A Lunar Dome north-east of the crater Schröter. Morphometric properties derived using terrestrial telescopic images.

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Introduction

In previous works Lena and Fitz-Gerald have described a dome located to the north-east of the crater Schröter at latitude 3.52° N and longitude 6.27° W (Lena and Fitz-Gerald, 2015; Lena and Fitz-Gerald, 2016). The dome, named as Schröter1 (Sc1), has a base diameter of 35 km. Its height, determined using GLD100 dataset, amounts to 200 m and the average slope angle ξ corresponds to 0.65°. It exhibits evidence of dark material likely pyroclastic volcanic deposits on its surface (Lena and Fitz-Gerald, 2015; Lena and Fitz-Gerald, 2016). The dome Sc1, not recognized in the USGS lunar geologic map I-548, is associated with a linear rille (a graben) traversing its northwestern summit, which would indicate structural control by subsurface geology (Lena and Fitz-Gerald, 2015; Lena and Fitz-Gerald, 2016). Graben features are commonly interpreted as fractural that occur as a result of the flexural uplift. The goal of this study is to demonstrate as high resolution terrestrial imagery of the elusive lunar domes is useful for the recognition of non-cataloged domes. In this note two recent images made by Viladrich and Teodorescu are presented.

Terrestrial telescopic images

Christian Viladrich has imaged the dome Sc1 on October 28, 2021 at 5:19 UT (Fig. 1), using a 500 mm Ritchey-Chrétien telescope.

