BAA Lunar Section
British Astronomical Association
Director: Bill Leatherbarrow

LUNAR SECTION CIRCULAR

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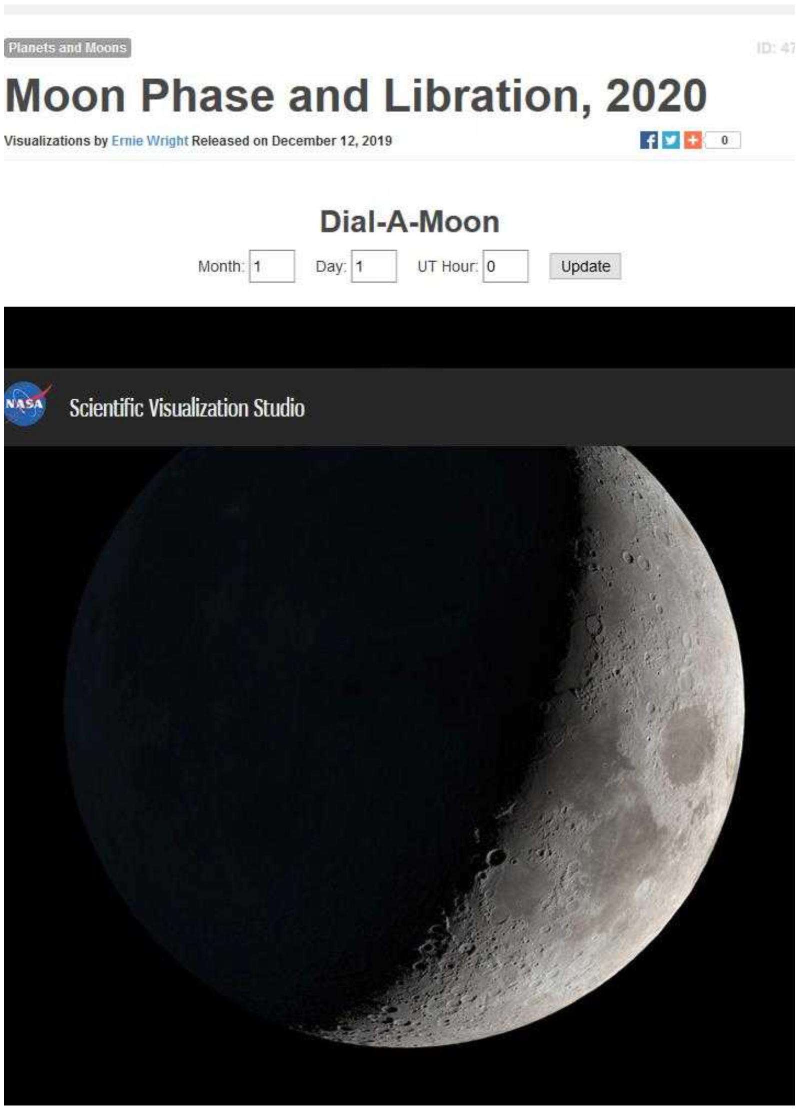
FROM THE DIRECTOR



I have recently received several queries from members of the Section, and from BAA members in general, about where best to find the sort of information on lunar phases and libration that will allow precise planning of a night's observation. You can, of course, find information on libration and the Sun's selenographic colongitude in tabular form in the BAA *Handbook*, but many will prefer something that will allow them to visualise the Moon's actual appearance for a given date and time. Many planetarium software packages will allow this, but to my mind the most useful tool is the 'Dial-a-Moon Phase and Libration' website produced for each year by NASA's Scientific Visualisation Studio.

I have recommended this tool before but now, at the start of a new year, might be the time for a reminder of what it offers. The 2020 version is now on line and may be found at: https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4768&button=recent. The home screen allows you to set the date and time of your planned observing session. This brings up an image of the Moon for that time, showing precise phase and libration. By clicking on that image you can download a detailed version showing the names of formations near the terminator, and by scrolling your mouse you can zoom into a particular area of interest. It's also a useful pastime for those nights when conditions do not allow real observation!

The run-up to Christmas is always a busy period, with the result that this issue of the Circular has been pieced together in snatched spare moments. I apologise for any shortcomings and especially to those contributors whose work I have not had time to include.

I wish you all clear skies for 2020!

Bill Leatherbarrow

OBSERVATIONS RECEIVED

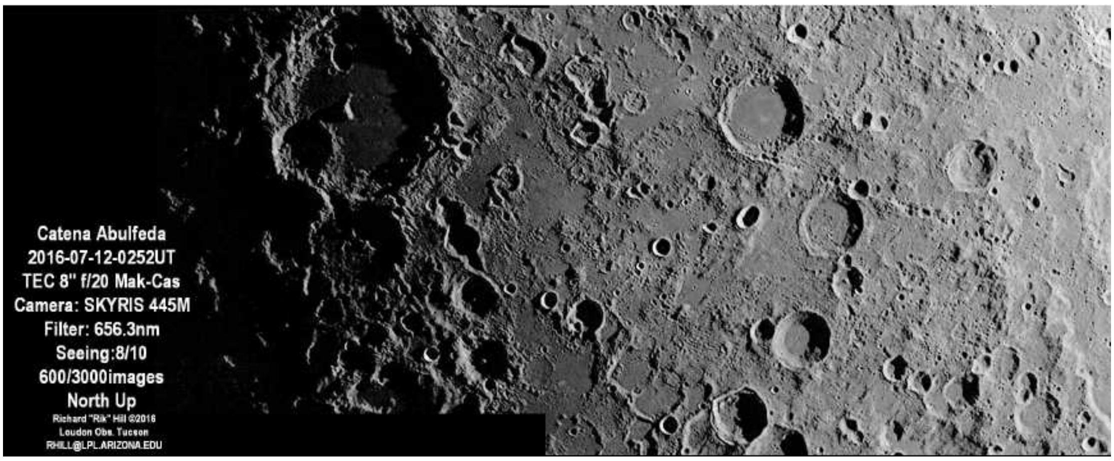
This month images have been received from the following observers:

Leo Aerts (Belgium), Maurice Collins (New Zealand), Arthur Coombs (Australia), Dave Finnigan, Mike Foulkes, Rik Hill (USA), Damian Peach, Bob Stuart, and the Director.

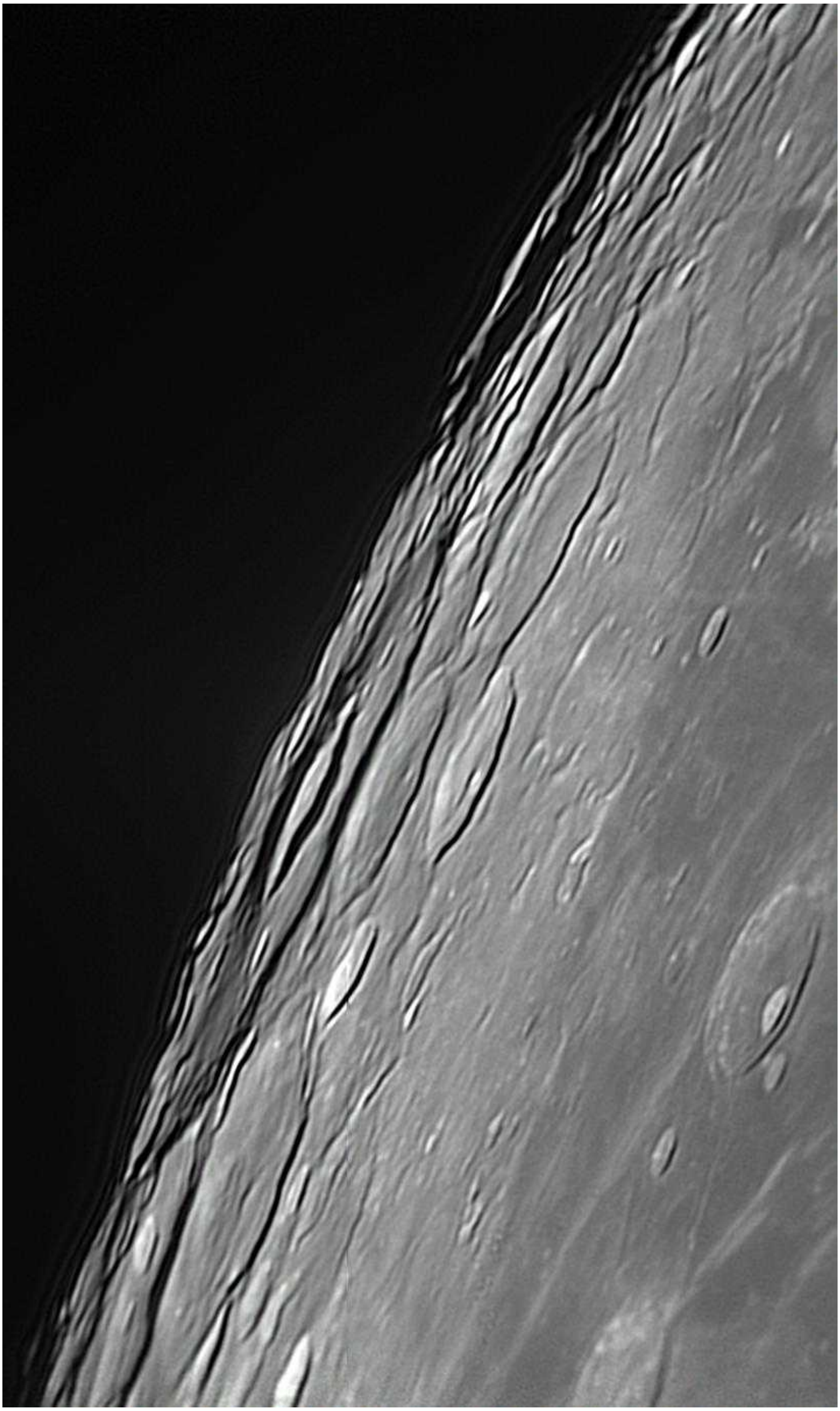
As usual, **Rik Hill** has sent in a fine series of images supported by informative accounts of the areas under observation. This month we feature his image of one of the Moon's lesser known crater chains, the Catena Abulfeda. Rik writes as follows:

'Because of the Ptolemaeus-Alphonsus-Arzachel trio on the west side and the Theophilus-Cyrillus-Catharina trio on the east side, this whole area gets overlooked by many observers. Besides being the just south of the Apollo 16 landing (one of the most difficult sites to locate) it contains a profusion of interesting craters and features. The large craggy crater on the left is Albategnius (139km dia.) with Klein (46km) sitting on its southwest wall. Due south of this is the large ruined crater Parrot (121km). Then east of this crater is a curious looking double crater with a valley cutting through the pair. The lower crater is Vogel (27km) and the upper one is the satellite crater Vogel B and the valley is an illusion crated by two smaller craters that were formed from separate impacts on the northern wall of the "B" crater and the southern wall of Vogel that just happened to be aligned with the centers of the other craters! Moving further south of these we see two craters Argelander (36km) and Airy (37km).

There are four large craters forming an eye catching north-south arc in the center of this image. The top one is Abulfeda (65km), below it is Almanon (51km), then Geber (46km) and lastly the doublet Abenezra (43km) and Azophi (49km). If you are going to this area find these first and use them as your guide to the rest of the area. Due east of Almanon is the crater Tacitus (41km). Notice the line of small craters between these last two running from the bottom of Abulfeda out past Tacitus. This is a "catena", a controversial Latin name for what we used to just call "crater chains". In this case this is officially Catena Abulfeda. There are several hypothesized origins of these. One is that they are just chance alignments of ejecta from a lager impact that laid down secondary craters in a row. There are a few candidate craters for the origin of such material here. Second would be the volcanic hypothesis that these would be a line of vents along a fault. Third is that a series of impacts from a fragmented asteroid or comet pieces, similar in nature to what we saw with SL9 on Jupiter, but with the Moon's much lower rotational velocity they are much closer together. In this case a look at the LROC QuickMap image of this crater chain makes the first hypothesis most likely. Go to QuickMap and take a look. What do you think?'



