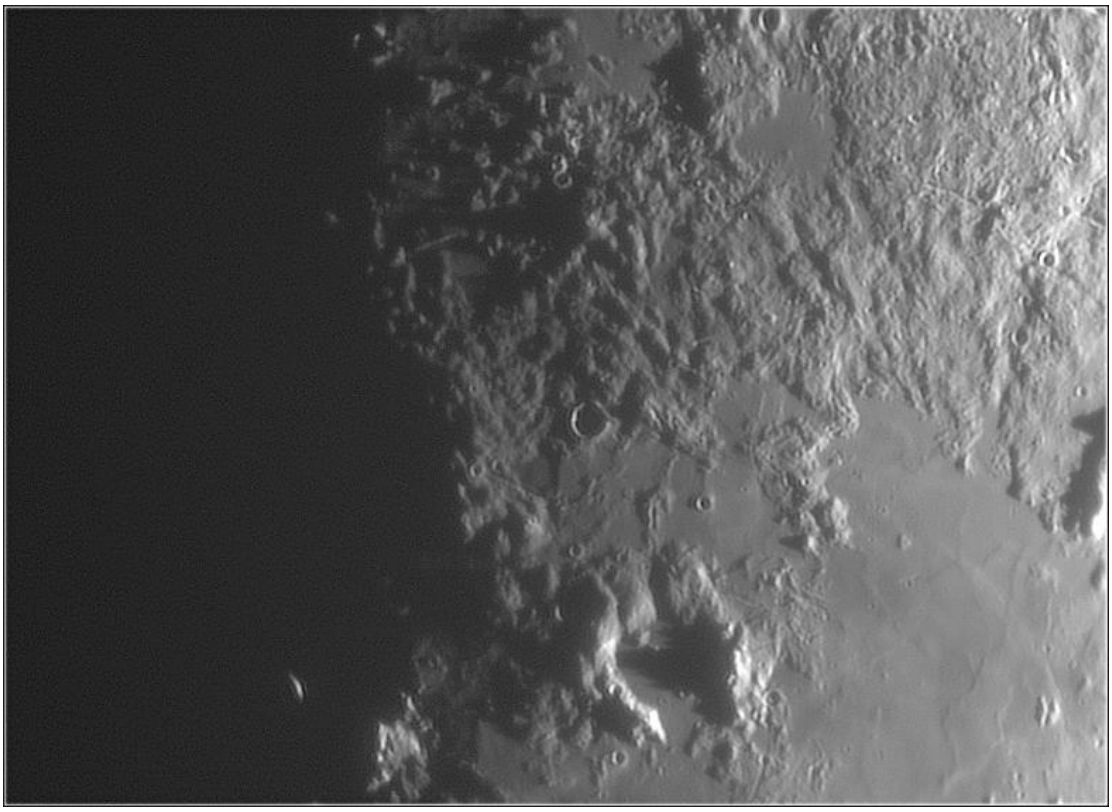
Director: Bill Leatherbarrow

LUNAR SECTION CIRCULAR

Vol. 58 No. 5 May 2021

FROM THE DIRECTOR



Gruithuisen's 'Lunar City', 21 March 2021 (image by Bill Leatherbarrow)

Over the centuries since the invention of the telescope many unusual structures have been reported on the surface of our Moon, ranging from 'disappearing' craters such as Linné to vast bridges spanning the shore of the Mare Crisium. Julius Schmidt's

announcement on 16 October 1866 that Linné, previously recorded by him and others as a 'deep crater, with a diameter of 5.6 English miles,' had disappeared to be replaced by a 'small whitish cloud' may indeed have shocked the selenographical world, but it is now clear that earlier observations had been inadequate. Likewise, John J. O'Neill's 1955 observation of a 'bridge' in the Mare Crisium turned out to be another trick of the eye. Nevertheless, such 'discoveries' do at least have the effect of stimulating interest and pricking the imagination.

Perhaps the most unusual and eccentric of such reports was that of the enthusiastic but odd Bavarian observer Franz von Paula Gruithuisen, who on 12 July 1822, using a 2.4 inch refractor, found nothing less than a lunar city. He recorded a series of regular ramparts that he termed the *Wallwerk* and ascribed to the construction activities of the Moon's inhabitants. The main axis of the structure runs approximately north-south and is located not far from the lunar meridian. Gruithuisen's sketches of it show a distinctive structure similar to the veins in a leaf.

Gruithuisen's Wallwerk, shown here with north up

Unlike O'Neill's bridge, Gruithuisen's *Wallwerk* can at least be recognisably identified when the lighting conditions are just right. It is located north-northwest of the crater Schröter and its southern tip is marked by the small 9.5km crater Schröter W. It may be seen just above centre in the Director's image on the front page of this issue.

Nigel Longshaw has written an excellent essay on Gruithuisen and his *Wallwerk*, which appeared in Volume IV (March 2016) of the Lunar Section publication *The Moon: Occasional Papers.* This is available to members on the BAA website at:

https://britastro.org/system/files/The%20Moon%202017-03.pdf

As Nigel points out the appearance of the *Wallwerk* is critically dependent upon just the right lighting conditions, with the result that it does not show well on most imagery from spacecraft. Also, it can give the impression of regularity most strikingly in small-aperture telescopes such as that used by Gruithuisen. The extra resolution

and detail yielded by large instruments can mean that the overall structure is lost in a maze of detail.

I recommend observers, visual and imaging, to read Nigel's paper and to attempt to capture Gruithuisen's elusive city on the Moon.

Bill Leatherbarrow

OBSERVATIONS RECEIVED

This month observations have been received from the following contributors:

Paul Abel, Leo Aerts (Belgium), David Arditti, Paul Brierley, Maurice Collins (New Zealand), Dave Finnigan, Rik Hill (USA), Rod Lyon, Phil Masding, Luigi Morrone (Italy), Mark Radice, Alexander Vandenbohede (Belgium), and the Director.

A reminder:

I would ask members who contribute their images to the BAA Members' Pages to copy them also to me if they wish them to be included in the Section archive and considered for the Section Circular.

This makes things a little easier for me, but it also avoids possible confusion, since I am aware that some BAA members are happy to post their work on their own pages, but do not necessarily want to participate in the activities of the Section.

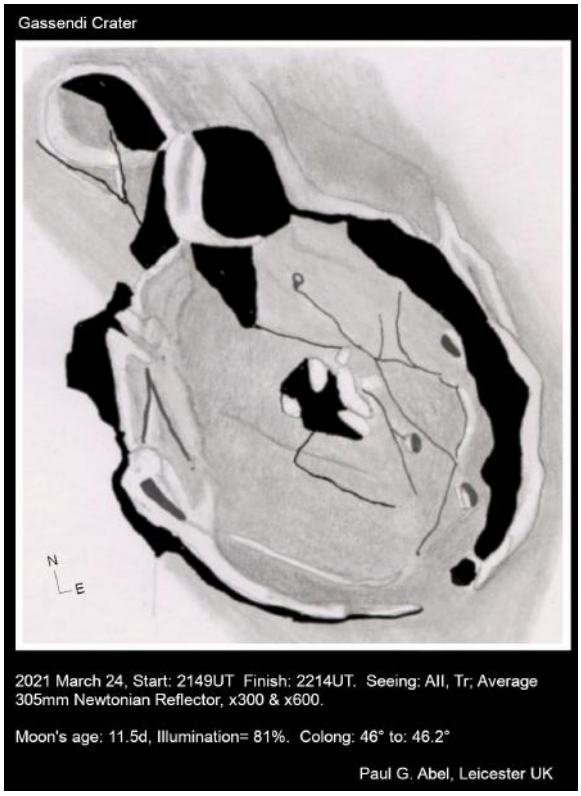
GASSENDI B – AN INTERESTING OBSERVATION Paul G. Abel

On 2021 March 24th, we had some very good seeing conditions (in fact it had been a run of three clear nights with good conditions) and I decided to make an observation of Gassendi crater, which at the start of observation was not far from the terminator. Using my 305mm Newtonian at powers of x300 and x600, I obtained some splendid views of Gassendi and in particular the rilles which cover the floor.

Towards the end of the observation, my attention was drawn to Gassendi B (this is the uppermost crater in my drawing). What stuck me was what I took to be a thin rille which seemed to pass out of the shadow of Gassendi A and proceed up to Gassendi B whereby it seemed to pass of the SW wall of B and down on to the crater floor close to the shadow. There was also some brighter material on the SW nearby.

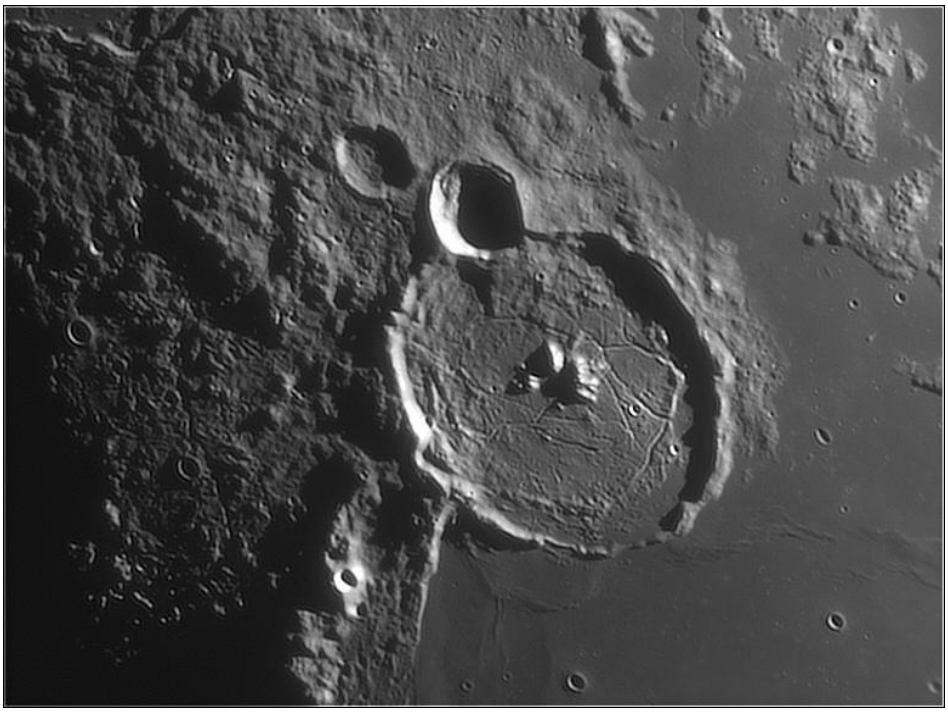
I had never seen anything like a rille system in this region and I was so taken by its presence that I added Gassendi B to my drawing and put in the rille as I observed. Once indoors I examined various images (both amateur and spacecraft) of the region and to my surprise there was no rille system present! Indeed, an examination of the region in Quickmap shows there is no rille in the area, however there is something

which looks like a crack or slump in the wall of B which, under the correct illumination may have given rise to the appearance of a rille.



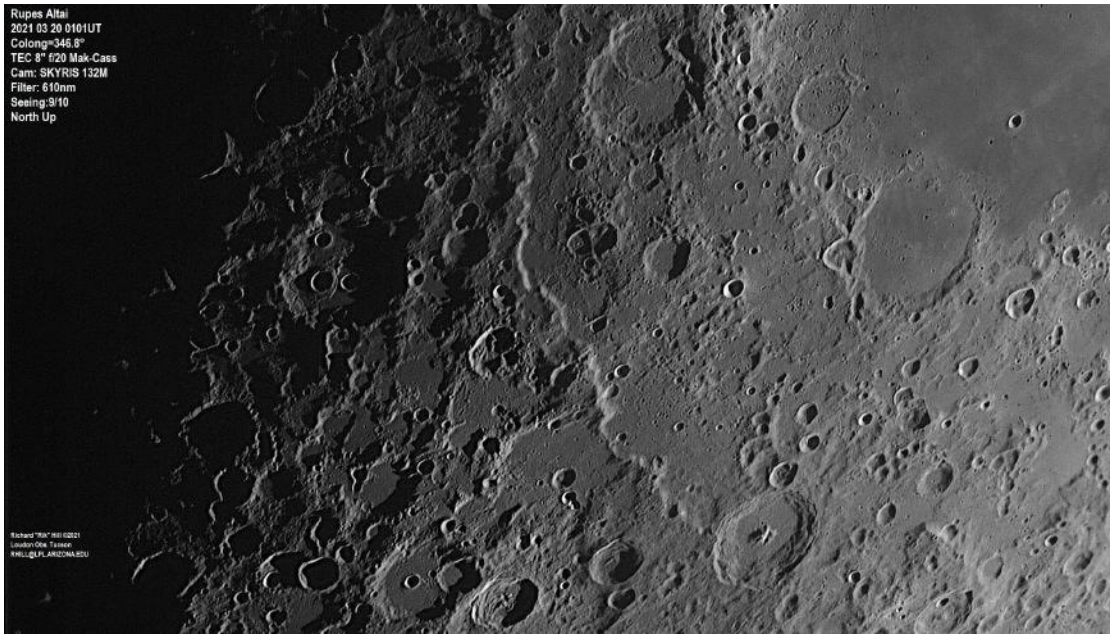
It would be interesting to see if anyone in the Section had made observations of this region under a similar angle of illumination to see if this is indeed the answer.

