Are the Domes in Lacus Veris Detectable in Telescopic Images?

Raffaello Lena

In a previous note (Lena, 2023) I have described Lacus Veris, Lacus Autumni and Schlüter crater.
Following my request, some images of these regions have been submitted by Robert Cazilhac.
These interesting images are shown in Figures 1 and 2 but, unfortunately, the times in UT are not available.

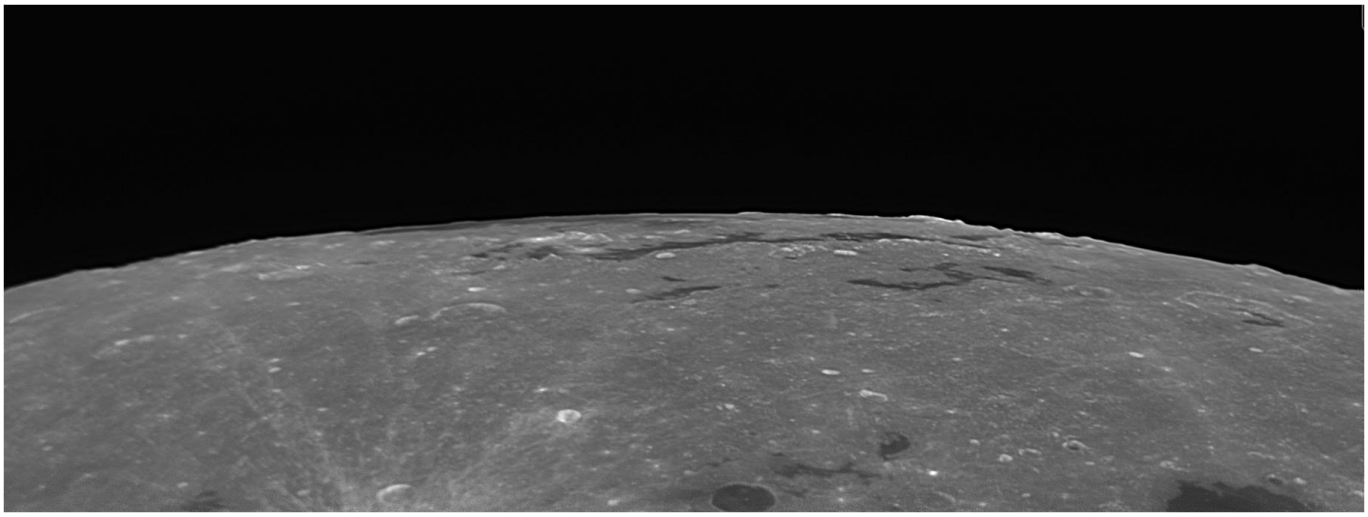

Figure 1: Image taken by Cazilhac on February 28, 2021. Telescope Schmidt Cassegrain 30 cm.