Our 'campaign' to observe the elusive crater Einstein under a favourable libration in November was defeated by the British weather. However, **Mike Foulkes**, Director of the BAA Saturn, Uranus and Neptune Section, succeeded in imaging the crater during another, slightly less favourable appearance on the evening of 11 December 2019. His image was taken at 21.43 UT using a C11 SCT. Mike comments that he has been able to observer this elusive crater only twice during a long observing career.



Much has been made in the past of the so-called ‘Lunar X’, an appearance near the craters Werner that is produced when the lighting and libration are just right. It is, of course, of no real geological significance, but it is striking when visible. On the evening of 9 December 2019, **Bob Stuart** detected a similar, but smaller ‘X’ feature near the crater Byrgius. Again, this is only a fleeting product of lighting conditions, but Bob wonders if it has been seen by others. Bob’s image was taken at 19.14 UT, using a 250mm Newtonian.

On the same evening at 19.26 UT, Bob also took the following image of Reiner Gamma and sunrise over the craters Hevelius and Cavalerius.

We are all familiar with the superb lunar imagery produced by **Leo Aerts**. Leo normally works with a C14 SCT, but this month he has sent in the following image of Aristoteles. What is striking about this image is that it shows detail comparable with Leo's other work, but was taken with a smaller telescope, a 175mm refractor, and at a time when the Moon was only 24° above the horizon!

Aristoteles, 3 December 2019 (Leo Aerts)

Arthur Coombs has submitted the following notes on the Mare Orientale, featured in an image by Dave Eagle in a recent issue of the LSC.

THE ORIENTALE BASIN RE-VISITED

David Eagle's image of Mare Orientale (Lunar Section Circular Vol.56, No.12 December 2019), caused me to revisit the Lunar 100 photographic record that John Robinson and I published after Charles Wood listed his L100 objects in 2004.

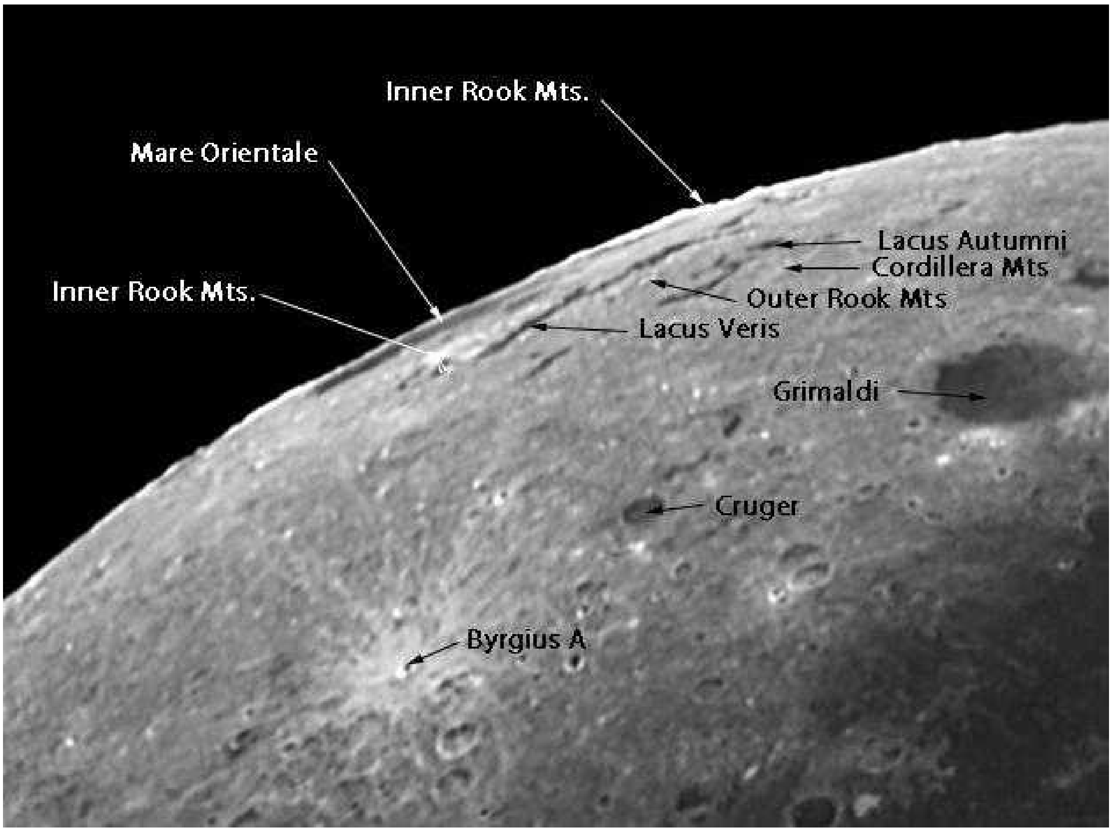


Fig. 1 Image taken on 2nd January 2005 at 17h 49m UT
Location 145º03' E, 37º45' S Heidelberg, Australia.

Camera technology and processing software has vastly improved in the past 15 years, hence the enclosed annotated image (Fig. 1) shows far less resolution than David's image. A Philips ToUcam webcam was used on an 8" f/7.5 Newtonian telescope to obtain an AVI; processing was carried out using Registax-2 software.

The libration of this 2005 image shows a little more of the western limb than David's image.

In order to identify the features with a reasonable degree of certainty, two other images captured by NASA are presented.

Fig. 2 shows the Orientale Basin taken by the Lunar Orbiter spacecraft in 1967. It clearly shows the overall structure including the Cordillera Mountains (Dia. 930-km); the Outer Rook Mountains (Dia.620-km); the Inner Rook Mountains (Dia. 480-km) and an un-named innermost ring (Dia. 320-km).

Fig. 3 is an albedo image which allows a very distinct sharp view of the lava which has breached the surface.

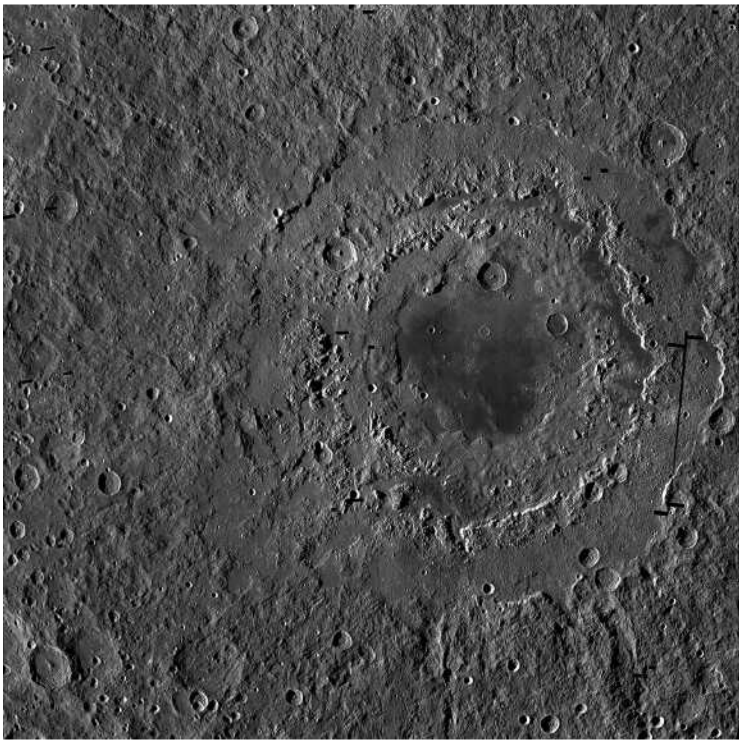


Fig. 2

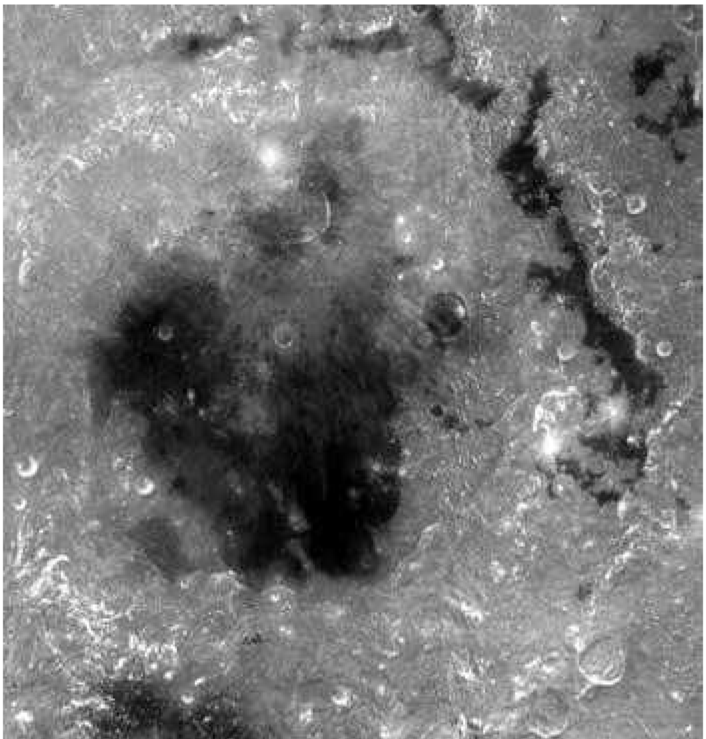


Fig. 3

Using Figs 2 and 3 as a reference, and returning to the annotated Fig. 1, the Cordillera Mountains can be seen on the outer side of Lacus Autumni – a relatively small area of lava.

The longer strip of lava, Lacus Veris, has leaked to the surface just inside the Outer Rook Mountains. Fig. 3 shows this very clearly, as does David's image.

The Inner Rook Mountains. which form a ring around the central mare basin are seen at the southern end of Lacus Veris as well as peaks on the western limb of the Moon. These sunlit features are more prominent on David's image than on the 2005 image.

Byrgius A is the centre crater of a bright ray system; Cruger and Grimaldi craters have also been identified.

The Orientale Basin presents a challenging structure to image from planet Earth, and an interesting exercise to identify features recorded.

LUNAR DOMES (part XXXIII): A swell in Montes Teneriffe, follow up

Raffaello Lena

In a previous article [1], I examined a swell of intrusive origin near Montes Teneriffe, calculating the morphometric properties (height, slope and volume). In fact, based on geophysical models this low dome, which I termed Teneriffe 1 (Ten 1), belongs to the In2 class of intrusive domes [2].

As reported in [1], Ten 1 is located at 49.08°N and 15.7° W and is also easily detectable in the Lunar Orbiter imagery and LROC WAC imagery (see Figs 1-2 of my previous note [1]).

The examined swell has been reported in BAA LS circular by Cook [6]. Maximilian Teodorescu, from Romania, has submitted an excellent hi-res image of Ten 1, which is shown in Figs 1-2.

