Lunar Domes (part XXIII): Mode of formation of a swell in Montes Teneriffe by Raffaello Lena

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The presence of a possible dome located in contact with Montes Teneriffe was reported in the October 2018 issue of the BAA lunar section circular [1], I have examined, being involved as coordinator in the Lunar domes project for BAA and ALPO, the proposed feature using GLD100 dataset and my analyses, including mode of formation, are reported below.

The examined feature, here termed Teneriffe 1 (Ten1), is located at 49.08°N and 15.7° W. It is also detectable as a swell in the Lunar Orbiter imagery and LROC WAC imagery as shown in Figs. 1-2. In Fig. 2, image taken under low solar illumination angle, the examined feature displays a curved edge with the shadow bending around it, showing that the centre of the structure is slightly higher than the edges.

It has a base diameter determined to 9.8x7.4km. The height of the dome Ten1 (Fig. 3) is determined to 55 ± 5m, resulting in an average slope of 0.72° ± 0.07°. The dome volume V is estimated by assuming a form factor of f = 1/2, which yields an edifice volume of 1.6km³.

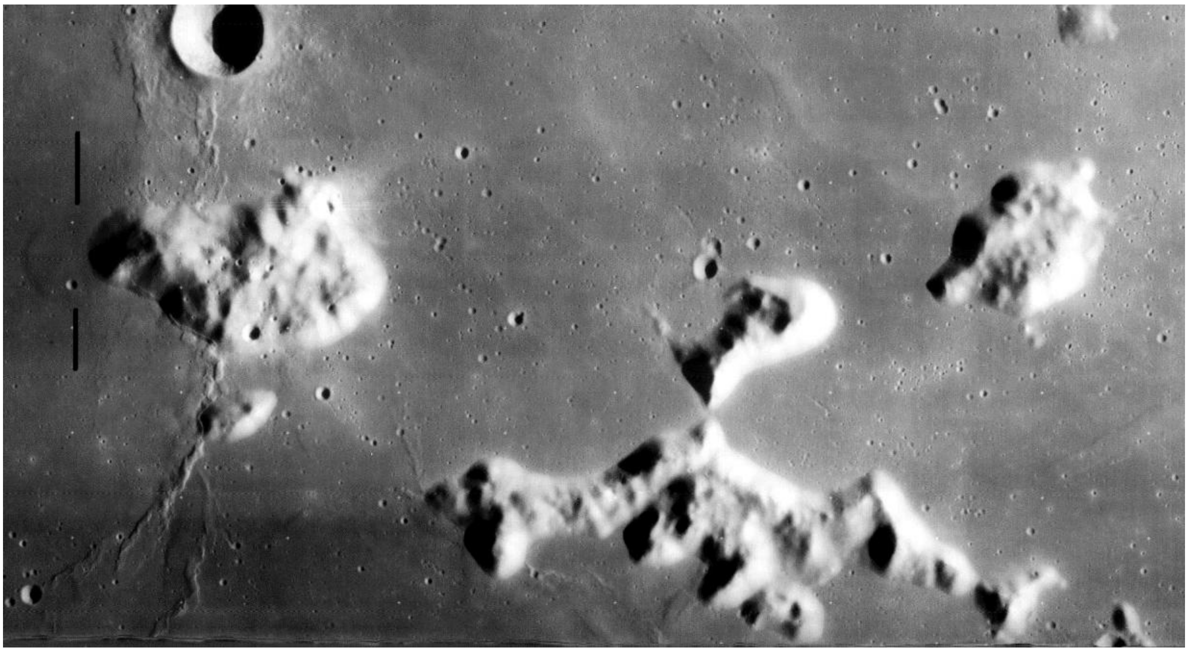

Figure 1. Lunar Orbiter image LO IV-127-H3 showing the dome marked with black arrows. An impact crater is located on the summit in the southern part.

