From the Director.

A NASA image of the successful splashdown recovery of the Artemis-I Orion module capsule.

A Happy 2023 to you all! It is really great that the Orion capsule from Artemis-I made it back to Earth OK with a successful splash down. As mentioned in past circulars, I said that it should be possible to image the spacecraft from the Earth, and although my own attempts failed, I was pleased to see a couple of images in the December edition of the Astronomer magazine, taken by David Briggs, showing the spacecraft at magnitude +17 (414 thousand km away) on 2022 Nov 30 UT from from an image stack taken from 18:40-18:50UT, and another at magnitude +15 (345 thousand km away) on 2022 Dec 8 UT 19:15-19:28. Please don't be put off by the faint magnitudes, as the spacecraft can change rapidly in brightness if you get sun glint off the solar panels, or if it does a course correction fuel burn - this would be especially bright in the near IR, or if the gas emission clouds scatter light and/or are ionized.

In this editorial, I thought that I would look ahead to highlights in 2023. Probably there will be no further manned missions to the Moon – we have to wait until 2024 for the orbital mission of Artemis-II. However, Elon Musk's Space-X is scheduled to fly some art-based astronauts around the Moon and back to Earth, as part of the "dearMoon" project this year. But, he first has to demonstrate his SpaceX starship on a sub-orbital flight, and also one or more unmanned orbital flight around the Moon and back before letting humans on-board – this could easily slip till 2024. Anyway, staring through a crystal ball, here are the known highlights of the coming year – something to add to your diary:

2023 Korea's Danuri mission entered orbit around the Moon on 2022 Dec 16 and will be doing lunar remote sensing and imaging as well as polarimetry of the surface. A NASA experiment, SHADOWCAM will be imaging inside permanently shadowed craters utilizing earthshine and scattered light off illuminated nearby crater rim, to see inside.

2023 Jan 1 A Uranus occultation, or a near miss, depending upon where you are in the UK – see Tim Haymes' Occultation section (or the BAA Handbook) for details.

2023 Mar A Falcon 9 rocket is scheduled to launch a Lunar lander for Intuitive Machines, a rover called Moon Mark, and a British rover from UK's Spacebit – destination somewhere between Mare Serenitatis and Mare Crisium.

2023 Spring - Astrobotic's Peregrine Lander (Mission One) aiming for touchdown in Lacus Mortis.

2023 Apr 20 A hybrid total and annular/total solar eclipse over mostly ocean, with land fall over the tip of NW Australia, East Timor and part of Indonesia. Elsewhere it will be a partial eclipse from Australia, New Zealand, Japan etc, but not from the UK.

2023 Apr 22 ± a few days - use a low light sensitivity video camera/CMOS camera to look for Lyrid meteor impacts in earthshine. Note ZHR here on Earth is only 15/h, but Apollo seismometers on the Moon used to pick up a peak of heavy impacts from these.

2023 Apr Japan's Hakuto-R lander and the United Aran Emirates Rashid lander are due to touch down in Atlas crater.

2023 Apr-Jun An orbiter and lander due to be launched on a Falcon 9 rocket. The IM-2 mission will land near the lunar south pole. A rover and hopper will also be sent to the Moon on the same mission.

2023 May 05 A Penumbral lunar eclipse visible in Europe, Africa, Asia, Australia etc, but not really visible from the UK except maybe in the extreme south east of the country.

2023 May 17 A Jupiter (and Ganymede) occultation during the day – again depending upon where you are in the UK – details will become available in the Occultation Section in a few months' time, or you can consult the BAA Handbook.

2023 Jun India's Chandrayaan 3 is due to launch a lander/rover to the Moon, possibly to the lunar south polar area.

2023 Jul Russia's Luna 25 is scheduled to launch the Luna-Glob lander to Boguslavsky crater. However a number of partner countries, who would have contributed experiments, have pulled out due to Russia's invasion of the Ukraine, so it might be a bit lighter in weight than was planned.

2023 Aug 11-14 (Peak on 13th) - use a low light sensitive video camera/CMOS camera to look for Perseid meteor impacts in earthshine, towards the N/NE/E limb area of the dark side. Note ZHR here on Earth is >80/h.

2023 Oct 14 An Annular eclipse of the Sun visible from America, Central America and the northern parts of South America. Visible as a partial eclipse over most of the Americas.

2023 Oct 18 Daytime occultation of 1st magnitude Antares visible from the UK. If you use high speed frame rates e.g. 100 per sec, you may be able to detect a fade due to the star's 0.041" angular diameter of 4 frames. Further details will appear later in the year in the occultation pages.

2023 Oct 20-23 - use a low light sensitive video camera/CMOS camera to look for Orionid meteor impacts in earthshine. Note ZHR here on Earth is 20/h, but they are fast at 65 km/s and so have a lot of kinetic energy.

2023 Oct 28 A partial lunar eclipse, but something like only 12% of the southern hemisphere of lunar disk will be covered. At least this will be visible from the UK – unless it is cloudy!

2023 Nov 9 A daytime occultation of Venus, visible from the UK – details will become available in the occultation section pages closer to the time.

2023 Nov 17-19 - use a low light sensitive video camera/CMOS camera to look for Leonid meteor impacts in earthshine. Note ZHR here on Earth is only 15/h, but travelling at 70 km/s they carry a lot of kinetic energy.

2023 Dec 14-19 (peak Dec 14) - use a low light sensitive video camera/CMOS camera to look for Geminid meteor impacts in earthshine. Unfortunately, from the UK, the Moon will be low down on the horizon at maximum, but gaining altitude over the following days. Note ZHR here on Earth is >50/h.

So good luck in 2023. As ever, please keep a look out for events to observe on Tim's Occultation pages in the lunar section circular, attempt to observe and send in images of the best appearances of the lunar basins and craters listed on the Basins and Buried Crater project website, and keep a look out for targets to observe on the lunar Schedule website. Above all, keep yourself busy observationally, as we always look forwards to receiving your observations whether they be sketches, written reports, or images.

Tony.

Communications Received.

K.C. Pau's comments on Lacus Mortis by John Duchek.

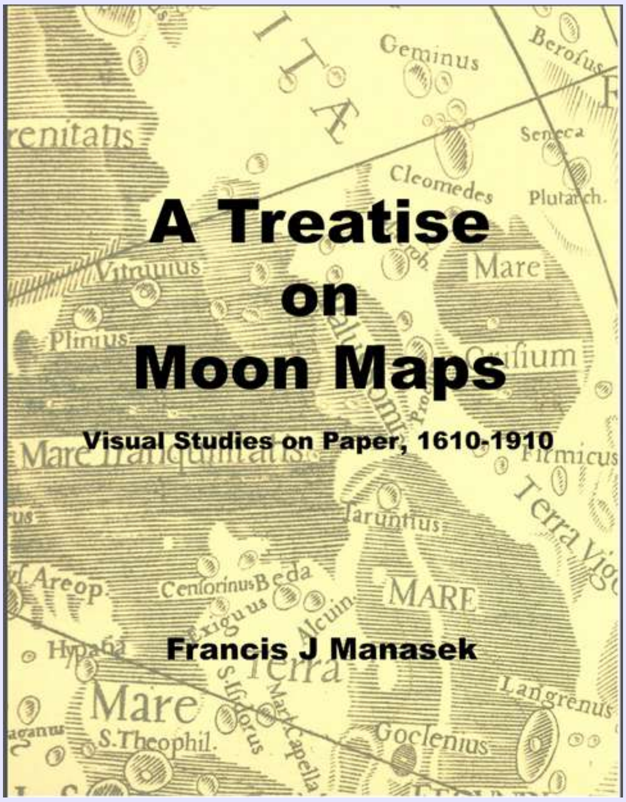
I am responding to the letter by K.C. Pau on page 3 of the December newsletter. On the drawing there are 3 white arrows. The middle arrow has a shadow that points to the crater south of the main crater. If we look at the 3 photos he provides they are labeled 3,4 and 4 (supposed to be 5). In figure 5, I see the shadow designated by the middle arrow. There is a v shaped shadow that points to the crater south of the main crater.

…...

Treatise on Moon Maps by Frank Manasek.

James Dawson has reminded us that the 'Treatise on Moon Maps by Frank Manasek' is available as a PDF (268.5MB) online for free here:

https://www.antiquaries.com/Intro.pdf



It is possible that Frank may updating the text in the next year or so, so something to look out for.

…...

Telescope and Observatory for Sale.
Rod Lyon (Cornwall, UK).

Observing during the early cold mornings I can no longer face, and in truth, many things are becoming difficult now. I have to reluctantly say that I am thinking seriously of disposing of my equipment. So, if you know of anyone who is interested in a 300mm Meade SCT LX90, together with all the eyepieces, ASI 224MC camera etc, plus the Pulsar 2.2 metre observatory - all as a complete package, I shall be open to sensible offers. The deal would be for the purchaser to come here, dissemble everything and take it all away. Any offers must take that into consideration. I attach some photos of my observatory and the telescope.

From the Director: As readers will have seen, Rod is one of our best astrophotographers, so if you do decide to make him an offer for his equipment, you will know that you will be getting quality equipment. Anybody interested can contact Rod on: tewennow @ btinternet.com

Lunar Occultations January 2023
By Tim Haymes

Time capsule: 50 year ago: in Vol 8 No.1
[With thanks to *Stuart Morris* for the LSC archives]

> *Mr P. Anderson (Brisbane,Australia) described the use of a "party clicker" as a time marker on audio recordings. He used continuous SW radio, and O-Cs are consistent by this method (+/- 0.11).
> *The Occultation report contains a long list of **fading events** observed at several location (Chile, Spain) over an extended period. The list will be continued.
> *Miss C. Botley compares the Alpine Valley to Great Glen. The lunar surface was better known than the depths of Loch Ness. In 1969 Midget Submarines explored the lake for the first time.

Graze of Uranus 2023 Jan 01 at 2240UT
Southern Limit
Uranus will graze the southern limb of the Moon at a cusp angle of 8 degrees South.
These locations (and placed in-between) are situated on or near the graze mid-line of Uranus:
Milford Haven, Laugharne, Brecon, Hereford, Ledbury, Evesham, Northampton, Huntingdon, Thetford, Lowestoft.

The mid-line is shown in green on the maps (Figs 2-4), and is where Uranus is half occulted and has a width of 7.5 Km. At magnitude 5.7 the event should be easy to observe. The Moon in 78% illuminated.
Further North, total occultations at the dark limb will occur. (Fig-1)

City	hh:mm:ss
Birmingham	22:39:08
Manchester	22:31:24
Leeds	22:30:33
Edinburgh	22:20:13
Aberystwyth	22:33:41
Belfast	22:19:54
London	not occulted

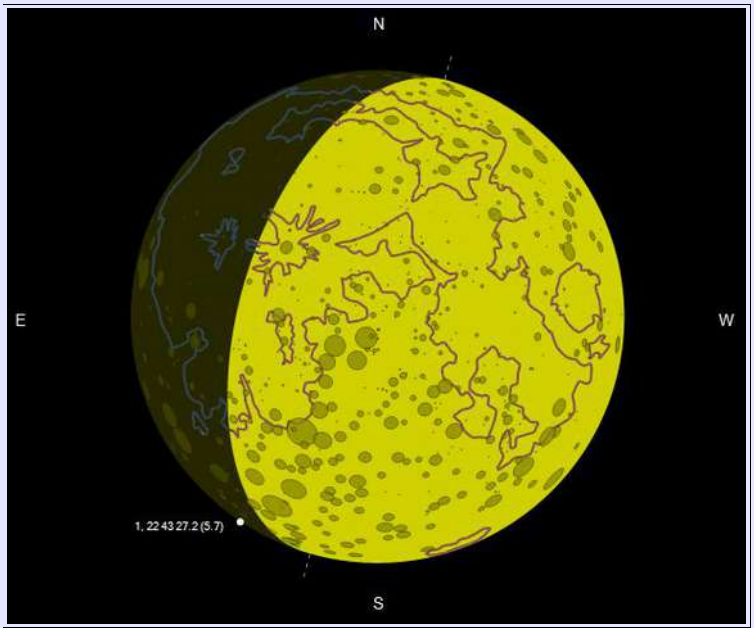


Fig.1 Outline of the Moon illustrating the total occultation of Uranus on 2023 Jan 01

Fig.2

Fig.3

Fig.4

Graze of Omicron Pisces on 2023 Jan 27th.

This 4th magnitude star grazes the southern limb at 2118UT near cusp angle 7 degrees (Fig.5). The Moon is 41% sunlit and favourably placed in a Friday evening sky at alt/az of 26/250. It is a red star (sp K0) and there is an unconfirmed companion of 8th magnitude. Details available from the Coordinator or Director.

Fig.5 Graze track of Omicron Pisces.

Occultation of Mars – Reported.

The event was observed in the early hours of Dec 12th. The BAA forum has several very nice images and videos. We thank Alex Pratt (Leeds) who helped spread the word and prediction times.

Fig.6 Image by Tim Haymes from a video.

Tim Haymes: The occultation was followed in 10x50 binoculars and a video taken through his C11. The view in binos was wonderful with the Red/White contrast being quite pronounced.

Occultation predictions for 2023 January (Times as other locations will +/- a few minutes)
Oxford: E. Longitude - 1 18 47.1, Latitude 51 55 40.3.
To magnitude r8.5 Moon altitude >7 degrees.

yy mmm	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Az	CA o	Notes
23 Jan	1	17	24	47.9	D	93066	B9	8.0	7.9	76+	122	-11	42	124	77N	
23 Jan	1	18	39	43.0	D	93079	F2	8.5	8.3	77+	122		50	147	51N	
23 Jan	1	18	43	46.7	D	403	B9	5.8	5.8	77+	122		50	148	57S	omicron Ari
23 Jan	1	22	47	35	Gr	Uranus		5.7	5.7	78+	124		42	** GRAZE:		
23 Jan	1	23	49	37.2	D	93148	K5	8.1	7.3	78+	124		35	251	70N	
23 Jan	2	0	28	59.8	D	423	F5	6.3	6.1	78+	124		29	260	80S	
23 Jan	2	19	2	49.4	D X	4604	A0	8.1	8.1	85+	134		52	136	50S	
23 Jan	2	19	3	0.8	D X	4603	A0	8.3	8.2	85+	134		52	136	49S	
23 Jan	2	20	18	18.2	D	520	F5	7.5	7.2	85+	135		58	164	60S	
23 Jan	3	0	55	46.8	D	76101	K0	8.1	7.6	86+	136		35	259	61S	
23 Jan	3	1	24	32.7	D	534	A0	6.1	6.1	86+	136		31	265	82N	
23 Jan	3	22	24	4	m	676	B8	7.2	7.0	92+	147		61	199	11S	
23 Jan	4	0	25	7.7	D	76651	F0	7.8	7.6	92+	147		49	243	17N	
23 Jan	4	5	3	9.9	D	714	F7	6.2	5.9	93+	149		9	298	34S	95 Tau
23 Jan	10	2	31	48.3	R	1444	K0	7.8	7.1	91-	145		56	177	43N	
23 Jan	11	4	17	33.5	R	1553	A0	7.8	7.8	85-	134		49	201	71S	
23 Jan	11	5	28	22.8	R	99227	K0	8.2	7.6	84-	134		43	224	72N	
23 Jan	13	3	51	56.4	R	119212	K0	7.5	6.9	69-	112		39	164	65S	
23 Jan	14	6	54	59.9	R	1850	K0	6.5	5.9	58-	99	-11	31	206	89N	
23 Jan	15	3	10	23.9	R	139418	K0	8.0	7.5	49-	89		19	134	88N	
23 Jan	15	6	3	3.2	R	139461	K2	8.3	7.6	48-	88		28	179	78S	
23 Jan	15	6	43	19.9	R	1959	K0	8.0	7.4	48-	88		28	190	63S	
23 Jan	16	3	41	12.8	R	158548	A2	7.9	7.8	38-	77		12	134	52N	
23 Jan	16	6	33	43.5	R	158593	K0	8.1	7.4	37-	75		23	175	45N	
23 Jan	18	5	48	15.7	R	184318	G5	8.4	8.0	18-	50		5	142	22N	
23 Jan	24	18	9	1.4	D	165525	G0	8.3	7.9	12+	40		16	228	76S	
23 Jan	26	18	5	12.6	D	109506	G0	7.6	7.3	30+	67		38	209	29N	
23 Jan	27	18	1	25.9	D	247	F2	6.3	6.1	40+	79	-12	46	195	79N	

23	Jan	27	18	55	33.8	D	110063	K2	7.3	6.6	41+	79		43	213	46N	
23	Jan	27	20	43	39.5	D	110096	F0	8.4	8.2	41+	80		31	243	39N	
23	Jan	27	20	45	8.9	D	110100	F5	7.9		41+	80		31	243	49N	
23	Jan	27	20	45	14.0	D	110099	F5	8.0	7.7	41+	80		31	243	49N	
23	Jan	27	21	25	12	Gr	257	K0	4.3	3.8	42+	80		24	**	GRAZE:	o-Psc
23	Jan	28	17	39	4	Gr	365	F5	8.6	8.4	51+	91	-9	51	**	GRAZE:	29 Ari
23	Jan	28	20	57	15.6	D	374	F8	6.0	5.7	52+	92		40	239	22N	
23	Jan	28	22	23	54.8	D	93018	K0	8.4	7.8	52+	93		28	258	82N	
23	Jan	29	18	21	15.2	D	480	A0	7.4	7.5	61+	103		57	167	88S	
23	Jan	29	18	53	22.3	D	93396	A0	8.3		61+	103		58	181	90N	
23	Jan	29	19	37	14.8	D	93400	F5	8.0	7.7	62+	103		57	199	38N	
23	Jan	30	14	43	2.1	D	599	K0	4.4	3.8	70+	113	14	28	89	62S	37 Tau
23	Jan	30	15	31	20.4	R	599	K0	4.4	3.8	70+	113	9	35	99	-36S	37 Tau
23	Jan	30	22	10	35.7	D	76531	K0	8.5	7.8	72+	116		50	239	83N	
23	Jan	31	0	8	28.7	D	76555	G5	7.2	6.6	72+	116		33	267	56N	

NOTE: The FAVOURABLE omicron Psc GRAZE on Jan27th is No2 in the BAAH 2023.
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 btinternet dot com
Interested in Grazes only? – please indicate your travel radius in Km and your home post code or nearest town. An aperture of 20cm will be used unless advised.

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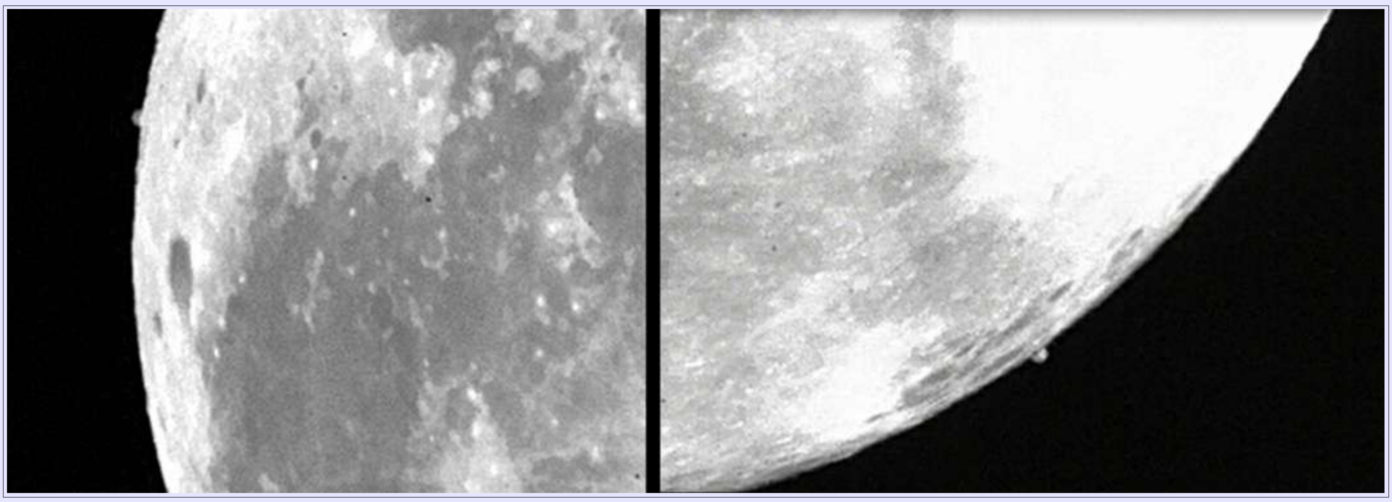
Mars occultation videos by Rik Hill.

Despite clouds Rik Hill managed to obtain video of the ingress and egress and these can be accessed via the links below:
Ingress:
https://www.lpl.arizona.edu/~rhill/Moon-Mars-occultation/Moon+Mars_ingress_612nm_132M%2022-12-07%2019-31-59.mov
Egress:
https://www.lpl.arizona.edu/~rhill/Moon-Mars-occultation/Moon+Mars_egress_610nm_132M%2022-12-07%2020-26-33.mov

Video taken with a Questar 3.5 at 610 nm, using a 132M Camera.
From the Director: I have taken relatively cloud free still frames from Rik's videos (below), then sharpened them and contrast stretched them. The ingress occultation is on the left and the egress is on the right. What I find interesting is that with the egress you can see a black line between Mars and the Moon, which is not visible on the ingress image. Black lines have been reported before with some planetary occultations by the Moon. On this occasion it is simply due to the fact that the Moon was not quite full and some tiny slither of terminator is visible on this side of the limb.