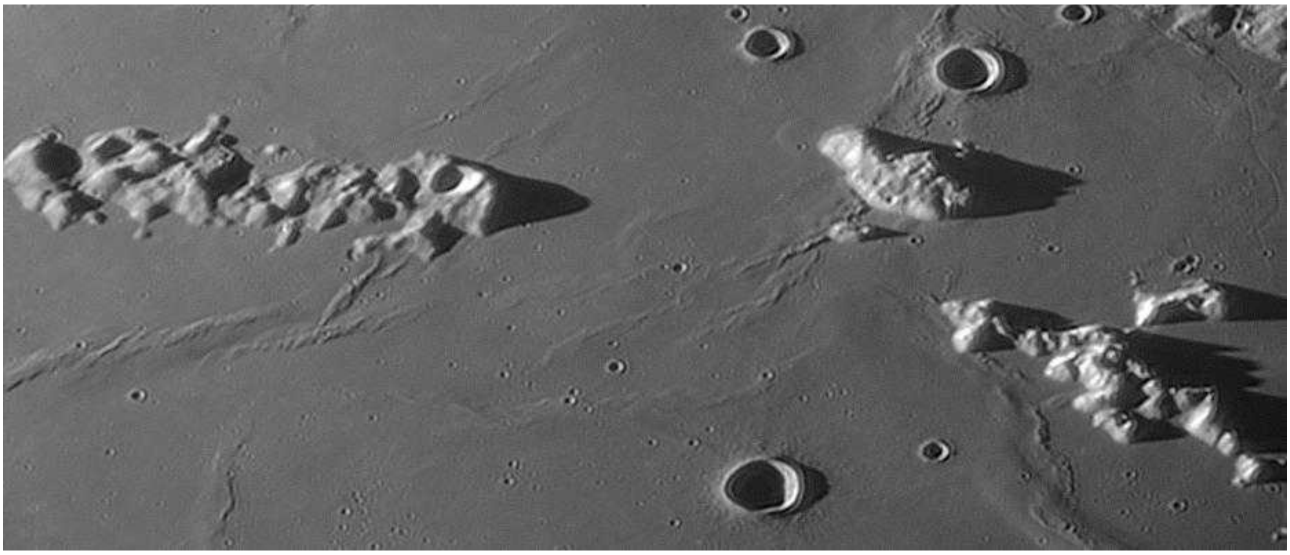


Figure 1. Image by Teodorescu taken on September 22, 2019 at 03:41 UT using a 355mm Newtonian telescope and ASI 174MM CCD camera.

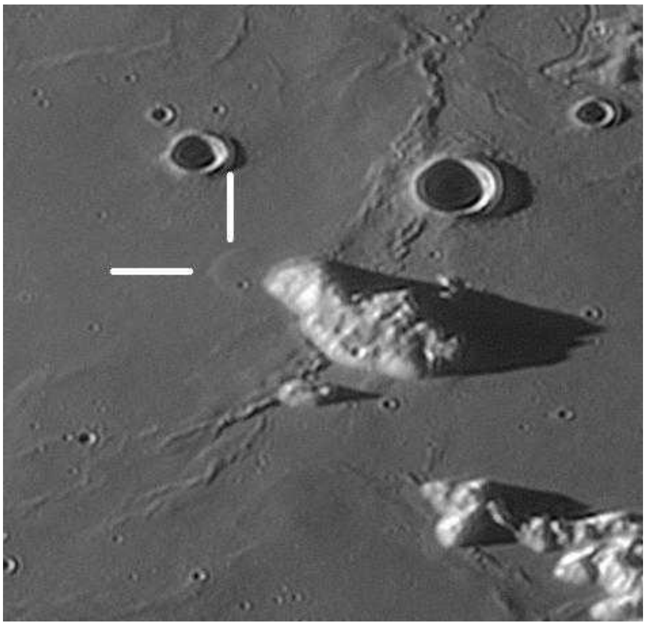


Figure 2. Enlarged image showing Ten 1, marked with white lines.

I have computed the height of Ten 1 using:

1) the GLD100 dataset, as described in [1]. This DEM has been constructed based on photogrammetric analysis of the LROC WAC image pairs [3]. A height of 55 ± 5 m was obtained from several measurements.

2) LOLA DEM, the Lunar Orbiter Laser Altimeter, a science instrument on the Lunar Reconnaissance Orbiter (LRO) spacecraft [4]. The precision of topographic data is estimated to be about 10 cm and the LOLA dataset was used as the reference for evaluating the quality of the GLD100 dataset. For these studies the dataset of LOLA Gridded Data Records (GDR) at a resolution of 512 pixels per degree is used to generate a set of geometric measurements. A height of 52 ± 5 m was obtained (Fig. 3) confirming previous computation.

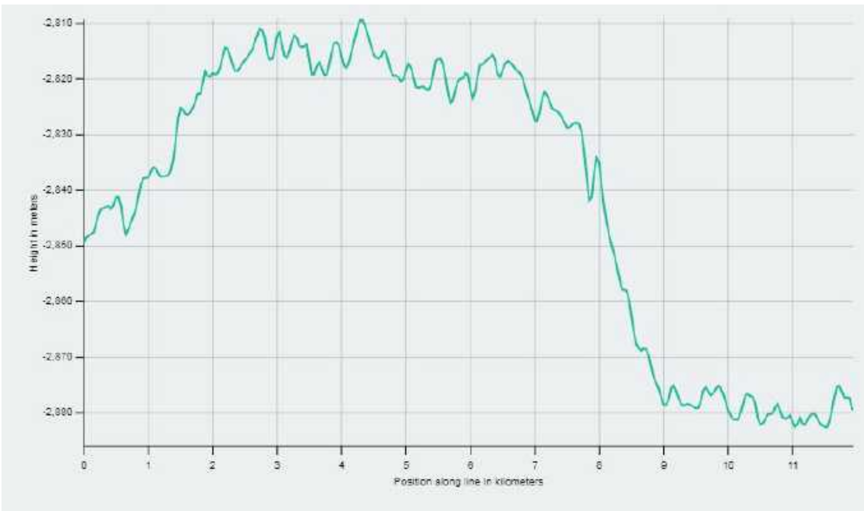


Figure 3. LRO WAC-derived surface elevation plot of an east to west cross-section of the dome Ten 1.

3) Generating a digital elevation model (DEM) of the dome based on the telescopic CCD image taken by Teodorescu. A well-known image-based method for 3D surface reconstruction is shape-from-shading (SfS). 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 [2, 5]. The height is thus obtained by determining elevation difference between the summit of the dome and its surroundings on the corresponding 3D profiles derived by shape-from-shading analysis. Based on the CCD image shown in Fig. 1, the dome height is determined to 48 m ± 5 m. Fig. 4 displays the reconstruction of part of the surface of Ten 1.

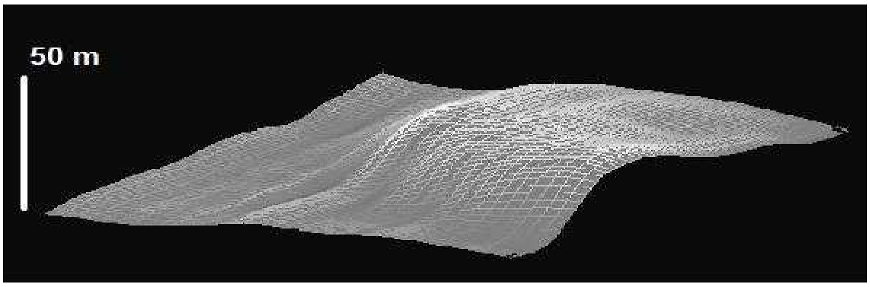


Figure 4. 3D reconstruction derived for the dome Ten 1 based on shape-from-shading (SfS) approach using the CCD image taken by Teodorescu. The vertical axis is 30 times exaggerated. The curvature of the lunar surface has been subtracted. The result is consistent with the measurements obtained using LOLA DEM and GLD100 dataset.

The spectral analysis shows a basaltic composition for the examined dome Ten 1 and the spectral data displays a spectrum corresponding to a classical pyroxene signature (Fig. 5). Chandrayaan-1 Moon Mineralogy Mapper (M^3) is an imaging reflectance spectrometer that can detect 85 channels between 460 nm and 3000 nm, and has a spatial resolution of 140 m and 280 m per pixel. For this analysis M^3 data, from OP2C1 orbital period, were calibrated and photometrically corrected and converted to apparent reflectance. In order to characterize the 1000 nm band, a continuum removal method that enhances the characteristic of the 1000 nm absorption band and more accurately shows the position of the band center is used. I fit a straight line between 750 nm and 1500 nm to remove the continuum. The spectral signature of olivine has a wide band centered beyond 1000 nm, while the pyroxenes displays a narrow trough around 1000 nm, with a minimum wavelength below 1000 nm, and a wide absorption band around 2000 nm. The spectrum of the dome summit (Fig. 5) displays two absorption bands centered at 970 nm and a wide band at ~ 2020 nm, corresponding to a classic clinopyroxene signature [2].

Figure 5. M^3 spectral analysis of the dome Ten 1.

References

[1] Lena, R., 'Lunar Domes (part XXIII): Mode of formation of a swell in Montes Teneriffe'. BAA LS Circular, Vol. 55, No. 11, November 2018.

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

[3] 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'. *J. Geophys. Res.* 117(E00H17). doi: 10.1029/2011JE003926.

[4] Smith, D.E. and 30 coauthors. 2010. 'The Lunar Orbiter Laser Altimeter investigation on the Lunar Reconnaissance Orbiter Mission'. *Space Sci. Revs*. 150, 209241.

[5] 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

[6] Cook, T. (2018), in 'LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME', BAA LS Circular, Vol. 55, No. 10, October 2018.

LUNAR OCCULTATIONS **January 2020** Tim Haymes

Wishing all observers '*clear skies*' in 2020.

Overview

The Moon starts the month in Aquarius, moving north into Cetus reaching 1st Q on about the 3rd. There is an even density of 7th and 8th mag stars presenting some opportunities to time sequential DD occultations during an evening, and depending on one’s instrumentation there are fainter stars (not in the list) down to mag 9. This continues through Aries and into Taurus. On Jan 7 a daylight occultation of 68 Tau is predicted in the BAAH. I have inserted approximate times in the listing. I usually exclude daytime events.

Passing into Gemini, the lunar phase approaches full. On Jan 9th at 1710UT mu Gem is occulted. The DD event should be easily observed despite the glare of the Moon provided the observer has a good horizon to the NE. The RB event is predicted at 1750UT.

I would be interested in receiving observations of mu Gem visually, or video or high speed CCD. Best of luck.

Heads Up!

(4) Vesta occults 5.3 magnitude HIP 14439 on 2020 Feb 11 22OO Hr

I draw occultation observers to this prediction, featured in BAAH p.53. It is a rare event for the UK for several reasons, principally because the star is bright by our standards and the duration long at up to 28 sec. Even so, some skill will be needed to locate the star in binoculars or a small telescope. The best place to see the occultation is Northern England and Scotland. The asteroid itself at magnitude 8 should also be seen nearby as it approaches the star, and this appulse can be followed during the evening anywhere in the UK.

If you live up north and you see or record the occultation, please send a report to me. I have prepared a web page on the subject:
http://www.stargazer.me.uk/call4obs/NextEvent4.htm

Conjunction (see BAAH p. 4)

Dave Herald (Murrumbateman, Australia) advises that a conjunction of Venus (-4.1) and Neptune (7.9) occurs on the evening of Jan 27th, at 20.1 hr. Earlier that evening around 18.15 UT the Crescent Moon (3 days past New) will be located 10 degrees south of Venus, at an elevation +8 degrees. There are no occultations, but I thought I would bring this to the reader’s attention.

