

#### From the Director:

I hope that you all had a good start to the New Year? I don't know if others have found this, but from about the start of December onwards, I have suspected that the weather forecasts here in the UK, have become extremely unreliable, and next to useless – certainly in Mid Wales. There have been situations when they were confidently predicting total cloud cover, and yet it turned out clear all night, and so I missed the opportunity to observe. On another occasion several forecasts inferred pretty much rainless conditions, so I set up the 8-inch outside on a perfectly clear night, nipped indoors for a few minutes, and came out again to find it raining cats and dogs. And then to add insult to injury, on another predicted "clear" night, I set up the 16-inch (this took about half an hour), went inside for a few minutes, and came out to find it snowing under a clear sky! Although these accounts clearly do not form a scientific statistical study, they have altered my observing routine into a more nervous/cautious approach, involving sticking my head outside more often to see what is going on, more so than I ever used to do. Is it a bug in weather prediction models, or just the weather becoming more changeable? In discussion with my PhD student, he recommends using the following web site: <a href="https://clearoutside.com">https://clearoutside.com</a> as it deals with cloud cover at 3 different levels and is more suited for astronomers than traditional BBC, Met Office etc domestic web sites. Barry Fitz-Gerald also recommends this as an alternative website: <a href="https://www.meteoblue.com">https://www.meteoblue.com</a>



The image above is a Green Bank Telescope (GBT) and Very Long Baseline Array (VLBA) radar backscatter image of Tycho crater, with 5 metre resolution. Image credit: Raytheon Technologies.

Lastly, although it has taken nearly three decades, Earth-based observing techniques have finally caught up with the former highest resolution state-of-the-art US Navy Clementine Moon mission from 1994. Using a transmitting power equivalent to that of a simple microwave oven, astronomers, transmitting from Green Bank radio telescope, and receiving on several wildly distributed dishes of the Very Large Baseline Array, have created this 5-meter resolution image of Tycho crater and its surroundings shown above, using a frequency of 13.6 GHz. By comparison Clementine HiRes camera achieved about 7-10 m image resolution. Radar images are somewhat different to optical light images in that they do not use the Sun to light up the surface (passive imaging), but instead provide a beam of electromagnetic radiation (active imaging) to illuminate the lunar surface. Some of this can penetrate slightly beneath the lunar surface and even let us see clearly into permanently shadowed areas. In theory one could potentially do radar interferometry and measure deflections in height, due to Earth tides or tectonic structural forces, at the cm scale. The main disadvantage of course is that we cannot see anything on the far side beyond the libration zones on the limb. For further details about these Radar images see the following website.

Tony Cook.

# Lunar Occultations February 2023 By Tim Haymes

#### Time capsule: 50 year ago: in Vol 8 No.2

\*Occultations are reported to the RGO \*Excellent drawings of the banding on Alhazen alpha (Mare Crisium) \*Complaints about the weather effecting observations !

[With thanks to *Stuart Morris* for the LSC archives ]

#### **Occultation of Mars 2022 Dec 12– Reported in January:**

The section would like to thank all the observers for sending in their observations and recordings. It was a dramatic event and many of the images shows extraordinarily good detail on the surfaces of both the planet and our Moon.

#### **Report of Graze of Uranus 2023 Jan 01 Southern Limit:**

Alex Pratt reports: My C11 at f/10 and Watec 910HX camera caught the ghostly disc of Uranus up to about a minute before disappearance at the dark limb, then it was swamped by the thin cloud and glare from the gibbous Moon.

#### Graze of Omicron Pisces on 2023 Jan 27th.:

This 4<sup>th</sup> magnitude star grazed the southern limb at 2118UT near cusp angle 7 degrees. The Moon was 41% sunlit and favourably placed in a Friday evening sky at alt/az of 26/250. From Oxford, the sky was clouded, so I don't expect any observations – but I live in hope !

Observing grazes is a local interest, unless one is prepared to travel some distance, perhaps combined with a weekend outing. So I took a long look at the graze region on Google Earth but found no "easy" access to the path. By this I mean a public carpark or semi-rural area within striking distance from Banbury via Motorways. Clearly the o-Psc event required local knowledge for planning purposes. See HBAA #2.

#### Moon-Venus-Saturn on evening of Jan 23<sup>rd</sup>:

T Haymes: I viewed this celestial alignment from our back garden. Earth-shine was prominent. Saturn was a lot fainter and seen when the sky had darkened at about 1800UT. Image details: Hand-held DSLR 50mm F2.5 lens at 1600 iso. The sky was mostly clear, a pleasant change. The secret is not to plan to view anything, otherwise Spode will "hear" of it.



**Occultation predictions for 2023 February:** (Times as other locations will +/- a few minutes) Oxford: E. Longitude - 1 18 47, Latitude 51 55 40 To magnitude r8.5 Moon altitude >7 degrees.

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23	Feb	1	18	21	36.7	D	77759	к3	7.7	7.0	86+	137		49	110	) 85N	
23	Feb	2	23	49	56.7	D	78957	G8	7.5	7.0	93+	149		59	225	5 78N	
23	Feb	3	1	58	45.2	D	79022	к0	8.0	7.6	93+	150		42	261	48N	
23	Feb	3	18	17	43.4	D	1169	K5	5.3	4.5	96+	158		32	88	62N	76
Gei	n																
23	Feb	7	5	40	38.8	R	99123	к0	7.3	6.5	98-	164		27	258	8 87S	
23	Feb	7	6	48	59.0	R	99149	A2	7.1	7.0	98-	163	-8	16	271	. 70S	
23	Feb	7	23	46	33.8	R	99421	К2	8.1	7.5	95-	155		40	135	5 70N	
23	Feb	8	3	10	1.5	R	1613	F5	8.1	7.9	95-	154		45	204	64S	
23	Feb	9	5	14	20.2	R	1722	<b>A</b> 0	7.7	7.6	89-	142		32	226	67N	
23	Feb	10	0	55	27.9	R	1802	К2	7.1	6.5	84-	132		28	137	20N	
23	Feb	10	3	52	0.9	R	1808	F5	7.0	6.7	83-	131		35	189	80S	
23	Feb	14	5	54	9.2	R	2283	B8	6.8	6.8	43-	83		14	172	2 70N	
23	Feb	23	18	53	31.3	D	109824	G5	8.8	8.3	16+	47		27	245	5 39N	
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nea	arby																
23	Feb	24	22	5	26.5	D	338	A5	7.8	7.7	26+	61		11	278	88S	
23	Feb	25	20	31	53.2	D	93270	A2	8.5	8.3	35+	72		35	254	73S	
23	Feb	25	23	11	7.5	D	93319	к0	7.6	7.1	36+	73		12	285	64N	

23	Feb	26	18	18	45.4	D	76311	в8	7.2	7.2	44+	83	-7 59	200	56S	
23	Feb	26	20	15	56.9	D	582	F2	5.6	5.4	45+	84	48	241	54N	32
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23	Feb	26	23	2	36.6	D	76406	F5	7.8	7.6	46+	85	24	277	47S	
23	Feb	27	22	4	25.8	D	733	<b>A</b> 0	7.2		55+	96	42	258	84S	
23	Feb	27	23	1	2.2	D	76835	<b>A</b> 0	8.5	8.3	56+	96	33	269	55S	
23	Feb	28	18	57	38	m	77398	в9	8.0	8.0	64+	106	65	171	7S	dbl*
23	Feb	28	20	11	20.5	D	77472	F0	8.7	8.3	64+	107	63	207	40S	
23	Feb	28	22	3	49.0	D	77561	к0	8.5	8.0	65+	107	51	247	77S	

See the December 2022 issue of LSC for an explanation of the table. *Detailed predictions at your location for 1 year are available upon request. Ask the* Occultation Coordinator: tvh dot observatory at binternet dot com, or the Director

Interested in Grazes only? – Indicate your travel radius in Km and your home post code or nearest town. An aperture of 15cm will be used unless advised. More predictions will be generated by this process.

#### **Two Occultation Extras!**



Occultation of Mars on December 12<sup>th</sup> 2022 imaged by **John Axtell** using an iPhone mounted on an eyepiece in my 20" dobsonian (Obsession Classic equipped with StellarCat drives)

John Comments "I hadn't actually planned to observe, so I didn't have scope or camera set-up ready. However nature intervened and woke me up at 3.45 a.m. so I just had time to grab a camera with the most powerful zoom lens. This is a Canon Powershot XD70 HS with an optical zoom of 65x. I didn't even have time to find a camera so the attached image was taken, single shot, leaning against a wall to steady the shot. It shows Mars just about to slip behind the Moon. What surprised me was that such a simple, relatively low priced camera could actually resolve Mars as a disc - there's even a hint of markings on the surface."



