From the Director

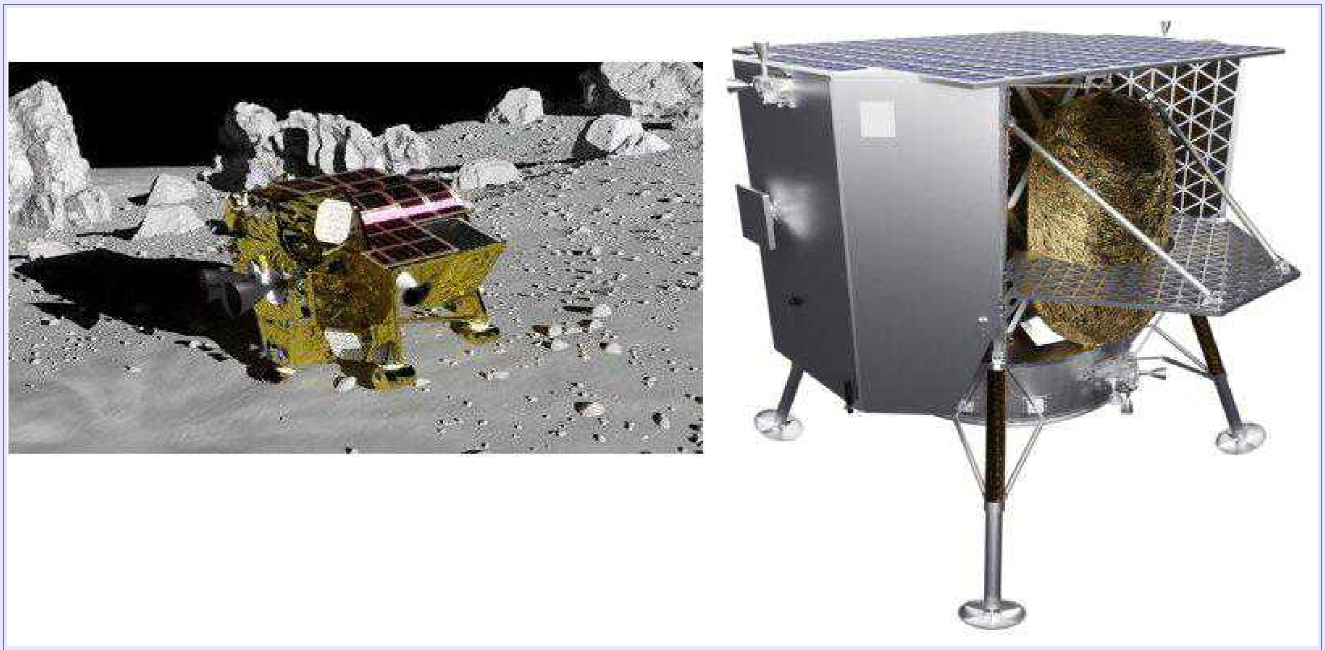

Figure 1. Lunar landers due to land in January and February 2023. (Left) Japan's SLIM lander which is already in orbit. (Right) The US Peregrine 1 lander due to launch early Jan.

A Happy New Year to our readers. Let us hope that the weather conditions improve as I am really missing being able to observe the Moon due to clouds, wind and rain etc - though as you will see from this circular, at least some of us have managed to find the occasional clear gap to make some observations.

Observing wise – if the weather does improve we have lots to look forwards to in 2024 – so maybe make some of these ideas your New Year's Resolutions? First of all there are plenty of lunar occultations listed in Tim Haymes occultation sub-section. If you have never observed a lunar occultation before, then give it a go in the coming year. Ideally we'd like you to video these as you can then replay them in slow motion and look for the characteristic two step fade that you get with double stars.

But even if you just watch visually, through a scope, these are fairly dramatic events – one of the few phenomena in astronomy that happen literally in the blink of an eye. Saying that, looking for impact flashes in earthshine also involves rapid phenomena, but unlike occultations of stars, are somewhat rarer – though your chances are maximized during traditional strong meteor showers e.g. the Quadrantid shower coming up in the early hours of the morning of January 3rd -5th. Again videos of earthshine are the way to go and you can combine impact flash monitoring with occultations – killing two birds with one stone.

If you have never taken an image of the Moon through a scope, why not try this out? Even if you just have a mobile phone with a camera, some impressive results can still be obtained just by holding the camera up to the eyepiece. Tracking scopes are obviously helpful, but I obtained some good results early on with a dobsonian. If you do not know when and what to image, then there is a list on: https://users.aber.ac.uk/atc/lunar_schedule.htm Anyway please email me anything you take as we maybe able to use them – though please make sure you add the date and UT.

Even if you are clouded out it is still possible to contribute e.g. by taking part in the Basins and Buried Crater programme. You just need to see if you can detect a basin or buried crater from the catalogs listed on: https://users.aber.ac.uk/atc/basin_and_buried_crater_project.htm by looking up their longitudes and latitudes on the NASA Lunar Reconnaissance Orbiter Camera web site: https://quickmap.lroc.asu.edu/ and simply seeing what is there, trying out different layers looking for evidence that these suggested buried craters or basins really do exist. Just email in what you find.

There are a couple of lunar eclipses in 2024. A penumbral eclipse on 25th March, where the Moon may get a very slight tint, and a partial eclipse on 28th September, though the Moon will merely graze the Earth's dark umbral shadow near the northern limb.

Then we have an amazing number of lunar missions lined up for 2024. Japan's SLIM lander is due to land on 19th January. in Shioli crater. The US Peregrine 1 lander is due to launch on 8th January and carries two rovers, one from the USA and another from Mexico, with a landing pencilled in on 23rd February. Also in February the US IM-1 lander mission will launch, along with a Canadian orbiter: Dodge-1.

The US IM-2 will launch some time in the first quarter of 2024 with landers, rovers and a relay satellite. Also in the same quarter, the US SHEPRA-ES mission will be launched and in May the Chinese will send up their Chang'e 6 to do a sample return from the Apollo basin on the lunar far side. The US IM-3 is due to launch in the second quarter of the year. The US Blue Ghost gets launched in the third quarter of the year and will land in Mare Crisium. Japan's Hakuto-R mission 2 will launch sometime this year.

Finally the crewed Artemis 2 may launch in November, but don't expect too many close up views of the Moon as it will do one flyby of the far side and spend most of the time in deep space, checking out the spacecraft systems and living arrangements. Any photos they take are likely to be through the capsule windows – so unfortunately nothing will be of high resolution. It is quite likely though that the mission could slip into 2025. I will keep you posted on news of each of these as and when I hear.

Tony Cook.

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Lunar Occultations January 2024 by Tim Haymes

Time capsule: 50 year ago: in Vol 9 No.1

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

*Railway interruptions feared: Some meetings postponed.
*Occultation sub-section – P Moore takes interim control.
*R..J. Livesey: Just how bad is British Seeing?
*Miss C.M. Botley. Interesting Occultations: Tau Tauri from MNRAS

Vol 72 No 6, p455-6. An observation of 1899 Oct 21, and other notes.

Occultation predictions for 2024 January (Times at other locations will +/- a few minutes)
Oxford: E. Longitude -001 18 47, Latitude 51 55 40
To magnitude ca v7.5

day yy	mmm	Time d	h	m	s	Ph	Star No	Sp D*	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Az	CA o	Notes
24	Jan	2	1	19	19.2	R	1645	cF8	6.7	6.4	69-	112		28	119	87N	
24	Jan	2	2	10	35.2	R	1648	G5	6.9	6.5	68-	112		35	131	37N	
24	Jan	2	3	55	10	R	1656	K2	7.4	6.6	68-	111		43	162	6S	
24	Jan	2	4	7	11	R	1656	K2	7.4	6.6	68-	111		43	167	24S	
24	Jan	3	3	49	31.5	R	1746	KF2	7.0	6.8	59-	100		35	150	15N	
24	Jan	4	2	9	25.8	R	1837	K2	7.4	6.6	50-	90		15	119	54N	
24	Jan	13	14	58	18.7	D	3175	G8	4.7	4.3	6+	29	8	19	191	21N	kappa Cap*
24	Jan	13	17	34	56.1	D	3191	cA5	7.4	7.3	7+	30	-11	9	226	34N	
24	Jan	13	18	2	1.1	D	164674	A8	7.6	7.4	7+	31		6	231	69S	
24	Jan	19	21	41	17.5	D	93309	K0	7.5	6.9	68+	111		48	234	89N	
24	Jan	20	17	11	12.7	D	584	cB9	6.1	6.0	76+	122	-6	46	114	65S	33 Tau
24	Jan	20	18	25	39.6	D	76366	K0	7.4	6.8	77+	122		56	136	63N	
24	Jan	20	21	38	4.3	D	598	SG0	5.5	5.0	78+	124		58	219	58N	36 Tau
24	Jan	21	0	29	9.1	D	76480	kA3	7.4	7.3	78+	125		35	265	50S	
24	Jan	21	21	32	56.8	D	76895	DB2	7.5		86+	136		64	195	73S	
24	Jan	21	21	47	13.8	D	750	SG2	6.9		86+	136		64	202	80N	
24	Jan	21	23	31	25.0	D	76945	A2	7.5	7.4	86+	136		53	241	89N	
24	Jan	22	1	8	3.1	D	76965	cG	7.6	7.2	86+	137		40	264	16N	
24	Jan	22	17	15	2.7	D	77621	M3	7.5	6.6	91+	146	-6	34	87	44N	
24	Jan	22	18	20	1.3	DD	890	cA0	4.6	4.6	92+	146		44	100	85N	136 Tau
24	Jan	22	19	30	37.8	RB	890	cA0	4.6	4.6	92+	147		54	118	-65S	136 Tau
24	Jan	22	19	33	28.6	D	77724	B1	7.0	7.0	92+	147		54	118	81N	
24	Jan	22	21	51	55.8	D	77804	A0	7.3	7.1	92+	147		66	176	32S	
24	Jan	22	22	57	41.8	D	909	SB9	6.0	5.9	92+	148		64	210	34S	
24	Jan	23	0	32	28.8	D	77909	wA0	7.6	7.6	93+	148		53	244	45S	
24	Jan	23	18	0	23.4	D	1042	cA2	6.7	6.6	96+	158		32	86	38S	
24	Jan	24	5	25	41.4	D	1088	A4	5.8	5.7	98+	162		18	291	46N	47 Gem
24	Jan	24	17	30	17.7	D	1169	K5	5.3	4.5	99+	168	-8	19	72	73N	46 Gem
24	Jan	28	5	50	45.1	R	99157	pF2	7.4		94-	153		30	249	56S	
24	Jan	31	6	56	20.9	R	1814	SK5	6.7	5.8	75-	120	-8	23	227	77N	

Notes
Kappa Cap* : Time at Greenwich
D* : The D column indicates a Double Star in the Washington Double Star Catalogue. The characters w,S,c etc indicate the type of double and is explained in Occult4 Help.

New doubles are being discovered in occultation recordings, particular close doubles not detectable by other measurement techniques. For example, 245 doubles have been discovered while observing asteroidal occultations. The separations are usually small and in the range 10-100 mas. Please send double star occultation reports to the LS.

Occultation of the Pleiades on morning 31st October 2023 from Peter Anderson (Brisbane, Australia)

I was rather startled to see 'Pleiades Lunar Occultation' in the AAQ calendar for 31st October 2023, because it had not appeared on my predictions that stopped at midnight. I quickly headed firstly for 'Stellarium' and then for my 'Occult' prediction programme to crank out a set of predictions for this even, and there it was – an occultation of many of the bright stars (see image) for the evening of 30th/31st October. The main events started after midnight and the bright stars to be occulted were mv2.9 Alcyone, mv3.7 Atlas, mv4.2 Merope, mv5.1 Pleione, mv6.3 24 Tauri and 26 Tauri, plus fainter stars.

From my site at The Gap in Brisbane, the events commenced at 12.30am on the 31st with Merope, then bright mv 2.9 Alcyone at 1.24am followed by further occultations and re-appearances with the final significant ones ending at 3.23 and 3.25am with the re-emergences of Atlas and Pleione.

Reflecting on this occasion, I have seen occultations of the major stars in the Pleiades on several occasions and they are at their best when a crescent Moon is involved, particularly a waxing crescent because the occultation events on the dark limb are very simple, straightforward, and easy. Also such events occur at a civilised hour of the evening. I have investigated future Pleiades occultations for the Brisbane area, helped by the 'Occult' programme, selecting those events involving mv2.9 Alcyone, and then referencing 'Stellarium' to follow each promising event. They are listed below:

October 8th 2028 – An 85% waxing Moon occults some of the Pleiades from 1.50am.

29th December 2028 - An 89% waning Moon occults the Pleiades from 1.20 am interrupted by Moonset around 1.50am. (Very low altitude throughout.)

21st February 2029 - A lovely 47% illuminated waxing Moon occults the Pleiades from dusk around 6.30pm when the event is already in progress, through to Moonset after 10pm. (February is typically a rainy month and I bet it will be raining!)

Tim Haymes writes:

Occultations of the Pleiades over UK are anticipated in the near future.

I have looked at the Occult4 prediction for the Pleiades in 2024 across the UK. The August 26 passage is the only one viewable when 27 Tau (Atlas) is occulted at about 0400 UT. There will be an update in a forthcoming circular.

The BAA Handbook 2024 (page 39) requires a typo correction. The "name" of ZC 560 is 27 Tau, and not that which is indicated.

Atlas (27 Tau) : Best graze of 2024?

A good graze for anyone to try with a small telescope or mounted binoculars, made even more interesting because the star is double (Possible multiple).

There is a graze of 27 Tau on Aug26, 0400 UT which crosses England from Lancaster to Hartlepool. The graze region is narrow. Mid time at Lancaster is 0411UT, Sun at -9, Moon Alt/Az = 56/141, CA 10 degrees North, Northern Limit.

Contact the coordinator for maps, or use this link:

https://1drv.ms/f/s!AlzLfUm3imzPqR-FOYt7AEKkXlvU

Reading the limb profile.

The green line on the Google Earth display (KLM) is the *lunar mean-limb*. When the limb profile (Fig-1) is viewed it will seen there is no graze for an observer situated on mean-limb line (White line on the limb profile). The most graze phenomena (in quick succession) will be seen at positions between 0.5 and 2.5 km South of the line. Places deeper into the shadow will cause phenomena to be restricted with a longer time interval from one edge to the other. Example at 5.5 km, a few events will be separate by 5 minutes. At 8.5 km the star will disappear, but may re-appear as several events after 6 minutes.

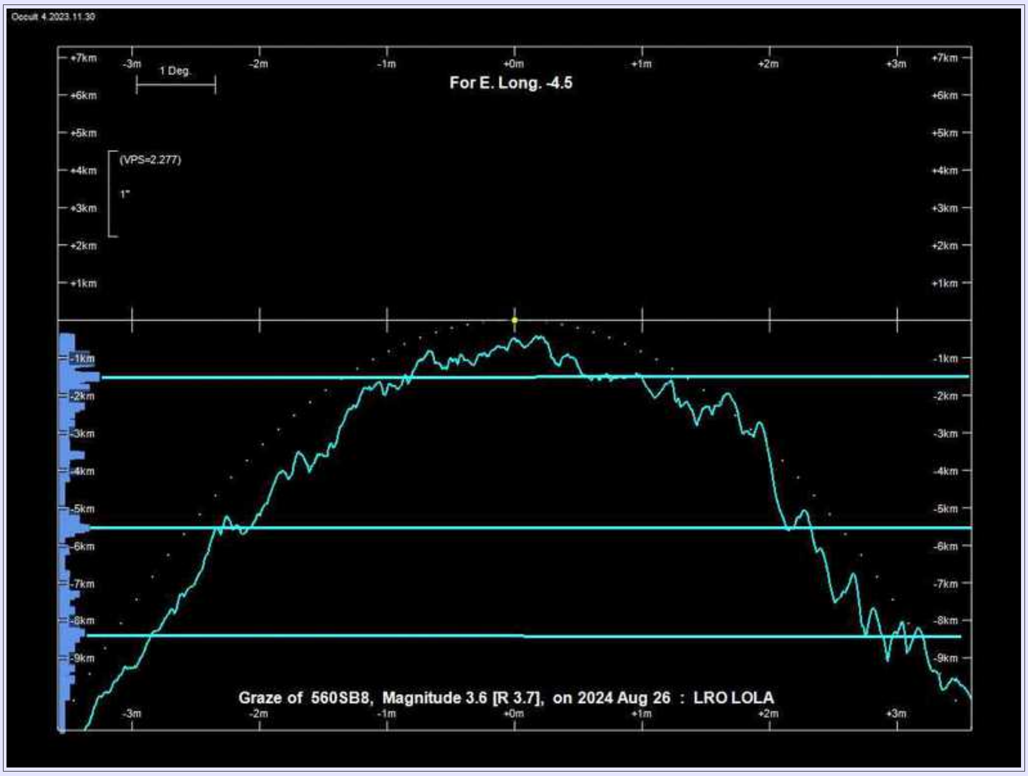

Fig.1: The lunar limb profile for Atlas graze occultation on 2024 Aug 26, 4h UT

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Upcoming Events: Museum of the Moon by Luke Jerram.

For those of you who have not yet seen this fabulous artwork there are a couple of opportunities in early 2024 to do so, these are:

Barnstaple Pannier Market 16th December 2023 – 6th January 2024

Winchester Cathedral 5th – 18th February 2024

St Giles the Abbot, Cheadle 15th March – 5th April 2024

Further info available at https://my-moon.org/tour-dates/

…........it is breathtaking so you will not be disappointed.

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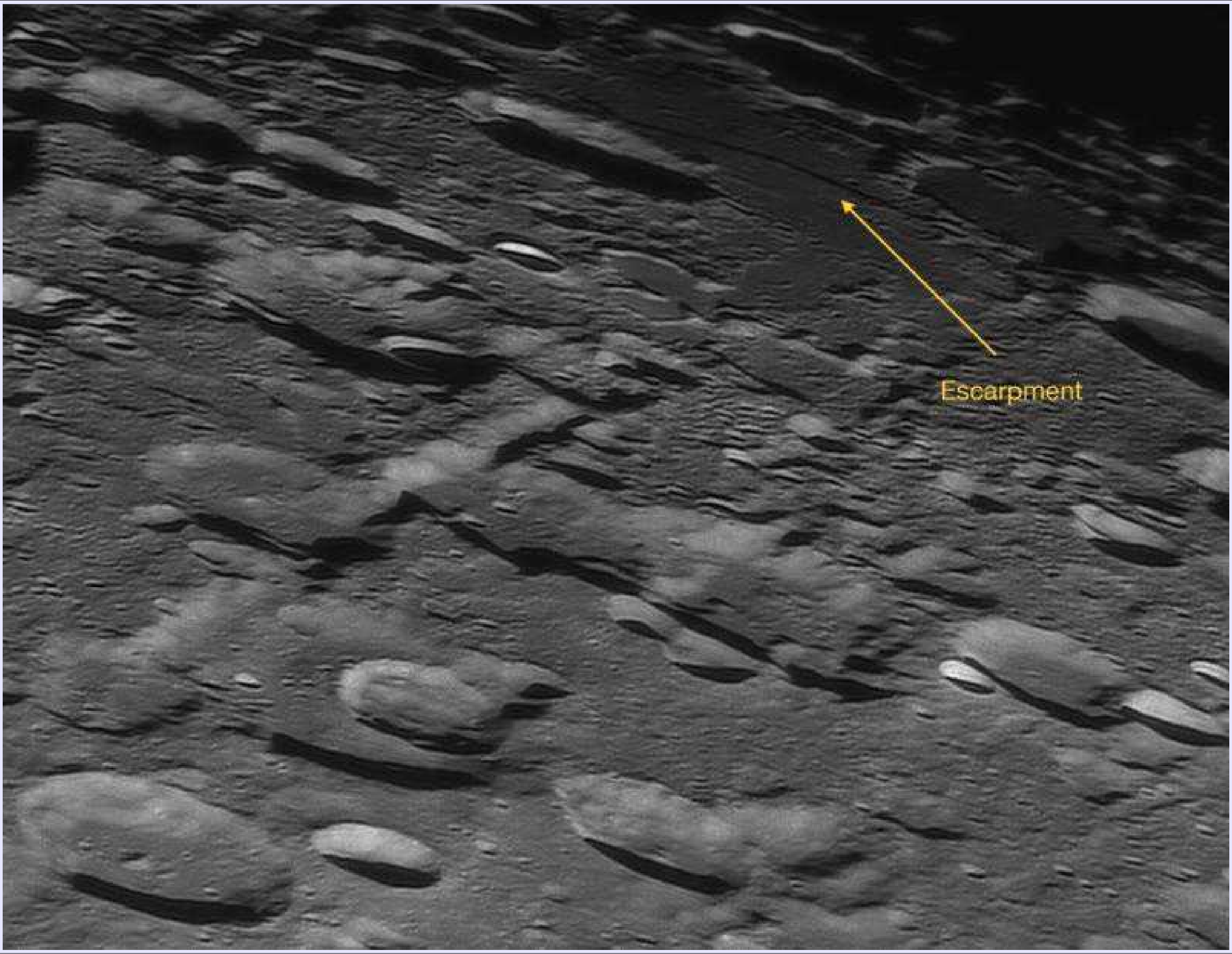
Letters and e-mails.