2019 December predictions for Manchester (Occult4 by D.Herald).
W. Longitude 002d 15’, Latitude +53 25’, Alt. 50m;

y	m	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Moon Az	CA o	Notes
20	Jan	2	18	12	31.5	D	128824	F0	8.7	8.6	46+	85		34	185	64N	
20	Jan	2	19	14	33.4	D	128840	K2	8.8	8.1	46+	85		32	203	54S	
20	Jan	3	17	47	30.1	D	109787	K0	7.6		55+	96		38	165	82N	
20	Jan	3	18	6	31.2	D	109783	G5	7.3	6.7	55+	96		39	171	40N	
20	Jan	3	20	32	12.7	D	109815	K2	8.7	7.9	56+	97		34	215	42N	
20	Jan	3	23	43	33.3	D	208	F0	7.0	6.8	57+	98		11	260	86N	
20	Jan	4	20	30	31.9	D	306	F0	6.8	6.6	65+	108		42	204	85N	
20	Jan	4	21	37	29.5	D	110349	F5	8.3	8.1	66+	108		36	224	66N	
20	Jan	5	19	58	10.1	D	93150	F0	8.4	8.1	74+	119		48	178	75S	
20	Jan	5	20	0	22.0	D	93151	G5	8.4	8.1	74+	119		48	179	88S	

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20 Jan  6 17 34 30.3 D   93523 G0  8.2  8.0   82+ 130     37 117  66N
20 Jan  6 18  5 43.1 D   93527 G0  8.5  8.2   82+ 130     41 125  72N
20 Jan  6 18  8 44.3 D   93528 G5  7.4  6.7   82+ 130     41 126  80N
20 Jan  7 15 30      DD    658     4.3                         14 078  45S  68 Tau Daylight
          16 10      RB     658      4.3                        20 086 -45S
20 Jan  8 19 24 15.2 D   77202 F8  8.2  7.8   95+ 155     43 114  69N
20 Jan  8 22 54 11.9 D   77293 O7  7.6  7.5   96+ 156     58 189  56S
20 Jan  9  0 58 11.9 D     851 A1  6.4* 6.4   96+ 157     49 234  68N  Dbl*
20 Jan  9 17 10 40.4 DD    976 M3  2.9  2.0   99+ 166  -8 17  75  40N  mu Gem
20 Jan  9 17 50 46.9 RB    976 M3  2.9  2.0   99+ 166     23  82 -53N  mu Gem
20 Jan  9 18  4 44.7 D   78352 A3  7.2        99+ 167     24  85  75N  Dbl*
20 Jan  9 20 12 46.9 D     997 A0  7.0  7.0   99+ 168     42 111  89S
20 Jan  9 23 58 43.2 D   78561 K2  7.4  6.6   99+ 170     59 192  85N
20 Jan 10  0 58 29.2 D   78599 K5  8.5  7.7   99+ 170     55 216  79S
20 Jan 10  3 23 17.2 D   78689 K2  8.0  7.3   99+ 171     38 257  79S
20 Jan 10  3 49 58.5 D   1033  A2  6.8  6.7   99+ 171     34 263  34N
20 Jan 11 23 13 17.7 R   80294 F8  8.0  7.7   98- 164     49 130  70S
20 Jan 12  1 10  9.5 R    1304 A0  6.8        98- 163     57 173  75N  Dbl*
20 Jan 12  1 23  9.3 R   80362 F0  8.5  8.4   98- 163     57 178  39S
20 Jan 12  3  3 22.2 R   80401 A5  8.5  8.4   98- 162     53 217  31N
20 Jan 12  3 36 28.2 R    1313 F8  7.6  7.3   98- 162     49 228  72S
20 Jan 12  4 24 46.2 R   80426 K0  7.7  7.2   98- 162     43 242  76S
20 Jan 12 23 19 28.5 R    1421 K0  8.0  7.2   93- 150     40 118  85S
20 Jan 13  1 31 58.5 R    1431 B9  8.3  8.3   93- 149     52 159  88N
20 Jan 13  6 11  9.8 R    1450 K0  8.0  7.3   92- 147     34 251  70N
20 Jan 13 23 44 44.2 R    1553 A0  7.8  7.8   86- 137     32 114  65S  78 Leo
20 Jan 14  0 40  5.5 R   99227 K0  8.2  7.6   86- 136     39 127  77S
20 Jan 14  2 36  0.4 R   99256 K0  8.3  7.8   86- 135     48 164  82S
20 Jan 14  7 16 56.0 R    1578 K0  6.9  6.2   84- 133  -9 28 250  53N
20 Jan 15  5 36 23.2 R  119008 F8  8.6  8.3   75- 120     40 207  49S
20 Jan 17  2 30  8   m    1923 K0  7.0*       54-  95     19 126   7S
20 Jan 17  5 10  4.9 R  139356 A3  8.4  8.3   53-  94     31 167  65N
20 Jan 19  4  1 35.6 R  159092 K0  8.4  7.8   32-  68      9 129  75N
20 Jan 19  4 12 29.1 R  159095 G5  8.7  8.2   32-  68     10 132  73S
20 Jan 19  4 19 44.4 R  159098 F0  8.1  7.9   32-  68     11 133  52S
20 Jan 19  5 51 17.3 R  159132 B3  8.2  8.2   31-  68     19 154  50N
20 Jan 20  5  8  4   m  159731 A0  7.8  7.6   22-  55      6 134  10S
20 Jan 20  7 13 29.9 R  159767 B9  8.0* 7.9   21-  55  -8 16 162  83S
20 Jan 21  5 58 26.6 R    2457 A1  6.3  6.2   13-  43      4 135  37N
20 Jan 28 19 23 15.0 D    3480 F5  7.2  6.9   13+  43      9 242  52S
20 Jan 29 19 49 35.4 D  128702 M*  8.8  8.2   21+  54     15 241  52S
20 Jan 29 20 10 22.8 D  128704 F8  9.0  8.8   21+  54     12 246  47N
20 Jan 29 20 37 15.4 D  128713 F8  8.7  8.5   21+  54      9 252  40N
20 Jan 30 19 40 53.7 D     151 K5  8.2  7.4   29+  65     25 233  71S
20 Jan 31 20 41 34.9 D     270 K0  8.4  7.9   38+  76     27 240  68N
20 Feb  1 21 11 38.3 D  110632 K5  9.0  8.4   48+  87     32 240  86N
20 Feb  1 23 33 50.2 D     393 K0  6.7  6.1   49+  88     13 271  35N  Dbl*
(AB 7.6,7.6 dT +0.1s)
20 Feb  2  0 43  9.4 D     398 K0  6.5* 5.9   49+  89      3 284  66S
20 Feb  2 17 49 25.5 D     475 A0  7.5* 7.5   56+  97  -9 50 161  51N
20 Feb  3 17 35 14.9 D     610 K5  6.1  5.1   66+ 109  -6 48 139  87N  Dbl*
20 Feb  3 18  6 43.3 D   93781 A0  7.6* 7.6   66+ 109 -11 51 149  64S
20 Feb  3 20 38 22.4 D   93811 K2  8.5  7.8   67+ 110     52 208  71N
20 Feb  3 23 56 44.6 D     629 G5  7.5* 7.2   68+ 111     29 262  47N
20 Feb  4  1 41 25.4 D     643 F6  6.8  6.6   69+ 112     14 282  42N
20 Feb  4 21 30  0.4 D     765 A5  5.3  5.2   77+ 122     55 209  37S  Dbl* 106 Tau
20 Feb  4 22  7  9.5 D   76982 F0  8.4  8.2   77+ 123     51 222  51S
20 Feb  4 22 23  1.0 D   76985 A2  8.0  7.9   77+ 123     50 227  28S
20 Feb  4 23  6 11.2 D   77012 F0  7.8  7.6   77+ 123     45 240  49S
20 Feb  5 19 26 18.5 D     911 B8  6.4  6.4   85+ 134     53 137  50N  141 Ori
20 Feb  5 20  5  9.9 D   77887 F8  8.2  7.9   85+ 134     57 151  71N
20 Feb  5 20  7 25.2 D   77891 K2  8.2  7.4   85+ 134     57 152  76N
20 Feb  5 20  7 53.5 D   77877 B9  8.0  8.0   85+ 134     57 153  30S
20 Feb  5 22 29 58.4 D   77976 K2  8.5  7.8   85+ 135     56 212  37S
20 Feb  5 22 49 31.8 D   77991 K5  8.7  7.8   86+ 135     55 219  36N
20 Feb  5 23 47 57.9 D     928 K4  5.9  5.1   86+ 136     48 237  37S
Predictions end on Feb 5th
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Notes on the Double Star selection.

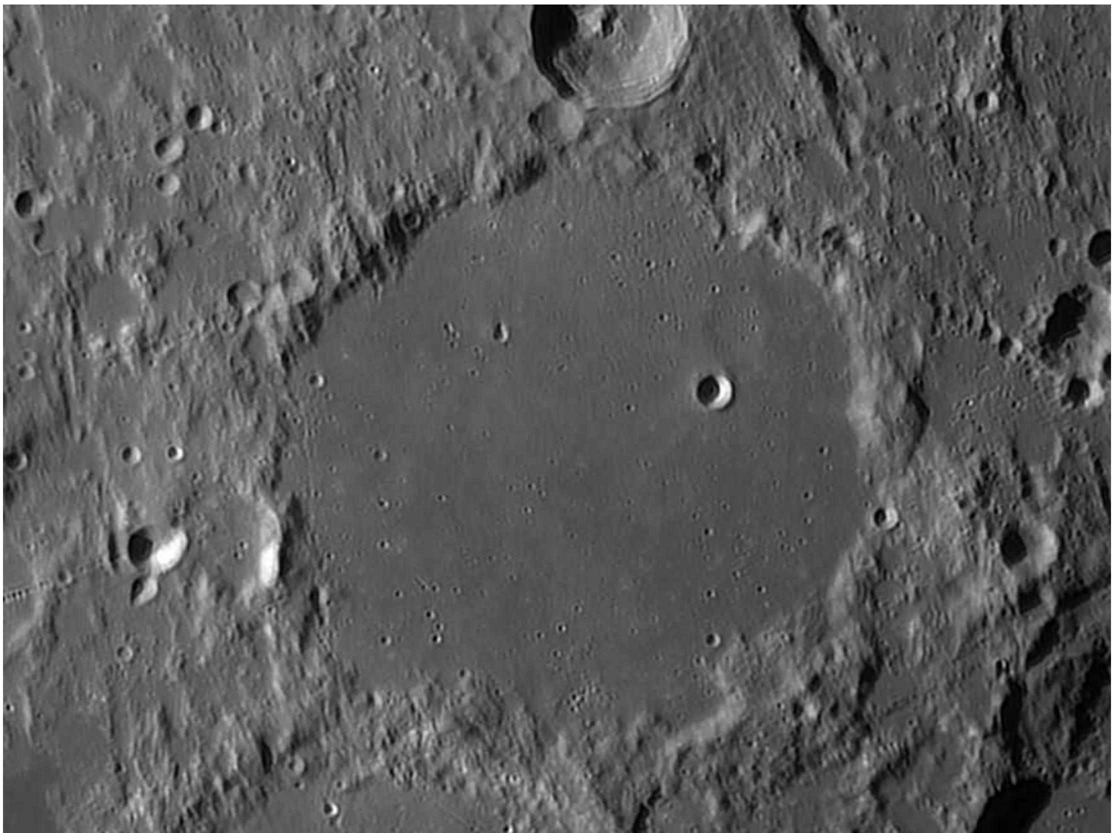
Doubles are selected from Occult 4, where the magnitudes of the pair are not more than 2 magnitudes different, the fainter companion is brighter than mag 9, and the time difference(dT) is between 0.1 and 5 seconds. **Please report double star phenomena.**

