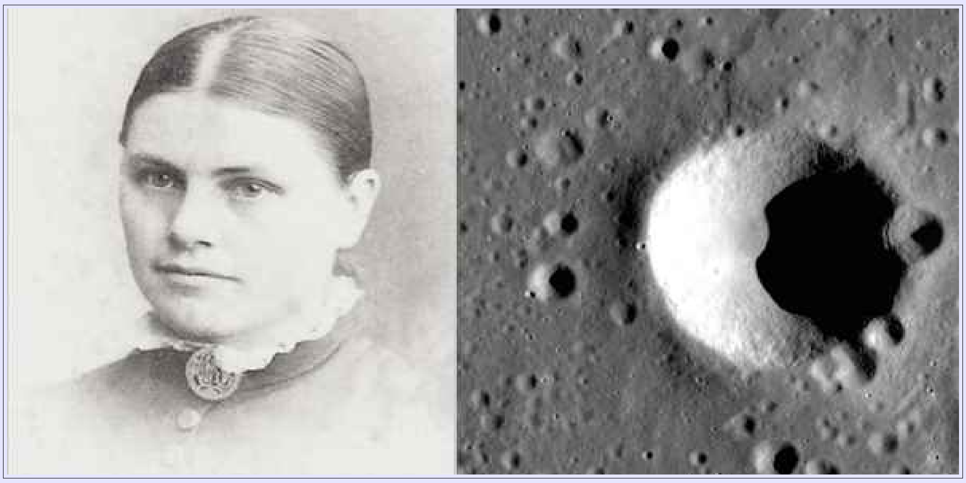
From the Director.



Lunar crater cataloguer: Mary Adela Blagg (1858-1944) and her 5 km diameter named crater on the Moon located at 1.5˚E, 1.2˚N. See: http://lroc.sese.asu.edu/posts/1093

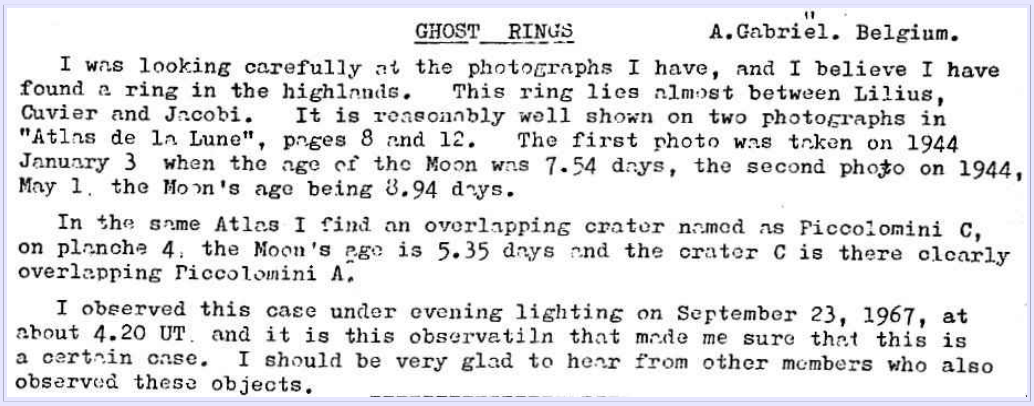
This month I thought it might be interesting to ask our readership about how to encourage younger members of the BAA, and indeed more female members, to join in with our Lunar Section activities. If one looks at the membership that we send the Lunar Section circulars out to, there are 220 subscribers in total, but only 17 are female members, or about 8%. Alas I don't have information on the ages of all our subscribers, but looking around at BAA meetings, and indeed local astronomical society meetings, one gets an overwhelming sense that the vast majority are retired. Looking back, from when I joined the Lunar Section (1975?) the demographics have not really changed much. There were a few young people around at the time such as Martin Mobberley, Nick James, Gerald North, Tim Haymes, Ken Kennedy, David Jewitt, but it would be really nice to see a few more young members join in observing, write articles, or run activities now. After all it is good practice, builds confidence and expertise, and has helped some go on to take scientific or technical career paths.

Although the proportion of female lunar and planetary scientists I encounter in my academic work looks healthy I would be interested to know what readers think we could do to see more female names mentioned in the circular and how we could change things to make the Lunar Section more welcoming to encourage wider participation. We definitely have had a few prominent women in the past, for example: Rosie Atwell, Marie Cook, Cicely Botley, Sally Beaumont, Winnie Cameron, Barbera Middlehurst. Also in lunar cartography a rather overlooked name is: Mary Adela Blagg, of Cheadle, UK, who compiled the first IAU catalog of lunar crater names, with Karl Müller in 1935, though she had been active from as early as 1907 sorting out positions and standardizing names of craters. It maybe a good opportunity for some of us to image this crater. Surprisingly I cannot find a Middlehurst crater on the Moon, though there is a Cameron crater, but this is named after the husband of Winnie Cameron, by his wife.

Basin and Buried Crater Project.

By Tony Cook.

No images or sketches have been sent in during the last month for this project, therefore I delved into the archives of the BAA Lunar Section Circular and came across something interesting in Vol 2, No. 11, Oct 1967, p3 – see Fig 1.



GHOST RINGS A.Gabriel. Belgium.

I was looking carefully at the photographs I have, and I believe I have found a ring in the highlands. This ring lies almost between Lilius, Cuvier and Jacobi. It is reasonably well shown on two photographs in "Atlas de la Lune", pages 8 and 12. The first photo was taken on 1944 January 3 when the age of the Moon was 7.54 days, the second photo on 1944, May 1, the Moon's age being 8.94 days.

In the same Atlas I find an overlapping crater named as Piccolomini C, on planche 4, the Moon's age is 5.35 days and the crater C is there clearly overlapping Piccolomini A.

I observed this case under evening lighting on September 23, 1967, at about 4.20 UT, and it is this observatiln that made me sure that this is a certain case. I should be very glad to hear from other members who also observed these objects.

Figure 1. A possible ghost ring/crater between Lilius, Curvier and Jacobi, mentioned on p3 of Vol 2, No. 11 BAA Lunar Section Circular from Oct 1967.

Although I don't have "Atlas de la Lune", the selenographic colongitude for 1967 Sep 23 UT 04:20 was 141.1˚ and the closest similar illumination image we have in the archives is one taken by Maurice Collins and is shown in Fig 2.

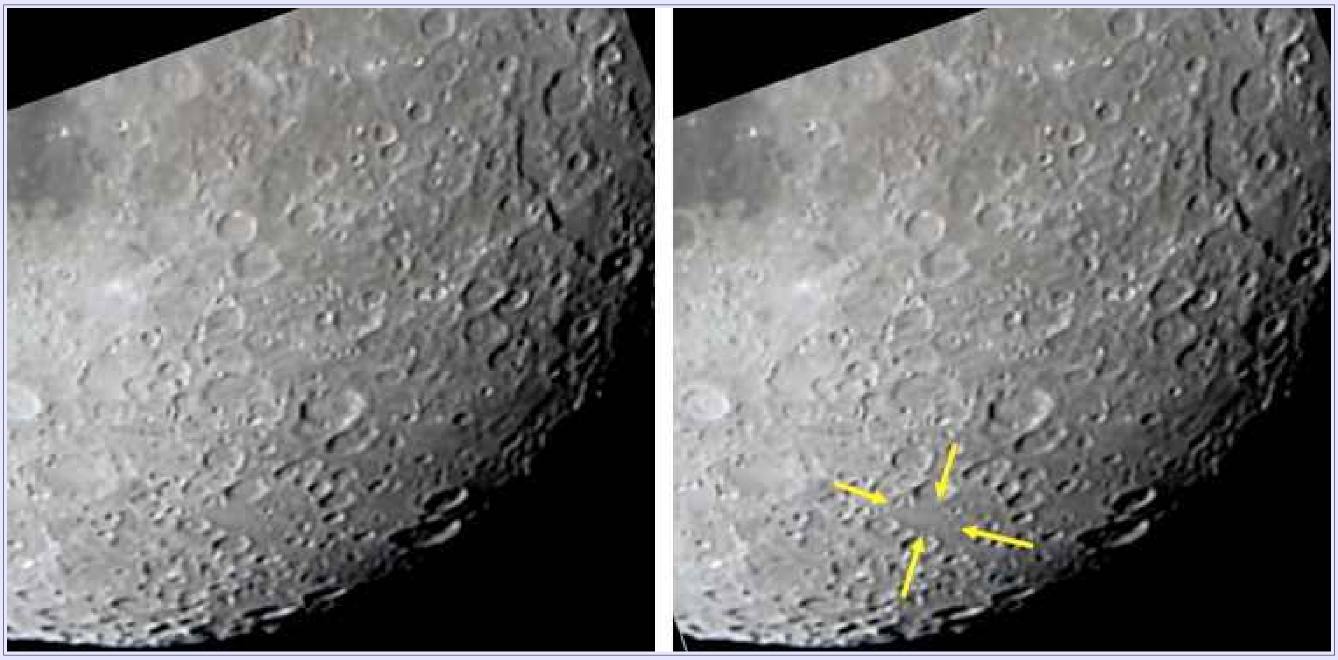


Figure 2. Location of a ghost crater in an image by Maurice Collins, taken on 2013 Jan 01 UT 11:27-11:34.

The buried crater appears to have a depth of approximately 300m (Fig 3), measured in the N-S direction, and is located at 9.7˚E, 53.4˚S with a diameter of 81 km. Interestingly the E-W depth is more difficult to measure as the topography is on a slope in that direction.

So what evidence is there for a buried crater here? In Fig 4 (Top left), it could be said that this might just be a flat highland area between craters, despite the arrows showing where to look for the perimeter of the buried crater. Fig 4 (top right) shows a hint of parts of a rim, and maybe a depression, though the former is far from conclusive. Fig 4 (bottom left) again hints at curvature which might be due to the rim. The azimuth slope direction plot in Fig 4 (bottom right) shows a circular region of mottled texture. On a scale of 0 to 10, 0 being not a buried crater and 10 being a crater, I would probably give this buried crater a weight of 2. I will add this to the list of buried craters in due course.

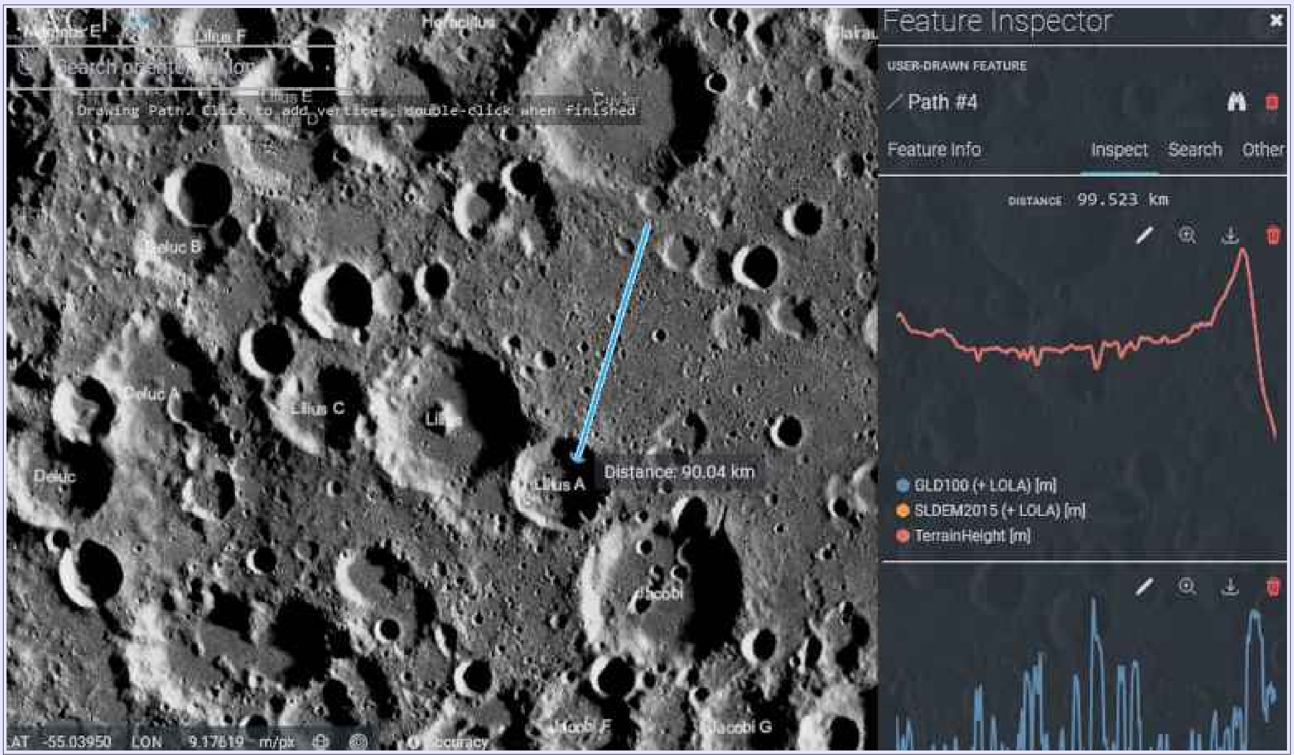


Figure 3. The N-S topographic profile measured through the proposed buried crater using the LROC Quickmap web page.

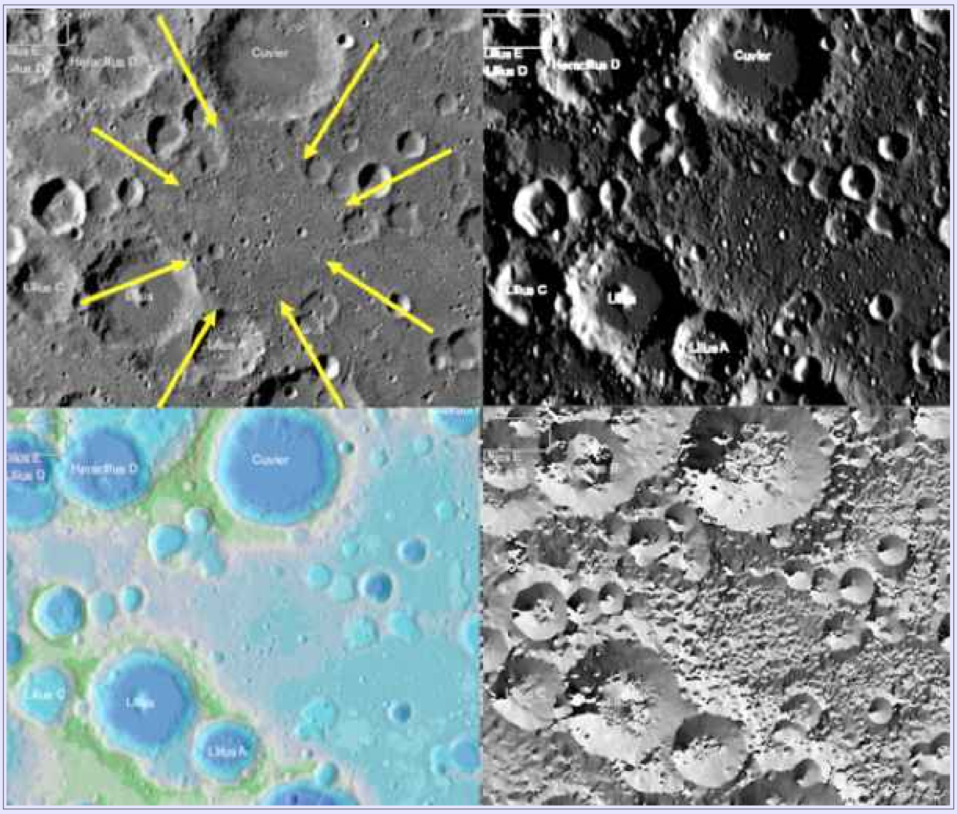


Figure 4. NASA LROC Quickmap views of the proposed buried crater area. (Top Left) A WAC mosaic of the near side with plenty of shadow. Arrows have been added to show the approximate location of the buried crater. (Top Right) A hill shaded view of the area. (Bottom Left) A hill shaded view colourized by topography. (Bottom Right) A slope azimuth map of the area.

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. Or you can even do this “virtually” with LTVT software. 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!

………

Lunar Occultations July 2023 by Tim Haymes

Time capsule: 50 year ago: in Vol 8 No.7

* Phil Ringsdore (then circulars Editor) retired due to ill health. P. Moore takes over.
* K. Gayner (then occultations Coordinator) writes Report-13 where a number of fade occultations are described and discussed. There is much excitement about the phenomenon.
* Occultation questionnaire. 33 questions on the subject of visual timing of occultations.
[- *A very interesting set of questions, probing the methodology of the technique – sub Ed]*

There are two grazes in the next 6 weeks:
SAO 76070 on July 13th, 0306 UT (see Fig-1)
Details are on HBAA 2023, page 44. The path crosses close to Mablethorpe (nr Skegness), down to Weymouth.
The most contacts will be seen between 2 and 3.5 Km South of the mean limb (kml file).
Prediction files can be found at this shared link:
https://1drv.ms/f/s!AlzLfUm3imzPpWhoAFuXc2us_EuQ

SAO 77028 on August 11th, 0144 UT (see Fig-2)
Details are on HBAA 2023, page 44. The graze zone is from Aberdeen, passing Dundee and Dublin.
The most contacts will be seen between 2 and 3.5 Km South of the mean limb (kml file).
Prediction files can be found at this shared link:
https://1drv.ms/f/s!AlzLfUm3imzPpWz0oXjOQSBp-sUC

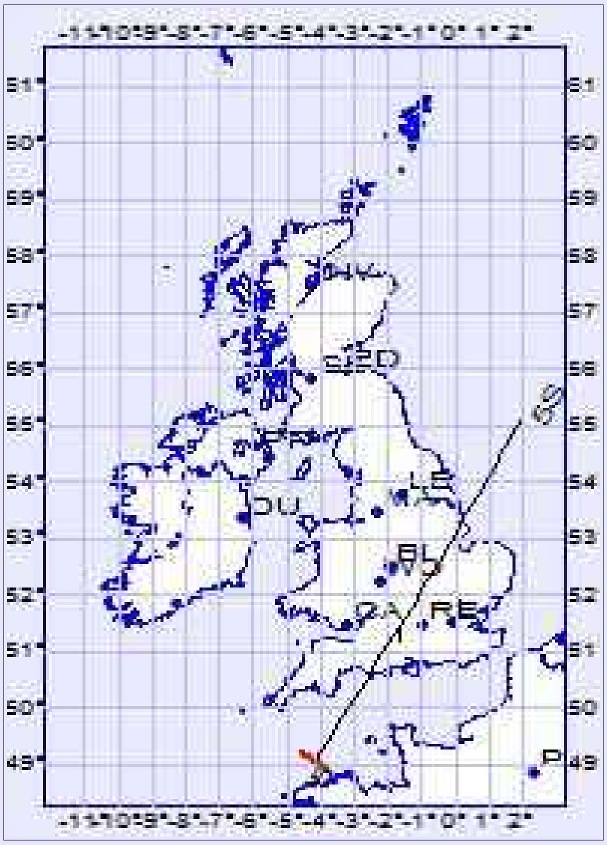


Fig.1

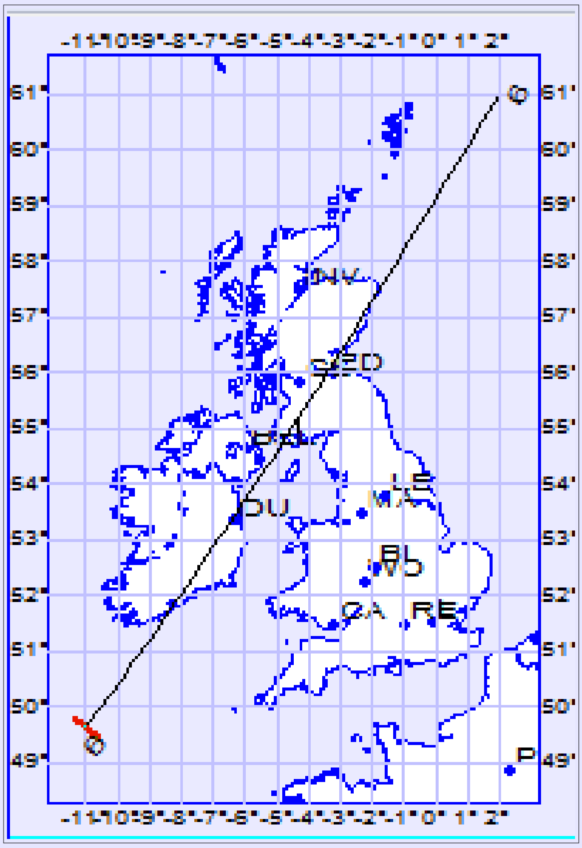


Fig.2

I hope the links work, and very good luck to UK observers in these areas.

Occultation predictions for 2023 July (Times at other locations will +/- a few minutes)
Oxford: E. Longitude -001 18 47, Latitude 51 55 40
To magnitude ca 8.0, Moon altitude >8 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	Jul	4	0	34	20.0	R	2831	kB2	6.0	6.1	99-	171		10	178	77S	
23	Jul	5	1	44	15.1	R	2998	A0	6.4	6.4	96-	157		13	179	81S	
23	Jul	6	1	40	26.3	R	3160	F7	6.7	6.5	90-	143		17	164	64N	38 Cap
23	Jul	9	1	29	43.3	R	36	G5	7.1	6.6	61-	103		18	118	21S	
23	Jul	10	1	23	5.9	R	155	PF4	6.4	6.2	50-	90		16	103	58N	77 Psc
23	Jul	10	1	24	24.4	R	109667	MF6	7.3	7.0	50-	90		17	103	59N	
23	Jul	11	0	50	16.6	R	92688	F5	6.8	6.5	39-	78		9	84	72S	
23	Jul	13	2	43	51.4	R	525	A*	6.5	6.4	20-	53	-9	20	81	64S	14 Tau
23	Jul	13	3	11	3	Gr	76070	dA5	7.2	7.0	19-	52	-7	24	85	HBAA #5	
23	Jul	14	3	13	25.1	R	76651	kF0	7.8	7.6	12-	41	-6	19	74	45S	
23	Jul	27	21	0	49.0	D	2235	kB9	6.3	6.3	70+	113	-8	12	203	54S	
23	Aug	4	1	58	36.0	R	3392	A2	7.3	7.1	92-	147		28	173	89N	
23	Aug	5	1	30	52.4	R	3526	cG9	4.9	4.4	84-	134		31	150	52N	27 Psc
23	Aug	5	2	44	43.4	R	147026	K2	7.9	7.3	84-	133		35	171	74N	
23	Aug	5	3	35	49.5	R	3535	B7	5.1	5.2	84-	133	-8	35	187	66N	29 Psc

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, or the LS 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.

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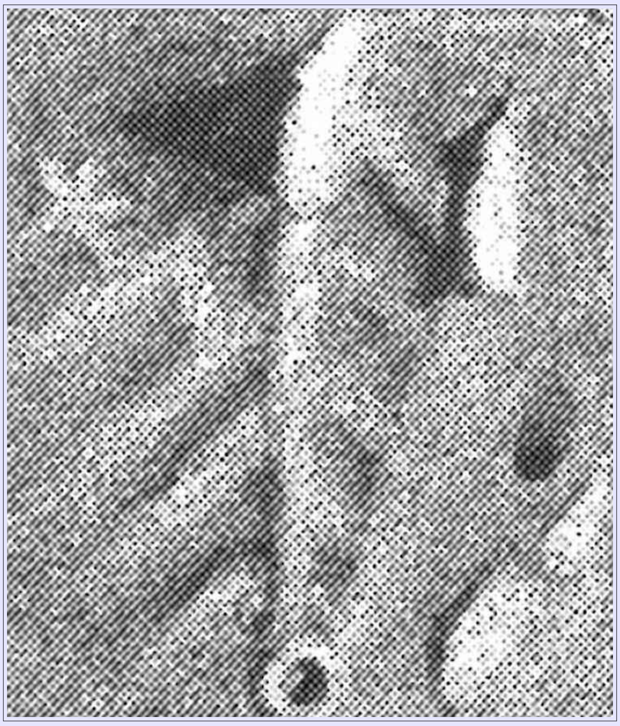
Communications Received from Members.

North of Schrőter.
By Bill Leatherbarrow.

