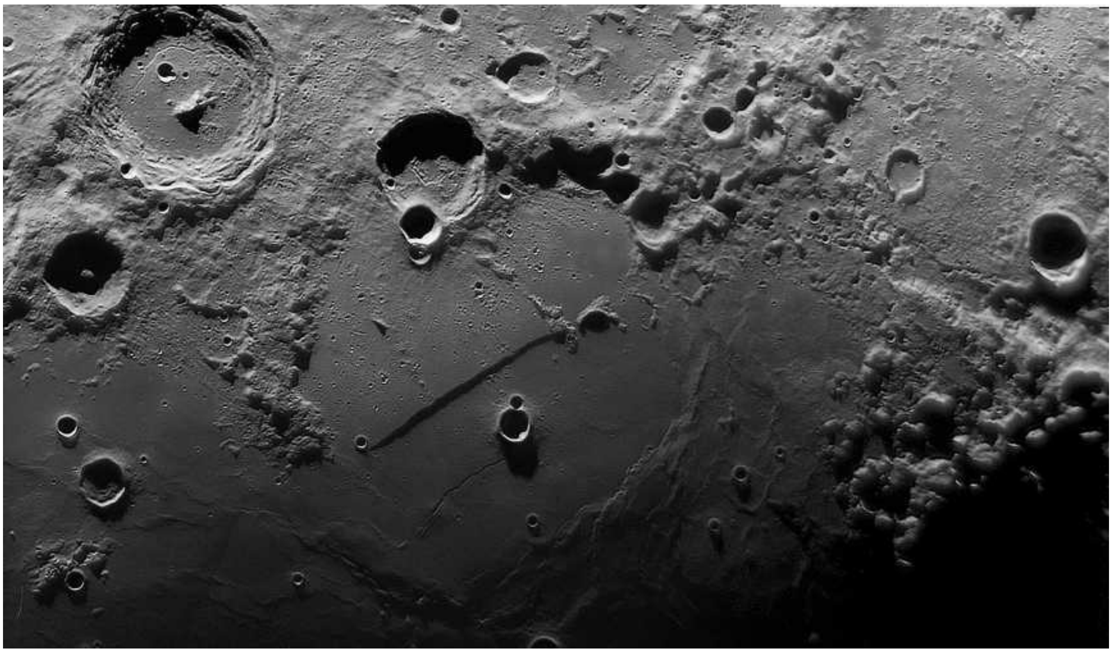
BAA Lunar Section
British Astronomical Association
Director: Bill Leatherbarrow

LUNAR SECTION CIRCULAR

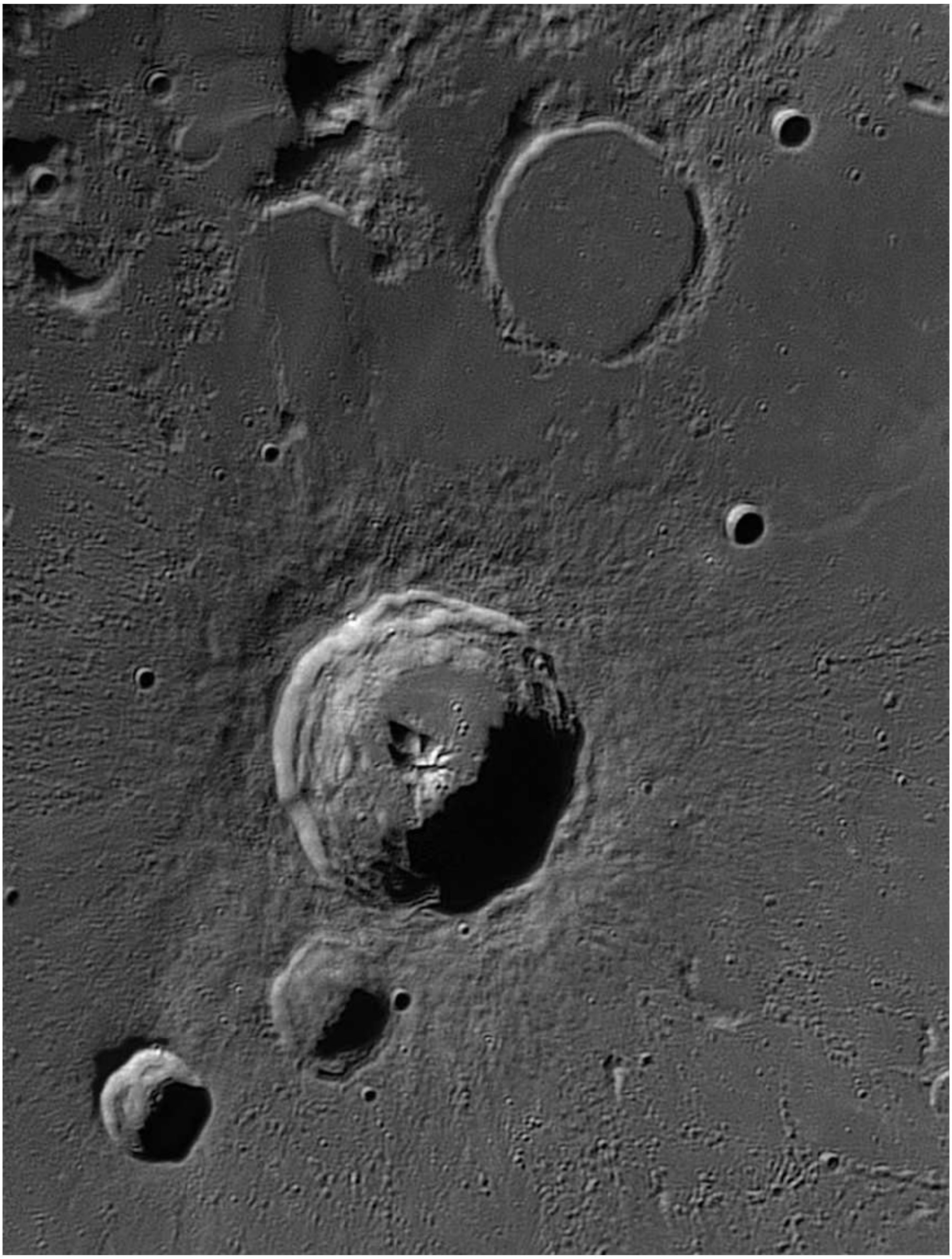
Vol. 58 No. 3 March 2021

FROM THE DIRECTOR

Our regular contributor Leo Aerts has submitted some reprocessed versions of images taken by him last year. He has been experimenting with the HDR function in Photoshop (version CS6 onwards) in order to try to squeeze out more detail without introducing processing artefacts. I think the results shown below are quite remarkable and are among the finest ground-based lunar images I have seen. I have not made careful measurements, but Leo's images – particularly the one of the Bullialdus area – show tiny pits that must be at (or beyond?) the theoretical resolution of his C14.



Rupes Recta, 1 April 2020, Celestron C14 (Leo Aerts)



Bullialdus, 2 May 2020, Celestron C14 (Leo Aerts)

Leo has not been alone in experimenting with new processing software and techniques. Bob Stuart, another regular contributor to our Section, has recently been trialling the software package Topaz Sharpen AI in order to bring out finer detail in his images, again with striking results.

Of course, Leo and Bob are among our finest and most experienced imagers and their results owe as much, if not more, to their skills as to the software used. But it struck me that many of us, who operate at lower levels of expertise, could perhaps benefit from trying out such techniques and software packages. I feel reasonably competent when it comes to the *capture* of lunar images, but my knowledge of *processing the results* is limited to the basic functions of Autostakkert, Registax and bits of my ancient version of Photoshop.

It might be useful to use the pages of this Circular to exchange ideas, thoughts and perhaps basic tutorials on processing techniques in the hope that this might help to ‘level up’ our skills. If anyone wished to contribute in this way I would be happy to make room in the Circular.

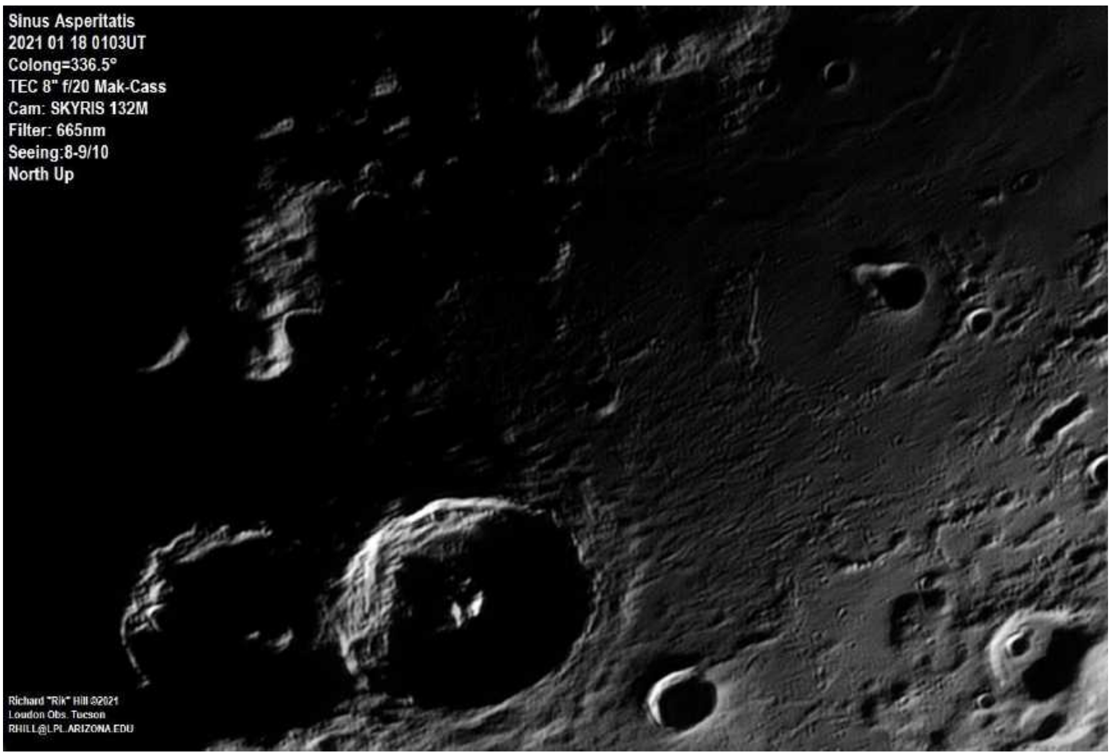
Bill Leatherbarrow

OBSERVATIONS RECEIVED

Images, drawings and reports have been received from the following observers:

Paul Abel, Leo Aerts (Belgium), John Axtell, Maurice Collins (New Zealand), Rob Davies, Daryl Dobbs, Dave Finnigan, Rik Hill (USA), Ken Kennedy, Phil Shepherdson, Bob Stuart, Alex Vandenbohede (Belgium), and the Director.

Rik Hill has submitted the following image and report:



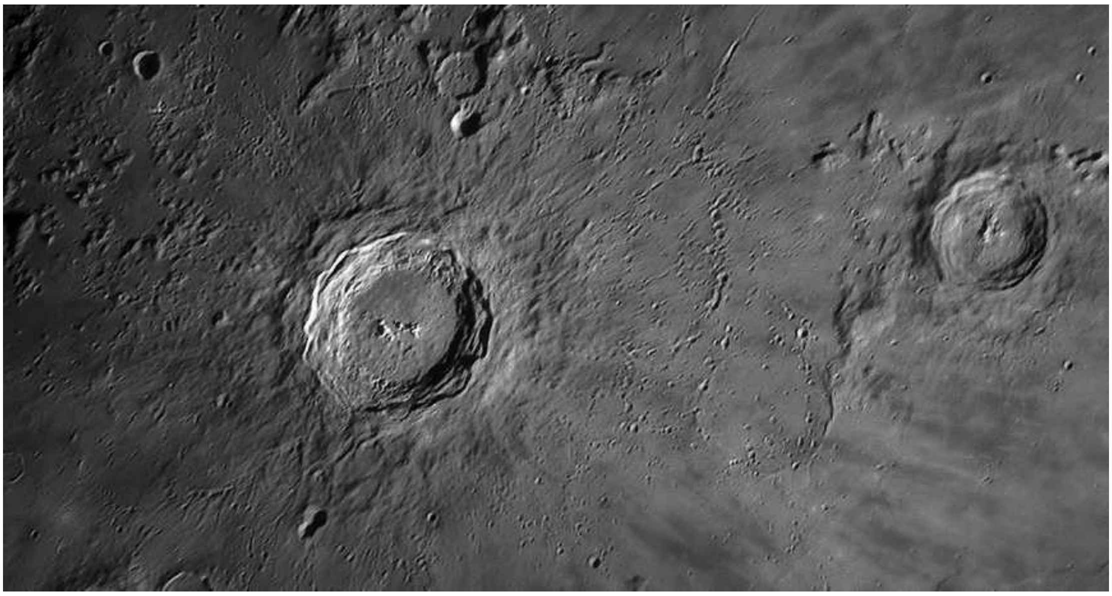
Rik writes:

‘North and east of the great crater Theophilus (diam. 104km) is Sinus Asperitatis (“Bay of roughness”) that opens towards Mare Tranquilitatis to the north. Right in the middle of the sinus is the pear-shaped crater Torricelli (roughly 20x30km) sitting off center in the ruins of an ancient unnamed crater about 90km diameter. Torricelli is undoubtedly the product of a two crater merger. The U-shaped feature at the top middle of this image is Hypatia (43km), an old partially ruined crater.