Key:

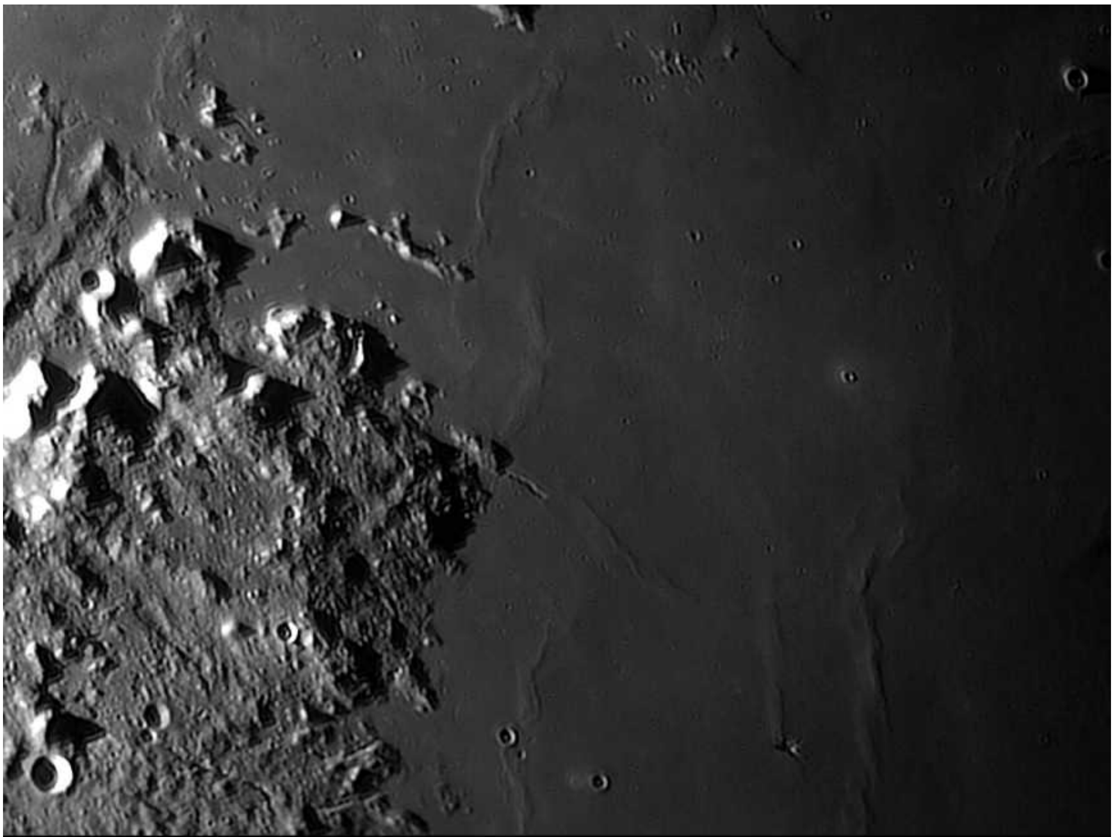
P = Phase (R or D), R = reappearance D = disappearance
M = Miss at this station, Gr = graze nearby (possible miss)
CA = Cusp angle measured from the North or South Cusp. Negative CA = bright limb
Dbl* = This is a double star worth monitoring.
Mag(v)* = asterisk indicates a light curve is available in 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
tvh.observatory@btinternet.com

FURTHER OBSERVATIONS RECEIVED

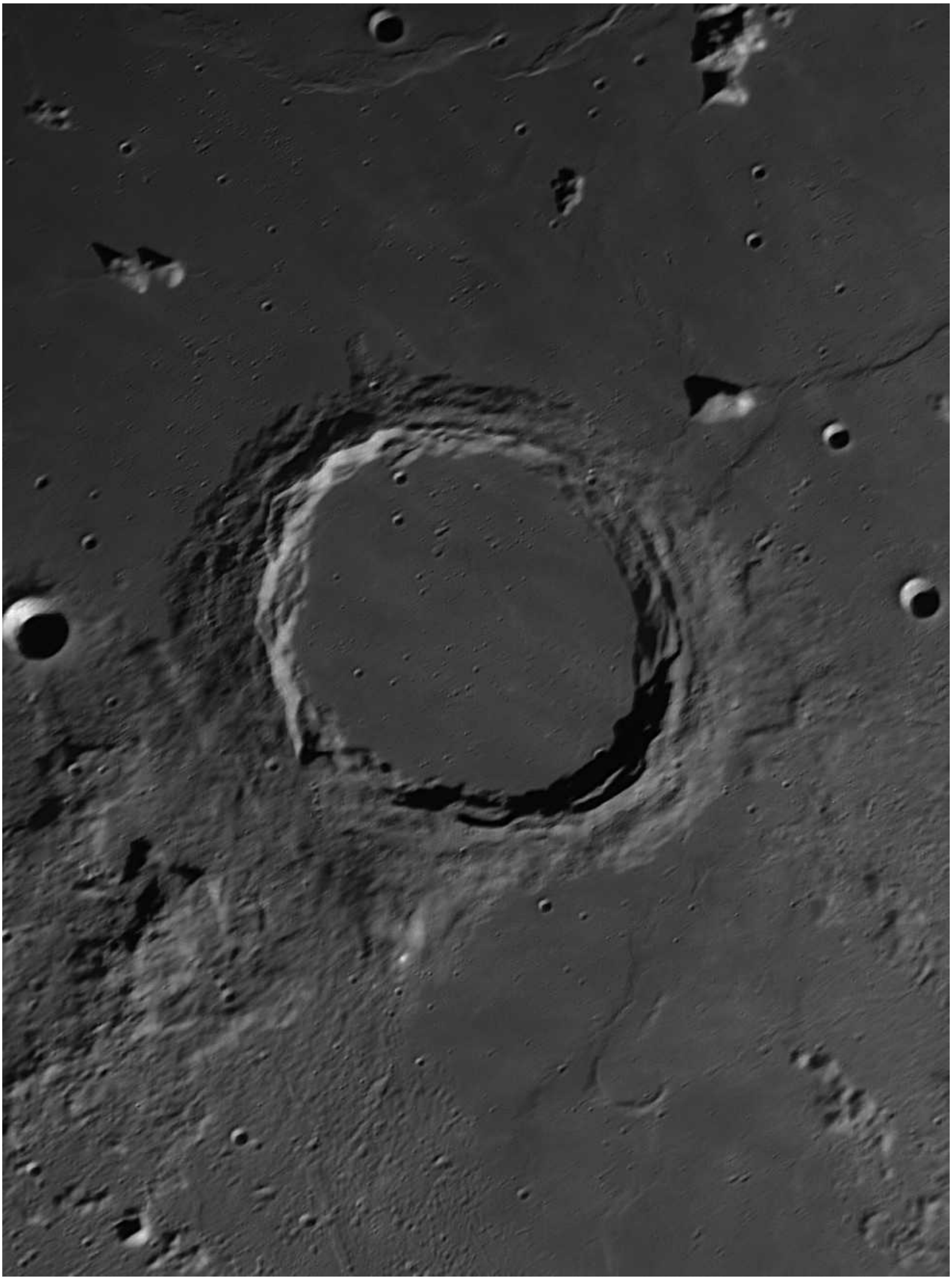


Ptolemaeus 2019.09.20   05:29 UT, S Col. 164.2°, seeing 6/10, transparency v.good.
Libration: latitude +04°44', longitude -07°10'
305mm Meade LX200 ACF, f 25, ZWO ASI 120MMS camera, Baader IR pass filter: 685nm.
640 frames processed in Registax 6 and Paintshop Pro 8.
Dave Finnigan. Halesowen



Linné, Krishna 2019.09.20 05:16 UT, S Col. 164.1°, seeing 6/10, transparency v.good.
Libration: latitude +04°45', longitude -07°08'
305mm Meade LX200 ACF, f 25, ZWO ASI 120MMS camera, Baader IR pass filter: 685nm.
640 frames processed in Registax 6 and Paintshop Pro 8.
Dave Finnigan, Halesowen

Damian Peach has once again used the 1-metre telescope at Chilescope to capture the breathtaking image of Archimedes that appears on the following page. The amount of detail visible on the crater floor is reminiscent of that seen via spacecraft imagery. Damian’s image was taken remotely on 6 December 2019.



LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME 2020 Jan

Tony Cook

Reports have been received from the following observers for Nov: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Alphonsus, Archimedes, Aristarchus, Bullialdus, Gassendi, and the north pole area. Alberto Anunziato (Argentina, SLA) observed: Langrenus, Posidonius and Proclus. Aylen Borgatello (Argentina - AEA) imaged: Proclus and Gassendi. Maurice Collins (New Zealand - ALPO/BAA/RASNZ) imaged: Aristarchus, earthshine, Einstein, Gassendi, Mare Frigoris, an occultation of Saturn, Tycho, and several features. Walter Elias (Argentina - AEA) imaged: Cleomedes, Langrenus, Plato and Theophilus. Desiré Godoy (Argentina - SLA) imaged: Alphonsus, Aristarchus, Bullialdus, and Gassendi. Victoria Gomez (Argentina - AEA) imaged Aristarchus. Facundo Gramer (Argentina - AEA) imaged: Alphonsus, Aristarchus, Jansen and Proclus. Sebastian Moreyra (Argentina - AEA) imaged Aristarchus. Trevor Smith (Codnor, UK - BAA) observed: Alpetragius, Aristarchus, Bullialdus, Gassendi, Herodotus, Kepler, Mare Crisium, Mons Piton, Plato, Promontorium Heraclides, Theophilus, Vallis Schroteri, and several features. Bob Stuart (Rhayader, UK – BAA) imaged: Birmingham, Clavius, Copernicus, Fontenelle, Gassendi, Goldschmidt, Hainzel, Kepler, Prinz, and Sinus Iridum. Sophie Stuart (Rhayader, UK – NAS) imaged: several features. Alan Trumper (Argentina – AEA) imaged Byrgius.

Please note that since the BAA's version of the TLP newsletter from December, some additional observations from October were received and these can be found in the ALPO December version of this newsletter.

News: Since the last newsletter I have been in contact with ALPO's Darryl Williams about his articles in the Sep and Nov 2019 TLO newsletter concerning thermal infrared imaging work and am looking into restarting some thermal IR observing of the Moon. If I can figure out how to improve on the resolution I was getting back in 2007, it might be worthwhile conducting some joint IR imaging. Darryl suspects that there may be 3 additional craters visible on the lunar eclipse image from 2007 (see Fig. 1) based upon a comparison with other published thermal IR eclipse images made with professional sized scopes.

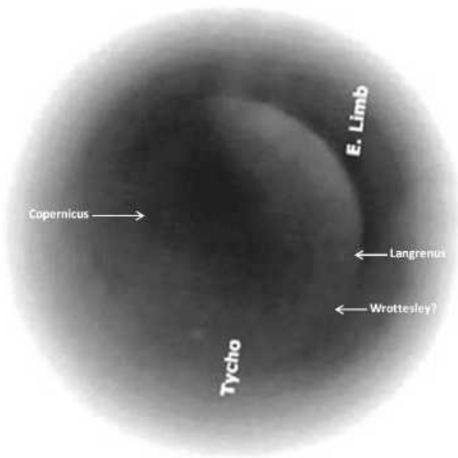


Figure 1. *Thermal IR image of the Moon captured by Anthony Cook during the 2007 Mar 03 lunar eclipse at 22:25 UT. White is hot and dark is cool. The locations of some craters have been annotated.*

Ivor Walton (BAA) pointed out that the timings for his 2019 Oct 18 observation (mentioned in the Dec newsletter) should have read: 10:48 and not 22:48, as apparently, he was using the MicroObservatory Robotic Telescope Network hosted by the Harvard-Smithsonian Center for Astrophysics (OWN – Observing With NASA. Telescope BEN (6-inch reflector) sited at Amado, AZ, USA (110.88°W, 31.68°N. This means that the repeat illumination description for Alphonsus on 2002 Sep 27 was in error. You can therefore ignore the associated repeat illumination description as this no longer applies. All observers are reminded to let me know if their observing stations differ to where they normally observe from as this can affect how the observational data gets searched for in the ALPO/BAA database.