Area north of Schröter, 28 May 2023, 21.31 UT, OMC300 Mak-Cass, Poor seeing
(Image by Bill Leatherbarrow)

At first glance this stretch of terrain north of Schröter (the degraded horseshoe-shaped crater right of bottom-centre in the above image) seems to contain little of interest, but the geologist will quickly recognise the extensive dark deposits as evidence of past volcanic mantling, possibly from explosive eruptions of volcanic ash. There are other similar deposits nearby in the region of Sinus Aestuum and Mare Vaporum. If you look to the northwest of Schröter and towards the centre of the image you will see a small 10km crater (Schröter W) containing an even smaller 4km crater (Schröter A). Immediately north of this you can just make out a series of fern-shaped ridges (they are best revealed under lower illumination than that offered by the present image).

These ridges comprise Gruithuisen's fabled 'lunar city'. Franz von Paula Gruithuisen (1774-1852) was a serious Bavarian physician and an eccentric observational astronomer who in 1822 claimed to have discovered evidence of a lunar city, consisting of artificial-looking linear ridges. He made several observations of this feature, which he termed the 'Wallwerk', and made extravagant claims about lunar inhabitants and their constructs, including what appeared to be a star-shaped temple. This is not the place to retell the story of Gruithuisen, particularly since it has been well done by Nigel Longshaw in a past issue of *The Moon: Occasional Papers of the BAA Lunar Section* (Vol. 4, March 2017), which is available for download from the Lunar Section website.



Sketch of the 'Wallwerk' by Gruithuisen (Wikimedia Commons). The 'star-temple' is shown at top-left.

Nigel's paper is well worth reading and Gruithuisen's 'city' is worth seeking out using a small or medium telescope when the lighting and seeing conditions are favourable.

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Response to 'Two new rilles are found near crater Beer' (K.C Pau July LSC, pp 4-7).
By Robert Garfinkle, FRAS (Lunar Section Historian)

The rills that K. C. Pau discussed on pages 4 to 7 of BAA Lunar Section Circular 60 No.6 June 2023, are still officially designated as a group as Rimae Archimedes on the electronic edition of LAC 41, but they are still officially designated individually as Rima Archimedes I through Rima Archimedes VI on the paper editions of LAC 41 (I-463).

The official designations for Roman lettered depression features and Greek lettered elevations are still valid. They have not been "abandoned." As told to me years ago (1994 and 2013) by Ewen Whitaker, the International Astronomical Union (IAU) adopted the Greek and Roman designations when they adopted the first official lunar nomenclature list in 1932. Unfortunately the United States Geological Survey (USGS), who established the electronic database and maintains it in Flagstaff, AZ, mistakenly used the date of 1935 when the list was published instead of the adoption date of 1932. Mary Blagg and Karl Muller presented the proposed list of named features to the IAU Nomenclature Committee. That list became the catalogue *Named Lunar Formations*. The IAU General Assembly adopted the list then (1932) and approved the funds to publish the list at their 1935 meeting. I have personally asked the USGS to correct this error, but they tell me that they lack the funds to correct the database.

In 1979, when Ewen and Leif E. Anderson were tasked by NASA to compile a new lunar nomenclature catalogue *NASA Catalogue of Lunar Nomenclature (NASA Reference Publication 1097)* [published in 1982], they were instructed to leave out the Roman and Greek designated . They were not given the funding to include them. This caused a fight between NASA and the IAU. The paper LAC charts and associated US government-printed Apollo mission Moon maps had all been published by then, so you now have two systems--one with the designations and one lacking a listing of them. The USGS does not have the authority or funds to include the individual Archimedes rills on the LRO electronic maps. They show just the two Rimae Archimedes.

In 1984, NASA published the *Atlas and Gazetteer of the Near Side of the Moon* (NASA SP-241). They listed almost all of the Roman numeral Greek letter designated formations. For Archimedes, they list 24 satellite craters, seven elevated features, and five rima (missing is Archimedes I). Ewen is one of the three authors of this book. After the fiasco of 1097, NASA relented and let the authors include the Roman and Greek features.

I cover all of this on pages G-1 and G-2 in Appendix G of my 3-volume lunar reference work *Luna Cognita* (Springer 2020) and give basic information on the Archimedes rima designated Roman I to VI in table G-1.

<u>White Spot in Cyrillus – in response to Leo Aerts image in the June 2023 LSC</u>
By Bob Stuart.

Thought you might be interested in this. I know the illumination is not the same angle, and Leo's image is more detailed (though we have achieved quite a few of the smaller floor craters on closer inspection that Leo has obtained, but not as sharp), but I have put a circle (see Fig.1) around a very small prominent white patch in the floor of Cyrillus, that on our image proves to be a crater, but pretty much all in shadow and not showing white at all. Presumably the whiter floor is indicative of it being recent. It does illustrate the different appearance of craters, especially small ones, with different illumination. There are other white patches which are common to both images, which is why I noticed this unilateral one in the first instance

Fig.1.

Tony Cook responded:

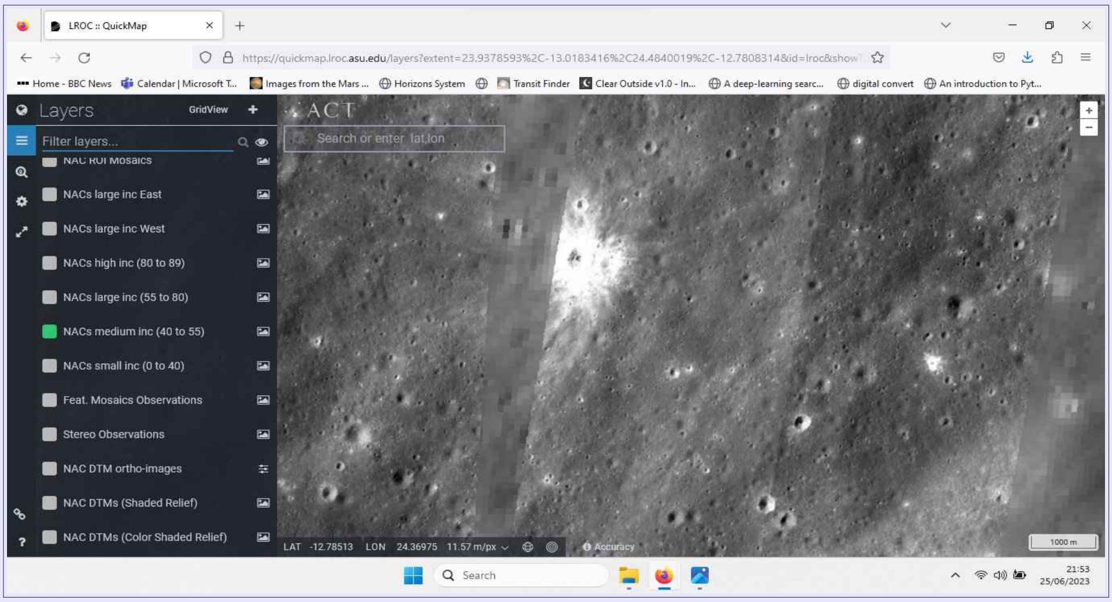

Fig.2

Taking a look at the NASA LROC Quickmap website (Fig.2), it turns out that the white spot is a small ray crater. The selenographic colongitudes are very different. In Leo's image it is 132.0 deg (morning) and in Bob's image it is 352.9 deg (evening). So slope angles and the sub-solar point can make all the difference. Maybe I should add this to the Lunar Schedule web site so we can find at what time the craterlet switches off in the lunar evening?

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Images and Drawings from Members.

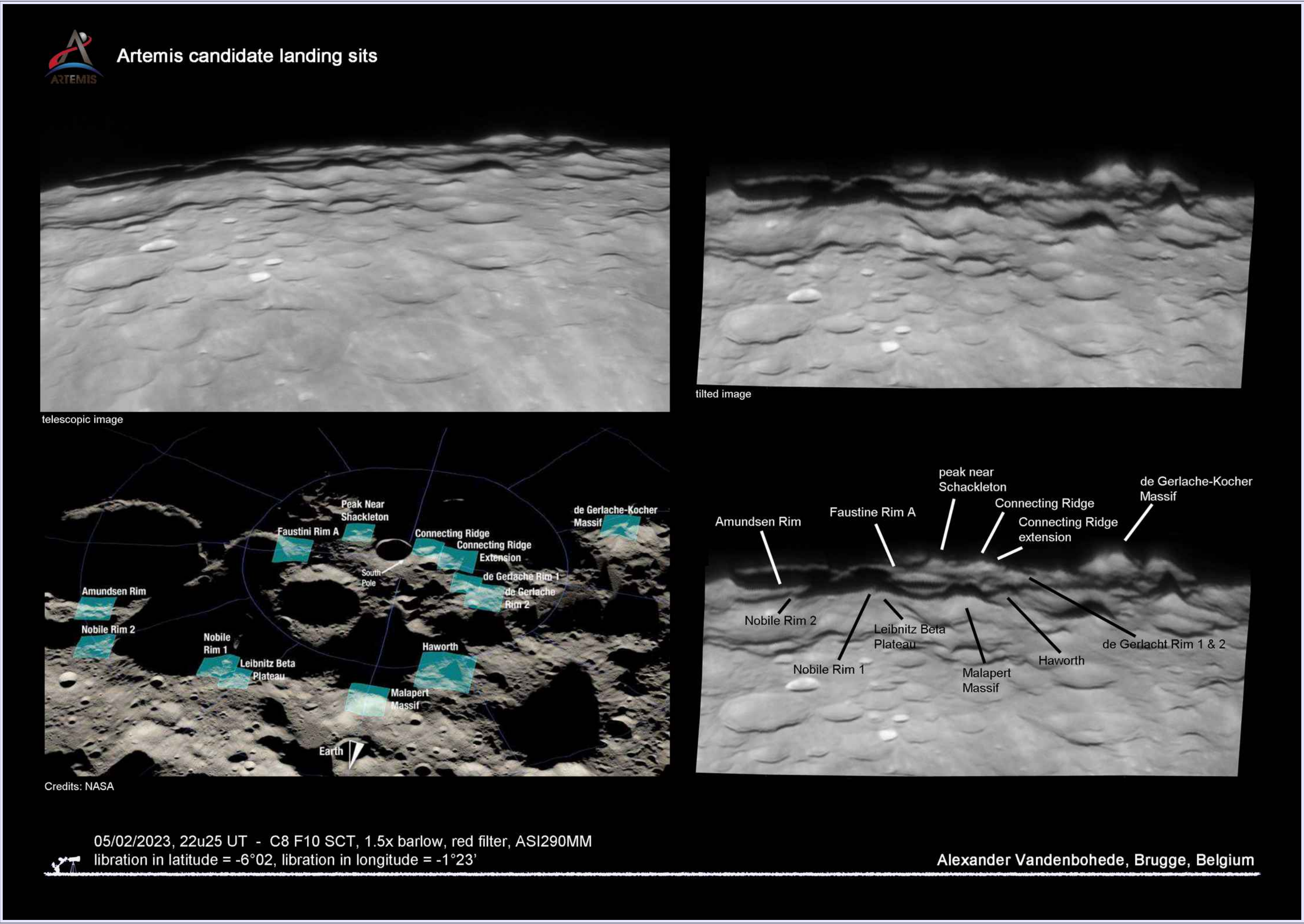
Grazing Occultation 62 Tauri.

Image by Klaus Brasch with details of time/date and equipment as shown.

Klaus Comments: *The attached image falls under the serendipitous but pretty category, obtained while testing my new Celestron-11 equipped with an f/7 focal reducer-coma corrector around sunset on this quite new Moon* *evening. Only after stacking and processing a series of exposures, did I discover this grazing occultation of 62Tauri. As the old saying goes: better lucky than smart! This was not a planned in advance lunar imaging session, just a quick test shot with my new scope and DSLR camera under less than ideal seeing conditions. I combined a short and a much longer exposure for the final image and used masks in Photoshop to bring out the earthshine and suppress the brightness of the crescent. That probably explains the unusual darkening near the terminator. No filters were used.*

………

Artemis Landing Sites.



Images taken by Alexander Vandenbohede with details of time/date and equipment as shown.

Alexander Commented: *I was able to observe the area on 25/02. Libration was quite favourable to observe the south pole. To have a better view on the candidate landing sites, I tilted the image a little bit using LTVT.*

………

Abenezra-Azophi.

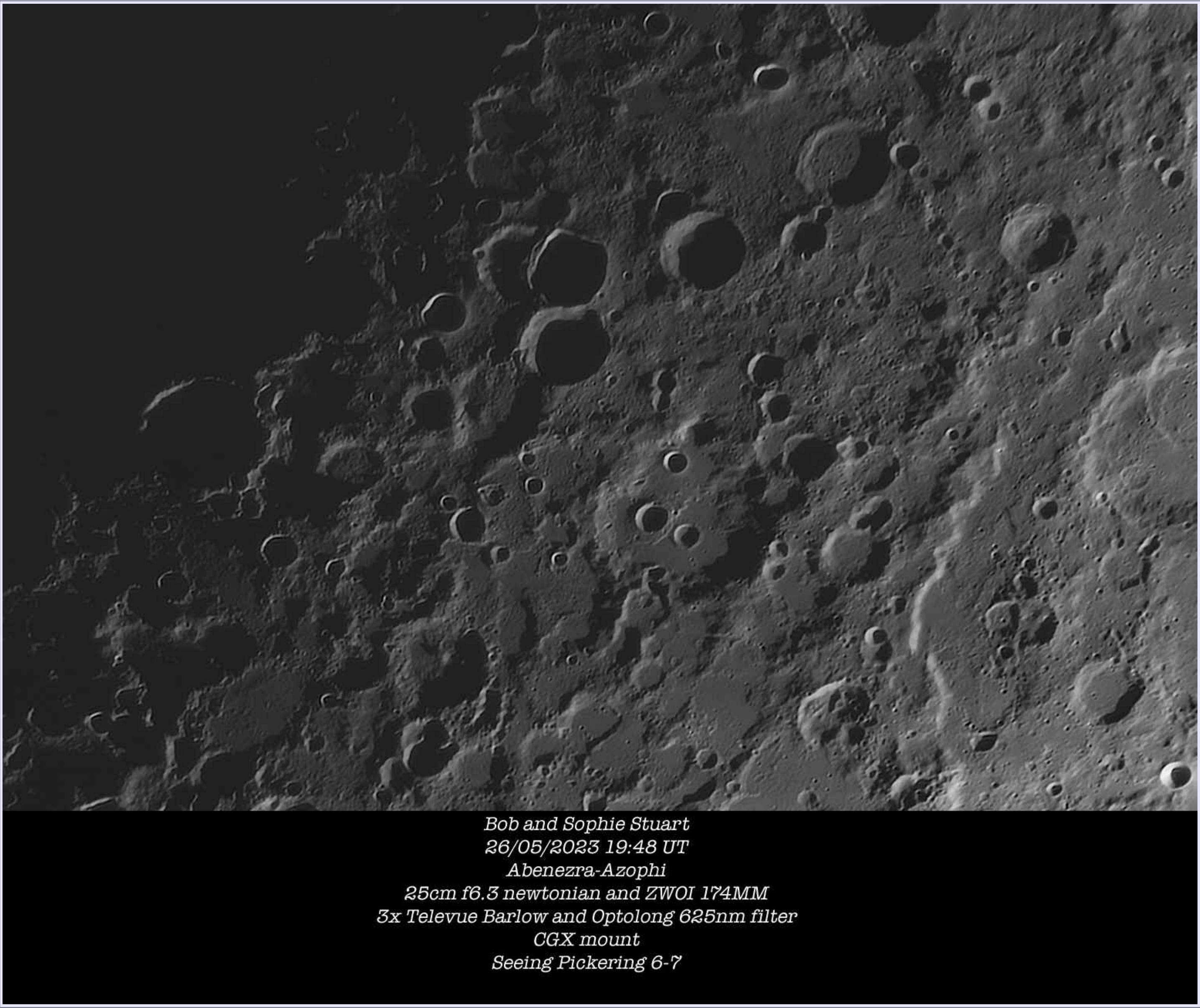


Image by Bob and Sophie Stuart, with details of time date and equipment as shown.

Geological Notes: This dramatic image image shows the two craters Abenezra and Azophi, shadow filled and just above the middle of the frame. The curve of Rupes Altai can be seen in the lower right of the frame as this area is just to the west of Mare Nectaris. This proximity might explain the rather straight northern section of rim in Abenezra, as this orientation is approximately radial to the basin, and possibly a result of the Abenezra cratering event exploiting fractures created during the basins formation. Catena Abulfeda is quite clearly shown in the top right of the frame, just clipping the rim of Almanon. This rather scrappy crater chain extends for some 210kms and is most likely the result of the impact of a tidally disrupted rubble pile Near Earth Asteroid.

Though not visible in this image due to the deep shadows, the interior of Abenezra has a most peculiar appearance due to what may have been a number or rim collapse events, with the younger collapse wedges bulldozing the previous ones, to form a peculiar swirl type pattern. This has mostly affected the southeastern part of the crater, and is quite unique, as no other craters in the area exhibit such a configuration despite presumably sharing similar a similar geological basement.

Clavius.

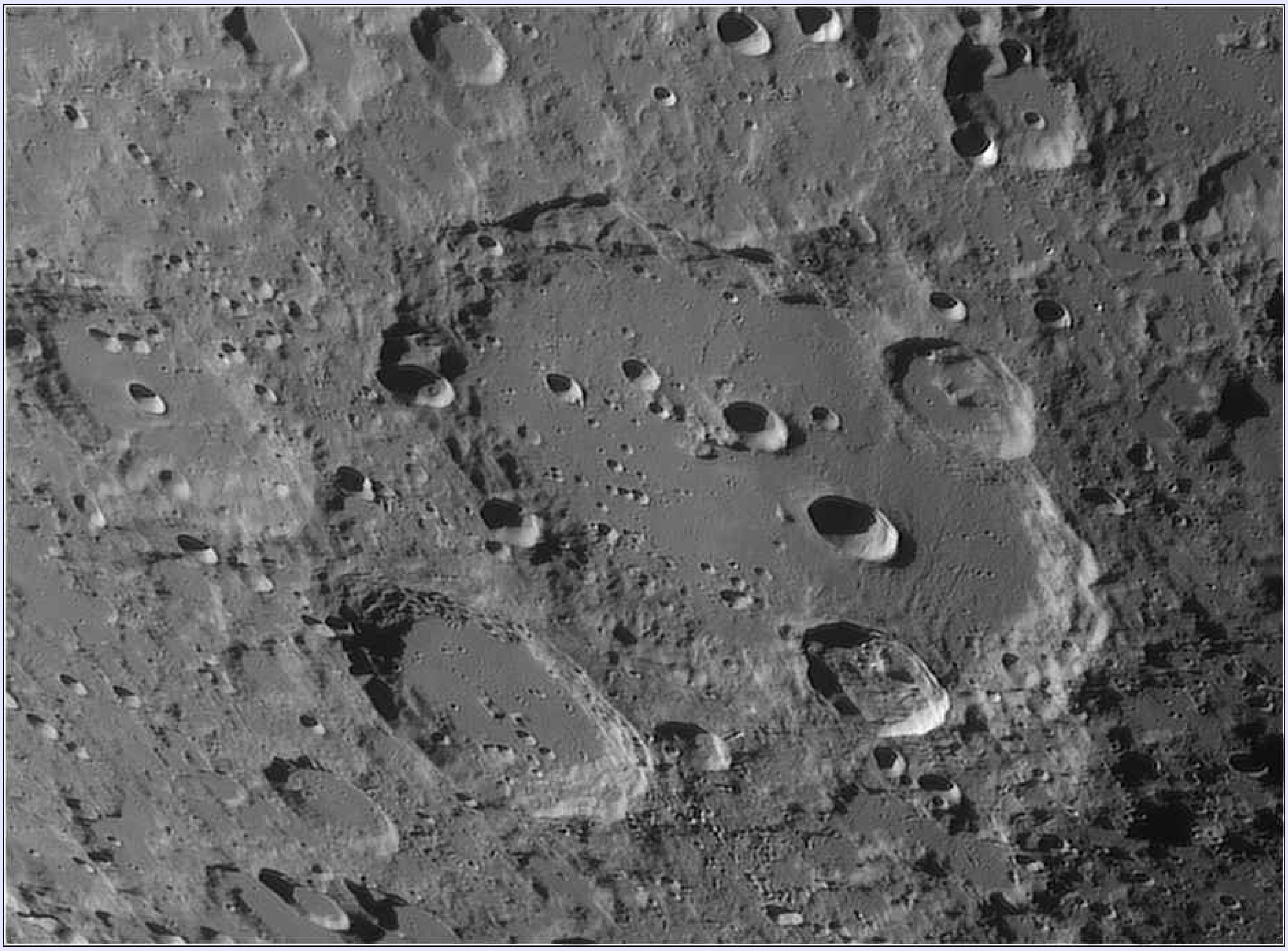
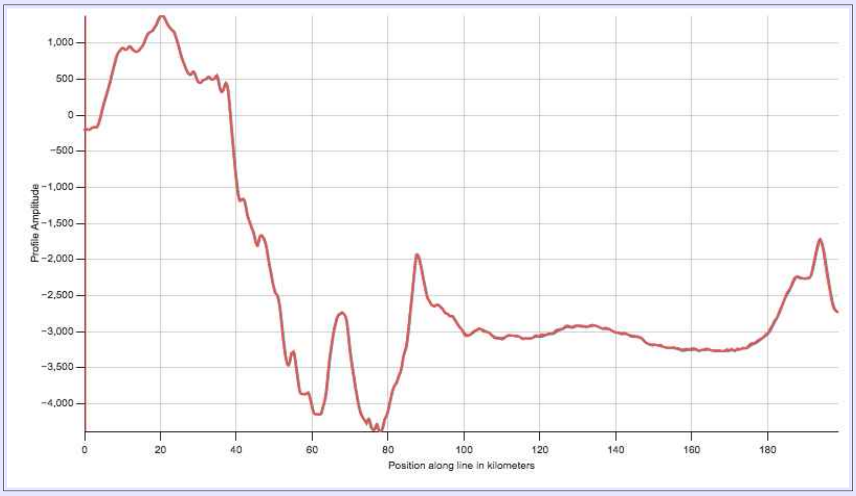


Image by William Leatherbarrow taken on the morning of 17 September. Taken under reasonable seeing with an OMC300 and ASI290 camera.

Geological Notes: This image shows the almost parallel crater chains that emerge from the 50km diameter Rutherfurd, and extend northwards across the floor of Clavius, and crossing the older, 27km diameter Clavius D. This distribution can be understood by looking at the topographic profile below which shows that Rutherfurd is really hemmed in to the south by the slopes of the inner rim of Clavius which partly limited the direction ejecta could travel, but also effectively mimicked a low angle impact, also contributing to the asymmetric distribution we see. The bulge on the floor of Clavius to the north of Rutherfurd in the profile is not a dome incidentally, it is where the profile clipped the glacis of Clavius D.



LRO Quicmap profile across the rim of Clavius (left) through Rutherfurd's central peak and onto the crater floor to the north (right)

Mare Marginis.

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

Geological Notes: The basalts of Mare Marginis were erupted into the northern part of the 454km diameter pre-Nectarian Marginis Basin, which you could be forgiven for overlooking as it is partly over-stamped by the younger but still pre-Nectarian Smythii Basin which is 700kms diameter. One of the claims to fame of Mare Marginis is the extensive lunar swirls that cover the surface around the crater Goddard, and these can be seen in this image as a bright patch near the limb towards the left edge of the image.

This picture shows the 144km diameter Neper on the southern edge of the mare, with its prominent central peak rising to over 2000m above the mare flooded crater floor. In the foreground we have the mare filled Condorcet (74kms diam) and to the left the central peak crater Hansen (41kms diam). To the left of Hansen we have Alhazen (34kms diam) which whilst looking unremarkable is quite an interesting crater. Its small flat floor is not mare filled, but it shows evidence for volcanism, possibly in the form of pyroclastic eruptions associated with some dark halo craters. It may even have been a small Floor Fracture Crater at some stage as there are also a couple of quite faint clefts in the crater floor, but this is speculation only. It is also, at least in my opinion a rather large Concentric Crater as rather than collapsing in a series of crescentic arcs as is the case with Hansen in Alhazen the rim appears to have collapsed in much larger sections, giving the inner walls more the appearance of a ring as opposed to a series of arcuate segments.

