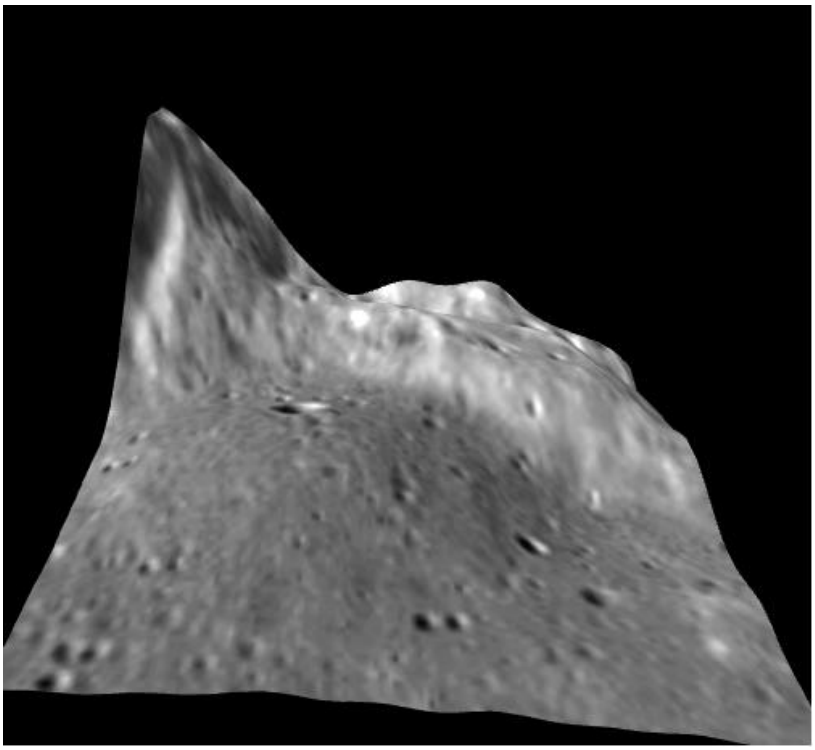

Figure 5. WAC mosaic draped on top of the global LRO WAC-derived elevation model (GLD100). The vertical axis is 7 times exaggerated.

Previous domes reported in Sinus Iridum, near Promontorium Laplace, are termed Laplace 5 and 6 (Figs. 1-4).

Laplace 5 (L5) has a diameter of 9.0 ± 0.5 km, height of 125 ± 15 m with an average slope of 1.60° ± 0.10°. The edifice volume is determined to 3.7 km^3. Laplace 5 belongs to class B_2. Rheologic modelling indicates that it was built by lava of moderate viscosity of 2.4 x 10^5 Pa s, erupting at a high effusion rate of 110 m^3 s^{-1} over a period of time of 1.2 years. The second elongated dome, named Laplace 6 (L6), with a low average slope of 0.7° ± 0.10° is considered a putative intrusive dome, and modelling results indicate that it belongs to class In2 [3]. A map of this region is published in our lunar domes atlas (http://sinusiridumdomes.blogspot.com/).

Spectral data have been obtained using Chandrayaan-1 Moon Mineralogy Mapper (M^3) an imaging reflectance spectrometer that can detect 85 channels between 460 to 3000 nm. The spectrum of the dome (Fig. 6) displays a narrow trough around 1000 nm with a minimum wavelength at 980 nm and an absorption band at 2000 nm, corresponding to a typical high-Ca pyroxene signature (Besse et al., 2014), indicating a basaltic composition. The highland to the north of the dome displays a spectrum of more feldspar composition, which lacks any observable mafic absorption feature in the range between 1000 and 2300 nm.
Thus the dome consists of mare material, which contradicts the possible interpretation that this feature is merely an elevated deposit of hummocky material.
The spectral properties of major lunar minerals exhibit absorption bands that differ by their shape and position along the spectral domain. Pyroxenes (orthopyroxenes and clinopyroxenes) have two absorption bands, one centered near 1000 nm and another near 2000 nm. Olivine has a complex absorption centered over 1000nm, with no absorption at 2000 nm. Therefore, olivine-rich lunar deposits are characterized by a broad 1000nm absorption band which is enhanced relative to the weak or absent 2000 nm band (Fig. 7).