The Director imaged this region shortly before Paul's drawing, at 21:19 UT:



RUPES ALTAI Rik Hill

Beset by clouds and winds for weeks now, I've gone back to the superb night March 19/21 when I found Rupes Altai, or the Altai Scarp as us old-timers once knew it, near the terminator showing off many wonderful treats that lie south of Theophilus. First is the anchor of the rupes at the bottom of the image just right of center, Piccolomini (90km diameter) with its spectacular stepped or terraced inner walls. To the left of Piccolomini is the smaller Rothmann (43km) with the heart shaped Rothmann B just below it. Farther on is Lindenau (54km). The scarp or rupes itself runs from Piccolomini north for some 495km terminating west or left of the crater Catharina (104km) at the top of the image, and is 1km high for much of its length. Below Catharina is the flat floored crater Polybius (43km) and west of it are two merged craters Polybius C and F (29km and 21km respectively). Notice the straight shared wall between them.

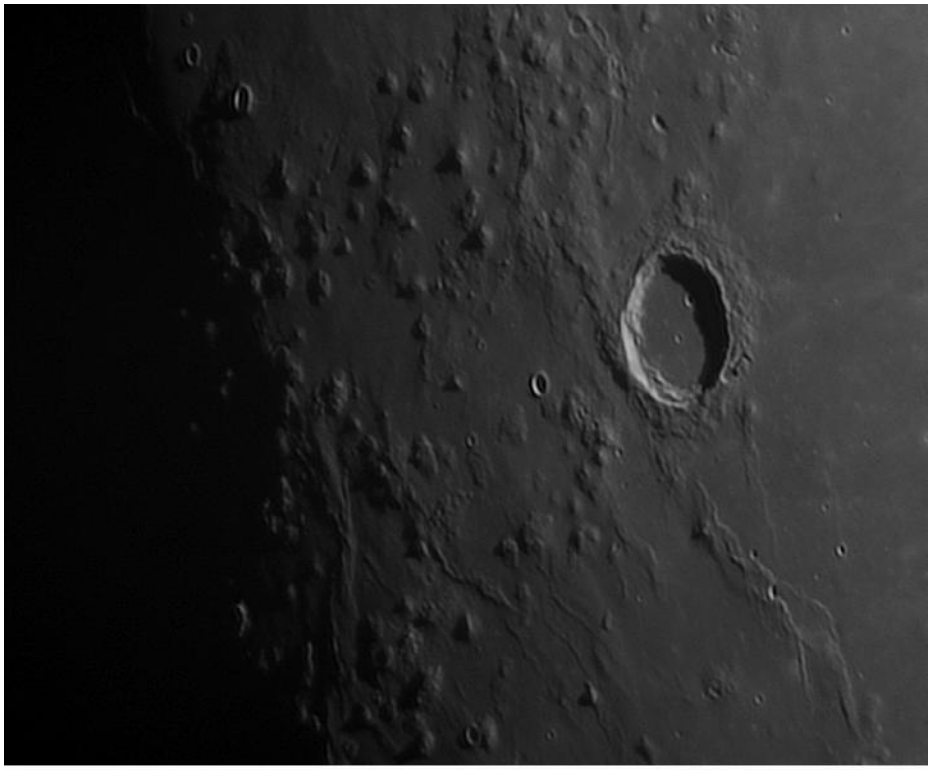


Another dominant feature in this crowded image is the 'U'-shaped Fracastorius (128km) east (right) of Catharina on the southern shore of Mare Nectaris. With this lighting you can see the skinny rille on its floor. The rille is only 1-1.5km across! Between Fracastorius and Catharina is a small copy of Fracastorius, Beaumont (54km) peppered with 1-3km secondary craterlets from the great Theophilus impact event to the north.

There is so much going on west of the scarp that it is impossible to detail it here but you can enjoy it and get out your atlas or go to the LROC QuickMap website and explore away!

Editor's note: Rik's image also shows well a D-shaped crater between Polybius and the Rupes Altai. This is Polybius K, known informally as 'Larrieu's dam', discussed by Nigel Longshaw in his paper 'Larrieu's Dam; the "rediscovery" of a seldom explored topographical lunar feature in the foothills of the Rupes Altai', *Journal of the British Astronomical Association* 118 (March 2008):87-90.

IMAGES GALLERY

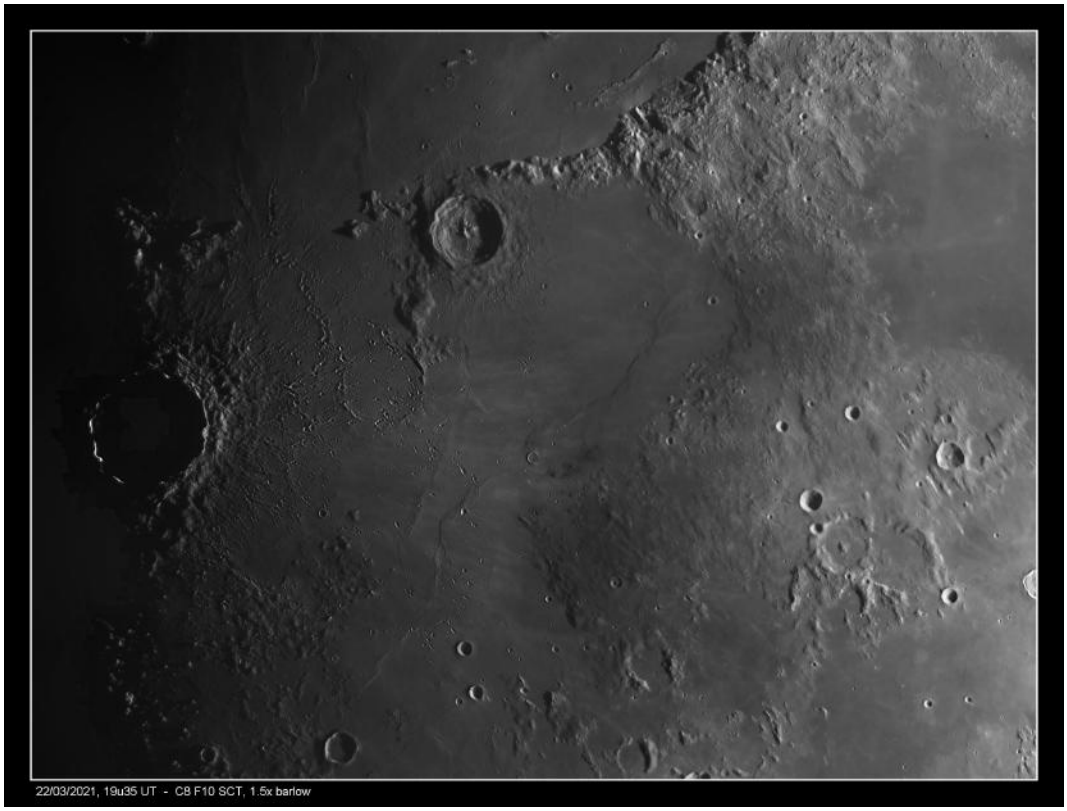


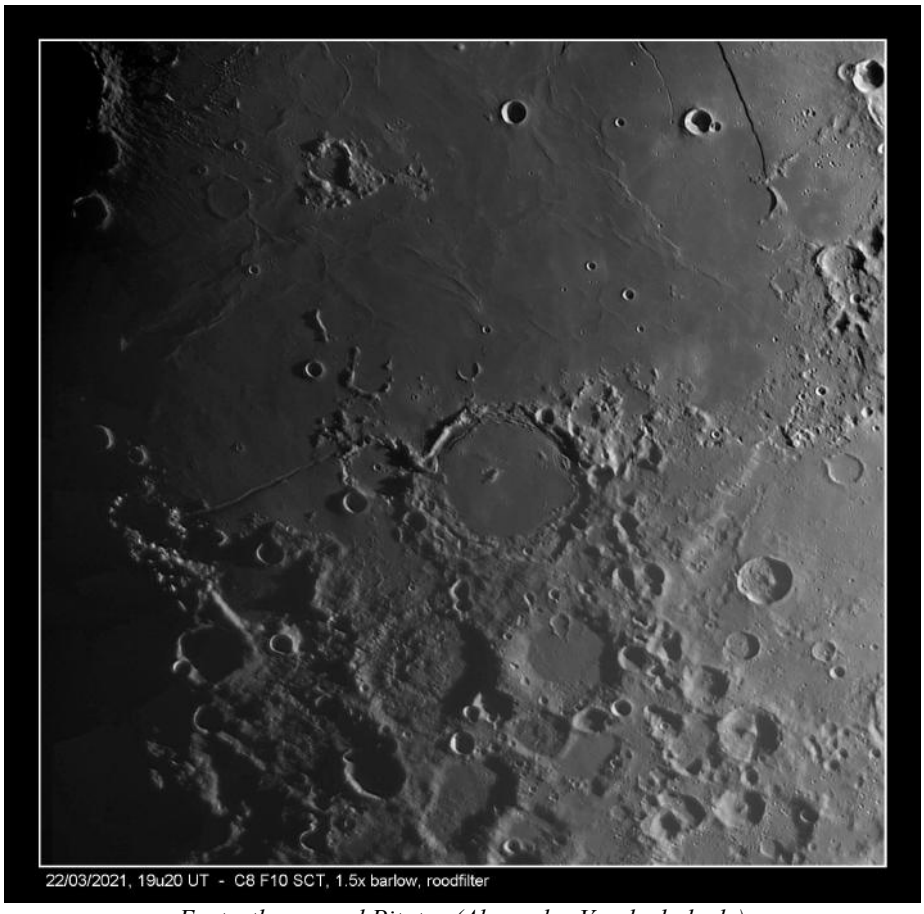
Marius and the Marius Hills
25 March 2021 2112Z
C11 f20 ASI224MC 685nm IR filter
Mark Radice RefreshingViews.com

Langrenus
28 February 2021 2245Z
C11 f20 ASI224MC 685nm IR filter
Mark Radice RefreshingViews.com

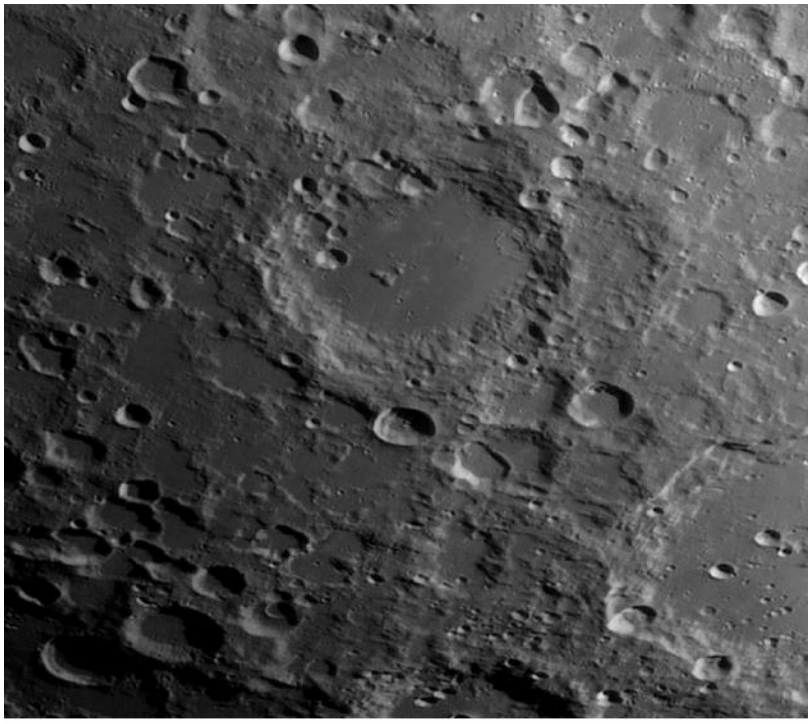

Rima Marius
2021-03-26 (yyyy-mm-dd) 19:56 UT
SCT C14 Edge HD 355mm Fornax Mount Camera ZWO ASI 174M - Barlow Zeiss Abbe
Baader R+IR Filter 610nm
© Luigi Morrone
Site Agerola - Italy


Reiner Gamma
2021-03-26 (yyyy-mm-dd) 19:48 UT
SCT C14 Edge HD 355mm Fornax Mount Camera ZWO ASI 174M - Barlow Zeiss Abbe
Baader R+IR Filter 610nm
© Luigi Morrone
Site Agerola - Italy