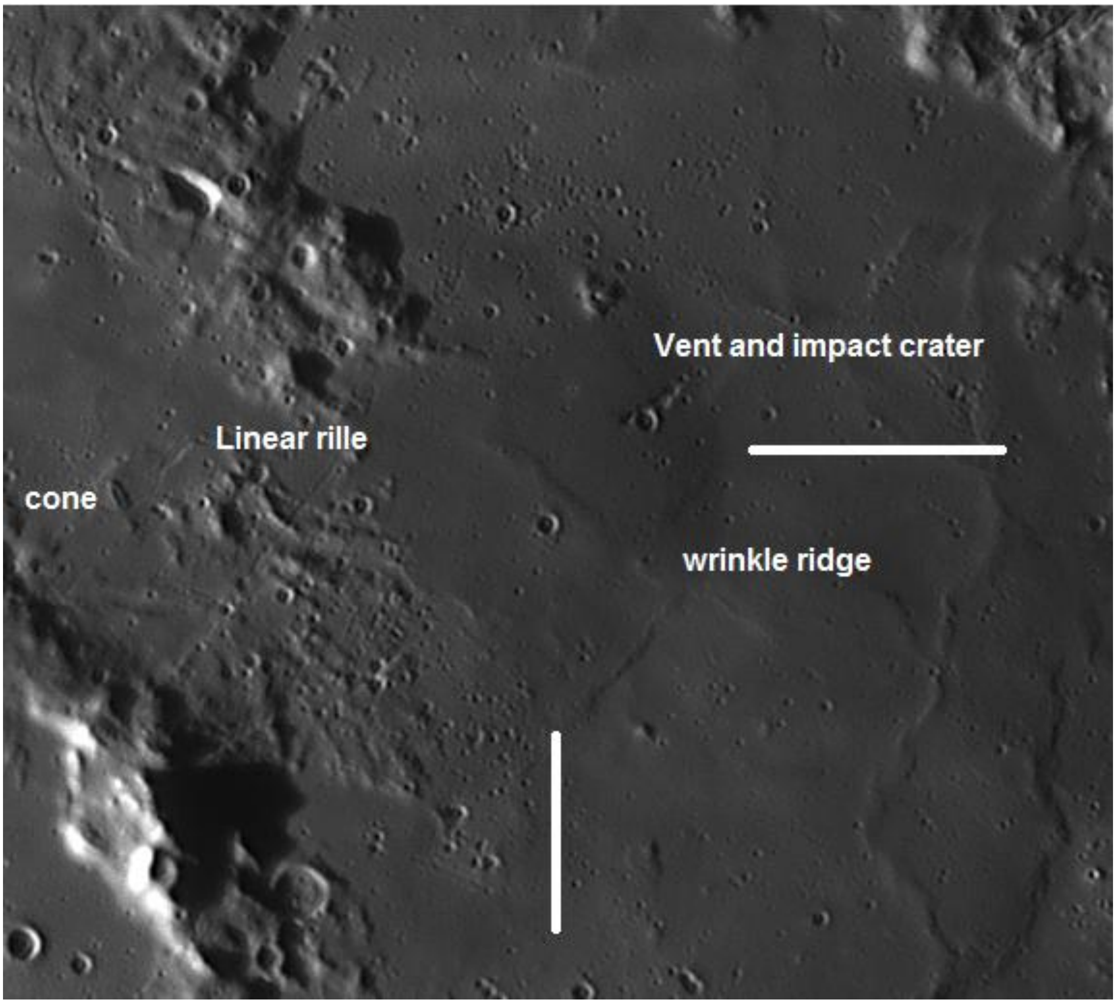

Figure 1: The dome Sc1 imaged by Viladrich on October 28, 2021 at 5:19 UT.

Figure 2 displays the WAC imagery for comparison with the telescopic terrestrial image.

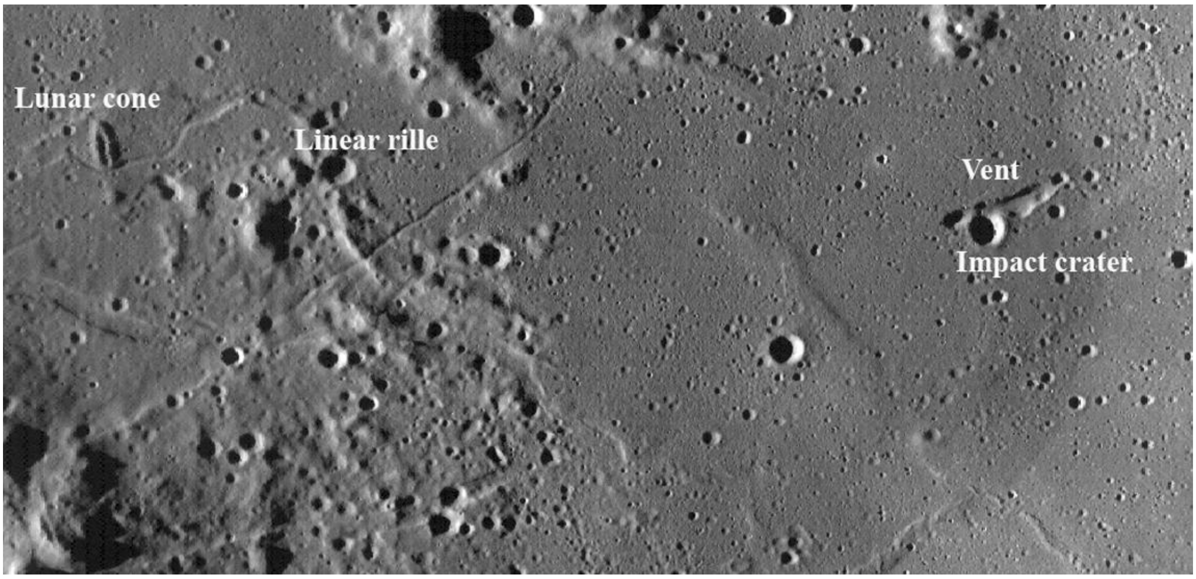

Figure 2: The dome Sc1 WAC imagery.

On the same night, but at 4:09 UT, Teodorescu has imaged the same region using a 355 mm Newtonian telescope (Fig. 3).

