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British Astronomical Association
Director: Bill Leatherbarrow

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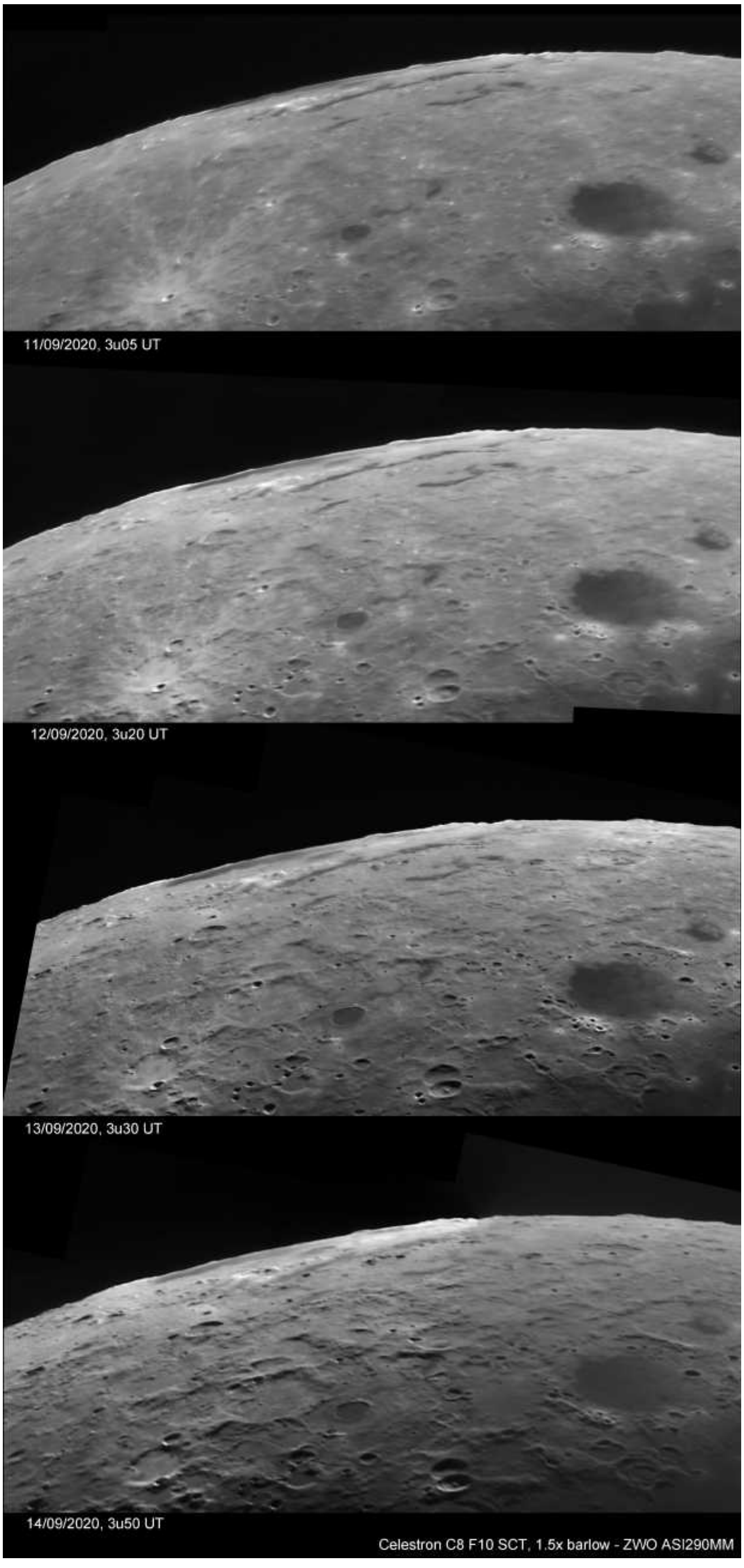
FROM THE DIRECTOR

Back in the 1950s Lunar Section members Alan Lenham and Keith Abineri published a paper in the BAA *Journal* on lunar craters that showed evidence of radial dusky bands on their internal slopes. The best-known example of such a banded crater is, of course, Aristarchus and it is now widely held that such banding is akin to scree slopes that formed in the aftermath of the impact process. At the time of Abineri and Lenham's paper the idea that lunar craters were of impact origin was not universally held, especially in the UK, so the nature of such bands was not properly understood. Earlier observers such as Robert Barker had even argued that the bands appeared to vary in extent and intensity over time.

I took an interest in banded craters in the early 1960s, by which time Lenham had moved to the USA to take up a post at what became Gerard Kuiper's Lunar and Planetary Laboratory. Abineri remained an active Lunar Section member and indeed was at the Section meeting in Keele in the summer of 1966, when I read my first ever paper as a nervous teenager – on banded craters!

One of the initial puzzles posed by banded craters was the fact that the bands seemed to appear most commonly on the inner western (IAU) slopes of craters. It soon became clear that their apparent paucity on eastern slopes was down to nothing more exotic than the fact that most people observed the Moon between New and Full phases, when our satellite is waxing in the evening sky and thus available at reasonable hours. During such phases it is the western slopes of craters that are mostly illuminated. Fewer observers got up in the small hours to observe eastern slopes illuminated during the Moon's waning phases.

Here in Sheffield I have a very poor view of the eastern sky, so I am rarely able to observe the Moon between Last Quarter and New, but it is more generally true that fewer people observe in the Moon's later phases. However, Alex Vandenbohede has submitted an intriguing series of images of the Mare Orientale region under a setting sun.



Alex writes: 'I was able to image the Orientale impact basin from 11 to 14 September under favourable libration. On 11 September, libration favoured the northern part of the basin. The location of maximum libration shifted towards to south in the next days so that the southern part of the basin was favoured on 14 September. During this time, sun height decreased also on the region. It was the first time I observed the region under a setting sun and a I found the view different from the situation when the sun is rising. The Montes Cordillera are almost invisible since the mountain range produces no shadow. One has to find it based on the Lacus Autumni and a number of craters. The inner and outer Montes Rook are, on the other hand, clearly visible on the observation of 13 and 14 September. I found it also interesting to see how bright the inner part of the basin was on 14 September, relative to the surroundings.'

Over the next couple of months the waning Moon will be reasonably well placed from northern latitudes and I would urge observers to make the most of any opportunities to draw or image features under a setting sun on the waning crescent.

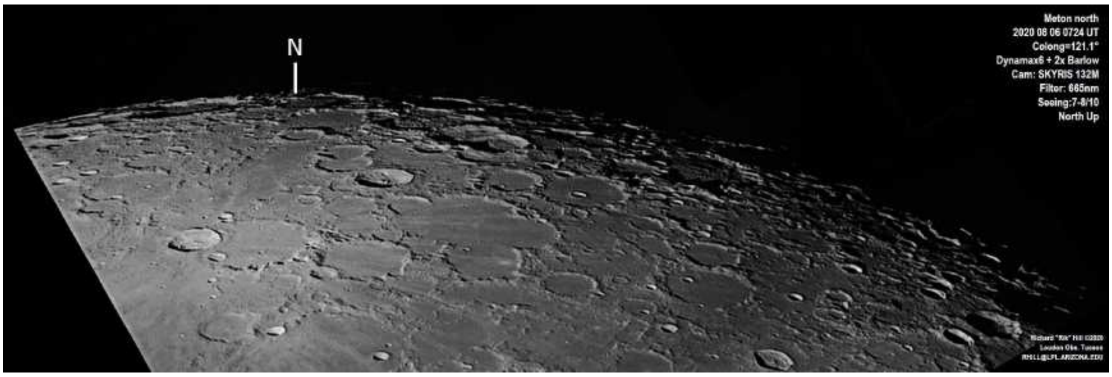
Bill Leatherbarrow

OBSERVATIONS RECEIVED

A rather thin month for observations, as is normal for this time of year. Images have been received from the following observers: David Arditti, Rik Hill (USA), Rod Lyon, Alex Vandenbohede (Belgium), and George Whiston.

David Arditti captured the close conjunction of Mars and the Moon on 6 September 2020.

Rik Hill made the following observation of the region around Meton on 6 August 2020.



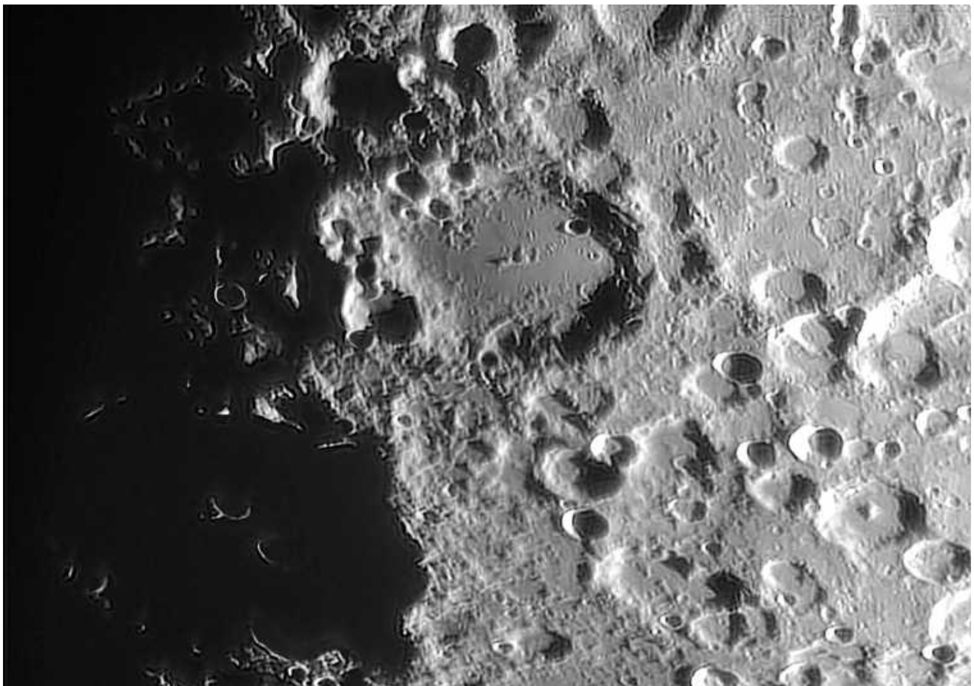
Rik writes as follows: ‘What we are getting here is a pretty good look at the north polar regions of the Moon during a relatively favorable libration. The location of the pole itself is denoted by the "N" marker so we can begin our exploration with that. There is a large foreshortened crater just to the left of the marker. This is Hermite (114km diameter). To the immediate lower right of the marker is Peary (77km) and just a little further to the lower left is Byrd (97km) both north polar explorers on Earth. On the near edge of Byrd is a very nicely defined crater Gioja (43km) on the edge of that crater directly under the marker. Farther down and slightly left, we see a well defined fairly recent crater (within the last billion years) with a faint but well defined ray system, Anaxagoras (53km).