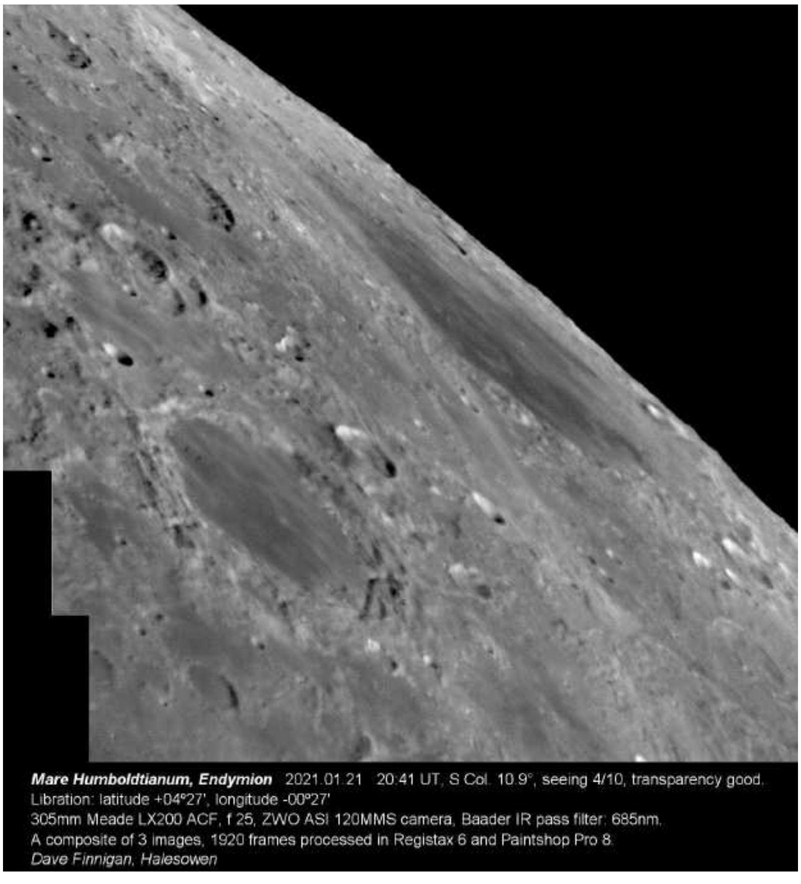
Of course the “elephant in the room” is Theophilus catching the first rays of the morning sunlight with its central peaks casting shadows across the floor of the crater. The low sun angle displays details in the ejecta blanket to the right of the crater down to Mädler (29km) below Theophilus with a little dorsum for a tail. To the left of Theophilus is a similar sized, impressive crater, Cyrillus (100km). With Theophilus on top of Cyrillus it's easy to say that Cyrillus is older, in this case by a billion years. Above these two craters is the magnificent bright Mons Penck (4000m tall). What a great view one would have from the top of this mountain looking over this sunrise selenoscape!’

IMAGES GALLERY

Bob Stuart has experimented with a high-pass technique on the following image of Copernicus, taken on 23 January 2021 at 18.07 UT.

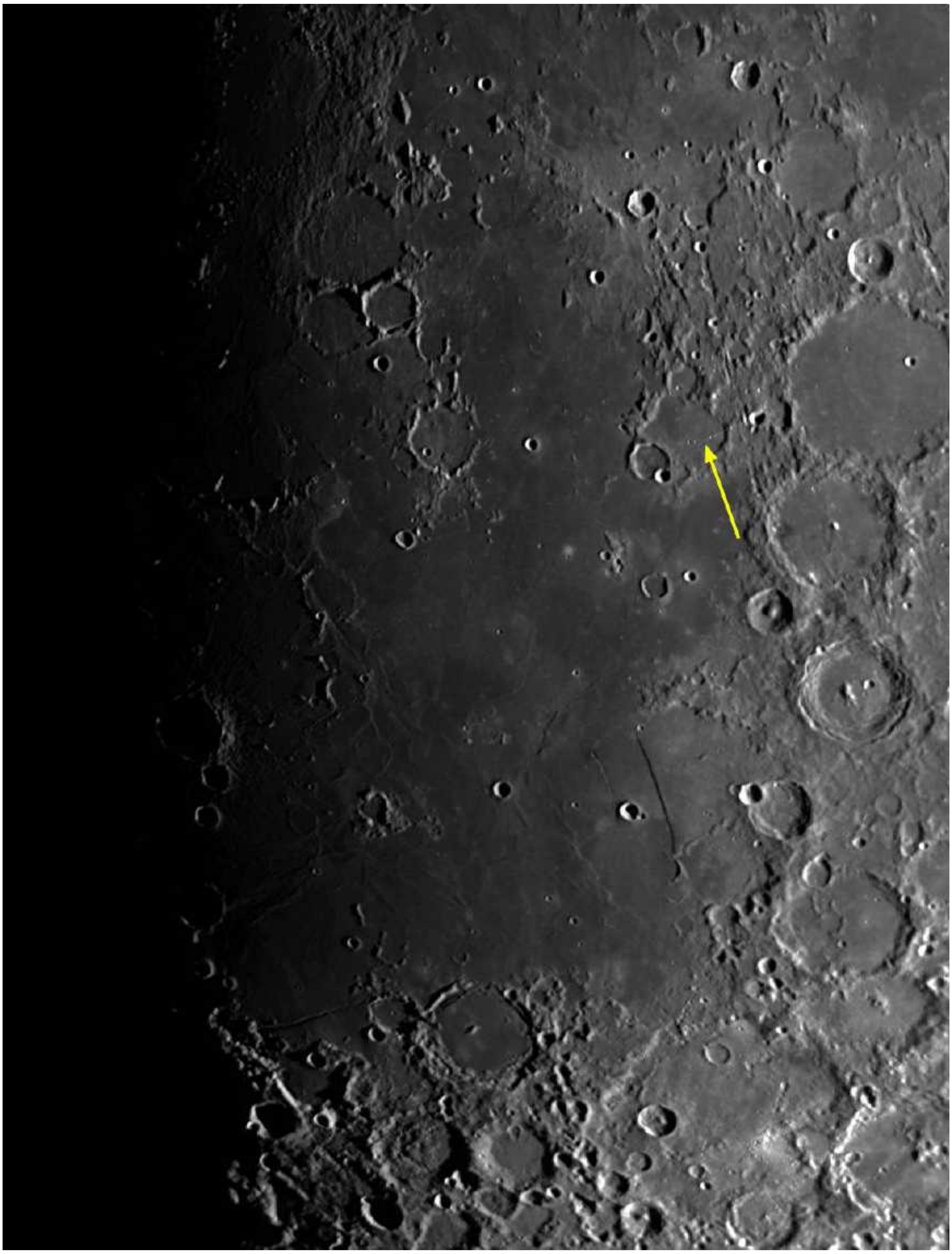


Fracastorius, 1 November 2015, 03.44UT (reworked by Leo Aerts)



Sunset over M. Crisium (Alex Vandenbohede)

Sinus Iridum, 23 January 2021, taken with C6 SCT and i-Phone (John Axtell)



Mare Nubium and Catena Davy, 22 Jan 2021, C8 SCT (Ken Kennedy)

(South is up in the above image)

A reminder for those submitting images:

I am always delighted to receive images for the LSC and the Section archive. It is very helpful to me if images could include essential information such as name of feature, date and time of observation (UT), telescope, and name of observer, either on the image itself or in the file name (ideally both). This makes preparation of the LSC and archiving much simpler. JPEG or PNG formats are preferred.

We now prefer the convention of North upwards, since this facilitates comparison with imagery from spacecraft.

WEIRD GAUDIBERT Barry Fitz-Gerald

The 33km diameter crater Gaudibert has been described by John Moore as one of the 'weirdest' craters on the nearside of the Moon [1] and that is undoubtedly true when you look at the SELENE image shown in Fig. 1.

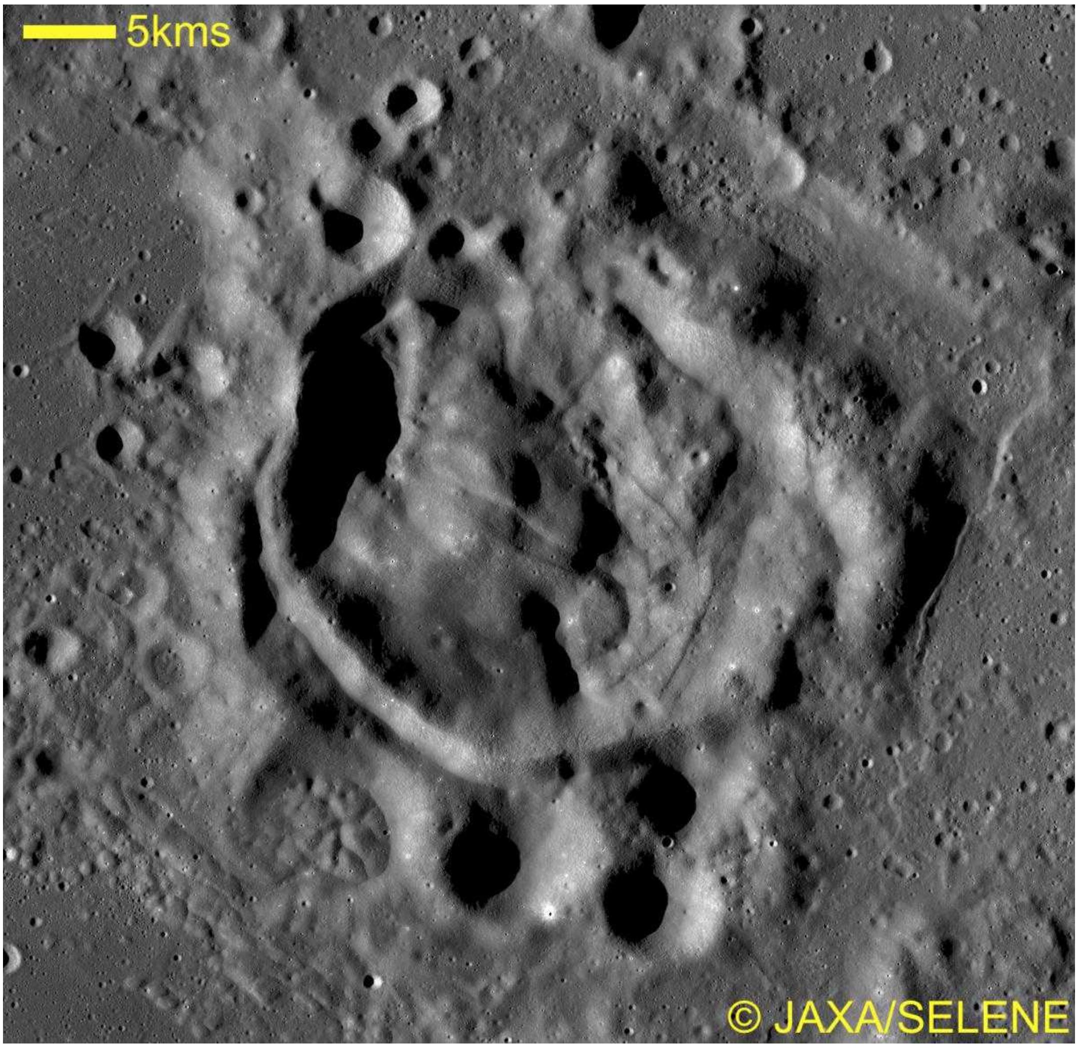


Fig. 1 SELENE evening image of Gaudibert. Note the pronounced inner ridge compared to the rather less obvious crater rim.

As can be seen the crater is a bit of a mess, with the western and southern part having what looks like a double rim, whilst to the east and north a rim is far less obvious. The crater interior consists of irregular hills, the largest of which has what appears to be a short graben running across the summit from north-west to south-east and bounded either side by two parallel fractures. A patch of low albedo material (rich in olivine and iron) is present on the south-western floor; this is likely to be volcanic pyroclastic deposits and surrounds a deep pit which may harbour a source vent. Further smaller patches of probable pyroclastic can be seen within the north-western quadrant of the crater. As the height of the 'rim' and crater floor vary considerably, determining a crater depth is problematic but an average depth of 1200m seems standard when taken across the crater in various directions. This is probably only half of the depth an unmodified lunar crater of this diameter should have.

Located as it is on the margin of an impact basin it is no surprise that it is surrounded by volcanically modified Floor Fracture Craters (FFC) such as Gaudibert B, Bohnenberger and the almost completely submerged Daguerre, and so it may be logical to seek a volcanic explanation for the bizarre morphology of Gaudibert as well. And this is the conclusion drawn in a study [2] that identified Gaudibert itself as a Class 4b FFC, which are ‘distinguished by a v-profile moat with a very pronounced inner ridge occasionally higher than the crater rim crest, a hummocky convex up central floor region, and subdued fractures.’ The study also postulates that the unusual appearance of this class of FFC is the result of the effects of the uplift being muted due to the presence of a locally thicker crust and viscous relaxation (sagging).

The ‘pronounced inner ridge’ used in the categorisation of this class of FFC is quite an unusual feature, being visually more prominent than the actual crater rim itself. In the case of Gaudibert the 'C'shaped inner ridge varies in height, being higher than the rim in the north-west, to being almost non-existent in the east. Where it is most prominent to the south-west it is some 200m lower than the rim, with its enhanced visibility being due to its sharpness compared to the more subdued and rounded rim.

Inner ridge-like structures are not unknown within other FFCs, Posidonius for example has a partial ring within the rim, and Haldane (Mare Smythii) has a largely intact hexagonal ring. Conspicuous quasi-hexagonal rings can also be seen in Lavoisier C and T, a pair of adjoining FFCs, a fact that suggests that the process that formed these rings occurred in both craters, possibly at the same time.

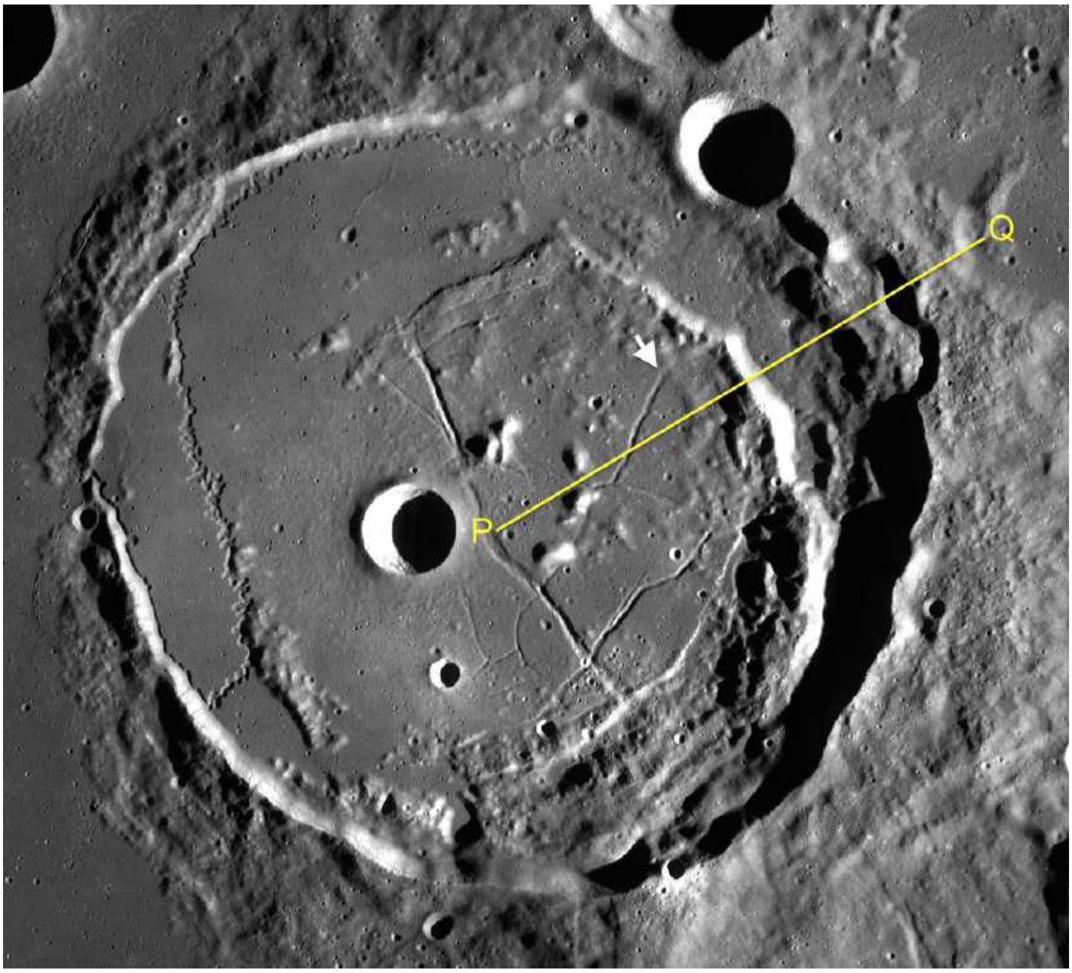


Fig. 2 LROC WAC image of Posidonius showing a partial inner ridge along the eastern part of the crater floor. The section along line P-Q is shown in Fig.3. Note the white arrow showing a floor fracture across the inner ridge.