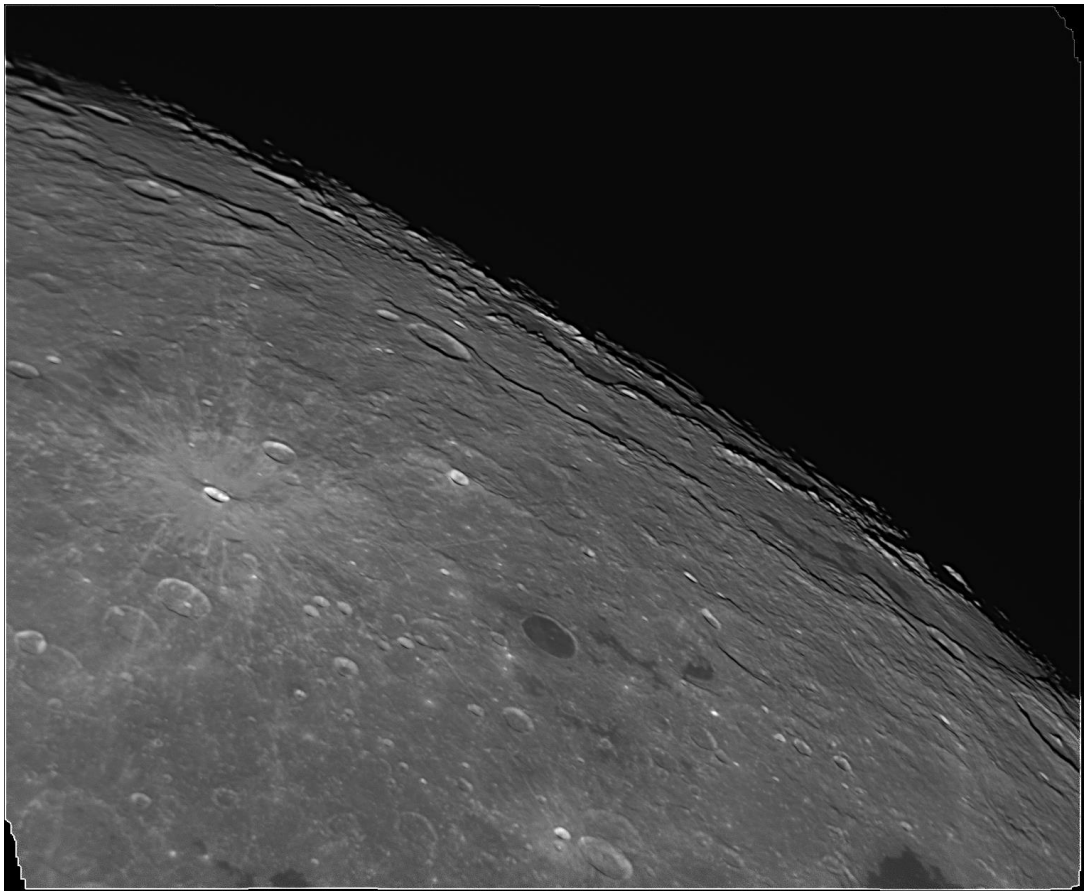

Figure 2: Image taken by Cazilhac on February 27, 2021. Telescope Schmidt Cassegrain 30 cm.

The dome Kopff 1 (Ko1) lies in Lacus Veris to the north of a plateau or two features like domes (identified with x). Fig. 3 displays the mentioned domes.

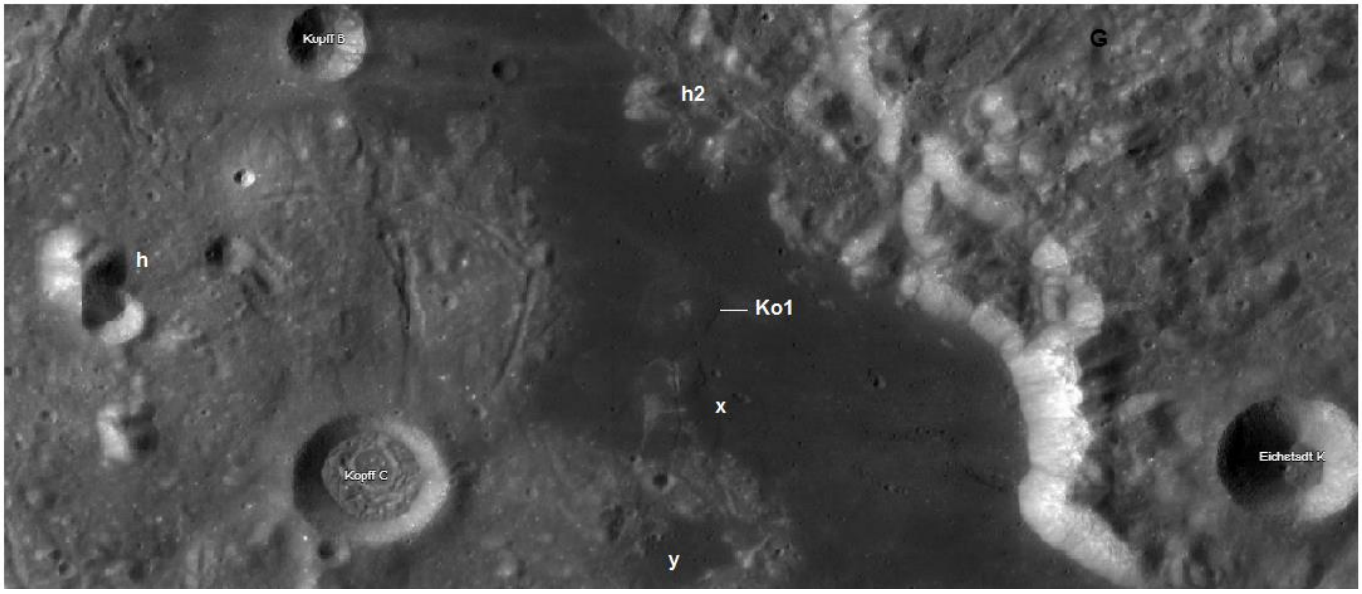

Figure 3: WAC imagery of the region of interest. The dome termed Kopff1 (Ko1) is located to the north (up) of an elongated swell (marked with the symbol x). In the image are marked some topographic points (h, h2 and y).

The images reported in Figures 1 and 2 have been studied using several lunar atlases, LRO WAC /NAC imagery, cylindrical projections and topographic benchmark (Fig. 3).

Results for the lower resolution image of February 28, 2021

Fig. 4 displays the transformed image which was corrected in various ways with a zenithal view (4C and 4D).