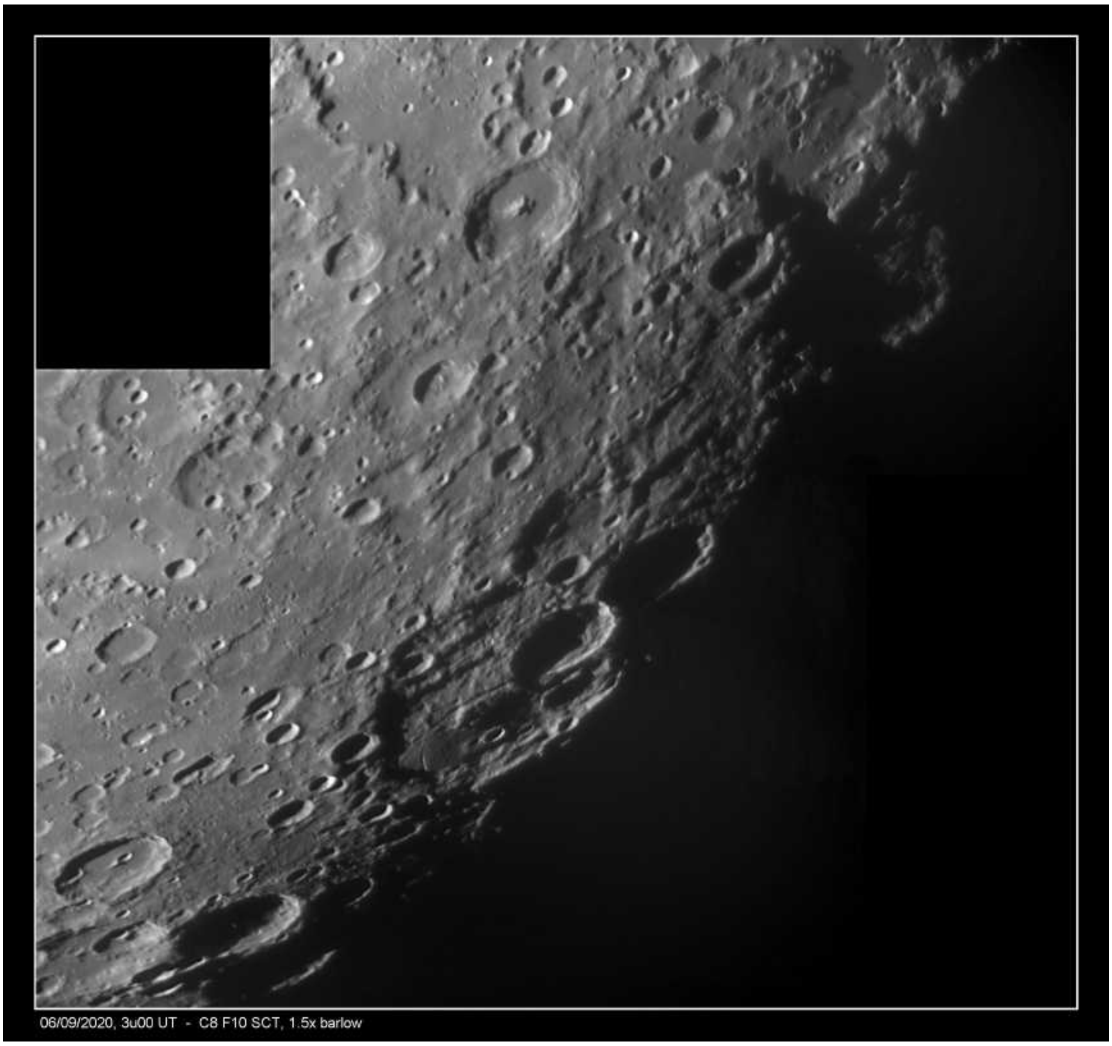
Over to the right Anaxagoras overlaps an old crater, Goldschmidt (124km) and farther right is Barrow (95km), a crater that should be watched for interesting shadow play at sunrise. Edging a little further right is a large cloverleaf shaped feature, Meton, that is the merge of four craters with the central plain listed as 126km with each of the side lobes having their own satellite designations and diameters. Meton is listed as 3.9-4.5 billion years old (b.y.o.) and is one of the more distinctive features on the north end of the Moon. Just above this is the much younger crater Scoresby (58km) and less than 3.2 b.y.o. To the upper right of this is a large crater with a distinctive small fresh crater on its floor, Baillaud (94km), a sort of a double crater with Euctemon (68km) adjacent to the upper left. Both of these craters may also be as old as 4.5 billion years! To the lower left is another similar crater with a small satellite crater on its floor, Arnold (99km). Then down in the lower right corner, above the name tag, is our last crater, Strabo (56km). You can see some of the terracing as the sun sets on this *impact* crater named for the man who was known for his commentary on *volcanism*!

This image was made from 3 1800 frame AVIs stacked with AviStack2 (IDL) and further processed with GIMP and IrfanView.’

Bullialdus 2020.09.10 - 09.39 UT
300mm Meade LX90, ASI 224MC Camera with Pro Planet
742nm I-R Pass Filter. Seeing: 7/10. Rod Lyon

George Whiston captured sunrise over Clavius on 30 May 2020, using a C11.





Janssen, 6 September 2020 (Alexander Vandenbohede)

Editor's note: In the September issue of the LSC I used an incomplete version of Raf Lena's note on the detection of rille-like features near Linné G. My apologies to Raf and to readers for this oversight. Rather than provide separate additions and errata, I think it best to republish in this issue the entire revised note (below).

DETECTION AND IDENTIFICATION OF TWO RILLE-LIKE FEATURES SOUTH OF CRATER LINNÉ G

Raffaello Lena and KC Pau

Introduction and observations

When Pau processed an image of Montes Caucasus, taken on 1 March 2020 at 11h33m UT, Colong 350° with his 250mm f/6 Newtonian reflector, like every other lunar amateur, his focus was on the mountains and the nearby Valentine dome. All of a sudden, a faint dark streak, south of crater Linné G, flashed into his eyes. Scanning this area carefully, Pau could confirm the streak was not an artifact. It was really there. Later, he compared the image with the LROC QuickMap (http://target.lroc.asu.edu/da/qmap.html). The same location shows faintly a delicate dark line (Fig. 1).

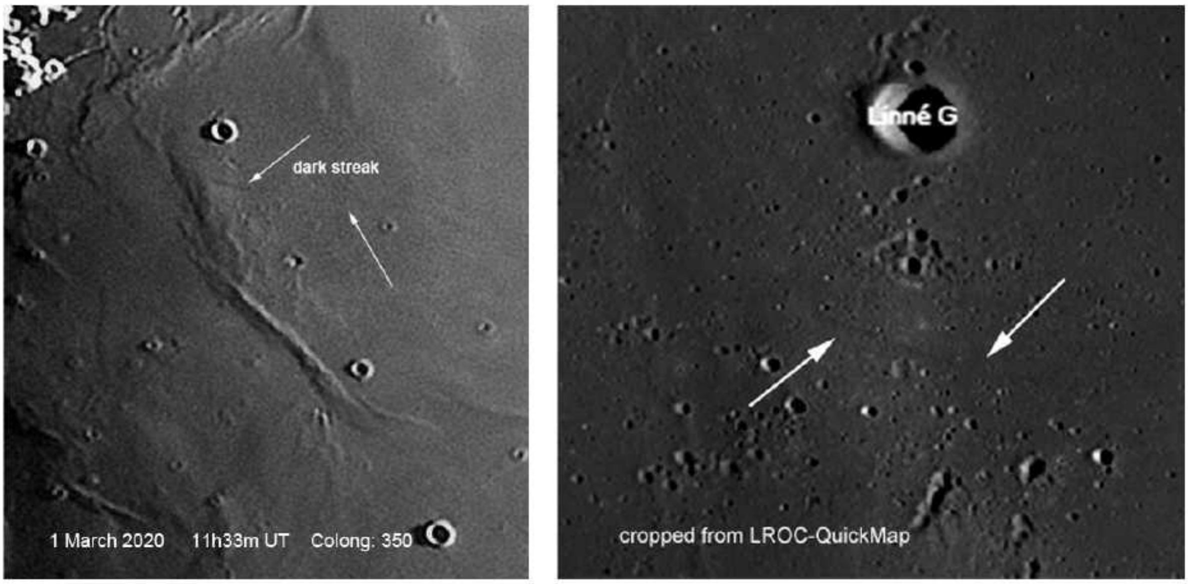


Fig. 1: Image by Pau (left). The dark streak is marked with white lines. Cropped image from LROC QuickMap (right).

Pau sent both his own image and that derived from QuickMap to the Director for his advice. His response was it looked like a tiny rille. The resolution of the image is not good enough to confirm that the streak is a real rille. Recently, Pau worked through his archive of lunar images and he found one image that had better resolution of the dark streak. In this image the streak looks really like two rilles that run parallel to each other (Fig. 2). The image was taken on 11 September 2017 at 21h05m UT, Colong 162°. Equipment used is same as the previous image, with a 2.5X Barlow and a QHYCCD290M planetary camera.

Pau sent the latest image to the Director for his advice. He advised Pau to contact Raffaello Lena for further analysis and interpretation. In fact the examined features do not really show up as such on QuickMap elevation profiles and 3D modelling.

Many rilles existing on the surface of the near-side Moon have been created by volcanism and tectonism. Some lunar rilles need an appropriate illumination condition to identify them, such as the *Rima Sheepshanks*. In this preliminary note we examine these two rille-like features using the LOLA DEM data set and the LTVT software package. Finally the Chandrayaan-1 M^3 data set was used to derive spectra that highlight mineralogical characteristics of lunar volcanic materials.

