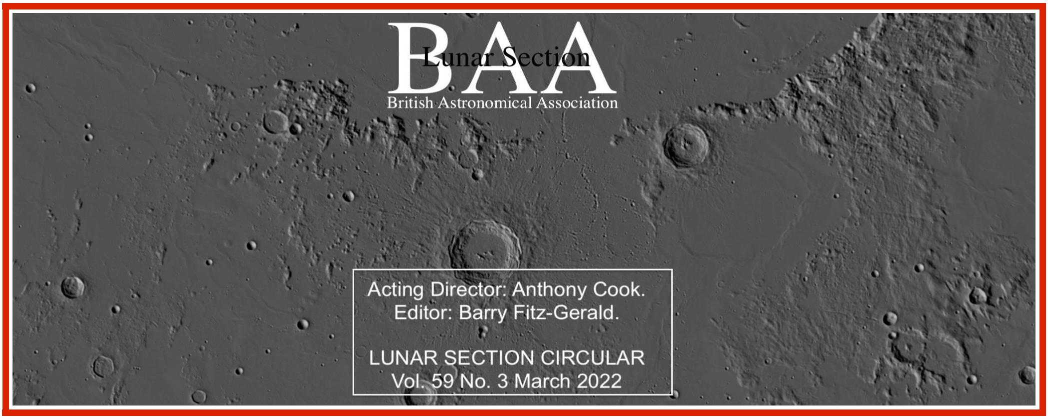


Editorial by Tony Cook.

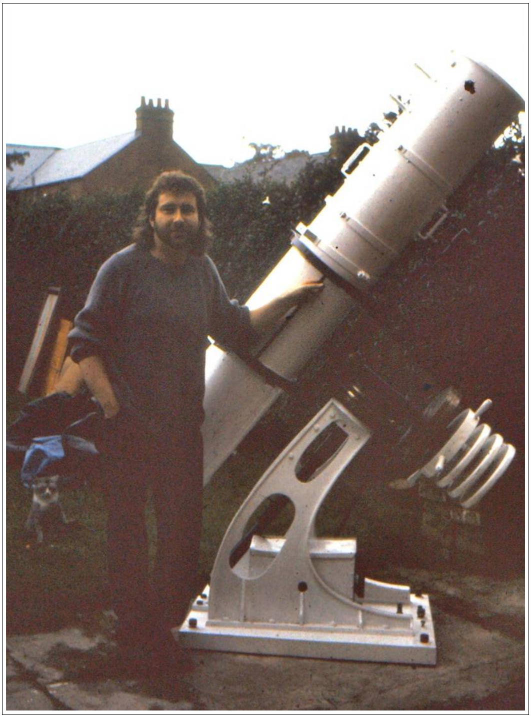
There are three items to mention in the editorial in this issue:

Firstly, I am pleased to say that we have a Lunar Section Meeting on Saturday 15th April down at the BAA Winchester Weekend. We have a diverse range of topics as you can see from the programme below. It will be really great to meet many of you in person, and we have a short panel session at the end to cover any questions not answered by the lecturers, or to test our general lunar knowledge. Although part of the BAA's Winchester Weekend, the Section meeting is free to Lunar Section members, however there is a limit on numbers (25 remaining seats the last time I looked), so please book through the BAA website: https://britastro.org/winchester2022 , as soon as possible, as it would be very unfortunate for people to turn up and find we don't have enough seats.

	Lunar Section Meeting
14:15 – 14:30	Overview of the BAA Lunar Section's Activities *Dr Tony Cook (Lunar Section Acting Director)*
14:30 – 15:00	Lunar Impact Flashes and How to Observe Them *Dr Tony Cook*
15:00 – 15:30	Lunar Geology - Old Lunar Questions Revisited? *Barry Fitz Gerald (Lunar Circulars Editor)*
15:30 – 16:00	Tea break
16:00 – 16:30	Lunar Occultations from a Personal Perspective *Tim Haymes (Lunar Occultations Coordinator)*
16:30 – 17:00	New Space Missions and the Prospect for Future Low Cost Lunar Exploration *Nick James*
17:00 – 17:15	Question Panel Session

Secondly, I would like to invite anyone with a modern astronomical USB camera (e.g. ASI 183MM (monochrome) or anything equivalent, capable of 30 fps or faster, with pixel binning) to have a go at videoing the lunar earthshine for impact flashes, from now until the end of April. There are no specific meteor showers on, apart from the Lyrids, however I have a PhD student, who has access to a metre aperture telescope at Côte d'Azur Observatory, Nice, France who will be observing in the short wave IR (SWIR) from approximately 1.2 to 1.7 microns in wavelength, and it will be important to capture as many observations as possible at visible wavebands so that we can compare the light curves with any impact flashes that he can detect in the SWIR.

It would also be a good opportunity to compare light curves in visible light to see how scintillation, or seeing, affects the relatively short duration light curve. Simultaneous observing may also give us the ability to confirm whether any flashes detected exhibit slight elongation, as has been hinted on a few rare occasions – maybe due to glancing blow impacts? We would like to include any of you who detect impacts in some form in scientific publications that might result at the very least in the acknowledgements. Please email me, at "atc @ aber. ac . uk" if you are interested, and I will send you some observing instructions. It is a relatively simple observational process and you can measure lunar occultations at the same time and send these off to Tim Haymes.



Rob Moseley standing next to the BAA Elliot Merlin 12 inch reflector which he used for some of his lunar and planetary observations from his backyard in Coventry. Image courtesy of Denis Buczynski.

Finally, I was sad to hear, through the BAA, that one of our past editors of the former BAA Lunar Section publication "The New Moon", Rob Moseley, has passed away. Rob, from Coventry, was a highly enthusiastic observer, and very passionate about visual observing, especially sketching the Moon, observing comets and double stars. He was editor of The New Moon from 1986 to 1991.

Observations Received:

Observations have been received from the following:

Leo Aerts (Belgium), Tony Cook (UK), David Finnigan (UK), Kris Fry (UK), Rik Hill (USA), Rod Lyon (UK), Bill Leatherbarrow (UK), K.C. Paul (Hong Kong), Bob Stuart (UK), Geoffrey White (UK), and Alexander Vandenbohede (Belgium)

Thermal infrared view north of Theophilus by Tony Cook.

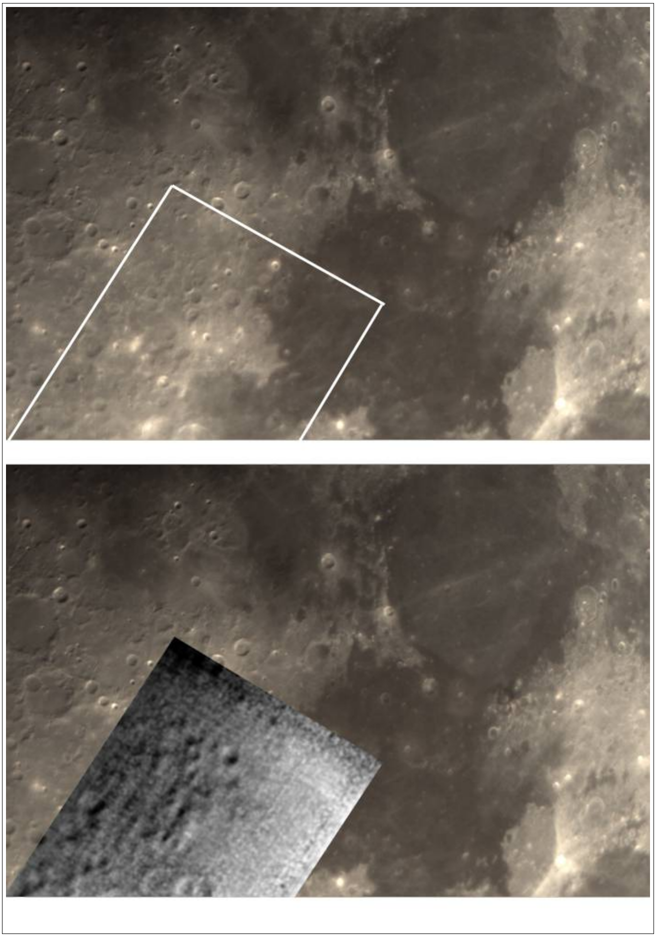


Figure 1. Images taken by Tony Cook, on 2021 Feb 10 UT 21:35, of the area north and west of Theophilus, also covering Mare Serenitatis and Mare Tranquilitatis. Telescope used: 16" Skywatcher Dobsonian, using Newtonian focus. **(Top)** A colour image in visible light. **(Bottom**) The visible light image with a thermal infrared monochrome image covering Theophilus and the area to the north. A special thermal IR transmitting lens was used over the fixed lens on this camera to provide eyepiece projection. White is hot and dark is cold!

Tony comments: Although I have taken lots of thermal infrared images of the Moon before, this has been with smaller telescopes such as an 8" or 6" Newtonian, and the results were mediocre in that you could barely see craters, and the image was often very weak. What a difference a larger aperture makes! The Seek Compact Pro camera is normally intended for use on mobile phones and is plugged into the USB socket. However, by using an extension cable and an improvised adaptor for eyepiece projection it can be placed into the 1.25” eyepiece tube. In the top optical image, we can see that the lunar surface is well past the terminator with very little shadow, so some features are becoming hard to see. In the lower thermal IR image, which is monochrome, we see apparently lots of apparent shadow still – though it is technically incorrect to say shadow as these are actually areas that “were in shadow” for longer than the surrounding terrain, and so have taken longer to warm up, hence still cooler. If you compare the optical image with the thermal IR image you can see that some bright (visible light) ray craters look dark/cool in the thermal IR and this is because fresh ray craters tend to have a lot of ejecta boulders in their ejecta, which both provide shadow (for longer than on normal terrain) earlier in the lunation, and take longer to soak up the heat. Probably the reverse would happen at sunset on the moon. Note also we see a lot of N/S ridges to the W/NW of Theophilus.

Using a thermal IR camera on a Newtonian scope is simple, but it is important to remember that they will not work on SCT scopes of refractors as thermal IR finds anything made of glass opaque. Also, the wavelength range is off the scale of what we normally use. Visible light ranges from 0.37 to 0.7 microns (370 to 700nm). Some CCD cameras let you see into the near IR i.e., up to 1.2 microns (1200 nm). This thermal IR camera covers the wavelengths of 7.5 to 14 microns (7400-14000nm) and because the wavelength range is between 13 to 26 times longer than at visible light wavelengths, resolution on the lunar surface is also 13-26x worse. Another amateur astronomer, Daryl Wilson of ALPO has already been experimenting with thermal IR imaging of the Moon for a while now and has published several articles in ALPO’s : The Lunar Observer.