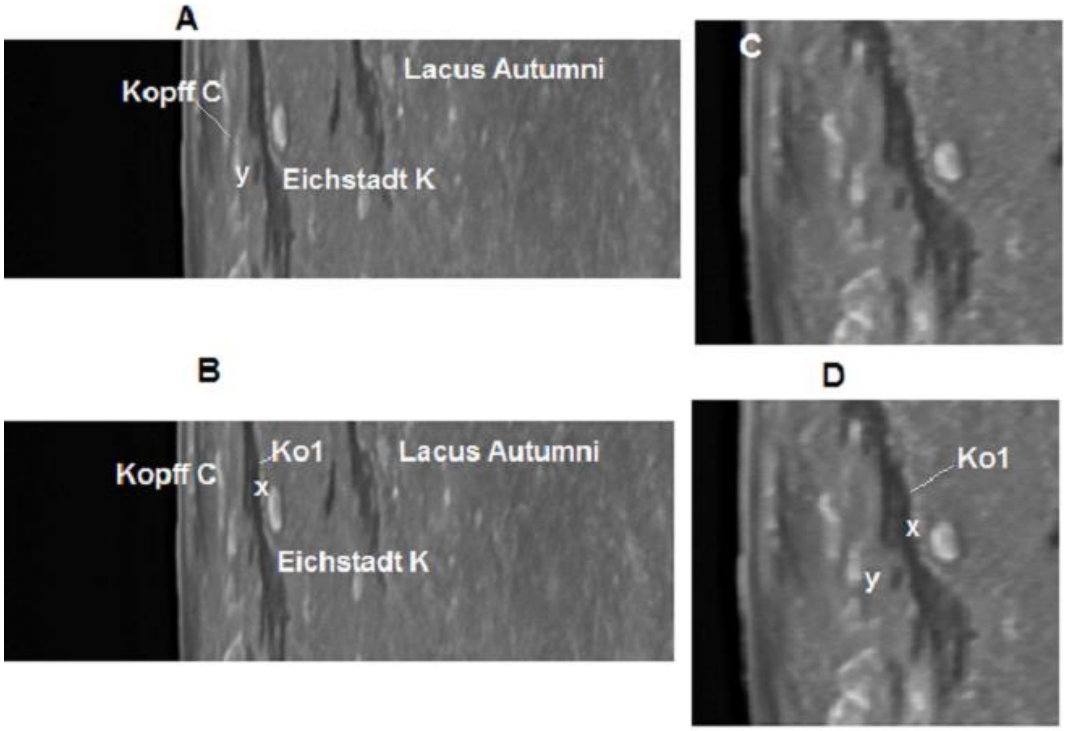

Figure 4: Results based on the image taken on February 28, 2021.The swell (x) and Ko1 are marked.

The dome Ko1 and the swell x are detectable like two bright spots. Superimposition and analysis carried out using WAC imagery confirm their position.

Results for the image of February 27, 2021

Fig. 5 displays the transformed image taken on February 27, 2021 which was corrected in various ways with a zenithal view (5E and 5F).

Based on this higher resolution image, and some topographic benchmark, Ko1 most likely was imaged but new images are recommended in Hires and with precise time (date and time in UT) to try other measurements and comparison.