The bright patch towards the right of the frame is not more swirl material, but the bright ejecta blanket of the relatively young crater Banachiewicz B (23kms diam) which is perched on the western rim of the much older eroded crater Banachiewicz (99kms diam).

Copernicus.

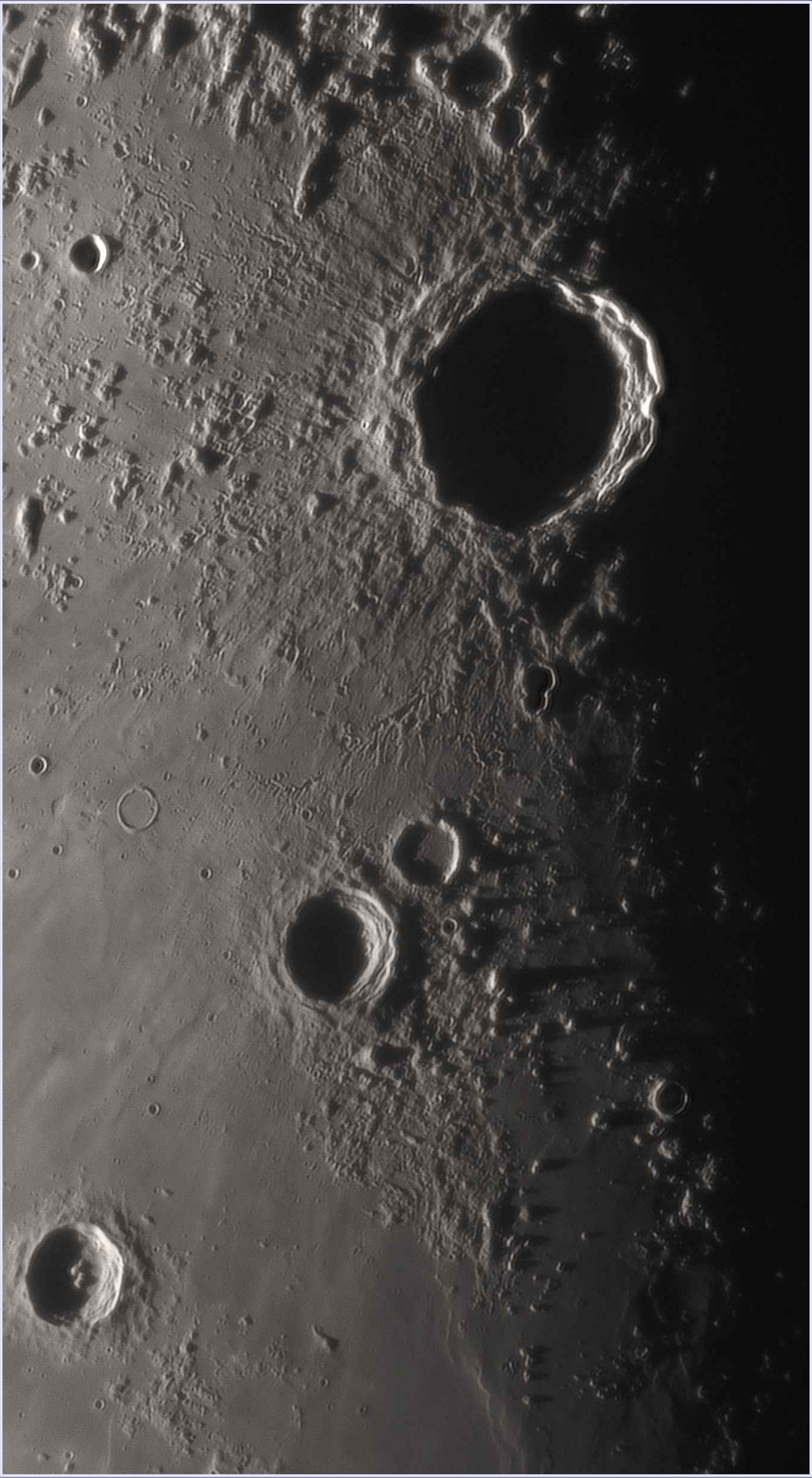
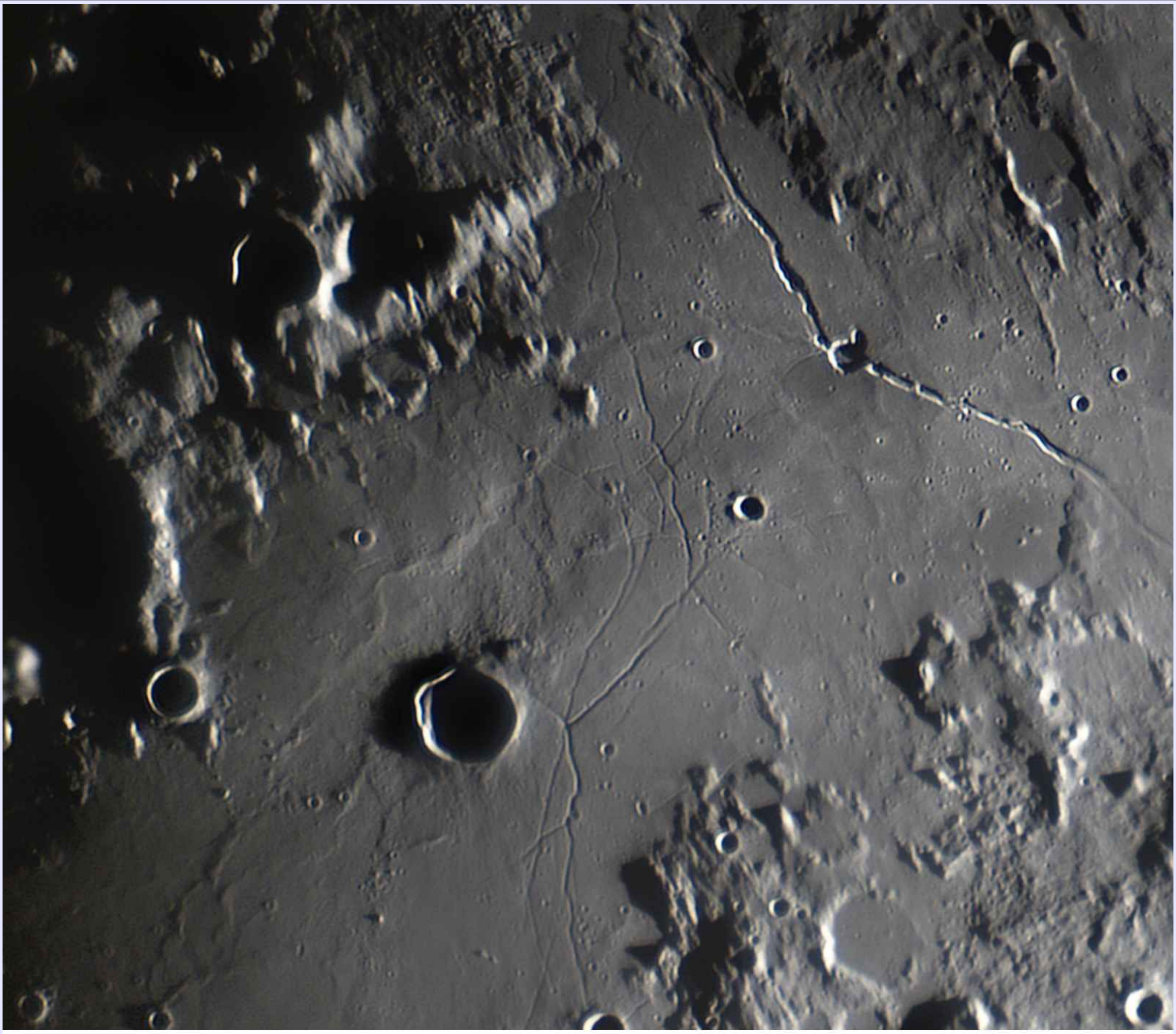


Image by Leo Aerts taken on October 19th 2022, and imaged with 25 cm f/15 Opticon Schmidt Cassegrain.

Geological Notes: A familiar image I suspect with most lunar observers – Copernicus under grazing illumination, but in this case it is evening and not morning, so maybe not so familiar after all unless you are a particular fan of getting up very early. The various forms of ejecta from Copernicus are picked out by the low sun, in particular the 'tick' shaped crater chain just to the north of Reinhold, one of the larger components of which is designated Copernicus F. This crater chain marks the western edge of the Zone of Avoidance (ZoA) in the ejecta blanket, as Copernicus was formed by a low angle impact from the south. The eastern edge of this ZoA is marked by another crater chain which includes the craters Fauth F and H.

In the 11:00 o'clock position to the rim of Copernicus is the faint line of Rima Gay-Lussac. This appears to pre-date Copernicus as it is scored by the ejecta from the latter, an may represent an older sinuous rille that existed here pre-impact. Its western end is a pit, about 600m deep and 4.5kms in diameter which might be a vent that supplied the rille. This little corner of the Moon has obviously been subject to volcanic activity as there is a lot of dark mantling material here and around Gay-Lussac H just to the west.

Triesnecker and Hyginus



Triesneker and Hyginus
27 February 2023 2055UT
C11 f20 ASI224MC IR-cut filter
Mark Radice RefreshingViews.com

Image by Mark Radice with details of time/date and equipment as shown.

Mark Comments: *The terminator was alongside Sinus Medii and the fascinating Triesnecker and Hyinus rilles. Although close together, it is interesting to note the differences between the two regions. Triesnecker itself is in shadow rendering its complex floor invisible but its peculiar bulge in the western wall is quite apparent. What is striking is the sheer number of rilles crossing the eastern surface, reminiscent of a railway network. It appears that Triesnecker is superimposed on the mare surface however I wonder how the rilles withstood the Triesnecker impact?*

Hyginus by contrast is a volcanic caldera shown by the absence of a crater rim. I did notice the sunlight shining through a gap in the wall, casting a bright ray shining across the crater floor. The long rilles to the north-west and south-east are quite a feature! Fascinating to think these are a collapsed volcanic rille.

12.6 day old Moon.

Image by Maurice Collins with details of time/date and equipment as shown.

Ed Comments: The May LSC featured an image by Maurice of the 12 day old moon, the phase in this image is a little more advanced at 12.6 days. That extra 0.6 of a day as well as the effect of libration has now exposed the eastern rims of Hevelius and Cavalerius to the first rays of a new lunar day. The entire floor of Schickard is also now illuminated showing the dark mare covered eastern and western floor and the lighter central zone. To the north of Mare Frigoris the central peak of Pythagoras is now catching the sun, whilst its floor is still in deep shadow. The astute observer will notice that north is down in this image, as Maurice is based in New Zealand.

Sinus Iridum.

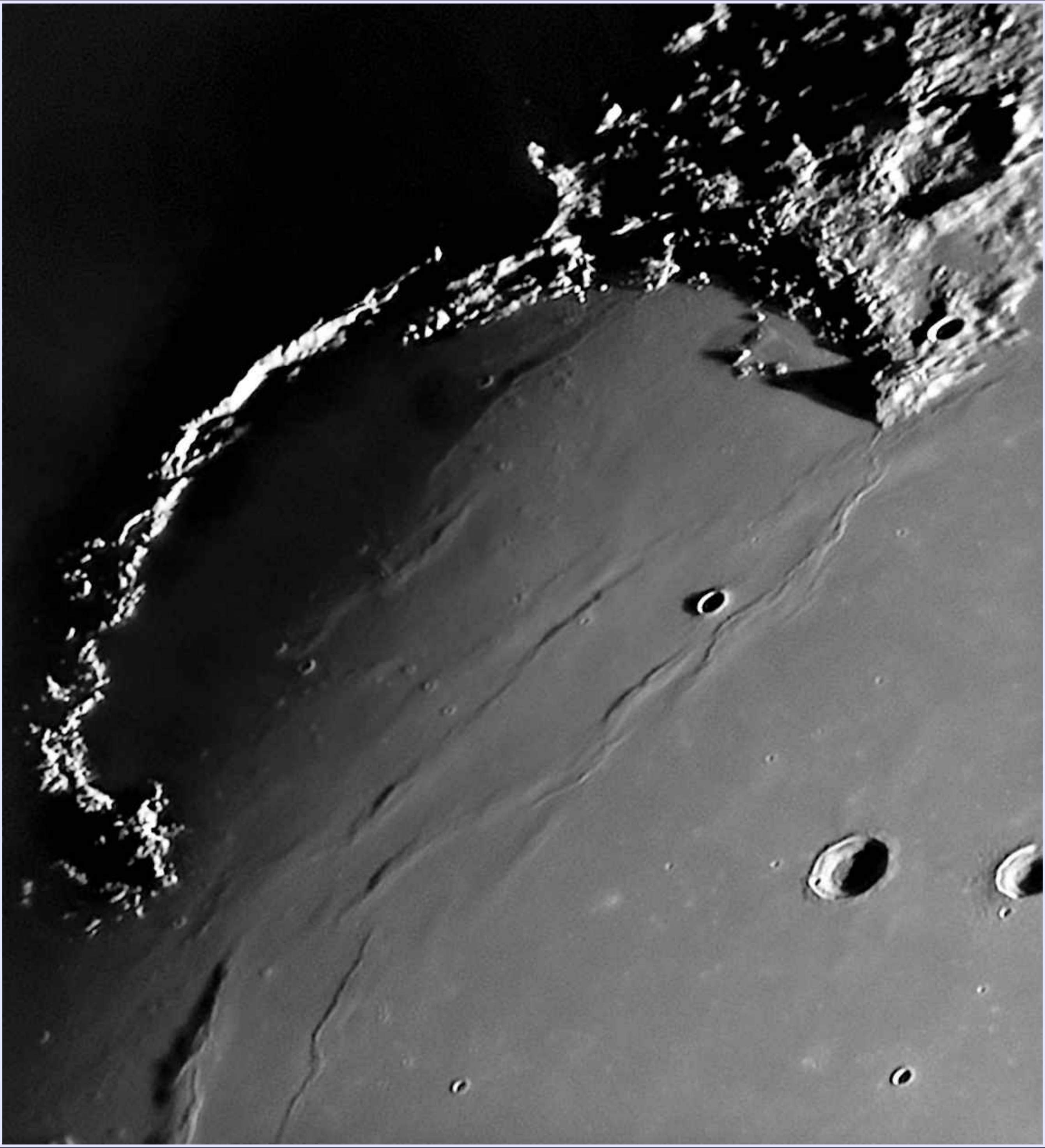


Image taken by K.C.Pau on 2nd January 2023 at 11h57m UT with a 250mm f/6 Newtonian x2.5X Barlow and QHYCCD290M camera.

Geological Note: The surface of Sinus Iridum slopes imperceptibly towards the north, and whilst this is not really apparent visually, this image demonstrates the fact as the northern part of the bay remains in shadow whilst the southern part is flooded by morning sunlight. The small crater at the mouth of the bay is Laplace A, and the wrinkle ridge to its north appears to overly one of the Imbrium basin rings as do Dorsum Heim, Zirkel and Grabau with which it is more or less continuous. The wrinkle ridge to the south, which starts at Promontorium Laplace *may* be related to the now submerged southern rim of the Iridum crater, though as you can see it does not sweep around to join up with Promontorium Heraclides as might be expected if this was the case. This wrinkle ridge is superimposed on top of the ridges marking the Imbrium ring as can be seen just to the south of Promontorium Laplace showing that the former post date the latter.

The Straight Walls

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

Rik Comments: *This field is south of the great crater Arzachel (100km diam.) and well known to the versed lunar observer for its many and varied features. The first feature is Arzachel itself, the southernmost of the trio with Ptolemaeus, Alphonsus that dominates the centre of the visible disk of the Moon. It is noted for its spectacular terracing and interior rimae one of which that arcs north-south just east of the oddly off centre peak on the floor and roughly concentric with Arzachel A (8 km). Below or south of Arzachel is the crater Thebit with the interesting configuration of Thebit A (19 km) on the northwestern portion of the wall and Thebit L (10 km) to the northwest of that. Then west of this is the iconic Straight Wall which is neither straight nor a wall per se. It is seen here as a dark diagonal slash on the eastern edge of Mare Nubium, running up from the a curious set of peaks below Thebit northwest to the little crater Thebit D (5 km). The wall is made up of a number of small faults 8-50km in length, with the cliffs being some 250-300m high and 2.5-3km in width, angled at less than 10o. The curious peaks are colloquially calledThe Stags Horn Mountains and are the remnants of previous features destroyed in the massive Nubium impact event.*

Just to the right of image centre is a particularly well defined good sized crater, Werner (70 km). Between it and Thebit is a larger crater, less well defined, Purbach (118 km) with remnants of now buried craters on it's northwestern floor. Above Werner is a very poorly defined crater, more of an oval plain, Blanchinus and north of it is LaCaille (both 68 km diam.). These are interesting because of their intersection. The raised terrain between the eastern wall of Purbach and the western walls of Blanchinus and LaCaille form what is known as the Lunar X at low sun angles. Can you see it here? Those familiar with the feature when it is on the terminator probably can. Before leaving this region notice the feature to the upper right of LaCaille. It appears like a deer hoof print in snow, more hoof-like than the popular Aries Hoofprint! In LROC images it appears to be the juxtaposition of two badly ruined craters that once shared a common straight wall. This is Delaunay (roughly 46km diam) and a much modified version of the two craters in the uppermost right corner of the image, Azophi (48 km) at bottom and Abenezra (41 km) above. You can see how the shared straight wall is flattened between them as in Delaunay thought these latter craters were not as ruined. This is truly a region of straight and not-so-straight walls!

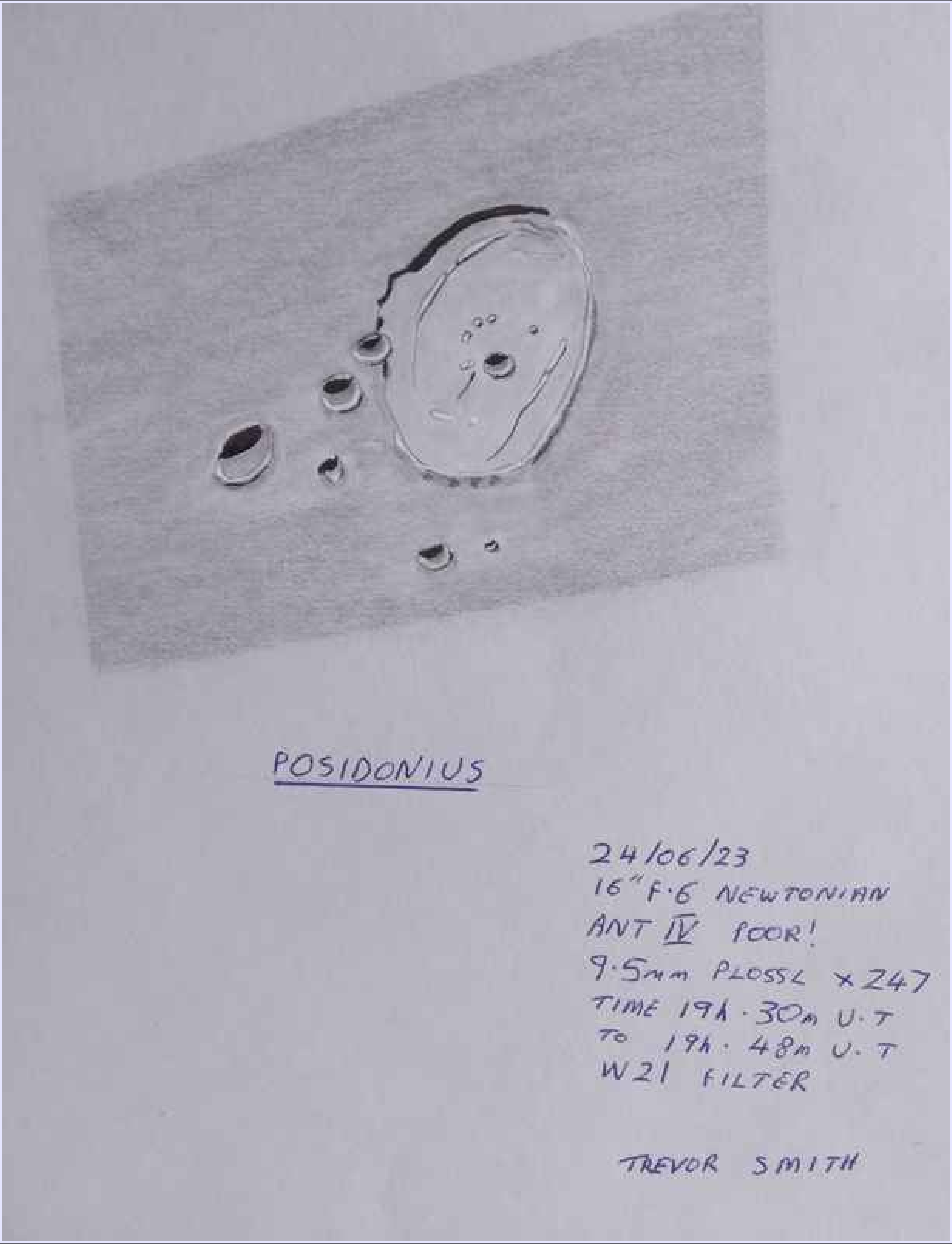
This montage was created from two images, each a 1500 frame AVI stacked with AVIStack2 (IDL) and assembled with MS ICE then finally processed with GIMP and IrfanView.

Montes Riphaeus.

Image by Rod Lyon with details of time/date as shown.

Geological Notes: This small arc of mountains *may* represent all that is left of the rim of the pre-Nectarian basin within which Mare Cognitum now lies. A reduced crustal thickness to the east of the mountains as revealed by GRAIL indicates the presence of the buried impact basin, now deep beneath the high titanium mare basalts. Montes Riphaeus are unusual in that the southern portion is one of the areas termed 'red spots' based on their spectral properties. Other 'red spots' including Hansteen Alpha, the Gruithuisen domes, and the Lassell massif appear to be the result of exotic volcanism of a more granitic nature than is common on the moon, whilst Montes Riphaeus do not appear volcanic and instead may represent material excavated during the formation of the Cognitum basin. Another 'red spot' Darney χ (chi) can be seen as the roughly circular patch of raise terrain off the southern tip of the mountains. This again appears not to represent a silicic volcanic feature comparable to the Gruithuisen domes but an ancient (3.94 Ga) piece of pre-mare terrain – but once again its true nature is still open to debate.

Posidonius.



Drawing and observing notes submitted by Trevor Smith. Details of time/date and equipment as shown in drawing.

POSIDONIUS

20/06/23 SAW CLEAR SKIES FOR A CHANGE HERE IN CODNOR DERBYSHIRE.

THE SKY WAS STILL VERY BLUE WITH THE SUN SETTING BEHIND MY NEIGHBOURS HOUSE. A QUICK LOOK AT THE MOON SHOWED A RATHER POOR AND UNSTEADY VIEW WITH NOT MUCH CONTRAST DUE TO THE LIGHT SKY. HOWEVER, THE 95 Km DIA CRATER OF POSIDONIUS WAS WELL PLACED AND LOOKING QUITE SPECTACULAR ON THE NORTH/EASTERN EDGE OF MARE SERENITATIS.

IN SPITE OF THE UNSATISFACTORY CONDITIONS I DECIDED TO MAKE A QUICK SKETCH!

POSIDONIUS IS WELL KNOWN FOR BEING A GOOD EXAMPLE OF A FLOOR FRACTURED CRATER, IT'S FLOOR WAS RAISED BY VOLCANIC FORCES LONG AFTER THE INITIAL IMPACT WHICH CREATED POSIDONIUS. THE RESULTING CRACKS OR RILLES ARE USUALLY QUITE OBVIOUS BUT TONIGHT THE CENTRAL INTERIOR RILLE WHICH RUNS NORTH TO SOUTH STUBBORNLY REFUSED TO SHOW ITSELF IN THE ANT IV SEEING.

POSIDONIUS UNDER BETTER CONDITIONS SHOWS A WEALTH OF FINE DETAIL. ONE INTERESTING FACT IS THAT JUST TO THE NORTH/EAST OF THE 15km DIA CRATER WHICH IS DESIGNATED POSIDONIUS A IS A MOUNTAIN WITH TWO PEAKS. THESE TWO PEAKS ARE SEPERATED BY A DISTANCE OF SOME 1·9 Km. GIVEN THAT THE MOON IS ROUGHLY 384,400 K.M FROM THE EARTH ON AVERAGE THIS MEANS THE TWO PEAKS ARE SEPERATED BY ALMOST EXACTLY ONE SECOND OF ARC. SO, THESE CAN BE USED TO GIVE A GOOD ESTIMATE OF YOUR TELESCOPES RESOLVING POWER AND/OR SEEING CONDITIONS!