Palus Putredinis & Montes Apenninus by Leo Aerts.

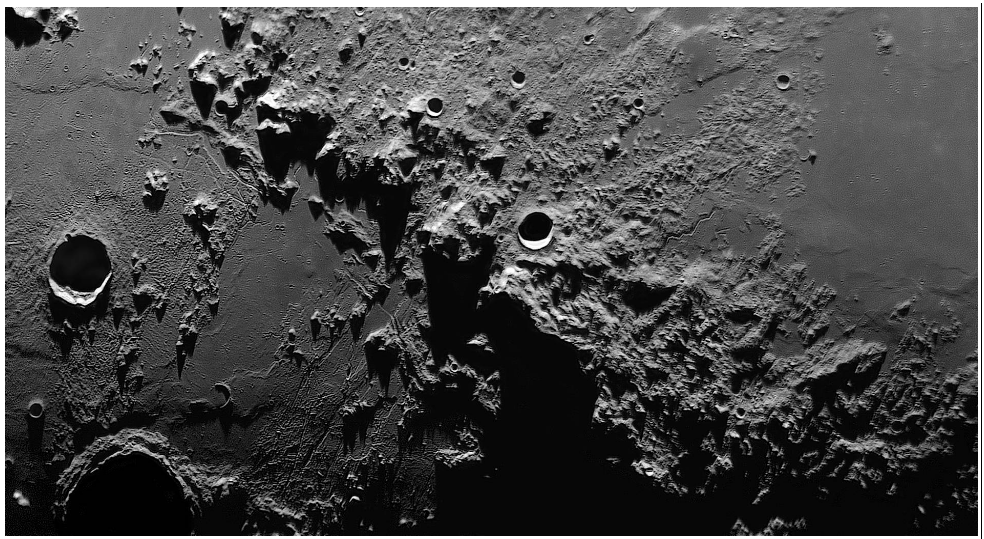


Figure 2. Captured by Leo Aerts on 2018 Mar 24 using a C14 scope with a red filter and a ASI 178MM camera. Image orientated with north towards the left.

Leo has sent us a reprocessed image of this area near to the Apollo 15 landing site, but with significant shadow. On the bottom left you can see the flat floor, but completely shadow filled 83 km diameter Archimedes crater. Palus Putredinis, or the Marsh of Decay, is a relatively featureless area that stretches from the east side of Archimedes to the curve of the Montes Apenninus. One volcanic dome is visible on Palus Putredinus, close the Montes Apenninus. What I really like about Leo's image, apart from the sharpness, is how much the geology stands out, especially ejecta patterns around Archimedes and Autolycus, and the radial impact basin gauges eastwards of the Montes Apenninus.

Mare Orientale by Alexander Vandenbohede.

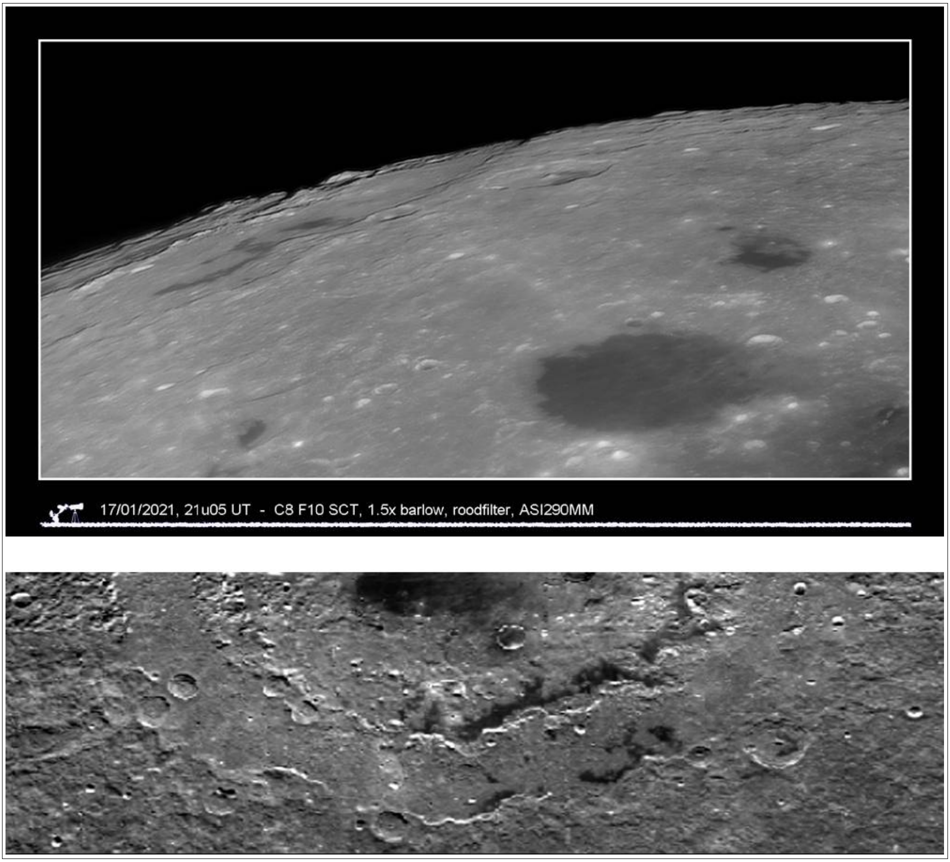


Figure 3. Eastern Mare Orientale. North is to the right and west towards the top. **(Top)** An image taken by Alexander Vandenbohede. Dates, UTs etc are given in the image. **(Bottom)** For comparison the eastern half of Mare Orientale from the NASA LROC Quickmap web site.

Mare Orientale is one of the younger impact basins \(~300 km in diameter) on the lunar surface with an age of 3.9 b.y. In Alexander's image we are seeing the eastern floor, beyond the inner rim of the crater. Note the curly shapes dark lava ponds agree in Alexander’s image and the LROC mosaic.

Boussingault by Bob Stuart.

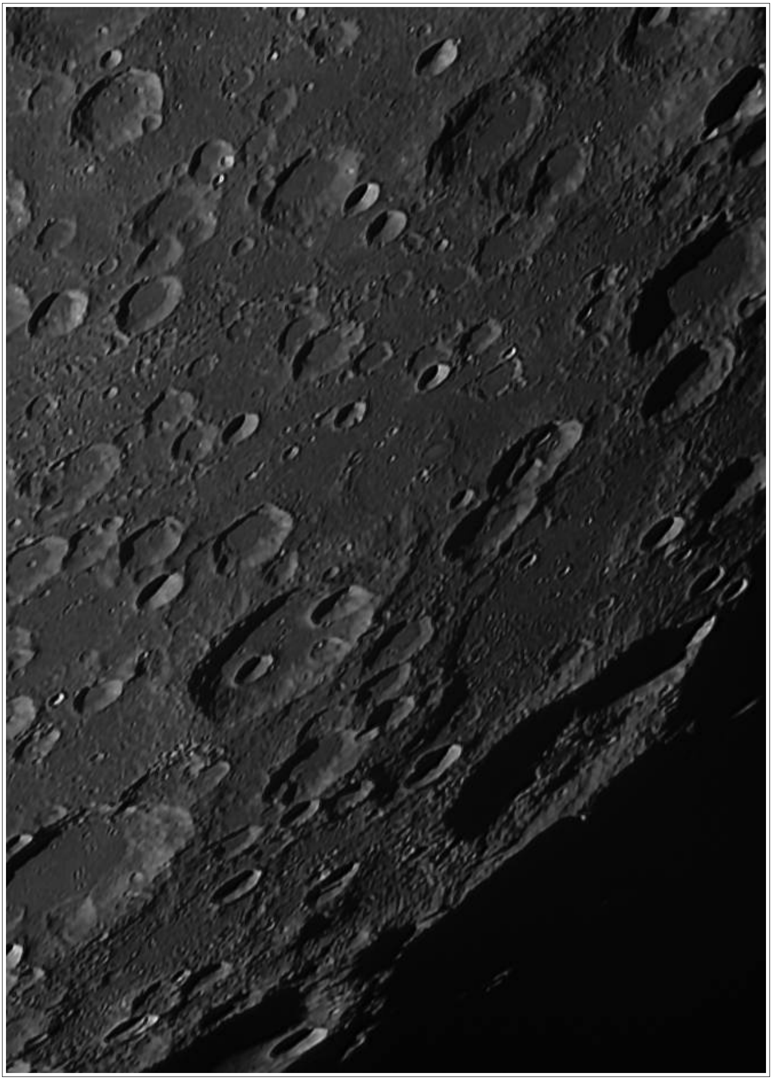


Figure 4. Boussingault as imaged by Bob Stuart on 2022 Jan 21 UT 00:40 and orientated with north towards the top.

Boussingault is a 131 km diameter crater on the SW limb of the Moon that looks 'tear' shaped. Although not visible in Bob’s image, due to shadow, there is another sizable crater on the floor of Boussingault.

Pitatus by Rod Lyon.

Figure 5. Pitatus as captured by Rod Lyon and orientated with north towards the top left. Observational details are recorded on the image.

Pitatus is an interesting crater, some 101 km in diameter, with a “central peak” that is offset from the centre, perhaps inferring a slightly oblique impact, and the floor has also been flooded with lava. There is a rille just visible inside its NW rim on the floor of the crater, part of a longer system of concentric rilles around the inner rim/floor interface. To the south west is another unusual crater the 88km diameter Wurzelbauer, somewhat degraded with a swath of what looks like highlands or hillocks across much of its floor, but might be ejecta covering? Wurzelbauer looks like it has an inner circular depression on its eastern side which might be the remains of another impact crater?

Crescent Moon by Kris Fry.