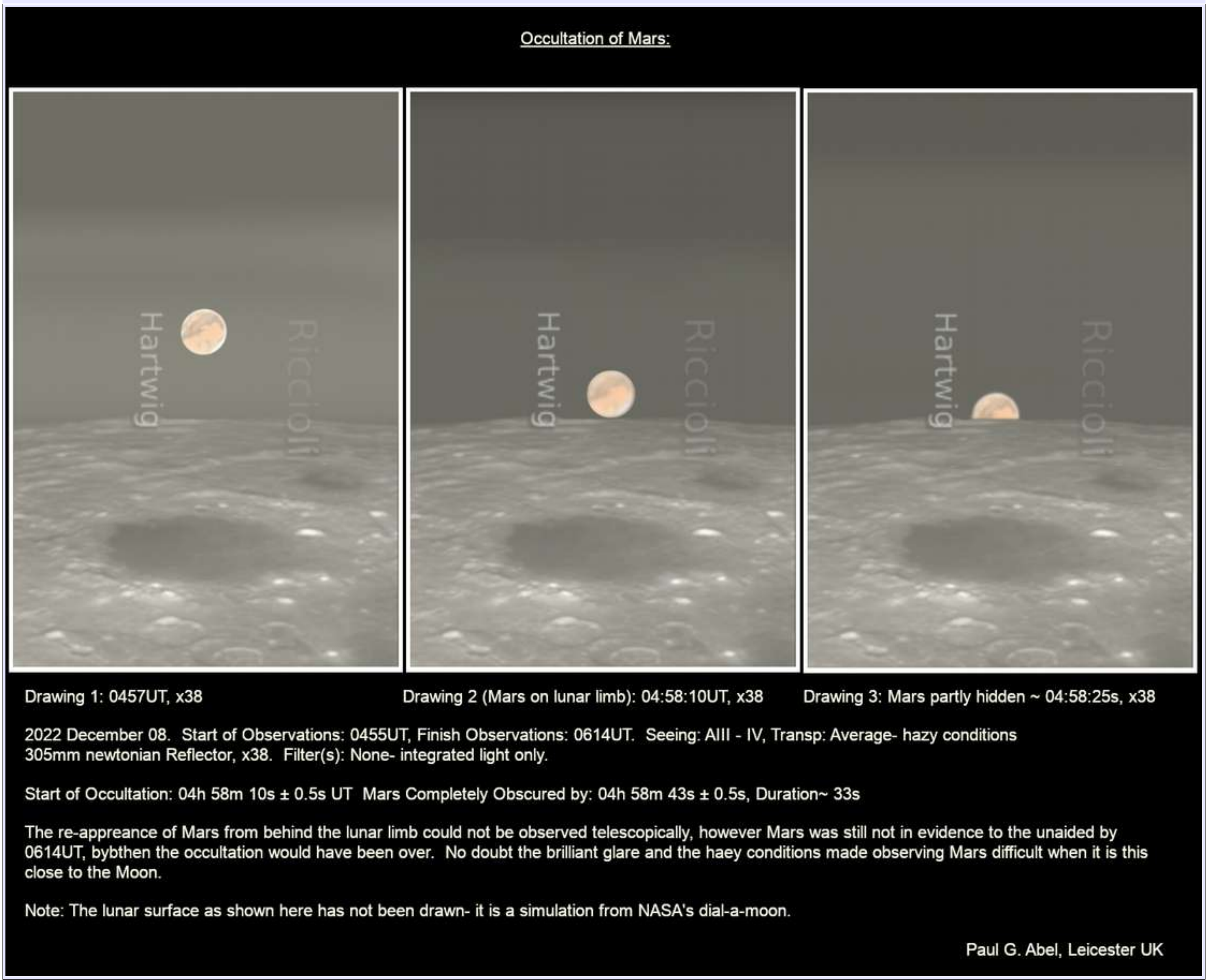
Mars Occultation by Mark Radice.

Editor Comments: Mark recorded this spectacular image of Mars sinking beneath the Mare Orientale from his driveway despite a temperature of -8°C in rural Wiltshire.

Mars Occultation by Dr. Paul G. Abel.

Please find attached my observation of the occultation of Mars on 2022 December 08. Please note that I have not drawn the lunar surface in these observations- they are a simulation from NASA's dial-a-moon, there wasn't time to draw the lunar surface and make accurate timings. What I have attempted to do is depict what the occultation looked like through the telescope. The Mars drawing included here is mine, and I have attempted to recreate the glare from the Moon which was considerable as the sky had become rather hazy at this point. Also given in the observation are details of the start and end times of Mars disappearance behind the western limb of the Moon- the approximate length from these timings was around 33s from Mars sitting on the western limb of the Moon to being totally obscured.

I was unable to see the re-appearance as the Moon was to far in the west from the site of my 12" Newtonian. I did note that by 0614UT, I was still unable to see Mars with the unaided eye- this is probably due to the glare from the Moon making it very difficult to see Mars.



Mars occultation egress by Les Fry.

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Images submitted to the Section.

Pythagoras.

Image by Alexander Vandenbohede.

Editor Comments: At 144kms in diameter Pythagoras (with the prominent central peak and positioned close to the limb in this image) is one of the larger nearside craters, but due to its position close to the limb and the effects of foreshortening this is not obvious. It is set amongst a field of ancient craters now filled with Imbrium ejecta such as Babbage, Anaximander and J. Herschel, and clearly post dates all of these as well the Imbrium Basin. It has been propose that Pythagoras is Eratosthenian in age and this estimate has been bolstered by recent findings* The crater is some 3,500m deep and its central uplift in the region of 2000m high. It has a spectacular ejecta field which blankets the adjacent terrain, as well as extensive impact melt ponds outside its northern and eastern rims, but again due to its position these are not at all apparent telescopically. The crater floor is dominated by extensive impact melt deposits, and in many ways it appears like a scaled up version of Copernicus. In outline however it has a somewhat polygonal as opposed to a circular planform. This may be related to its formation on the margins of the Imbrium basin who's fractures and faults may have had an influence on the crater shape as it formed.

Xuting, H, *et.al*. (2022) Absolute model ages of three craters in the vicinity of the Chang'E-5 landing site and their geologic implications, Icarus, Volume 372.

Rima Cauchy and Environs.

Image by Dave Finnigan with details of date/time and equipment as shown in caption.

Editor Comments: Rima Cauchy is the graben to the north of the carter Cauchy, and Rupes Cauchy is the scarp to the south of the crater. According to IAU definitions a Rima is a “fissure” and a Rupes is a “scarp”, which is pretty clear in this image, but in this case it is likely that the Rupes started out as a Rima, but that the southern edge subsided and was inundated with mare lavas from the south, leaving the northern edge standing in isolation as a scarp. You can see towards the west the scarp does in fact become a graben – revealing its true identity - and Dave's image also shows two collapse pits which have formed at the very western end of this graben like section. These *almost* parallel graben mark the sides of an gentle elongated uplift that may be related to subsurface volcanism, and the subtle domes visible to the south of Rupes Cauchy are tangible evidence for volcanism in this area. A small dome located between the two obvious ones in this image is worth exploring with the LRO Quickmap as it is riddled with 'Irregular Mare Patches' or 'IMP's', which indicate sites where the surface regolith has been eroded by venting of gasses from the sub-surface, the same process that produced the famous 'Ina' structure to the north of Mare Vaporum. To be fair, other hypotheses have been touted to explain IMP's but the gas release one by far the most convincing.

You can see quite clearly the 'fork tail' pattern which forms the Zone of Avoidance in Cauchy's ejecta, a clear indication of a low angle impact from the west.

Piccolomini - Rupes Altai.

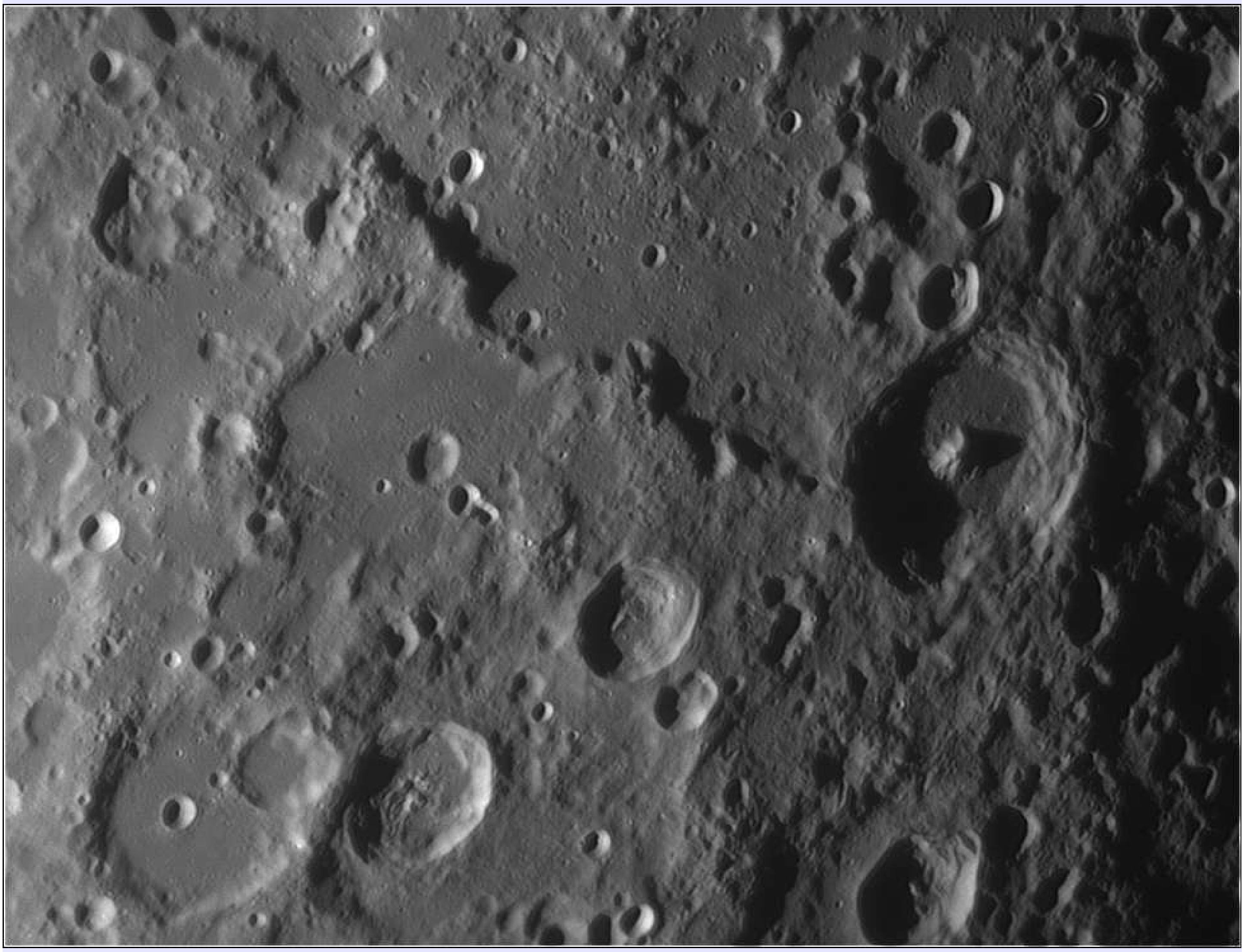

Image taken by Bill Leatherbarrow with his OMC300 and ASI290 camera.

Editor Comments: It is easy to get drawn in by the spectacular crater Piccolomini with its 2500m high central peak perched on the outer ring of the Nectaris Basin which can be seen as the Rupes Altai in this image, heading up towards the top left of the frame, but for me the real star of the show lies 130kms to the west. This is the triple crater consisting of the larger (11km diameter) Rothmann H the smaller Rothmann J and an un-named crater between the two, which together form the keyhole shaped structure just to the left of the centre of the frame. From the ejecta pattern it is possible to say that this was formed by three impactors travelling together in trail, from NW to SE, but sufficiently separated that each produced its own crater on impact. The most likely culprit is a tidally disrupted asteroid, or a body consisting of individual components that took on the trail formation following gravitational interaction with the Earth and Moon. The images of Comet Shoemaker–Levy 9 will give you a good idea of what went on here, but on a somewhat grander scale.

If you have a look at the LRO images for the area and select an overlay that depicts optical maturity you will find two smaller craters lying between this triplet and the rim of Rothmann (the largish crater just below the middle of the frame) which are in line with the long axis of the multiple crater. These may represent fragments of the original impactor that struck the surface further down range, so maybe not a triplet impact but *pentuplet impact!*

Bill's image also shows the rather odd ridge like central peak on the floor of Rothmann itself, and the strange arcuate ridges on the floor of Lindenau produced by the collapse of the western rim.

Furnerius, Stevinus and Snellius.

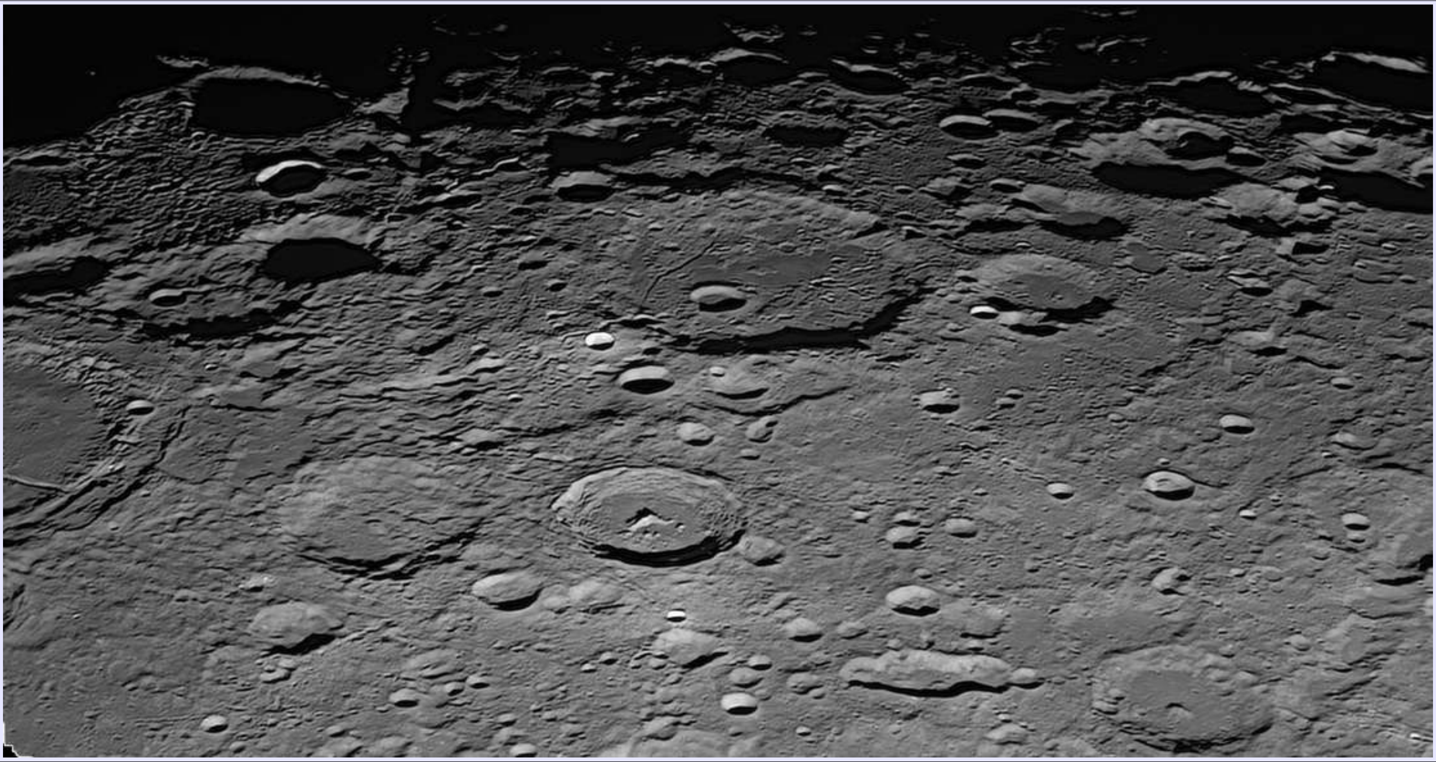

Image by Leo Aerts imaged with a 25 cm f/15 Opticon Schmidt Cassegrain and ASI 290MM webcam.

Editor Comments: This image is packed with detail. Centre stage (well, just below centre) is the 71km diameter crater Stevinus, which has a prominent, crescentic central peak which measures some 20kms long north-south and 6kms east-west. The crater itself is *slightly* shorter along a north-south axis (~67kms) compared to the east-west axis (~71kms) and these two facts might suggest a low angle origin from either the north or south. Cutting across the bottom right corner of the frame is a section of Vallis Rheita, a crater chain often cited as being radial to Mare Nectaris and therefore likely to have formed as a result of the basin forming impact. You can make out faint linear features running parallel to Vallis Rheita, these are probably the Nectaris equivalent of the Imbrium Sculpture, produced by low angle ejecta from the basin scouring the surface as it left the impact site.

The 135km diameter Funerius probably dates to the pre-Nectarian period, and has been the dumping ground for ejecta from all the nearby younger craters including Petavius and Stvensius and a host of smaller craters such as the very bright Funerius A which is perched just outside its northern rim. A small patch of mare like material has erupted on its floor, and the graben Rima Furnerius can be seen crossing the northern part of the crater, cutting both the mare unit and the lighter but older crater floor.

The oddly elongate Rheita E towards the bottom of the frame certainly looks like a secondary cluster, but we cannot blame Nectaris for this as it is far from being radial to that basin, but which basin it belongs to – if it is a secondary – is another matter. Another oddly shaped crater Adams B can be seen mostly in shadow and set within Petavius ejecta towards the top left of the frame. This is not a basin secondary but a genuine multiple simultaneous impact which consisted of at least three but probably more individual components striking the surface at the same time.

The timing of this image brings out the secondary craters and rugged ejecta surrounding Petavius, which is still conspicuous despite dating to the Lower Imbrian (3.85 to 3.8 billion years).

Mare Australe.

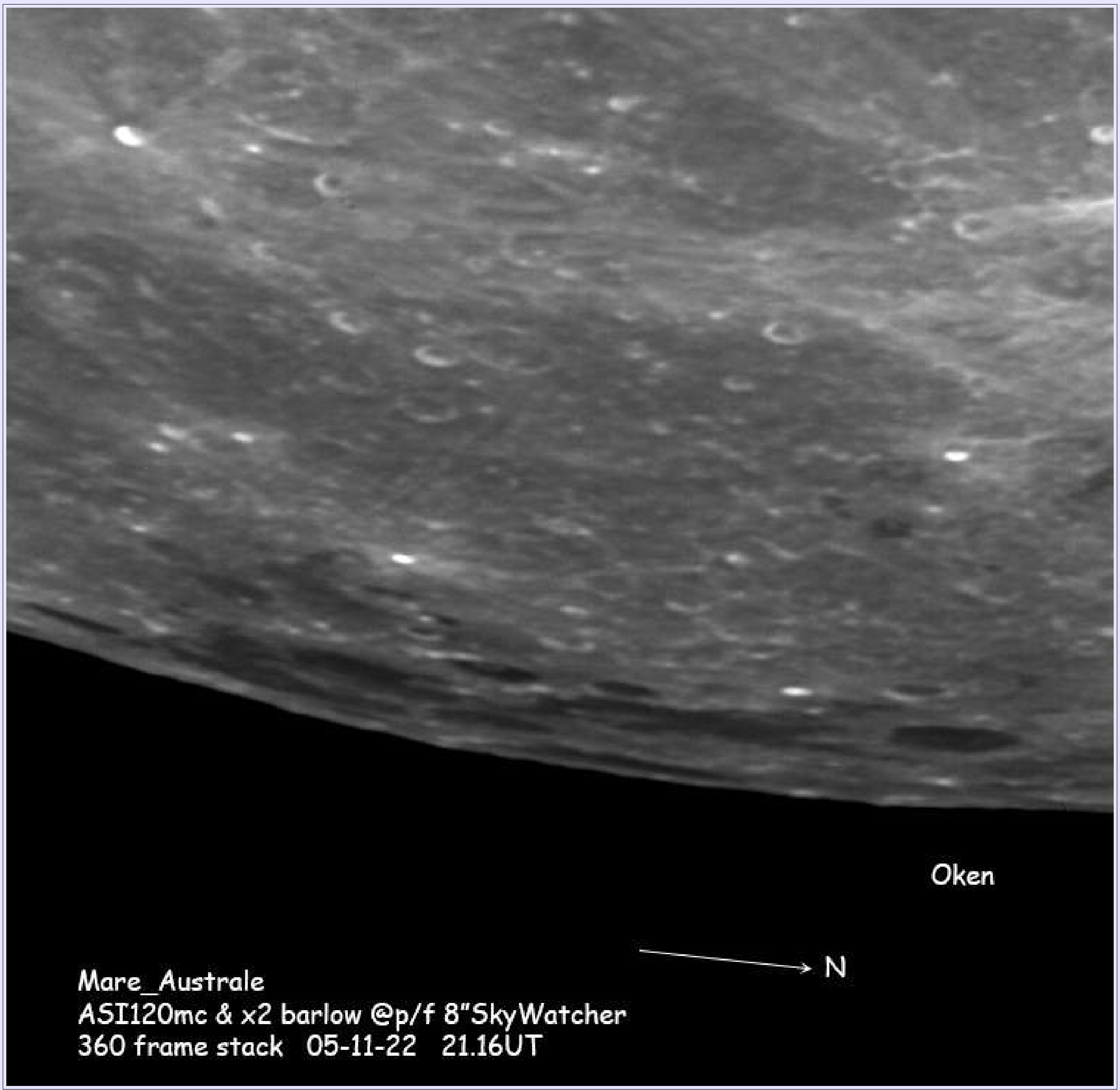

Image by Les Fry with details of date/time and equipment as shown in caption.

Editor Comments: It is tricky getting your bearings when things are as foreshortened as they are in Les's image, but he has kindly labeled Oken which is the mare filled crater to the right of the frame. The lava filled depressions we see making up this rather fragmentary mare are thought to lie within an ancient Pre-Nectarian Australe Basin, but there is not much in the way of topography to suggest the presence of a basin, and no obvious circular gravity anomalies in the GRAIL data typically seen in other ancient basins, though a recent study has identified a gravity anomaly over the northern section of the area that may support the idea of an ancient basin*. One explanation that has been proposed is that any basin structure has been so battered and eroded that it is no longer visible. Possible ring like structures have been proposed following a rather mathematical analysis of the surface, and these have been proposed as evidence for elusive basin structures** but all of these strands are only suggestive and far from being definitive. The basalts we see as the mare units range in age from 3.71–3.8 Ga to 3.36–3.46 Ga, suggesting protracted volcanic activity.