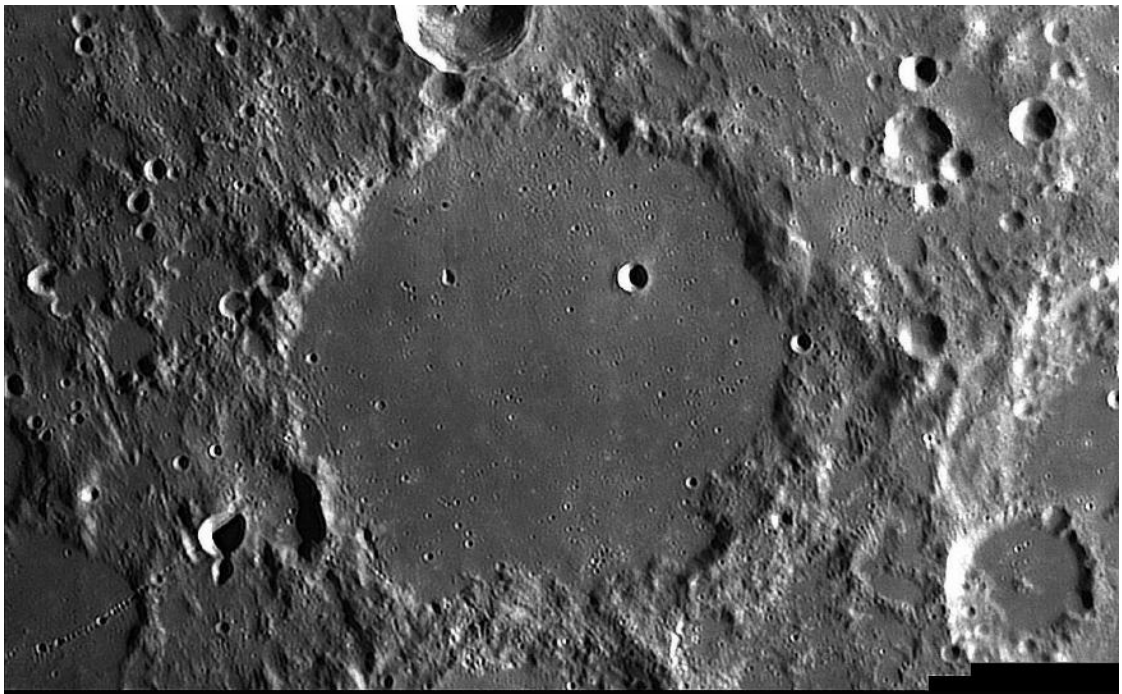
Eratosthenes and Pitatus (Alexander Vandenbohede)



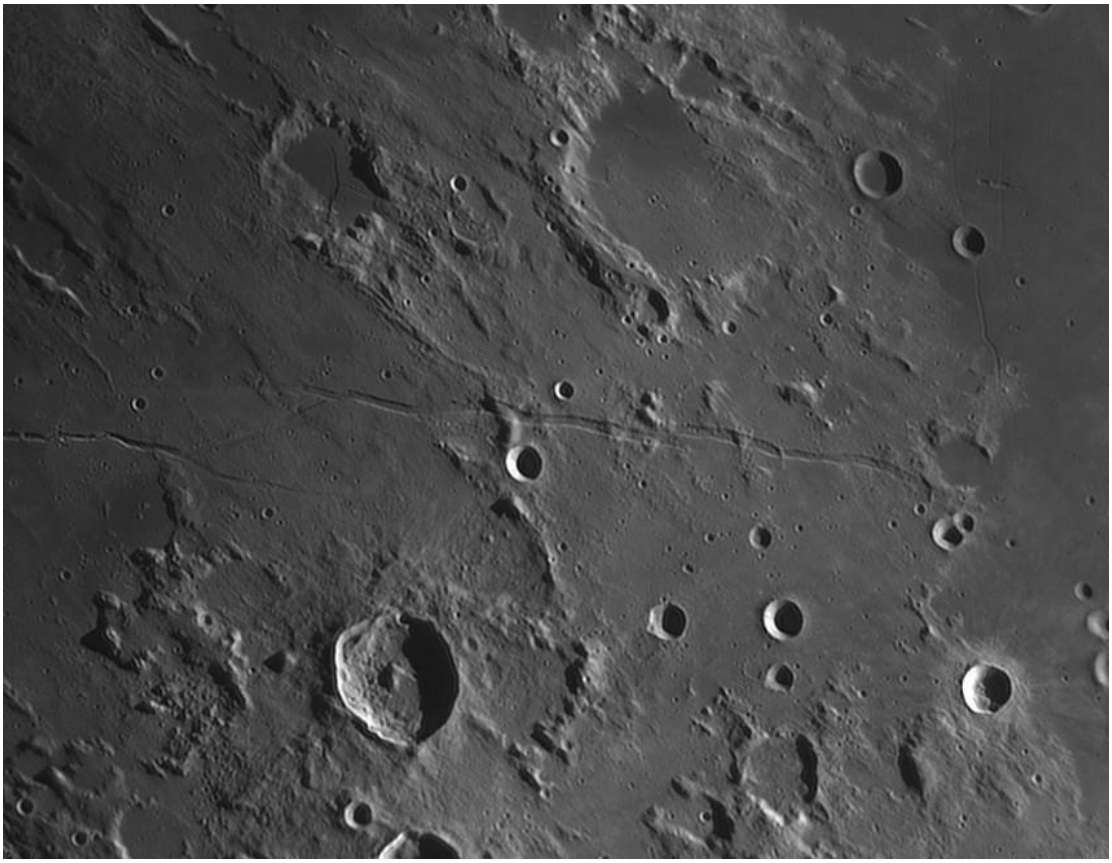
Longomontanus 2021.03.24 - 19.20 UT
300mm Meade LX90, ASI 224MC Camera with Pro Planet 742nm I-R Pass Filter. 300/3,000 Frames. Seeing: 8/10, very slight haze.
Rod Lyon

Rümker_2021-03-26_0807UT (Maurice Collins)

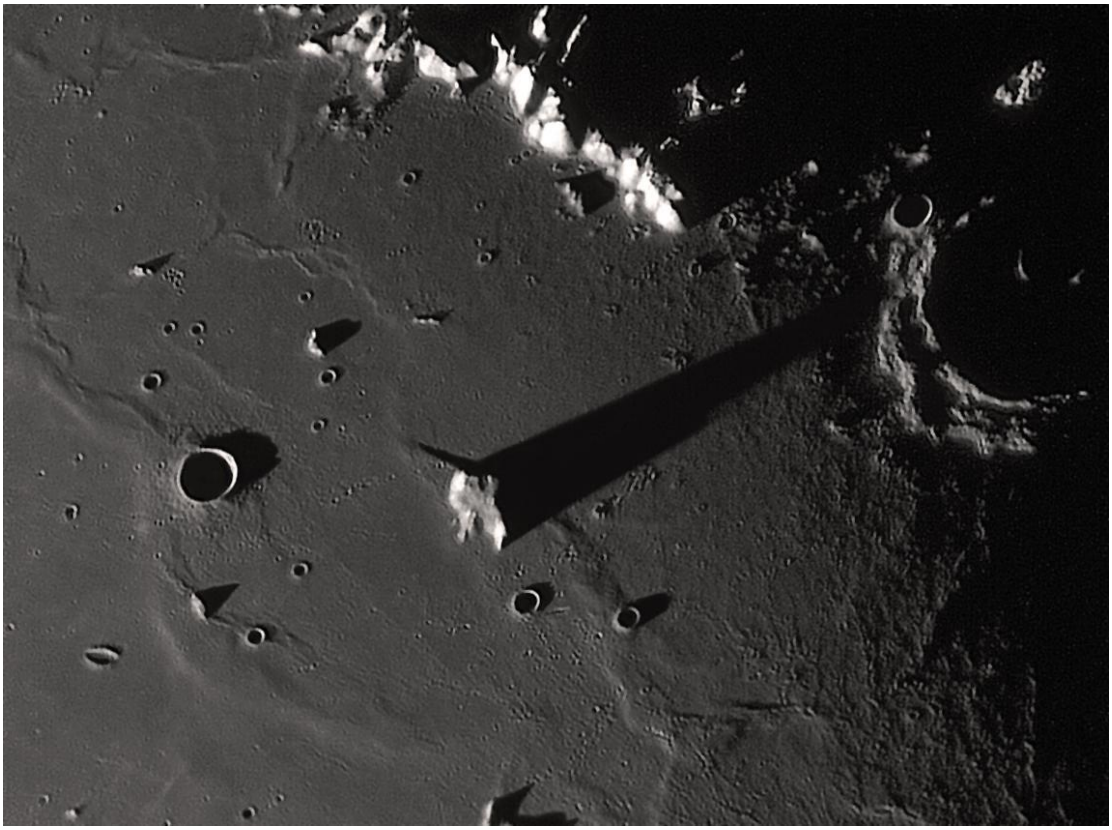
Copernicus, Stadius, Eratosthenes, 2021 March 22 19:57. C14 f/11, FLIR Chameleon 3, IR 742nm. David Arditti, Stag Lane Observatory, Edgware, Middx.



Ptolemaeus, Müller, Catena Davy 2021.03.22 20:16-18 UT, S Col. 20.8, seeing 6/10, transparency very good.
Libration: latitude -03°06', longitude -06°55'
305mm Meade LX200 ACF, f 25, ZWO ASI 120MMS camera, Baader IR pass filter: 685nm.
A composite of 3 images, 2400 frames processed in Registax 6 and Paintshop Pro 8.
Dave Finnigan, Halesowen

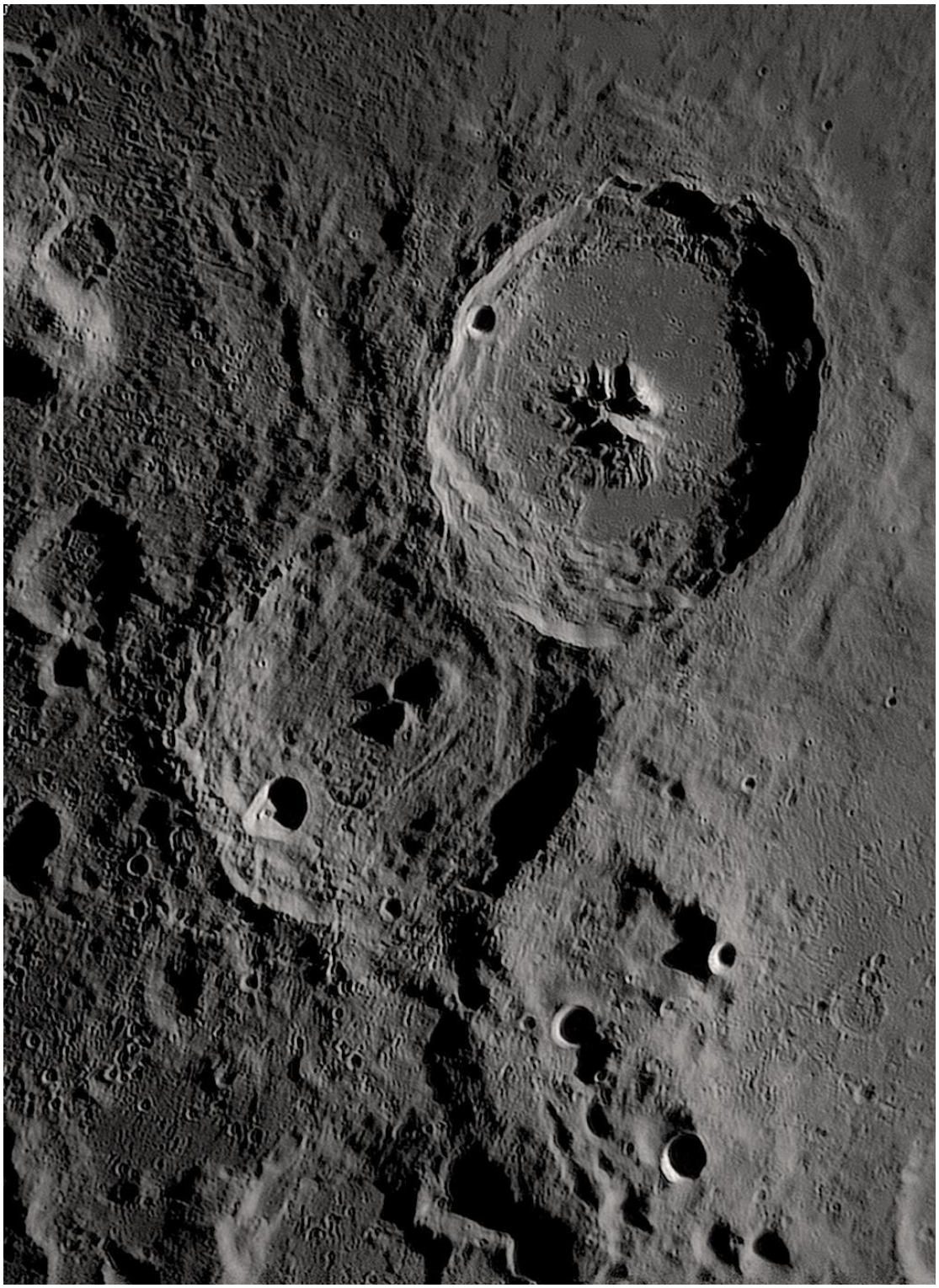


Rima Ariadaeus, 2021-04-19, 250mm SCT (Phil Masding)



Mt Piton, 2016-08-16, C14 SCT (Leo Aerts)

Leo Aerts has spent some of the cloudy winter nights reworking some of his older captures. The previous page depicts a dramatic sunset over Mt Piton. The image of Theophilus (below) Leo considers one of his best.