TREVOR SMITH.

Mersenius.

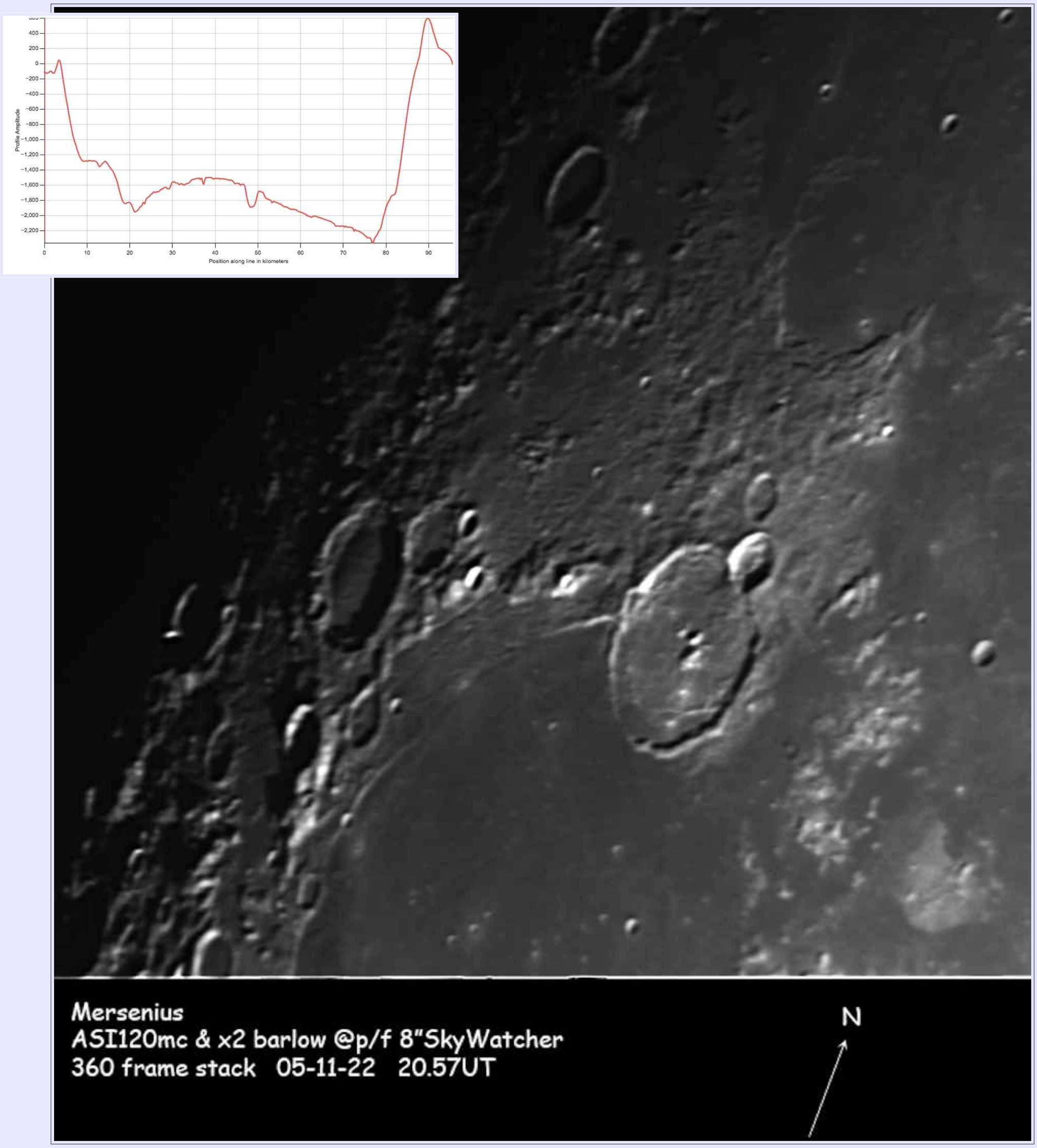
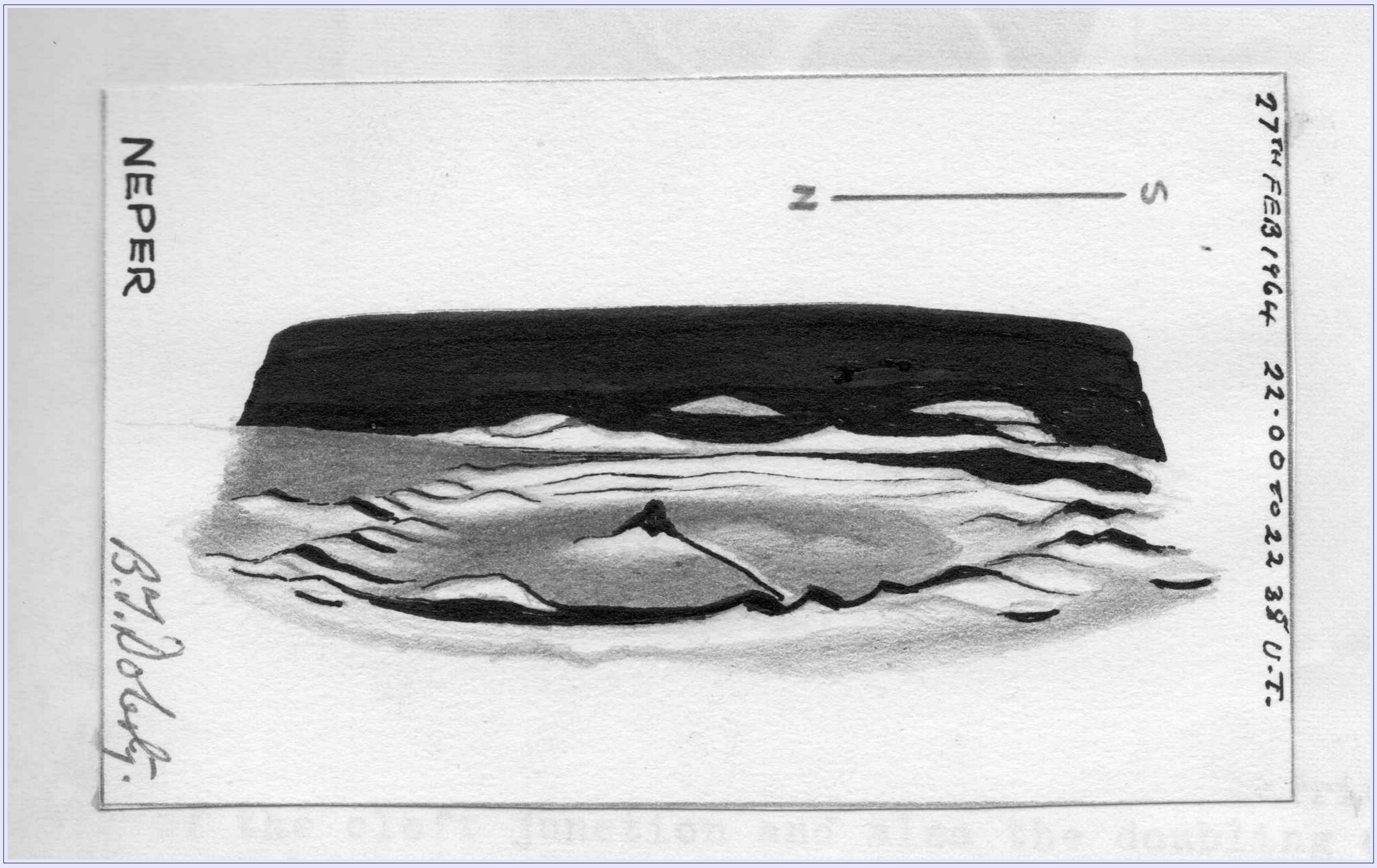


Image by Les Fry with details of time/date and equipment as shown.

Geological Notes: Last month's LSC included a drawing by Paul Abel of Mersenius, and in his observing notes he mention the shelf which lies on the western wall. This can be seen clearly in Les's image, but the image also shows a deep line of shadow between this shelf and the illuminated central part of the crater floor. You will note that the eastern floor is still in shadow whilst the central part is bathed in sunlight, this is because the crater floor bulges upwards in the middle as Mersenius is a Floor Fracture Craters (FFC) and has been modified by a magma body intruding beneath the crater floor. The line of shadow noted above between the shelf on the western wall and the crater floor is the result of there being a shallow 'moat' (~100 to 150m deep) between the two and surrounding the crater floor. This 'moat' is typical of FFC’s, and I have included a topographic profile of the crater as an inset to the image to shows the moat and the shelf. The moat as noted extends around the circumference of the upwards bulging crater floor which is some 650m higher in the centre than the base of the moat.

From the Archive.



NEPER.

Observation by B.T. Doherty. 1964 Ferbruary 27. 2200-2235h. 8½" rfl x 274. Seeing: 8/10 Colong 90°.1 W.

First I noticed the beautiful mountainous structure of the north and south walls. The floor of the crater was extremely dark and contained various features: 1 - a double mountain peak; 2 - two hills south of the peak; 3 - a very fine rille; 4 - a prominent crater of which only the west wall was visible. Looking at the crater, one thing struck me: it seemed as though the lunabase from the adjacent mare (Mare Marginis) had flowed into the crater through the northern wall as the mountains on this particular wall were not as bright nor as high as on the southern wall. West of Neper are what appear to be the eastern wall and the central mountain of yet another large crater.

Drawing and notes on Neper by B.T.Doherty from The Moon. Bulletin of the Lunar Section of the British Astronomical Association. Vol.12, No.4

I selected this drawing to complement the image of Mare Marginis by Dave Finnigan in this issue that shows the crater Neper. Neper's central peak (~ 2200m high) is unusually prominent as compared to the height of the rim, and it also has a rather odd morphology, with rather flattish platform like sections at various points around the edge. Though not obvious, it is a Floor Fracture Crater (FFC), but the fractures are mostly obscured by the mare lavas that subsequently flooded the crater floor. One of these was however spotted by B.T. Doherty and is represented by the linear feature extending from the central peak towards the western rim in the drawing. This fracture actually crosses the central peak from the eastern side of the crater, but it is *extremely* faint and not at all obvious in the spacecraft imagery. Where it crosses the peak it appears to be a graben, indicating that the peak was affected by the floor uplift during the FFC phase – possibly explaining its unusual prominence and odd morphology. Yet another demonstration of the power of visual observations!

Lunar domes (part LXVII): Lacus Veris, Lacus Autumni and Schlüter crater.
By Raffaello Lena.

During an observation carried out on May 6 2023, using a Mak Cassegrain 18 cm, I imaged the western limb of the Moon including Lacus Veris, Lacus Autumni and Schlüter crater (Fig.1).

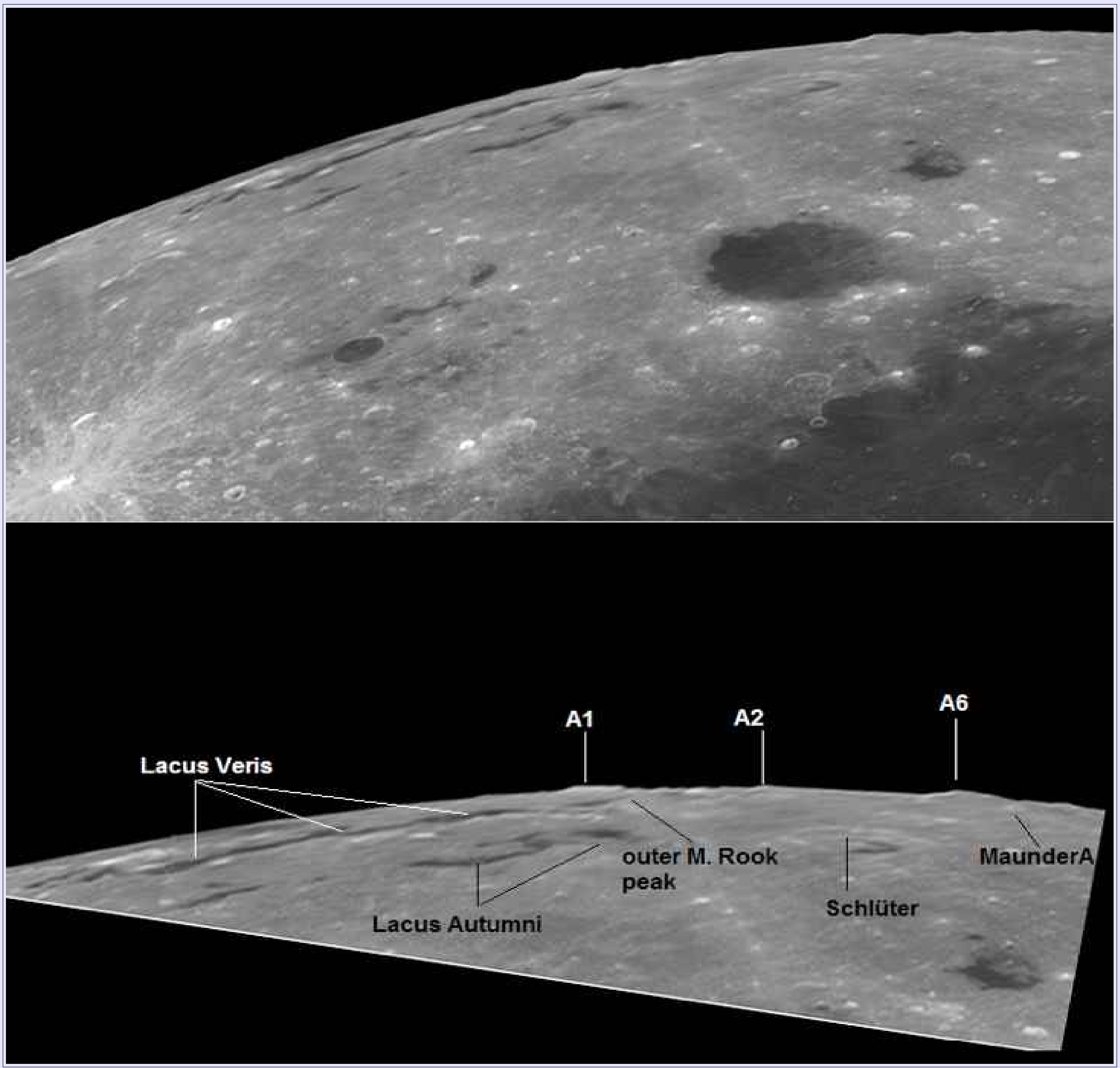


Figure 1: (Top) Image of the author including the described region of Lacus Veris, Lacus Autumni and Schlüter crater. May 6 2023 at 00:10 UT; (bottom) crop of the image with the examined features.

Lacus Veris (Fig.1) lies between the ring-shaped inner and outer Rook Mountains that form part of the Orientale impact basin. Due to the unfavourable librations, Mare Orientale is not visible in the field of view. Some peaks have been identified in the image shown in Fig. 1 according to the work by Vandenbohede (J. Br. Astron. Assoc. 132, 2, 2022). The location of the peaks is shown in Figure 2.

As described by Greeley (1976), Lacus Veris contains sinuous rilles formed from lava tubes and channels and lunar mare domes. Fig. 3 displays the presence of a complex structure, which is related with two lateral plateau-like features. This irregular and elongated swell (marked with the symbol *) is bisected by a central rille suggesting a possible laccolithic nature of this feature (Lena et al., 2013).

To the north is located a lunar dome termed Kopff1 (Fig. 3). It has been studied in the past: Kopff1 is 190m high, with a diameter of 7km yielding an average flank slope of 3.27° (Fig. 4). The edifice volume, computed assuming a parabolic shape, was determined to 4.6km^3.

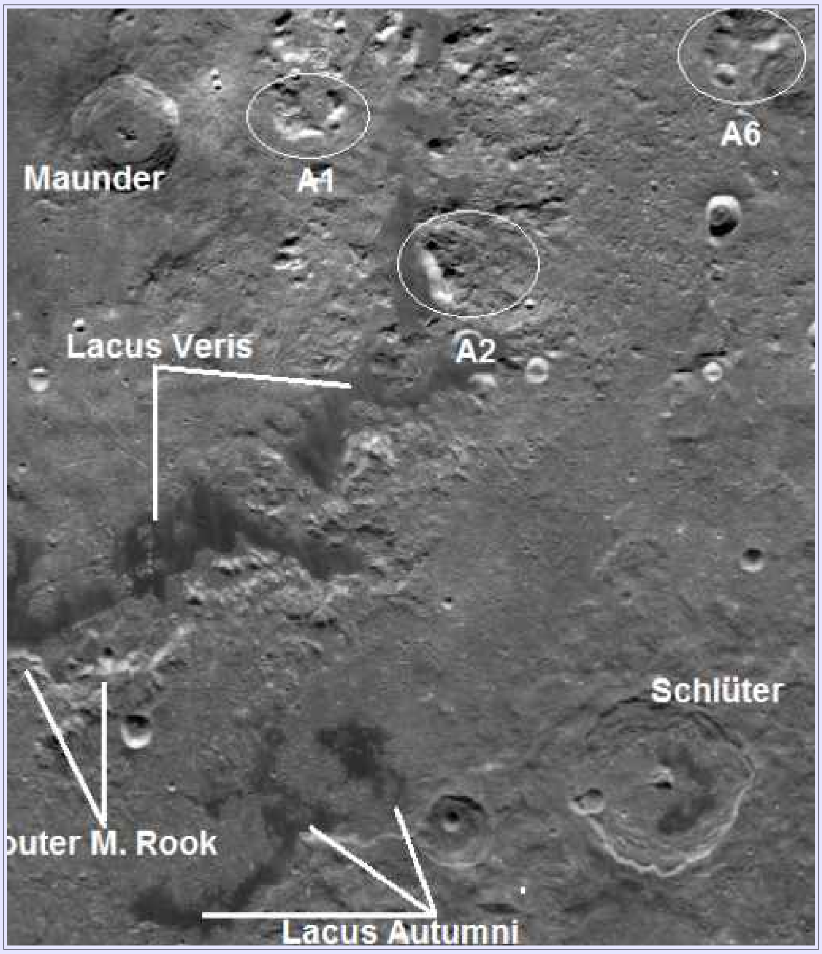


Figure 2: WAC imagery of the examined region. Identification of the peaks imaged in the telescopic image of Fig. 1.

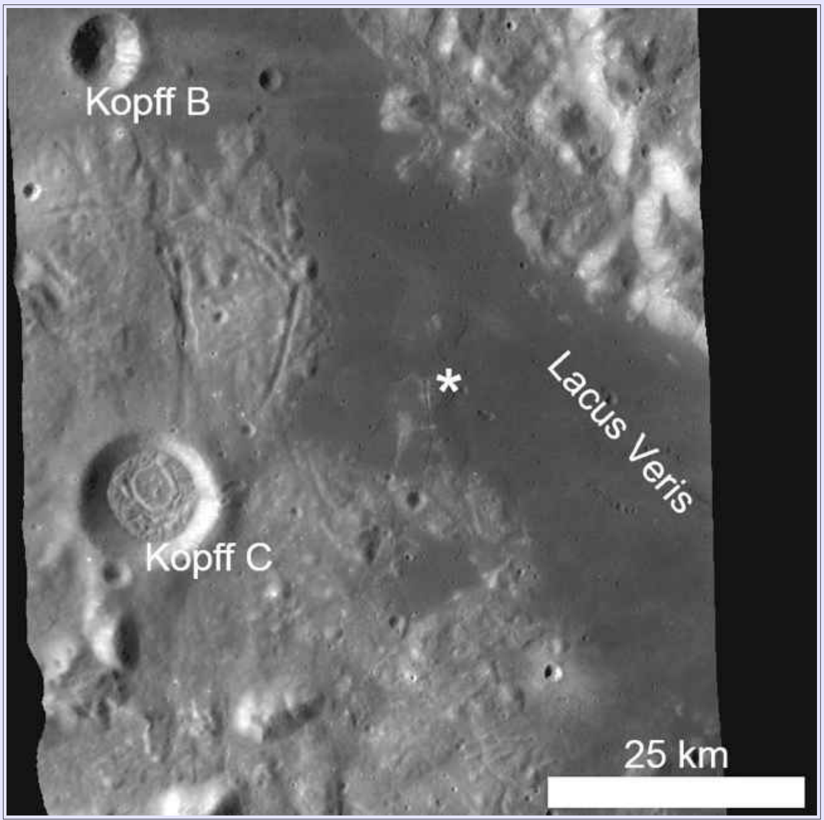


Figure 3: WAC imagery of the region of interest. The dome termed Kopff1 is located to the north (up) of an elongated swell (marked with the symbol *).

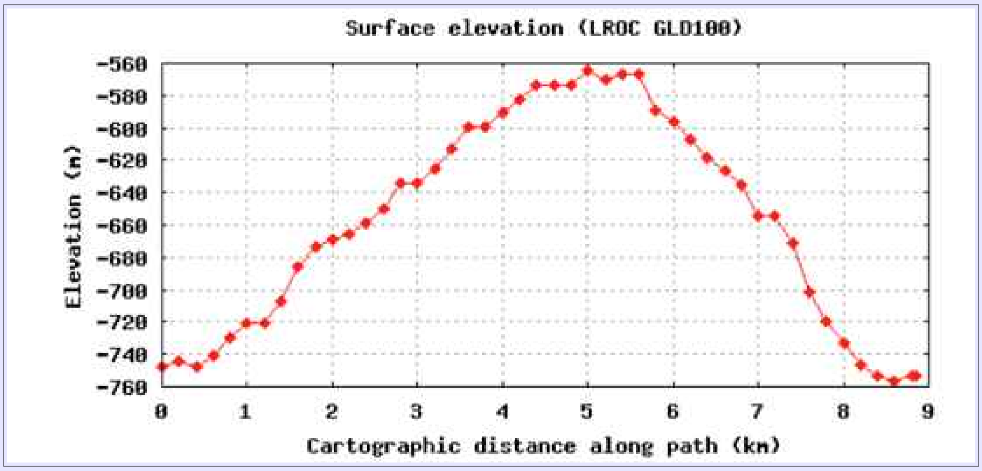


Figure 4: LRO WAC-derived surface elevation plot of an east to west cross-section of the dome Kopff1.

Volcanism in Schlüter.

Schlüter is an impact crater (diameter of 89km) located northeast of Orientale basin (~300 km north of Kopff crater), and it has a central peak and floor fractures. It is detectable in Fig. 1 showing some dark patches, likely DMDs. A WAC image of Schlüter is shown in Fig. 5.

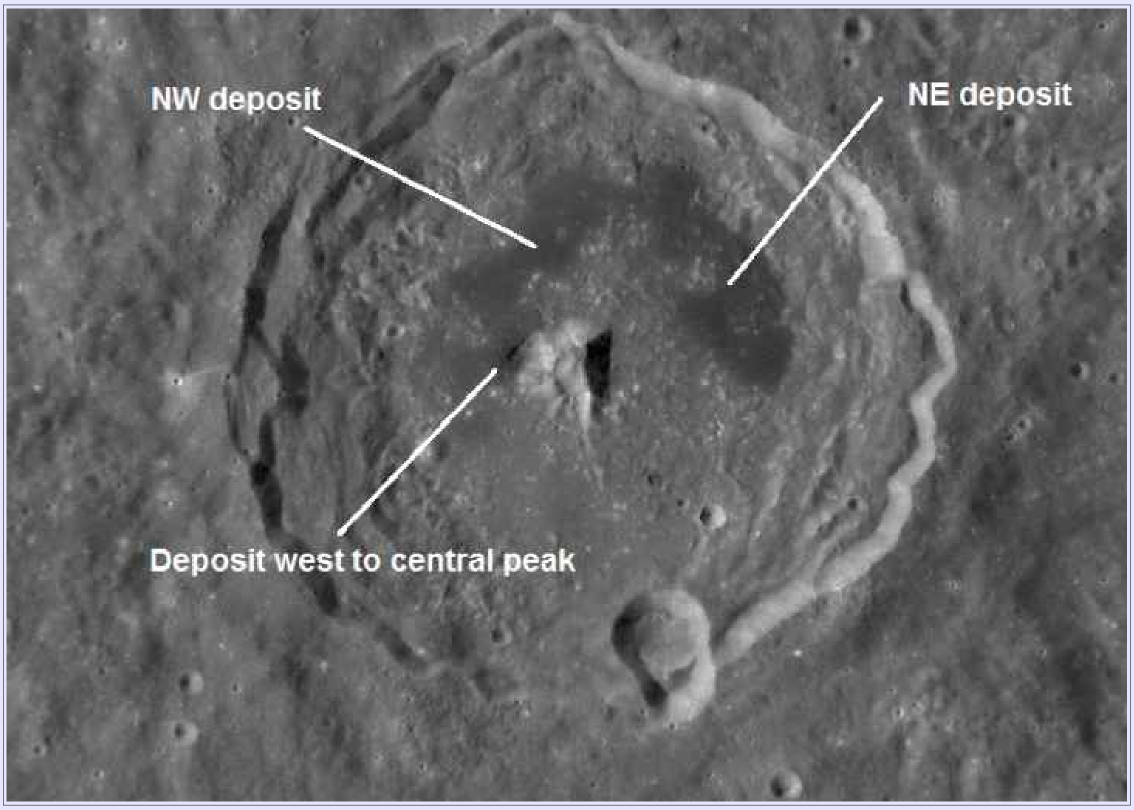


Figure 5: Schlüter. WAC imagery.