*Neumann, G. A., Zuber, M. T., Wieczorek, M. A., Head, J. W., Baker, D. M. H., Solomon, S. C., et al. (2015). Lunar impact basins revealed by gravity recovery and interior laboratory measurements.Science Advances,1(9), e1500852. https://doi.org/10.1126/sciadv.1500852

** Meng, Z. G., Chen, S. B., Zheng, Y. C., Cheng, W. M., Zhu, Y. Q., Cai, Z. C., et al. (2020). Mare Deposits Identification and Feature Analysis in Mare Australe Based On CE-2 CELMS Data. *Journal of Geophysical Research: Planets*, 125, e2019JE006330. https://doi.org/10.1029/2019JE006330

Hevelius and Cavalerius.

Hevelius & Cavalerius 2022.09.21 - 06.37 UT
300mm Meade LX90, ASI 224MC Camera with Pro Planet 742nm I-R Pass Filter.
750/3,000 Frames. Seeing: 6/10, with light sky and turbulence. Rod Lyon

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

Editor Comments: This view of the western shore of Oceanus Procellarum shows the 113km diameter Floor Fracture Crater Hevelius, with the younger 60km diameter Cavalerius immediately to the north. The light ray system of Cavalerius is visible on the mare surface, but the other pale features running in a line from top middle down towards the lower right are part of the Reiner Gamma lunar swirl system. There are many competing hypotheses for what these swirls represent, but the front runner appears to be the idea that a 'magnetic stand off' effect shields the surface from radiation and inhibits the worst ravages of space weathering on the lighter parts. Recent research however suggests that the brighter parts occupy slightly lower terrain (in Mare Ingenii at least) and that these may trap mobile dust grains in the 10–1,000 µm size range*. So magnetic shielding may not be the *whole* story, and with dust migration playing an additional and possibly significant role.

*Domingue, D., Weirich, J., Chuang, F., Sickafoose, A., & Palmer, E. (2022). Topographic correlations within lunar swirls in Mare Ingenii. *Geophysical Research Letters*, 49, e2021GL095285. https://doi.org/10.1029/2021GL095285

Gambart.

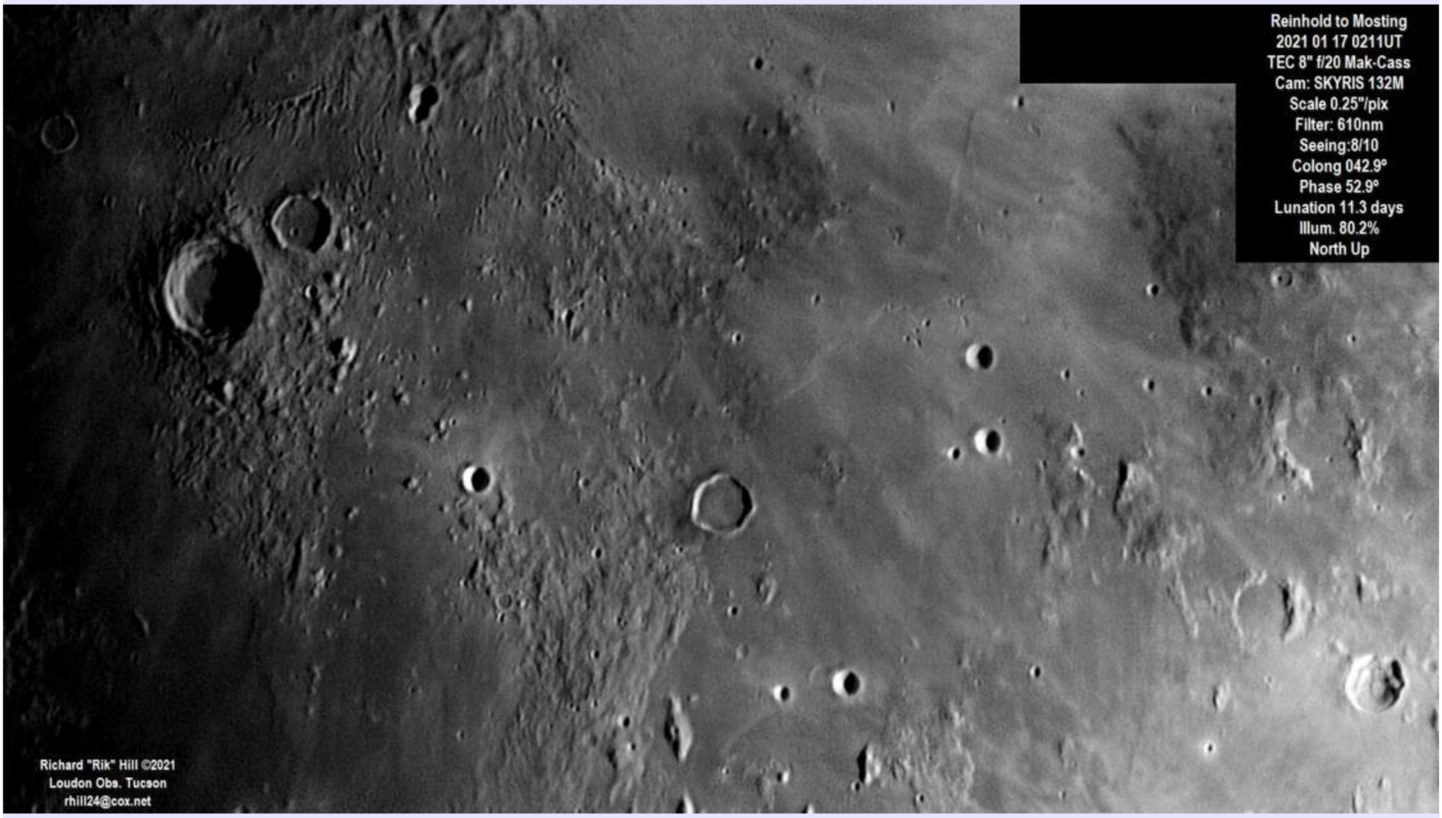

Image by Rik Hill. Details of time/date and equipment in caption.

Rik Comments: *"This overlooked region is southeast of the great crater Copernicus. On the left side of the image is the beautifully terraced crater Reinhold (diam. 49km). Just above and right of Reinhold is the ring crater Reinhold A (24km) and further on the smaller twin craters Fauth (12km) and below it Fauth A (8km). Normally I wouldn't bother with craters of this size but these two figured prominently in the foreground of the famous New York Times "Picture of the Century" on Nov.24, 1966. A restored copy of that Lunar Orbiter 2 image can be seen at donaldedavis.com/2004%20new/COPERNho.gif. I looked these craters up right away in 1966 when I first saw the Orbiter image.*

Dead centre in this image is another very old ghost or ring crater Gambart (26km) of Pre-Imbrian age (3.85-4.55 billion years old) flooded with ejecta from the many large nearby impacts. Then on the right edge of this image is the crater Mosting (27km) with Sommering (29km) the ghost crater just to the left of it the same age as Gambart as the flooding might indicate. Above these two is the ruined crater Schroter (35km) Between and above a line between Sommering and Gambart and are two vertically aligned relatively recent craters of similar size. The upper is Gambart C (12km) and below it is Gambart B (11.5km). Between them and just to the left you can just make out 2 of the Gambart Domes, the left one sporting a nice central pit. Another dome can be seen south of Gambart itself by first spotting the small clear crater Gambart N (5 km) well seen in this image. Below and to the left is a slightly brighter portion of the mare and you may see the small pit there in the centre of the bright region in its own dark patch. This is Gambart 1. Look and the curious mountain further south and left. It's has a crater in its summit but it is not volcanic. There are a number of such features on the Moon.

Before leaving this region, be sure to enjoy the hummocky terrain to the southeast of Reinhold. Then above Reinhold you can see a lot of the ejecta and secondary cratering from Copernicus. This is very interesting when on the terminator.

This is an image from a single 1800 frame AVI stacked with AVIStack2 (IDL) and further processed with GIMP and IrfanView."

Aristoteles and Eudoxus.

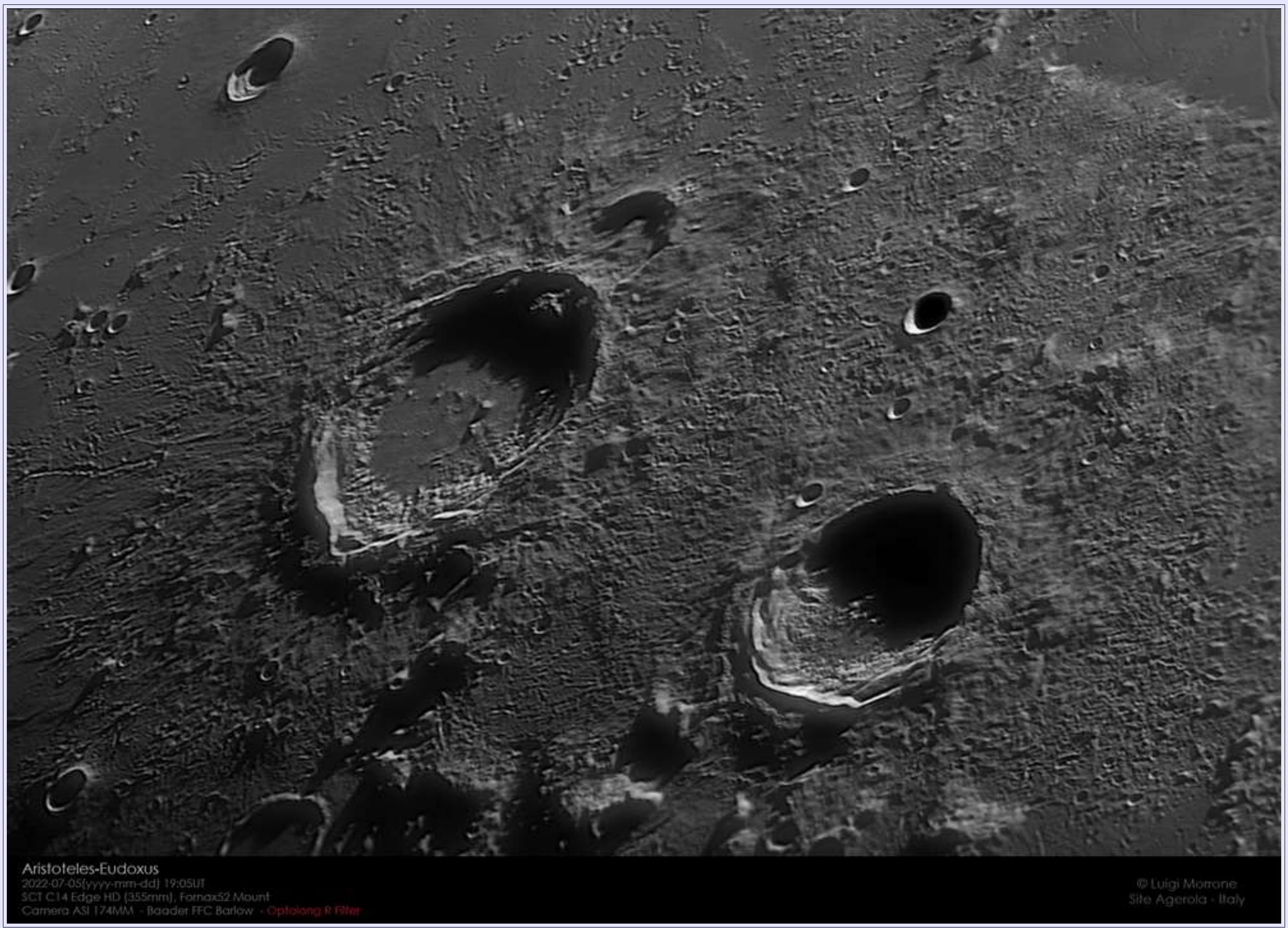

Image by Luigi Morrone with details of time/date and equipment used in caption.

Editor Comments: The Eratosthenian aged crater Aristoteles is some 87km in diameter and 3,500m deep. There is no obvious central peak, with just a few isolated hills protruding above the impact melt dominated crater floor. It has occasionally been referred to as Floor Fracture Crater, but there is not much in the way of evidence to support this. It has attracted a lot of attention recently because of its extremely heterogenous mineralogy which includes exposures of what appears to be troctolite, a rock composed minerals olivine, pyroxene and calcium rich plagioclase and with a whiff of chromite, particularly along the western and north-western edges of the crater*. This material, which appears to be present as boulders and clasts, is likely to represent rocks excavated from deep within the crust during the impact event. Some of these olivine rich areas correspond to low albedo patches that can be seen telescopically on the north-western wall.

A spectacular 50km long tongue of impact melt reaches away to the north from the northern rim – this gives way to a crater chain rather like the Stadius crater chain to the NE of Copernicus. This is visible in Luigi's image, towards the middle left edge of the frame. Further crater chains fan out either side of this feature to the north of Aristoteles, but are absent to the south. This *may* indicate an impact caused by a low angle projectile arriving from the south, but there is always the possibility that the ejecta from the younger 70km diameter Eudoxus may have buried any similar structures here. As with its larger neighbour, Eudoxus does not have a single central peak but an irregular ring of low hills, something seen in craters in the diameter range of between(50–205 km) and possibly a transitional stage between complex craters and peak ring craters**.

*Bhattacharya, Satadru & Chauhan, Dr. Mamta & Chauhan, P. (2014). Compositional heterogeneity of crater Aristoteles as revealed by Chandrayaan-1 moon mineralogy mapper (m3) data.

**Baker, David & Head, James & Fassett, Caleb & Kadish, Seth & Smith, Dave & Zuber, Maria & Neumann, Gregory. (2011). The transition from complex crater to peak-ring basin on the Moon: New observations from the Lunar Orbiter Laser Altimeter (LOLA) instrument. Icarus. 214. 377-393. 10.1016/j.icarus.2011.05.030.

Zucchius

Image by Bob Stuart.

Editor Comments: The 63km diameter Zucchius stands out in high sun images such as this, as well as in the eyepiece due to the dark markings just outside the eastern rim. This appears to be iron rich impact melt deposits that have spilled over the rim which is much lower here (by ~1000m) than to the west. This forms small melt pools and streamers that extend down the glacis coating the terrain in this dark material. The dark halo around the southern rim is also in all likelihood impact melt. Zucchius is another one of those craters that lacks a discrete central peak but instead has an untidy cluster of small hills. Craters in the size range seem prone to have this configuration of hills instead of a discrete peak, and this may be a result of a reduced central uplift volume and interactions with the impact melt sheet that forms in the crater during the impact process*.

*Bray, V., Atwood-Stone, C. & McEwen, A. (2012). Lunar Crater Peak and Peak-Ring Volumes from the LROC Global Lunar DTM 100. Geophysical Research Letters, Vol. 39, L21201, doi:10.1029/2012GL053693.

Basin and Buried Crater Project.
By Dr. Tony Cook

This month I thought that I would include a short article, received from Dominique Hoste (See below). We will have another article of his next month on the Flamsteed-Billy basin. 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:

https://users.aber.ac.uk/atc/basin_and_buried_crater_project.htm.

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.

The Smythii impact basin and looking for its impact melt.
by Dominique Hoste.

The Smythii basin dates back to the pre-Nectarian period, and the impact occurred after an earlier Marginis basin. The rings of Smythii basin overlay/intersect those of the Marginis basin. We can distinguish three rings, seen at the topography (LROC LOLA) and gravity (GRAIL or KAGUYA mission) maps (Figs 1 to 4).

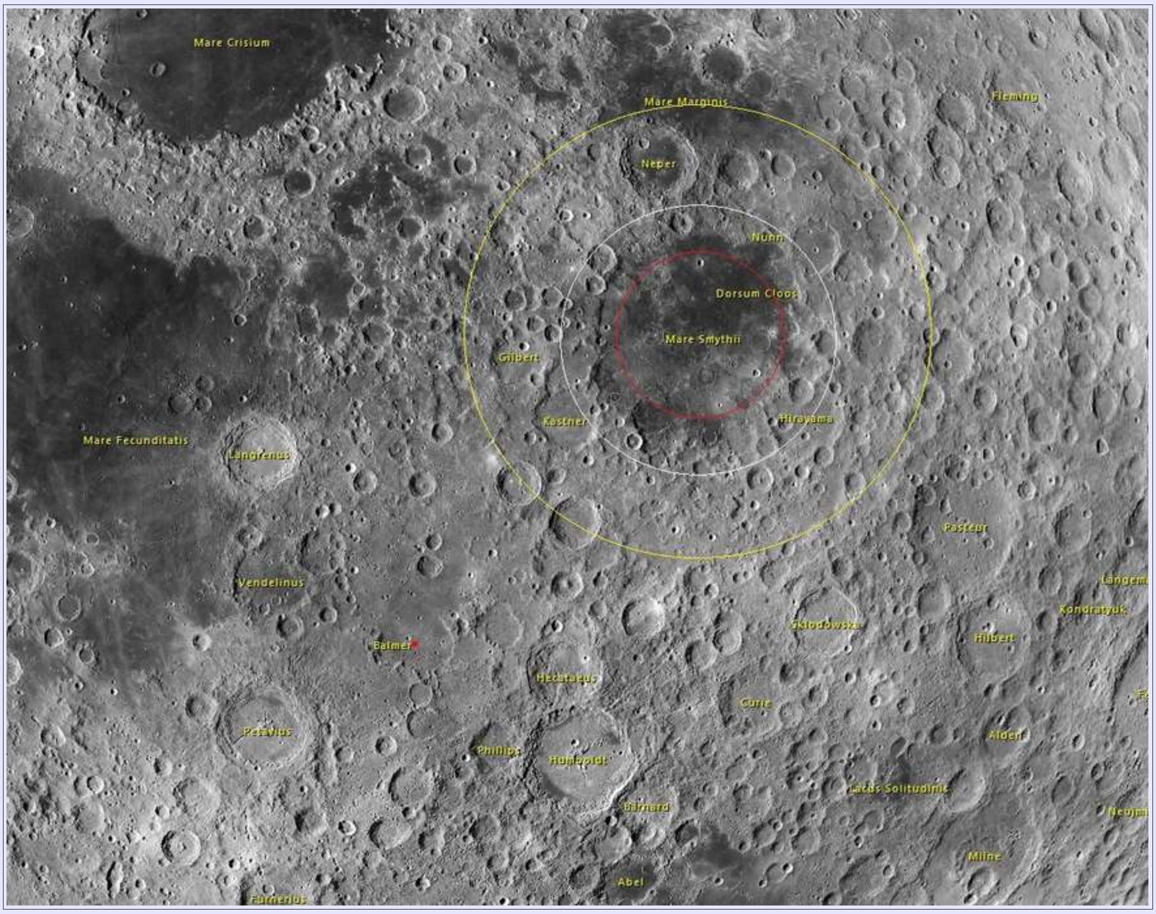

Figure 1. The rings of the Smythii basin overlaid on a map projected image mosaic.

The dark basalt of Mare Smythii inundates the inner basin of Smythii. It also inundates the bottom of the Neper crater (Coloured brown in Fig 5). Mare Marginis, ejecta of the Neper crater and other degraded lunar highland material overlay to the north of the Smythii basin (Coloured green in Fig 5).

The basalt of Mare Smythii was originally a mixture of impact breccia, melt sheet and lava. The inner depression was subsequently overlain by many impact craters after the Smythii impact, and therefore mixtures of breccia and ejecta from these younger craters have degraded and covered the surface, making the Smythii melt no longer visible in the northern part of the central depression (Colored brown within the rectangle in Fig 5), and also causing the zone of melt and breccia to the south in the central depression to be very difficult to see as well (Blue inside the rectangle in Fig 5).

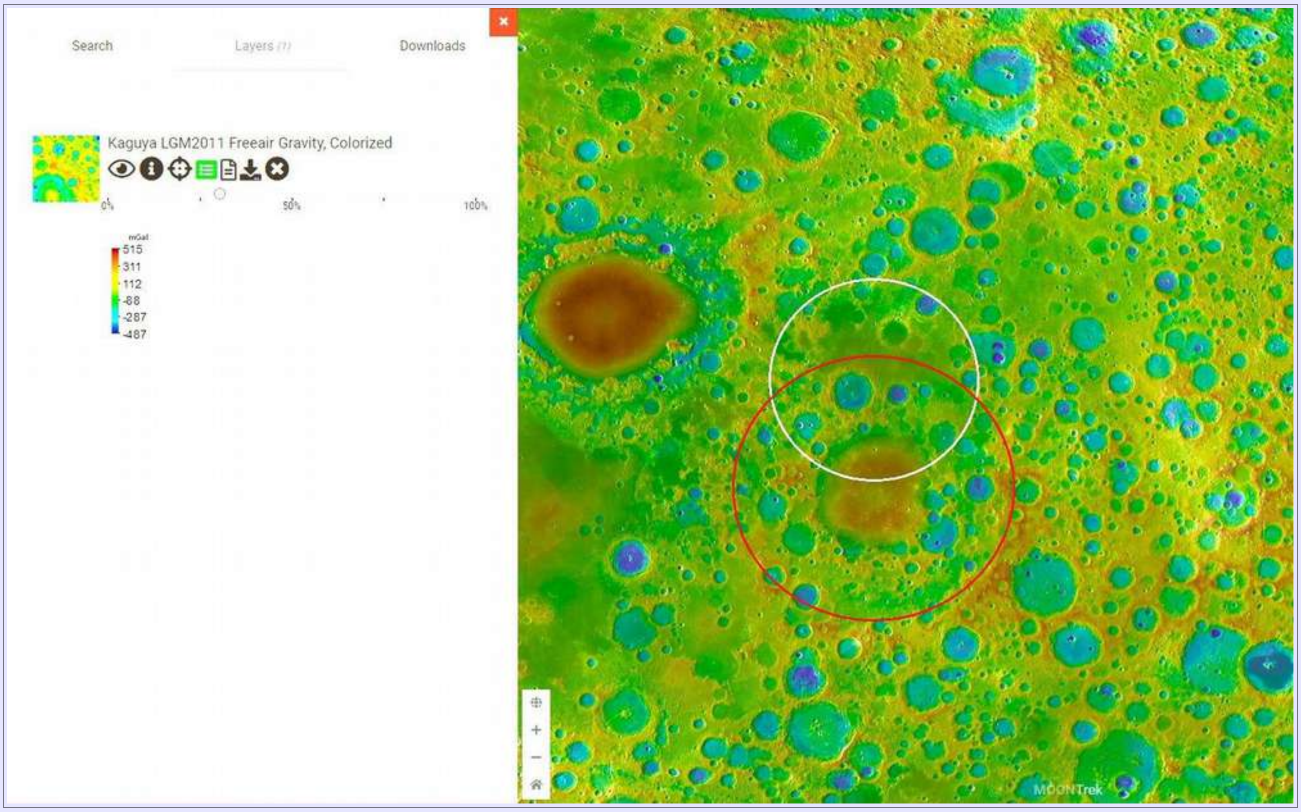

Figure 2. The main rings of Mare Marginis and the Smythii basin – using Kaguya gravity data.