LUNAR DOMES (part XLVII): Domes in Mare Undarum Raffaello Lena

In this contribution I examine five lunar domes in Mare Undarum. Four domes termed Condorcet 1–4 are located between the craters Condorcet P and Dubyago, immediately east of Dubyago V and W. The fifth dome, termed Dubyago 3, is located about 35 km further south (Fig. 1).

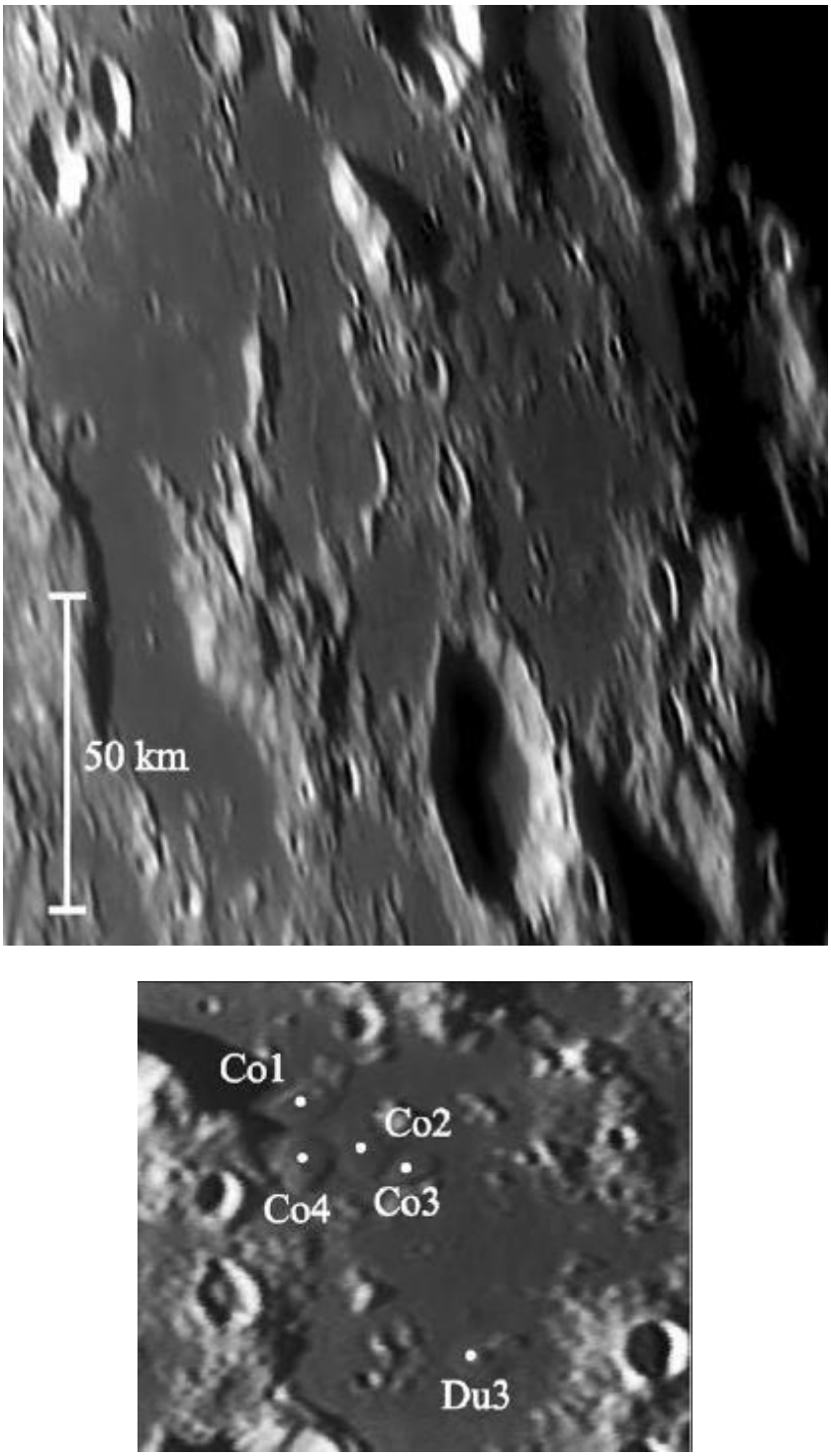


Figure 1: Image of the examined domes taken by Paolo Lazzarotti with a Gladius CF 315, termed Condorcet 1-4 and Dubyago 3.

The region under study is situated in a major trough concentric to the Crisium basin. The domes Condorcet 1–3 are aligned radially with respect to the Crisium basin. Similar dome configurations aligned radial to major impact basins are known from other lunar mare dome fields (Lena et al., 2013).

The spectral signature of the domes derived from Clementine UVVIS imagery reveals that they consist of basaltic lava with a low TiO_2 content below 2 wt% and with a FeO content around 10 wt%. Three examined domes exhibit highland components in their soils, which is attribute to lateral mixing between the material in the mare ponds and the surrounding highland material due to random impacts (Lena et al. 2008).

All five domes have moderate diameters between 10 and 12 km. Condorcet 1-3 are similar to effusive domes of intermediate flank slope between 1° and 2° like those situated in the Hortensius/Milichius/T. Mayer region, while Condorcet 4 has a steeper flank slope of 2.8° and a large volume. Dubyago 3 displays an average slope of 0.9° (Table 1). The Condorcet domes are also prominent in the WAC imagery shown in Fig. 2.

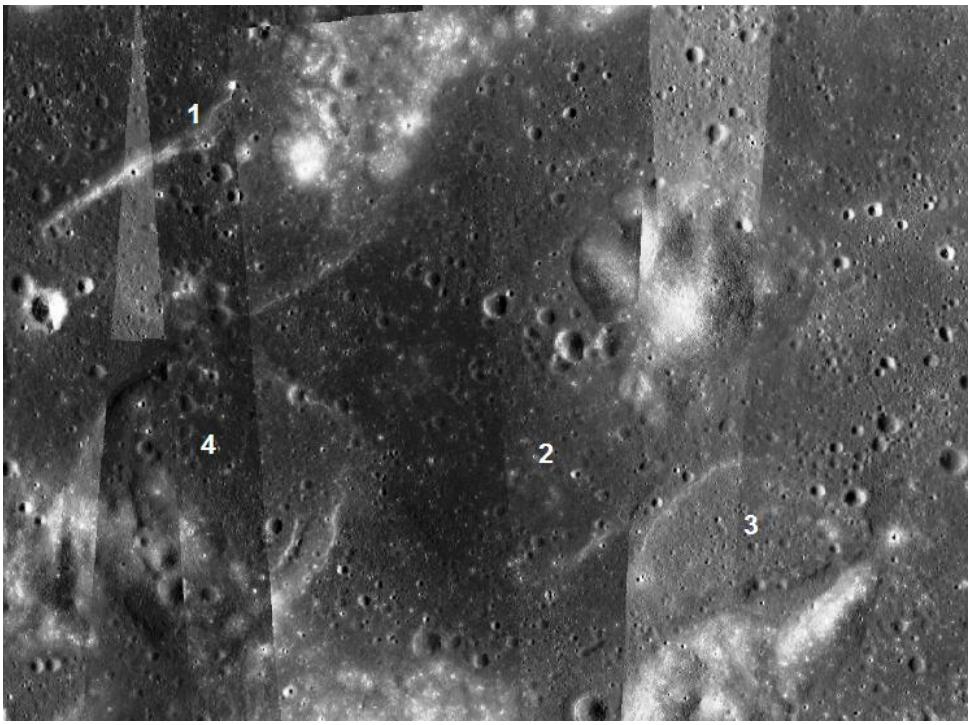


Figure 2: WAC imagery of the examined domes, termed Condorcet 1-4.

Table 1: morphometric properties

Dome	Latitude (°)	Longitude (°)	Diameter [km]	Slope [°]	Heigth [m]
Condorcet 1	06.71	70.30	9.7± 0.5	1.77± 0.2	150± 20
Condorcet 2	06.73	70.64	10.3± 0.5	1.45± 0.2	130± 15
Condorcet 3	06.67	70.93	11.2± 0.5	1.13± 0.2	110± 15
Condorcet 4	06.72	70.30	11.1± 0.5	2.78± 0.2	260± 30
Dubyago 3	05.54	71.30	9.0± 0.5	0.9± 0.1	90± 10

I have recently used a nearly global lunar DEM, comparing the results to old previous measurements (Lena et al., 2008, Lena et al., 2013) described above (Table 1). ACT-REACT Quick Map tool is thus used to access the LOLA DEM dataset, allowing us to obtain the cross-sectional profiles (Figs 3-6).

Note the agreement of the measurements carried out on the telescopic image and the LOLA DEM. The similar values and overlapping error intervals (±10%) indicate a good reproducibility of the dome heights using different image data (LROC data and telescopic images).

The 3D reconstruction (Fig. 7) is obtained using WAC mosaic draped on top of the global WAC-derived elevation model (GLD100).

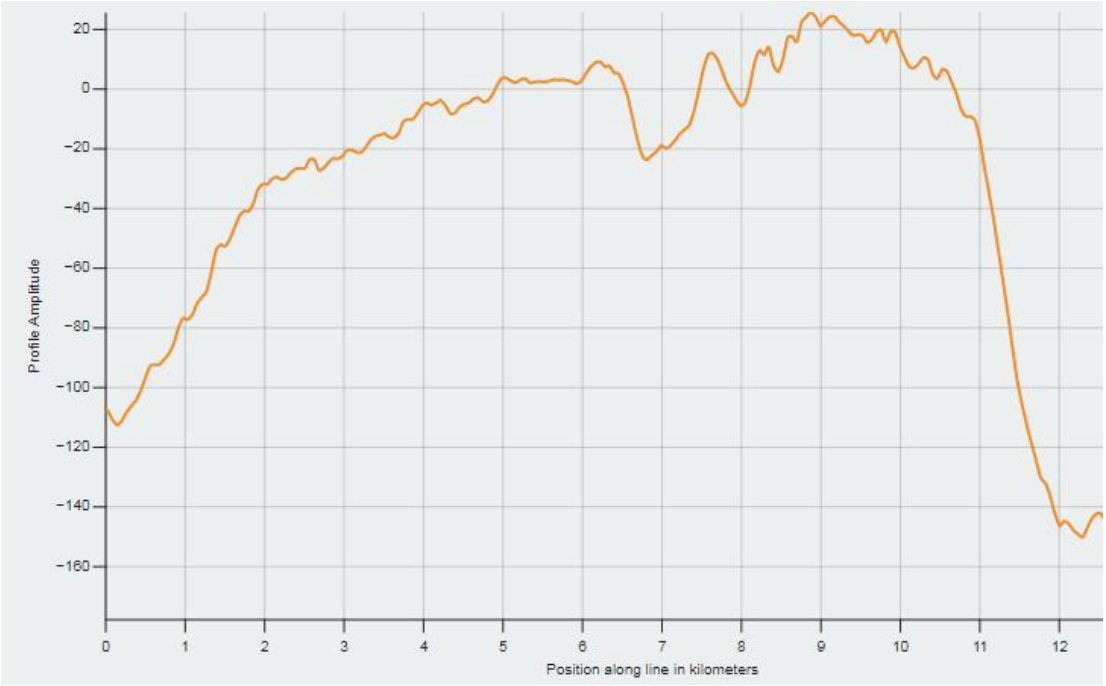


Figure 3: Sectional profile in E-W direction of Condorcet1based on LOLA DEM.

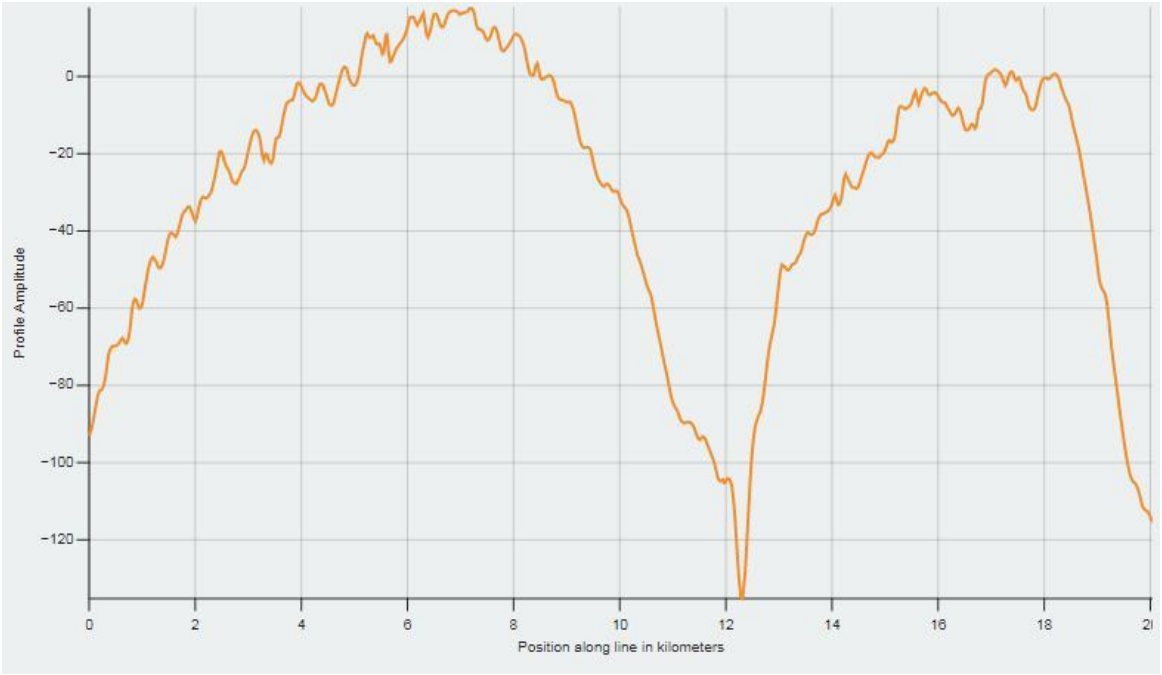


Figure 4: Sectional profiles in E-W direction of Condorcet2 and 3 based on LOLA DEM.