Post-Uranus occultation from 2023 Jan 01 imaged by **Tony Cook** with taken with an 8-inch reflector, ZWO ASI178MC camera at Newtonian focus, from Newtown, Mid-Wales, UK.

**Tony Comments:** "Unfortunately cloud and rain prevented me from seeing the disappearance and reappearance, but I did manage to get a slight gap in the clouds in order to take this rather over exposed image. If I had been living in South-Wales then the occultation would have been a graze. The magnitude of Uranus was +5.7."

#### **Communications Received.**

#### Lunar Imaging Help by John Axtell.

The main reason for writing is to ask advice as to whether the Lunar Section, or BAA more generally, has a recommended workflow, or preferred YouTube or other video tutorial, leading one through the capture and processing of lunar images? I have at long last taken the plunge and have started using my planetary camera ZWO ASI120 MC, but just on my Celestron C6 mounted on an iOptron Mini Tower II mount (Alt-az of course) and am pleased with my initial results of Jupiter and Mars. The software used for capture was SharpCap, followed by PIPP, then AutoStakkert for stacking, wavelets for detail in Registax, final contrast/brightness adjustment in GIMP. I've now tried the ZWO on the Moon for the first time a couple of night's ago, again with the C6. I tried several different YouTube tutorials, but I got my best result with SharpCap, Registax, Gimp - (see below image). It's reasonable, but I've learned to centre my target better to allow for drift, which in this case took out one of the chain of three craters that were my target. I found some of the tutorials I watched suggested differing routes, settings, options etc - so I thought that there might be one that Lunar Section colleagues thought best, or maybe an earlier edition of our Newsletter might have covered this.

**From the Director** – this is a common question often asked, but we have not really addressed this much recently in the Lunar Section Circular. If any members have advice for John, please email me and I shall pass this on to him and also publish it in the Lunar Section Circular (if you wish me to?)



Image by John Axtell taken on 2022 Dec 29 UT 17:24

### Sinus Amoris by Bill Leatherbarrow.

I was struck by Dave Finnigan's excellent image of the Cauchy rille, fault and domes in the January 2023 issue of the LSC. Dave's image captures the most immediately striking parts of a much larger area, remarkable for a wide range of geological features of volcanic origin. Other parts of this region are less frequented by observers and imagers, such as the area around Jansen and Gardner. Another neglected corner is the fetchingly named Sinus Amoris ('The Bay of Love'). Tucked away in the northeast corner of Mare Tranquillitatis, Sinus Amoris is one of those small isolated pockets of mare material that make up the Moon's lesser *maria*. Its small size and location at the margins of Tranquillitatis mean that it is often overlooked, but it was beautifully displayed at the evening terminator on the morning of 11 January 2023.

Sinus Amoris is well worth a telescopic visit, if only for the questions it poses about possible past volcanic and tectonic activity in the area. Obviously it has been flooded by mare lavas, but its surface also shows evidence of possible volcanic domes, wrinkle ridges and, under higher illumination, suggestions of several discrete lava flows. But to my mind the most interesting feature is Mons Maraldi, near the western 'shore' of the bay. Crater Maraldi is a dark-floored flooded enclosure some 40 km in diameter. It is obvious near the bottom centre of my image. Mons Maraldi is the prominent mountain mass just above Maraldi in the image. The 3-D image below has been constructed using QuickMap and shows a fairly steep-sided protuberance rising some 800m above the mare plain.

The question is: Is Mons Maraldi simply an isolated block of highland material surrounded by mare lavas or is it a volcanic dome? Its slopes are quite steep for a dome, but its general appearance puts me in mind of such volcanic features as the nearby Gardner 'Megadome' some 140 km to the south, the Mons Gruithuisen domes on Mare Imbrium, and perhaps Mons Rümker on Oceanus Procellarum.

On my image and the QuickMap visualisation Mons Maraldi appears to be covered in lumpy mounds, rather like Rümker, although the flank slopes of Rümker appear to be much less steep. My image also shows what appears to be a prominent summit pit on Mons Maraldi, although this is not immediately evident on the 3-D model or QuickMap imagery. There are, though, possible suggestions of a large shallow summit caldera.



Fig. 1 Sinus Amoris, 2023 January 11, 05.50 UT, col. 140.6, OMC300 Mak-Cass (image by Bill Leatherbarrow).



Fig. 2 Mons Maraldi, 3-D ground view generated from QuickMap.

The jury is definitely out on this question and more work is needed!

#### Images and drawings submitted.

Gassendi and Delisle and Diophantus. By Trevor Smith.





Editor Comments: Two drawings by Trevor and observing notes describing what must have been a very satisfying evenings viewing.



Image by Alexander Vandenbohede with details of equipment and time/date in caption.

Editor Comments: There are at *least* two basins on view here, the 280km diameter Bailly Basin towards the limb and the ~480km diameter Schiller-Zucchius basin which peeps out from the lower half of the frame. The former is thought to be Nectarian in age and the latter pre-Nectarian. A further basin, the Bailly-Newton Basin is off to the left of the frame and lies between Bailly and Newton. Don't go looking for it though, it is highly degraded and its location was re-evaluated by Tony Cook and collaborators in a 2021 study using digital terrain data\*, the basin having been discovery some time previously\*\*

The interior of Bailly is fairly rugged, without the patches of mare that make the Schiller-Zucchius basin slightly more conspicuous. The western floor is covered with ejecta and secondary craters from the 167km diameter Hausen, which can be seen between Bailly's rim and the limb and towards the top right of the image. You can see the Hausen central peak in Alexander's image, but visibility of this crater is very dependent on libration, which is a shame as it would be a spectacular sight, dwarfing most of the more favourably placed near side craters. The central peak is interesting as it is offset quite significantly towards the eastern rim, so positioned closer to the observer than the actual centre of the crater. Craters of this diameter are in the range where the central peaks give way to peak rings, and some of the hills surrounding the central peak may indicate the onset of that transition in this case. The two medium sized craters with central peaks just this side of Bailly are Zucchius (63kms) and Bettinus (71kms).

# \*https://meetingorganizer.copernicus.org/EPSC2021/EPSC2021-724.html

<sup>\*\*</sup>Cook, A.C., Watters, T.R., Robinson, M.S., Spudis, P.D., and Bussey, D.B.J. (2000) Lunar polar topography derived from Clementine stereoimages Journal of Geophysical Research, Vol. 105, No. E5, Pages 12,023-12,033



Drawing by Massimo Guintoli

**Editor Comments:** This drawing captures the stark lunar limb silhouetted agains the blackness of space, which is always an entrancing when viewed telescopically. Massimo has labeled the most conspicuous of the peaks as M4 using the designation devised by Ewen Whitaker to identify these isolated south polar mountains with the letter M and a number, with M5 being the most prominent. An interesting discussion of this limb region can be found Whitaker's 1954 article available in the BAA Journal archives\*. Harold Hill also observed and drew this area extensively for many years and his work on this and more is discussed in a BAA Journal article by Richard Baum\*\*. These peaks were formerly known as the Leibnitz Mts until the IAU 'decommissioned' that name, as the 10,000m high features in fact form part of the rim of the South Pole-Aitken Basin and not a mountain range as such. As for any of these peaks being perpetually illuminated and eligible for the moniker 'mountain of Eternal Light', Whitaker, in a comment in Baum's article\*\* concluded, following a study of Lunar Orbiter images, that this was not the case and that even the highest peak, M5 probably experienced between 8 and 9 days of darkness.

A fair amount of effort has been spent by telescopic observers recording and charting these peaks and it interesting to search the BAA archives to see the ways this limb region has been portrayed in the past. The following drawings and charts are examples gleaned from those archives to illustrate the various ways this has been achieved. Note that the Whitaker chart was not drawn at the eyepiece but was prepared from photographs taken hrough the 13 inch refractor and 36-inch reflector of the Royal Observatory, Greenwich and other sources.



Drawing by Harold Hill.



Drawing by Grahame Wheatley (The New Moon Vol.11, No.3 Spring 2002



Chart by Ewen Whitaker

\*Ewen Whitaker. 1954. The Lunar South Polar Regions. *Journal of the British Astronomical Association*, Vol. 64, No. 6, pp. 234-242.