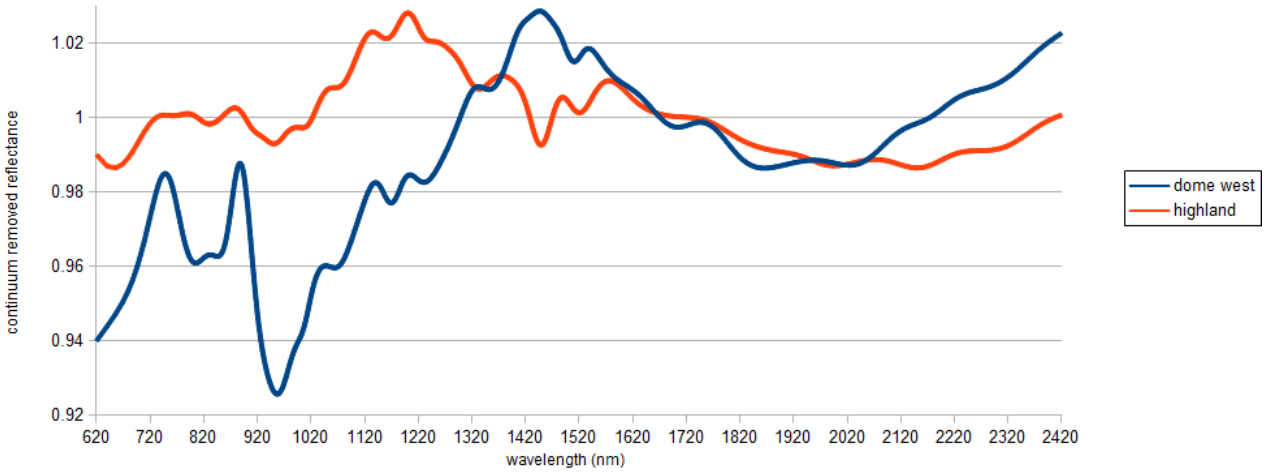

Figure 6. Moon Mineralogy Mapper (M^3) spectra of the examined dome identified by Teodorescu and the highlands north of the dome.

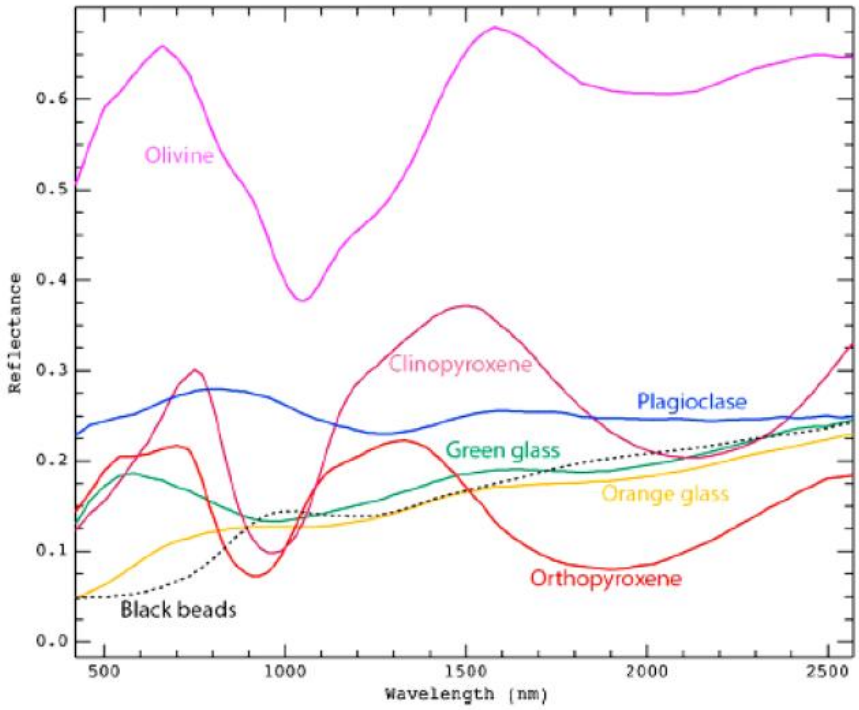

Figure 7. Spectral properties of major lunar minerals, including volcanic glasses.

We encourage more high-resolution imagery of this dome, which has been not characterized in the morphometric and spectral properties yet. Further analyses are in progress. Please check also your past imagery and send them to us for the ongoing study (lunar-domes@alpo-astronomy.org).

References

[1] Basaltic Volcanism Study Project, 1981. Basaltic Volcanism on the Terrestrial Planets. New York: Pergamon Press.

[2] Lena, R., Lunar domes, chapter in Encyclopedia of Lunar Science Editor: Brian Cudnik, 2015, Springer ISBN: 978-3-319-05546-6.

[3] Lena, R., Wöhler, C., Phillips, J., Chiocchetta, M.T., 2013. Lunar domes: Properties and Formation Processes, Springer Praxis Books.

[4] Besse, S., J. M. Sunshine, and L. R. Gaddis (2014), Volcanic glass signatures in spectroscopic survey of newly proposed lunar pyroclastic deposits, J. Geophys. Res. Planets, 119, doi:10.1002/2013JE004537.