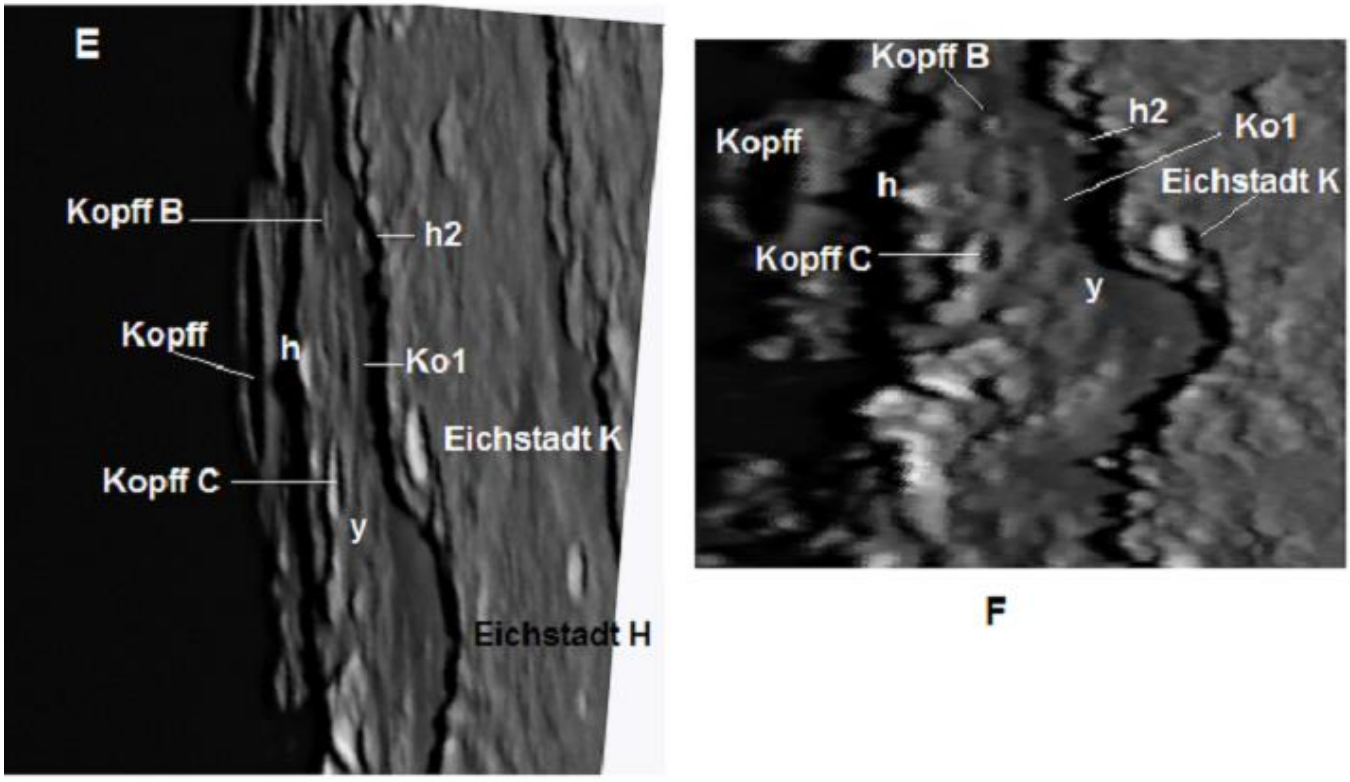

Figure 5: Results based on the image taken on February 27, 2021.The probable position of Ko1 is marked, perhaps unresolved with the swell x.

Lacus Veris lies between the ring-shaped inner and outer Rook Mountains that form part of the Orientale impact basin. Mare Orientale was created by an impact of a huge meteorite that lifted the mountains bordering the basin. The Mare Orientale is surrounded by two mountain ranges, one internal, more than 700 kilometers in diameter, the Montes Rook and the other external, more than 900 kilometers, the Montes Cordillera (Greeley, 1976).

Volcanism in Lacus Veris and identified domes

Volcanic phenomena have occurred in these regions with the formation of lava plain and also lunar domes (in Lacus Veris near the crater Kopff). During a recent survey I have identified four domes under investigation (Fig. 6). This study, including spectral data, is ongoing.