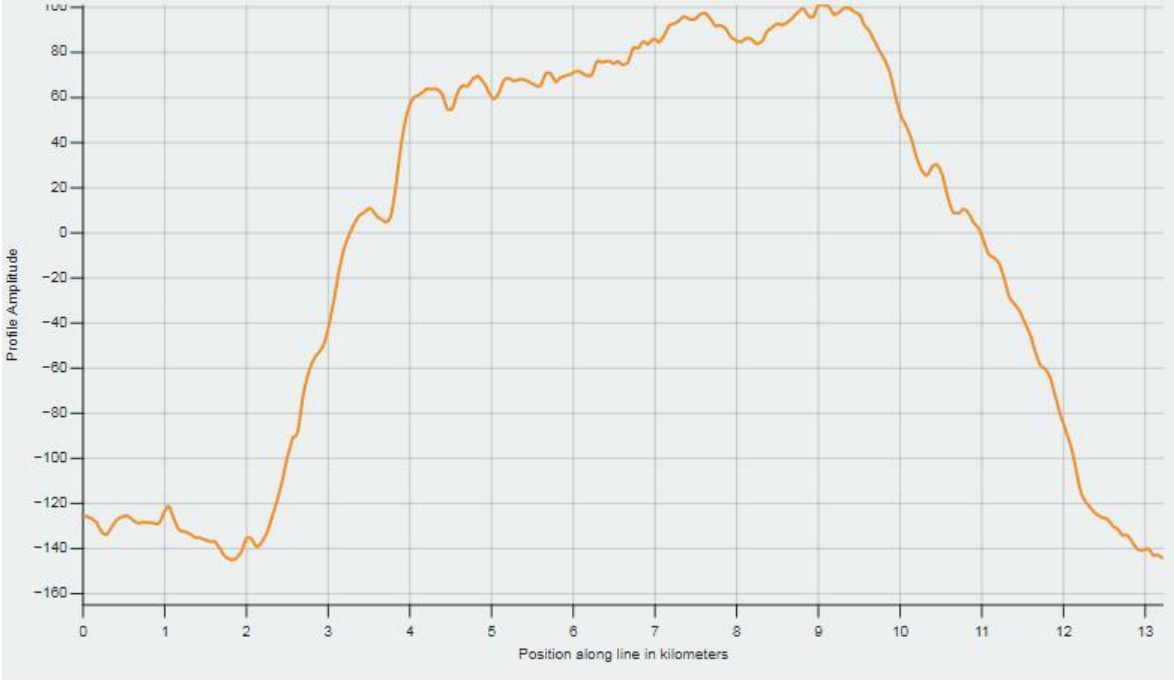


Figure 5: Sectional profile in E-W direction of Condorcet4 based on LOLA DEM.

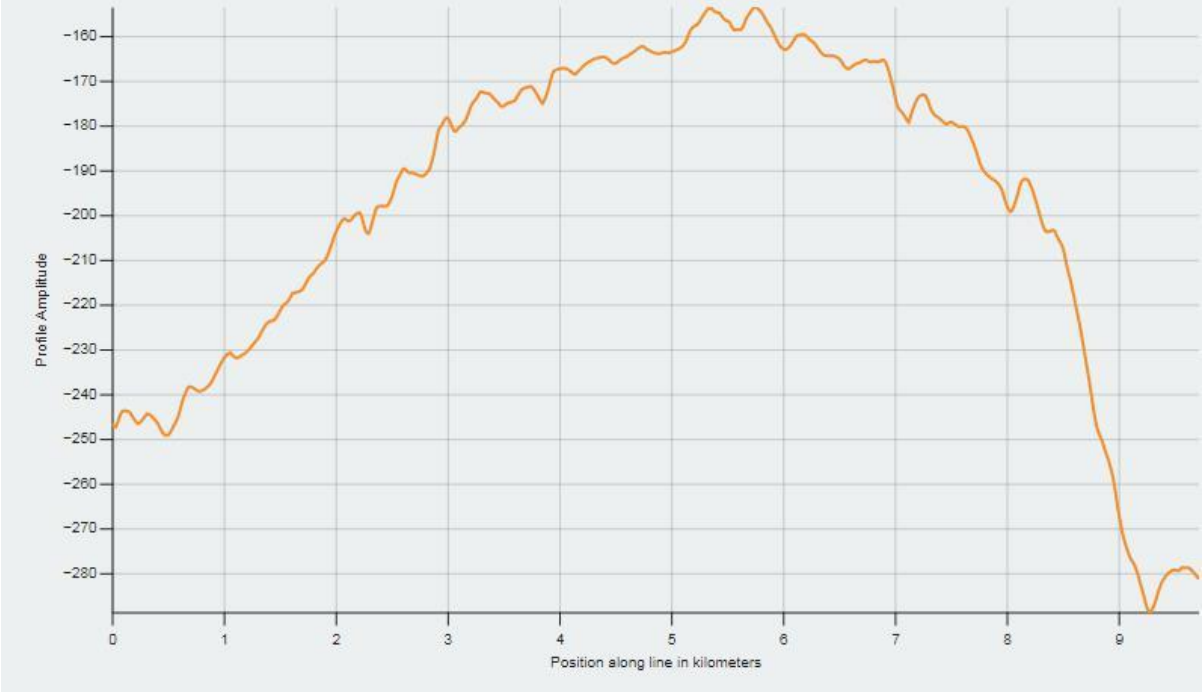


Figure 6: Sectional profile in E-W direction of Dubyago3 based on LOLA DEM.

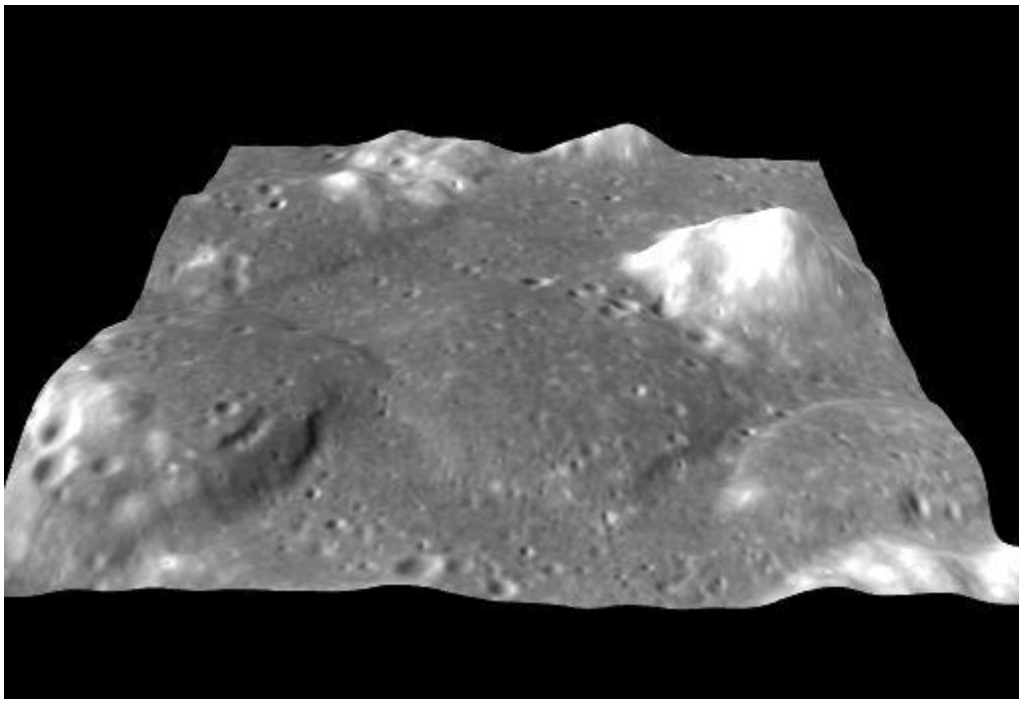


Figure 7: 3D reconstruction obtained with GLD 100 dataset of the Condorcet domes which are prominent.

The steeper dome Condorcet4 clearly belongs to class B_1 while its neighbour Condorcet2 with its low flank slope and rather low edifice volume belongs to class B_2.

The dome Condorcet 1 is of class B_2 with some tendency towards class C_1, while the low dome Condorcet 3 is a typical class C_1 representative with respect to its

morphometric properties. Condorcet 3, which belongs to class C_1, shows a shallow flank slope mainly due to the low viscosity of the lava from which it formed and the high lava effusion rate.

The dome Dubyago3 can be assigned to class C_1 according to its morphometric properties.

Comparable effusion rates of 89 and 102 $m^3 s^{-1}$ for the domes Condorcet 1 and 4, respectively, have been derived. For the domes Condorcet 2 and 3 higher effusion rates of 172 and 309 $m^3 s^{-1}$, respectively, are inferred.

Condorcet 1–3 formed out of lavas with viscosities between about 7×10^4 Pa s and 5×10^5 Pa s over periods of time between 0.5 and 3.4 years.

Condorcet 4 is quite different with respect to its morphometric properties and the conditions under which it formed. It originates from lavas of a high viscosity of 5.3×10^6 Pa s, erupting over a comparably long period of time of 4.8 years.

This study has also been the object of a *LPOD* by Chuck Wood under the title *'Learning a Lot about Little Hills'*.

The search for lunar domes in the easternmost regions of the Moon can be a goal for amateur astrophotographers and astronomers. The domes in Mare Undarum are an example of the volcanic activity that also occurred in these regions. It is interesting to continue to monitor neighboring regions such as Mare Spumans in grazing light conditions.

References

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

[2] RaffaelloLena, ChristianWöhler, Maria Teresa Bregante, Paolo Lazzarotti, Stefan Lammel, 2008. 'Lunar domes in Mare Undarum: Spectral and morphometric properties, eruption conditions, and mode of emplacement'. *Planetary and Space Science*. Volume 56, Issues 3–4, March 2008, Pages 553-569.

[3] Wood, C. LPOD, June 11, 2008. Learning a Lot about Little Hills https://www2.lpod.org/wiki/June_11,_2008

LUNAR OCCULTATIONS **May 2021** Tim Haymes

Time capsule: 50 year ago:

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

- NASA proposes a Lunar Base.
- Early Moon sighting – 14/15 hrs old is considered a limit. Miss C.Botley cites an observation reported in year 1895 of 14.75hr.
- D.Hall – Occultations: three visual timings with DIZ/stopwatch. Note: Mr. Hall's three observations can be seen in Occult4 database.

Reports Received

Carl Willits *(Newcastle*) requested prediction details for omega Tauri graze on April 15th near the Northern limit. He reports: 'I observed last week's grazing occultation but only from home, one reason being that, as yet, I have not got a portable telescope that I can put in the car to get to the graze track. It was interesting, nevertheless, to observe the disappearance and quite quick reappearance so close to the pole.'