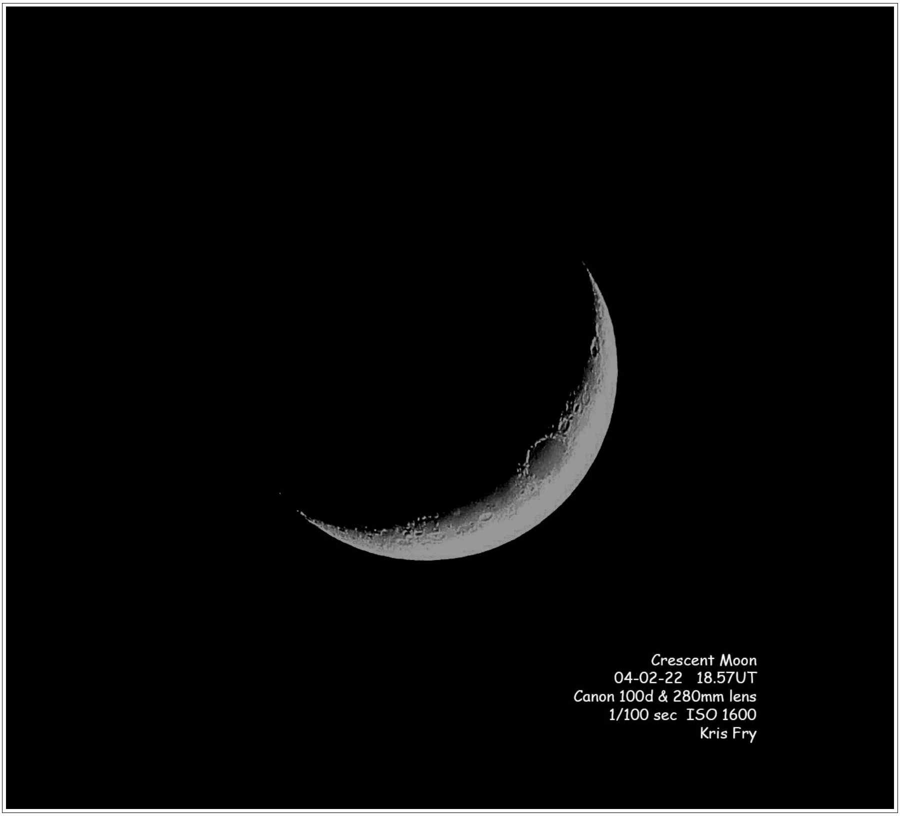


Figure 6. Image of the crescent Moon taken by Kris Fry (NAS) – observational details contained on the image. North is towards the top right.

Although of low resolution, as it was taken through a 280mm telephoto lens, this view of the Moon shows the Mare Crisium 556 km diameter impact basin in all its glory with the primary basin rim standing out beyond the night side of the terminator. If you could view the basin from directly overhead it is certainly not circular and so was presumably produced by an asteroid coming in at an angle to the surface in an E-W or W-E direction. The age of the basin pre-dates the Imbrium basin on the NW quadrant of the Moon.

Hippalus and east Mare Humorum by K.C. Paul.
This is a fantastically detailed image showing the concentric wrinkle ridges and rilles on the eastern side of Mare Humorum. Hippalus is an upside down horse-shoe shaped 58 km diameter crater, just below the centre of the image. One of the circular Mare Humorum rilles curls through it.

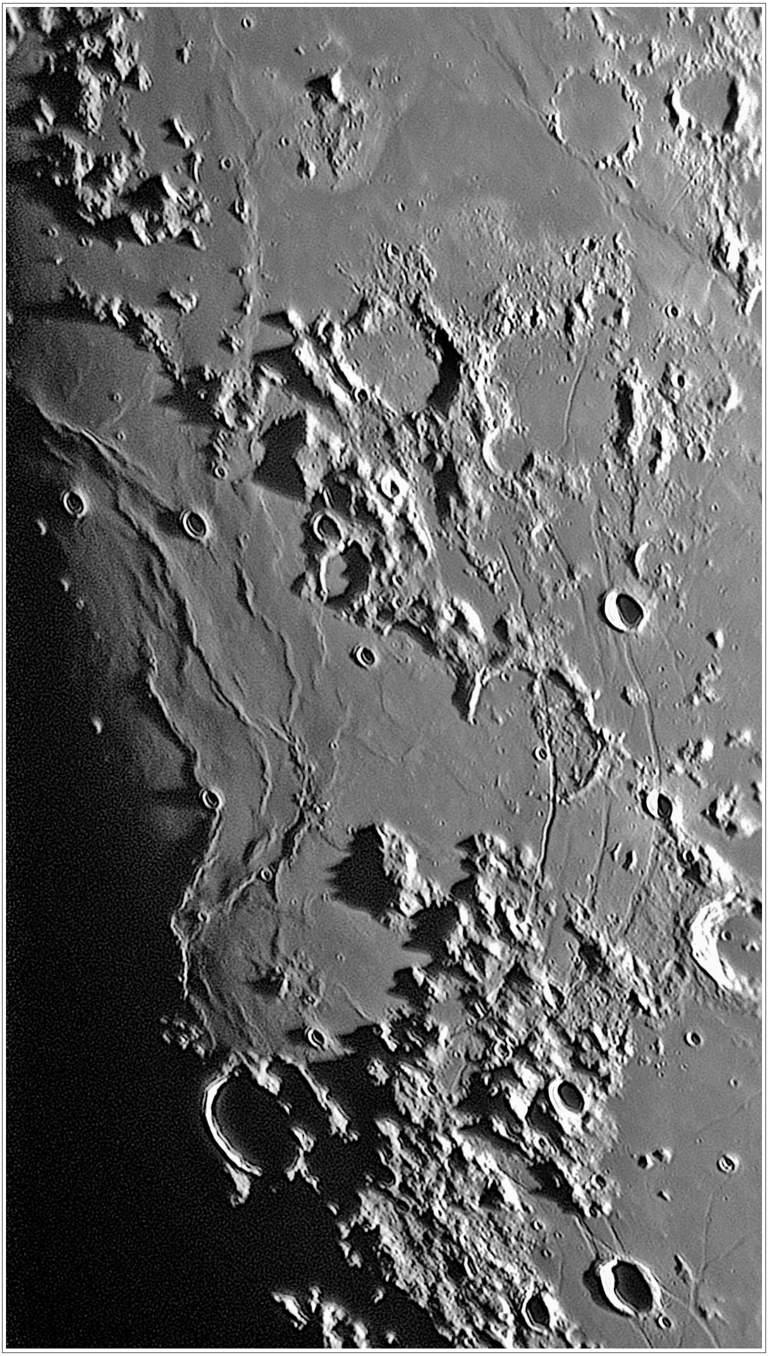


Figure 7. Captured by K.C. Paul on 2018 Mar 27 UT 13:02 through a red filter. North is towards the top. Taken with a 250mm f/6 Newtonian reflector, through a x2.5 Barlow using a QHYCCD290M camera.

Plato by Dave Finnigan.

Apart from the amazing detail in this image, which reveals 9 craterlets on the floor of Plato, we have a very nice view of the sinuous rille running along the highlands to the east of the crater, and another one off the western edge, and yet another one down the outer flanks of the SW exterior rim. The whole of the region around Plato indeed has several other examples of sinuous rilles if one is prepared to look.

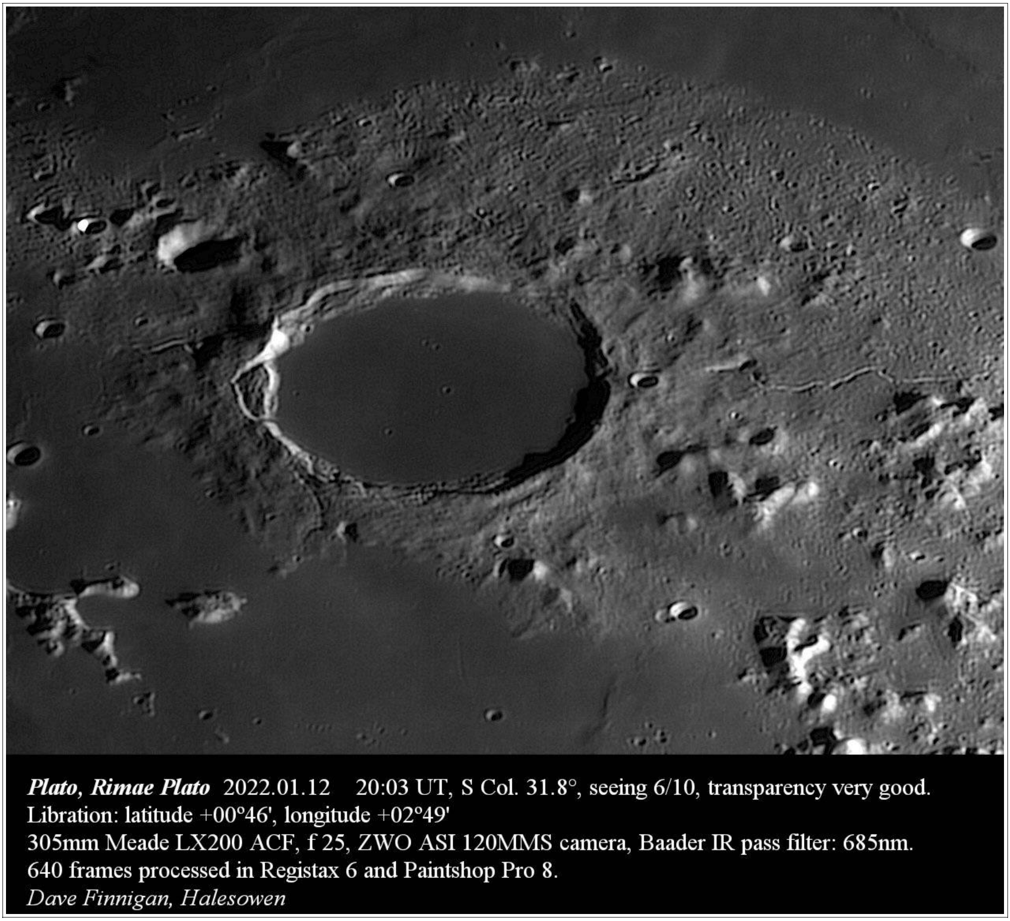


Figure 8. Plato as imaged by Dave Finnigan at the dates and UTS given in the image.

Venus and the Moon by Geoffrey White.

Geoff comments: As New Moon is today, I went on to our roof early on Sunday morning here in Malta hoping to see the last of the old Moon. I couldn't see the Moon but Venus was incredibly bright. A couple of minutes later I did spot the Moon very low down. It was still fairly dark as sunrise wasn't due for about half an hour but by Monday, the Moon would have been lost in the glare.

Figure 9. Captured by Geoffrey White, using an automatic Lumix camera. Image capture time 2022 Jan 30 @ 06:25.

Sinus Iridum by Bill Leatherbarrow.