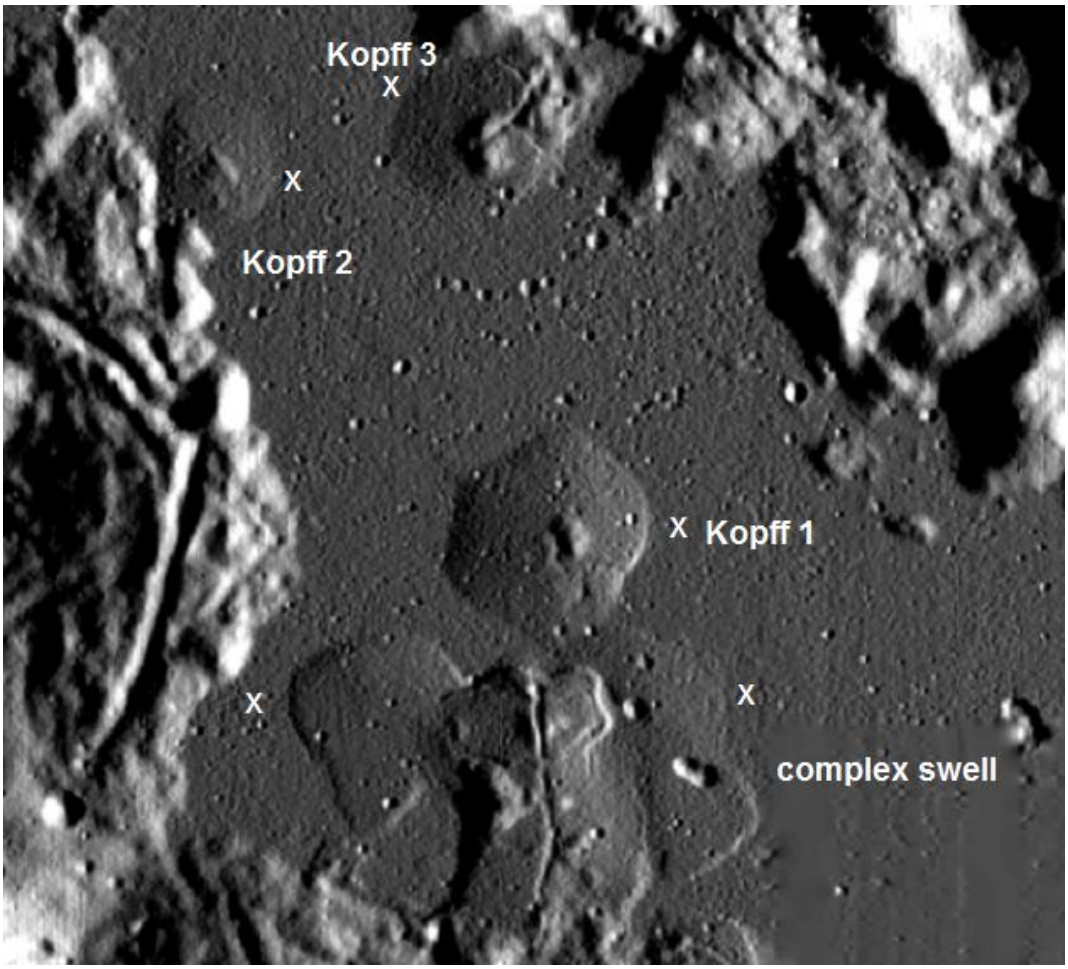

Figure 6: Lacus Veris, WAC imagery. Identified domes are marked with the symbol x.

Kopff 1: The first examined dome termed Kopff 1 lies at coordinates 17.76° S and 85.25° W, with a diameter of 7.3 km. Kopff 1 is 165 m high with an average flank slope of 2.6°. In the summit is embayed a non volcanic hill, rising for 60 m. Thus, Ko1 is 220m higher than the mare (Fig. 7). The edifice volume, computed assuming a parabolic shape, is determined to 3.4 km^3. The rheologic model applied to Ko1 dome yields a low effusion rate of 54 $m^3\ s^{-1}$ and a high lava viscosity of 3.1 x 10^6 Pa s, computed based on a lava density of 2800 kg m^{-3}. It formed over a period of time of about 2.0 years.

The 3D reconstruction of Ko1 is shown in Fig. 8.

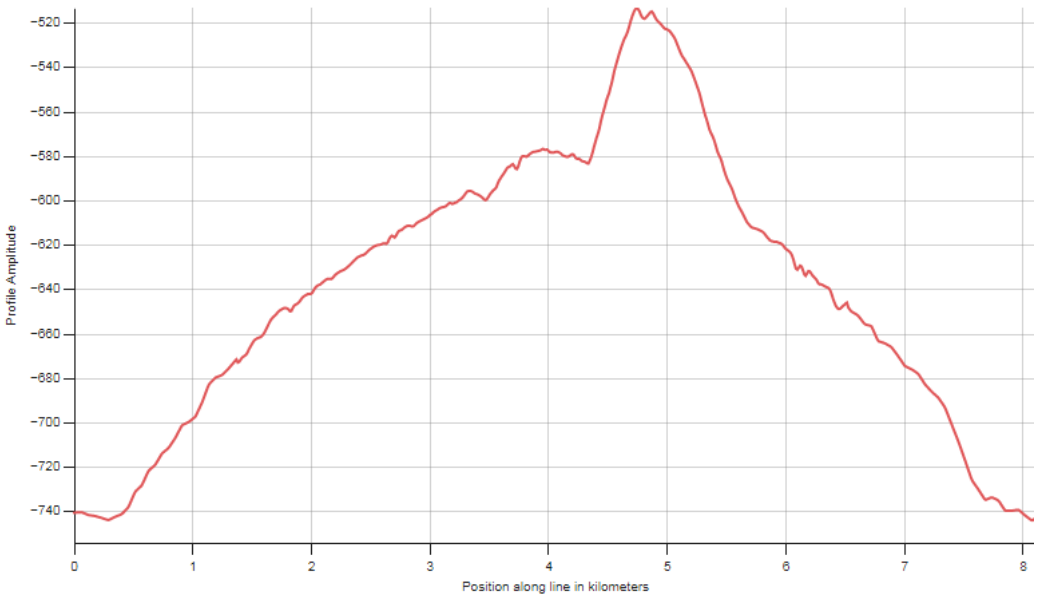

Figure 7: LRO WAC-derived surface elevation plot of an east to west cross-section of the dome Kopff 1.