A good place to start working out the nature of these 'inner ridges' is Posidonius despite the fact that here it is only present as an incomplete arc as shown in Fig. 2. The uplifted and somewhat hexagonal crater floor is tilted upwards in the east (the western part being submerged in mare type lavas) and the inner ridge can be seen running along the elevated outer edge. Fig. 3 is a cross section of the crater floor across the inner ridge and up and over the rim, and shows that the inner ridge is about 600m high and 5kms wide at its base, so a not insubstantial structure. But what relationship does it have with the crater floor?

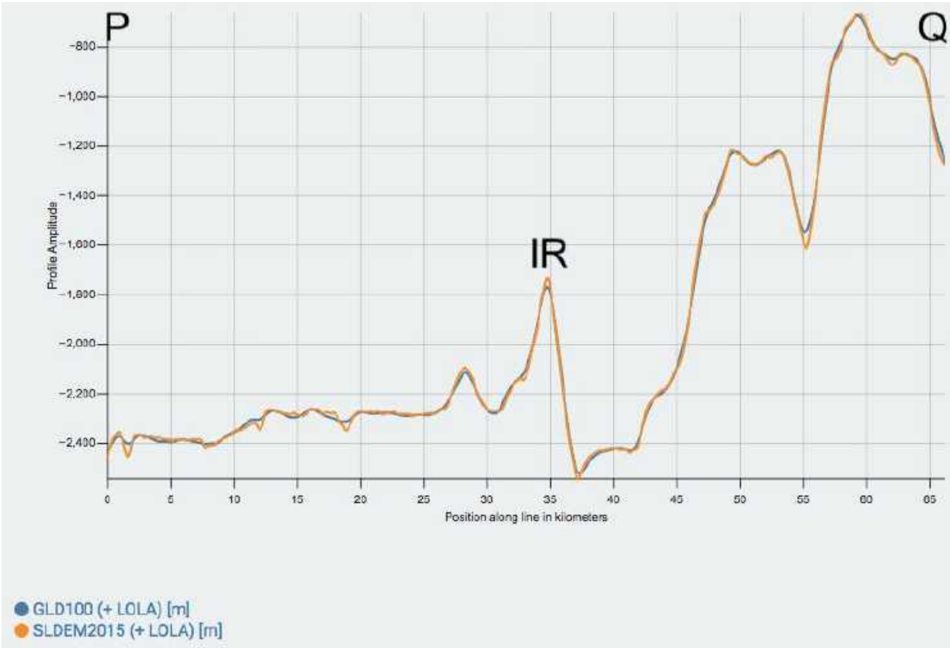


Fig. 3 Cross section along line P-Q in Fig. 2. Note the inner ridge along the edge of the slab of uplifted crater floor.

One possible explanation is that the ridge is not part of the crater floor but uplifted terrace material that had collapsed downwards off the rim during the crater modification stage. Consider the following scenario, a large complex crater (such as Posidonius) forms on the edge of a mare, finishing up with a flat crater floor filled with fall-back debris and impact melt ponds, surrounded by terraces of slumped material where the inner rim has collapsed inwards. Subsequently a plug of magma ascends into the crust beneath, pushing the crater floor upwards and producing the fracturing characteristic of FFCs. In the 'standard model' of FFC formation, the magma forms a horizontal sheet or sill beneath the floor, pushing it upwards as more magma arrives from below. It is however prevented from spreading too far laterally by the weight of the crater rim, confining the uplift to the crater floor only.

This uplift produces a concentric, somewhat hexagonal suite of fractures around the crater floor, which effectively isolates the central part of the floor from the rest of the crater, leaving it free to ascend as magma continued to push upwards. In many FFCs (such as Pitatus and Alphonsus) such fractures can be seen around the edge of the crater floor and inside the crater rim. If however the magmatic intrusion spread laterally beyond the crater floor even and under the rim, despite the weight of it pushing downwards, these fractures might open up *beneath* the slumped terraces. In this case, as the isolated crater floor rose it would carry with it a wedge of terrace material around its edge, as this would also be effectively isolated from the rest of the crater structure. This is what we may have in Posidonius, with the inner ridge where present, representing a wedge of this terrace material that has hitched a ride upwards as the crater floor rose. A radially orientated fracture in Posidonius can seen to extend across the inner ridge, indicating that the fracture is younger than the ridge which would be expected in the above sequence of events. A more widespread uplift might also de-stabilise the entire crater rim by opening up the concentric fractures that formed at the same time as the crater was excavated. This possibility will be explored below.

Support for this possible scenario can be seen in the composition of these inner ridges as shown in the Quickmap data illustrated in Fig. 5. Firstly in Posidonius the inner ridge can be seen to have the same plagioclase-rich signature as the rim and terraces into which they merge in the south-east. The plagioclase signature is quite extensive across the crater floor as well, which probably as a result of lateral spreading and accumulation of highland ejecta. Haldane's inner ridge also shows a similar plagioclase rich signature to its rim, and the same applies to Lavoisier C and T.

Gaudibert also shows this relationship with the inner ridge and rim having comparable plagioclase abundances. So these ridges appear to be derived from the rims and not any volcanic processes taking place as the crater was modified to become an FFC.

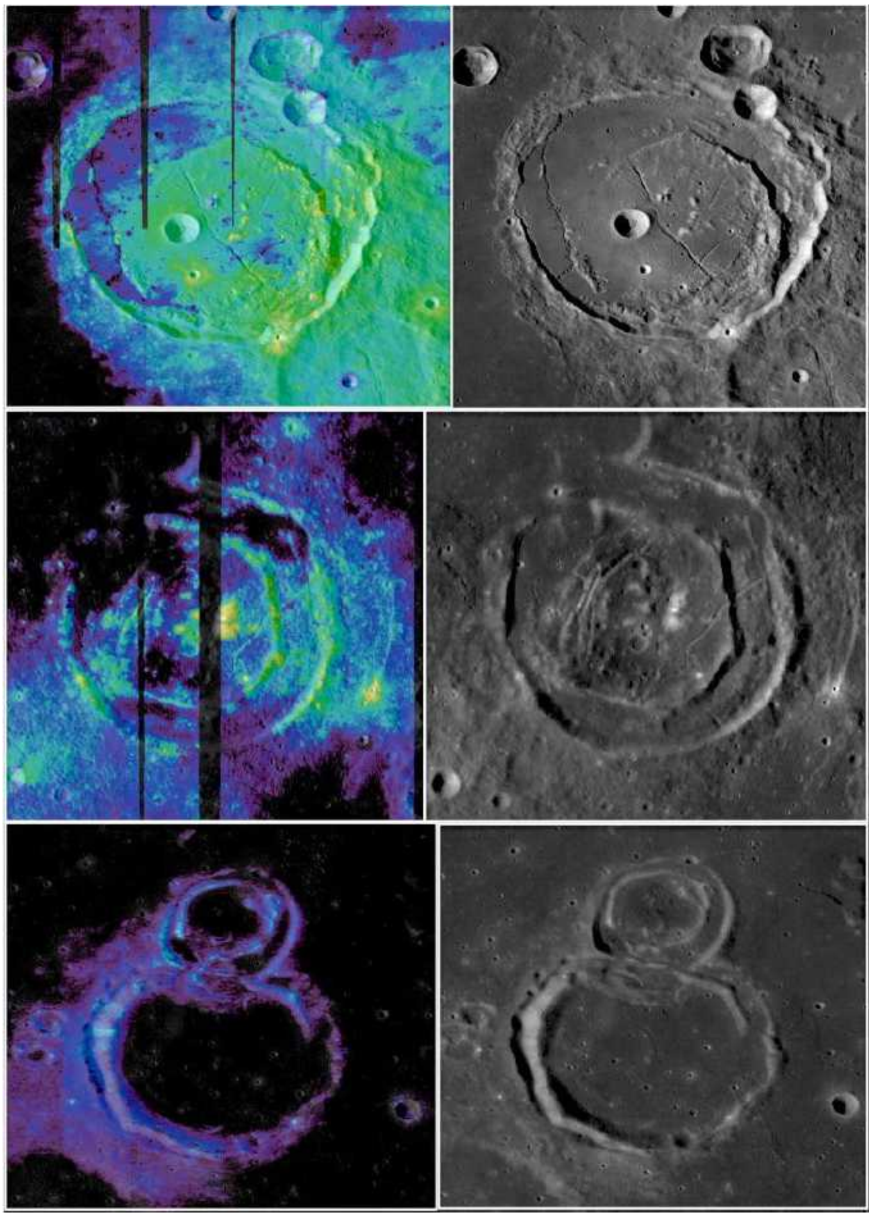


Fig. 5 Kaguya Mineral Map Plagioclase abundance shown in left panels and WAC image in right panels for Posidonius (top) Haldane (middle) and Lavoisier C and T (bottom). Note that the plagioclase abundance of the inner ridges matches those of the crater rims. Plagioclase abundance is colour coded from high in shades of green to low in bluer shades.

The situation here is rather reminiscent to that seen in the unusual morphology of Concentric Craters (CCs) such as Hesiodus A where the inner ring or torus has the same composition as the rim, despite the prevailing consensus that they are the product of volcanic intrusions [3]. As hardly any CCs show any indications of effusive volcanic activity, that is eruption of volcanic material at the surface, I suspect that this view is incorrect, and suggested instead that they formed following a symmetrical rim collapse as a result of localised uplift [4],[5]. Consideration of a similar process might shed some light on our original subject Gaudibert.

As already noted, a large complex crater like Posidonius will probably experience rim collapse during the crater modification stage soon after its formation. This will produce a suite of terraces such as those we see in well preserved or fresh craters like Copernicus, and it is possible that some of this material may find itself raised up on the ascending crater floor in a FFC as outlined above for Posidonius. Some of these inner ridges however look more like a single torus or ring (such as Haldane and Lavoisier C and T in Fig. 5) and not an irregular ring of collapse terraces where the degree of collapse might vary around the crater circumference. In fact, notwithstanding the somewhat hexagonal configuration of some of these ridges, these FFCs look like very large examples of CCs. It might then be worth considering that these inner ridges formed in the same way as the rings in CCs, in a single collapse event due to uplift and de-stabilisation of the concentric fractures that probably surround all impact craters.

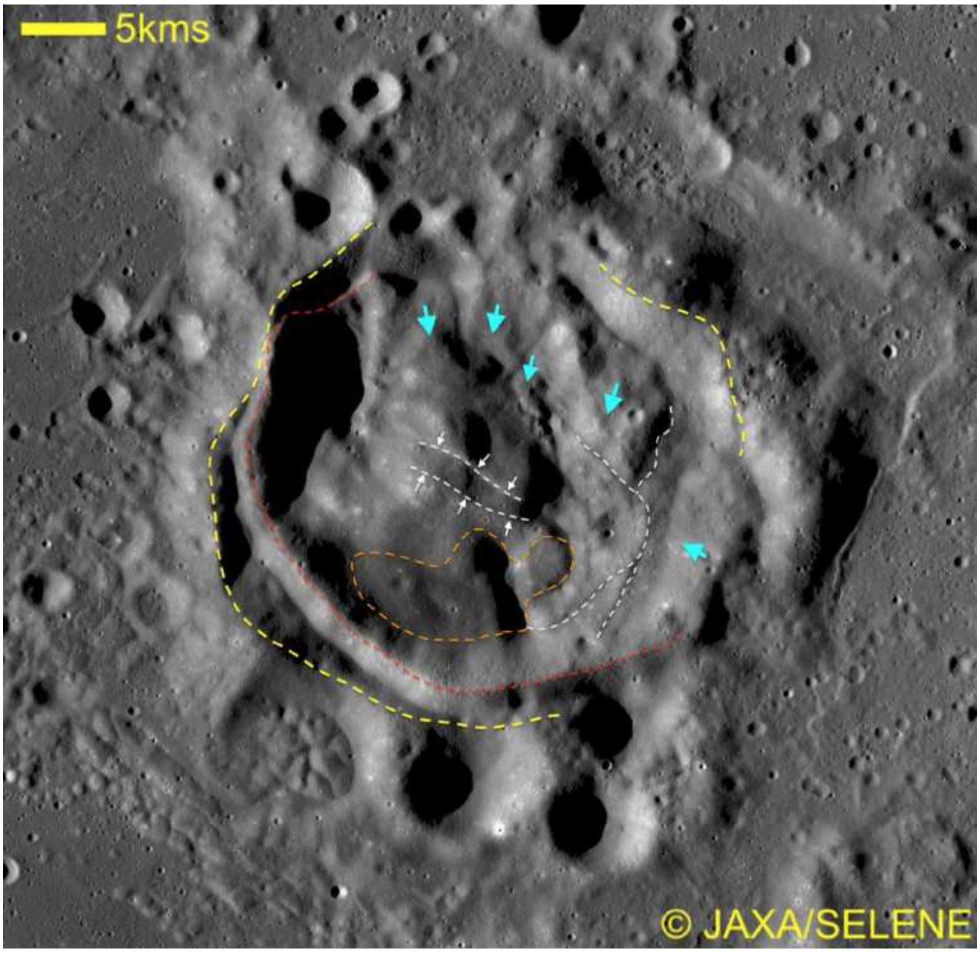


Fig. 6 Annotated version of Fig. 1 showing scarp fronts (white dashed lines) which represent sheets of unconsolidated debris displaced by the collapse of the rim and inner ridge. The two scarps that run parallel across the central mound approached from different directions (white arrows indicate direction of movement). The inner ridge collapsed in the east in a series of large slumps (blue arrows) and is only preserved in the west and south (red dashed line). The original crater rim (yellow dashed line) is also only readily apparent to the west. A large pyroclastic deposit (orange dashed line) is associated with a deep pit, possibly a vent on the southern part of the crater floor.