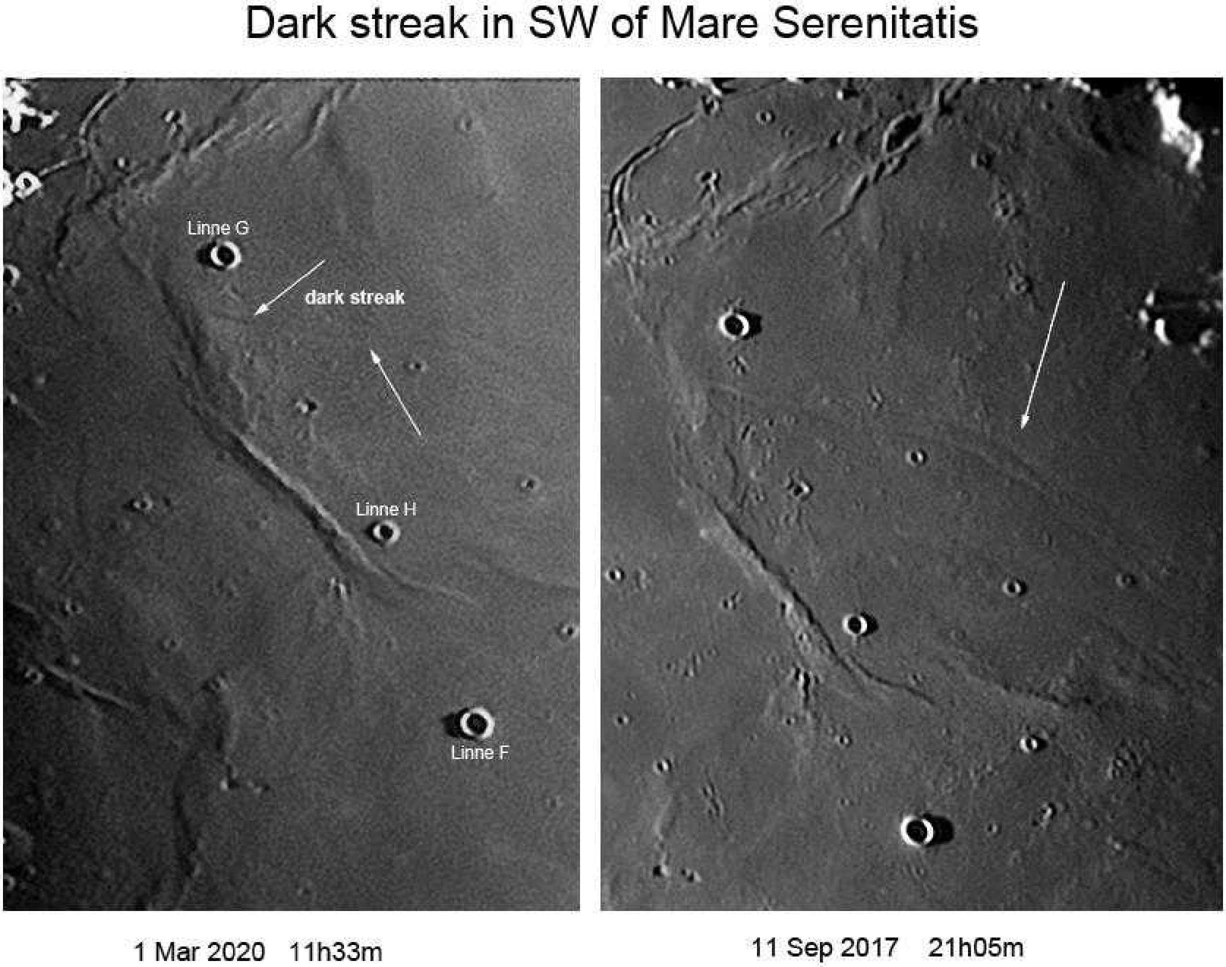


Fig. 2: Images by Pau as described in the text. In the image taken on 11 September 2017 two rille-like features run parallel to each other.

Rendered Images of the examined rille-like features based on LOLA DEM

Generating an elevation map of a part of the lunar surface requires its three-dimensional (3D) reconstruction. Recently, a global lunar digital elevation map (DEM) obtained with the Lunar Orbiter Laser Altimeter (LOLA) instrument on the Lunar Reconnaissance Orbiter (LRO) spacecraft has been released. A synthetic image of the lunar surface can be generated based on an available DEM as seen from a given direction for lighting from some other specified direction. The LTVT software by Mosher and Bondo was used to generate a synthetic view of selected parts of the LOLA DEM.

A rendered image displays the shadow length cast by a dome and or a crater and is useful for simulating particular situations, showing how rapidly the appearance of these features changes with increasing solar elevation. LOLA DEM was thus used for rendered images with different solar illumination angle, which show the examined structures at times of 3h00m UT, 5h00m UT, 8h00m UT and 11h30m UT respectively of the same day as Pau's first image (cf. Figs 3-6). The simulation effectively displays two rilles that run parallel to each other (termed R1 and R2 and marked with white lines).

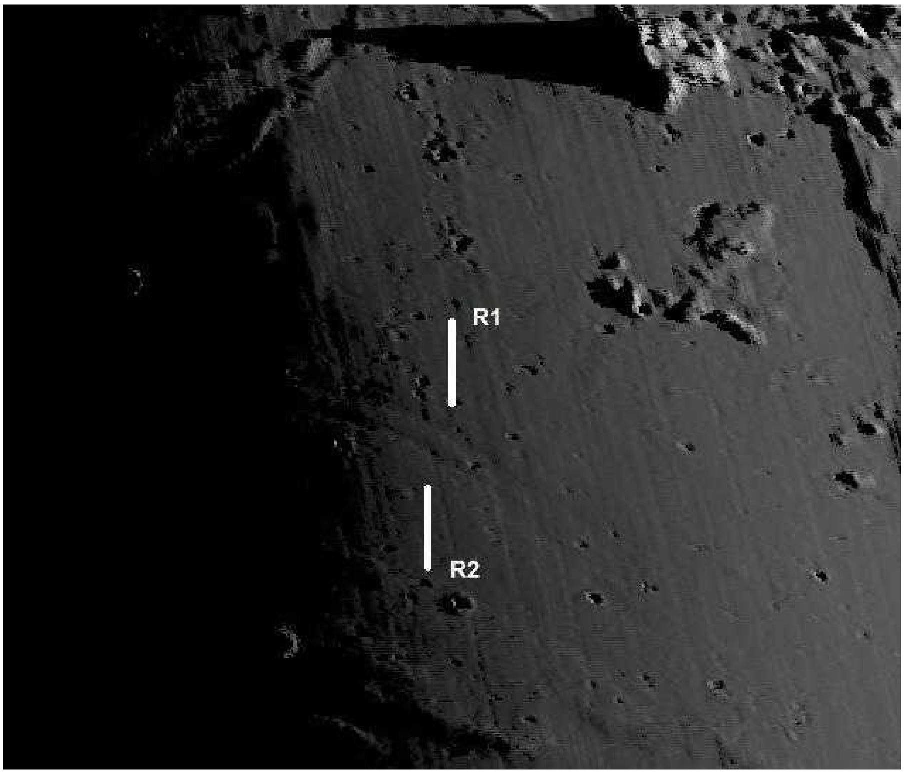


Fig. 3: Rendered image based on the LOLA DEM using LTVT for 1 March 2020 at 03h00m UT.

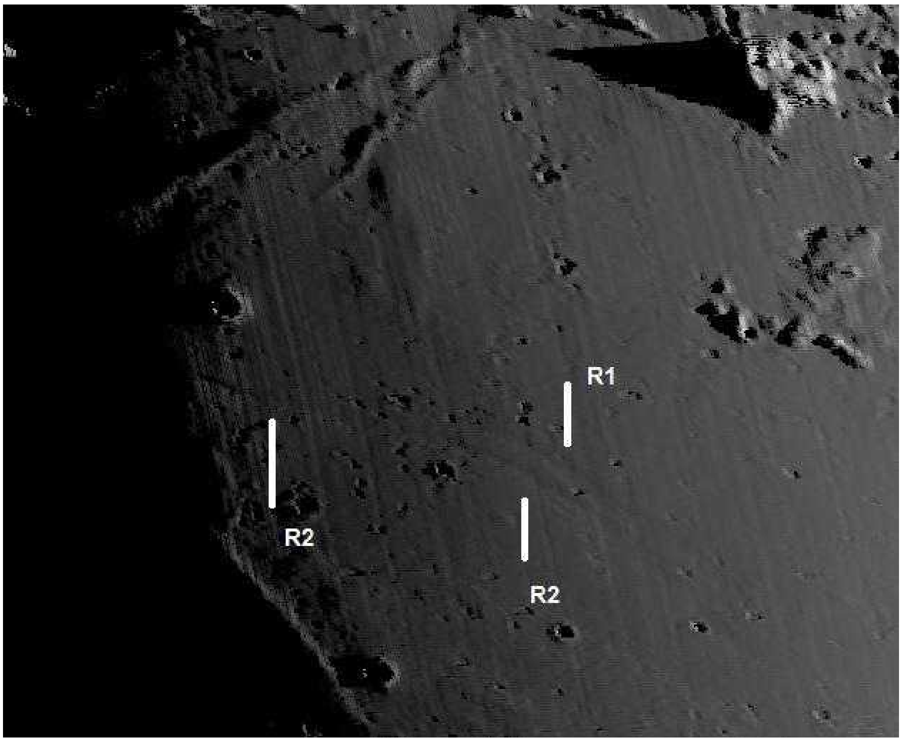


Fig. 4: Rendered image based on the LOLA DEM using LTVT for 1 March 2020 at 05h00m UT.

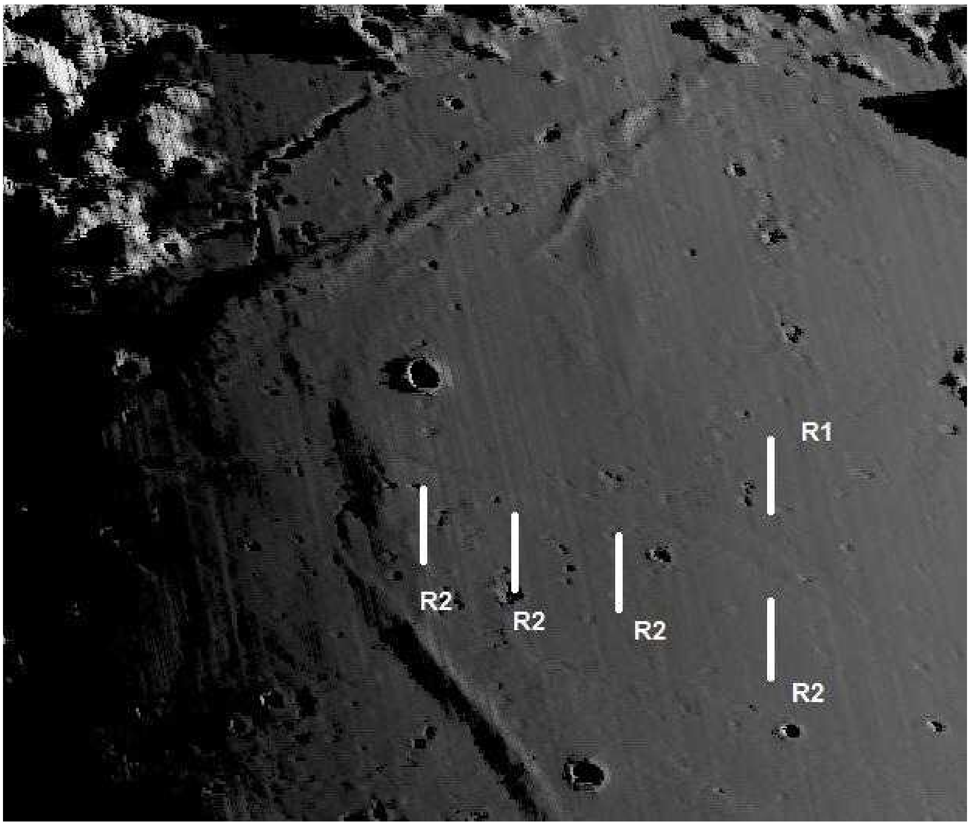


Fig. 5: Rendered image based on the LOLA DEM using LTVT for 1 March 2020 at 05h00m UT.