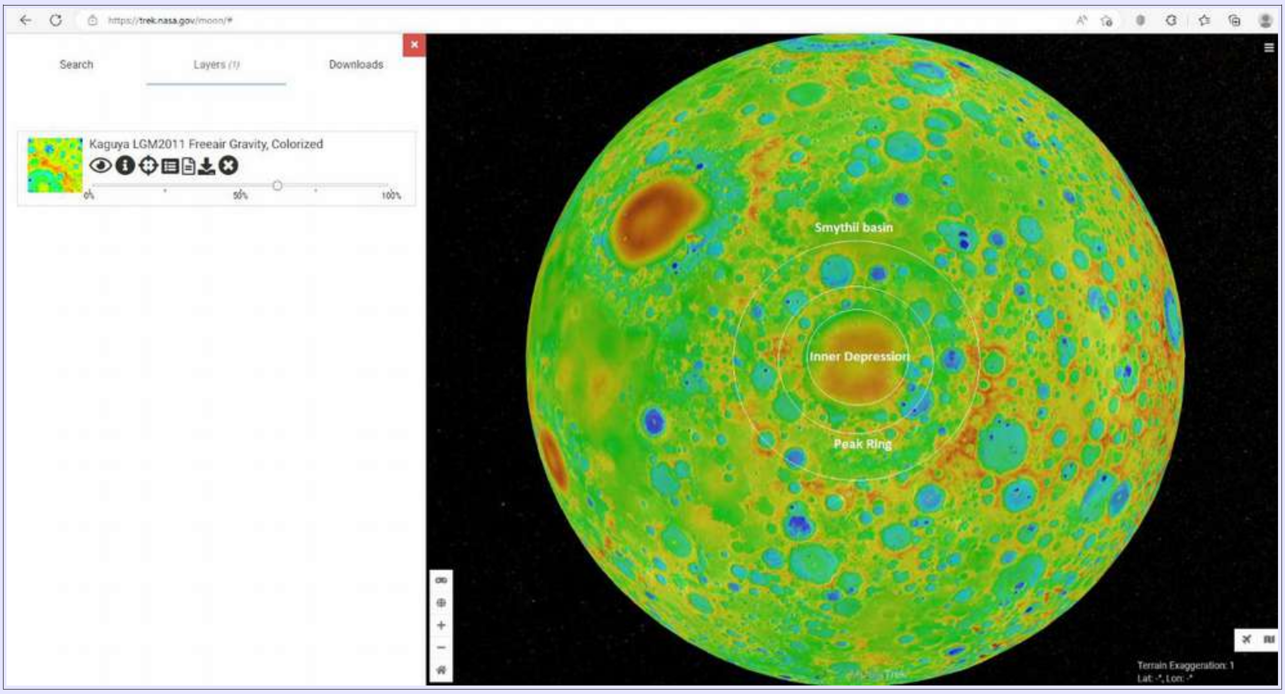

Figure 3. The rings of the Smythii basin overlaid on Kaguya gravity data.

This can also be seen in Fig 6, the plagioclase map: dark in the north (A), and dark-green-yellow in the south (B). Plagioclase is both common and characteristic of the Moon's highland crust. The impact of the Smythii basin occurred on the pre-existing highlands in its region. The impact here caused a melt on the highland crust in the central depression. How can we find the melt to date this impact radio-isotopically? Two craters in the northern part of the central depression, Schubert C and Haldane are important here.

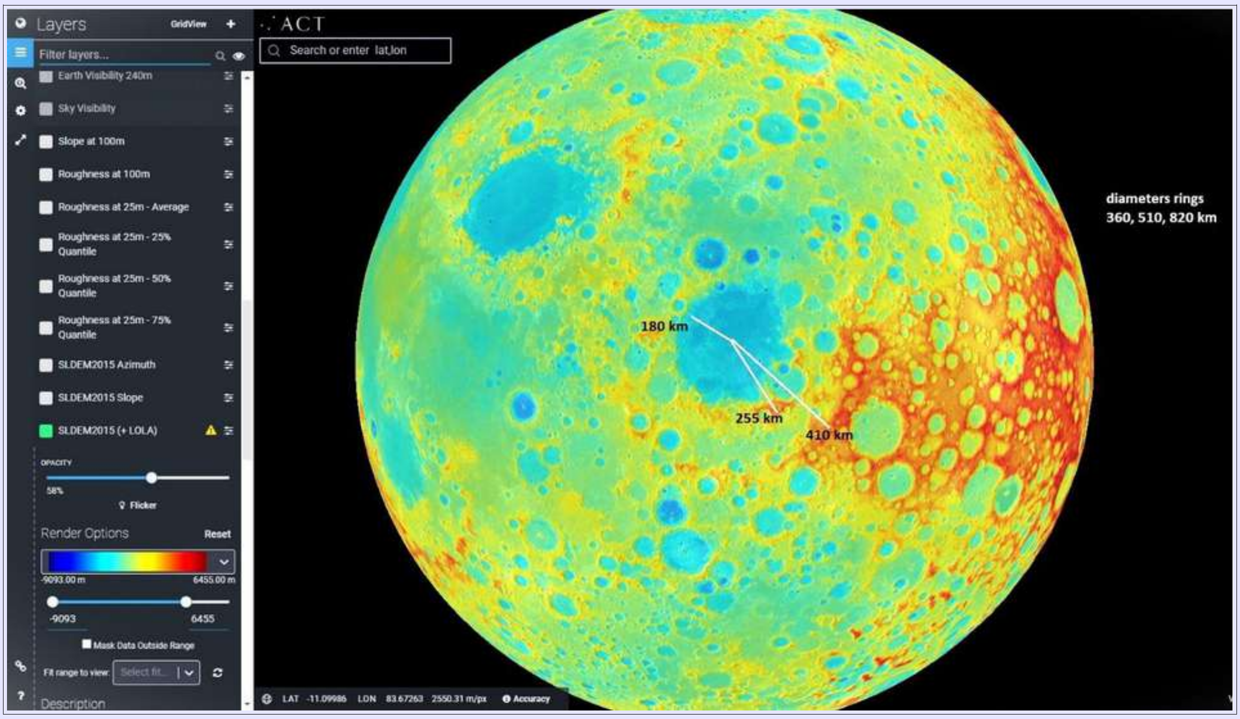

Figure 4. The corresponding ring diameters as measured using NASA's ACT Quickmap web site.
The diameter of the rings are for the central depression 360 km, for the peak ring 510 km and the basin rim 820 km. The highest gravity gradients are noted in the center of the central depression, as well as on the peak ring and on the south-eastern part of the outer ring.

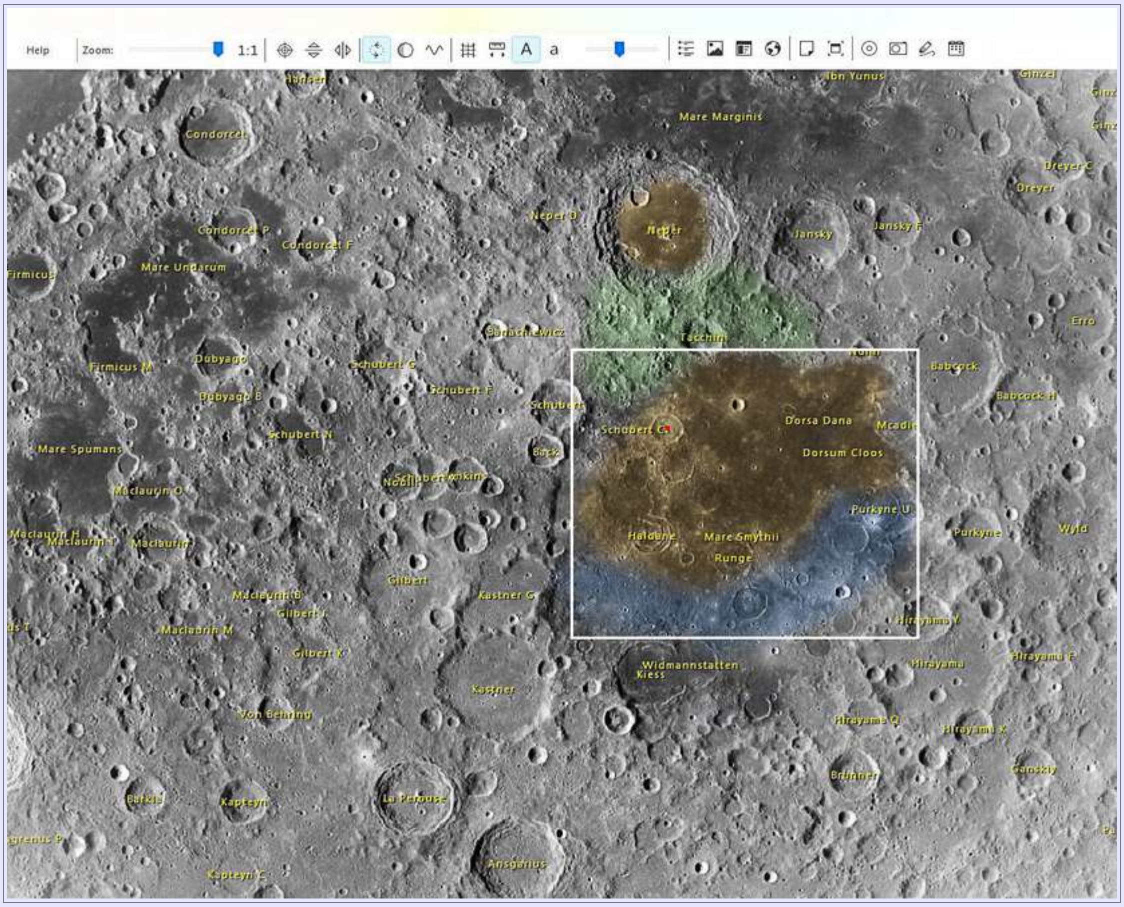

Figure 5. The inner depression of the Smythii impact basin lies inside the rectangle. The colours depict some of the geological units in the area.

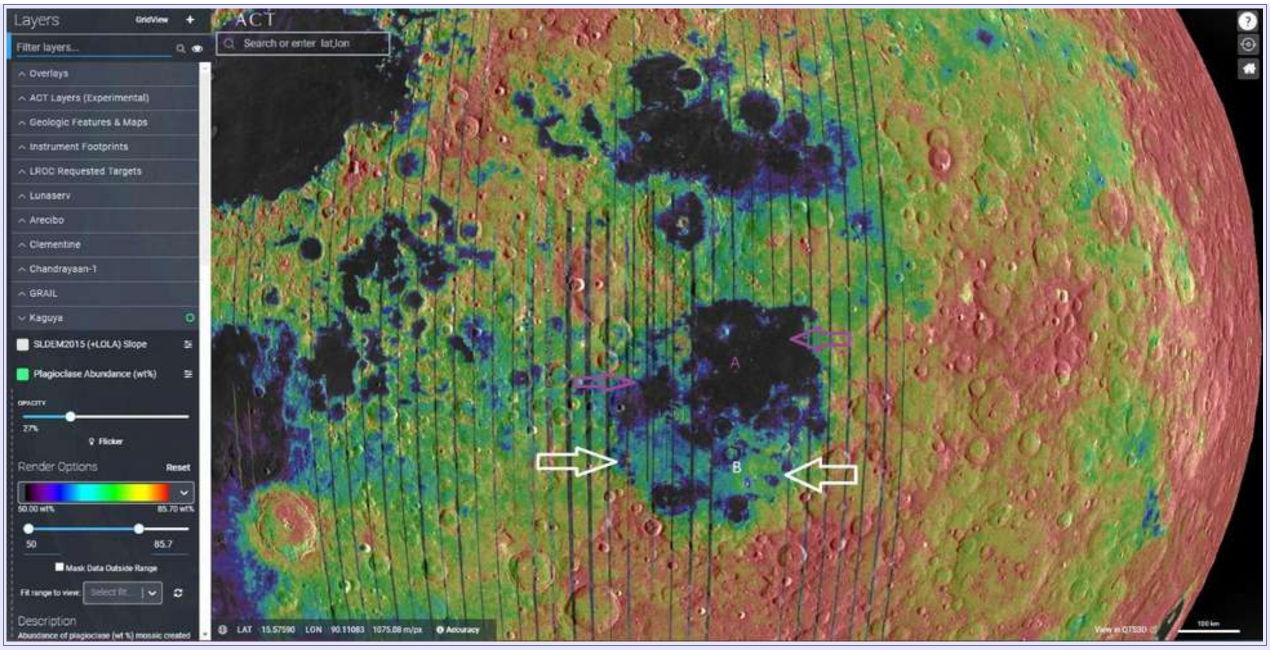

Figure 6. Plagioclase map of the area around Mare Smythii

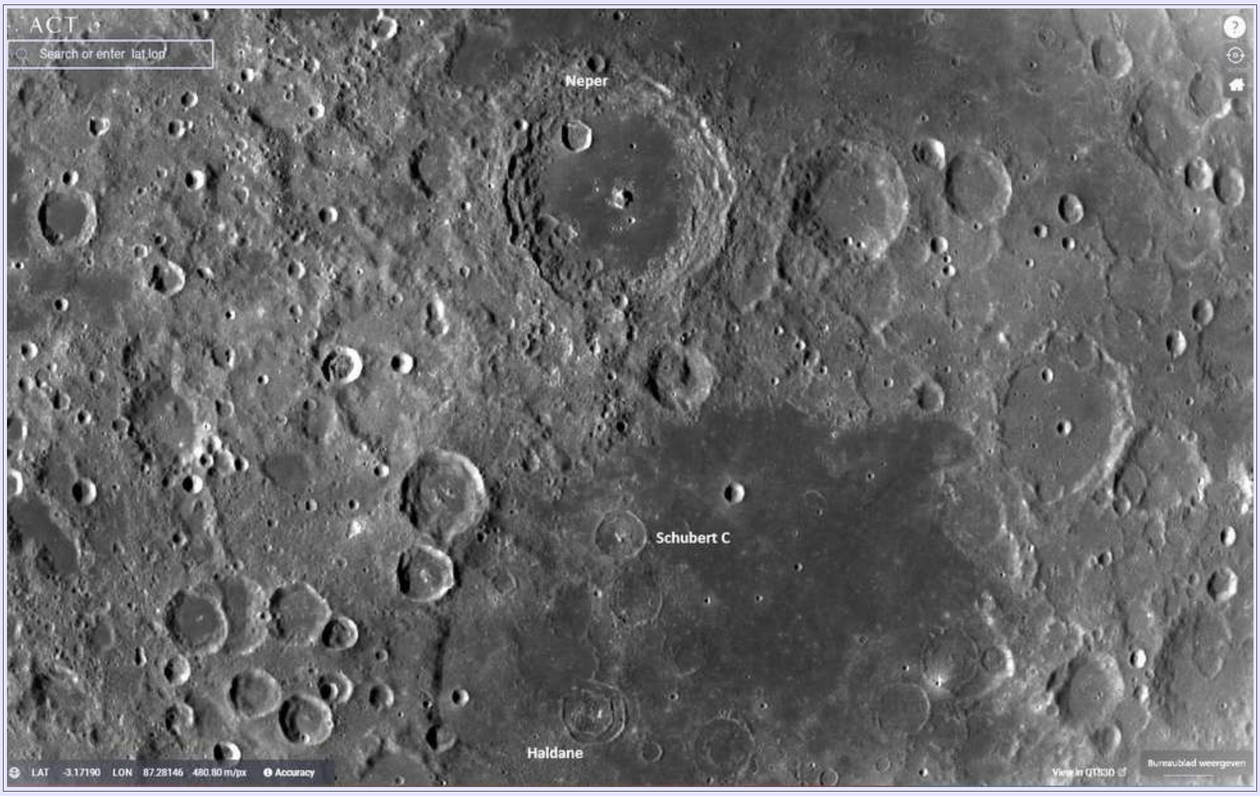

Figure 7. Close up of important craters around Mare Smythii in a NASA Quickmap map projected image mosaic.

During their impact, when the central mountain was formed, mountains on their crater rim (as well as other mountains inside), the highland basin structure came to the surface (mantle uplift), along with the pure melt of the Smythii basin. We see this on the distribution of red color on these craters, on the plagioclase map of Kaguya mission. Schubert C is the biggest candidate for exploration. Possibly this could be a site for future lunar missions, according to the reference at the end of this article. The central mountain of Neper also shows this feature, but there is doubt about the purity of the melt there (Figs 7 & 8).

Determining the age of impact melt deposits is a top priority for lunar science. Establishing an accurate chronology of lunar basin impacts would also tell us a lot about the corresponding Earth impact flux, which affected profoundly the surface of our planet, as well as the habitability of early Earth.

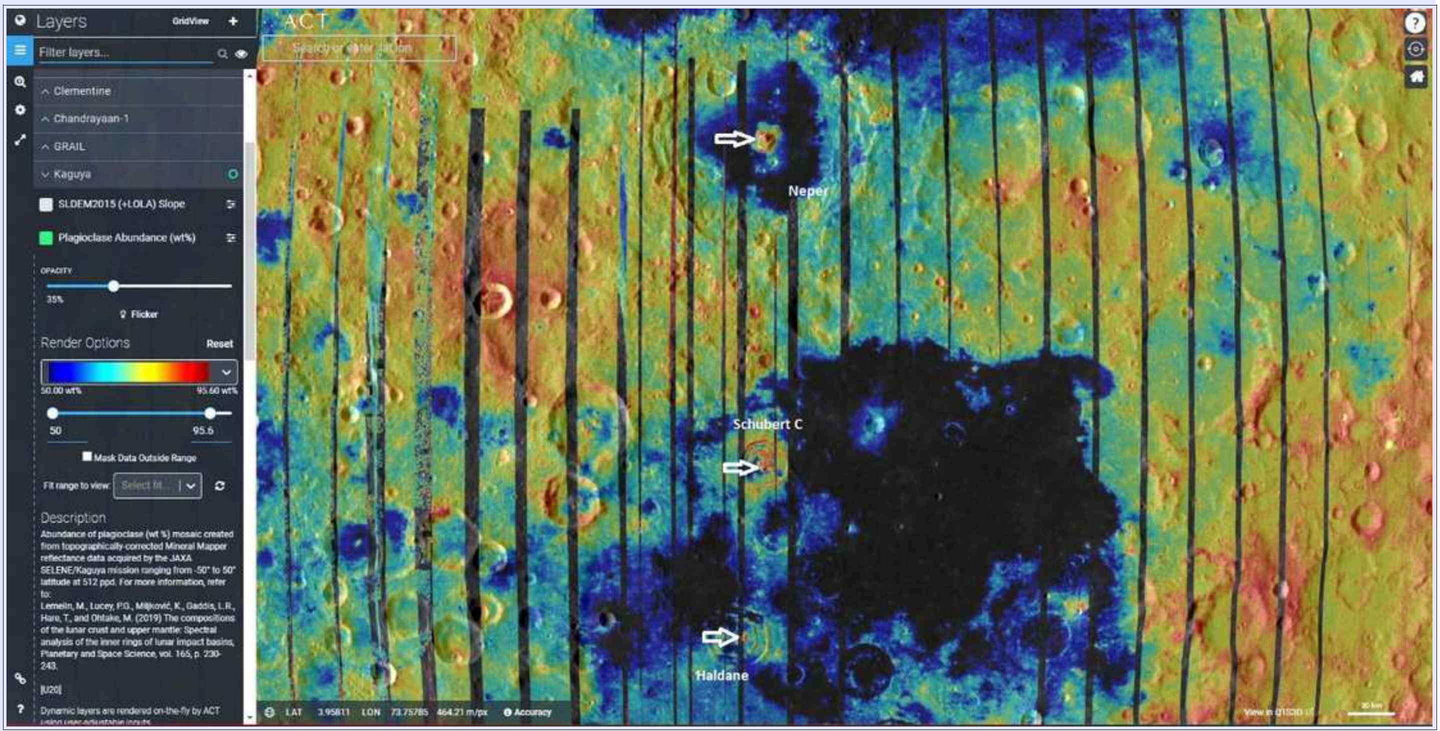

Figure 8. The Smythii impact basin – the arrows indicate outcrops of Mare Smythii melt in three craters mentioned in the main text.

References:

The Planetary Science Journal, 3:48 (11pp), 2022 February https://doi.org/10.3847/PSJ/ac51e2
Identifying Impact Melt from the Smythii Basin: Toward an Improved Chronology for Lunar Basin Formation Kirby D. Runyon1 , Lyle Nelson2 , and Daniel P. Moriarty III3 1 Planetary Exploration Group, Johns Hopkins APL, 11101 Johns Hopkins Road, Laurel, MD 20723, USA; kirby.runyon@jhuapl.edu 2 Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, MD, 21218, USA 3 USRA and NASA Goddard Space Flight Center, Planetary Geodynamics Laboratory, Code 698, Greenbelt, MD 20771, USA Received 2020 August 9; revised 2021 December 19; accepted 2022 January 27; published 2022 February 28.