A crater the size of Gaudibert may well have had a post-modification stage appearance similar to the highland crater Godin, with a central peak and terraces, though Godin's floor appears to be completely obscured by these terraces. Of course Gaudibert is not located in the highlands but straddles one of the inner rings of Mare

Nectaris, but it is likely that this would also be composed of highland material excavated during basin formation. Magmatic intrusions along the edge of the mare subsequently gave rise to small FFCs such as Bohnenberger and produced the pyroclastic deposits visible as dark mantling over surface around Gaudibert B (another small FFC). In these small FFCs, which are classified as Class 4a [2] the magma was restricted to small domed intrusions beneath the crater, with the resulting uplift being confined to the central part of the crater floor causing it to bulge upwards and fracture. In the case of Gaudibert however the intrusion and subsequent uplift may have extended horizontally beyond the crater floor and possibly beneath the crater rim as outlined above. This may have de-stabilised the rim causing it to collapse as a unit and in a single event, leading to the formation of the continuous inner ridge see. At a later stage the eastern section of the inner ridge itself then collapsed, leaving behind only a C shaped arc to the west and south.

These collapses bulldozed any pre-existing terrace and floor material inwards towards the centre of the crater, giving rise to the irregular and somewhat chaotic floor we see today. This conclusion is supported by the presence of a number of scarps visible within the crater which represent the front of sheets of unconsolidated debris pushed ahead of the collapsing rim material. Fig. 6 is an annotated version of Fig. 1 showing the positions of some of the salient features involved in this scenario. This model allows a re-interpretation apparent graben crossing the central mound, with an alternative view that the two linear features are not bounding fracture but two parallel scarps facing each other representing debris thrust ahead of the collapses of the eastern and western inner rim. These scarps have almost met at the summit of the central mound, stopping short of each other by about 1.5kms. Being somewhat pedantic, this effectively removes one of the criteria used to classify Gaudibert as an FFC.

Fig. 7 SELENE image of terrain between Gaudibert and Mare Nectaris showing a surface of rounded hills and rectilinear blocks which may be a result of seismic shaking.

Several other scarps are visible on the south-eastern crater floor, again indicative of collapse fronts, whilst to the north-east several large slumps represent what is left of the rim and the inner ridge. From this it is apparent that the odd appearance of Gaudibert is the result of extensive collapse, in all probability caused by uplift due to magmatic intrusion below. The involvement of some form of volcanism is indicated by the fact that pyroclastic deposits are present within the crater clearly mantling the collapse deposits, which shows that their eruption post dates the uplift and subsequent collapse of the rim.

A curious bit of topography immediately to the south-west of Gaudibert may be connected to the uplift that affected the crater. Fig. 7 shows a detail of the shore of Mare Nectaris, where the highland terrain is broken up into individual rounded hills (~500m to 1km in diameter) and slightly larger more rectilinear blocks. This strange topography may represent a surface disrupted by seismic shaking associated with the intrusion beneath Gaudibert. Having said that, the mare surface between Gaudibert and Daguerre is broken up into a number of plate-like slabs, probably a result of localised crustal downwarping which may also have generated seismic shaking. The presence of a prominent lobate scarp immediately to the east of Gaudibert is also an indication of tectonic activity which could be implicated in the modification of the crater.

An obvious question is why should these inner ridges be so prominent compared to an apparently subdued rim, with Lavoisier C and T being a very good example this phenomenon. The most likely explanation is that the inner ridge simply got carried upwards on the ascending crater floor to the point where it equalled or even exceeded the height of the rim. Further collapse of the rim as the uplift continued might also reduce the relative height difference further, enhancing the prominence of the ridge as compared to the rim.

In conclusion, Gaudibert may have acquired its weird appearance as a result of the collapse of the entire rim during a catastrophic single event. This was caused by uplift due to the inflation of a magmatic body beneath the crater which destabilised the rim in a manner similar to that seen in smaller CCs. The collapsing material displaced pre-existing floor material shunting it across the crater interior in a series of sheets, the fronts of which are preserved as low scarps. These have been identified previously as fractures leading to the crater being classified as an FFC, a conclusion that appears unwarranted. The involvement of volcanism is demonstrated by the presence of pyroclastic deposits, and it is possible that beneath the crater floor deposits fractures do exist, but no surface expressions are evident. A similar process may have occurred in larger FFCs such as Haldane and the Lavoisier pair, with a single large collapse event affecting the rim. In other FFCs such as Posidonius where the inner ridge is less complete or well developed, a single collapse event may not have occurred and the ridge simply represents a wedge of conventional slump terrace deposits draping the edge of the uplifted floor.

Barry Fitz-Gerald. (barryfitzgerald@hotmail.com)

Acknowledgements:

LROC images reproduced by courtesy of the LROC Website at http://lroc.sese.asu.edu/index.html, School of Earth and Space Exploration, University of Arizona.

Selene images courtesy of Japan Aerospace Exploration Agency (JAXA) at:
http://l2db.selene.darts.isas.jaxa.jp

References:

1. Moore, J. (2014), *Craters of the Near Side Moon*. CreateSpace Independent Publishing Platform.

2. Jozwiak, L. M., J. W. Head, M. T. Zuber, D. E. Smith, and G. A. Neumann (2012), 'Lunar floor-fractured craters: Classification, distribution, origin and implications for magmatism and shallow crustal structure', *J. Geophys. Res*., 117, E11005, doi:10.1029/2012JE004134.

3. Trang, D., et.al. (2016), 'The origin of lunar concentric craters'. *Icarus*, Volume 278, pp. 62-78

4. Fitz-Gerald. B. (2012), 'Concentric Craters'. *The Moon: Occasional Papers of the BAA Lunar Section*, Volume 2.

5. Fitz-Gerald. B. (2016), 'More Concentric Craters'. BAA Lunar Section Circular, Vol. 53, No. 1.

LUNAR DOMES (part XLV): Domes in Capuanus

Raffaello Lena

Capuanus is a ruined crater in Palus Epidemiarum, a small lava plain at the south western edge of Mare Nubium. In this region tectonic features, such as the complex rille systems of Rimae Ramsden and the long graben Rima Hesiodus are located. The floor of Capuanus is lava flooded plain as is the surrounding terrain (Wilhelms, 1987). Figures 1a-d display the examined domes, termed Ca1-3. All images, shown in rectified view, are oriented with north to the top and west to the left.

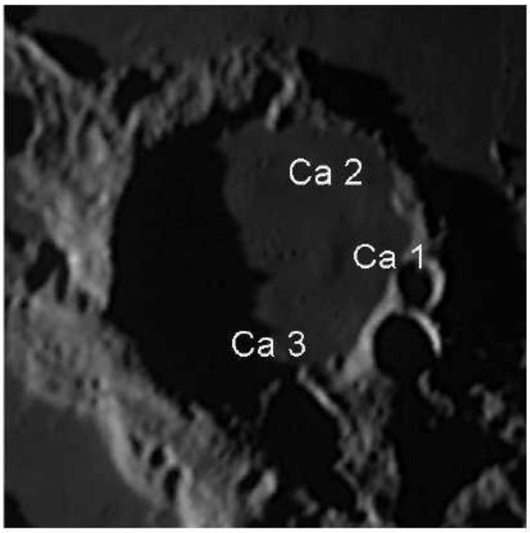


Fig. 1a

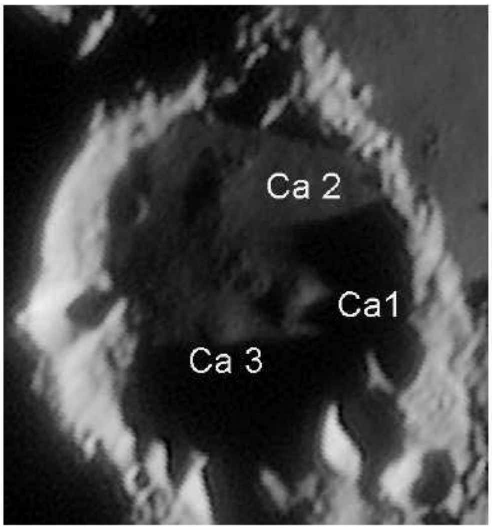


Fig. 1b

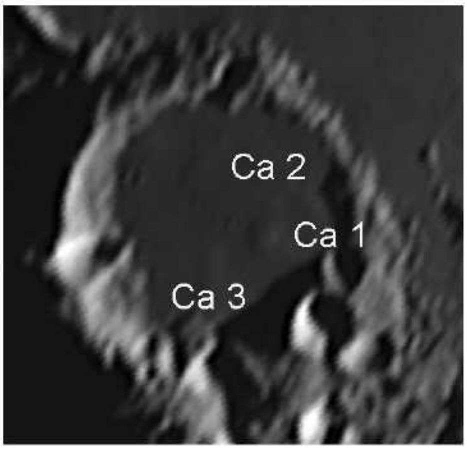


Fig. 1c

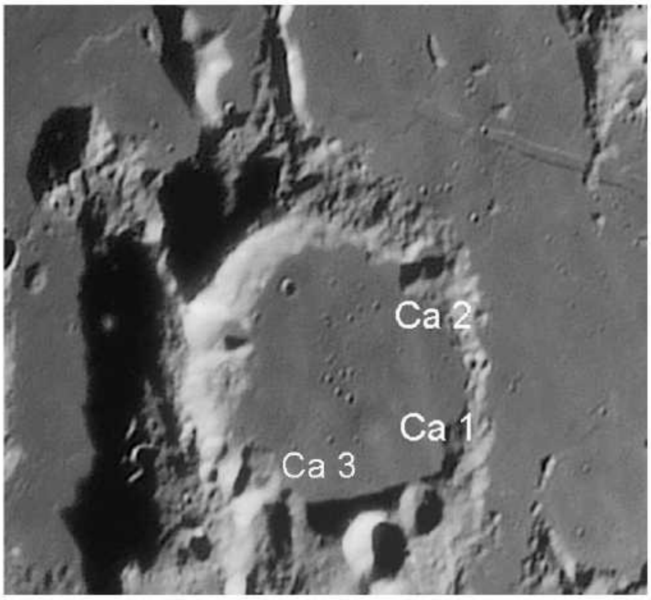


Fig. 1d

Figure 1a (Jim Phillips), 1b (Stefan Lammel), 1c (Jim Phillips), 1d (Stefan Lammel).

Fig. 2 displays the Lunar Orbiter frames IV-131-H3. A comparison of Fig. 2 with the images shown in Fig. 1 displays that the domes are almost completely undetectable at high solar angle.

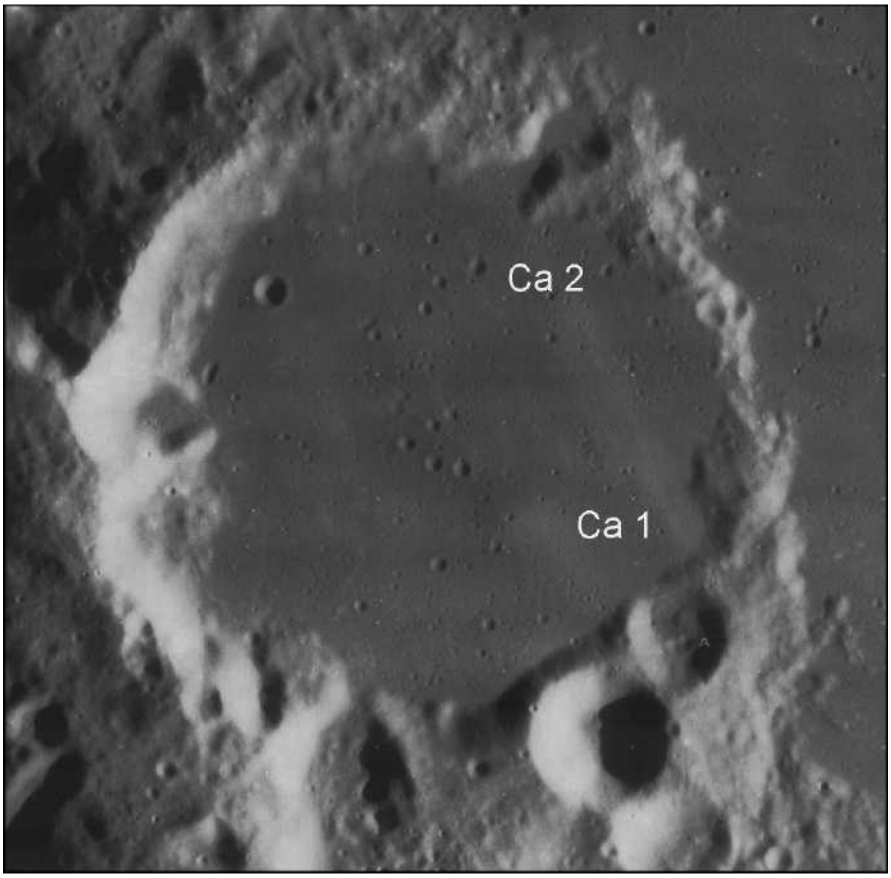


Figure 2: Lunar Orbiter frames IV-131-H3.

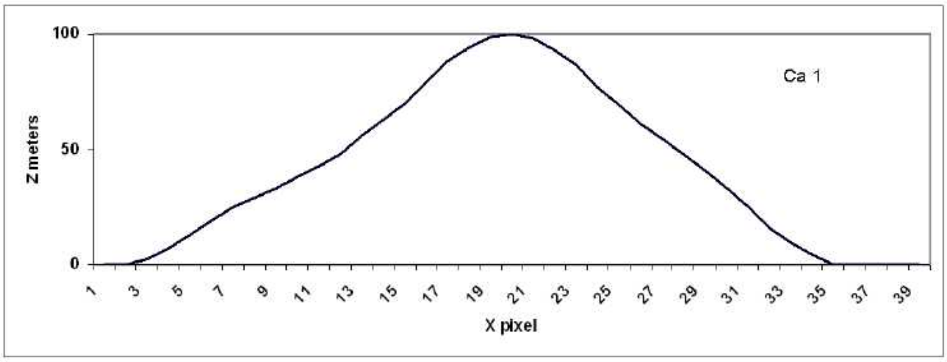
The morphometric properties of the Capuanus domes, obtained using terrestrial telescopic images, are reported in Table 1.