\*\*Baum, Richard. "Harold Hill and the south polar region of the moon." *Journal of the British Astronomical Association*, vol. 120, No. 2, Apr. 2010.

#### Petavius.



Image taken by K.C Paul with his 10" f/6 Newtonian reflector with 2.5X barlow and QHYCCD290M

**K.C Comments**: The image was taken on 12 September 2022 at 15h23m UT. Seeing is moderate and transparency is poor with hazy sky. Petavius is quite near the evening terminator so that its radial ridges are displayed marvellously. As usual, the central rille is most attractive. The dome at the south-eastern edge of the crater floor is clearly shown with summit crater pit. The Palitzsch valley is hidden in darkness.



Image by Maurice Collins taken using a Celestron C8 on 28th October 2022.

**Editor Comments:** Maurice's image shows the terminator bisecting the 70km diameter Mons Rumker and hints at its ruggedness which is the result of a surface of superimposed domes, pits and ridges. It is remarkably conspicuous, despite the flanks having a slope of only some 3° and the total height of 1300m.



The LRO image above is shown together with a drawing made by A.K.Herring using a 12.5" reflector in 1960 (The Moon Vol.9, No.1), and as can be seen the telescopic view captured this diverse landscape in some detail, giving a hint of its rather complex origins as the site of protracted volcanic activity. Most of the prominent LRO features are present in Herring's drawing.



Drawing by Massimo Alessandro Bianchi, between 20:16-21:27UT on 2022-Oct-07 using a Vixen VMC 260L f/11.5 Mak-Cass. - Mag. 500x - Seeing III - Transp. 3

Editor Comments: This drawing was made by Massimo in response to an ALPO request. Most drawings of the bands of Aristarchus show them as extending from the floor to the rim, with relatively straight margins, whereas Massimo has recorded them as more circular to sub-circular patches. This impression of circularity has been recorded previously and one example is illustrated in the below image (middle picture – note, north is *down* in these drawings) in an article by Robert Barker\*



The ejecta of Aristarchus is dominated by plagioclase rich deposits, reflecting the anorthositic highland composition of the bedrock at the impact site. The bright areas shown in the drawings correspond to where the concentration of this mineral is the highest. The darker bands appear to be dominated by impact melt streams with a higher pyroxene content and exhibiting the distinctive 'congealed toffee with cracks' morphology of this type of rapidly cooled molten rock. If you examine the LRO NAC images of the western wall you can see that this melt has pooled in the terraces within the dark bands where it has drained downwards immediately post-impact but such ponds are absent in the terraces within the lighter areas. The central peak is depicted as a bright feature, which is not surprising as it is probably comprised largely of bright anorthosite.

\*Barker, R. (1942) The Bands of Aristarchus. Popular Astronomy, Vol. 50, p.192



Image by Rik Hill with details of equipment and time/date shown in caption.

**Rik Comments:** On the south side of the of the east end of Mare Frigoris is the great crater Aristoteles (90km dia). Visible 6 days into the lunation it is very obvious being almost the same size as Copernicus. It is certainly large enough, but has no defined central peak, only a few hills at its centre. The walls are wonderfully terraced especially on the east side with a well defined ejecta blanket beyond showing a nice radial splash pattern to the north. Mitchell (31km) on the eastern wall of Aristoteles, is completely overlain by ejecta from its larger, much younger neighbour. To the west is an even older ring crater Egede (37km) nearly completely buried by ejecta from numerous impacts and floods.

To the south of Aristoteles is another similar though slightly younger crater Eudoxus (70km). This crater also is large enough but lacks a clear central peak with only about a dozen smaller hills in the centre. The ejecta blanket is closer in to the crater and more hummocky lacking any radial splash. Here too notice the terracing is better defined on the eastern half of the crater. Farther south is a flat area that is Alexander (85km) just the ruins of a very ancient crater some 4 billion years old. West of Eudoxus are two craters the largest of which is Lamech (14km) and a little farther on the land rises to a wonderful plateau bounded on the west and south by spectacular kilometre high cliffs. What a magnificent sight this would be from the surrounding mare surface.

On the right edge of this image is the crater Burg (41km) that sits in the centre of the fascinating Lacus Mortis (155km) that contains numerous rimae of differing origins one of which, Rima Burg, you can see going from the west wall of the lacus to just north of Burg. Off the south edge is another very different rima, an obvious vertical fault. Notice how straight that west wall of the lacus is. The walls of this lacus are very polygonal when the whole of it is shown. But that's for another day.

This was created from several 1800 frame AVIs stacked with AVIStack2 (IDL) and combined with Microsoft ICE. Final processing was done with GIMP and IrfanView.

#### Aristarchus, Herodotus and Vallis Schroteri.



Aristarchus, Herodotus and Vallis Schroteri 2022.09.21 - 06.32 UT 300mm Meade LX90, ASI 224MC Camera with Pro Planet 742nm I-R Pass Filter. 750/3,000 Frames. Seeing: 6/10, light sky and turbulence. Rod Lyon

Image by Rod Lyon with details equipment and time/date in caption.

**Editor Comments:** The Aristarchus plateau is probably one of the most geologically interesting features on the lunar near side, and no doubt one of the most photographed. This image shows a couple of interesting and maybe sometimes overlooked features of interest, the first being the ray extending from bottom left and passing north of Seleucus and then to the north of Montes Agricola. This ray originates from the crater Glushko, which is over 1000kms away to the south-west. The ray is rich in plagioclase feldspar derived from the highlands at the impact site. The ray just clipping the southern rim of Seleucus is also from Glushko. The second feature is a rather nice lunar volcano Herodotus Omega, which is located south of Herodotus, and shows up in this image as a dome with a summit crater. It has a diameter of some 14kms and summit height above the mare of 200m, and with a flank slope of a breathtaking 3° or so. A short lava channel leads from the summit crater down the eastern flank, but the lavas that erupted from it are probably now buried by the younger mare lavas of Oceanus Procellarum.

Posidonius.



Image by Dave Finnegan with details of equipment and time/date in caption.

**Editor Comments:** This rather nice image by Dave shows the tilted and displaced floor and peak ring of Posidonius rather well. This crater is a veritable cornucopia of geological interest, and it is well worth exploring using the various spacecraft image sets such as LRO or SELENE. The bright 2km diameter Posidonius Y can be seen perched on top of the wrinkle ridge Dorsa Smirnov, and though not apparent in this image the impact is located at exactly where the Dorsa bifurcates into a northern and western arm. The crater itself is extremely young and has excavated older low titanium basalts from beneath high titanium basalts that form the surface locally in this eastern part of Mare Serenitatis. Because of its youth, its ejecta blanket is extremely well preserved and exhibits curious features called 'crater concentric ridges' which are quite ephemeral in nature and still not completely understood\* To the north of Posidonius is the small Floor Fracture Crater Daniel (28kms diam) which has been the subject of several TLP reports in the past, particularly involving the reduced visibility of the south-eastern rim. This may be a consequence of the fact that the crater formed by an impactor travelling from the top left of the frame down towards the right (NW-SE) which resulted in it having a rather saddle shaped rim, with low points in the up-range to down-range direction. This would explain the variability in the rims' appearance as the south-eastern rim (down-range) is only 340m high compared to 1000m or so for the cross-range rims.

\*Atwood-Stone, Corwin & Bray, Veronica & Mcewen, Alfred. (2016). A New Study of Crater Concentric Ridges on the Moon. Icarus. 273. 10.1016/j.icarus.2016.03.012.

#### Theophilus, Archimedes, Arzachel and Maurolycus.



Images taken by Leo Aerts using a Celestron C14 SCT.

**Editor Comments:** This quartet of images was submitted by Leo with the comment that they were at about the limit for a C14 under Belgian conditions. Personally, I would be very happy to achieve this sort of resolution as the amount of detail is quite impressive. At 115kms in diameter Maurolycus is the largest, followed by Theophilus at 98kms, Arzachel at 96kms and finally Archimedes at 81kms. They are all complex craters with central peaks, but in the case of the mare filled Archimedes the peak is now drowned by the basalt lavas that flooded the crater. The variation in morphology of the central peaks if noticeable, with the rather complex but somewhat symmetrical example in Theophilus bearing an uncanny resemblance to the crown of a pig's molar tooth, and those in Arzachel and Maurolycus being somewhat elongate. This elongate form may be related to the fact that the lunar highlands are criss-crossed by numerous ancient fractures and faults, and central peak formation might be influenced by these linear lines of weakness. It is also interesting to note the similarity between the central peak of Theophilus, and that of Piccolomini, both of which straddle rings of Mare Nectaris\*, so possibly sharing a comparable geological substrate as far as central peak formation goes.