Lastly, I forgot to apply the correct affiliation to Rik Hill's observation in the Dec newsletter, this of course should be ALPO/BAA.

TLP reports: No TLP reports were received in November.

Routine Reports: Below are a selection of reports received for Nov that can help us to re-assess unusual past lunar observations – if not eliminate some, then at least establish the normal appearance of the surface features in question. Note that some observations sent in have not been used in this newsletter because they do not cover repeat illumination predictions. However, they will be kept in our database and used as reference images should a TLP be reported under similar illumination in the future.

Jansen: On 2019 Nov 02 UT 23:31 Facundo Gramer (AEA) imaged this crater under similar illumination (±0.5°) to the following report:

Jansen-Maskelyne 1969 Jul 20 UT 00:53-01:00 Observed by Jean and Collak (Montreal, Canada, 4" refractor and 6" reflector) "Jean and Collack noted obscur. between Jansen and Maskel. from term. No features discernible here whereas Proc. & Theoph. were already vis." NASA catalog weight=2. NASA catalog ID #1169. ALPO/BAA weight=2.

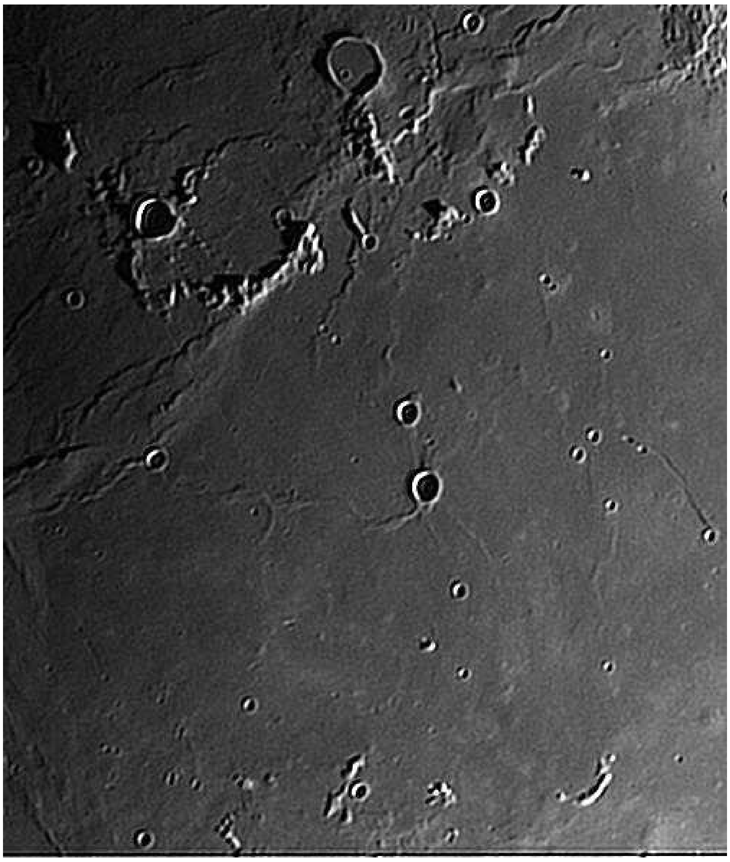


Figure 2. *Jansen as imaged by Facundo Gramer (AEA) on 2019 Nov 02 UT 23:31 and orientated with north towards the top. Jansen is located near the centre of the top edge.*

Facundo's image (Fig. 2), although not showing Maskelyne (beyond the bottom edge), clearly shows no obscuration or lack of detail in the region described by Jean and Collack. Therefore, we shall leave the weight at 2 for now.

Proclus: On 2019 Nov 02 UT 23:46 and 23:55-23:59 Aylen Borgatello (AEA) imaged and Alberto Anunziato (SLA) observed visually this crater under similar illumination (±0.5°) to the following reports:

near Proclus 1970 Apr 12 UT 00:15, 00:20 Observed by Loocks(Valparalso, Chile, 12" reflector, x88) "Brilliant in area NW of crater. No change in brightness Contrast to opacity of illuminated fraction of this day. Later saw a flash on the moon. (Apollo 13 watch)." NASA catalog weight=2. NASA catalog ID #1239. ALPO/BAA weight=2.

On 1982 Oct 22 at UT23:45-00:10 K. Marshall (Medellin, Columbia) found the W-NW rim of Proclus was both red and very bright, no similar colour effect was seen elsewhere on the Moon. The Cameron 2006 catalog ID=187 and the weight=3. The ALPO/BAA weight=3.

On 2009 Mar 31 at UT 19:26-19:50 Cook M.C. (Mundesley, UK, 90mm Questar reflector, x130, seeing II-III, transparency poor to moderate). The crater had its north-east to west wall illuminated and a central feature on the floor, faintly seen. The crater itself though was much brighter in a red filter, bright in a yellow filter, but dull in a blue filter. Possible variation seen whilst using the red filter, but this may have been due to haze. All other features behaved normally. The ALPO/BAA weight=3.

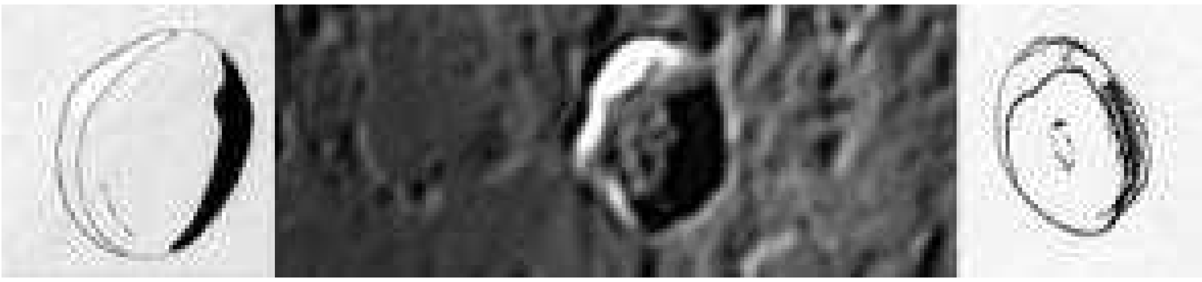


***Figure 3.** Proclus with north towards the top. **(Left)** A sketch by Kevin Marshall (BAA) made on 1982 Oct 22 UT 23:45 **(Centre)** An image by Aylen Borgatello (AEA) made on Nov 02 UT 23:46. **(Right)** a sketch by Marie Cook (BAA) made on 2009 Mar 31 UT 19:26-19:50.*

Alberto's visual observation, which is the most similar observing technique to all three TLP listed above, describes how he could distinguish nothing that he regarded as an abnormality in the north west area of the crater. Aylen's image (Fig. 3 – Centre) backs this description up – although the NW rim looks bright, this is normal for this colongitude. We can therefore say that the Loocks report from 1970 is perfectly normal, apart from a flash seen elsewhere on the Moon. I shall therefore remove this from the TLP database by giving it a weight of 0. Incidentally the flash that Loocks mentions was in Aristarchus, at magnitude 10, and is still retained in the ALPO/BAA catalog.

With regard to the Marshall (Fig. 3 – left) and Cook (Fig. 3 – right) reports, we can now exclude their comments about the NW wall being bright from their TLP descriptions as anything abnormal, and instead concentrate on both descriptions noting that some red was visible. In the Marshall report red is on the NW rim (See Fig. 1 – left), and nowhere else on the Moon. In the Cook report the whole crater is brighter in red than in other filters – furthermore, a faintly visible central feature on the floor is mentioned and drawn (Fig. 3 – right) and this is also shown in Aylen's image (Fig. 3 – centre). Alberto makes no mention of colour and Aylen's image is in monochrome, so we are none the wiser over the colour effects – so will therefore leave the weights of the Marshall and Cook TLPs at 3 – but the descriptions will be amended.

Maskelyne and Menelaus: On 2019 Nov 04 UT 08:01-08:20 Maurice Collins (ALPO/BAA/RASNZ) produced a whole Moon mosaic under similar illumination (±0.5°) to two TLP observations made by a past New Zealand Observer - Wheelan:

On 1969 Jul 21 at UT09:30 Whelan (Wellington, New Zealand, 10" and 6" reflectors. Other observers involved were: Mackrell (New Zealand, 6" reflector) and Spellman (4" reflector) observed Maskelyne crater undergoing a whitish glowing brightening. Shadowy filling of whole crater. Apollo 11 watch. The Cameron 1978 catalog ID=1179 and the weight=3. The ALPO/BAA weight=2.

On 1970 Apr 13 at UT09:00-09:03 Whelan (Walters, New Zealand, using a 10" reflector) observed Menelaus to have a deep red cloud that seemed to surge upward from outside the southern edge of the crater wall and disperse around the outside edge, spreading out on reaching Mare Serenitatis. All clear again though by 09:03UT, (Apollo 13 watch). Drawing supplied. Cameron 978 catalog ID=1246 and weight=3. ALPO/BAA weight=3.

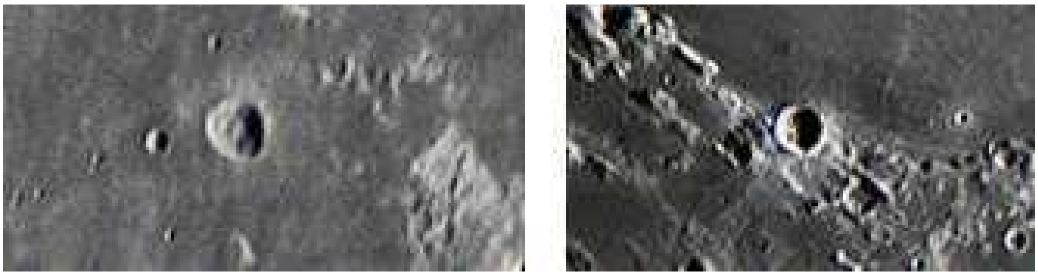


Figure 4. *Colour images from a larger mosaic of the whole Moon by Maurice Collins (ALPO/BAA/RASNZ) taken on 2019 Nov 04 UT 08:01-08:20 and orientated with north towards the top.* ***(Left)*** *Maskelyne crater.* ***(Right)*** *Menelaus crater.*

There is no sign of Whelan's whitish glowing Maskelyne (Fig. 4 – Left), though Whelan's description of a shadowy filling is correct as this is the normal appearance at this colongitude. Neither is there any sign of a deep red in Menelaus or indeed a spreading cloud (Fig. 4 – Right). Therefore, we shall leave the weights of these two TLP as they were.

Mons Piton: On 2019 Nov 05 UT 20:10 Trevor Smith (BAA) sketched this mountain peak under similar illumination (±0.5°) to the following report:

Piton 1960 Nov 27 ? UT 00:00? Observed by Schneller (Cleveland, OH, USA, 8" Reflector, x53), "Red obscuration concealing peak, @10m2 (if near SR, date is 27th; ancillary data given for 27th -- date not given)." NASA catalog weight=3 (average). NASA catalog ID #731. ALPO/BAA weight=2.