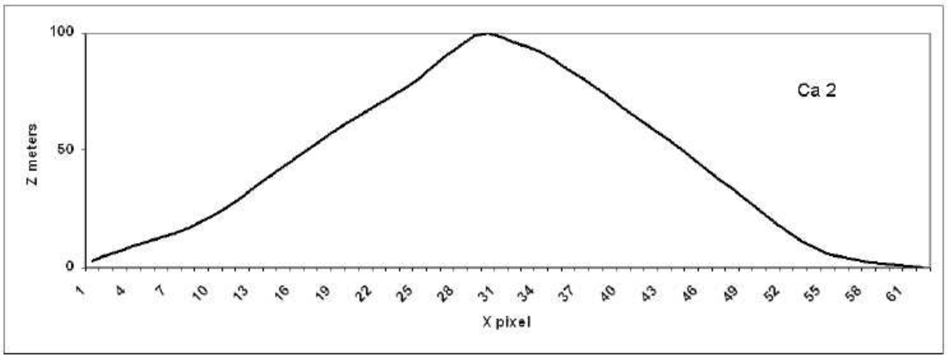
Table 1: Properties of the examined domes.

Dome	Long [°]	Lat [°]	Height [m]	Slope [°]	D [km]	V [km^3]	Class
Ca 1	-26.24°	-34.20°	100	1.63	7.0	1.90	C_2
Ca 2	-26.78°	-33.70°	100	1.27	9.0	3.17	C_2
Ca 3	-26.70°	-34.40°	50	1.04	5.5	0.59	E_2

The domes Ca1 and Ca2 belong to the class C_2. Their heights were determined to 100 m ± 10 m, resulting in flank slopes of 1.63° ± 0.10° and 1.27° ± 0.1°, respectively (Fig. 3). The edifice volumes correspond to 1.90 km^3 and 3.17 km^3 for Ca1 and Ca2.

According to the rheologic model by Wilson and Head (2003) their effusion rates are determined to 125 and 206 m^3 s^{-1} for the two domes. They were formed from lava of viscosities of 1.3 x 10^5 and 7.3 x 10^4 Pa s over a similar period of time of 0.50 and 0.48 years, respectively. The inferred rheologic properties are thus comparable to those of the class C_2 domes in the Cauchy region in Mare Tranquillitatis, such as Cauchy ω and τ (Lena et al., 2013).





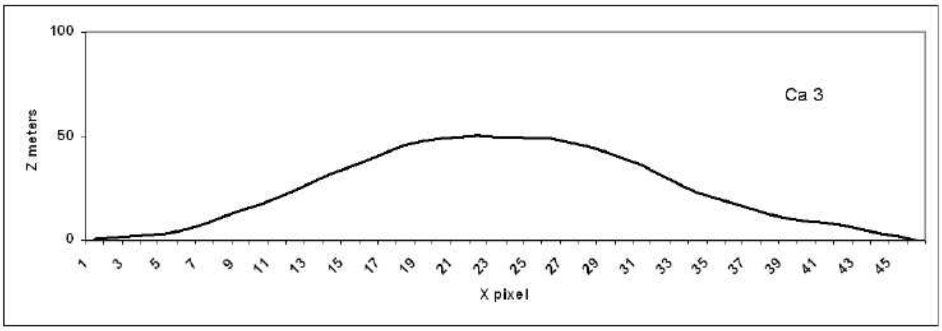


Figure 3: E-W sectional profiles of the domes Ca1-Ca3 based on photoclinometry and Shape from Shading (Lena et al., 2013; Horn, 1989).

The height of the third examined dome (Ca3) was determined to 50m ± 5 m, resulting in flank slope of 1.04° ± 0.10°. The edifice volume corresponds to 0.59 km^3. Capuanus 3 shows a shallow flank slope mainly due to the low viscosity of the lava from which it formed (8.5 $x10^3$ Pa s). According to its different character the magma rise speed was higher than for Ca1 and Ca2 domes, probably due to a higher lava temperature and thus a decreased degree of crystallisation during magma ascending at higher speed through a narrower and shorter feeder dike. Due to its morphometric properties, Ca3 is a typical exemplar of the class E_2. The inferred rheologic properties are comparable to those of the dome M7 in the Milichius region and to some aligned domes in the northern Mare Tranquillitatis (Lena et al., 2013). M7 and Ca3 are characterised by comparably flank slopes, edifice volumes and rheologic properties suggesting that these domes were originated by lava of moderate viscosity ascending through narrow (< 10 m) and short (<30 km) feeder dike in the upper crust.

Figures 4-6 show the 3D reconstruction results obtained with LOLA DEM dataset and in clear agreement with the results previously obtained using CCD telescopic images and photoclinometry and shape from shading analysis.

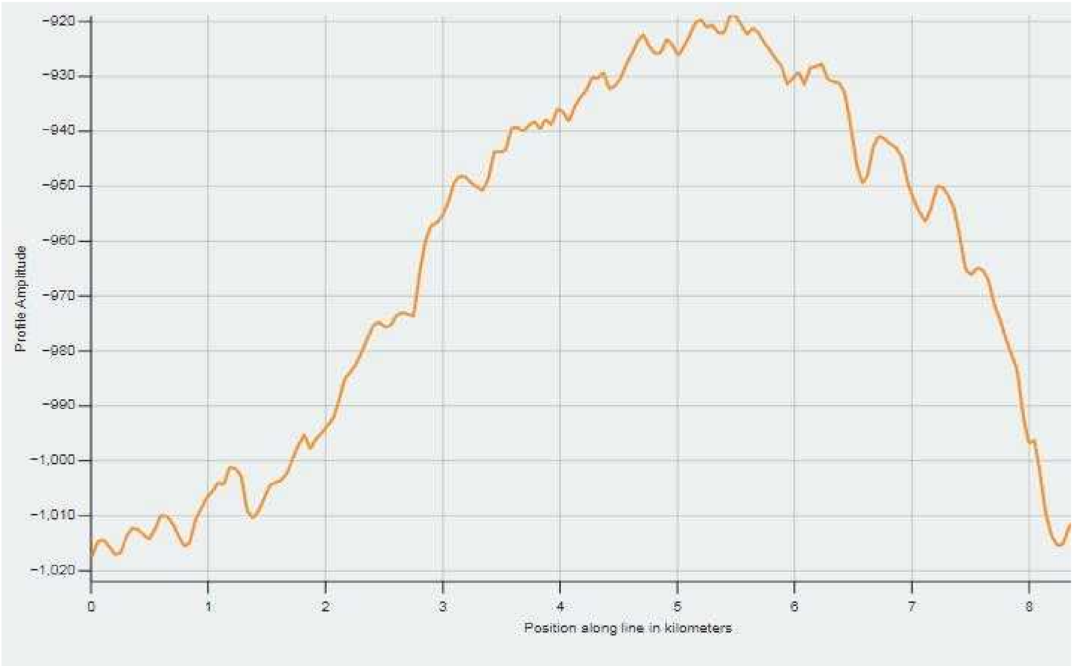


Figure 4: Sectional profile of Ca1 based on LOLA DEM dataset.

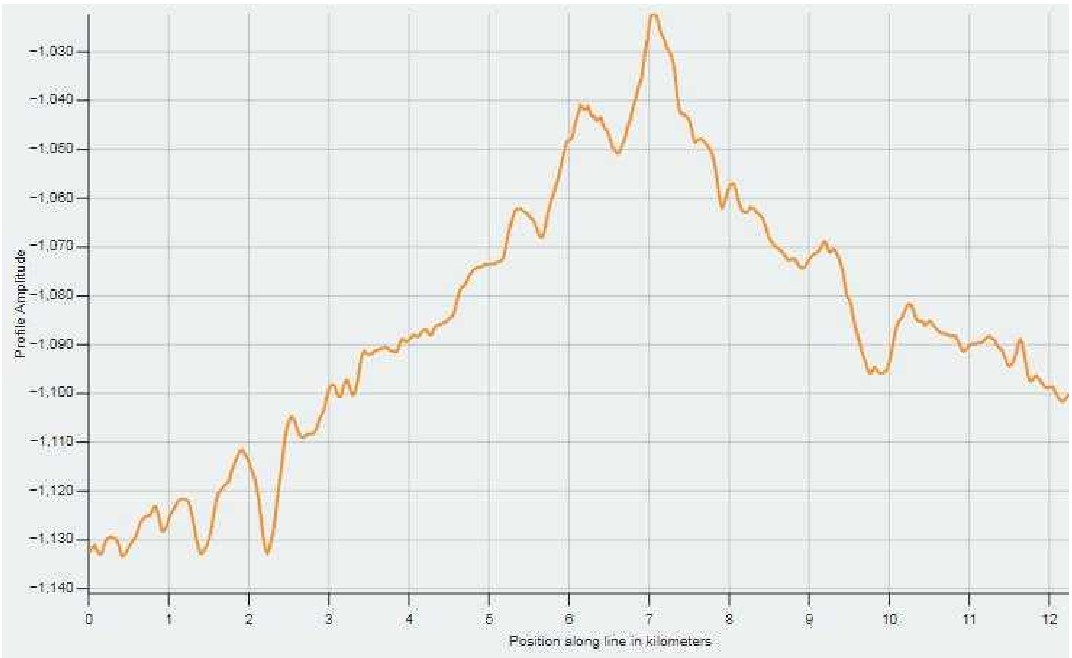


Figure 5: Sectional profile of Ca2 based on LOLA DEM dataset.

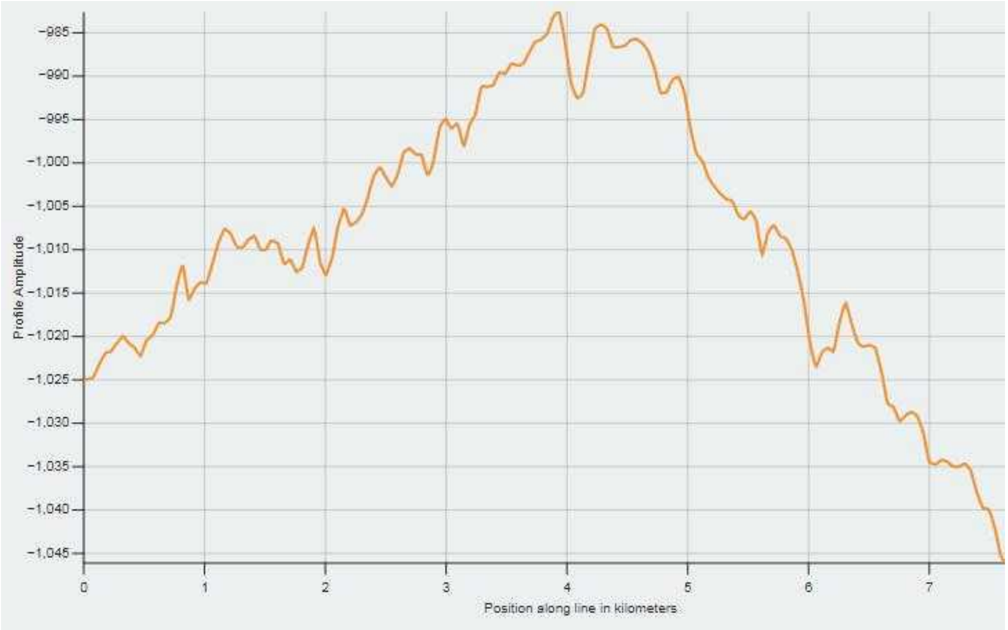


Figure 6: Sectional profile of Ca3 based on LOLA DEM dataset.

In previous studies I computed the shadow length to determine the height of the domes Capuanus 1 (Ca1) and Capuanus 2 (Ca2) using the image of Fig. 1b and the *Lunar Terminator Visualization Tool* (LTVT). From the shadow length l, corrected for foreshortening, and the local solar altitude μ the height h of a dome is given by (1)

$h = l \tan \mu$ (1)

The average slope ξ is then calculated by (2)

$\xi = \text{INV} \tan (h / R)$ (2)

where R is the radius of the dome and h its height.

For the domes Ca1 and Ca2 heights of 100 m ± 10 m and 95 m ± 10 m were obtained, respectively. This result, based on shadow length measurement, yields slope and height value consistent with those obtained by the image-based 3D reconstruction approach and recently obtained using the LOLA DEM (Figs 3-6). Brungart (1964) determined values for the dome heights and flank slopes based on shadow length measurement but at the same time characterizes the obtained results as merely representing order of magnitude estimates.

For the dome located at 26.06° W and 34.06° S (entry no. 30), corresponding to Capuanus 1 dome, Brungart states a height of 376 m with an average slope of 3.5° which is clearly wrong (Lena at al., 2013).

A section of the LOLA DEM displaying the examined region is shown in Fig. 7, a rendered image obtained using LTVT and assuming the same illumination conditions as in Fig. 1b. A rendered image displays the shadow length cast by a dome and is useful for simulating particular situations, showing how rapidly the appearance of domes changes with increasing solar elevation. LOLA DEM was thus used for rendered images confirming the presence of the examined domes (Fig. 7).

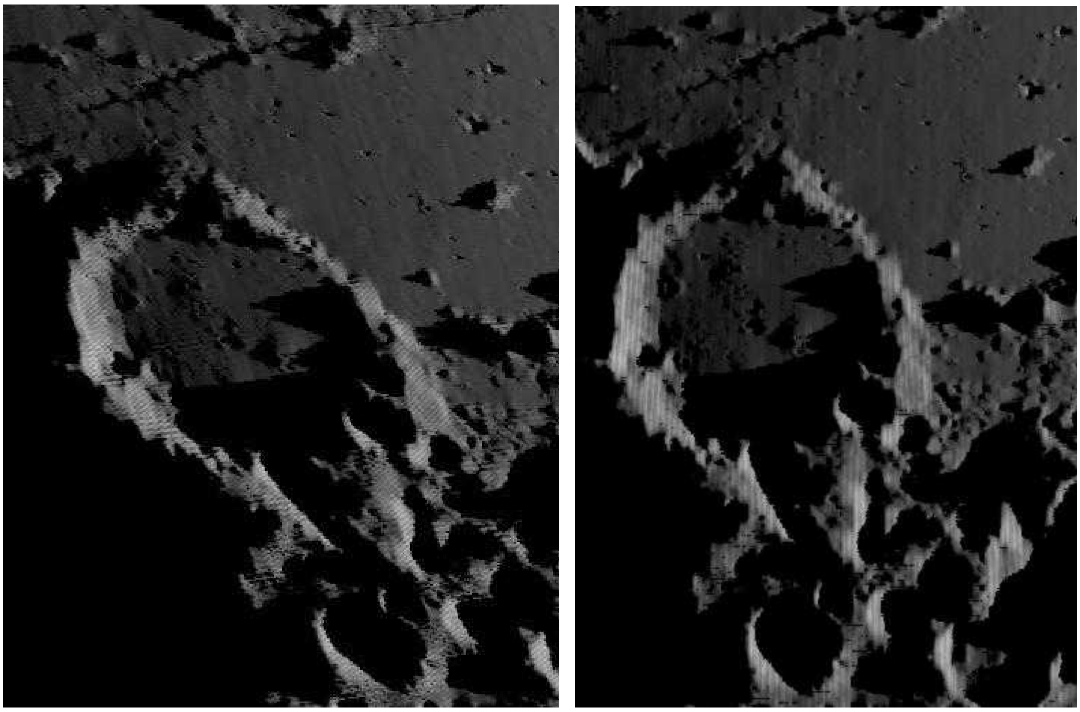


Figure 7: Rendered image based on LOLA DEM dataset.