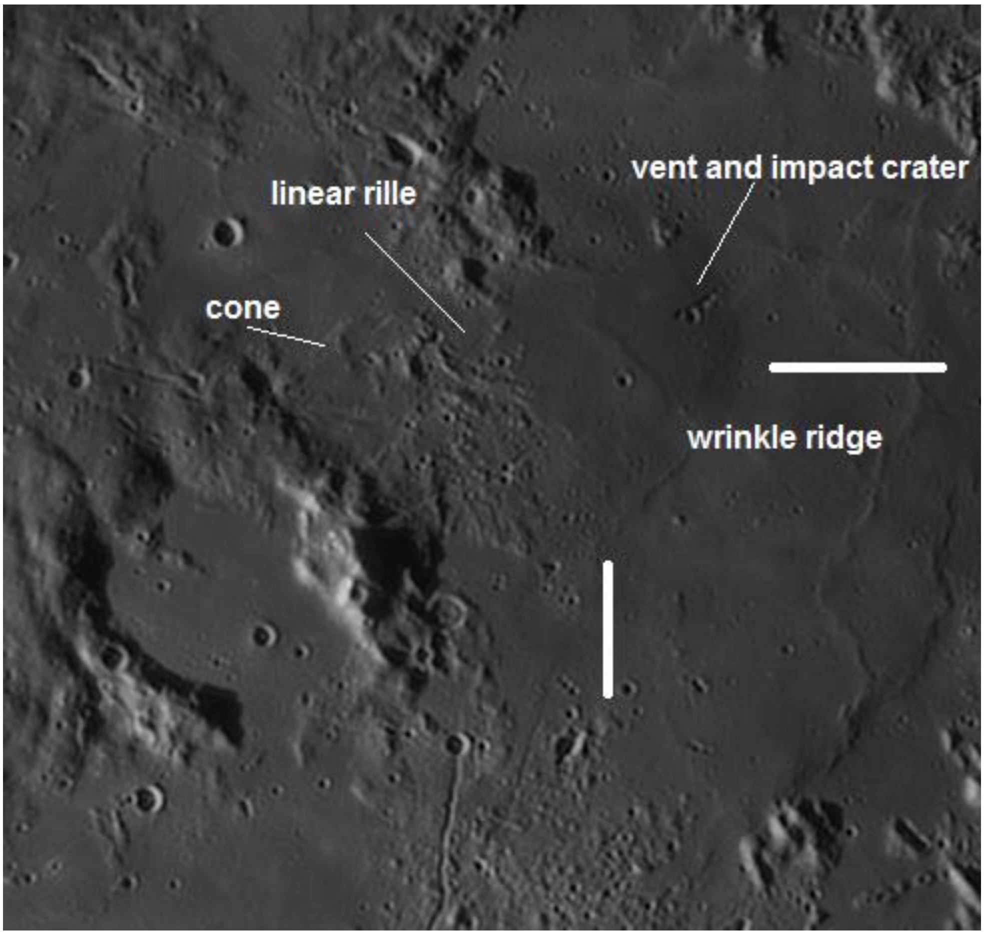

Figure 3: The dome Sc1 imaged by Teodorescu on October 28, 2021 at 4:09 UT.

In figures 1 and 3 the principal features described in the works published by Lena and Fitz-Gerald (2015; 2016) are marked.

Digital elevation model (DEM)
Generating a DEM of a part of the lunar surface requires its three-dimensional reconstruction. Well-known image-based methods for three-dimensional surface reconstruction are photoclinometry and shape from shading (SFS). They make use of the fact that surface parts inclined towards the light source appear brighter than surface parts inclined away from it. Both methods aim at deriving the orientation of the surface at each image location by using a model of the reflectance properties of the surface and knowledge about the illumination conditions.

The photoclinometric approach performs a 3D reconstruction of the surface along one-dimensional profiles, while the SFS technique yields an elevation value for each image pixel (Horn, 1989). The iterative scheme used for photoclinometry and SfS approach is described in preceding articles (Lena et al., 2013; Lena et al., 2006; Wöhler, Lena et al., 2007; Wöhler, Lena et al., 2007).

Using the Lunar Terminator Visualization Tool (LTVT) software package by Mosher and Bondo (2006), I have determined the selenographic positions of the examined dome. LTVT is a freeware program that displays a wide range of lunar imagery and permits a variety of highly accurate measurements in these images. Selenographic coordinates, sizes, and shadow lengths of features can be estimated based on a calibration procedure. This calibration allows LTVT to make the spatial adjustments necessary to bring the observed positions of lunar features into conformity with those expected from the Unified Lunar Control Network (ULCN, 1994). The ULCN is a set of points on the lunar surface whose three-dimensional selenodetic coordinates (latitude, longitude, and radial distance from the lunar centre) have been determined by careful measurement. Typically these points consist of very small craters.

The image shown in Fig. 1 was transformed in cylindrical projection. The 3D reconstruction obtained using photoclinometry and Shape from Shading (SfS) is reported in Fig. 4.