An escarpment by Brisbane H.

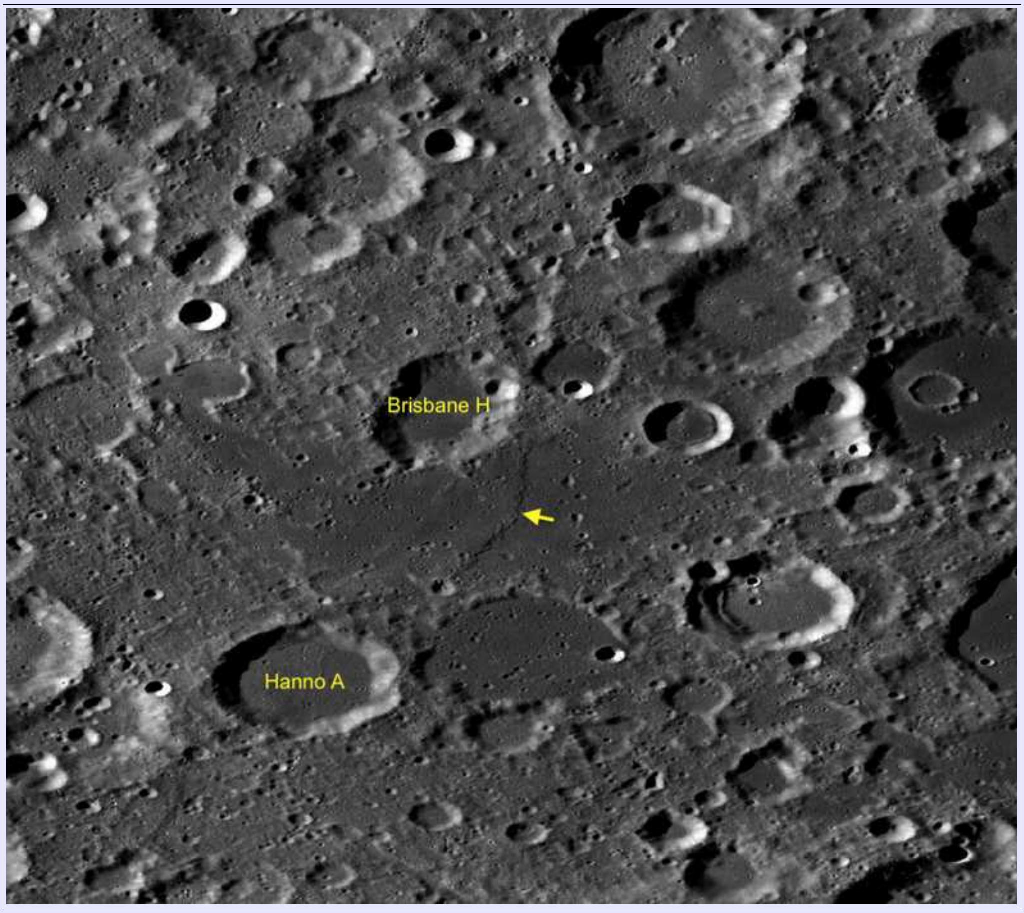
The following was sent via e-mail to David Teske who forwarded it on to Tony Cook:

"I have a question for you, are you aware of a undesignated escarpment on the south east limb of the moon, near the crater Brisbane H? I first became aware of it in an imaged I took last year and have researched it but have come up with zero references for it but LORC shows it well. My measurements make it approximately 46 km long with a drop of over 120m over a 1.5 km distance. Not the largest escarpment but certainly not the smallest. So I cannot believe that this has not been recorded at some point."



Ed. Comments: *David points out that the escarpment, pictured above does not appear in any of the usual references such as Rukl, John Moore's Features of the Moon, or Luna Cognita by Garfinkle.*

I took a quick look at the LRO Quickmap and could see that this escarpment is a wrinkle ridge (see image below) extending across a small mare like plain to the west of Mare Australe between the craters Hanno and Brisbane H. There are many other wrinkle ridges nearby, with prominent ones crossing Brisbane Z, Oken and the smooth plains units between these two craters. Regarded as being the result of compressional forces, these ridges are probably a crustal response to the infilling of craters and topographic lows within Mare Australe with basaltic lavas. Clearly these eruptions have not produced a circular Mare such as Humorum or Crisium, but these two are well established as being impact basins, whereas the jury is still out on whether Mare Australe is actually a buried impact basin.*



Clearly this is quite an interesting area and if you have any comments, observations or images that may be relevant to David's e-mail please send them in. I for one would be interested to know if these ridges can be traced on to the adjacent highlands or whether they are restricted to the smooth plains units.

*Meng, Z. G.et al. (2020). Mare Deposits Identification and Feature Analysis inMare Australe Based On CE- 2 CELMSData. Journal of Geophysical Research:Planets, 125, e2019JE006330. https://doi.org/10.1029/2019JE006330

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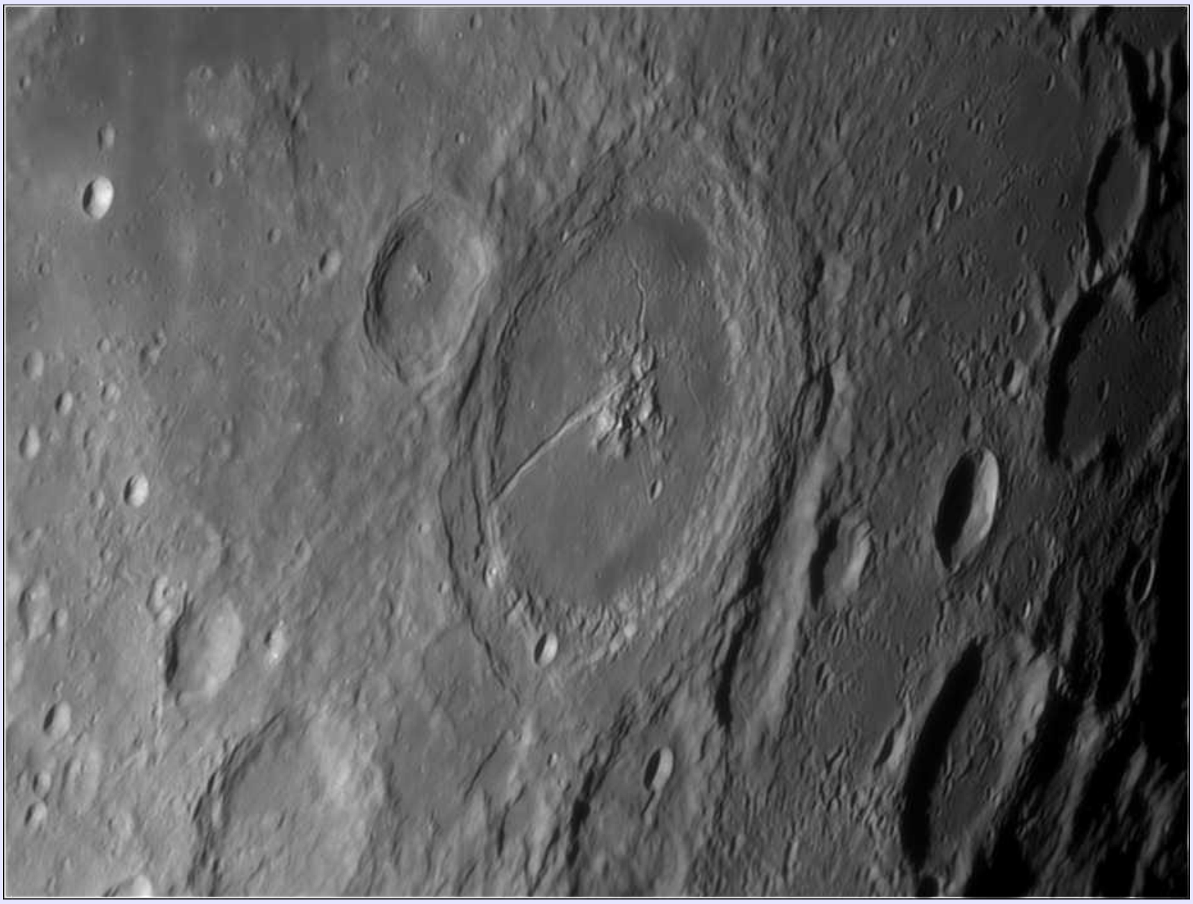
Lunar Halo – 2023 November 25d 22 . 10 UT by Alan Heath.

The ring around the Moon was seen on Saturday evening in Staffordshire, the West Midlands, Surrey, Berkshire, Dorset, Yorkshire, Cumbria, Derbyshire and the Isle of Wight, according to the BBC News.The phenomenon is caused by the refraction of moonlight from ice crystals in the upper atmosphere. My attention was drawn to this by my daughter with whom I am staying due to house being flooded in October. The Phase of the Moon was two days from full. There was a halo close to the Moon which showed a multitude of colours and with the Moon being 0.5 degree was estimated to have a radius of about 2.0 degrees. Much further out and also much fainter was a Halo the diameter of which was about 50 degrees. The radius of the Halo was therefore around 25 degrees which agrees well with the expected 23 degrees. The measures were taken from a photograph taken on a mobile phone and also from a photograph on BBC News taken in Ashbourne. Another view of the Moon on Sunday November 26d 02.10 UT did not reveal any sign of the Halo.

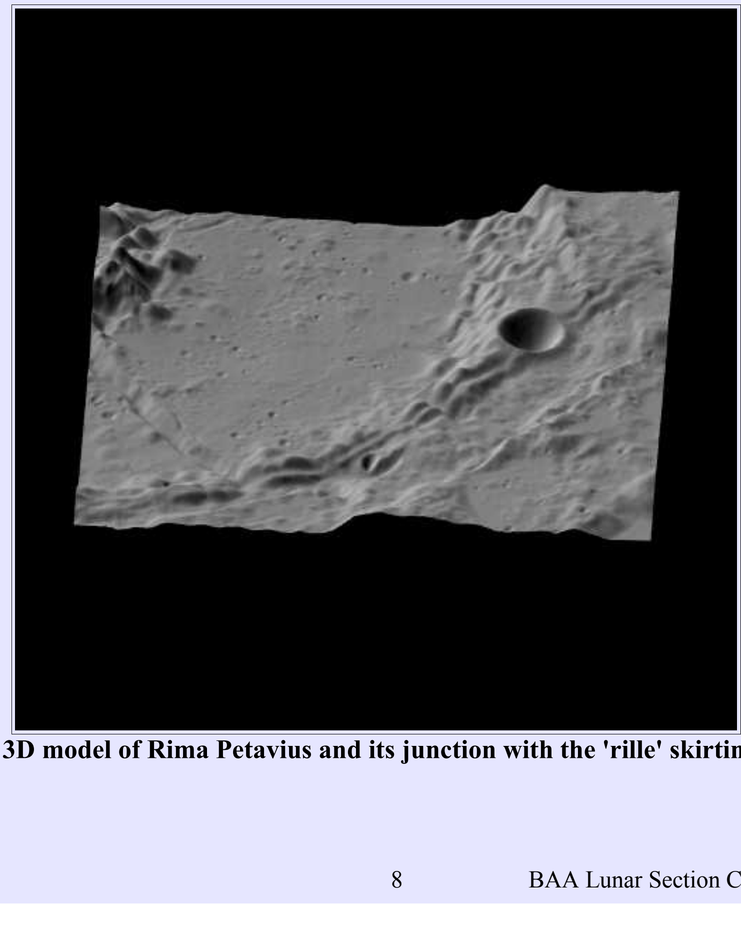
According to the Met Office, the halo can mean rainfall might be approaching. Monday November 27 was cloudy with rain all day locally. I have not seen many Solar Halos but this is the first Lunar Halo I have seen. It is worth noting that the type of cloud required for this phenomenon to be seen is Cirrostratus which are at a height of around 10 km forming an even veil which is thin.

Petavius by Bill Leatherbarrow.

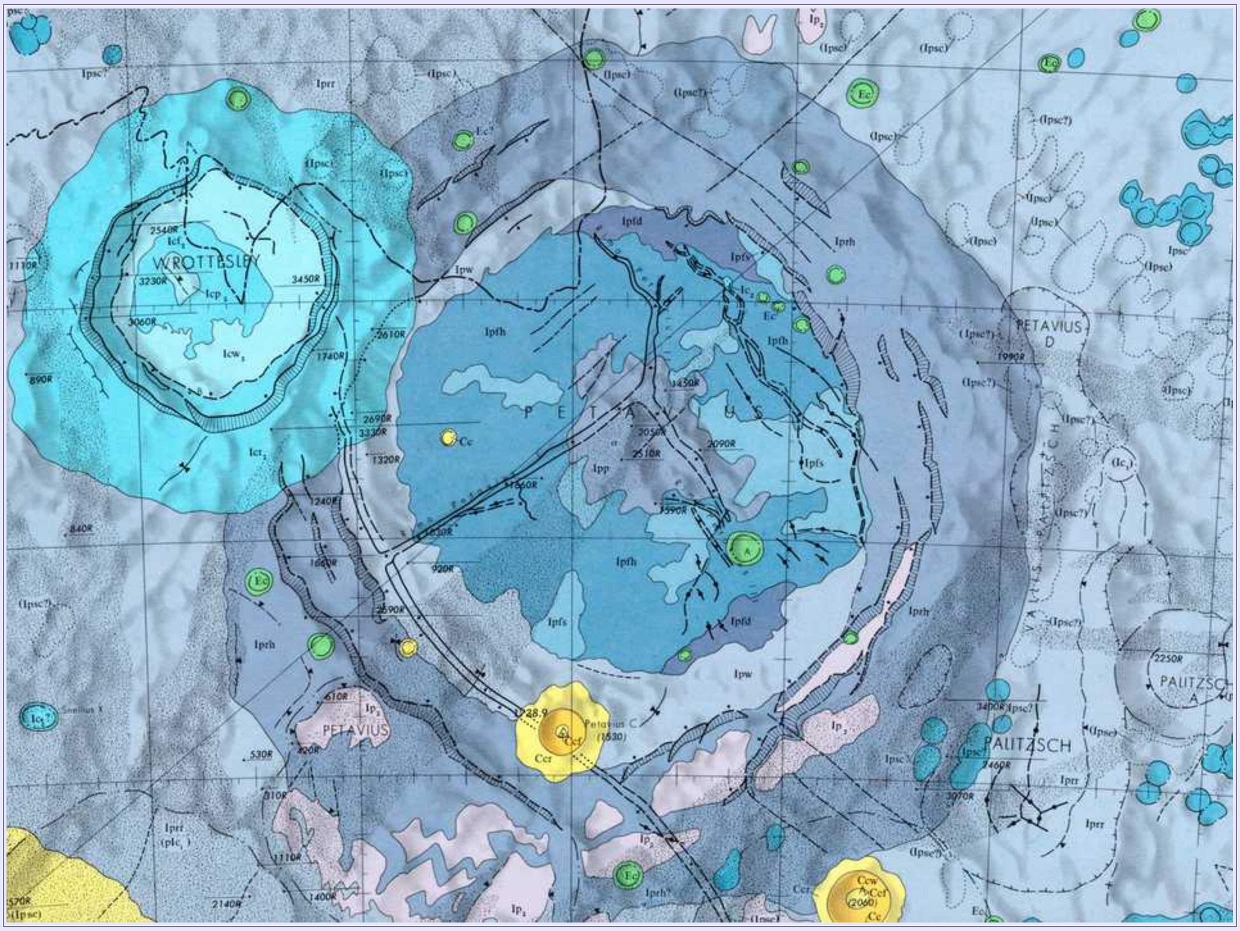
I had always assumed that the feature that Rima Petavius meets at the SW rim of Petavius, and which appears to continue S to join Rima Hase was itself a rille concentric to the rim of Petavius. However, it looks odd and QuickMap 3D modelling suggests that it is not a rille at all, but twin parallel ridges – v. odd!



Petavius imaged by Bill Leatherbarrow using an OMC 300 Maksutov Cassegrain.

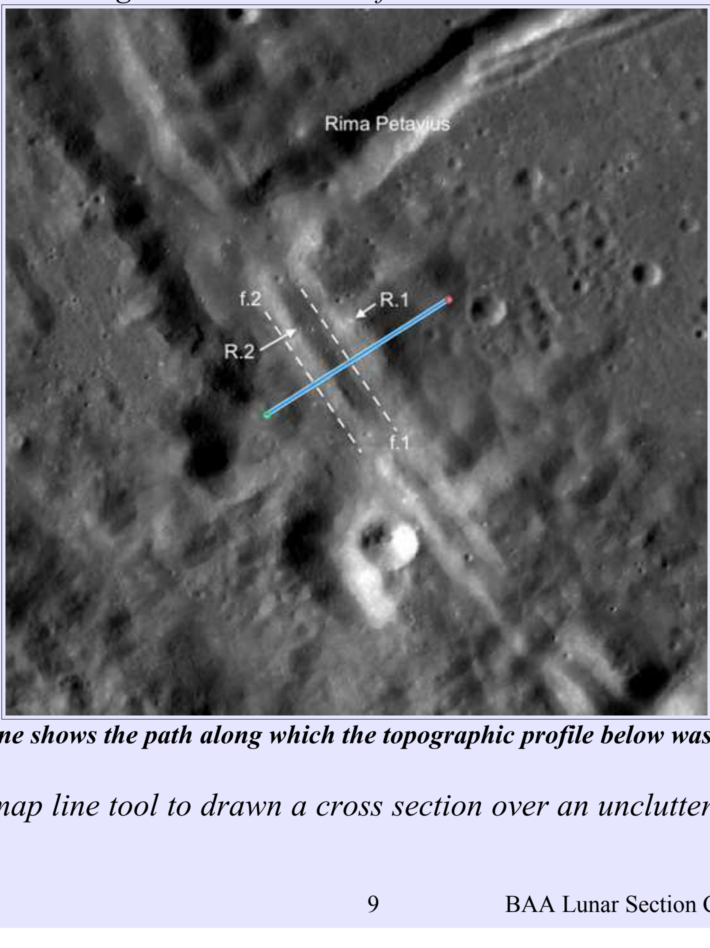


LRO QuickMap 3D model of Rima Petavius and its junction with the 'rille' skirting the western rim.