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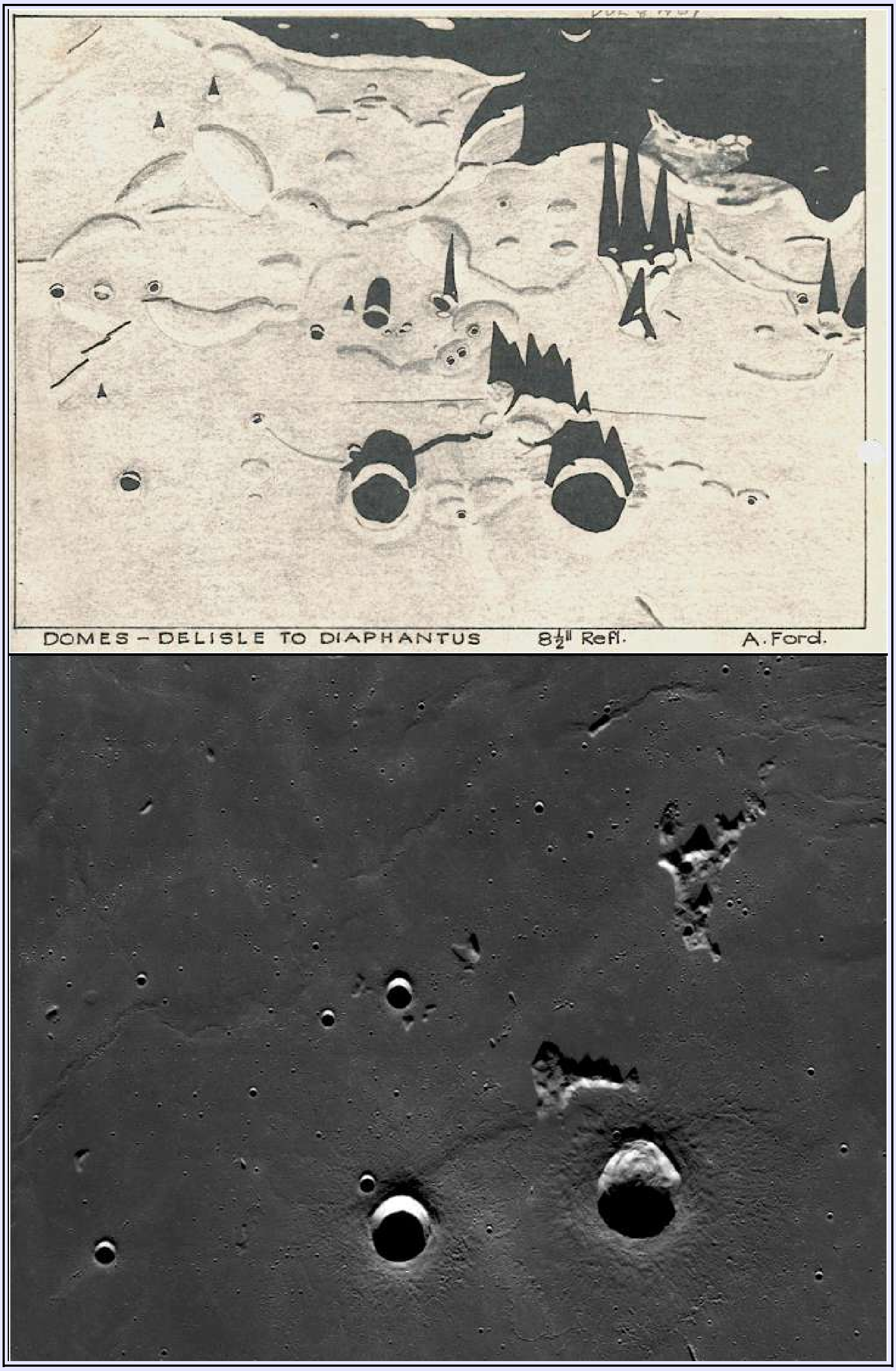
The Moon, Vol.8 No.1 October 1959 Domes – Delisle to Diophantus



Top, a drawing by A.Ford from 'The Moon' and below the same area as imaged by LRO. He used an 8.5" Reflector at x280 between 20:20 and 21:45 on the 30th January 1958. The numerous dome like features he observed appear to relate to undulations in the mare surface as opposed to discrete volcanic structures, though a number of the craters he recorded may well be collapse pits of volcanic origin. The sinuous rille lying between Delisle and Diaphantus can just be glimpsed in the LRO image but surprisingly was not recorded by Ford, as it was probably at the limit of resolution of his instrument. These drawings could I suspect provide clues for modern dome hunters to follow up on using LRO and other images.

Lunar domes (part LXI): cones in Mare Serenitatis.
by Raffaello Lena.

Lunar cones come in many shapes and sizes: circular (Osiris in Mare Serenitatis), breached cones (Isis in Mare Serenitatis), or cones that are elongated and aligned along a rille. The presence of lunar pyroclastic constructs implies that gas was released from the erupted magma, causing disruption of the magma and subsequent dispersal of the clasts.

Isis, located in Mare Serenitatis (18.96°N, 27.48°E), is a 1.7km diameter cone that is also C-shaped, smooth-sided, and has a gap and a lava channel. Isis is 60m in height and has a slope of 4.0° [1]. This feature is similar in morphology to some Marius Hills cones. Osiris is another similar volcanic construct ~2.3km in diameter, located southeast of Isis (18.60°N, 27.60°E). It does not have a gap in the cone wall. This feature is reported as 73m high, and with an average slope of 3.54° [1]. Both of these cones are similar in diameter to the cones of the Marius Hills, but have lower slopes. Figure 1 displays two examined lunar cones.

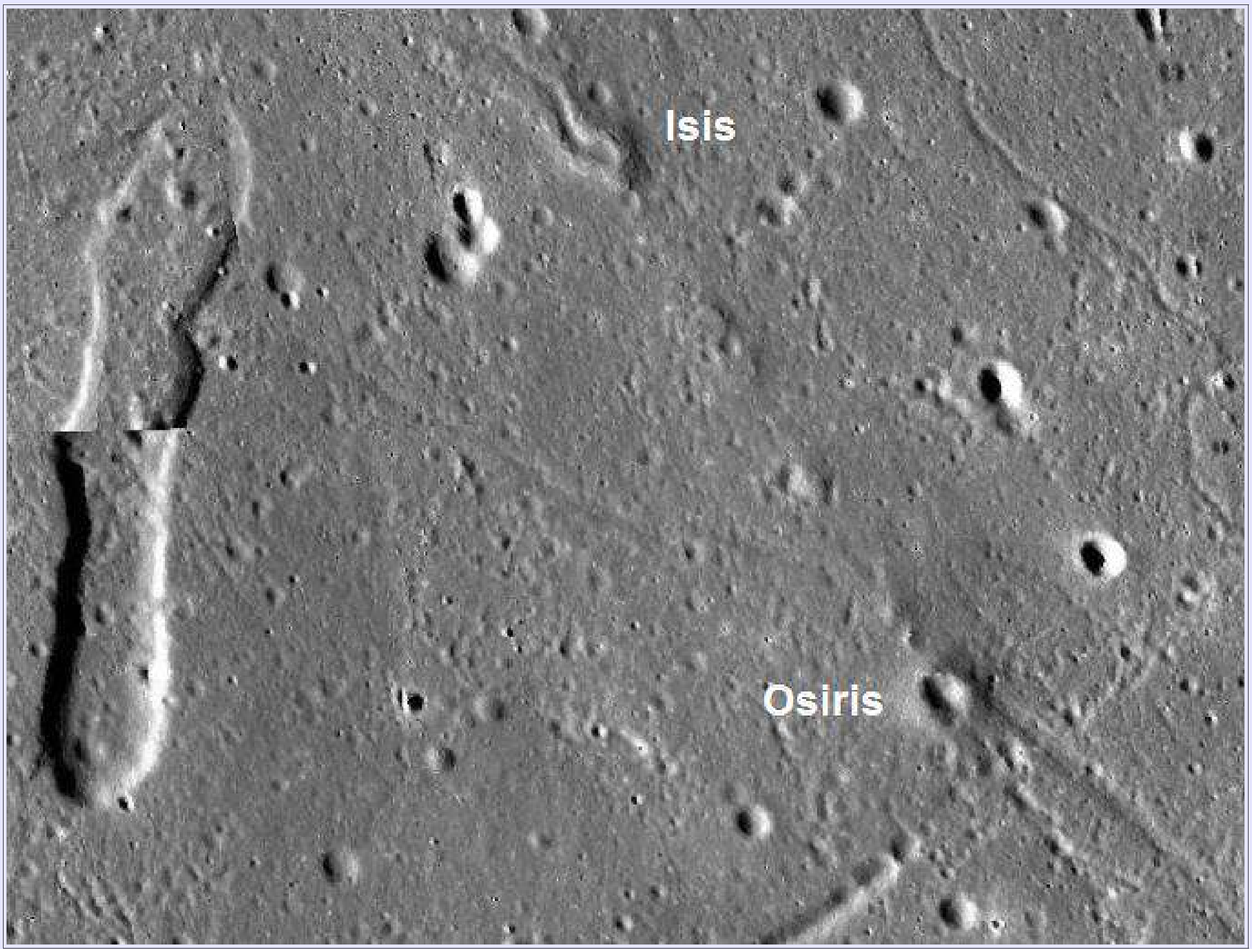


Figure 1: LRO WAC imagery with two lunar cones Osiris and Isis in Mare Serenitatis. Isis is to the north, Osiris is to the south, and smaller cones are in between. All the cones are aligned linearly along the extension of a graben visible to the south.

The smaller volumes for the lunar cones imply that their construction rates were low and their magma chambers were smaller and at shallower depths than is typical for the terrestrial cones [2].

A terrestrial telescopic image of this lunar region is shown in Fig. 2. It was taken by Christian Viladrich on October 15, 2022 at 01:02 UT, using a RC 500mm of diameter. An enlarged image of these two cones is shown in Fig. 3.

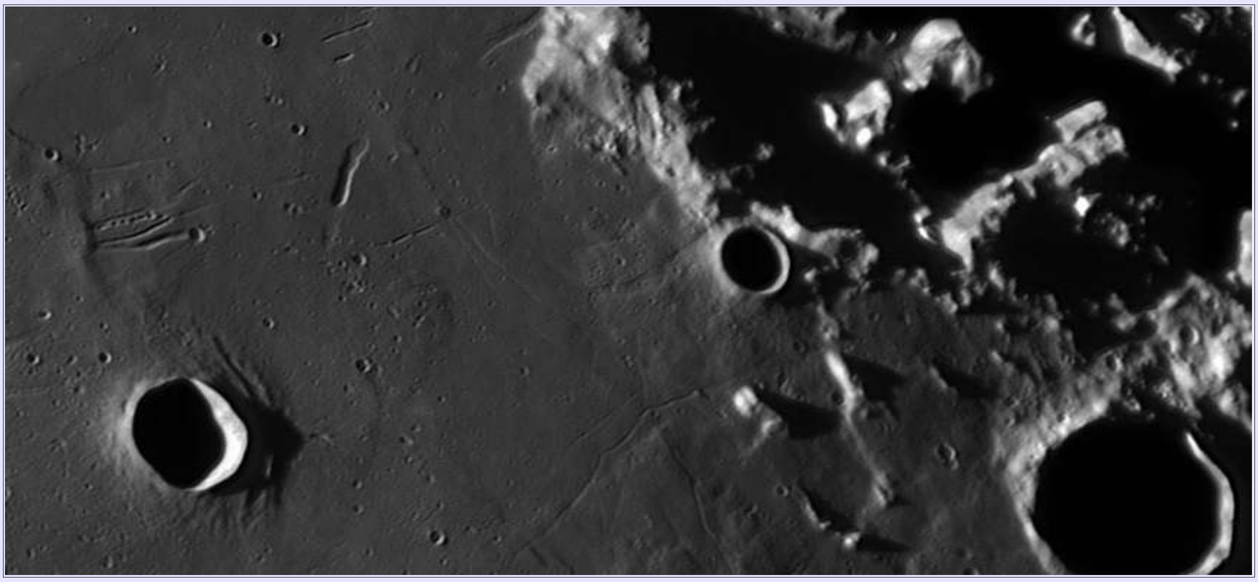


Figure 2: Image taken by Viladrich on October 15, 2022 at 01:02 UT, using a RC 500mm of diameter.

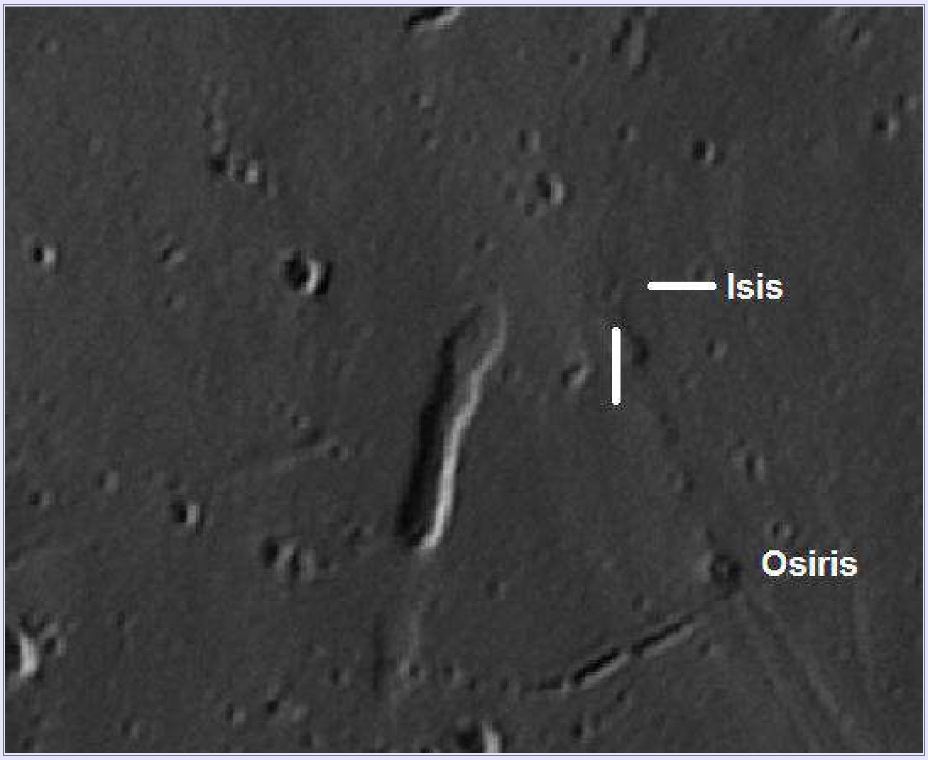


Figure 3: Enlarged image of the examined cones detected in the image taken by Viladrich shown in Fig. 2.

The telescopic image highlights Osiris and Isis: the latter feature appears in fact breached and with the classic C-shape even if less prominent than the profile of Osiris (Fig. 3), for which it was possible to obtain a 3D reconstruction as described below.

3D reconstruction using LRO LOLA DEM

Using ACT react quick map I have derived the 3D reconstruction of the examined cones, as shown in Fig. 4 for Osiris and Fig. 5 for Isis.

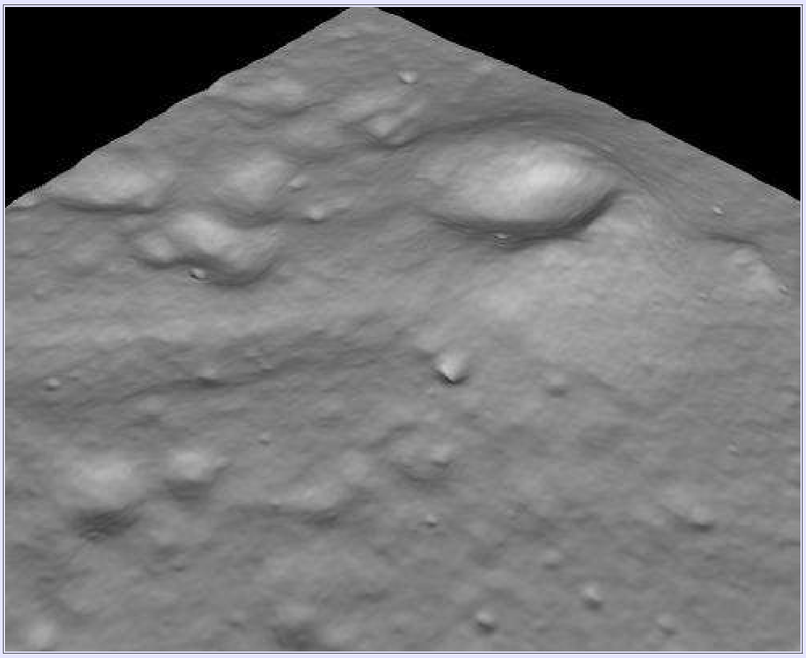


Figure 4: 3D reconstruction of the lunar cone Osiris based on LOLA DEM using ACT React quick Map.

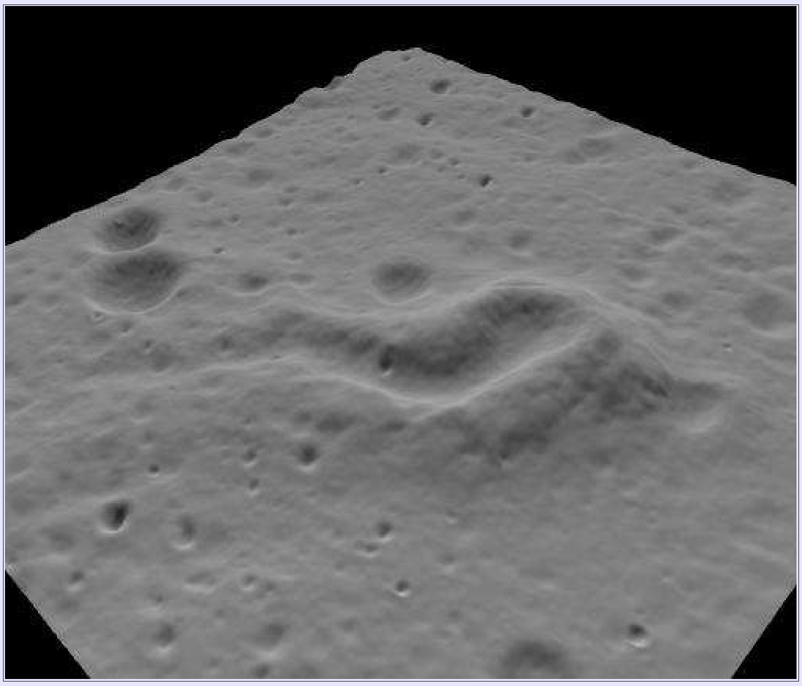


Figure 5: 3D reconstruction of the lunar cone Isis based on LOLA DEM using ACT React quick Map. It has a breached rim and displays a lava channel starting from the summit.

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.

Morphometric properties based on LRO LOLA DEM and NAC imagery.

ACT-REACT Quick Map tool was used to access to the LOLA DEM dataset, obtaining the cross-sectional profile of the cone Osiris used for comparison with the telescopic image (Fig. 6). Osiris displays an asymmetric profile with the western side topographically higher than the eastern size by about 30m. The maximum elevation amounts to 95m. The diameter is determined to 2.4km.

Figure 6: Osiris, LRO WAC-derived surface elevation plot in East-West direction based on LOLA DEM.

As described by the author [3] the tool called Terrain Shadows, released through the ACT React Quick map website, allow specific information regarding the 3D reconstruction of different types of volcanic construct including lunar domes and cones, and thus expanding the possibility of study for amateur astronomers. A realistic view based on NAC digital elevation-QuickMap Terrain Shadows- displays the shape of Osiris (3D reconstruction shown in Fig. 7).

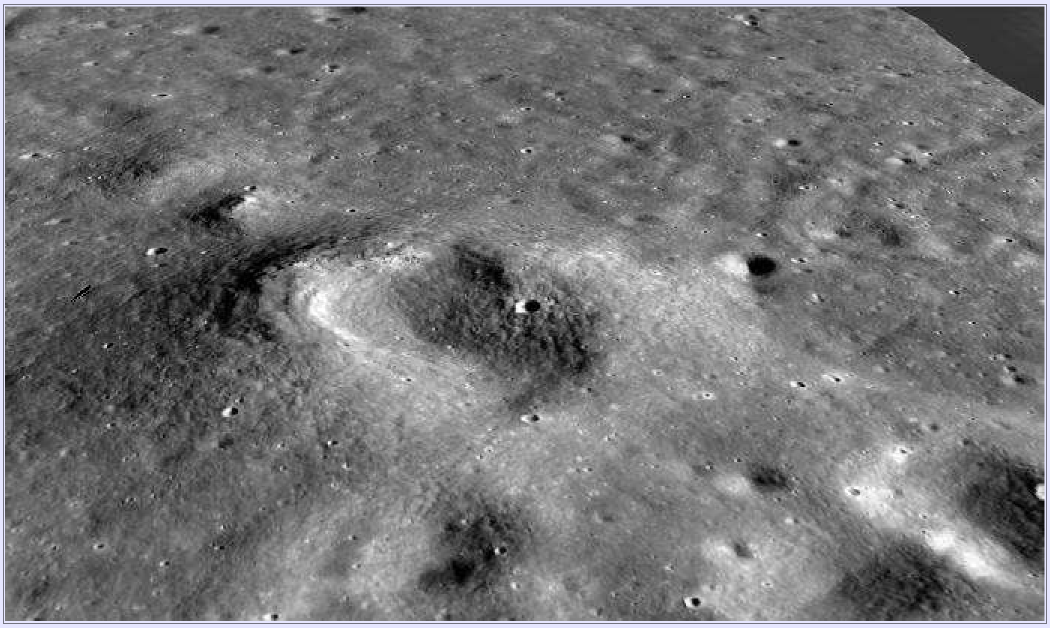


Figure 7: Cone Osiris. ACT REACT Quick Map tool-3D reconstruction using NAC imagery and the tool QuickMap Terrain Shadows.

Based on the LOLA DEM dataset, for Isis the maximum elevation amounts to 70m for the western side and 60m for the eastern side, with a diameter determined to be 1.8km (Fig. 8).

Figure 8: Isis, LRO WAC-derived surface elevation plot in East-West direction based on LOLA DEM.