The examined domes have a moderate R_{415}/R_{750} ratio of 0.60-0.62. A cluster of moderately blue units, including Ca1 have R_{415}/R_{750} values of about 0.62 while Ca2 dome has the lowest R_{415}/R_{750} ratio and therefore appear reddish in Clementine color ratio image.

All three domes consist of typical mature mare basalt, where the composition of Ca2 and Ca3 corresponds to low-Ti basalt (1-1.1 wt %) while Ca1 consists of basalt having a higher Ti content (2.1 wt %). The domes and the observed variety of basalt compositions suggest a complex volcanic history of Capuanus crater.

References

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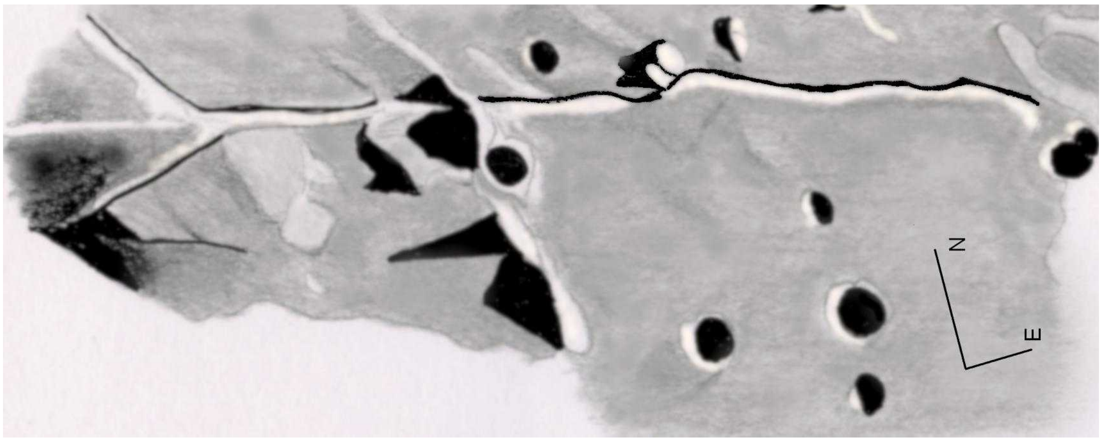
[2] Lena, R., Wöhler, C., Phillips, J., Chiocchetta, M.T., 2013. *Lunar domes: Properties and Formation Processes*, Springer Praxis Books.
[3] B. K. P. Horn, Height and Gradient from Shading, MIT technical report, AI memo no. 1105A, 1989.
http://people.csail.mit.edu/people/bkph/AIM/AIM-1105A-TEX.pdf
[4] Wilson, L., Head, J. W., 2003. 'Lunar Gruithuisen and Mairan domes: Rheology and mode of emplacement'. *J. Geophys. Res*. 108(E2), pp. 5012-5018.
[5] Brungart, D. L. 1964. The Origin of Lunar Domes, Thesis, Air Force Institute of Technology, MECH/GSF-64-32, 191 pp.

TWO VIEWS OF RIMA ARIADAEUS, 20 February 2021



Drawing by Paul Abel, 18 February 2021, 20.33 – 2053 UT
305mm Newtonian, x 300, Seeing: Antoniadi II

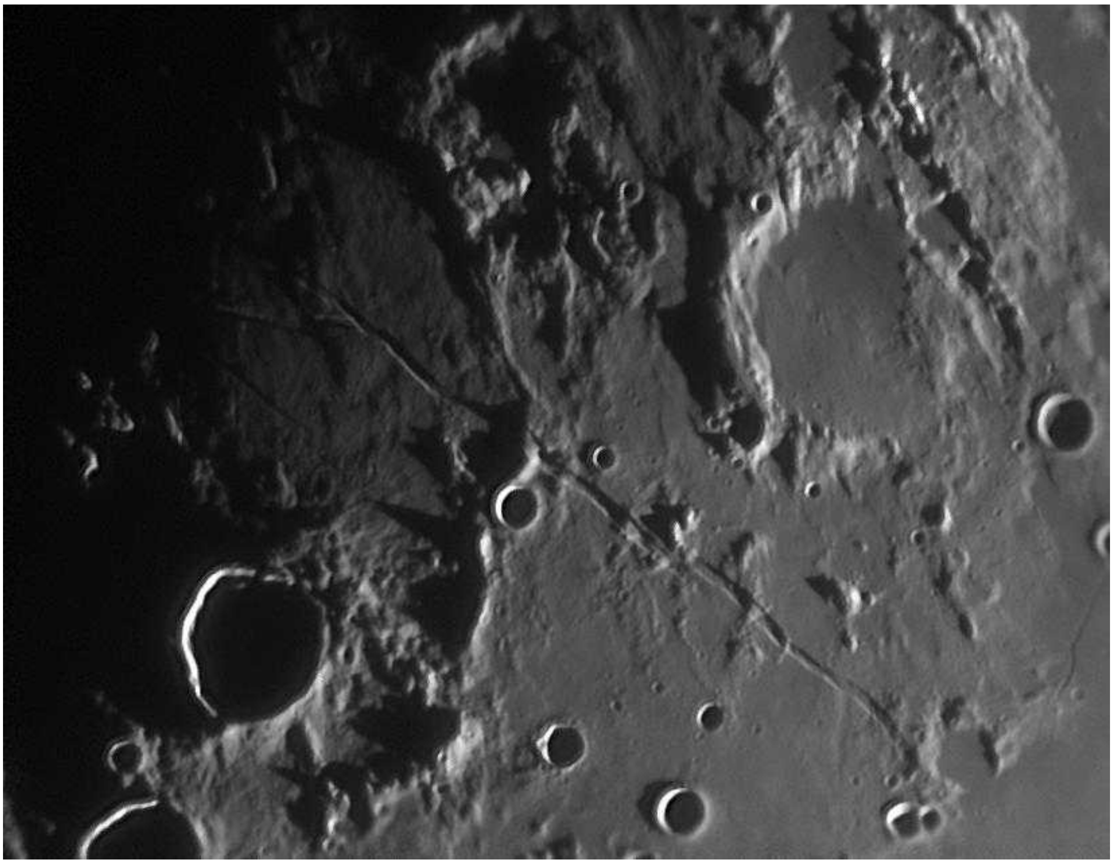


Image by Bill Leatherbarrow, 18 February 2021, 20-04 UT, OMC300 Mak-Cass, Seeing: Ant III

LUNAR OCCULTATIONS **March 2021** Tim Haymes

Time capsule: 50 year ago:

[With thanks to *Stuart Morris* for the LSC archives. https://britastro.org/downloads/10167]

- Dr R. Maddison resigns. Phil Ringsdore becomes Acting Director.
- J. Coates: A 3" refractor is held in high esteem owing to its portability, reasonable magnifying power and steady images.
- There were no occultation reports in March 1971

Reports

Brian Mills (Hildenborough) reports 40 timings for the period 2016-2020. Occult 4.11 was used to prepare the data for submission to IOTA. Timings were made by stopwatch and telephone method (Visual) with a 30.5 cm aperture. The report was sent to European collector (Jan Manek) at lunoccult@iota-es.de.

Tim Haymes (Oxfordshire) has received reductions for his 2020 reports. The timings were made QHY174-GPS camera, and C11 with an accuracy of +/-0.02 sec (25 fps).

The report contains mean residuals as follows:

	mas **	time /sec
Report-1	+19 +/-20	+0.06 +/- 0.05
Report-2	+8 +/-14	+0.01 +/- 0.05

** milli-arc seconds

The mean error is small, so the deviation must contain even smaller contributions from other sources: Moon, Earth, Star, calibration.

The camera was used without calibration in the first half of the year. After calibration, the errors appear to have been reduced. A method of All-of-System Time Testing, is described by Herald and Gault in JOA, https://iota-es.de/JOA/JOA2020_1.pdf

The process of calibrating the QHY174-GPS has not been an easy ride, but as the user base increases the process has been better understood.

I refer the reader to Kai Getrost's Zoom lecture on this page:
http://occultations.org/community/meetingsconferences/na/2020-iota-annual-meeting/presentations-at-the-2020-annual-meeting/

There are no regular users of the QHY174-GPS camera in the Lunar Section apart from myself. Globally there is a user base I estimate in the region 100, located in the US and Europe where the camera is used for both asteroid and lunar occultations. The demand on accuracy is greater for lunar events.

Observing Possibilities (..continued from last month)

Features of Occult4 Tim Haymes

This is prediction and analysis software developed and maintained by Dave Herald (Marrumbateman, AU). I started using it before it became fully integrated with *Windows* (some time ago!). Operation of the program is split into clear areas of functionality. This means it can be learned in stages.

Installation

Occult4 can be installed in any folder. For Win 10 I put it in a dir off C-drive (not X86). This avoids some frustrations with possible 'permissions'.

Once downloaded the user is prompted to fill in some information and to download essential data files. The Maintenance Section is where the user can make further changes and download updates to the catalogues. One important item is to set up a site file, and add 'Home' to it. I then added some other locations of interest. The introduction to Occult 4 is here: http://www.lunaroccultations.com/iota/occult4.htm
It's important to download all the catalogues except the very big ones. These have a warning! Once the basic files are available we can do lunar predictions and see a preliminary analysis, or search for historic observations. One can now plot them on the lunar limb and see how accurate they were.

Lunar Predictions

This is an essential tool for observers. The user is presented with three options, Single Objects, Single Sites, or Multiple sites.

I use Predictions for single sites – my home position. The magnitude limit is controlled by telescope aperture (see Maintenance section), or 2.Star cat (Fig. 1). One of the menu items allows the limit to be changed in magnitudes if required [Mag Limit adjust..]

Fig. 1 The Menu of options for Lunar Predictions in Occult4

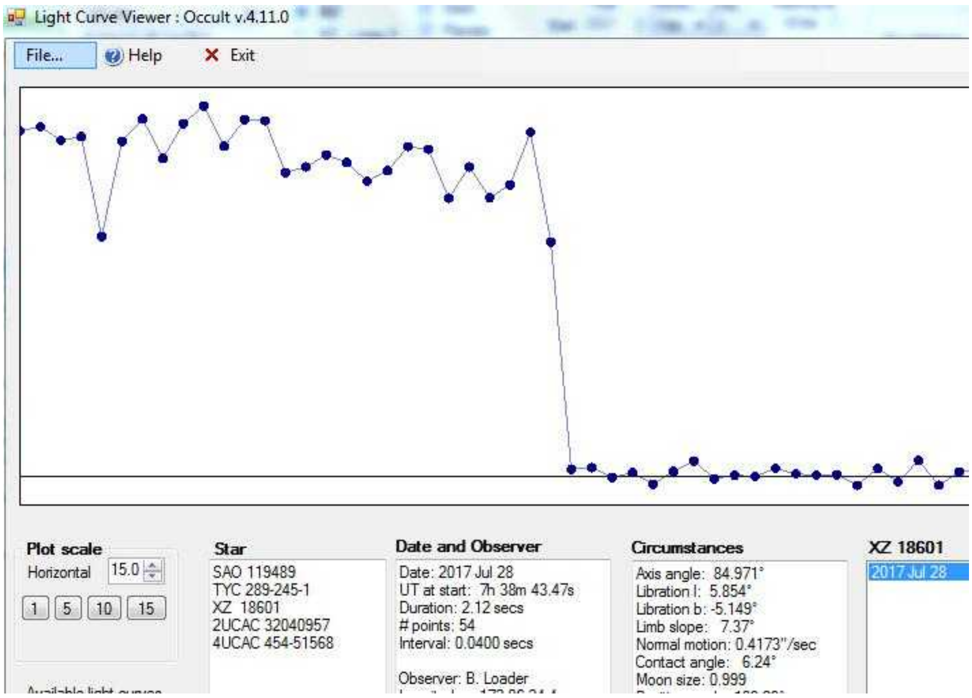
The default period is one day starting at 0hrs using the XZ catalogue (downloaded during the install process). One would normally select Stars, but Planets can be added to see what is coming up in the future. So select Planets (only) and change the prediction period to 5 years (say). You may be surprised to find that the major planetary satellites are also predicted.

The normal operation of the prediction is to alert the observer to grazes near the Home location. This is helpful, but quite often they may be unobservable. Nevertheless, it is a useful hint. The Graze line can be opened with right click to select more options, such as to compute predictions. From here right click will give further options to display the graze line and limb profiles.

The default predictions contain a lot of data and to simplify the output I use the Set Output filter. There is also a ‘Short Output’ button which will remove some of the less useful columns, such as RA and Dec of the star.

Occult is full of functionality. Right click on a prediction line with an asterisk will give the option to show observed light curves. One of the reporting options not in lunarreport.exe (see last month) is the ability to report a light curve obtained from Video. These are then available to be seen by other users of occult:

y	m	day d	Time h	m	s	P	Star No	Sp D	Mag v	Mag r V	% ill	Elon	Sun Alt	Moon Alt	Az	CA o
21	Feb	2	0	13	36.1	r	119493	G0	9.0	8.6	79-	125		22	118	14N
21	Feb	2	0	34	49.2	r	1806	K5	9.1*	.3	79-	125		24	124	53S



Example of a light curve

Last but not least, the predictions hold information on Double Star occultations giving magnitudes and separations. The step time is also predicted. Many are unconfirmed ‘occultation’ doubles reported from previous visual timings.

At a lunar rate of motion of 0.5deg / hour (the exact figure is given in the predictions), a distance of 0.5” arc is covered in 1 second of time. This means we are able to resolve close doubles quite easily. The step time will depend on a number of factors.

Next Month, I will introduce some more features in Occult4.