\* See the image by John Axtell later in this LSC.

#### Zucchis, Bettinus, Kircher and Casatus.



Image by Les Fry with details of equipment, time and date in caption.

**Editor Comments:** The bright ray clipping the southern rim of Longomontanus and heading towards the terminator across the northern rim of Scheiner is from Tycho and forms the southern edge of the crater's 'Zone of Avoidance' – as Tycho resulted from a low angle impact from the south-west. The rays from Tycho give the southern highlands a distinctly stripey appearance under some conditions of illumination, and it looks like a fair proportion of the lunar surface was probably in receipt of bits of the Tycho impact site when the crater formed. At the antipode to Tycho, some 5,400kms away on the far-side is a peculiar rocky impact melt deposit thought to have formed when rays travelling away from the impact site and in opposite directions met, collided and deposited molten ejecta on the surface. However, in the 2 hours or so that it took the ejecta, travelling at 2.500kms/hr to reach the far-side the Moon had rotated slightly and the deposits are not exactly at the antipode but displaced ever so slightly to the west\*.

\* Band field. J.A., et.al (2017) Distal ejecta from lunar impacts: Extensive regions of rocky deposits. Icarus, Vol.283 pp282-299



Image by Bill Leatherbarrow using his OMC300 and ASI290 camera on November 5th 2022.

**Editor Comments.** Along with the above image Bill sent the following note: "*The J. Herschel one shows well the strange swirling of ejecta material from the Imbrium impact on the floor of the crater. I wonder if Barry has an explanation for that!*" Well, I will have a try – so this section will be a little longer than the usual comments.

These odd swirling features were picked up early on by visual observers as shown in the 1959 drawing by Keith Abineri (below) and which is reproduced from 'The Moon, Vol.8, No.1 October 1959". Keith was observing well before the 'Space Age' and the flood of high resolution spacecraft images we now have available, so he would have been unaware of some of the more bizarre geological formations we find on the lunar surface. In the early 90's, I spent several very happy hours discussing lunar geology and pouring over Lunar Orbiter images with Keith, and one of the topics we mulled over was the very strange topography of the Vallis Inghirami and nearby craters such as Inghirami itself, Rocca, Darwin and Riccioli, where streamer like ribbons of material and heaped dune like deposits dominate the surface. These were clearly associated with the Orientale basin and formed part of the basin ejecta called the Hevelius Formation, but they were very un-lunar like and difficult to account for on an airless body.

In the case of Vallis Inghirami, the morphology of the Hevelius Formation strongly suggests emplacement as a fluidized, possibly melt rich surface hugging deposit, with lineations both radial to the basin centre as well as crescentic cross ridges and furrows which were convex on the basin side – recalling the surface of some lava flows. A radial flow of semi molten ejecta away from the Orientale Basin would seem to be a reasonable explanation for this topography, but what puzzled us more were the odd dune like units which appeared to be located preferentially within the craters noted above, and often piled up on the crater floor furthest away from the basin and just inside the crater rim.



Drawing of J. Herschel by Keith Abineri, March 21<sup>st</sup> 1958 using an 8" reflector at x232. Note the curvilinear features on the crater floor and represented with the darker shading.



LROC WAC image of Inghirami showing the swirling Hevelius Formation ejecta that has both elements radial and perpendicular to the Orientale Basin which is located towards the top left of the frame.

A phrase we encountered in relation to these features was 'deceleration dunes' with the implication that they formed as an outward flow of possibly particulate ejecta stalled and was deposited, often on the basin side of obstacles, such as the inner crater walls furthest from the basin centre. In places the dunes look rather like

terrestrial 'barchan dunes' the crescentic form typical of desert environments on earth. But here we have an atmosphere and wind in which the particles of sand are suspended, so on an airless moon how could these features possibly form? The presence of some form of gas phase produced as the basin was excavated and forming a temporary atmosphere of vaporised rock has been suggested, or even one composed of volatile gasses if the impactor was cometary in nature. <sup>[1 & 2]</sup> This seems to be a reasonable scenario that could produce a sufficiently dense but ephemeral local atmosphere to allow the suspension of particulate debris and the formation of dunes as the outwards flows encountered obstacles, stalled and dumped their suspended load of pulverised target rock. More recently it has been suggested that volcanic activity early in lunar history could have resulted in the existence of a temporary lunar atmosphere<sup>[3]</sup> so could dunes have formed under these conditions? Well, not really as the peak of such volcanism occurred ~3.5Ga, and the Orientale Basin is believed to date to somewhere in the order of ~3.8Ga. Also the rate of loss of such an atmosphere has been determined to be extremely rapid<sup>[4]</sup> meaning that its role in the formation of surface features, if it existed at all was probably inconsequential.

Anyway, returning to J. Herschel, the image below is a WAC image with a low angle illumination, which brings out the swirling nature of the deposits on the floor of the crater.



LROC WAC Lunar Globe 3D image of J. Herschel with nearside big shadows selected. This simulates a view of the crater from directly overhead.

The similarity to what we see in Inghirami is fairly striking, with linear features radial to Imbrium as well as curving lines of dune like structures orientated at right angles to this. The deposits are deepest towards the craters northern rim (~600m) which is the down-range rim relative to the Imbrium Basin, the same situation we see in the craters around Orientale such as Rocca and Darwin. I think it is fairly safe to say therefore that what we see in the case of J. Herschel is a direct analogue to what we see in the dune like Hevelius Formation deposits around the Orientale Basin – but originating in the Imbrium basin forming impact. There may be a terrestrial analogue here, albeit one on a much smaller scale. Base surges are destructive volcanic events where a column of volcanic gas and ash erupting from a vent collapses and spreads downwards and outwards in the form of ground hugging flows of hot gas charged with pulverised rock and ash. These flows can produce deposits that form dune fields, but these dunes are only in the 1 to 2 meter size range as compared to tens to several hundred meter size range we see in places like Rocca, but then again the scale of a volcanic eruption is many orders of magnitude smaller than a basin forming impact, and a difference in scale might be expected. These terrestrial dune fields are relatively ephemeral due to their unconsolidated nature, and are only well preserved in recent eruption scenarios such as the 2020 eruption of Mt. Taal<sup>[5]</sup>. A base surge type phenomenon

was suggested by early researchers to explain these unusual lunar features<sup>[1]</sup> and their formation in terrestrial volcanic episodes might be a good pointer to their presence on the Moon and the physical conditions necessary for their formation. So maybe not everything that happened on the Moon did so in a vacuum!

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#### Rima Ariadaeus.



Drawing by Dr. Paul Abel.

**Paul Comments:** "Attached is an observation of Rima Ariadaeus I made on 29th December between 1946UT and 2001UT. Seeing was rather good and at a power of x230, there were a number of interesting features. The rille appears to start on the southern edge of crater Ariadaeus and passes west past crater Silberschlag. The rille seemed to pass over the region just north of the Silberschlag and into the region west of Silberschlag. This region was close to the terminator and so the region was highly complex. Interestingly, in the moments of very good seeing it looked like the rille was visible inside the shadow created by the rampart west of Silberschlag (probably an illusion?). The whole rille is rather striking at this angle of illumination."

#### Bullialdus.



Image by Ken Kennedy taken with a Celestron 8 at f10 mounted on a Skywatcher AZEQ5 and Altair GP-CAM. (North is up).

Ken Comments: "It was a nice clear night on the 2nd January and at last the Moon, at a civilized time, is getting to a better elevation. My imaging was curtailed after a few runs by the laptop battery succumbing to the cold conditions which was rather annoying as I had a few other areas in mind. I haven't taken Moon images for some time so I started on the region around Bullialdus. It's a crater that always draws my eye to it as it looks sharp and fresh between the ruined flooded craters Lubiniezky and Kies. However, on that evening, the eastern rim of Gassendi was just emerging from shadow and the arcuate rilles of Rimae Hippalus were clearly visible as were the wrinkle ridges on the eastern side of Mare Humorum. A really interesting area which I had hoped to image the following night, but this was prevented by inevitable cloud cover!"

Theophilus, Cyrillus and Catharina.



Image by John Axtell using a Canon EOS550D (1/400 sec, ISO 800) mounted straight into the focuser of his Obsession 15" Classic (an undriven dobsonian). Taken on 27th Jan at 19.32. Cropped from a larger image.