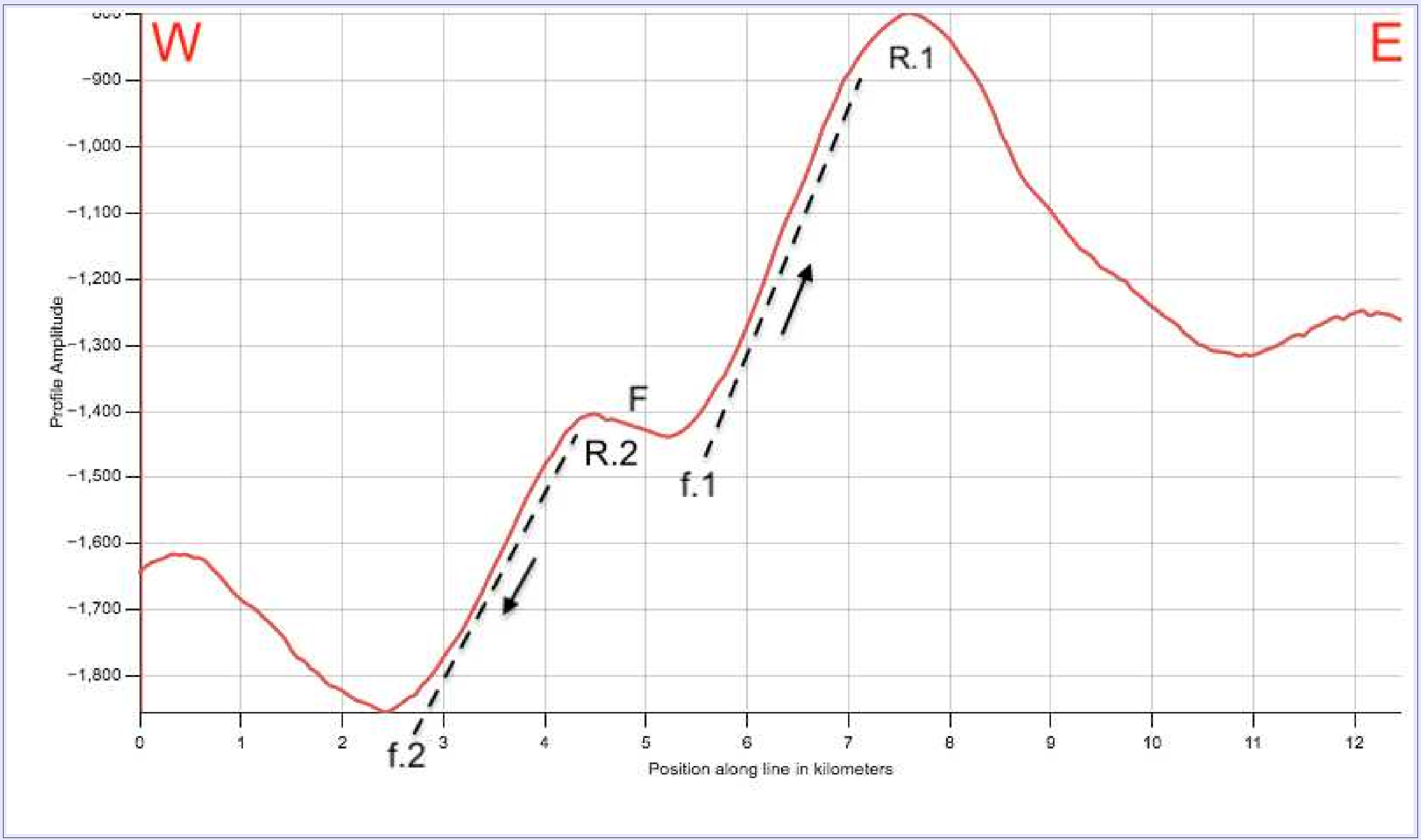
U.S. Geological Survey Map 794 map of the Petavius quadrangle of the Moon. Note the confluence of Rima Petavius with the continuation of Rima Hase which passes through Petavius C.

Ed. Comments: *I think that what we are seeing is the continuation of Rima Hase across the western floor, but we see it as two ridges and not a trough as the direction of 'throw' has been reversed along the western fault.*



Blue line shows the path along which the topographic profile below was taken.

I have used the LRO Quickmap line tool to drawn a cross section over an uncluttered part of that double ridge *(above shown with the blue line) with the topographic profile being shown below. The crest of the easternmost ridge is shown as R.1, and its west facing side is in fact the fault surface with the terrain to the east (right) having moved upwards along a fault marked f.1 in the diagram. This fault is the eastern bounding fault of the graben and can be traced to the SE as the eastern bounding fault of Rima Hase as shown in the USGS map. In the case of the western ridge R.2, the movement along the western bounding fault f.2 has been reversed, and instead of the terrain to the west being uplifted (to produce a graben) it has actually been down-thrown to produce the another parallel ridge, R.2. The platform F represents what should have been the floor of the graben, but this is now a step like feature.*



Dashed lines represent faults and black arrows indicate the direction that the terrain has moved, so the terrain east of f.1 has been uplifted whilst the terrain to the west of f.2 has subsided.

What produced this reversal is a bit of a mystery, but I would suspect it has something to do with the location of the graben, running through the terraces of the crater and the possible impact the uplift of the crater floor during the Floor Fracture Crater phase.

Of course this is just one potential interpretation – any other hypotheses welcome!

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A curious lunar valley by Nigel Longshaw.

I was interested by your comments and assessment of Les Fry's image on pages 20 and 21 of last month's LSC. Many years ago I copied some notes from the ALPO publication The Strolling Astronomer, with the intention of having a look at the 'Curious Lunar Valley' reported by A.K.Herring, needless to say I never got round to it! Your notes brought this back to my mind so I searched out what I had saved at the time – see attached.

The material in this note was communicated by Mr. Alika K. Herring, 825 Mancos Place, Anaheim, CA 92806. Mr. Herring was at one time a Lunar Recorder of the ALPO. For a number of later years he carried on professional lunar research at the Lunar and Planetary Laboratory of the University of Arizona. He is also highly regarded as a maker of telescope mirrors of great optical excellence. We shall quote portions of letters he wrote on October 8, 1976 and March 23, 1977.

"Several years ago, while examining some lunar photographs I had just taken of the nearly First Quarter Moon, I noticed a wide shallow valley or trough extending for some distance across the lunar surface. It is pretty ill-defined, but I think it can pretty definitely be traced from Julius Caesar to Aliacensis. [See Figures 49 and 50.]

"Oddly enough, the bright Bessel ray seems to line up with this feature and seems to extend as far as Hercules. Probably this bright streak has no connection with the valley; but it is curious that if you lay them out on a lunar globe, they all form part of a great circle.

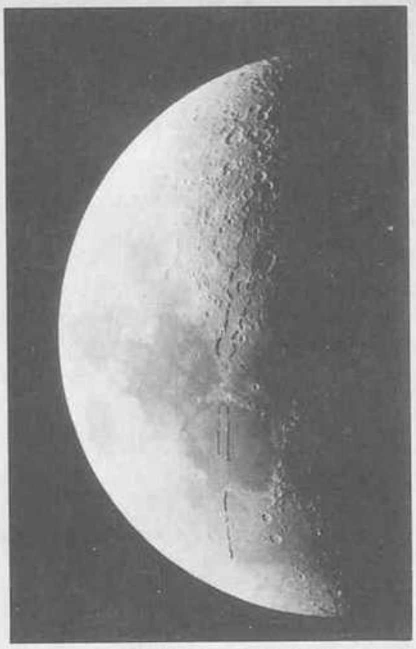

Figure 49. Photograph of the Moon by Alika K. Herring on April 7, 1976 at 4^h20^m, U.T. 12.5-inch reflector, 48X eyepiece projection. Tri-X film. Exposure 1/50 second. Simply inverted view with south at top. Colongitude = 0°6. Attention is directed to a wide shallow lunar valley extending from Julius Caesar to Aliacensis. The bounds of the valley and of the Bessel bright ray across Mare Serenitatis are enhanced with ink marks. See also text.

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"...As far as I know, this feature has never been previously observed or reported. Obviously the visibility of the valley is dependent on a critical angle of illumination. I would hesitate to say what significance it might have ....It would certainly be interesting to find out what kind of response [the valley] would arouse in other lunar observers, since some of them may even have difficulty in detecting it. As an experiment, I showed the discovery photograph to several people, some of whom could readily see the feature while others could not.

"The valley will be seen best with a very low power, for a general instead of a specific view is preferred. Also, the angle of illumination is critical for a best view; the rudimentary scarps along each side are generally low and tend to disappear with only a slight change in lighting. However, the valley itself can still be detected in some degree for several days afterwards, I think primarily because the floor of the feature appears to be somewhat smoother than the adjacent terrain on each side.

In my opinion the alignment with the Bessel ray is most likely coincidental. My reasoning on this question is as follows: I think the valley itself is very probably a 'fossil' feature which almost certainly predates the surface as we now see it. It was probably a very conspicuous feature at one time but has been almost obliterated by later events in the formation of the lunar surface. There is very good evidence that the lunar rays slowly darken and disappear under the bombardment of the solar wind and other solar radiations, which indicates that the bright rays we see were probably formed quite recently, geologically speaking. I therefore believe that there was a considerable span of time between the two features."

Mr. Herring further notes that the valley is present on an undated photograph hanging on the wall of Mr. Thomas Cave's private observatory in Long Beach, California. Some of our readers must have seen it there.

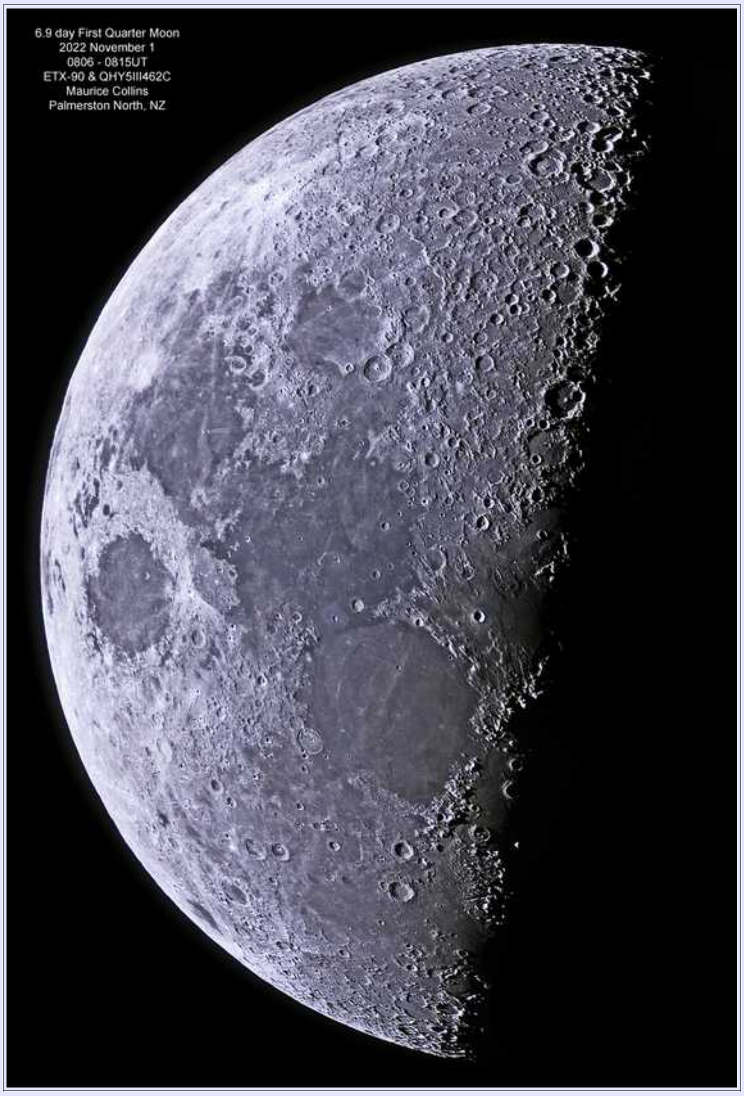
If the optimum conditions for the visibility of this lunar valley occur at colongitude 0°, then in the near future searches might be made near the following Universal Time dates and times in 1977: June 23, 23 hrs.; July 23, 10 hrs.; August 21, 21 hrs.; and September 20, 9 hrs.

I think this relates to the area described by yourself in the latest circular and it appears that Herring had a similar impression to yourself, but perhaps on a larger scale. It is interesting that the effect of a long shallow valley might be lighting dependant, as Herring notes, and its detection might be better suited to low powers on smaller telescopes. Also interesting that Herring says some people could detect the valley while others could not, a case of individuals gestalt perception perhaps. Might be worthwhile gathering some observations and images under appropriate lighting conditions.

OBSERVATIONS AND COMMENTS

More on the Curious Lunar Valley. Mr. Rodger W. Gordon of Nazareth, PA communicated on June 15, 1977 an interesting sequel to Mr. Alika Herring's "curious lunar valley" article (Journal A.L.P.O., Vol. 26, Nos. 9-10, pp. 209-211). The article reminded him forcibly that he had seen this very same feature on either May 25 or 26, 1977 (U.T. date) without realizing its unusual nature. He was using a 3.5-inch Questar at 80X, showing the whole Moon with a 50° apparent field. The feature was obvious, perhaps in large part because the eyepiece used did show the entire Moon. The observer recorded nothing at the time--he was just enjoying some lunar gazing. Perhaps the low power is a clue to why the feature is not better known --active lunar observers would usually employ higher powers.

Mr. Gordon points out that there is a fair view of this feature, much less striking than in his visual observation, in Kopal's Photographic Atlas of the Moon, Plate VI, taken on August 18, 1961 at 20^h13^m, U.T., colongitude 0°.14.



Ed. Comments: *The last image is by Maurice Collins and is included for comparison with the image shown overleaf and showing the location of this possible lunar valley. Having said that - can you actually see it? The terminator position in this image corresponds to the western edge of the feature, but its perception may vary from one viewer to another as Nigel points out.*

Images sent in.

Mare Marginis and Neper and Mare Undarum.

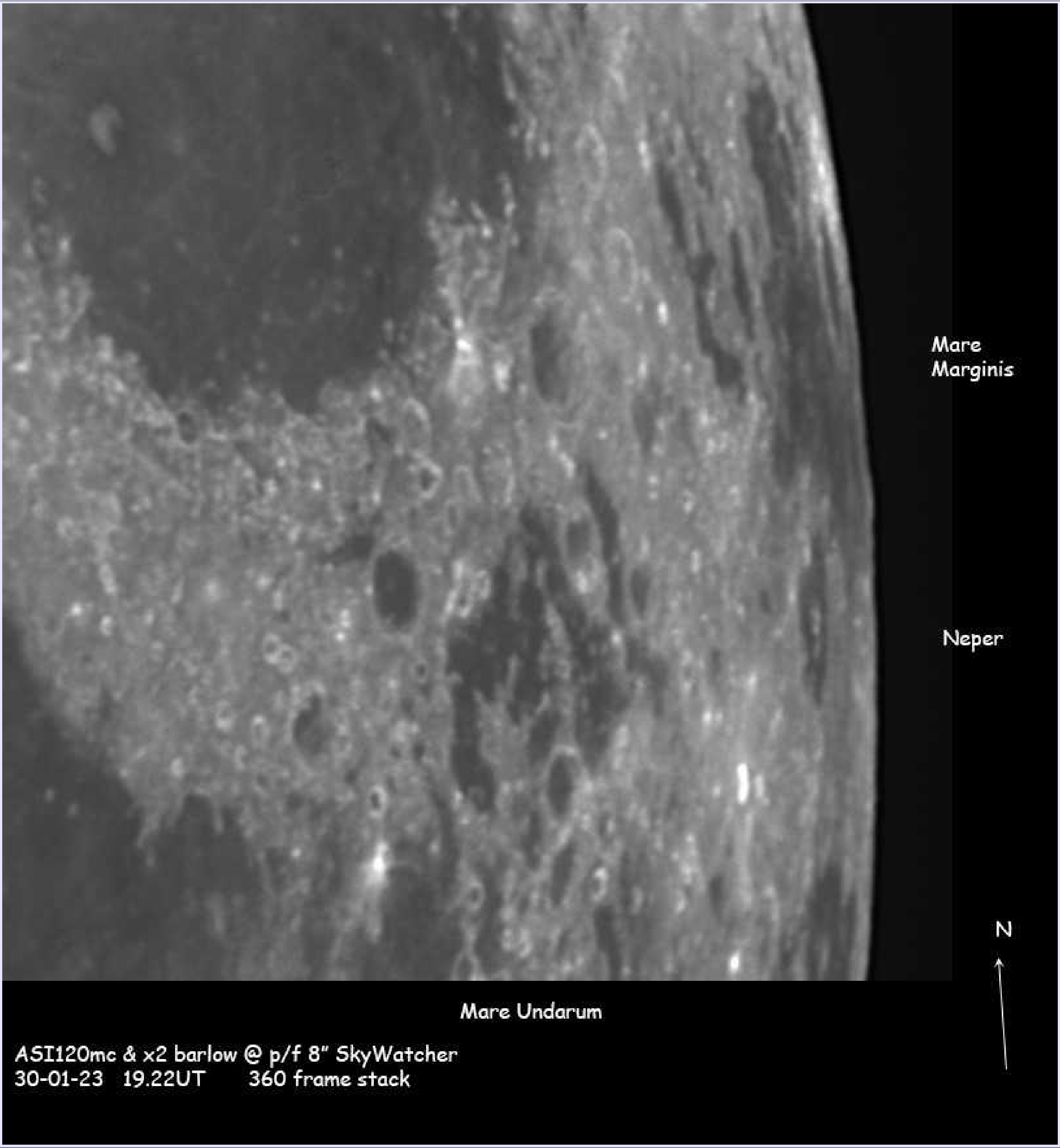


Image by Les Fry with details of time/date and equipment as shown.

Partial lunar eclipse of 28th October 2023.

Images by Glenn Bates and taken from Milton Keynes.

Tycho's 'Ring of Fire'.