Dark units covering fractures and hummocks are visible in the northern and west central part of the crater floor. Gustafson et al. (2012) identified three areas of possible pyroclastic deposits within Schlüter: two associated with the mare materials in the western and northeastern portions of the crater floor and a third possible deposit just west of the central peak. Hence also in Schlüter volcanic activity occurred.

Spectral data

In this study I used the approach described by Besse et al. (2014) based on the M^3 spectral data of recognized Dark Mantling Deposits (DMDs) including mineralogical evidence indicative of the presence of volcanic glasses.

Pyroxenes have two absorption bands, one centred near 1000nm and another near 2000nm; these band centers move to longer wavelengths as Ca and Fe substitute for Mg.

Olivine has a complex absorption band centred beyond 1050nm that moves as Fe substitutes for Mg (Besse et al., 2014). Significant amounts of olivine in lunar volcanic deposits will broaden the pyroxene absorption at 1000nm and shift it to longer wavelengths, while the 2000nm band remains fixed. Because olivine lacks a band at 2000nm, the 1000nm absorption in olivine-rich lunar deposits will be strengthened relative to the 2000nm band.

The presence of Fe-rich volcanic glasses in lunar soils causes broad and shallow absorption bands because of the amorphous structure of the glasses as described by Besse et al. (2014). The 1000nm band center of lunar glass is generally shifted to longer wavelengths when compared to pyroxene, and the 2000nm band center to shorter wavelengths. Thus, the 1000 and 2000nm band center positions of lunar glasses will typically appear close together than those of pyroxenes.

M^3 Spectral data

From the M^3 observations, the Schlüter DMDs exhibit different mineralogy. The change in position and shape of the absorption is also consistent with the presence of volcanic glass. These results are confirmed by the spectra reported in Fig. 7. The 1000 and 2000nm band locations are shifted to longer and shorter wavelengths, respectively, and attributed to volcanic glass contribution.

Band center at 2000 nm

This parameter was derived from standard processing and calibrated level 2 of M^3 data. The 1000nm band center of lunar glass is generally shifted to longer wavelengths when compared to pyroxene, and the 2000 nm band center to shorter wavelengths. Figures 6a and 6b display the derived values for the examined deposits, which range from 1950nm to 2200nm.

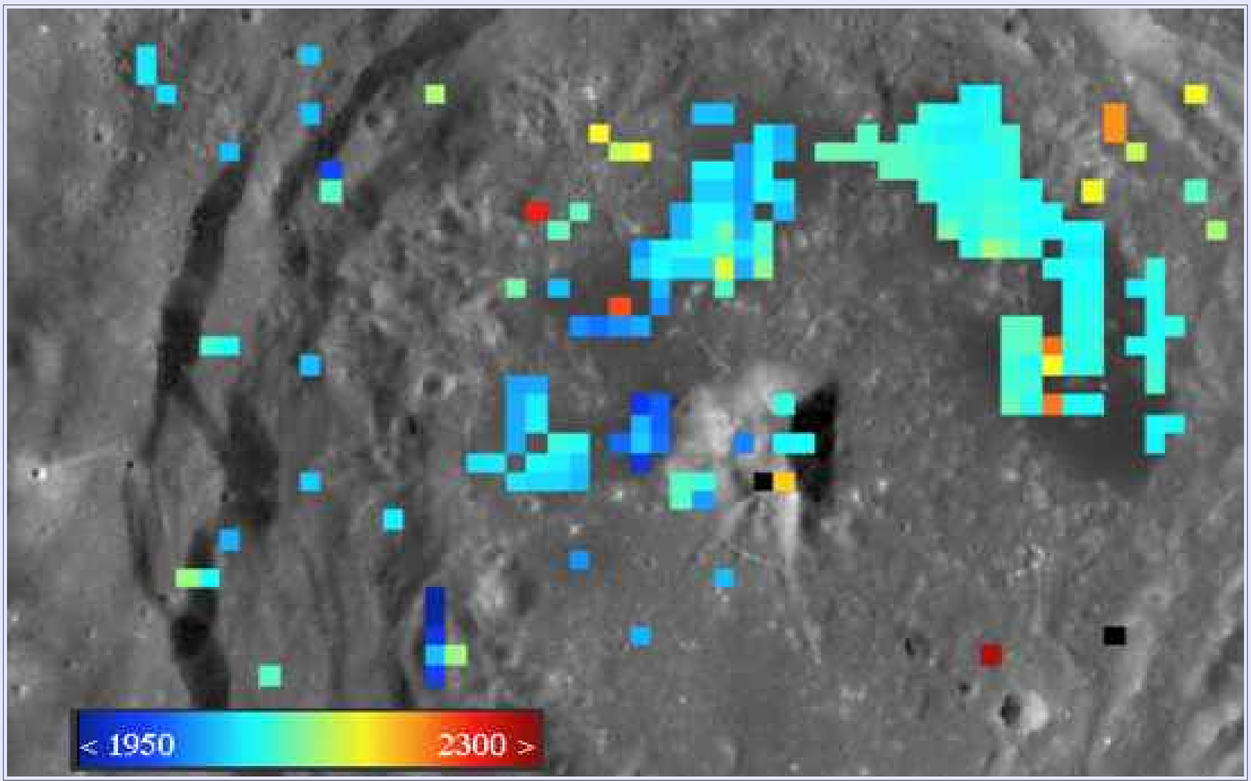


Figure 6a: Centre of the 2000nm spectral absorption band, sensitive to pyroxene composition. Shorter-wavelength band centers are associated with glasses. To minimize the effects of noise, only pixels with band depths greater than 0.05 are shown.

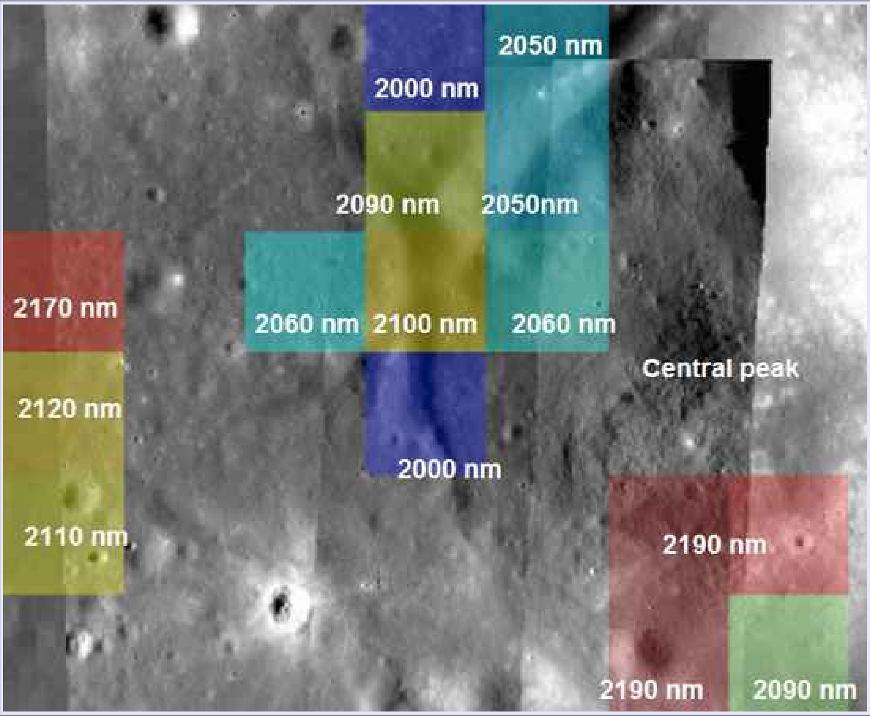


Figure 6b: Center of the 2000nm spectral absorption band, sensitive to pyroxene composition near the central peak. Shorter-wavelength band centers are associated with glasses. To minimize the effects of noise, only pixels with band depths greater than 0.05 are shown.

As shown in Fig. 7, the 1000nm band of the DMD west of the central peak is broad suggesting that a component such as volcanic glass or olivine may be present.

Table 1 displays the absorption bands center derived for the sampled regions.

Feature	1000nm band	2000nm band	OPX wt%	CPX wt%	FeO wt%
West of central peak	980 and 1120	2000-2060	23.0-30.0	7.0-14.0	16.0
North west deposit	980	2150	14.0-22.2	13.1-22.0	12.5
North east deposit	990	2160	13.0-18.0	14.0-24.0	13.2

Table 1: Absorption bands center for Schlüter pyroclastic deposits. The presence of volcanic glass in a spectrum is considered to be the strongest evidence in support of a pyroclastic origin. **OPX (orthopyroxenes),** ***CPX (clinopyroxenes) and Iron oxide in wt%.***

The pyroclastic deposit to the west of the central peak displays a FeO of 16.0 wt %, and lower amounts in the northern deposits. As shown in Fig. 7, the 1000nm band of the DMD west of the central peak is broad suggesting that a component such as volcanic glass or olivine may be present.

The deposit west of the central peak shows an enhanced abundance of orthopyroxene (OPX) from 23.0 wt % to 30.0 wt % and a lower abundance of clinopyroxene (7.0-14.0 wt %) if compared with two deposits to the north, suggesting the presence, in the examined region, of volcanic products of different composition (Table 1).

Although the wider and shifted 1000nm absorptions could also be attributed to the presence of olivine in the deposit located to the west of central peak, the shift to shorter wavelengths of the 2000nm absorptions and the relative strength of the 2000nm band are indicative of the presence of volcanic glasses signature.

Besse et al. (2014) describe the Schlüter deposit to the west of central peak with a 1000nm band at 980 and 1120nm (broad) and 2000nm band at 2050nm, in good accord with the analysis reported in this note by the author (Table 1).

In particular, the deposit located west of the central peak displays a vent-like structure that correlates well with the extent of mafic signatures. The two deposits to the north exhibit different spectral properties with higher Ca-pyroxene content but with absence of volcanic glass signature.

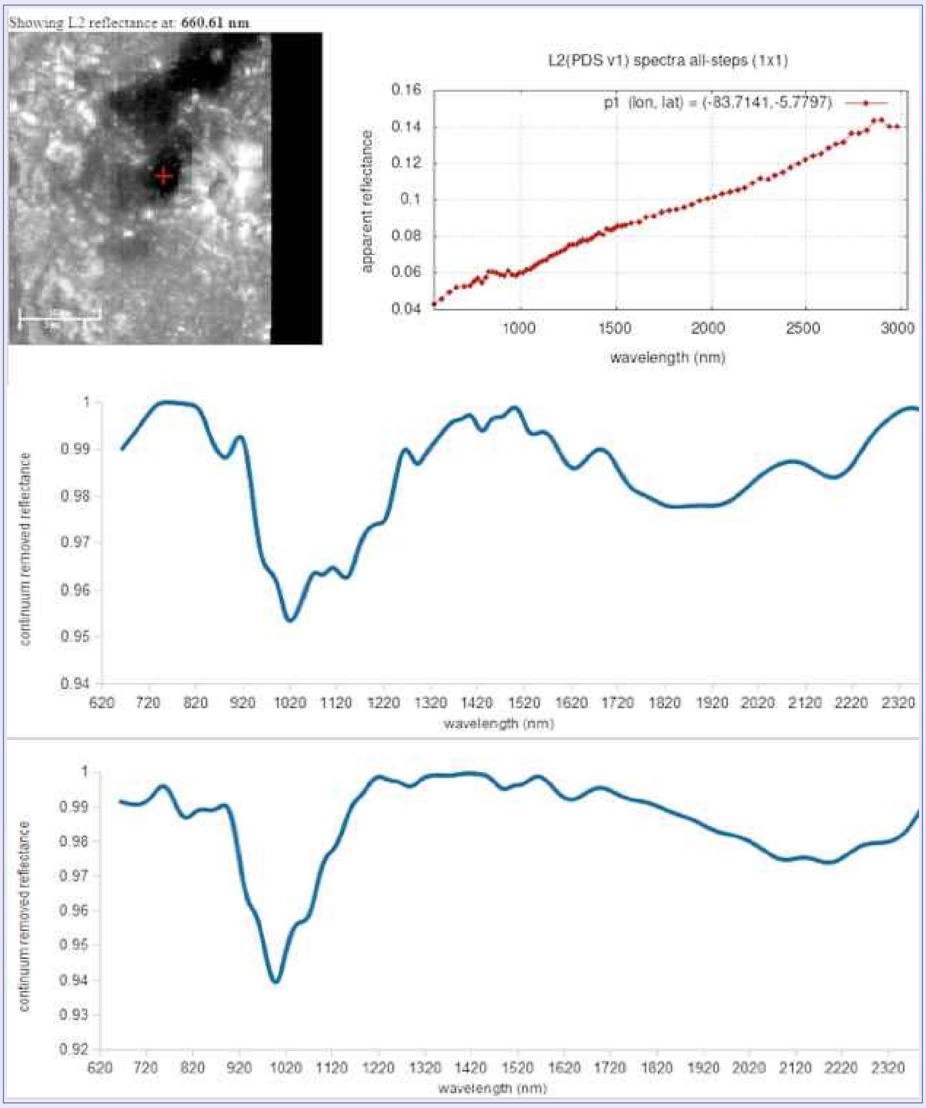


Figure 7: M³ spectra Orbital period OP2C1. Note the broad 1000nm absorption band for Schlüter to the west of central peak (middle). (Bottom) Spectrum of the northern deposits.

Contribution of Volcanic Glasses.

A cluster of possible DMDs with band positions very close to the orange glass is used as a criterion to characterize them as DMDs (Fig. 8). Based on this diagram the Schlüter deposit to the west of central peak is plotted in the orange glasses field. The other two deposits are plotted in the mare basalts signature.

Conclusion.

This note describes some potential observing projects regarding the little-known lunar areas Luna Incognita, and Mare Orientale which need specific libration to be observed. It would be interesting to receive any terrestrial telescopes images of Mare Orientale, including Lacus Veris, for further studies.

Lacus Veris and Lacus Autumni can imaged by terrestrial telescopes despite the foreshortening effect. Volcanic phenomena have occurred in these areas with the formation of lava plain and also lunar domes (in Lacus Veris near Kopff as described above). Dark Mantling deposits are also observable in the Schlüter crater and through the images of the probes and spectral analysis their composition can be identified.

In this note the presence of volcanic glass signature was highlighted within a restricted area to the west of the central peak, confirming the analysis in the literature (Besse et al., 2014). The use of these techniques can broaden amateur astronomy activities to understanding the evolution and geological processes that have occurred in the Moon.

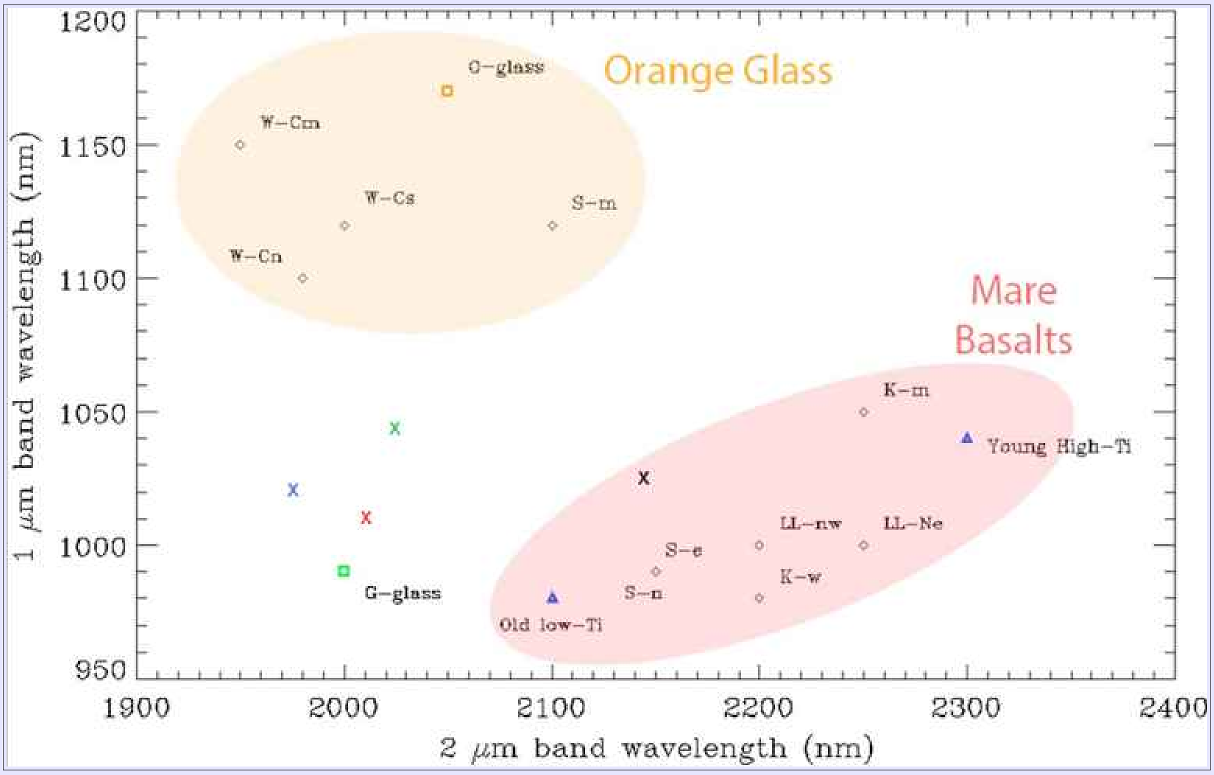


Figure 8: Diagram of the band position at 1000 and 200nm. Adapted by the work of Besse et al. (2014).

References.

Besse, S., J. M. Sunshine, and L. R. Gaddis (2014), Volcanic glass signatures in spectroscopic survey of newly proposed lunar pyroclastic deposits, J. Geophys. Res. Planets, 119, doi:10.1002/2013JE004537.

Greeley, R. (March 15–19, 1976). "Modes of emplacement of basalt terrains and an analysis of mare volcanism in the Orientale Basin". Proceedings, 7th Lunar Science Conference. Houston, Texas: Pergamon Press, Inc. pp. 2747–2759.

Greeley, R. (March 1976). "Mare Emplacement in the Orientale Basin". Proceedings, Lunar and Planetary Science Conference 7. pp. 334–335.

Gustafson, J. O., J. F. Bell III, L. R. Gaddis, B. R. Hawke, and T. A. Giguere (2012), Characterization of previously unidentified lunar pyroclastic deposits using Lunar Reconnaissance Orbiter Camera data, J. Geophys. Res.,117, E00H25,doi:10.1029/2011JE00389

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

………...

Not completely smooth.
By Barry Fitz-Gerald.

In the December 2001 LSC, Raffaello Braga reported a probable dome in Mare Humorum[1] to the ESE of the 5.6km diameter crater Doppelmayer J, and included in his article a photograph of the previously un-reported structure taken with the 2.2metres Max-Planck Gesellschaft ESO telescope at La Silla, Chile (Fig.1).

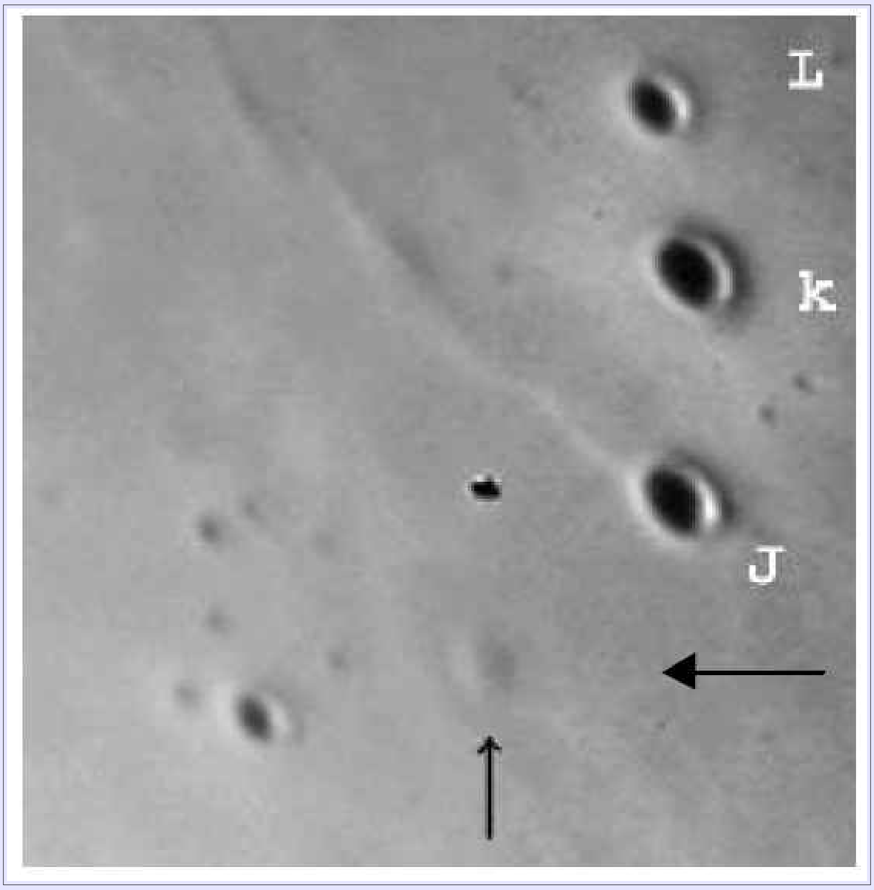


Fig.1 Image reproduced from Raffaello Braga's article in the December 2001 LSC of the new dome in Mare Humorum.

A follow up article by Raffaello appeared in the May 2002 LSC[2], and in the meantime Nigel Longshaw observed and drew the area (Fig.2) including the dome in November 2001[3]. Nigel was using a 15cm Maksutov Cassegrain for his observations, but clearly the dome was a somewhat tricky target, so probably a larger aperture would be required to make it out clearly. This dome is shown on Raf Lena's GLR Group Dome Map[4] making it one of the (if not *the*) only domes present within this area of mare.

We now have the LRO and SELENE images to look at and can get a better idea of what this dome looks like, and it is quite unlike most of the lunar domes we are familiar with. The LRO imagery (Fig.3) shows the dome to be a kite shaped structure, approximately 5km x 4.5km but only elevated some 80-90m above the mare surface. This broadly agrees with the vital statistics reported by Raffaello of a diameter of approximately 4.7kms, a height of between 140 and 120m and a mean slope of between 1° and 3°. Nigel also suggested a major axis of less than 5kms – not a bad estimate I would say! There is what might be taken for a summit crater, but whether this is a summit crater or just a crater on the summit is a moot point. This is because, despite being elevated above the surrounding mare, this structure exhibits nothing of a compelling nature to indicate it is of volcanic origin, with no real difference mineralogically between it and the surrounding mare, and nothing in the way of lava flows or indications of pyroclastic deposits. This is not however definitive evidence that it is *not* volcanic, as there are plenty of examples of probable lunar volcanic domes that tend to blend into the background mare without flaunting any signs of their true origin.