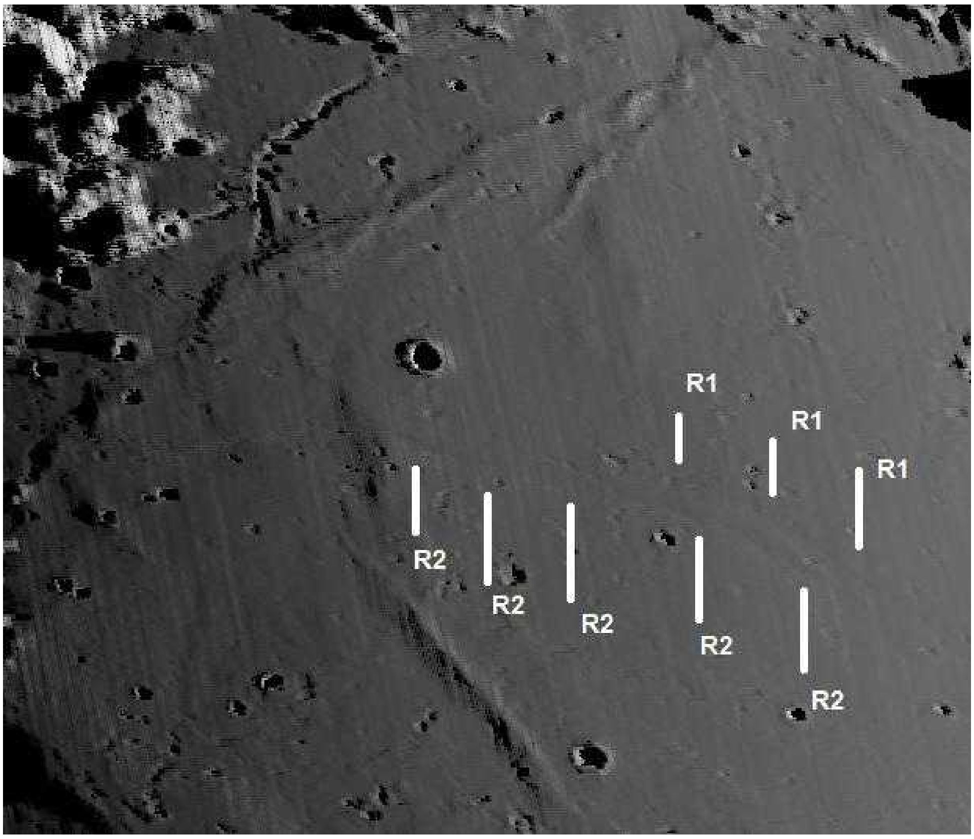


Fig. 6: Rendered image based on the LOLA DEM using LTVT for 1 March 2020 at 011h30m UT.

Thus the rendered images based on LOLA DEM indicate the real presence of these elusive features: they are clearly detectable under a strongly oblique solar illumination angle (about 1°, see Fig. 4).

Spectral Analysis

M^3 is an imaging reflectance spectrometer that can detect 85 channels between 460 to 3000 nm, and has a spatial resolution of 140 or 280 meters per pixel. Data have been obtained through the M^3 calibration pipeline to produce reflectance with photometric and geometric corrections using image set taken during the optical period OP1B. A continuum removal method that enhances the features in the 1000 nm absorption band and more accurately shows the position of the band centre has been used fitting a straight line between 750 and 1500nm to remove the continuum (Fig. 7).

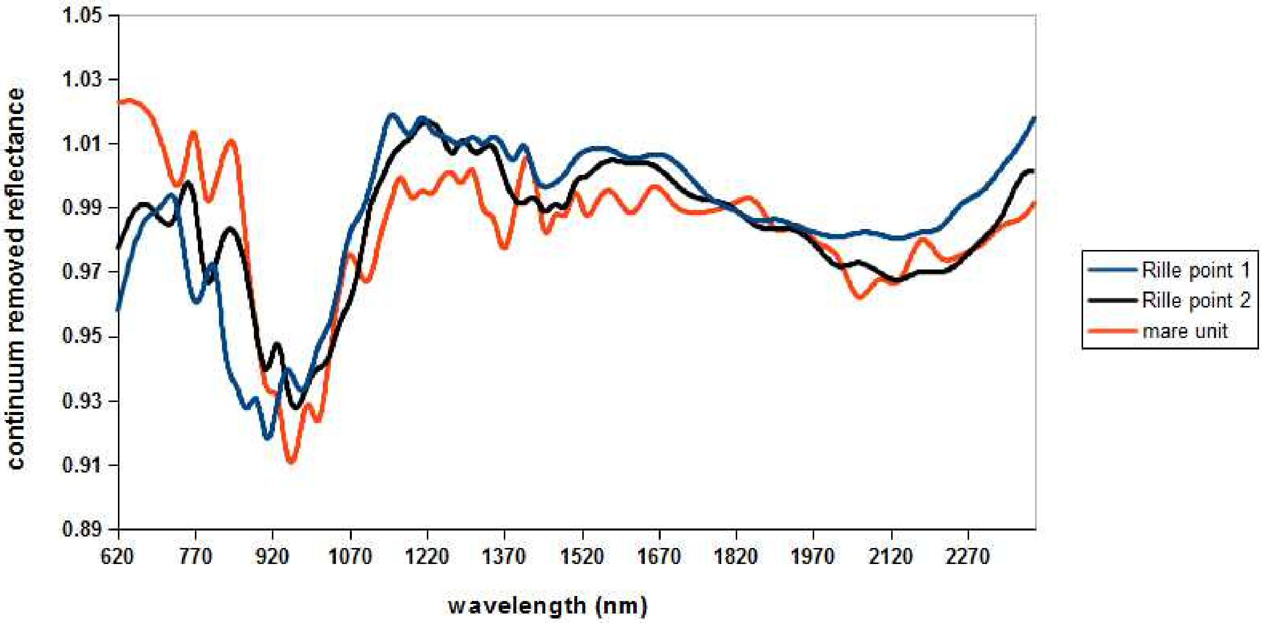


Fig. 7: Moon Mineralogy Mapper (M^3) spectra of the examined features (rille point 1 and point 2 at 35.49° N 13.06° E and 35.44° N 13.15° E) and the mare unit (35.50° N 13.72° E).

The spectra of the two points of the rille R2 (Fig. 7) display a narrow trough around 1000nm with a minimum wavelength at 960nm and an absorption band at around 2000nm, corresponding to a typical pyroxene signature, indicating a basaltic composition. Fig. 7 also display the spectrum of the mare unit (35.50° N 13.72° E) with similar absorption bands, demonstrating the basaltic composition of the examined features described in the current article.

Reconstruction based on WAC imagery

Our data show very clearly there are two long and elusive rille-like features oriented roughly radially with respect to Mare Imbrium. There are small craters present on the floors of both rille-like features (from LROC WAC imagery), which suggests that the examined features are older than these superimposing craters. R1 and R2 look like degraded old structures.

A 3D reconstruction is shown in Fig. 8, as seen from two directions. It was obtained using a WAC mosaic draped on top of the global WAC-derived elevation model (GLD100) applying a high-pass filter. In the image in Fig. 8 the north and south edges of the westernmost section of the R2 structure are marked. Moreover, the presence of a fault in the northernmost stretch is highlighted, probably indicating the presence of a degraded and shallow valley.

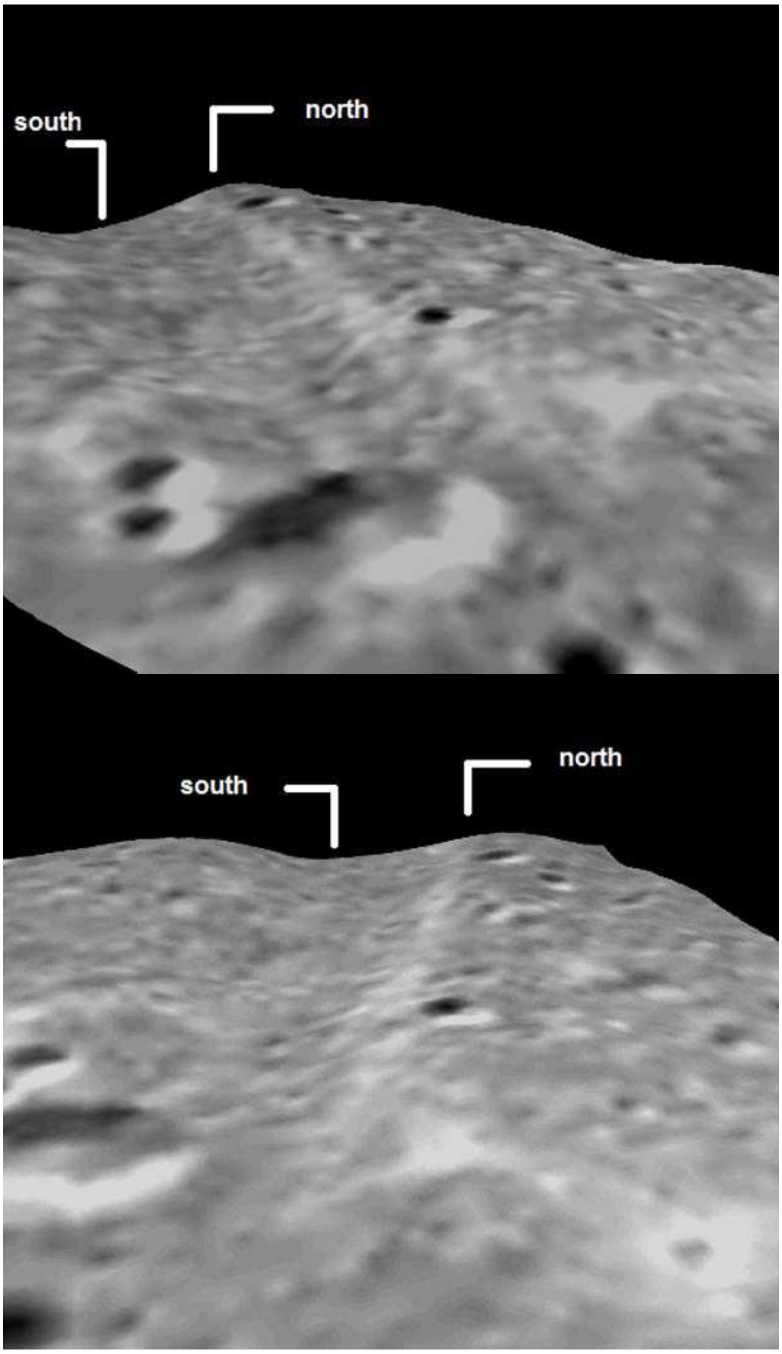


Fig. 8: 3D reconstruction obtained using WAC mosaic draped on top of the global WAC-derived elevation model (GLD100).