**John Comments that this image shows:** ".....that delightful grouping of Theophilus, Cyrillus and Catharina. I was pleased how the multiple peaks of the central mountains of the first two showed nicely. What particularly interested me about this cropped view is how the sunlight is nicely illuminating the walls of Rupes Altai, and the almost semi-circular track of that can be nicely seen around the trio of craters delineating the boundary of the Nectaris impact basin. A matching semi-circle, but a ghostly one, can be seen a similar distance away to the right of Mare Nectaris as a light curve passing through the crater Crozier."

**Editor Comments:** The '*light curve passing through the crater Crozier*' has puzzled me for some time – I do not think it marks a basin structure, but appears to be a crater ray that originates somewhere to the south and travels north across Mare Fecunditatis. But the origin of the ray is a mystery – it is relatively enriched in plagioclase compared to the mare surface, so likely comes from a highland crater. It could be from Stevinus, where a double, plagioclase rich ray can be seen in the mineralogical data (visible in John's image- Stevinus is towards the lower right of the frame) heading away from the northern rim – but this would involve a dog-leg deviation in the ray by a few degreed to the west and just to the south of Crozier, which would be unusual. Alternatively it could come from Petavius B, but this would involve an even greater deviation in the course of any ray's trajectory. Unfortunately picking out the different rays associated with Stevinus, Stevinus A and Furnerius A is a bit like untangling a very long string of Christmas tree lights, so any suggestions would be welcome.



Image by Luigi Morrone on 1<sup>st</sup> January 2023 at 17:15hrs Using a Celestron C14 Edge HD, Fornax-52 – Camera ASI174MM, FFC Baader Barlow & Optalong Filter.

**Editor Comments:** In various on-line discussions, the visibility of the sinuous rille running along the floor of the Alpine Valley is frequently touted as being difficult under anything other than ideal seeing conditions and with a large aperture. Clearly Luigi benefited from both of these conditions to record this fine high resolution image of this elusive target. The image also reveals a wealth of other details, including Rima Plato that emerges from a pit on the north eastern glacis of Plato and cuts through the rather rubbly looking terrain between Plato and Mare Frigoris before apparently opening out into that mare near the concentric crater Archytas G. Well, maybe not, as using the LRO imagery you can see that this rille apparently disappears as it approaches a small (~3.5km diam, and marked with yellow arrow) fresh crater, despite being over a healthy 200m deep just prior to reaching it. The small crater has excavated to a depth greater than this, and so you might expect a little local obliteration of the rille, similar to that seen around Sirsalis J where it straddles Rimae Sirsalis. The crater ejecta however would also not be sufficiently deep or extensive to bury this 200m deep rille completely, and it should show up as a shallow trench even if ejecta filled.

Another point is that the short section of rille that enters Mare Frigoris appears to start in a pit of its own – as if it is a separate rille and not a continuation of Rima Plato – which would be the logical assumption. But even this might be incorrect as this short section of rille appears to be part of and line up with a discontinuous series of pits that start near the crater Alpes A (blue arrow) and meanders its way towards Mare Frigoris. So what is going on here? Are we looking at one or two rilles, what is the line of pits, are they collapse pits or just a secondary crater chain? Is the end of Rima Plato buried by the small crater, or does it change nature from being an open channel to being a lava tube with no surface expression, and the presence of the small crater is a just coincidence? Again, answers on a postcard to the Editor please.



Image by Bob and Sophie Stuart with details of equipment and time/date in caption.

**Editor Comments:** Though showing Cusanus and Petermann towards the limb, the crater young Thales is hogging the limelight in this image with its conspicuous Zone of Avoidance to the north edged with curving bright rays whilst more bright rays spread out to the west, east and south. This ray configuration is termed 'cardioid', as in plan form it looks rather heart shaped, well a cartoon heart – not a real one.

#### <u>Lunar domes (part LXII): Lunar domes near the crater Cleomedes preliminary investigation.</u> By Raffaello Lena

The *Nectarian*-aged Crisium basin exhibits an extremely thin crust (Fig. 1). This large multi-ring impact basin is characterized by prolonged lunar volcanism ranging from the *Imbrian* age to the *Eratosthenian* period, forming the *high-Ti* mare unit, *low-Ti* mare basalts, and *very low-Ti* mare unit <sup>[1]</sup>. The major phase of *low-Ti* basaltic volcanism occurred ~3.5 billion years ago, forming the Im2 and Im3 units in the western area, as described by Lu et al. <sup>[1]</sup>. The Crisium Basin concentric structure consists of a series of raised rings and intervening troughs. Three rugged rings are delineated in the circum-mare terra and another lies within the mare. Rings are approximately 210, 250, 340, and 485km from the basin center.

The crustal thickness is inferred from the Bouguer gravity map. If the density of the crust is assumed to be uniform, then the gravity anomalies visible in the Bouguer gravity map can be explained by variations in the thickness of the crust<sup>[2]</sup>. Highs in gravity indicate places where the mantle is closer to the surface, and hence where the crust is thinner (Fig. 1).



Figure 1: Crisium basin. GRAIL crustal thickness map at 16pixels/degree. It includes shaded relief of surface features. Crisium basin exhibits an extremely thin crust.

In this note I examine two volcanic constructs, identified using telescopic terrestrial image (Fig. 2). A full article will be submitted to JBAA, including estimation of viscosities, eruption rates, eruption durations, and make assumptions on the feeder dikes geometry (e.g., dikes length and width).

The image (Fig.2) of the examined region was taken on October 13, 2022 at 00:20 UT by Viladrich using a Ritchey Chretien 500mm telescope. For image acquisition an ASI 1600 camera was employed with a red filter.

Two domes like features located to the west of Cleomedes F are detectable in the enlarged images shown in Figures 3-4.



Figure 2: Image made by Viladrich on October 13, 2022 at 00:20 UT. Crop of the original image of the Crisium basin. The craters Peirce, Swift and Cleomedes F are labelled.



Figure 3: Two examined features near Cleomedes F crater, named Cleo1-2 and marked with white lines. Enlarged image 155X.



Figure 4: Two examined features near Cleomedes F crater. The image is enhanced in contrast.

In the LRO WAC imagery the examined domes are not as prominent as in the telescopic terrestrial image taken under lower solar illumination angle and with a telescope of large diameter. Based on ACT react quick map and the Tool *Terrain Hill shade* the examined domes are detectable as shown in Fig. 5.



Figure 5: LRO WAC image. A synthetic image of two examined features (Cleo 1-2) is derived based on ACT react quick map and the Tool Terrain Hill shade. The examined features are not as prominent as in the telescopic terrestrial image. Two domes are located near a wrinkle ridge but are not connected to the ridge.

The dome termed Cleomedes1 is located at 54.8° E and 21.8° N, with a diameter of 4.0 km. The height amounts to  $40m \pm 5m$ , yielding an average flank slope of  $1.14^{\circ} \pm 0.1^{\circ}$ . ACT-REACT Quick Map tool (<u>http://target.lroc.asu.edu/da/qmap.html</u>) was used to access to the LOLA DEM dataset, obtaining the cross-sectional profile (Fig. 6). The dome edifice volume is determined to 0.3 km<sup>3</sup> assuming a parabolic shape.



Figure 6: LRO WAC-derived surface elevation plot in East-West direction of Cleomedes 1 based on LOLA DEM.

The Clementine UVVIS spectral data indicate red lavas, thus with low  $TiO_2$  content corresponding to 1.17wt%. The FeO content of the dome amounts to 13.2 wt %. Similar values for  $TiO_2$  and FeO content are obtained in nearby mare units.  $TiO_2$  and FeO contents are estimated utilizing the Selene Multiband Imager (MI) dataset.

The dome Cleomedes 2 lies at coordinates 55.2 ° E and 21.9° N with a base diameter of 3.5km. The height amounts to  $35m \pm 5m$  yielding an average flank slope of  $1.1^{\circ} \pm 0.1^{\circ}$ . ACT-REACT Quick Map tool was used to access to the LOLA DEM dataset, obtaining the cross-sectional profile (Fig. 7). The dome edifice volume is determined to 0.17 km<sup>3</sup> assuming a parabolic shape.



Figure 7: LRO WAC-derived surface elevation plot in East-West direction of Cleomedes2 based on LOLA DEM.

These two effusive domes are not reported in the USGS I-707 map by Casella and Binder (1972, <u>https://www.lpi.usra.edu/resources/mapcatalog/usgs/I707/72dpi.jpg</u>) nor in the revised catalogue of lunar domes by Kapral and Garfinkle<sup>[4]</sup> (<u>http://digilander.libero.it/glrgroup/kapralcatalog.pdf</u>).