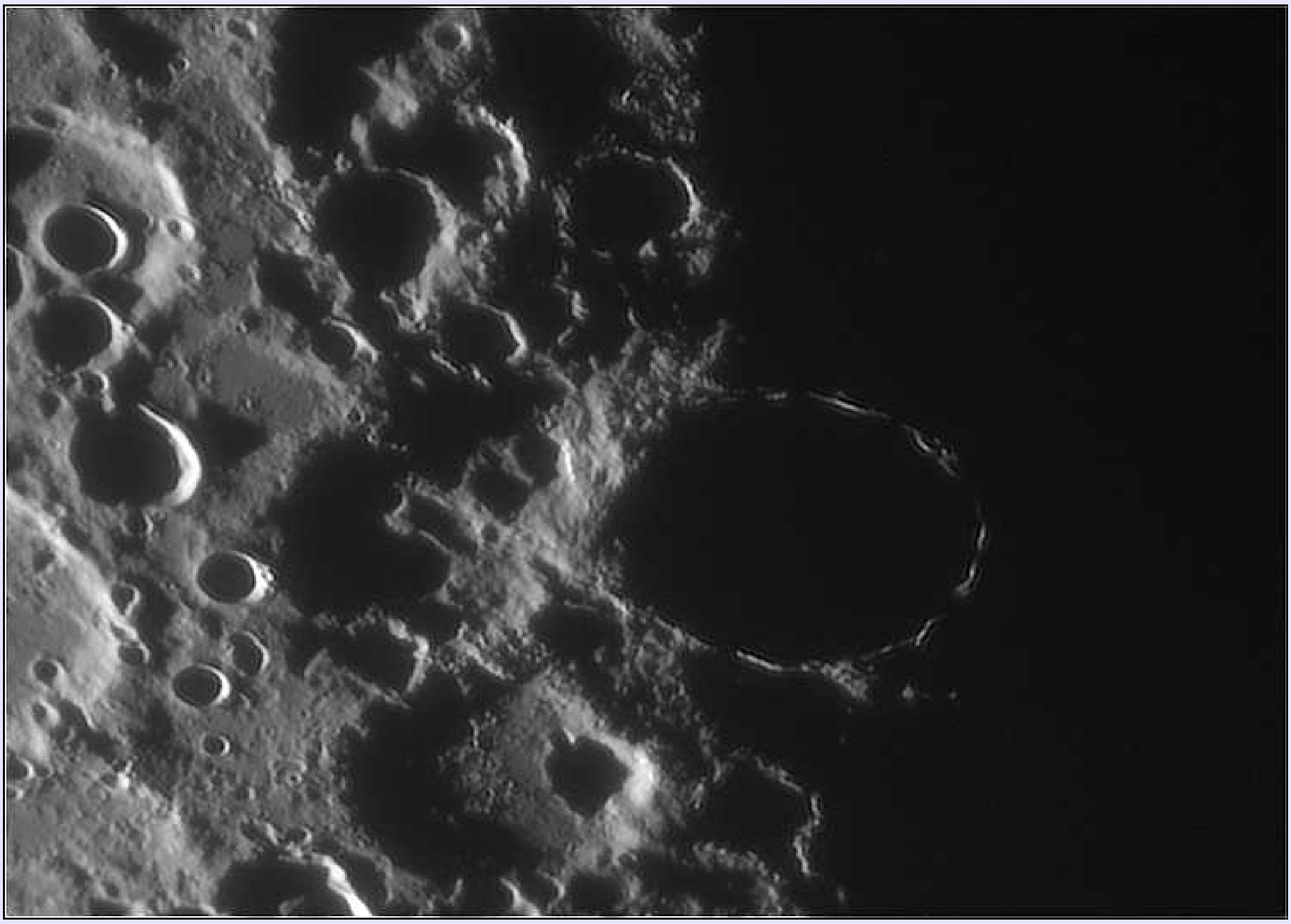
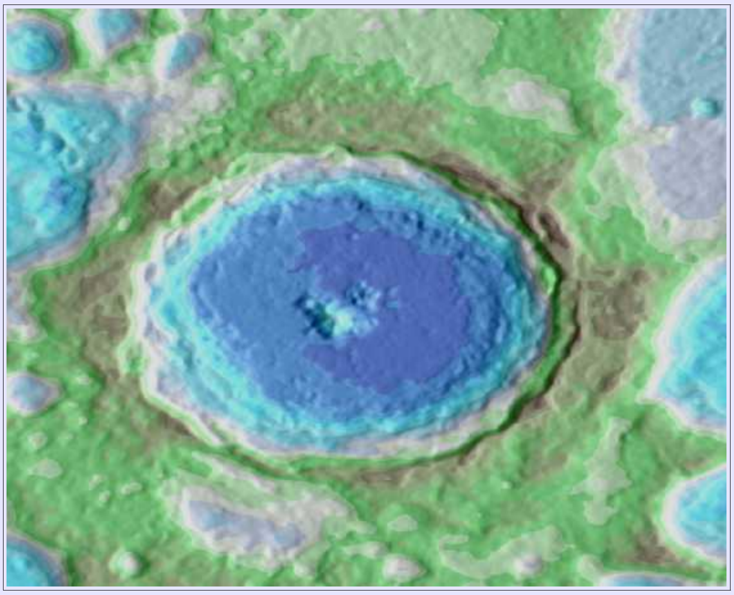


Image by William Leatherbarrow taken on the early morning of 6 December 0553UT, with an OMC300 Mak-Cass and ASI290MM camera.

Bill Comments: *I got up early to catch the last minutes of sunlight over Tycho, when the combination of colongitude, libration, reasonable seeing and clear skies allowed me to capture the 'ring of fire' effect that, to my recollection, eluded the best efforts of Harold Hill. He spoke about it much, but the archive I hold doesn't include a drawing. Nor can I recall a drawing in TNM. Generally speaking, Harold tried to avoid lunar favourites such as Tycho. Seeing was only average (III on the Antoniadi scale), but an IR 742nm pass filter and the magic of Autostakkert and Registax turned a sow's ear into something approaching a silk purse!*



Colour Shaded Relief derived from the Global WAC showing the sunlit peaks from Bill's image corresponding to the highest parts (dark brown) of the crater rim.

Cleomedes.

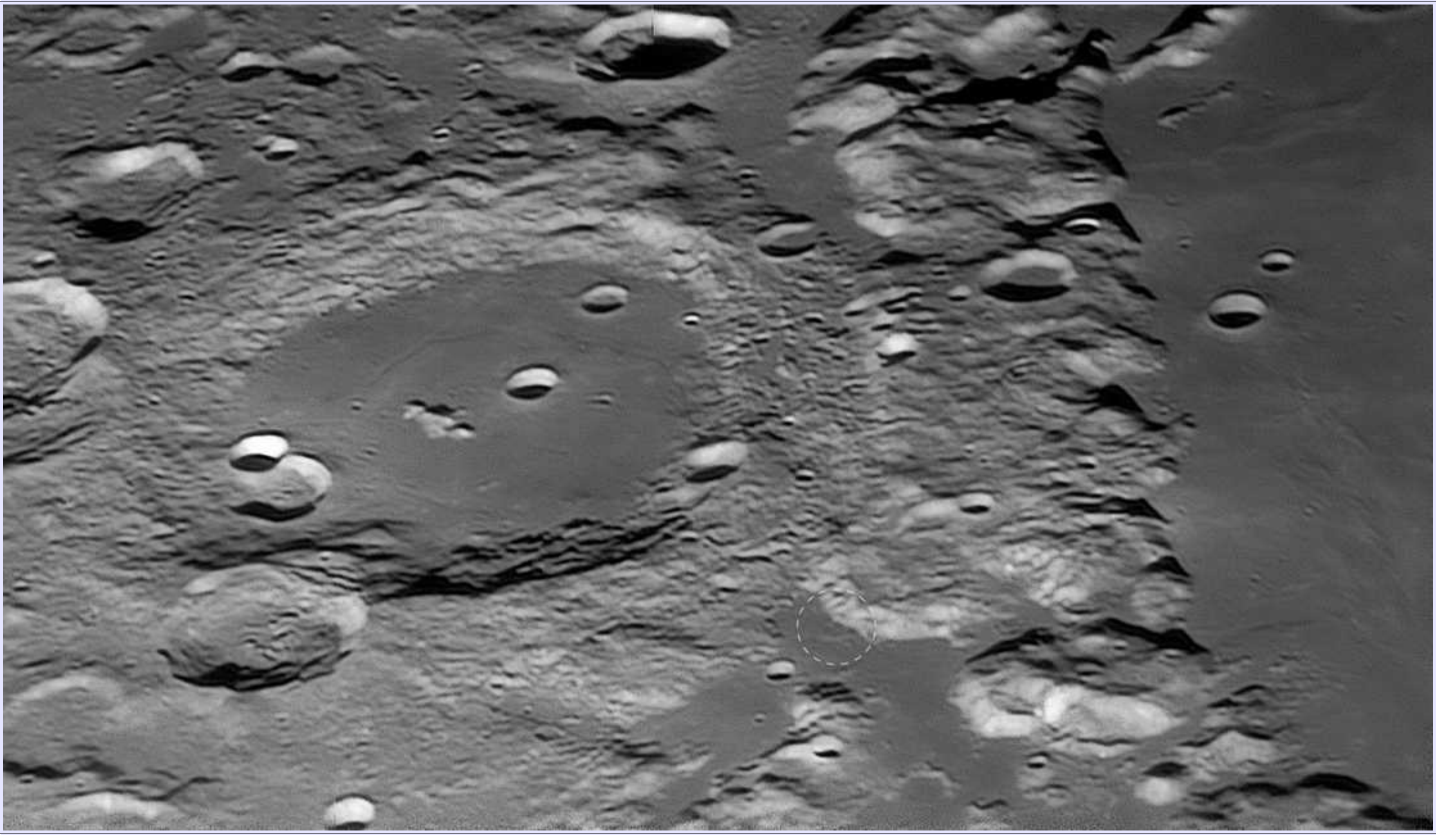
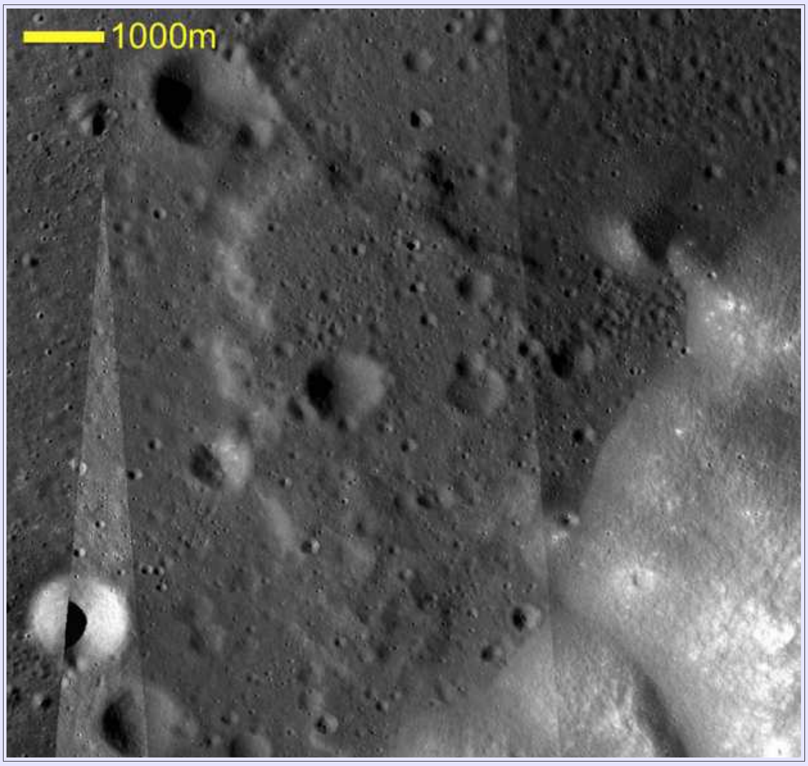


Image by Leo Aerts taken on 12th October 2022 with a 25 cm f/15 Opticon Schmidt Cassegrain and ASI 290MM webcam.

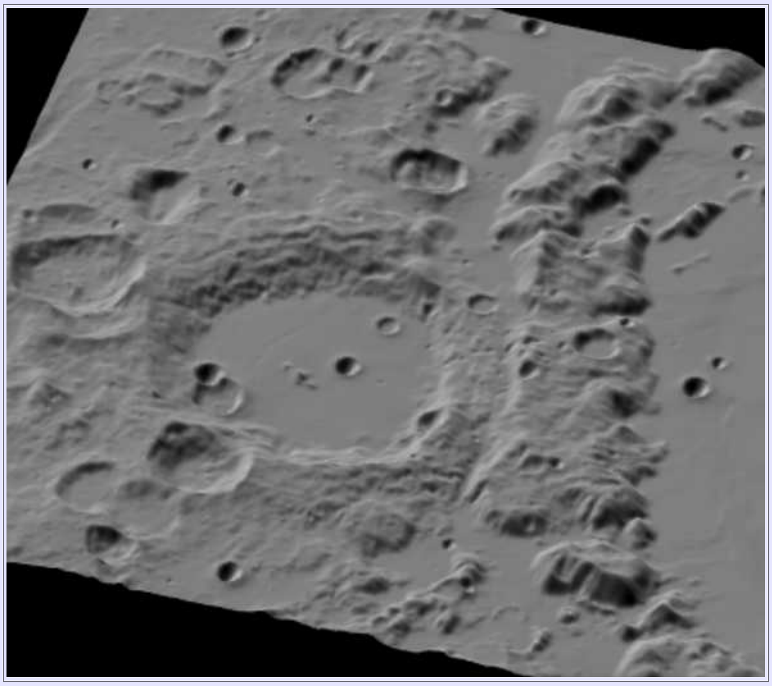
Geological Notes: Cleomedes itself is covered in some detail a little later in this LSC, so we can instead concentrate on some of the other unusual features shown in Leo's image. The small broken circle marks the position of a small and quite unusual volcanic feature which sits on the edge of a small patch of mare to the SW of Cleomedes. It is about 6km long, 4km wide and a shade over 250m high, with a fairly flattish looking top and margins that shows hints of lobes and stubby projections.



LRO NAC image of the feature identified in the circle in Leo's image.

The mineral overlays in Quickmap show it to be more or less identical to the mare on which it sits – so probably of a basaltic composition, and it has a similar concentration of craters compared to the adjacent mare surface. What exactly it is is not clear, but the appearance suggests some form of volcanic structure built up of lavas of a viscous nature - not a characteristic of basaltic mare lavas which are notable for their low viscosity. There are however a number of structures such as this in the surrounding terrain, of similar size, height and composition to the mare surfaces on which they are found*. Maybe they represent a late stage of volcanism as they all appear to lie on top of the basalts surrounding them – and most of them appear concentrated around Mare Crisium, but their exact nature is a bit of a mystery.

The next thing of interest is the rather straight appearance of the southern rim of Cleomedes – you can see it quite clearly in the image and also in the 3D rendition below. This appears to be the result of the presence of what appears to be a system of faults running tangential to the rim of Mare Crisium and trending approximately NE to SW, with another element being visible as the prominent north facing scarp to the south of Cleomedes's southern rim.



Quickmap 3D rendition of Cleomedes and the northern part of Mare Crisium. Note the straight southern rim and the prominent north facing scarp to its south which forms one of the basin rings.

These faults may be tectonic features that pre-date the basin, but it is more likely that they relate to the basin itself, and the scarp mentioned forms the edge of an uplifted crustal block that forms one of its rings. Whatever the nature, these alignments were noted by Frisoff as part of his charting of the enigmatic Lunar Grid system** so it is clearly visual telescopically under favourable illumination.

***See 'Viscous flows vs kipuka' in Lunar Section Section Circular Vol. 52 No. 1 January 2015.**
****Moon Atlas by V. A. Firsoff. The Viking Press, New York, 1961.**

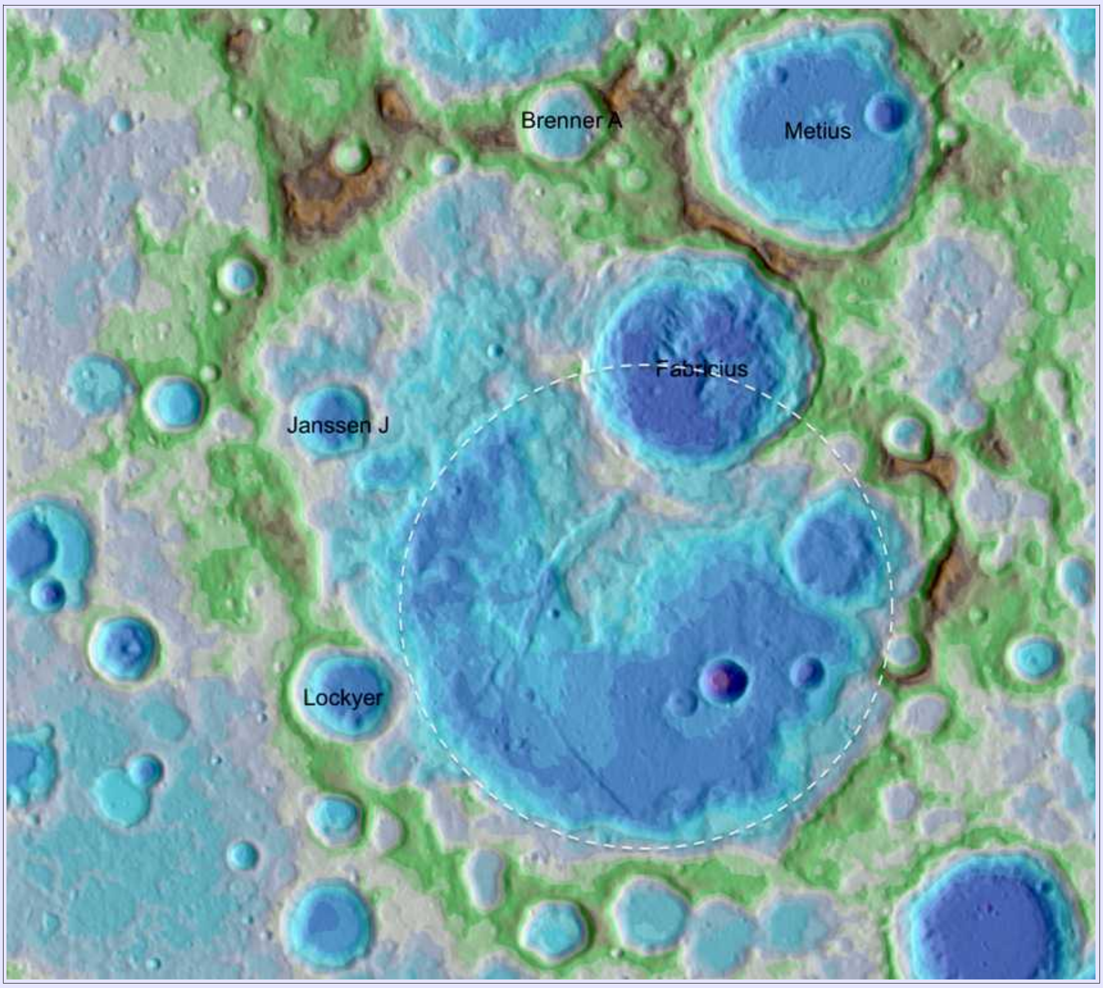
Janssen and Rhieta Valley.

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

Geological Notes: This has been pointed out before, but is Janssen one elongate crater or is it one crater overlapping an older one? As its northern part is filled with ejecta from Nectaris it is clearly pre-Nectarian in age, but this infilling has also obscured the actual location of the northern rim. Is it the curving ridge that extends from the western rim of Fabricius towards the crater Lockyer (which just straddles the western rim) or is it the more prominent ridge that runs from Brenner A and curves down to the west of Janssen J towards the northern rim of Lockyer.

If we go for the first option, then we could just about squeeze in a circular outline (white circle in the image below) that could be a younger crater with a diameter of about 166kms which has overlapped the southern part of an older crater which lies just to the north. So far so good – but if what appears to be the central peak (traversed by Rimae Janssen) is a central peak then it is displaced by quite a distance to the NW compared to the geometric centre of the proposed crater. There are a number of craters with offset central peaks, but these all tend to be Floor Fracture Craters (FFC) where the actual crater floor has decoupled from the crater itself, taking the centra peak with it, but Janssen is not a FFC and the fractures crossing its floor probably originate from more widespread tectonic activity.

If however we go for the second option, and think of Janssen as being an elongate crater measuring some 240kms by 190kms, then the location of the central peak (if that is what it is) is somewhat more centrally located. So which one is it? I think I would favour the first option (overlapping craters) but I am open to any arguments to the contrary – so please send in your opinions.



Quickmap Colour Shaded Relief Map of Janssen.

Mark's image also shows the ridiculously complicated central peak complex of Fabricius, with a chevron shaped element located to the east of the crater centre, and a further element made up of what appears to be an up-ended stack of slabs towards the north. One possible explanation for this complicated arrangement is that the northern 'slabby' element represents collapsed material that originated from the north-eastern inner wall. In Mark's image you can see a higher albedo patch on the inner wall to the NE, this represents a precipitous slope over 4000m high with an inclination of well over 30° - so clearly some substantial slumping has taken place here.

Fabricius may also be a FFC, with a positive sub-surface gravity anomaly suggesting a body of solidified magma beneath the floor, and a series of fractures crossing the crater floor. This is unusual in a highland setting as FFC's are normally found adjacent to the mare where upwelling plumes of magma are probably more frequent. These fractures however appear to traverse a floor that looks like the original impact melt sheet that formed immediately post-impact, if this is the case the uplift that produced the fractures must have occurred soon after the crater formed. There is obviously plenty of stuff to investigate in *both* Janssen and Fabricius – which is possibly something to idle away the odd cloudy night with!

13 Day old Moon.

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

Lacus Mortis.

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

Rik Comments: *The region of Lacus Mortis (left of center) is the hexagonal plain with the nearly central crater Burg (41km dia.) that has a valley dividing its central peak in two, surrounded by nice hummocky terrain for another 40km or so. There are some interesting rimae (what we used to call "rilles") around the Lacus starting at the 8 O'Clock position from Burg where there is a shear fault that points to the north from the rim of the Lacus. Moving up from there is a graben that extends out to the north of Burg. Then above Burg is a short rima only about 25-30km long, that appears to be a catena formed from impact debris. probably from the Burg impact since it is the youngest in the area, being of Copernican age (1.1 billion years ago to present).*

Below Burg are a pair of craters, the flat floored or flooded crater Plana (42km) and to the right of it is a smaller flat floored crater Mason. Between them and below (south) is the crater Mason B, a very fresh crater as is the small unnamed 3km crater below and to the right of it. About 20-25km below Mason B on the plain of Lacus Somniorum, is a low isolated dome. Moving further south you come to the crater Grove (29km) at the bottom of this image. Due east of Burg (right) are the two large craters. The nearest being Hercules (68km) with the large Hercules G (13km) crater on its floor. Then deep in evening shadow further east is Atlas. These two craters are more familiar to the amateur observer as two of the more identifiable features in the waxing crescent moon.