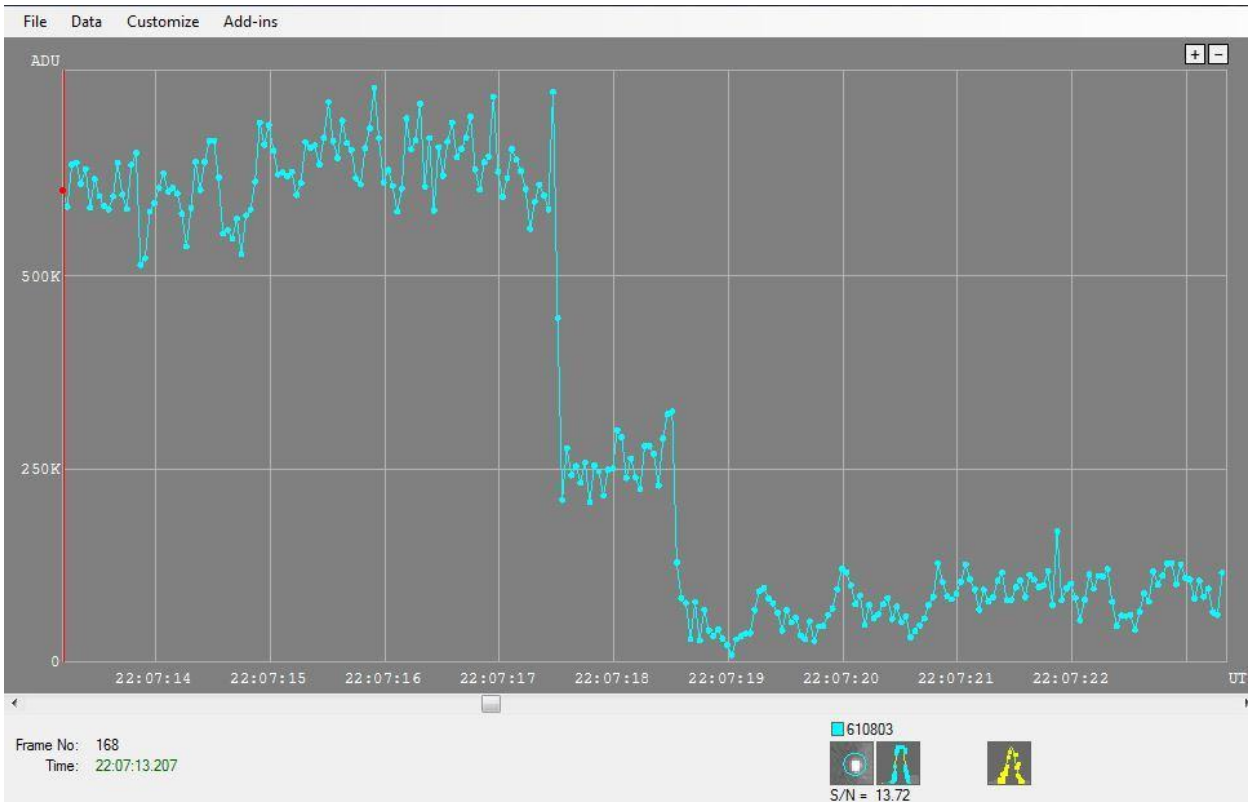
Tim Haymes *(Steeple Aston)*: I mentioned last month that April 18th might be a good night for timing occultations. The weather was fine and clear and twenty DD events were recorded by video down to magnitude 10.3. The Earth lit limb was very obvious and clear.
The Equipment used: 30cm F/4, QHY174m-GPS at 25fps and SharpCap in SER format. Disappearance times were obtained with TANGRA software by Hristo Pavlov. Some of the fainter stars were too dim and these timings were obtained from the onscreen GPS time stamp. The on-screen time is the start of the exposure so these times were corrected to mid frame times by addition of 20ms. Tangra will make this correction when the QHY174GPS camera is used.

Double Star STF1000

Fig. 1 is a Tangra light curve for double star STF1000 observed on April 18th. The components of the double have separate identities and were reported as individual timings. Video was important in determining the times for the B component which was South of the A component with a step duration of 1.04 sec.

The observed DD times were: (A) 2207 17.58s UT and (B) 2207 18.62s UT. Occult4 gives: AB 7.9 9.2 3.8" 163.7 dT+1.7s [magA,magB,sep",PA, step] The components were: A:SAO 78898 and B: X 95671, and the observed step time was shorter than prediction: 1.0s vs 1.7s.

Fig.1 Tangra light curve from analysis of the SER file of STF1000 recorded at 2207UT, on 2021 April 18th by T Haymes (below)



Features of Occult4: Reporting Lunar Occultation light curves

(Prediction and Analysis software developed and maintained by Dave Herald (Marrumbateman, AU)

Occult4 is used to report timings. The data file is sent the European coordinator – Jan Manek. Light curves are sent direct to Dave Herald.

A light curve is obtained from a video such as the double star recording above. It shows the relative photometric data points for the ingress or egress which is usually an on/off event. The light curve can sometimes contain other information so it should be included with the observed time as a separate report. Light curves can be viewed with Occult4, and more usefully from the prediction page if a previously submitted light is available.

I will describe how a report is made using my observation:-

On the Occult reporting page (Fig. 2), first highlight the observation for which a light curve (LC) will be generated. The LC should be saved first as a CSV during the analysis with TANGRA.

For the highlighted observation (select with the mouse) open the Light Curve report (Fig. 2, circled in red). A new form will open (Fig. 3). First time of use will need

some information added and this can be saved as default next time. The remainder of the info is taken from the reported observation.
In the empty box, find the CSV file and display it (Fig. 3). Use the mouse to select the region containing the event – I select a few seconds on both sides of the event only. Save the report.

There are some other features of Occult that are displayed while creating the report, which for reasons of brevity I have not included here. Occult can be configured to send report to D. Herald with the [Save and Email] button. Please contact me if you have questions.

Fig. 2 Occult4 Lunar report page (below)

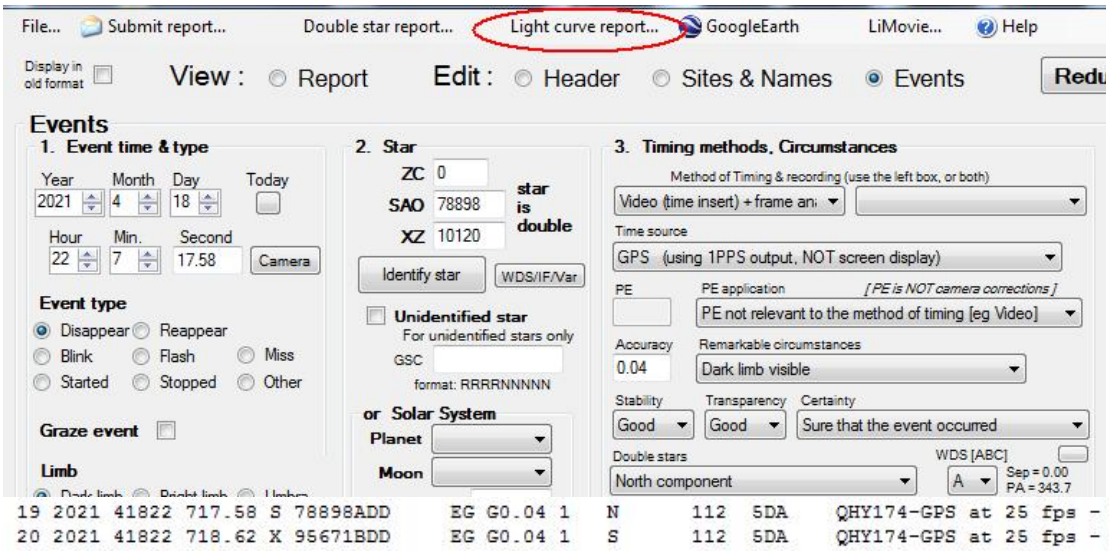
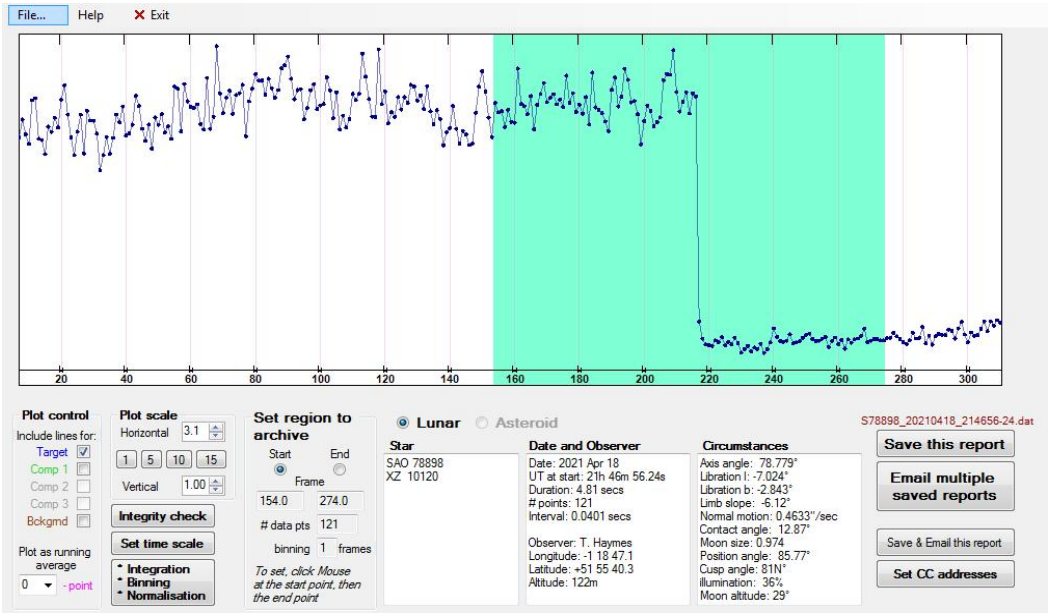


Fig. 3 Light Curve report with blue area selected (below)



Occultation prediction for Northern Oxfordshire in 2021 May

E. Longitude - 1 18 00 , Latitude 51 55 00, Alt. 119m; Moon Alt>5 degrees
Some fainter predictions are omitted near Full Moon.

y	m	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% Elon ill	Sun Alt	Moon Alt	Moon Az	CA	Notes
21	May	1	3	24	3.1	R	2673	A3	6.3		78-	124	-10	11 172	28S	Dbl*
21	May	1	3	28	54.6	R	2669	A7	6.4		78-	124	-10	11 174	66S	Dbl*
21	May	4	3	16	20.2	R	190337	K0	7.2	6.6	47-	86	-10	4 132	66N	
21	May	4	3	32	5.1	R	3141	K3	5.8	5.0	46-	86	-8	6 136	58S	35 Cap
21	May	14	22	5	44	M	882	G8	5.0*	4.4	8+	33		5 304	3N	132 Tau
21	May	15	20	48	47.3	D	78606	K2	8.7	8.1	14+	44	-8	23 282	57N	
21	May	15	22	37	17.9	D	1030	A3	3.1	2.3	15+	45		8 301	34N	epsilon Gem
21	May	15	23	16	11.5	D	78706	K2	7.0	6.1	15+	45		3 308	29S	
21	May	16	21	29	32.6	D	79523	M5	7.7	6.8	22+	56	-12	24 280	33S	
21	May	16	22	39	40.6	D	1155	F0	6.4	6.2	22+	56		14 292	83N	
21	May	16	23	1	17.2	D	79578	A0	8.8	8.8	22+	56		11 296	85N	Dbl*
21	May	16	23	5	53.2	D	1157	A2	6.2	6.2	22+	56		10 296	76S	
21	May	18	0	40	20.2	D	1285	G0	8.4	8.1	32+	69		3 303	88S	
21	May	18	22	16	35.8	D	98547	G0	8.7	8.4	41+	79		28 266	70S	
21	May	18	22	48	13	M	1393	G7	6.5*	6.0	41+	79		24 272	5N	
21	May	18	23	51	18.2	D	98567	A3	7.5	7.4	41+	80		14 283	20S	
21	May	19	0	30	50.1	D	1400	F5	8.3*		42+	80		9 290	49N	Dbl*
21	May	19	0	49	46.9	D	98603	M2	8.9*	8.1	42+	80		6 294	77N	
21	May	19	22	7	22.6	D	99030	F8	8.8	8.4	51+	91		34 250	63S	
21	May	20	0	53	43.7	D	1514	A1	6.2	6.2	52+	93		9 283	63N	42 Leo
21	May	20	23	17	17.2	D	99474	F8	8.4		62+	104		27 251	84S	Dbl*
21	May	21	0	45	3.3	D	1622	K2	8.2*	7.6	63+	105		14 269	78N	
21	May	21	21	49	4.2	D	119146	F5	8.4	8.2	72+	117		38 214	83N	Dbl*
21	May	23	21	10	10.6	D	139508	M*	8.1	7.3	90+	144	-8	30 170	53N	
21	May	23	22	0	59.7	D	1969	K0	7.1	6.4	90+	144		30 185	50N	
21	May	23	22	36	7.9	D	139534	F5	8.9	8.7	91+	144		29 195	52N	
21	May	24	0	1	41.4	D	139556	G0	7.7*	7.4	91+	145		24 217	22N	
21	May	24	0	3	48.6	D	1975	G5	8.7	8.3	91+	145		23 217	29S	
21	May	24	0	21	8.2	D	139567	K2	7.8*	7.1	91+	145		22 221	43N	
21	May	24	21	56	37.0	D	2092	K4	7.0	6.1	96+	158		24 170	42S	
21	May	24	22	1	15.5	D	158730	K0	8.4	8.0	96+	158		24 171	85S	
21	May	24	22	22	33.9	D	2096	G6	8.0	7.6	96+	158		24 176	61N	
21	Jun	2	1	41	22.1	R	165327	F0	7.8	7.6	52-	93		2 116	82N	
21	Jun	2	2	26	35.2	R	165339	F8	8.3	8.0	52-	92	-10	8 125	66N	
21	Jun	4	2	34	38.4	R	128739	A0	7.4	7.4	32-	69	-9	6 103	46N	

Notes on the Double Star selection

Doubles are selected from Occult4, 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: tvh dot observatory at btinternet dot com

LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME

Tony Cook

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

News: David Teske, ALPO Lunar Section director has received a set of record cards that Winnie Cameron used for her TLP catalogues – these were kindly supplied by David Darling. We would like to thank David for supplying these to the ALPO Lunar Section archive as these will be incredibly useful in checking for typos in the ALPO/BAA TLP database, much of which is derived from the published 1978 NASA catalogue on TLP.