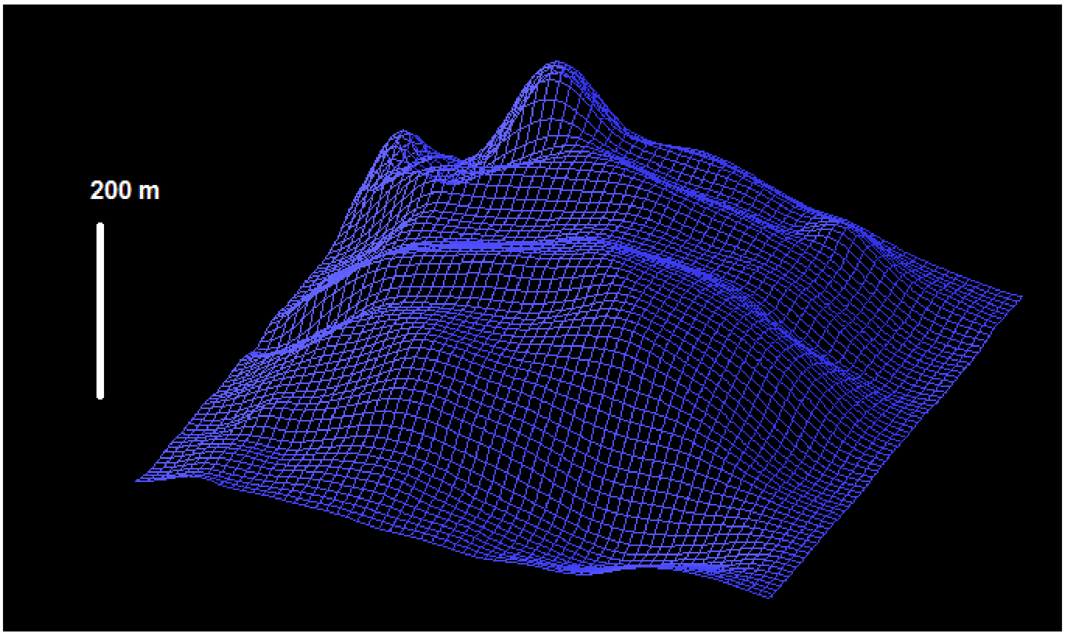

Figure 4: DEM of Sc1 derived using the image of Fig 1.The lunar curvature was subtracted. The vertical axis is thirty times exaggerated.

The height h of Sc 1 is thus obtained by measuring the altitude difference in the reconstructed 3D profile between the dome summit and the surrounding surface, considering the curvature of the lunar surface. The average flank slope was determined according to: slope = arctan 2h/D, with D the diameter in km. The dome has a base diameter of 35 ± 0.2km. Its height amounts to 198m ± 20 m, while the average slope angle ξ corresponds to 0.64° ± 0.06° in accord with the measurements obtained using GLD100 dataset.

A refined approach was then used to construct a rendered view using the telescopic image superimposed onto the corresponding DEM of Fig. 4. Figure 5 attempts to give a realistic 3D impression of the dome as viewed from the south and the south-east direction. Moreover the data obtained with terrestrial telescopic image shown evidence of extensional forces in the form of graben, compression in the form of wrinkled ridges and the elongated fissure, likely a vent, located on the dome flank (Figs. 1-2 and 5).