Notice above Atlas there is the hint of a crater outline. This is Atlas E (59km), very ancient possibly pre-Imbrian, and deeply overlain by ejecta from both Atlas and Hercules. Further north you can just make out Keldysh (33km) almost completely in the night's shadow.

This image was made from portions of two 1800 frame AVIs stacked with AVIStack2 and knitted together with MS ICE. Final processing was done with GIMP and IrfanView.

Ptolemaeus and Albategnius.

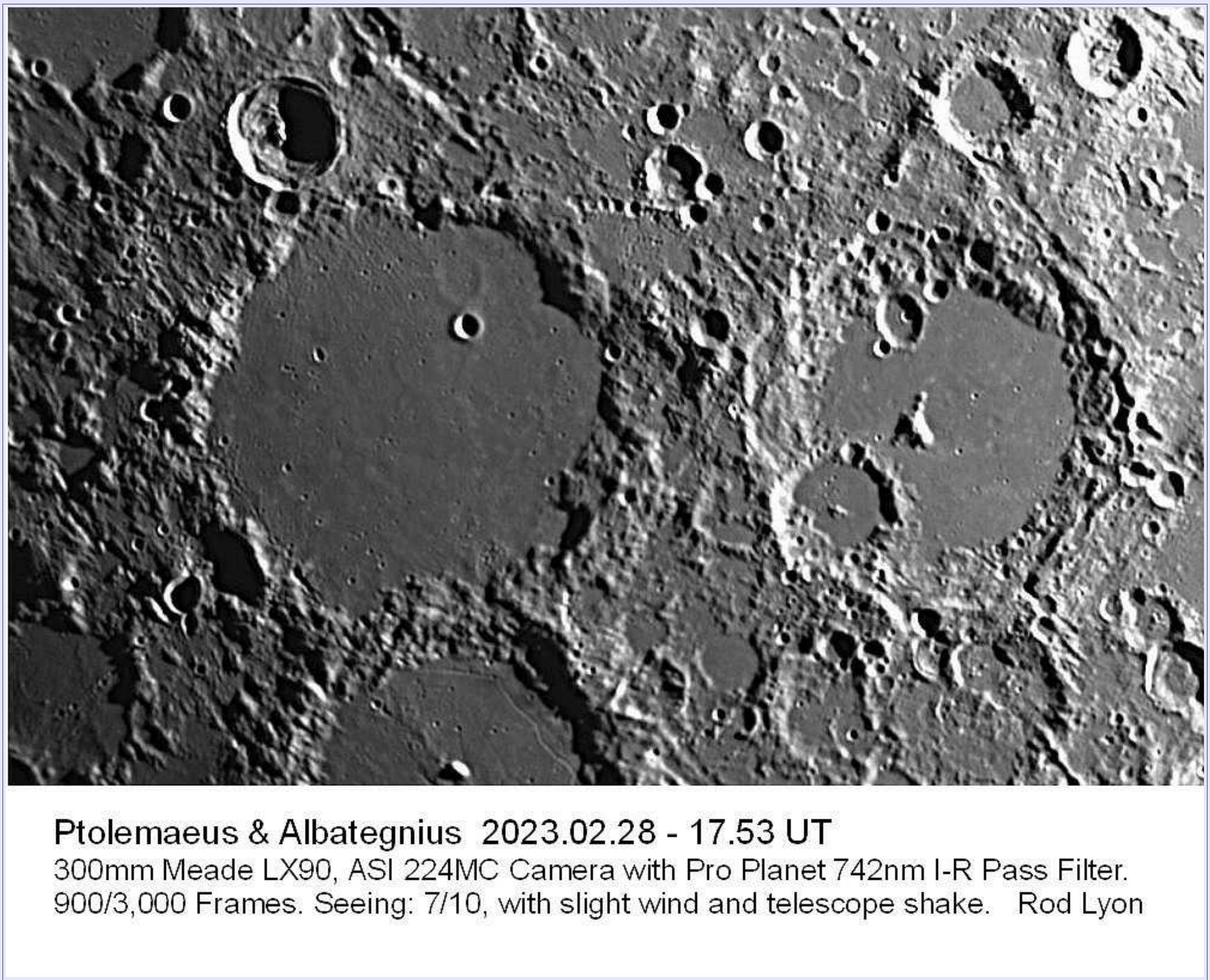


Image by Rod Lyon with details of time/date and equipment as shown.

Geological Notes: Some interesting crater chains or 'catena' are visible in this image. The major lineations here belong to the 'Imbrium Sculpture' and trend NNW-SSE, more or less radial to the Imbrium Basin, and consist of gouges and the smaller scale scouring evident along the north-western rim of Ptolemaeus. A distinct but short catena can be seen just clipping the northern rim of Ptolemaeus from the east, running west from the rather scrappy crater Müller and including Müller A and F and possibly Ptolemaeus G. Where the catena is clearest, the easternmost crater components can be seen to be overlain by their companions further west, indicating an origin of the impactors from the east. Another *possible* catena can be seen running tangential to the northern rim of Albategnius, on a slightly different alignment to the previous one. At the eastern end of the chain is Albategnius H and at the western end Albategnius M, but whether these are part of the chain or indeed if there is actually a chain there at all is not clear, but Rod's image is suggestive. If these are crater chains – what is their origin? The most likely interpretation is that they are the result secondary impacts, but if this is so, what is the parent impact structure?

Of less contentious origin is the crater chain running north up the extreme western floor of Ptolemaeus. This lines up with the ridge that bisects Alphonsus, which is an ejecta feature from Arzachel, and so the chain most probably is the result of secondary impacts from Arzachel. This transition in the nature of ejecta from being depositional (in the form of ridges, frequently in the 'herringbone' pattern) near the crater to erosional (in the form of secondary crater chains) further away is not unusual and can be seen in the ejecta of many lunar craters.

Aristarchus, Prinz and Krieger.

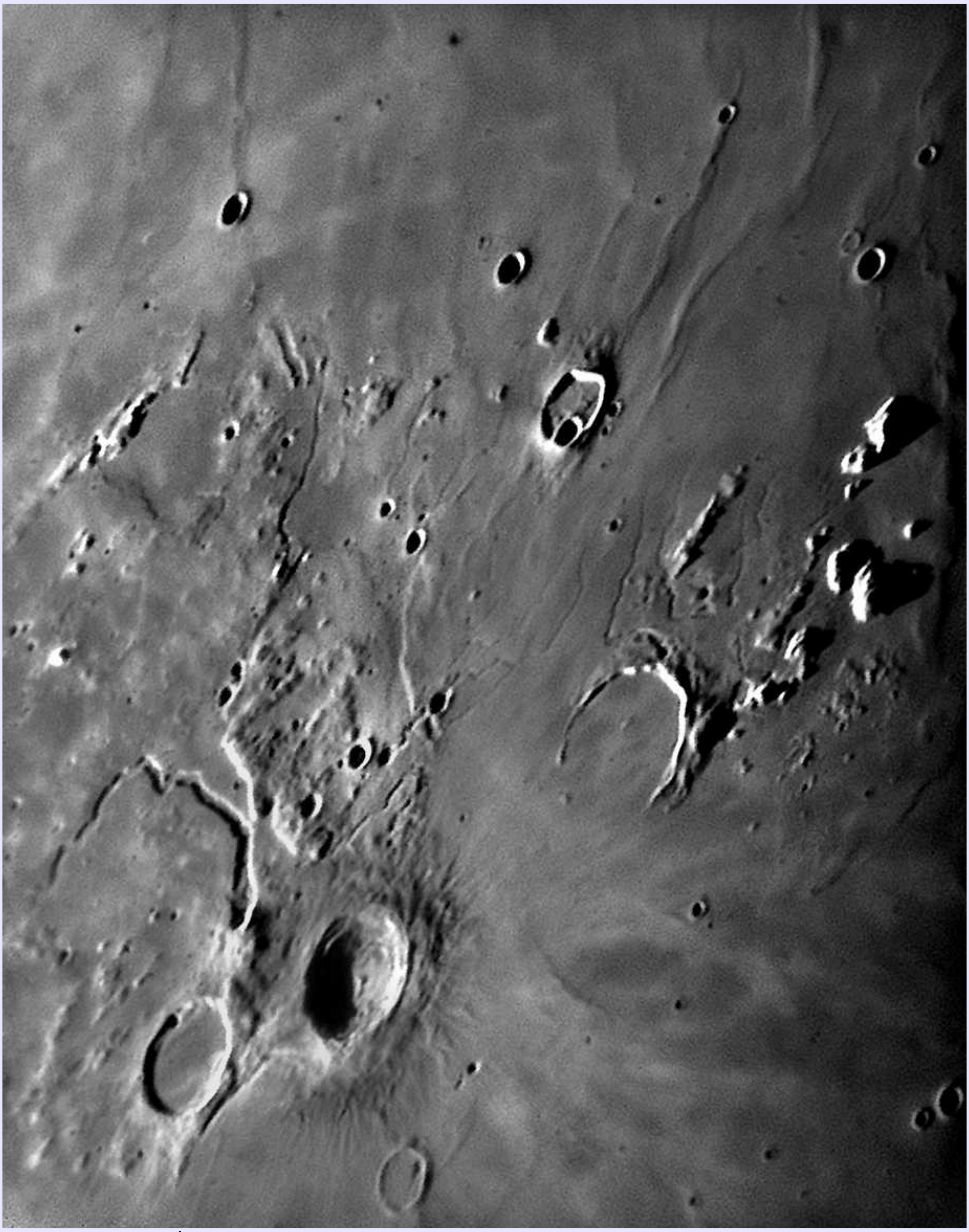


Image by K.C.Pau taken on 7th December 2023 at 2211 UT with a 250mm f/6 Newtonian reflector* + 2.5X barlow + QHYCCD 290M camera.

**I asked K.C for some details of his telescope and he replied that the mirror was made by Royce Precision Optical Components in US, and the scope was obtained second-hand from a friend in 2003. He stated that the coatings were now starting to deteriorate, but he regards it as a wonderful instrument, and his results would confirm that.*

I thought it might be interesting if members could send in images and a short description of their favourite lunar telescope and any modifications they have made for either visual or imaging – so please send us your telescope pics and tips for inclusion in the LSC.

Grimaldi, Rimae Grimaldi and Damoiseau.

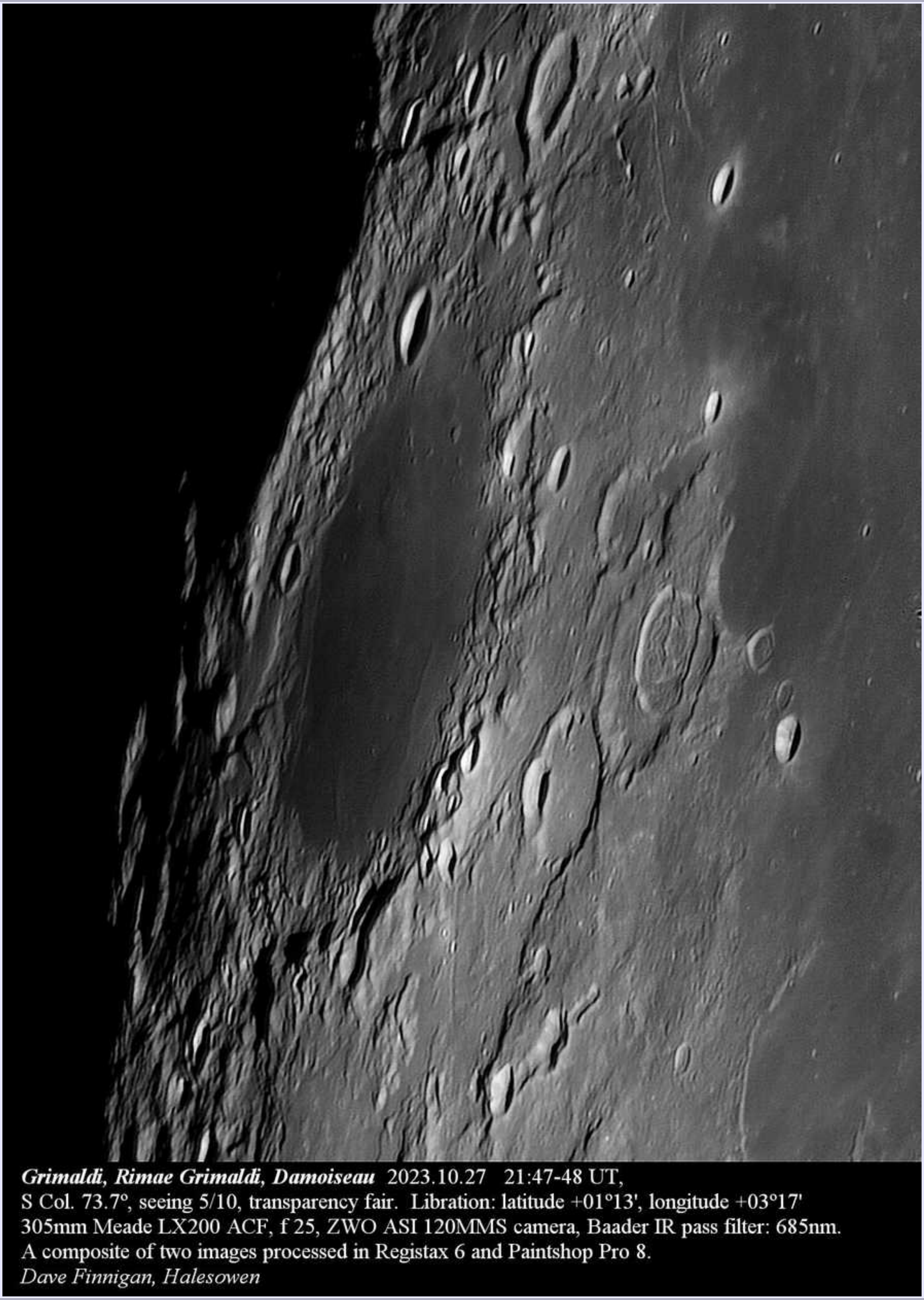
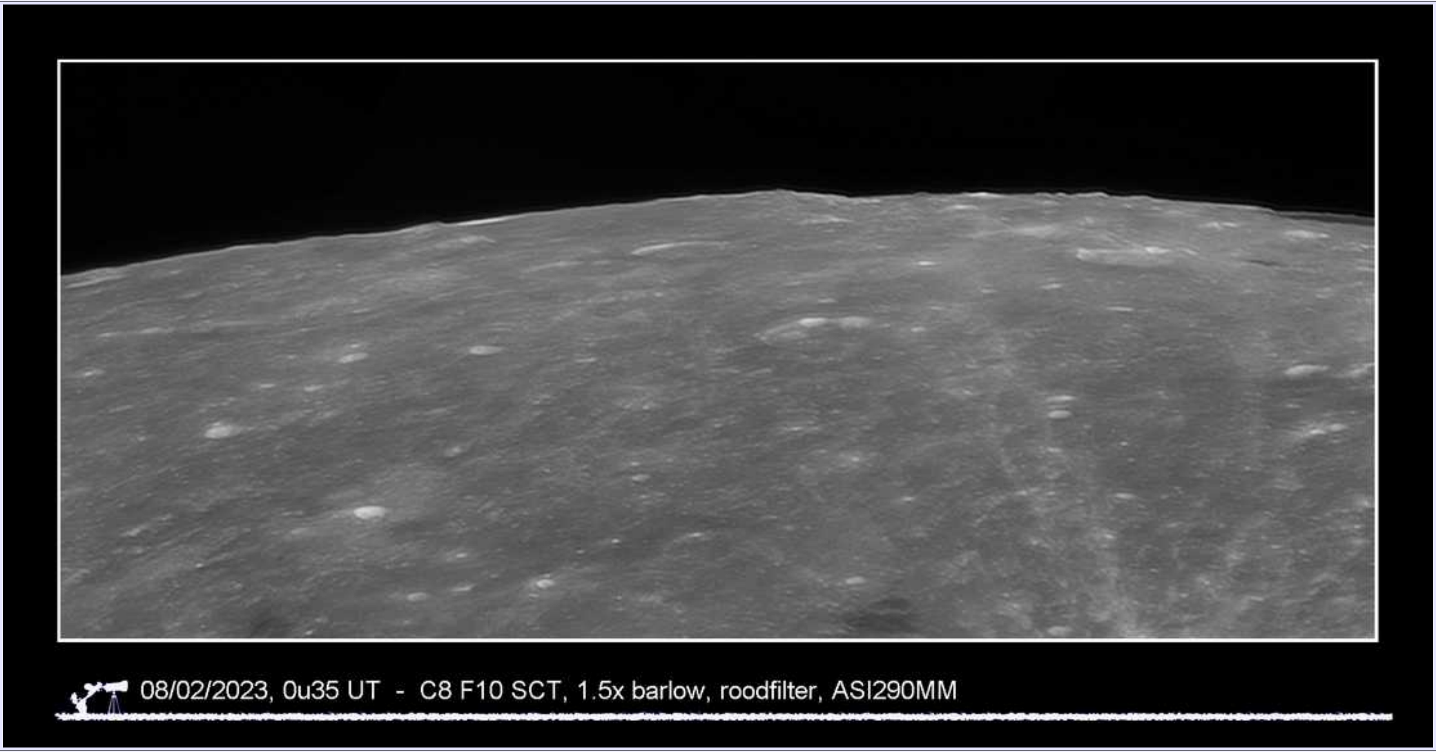


Image by David Finnigan with details of time/date and equipment as shown.

Geological Notes: On the far side of Grimaldi is the 14km diameter Grimaldi A, and if you look at the basin rim just beyond and to the south of it you will see a gap which opens to the west. A tongue of melt rich ejecta from the Orientale Basin has surged through this gap and can be seen as a smooth surfaced lobe to the south of A, the eastern edge of which (running down from the southern rim of A) forms a 500m high scarp with an inclination of about 10° and which is just catching the morning sun in this image.

The Orientale Basin.