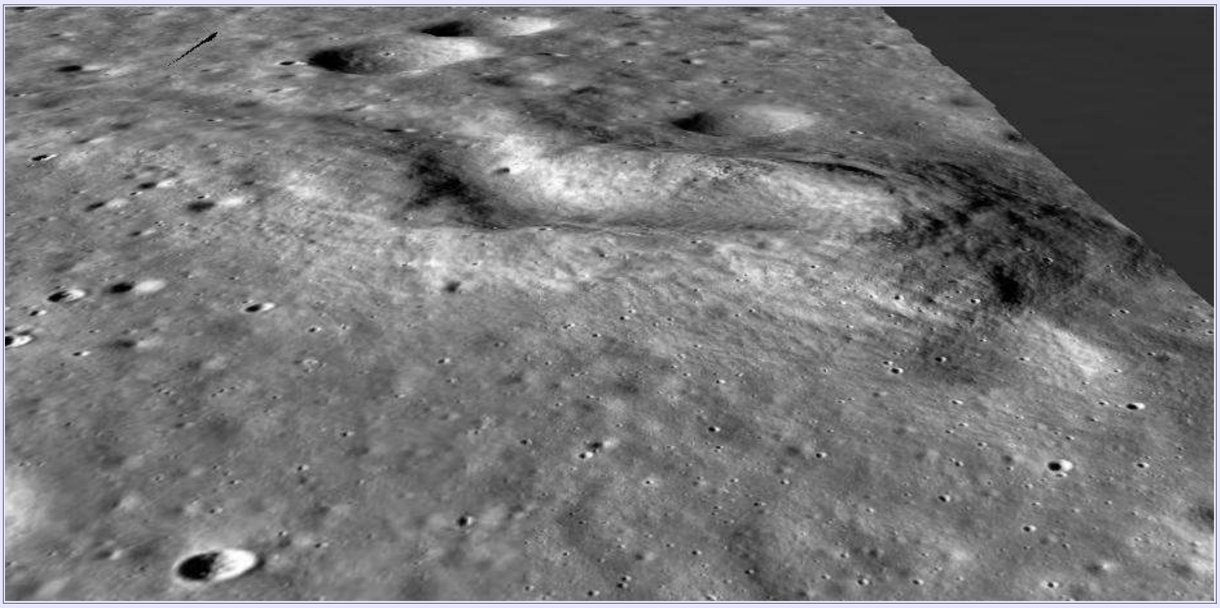


Figure 9: Cone Isis. ACT REACT Quick Map tool 3D reconstruction *using NAC imagery and the tool QuickMap Terrain Shadows.*

3D reconstruction based on terrestrial telescopic image

The purpose of this work was to derive the height of Osiris on the telescopic image of figure 2, and verify the result obtained by comparing it with the height derived in Figure 6 (LOLA DEM).

A well-known image-based method for 3D surface reconstruction is the shape from shading (SfS) approach [2]. This technique makes use of the fact that surface parts inclined towards the light source appear brighter than surface parts inclined away from it. The SfS approach aims to derive the orientation of the surface at each image location by using a model of the reflectance properties of the surface and knowledge about the illumination conditions, finally leading to an elevation value for each image pixel [4]. The height h of Osiris is obtained by measuring the altitude difference in the reconstructed 3D profile between the dome summit and the surrounding surface, considering the curvature of the lunar surface. The 3D reconstruction is shown in Figs. 10-11. The height of Osiris amounts to 95m±10m, in excellent accord with the derived height based on spacecraft data using the LOLA DEM dataset (Fig. 6).

On the other hand, the lower profile of the detected cone Isis, in the telescopic image of Fig. 2, has not allowed a satisfactory reconstruction, which was only derived using the NAC imagery and LOLA DEM (Figures 8-9). In fact based on Figure 2, Isis and the other cones along the rille are too small and with low profile to be resolved for a 3D reconstruction based on the terrestrial telescopic image.

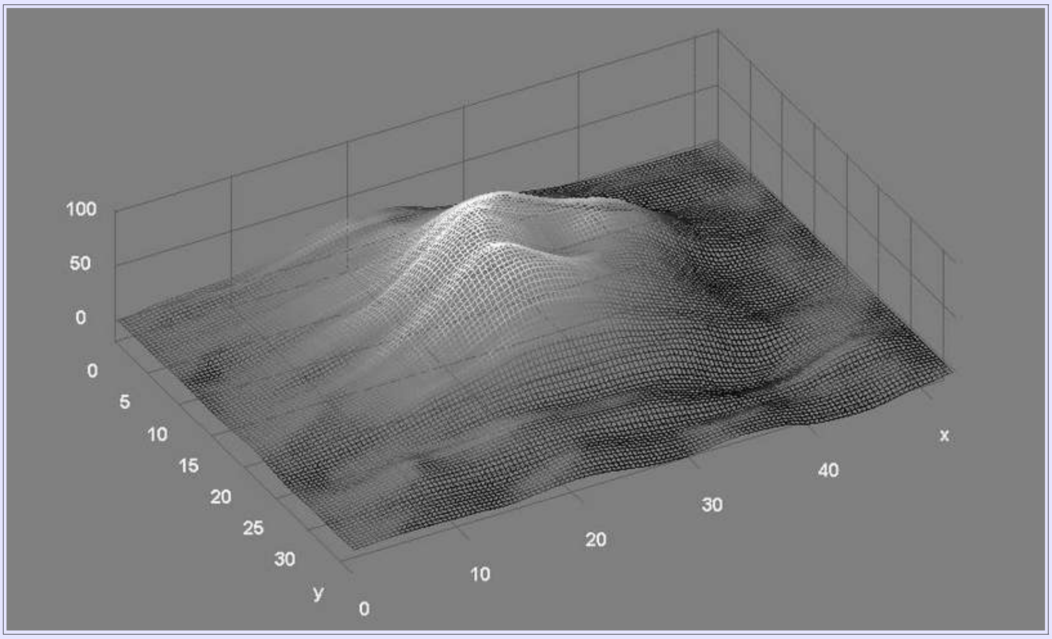


Figure 10: 3D reconstruction of Osiris using the terrestrial telescopic image, vertical axis is 30 times exaggerated.

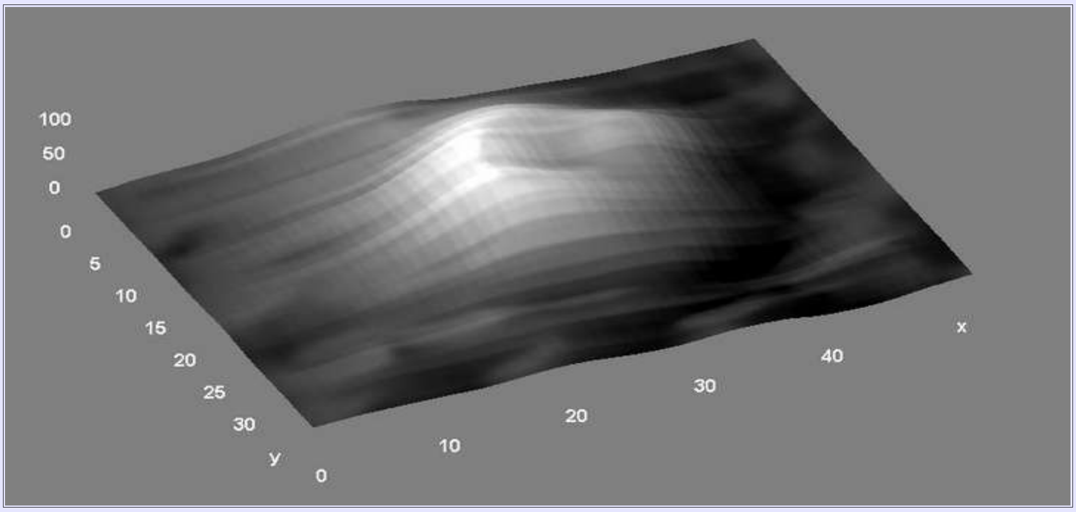


Figure 11: 3D reconstruction of Osiris using the terrestrial telescopic image, rendered as meshed solid, vertical axis is 20 times exaggerated.

Mode of formation and spectral analysis.
The cones most likely formed along a rille by degassing of a near-surface dike [5]. At a certain depth below the surface, the dike will cause enough extension to produce a graben. If the dike is shallow enough, then degassing of the dike can occur and pyroclastic cones will be produced [5-6]. However dark mantle deposits are not present for both two examined cones and spectral analysis indicate the absence of volcanic glasses signatures.

For this study I have derived abundance maps in wt% of FeO, plagioclase, olivine, clinopyroxene, orthopyroxene and TiO_2 content created from topographically-corrected Mineral Mapper reflectance data acquired by the JAXA SELENE/Kaguya. Osiris displays a TiO_2 content of 7.0-8.5 wt% and low plagioclase content (<50.0 wt %). The FeO content varies from 19.0 wt % to 21.0 wt % like the nearby mare units (Fig.12). It has an enhanced abundance of orthopyroxene (from 36.0 wt % to 50.0 wt %) and clinopyroxene (23.0-48.0 wt %). The olivine abundance amounts to 7.0-10.0 wt %.

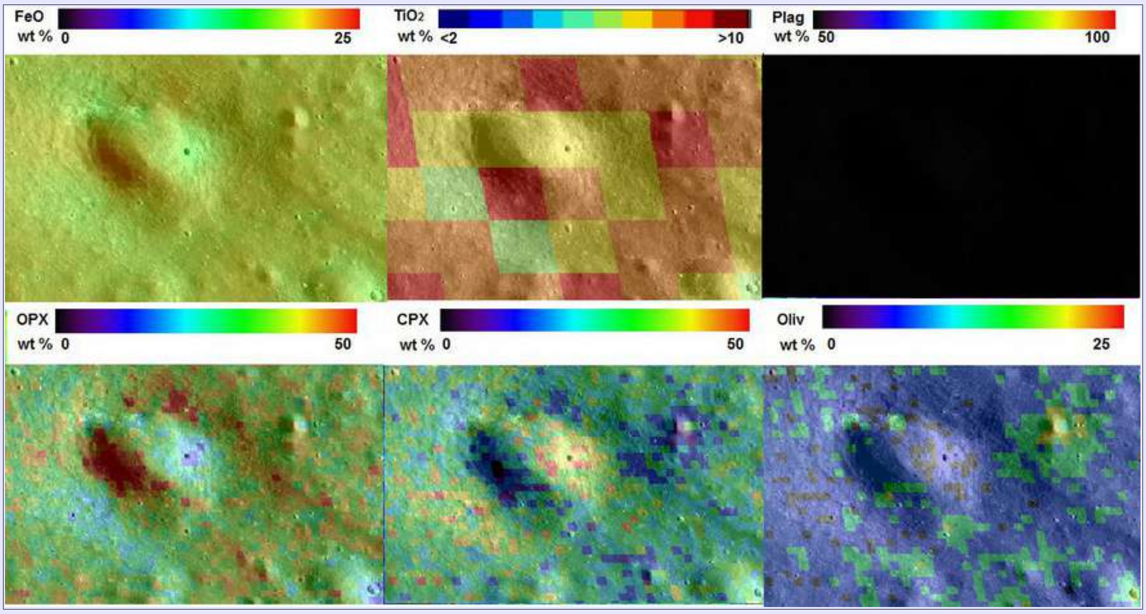


Figure 12: Osiris. Top (left) FeO, (middle) TiO_2, (right) plagioclase. Bottom (left) orthopyroxene, (middle) clinopyroxene, (right) olivine content. Derived abundance maps in wt%.

Isis displays a TiO_2 content of 5.9-7.2 wt% and low plagioclase content (<50.0 wt %). The FeO content varies from 17.0 wt % to 21.0 wt % (Fig.13). It has an abundance of orthopyroxene from 6.0 wt % to 25.0 wt % and clinopyroxene from 36.0 wt% to 49.0 wt %. The olivine abundance amounts to 12.0-24.0 wt %.

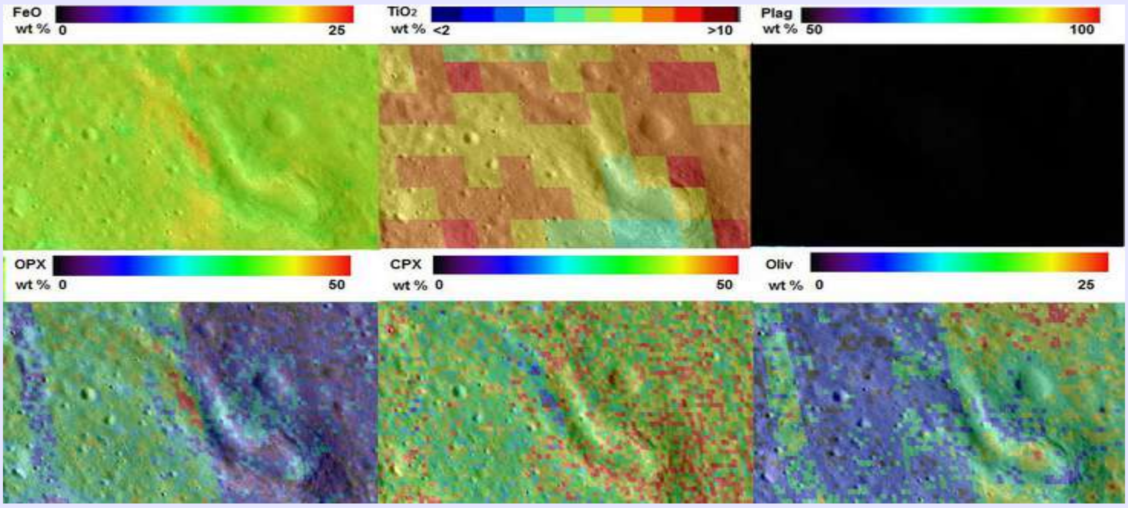


Figure 13: Isis. Top (left) FeO, (middle) TiO_2, (right) plagioclase. Bottom (left) orthopyroxene, (middle) clinopyroxene, (right) olivine content. Derived abundance maps in wt%.

Conclusion.

Osiris has a height of 95m and a width of 2.4km on the basis of the derived profile, with an average flank slope of 4.5°. Isis has a more asymmetric shape than Osiris, both along and perpendicular to the rille. Isis is 70m high and 1.8 km in diameter on the derived profile, with an average flank slope of 4.4°.

Isis and Osiris are aligned linearly, supporting eruptions from near-surface dikes that did not emplace dark mantle deposits. Isis and Osiris may not have dark mantle deposits because (1) they have been embayed by younger mare that would have covered them up or (2) little fine-grained clasts were produced in the eruptions. Isis is breached to the north indicating that it produced an associated lava flow where clasts were hot enough to coalesce and form lava, while at Osiris, all clasts were cold enough to form only spatter as explained in [7].

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In and around Torricelli.

By Barry Fitz-Gerald.

Whilst looking through some of the past LSC's in the section archives, I came across an interesting article by C.E.R.Brook[1] entitled “Has there been a recent landslip in Torricelli”. As you will know, Torricelli is the pear shaped crater in Sinus Asperitatis, some 170kms to the north of Theophilus. The article pointed out an apparent discrepancy between the Lunar Orbiter IV image of the crater taken between the 11th and 26th May 1967 (Fig.1) and a drawing made by Harold Hill on August 17th 1987 and included in his book 'A Portfolio of Lunar Drawings' on page 177[2].

Fig.1 Lunar Orbiter IV077-H3 showing the pear shaped crater Torricelli lying within what appears to be the larger flooded crater Torricelli R. The suspected landslip reported by Brook in the LSC article affected the southern rim of Torricelli.

In the article Brook noted that Hill's drawing indicated the presence of a landslip affecting the southern rim, but that this feature was not present in the Lunar Orbiter images, possibly suggesting some form of collapse during the intervening 20 years or so. Such a recent event *should* leave fairly unambiguous traces in the form of changes not only in gross morphology but also in terms optical maturity and other aspects of the regolith such as thermal and particle size properties which can be determined via multispectral data.

If you compare Fig.1 to Fig 2a you can see that there is a 'landslip' feature in both images that corresponds in position to that shown in Hill's drawing, so Brook was quite right in having a high regard for Hill's prowess as an observer, and the landslip is real. In these images the landslip (Fig.2a yellow arrow) takes the form of a grove in the southern inner wall with a bulbous debris apron below on the crater floor.

The rest of the images in Fig.2(b-d) show the optical maturity, rockiness and nighttime temperatures within the crater, and what can be seen is that whilst some areas of the crater walls are optically immature, and correspond to rocky areas that retain their nighttime temperatures, the area of the landslip is really not one of them, with the bulbous debris apron showing up as optically mature and without a large rocky surface fraction. So, the large landslip off the southern wall is certainly not a recent feature, and probably dates back to some time in the Eratosthenean or Copernican period and not the 1967-1987 time frame.

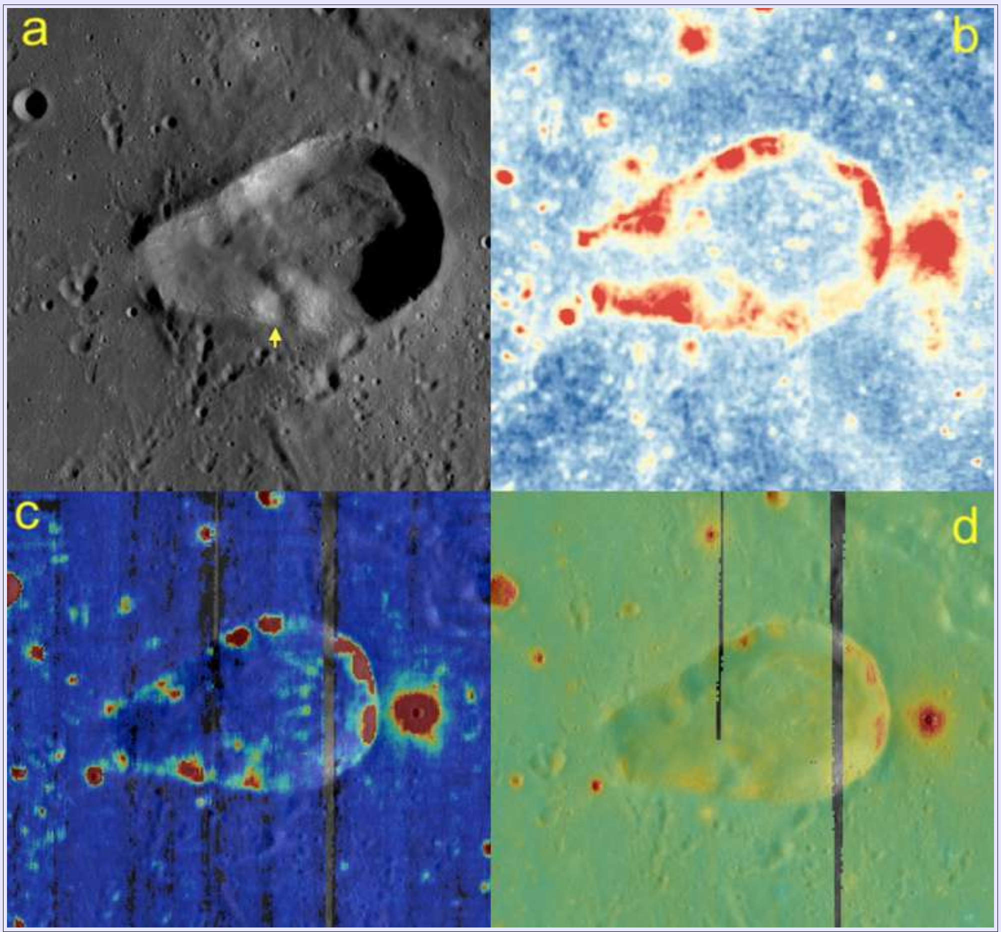

Fig.2 Torricelli as seen in an LRO WAC image (a), Clementine UVVIS derived optical maturity in which red is optically immature, blue is optically mature (b), Lunar surface rock abundance from LRO Diviner Radiometer data in which red indicates a high degree of 'rockiness' (c) and Soil temperatures over the lunar night also from LRO Diviner Radiometer data (d). The yellow arrow in a shows the position of the landslide.

The inner wall of the crater has a number of other landslips present, none as prominent as the one already noted, and mostly affecting the northern rim. This can be seen in Fig.3 where the northern rim has a number of scallops, each with a debris apron beneath, with the westernmost scallop being the most prominent. This image also shows a number of secondary craters formed by debris ejected from Theophilus, which approach the southern rim of Torricelli, and probably cross the western end of the crater, though none are visible on the crater floor itself. It is likely that these secondary impacts disrupted the crater rim but obviously these would be contemporaneous with the formation of Theophilus.

Torricelli itself is widely regarded as being either being the result of a low angle impact [3] or a double crater.

Fig.3 provides evidence for the former interpretation, in that apart from the elongate shape, the crater has a clearly depressed eastern rim (which shows up in the shadow it casts on to the crater floor) which would be in the up-range direction (the direction from which the impactor arrived) whilst the western rim as such is absent, and likely to be the result of ejecta heading off in the downrange direction at an *extremely* shallow angle. This may have included ejecta travelling along the surface downrange of the crater which would result in linear scouring, a phenomenon that has been reproduced experimentally[4] and which appears to have occurred to the west in the case of Messier A. In the present case a couple of extremely faint linear features leading away from the western edge of the crater may be a result of this type of process. These observations indicate an impactor travelling from east to west.

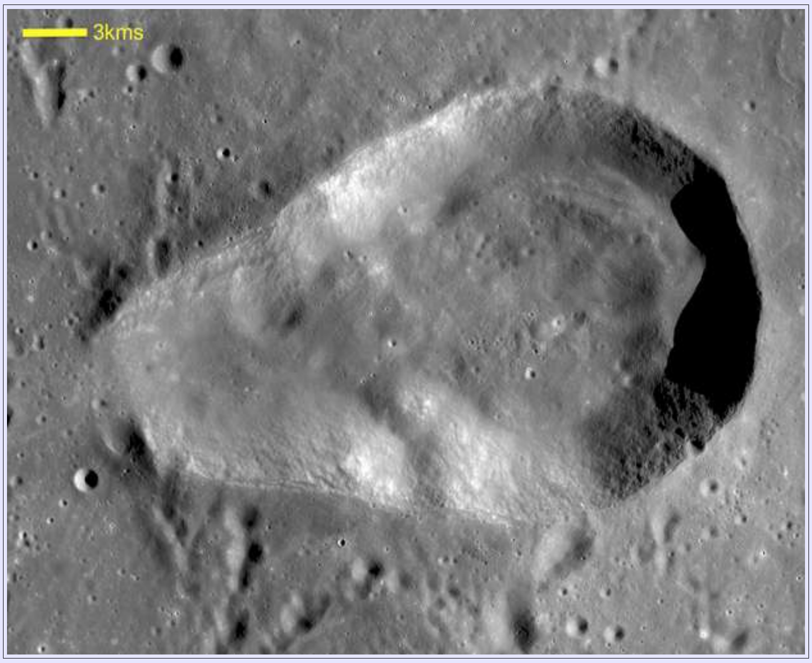

Fig.3 Torricelli as seen by SELENE showing the pear shaped outline, the large landslip off the southern rim and a series of smaller ones down the northern wall. Note the secondary crater clusters from Theophilus to the south of and probably crossing the western end of the crater. The shadow cast by the eastern rim shows that is is depressed, a typical feature of low angle impact craters.