Using the ACT-REACT tool, and LOLA DEM, it is possible to determine distances, profiles and depths of several lunar features. At the northern branch, the degraded valley south of Linné G (R2) is only about 22m deep, while the southern branch is about 17m deep (Fig. 9). The average width of the least-disturbed linear sections amounts to ~1600 m.

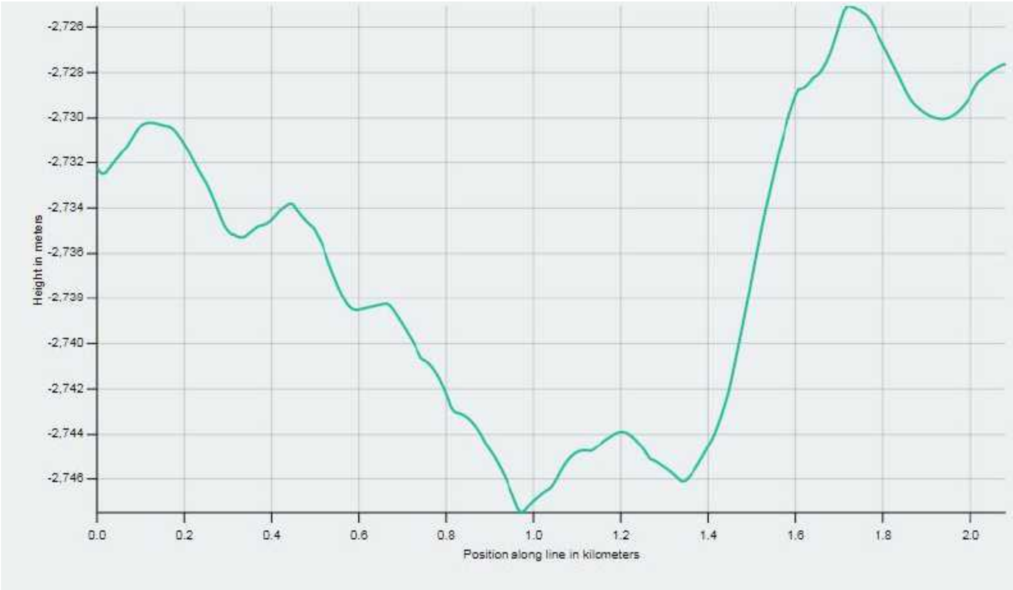


Figure 9: Cross-sectional profile of the R2, derived with the ACT-REACT Quick Map.

Summary and Conclusion

Our data show very clearly there are two long and elusive rille-like features, probably shallow valleys, oriented roughly radially with respect to Mare Imbrium. They deserve further investigation and imagery. We encourage more high-resolution imagery of this area so we can have more data to identify their shape and size. Please check also your past images and send them to us for the ongoing study.

It once again shows that with today imaging technology, there is still a chance for amateurs to study elusive features on the Moon. In combination with high-resolution images, such investigations might greatly extend our present knowledge of the processes occurred on the Moon.

References

[1] Basaltic Volcanism Study Project, 1981. *Basaltic Volcanism on the Terrestrial Planets*. New York: Pergamon Press. http://ads.harvard.edu/books/bvtp/

[2] Besse, S., J. M. Sunshine, and L. R. Gaddis (2014), 'Volcanic Glass Signatures in Spectroscopic Survey of Newly Proposed Lunar Pyroclastic Deposits', *Journal of Geophysical Research - Planets*, Vol. 119, doi:10.1002/2013JE004537.

[3] Green, R.O., et al., 2011. 'The Moon Mineralogy Mapper (M^3). Imaging Spectrometer for Lunar Science'. *Journal of Geophysical Research – Planets*, Vol. 116, E10. Available at: https://doi.org/10.1029/2011JE003797

[4] Mosher, J., & Bondo, H., 2006. Lunar Terminator Visualization Tool (LTVT). See: https://github.com/fermigas/ltvt/wiki

[5] Scholten, F., Oberst, J., Matz, K. D., Roatsch, T., Wählisch, M., Speyerer, E. J., Robinson, M. S., (2012). GLD100: 'The Near-global Lunar 100 m Raster DTM from LROC WAC Stereo Image Data'. *Journal of Geophysical Research*, Vol. 117 No. 3 (E00H17). doi:10.1029/2011JE003926

[6] Smith et. al. (2010). 'The Lunar Orbiter Laser Altimeter Investigation on the Lunar Reconnaissance Orbiter Mission'. *Space Science Reviews* Vol. 150: pp. 209-241, doi:10.1007/s11214-009-9512-y.

LUNAR DOMES (part XL): Domes near Maraldi D Raffaello Lena

Important clusters of lunar domes are observed in the Hortensius/Milichius/T. Mayer region in Mare Insularum and in Mare Tranquillitatis around the craters Arago and Cauchy [1-6]. A first map of the Cauchy shield was performed based on our previous works [4, 7-14] and describes morphometric properties of forty-eight domes, termed C1-C33, Vi1-8, D (Diana) and NTA1-NTA6. In this contribution I provide an analysis of further eight lunar domes detected using CCD telescopic image and located principally near Maraldi D, in the northern region of the Cauchy shield. The examined domes described in the current note (Table 1) are reported in red label in Fig. 1. Some domes have already been measured in previous studies [4, 7-14] and are reported in brackets. In the LRO WAC imagery the examined domes are not as prominent as in the telescopic CCD image taken under lower solar illumination angle.

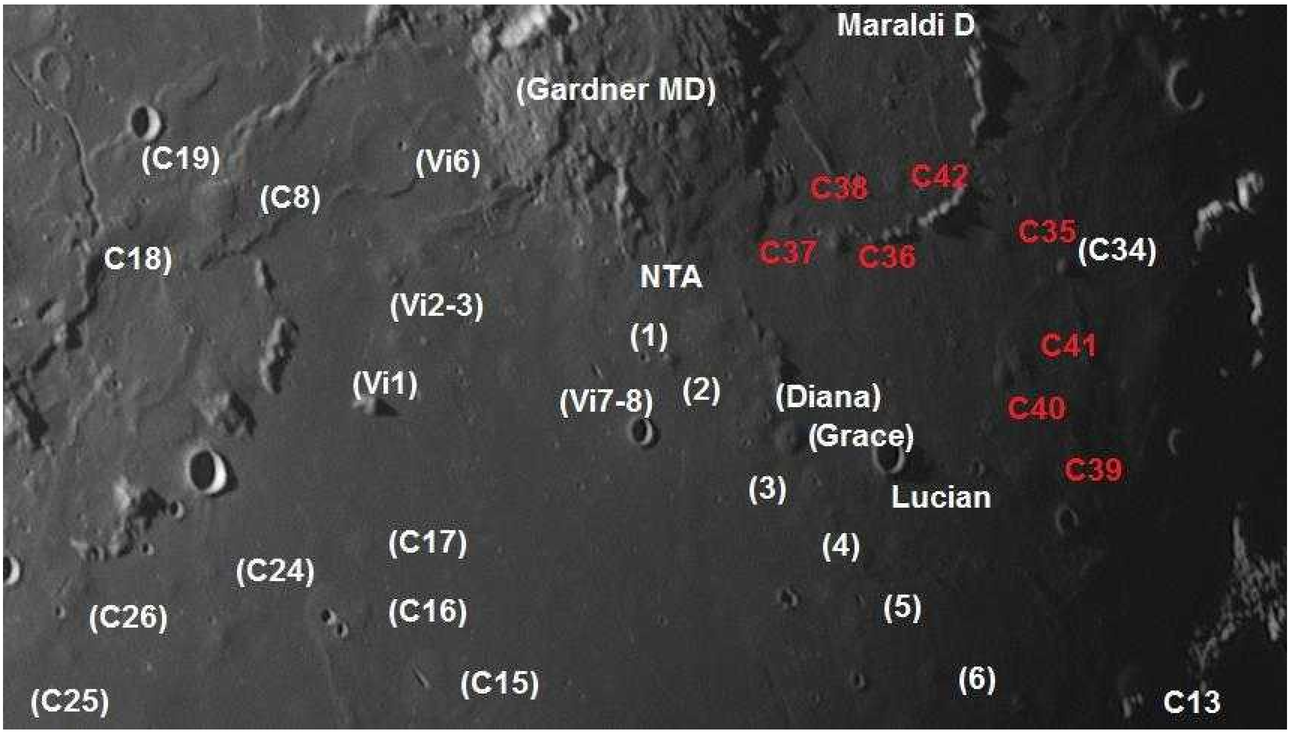


Figure 1: Telescopic CCD image made on December 16, 2019 at 00:44 UT by Teodorescu. The identified domes are marked in red (C35-C42).

Domes	Latitude (°)	Longitude (°)	Diameter (km)	h (m)	slope (°)	Volume Km^3	Class
C35	16.01	37.52	7.0 ± 0.3	45 ± 5	0.73 ± 0.1	0.86	A
C36	15.62	36.04	5.7 ± 0.3	120 ± 10	2.3 ± 0.2	1.4	A-C_2-E_1
C37	15.60	35.60	3.6 ± 0.3	70 ± 10	2.2 ± 0.2	0.36	A-E_1
C38	15.80	35.52	7.0 ± 0.3	95 ±10	1.5 ± 0.1	1.8	A-C_2
C39	14.51	38.02	12.0 ± 0.3	65 ± 10	0.62 ± 0.06	3.7	A-C_2
C40	15.15	37.68	4.8 ± 0.3	80 ± 10	2.0 ± 0.2	0.7	C_2-E_1
C41	15.27	37.79	9.8 ± 0.3	70 ± 10	0.82 ± 0.1	2.6	C_1
C42	16.13	36.49	6.4 ± 0.3	55 ± 5	0.98 ± 0.1	0.9	A-C_2

Table 1: Morphometric properties of the examined domes.