TLP reports: Two items have come to light during April, though I think neither is a TLP.

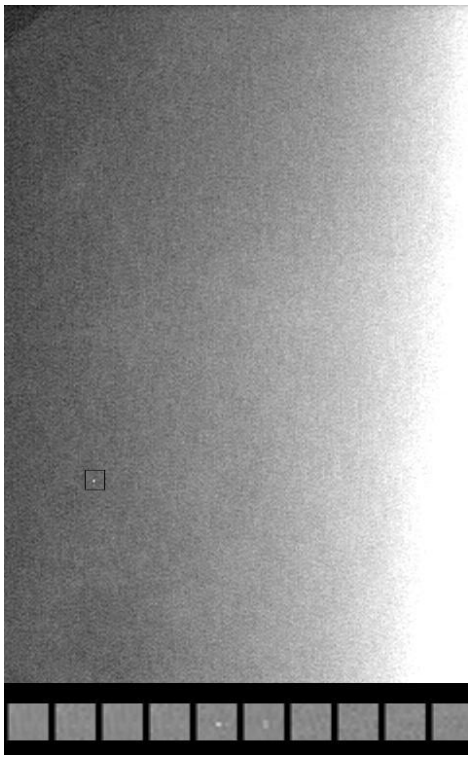


Figure 1. *A contrast stretched single TV frame of Earthshine, orientated with north towards the top. (Bottom Insert) deinterlaced TV fields 1/50th sec apart of the flash.*

Flash in Earthshine: On 2021 Apr 17 UT 20:35:12 (possibly +/- a few secs in case computer Internet time was off) I detected a flash in the lunar earthshine. Although the flash was compact and had a sharply defined edge, which would indicate a likely cosmic ray air shower detection by the camera, it was also visible on two adjacent deinterlaced TV frames, which is not normal for cosmic rays. Again, the sharpness gives me serious doubts it was a real impact flash on the Moon. The only other explanation I can think of is maybe my video capture device dropped a TV field at this point and interpolated the missing TV field with the next frame? Anyway, if anybody was videoing earthshine on the Moon at this time, please check your videos please at around the UT given. If it is not on your video then it is clear it was a cosmic ray after all!

Riccioli: On 2021 Apr 25 UT 19:42-20:32 Franco Taccogna (UAI) noted in some images that the W and SW rim of the crater had a red/pink cast to it. There was a crater to the NE that also had a similar tinge of colour. However nowhere else on the Moon was this colour so noticeably imaged. Franco sent me a WhatsApp message at 19:42UT and I was soon able to set up a telescope and obtain some colour imagery myself. From the UK the Moon was much lower and there was atmospheric spectral dispersion on most crater rims. I sent out an alert via Twitter and Paul Zeller in the US was able to capture some images a few hours later (not shown here), but these don't show any colour here.

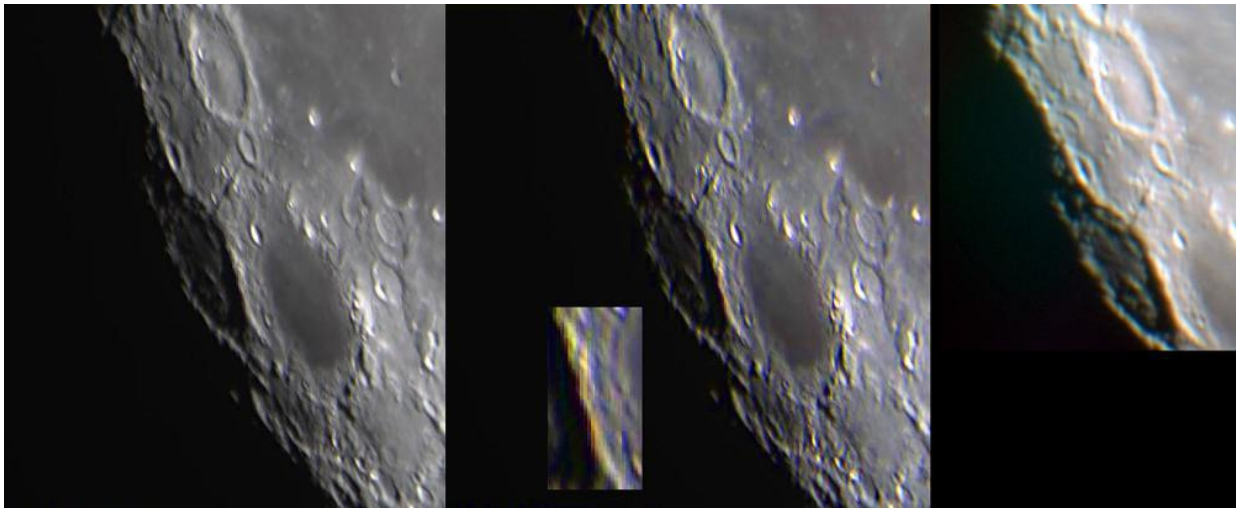


Figure 2. *Images of Riccioli obtained on 2021 Apr 25 and orientated with north towards the top. In all cases colour saturation has been increased to 70%.* ***(Left)*** *image by Franco Taccogna taken at 20:32 UT.* ***(Centre)*** *The same image but with colour saturation increased to 70%. The inset here shows an enlargement of the W-SW rim of the crater.* ***(Right)*** *Image by Anthony Cook taken at 20:26UT and with colour saturation increased to 70%.*

I suspect what might have been happening was that apart from atmospheric spectral dispersion (much worse from the UK as the Moon was lower), because of the thin nature of the rim and its orientation, this lay over more red pixels on the colour Bayer matrix on Franco's camera than over blue or green pixels, and consequently resulted in a slightly redder cast on the rim. This theory is partly supported by the inset enlargement in Fig. 2 (Centre|). I have noticed Bayer filter effects before – they can often colourize thin but bright features on the Moon. To check for this effect in future

– if you suspect colour, try rotating your camera through say 30° or 45°and see if the colours change in the image.

Level 1 – All Reports received for March: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Aristarchus, Birt, Curtis, Hyginus N, Plato, Proclus, Ross D and Theophilus. Massimo Alessandro Bianchi (Italy – UAI) imaged and observed visually: Bailly. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Aristarchus, Babbage, Clavius, Copernicus, Gassendi, Mons Rümker, Plato, Schiller, Theophilus, Tycho, Wargentin and obtained some whole disk image mosaics. Anthony Cook (Newtown and Mundesley, UK – ALPO/BAA) obtained video of earthshine in monochrome and several features on the illuminated side in colour. Valerio Fontani (Italy – UAI) imaged: Eudoxus. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Clavius, Mons Argaeus, and Rupes Altai. Leandro Sid (Argentina – AEA) imaged: Hyginus, Mare Crisium, and Proclus. Trevor Smith (Codnor, UK – BAA) observed: Censorinus, Plato and Proclus. Aldo Tonon (Italy – UAI) imaged: Bailly and Copernicus. Gary Varney (Pembroke Pines, FL, USA – ALPO) imaged: Mare Crisium and Petavius. Fabio Verza (Italy – UAI) imaged: Bailly, Eudoxus and Lichtenburg. Luigi Zanatta (Italy – UAI) imaged: Copernicus and earthshine.

Level 2 – Example Observations Received:

Plato: On 2021 Mar 01 UT 04:20-04:40 Trevor Smith (BAA) observed visually this crater under similar illumination to the following 1970s report:

Plato 1971 Dec 05 UT21:00-21:10 D.B.Taylor (Dundee, UK, 10" refractor, conditions poor and turbulent). Observer suspected colour orange near bright spot - on north wall. Observation ceased due to being clouded out. ALPO/BAA weight=1.

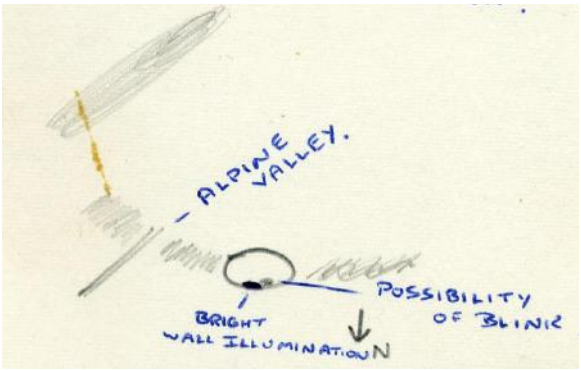


***Figure 3**. Sketch by David B. Taylor of Dundee, Scotland, made on 1971 Dec 05 UT 21:00-21:10 and orientated with north towards the bottom.*

Trevor, using a 16” Newtonian, looked for signs of orange colour or bright spots on the north wall. Perhaps not surprisingly no orange colour was seen, but curiously he found no sign of any bright spot on the north wall either. This is odd because David Taylor’s original sketch, quite clearly depicts a bright area on the north inner rim. Indeed, according to Trevor, all looked normal and the central craterlet was visible but no sign of the other craterlets as the seeing was worsening.

Earthshine: On 2021 Mar 14 UT 18:41 Luigi Zanatta (UAI) imaged the lunar crescent and earthshine under the following Lunar Schedule request:

BAA Request: Please try to image the Moon as a very thin crescent, trying to detect Earthshine. A good telephoto lens will do on a DSLR, or a camera on a small scope. We are attempting to monitor the brightness of the edge of the earthshine limb in order to follow up a project suggested by Dr Martin Hoffmann at the 2017 EPSC Conference in Riga, Latvia. This is quite a challenging project due to the sky brightness and the low altitude of the Moon. Please do not attempt if the Sun is still above the horizon. Do not bother observing if the sky conditions are hazy. Any images should be emailed to: a t c @ a b e r . a c . u k

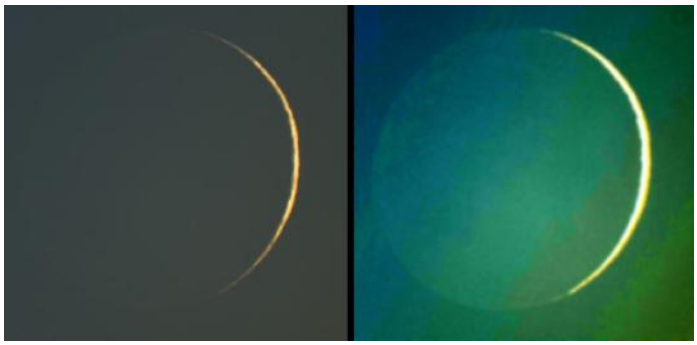


Figure 4. *The crescent Moon as imaged by Luigi Zanatta (UAI) on 2021 Mar 14 UT 18:19. Image distorted due to atmospheric refraction and oriented with north towards the top, with horizon to the right.* ***(Left)*** *Original image.* ***(Right)*** *Contrast stretched version.*

As you can quite clearly see from Fig. 4, there is no sign of a bright arc around the earth lit limb. My theory is this only becomes visible when the libration is right and brings the far side highland over into view on much of the dark limb – nothing to do with levitated dust. We need to collect a few more examples before we can say for certain. So, keep on observing.

Eudoxus: On 2021 Mar 19 UAI and BAA observers imaged the Moon according to the following lunar schedule request:

BAA Request: Eudoxus - please try to image the shadow filled interior of this crater. We are trying to explain an observation from Meudon Observatory in France made in 1881 for which we don't have the precise UT. You may or may not need to overexpose the image - it is not clear from the original report whether it was faint light inside the shadow filled interior, or sunlit highland emerging from the shadow? Please send any images to: a t c @ a b e r . a c. u k .