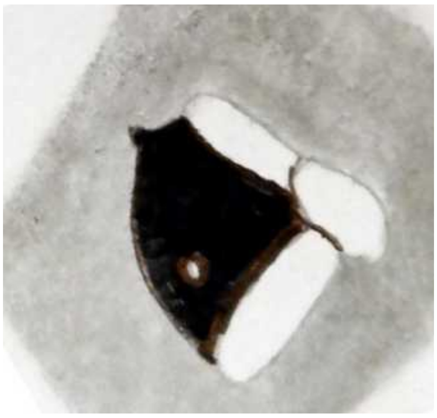


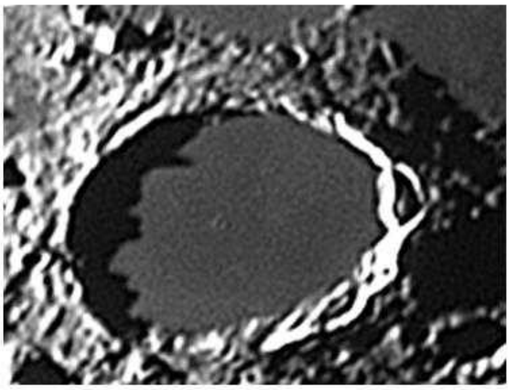
Figure 5. *Mons Piton as sketched by Trevor Smith (BAA) on 2019 Nov 05 UT 20:10 and orientated with north towards the top.*

Trevor's sketch (Fig. 5) and visual descriptive report reveal no sign of any red obscuration concealing the peak – therefore I guess we shall have to leave the weight of the 1960 report at 2 for now, but at least we have a good idea of the mountain appearance based upon Trevor's sketch.

Plato: On 2019 Nov 06 UT 02:42 Walter Elias (AEA) imaged this crater under similar illumination (±0.5°) to the following report by H.P. Wilkins and Patrick Moore:

Plato 1952 Apr 03 UT 20:45-21:30 Observed by Wilkins and Moore Meudon, France, 33" x460) whilst checking up on a 1923 28" refractor sketch by W.H. Stevenson's, thr failed to detect a prominent floor craterlet (featured in the 1923 sketch) just inside the W wall. They suspected an obscuration.

Interestingly the whole floor was reported to be lacking in detail many hours later as observed by Cragg in the USA. NASA catalog weight=5. NASA catalog TLP ID No. #550. ALPO/BAA weight=2.



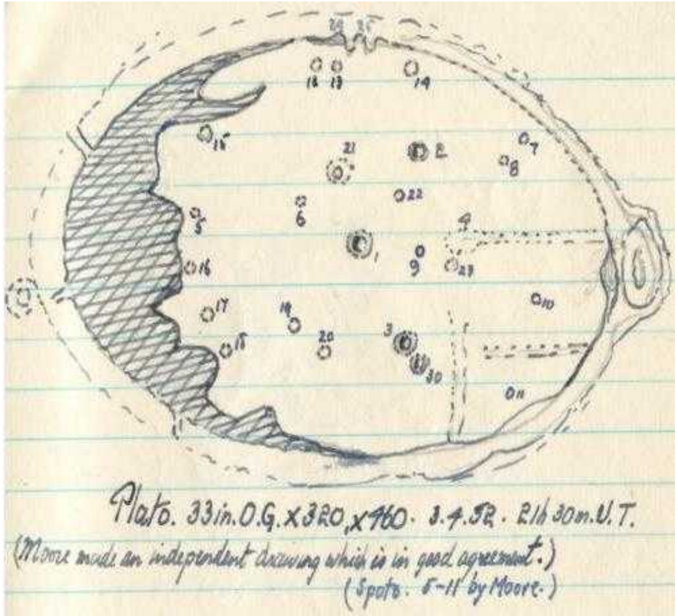


Figure 6. *Plato orientated with south towards the top.* ***(Left)*** *an image by Walter Elias (AEA) taken on 2019 Nov 06 UT 02:42.* ***(Right)*** *A sketch made by H.P. Wilkins, using the 33" Refractor at Meudon France – on 1952 Apr 03 UT 20:45-21:30 – taken from the BAA Lunar Section Circular 2011 May p.11.*

Walter, although using a was using a Celestron CPC 1100, had bad seeing on that night, and what with the size difference compared to the Meudon refractor, it is not surprising that only a central craterlet is visible in Walter's image (Fig. 6 – Left) compared to the mammoth amount of detail seen in the Wilkins sketch (Fig. 6 – Right). It just goes to show how atmospheric conditions can have a significant effect on the visibility of floor craterlets in Plato. For now, we shall leave the Wilkins and Moore report with a weight of 2.

Aristarchus: On 2019 Nov 08 UT 01:03 and 01:40-02:00 Desiré Godoy (SLA) and Jay Albert (ALPO) respectively imaged and visually observed the area around where Aristarchus should be under similar illumination (±0.5°) to the following report:

Aristarchus 1969 Jul 25 UT 02:15-03:00 Observed by Jose L. da Silva (Rio de Janeiro, Brazil, 13" refractor) "Unusual brightness whole time in center of W. inner slope; rest of crater & Herodotus appeared normal. SW to NW inner slope had pronounced brightness. Aris. still in dark! Apollo 11 watch)." NASA catalog weight=3. NASA catalog ID=1186. ALPO/BAA weight=2.

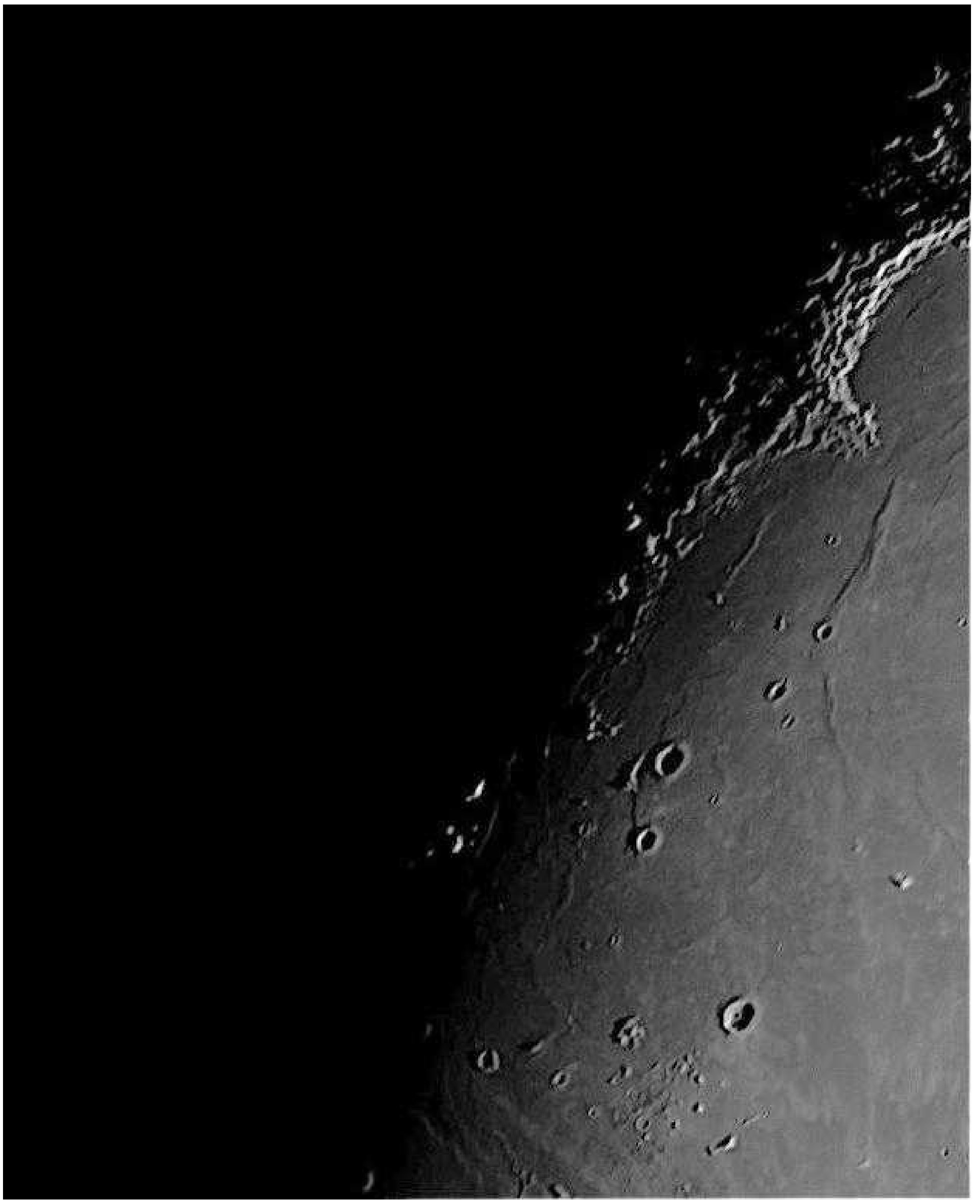


Figure *7. Montes Harbinger and Sinus Iridum, taken by Desiré Godoy (SLA) on 2019 Nov 08 UT 01:03, and orientated with north towards the top. The image has been non-linearly contrast stretched to bring out detail near the terminator.*

Jay reports that both Aristarchus and Herodotus were beyond the terminator and so could not be seen. He saw that the Sun was rising over Montes Harbinger with its E facing peaks brilliantly lit. He noted that a few of those mountains were large and could easily have been mistaken for crater rims emerging from the darkness. This is confirmed in Desiré's image, taken a little earlier in Fig. 7. With regards to Jay's theory that da Silva mistook Montes Harbinger for Aristarchus and Herodotus, this is possible, although the da Silva report is very specific about W, SW, NW slopes, which of course are not visible on Montes Harbinger. An alternative explanation is that da Silva got the date wrong and it should have been 1969 Jul 26 – this does sometime happen with observers who live many tens of degrees away from 0° longitude here on Earth. Indeed, for the 1969 Jul 25 UT 02:15-03:00 quoted by da Silva, the Sun would have had an altitude of -7.1° to -5.8° at the crater, and so would have clearly been in darkness. I will change the date from the 25th to 26th and because the original observer may have made either a feature mis-identification or date error, and will also change the ALPO/BAA weight from 2 to 1.

Plato: On 2019 Nov 08 UT 19:34 Sophie Stuart (NAS) imaged the Moon in colour and this matched similar illumination (±0.5°) to the following report:

On 1938 Mar 13 at UT 04:00-06:00 Barker (Chestnut, England, UK) noted a slight reddish colour in Plato. However, Fox (Newark, UK, 6.5" reflector, x240) saw none on the south east wall, but instead saw a yellowish glow on the southern floor at the same time (confirmation?). Apparently, Fox saw the same effect on Apr 10, 11, and May 8-11, then on June 8-10. The Cameron 2006 catalog ID=432 and the weight=5. The ALPO/BAA weight=3.

Figure 8. *Plato imaged by Sophie Stuart (NAS) on 2019 Nov 08 UT 19:34 and orientated with north towards the top. The image is a subsection from a larger whole Moon mosaic and has been contrast stretched and had colour saturation increased by 40%.*

Sophie's image (Fig. 8) shows no sign of any red on Plato, despite having had the colour saturation increased. Neither is there a yellowish glow to the southern floor. There is however a tinge of brown on the edge of the shadow on the NW floor but this is due to atmospheric spectral dispersion as it is visible on other crater shadows too. We shall therefore leave the weight at 3 as what was described back in 1938 was not normal.