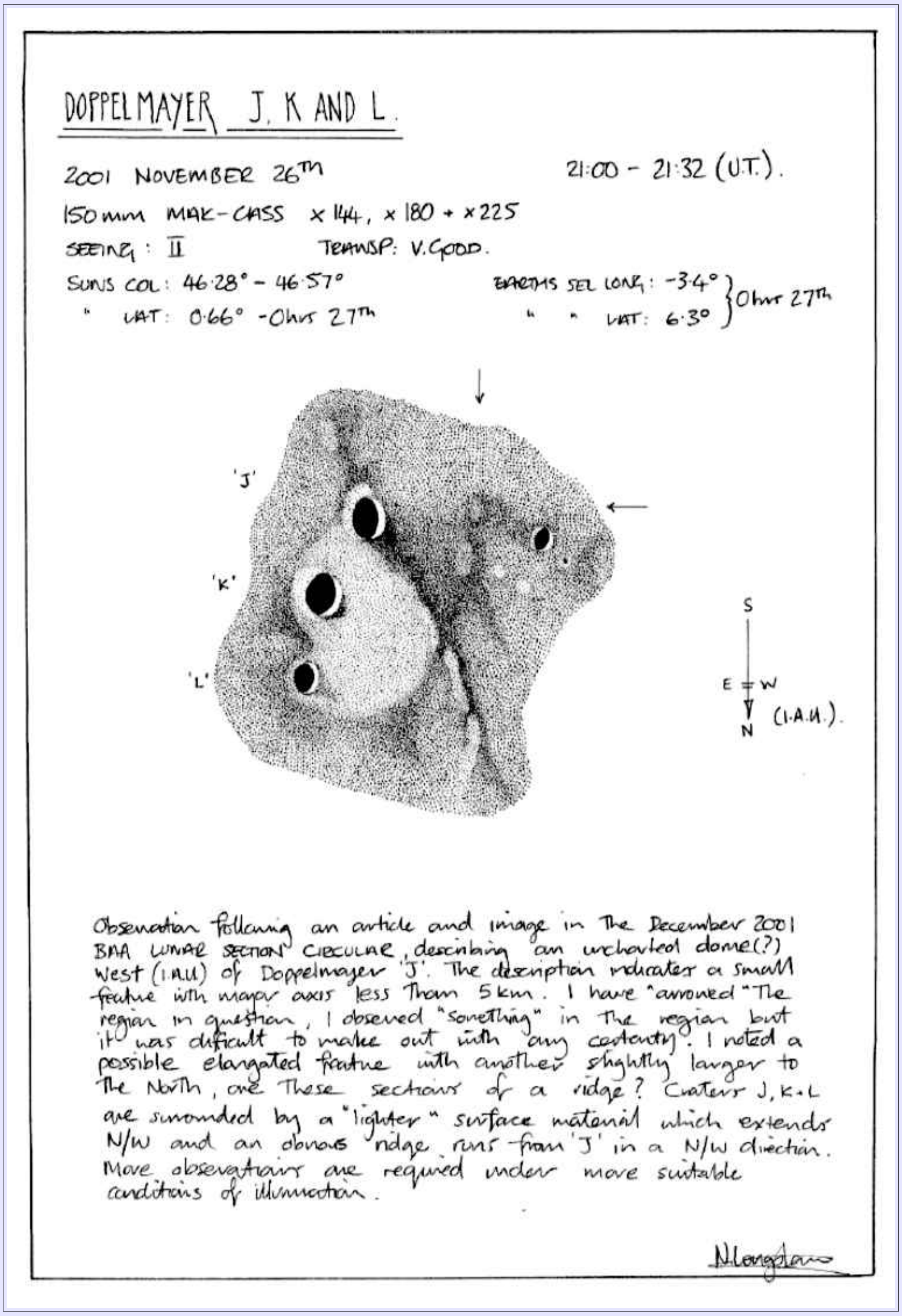


Fig.2 Drawing by Nigel Longshaw reproduced from the February 2002 LSC.

The LRO images reveals a rather angular, slab like configuration, with a prominent scarp between 40 and 60m high running NE-SW with a section of the dome to the east lower than that to the west. The face of this scarp is quite bouldery where rocks have eroded away from higher levels. So, could this be a fault that traversed the dome, with the eastern side being the 'downthrow' side – that is having subsided relative to the western part? There is a certain amount of evidence for this in the form of a continuation of the scarp onto the mare surface to the NE, but this continuation is, to say the least, extremely faint.

The 'slabby' nature of the dome surface is revealed in the very low angle illumination NAC image seen in Fig.4. This suggests another possible mode of origin, in which the dome is not a volcanic structure, but slabs of rafted basalt crust that solidified over a still molten layer. If this molten layer subsided, the solid crust would subside with it, possibly cracking into large slabs as it did so, particularly if it became 'grounded' on a previously submerged hill or crater rim. This type of process *might* explain the unusual morphology of the dome and will be explored further, once we have surveyed some nearby areas and features.

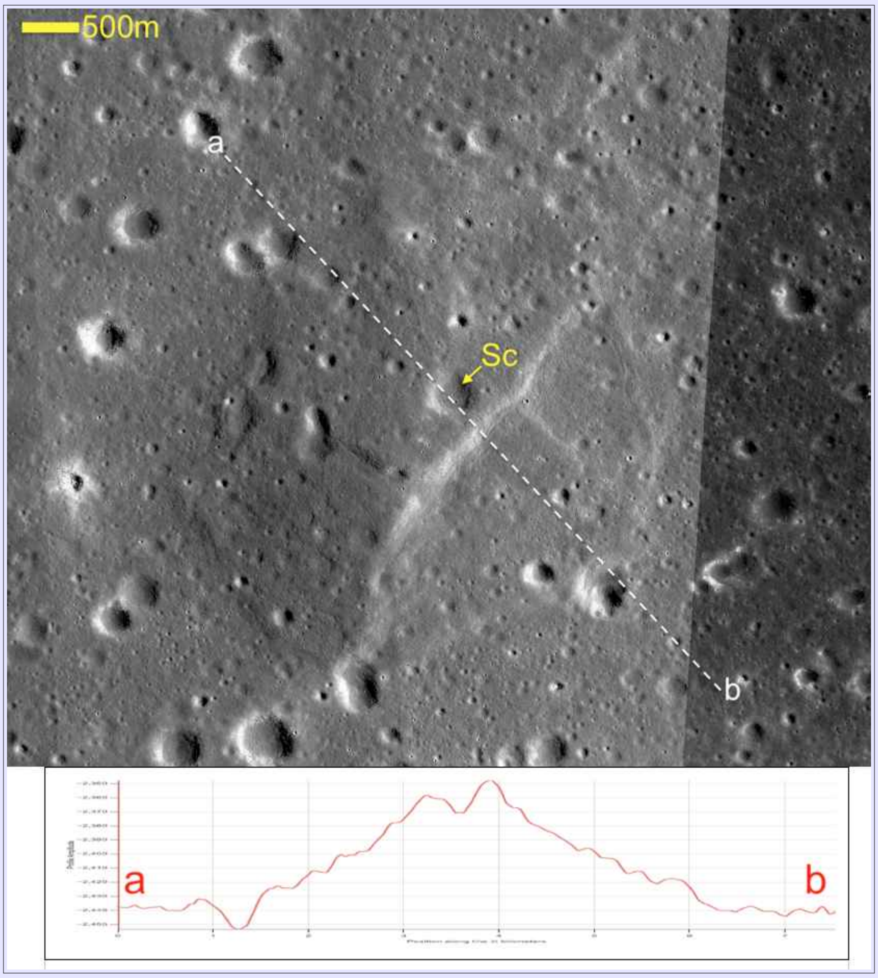


Fig.3 LRO NAC image of the dome reported in the 2001 LSC by Bragga. The topographic profile along line a-b is shown below, but with considerable vertical exaggeration. Sc might be a summit crater or just a crater on the summit.

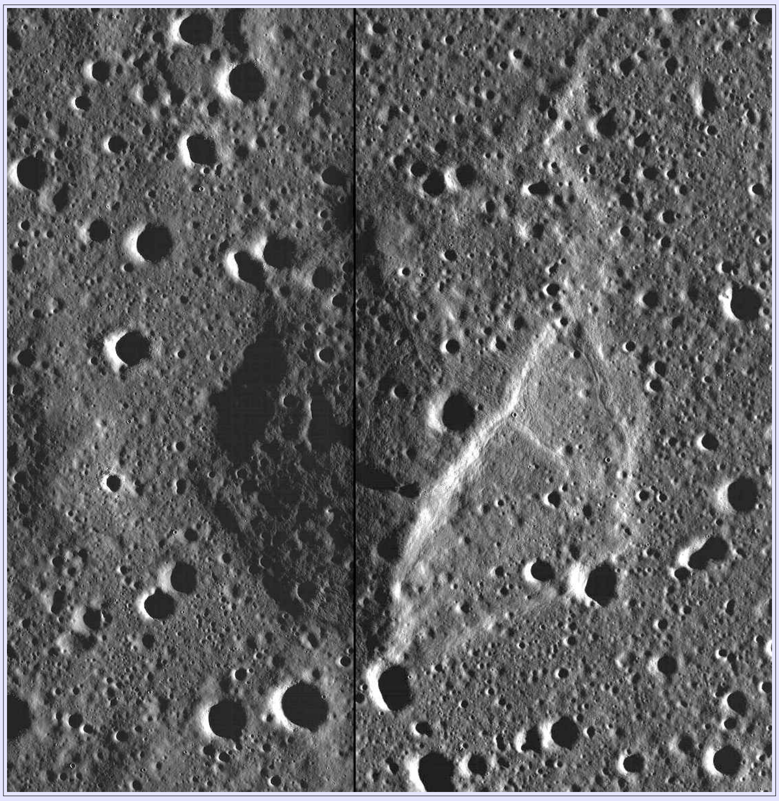


Fig.4 LRO NAC image at extremely low angle of illumination showing the 'slabby' nature of the dome.

Moving on from the dome itself, it is apparent in some of the imagery, particularly those with low angle illumination (such as the WAC Nearside (big shadows) overlay in Quickmap), that the mare surface to the south is far from being the smooth lava plain we normally associate with basalt lava flows. Fig.5 is an LRO WAC image with 'big shadows' (that is, grazing morning illumination) and this rather rough texture can be seen within the area approximately bounded by the yellow dotted line. This area is also identified in Box.1 of Fig.8.

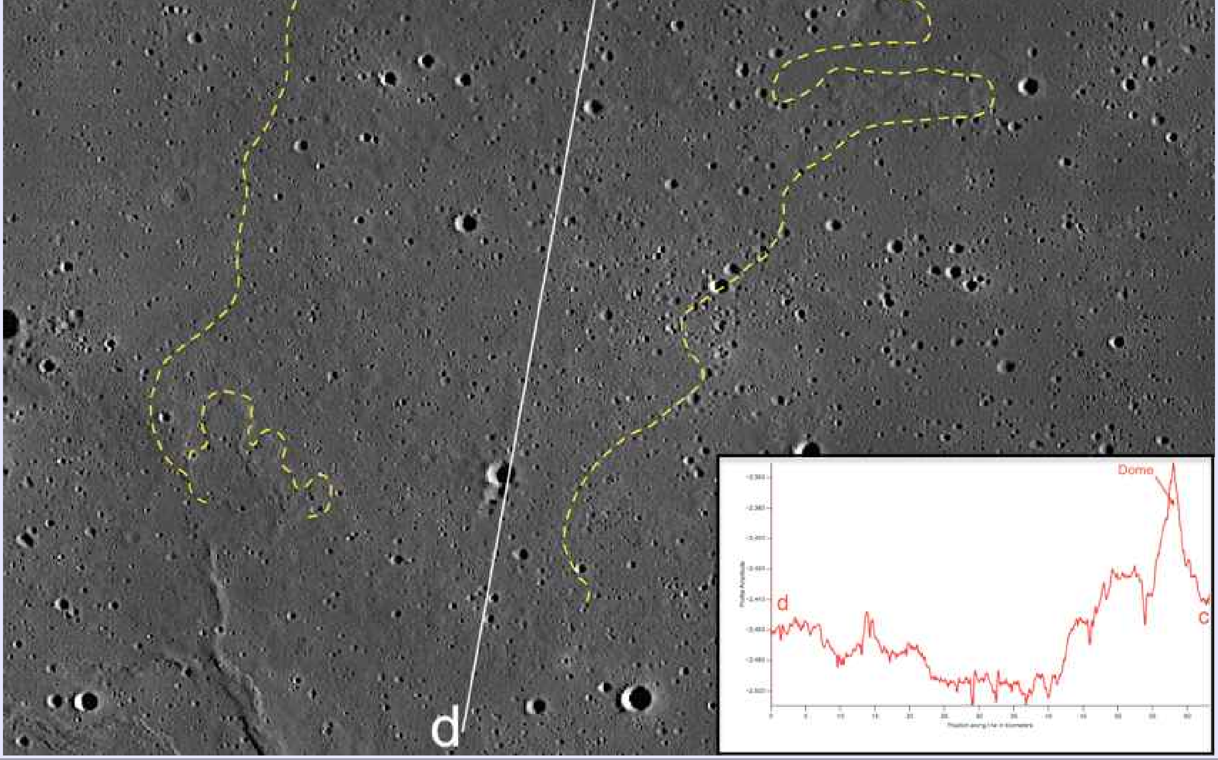


Fig.5 A LRO WAC image of the depressed area (approximately within the yellow dashed line) to the south of the dome showing the roughness of the surface which is only really apparent in very low angle illumination views. The topographic cross section in the inset shows how the area is depressed relative to much of the surrounding mare. The dome is just below the letter C at the end of the white line.

This roughness is quite subtle but quite real and can be seen in the LOLA surface roughness data in Quickmap, which is probably the best place to explore the images of this area, as the screenshots provided with this article do not portray the texture particularly well. As can be seen from the topographic chart inset in Fig.5, the rough area is somewhat depressed beneath the surrounding mare, and a longer transect across Mare Humorum from SW to NE shows that this area is one of the lower parts of the mare surface (Fig.6). The roughness itself is best described as appearing to be numerous rounded hills and ridges, on the order of several hundred meters long/wide and between 5 and 20m high (Fig.7). In high resolution images taken by various observers, the area appears to be pretty much the same as the rest of the mare surface, so probably any irregularities are well below the resolution of amateur equipment, and the only distinguishing feature visually appears to be irregular higher albedo like patches over parts of this south-western quadrant of the basin. A further rough patch can be seen to the west of the crater in the top left of Fig.5 and located in Box.2 of Fig.8. This is less extensive than the one to the south of the dome, but it may well be a continuation of the same terrain albeit with a less rough area in between, thus dividing a larger rough patch into two smaller ones.

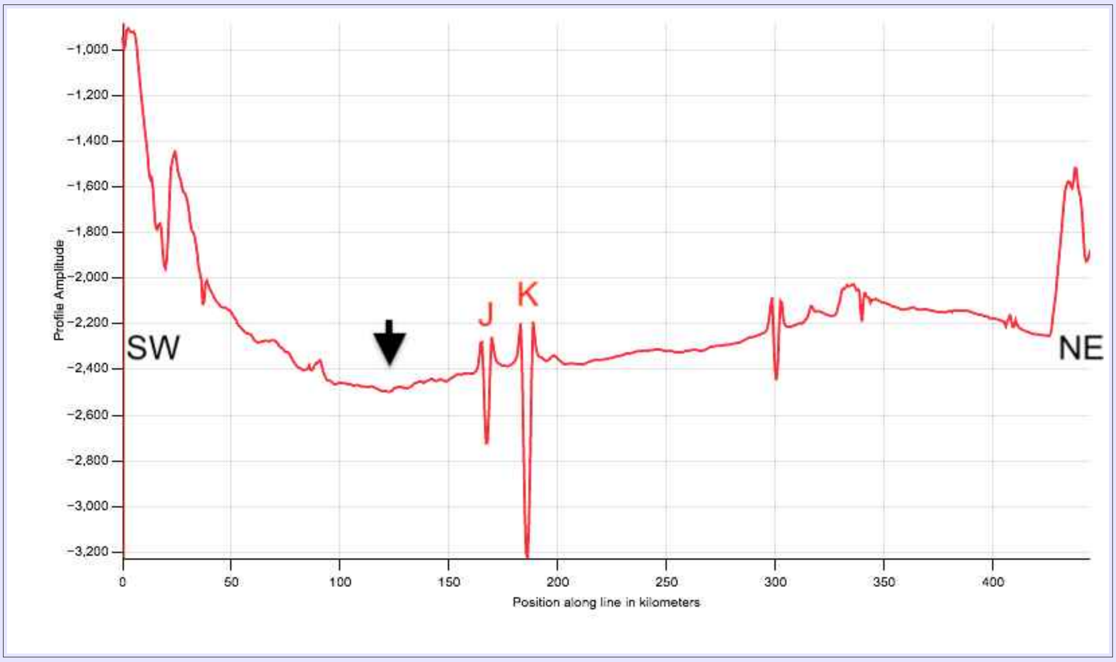


Fig.6 Topographic profile across Mare Humorum from SW to NE and passing over the rough area shown in Fig.5 (identified with black arrow). The craters Dopplemeyer J and K are shown.

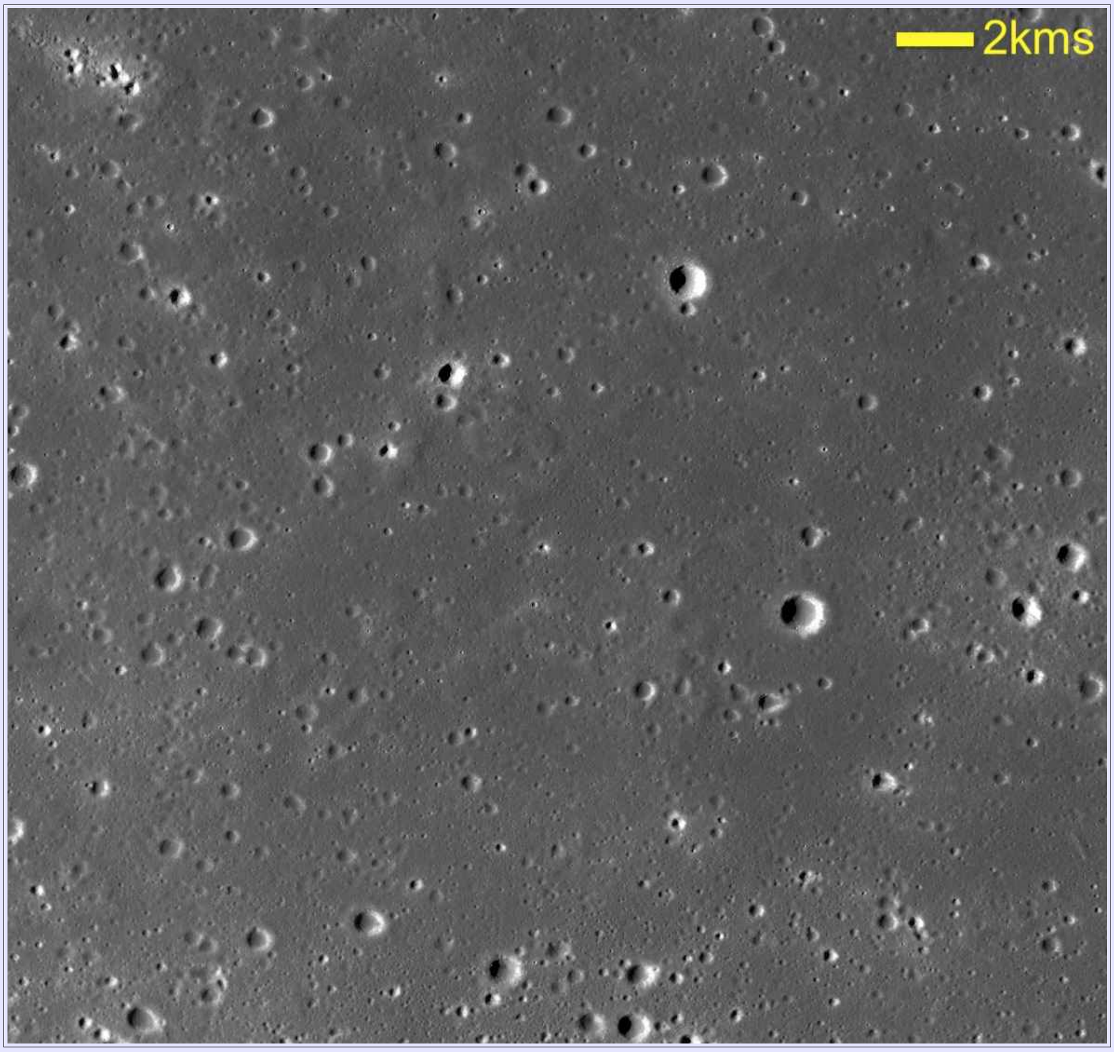


Fig.7 A SELENE image of part of the rough area within the yellow dashed line of Fig.5. Some of the positive relief areas of roughness can be seen, but the variation in height to insufficient to show up well.

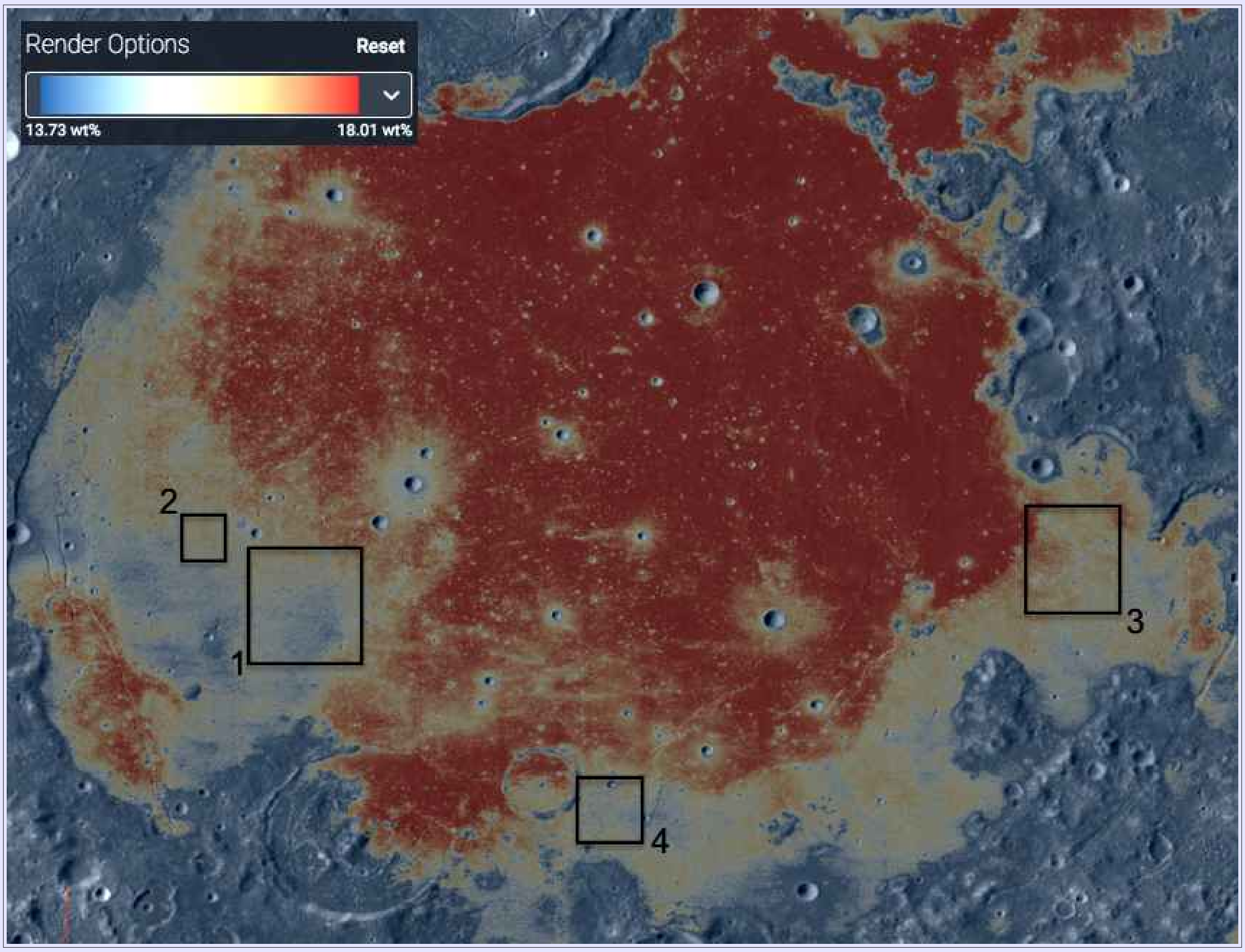


Fig.8 Abundance of FeO (wt %) map for Mare Humorum based on SELENE/Kaguya Mineral Mapper reflectance data. Reds denote high FeO content and blues low. This plot is essentially a negative version of the plagioclase abundance map.