Generating an elevation map of a part of the lunar surface requires its three-dimensional (3D) reconstruction. A well-known image-based method for 3D surface reconstruction is shape from shading (SfS). It makes use of the fact that surface parts inclined towards the light source appear brighter than surface parts inclined away from it. The SfS approach aims for 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, finally leading to an elevation value for each image pixel [15]. The SfS method requires accurate knowledge of the scattering properties of the surface in terms of the bidirectional reflectance distribution function (BRDF).

The height h of a dome was 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 [4]. The average flank slope ζ was determined according to: $\zeta = \arctan 2h/D$.

The uncertainty results in a relative standard error of the dome height h of ±10 percent, which is independent of the height value itself. The dome diameter D can be measured at an accuracy of ± 5 percent. The 3D reconstructions of C35-C42 are shown in Fig. 2.

LOLA DEM

The ACT-REACT QuickMap tool was used to access the LOLA DEM dataset, allowing us to obtain the cross-sectional profiles for the examined domes (Fig. 3). Note the agreement of the measurements carried out on the CCD telescopic image and the LOLA DEM.

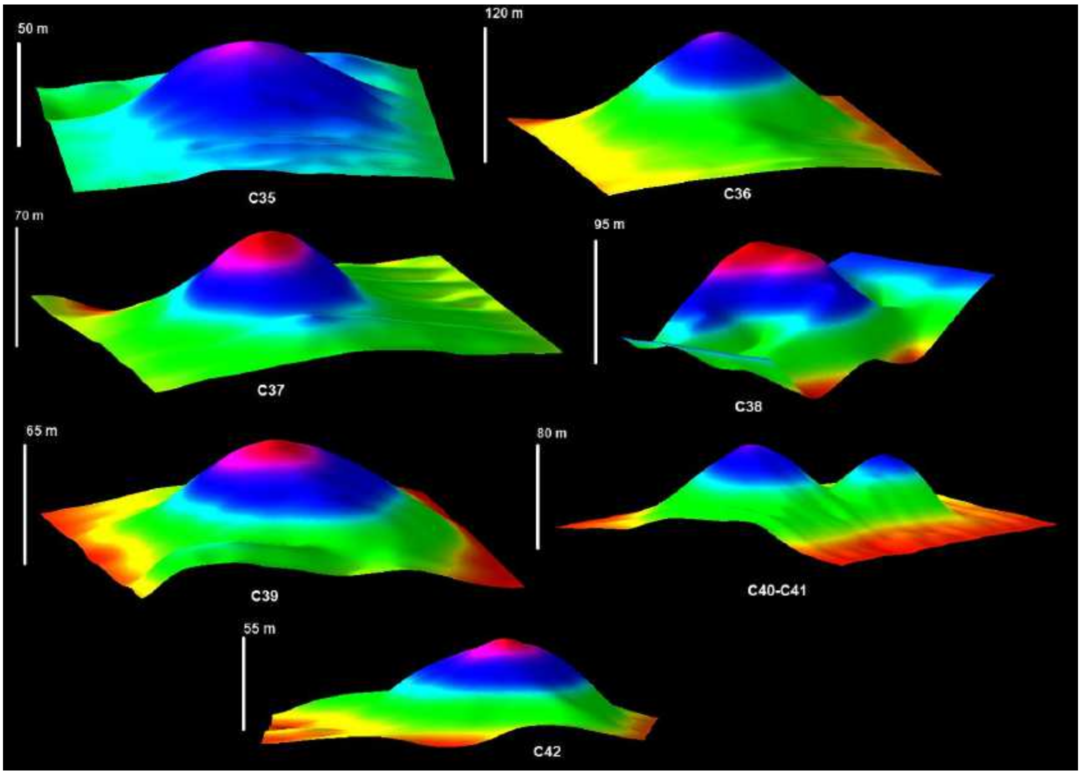


Figure 2: 3D reconstructions of C35-C42 based on terrestrial CCD image of Fig. 1 by photoclinometry and SfS analysis. The vertical axis is 20 times exaggerated.

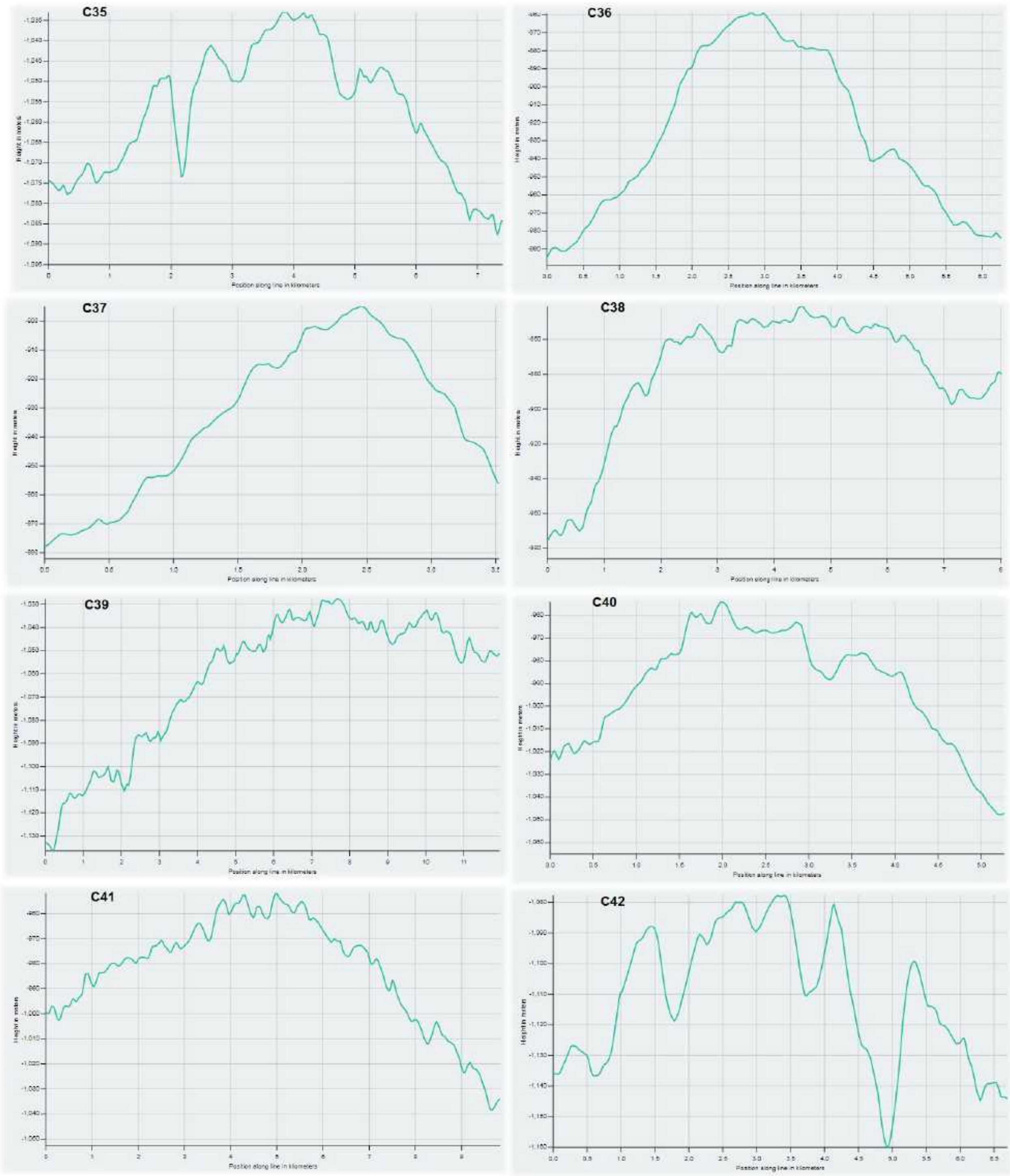


Figure 3: LRO WAC-derived surface elevation plot of C35-C42 based on LOLA DEM.

Based on the spectral and morphometric data obtained in this study, C41belongs to class C_1, while the dome C35 belong to class A. The other domes belong to class A-C_2 or are intermediates belonging to class A-C_2-E_1, A-E_1 and C_2-E_1.

They span a continuous range of properties from spectrally blue (class A) to red (class E) soils and from very low (class A) to steep (class E_1) or shallow (class E_2) flank slopes. The class E domes represent the smallest volcanic edifices formed by effusive mechanisms observed to date. Domes of class C_2 are characterized by gentle flank slopes, moderate volumes which are higher than those of class A. They originate from moderately viscous lavas between 10^4 and 10^7 Pa s. The corresponding effusion rates between 100 and 300 $m^3 s^{-1}$ are comparable to those estimated for the class A domes, but the class C_2 domes were formed over longer periods of time between about 0.8 and 5 years.

References

[1] Wilhelms, D. E., 1987. The geologic history of the Moon. USGS Professional Paper 1348.

[2] Head, J. W., & Gifford, A., 1980. 'Lunar mare domes: classification and modes of origin'. *The Moon and Planets*, 22, 235–257.

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

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

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

[6] Lena, R., 'Magmatic Intrusion Structure', chapter in *Encyclopedia of Planetary Landforms,* Eds Henrik Hargitai, Ákos Kereszturi, 2015, Springer ISBN: 978-1-4614-3133-6.

[7] Lena, R. Lunar Domes Atlas http://lunardomeatlas.blogspot.it/ and the Vitruvius Cauchy Quadrant http://vitruviuscauchy.blogspot.it/

[8] Wöhler, C., Lena, R., & Phillips, J., 2007. 'Formation of lunar mare domes along crustal fractures: Rheologic conditions, dimensions of feeder dikes, and the role of magma evolution'. *Icarus*, 189 (2), 279–307.

[9] Wöhler, C., Lena, R., Lazzarotti, P., Phillips, J., Wirths, M., & Pujic, Z., 2006. 'A combined spectrophotometric and morphometric study of the lunar mare dome fields near Cauchy, Arago, Hortensius, and Milichius'. *Icarus*, 183, 237–264.

[10] Lena, R., Lazzarotti, P., 2014. 'Domes in northern Mare Tranquillitatis: Morphometric analysis and mode of formation'. *Selenology Today*, 35, 12-24.

[11] Lena, R., Lazzarotti, P., 2015. 'Domes in northern Mars Tranquillitatis, near the craters Vitruvius G & M', *J. Br. Astron. Assoc*. 125, 2, 97-104.

[12] Lena, R., Phillips, J. 'Lunar domes in the Cauchy shield: Morphometry and mode of emplacement'. LPSC 43th, 2012, https://www.lpi.usra.edu/meetings/lpsc2012/pdf/1005.pdf

[13] Lena, R., Phillips, J. 'Lunar domes in the Cauchy shield: Morphometry and mode of formation'. 49th LPSC, 2018, https://www.hou.usra.edu/meetings/lpsc2018/pdf/1005.pdf

[14] Lena, R., Phillips, J. 'The Cauchy Shield: Morphometric Analysis and Mode of Formation'. *The Moon (Occasional Papers of the Lunar Section of the British Astronomical Association*).Volume 5. November 2017.