Herodotus: On 2019 Nov 08 UT 20:49 Bob Stuart (UAI) imaged this area in monochrome under similar illumination (±0.5°) to the following report:

On 1989 May 17 at UT Fabian (Chicago, IL, USA, 4" reflector, x35-x50 and 8" reflector) noted a pale blue colouration in the ridges situated west of Aristarchus and north of Herodotus craters, in the vicinity of the terminator (and on the night side). Aristarchus itself did not have any colour. It was only area with such color though there were numerous others of similar elevation and relation to term. The colour was seen in a 4" Cassegrain telescope, but when an 8" reflector was used at 02:30UT, even with the same eyepieces. Cameron comments that maybe the larger telescope spread the colour out? The sketch that Fabian supplied, suggested to Cameron that the TLP was located at Herodotus, and the ridge was part of Schroter's valley - Cobra Head. The Cameron 2006 catalog ID=364 and the weight=2. The ALPO/BAA weight=2.

Figure 9. *Aristarchus as imaged by Bob Stuart (BAA) on 2019 Nov 08 UT 20:49 in monochrome and orientated with north towards the top.*

Although Bob's image (Fig. 9) is in monochrome, we can at least see the ridges west of Aristarchus and north of Herodotus mentioned in the Fabian report. So, we at least now have a good representation of what the area should have looked like back in 1989. The weight shall remain at 2 for now.

Full Moon: On 2019 Nov 12 UT 21:21 Aldo Tonon (UAI) imaged (Fig. 10) the Full Moon, a target on the Lunar Schedule web site: Aristarchus (205.6), Spot near Hell (181), Proclus (168), Tycho (164), Censorinus (159), Copernicus (140), Kepler (124) Plato (63). From this we are able to measure the relative brightness of several lunar features, some of which it has claimed have varied in brightness. Interestingly on this occasion Aristarchus comes out brightest, whereas in the November newsletter, Censorinus was brightest and Aristarchus ranked 4th on the list. Full Moon is thought to be a good time to study the brightness of lunar features as the measured brightness is supposedly directly proportional to albedo. However, Full Moon is also a time when there is an exponential-like increase in the lunar phase function occurs, so phase angle photometric effects may be having a big effect on the relative brightness of features and this is dependent upon the alt/az of the Sun (and observer) as seen from the feature concerned. We are gradually building up a set of imagery of the Full Moon under lots of different topocentric librations and selenographic colongitudes/sub-solar latitudes.

Figure 10. *The Full Moon as imaged by Aldo Tonon (UAI) on 2019 Nov 12 UT 21:21 and orientated with north towards the top.*

Aristarchus: On 2019 Nov 14 UT 02:54 Victoria Gomez (AEA) imaged the crater in colour under similar illumination (±0.5°) to the following two reports:

Aristarchus (Bartlett, 1965 Oct 12 UT 02:15-20:25, 5-inch reflector x280) - NASA catalog quotes "Nimbus was only a dark violet hue". NASA catalog weight=4. NASA catalog ID #904. ALPO/BAA weight=1.

Aristarchus 1975 Feb 27/28 UT 22:00-01:00 Observers: Robinson (Teignmouth, England - 10" reflector), Fitton (Lancashire, England - 8" reflector), Amery (Reading, England - 8" reflector), Mills Observatory (Dundee, Scotland, 10" reflector) - NASA catalog states: "Robinson at 2200h got blink on E.wall, strong at 200x till 2225h. (Fitton) at 2200h (moon low) at 200x saw vivid blue to N., vivid yellow & orange to S. in Aris., Proc., Menelaus, & many other bright craters til 2300h. Then Aris. less blue & mare obj. no colors. No blinks in these craters. No obscur. Polariz. normal till 2330h using many rotations. At 2330h Aris. blue in N. but fainter. Only Proc. remained blue till 0020h (28th). Photo-electric scan at 2340h was normal for Aris. (600 microamps) compared with Tycho (900 microamps), total of 10 scans. all neg. with 15km resolution. Blink neg. but blue still vis. in N. in white light till 0030h. At 0100h (S=III at 200x) Proc. clear of blue, Aris. nearly *clear, blink neg. (Amery) at 2310h saw blue on N.rim of Aris., no color in other craters at 300x. No blink in Aris. S. part of Aris. indistinct but abnormal. No blink till 2350h. (Mills Observatory) at 0000h checking rep'ts got blink in S.part of Aris. Blue only in N.part. Similar blue in bright craters in E.hemisphere & blue halo on S.limb till 0020h. Concluded due to optical effects. Fitton says due to atm. effects from high press. sys. W. of obs (blue on one rim & red on other due to chrom. aberr. ? If spurious, should get no blink & similar crater conditions should exhibit same phenomena all over Moon). NASA catalog weight=5. NASA catalog TLP ID No. 1400. ALPO/BAA weight=3.*

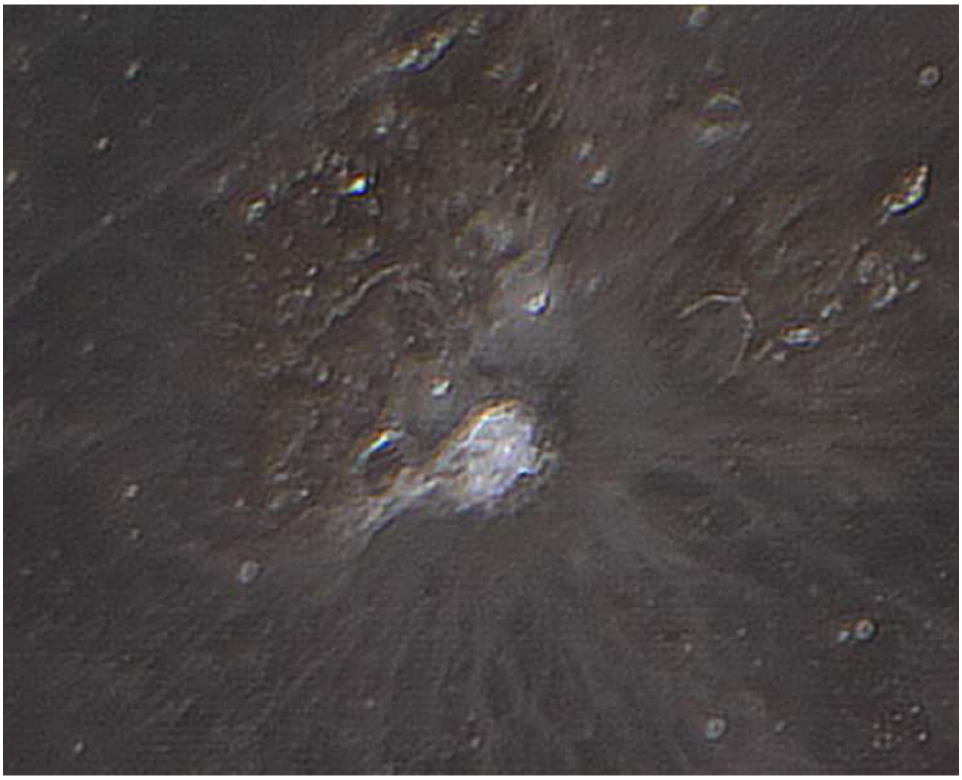


Figure 11. *Aristarchus as imaged by Victoria Gomez (AEA) on 2019 Nov 14 UT 02:54, with colour saturation increased to 30% and orientated with north towards the top.*

Victoria's image (Fig. 11) shows up some of the brown Oceanus Procellarum colour and a slightly stronger brown for the Aristarchus plateau. Aristarchus itself has a very slight blue cast, but not as much as I have seen in other colour images and certainly does not replicate much of what was described in the 1965 and 1975 reports. We shall therefore leave the weights of these TLP as they are for now.

Aristarchus: On 2019 Nov 14 UT 04:19 & 04:21 Sebastian Moreyra (AEA) imaged the crater in colour under similar illumination (±0.5°) to the following two reports:

On 1981 Oct 15 at UT06:03-05:51 D. Louderback (South Bend, WA, USA, seeing=1-2 and transparency=5) The Cobra Head had a brightness of 8, though normally it should be less than 7. The Cameron 2006 catalog ID=156 and weight=3. ALPO/BAA weight=1.

On 1992 May 19 at UT 01:00-02:05 P. Moore (Selsey, UK, 15" reflector, x260) saw at 01:25UT an unmistakable red-orange glow on the south and south-east rim with the "Spur". Apparently, Chapman (Kent, UK) detected it easily. At 01:33UT the colour was barely visible. No TLP alert was issued because the southern edge of Mons Pico also exhibited a hint of colour, and anyway the seeing conditions were poor. Despite this no other features revealed colour. The Cameron 2006 catalog ID=446 and the weight=0. The ALPO/BAA weight=1.

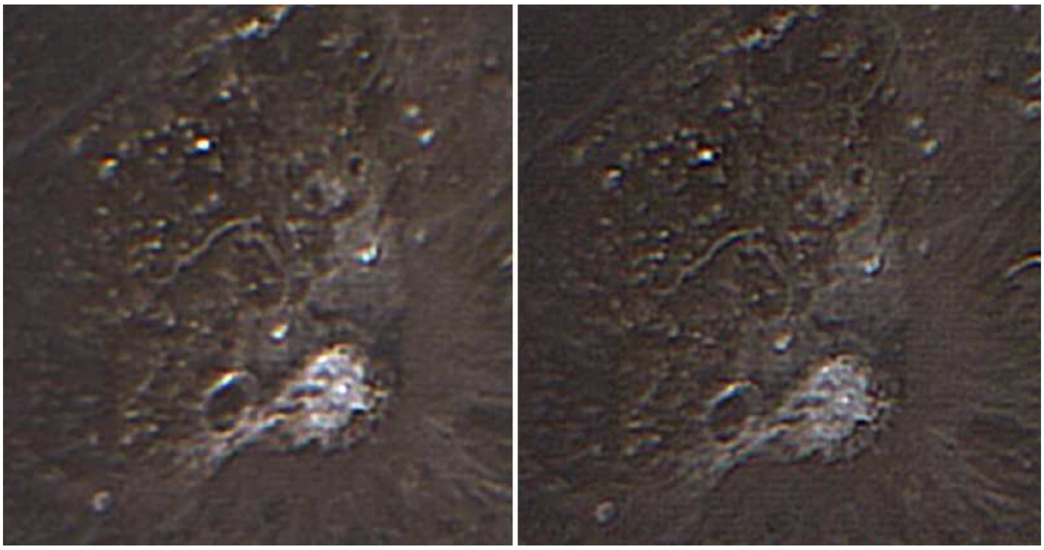


Figure 12. *Aristarchus as imaged by Sebastian Moreyra (AEA) on 2019 Nov 14 UT. Orientated with north towards the top and colour saturation increased to 30%.* ***(Left)*** *04:19 UT view.* ***(Right)*** *04:21 UT view.*

Concerning Louderback's remark that the Cobra's Head had a visual brightness of 8 whereas it is usually 7, as you can see from Sebastian's example images (Fig. 12) the Cobra's Head is a bit fainter than the central peak of Aristarchus. However, quibbling over whether it is at a visual intensity of 7 or 8 seems a bit pointless considering the effect that blurring in our atmosphere has on point-like features. I will therefore lower the weight from 1 to 0 and remove it from the ALPO/BAA database.

With regard to the Moore TLP, Fig. 12 shows no red on the S and SE rims – if anything perhaps a hint of blue on the SE and red on the NW. For now, we shall leave the weight at 1.

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

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