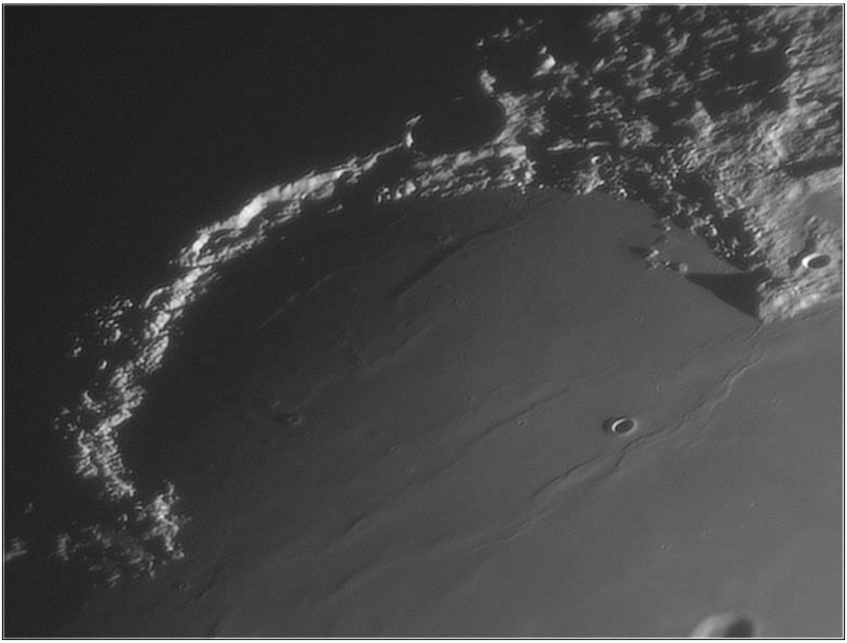


Figure 10 Sinus Iridum as imaged by Bill Leatherbarrow on 2022 Feb 11 UT 20:56 and orientated with north towards the top.

Sinus Iridum is an almost basin class crater at 250 km in diameter, Several, linear and parallel; wrinkle ridges cross the floor E-W. The mountain peak, with a tapered triangular shadow, on the SE corner of this flooded large crater is Promontorium Laplace which stands nearly 3 km above its surroundings.

Archimedes by Rik Hill.

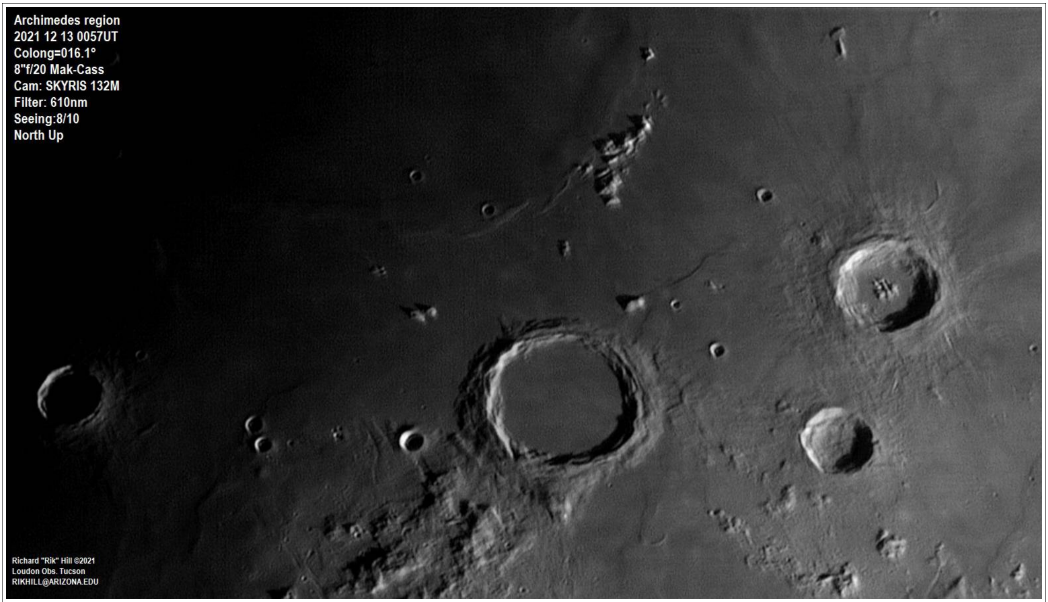


Figure 11. Archimedes and environs as imaged by Rik Hill.

Rik Comments: Just below the center of this image is Archimedes (diameter 85kms) one of those craters that newcomers to lunar observing learn quickly. It's an area of few craters so it stands out with it's relatively smooth flat floor. It's famous for several things. One are the tiny 1-2km craterlets on the floor that amateurs have used for many years to gague the quality of the night. Also there have been numerous reports of colourations on the floor that makes it one of the better known sites for suspected transient lunar phenomena. Because the moon has only a quarter the radius of the earth, if you stood in the center of Archimedes you might just see the tops of the crater walls, but it would be unlikely that you would get the sense that you were in a crater!

On the right side of the image are two more good sized craters. The upper one is Aristillus (56kms) with its curious central peaks and nicely terraced walls. Below is Autolycus (41kms) with a small rima on its floor. Above Archimedes is the cluster of the Montes Spitzbergen. They look tall, but are only around 1400m high. Nevertheless they sparkle in the morning sunlight, a glorious sight. The smaller crater just left (west) of Archimedes is Bancroft (14kms) with the twin craters Beer (4kms) south and Fueillee (10kms) north. I have to admit, they look more equal in size than that!

Below Bancroft are the Montes Archimedes. These get a bit taller than the Montes Spitzbergen, rising as much as 2km high. Finally the large crater mostly in shadow on the left edge of the image is Timocharis (36kms). It has a central peak, but the sun is not yet high enough there to show it here. This composite was made of two images each made from 1800 frame AVI's stacked with AVIStack2 (IDL) assembled with Microsoft ICE and finished off with GIMP and IrfanView.

Enjoy! Rik.

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Lunar Occultations for March 2022.
By Tim Haymes.

Time capsule: 50 year ago in the 1972 issue:

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

- ! P Moore (Director) requests occultation observers to form a “network”
- ! Lunar occultations become a formal Section project.
- ! Mr H.E.Robin* described his timing method at a recent LS Meeting. He used MSF 60kHz continuous time pips and a portable tape recorder.

* A typo’ in the LSC. The report is by H.K Robin, 1972,**82**,4 His main interest was in photometry, solar and planetary work.

Search for the *Endurance* – Shackletons’s vessel that sank in the Weddell Sea, 1915
You may have read on the BBC news etc, that Lunar occultation timings were recorded by the ship’s navigator, Frank Worsley, and used to make correction to the chronometers. I attach a link to the main article, and there are references within to pdfs of the occultation methods. To make and record these observations in such severe conditions is extraordinary, and then to follow up with hand written computations.The aim of the pre-print is to provide an improved estimate of the sinking point in Long/Lat for follow-up exploration in the Weddell Sea.
http://fer3.com/arc/imgx/OccultationCEPreprint.pdf

Occultation of 3C273 on Feb 19, 2022 at Parks radio telescope.
More senior members in the LS may recall the lunar occultation of this radio source in 1962 being reported by radio astronomers at Parks. The point source nature was the first recording of a quasar. The event is being celebrated at the Parks radio observatory, Australia, where they have re-enacted the original detections (with chart recorder) during the current series of predictions in the southern hemisphere. 3C273 is in Virgo at 12:29:06 +1:03:00 (J2000).There is a very nice history which contains log books, discussions and simulations.
https://www.parkes.atnf.csiro.au/people/sar049/3C273/

Observations reported.
T. Haymes: Two DD events timed on Feb 4th: XZ32430, S128637. Instrument C11 and QHY174mGPS at 25 fps.
His residuals for 2021 have been received from the European Collector. There were two remarks:

1) One star was miss-identified, 2) One observation needed a 1.0 sec correction because GPS was not fully synchronised.

Occultation predictions for 2022 March (Times as other locations will +/- a few minutes)

E. Longitude - 1 18 47.1, Latitude 51 55 40.3. To magnitude 8.5

y	m	day d	Time h	m	s	P	Star No	Sp D	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Moon Az	CA o	Notes
22	**Mar**	**5**	**20**	**39**	**41.7**	**D**	**219**	**K4**	**4.8***	**4.1**	**11+**	**38**		**5**	**273**	**85N**	**mu Psc**
22	Mar	5	21	3	31.1	D	109935	G5	8.3*	7.8	11+	38		2	278	34S	
22	Mar	6	20	6	29.2	D	331	A0	8.5	8.4	17+	49		21	262	79S	
22	Mar	8	23	7	14	m	76328	G5	7.9	7.4	36+	73		15	285	1N	
22	**Mar**	**9**	**22**	**19**	**45.9**	**D**	**716**	**B5**	**6.3**	**6.3**	**45+**	**84**		**31**	**270**	**58N**	
22	Mar	9	22	44	11.7	D	76742	G8	8.2	7.6	45+	84		27	274	49N	
22	Mar	10	0	20	3.4	D	727	G0	8.5	8.2	45+	85		13	291	41S	
22	Mar	10	1	55	15.6	D	76814	K0	7.4	6.9	46+	85		1	309	65S	
22	Mar	11	0	18	26.1	D	77399	A	8.5	8.4	55+	96		22	284	72N	
22	Mar	11	0	56	11.6	D	77441	A0	8.2		55+	96		17	290	74S	Dbl*
22	Mar	11	1	11	6.5	D	867	B1	6.8	6.8	55+	96		15	293	88N	
22	Mar	11	1	11	44.9	D	77455	A0	8.3	8.2	55+	96		14	293	56S	
22	Mar	11	23	4	42.1	D	78468	A2	8.2	8.1	64+	106		41	261	87N	Dbl*
22	Mar	12	18	47	16.1	D	79277	F0	8.1		72+	116	-7	60	143	79N	
22	Mar	12	20	31	2.4	D	79319	K2	7.9	7.3	72+	116		64	193	83N	
22	Mar	13	1	26	19.2	D	79444	K2	8.5	7.8	73+	118		27	278	77N	
22	Mar	13	3	41	5.1	D	79521	G2	7.4	7.0	74+	119		8	301	35S	Dbl*
22	Mar	13	23	31	18.1	D	80105	A0	7.9	7.9	81+	128		50	240	86N	
22	Mar	14	0	12	48	M	1251	B9	5.9	5.9	81+	129		44	251	3N	lambda Cnc
22	Mar	14	1	27	43.5	D	80146	A2	8.0	7.9	82+	129		33	267	82N	
22	Mar	14	2	27	31.2	D	80173	K0	8.3	7.8	82+	130		24	278	40N	
22	Mar	14	3	23	12.1	D	1267	A0	8.1	8.0	82+	130		15	288	82S	
22	Mar	14	23	48	8.0	D	80693	G0	8.4	8.1	88+	140		51	228	76S	
22	Mar	16	3	50	53.8	D	98984	F0	8.0	7.8	95+	153		20	270	85S	
22	Mar	19	22	43	28.3	R	139271	F2	8.3	8.0	96-	158		22	133	72N	
22	Mar	20	2	55	53.1	R	139327	K2	8.0	7.2	96-	157		29	202	60N	
22	Mar	20	22	15	0.5	R	2025	A2	6.8	6.8	91-	146		7	120	75S	
22	Mar	20	23	28	14.9	R	158405	K0	7.5	6.8	91-	145		16	135	53N	
22	Mar	21	4	41	28	m	X128563		8.2	7.9	90-	143		19	214	10S	Dbl*
22	Mar	21	4	41	33	m	X 37784	F8	7.4	7.1	90-	143		19	214	10S	Dbl*
22	**Mar**	**21**	**4**	**43**	**15.6**	**R**	**2053**	**A1**	**4.5**	**4.5**	**90-**	**143**		**19**	**214**	**89S**	**lambda Vir**
22	Mar	22	1	51	41.0	R	159052	F7	8.4	8.1	83-	131		18	159	54N	
22	Mar	22	2	12	24.7	R	2166	K2	8.0	7.3	83-	131		19	163	38N	
22	Mar	22	5	4	39.2	R	159116	A5	7.2	7.1	82-	130	-10	16	205	61S	
22	Mar	23	3	10	2.0	R	184172	A2	8.4	8.3	73-	117		14	165	25S	
22	Mar	23	3	25	22.0	R	184173	M0	8.2	7.3	73-	117		15	169	90N	
22	Mar	23	4	0	9.0	R	184189	A3	7.8	7.7	73-	117		15	177	78S	
22	Mar	24	3	21	10.4	R	185102	K0	8.4	7.8	62-	104		8	155	51S	
22	Mar	25	3	35	10.6	R	2634	B8	7.2	7.2	51-	91		4	146	69N	
22	Mar	25	4	24	6.7	R	186566	B9	7.8	7.7	50-	90		7	156	29N	
22	Mar	25	4	58	47.4	R	2643	K1	6.7	6.0	50-	90	-10	9	163	83S	
22	Mar	25	5	8	28.2	R	186598	B9	7.5	7.4	50-	90	-8	9	165	49S	Dbl*
22	Apr	3	21	11	54.3	D	93111		8.5	7.8	7+	30		2	292	89N	
22	Apr	4	20	57	42.2	D	519	K5	7.6	6.7	12+	41		13	284	36S	
22	Apr	4	22	15	47.2	D	93526	A*	7.7	7.5	13+	42		3	298	68N	