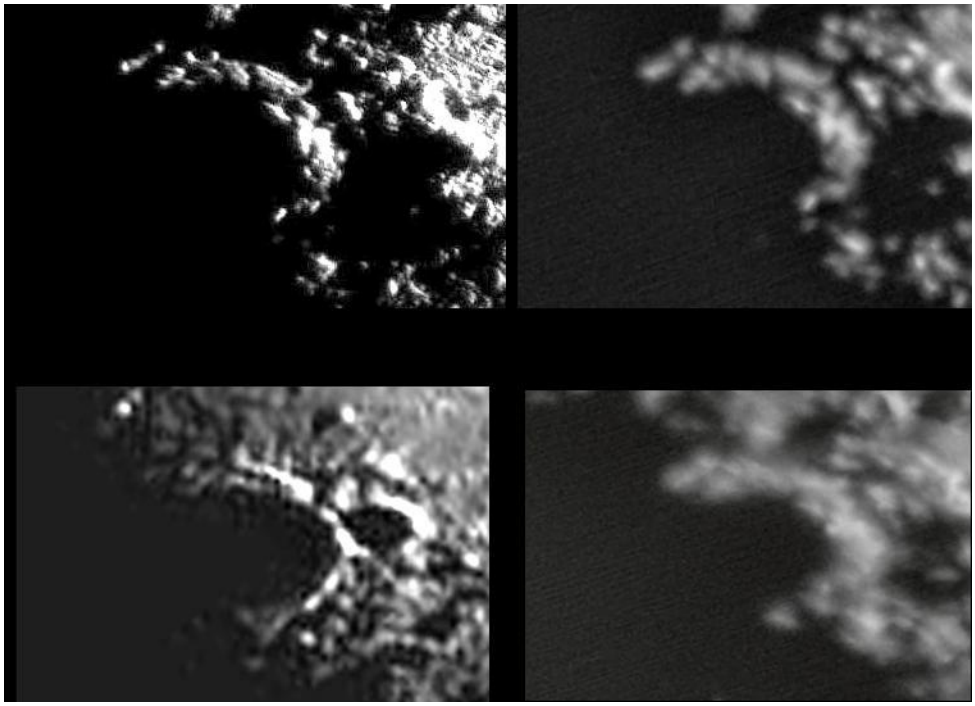


Figure 5. *Eudoxus as imaged on 2021 Mar 19 and orientated with north towards the top.* ***(Top left)*** *Taken at 18:41UT by Fabio Verza (UAI).* ***(Top Right)*** *Taken at 19:44 UT by Aldo Tonon (UAI).* ***(Bottom Left)*** *taken at 19:00 UT by Ivan Walton (BAA).* ***(Bottom Right)*** *Taken at 20:34 UT by Aldo Tonon (UAI).*

The original observations of Eudoxus made in 1881 implied some unusual light inside the crater. Clearly nothing unusual is seen here; indeed the west rim is not even illuminated. I think we shall try moving the colongitude to a bit later to see if anything else can be seen inside the crater. It is possible that the 20:00UT given by Cameron to Trouvelot's 1881 observation was guessed at – Meudon sunset at the time was at 19:44 and the Moon effectively had set by midnight, so UTs later than 20:00 are possible. And will be investigated.

Curtis: On 2021 Mar 22 UT 01:15-01:30 Jay Albert (ALPO) observed and at 00:55, 00:58, 01:07 Leandro Sid (AEA) imaged this area under similar illumination to the following report:

Williams of the UK, on 1892 Sep 20 at Moon's age 8.4 days, noticed a spot that had been seen on the 21st and 23rd of the same year with abnormal brightness. The spot was near Picard. Williams comments the spot was "nearly as large but a little fainter than Picard. This observation was reported in the Astronomical Register of the Royal Astronomical Society and is not included in the Cameron catalogs. It is one of many measurements of the brightness of this spot for different illumination angles and is one of three outlying brightness points spotted on a graph by Williams. The ALPO/BAA weight=3.

Jay commented that *'Curtis was barely distinguishable as a crater and was surrounded by what appeared to be a small, circular light spot (possible ejecta field) less than half the size of Picard and E of the latter. This light spot was not particularly bright, but lighter than the surrounding mare'.* Jay used a Celestron 8" Evolution SCT at x290 with transparency at magnitude 4 and seeing at 7-6/10. The

appearance is confirmed in one of Leandro Sid's images of which the one taken at 01:07UT had the highest resolution and is shown Fig 6.

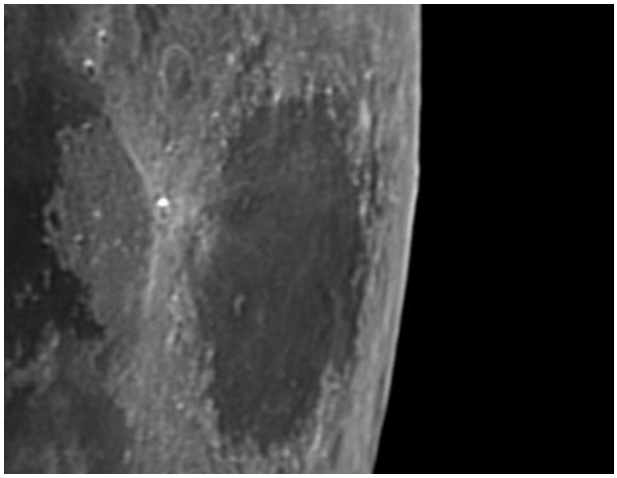


Figure 6. *Mare Crisium with Picard and Curtis just to the right and below the centre of the dark mare.*

Pallas: On 2021 Mar 22 Maurice Collins (ALPO/BAA?RASNZ) Imaged the whole Moon and captured this crater under similar illumination to the famous Leon Stuart photograph of a candidate dayside impact flash:

Pallas-Schroter 1953 Nov 13 UT 02:00 Observed by L.Stuart (USA) "Saw and photographed a bright spot on term. between these two craters. Used Kodak 103aF3." NASA catalog weight=5 and catalog ID #559. ALPO/BAA weight=5.

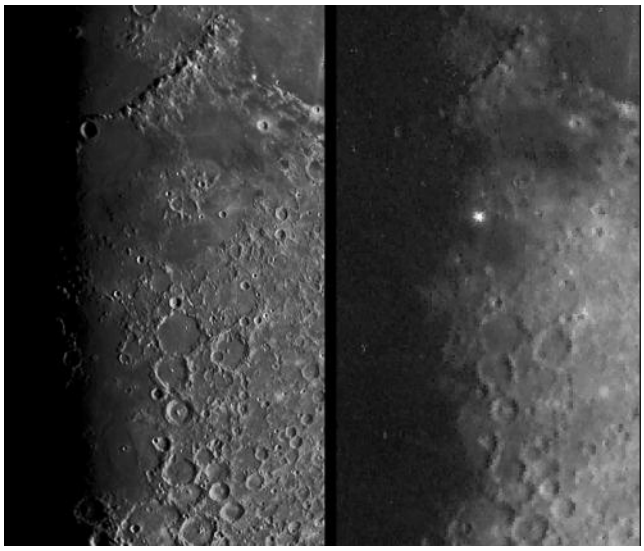


Figure 7. *The region of the Moon in the vicinity of Pallas crater, and orientated with north towards the top.* ***(Left)*** *Image by Maurice Collins (ALPO/BAA/RASNZ) taken on 2021 Mar 22 UT 07:16-07:19.* ***(Right)*** *Image taken by Dr Leon Stuart on 1983*

We have covered this before, including using modern CCD images to help refine the position of the original flash in the photograph that Leon Stuart took (see: https://meetingorganizer.copernicus.org/EPSC2017/EPSC2017-971.pdf). Maurice's image (Fig. 7) can be used to help refine the position further and also for image subtraction purposes to reveal the appearance of the flash only.

Bailly: On 2021 Mar 27 several UAI observers imaged this crater under the following lunar schedule request:

BAA Request. Please observe visually or image this crater in colour to see if you can detect any colour on part of the floor. Please email any observations to: a t c @ a b e r . a c. u k .

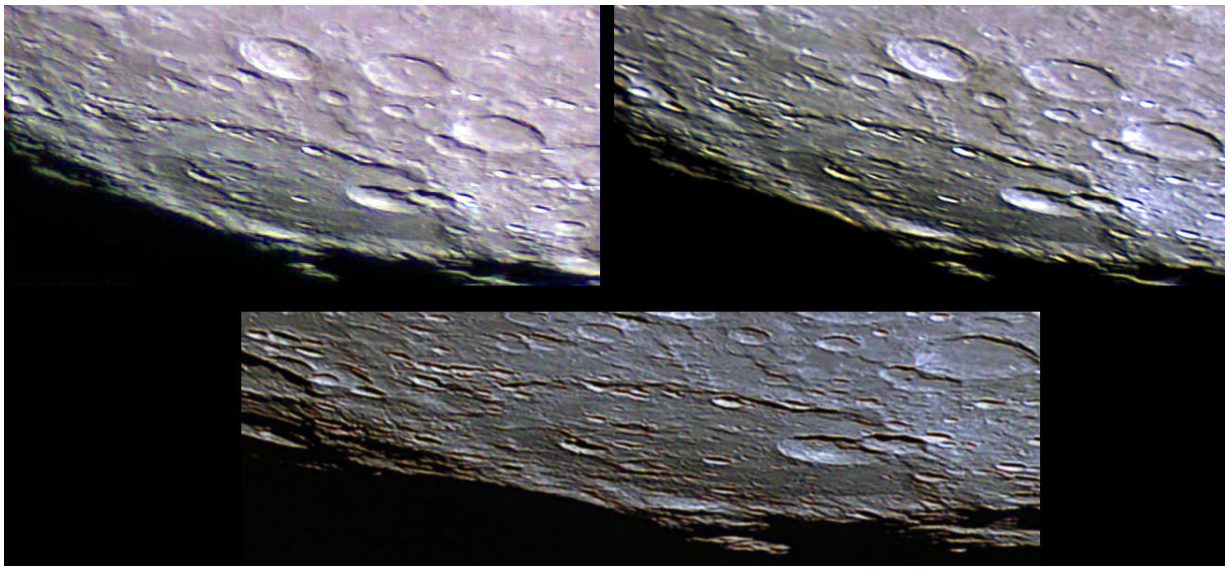


Figure 8. *Bailly as imaged by UAI members on 2021 Mar 22. Orientated with north towards, colour normalized and colour saturation increased to 70%.* ***(Top Left)*** *Image taken by Bianchi at 18:56 UT.* ***(Top Right)*** *Image taken Fabio Verza at 20:25 UT – note that the yellows on some of the crater rims may be related to the Bayer colour mask effects on fine structures or possibly atmospheric spectral dispersion? There are hints in Massimo's image as well, but not so pronounced.* ***(Bottom)*** *Image by Aldo Tonon taken at 22:52UT at higher resolution.*

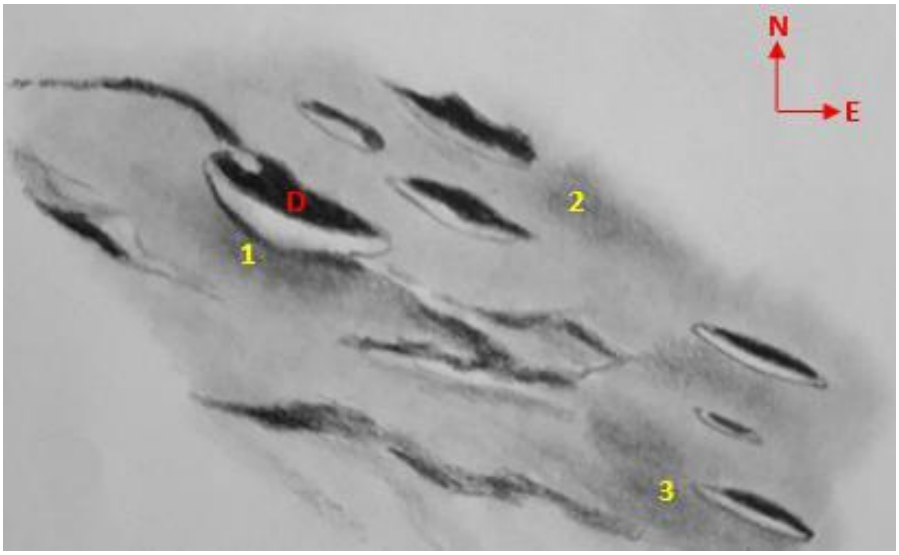


Figure 9. *Bailly as sketched by Massimo Alessandro Bianchi (UAI) made on 2021 Mar 22 UT 19:35-19:58.*

This actually refers to what was known as a permanent blink area that Flyde Astronomical Society observer, Chris Lord, found in 1974 Oct 29 UT 22:00-23:00. Permanent blinks are when you use red and blue filters and find one area of the Moon is brighter in one filter than in the other. However, unlike coloured TLPs, permanent blinks are always seen at similar colongitudes. In the case of Chris' observation of Bailly, he found the south west (IAU) floor was darker in a blue filter than in a red filter. However, he didn't say on how many occasions he had seen this effect.

It is interesting that despite increasing colour saturation to 70%, no obvious sign can be seen of the SW floor has any colour to it at all. In addition, Massimo Alessandro Bianchi made a visual observation from 19:35-19:58 (provided a sketch – Fig. 9) and comments: *'Clear sky, medium turbulence. During the observation, I didn't notice the presence of colours on the crater floor. In the northwestern part, near the crater Bailly D, darker areas were present. Their intensity reflects the numbering in the figure (1,2,3). Using the following filters increased the albedo difference of these areas compared to the surrounding plain, always respecting the order indicated: Red #25, Green #58, Yellow #12 (in descending order of intensity of the phenomenon). With the Dark Blue filter #38A the differences diminished, almost disappearing (I don't know if it was due to the small diameter of the instrument)'.* In addition, there was another colour image (Fig. 8 bottom), by Aldo Tonon, taken at 22:52, which was outside the repeat illumination window, but again shows no colour tinge on the floor either. I wonder if the 1974 report should be classed as a TLP given that there are no obvious signs of colour shading on the SW floor.

Level 3 - In Depth Analysis:

Again, this month I am out of time, due to coursework marking, to cover this. I look forwards to the summer months to try to do some more in-depth analysis.

General Information: For repeat illumination (and a few repeat libration) observations for the coming month - these can be found on the following website: 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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