[15] Horn, B. K. P., 1989. 'Height and Gradient from Shading'. MIT technical report 1105A. http://people.csail.mit.edu/people/bkph/AIM/AIM-1105A-TEX.pdf

LUNAR OCCULTATIONS **October 2020** Tim Haymes

Time capsule: 50 years ago (LSC Vol. 5, No. 10)
[With thanks to *Stuart Morris* for the LSC archives]

- R. Turner (Brighton): List of Domes catalogued by ALPO, Jan 1969.
- P. Darnell (Denmark) - Director of the Danish section for occultations remarks: He was surprised to read of an 8.5 mag star occultation observed by Mr.Hall. Danish observers believed firmly that reflectors were of no use and did not try! (owing to stray light). Mr Darnell says he will never get tired of these fascinating phenomena.

Observer News

T. Haymes (Steeple Aston) and S. Kidd (Stevenage) attempted to time the daylight occultation of mu Lib (v5.3) on 2020 Sept 20, 1847UT. Sky conditions deteriorated towards the event time causing the sky to turn milky. So the background was too bright to record the star with a digital USB camera. It would have been a challenge in blue-sky conditions. The Moon was found in binoculars (Phase 16%, altitude 14 degrees) and recorded with short exposures but the star was not detected.

T. Haymes: C11 at F5.6, Camera: QHY174mGPS, Filter: W25 Red, exp 3ms.
S. Kidd: C14 at f11, Camera: ZWO ASI174.

Grazing Occultation of 25 Ari, September 7

A request for data on the graze was sent to P. Clark located near Flamborough Head. No report has appeared. The data on grazes in the 2020 BAAH can be found at this link: https://britastro.org/downloads/17673.

Graze reports are invited for inclusion in the LSC and any stories.

Graze predictions for November 06/07/08

The BAAH lists three events over Southern England in November: SAO-79805, SAO-79864 and SAO-80552. See Fig 1. Two on the night Nov 06/07, and one on Nov 08. All occur at the Northern cusp, phase about 60%.

#13 Nov 06-2355UT, SAO-79805 mag 6.8, cusp angle 9.9, Alt. 26d
#14 Nov 07-0224UT, SAO-79864(d)mag 6.4 cusp angle 6.8, Alt. 48d
#15 Nov 08-0327UT, SAO-80552 mag 7.6 cusp angle 4.0, Alt. 47d

Fig. 1: November graze paths

Guidance on planning a graze observation

If you are in a graze zone then you are lucky. But a potential observer still needs to know where that zone is and to plan accordingly. The green line is not a zone of observability but the line where the star grazes the mean limb of the Moon.

The location and width of a graze zone will depend on the shape of the Moon at that point. The limb profile provides graphical information on the actual shape of the limb (as it is known, see Fig. 2. Thus the observer can find somewhere suitable to set up using Google Earth.

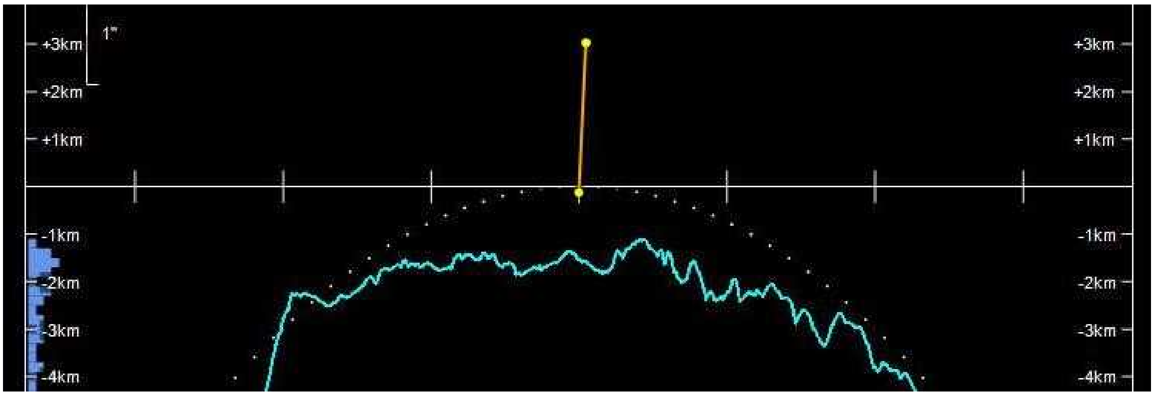


Fig. 2: Limb profile for SAO-79864(d) on 2020 Nov 7th

Referring to Fig. 2 it is clear that lunar limb is well below the mean limb. Observers will need to position themselves between 1 km and 2 km south of the mean limb. Also, the star is a double and the mean limb is shown for the brighter component. When occulted, the fainter companion will remain visible: Fascinating! So it is possible to split very close doubles by this technique, and make discoveries.

Read about Alex Pratt's discovery in https://iota-es.de/JOA/JOA2020_2.pdf

2020 October predictions for Manchester (Occult4 by D.Herald).
W. Long. 002d 15', N Lat. +53 25', Alt. 50m

		day	Time			Ph	Star	Sp	Mag	Mag	%	Elon	Sun	Moon		CA	
y	m	d	h	m	s		No		v	r	ill		Alt	Alt	Az	o	Notes
20	Sep	30	23	37	39.9	D	3536	M3	4.4	3.5	99+	168		31	182	56S	30 Psc Dbl*
20	Oct	2	22	54	25.1	R	210	B9	6.6	6.7	99-	167		35	144	51S	STF 122
20	Oct	3	23	23	30.9	R	322	G0	5.6	5.3	96-	157		39	139	82N	64 Ceti
20	Oct	3	23	36	17.7	DB	327	G8	4.4	3.9	96-	157		40	142	-30N	xi Ceti
20	Oct	4	0	38	8.9	RD	327	G8	4.4	3.9	96-	156		44	162	75N	xi ceti
20	Oct	5	5	6	9.9	R	93261	G8	7.4*	6.9	91-	144	-12	38	236	47S	
20	Oct	5	21	12	0.0	R	527	K0	6.2	5.7	86-	136		17	84	76N	
20	Oct	6	3	57	7.2	R	93630	G0	7.5	7.2	84-	134		53	203	50S	
20	Oct	6	22	15	38.7	R	93973	F6	7.1	6.8	78-	125		22	85	68S	
20	Oct	7	3	2	34.8	R	700	B8	5.9	5.9	77-	123		57	162	81N	HU Tau
20	Oct	7	21	19	7.1	R	792	G8	5.0	4.5	70-	114		9	65	67S	109 Tau
20	Oct	8	1	55	17.5	R	77191	K0	7.2	6.6	69-	112		48	121	83S	
20	Oct	8	4	43	22.8	R	77246	K0	7.9	7.2	68-	111		60	184	62N	
20	Oct	8	23	13	58.1	R	956	B3	6.2	6.0	60-	102		19	75	89S	9 Gem
20	Oct	8	23	55	28.9	R	960	G5	6.6	6.1	60-	101		24	83	38S	10 Gem
20	Oct	9	1	24	40.1	R	972	K0	7.3	6.6	59-	101		37	100	50S	
20	Oct	13	2	51	9.0	R	98984	F0	8.0	7.8	18-	51		12	80	87S	
20	Oct	13	5	14	46.4	R	99030	F8	8.8	8.4	18-	50		32	109	79N	

20	Oct	14	4	24	23.5	R	99474	F8	8.4		10-	37		14	91	51S	
20	Oct	20	18	13	25.4	D	2513	A3	4.2	4.0	21+	55	-11	6	215	70N	44 Oph Dbl*
20	Oct	21	18	18	49.7	D	2672	K1	2.8*	2.3	31+	68		8	203	58N	lambda Sag
20	Oct	24	19	15	5.6	D	190252	F2	7.2	7.0	62+	104		16	180	87S	
20	Oct	26	19	56	58	Gr	3374	K3	6.1	5.4	80+	127		21	**		GRAZE: nearby
20	Oct	28	20	35	27.1	D	60	K2	6.9	6.1	93+	149		31	152	55N	
20	Oct	29	23	20	53.7	D	188	F0	7.6	7.4	97+	161		39	189	62N	
20	Nov	2	0	51	57	R	93484	F5	7.0	6.8	98-	164		53	178	33N	
20	Nov	2	22	23	53.6	R	93844	K0	7.6	6.9	95-	154		40	113	63N	
20	Nov	3	19	42	29.3	R	752	A7	4.6*	4.5	91-	145		12	70	59S	iota Tau Dbl*
20	Nov	3	23	20	56.1	R	77003	A0	7.6		90-	143		43	113	68S	Dbl*
20	Nov	4	22	27	5.7	R	77851	A0	7.4	7.3	84-	132		30	89	81S	
20	Nov	5	3	1	51.1	R	78051	A2	7.6	7.5	82-	130		61	171	59N	
20	Nov	5	5	32	17.4	R	78122		7.9	7.5	82-	130		52	232	44S	
20	Nov	5	5	36	8.5	R	78121	F0	7.5	7.3	82-	130		52	233	54S	
20	Nov	5	6	47	48.0	R	954	G8	6.1	5.6	82-	129	-5	42	252	52S	8 Gem Dbl*
R954 = 8 Geminorum is double: ** 6.9 6.9 0.10" 90.0, dT = +0.24sec																	
20	Nov	5	21	49	47.7	R	1052	F8	6.8	6.5	76-	121		17	73	72N	

Predictions up to Nov 5th

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: Tim Haymes

LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME

Tony Cook

Introduction: In the set of observations received in the past month, these have 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) and topocentric libration (±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: Three reports have been received, though none are TLP:

Figure 1. *The NE part of the Moon as imaged by Leandro Sid (Argentina – AEA) with north towards the top and colour saturation increased to 75%*

Proclus, Römer, Theophilus and Carmichael: On 2020 Sep 23 UT 01:18 Leandro Sid (Argentina – AEA) imaged the region of the Moon that included Mare Crisium and noticed pink colour on the north-western floor of Proclus. As you can see from Fig. 1, once colour saturation has been turned up, indeed there is a hint of pink there. However, there is an even stronger colour, orange in the crater Römer, some colour on the rim of Carmichael, as well as colour in Theophilus, Isidoris etc. The chances of TLP breaking out in several very widely separated locations seems extremely unlikely, but it is also odd that colour is not present on some other craters. It may be chromatic aberration or atmospheric spectral dispersion, or some form of data compression noise or imaging artefact introduced by the smartphone camera? If I find out anything more then I will let you know. But I would like to thank Leandro for sending this image in to query.