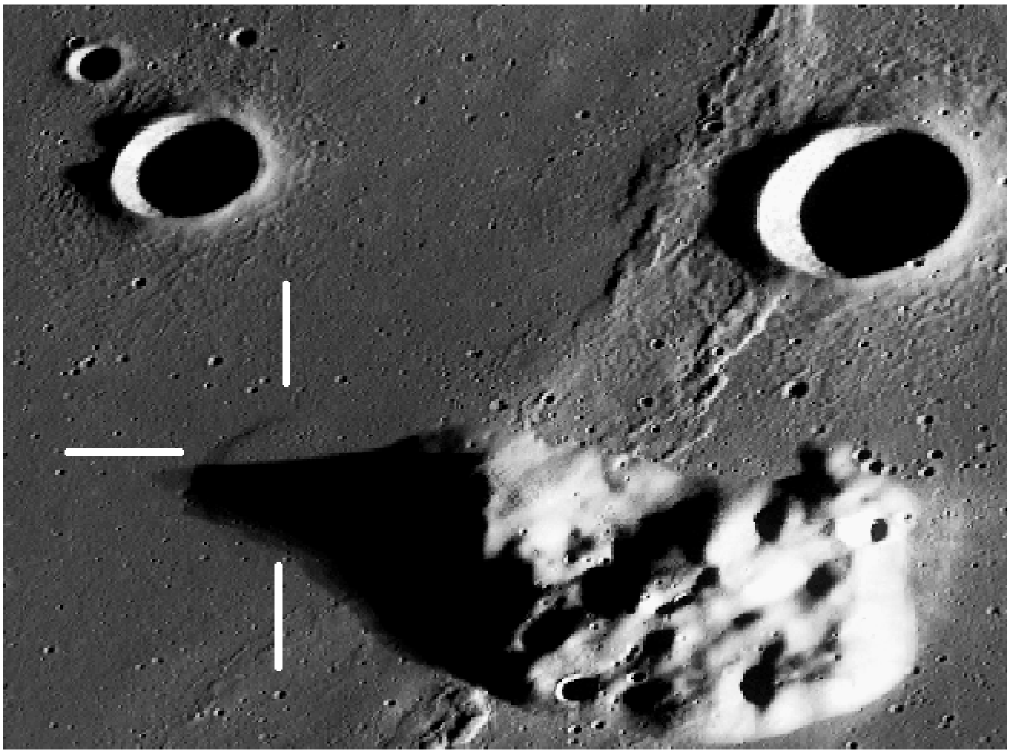

Figure 2. WAC imagery under low solar illumination angle. The dome is marked with white arrows.

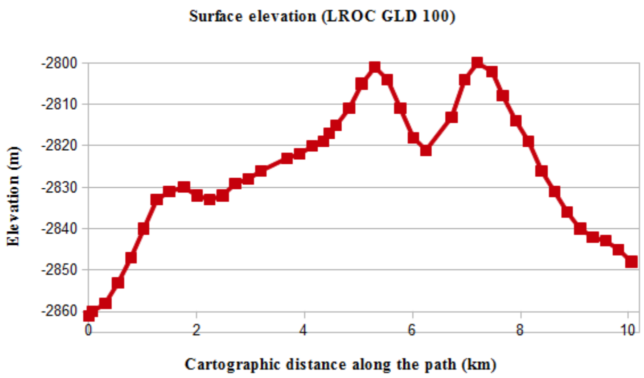

Figure 3. Cross-sectional profile of Ten1 based on GLD100 dataset.

It displays an elongated shape. The profile of domes that are flat and elongated suggests that there was not a gradual formation at the vent (the rising lava did not build up the dome in a series of flows) but a subsurface intrusion of magma, a possible intrusive origin, and interpreted as laccoliths. In this case, magma accumulates within the lunar crust, slowly increasing in pressure and causing the crustal rock above it to bow upward [2-3]. The adopted criteria for identification of possible intrusive domes, also known as swells, are non-circular outline that can be described by a major axis **a** and a minor axis **b** and its circularity as **c = b/a (**c= 0.75). The effusive domes always have circularity values higher than 0.9, having flank slopes below 0.9° and displaying effusive vents. On the other hand, I have identified domes, of possible intrusive origin, having circularity values well below 0.8 and flank slopes <0.9° [2-3]. Based on the classification scheme introduced for lunar domes, the examined feature fits the class In2 of putative intrusive domes [4-5]. The first class, In1, comprises large domes with diameters above 25 km and flank slopes of 0.2°–0.6°, class In2 is made up by smaller and slightly steeper domes with elongated shapes and diameters of 10–15 km and flank slopes between 0.4° and 0.9°. Domes of class In3 have diameters of 13–20 km and flank slopes below 0.3° (Fig. 4).

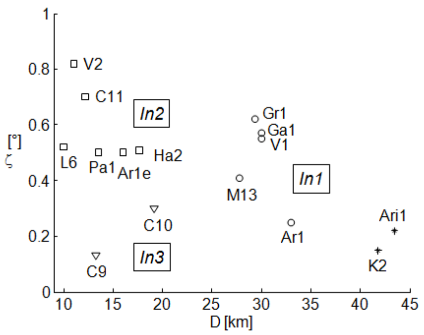

Figure 4. Diameter D vs. flank slope ζ diagram (indicating the dome classes In1–In3) of the candidate intrusive domes as introduced in [2-5].

The morphometric properties of the intrusive dome classes have been related to the modelled laccolith parameters by Wöhler and Lena [5]. To estimate the geophysical parameters of lunar intrusive domes, especially the intrusion depth and the magma pressure that occurred during their formation, I have utilised the laccolith model by Kerr and Pollard [6]. Based on geophysical models, intrusive domes of class In1 are characterised by uppermost basaltic layer thicknesses of 0.3-0.6km and more, intrusion depths of 2.3-3.5km and magma pressures of 18-29 MPa. For the smaller and steeper domes of class In2, the uppermost basaltic layer has a thickness of typically 0.1-0.2km, the magma intruded to shallow depths between 0.4 and 1.0km while the inferred magma pressures range from 3 to 8 MPa. Class In3 domes are similar to those of class In1 with similar thicknesses of the uppermost basaltic layer ranging from 0.4 to 1.2 km, intrusion depths of 1.8-2.7 km, and magma pressures of 15-23 MPa. I have inferred for the dome Ten1 a thickness of the uppermost basaltic layer of 0.2km, an intrusion depth of 0.35km, and a maximum magma pressure of 2.9 MPa. Moreover, it displays morphometric properties comparable to other domes of class In2, some of them have been described in previous articles appeared in the Journal of the British Astronomical Association [8-9], e.g. the domes termed V2 and Ha2. When assuming an intrusive origin of the dome, this would indicate that laccolith formation proceeded until the second stage characterised by flexure of the overburden [7].

References

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