This roughness may be a result of the thickness or rather thinness of the mare basalts in the areas around the edge of the basin. Fig.8 shows a Quickmap overlay depicting the abundance of FeO (iron oxide) derived from SELENE/Kaguya data over Mare Humorum. As can be seen the western edge of the mare (with the exception of the area around Rimae Doppelmayer) shows up as blue in this rendering, which indicates a lower abundance of FeO (iron oxide) which is a signature feature of mare basalts – which show up a red. This distribution map is almost a negative of the one showing plagioclase abundance, so where FeO is abundant plagioclase is not and vice versa. So our rough patch has a low iron content but high plagioclase one. As noted above, this area visually has a patchy higher albedo appearance, despite appearing to be mare like in appearance. A possible explanation is that the mare lavas here are relatively thin, and as a consequence many impact craters penetrate it and excavate the underlying layers which are of a highland composition. This would spread a plagioclase rich mantling over the surface, obscuring the iron rich signal of the surface basalts. There is a third area of this rough terrain (Box.3 Fig.8) on the eastern shore of the mare, to the south of Hippalus A, and as with the previous two it is located on a mare surface which shows a lower iron content than the more central areas of the basin.

Another type of anomalous surface can be seen to the SE of the rim of the mare flooded crater Puiseux (Box.4 Fig.8). This surface however is quite different to the rough surface discussed above, and has a distinctly 'etched' appearance, with numerous hollows and channels separated by small flat topped hills which appear to be remnants of a heavily eroded mare surface (Fig.9). This type of 'etched' terrain is often seen in locations where 'lava lakes' existed, but subsequently drained away, either by out-flow via a channel that breached the lake rim or possibly by draining via some sub-surface route, though evidence for this latter scenario would be difficult to demonstrate. What is also frequently seen in these former lava lakes are 'tide marks' in the form of narrow terraces around the edges of some of the former lakes. These possibly form where the lava level stabilised at a lower height and either thermally eroded into the shores of the lake to produce what in effect would be a narrow beach (I prefer yellow sandy ones) or the lava at the edges chilled to produce a solidified rim around the still molten body.

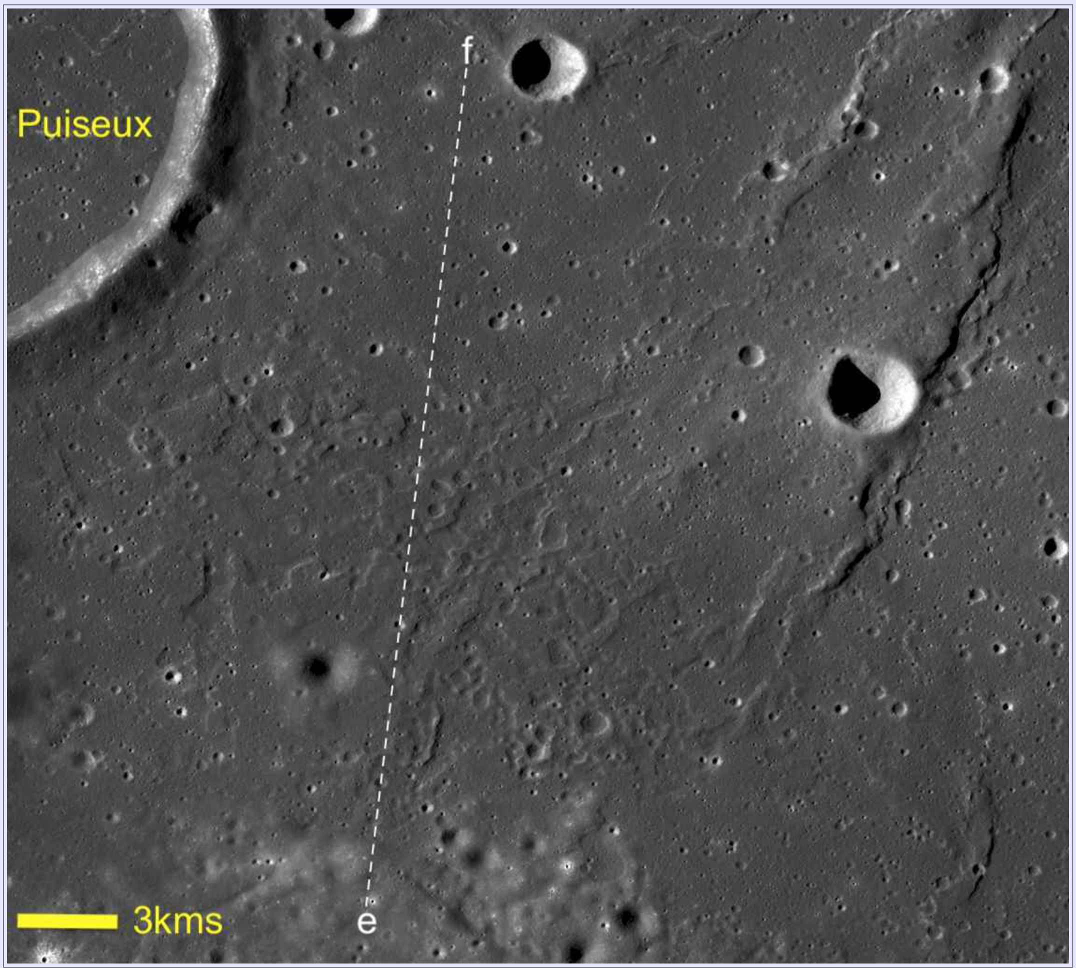


Fig.9 SELENE image of the etched terrain to the SE of Puiseux. The plot along line e-f is shown below in Fig.10.

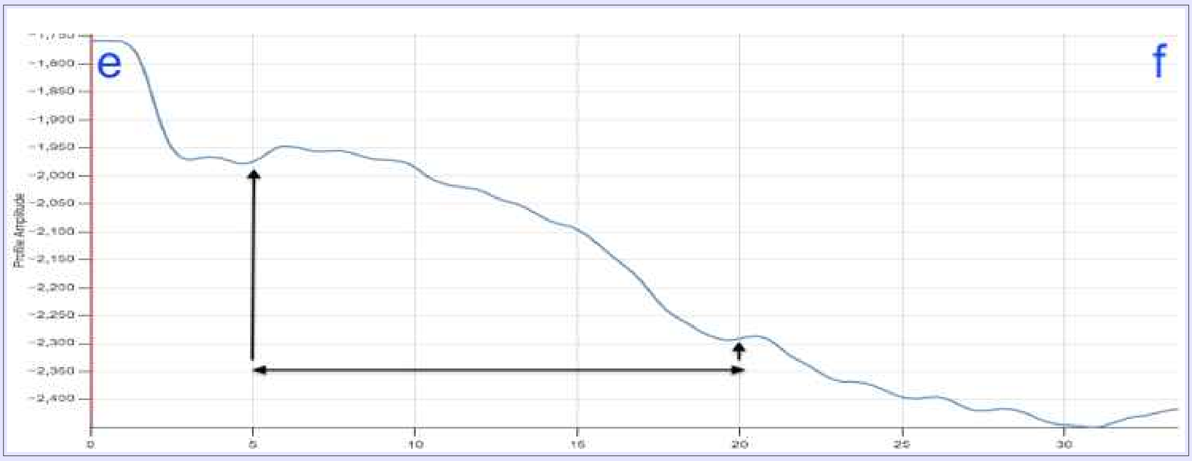


Fig.10 Plot along line e-f in Fig.9. The etched terrain is located on the slope between the two black arrows.

The etched terrain here shows evidence for both out-flow channels and has a number of tide marks which indicate different lava levels at various times, both quite reminiscent of the lava-lake situation. If a lava lake existed here it would imply the presence of a magma source in the form of a vent or vents somewhere in the area, but none are evident. This terrain also slopes downwards towards the north and the centre of the basin (Fig.10), so this is not a level surface on which a lake might form, but then again it may have been level before the middle of the Humorum basin sagged under the weight of the basalt pile accumulating within it.

Another possibility is this terrain was formed as the shallow margins of the basin became flooded by molten basalt lavas that thermally eroded the underlying surface to produce the etched pattern we see. Subsequently this molten lava retreated northwards, back into the basin, exposing the etched surface beneath and producing some of the channel like features and high tide marks we observe.

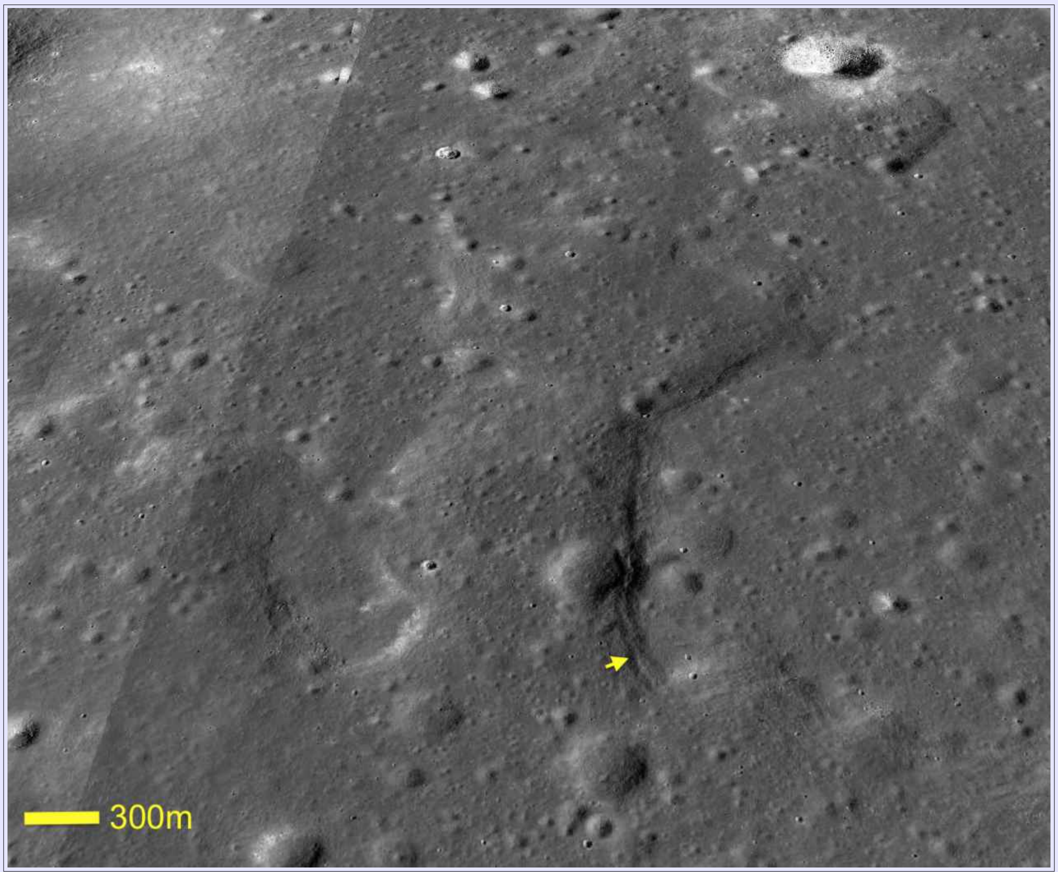


Fig.11 LRO-NAC view of an apparent open channel along which molten lava has flowed – the view is south facing and so the lava would have been flowing north (towards you) and into Mare Humorum. The yellow arrow marks a bench like high tide mark produced by a lower lava level possibly eroding into the channel side.

As is evident from Fig.8 this area is also on the ring of lower iron content surrounding the southern part of the mare, indicating that terrain of a highland composition, possibly forming part of the original Humorum basin floor, is only thinly covered by basaltic layers.

So, what does all this signify? Well the rough terrain and the etched terrain may be explained by an inundation of the original highland dominated basin floor by basalt lavas which not only covered the underlying terrain but thermally eroded this basement to produce an essentially uneven bed to a shallow molten lava lake. A drop in the level of this lake, whilst it was still molten might then expose the higher parts of this irregular bed producing the rugged terrain to the south of Doppelmayer J, whilst more complete drainage might reveal more of this eroded bed such as the etched terrain to the SE of Puiseux, and where northwards flowing basalts might produce channels such as that seen in Fig.11. The high tide marks might indicate that the lava level dropped in stages, temporarily stabilising before dropping further to expose these narrow terraces again visible in Fig.11. Whether this mechanism is feasible is open to debate, and one argument agains it would be the likely period of time a shallow lava lake would remain molten and able to flow away, and indeed what would cause the lowering of the level in the first place.

The depth of the channels and hollows within the etched terrain are in the region of 30-40m and so any lava lake that existed here would have to be at *least* this deep and probably much deeper to inundate the area and then have enough volume and erosive power to carve the sort of channel we see in Fig.11 – could such a depth of magma remain molten long enough to be capable of flowing away?

Returning to the dome that started this article, it is in some ways comparable to structures that Raf Lena and I described in a recent Journal article[5] and where I suggested that they might be stranded slabs of solidified lava that formed as a partly molten lava body drained, and a solidified crust became 'hung up' on previously submerged hills. This proposed process is shown in the cartoon form in Fig.12 where a body of lava is shown that has submerged a hilly basement terrain, possibly of a highland composition. In the top panel a solid lava crust can be seen that has formed over and floats on the underlying molten lava. If the lava level fell, so to would the floating lava crust, which might then encounter some of the higher points of the submerged terrain as shown in the lower panel.

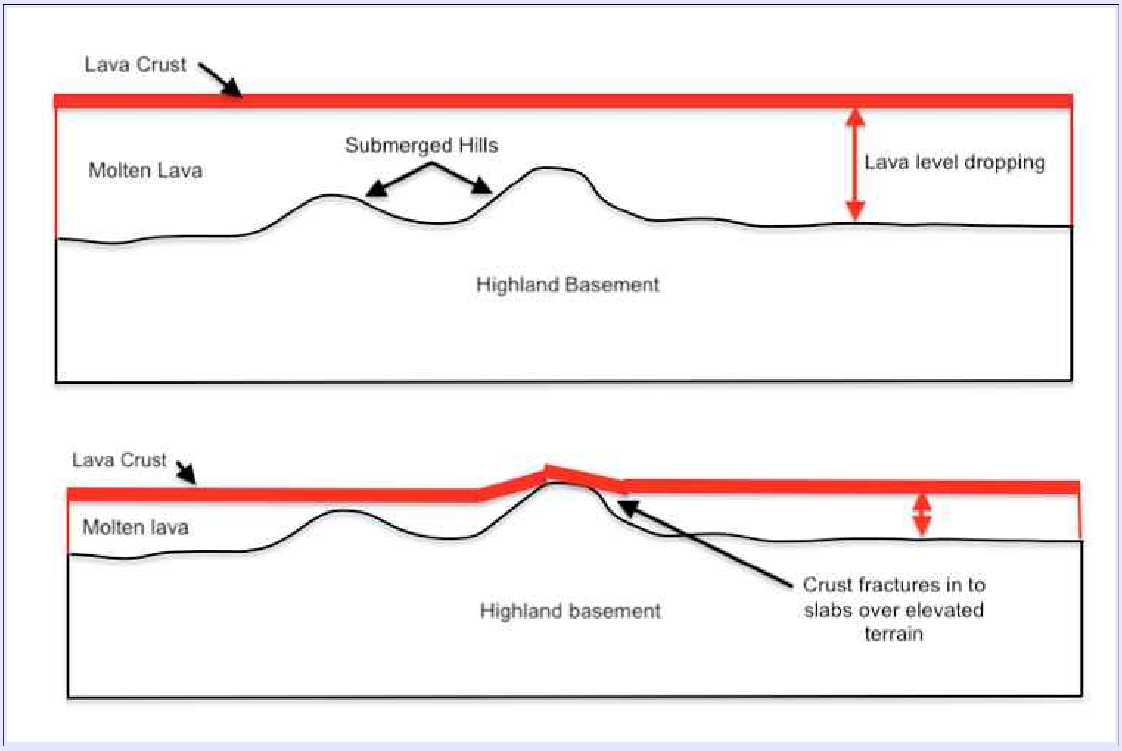


Fig.12 Explanation of the above cartoon in text.

Where this happens the solidified crust fractures and cracks as it becomes stranded on these high points, forming the slab like features seen in the Journal article cited above, and possibly the structure near Doppelmayer J. The fact that this process also involves dropping lava levels might be consistent with what we see in the rugged and etched terrain already discussed.

As always, comments and criticisms welcome!

References:

1. ***A probable Dome in Mare Humorum*** by Raffaello Braga. The Lunar Section Circular Volume 38 No.12 December 2001.

2. ***More on the Dome in Mare Humorum*** by Raffaello Braga. The Lunar Section Circular Volume 39 No.5. June 2002.

3. The Lunar Section Circular Volume 39 No.2. February 2002.

4. http://www.fabiolottero.it/lac/map.htm (accessed 29/06/2023)

5. Lena. R and Fitz-Gerald.B (2023) ***Lunar volcanic complex north-west of Lichtenberg.*** JBAA. February Vol. 133, No. 1

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Lunar Geological Change Detection Programme.
By Tony Cook.

TLP Reports: No impact flash observations have been received since the last newsletter. One candidate TLP report was received for Gassendi, but is listed under the repeat illumination reports below, even though it is seen in a different part of the crater.

Routine reports received for May included: Jay Albert (FL, USA – ALPO) observed: Gassendi, Mons Pico, Plato and several features. Alberto Anunziato (Argentina – SLA/ALPO) observed: Alpetragius, Eratosthenes, Pitiscus and Tycho. Anthony Cook (Newtown & Mundesley, UK – ALPO/BAA) imaged: several features in the Short-Wave IR and in visible light. Walter Elias (Argentina – AEA) imaged: Proclus and Romer. Massimo Giuntoli (Italy – BAA) observed: Cavendish E. Jean Marc Lechopier (Spain – UAI) observed: Censorinus. Bob and Sophie Stuart (- BAA/NAS) imaged: Abenezra, Abulfeda, Agrippa, Albategnius, Alanon, Alphonsus, Aristotles, Burg, Cassini, Cyrillus, Delambre, Delaunay, Gamma Frisius, Godin, Heraclitus, Hipparchus, Julius Caesar, La Caille, Lade, Lilius, Lindsay, Mare Nectaris, Mare Serenitatis, Maurolycus, Menelaus, Messier, Montes Apenninus, Mutus, Nasireddin, Palus Putredinis, Piccolomini, Posidonius, Purbach, Regiomontanus, Rima Ariadaeus, Sacrobosco, Sinus Medii, Stofler, Tannerus, Theophiulus, Torricelli, Triesnecker, Vallis Alpes, Werner and Zollner. Aldo Tonon (Italy – UAI) imaged: Censorinus and Herodotus. Fabio Verza (Italy – UAI) imaged: Censorinus. Garry Varney (Pembroke Pines, FL, USA – ALPO) observed: several features. Ivan Walton (Codnor, UK – BAA) imaged Gutenberg and several features).

Analysis of Reports Received (May):

Gassendi: On 2023 May 02 UT 01:21 Jay Albert (ALPO) imaged this crater under the following repeat illumination observations:

On 1967 May 20 at UT 21:05-21:20 Kelsey (Riverside, CA, 8" reflector, x300) using an English Moon blink device found colour on the south west part of the floor. Note that for the times given by Cameron, the Moon was below the horizon from California - so possibly these are local times and these times need to be correctly converted into UT? The Cameron 1978 catalog ID=1037 and weight=3. The ALPO/BAA weight=1.

and at 01:35-02:23UT observed this crater under the above repeat illumination observation and the following below:

Gassendi 1966 Oct 25 UTC 22:30-23:10 Observed by Moore and Moseley (Armagh, Northern Ireland, 10" refractor) and Sartory(England, 8.5" ? reflector) "2 faint blinks (Eng.) on NW (IAU ?) wall. (Indep. confirm.?). NASA catalog weight=5. NASA catalog ID #987. ALPO/BAA weight=4.

Jay checked the crater without filters as well as comparing with W25 red and W44A blue filters using 226x. He saw no colour on the SW part of the crater floor or on the NW wall. Using the filters, however, he did note that the high peak on the S wall was brighter in blue than red. He tried this filter blink a number of times because he had never seen this before in Gassendi, but the result was the same each time. We shall leave the weights of the two TLP observations as they are, but consider moving Jay's report to TLP status of weight 2. I would have given it a 3 but it does not show in the image (Fig 1), possibly because the peak on the south rim was saturated and unable to show colour?

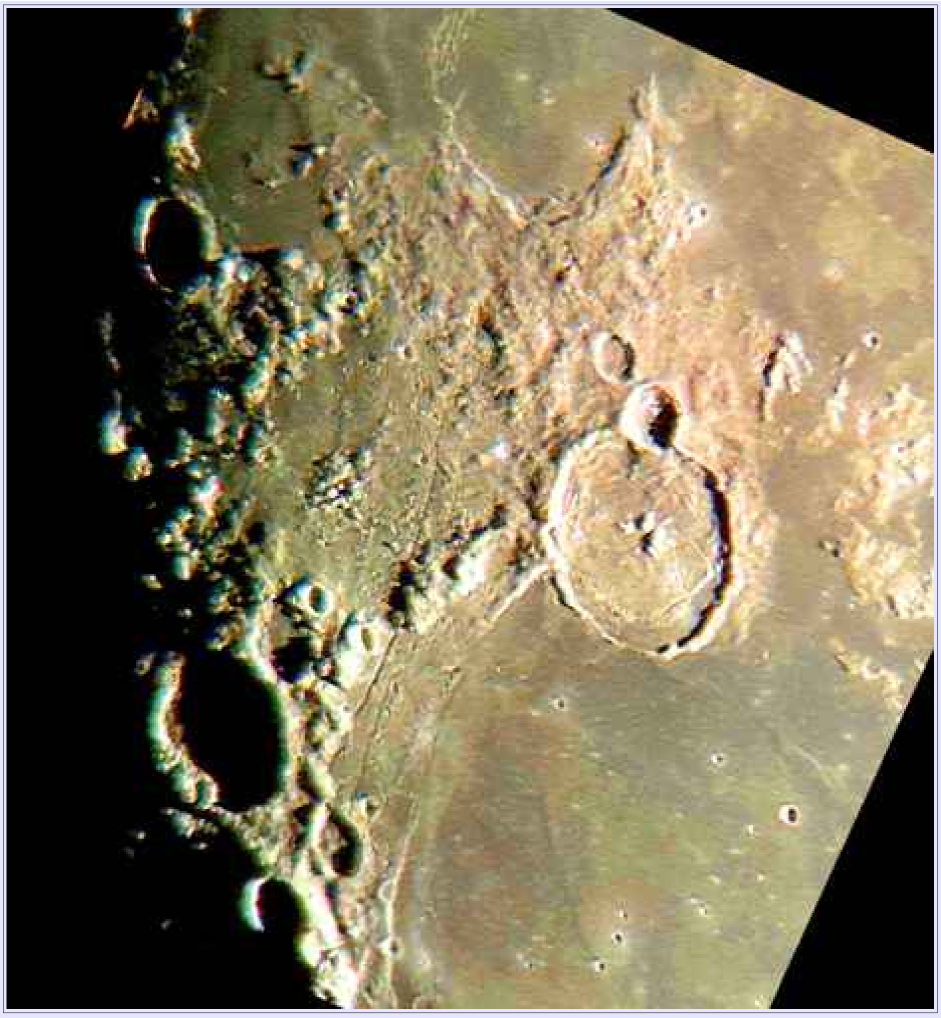


Figure 1. Gassendi as imaged by Jay Albert (ALPO) on 2023 May 02 UT 01:21 and mirror image reversed and orientated with north towards the top. Camera used was an iPhone 14Pro attached to a Celestron NexStar Evolution 8" SCT via a 9mm orthoscopic eyepiece. Transparency was magnitude 3 and seeing was 7/10. The image has had its colour saturation increased.