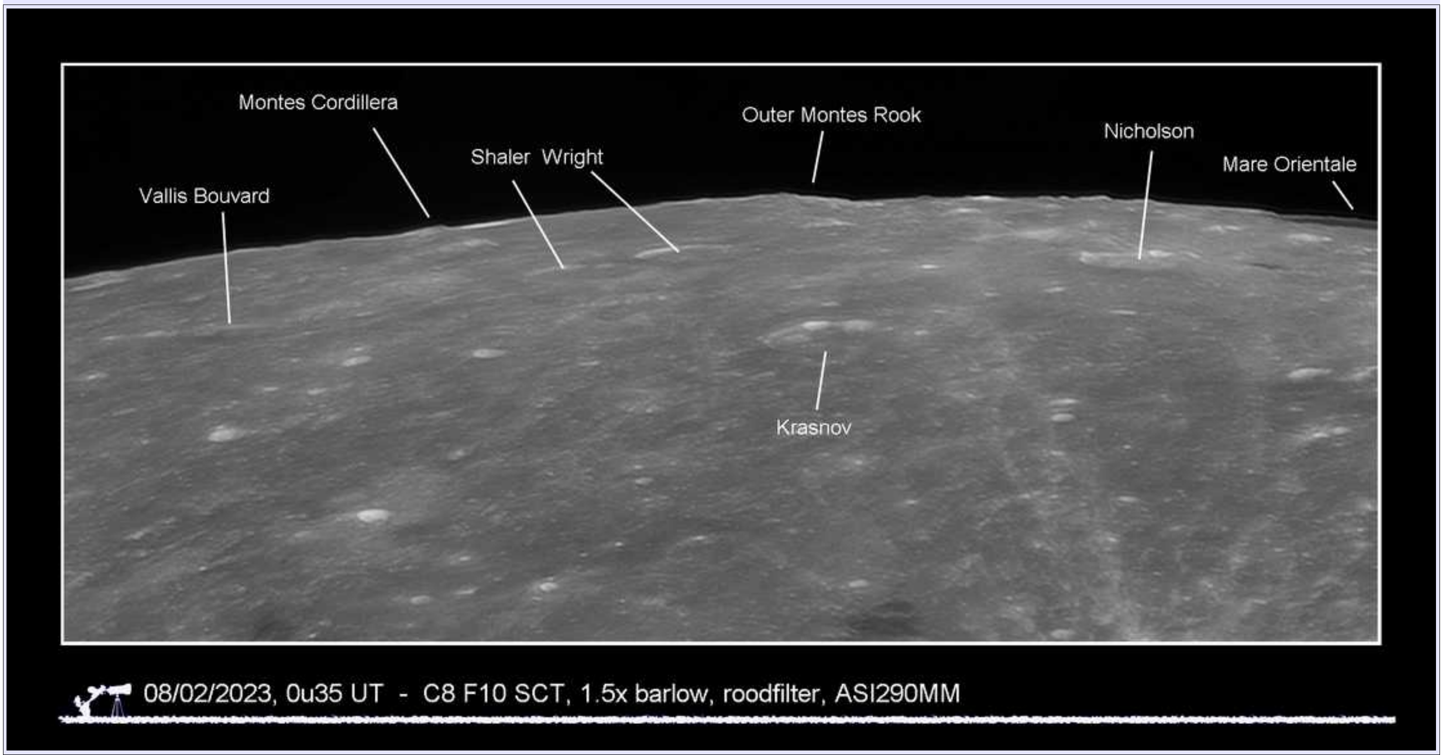


Image and labelling by Alexander Vandenbohede with details of time/date and equipment as shown.

Alexander Comments: *Libration was quite favourable for this observation of the southern part of the Orientale basin. The southern part looks less impressive than the northern in terms of relief along the limb. The reason for this is mainly due the Montes Rook. The inner Montes Rook are almost not developed at all while the outer ones are relatively low. This is perhaps due to the fact that the Orientale impact was a quite shallow (20° to 45°) coming from the northeast and due to the fact that a older basin existed already in that southern area (interacting with the development of the ring structures).*

Plato and Alpine Valley.

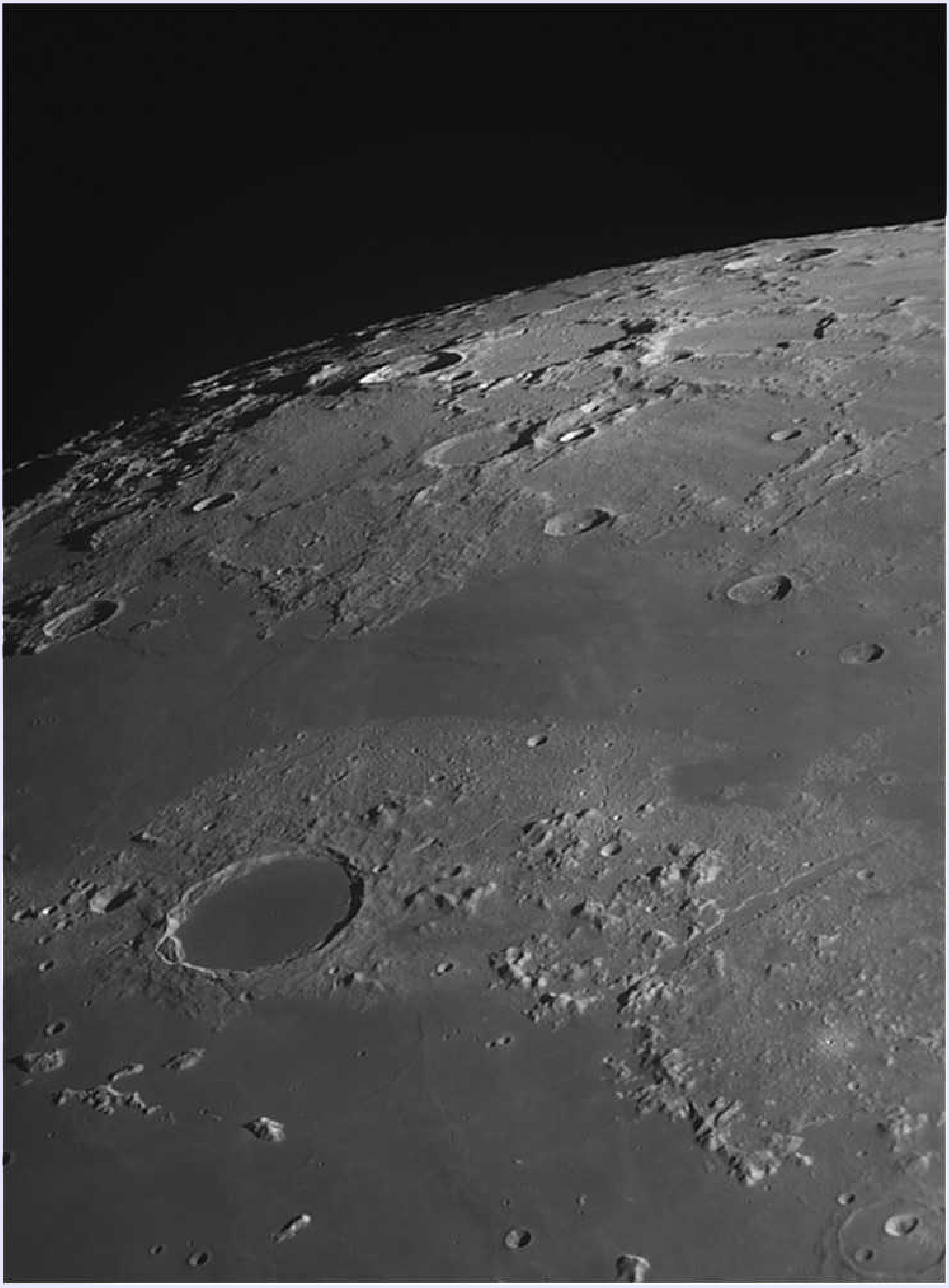


Image by Bob Stuart taken and on the 02/03/2023 at 17:00 UT with a 25cm Newtonian, 3x Televue Barlow, ZWOI 174MM camera with a 850nm IR filter. The image was taken in daylight but the use of the filter produced a good black background and in less that ideal seeing.

Mare Crisim, Langrenus and Petavius.

Image by Chris Longthorn taken on 29th November between 21:10 to 21:21 using a StellaLyra 200mm F/8 Ritchey Chretian Classical Cassegrain and a ZWO ASI 224MC camera at prime focus. Processed using AutoStakkert for the stacking of about 300 frames from 1000, followed by Van Cittert Deconvolution in Astrosurface. Finished Adobe Photoshop. Original stacks then stitched together and re-processed with enhanced saturation to make a mosaic.

Basin and Buried Crater Project by Tony Cook.

Unfortunately no images or sketches have been sent in specifically for the BBC project recently, nor any armchair work done at the computer, so I thought that I would pick another candidate buried crater from the catalog, and look at evidence for there being a crater there, or not? So this month's buried crater is: PFC 14, which is provisionally located at 83.0˚W 46.4˚N with a diameter of 63 km.

Just to remind the reader, PFC stands for "Partly Filled Crater". The PFC's listed come from the paper by: A.J. Evans, J. M. Soderblom, J. C. Andrews-Hanna, S. C. Solomon, and M. T. Zuber (2016), Identification of buried lunar impact craters from GRAIL data and implications for the nearside maria, Geophys. Res. Lett., 43, 2445–2455, doi:10.1002/2015GL067394.

So let's look at the NASA Quick Map web site and see what is there at this location. This clearly shows quite clearly a complete, albeit degraded, crater here with an existing name of "Gerard Q" (See Fig 1) and so it is not correct to suggest that this was completely unknown. Using measurements taken using NASA Quickmap web site, the diameter of this crater is 66.3 km, i.e. 3.3 km bigger than the catalog entry, and located at 83.2˚W 46.6˚N. The crater may have a central ring of hills, as some larger craters do, though the hummocky terrain on the W/N/NW interior makes interpretation difficult.

Figure1 LROC Quickmap WAC nearside mosaic (WAC+NAC+NAC_ROI) centred on the approximate location of PFC 14.

The lava filling of the eastern floor shows up well in the Iron Oxide (FeO) plot in Fig 2. There are a lot less mare areas on the lunar far side due to the thicker crust, but PFC14 is in a half way house situation, being very close to the far side.

As always, azimuth direction plots of the slope on the surface can be quite revealing. Fig 3 shows the rim of PFC 14 a lot clearer than in Fig 1, and its pentagonal in shape. N-S and NW-SE trending rilles are visible externally from the crater and there is a curved rille to the NW. PFC14 appears to have formed over the top of another crater, to the NW, some 44 km in diameter and centred on 84.1W, 47.4N, which I will add to the list of buried craters

As we have identified PFC14 as Gerard Q, and it's an IAU named crater, we can remove it from the Buried Crater list, and should not have appeared in the Evans et al. paper in the first place. We can however add the new 44 km diameter, half buried, crater to the list instead.

Figure 2 LROC Quickmap FeO abundance map, based upon Clementine UVVIS waveband imagery - centred on the approximate location of PFC 14.

Figure 3 LROC Quickmap SLDEM2015 Azimuth plot.

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!

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Cleomedes by Barry Fitz-Gerald and Raffaello Lena.

The 145km diameter crater Cleomedes is a prominent feature located just outside the northern rim of Mare Crisium. It probably straddles one of the outer basin rings, and the slightly domed floor is some 4,500m below the level of the crater rim. The crater floor itself consist of light plains which are likely to be volcanically derived, with a mantling of material derived as ejecta from the surrounding highlands. This interpretation is suggested by the observation of mafic ejecta surrounding some of the small craters that penetrate this superficial lighter layer. Cleomedes is a Floor Fracture Crater (FFC) and Rima Cleomedes demonstrates that the crater floor has undergone an episode of uplift, though the various graben that cross the crater floor are partially obscured, suggesting infilling by younger deposits of a volcanic or impact derived nature.

In telescopic images a small indistinct patch of a lower albedo material forms a small arc on the south-western crater floor, this is identified on the USGS Geological Map of the area as 'mare material', suggesting the eruption of a basaltic type of lava within this corner of the crater. Some high resolution images also show hints of a small raised area within this darker patch, and this appears on further examination to be a small volcanic feature of some form.

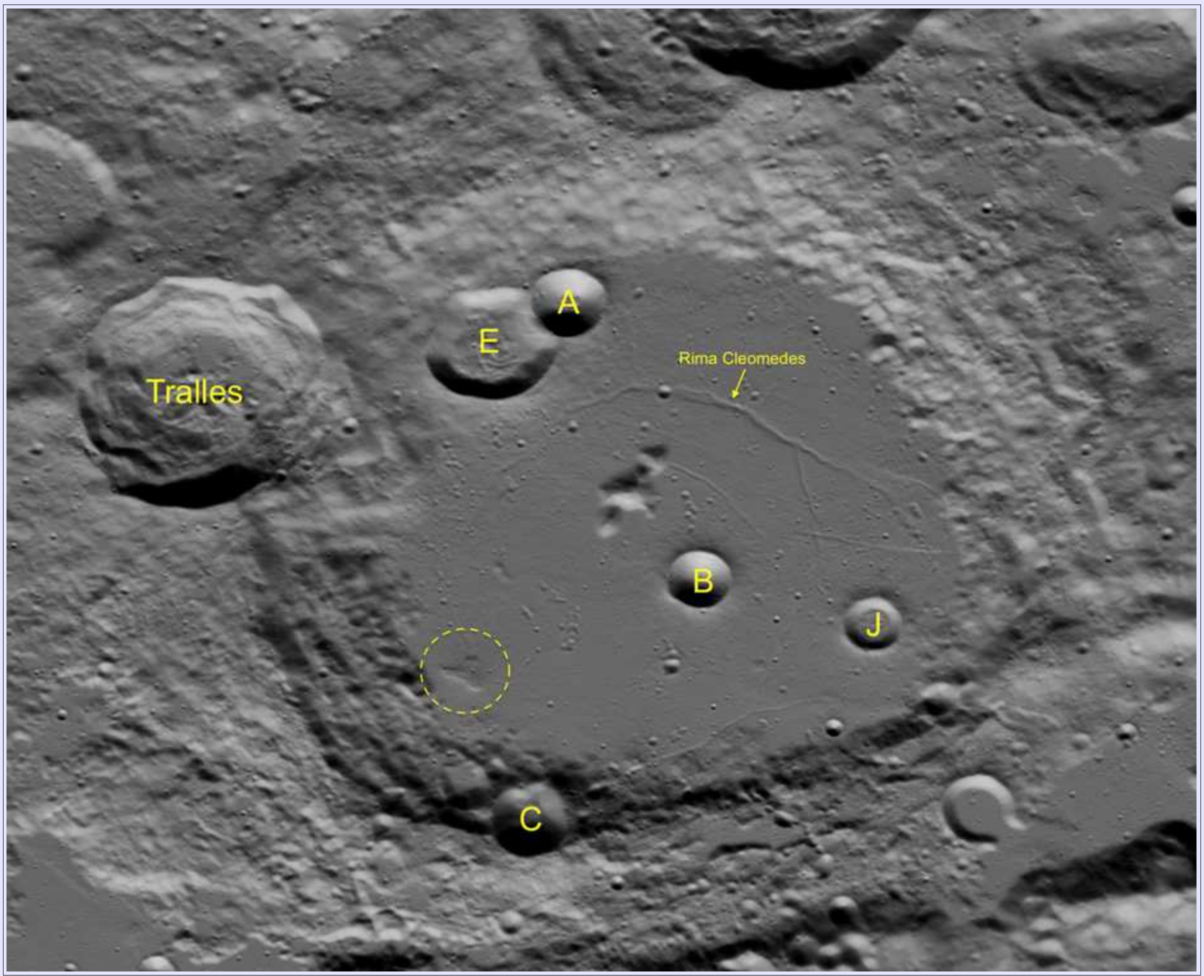

Fig.1 Terrain Height rendition of Cleomedes from LRO Quickmap showing location of small volcanic feature (yellow circle).

Fig.1 shows the location of this feature, which as can be seen is an irregular 'arrowhead' shaped hill with dimensions approximately 8km east-west and 5km north-south, and rising some 300m above the surrounding surface. Topographically it takes the form of a small, low *almost* flat topped plateau with, in places irregular lobe like margins. As noted above it has a roughly arrowhead shape, with the tip of the arrow pointing towards the SE. At the tip of the arrow so to speak is what appears to be a small (~500m diameter) crater that is slightly raised above the general level of the feature and may represent a volcanic cone. This is discussed in detail in the spectral investigation section below.

The surface of the 'arrowhead' appears to be just as cratered as the surrounding mare, but speculating that any of these are volcanic vents would be fraught with uncertainty. There is however a possible candidate in the form of a 700m diameter crater or vent on the eastern flank of the structure (Fig.2) which has a dark halo that extends eastwards onto the mare surface where it forms a low albedo patch which is identified as 'mare material' in the USGS Geological Map. One possible interpretation is that this dark material is either a lava or pyroclastic deposits and that this crater or vent was the source of this dark surface material. There are two other possible volcanic features within this dark area, and located close to the inner crater wall of Cleomedes, but these are quite small and probably well beyond the reach of telescopic observers.

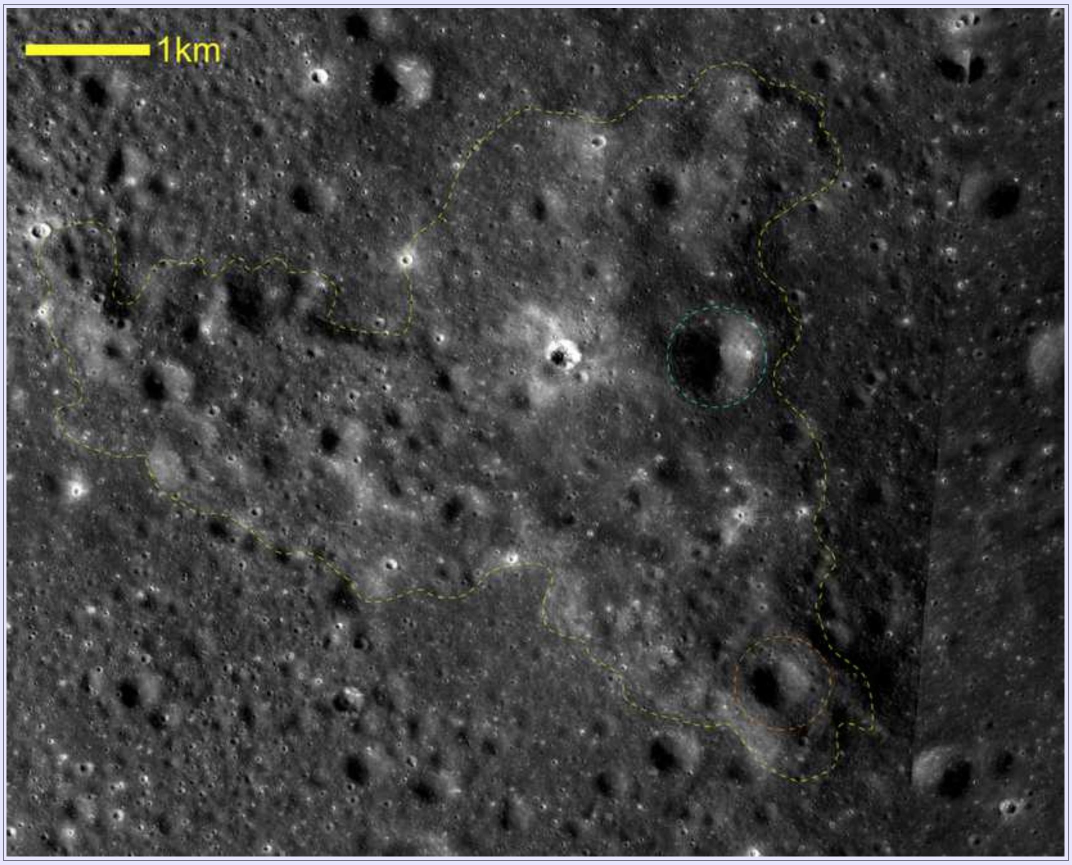

Fig.2 LRO-NAC image (Medium incidence) of the volcanic feature shown in Fig.1 in the yellow circle. The outline is picked out using a yellow dashed line, the orange and blue circles marks possible volcanic cones. The possible cone marked with the blue circle is surrounded by a dark material that extends onto the mare surface to the east.

The irregular shape is not what you might expect for a volcanic structure, these tend to be slightly more symmetrical as we see in the common or garden lunar dome. Irregular shapes are however not uncommon, many of the cones in the Marius Hills for example are less than perfectly round, and have more of a 'cow pat' outline compared to the rather more pimple like shape of those around Hortensius. This is probably down to the mode of eruption, with more gassy, explosive activity producing the irregular Marius domes, and less dramatic low viscosity lava eruptions producing the more rounded examples.

The viscosity of the lavas (and possibly eruption temperature) will also play a part, with viscous lavas producing steeper sided structures, and short stubby lava flows, but these are infrequently encountered on the Moon. The structure described here may therefore have more in common with either the Marius mode of eruption (gas rich and explosive) or the high viscosity variants. The association with the mare like low albedo area might also suggest that it was also involved in the eruption of low viscosity basaltic lavas or pyroclastic material of some sort, so possibly more in common with the Marius type of dome, which are known to be of largely basaltic composition despite their rugged appearance.

The location of this (as well as the smaller suspected volcanic vents) structure along the margins of the crater floor may also be significant, in that it *may* overlie a section of Rima Cleomedes, which can be traced vaguely to the south of Cleomedes E and possibly just north of the feature itself, where it just about visible as an approximately 1km wide and 30 to 40m deep trench. This would be quite logical as these extensional graben might well form conduits for ascending lavas, and as Cleomedes is a FFC, it would have had, at some stage a molten lava body beneath its floor.