According to the classification scheme for lunar mare domes <sup>[3]</sup> Cleomedes1 and 2 belong to class  $E_2$  due its small diameter and average flank slope<2°. The class E domes represent the smallest volcanic edifices formed by effusive mechanisms observed to date <sup>[3]</sup> characterized from steep (class  $E_1$ ) or shallow (class  $E_2$ ) flank slopes.

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#### More from the Archive:



Bailly as drawn by A.P. Lenham and from the article 'Bailly' by A. P. Lenham and K. W. Abineri in the JBAA Vol.66, No.1, December 1955. Please Alexander Vandenbohede's image of Bailly in the images and drawings section of this LSC.

#### **Basin and Buried Crater Project.** By Dr Tony Cook.

The Flamsteed-Billy Basin (45°W, 7°S)



Figure 1. The location of the Flamsteed-Billy basin main (white circle) and peak ring (orange circle) - according to Dominique Hoste) on the NASA/ACT Quickmap website under the stereo WAC/LOLA colourized topographic digital elevation model.

The 570 km diameter Flamsteed-Billy basin lies on the south western part of the nearside of the Moon's disk, and is designated as "uncertain" in the Lunar Wiki, probably because it is so highly degraded and flooded by mare basalts – so it is likely Pre-Nectarian in era. Liu *et al* (2022) give a diameter of 580 km for the main ring and 399 km for the inner peak rim. By looking at topography (Fig 1), gravity (Fig 2) and crustal thickness (Fig 3) maps, Dominique Hoste has written in to confirm that it is a "peak-ring" basin – as this shows up well in the crustal thickness map (Fig 3). They have also provided some cross-sectional radii (Fig 3), which when averaged allow the following diameters for the main and peak rings to be derived:  $630 \pm 13$  km and  $309 \pm 8$  km respectively.

The errors I added are from the standard deviations of their given measurements. Using standard deviations is a good way to work out how degraded basin ring structures are. Of course if a basin is elliptical then this won't help as the standard deviations of an attempt to fit a default circle to an elliptical basin would be increased as the eccentricity departs from 0.0, but there are no indications in Figs 2 and 3 that this is the case. Dominique's main ring measurement is larger than the Liu *et.al (ibid)* value, but smaller for the peak ring. It is perhaps unsurprising that measurements of degraded structures are very subjective. It might be helpful if other readers could try to measure the Flamsteed-Billy basin rings so that we can come up with a consensus on the mean ring diameters and associated error associated error – though I appreciate that it's a real challenge to identify what features on the Moon are actual remnants of the rings and which aren't. The best strategy, is to use lots of datasets like: shallow illumination telescope images or virtually computed hill shadings, spacecraft gravity, topographic data, and anything else that might give us clues to define the basin shape and size.

If you think that you have discovered a new impact basin, or unknown buried crater, please check whether it has been found previously on the following web site, and if not email me its location and diameter so that I can update the list: <u>https://users.aber.ac.uk/atc/basin\_and\_buried\_crater\_project.htm</u>.

Alternatively, if you want an observational challenge, try to see if you can image one of more of the basins or buried craters at sunrise/set and establish what colongitude range they are best depicted at. Or you can even do this "virtually" with LTVT <u>software</u>. As you can see from the tables on the web sites there are lot of blank cells to fill in on the sunrise and sunset colongitude columns – so a good opportunity for you to get busy!



Figure 2. Dominique Hoste's estimated locations of the main ring of the Flamsteed-Billy basin main ring as seen on the Kaguya Free Air gravity dataset.



Figure 3. Dominique Hoste's attempts at radii measurements of the main and peak rings of the Flamsteed-Billy basin using the NASA/ACT Quickmap website crustal thickness layer.

# **References:**

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Lunar Wiki (accessed 28/1/2023) https://the-moon.us/wiki/Flamsteed-Billy\_Basin

#### LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME By Dr.Tony Cook

**News:** Congratulations to Luigi Zanatta (Italy – UAI) for being the first to discover a bright impact flash on 2022 Jan 26 UT 20:33:30 and this was then confirmed by my PhD student, Daniel Shewood, who was observing remotely from Observatory De La Côte D'azur, France. The flash was located a few hundred km east of Aristarchus. More about this in a later newsletter, once some analysis has been done.

#### TLP Reports: Sulpicius Gallus M



**Figure 1.** Sulpicius Gallus M is the brightest feature in the main image and was taken by Franco Taccogna on 2022 Dec 31. The inset is a similar illumination by Rik Hill taken on 2014 Mar 10 UT 01:40.

Although this turned out not to be a TLP, I just want to say that Franco Taccogna (UAI) noticed that Sulpicius Gallus M was exceedingly bright compared to other features (See Fig 1) on 2022 Dec 31 UT 17:00-18:00. Alexandre Amorim, observing from Brazil a few hours later noted that it was bright, certainly brighter than it appeared in the Hatfield Lunar Atlas. However, analysis of past images in the ALPO/BAA archives, at similar illumination revealed that this was normal appearance (See Fig 1 – top right inset) for this crater. Although this is not a TLP we will include it in the Lunar Schedule web site, just to see at what selenographic colongitude it attains this brilliance. "M" turns out to be a very interesting volcanic vent.

Last Minute Report received for November: Valerio Fontani (Italy – UAI) imaged: Cassini E.

**Routine Reports received for December included**: Alexandre Amorim (Brazil – ALPO) observed: Sulpicius Gallus M. Jay Albert (Lake Worth, FL, USA – ALPO) observed: Aristarchus, Mons Vinogradov, Picard, and Plato. Alberto Anunzatio (Argentina – SLA) observed: Eratosthenes, Gassendi, Mare Crisium, Mont Blanc, Plato and Sinus Iridum. Anthony Cook (Newtown, UK – ALPO/BAA) imaged: several features in the Short-Wave IR (1.5-1.7 microns). Walter Elias (Argentina – AEA) imaged: Eratosthenes and Tycho. Valerio Fontani (Italy – UAI) imaged: Tycho. Nigel Longshaw (Oldham, UK – BAA) observed: Madler. Eugenio Polito (Italy – UAI) imaged: Tycho. Trevor Smith (Codnor, UK – BAA) observed: Eratosthenes, Manilius, Plato, Timocharis, Tycho and several features. Bob Stuart (Rhayader, UK – BAA) imaged: Adams, Amundsen, Ansgararius, Banachiewicz, Beheim, Boguslawsky, Cabeus, Condorcet, Demonax, Drygalski, Gill, Hano, Hecataeus, Helmholtz, Humboldt, Kastenr, Nox-Shaw, La Perouse, Le Gentil, Malapert, Mallet, Mare Australe, Marinus, Mutus, Neumayer, Oken, Pontecoulant, Schomberger, and Wexler. Franco Taccogna (Italy – UAI) imaged: Sulpicius Gallus M and Tycho. Aldo Tonon (Italy – UAI) imaged: Eudoxus and Tycho.

#### Analysis of Reports Received:

**Cassini E:** On 2022 Nov 30 UT 17:48-18:08 Valerio Fontani imaged this area under similar illumination to the following report:

Cassini E 2002 Dec 11 UT 16:30-18:46 Observed by Knott (Liverpool, England, 216mm Newtonian, x216, red and blue filters used) seeing III, transparency good) "Observations carried out of the area extending from the Alpine Valley to the Crater Cassini. At 17:12 a pin point bright flash was seen NW of the rim of the crater E in white light. A 2nd pin point flash was also seen at 18:18, this time thru a blue filter. The 2nd flash was also seen on the NW rim of the crater E. The observer does not think this was a TLP as the seeing was III, but the flash was so bright as to be startling. Other peaks within the Alps were bright but were much less so in red and blue filters, where the rim of the crater E. NW edge was very bright in all filters, including white light. Incoming cloud prevented further observation." BAA Lunar Section report. ALPO/BAA weight=1.



**Figure 2.** The area in the vicinity of Cassini E as imaged by Valerio Fontani on the dates and UTs given in the images above. North is towards the top. Cassini C is just to the lower right of the centre of each image and Cassini E is slightly above this (marginally smaller than Cassini C) but not very clearly defined as a crater at this stage in the illumination.