Predictions up to April 5th

Key:

P = Phase (R or D), **R** = reappearance **D** = disappearance

M = Miss at this station, Gr = graze near this station (possible miss)
CA = Cusp angle measured from the North or South Cusp.
Mag(v)* = asterisk indicates a light curve is available in Occult-4
Star No:
1/2/3/4 digits = Robertson Zodiacal catalogue (ZC)
5/6 digits = Smithsonian Astrophysical Observatory catalogue (SAO)
X denotes a star in the eXtended ZC/XC catalogue.
H denotes the HIPparchus 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. Ask the **Occultation Subsection Coordinator**: tvh dot observatory at btinternet dot com

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Lunar domes (part LVI): A lunar cone in Marius hills and its composition.
By Raffaello Lena

The Marius Hills volcanic complex (MHC) is one of the largest volcanic complexes on the Moon. The diversity of the geologic features (e.g., cones, domes, rilles, lava flows) indicates that volcanic activity was very important and very complex in this area. In this note I will describe another volcanic construct, which displays the presence of a cone superimposed on its summit (Fig. 1). The examined lunar cone is located at 13.7° N and 56.84° W.

Figure 1: Image taken by Wirths using a 355 mm Newtonian telescope and ASI 174MM camera. The cone is marked with white line and appears like a hill.

In Fig. 2 the foreshortening effect is deleted and the image is seen as cylindrical projection. The NAC image of this feature shows its real nature. It has a breached rim and displays a lava channel starting from the summit (see Fig. 3). Lunar volcanic cones form from explosive eruptions with the release of large amounts of dissolved gas (called degassing) when viscous magma rises to slowly fill the volcanic vent [Lena et. al, 2013].

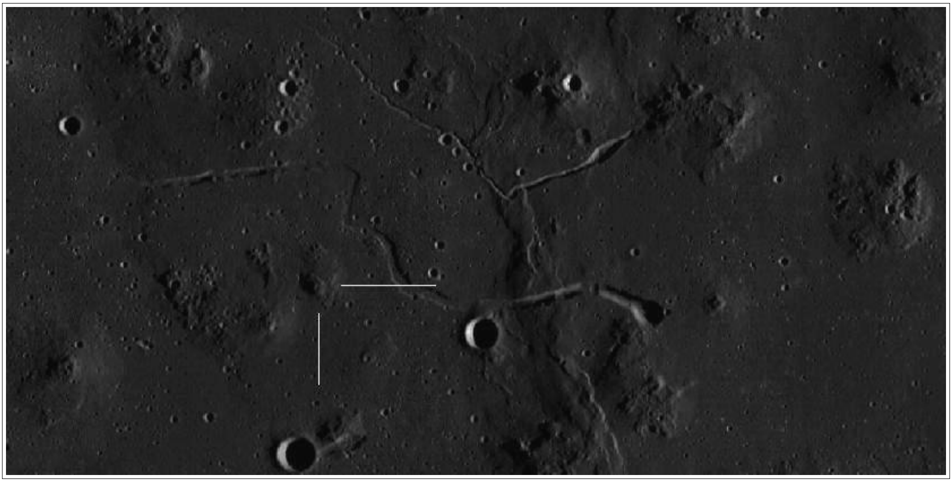

Figure 2: WAC imagery. The lunar cone is marked with white line and appears like a hill.

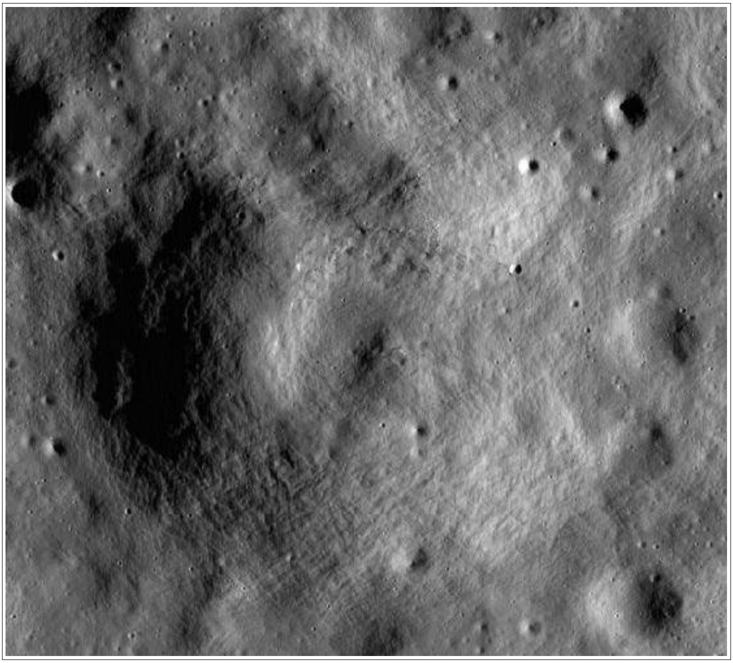

Figure 3: NAC image of the lunar cone with relatively large and breached depression at the summit.

It lies on the top of a volcanic dome 90 m high. ACT-REACT Quick Map tool was used to access to the LOLA DEM dataset, obtaining the cross-sectional profile of the cone (Fig. 4).

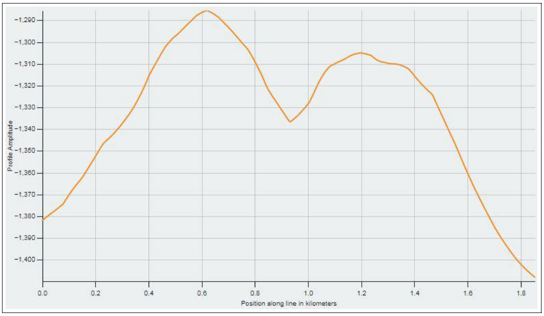

Figure 4: Derived surface elevation plot in East-West direction based on LOLA DEM.

The height of this cone amounts to 95 ± 10 m, the diameter is determined to 1.9 ± 0.2 km yielding an average flank slope of 5.6° ± 0.5°. A realistic view based on NAC digital elevation-*QuickMap Terrain Shadows*- displays the volcanic construct of C shape (3D reconstruction shown in Fig. 5).

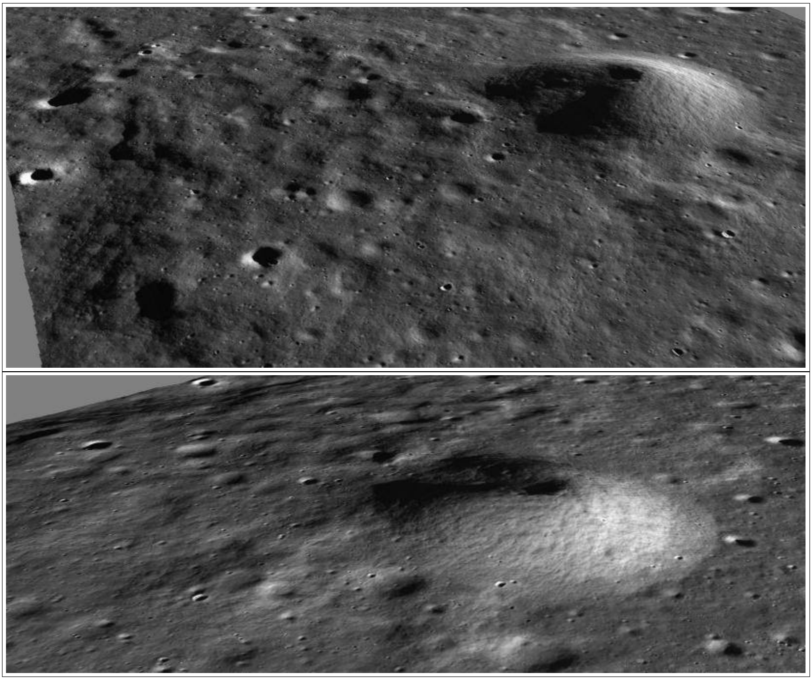

Figure 5: ACT REACT Quick Map tool- 3D reconstruction as seen from two different directions based on NAC imagery. Note the breached rim of the examined feature.

Composition.