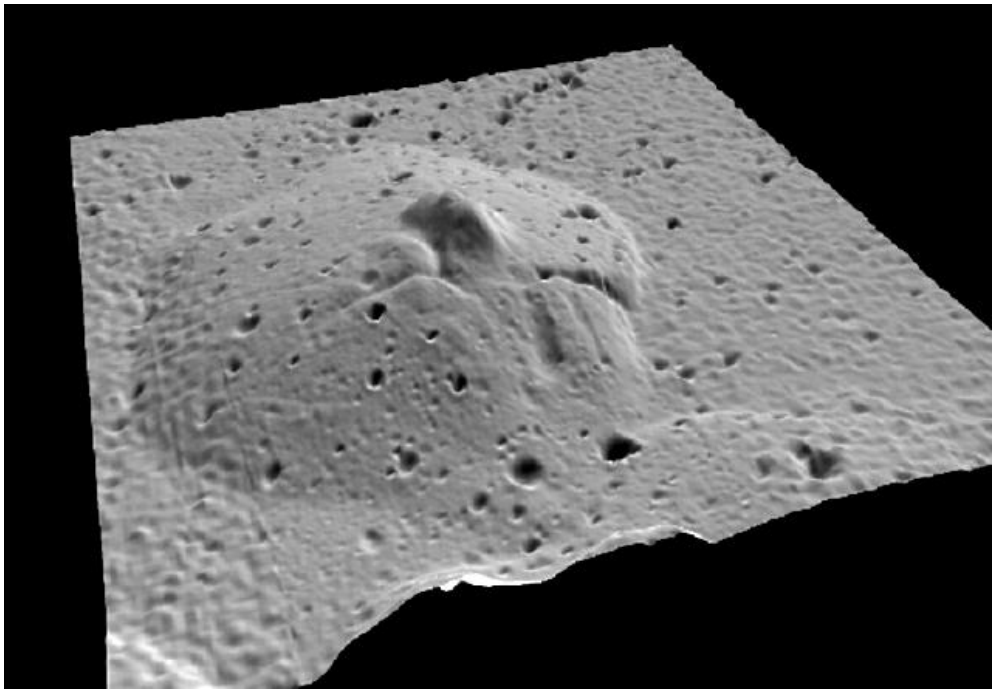

Figure 8: 3D reconstruction of Kopff 1. The vertical axis is 7 times exaggerated. Some rilles are located on its summit.

Kopff 2: The dome termed Kopff 2 lies at coordinates 17.29° S and 85.70° W, with a diameter of 5.6 x 5.2km. Kopff 2 is 45 m high with an average flank slope of 0.9°.
In the summit is embayed a non volcanic hill, rising for 50 m (Fig. 9). The edifice volume, computed assuming a parabolic shape, is determined to 0.5 km^3. The rheologic model (Lena et al., 2013) applied to Ko1 dome yields a low effusion rate of 112 m^3 s^{-1} and a lava viscosity of 1.2 x 10^4 Pa s, computed based on a lava density of 2800kg m^{-3}. It formed over a period of time of about 0.15 years.

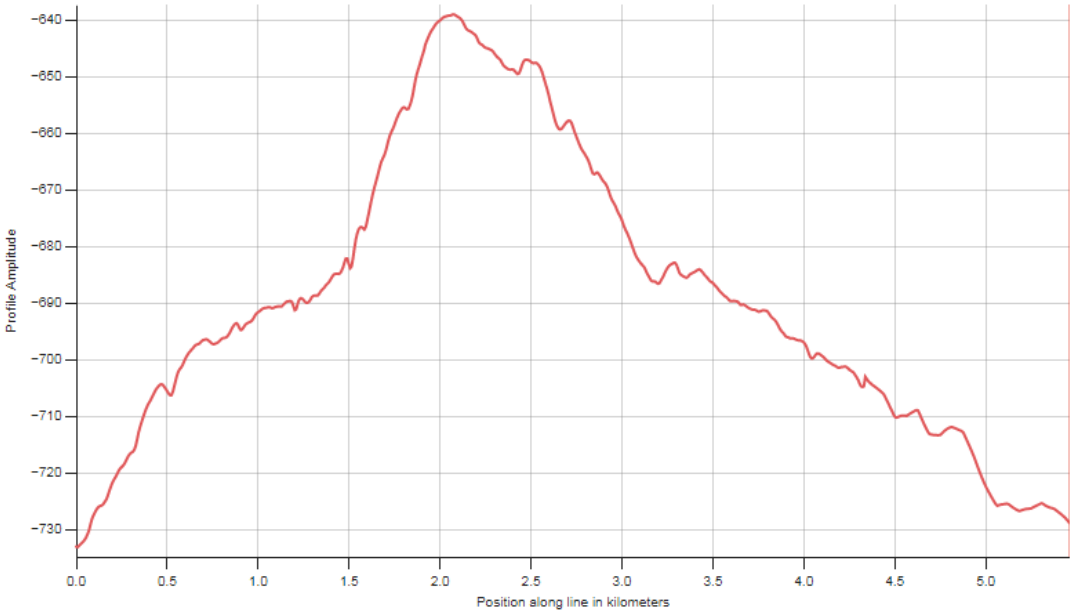

Figure 9: LRO WAC-derived surface elevation plot of an east to west cross-section of the dome Kopff 2.

The 3D reconstruction of Ko1 is shown in Fig. 10.