Fig.4 LRO three colour mosaic of Torricelli showing low albedo streaks draped up and over the eastern rim and the low albedo area between its rim and the NE rim of Torricelli R

The surface immediately to the east of the crater has a distinctly low albedo when viewed through the eyepiece. This may represent a 'Zone of Avoidance' (ZoA) where the pre-impact mare like surface is preserved and not covered in ejecta. Fig.4, which is a three colour mosaic image shows dark markings that originate on the crater floor and climb up the eastern wall either side of the low point and extend out onto the adjacent mare. These appear to mark the edges of the ZoA and are iron rich in nature. These may represent impact melt deposits produced either during the impact itself or displaced from the crater floor as the walls collapsed immediately post impact. As a result of this 'coating' of melt the eastern inner walls are particularly rocky in nature (see panel c in Fig.2).

There is plenty of ejecta surrounding Torricelli, and as with many low angle impacts this takes the form of a 'Butterfly Wing' type pattern, with material concentrated in a cross-range direction. In Fig.5 you can see numerous radially orientated secondary craters within a distal ejecta field to the north of the crater (between the orange dashed lines) conforming to the 'Butterfly Wing' pattern. These are not to be confused with the numerous secondary craters from Theophilus which litter the area, many of which appear to have landed fairly close to Torricelli's southern rim. This distal ejecta is overlain by a lobe of proximal ejecta (within the yellow dashed line in Fig.5) which again forms a 'Butterfly Wing' distribution, and forms a sloping glacis to the north and south of the crater rim. The ejecta pattern to the south of the rim is less conspicuous as it has been 'overprinted' by Theophilus secondaries, and it is not beyond the realm of possibility that the landslide noted at the start of this piece occurred as a consequence of the nearby impacts of these secondaries destabilising the souther crater rim. Through the telescope these 'Butterfly Wings' can be discerned as areas of lighter albedo material to the north and south of the crater.

Another feature to the south of the crater that may have a bearing on its origin is a short, sinuous ridge (white arrow in Fig.5) which has been recorded by numerous observers, and can be seen in some detail in Peter Grego's excellent drawings in a previous LSC[5]. Clearly this feature is more prominent in the eyepiece than in the imagery, yet another reason to continue visual observations despite the wealth of spacecraft data available. Also a number of amateur images available online show this ridge as a far more pronounced feature, just as Peter recorded it rather than as it is portrayed in the LRO and SELENE images.

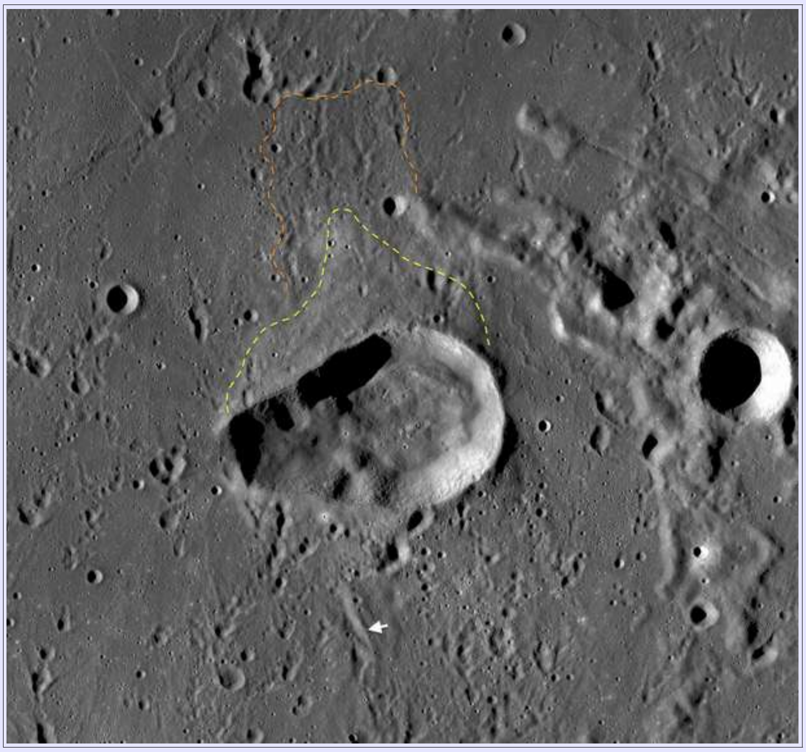

Fig.5 Torricelli's 'Butterfly Wings' composed of proximal (inside yellow dashed line) and distal (inside orange dashed line) ejecta with the latter dominated by crater chains. Small ridges to the west (white arrows) may represent scouring produced by fragments of the impactor travelling along the surface. SELENE/JAXA image. The white arrow indicates a sinuous ridge that may indicative of a multiple impact origin for Torricelli.

This ridge may be a feature produced by the impact of secondary craters from Theophilus, but alternatively it may represent the type of ridge that forms when two craters form simultaneously, another process that has been demonstrated experimentally[6]. Could this indicate that the impact that formed Torricelli was not just a low angle impact, but a low angle multiple impact? Maybe this is reading too much into the visible features, and it is odd that there is no complimentary ridge to the north of the crater, but then again impacts can be messy, and the distribution of ejecta can often be far from symmetrical.

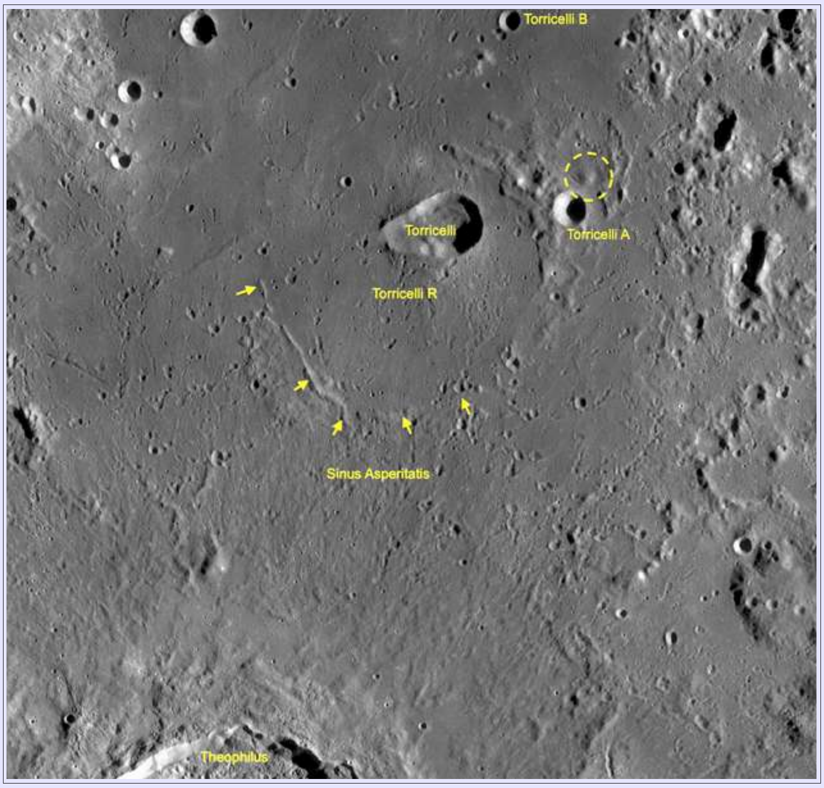

Fig.6 LRO WAC image of Torricelli R with its southern rim marked by yellow arrows.

Looking more widely, Torricelli lies within the ruined crater Torricelli R, which is 87kms in diameter and represented by only partial low arcs to the NE and SW (Fig.6). This ancient crater lies within Sinus Asperitatis, and has been flooded by the high titanium basalts that dominate Mare Tranquillitatis to the north. The surface of southern Sinus Asperitatis is dominated by the dense 'herringbone' pattern of secondary craters from Theophilus. This field of distal ejecta is rich in material of a highland composition which presumably originated from the Theophilus impact site *or* was excavated from beneath the basalt lavas of the sinus. A peculiarity in the distribution of this 'herringbone' pattern emerges when we look closer, as is shown in Fig.7 which is a Terrain Hill Shade rendition of the area from Quickmap. In this image we can see that the dense 'herringbone' pattern of the secondary craters extends up to but not beyond the *apparent* southern rim of Torricelli R. There are a few crater chains and secondary craters north of this line, but not of the density seen to the south. Looking more closely at this '*rim*' we can see that it takes the form of a chevron, with the western arm having a somewhat ridge like, slightly zig-zag configuration (Fig.8). The eastern arm lacks the ridge like feature and is composed of a line of small hills that are discontinuous and far less prominent. The arms of the chevron are straighter than might be expected if they were sections of a crater rim, which might be expected to be somewhat more curved.

A possible explanation for this chevron shaped structure might be found to the south of Horrocks, where a similar chevron shaped structure, albeit on a more modest scale can be seen. This structure is composed of ridges of ejecta material that formed along the edge of a Zone of Avoidance, as Horrocks is a crater formed by a low angle impact from the south. Being of Eratosthenian age, any bright rays Horrocks may have had are now obliterated, but initially its ray system would have looked rather like that of Tycho, or the far side craters Jackson and Ohm, with a prominent wedge missing to the south where the ZoA formed. These ridges are now the only remaining clues as to the original configuration of the ejecta blanket. As can be seen in Fig.9 the chevron is asymmetric, with the western branch more prominent than the eastern, and with a suggestion that the hummocky remnants of the secondary crater field is not as prominent to the south compared to the north. In these respects this structure is uncannily similar to what we see in the rim of Torricelli R.

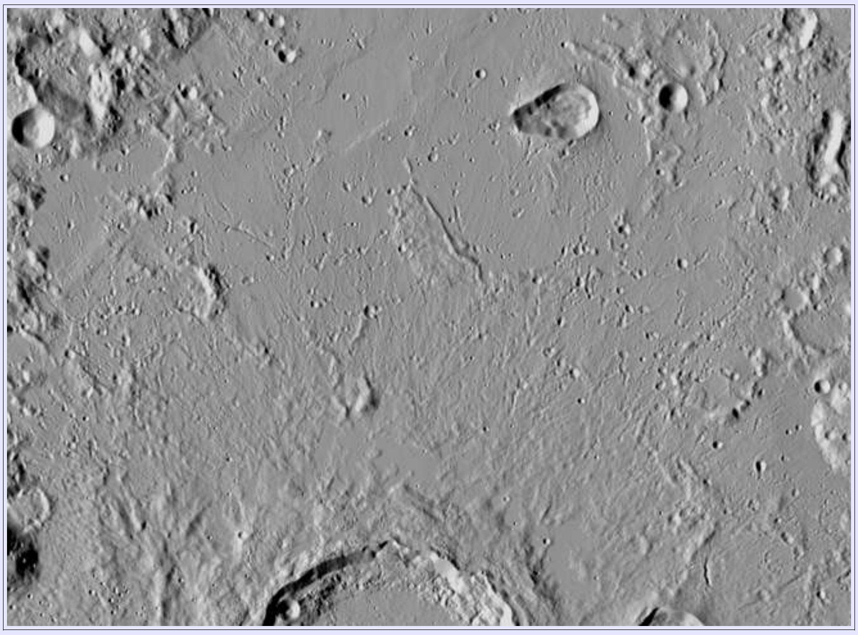

Fig.7 A Terrain Hill Shade rendition Sinus Asperitatis, showing the distribution of Theophilus secondary craters which extends up to but only sparsely beyond the '*southern rim*' of Torricelli R.

Fig.8 LRO WAC image of the 'southern rim' of Torricelli R showing the chevron shaped configuration, ridge like western arm and more subdued eastern arm.

This is a tantalising possibility – is Theophilus the result of a low angle impact, in this case from the NE? One possible argument against this rather fanciful idea is the distance separating the north-eastern rim of Theophilus and the apex of the chevron, some 95kms which is just shy of 2 crater radii (~98.5kms) whereas the comparable distance in the case of Horrocks is 0.6 of a crater radii. This need not be a fatal flaw in the argument however as in the case of Jackson this distance is 1.3 crater radii and in Ohm it is closer to 1.6 crater radii. So the edge of the ZoA can be some distance from the crater rim, though it must be admitted that in this case the distance seems to be quite substantial compared to the usual low angle suspects. The astute observers will also point out the fact that the bright rays of Theophilus do not obviously show a ZoA to the NE, to which I can only suggest the rather lame explanation that impacts can be messy and the ejecta flow field of low angle impacts can change from asymmetric to symmetric as the impact progresses. This is a less than convincing argument, but the parallels with the Horrocks chevron are striking.

Fig.9 SELENE image of the chevron shaped feature to the south of Horrocks which defines the edge of aa now invisible ZoA.

So maybe the southern rim of Torricelli R is not in fact a rim at all, but an ejecta feature associated with the formation of Theophilus. Alternatively of course the similarity between what we see here and to the south of Horrocks is no more than coincidence and this feature is no more than the southern rim of an ancient and now flooded Torricelli R. I suspect there may be more arguments against this interpretation than for it, and would welcome any comments you may have - either way!

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Lunar Geological Change Detection Programme.

By Dr. Tony Cook.

News:

I have come across a couple of TLP publications, previously unknown to me whilst Googling. Firstly "Transient Lunar Phenomena, Outgassing Events, and the Lunar Gravity Field: Impacts to Sustained Human Presence on the Moon" a Master's thesis by Cameron Nardini of the American Military University, published June 2022. This finds no significant statistical correlation with the lunar gravity fields – though he did find a correlation of TLP locations with past areas of volcanic activity, young age features and mare/highland boundaries. Another publication I found was "Lunar TLP's and the Tectonic Processes of the Earth and the Moon" by Dimita Ouzounov et al. in the US again. Presented at the European Geophysical Union General Assembly in 2022. They seem to suggest that there is a causal relationship between major earthquakes (here on Earth) and TLP events on the Moon – of this I am highly sceptical, though it may possibly be related to Moon: Earth tidal interaction effects. One of the problems of both these studies is that they do not take into account control data when doing statistics on TLP. Only using control data, i.e. knowing what are the most favourite features on the Moon that observers look at, and when, can we attempt to remove observational bias that has blighted most past TLP studies.

TLP Reports:

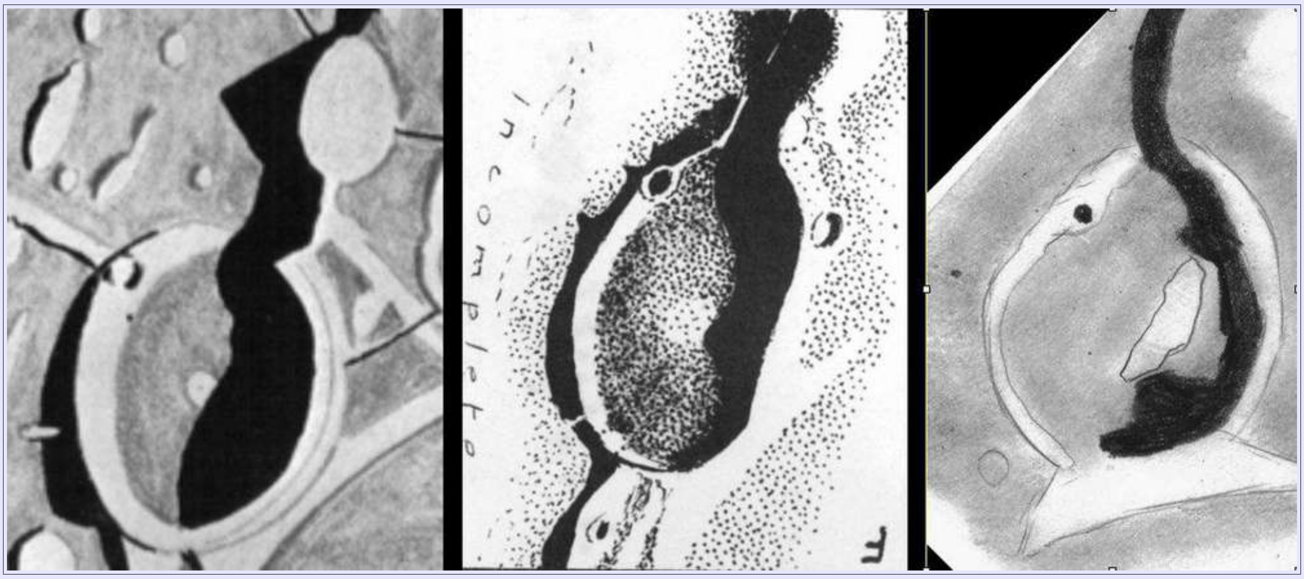

Figure 1. Herodotus orientated with north towards the top. **(Left)** A sketch by H.P. Wilkins (BAA) from 1950 Mar 30 UT 19:00?. **(Centre)** A sketch by Harold Hill (BAA) from 1966 Nov 24 UT 21:50. **(Right)** A sketch by Alberto Anunziato (SLA) made on 2022 Nov 6 UT 00:05-00:38.

One sighting (or more of a glimpse really) of a light patch on the floor of Herodotus was made by Alberto Anunziato (SLA) on 2022 Nov 06 UT 00:05-00:38UT. He noted that he could not see the central pseudo peak, but instead observed a central patch (see Fig 1 - Right). He then goes onto say that he was not sure if this was a genuine observation, or a biased observation – based upon the written account in the repeat illumination predictions. Seeing detail on the floor of Herodotus was at the limit of his telescope (a Meade EX 105, x154). Fig 1 (Left and Centre) refers to two of the TLP reports below – for Bartlett's report we have no sketch in the archive. The Fig 1 sketches have been ordered by the shadow thickness. Alberto's sighting is slightly off-centre, more elongated in appearance, and unlike the Hill and Wilkins reports is more offset from the shadow too. We shall assign a weight of 1 to reflect Alberto's uncertainty.

Herodotus 1950 Mar 30 UT 19:00? Observed by Wilkins (Kent, UK, 15" reflector) "Transient c.p. (similar phen. to Bartlett's in later yrs.? see #532). NASA catalog weight=4. NASA catalog ID #523. ALPO/BAA weight=3.

Herodotus 1956 Nov 15 UT 01:05-01:30 Observed by Bartlett (Baltimore, MD, *USA, 3.5" reflector x100) "Pseudo c.p. clearly seen est. I=5.5, Wratten filters showed it neutral to green, red, & yellow, but duller in blue. Floor est. 2deg, distinctly olive-green. Precise time at 0117 at col. 55.27deg" NASA catalog weight=4. NASA catalog ID #655. ALPO/BAA weight=3.*

Herodotus 1966 Nov 24 UT 21:50 H. Hill (UK, 7.25" reflector, x240), seeing 4-6/10, transparency 4/5) sketched a central white diffuse patch inside the floor of the crater, with a size of about 1/7th the diameter of the crater. The eastern edge of the white patch was encroached by the shadow of the eastern rim. ALPO/BAA weight=3.

Routine Reports received for November included: Jay Albert (Lake Worth, FL, USA – ALPO) observed: Alphonsus, Aristarchus, Linne, the lunar eclipse, Maginus and Plato. Alberto Anunzatio (Argentina – SLA) observed: Aristarchus, Herodotus, Lichtenberg, Macrobius, Mare Vaporum and Pallas. Massimo Alessandro Bianchi (Italy – UAI) imaged: Plato and Sirsalis. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Copernicus, the lunar eclipse and several features. Anthony Cook (Newtown, UK – ALPO/BAA) imaged: several features in the Short-Wave IR (1.5-1.7 microns). Walter Elias (Argentina – AEA) imaged: Riccioli. Valerio Fontani (Italy – UAI) imaged Plato and Sirsalis. Les Fry (Mid Wales, UK) imaged: Clavius, Copernicus, Gassendi, Hansteen, J. Herschel, Kepler, Lacus Excellentiae, Mairan, Mare Australe, Mare Smythii, Mersenius, Palus Epidemiarum, Philolaus, Prinz, and Vallis Schroteri. Rik Hill (Tucson, AZ, USA - ALPO/BAA) imaged: the lunar eclipse. Eugenio Polito (Italy – UAI) imaged: Lichtenberg, Plato and Sirsalis. Trevor Smith (Codnor, UK – BAA) observed: Aristarchus, Mare Smythii and Plato. Gary Varney (ALPO) videoed the lunar eclipse – see this link.

Analysis of Reports Received:

Linne: On 2022 Nov 02 UT 00:40-00:50 Jay Albert (ALPO) observed this crater under similar illumination to the following report:

In 1866 Oct 16 at UT 23:00 Schmidt (Athens, Greece, 7" refractor) observed that Linne crater had disappeared and been replaced by a white patch with a small hill or craterlet. White part seems to increase in size. Cameron says probably not a TLP. The Cameron 1978 catalog ID=145 and the weight=0. The ALPO/BAA weight=1.

Figure 2. Linne as imaged by Brendan Shaw on 2012 Nov 21 UT 18:34 and orientated with north towards the top.

Jay was using an 8" Celestron NexStar Evolution SCT at x226. Transparency was 3rd magnitude, and seeing was 5-6/10. He noted that: "Linne did not disappear". Instead, it was its usual white, circular patch with the craterlet inside. The craterlet was particularly difficult to see on this night due to passing cumulus affecting the seeing, and only visible with patience. This neatly describes the appearance that Schmidt gives. Also, I came across a repeat illumination image (Fig 2), from 2012, in our archives. Again, this illustrates quite clearly what Schmidt saw was perfectly normal. We shall adjust the weight from 1 to 0 and remove it from the ALPO/BAA database of TLP. The change in size that Schmidt refers to might be his recollection of the size at different observing runs, or more likely how the apparent size gets altered by atmospheric seeing. We have covered repeat illumination of this TLP before in the 2017 Jan newsletter.