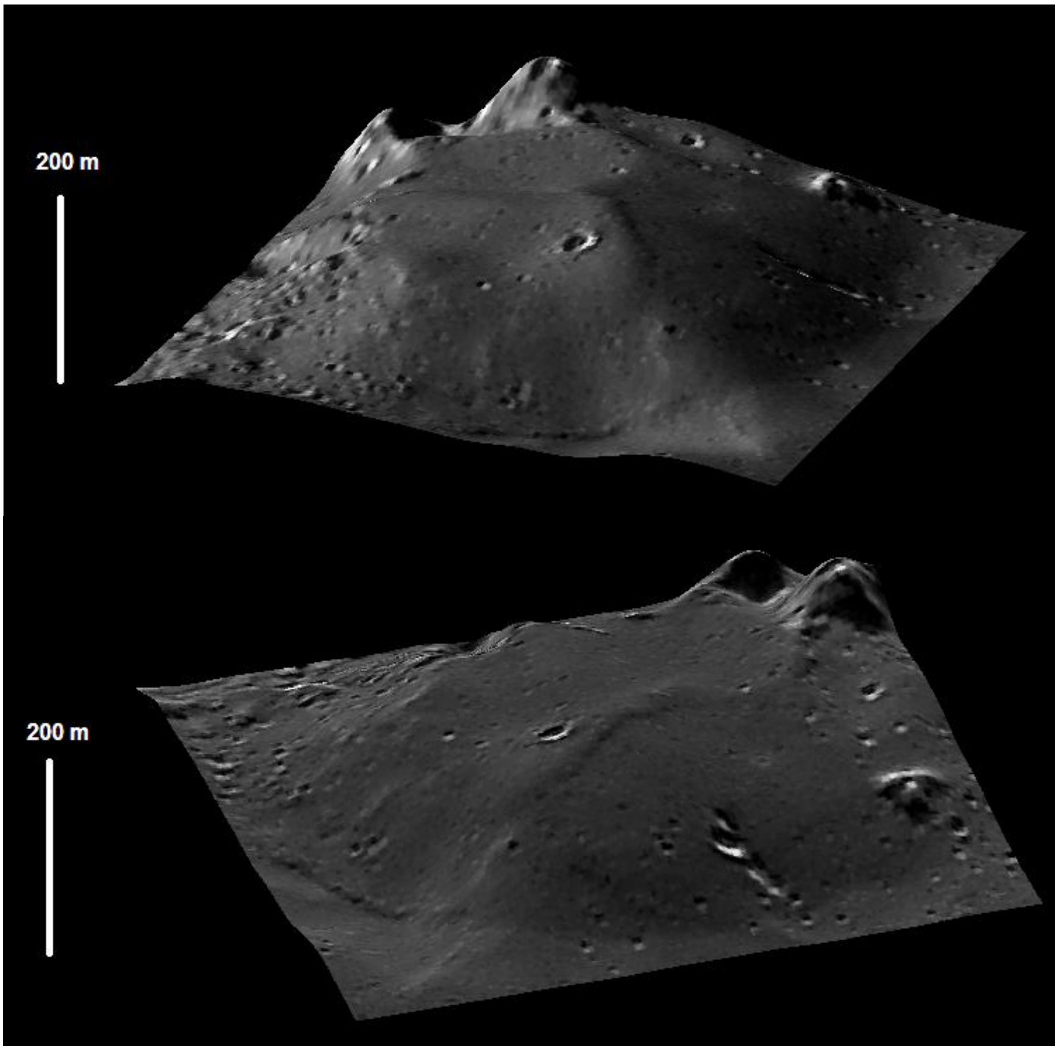

Figure 5: The dome Sc1 as viewed from the south (top) and the south-east direction (bottom).

Analysis carried out on the image of Fig. 2 gives similar results, shown in Fig. 6. Its height, based on the analysis carried out on the image of Fig. 3, amounts to 202m ± 20 m, while the average slope angle ξ corresponds to 0.64° ± 0.06°