The mafic minerals (e.g., pyroxene and olivine) of mare basalts can be identified through their characteristic spectral absorption features. Pyroxene displays two absorption peaks at approximately 1,000 nm (Band I) and 2,000 nm (Band II) [Besse et al., 2011]. In contrast, the olivine reflectance spectrum is revealed by a broad and asymmetric 1,000 nm absorption, but lacks the 2,000 nm absorption. The broad Band I absorption in olivine is caused by three distinct absorption bands [Besse et al., 2011; Besse et al., 2014]. The central absorption, located just beyond 1,000 nm, is caused by iron in the M2 crystallographic site. The two weaker absorptions near 850 and 1,250 nm are the result of iron in the M1 site. The Band I "secondary" absorption near 1,250 nm allows olivine to be detected when admixed with the spectrally "stronger" pyroxene. The band centers are influenced by the amount of Fe^{2+} and Ca^{2+}: with increasing Fe^{2+} and Ca^{2+}, the band centers move slightly to the longer wavelength. However, in the case of olivine-pyroxene mixtures, Band I is dependent on the relative abundances of both olivine and pyroxene.

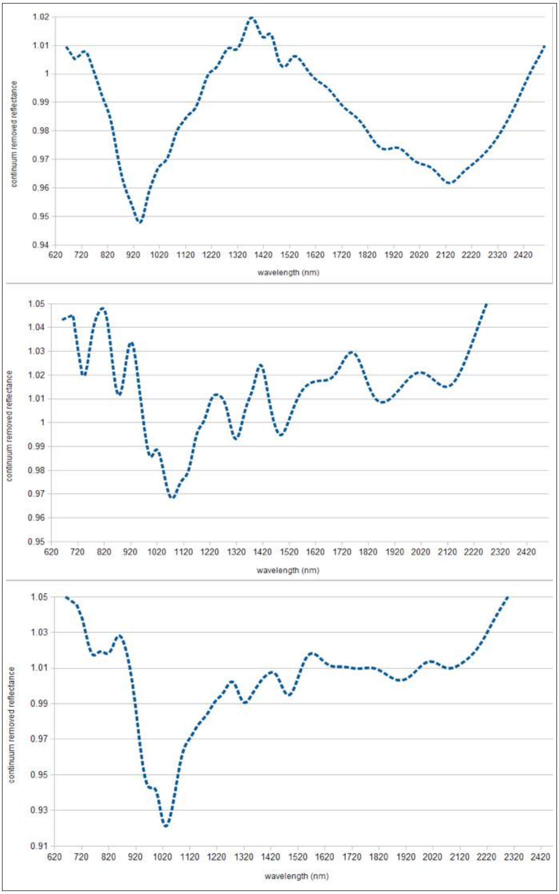

Figure 6: M^3 spectra of the lunar cone described in this article. (Top) breached summit Centre. (Middle) Western flank, WF. (Bottom) Southern flank, SF.

Thus, the 1,000 and 2,000 nm band positions can be used to distinguish between orthopyroxene (OPX; band centers between 900-940 nm and 1,800–1,950 nm), clinopyroxene (CPX; 980–1,040 and 2,050–2,400 nm), and iron-bearing glass (1,060–1,200 and 1,900–2,050 nm). Mixtures of these minerals have band centers that fall in the intermediate regions between the end members (Horgan et al., 2014). Olivine exhibits a band typically centered near 1,050–1,080 nm and plagioclase feldspars exhibit broad and shallow bands centered between 1,250 and 1,350 nm, but neither exhibits a corresponding 2,000 nm band.The obtained spectra, using M^3 dataset –orbital period OP1B- (Fig. 6), can be separated into two groups:

(1) Spectra with a 1,000 nm absorption centered at 940-950 nm, with secondary shoulder at 1,050 nm, and a 2,000 nm absorption centered at 2,100 nm (corresponding to a mixture of pyroxenes and olivine) and

(2) Spectra having asymmetric 1,000 nm absorption bands centered at longer wavelengths (e.g., 1,050-1,060 nm) and weak 2,000 nm absorption band centers shifted to shorter wavelength (~1,090 nm). Spectra determined on the flank (WF and SF) correspond to the second category. On the other hand spectra of the lava channel correspond to the first category.Spectra of high-calcium pyroxene mixed with Fe-bearing glass can be virtually indistinguishable from common Fe-bearing olivine compositions. This effect, combined with the fact that Fe-bearing glass is generally much more difficult to detect than other ferrous minerals, may be causing glass occurrences on planetary surfaces to be underreported.

Although the wider and shifted 1,000 nm absorptions could also be attributed to the presence of olivine, the shift to shorter wavelengths of the 2,000 nm absorptions and the relative weak of the 2,000 nm band are more indicative of the presence of volcanic glasses. The spectra of both volcanic glasses exhibit the same characteristic as the second group of in situ measurements with shifted absorption bands [Horgan et al., 2014].

Thus the localized spectrum of the breached rim in Fig. 6 (Top) may represent a final effusive product richer in olivine rich basaltic composition, while the spectra of the flanks may more likely be constituted by Fe-rich glasses material intermixed with basalts.

The Multiband Imager (MI) data has been used for compositional analysis. MI is a high-resolution multispectral imaging instrument on board SELENE. It has five visible (VIS) bands (415 nm, 750 nm, 900 nm, 950 nm, and 1000 nm) and four near-infrared bands (1000 nm, 1050 nm, 1250 nm and 1550 nm).
The lunar cone displays a TiO_2 content of 9-10 wt% and low plagioclase content (<30.0 wt %). The FeO content varies from 19.0 wt % to 21.0 wt % like the nearby mare units.

This lunar cone has an enhanced abundance of orthopyroxene (from 47.0 wt % to 50.0 wt %) and a lower abundance of clinopyroxene (15.0-26.0 wt %) if compared with nearby mare units (Fig. 7).

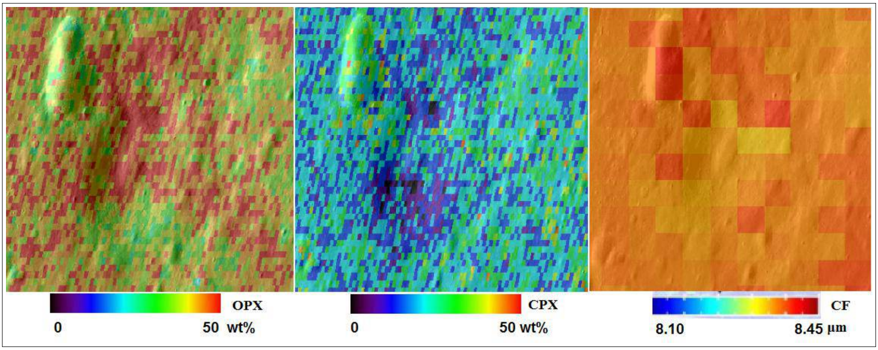

Figure 7: Derived abundance maps in wt% (left OPX, middle CPX) and Diviner CF (right).

Furthermore, the spectra indicating glassy material display in the same area a higher CF value than the nearby unit, based on Diviner dataset: they exhibit enhanced CF values that reach as high as 8.45 µm, where other areas (including the rim of the cone) display CF values of 8.25–8.30 µm (Fig. 7). Hence the western and southern part of the examined cone is likely dominated by a glass component, and a map is shown in Fig. 8.

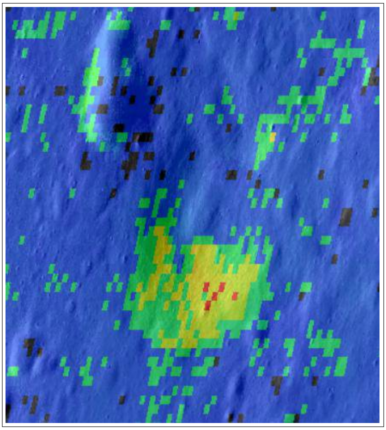

Figure 8: Derived glass composition. For this analysis I have chosen to interpret the MI-derived olivine concentrations as Fe-rich glasses material intermixed with basalts.

Scenarios explaining the observed asymmetry of C-shaped cones include: (1) the non-uniform eruption and emplacement of pyroclastics and lava around the vent resulting in asymmetrical construction of the rim; (2) pre-existing topography directs erupting lavas away from the vent in the downslope direction and prevents the construction of the downslope wall, resulting in an asymmetrical cone; (3) a directional weakness formed in a symmetrical cone due to a pileup of lava and/or pyroclastics on one side results in the collapse of one wall of the cone and is accompanied by a breakout of lava from the cone wall; (4) pre-existing topography controls the flow direction of erupting lavas and results in the destruction of the downslope rim through thermal erosion.

Detailed analysis of individual lunar cones and the immediate surrounding area is ongoing to determine the extent of deposits, variations in mineralogy within a deposit, and eruption dynamics of volcanism in this region. Further analysis of volcanic features in this region is being conducted to understand the regional geology and relationships between various volcanic features.

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

Besse, S., Sunshine, J. M., Staid, M. I., Petro, N. E., Boardman, J. W., Green, R. O., Head, J. W., Isaacson, P. J., Mustard, J. F. and Pieters, C. M. (2011). Compositional variability of the Marius Hills volcanic complex from the Moon Mineralogy Mapper (M^3), J. Geophys. Res., 116, E00G13, doi:10.1029/2010JE003725.

Horgan, Briony H.N., Cloutis, Edward A., Mann, Paul and Bell, James F. Near-infrared spectra of ferrous mineral mixtures and methods for their identification in planetary surface spectra. Icarus, Volume 234, 2014, 132-154, ISSN 0019-1035, https://doi.org/10.1016/j.icarus.2014.02.031

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

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Lunar Geological Change Detection Programme by Tony Cook.

TLP reports: No TLP reports have been received for January.