Gassendi: On 2022 Nov 05 UT 20:49 Les Fry (NAS) imaged this crater in monochrome under similar illumination and topocentric libration to the following report:

Gassendi 1968 Oct 03/04 UT 19:30-19:50 & 00:20-01:40 Observed by Rawlings (Aylesbury, UK, 6" reflector low magnification) and by Moore (Selsey, Sussex, UK, 12.5" reflector, x360) "Slight blink (Eng.) arcuate in shape, N. of c.p. (Rawlings dubious). Moore, with blink device saw none at 0020-0140h. No TLP in Gass., Ptol. or Aris. 5th or 6th.". NASA catalog weight=1. NASA catalog ID #1093. ALPO/BAA weight=1.

Figure 3. A monochrome image of Gassendi, orientated with north towards the top, as imaged by Les Fry (NAS) on 2022 Nov 05 UT 20:49.

Although the image that Les took (Fig 3) was not in colour, it does provide a very useful view of what the normal appearance of Gassendi would have been on that night in 1968. There is no obvious "arcuate" structure north of the central peak, but as that was supposed to be in colour we are none-the wiser from this image. Alas Rawlings and Moore provided no sketches. We shall leave the ALPO/BAA weight at 1 for now.

Plato: On 2022 Nov 07 UAI observers: Massimo Alessandro Bianchi (UT 19:42 and 19:44), Valerio Fontani (UT 19:25-19:56) and Eugino Polito (UT 19:07, 19:30, 19:35 and 19:45) imaged this crater in colour under similar illumination to the following report:

Plato 1788 Dec 11 UT 22:00. Bright point seen on the dark part by observers in Mannheim. Cameron 1978 catalog ID is 38 and the weight assigned is 5. ALPO/BAA weight=1.

… and under similar colongitude, according to the Lunar Schedule request website, to the following reports:

Plato 1938 Feb 14 UT 00:25 Observed by Fox (Newark, England, 6.5" reflector, x240) "Prominent gold-brown spot on E. wall with yellow glow without definite boundary, spreading over floor." NASA catalog weight=3. NASA catalog ID #431. ALPO/BAA weight=3.

On 2013 Jan 25 UT 19:05-19:15 R. Braga (Milan, Italy, 115mm refractor, x267, seeing III, transparency average) observed that Plato in general was normal in appearance, but the east rim was showing a remarkable golden (yellow-golden) hue. This was a repeat illumination observation for a W.E.

Fox TLP observation from 1938 Feb 14. The observer was wondering whether they were in some way biased after reading the original report description - so uncertain over this being a TLP. In view of uncertainty ALPO/BAA weight=1.

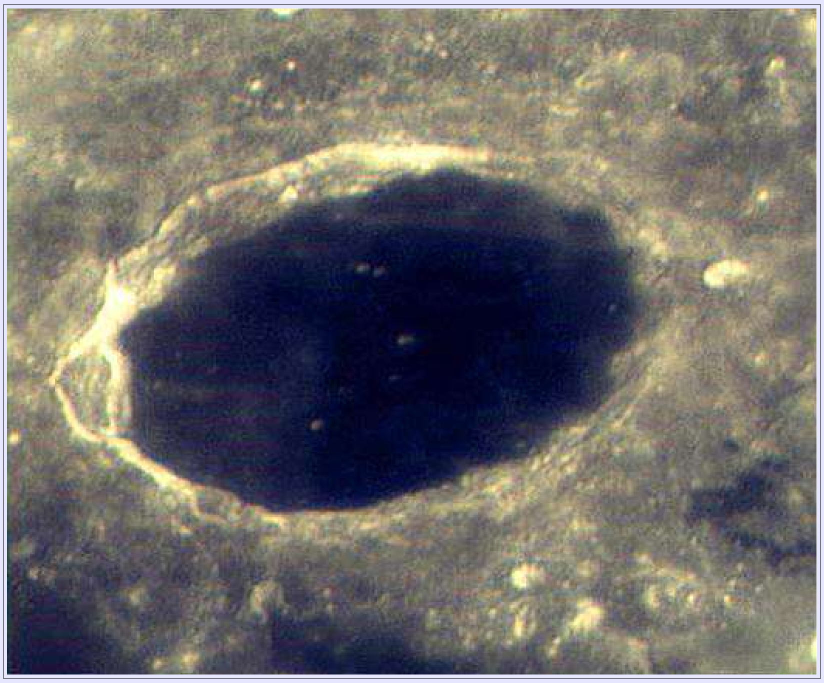

Figure 4. Plato by Massimo Alessandro Bianchi, taken on 2022 Nov 07 UT 19:44 and orientated with north towards the top. The image has been sharpened, colour normalized and then had its colour saturation increased to 50% using GIMP.

Massimo's image (Fig 4) shows a nice yellow colour all over the highlands around Plato, and blue on the floor. There is no sign of a special gold colour or spot on the east rim. Just as a check I decided to apply the same process to Valerio and Eugino's wider area images (See Fig 5 left and Right respectively). These do not show the yellow colour that Massimo's image shows everywhere, so it must be an artefact of the camera or processing. However they do not show any gold colour on the eastern rim either. So we shall leave the weights of the 1938 and 2013 reports as they are. The 1938 and 2013 reports were covered in the 2015 Feb and 2018 Jan newsletters for similar illumination observations.

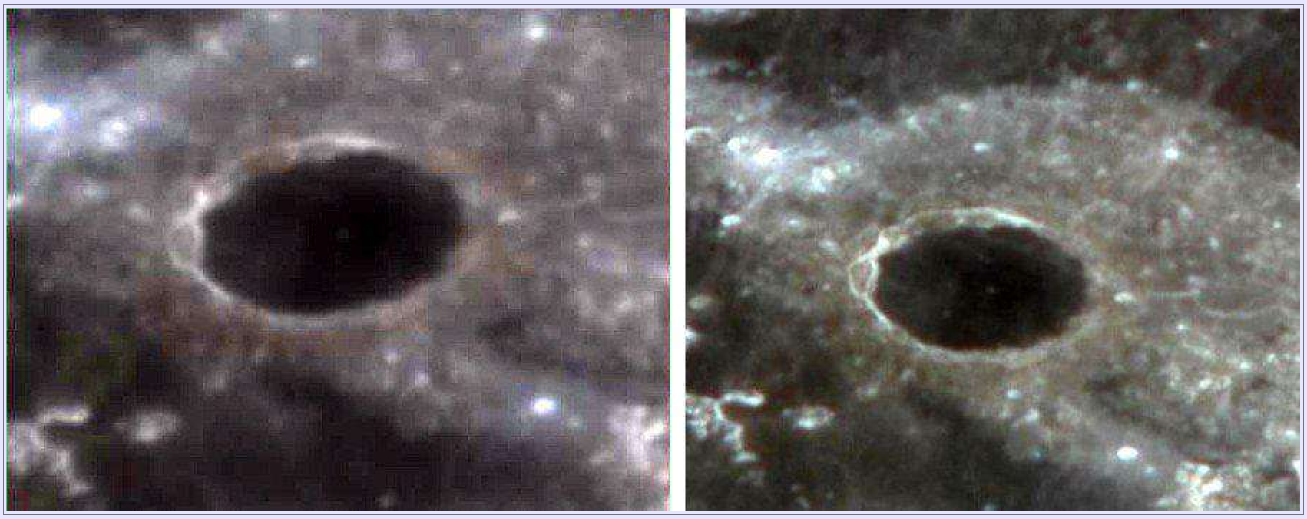

Figure 5 Plato on 2022 Nov 07 taken by UAI observers. Images have been colour normalized and then had their colour saturation increased to 50% using GIMP. **(Left)** Taken by Valerio Fontani at 19:57 UT. **(Right)** Taken by Eugenio Polito at 19:30 UT.

With regard to the 1788 report, instinct might suggest the central craterlet as the explanation. However consulting the Cameron TLP catalog cards, it says the report comes from a Phil Ringsdore article in Planetarium I(3) March 1968 – which unfortunately I do not have a copy of. Furthermore it goes onto say: "*Whitish bright spot shining somewhat hazily and 4-5" in diam, 5th mag (to naked eye* – I guess she means looking through the scope*) – in bright mountainous region 1' 18"* (that's about 80 km) *S.E. of Plato (IAU) bordering M. Imbrium. Nothing similar in earthshine – details were distinct + familiar obj. recognized. It became inconspicuous at times, finally uncertain 15 m + then disappeared. Manillius + Menelaus equally visible + distinct before + after. Drawing on Oct 2, 1787 did not show any trace of white spot + never seen again*. So I think that I will leave the weight at 1 for now and even consider if the date might not be correct as there seems to be some discussion of this on the index card and the mention of earthshine would have to be on a different date as Figs 4 and 5 are well past this lunar phase stage.

Riccioli: On 2022 Nov 08 UT 00:17 Walter Elias (AEA) imaged this crater under similar illumination to the following report:

Riccioli: 1964 Jun 24 O. Brittman (Elgin, IL, USA, 3" refractor and 6" reflector, x250) - During an eclipse of the Moon the crater appeared normal until it emerged from the shadow. In the north east the dark floor was not its normal hue and two light areas appeared to join. The emerging patches became less and less bright, finally disappearing at 0345 UT when the crater returned to normal. Cameron 2006 catalog extension ID=10 and weight=2. ALPO/BAA weight=2.

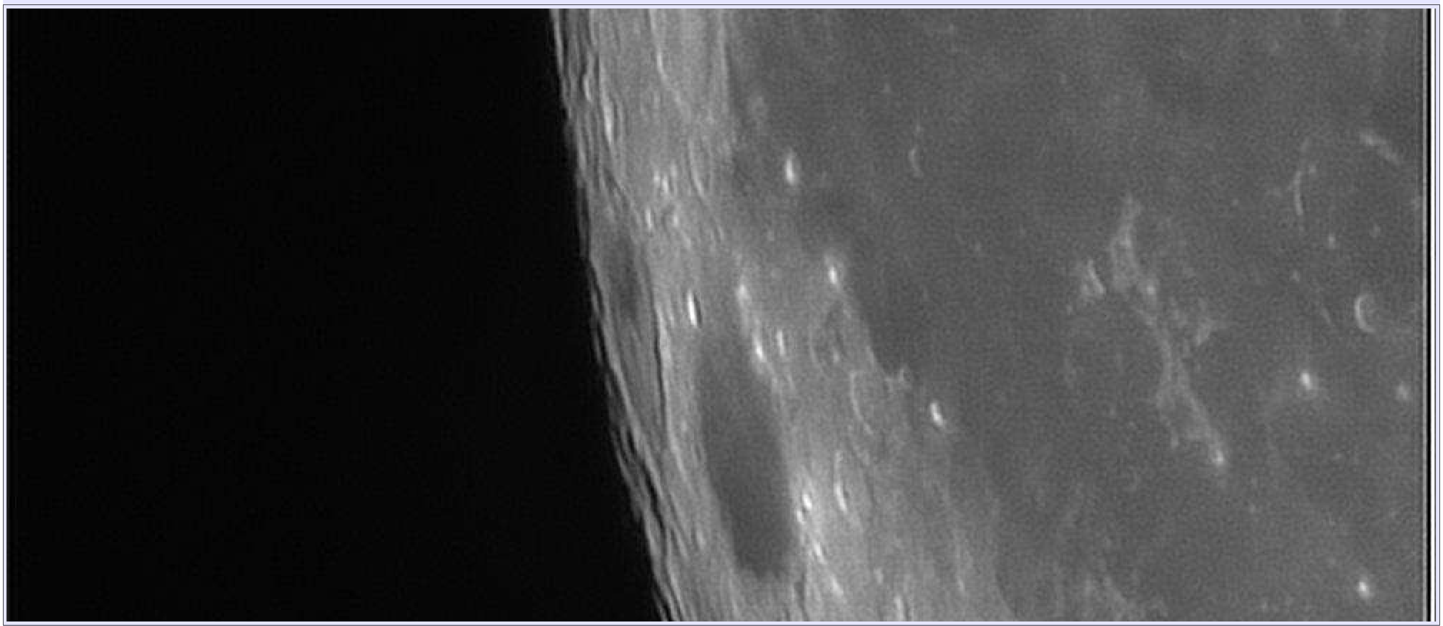

Figure 6. Riccioli, just NW of Grimaldi, on the limb of the Moon - orientated with north at the top. Imaged by Walter Elias on 2022 Nov 08 UT 00:17.

Although there was not an eclipse at this time, Walter's image (Fig 6) does at least show what the normal appearance should be like at this stage in the illumination, apart from libration effects, and so is a useful comparison image.

Lunar Eclipse: On 2022 Nov 08 UT 10:03-11:44 Maurice Collins imaged the eclipse at intervals. There are numerous repeat illumination TLP reports that we could compare his images with, but I have picked a couple below as they are repeat viewing angle (topocentric libration) as well to within ±1.0˚:

On 1912 Apr 01 at UT 22:00-23:00 LeRoy (France?) during an eclipse, observed Tycho to be visible as a very bright spot standing out in the slate grey shadow. Apparently only Tycho was seen during the eclipse. The mid eclipse point was at 22:14UT. The Cameron 1978 catalog ID=236 and the weight=1. The ALPO/BAA weight=2.

On 1978 Sep 16 at UT 18:28-18:57 G. Searle (Concord, Sydney, NSW, Australia, 8" reflector, x100, x160, S=III) observed a bright star-like point on the western (IAU) edge of Mare Tranquilitatis (x100) that appeared unlike any other crater and a check of the location revealed no suitably bright crater in that region (from a map?). Changed to a higher power (x160) and it was still there, but not as conspicuous. Observer thinks that this may have been due to the Moon's low altitude (16 deg) and the seeing. At 18:35 he compared it to the brilliant crater Proclus and found the star-like point to be 75% of the brightness of Proclus. Ken Wallace (Australia) had been taking photos and observed the object at 17:37.5UT. The object gradually faded over the next 15 minutes and by 18:52UT could only be seen in averted vision at x100. By 18:57UT it was gone. The Cameron 2006 catalog ID=38 and weight=5. The ALPO/BAA weight=3.

Figure 7. The eclipsed Moon as imaged by Maurice Collins on 2022 Nov 08 UT 10:59.

Well as you can see from Fig 7, although the topocentric libration was the same as it was back in 1912, Tycho is not especially bright here. I therefore decided to find out more about the 1912 Apr 01 lunar eclipse. Apparently, it was partial with only the southern latitudes of the Moon in the umbra. It is therefore not surprising that Tycho was bright as it would have been near the edge of the umbra. I think we will lower the weight from 2 to 1, until I can find out more about the original observation e.g., if any photos were taken?

For the Grant Searle report from 1978, at least this was a “total eclipse”, as I remember making some naked eye sketches myself. Looking at Maurice’s image (Fig 7), well there is a “star-like point” on the western shore of Mare Tranquilitatis, and it is called “Dionysius” – just a simple bright ray crater only 18 km in diameter. I am not sure how experienced Grant Searle was – if he had used a crater outline map of the Moon, or an airbrush map, it might not have been located – only a Full Moon map would give a positive identification of this bright ray crater. Grant comments that it was 75% the brightness of Proclus. Well, if you look at Fig 7, isn’t this what we see for Dionysius compared to Proclus? Ken Wallace says that he took photos and mentions that the object fades – if anybody, “down under” (Australia), knows about the whereabouts of Kens photos then I would be really keen to see them. Regarding the apparent fade – there could be a number of reasons: the Moon was low down, hence more absorption, we do not know what atmospheric transparency was like, also radial density variations in the umbral shadow etc.? For safety I will lower the ALPO/BAA weight from 3 to 2 until we obtain more evidence. We have covered a repeat illumination observation of this before in the 2014 Dec newsletter.

Lichtenberg: On 2022 Nov 08 UT Eugino Polito (UAI) took a sequence of colour images of this area following a request on the Lunar Schedule web site for the following:

BAA Request: An important historical TLP sketch of this crater, and its surrounds, made by Richard Baum back in 1951 seems to have the wrong UT? It is very important that we establish what the UT and date of this observation actually was. In this prediction we are seeing if his date was off by 1 day. Please email any sketches, monochrome, and especially colour images to: a t c @ a b e r . a c. u k

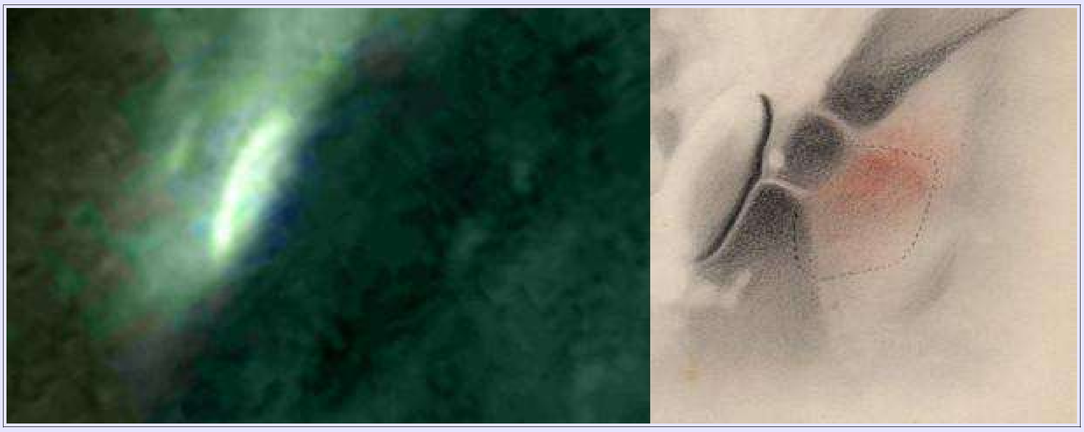

Figure 8. Lichtenberg**. (Left)** a close up of an image by Eugino Polito taken on 2022 Nov 08 UT 18:19. Image has cut out from a much larger image of the area, then has been colour normalized and then had its colour saturation increased to 50% using GIMP. **(Right)** A sketch made by Richard Baum (BAA) made, according to his log book, on 1951 Jan 21 UT 18:19-18:39.

We covered something similar last month for a 1988 Harold Hill report of colour in the same vicinity, so there might be something in those two reports? However, on this occasion, despite extensive colour enhancement, Eugino's image shows no similar colouration east of the crater that was depicted in Richard Baum's 1951 report. At least the illumination seems similar, so we can now assume that the original date given in Richard Baum's observational note book of 1951 Jan 21 was actually 1951 Jan 22. I think we can remove this from the Lunar Schedule website now that we are sure about the day. Repeat illumination observations of the 1951 Baum observation have been covered before in the 2020 Jun, 2021 Apr & Jul newsletters.

Aristarchus: On 2022 Nov 08 UT 22:58-23:10 Trevor Smith (BAA) observed this crater under similar illumination to the following four reports:

Aristarchus 1956 Nov 17/18 UT 23:30-00:30 Observed by Argentiere et al. (Itatiba City, Brazil, 20, 10 and 6 cm reflectors) Crater may have been brighter than expected(?) during a lunar eclipse. NASA catalog weight=3. NASA catalog ID #658. ALPO/BAA weight=1.

On 1956 Nov 18 at UT 00:00? an unknown observer (Cameron gives an AGU meeting reference) apparently saw a TLP in Aristarchus crater. The Cameron 1978 catalog ID=657 and weight=0. The ALPO/BAA weight=1.

On 1964 Dec 19 at UT 03:13-03:14 Budine and Farrell (Binghamton, New York, USA, 4" refractor, x200, S=7, T=5) observed that Aristarchus brightened five times over 1 minute during a lunar eclipse. The Cameron 1978 catalog ID=870 and weight=5. The ALPO/BAA weight=3.

On 1964 Jun 25 at UT ~01:07 Titulaer (Utrecht, the Netherlands) observed that Aristarchus crater was very bright during an eclipse. The Cameron 1978 catalog ID=822 and weight=4. The ALPO/BAA weight=1.

Trevor was using a 16” Newtonian at x247 under Antoniadi III/IV seeing conditions. A small star like speck of light could be seen on the NW rim. However, due to the seeing it appeared to flash on and off at times, making it look artificial in appearance. Everything else in the neighborhood of Aristarchus looked normal and there were no signs of spurious colour or obscurations. Trevor wonders if this is what Vreeland observed in an earlier selenographic colongitude back in 1949: *“In 1949 Apr 13 at UT 05:00 Vreeland and others (Mill Valley, CA, USA, 4.5" refractor) observed in Aristarchus a brilliant star-like point just after 3rd contact. This was not seen before or during totality. He thinks that it was a high peak catching the sunlight before the rest of the surface. It remained bright but larger as the sun hit it. The Cameron 1978 catalog ID=517 and the weight=1”.* I certainly think this is possible. Was anybody else observing at the same time as Trevor?

Concerning the repeat illumination reports above, these are all during lunar eclipses, which clearly Trevor was not able to see as it was earlier in the day when the Moon was below the horizon from the UK. The prediction software sometimes throws up Wobblies like this as it works with a ±0.5˚ tolerance in selenograhic colongitude and sub-solar latitude, not to mention the additional tolerance from the angular width of the umbra being 1.4˚. However, looking more closely at the 1956 Nov 18 observations, the official start and end of the umbral phase was between 06:03 and 07:27 UT, on that date, so quite clearly the first 1956 TLP report, during the eclipse, was probably using local time and not UT. This will be corrected. For the 1964 lunar eclipses, the June one was on 1964 Jun 24/25 UT 23:10-03:03 (U1 and U4 contacts) and the December one was on 1964 Dec 19 UT 00:59-04:15 (U1 and U4 contacts), so neither of those times needs adjusting.

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 . 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: http://users.aber.ac.uk/atc/tlp/spot_the_difference.htm . If in the unlikely event you do ever see a TLP, firstly read the TLP checklist on http://users.aber.ac.uk/atc/alpo/ltp.htm , and if this does not explain what you are seeing, please give me a call on my cell phone: +44 (0)798 505 5681 and I will alert other observers. Note when telephoning from outside the UK you must not use the (0). When phoning from within the UK please do not use the +44! Twitter TLP alerts can be accessed on https://twitter.com/lunarnaut .

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

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