Occultation predictions for Northern Oxfordshire in 2021 March

E. Longitude - 1 18 00 , Latitude 51 55 00, Alt. 119m;
Some fainter predictions are omitted at Full Moon.

y	m	day d	Time h	m	s	P	Star No	Sp	Mag r	Mag	% ill	Elon	Sun	Moon Alt	Alt	CA Az	Notes o
21	Mar	1	4	43	35.6	R	1781	M*	7.6*	6.8	95-	155		28	230	74S	
21	Mar	2	1	28	0.2	R	139220	K2	8.4	7.9	90-	143		32	159	84N	
21	Mar	2	23	56	30.4	R	139704	K0	7.3	6.7	82-	130		14	126	53S	
21	Mar	3	1	50	8.6	R	158366	G5	8.0	7.5	81-	129		24	153	32S	
21	Mar	3	2	53	52.5	R	2028	G8	6.5*	5.9	81-	129		27	170	89S	96 Vir
21	Mar	3	4	4	50.0	R	158411	M*	8.0	7.2	81-	128		27	189	54N	
21	Mar	4	2	24	9.9	R	159001	F5	8.1		71-	115		18	150	36N	
21	Mar	4	4	10	43.7	R	2159	K5	5.2	4.4	71-	115		22	176	51S	nu Vir
21	Mar	5	4	38	36.5	R	184105	K3	7.4*	6.9	60-	101		17	170	26N	
21	Mar	5	5	33	59.4	R	2307	B1	3.9*	4.0	59-	101	-11	17	183	54N	omega 1 Sco
21	Mar	5	6	5	4.3	R	2310	G6	4.3*	3.9	59-	100	-6	17	191	84N	omega 2 Sco
21	Mar	5	6	7	38.0	R	184137	G5	7.9*	7.2	59-	100	-6	17	191	81S	
21	Mar	7	4	30	59.5	R	186235	F2	7.2	6.9	37-	75		5	144	67N	
21	Mar	15	19	44	54.0	D	109887	K2	9.0	8.5	5+	27		6	270	53N	
21	Mar	16	20	43	54.0	D	110394	F0	8.8	8.6	10+	38		7	277	43N	
21	Mar	17	19	35	16.1	D	93181	F5	8.9	8.7	17+	48		27	258	27S	
21	Mar	17	20	9	36.6	D	93191	G5	8.5	7.8	17+	48		22	265	46S	
21	Mar	18	19	54	34.0	D	93559		8.8	8.5	24+	59		34	256	75N	
21	Mar	18	22	38	37.5	D	93592	F0	8.9	8.7	25+	60		9	288	32N	
21	Mar	19	19	10	55.7	D	76632	A0	8.6	8.5	33+	70	-9	48	236	83S	
21	Mar	19	21	47	35.7	D	76657	G0	8.4	7.9	33+	71		26	272	67S	
21	Mar	19	21	53	58.8	D	690	F8	8.0	7.7	34+	71		25	273	65S	
21	Mar	20	0	21	20.8	D	76692	F5	8.1*	7.8	34+	72		4	300	47N	
21	Mar	20	23	6	18.8	D	819	B9	8.3	8.2	43+	82		23	279	34S	
21	Mar	21	19	32	33.7	D	78139	K5	8.3	7.4	52+	92	-12	60	213	55S	
21	Mar	21	22	20	15.7	D	78236	G0	7.6	7.3	53+	93		39	261	66S	
21	Mar	21	23	3	36.3	D	78266	G5	8.7	8.1	53+	93		32	270	58S	
21	Mar	21	23	49	56.0	D	78301	K0	8.7	8.1	53+	94		25	278	72S	
21	Mar	22	20	2	17.4	D	79140	M*	8.0	7.1	62+	104		61	203	72S	
21	Mar	22	21	7	36.4	D	79181	F5	8.8	8.5	62+	104		56	228	83S	
21	Mar	22	21	49	40.6	D	1097	A1	6.9	6.9	62+	104		51	241	75N	
21	Mar	22	22	28	17	Gr	1099	M1	5.8	5.0	63+	105		45	252	2N	52 Gem
21	Mar	22	22	28	21	Gr	1099	M1	5.8	5.0	63+	105		45	**	GRAZE:	
21	Mar	22	22	44	9.5	D	79227	K2	9.0	8.3	63+	105		43	255	69N	
21	Mar	22	23	5	45.7	D	79238	A0	7.3	7.3	63+	105		40	260	88S	
21	Mar	23	23	29	33.6	D	1239	A4	6.6	6.5	73+	117		43	252	75N	
21	Mar	24	21	45	35.1	D	1357	G0	7.7	7.3	81+	129		58	199	76S	
21	Mar	26	2	18	59.4	D	98984	F0	8.0	7.8	90+	143		28	259	68N	
21	Mar	27	3	21	12.3	D	1612	F5	7.3	7.1	96+	157		22	258	72N	
21	Mar	29	23	38	12.9	R	139493	F5	8.0	7.8	98-	162		27	152	62S	
21	Mar	30	0	21	58.6	R	139508	M*	8.1	7.3	98-	162		29	164	40N	
21	Mar	30	1	9	56.6	R	1969	K0	7.1	6.4	97-	162		30	177	38N	
21	Mar	30	3	23	44.3	R	139567	K2	7.8*	7.1	97-	161		25	213	31N	
21	Mar	31	0	44	40	m	2092	K4	7.0	6.1	92-	148		21	157	16S	
21	Mar	31	1	45	30.8	R	2096	G6	8.0	7.6	92-	148		24	172	67N	
21	Apr	2	3	46	14.5	R	2407	F3	7.0	6.7	74-	119		15	175	58N	15 Oph
21	Apr	4	4	57	29	m	2740	G8	6.3*	5.8	52-	93	-6	10	164	7S	

Prediction to April 5th to magnitude 8.9

Notes on the Double Star selection:

Doubles are selected from Occult 4, where the fainter companion is brighter than mag 9.0, and the time difference(dT) is between 0.1 and 10 seconds. **Please report double star phenomena.**

Key:

P = Phase (R or D), **R** = reappearance **D** = disappearance
M = Miss at this station, Gr = graze nearby (possible miss)
CA = Cusp angle measured from the North or South Cusp. (-ve indicates bright limb)
Dbl* = A double star worth monitoring. Details are given for selected stars.
Mag(v)* = asterisk indicates a light curve is available in Occult-4
Star No:
1/2/3/4 digits = Zodiacal catalogue (ZC) referred to as the Robertson catalogue (R)
5/6 digits = Smithsonian Astrophysical Observatory catalogue (SAO)
X denotes a star in the eXtended ZC/XC catalogue.
The ZC/XC/SAO nomenclature is used for Lunar work. The positions and proper motions of the stars in these catalogues are updated by Gaia.

Detailed predictions at your location for 1 year are available upon request.
Occultation Subsection Coordinator: occultations at stargazer dot me dot uk
Tim Haymes, LS Coordinator (occultations)

LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME

Tony Cook

Introduction: The set of observations received in the past month has been divided into three sections: Level 1 is a confirmation of observation received for the month in question. Every observer will have all the features observed listed here in one paragraph. Level 2 will be the display of the most relevant image/sketch, or a quote from a report, from each observer, but only if the date/UT corresponds to: similar illumination (±0.5º), similar illumination and topocentric libration report (±1.0º) for a past TLP report, or a Lunar Schedule website request. A brief description will be given of why the observation was made, but no assessment done – that will be up to the reader. Level 3 will highlight reports, using in-depth analysis, which specifically help to explain a past TLP, and may (when time permits) utilize archive repeat illumination material.

TLP reports: No TLP reports were received in January.

Level 1 – All Reports received for January: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Aristarchus, Censorinus, Daniell, Mons Piton, Plato, Ptolemaeus, Ross D, Timocharis, and Torricelli B. Alberto Anunziato (Argentina - SLA) observed: Aristarchus, Eratosthenes, and Plato. Massimo Alessandro Bianchi (Italy – UAI) imaged several features. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged several features. Rob Davies (Devil's Bridge, UK – BAA/NAS) imaged: Bullialdus, Copernicus, Palus Epidemiarum, and Sinus Iridum. Anthony Cook (Newtown, UK – ALPO/BAA/NAS) videoed several features. Daryl Dobbs (Risca, UK - BAA) observed: Alphonsus, Birt, and Proclus. Les Fry (West Wales, UK – NAS) imaged: Anaxagoras, Atlas, Bullialdus, Janssen, Lacus Timoris, Montes Carpatus, Montes Riphaeus, Palus Epidemiarum, Palus Somni, Plato, Promontorium Kelvin, Promontorium Laplace, Santbech, Sinus Iridum, and Vlacq. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Archimedes, Aristarchus, Petavius, Sinus Asperitatis, Vallis Rheita and several features. Davide Pistritto (Italy – BAA) imaged

Eudoxus. Trevor Smith (Codnor, UK – BAA) observed: Alphonsus, Aristarchus, Bullialdus, Censorinus, Curtis, Eratosthenes, Herodotus, Hyginus N, Mons Piton, Plato, Proclus, Sinus Iridum, and Vallis Schröteri. Bob Stuart (Rhayader, UK – BAA/NAS) imaged: Atlas, Capella, Carmichael, Clavius, Macrobius, Maskelyne, Römer and several features. Franco Taccogna (Italy – UAI) imaged Eudoxus. Aldo Tonon (Italy – UAI) imaged: Aristarchus and several features. Gary Varney (Pembroke Pines, FL, USA – ALPO) imaged Theophilus. Fabio Verza (Italy – UAI) imaged Aristarchus.

Level 2 – Example Observations Received:

Eudoxus: On 2021 Jan 19 UT 16:26, 16:28 Franco Taccogna (UAI) and at 18:19 UT Davide Pistritto (BAA) imaged this crater for a repeat illumination request for the following TLP report:

```
On 1881 May 04 at UT 20:00? Trouvelot (Meudon, France) observed an unexplained light inside Eudoxus crater. The Cameron 1978 catalog ID=222 and the weight=3. The ALPO/BAA weight=3.
```

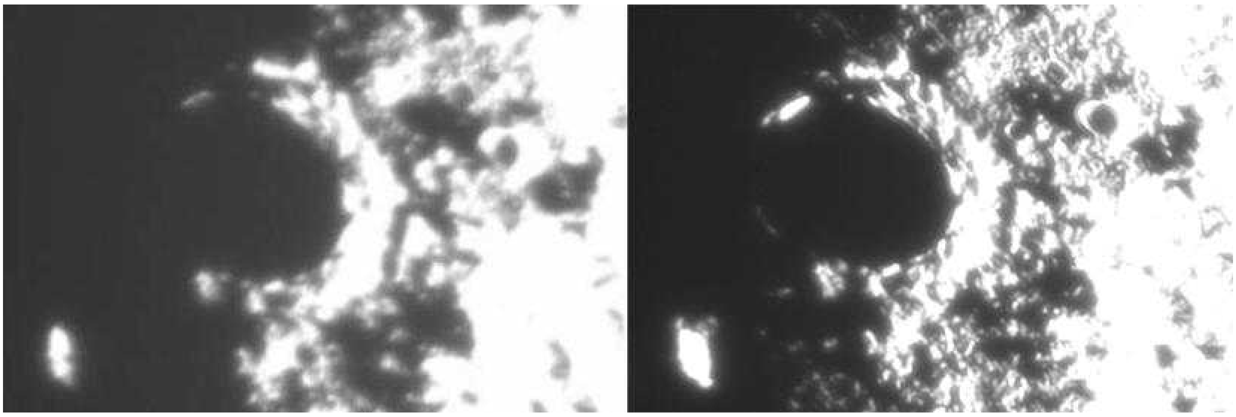


Figure 1. Contrast *stretched views of Eudoxus, taken on 2021 and orientated with north towards the top. (Left) As imaged by Franco Taccogna (UAI) at 16:28UT. (Right) As imaged by Davide Pistritto (BAA) at 18:19UT.*

There is nothing unusual in the shadowed area of either image in Fig 1, despite contrast stretching, though there is a filament from the south western rim starting to appear in Davide's image, though whether Trouvelot would have been tricked by this is doubtful.

Ptolemaeus: On 2021 Jan 21 UT 02:40-03:00 Jay Albert (ALPO) observed visually and imaged this crater for a repeat illumination request for the following report:

Ptolemaeus 2020 Feb 01 UT 19:40-19:50 P. Shepherdson (York, UK, 102mm Mak - BAA) saw an "ashen" sliver of bright light across the floor. Images taken. This maybe normal appearance - though observer re-observed in May and found the effect different in that there was no "ashen" like effect. Visual sketches and time lapse image sequences welcome. If doing visual work - try using a polaroid filter and rotate it to see if that makes any difference. For imaging work, please over-expose slightly to bring out detail on the floor; you could also try colour imaging of the floor as an interesting experiment - though for comparison purposes image other terminator features exhibiting shadow spires. ALPO/BAA weight=1.

Figure 2. *Ptolemaeus as imaged by Jay Albert (ALPO) with an iPhone held up to the eyepiece on 2021 Jan 21. Colour saturation increased to 60% and orientated with north towards the top.* ***(Left)*** *Taken at 02:53UT.* ***(Right)*** *Taken at 02:56UT with a slightly longer exposure to bring out detail in the shadow.*

Jay commented that he easily saw what he regarded as the 'ashen sliver of light' on the shadowed floor of the crater. The sliver ran roughly E-W and was located S of the central part of the floor, but not close to the S wall. He used 290x to observe visually and used the same eyepiece for iPhone images (See Fig. 2) of Ptolemaeus. The nature of the original TLP report depends upon what an observer's definition of 'ashen light' means. There are several references to past 'ashen' light effects on flat-floored craters e.g., the floor of Plato and Ptolemaeus. I sent the images to Phil Shepherdson for his comments and he replied: *'What intriguing images. My recollection is how ghostly white and stark the streak was across the floor and these two images certainly come very close to what I observed that night. If only it had been a better night for me, I would have taken better images'.*

Proclus: On 2021 Jan 21 UT 19:35-20:05 Daryl Dobbs (BAA) viewed this crater under similar illumination to the following reports:

On 1995 Jul 06 at UT 03:22-03:57 R. Spellman (Los Angeles, USA found that the floor of Proclus appeared to darken slightly through a blue filter. The ALPO/BAA weight=2. Source of this observation came from Spellman's web site.

Proclus 1972 Aug 17 UT 20:05-21:10 Observed by Haiduk (13.25E, 52.5N, 60mm refractor, S=1, T=3) "Well visible bright area at the NE wall, end of event uncertain for seeing became poor" Hilbrecht & Kuveler Moon & Planets (1984) Vol 30, pp53-61.

Daryl comments that: with respect to the first report that he had observed this area many times, it appeared perfectly normal. A dark area under the SE wall was observed, but had seen this feature before and it looked like lava. It was easier to see through a blue filter than the others he used but this was more down to reducing the glare – in his opinion. If this was the feature in the above report then it was normal. A blue filter did enhance the view more so than through yellow, green or red in which he found it harder to see.