Cavendish E: On 2023 May 04 UT 19:40 Massimo Giuntoli (BAA) found that the crater had a normal appearance. A 7.6 cm Newtonian used at x180 and seeing was Antoniadi IV.

Romer: On 2023 May 08 UT 02:18 Water Elias (AEA) imaged this area under similar illumination to the following report:

On 1979 Sep 09 at UT08:00-08:15 D. Darling (Sun Praire, WI, USA, 12.5" reflector, x75 and photography used, seeing 4/10 and the Moon's altitude was 45deg) photographed Romer crater and recorded two adjacent bright cigar shaped objects - these were the same size as an observation made in 1987. Darling believes that these are ridges. Cameron comments that in LO-IV 192-3,2 a ridge is revealed on the inside wall that matches the description. Cameron 2006 catalog ID=66 and weight=2. ALPO/BAA weight=1.

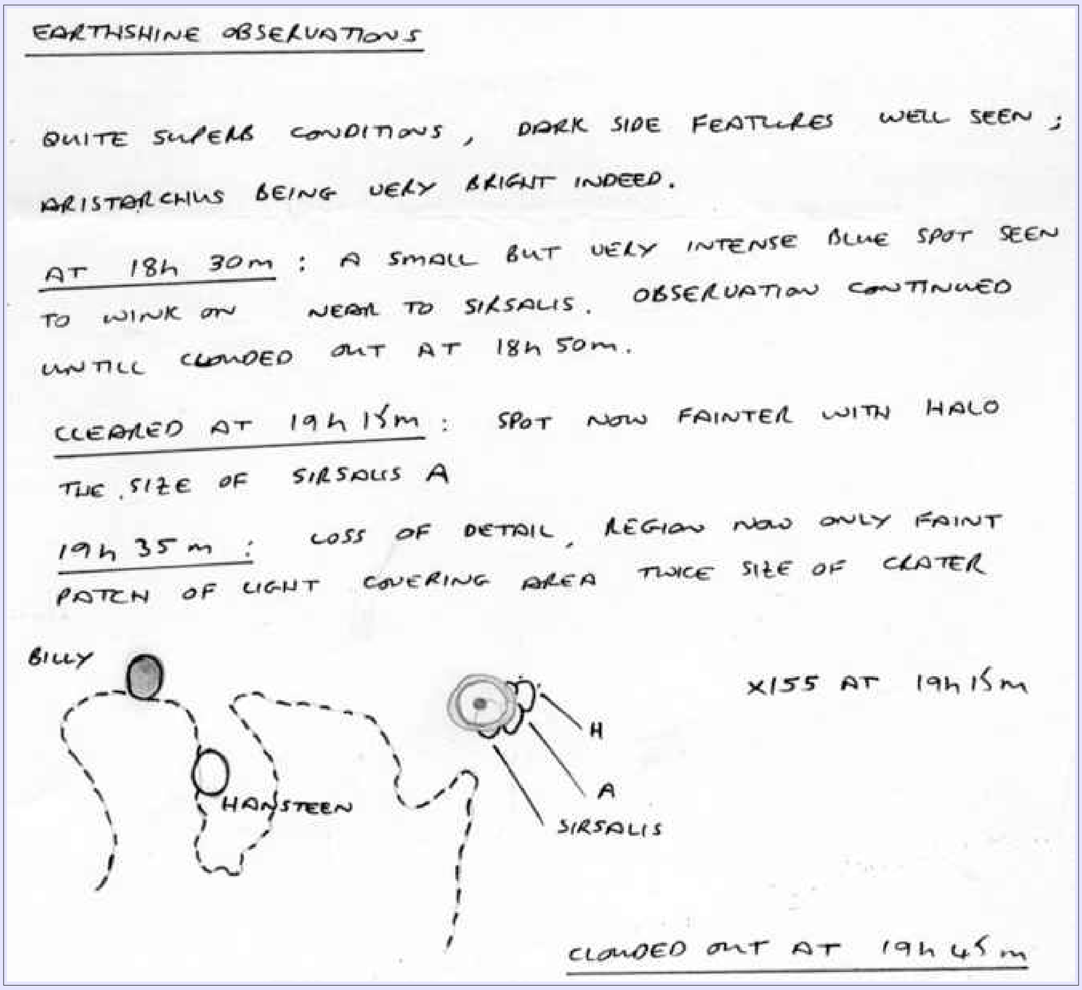
No sign of what David Darling describes can be seen in Fig 2. Therefore we shall leave the weight as it is.

Figure 2. Romer as located close to the centre of the image – taken by Walter Elias on 2023 May 08 UT 02:18 and orientated with north towards the top.

Sirsalis: On 2023 May 24 Ivan Walton (BAA) imaged the whole Moon under similar illumination and topographic libration to the following curious earthshine TLP report (See Fig 3):

Sirsalis 1990 Mar 01 UT18:30-19:45 M. Holmes (Rochdale, UK, 21.5cm Newtonian, seeing Antoniadi I/II, Transparency very good) was observing in earthshine and saw an intense blue spot "wink on" near to Sirsalis (sketch shows location on SE rim), until clouded out at 18:30. When the sky cleared at 19:15UT the spot was still visible but fainter, with a halo, the size of Sirsalis A. By 19:35 there was a loss of detail, region only a faint patch of light covering area twice the size of Sirsalis crater. Clouded out permanently at 19:45UT. Cameron 2006 catalog event #392, weight=0. ALPO/BAA weight=3.

Although Ivan's image was originally intended to show details on the dayside of the Moon, I took the opportunity to do a contrast stretch just in case any earthshine was visible, or there was a bright spot where Sirsailis was, but there is nothing there (Fig 4). Readers who are familiar with Sirsalis under Full Moon or indeed earthshine conditions, will know that Sirsalis A is quite a very bright craterlet. What was unusual was the size, change in size, brightness, and 1 hour duration of this event. One other observer was observing earthshine that night, Sally Beaumont, but that was later at 20:00 and she reported: *"earthshine was visible but not nearly as much detail as yesterday. The western limb was very bright. Aristarchus could be made out faintly, especially with averted vision"*. I am not sure why the Cameron (updated) catalog assigns a weight of 0 (no reason is given), in my view the ALPO/BAA weight of 3 is justified.



EARTHSHINE OBSERVATIONS

QUITE SUPERB CONDITIONS, DARK SIDE FEATURES WELL SEEN; ARISTARCHUS BEING VERY BRIGHT INDEED.

AT 18h 30m: A SMALL BUT VERY INTENSE BLUE SPOT SEEN TO WINK ON NEAR TO SIRSALIS. OBSERVATION CONTINUED UNTILL CLOUDED OUT AT 18h 50m.

CLEARED AT 19h 15m: SPOT NOW FAINTER WITH HALO THE SIZE OF SIRSALIS A

19h 35m: LOSS OF DETAIL, REGION NOW ONLY FAINT PATCH OF LIGHT COVERING AREA TWICE SIZE OF CRATER

CLOUDED OUT AT 19h 45m

Figure 3. A sketch of the Sirsalis area, made in earthshine, by Mark Holmes (BAA) made on 1990 Mar 1 UT 18.50-19:45. North is towards the bottom.

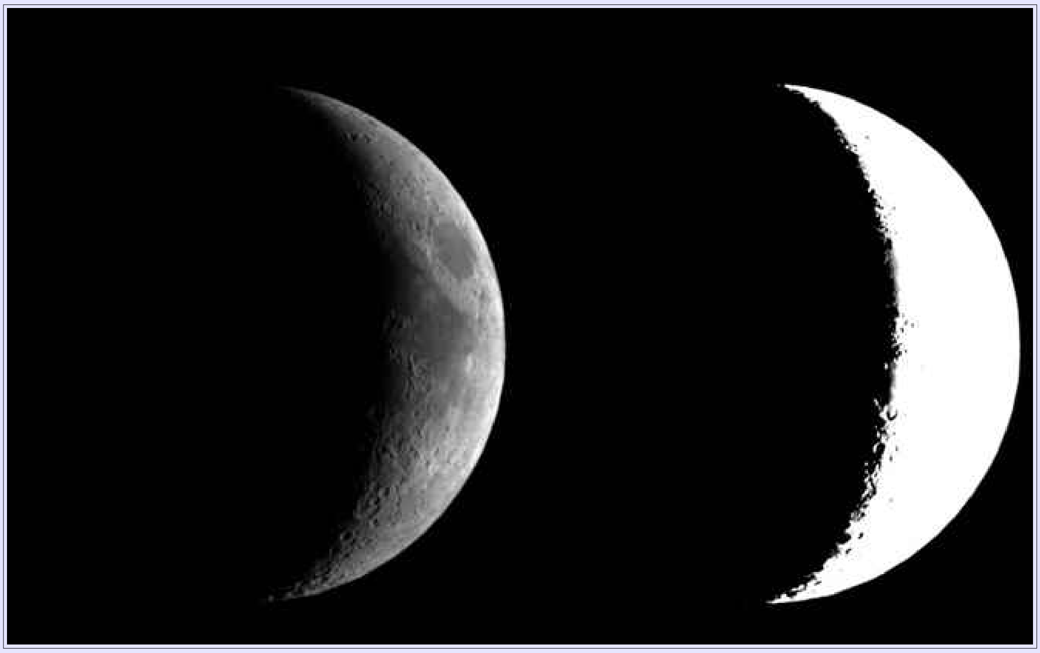


Figure 4. The crescent Moon on 2023 May 24 UT 21:40 by Ivan Walton (BAA). (Left) Original image. (Right) Contrast stretched version.

Censorinus: On 2023 May 25 UAI observers: Jean Marc Lechopier, Aldo Tonon, and Fabrio Verde respectively observed, imaged and imaged for the following lunar schedule request:

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

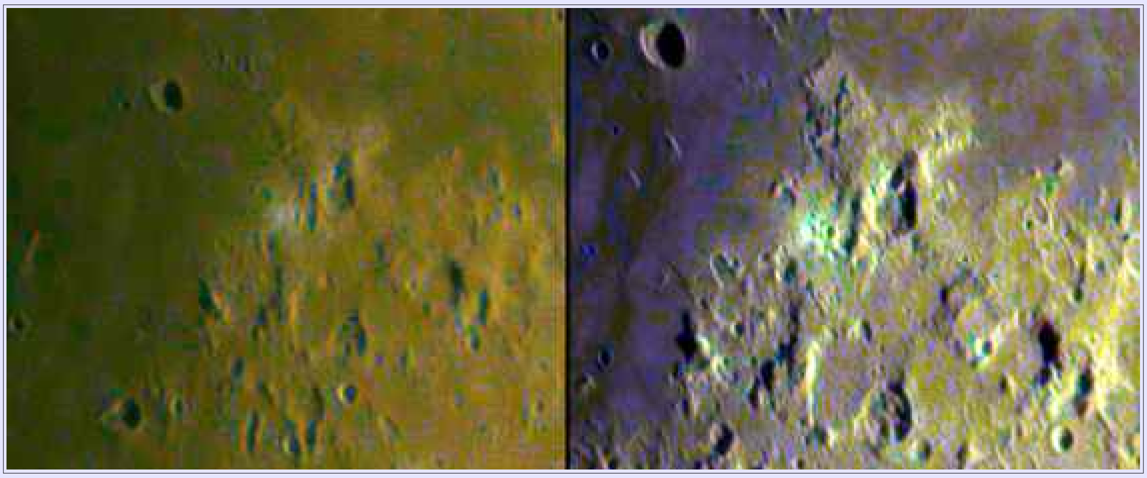


Figure 5. The Censorinus area with north towards the top on 2023 May 25. Images have been colour normalized and then had their colour saturation increased significantly. (Left) Image taken by Aldo Tonon (UAI) at 21:01UT. (Right) Image taken by Fabio Verza (UAI) at 21:07 UT.

Jean Marc observed visually between 19:50 (with alternating clouds and clear spells) and 22:10 using a 150/1200ed Skywatcher refactor (x240-300) under good seeing conditions. Jean Marc says that Censorinus is a small crater of 4 km in diameter in the centre of a luminous area of about 20 km in diameter in the shape of a butterfly. Its bottom was half filled by the shadow of its eastern wall. Observing ended due to a deterioration in seeing as the Moon got closer to the horizon. No colour was seen.

So let us see if anything showed up in the imaging? Fig 5 shows some colour enhanced views by Aldo Tonon and Fabio Verza. The colour saturation has been pushed to its limits, but does appear to show some blueness that Jean Marc did not see visually. However we have to be a little careful as the colour saturation enhancement could be enhancing atmospheric spectral dispersion or chromatic aberration. Anyway the colongitude appears to be about 329.2˚. It probably does not make any sense to continue observing this as at a colongitude earlier than this as we are unlikely to see anything in the images and certainly not visually – cameras being more sensitive to colour. So will remove this from the lunar schedule program as the job is now done!

Sabine: On 2023 May 26 UT 19:37 Bob and Sophie Stuart (BAA/NAS) imaged (Fig 6 – top) this crater under similar illumination to the following report:

Sabine 1967 Sep 11 UT 00:32,00:45 Observers: Jean at al. (27 obs., 21 telescopes, Montreal, Canada, 3-6" refractors, reflectors) "A black, rectangular-shaped cloud vis. in M.Tranquill, moving W-E (IAU ?) & dissipated nr. term., surrounded by viol. colour. Bright yellow flash at 00:45, (obs. In response to request to obs. impact of Surveyor V at 0046) NASA catalog weight=3. NASA catalog ID #1043. ALPO/BAA weight=2.

The account of Mrs P. Jean's (Montreal, Canada) observing team appeared in the BAA Lunar Section Circular, Vol 2, No. 11, p3 and was:

"At the request of the Space Centre, Pasadena, California, I organised an observation night for Surveyor V. We had 27 observers, 21 telescopes 3 to 6" refractors and reflectors. We followed instructions by telephone and I

report a TLP near Sabine Crater, west side - around the impact point of Surveyor V. Two observers have seen a black cloud visible 8-9 seconds, surrounded by violet colour in M.Tranquilitatus at 0o32m UT. Also at 0h45m three observers saw a bright yellow flash visible a fraction of a second near Sabine crater, west side. A V shaped umbra west of Sabine was clearly visible, very long and black. Two refractors, 4 and 6 inches were used for this observation x150 - x175. We were glad to have worked in co-operation with NASA for this occasion.

I wonder if other members have seen these phenomena? We were very fortunate with the weather and for the positions of the moon at that date."

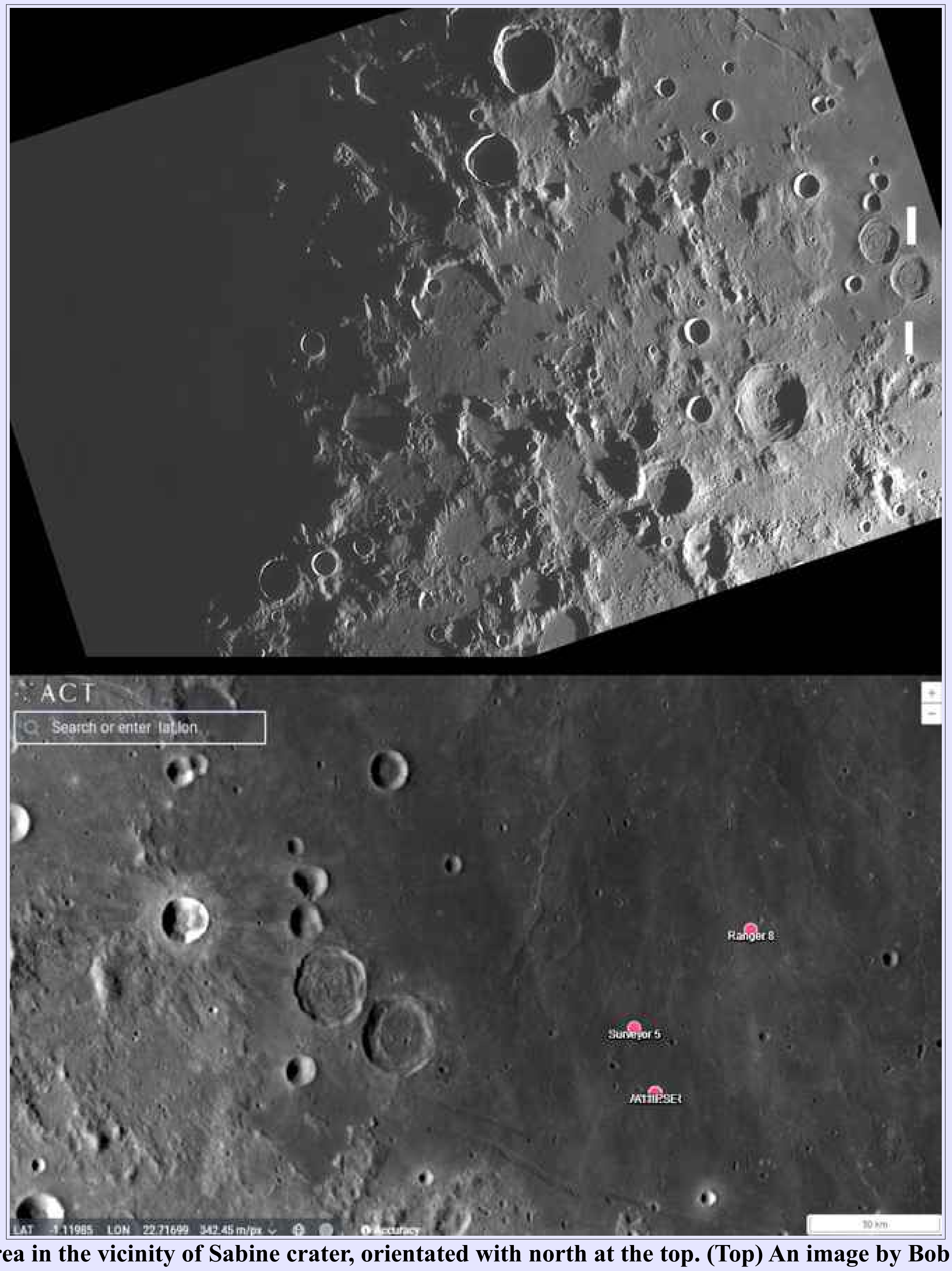


Figure 6. The area in the vicinity of Sabine crater, orientated with north at the top. (Top) An image by Bob and Sophie Stuart, taken on 2023 May 26 UT 19:37 – the location of Sabine lies between the two rectangular markers. (Bottom) A NASA Quickmap view of the landing site of Surveyor V and Apollo 11.

According to the NASA report, the spacecraft landed at 00:46:44 UT, which might correspond to the 2nd report of 00:45UT that Jean gives. However, in the opinion of Winnie Cameron, the compiler of the NASA catalog of TLP, she told me that reports from P. Jean were often riddled with mistakes and some far-fetched descriptions. Given that 27 observers were taking part in this Surveyor V watch (location of the Surveyor V landing site is in Fig 5 (Right), I am surprised that only 2 observers saw the 0h:32min report and only 3 saw the 2nd report. It is possible that one of these reports may have been the carrier rocket stage that got Surveyor from Earth orbit to the Moon – alas I have no information on that. Also there is no mention that I can find in the Surveyor V Science report of P. Jean's observers. If any readers took part in the Surveyor V landing watch, organized by NASA JPL, I would certainly be interested to hear from them, or indeed anyone who knew P. Jean of Quebec, so as to set the record straight. Likewise if anyone knows about the fate of the Surveyor V carrier stage? Incidentally in the BAA Lunar Section Circular account, the E/W coordinates are probably "classical", so when she says "West" it is really "East" IAU directions. But anyway at least we have a good image now of what Sabine crater would have looked like on the night of the Surveyor V landing. I am tempted to lower the weight from 2 to 1 in view of the small scopes used.

Tycho: On 2023 May 28 UT 22:50-23:10 Alberto Anunziato (SLA/ALPO) observed this crater for the following repeat illumination report:

Tycho 1995 Mar 10 UT 20:00-23:34 observed by G. North (UK) seen to have greyness inside parts of its shadow. Confirmed by J.D. and M.C. Cook. Possibly light scattered of illuminated wall into shadow or highland starting to break through the shadow. ALPO/BAA weight=1.

Alberto could see two zones in the shadow that were less dark than the rest. It was possible however, that the observation was biased by reading about the North TLP report? Anyway, he could see a grey zone in the shadow, marked by the number 1 in the sketch, and after some minutes a second grey zone (marked 2), but he was not so sure of this second zone. Alberto made this report in case the location of his "grey zones" matched the same location as was reported by North. As you can see from Fig 7, Alberto's sketch seems to correspond to Jeremy Cook's sketch but differs to the odd appearances in Gerald North and Marie Cook's sketch. I think that we may increase the weight of this TLP to 2 as the appearances are so different.

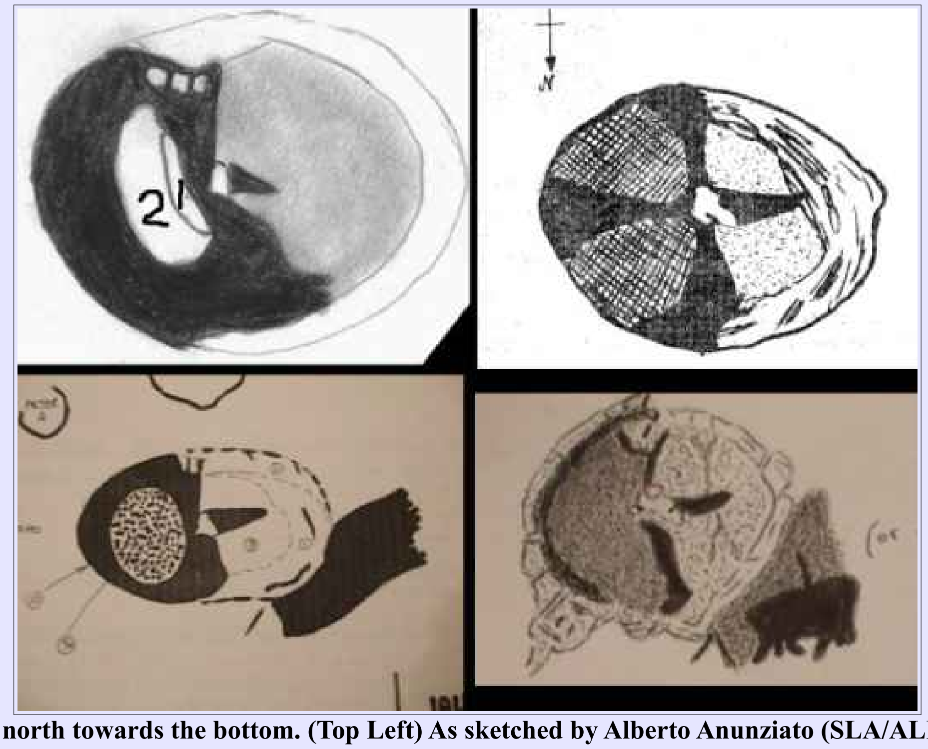


Figure 7. Tycho with north towards the bottom. (Top Left) As sketched by Alberto Anunziato (SLA/ALPO) on 2023 May 28 UT 22:50-23:10 – this has been mirror reversed and re-annotated. (Top Right) As sketched by Gerald North (BAA) on 1995 Mar 10 at UT 20:00. (Bottom Left) As sketched by Jeremy Cook (BAA) on 1995 Mar 10 at UT 22:45. (Bottom Right) As sketched by Marie Cook (BAA) on 1995 Mar 10 at 23:00UT.

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

Dr Anthony Cook, Department of Physics, Aberystwyth University, Penglais, Aberystwyth, Ceredigion, SY23 3BZ, WALES, UNITED KINGDOM. Email: atc @ aber.ac.uk

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Items for the August circular should reach the Director or Editor by the 25th July 2023 at the addresses show below – Thanks!

BAA LUNAR SECTION CONTACTS:

Director: Dr. Tony Cook (atc @ aber.ac.uk)
Lunar Section Circular Editor: Barry Fitz-Gerald (barryfitzgerald@hotmail.com)
Committee members:
Tony Cook (Coordinator, Lunar Change project) (atc @ aber.ac.uk)
Tim Haymes (Coordinator, Lunar Occultations) (occultations @ stargazer.me.uk)
Robert Garfinkle (Historical) (ragarf @ earthlink.net)
Raffaello Lena (Coordinator, Lunar Domes project) (raffaello.lena59 @ gmail.com)
Nigel Longshaw
Barry Fitz-Gerald (barryfitzgerald@hotmail.com