Unknown: On 2020 Sep 22 someone from Florida (I'm not giving their name here) emailed me the following: *'Hello. I am an amateur astronomer, frequently on my Orion SkyScanner. Even though I've heard about TLPs for years, my mind was blown when I saw it for myself just yesterday. I am all in. Can I help?'* I emailed them back for further detail but have not had a reply. This will be given an ALPO/BAA weight of 0 as it is just too vague!

Ptolemaeus: I received the following communication from Alexandre Amorim in Brazil: *'Well, I want to share a curious experience regarding the crater Ptolemaeus. Observer Nelson Travnik (85 years-old) told me about his last (and second time) observation of this crater in 27 Jul 2020, 23:00 UT, about the "kind of glimmering mist lifted & wafted inside the shady hollow of the crater" etc... etc... etc... - as he observed first in 14 Apr 1970 at 00:45 UT (See. #1248 in Cameron Catalog, 1978). I talked to him: Mr. Travnik said: "OK, it's a beautiful phenomenon, but.... it is Normal! Every time near colongitude 1.4° this phenomenon occurs. Even in my Astronomy Yearbook for 2020, page 76, I published those dates which the beginning of illumination in Ptolemaeus will be observable in Brazil..."'.* We shall update the Lunar Schedule web site to include this colongitude since the effect, although not a TLP, is spectacular and this crater has cropped up in the last few newsletters.

Level 1 – All Reports received for August: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Birt, Copernicus, Hyginus, Mons Piton, Plato, Posidonius, Promontorium Agassiz, Theophilus and Tycho. Alberto Anunziato (Argentina - SLA) observed: Biot, earthshine, and Posidonius A. Walter Elias and other AEA team members (Argentina) imaged: Aristarchus. Valerio Fontani (Italy – UAI) imaged: Mons Pico and Tycho. Desiré Godot (Argentina – SLA) imaged: Eudoxus. Rik Hill (Tucson, AZ, USA - ALPO/BAA) imaged: Endymion and Meton. Trevor Smith (Codnor, UK – BAA) observed: Plato and Plinius.

Level 2 – Example Observations Received:

Aristarchus: On 2020 Aug 02 UT 01:10 Walter Elias and colleagues (AEA) took a colour image of this region under similar illumination to the following past TLP reports:

On 1963 Nov 29 at UT 01:30-03:00 Fisher (Colefax, CA, USA, 20cm reflector, thin streamers of cloud across sky, but no wind) Aristarchus had a faint pale-yellow tint along the rim and the crater was very bright. No detail seen in in Vallis Schroteri. Yellow spot also seen on the northern limb (Carpenter and Pythagoras?). Both effects had been seen the previous night and were confirmed by friends. Colour still present when observing stopped at 03:00 UT. The ALPO/BAA weight=1.

Aristarchus, Herodotus - 1967 Sep 16 UTC 23:50-23:55 observed by Seeliger (Dresden, Germany, 30" reflector, 90, 140x) "Dark streaks on E.(ast. ?) outside walls of both craters. No shadow from Herod. wall. Drawings (wall < 18 deg slope if no shadow normally)." NASA catalog weight=3. NASA catalog ID=#1044. The ALPO/BAA weight=1.

Figure 2. *The Aristarchus region as imaged by AEA observers on 2020 Aug 02 UT 01:10 and orientated with north towards the top. The image has had colour saturation increased to 30%.*

The image submitted by the AEA observers shows the nice brownish colour of the Aristarchus plateau and some equally nice blue colouration in the crater itself. With regard to the two repeat illumination events, Fig. 2 is what they should have seen, but the descriptions differ to what is in the image. We shall leave the weights at 1 for both these past TLPs for now.

Plinius: On 2020 Aug 08 UT 00:30-00:45 Trevor Smith (BAA) observed this crater visually under similar illumination to the following Victorian era report:

Plinius 1889 Sep 13 UT 23:00? Observed by Thury (Geneva, Switzerland) NASA Catalog Event #265, NASA Weight=3. Event described as: "Unusual black spot with intensely white 4" border over CP. Normal aspect is 2 craters. #260 says that Gaudibert saw same thing in Sep. - confirmed". References: Nature 41, 183, 1890 (April). The ALPO/BAA weight=1, this is probably perfectly normal.

Trevor was using a 6-inch f/5 reflector that had been made in the 1950s by mirror maker Jim Hysom. Trevor states that no unusual black spots were seen, and everything looked normal! We shall leave the weight at 1 for now.

Eudoxus: On 2020 Aug 28 UT 23:45 Desiré Godoy (SLA) imaged this crater, using a 20cm refractor, and a QHY5-II camera with a 742nm filter, under similar illumination and similar viewing angle to the following report:

On 1882 Jan 29 at UT 17:00-17:30 an unknown observer noted an unusual shadow in Eudoxus crater. The Cameron 1978 catalog ID=227 and the weight=2. Reference: Sirius Vol 15, 167, 1882. The ALPO/BAA weight=2.

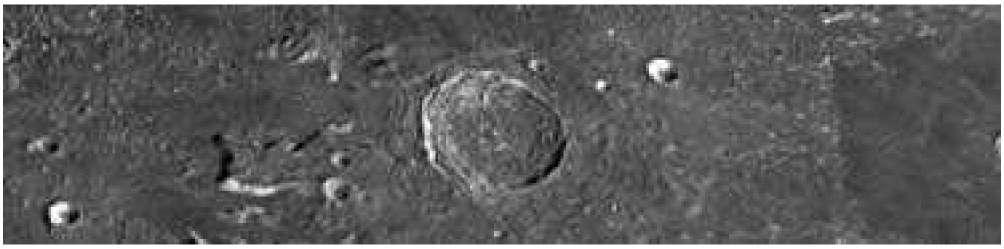


Figure 3. *Eudoxus as imaged by Desiré Godoy (SLA) on 2020 Aug 28 UT 23:45. Orientated with north towards the top.*

As you can see from Fig. 3, there is nothing unusual in the shadow appearance in this crater. Alas, I cannot find the Sirius journal on-line and so cannot glean much more information about this report. We do not even know in which country the observer was? For now, I shall leave the ALPO/BAA weight at 2.

Level 3 - In Depth Analysis:

Mons Pico: On 2020 Aug 03 UT 21:06 Valerio Fontani (UAI) imaged this mountain after the following Lunar Schedule request:

BAA Request: Any colour visible on this mountain? Check with red and blue filters e.g. Wratten 25 and 441, else obtain some colour images, taking care to under expose slightly so as not to saturate the mountain. Any sketches, visual descriptions, or images taken, should be emailed to: a t c @ a b e r . a c. u k .

Figure 4. *Mon Pico as imaged by Valerio Fontani (UAI) on 2020 Aug 03 UT 21:06 and orientated with north towards the top.* ***(Left)*** *Section of the original image.* ***(Right)*** *Image with colour saturation increased to 70%.*

This actually refers to a TLP from 1996 Dec 24: *'On 1996 Dec 24/25 at 18:12-00:02UT P. Moore (Selsey, UK, using a 15" reflector x250-360, and seeing III) saw a strong orange colour on the south wall and floor of Aristarchus. He suspected it to be spurious colour but could not detect colours on any other craters. The colour remained but at 18:12 UT he suspected a trace of colour on Mons Pico but was not sure. However, he reported it to the TLP coordinator of the BAA Lunar Section. The orange in Aristarchus gradually faded and had almost vanished by 00:20UT when seeing was too bad to continue observing. At 02:30UT he was able to re-observe again and there was still a very slight hint of orange in Aristarchus - but he comments that if he had not been looking for it, he might not have noticed. ALPO/BAA weight=2.'* The report by Patrick Moore is mostly about Aristarchus, but the Mons Pico part is really just about a hint of colour. I think we can probably reduce the weight to 1 for now, though it is interesting that Valerio's image (Fig. 4) shows no colour here.

Biot: On 2020 Aug 23 UT 21:45-22:00 Alberto Anunziato (SLA) observed visually this crater under similar illumination to the following report:

On 1969 Jul 19 at UT 16:00-18:01 Azevedo at al. (Joao Pessoa, PB, Brazil, 8" reflector) saw that the west wall of Biot was unusually bright. Had seen it without this condition several months earlier. This was from the Apollo 11 watch. Jose da Silva says that this was not a TLP as the observers were inexperienced. The Cameron 1978 catalog ID=1163 and weight=0. The ALPO/BAA weight=1.

Alberto, using a 105 mm. Maksutov-Cassegrain (Meade EX 105), at x154, found that the west wall of Biot was very bright but that it looked normal, indeed very similar to the west wall of Biot A. We shall therefore lower the weight from 1 to 0 and remove it from the ALPO/BAA TLP catalog.

Mons Piton: On 2020 Aug 26 UT 00:40-01:00 Jay Albert observed visually and at 01:48 imaged this mountain under similar illumination to the following report:

Mt Piton 2001 Sep 24 UT 19:25-19:55 Observed by Marie & Jeremy Cook (Frimley, Surrey, UK) described Mt as the brightest point on the terminator flaring seen on the southern end and red in colour. Observers really thought it was normal (not a TLP) to be this bright and the flaring was spurious colour. Worth checking out just in case, and also because it looks spectacular. ALPO/BAA weight=1.

Figure 5 *A camera phone image of the vicinity of Mons Piton taken on 2020 Aug 26 UT 00:40-01:00 by Jay Albert (ALPO) and orientated with north towards the top.*

Jay was using a Celestron NexStar Evolution 8" SCT at x51 and x226. The twilight sky was hazy, partly cloudy with fast moving puffs of cumulus and a partial blanket of very thin cirrus above. Transparency was first magnitude and seeing was initially 4, increasing to 5/10 as the wind diminished. Mons Piton was by far the brightest feature on the Moon; perhaps the brightest he had ever seen it. Some flaring was seen at higher power, especially on the south part of the mountain, due to the breeze and mediocre seeing. An image was taken (Fig. 5). There was an earlier repeat illumination prediction that was just outside the observing window by 19 min:

On 1987 Jun 04 at UT02:26-03:26 D. Darling (Sun Praire, WI, USA, S=G and T=4) observed that Mons Piton was the brightest object on the Moon that he had ever noted before. Variations seen gave the mountain a "silvery" shine. The abnormal brightness was confirmed by another independent observer. The Cameron 2006 catalog ID=302 and the weight=5. ALPO/BAA weight=2.

From my own experience I can vouch for the fact that small bright features on the Moon look even brighter at low magnifications, through an eyepiece, as they become point-like. This effect is not always well captured in images as they tend to saturate on the brightest features. I will reduce the weights of both these TLP to 0 and remove them from the ALPO/BAA TLP database.

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 .

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