With respect to the second report, he noted that: the NE wall was indeed bright, but no brighter than usual, filters didn't make any difference, perhaps with a small refractor and poor seeing the observer had internal reflections in his telescope/eyepiece combination. Daryl certainly didn't see anything unusual.

Plato: On 2021 Jan 21 UT 23:30-23:35 and 23:45-00:07 Alberto Anunziato (SLA) observed visually this crater under similar illumination to the following report:

Plato 1925 Jun 20 UT 20:00? Observed by Markov (Russia) "Light bands in bottom seen in shadow & did not seem to be elevations. These have been seen 5X from 1913-1922." NASA catalog weight=3. NASA catalog ID #391. ALPO/BAA weight=2.

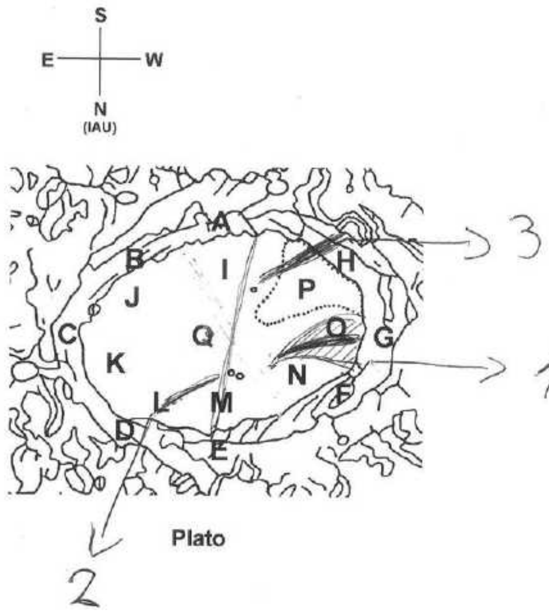


Figure 3. *Plato with the locations of annotated stripes indicated by Alberto Anunziatio from 2021 Jan 21 UT 23:30-23:35 and 23:54-00:07. Orientated with north towards the bottom.*

Alberto comments that he could distinguish a narrow stripe which was not too bright, in the dark part of the crater, marked as ‘A’ in Fig 3. There was another stripe, but even less bright (almost invisible at times) in the brighter part of the floor, and marked as (2) in Fig 3. At 23:54-00:07UT a new stripe was seen in the darker (west) section of the floor and is indicated by a 3 in Fig 3. Stripe No. 1 was the widest of the stripes and could be an extension.

Copernicus: On 2021 Jan 23 UT 19:28 Rob Davies (BAA) imaged this crater under similar illumination to the following report:

Observed by G.H. Johnstone of Albuquerque, NM, USA on 1954 Nov 05 UT 20:00 (according to Cameron), but 02:00-04:00 according to the original observation and at colongitudes 34.7 to 35.7 deg. 4" reflector, x150 used. The observer reported that the western part (about 1/3rd of the interior) was pitch black with shadow. However, there was a zone about as wide, or perhaps only a fourth of the total width that was distinctly a lighter bluish shade, almost like twilight. The shadows of the peaks on the western edge of the rim were clearly seen crossing this bluish shadowed area. Then this area ended sharply, and the far side was bathed in light from the rising sun. The shadows of the peak were sharply defined across the twilight zone, and the edge of the pitch-black shadow was easily defined but not as sharp as the darker shadows crossing the blue twilight zone. The observer checked other craters but did not see this condition in any of them - they all had the abrupt division between black and white that we would normally *expect to see. Cameron 1978 catalog ID=579 and weight=2. Reference 1962 edition of ALPO's Journal: The Strolling Astronomer. ALPO/BAA weight=3.*

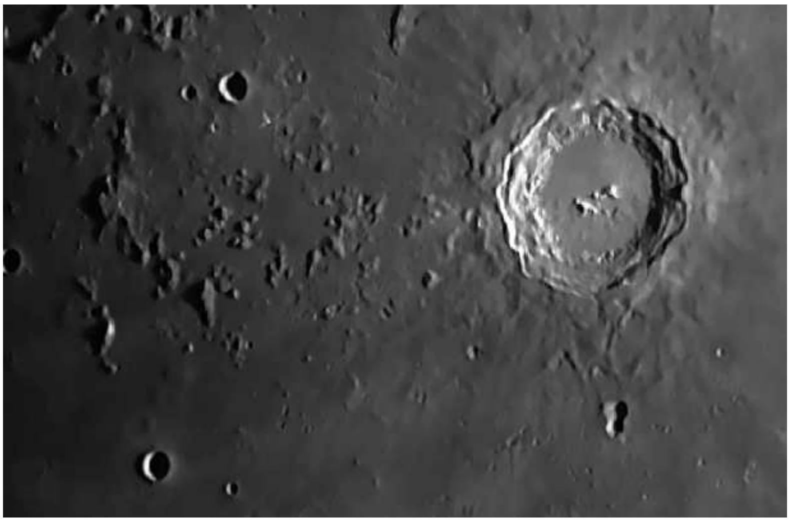


Figure 4. *Copernicus as imaged by Rob Davies (BAA) on 2021 Jan 23 UT 19:28 and orientated with north towards the top.*

As you can see from Fig. 4, although the quoted colongitudes are correct (see p. 142 of the *Hatfield Lunar Atlas: Digitally Enhanced Version*), the description is not typical for the colongitudes given; indeed it would have been closer to a colongitude of ~26°.

Plato: On 2021 Jan 23 UT 19:23-20:00, 20:23-20:40, 22:07-22:25 Trevor Smith observed and at 20:16 Les Fry imaged this crater under similar illumination to the following two reports:

1981 Jun 12 Palo: P. Moore at 21:10 found the southern wall (and onto the southern floor) of the crater to be indistinct. Elsewhere in the crater everything was sharp. The effect was still seen at 21:42UT, but less strong. A check was made for colour with a Moonblink device, but none was seen. There was still a trace of this effect at 21:44UT, although detail was now becoming visible. By 21:48UT vertical streaks were seen crossing the floor from the obscuration area and these were more visible in the red filter and not in the blue. Cameron comments that undefined patches on the floor of Plato are not normal. By 21:55UT some craterlets on the floor started to become visible and the TLP for Moore ended by UT22:23. P.Foley was alerted by Moore and saw a "massive dense obscuration on the south wall, south floor and south outer glacis to the Mare". Foley noted that by 21:50UT the effect was fading and finished by 22:03UT. Foley reported an orange translucent haze covering half of the floor, but floor craterlets could be seen on and off - however his atmospheric seeing conditions were IV. At 22:00 UT Foley reported the floor close to the north wall to be "milky or misty". No detail was visible at 21:15UT and variability in the floor continued until 23:10UT. Hedley-Robinson was alerted at 21:35UT and found no difference between red and blue views of the area, however he did find that the south rim was indistinct although this effect had lessened by 22:00 UT and was normal by 22:17UT. M. Mobberley saw a white spot on the floor at 21:20 UT, whereas he normally would have expected to see craterlets. Mobberley was alerted at 21:40 UT and took some colour photos. He also made sketches that showed variability in the floor and dark lines and patches in the north west corner. However, the altitude of the Moon was low. Cameron mentions that two of the photos show loss of detail at the south wall and beyond, and also a change in the floor markings. The north wall at 21:50UT was strangely reddish (didn't think this was spurious colour). The rest of the wall was sharp at 22:20UT through a yellow filter. Large bright patch in the centre and rest of the floor was apparently of the same shading as Mare Imbrium.

The above notes are based upon the Cameron 2006 catalog extension TLP ID 145 and weight=4. ALPO/BAA weight=3.

Plato 1870 May 10 UT 22:00 Observed by Birt (England) "Extraordinary display of lights. Says not effect of sunlight" NASA catalog weight=4). NASA catalog ID #167. ALPO/BA|A weight=3.

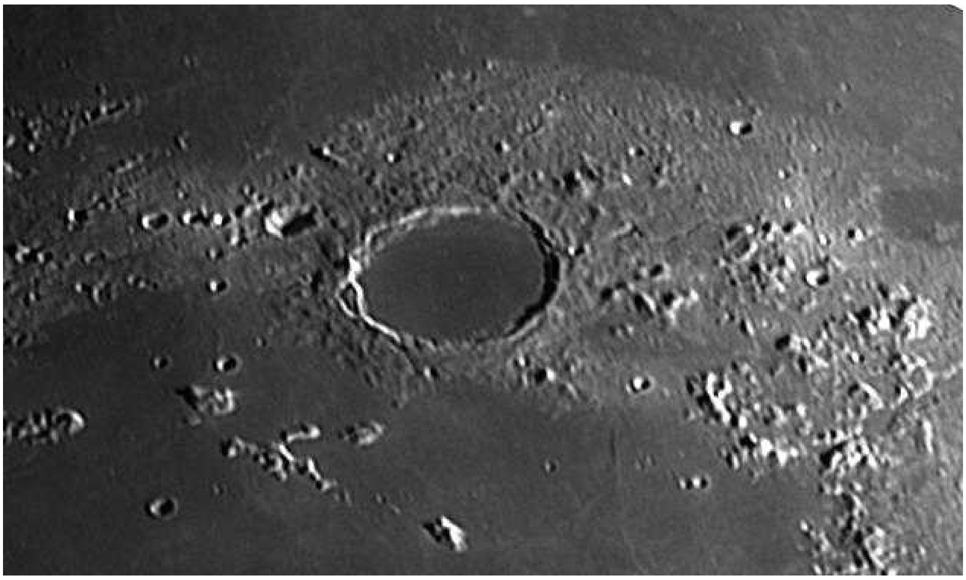


***Figure 5.** Plato as imaged by Les Fry (NAS) on 2021 Jan 23 UT 20:16.*

Trevor (observing from 19:40-20:05UT) comments that, unlike the Patrick Moore report, the southern wall was NOT indistinct; rather, the whole of Plato was quite sharp and the central craterlet was quite clearly visible. Indeed the Les Fry image (Fig. 5) shows at least 3 craterlets visible on the floor and the southern rim sharp, although less contrasty than other parts of the rim. Trevor goes on to add that at times four or five craterlets came into view visually and he could see much detail on the floor in the form of lighter streaks and patches. Indeed, during the best moments of seeing he thought he could glimpse half or dozen or so radial lines/bands stretching all the way across the floor from the NW-SE. These were only impressions (not too sure) seen about five times and were only there for a fraction of a second between 19:40 and 20:05UT.

Aristarchus: On 2021 Jan 24 at 21:46 UT Aldo Tonon (UAI) and at 21:21 and 22:23 Fabio Verza (UAI) imaged (See Fig. 6) this crater for the following repeat illumination request:

ALPO Request: On 2013 Apr 22 Paul Zellor noticed that the two closely spaced NW dark bands in Aristarchus had some (non-blue) color to them. Can we confirm his observation of natural colour here? Ideally you should be using a telescope of 10" aperture, or larger. Please send any high resolution color images, detailed sketches, or visual descriptions to: a t c @ a b e r . a c. u k .

Figure 6. *Aristarchus as imaged on 2021 Jan 24, by UAI observers, orientated with north towards the top and colour saturation increased to 60%.* ***(Left)*** *image by Aldo Tonon at 21:46 UT.* ***(Right)*** *image by Fabio Verza at 22:23.*

Full Moon: On 2021 Jan 28 UT 21:42 Massimo Alessandro Bianchi (UAI) imaged (Fig. 7) the Moon for the following repeat illumination request:

ALPO Request: Please take images of the Full Moon, but make sure you under expose as we want to avoid bright ray craters like Aristarchus, Tycho, Proclus etc from saturating. The purpose behind this is we want to compare with images of Earthshine which are essentially zero phase illumination images, like at Full Moon. There have been reports in the past that Aristarchus varies greatly in brightness compared to other features. David Darling (a past TLP coordinator) has suggested this was simply due to libration effects, i.e., viewing angles, so we would naturally like to test this theory out. Also, if you have any past images of close to Full Moon, please send these in too if the above-mentioned craters are not saturated. Pretty much any size telescope can be used to take these images so long as we can clearly see the above craters. Obviously do not attempt this if the sky is cloudy or hazy. Observations will be presented in the "Lunar Observer" - a monthly publication of the Lunar Section of ALPO. All reports should be emailed to: a t c @ a b e r . a c . uk

Figure 7. *The Full Moon as imaged by Massimo Alessandro Bianchi (UAI) on 2021 Jan 28 UT 21:42 and orientated with north towards the top.*

In terms of relative brightness, we have: Censorinus (214), Tycho (207), Proclus (187), Aristarchus (171), Copernicus (166). Kepler (143), Plato (102).

Level 3 - In Depth Analysis:

Note that no level 3 analysis has been possible this month due to pressure of work. Hopefully I can resume this next month, but I think you can judge for yourselves whether the weights need changing by comparing the images/observations to the original reports.

General Information: For repeat illumination (and a few repeat libration) observations for the coming month - these can be found on the following web site: http://users.aber.ac.uk/atc/lunar_schedule.htm . Only by re-observing and submitting your observations can we fully resolve past observational puzzles. To keep yourself busy on cloudy nights, why not try ‘Spot the Difference’ between spacecraft imagery taken on different dates? This can be found on: http://users.aber.ac.uk/atc/tlp/spot_the_difference.htm . If in the unlikely event you do ever see a TLP, firstly read the TLP checklist on http://users.aber.ac.uk/atc/alpo/ltp.htm , and if this does not explain what you are seeing, please give me a call on my cell phone: +44 (0)798 505 5681 and I will alert other observers. Note when telephoning from outside the UK you must not use the (0). When phoning from within the UK please do not use the +44! Twitter TLP alerts can be accessed on https://twitter.com/lunarnaut .

Dr Anthony Cook, Department of Physics, Aberystwyth University, Penglais, Aberystwyth, Ceredigion, SY23 3BZ, WALES, UNITED KINGDOM. Email: atc @ aber.ac.uk

BAA LUNAR SECTION CONTACTS

Director and Circulars Editor	
Bill Leatherbarrow	(w.leatherbarrow1 @ btinternet.com)
Assistant Director	
Tony Cook (Coordinator, Lunar Change project)	(atc @ aber.ac.uk)
Website Manager	
Stuart Morris	[contact link via the Section website at https://britastro.org/section_front/16]
Committee members	
Tim Haymes (Coordinator, Lunar Occultations)	(occultations @ stargazer.me.uk)
Robert Garfinkle (Historical)	(ragarf @ earthlink.net)
Raffaello Lena (Coordinator, Lunar Domes project)	raffaello.lena59 @ gmail.com
Nigel Longshaw	
Barry Fitz-Gerald	