Routine Reports received for January included: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Aristarchus, Daniel, Kepler, Piccolomini, Plato, Proclus and Theophilus. Alberto Anunziato (Argentina – SLA) observed: Gassendi, Messier A, Plato, Puiseux. Tycho and several features. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Lacus Mortis, Theophilus and several features. Anthony Cook (Newtown – ALPO/BAA) videoed earthshine and imaged several features. Walter Elias (Argentina – AEA) imaged: Albategnius, Alphonsus, Chacornac, Fracastorius, Halley, Hyginus N, Maskelyne, Menelaus, Montes Teneriffe, the lunar disk, Protagoras, Petavius, Plato, Theaetetus, and Tycho. Valerio Fontani (Italy – UAI) imaged: Censorinus, Copernicus, Herodotus and Vallis Schroteri. Les Fry (West Wales – NAS) imaged: Arzachel, Bullialdus, Clavius, Copernicus, Dorsum Bucher, earthshine, Eratosthenes, Fra Mauro, Gassendi, Hainzel, Kepler, Mare Crisium, Mare Humboldtianum, Mare Smythii, Miller, Montes Alpes, Montes Apenninus, Montes Recti, Pitatus, Rupes Recta, the southern limb of the Moon, the lunar south pole, Scheiner, Schiller, Sinus Iridum, Thales, Tycho and W Bond. Massimo Giuntoli (Italy) observed Cavendish E. Mark Radice (Near Salisbury, UK – BAA) imaged: Aristarchus, Gassendi, Jansen, Kepler, Mare Orientale, Marius, Messier, Neander, the southern lunar limb, the lunar south pole, Schiller and Taruntius. Trevor Smith (Codnor, UK – BAA) observed: Aristarchus, Atlas, Curtis, Daniell, earthshine, Moltke, Plato, Proclus, Torricelli B and several features. Bob Stuart (Rhayader, UK – BAA) imaged: Aristarchus, Aristotles, Atlas, Bohnenberger, Boussingault, Brenner, Capella, Clavius, Democritus, Fracastorius, Gassendi, Gutenberg, Hainzel, Herschel, Hommel, Isidorus, Jansen, Kepler, Macrobius, Magelhaens, Manzinus, Mare Frigoris, Mare Imbrium, Mutus, Neander, Nearch, Piccolomini, Possidonius, Prinz, Romer, Santbech, Schickard, Schiller, Sinus Iridum, Taruntius, and Vlacq. Franco Taccogna (Italy – UAI) imaged: Herodotus and Vallis Schroteri. Aldo Tonon (UAI) imaged: Bailly, Censorinus, Herodotus, Kies, and Vallis Schroteri. Gary Varney (Pembroke Pines, FL, USA – ALPO) imaged Aristarchus.

Routine Reports Received:

Note that time is limited this month for a full analysis, so it will be left up to the reader to compare the original and modern-day observations:

Theophilus: On 2022 Jan 08 UT 01:55-02:30 Jay Albert observed Theophilus, Proclus and Piccolomini craters under similar illumination to the following report:

On 1990 Aug 26 at UT 02:30-03:30 W. Cameron (Sedona, AZ, USA, 8" reflector, x110 and x220, seeing=good) observed that the west wall of Theophilus crater was red (on terminator). However, Posidonius was also on the terminator and no colour was seen elsewhere along the terminator, however Proclus and Piccolomini had pink interiors. At a higher power of x220 a prismatic effect was seen on the terminator in Theophilus and other craters - "even on W rim of a crater due W of Theoph.". CED measurements of Theophilus... 3.5, 3.9, 3.5. The Cameron 2006 catalog ID=407 and the weight=3. The ALPO/BAA weight=1 because the Moon was below the horizon at this time.

Jay used a Celestron NexStar Evolution 8” SCT, with a magnification initially of 185x and then 226x. Transparency was initially 4th magnitude dropping to 3rd by the close of the session due to increasing haze. Seeing dropped from 6/10 to 3/10. The interior of this crater was in full shadow. The exterior E wall was highly detailed, but only fragments of the other rims of the crater were sunlit. I did not see the reported red color on the interior W wall at first using 185x. On closer inspection at 226x, I did see color on the central, brightest fragment of the interior W rim. The lower part of this rim fragment was a razor thin red line. Above the red was a thicker strip of white and on top was a razor thin blue line. This color pattern is typical of the kind of atmospheric spectral dispersion that can be observed on bright objects during periods of bad seeing.

Censorinus: On 2022 Jan 08 UT 17:48 Valerio Fontani captured an image that corresponded to the colongitude range in the following Lunar Schedule request:

ALPO Request: The aim here is simply to see at what earliest colongitude can you record with a colour camera, natural blue *colour on the crater during sunrise. The effect can be quite impressive. Try to get the exposure right else the crater will be saturated white and you will not capture any colour. Please send your images to: a t c @ a b e r . a c . u k*

Figure 1. Censorinus at 17:49 UT as imaged by Valerio Fontani with north towards the top. Image has been colour normalized and had its colour saturation increased to 60%.

Fig 1 Shows a hint of blueness in the ejecta blanket around the crater. Therefore, the blue colour appears as early as a colongitude of 341.0°.

Proclus: On 2021 Jan 11 UT 18:55 Les Fry (NAS) imaged Mare Crisium under similar illumination to the following ng report:

Figure 2. Proclus enlarged up from a bigger image of Mare Crisium captured by Les Fry (NAS) on 2021 Jan 11 at 18:55 UT. North is towards the top.

Proclus 1976 Jul 06 UT 01:35 Observed by Bartlett (Baltimore, MD, USA, 3" refractor, 40-450x, S=6, T=3) "Nothing vis. on floor (albedo=2 deg?)(usually features are vis.)" NASA catalog *weight=4.NASA catalog ID #1437.*

Well, according to the image that Les took (Fig 2) there is some detail on the floor of Proclus, so a lack of detail (as seen by Bartlett) would be unusual. We shall therefore leave the weight as it is, but continue to collect similar resolution images captured with a view to seeing if the atmospheric conditions could have contributed to Bartlett's observation

Herodotus: On 2022 Jan 14 UT 16:16 to 17:14 Franco Taccogna (UAI) imaged this crater for the following Lunar Schedule request:

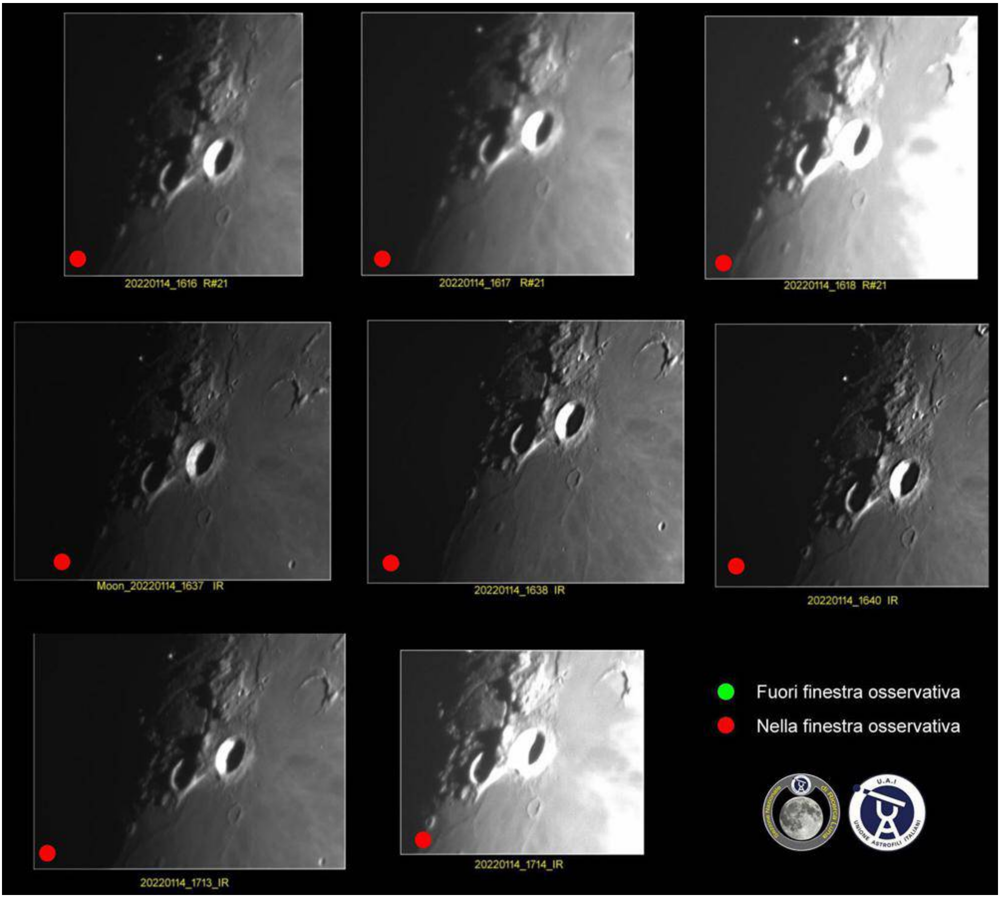

Figure 3. Herodotus as imaged by Franco Taccogna on 2022 Jan 14 at the UTs given in the image. North is towards the top.

BAA Request: Some astronomers have occasionally reported seeing a pseudo peak on the floor of this crater. However, there is no central peak! Please therefore image or sketch the floor, looking for anything near the centre of the crater resembling a light spot, or some highland emerging from the shadow. All reports *should be emailed to: a t c @ a b e r . a c . u k*

Nothing unusual seems to have been seen this time around, but we will continue looking as it seems to be around this range of colongitudes that very occasionally these effects have been seen. We also have a good time sequence in Franco's images in Fig 3.

Gassendi:
On 2022 Jan 14 Mark Radice (BAA) at 22:18 UT and Bob Stuart (BAA) at 22:07 UT imaged this crater under similar illumination to the following report:

Gassendi 1939 Aug 27 UT 02:00 Observed by Haas? (NM? USA, 12" reflector?) "NE part of c.p. was I=6.4, compared with I=9.4 on 9/28/39 (see #462) under similar cond.@ NASA catalog weight=4. NASA catalog ID# 458.

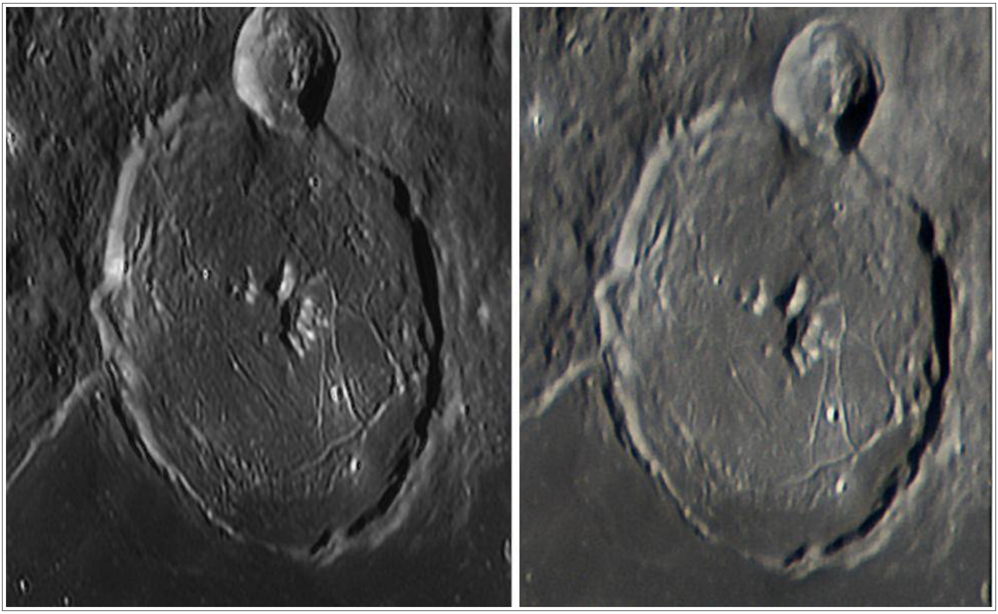

Figure 4. Gassendi as imaged on 2022 Jan 14 and orientated with north towards the top. **(Left)** Imaged by Bob Stuart at UT 22:07 UT. **(Right)** imaged by Mark Radice at 22:18 UT.