Its interesting, looking at Valerio's images, that Cassini E is not very well defined, though you can just about make out the illuminated western rim. Nor is it especially bright, even in Valerio's sharper images on the far left and left of Fig 2. So whatever made a flash of light at 17:12 and 18:18 visible to John Knott on 2002 Dec 11 must have been unusual. We shall leave the weight at 1 for now, but could consider raising this in future, depending upon what other images we can find under similar illumination. We have investigated a repeat illumination observation before, for Cassini E, in the 2020 August newsletter.

**Alphonsus:** On 2022 Dec 01 UT 21:38 Les Fry (NAS) took an image of Rupes Recta, that by chance captured half of Alphonsus under similar illumination to the following report:

On 1993 Jun 27 at UT 19:55-20:21 and 20:24-21:04) D. Kane (England? UK, 4" refractor) discovered that the central peak of Alphonsus crater was very bright. The central peak was also brighter in red than in blue light. However G. North (Herstmonceux, UK, 6" reflector, x135, seeing V-III) and M. Cook (Frimley, UK, 4" reflector, x10, seeing=III) observed that the

central peak was normal, however they did not use filters. The Cameron 2006 catalog ID= and weight=3. The ALPO/BAA weight=2.



**Figure 3.** Half of Alphonsus as imaged by Les Fry on 2022 Dec 01 UT 31:38 and re-orientated with north towards the top.

Although the image (Fig 3) that Les took was monochrome and it was never intended to target Alphonsus, we do see just over half of the central peak. It does not look especially bright; therefore we shall leave the weight at 2 for now.

**Sinus Iridum:** On 2022 Dec 04 UT 03:05-03:25 Alberti Anunziatio (SLA) observed and sketched this area under similar illumination to the following report:

Sinus Iridum 1996 Apr 28 UT 20:00 Observed by Brook (Plymouth, UK, 60mm refractor, x112, seeing III, slight breeze, twilight) "dark shaded area on floor ~1/4 diameter of Sinus Iridum on western interior by rim" BAA Lunar Section Observation. ALPO/BAA weight=1.



**Figure 4.** Sketches of Sinus Iridum, orientated with north towards the bottom. (Left) By Clive Brook from 1996 Apr 28 UT 20:00. (Right) By Alberto Anunziato from 2022 Dec 04 UT 03:05-03:25 – detail to the northern shore of Sinus Iridum not shown.

Alberto was observing the dorsa in Sinus Iridum (Fig 4 -Right) and thought he saw something similar to the written description of what Brook saw, and reported in the December edition of the ALPO The Lunar Observer stating: *"I don't know what the darker spot seen in the western sector is due to, framed in bright lines, I* 

estimate that it corresponds to differences in the types of lavas present in Sinus Iridum (easier to observe near full moon)". Alberto did not have access to Clive Brook's sketch (Fig 4 – Left), so did not know that the positions of the dark patch was not at the same position as depicted by Clive Brook back in 1996, however Clive was using a small telescope, so maybe the positional accuracy of his sketch was not great. We have covered repeat illumination observations of this TLP before in the 2016 Oct, 2017 May, 2018 Apr, 2020 Mar, Apr & Aug newsletters. We shall leave the ALPO/BAA weight at 1 for now.

**Madler:** On 2022 Dec 7 UT 20:30 Nigel Longshaw (BAA) observed Madler under similar illumination to the following report:

Madler 1940 Sep 16 UT 02:10 Observed by Haas (New Mexico? USA, 12" reflector?) "Bright spot on S. rim was I=5.8 comp. with 8.9 on Aug 17 (see #470)." NASA catalog weight=4. NASA catalog ID #473. ALPO/BAA weight=2.

Nigel comments: "I have managed a couple of repeat illumination observations of Madler this year in relation to the Haas report that a 'spot' on the southern rim was seen as dimmer in Sept 1940 than it was in August. I observed on 2022 March 16 (Fig 5) and 2022 Dec 7 (Fig 6). Under high illumination the cater walls are broken into a series of spots and arcs – see attached sketches –do you think the Haas report refers to the section of the southern wall which is seen as a bright spot? If so, I recorded the spot of similar brightness on both occasions. I was however a little confused with the figures in the repeat illumination text for the 1940-8-17 observation so I checked back with the entry number 470 in the NASA catalogue. I think the figures in the repeat illumination text need changing to reflect the catalogue entry when on 1940-8-17 Haas recorded a bright spot as I=8.9. Essentially the catalogue entries indicate Haas has an intensity estimate of 8.9 on 1940-8-17 but recorded I=5.8 on 1940-9-16." In a subsequent email he says: "I located the description in my copy of the Haas paper last night - unfortunately, it does not give any further information regarding the precise location of the 'spot'. However, looking at some of the drawings/intensity estimates of other features included in the paper I wonder if the observation of Madler relates to a smaller feature than the appearance of the southern rim indicated in my sketches."



**Figure 5.** Madler as sketched by Nigel Longshaw (BAA) in March 2022. Date and UT given on the sketch. Elger scale intensity visual measurements arrowed. North is towards the bottom.



**Figure 6.** Madler as sketched by Nigel Longshaw (BAA) in December 2022. Date and UT given on the sketch. Elger scale intensity visual measurements arrowed. North is towards the bottom.

As we have copies of Cameron's card index system that went into her production of her 1978 catalog, I thought that I would include a copy here (Fig 7), however as you can see this individual card refers to many TLP from the paper by Haas "Does Anything Ever Happen on the Moon?", and it does not really enlighten us. Many years ago, in correspondence with Walter Haas, I was trying to find out whether the TLPs attributed to him in the Cameron catalog had the correct data and weights. For the 1940 Sep 16 event he wrote back to say that the date and UT and weights were indeed correct but that it was "hard to say whether 470 or 473 is the normal aspect of a feature in Maedler". #470 being an entry of an earlier TLP he saw in Madler on 1940 Aug 17 at 06:05 UT, and #473 being the 1940 Sep 16 event. I think for now we should just keep on monitoring Madler (visually or with CCD) at the appropriate repeat illumination and see if we can find any variations in brightness of its associated spots.

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Figure 7. The card for the 1940 Sep 16 Madler TLP from the Cameron 1978 catalog.

# **Aristarchus:** On 2022 Dec 10 UT 04:30-04:45 Jay Albert (ALPO) observed visually this area of the Moon under similar illumination to the following report:

On 1990 Dec 03 at UT23:00-01:30 M.C. Cook (Frimley, Surrey, UK) noticed that the central peak of Aristarchus was quite bright and extended to a circular region in the east in the crater "sprout" area - Cameron suggests that this is Bartletts self-defined EWBS area?. Beyond the rim to the east was very bright. However no colour effect was seen in filters. A sketch was supplied. Cameron notes the coincidence of perigee and full Moon. The Cameron 2006 catalog ID is 416 and the weight=3. The ALPO/BAA weight=1.



**Figure 8.** Aristarchus TLP report by Marie Cook from 1990 Dec 03. Note that the sketch of Aristarchus has been mirror flipped to put north at the top and west on the left.

Jay noted that the central peak was very bright (as stated in the TLP report), but that the peak did not appear extended in any way in the east of the crater. Despite the crater being very bright in full sunlight, the vertical bands on the interior wall were still visible. An especially bright spot was seen on the NE rim completely separated from the central peak on the crater floor. Jay had seen that NE bright spot on several occasions before. He noticed no colour in or around the crater. A variable polarizer filter was used to cut the glare of the crater and improve the detail after the initial unfiltered viewing part of the session. For a comparison I have included a copy of Marie Cook's original report (Fig 8). As there are differences between these two similar illumination observations, we shall keep the ALPO/BAA weight at 1 for now but consider raising it if other repeat illumination observations, to within  $\pm 0.5^{\circ}$ , also show a similar discrepancy.

**Eratosthenes:** On 2022 Dec 16 UT 06:55-07:15 Trevor Smith (BAA) observed this crater visually with a 16-inch reflector under similar illumination for the following report:

Eratosthenes 1976 Aug 18 UT 06:12 Observed by Bartlett (Baltimore, MD, USA, 4.5" refractor, 45, 225x, S=6, T=3-2) "Again, c.p. is vis. within shadow but much brighter than on Aug, 4 (4 deg) & similar to June at same col. The 2nd bright spot seen in June was not seen tonite. (roughness on walls seen in LO IV & V pics show why these pseudo-shadows appear)." NASA catalog weight=4. NASA catalog ID #1445. ALPO/BAA weight=2.