Mineralogical Study.

The Clementine colour ratio image of the area around the feature (X in Fig.3) displays an orange colour, indicating a low TiO_2 content < 2 wt%.

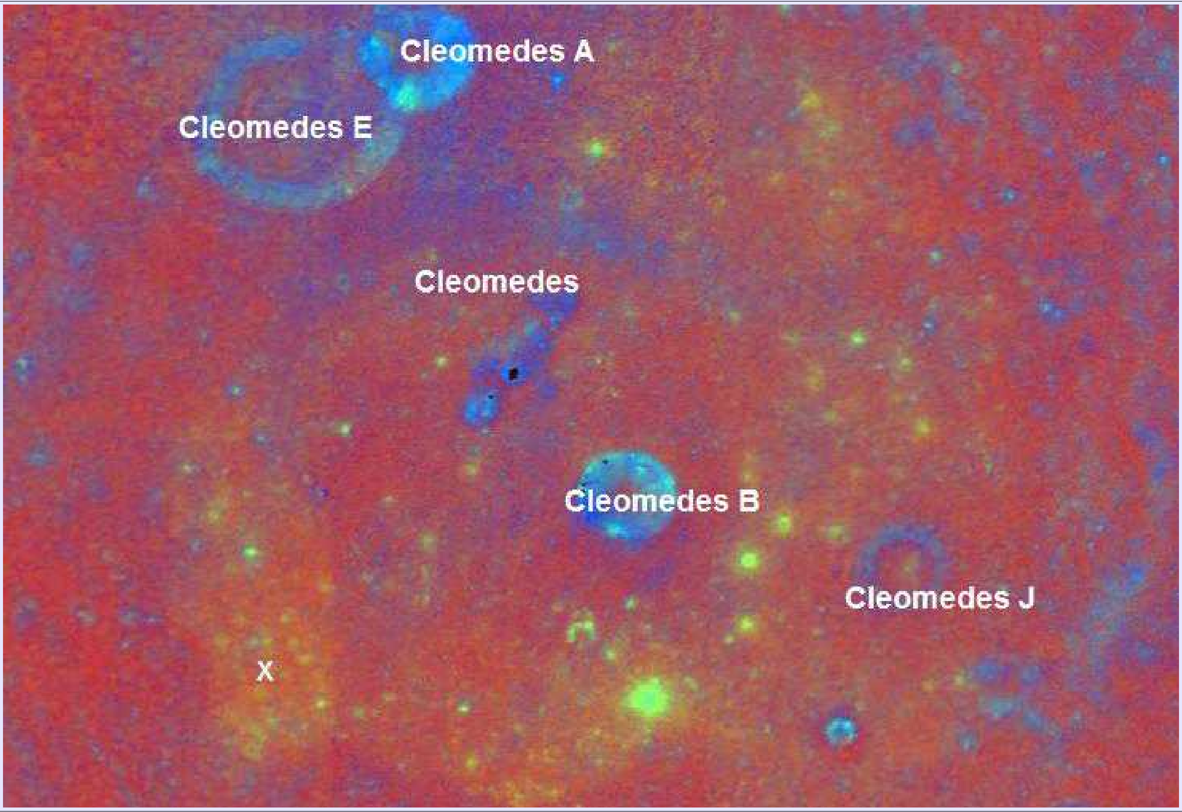

Figure 3: Clementine colour ratio image obtained assigning the R750/R415, R750/R950 and R415/R750 into the red, green,and blue channels, respectively.

The possible vent circled in orange in Fig.2 was analysed, as this appeared to offer the most likely evidence for volcanic activity and may well, according to the current evidence be a volcanic cone. Lunar volcanic cones form from explosive eruptions with the release of large amounts of dissolved gas (called degassing) when viscous magma rises to slowly fill the volcanic vent.

The ACT-REACT Quick Map tool was used to access to the LOLA DEM dataset, obtaining the cross-sectional profiles (Figs. 4A-4C). The suspected cone is topographically higher 75± 10m than its surroundings. The diameter is measured to as 1.35 ± 0.15km, yielding an average flank slope angle of 6.6° ± 0.6°. The possible vent marked with the orange circle in Fig.2 is 55m deep and has a diameter of about 500m.

The volume of the cone is estimated to be 0.06 Km^3 assuming a parabolic shape. A 3D reconstruction of this small cone, which will be termed Cleo3 (as Cleo1 and 2 are already ascribed to features described by Lena in a forthcoming JBAA paper), at higher resolution is shown in Fig. 5. Note the tilt of the cone which displays lower height to the northwest and higher height in southeast direction.

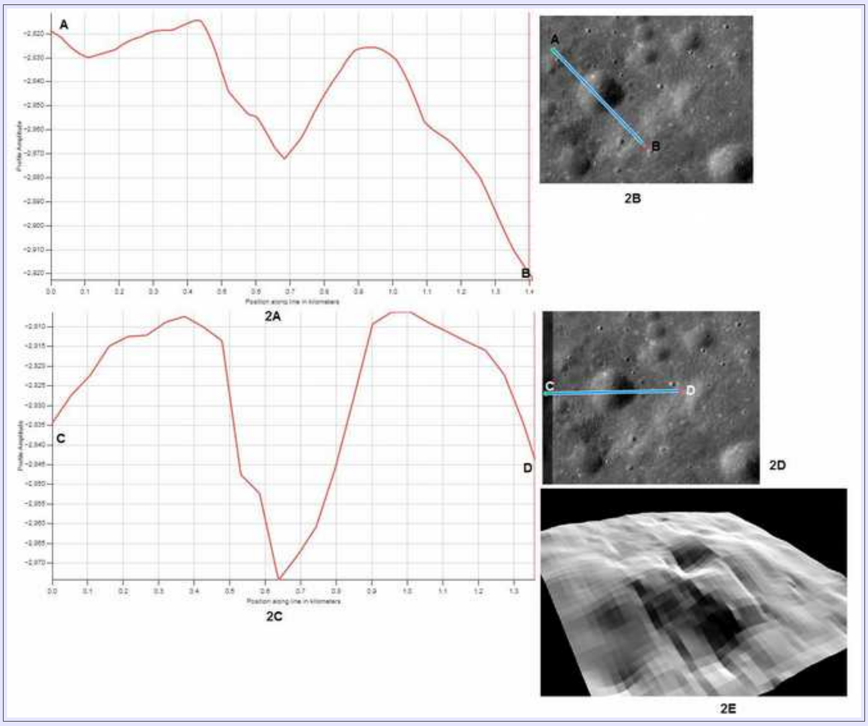

Figure 4A-E: LRO WAC-derived surface elevation plot in North-South and East-West direction based on LOLA DEM.

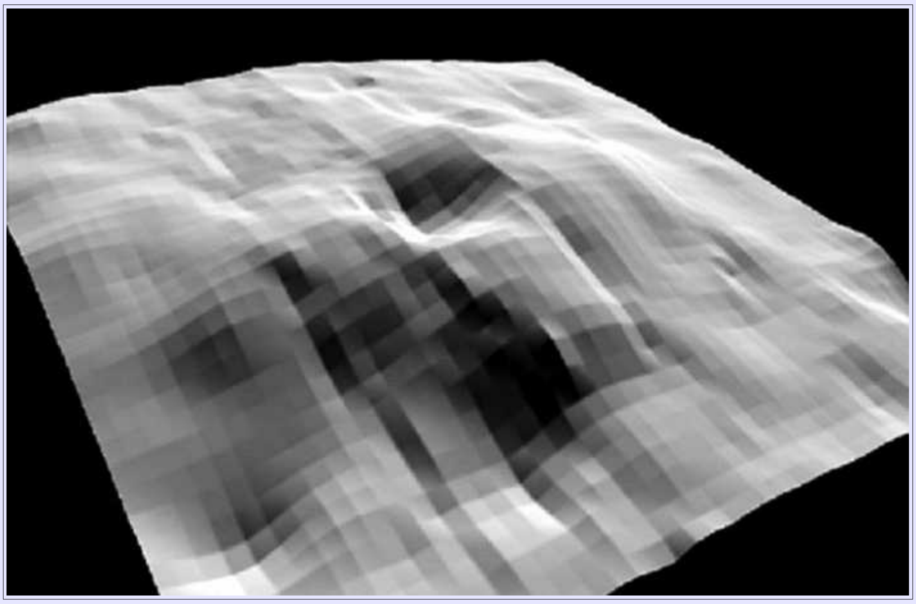

Figure 5: 3D reconstruction based on LOLA DEM.

A more realistic view based on NAC digital elevation-QuickMap Terrain Shadows illustrating the the shape of the cone is shown in Fig. 6.

Classification.
Based on morphometric data, we suggest Cleo3 is lunar cone. Lunar cones form a separate group in the lunar domes classification scheme (Lena et al., 2013), which is shown on the Principal Component Analysis (PCA) plot shown in Fig. 7, and where Cleo3 is marked with the symbol X.

Compositional Analyses
Bulk Silicate Mineralogy: The Diviner Lunar Radiometer Experiment is a multispectral radiometer onboard

LRO. The three “8 μm” channels centred at 7.8, 8.25, and 8.55 μm can be used to map the position of Christiansen Feature (CF), which is related to silicate polymerization. The CF position occurs at shorter wavelengths for felsic and feldspathic compositions and longer wavelengths for mafic compositions (Greenhagen et al., 2010). Cleo3 has a CF value of 8.33μm, consistent with a basaltic composition, implying a relatively low SiO_2 content.

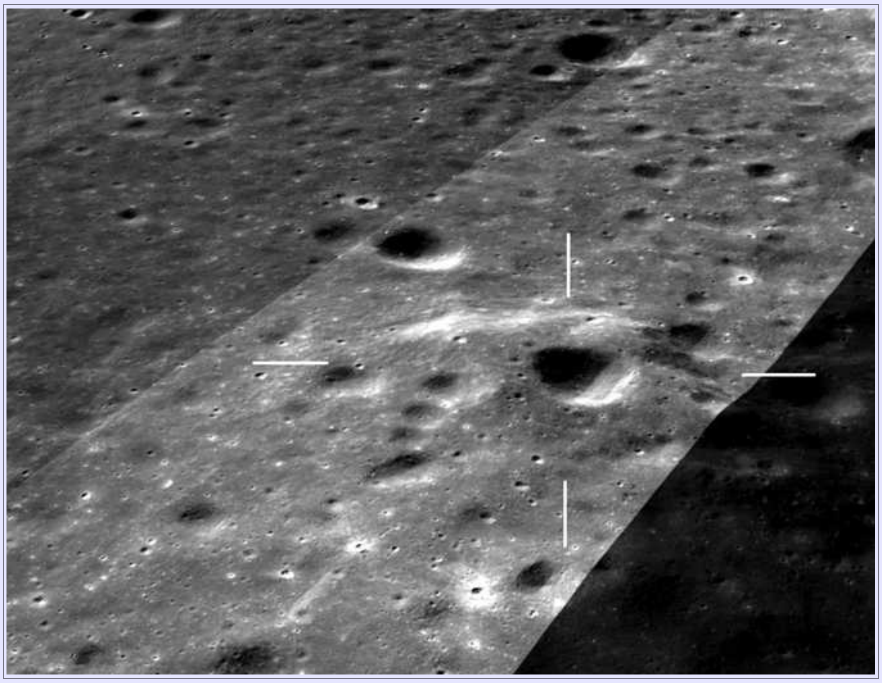

Figure 6: ACT REACT Quick Map tool-3D reconstruction of Cleo3 (marked with white arrows) using NAC imagery and the tool QuickMap Terrain Shadows.

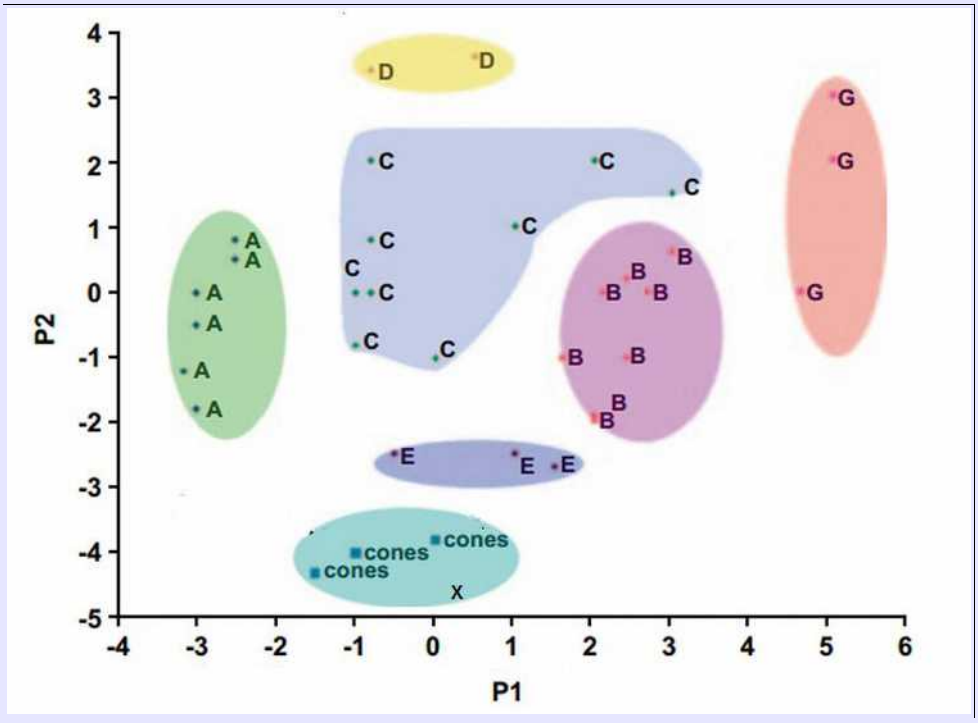

Figure 7: Classification scheme of effusive lunar mare domes and lunar cones based on a Principal Component Analysis (PCA) plot. Scores P1 and P2 of the features vectors describing the domes on the first two principal components of the data distributions. The dome classes A–E and G (highland domes including Gruithuisen domes) and the lunar cones are indicated. Note that the examined feature belongs to the cones cluster. Cleo3 is marked with the symbol X.

Mineralogical composition: For this study Lena 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 (Fig. 8). Cleo3 displays a TiO_2 content < 2.0 wt% and low plagioclase content (49.0-54.0 wt %). The FeO content varies from 12.0 wt % to 15.0 wt %. It has an enhanced abundance of FeO, if compared with nearby mare units. Cleo3 has an enhanced abundance of orthopyroxene (from 10.0 wt % to 19 wt %) if compared with nearby mare units and an enhanced abundance of clinopyroxene (27.0-36.0 wt %) which is similar to nearby mare units. The olivine abundance amounts to 6.0-12.0 wt %. According to the derived FeO and TiO_2 content the main rock type is low-Ti basalt.

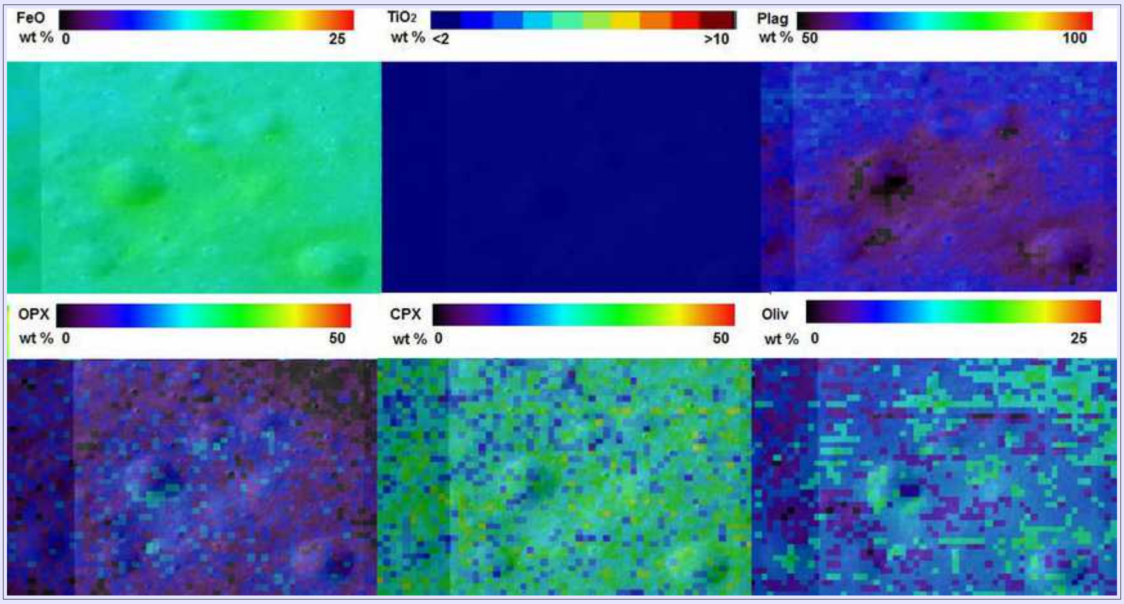

Figure 8: Top (left) FeO, (middle) TiO_2, (right) plagioclase. Bottom (left) orthopyroxene, (middle) clinopyroxene, (right) olivine content. Derived abundance maps in wt%.

M^3 spectral data: Spectral data from M^3 reveals that the dominant mafic mineral is high-calcium pyroxene which has diagnostic absorption features at 1,000 and 2,100-2,200nm. Considering the resolution and small size of Cleo3, only a rough spectrum was obtained but this probably includes a signal from other nearby rock units However, based on the orbital period OP2C3, Cleo3 shows absorption bands centre at 970nm and 2,180nm. The 1000nm band centre for lunar glasses is generally shifted to longer wavelengths when compared to pyroxene, and the 2000 nm band centre to shorter wavelengths. Furthermore dark mantle deposits are not detectable and spectral analysis indicate the absence of volcanic glasses signatures. A spectrum of the nearby mare has been derived showing similar dominant mafic mineral of high-calcium pyroxene (Fig. 9).

Mode of formation

Many lunar cones have a breached rim (a typical example is the cone termed Isis in Mare Serenitatis, of C-shape). 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.

Cleo3 does not have any indication of a breached rim, and instead displays a possible summit vent, supporting eruptions from near-surface dikes that did not emplace any visible dark mantle deposits. It 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. A plausible explanation for Cleo3 is all clasts were cold enough to form only spatter as explained by Weitz &Head (1999).

Figure 9: M^3 spectra obtained for the mare unit to the east of the lunar cone.

In Fig.2 a second possible candidate volcanic feature has been identified with a blue circle. This feature is about 1 km in diameter and 90-100 m depth (Fig. 10). Any rim around the crater is low and inconspicuous therefore it cannot be classified as a cone but may be, and assuming a volcanic origin, a caldera or structure similar to terrestrial Maar, which is a volcanic crater formed by explosive activity but little or no eruption or lava.

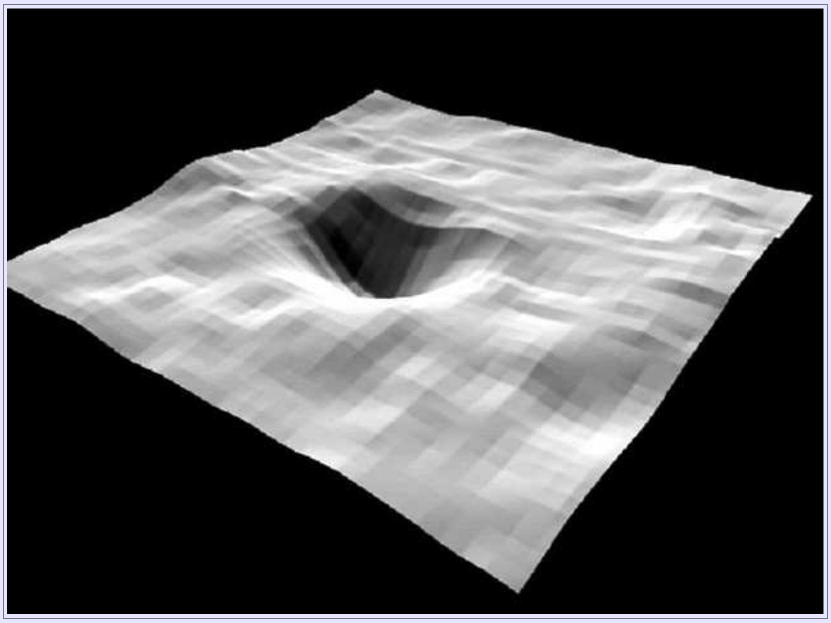

Figure 10: 3D reconstruction based on LOLA DEM.