At least we now have the normal appearance of what the crater would have looked like (Fig 4) to Walter Hass under ideal observing condition for that illumination.

Aristarchus: On 2022 Jan 15 UT 23:29 Gary Varney (ALPO) imaged this region under similar illumination to the first report below and under similar illumination and topocentric libration to the 2nd report below:

Vallis Schroteri - 1893 Jan 30 W.H. Pickering observed Variations in vapor column rising from the Cobra Head feature (seen on several nights *in succession) and also in the visibility of craterlets A, C, F. Sunrise +2d. (time est. fr. gives colongitude). Cameron 1978 catalog ID=279 and weight=3. Pickering was observing from the southern station of Harvard University in Arequipa, Peru.*

Aristarchus - 1985 Dec 25 Louderback observed that the south west wall was a creamy deep yellow. There was also strong fluorescent blue on the west wall of the Cobra Head - Schroter's Valley area and this was similar to the violet glare seen on Aristarchus at times. Violet was seen between Aristarchus and the Cobra Head. Seeing conditions were poor. Brightening of a point near C occurred roughly every 10-15 seconds and lasted 0.5 sec - (Cameron concludes that this was not due to the Earth's atmosphere). A 0.2 step drop in brightness was seen on point A (twin spots). point C had reduced by 0.6 steps. Elsewhere was stable in brightness. Cameron 2006 catalog ID=281 and weight=4. ALPO/BAA weight=3.

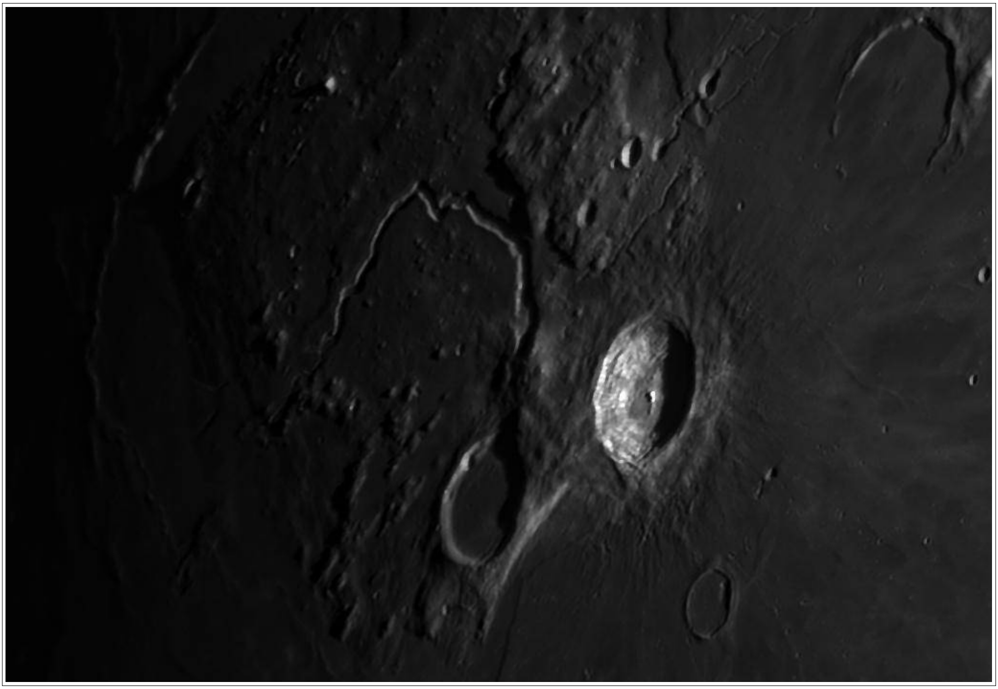

Figure 5. Aristarchus as imaged by Gary Varney (ALPO) on 2022 Jan 15 UT 23:39 and orientated with north towards the top.

I have no idea what craterlets or points A,C and F are, but at least we have a view of what the crater looks (Fig 5) like under normal circumstances for these two TLP reports.

Bailly: On 2022 Jan 16 UT 23:02 Aldo Tonon (UAI) obtained a colour image of this crater following 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 6. Bailly as imaged by Valerio Fontani on 2022 Jan 16 UT 23:02, orientated with north towards the top. The image has been colour normalised and then had its colour saturation increased to 80%.

This actually corresponds to a 1974 Oct 29 UT 22:00-23:00 report where Fylde Astronomical Society observer, Chris Lord, noted the south western floor to be darker in the blue than the red light. Wratten 25 & 44a and then Wratten 29 and 47b filters were used back then. Chris Lord suspected that the crater may have had a greenish colour to the floor and that this was an effect that could always be seen around the range of colongitudes. In Fig 6 we can see perhaps a hint of green on the SW floor, though it may just be a darker shade of grey?

Cavendish E: On 2022 Jan 16 UT 21:45 Massimo Giuntoli observed this crater visually in part of a programme to monitor its brightness. He has on occasions noted this crater to be very bright before. However, on this night he noted that the southern floor of the crater was bright but not brilliant i.e., just normal appearance. He was observing under Antoniadi III/IV seeing with a 15cm diameter refractor, x240, with a W8 filter. The selenographic colongitude was 81.2° and sub solar latitude -1.3° The libration was lat. -4°26' long. -2°33'.

Eimmart: On 2022 Jan 17 UT 22;05-23:10 Trevor Smith observed this crater visually under similar illumination, and topocentric libration, to the following TLP report:

Louderback, of South Bend, WA, USA observed a bright area over

Mons Anguis and Eimmart - it resembled a comet and had a bluish colour and varied in brightness. The colour was confirmed as it was not seen in a red filter but could be seen in blue and white light. Other features were checked but did not show anything similar although a violet glare was suspected in the blue filter. A sketch was made. Observer made Eimmart 8 in brightness at 07:30UT. Noted that the area around Eimmart appeared opaque at times and less so at other times. At 08:52UT the phenomenon was seen again. On May 2nd a bright spot was still seen in the region but it was not changing dimensions. During the observation on Apr 30th the atmospheric transparency was excellent. A 2.5" refractor was used. Reference: Personal communication from Louderback to Cameron on 1980 Jul 16th. The Cameron 2006 catalog extension ID of this TLP was 93 and the weight was 4. ALPO/BAA weight=3.

Trevor commented that he could see no resemblance to a comet shape, nor any bluish colour. All looked perfectly normal. We shall leave the weight at 3.

Fracastorius: On 2022 Jan 19 UT 02:16 Walter Elias (SLA) imaged this crater under similar illumination to the following report:

Fracastorius 1975 Jul 24 UT 22:52 Observed by Robinson (Teignmouth, England, 10" ? reflector or 4" refractor?) "Fracastorius had a blink(red or blue?)" NASA catalog weight=3. NASA catalog ID #1409. ALPO/BAA weight=2.

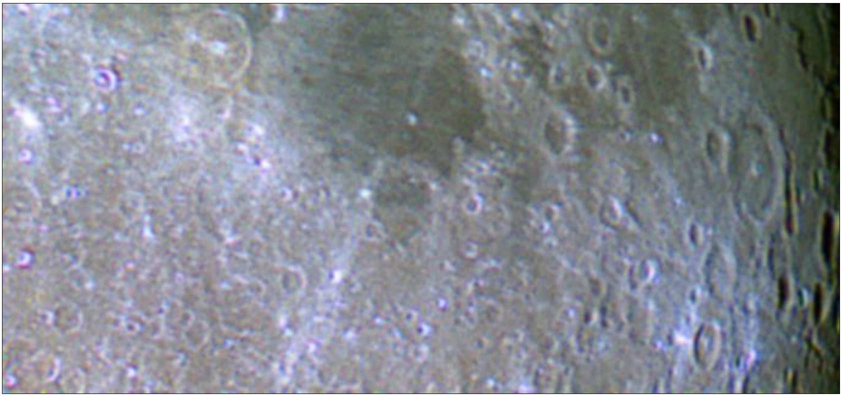

Figure 7. Fracastorius as imaged by Walter Elias (AEA) on 2022 Jan 19 UT 02:16. Image has north at the top, has been colour normalised, and had its colour saturation increased.

It can be seen from Fig 7, that there is no natural colour here that would have been detected in a Moon Blink device. Therefore, the weight shall remain at 2 for now. Sometime people have said that Fracastorius was a permanent blink side, meaning when one used coloured red/blue filters, it always appeared brighter in one filter rather than the other. From Walter's image this would appear not to be the case either.

Puiseux: On 2022 Jan 22 UT 05:05-05:15 Alberto Anunziato (SLA) observed the crater under similar illumination to the following report:

On 1979 Jul 14 at UT 00:24-01:10 P. Madej (Huddersfield, UK, 15cm reflector, x35, x52, x73 and x110, seeing IV-V, transparency very good). Note that the observing date was also written as Jul 18th in the original report? Puiseux was very clear in white light, but could not see the central peak. The central peak though was visible through a Wratten 15 (yellow) filter. The ALPO/BAA weight=1.

Alberto comments that the bright point on the centre of the crater was hardly visible, and thought that this could be the central peak? Alberto was using a 10.5cm Meade EX 105 scope.

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 in this way 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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BAA LUNAR SECTION CONTACTS:
Acting Director: Tony Cook (atc @ aber.ac.uk)
Lunar Section Circular Editor: Barry Fitz-Gerald (barryfitzgerald@hotmail.com)
Website Manager: Stuart Morris [contact link via the Section website at https://britastro.org/section_front/16]
Committee members:
Tony Cook (Coordinator, Lunar Change project) (atc @ aber.ac.uk)
Tim Haymes (Coordinator, Lunar Occultations) (occultations @ stargazer.me.uk)
Robert Garfinkle (Historical) (ragarf @ earthlink.net)
Raffaello Lena (Coordinator, Lunar Domes project) (raffaello.lena59 @ gmail.com)
Nigel Longshaw