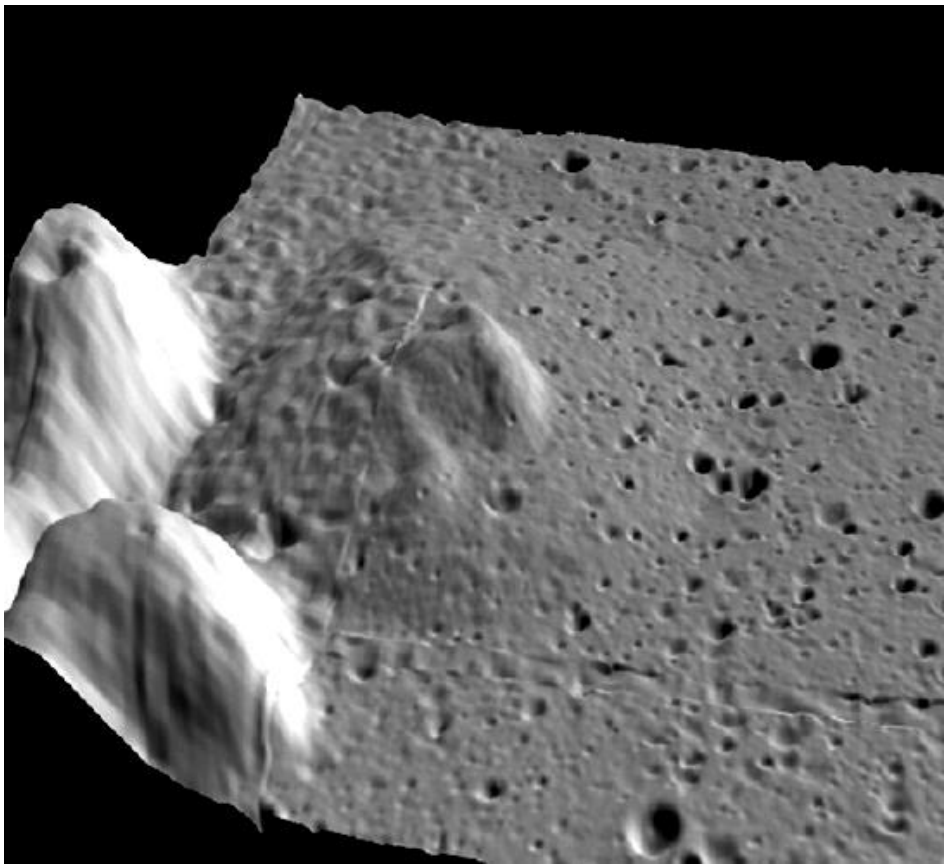

Figure 10: 3D reconstruction of Kopff 2. The vertical axis is 7 times exaggerated.

Kopff 3: The dome termed Kopff 3 lies at coordinates of 17.25° S 85.35° W, with a diameter of 6.6 x 7.2 km. Kopff 3 is 130m high with an average flank slope of 2.2° (Fig. 11).

The edifice volume, computed assuming a parabolic shape, is determined to 2.6km^3. The rheologic model applied to Ko1 dome yields a low effusion rate of 62 m^3 s^{-1} and a lava viscosity of 1.1 x 10^6 Pa s, computed based on a lava density of 2800 kg m^{-3}. It formed over a period of time of about 1.3 years.