Trevor comments: "Bartlett reported on 1976-6-20 that the floor was covered in shadow and the central peak was seen as a bright spot. Another tiny spot was seen on the south/east floor. I looked and the detail on and around the terminator was quite strong. The floor of Eratosthenes was about three quarters full of black shadow. The central peak was split into three parts with the black floor shadow all around it. The terracing to the inside eastern rim was bright and very easy to see with much fine detail visible. A very tiny but quite bright pin point of light was just visible in the dark shadow to the south/east of the central peaks. (See quick sketch)" (Fig 9). We shall leave the weight at 2 for now.



Figure 9. Eratosthenes as sketched by Trevor Smith (BAA) for the date and UT given on the observation. Note that north is towards the left.

**Tycho:** On 2022 Dec 16 UT 08:41-08:42 Walter Elias (UAI) imaged this crater under similar illumination to the following report:

Tycho 1992 Aug 21 UT 07:58-10:59 Observed by Darling (Wisconsin, USA, 16" & 11" reflectors, visual, photographic, CCD video observations made) "At 08:56UT a V-shaped glow started to appear in the shadow to the east of the central peak" ALPO TLP report. See: http://www.ltpresearch.org/ltpreports/ltp19920821.htm ALPO/BAA

See: http://www.ltpresearch.org/ltpreports/ltp19920821.htm ALPO/BAA weight=1.



**Figure 10.** Enhanced images, and a sketch of Tycho, with north towards the top. (Left) Walter Elias' image from 2022 Dec 16 UT 08:42 Selenographic Co-longitude = 186.1°. (Centre) Sketch by David Darling from 1992 Aug 21 UT 09:46 Selenographic Co-longitude = 187.0°. (Right) Image by David Darling from 1992 Aug 21 UT 09:56 Selenographic Co-longitude = 187.1°.

Although Walter's image (Fig 10 – Left) is lower in resolution than David Darling's 1992 image, it is starting

to show the first signs of the illuminated V-shaped neckless formation. From the UK, Trevor Smith (BAA) was observing visually a little earlier at 07:55-08:10 UT (Selenographic Co-longitude = 185.7°-185.8°) and did not see any sign of a "V" shaped formation or any glow or obscuration east of the central peak. So this effect is fairly rapid and we have seen it before under another repeat illumination observation covered in the 2012 Dec newsletter (p13 in ALPO TLO and p34-35 in the BAA LSC). So I am now fairly confident that David Darling's original observation was not a TLP, but out of curiosity we will put it onto the Lunar Schedule website to see if we can get some higher resolution time lapse image of this V shape forming.

**Eudoxus:** On 2022 Dec 30 UT 16:52, 17:00, 17:07 Aldo Tonon imaged this crater for the following lunar schedule request:

BAA Request: Eudoxus - please try to image or sketch the crater. This is to try to explain a line of light effect seen inside this crater by French astronomer Trouvelot back in Victorian times. The BAAs Nigel Longshaw says that this may be seen between colongitudes of 0.3 to 1.2 degrees. Please send any images or sketches to: a t c @ a b e r . a c. u k .



Figure 11. Eudoxus as imaged by Aldo Tonon (UAI) on 2022 Dec 30 UT 17:00 and orientated with north towards the top.

At the date and UT given by Aldo (See Fig 11), the selenographic colongitude was 0.8°. There are a couple of faint incisions at the north and south ends of the interior shadow, that pass across respective sides of the crater rim, and a curved piece of illuminated inner terrace showing up on the eastern edge of the interior shadow. Whether any of these are what Touvelot was referring to as a "line of light effect" is unclear to me?

**Tycho:** On 2022 Dec 31 UT UAI members: Franco Taccogna, Eugenio Polito, and Aldo Tonon, imaged this crater for the following lunar schedule request:

BAA Request: How early can you see the central peak of this crater illuminated by scattered light off the crater's west illuminated rim? High resolution and/or long exposures needed to capture detail inside the floor shadow. All images should be sent to me on the email address below, whether or not you were successful in capturing the central peak: a t c @ a b e r . a c. u k

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Figure 12. Images of Tycho orientated with north towards the top. Subsequent solar altitudes calculated with LTVT but manually using the cursor to point at the location of the central peak, so we could easily have an error of the order of ±0.03°. (Far Left) An image by Brendan Shaw taken on 2003 May 09 UT 21:04 (Alt<sub>0</sub>=1.11°) clearly showing the central peak as pointed at by the yellow tick marks. (Left) An image by Franco Taccogna taken on 2022 Dec 31 UT 16:10 (Alt<sub>0</sub>=1.80°) and not showing the central peak. (Centre) An image by Franco Taccogna taken on 2022 Dec 31 UT 16:20 (Alt<sub>0</sub>=1.82°) and now showing the central peak. (Right) An image by Eugenio Polito taken on 2022 Dec 31 UT 16:25 (Alt<sub>0</sub>=1.84°) and not showing the central peak. (Far Right) An image by Franco Taccogna taken on 2022 Dec 31 UT 16:25 (Alt<sub>0</sub>=1.84°) and not showing the central peak. (Far Right) An image by Franco Taccogna taken on 2022 Dec 31 UT 16:26 (Alt<sub>0</sub>=1.90°) and more clearly showing the central peak.

This lunar schedule request refers back to an image taken by Brendan Shaw which showed the central peak of Tycho to be visible when the Sun was too low to illuminate it directly. As you can see from Fig 12 (Far Left) the solar altitude was  $\pm 1.11^{\circ}$  from the bottom of a mostly shadow filled crater. Simulations show that even allowing for the height of the central peak, and a 0.5° angular diameter of the Sun, the central peak ought not to be illuminated by direct sunlight. Instead, it is theorized that it is being illuminated by scattered light off of the western sunlit rim. However, this theory is contradicted by images taken by UAI observers on 2022 Dec 31, which show that despite more modern imaging techniques, that the central peak is not visible at a higher solar altitude of  $\pm 1.80^{\circ}$  (Fig 12 – Left), and barely starts to become visible at  $1.82^{\circ}$  (Fig 12 – Centre), even at an altitude of  $\pm 1.90^{\circ}$  (Fig 12 – Far Right) it is not as strong as it was back in 2003. To rub home the point, both Aldo Tonon – working at lower resolution, and Eugenio Polito (Fig 12 – Right) who used higher resolution but less exposed than Franco's images, were not able to detect the central peak at all.

So, what could be going on? Here are four possible theories. 1) Atmospheric seeing, transparency, atmospheric scattering, and image contrast/exposure is/are affecting the visibility of the central peak, after all it was not seen in Aldo Tonon and Eugenio Polito's images. 2) The peak is being illuminated by sunlight scattered off the western illuminated rim. But if so, this is a large angular extended source of illumination from an arc about 180° in length, so one would have thought this would not only illuminate the central peak but also some of the shadowed floor, and there should not be a significant change in its brightness over a ten-minute period from the western rim as we saw in Franco Taccogna's images. 3) Although virtual computer models show no light breaking through gaps in the eastern rim, with the Sun so low, maybe the digital elevation models are not accurate enough? 4) And now the most unlikely theory – Tycho is known to have electrostatically charged dust particles levitating above the horizon at sunrise and sunset as imaged by Surveyor 7 in the 1960's. Charged dust particles hop from dark areas in shadow into the sunlight at sunrise – perhaps dust particles on the slopes of the central peak are levitating and forming a brief cloud over the top of the peak, making it into sunlight, and then falling out of the sky once they lose their charge from the solar UV? There is no proof yet that this would work though, nor have sufficient quantities of dust particles to scatter the sunlight. However, a NASA experiment (Shadowcam) on the recent Korean Orbiter will be imaging the shadowed areas inside craters near the south pole, so if dust levitation is taking place on the borders of shadows or at the tops of shadowed peaks on crater floors, this is where it might be detected. If not, then its more likely to be one of the simpler explanations (1,2,3) which explain the 2003 TLP. Anyway, in the mean-time, please keep on trying to image the floor of Tycho when it is predicted by the Lunar Schedule website or on the repeat illumination website.

**General Information:** For repeat illumination (and a few repeat libration) observations for the coming month - these can be found on the following web site: <u>http://users.aber.ac.uk/atc/lunar\_schedule.htm</u>. By re-observing

and submitting your observations, only 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: <u>http://users.aber.ac.uk/atc/tlp/spot\_the\_difference.htm</u>. If in the unlikely event you do ever see a TLP, firstly read the TLP checklist on <u>http://users.aber.ac.uk/atc/alpo/ltp.htm</u>, 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 <u>https://twitter.com/lunarnaut</u>.

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Items for the March circular should reach the Director or Editor by the 20th February 2023 at the addresses show below – Thanks!

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