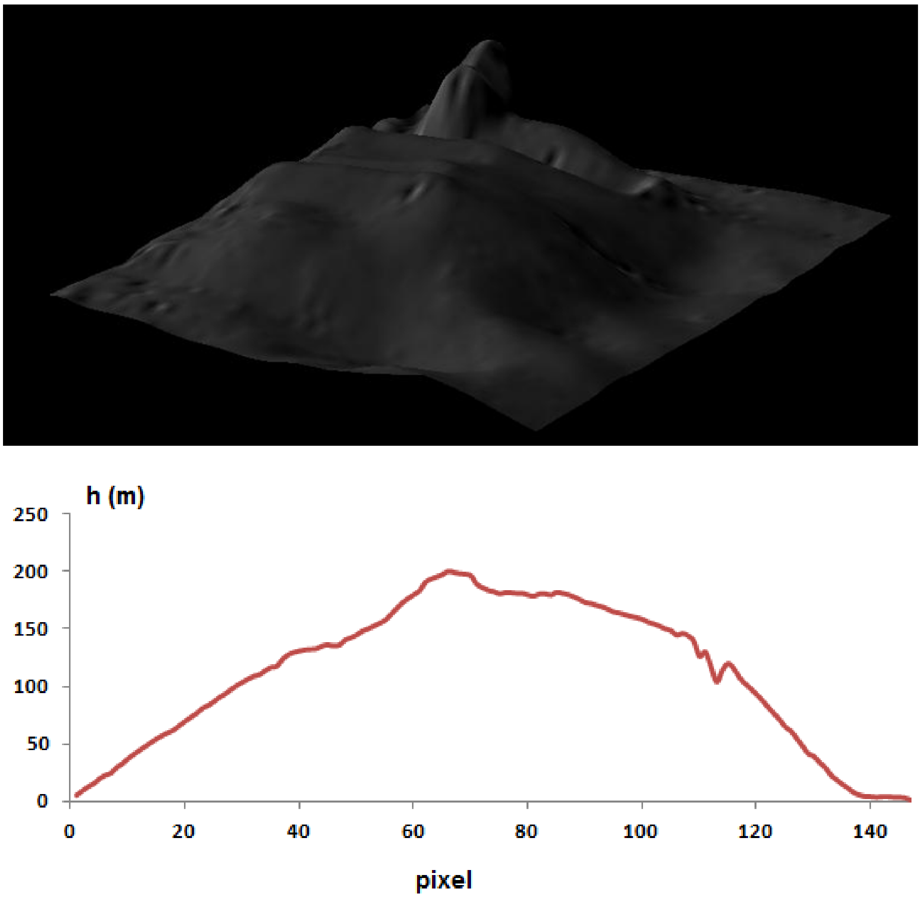

Figure 6: The dome Sc1 as viewed from the south (top) and the profile in E-W direction (bottom). The vertical axis is thirty times exaggerated.

As further comparison, Fig. 7 displays the 3D reconstruction presented by Lena and Fitz-Gerald in previous articles (Lena and Fitz-Gerald, 2015; Lena and Fitz-Gerald, 2016) obtained with the WAC image draped on top of the global LROC WAC-derived elevation model (GLD100). The elevation of the dome corresponds to 200 m.

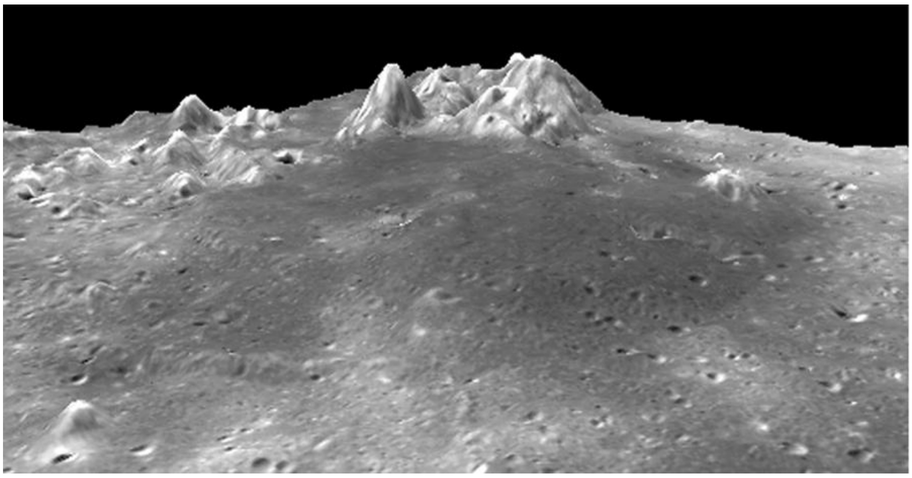

Figure 7: WAC draped on top of the global LROCWAC-derived elevation model (GLD100).The vertical axis is seven times exaggerated.

Conclusion

High resolution CCD imagery of the elusive lunar domes is the most difficult branch of the astrophotography of the Moon. The recording of finer details will be obtained with telescopes optically of high quality, large diameter, and favorable observing sites in order to reduce the effect of the atmospheric turbulence. Using the described approach, based on the analysis of two excellent terrestrial telescopic images, it is possible to determine that this feature is clearly a low profile dome like structure and elevated above the mare surface.

Consequently, ground-based images obtained using telescopes and CMOS cameras like those commonly used by well-equipped amateur astronomers are of great value for the morphologic and morphometric analysis of lunar domes.

References

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