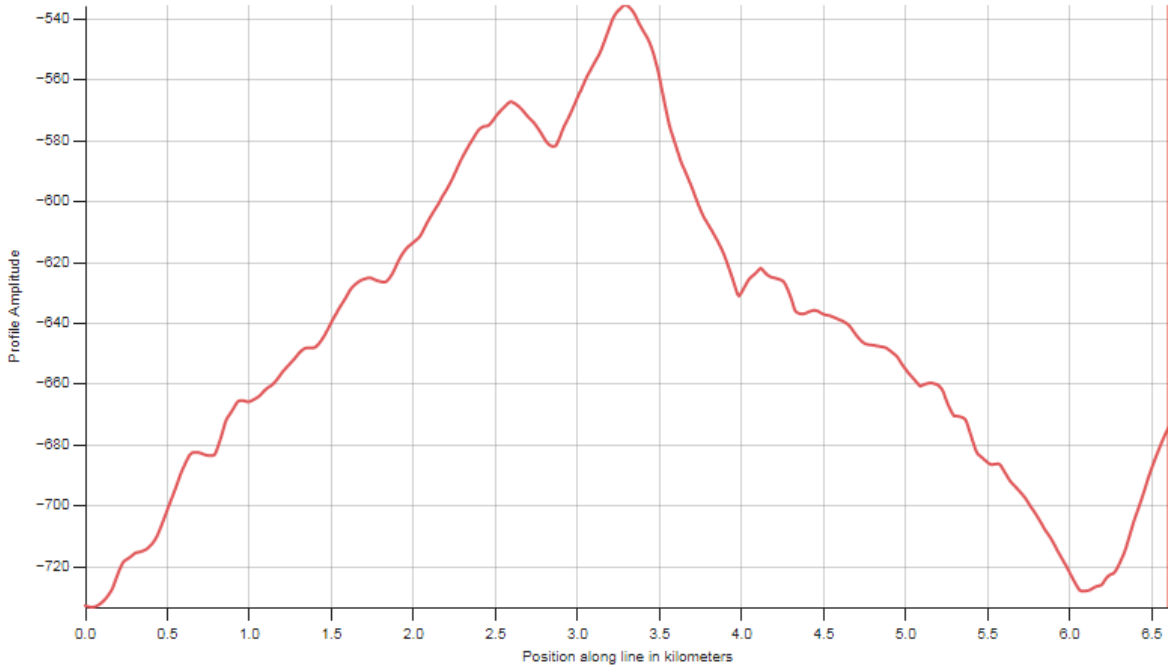

Figure 11: LRO WAC-derived surface elevation plot of an east to west cross-section of the dome Kopff 3.

The 3D reconstruction of Ko3 is shown in Fig. 12.

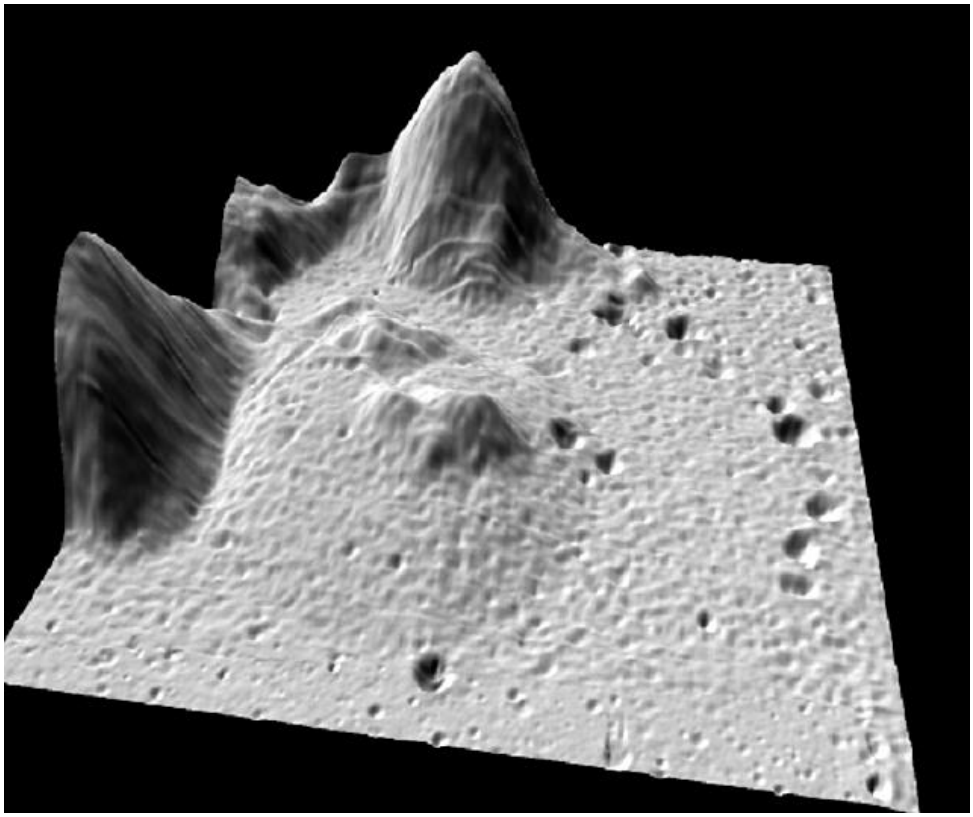

Figure 12: 3D reconstruction of Kopff 3. The vertical axis is 7 times exaggerated.

Summary and request of images

I have described some domes in Lacus Veris. These results are preliminary and under investigation.

It would be interesting to receive any images of Mare Orientale, including also Lacus Veris, made with terrestrial telescopes for further studies investigating if the described domes in Lacus Veris can be imaged using telescopic images and deleting, with some software, the foreshortening effect.

Preliminary analysis carried out on two images taken by Cazilhac would indicate that some of these domes are detectable. Of course, we need of more images in Hires for a complete investigation about this specific project.

The recognized domes, reported in this note, are under spectral and mineralogical investigation.
Please check also your past imagery and send them to us for the ongoing study (email: lunar-domes@alpo-astronomy.org).

References

Greeley, R. (March 15–19, 1976). "Modes of emplacement of basalt terrains and an analysis of mare volcanism in the Orientale Basin". Proceedings, 7th Lunar Science Conference. Houston, Texas: Pergamon Press, Inc. pp. 2747–2759.

Greeley, R. (March 1976). "Mare Emplacement in the Orientale Basin". Proceedings, Lunar and Planetary Science Conference 7. pp. 334–335.

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

Lena, R. Lunar domes (part LXVII): Lacus Veris, Lacus Autumni and Schlüter crater. BAA LS Circular, July 2023.