As already noted these features lie on the irregular shaped 'arrowhead' plateau, which the Clementine colour ratio image (Fig. 3) displays as orange, suggesting a basaltic composition. Spectral data from M^3 reveals that the dominant mafic mineral is high-calcium pyroxene which has diagnostic absorption features at 1,000 and 2,100-2,200nm (Fig. 11).

This plateau displays a TiO_2 content < 2.0 wt% and higher plagioclase content of 60.0-67.0 wt % when compared with Cleo3 alone. The FeO content varies from 10.0 wt % to 13.0 wt %, similar to the nearby mare unit. The clinopyroxene abundance amounts to 18.0-26.0 wt %. According to the derived FeO and TiO_2 content the main rock type is low-Ti basalt. This irregular structure has a base diameter of 8.0 x 6.0km a height of 280m ± 30m (Fig. 12) yielding an average flank slope of 4.8° ± 0.4°. The edifice volume is approximately 19.0 km assuming a parabolic shape. The mineralogical composition and the CF value of 8.35µm, indicate a basaltic composition. Therefore, it has relatively low SiO_2 content, setting it apart from highland domes. A possible origin due to different effusive episodes seem likely, implying it is a non monogenetic volcanic construct originating from gassy, explosive activity and/or with several effusive phases over time.

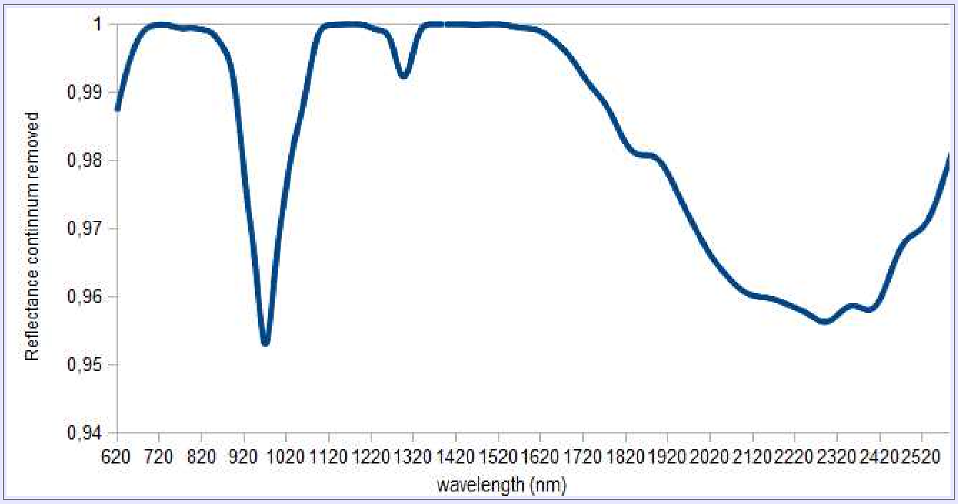

Figure 11: M^3 spectra obtained for the examined arrowhead feature corresponding to basaltic signature, high calcium pyroxene composition.

Figure 12: LRO WAC-derived surface elevation plot in East-West direction based on LOLA DEM.

Conclusion: The arrowhead shaped plateau in the SW quadrant of Cleomedes described in the above article appears to be a volcanic structure of basaltic composition (low-titanium/low-silica and high-calcium pyroxene) with a possible volcanic cone (which is named here as Cleo3) perched on it's southern tip. This suspect cone is slightly elevated above the general level of the plateau, suggesting it was formed by the eruption of lavas or pyroclastic deposits, but evidence for either is scant.

A possible vent further north on the plateau has been identified, but again evidence to back this identification up is not particularly strong and alternative interpretations such as that of a simple impact crater are equally probable. What the structure does however demonstrate is the presence of a form of basaltic volcanism that potentially involved a lava of slightly more viscous nature than that usually associated with mare basalts, and possibly multiple explosive eruptions to build up an irregularly shaped edifice.

The structure *may* overlie a branch of Rima Cleomedes, which formed during the Floor Fracture Crater phase of the crater's history, and which potentially provided conduits for the ascent of the lavas responsible via its fractures and faults. The overall correspondence between the composition of the structure and the surrounding mare like units suggest a common magmatic source, and the difference in eruption style (low viscosity forming the mare units and high viscosity forming the plateau) might reflect a slight evolution in the composition of that magma source as a function of time possibly through fractional differentiation and cooling. Therefore it may represent quite a late stage in the volcanic history of the crater Cleomedes.

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https://doi.org/10.1029/1998JE000630

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Lunar Geological Change Detection Program
By Tony Cook.

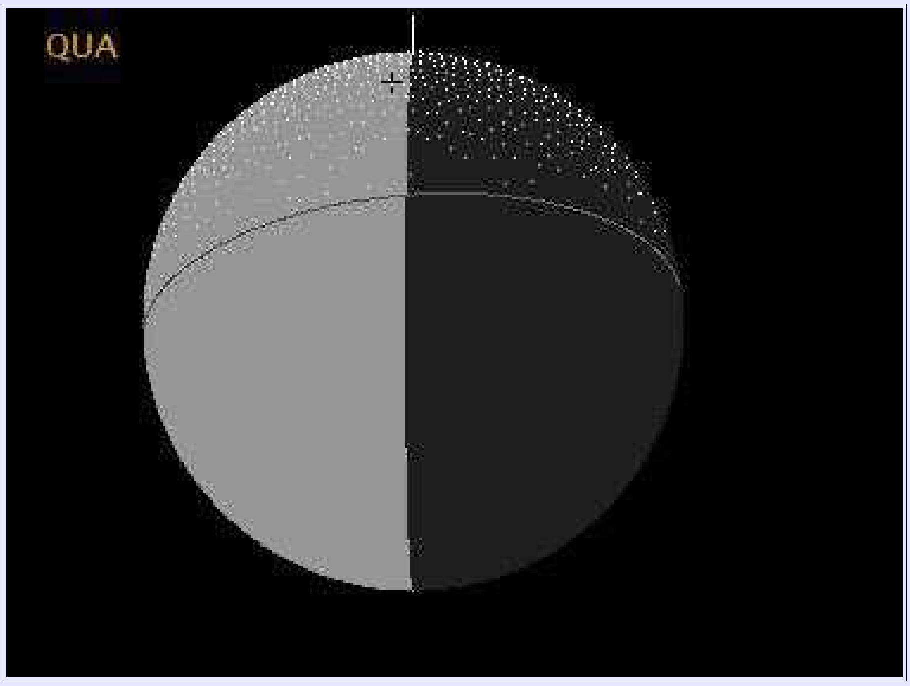

Figure 1. A lunarscan display of the predicted impact distribution of Quadrantid meteoroids on the Moon at 06:30UT on 2024 Jan 04.

News: Please keep a look out for Quadrantid meteors impacting the earthshine part of the Moon on 2024 Jan 03-05, though the peak will be on Jan 04 UT 06:30 ± 1 days. Note that any Quadrantid impacts will be more likely to be seen on the upper northern hemisphere/N-NE limb. From Earth the ZHR rate is 80+, so your chances of detecting an impact flash in the lunar earthshine are not too dissimilar to other major showers such as the Geminids or Perseids, and also the velocity of the meteoroids, at 40 km/s is favorable. Just think a 1g mass meteoroid striking the Moon at this speed would release 0.8 million Joules of energy!

Its best to use a camera running at least 10 frames per sec and ideally 20-30 or faster. You can use software such as ALFI or FDS to search for the short < 0.1 sec impact flashes, after, and in the case of FDS during the recording of the video. Try to keep sunlit peaks out of the field of view if possible. Please send any detections of impact flashes to ALPO's Impact Flash coordinator, Brian Cudnik (bmcudnik @ gmail.com), or to myself (atc @ aber.ac.uk) or at the very least let us know the date of your observations and the start and end UTs, even if you detect no flashes. Try also to video some stars near the Moon, especially occultations, as these are useful to calibrate any impact flashes against.

TLP Reports: No TLP reports were received for November, but on 2023 Dec 15 UT 21:27-22:20 Lawrence Garrett (Fairfax, VT, USA) was making visual observations of the earthshine part of the Moon. He had intended to do some CCD video of impact flashes, but in view of the Moon's low altitude, limited time available, and threat of cloud, he decided to stick to visual observing using his 6" f/8 reflector at x72. At least 9 flashes were seen in earthshine, one on the terminator and one on the bright lunar disk – however these were all pin-point in size and so dismissed as cosmic rays. However, four more notable flashed were seen, as shown in Fig 2. Flash #1 seen at 21:47:28UT a grey flash and larger than typical pin-point cosmic rays. Flash #2 seen at 21:53:12UT a grey flash and larger than typical pin point cosmic rays. Flash #3 seen at 21:57:00UT ±2 sec a grey flash and larger than a typical pin point cosmic ray. Flash #4 seen at 22:05:54UT±2 sec appeared as a=a white flash near the limb and was the brightest of all the flashes seen that evening. It was one of six limb flashes seen but was the only one noticed without averted (side) vision.

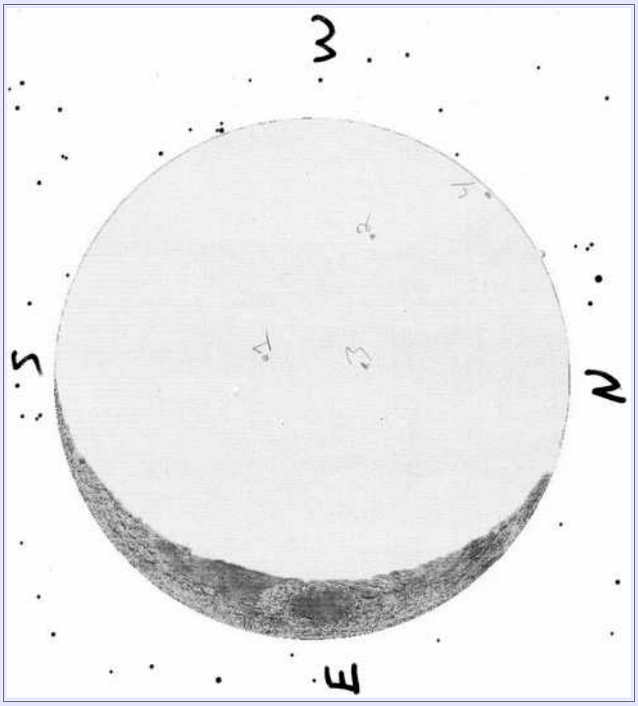

Figure 2. A sketch of the locations of four candidate impact flashes seen visually on the Moon by Laurence Garrett on 2023 Dec 15. The Moon's orientation is as depicted by the annotation. This is a "negative" or inverted grey-tone image i.e. dark is bright and bright is dark.

Visual sightings of possible impact flashes have been seen before – many are listed in the TLP catalog, and Brian Cudnik of ALPO has seen some too. However it's really important that we get confirmation, either a second video report or a video capture. So if anybody else was observing earthshine, in a similar longitude range to Vermont, please get in touch.

Routine reports received for October included: Alberto Anunziato (Argentina – SLA) observed: Aristarchus, Mare Crisium and Torricelli B. Massimo Alessandro Bianchi (Italy – UAI) imaged: Cyrillus. Robert Bowen (Mid Wales, UK) imaged: several features. Maurice Collins (New Zealand - ALPO/BAA/RASNZ) imaged: Aristarchus, Bailly, Oceanus Procellarum, and several features. Valerio Fontani (Italy – UAI) imaged: Copernicus, Deslandres, and Lansberg. Les Fry (West Wales, UK – NAS) imaged: Aristarchus, Atlas, Gassendi, Janssen, Marius, Nearch, Palus Somni, Rheita, Schickard and Schiller. Bill Leatherbarrow (Sheffield, UK – BAA) imaged: Aristarchus, Balmer, Langrenus, Mare Crisium, Messala, and Petavius. Chris Longthorn (UK – BAA) imaged: several features. Aldo Tonon (Italy – UAI) imaged: Cyrillus. Ivan Walton (UK - BAA) imaged: Delsandres and Littrow.

Analysis of Reports Received (November):

On 2023 Nov 18 Alberto Anunziato (SLA) observed Mare Crisium visually under similar illumination to the following report:

On 1983 Feb 18 at 19:00?UT P.W. Foley (Kent, UK) noted that the southern Mare Crisium appeared to be obscured by a pale grey haze. Cameron 2006 catalog extension ID=205 and weight=3. ALPO/BAA weight=2.

Alberto was using a 105 mm. Maksutov-Cassegrain (Meade EX 105) with a magnification of x154 and commented that he could see no pale grey haze in the southern part of Mare Crisium. Just out of interest I searched the ALPO/BAA observational database for similar illumination images and came up with this nice one by Rik Hill (See Fig 3) which also shows the southern part of Mare Crisium to appear normal. We shall leave the weight of the 1983 report at 2 for now.

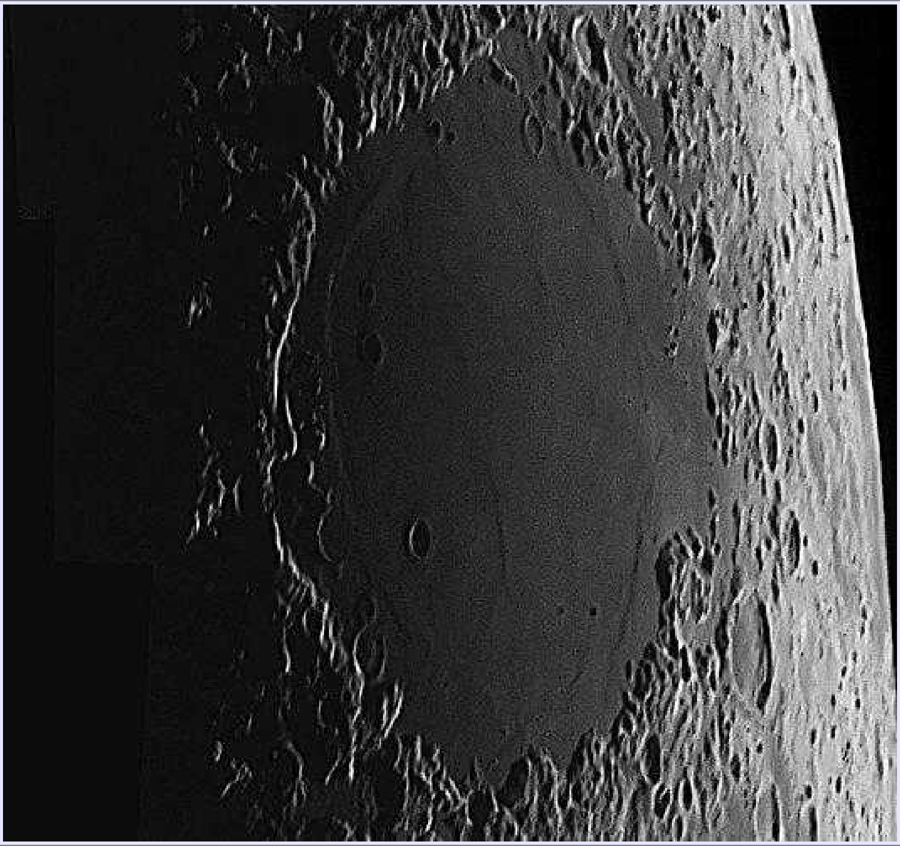

Figure 3. Mare Crisium on 2018 Apr 19 UT 02:09 as imaged by Rik Hill (ALPO/BAA) and orientated with north towards the top.

Cyrillus: On 2023 Nov 19 UAI observers: Massimo Alessandro Bianchi at 17:24 & 17:26UT and Aldo Tonon at 17:37UT imaged this crater for the following lunar schedule request:

BAA Request: Cyrillus. There is a small white craterlet just north of the three central peaks. We are interested to receive high resolution images of this in order to find out at what selenographic colongitude, in the lunar evening, that it loses its white spot appearance. Please use scopes larger than 5 inches in diameter.Please email these to: a t c @ a b e r . a c . u k

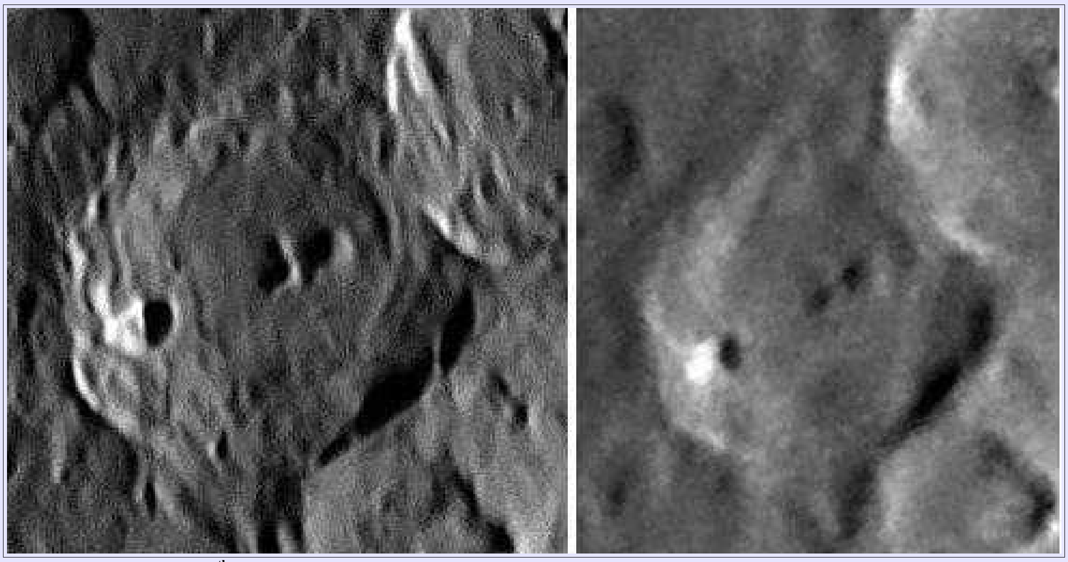

Figure 4. Cyrillus on 2023 Nov 19th imaged by UAI observers and orientated with north towards the top. (Left) by Massimo Alessandro Bianchi at 17:24 UT. (Right) by Aldo Tonon at 17:37 UT.

No sign of the white spot can be seen north of the three central peaks in Fig 4. The original image showing this was taken by Leo Aerts, on 2015 Oct 31 UT 03:16. Therefore at a selenographic colongitude of 352.0˚ (this is in the lunar morning) the spot is not visible, though Leo's image was of exceptionally high resolution and the selenographic colongitude was 132.0˚. I will tweak the selenographic colongitude setting in Lunar Schedule to make it more appropriate and include similar solar altitudes for both the morning and the evenings - 180˚ apart. I think I will also increase the required aperture, as slightly higher resolution may be needed.

Alphonsus: On 2023 Nov 22 UT 00:31 Ivan Walton, using a remotely operated telescope in Chile, imaged this crater under similar illumination to the following report:

Alphonsus 2004 Feb 29 UT 19:00-19:15 Observed by Brook (Plymouth, England, 60mm OG x120) "Checked central peak of Alphonsus using 60mm OG x120 + right angle prism. Moon at very high elevation, seeing excellent once clouds had dispersed, transparency also excellent. Time of observation 19-00 hrs UT to 19-15 hrs UT. Noticed fluctuation of brightness of A's central peak compared with the peak of Arzachel. Alphonsus' peak generally brighter." BAA Lunar Section report. ALPO/BAA weight=2.

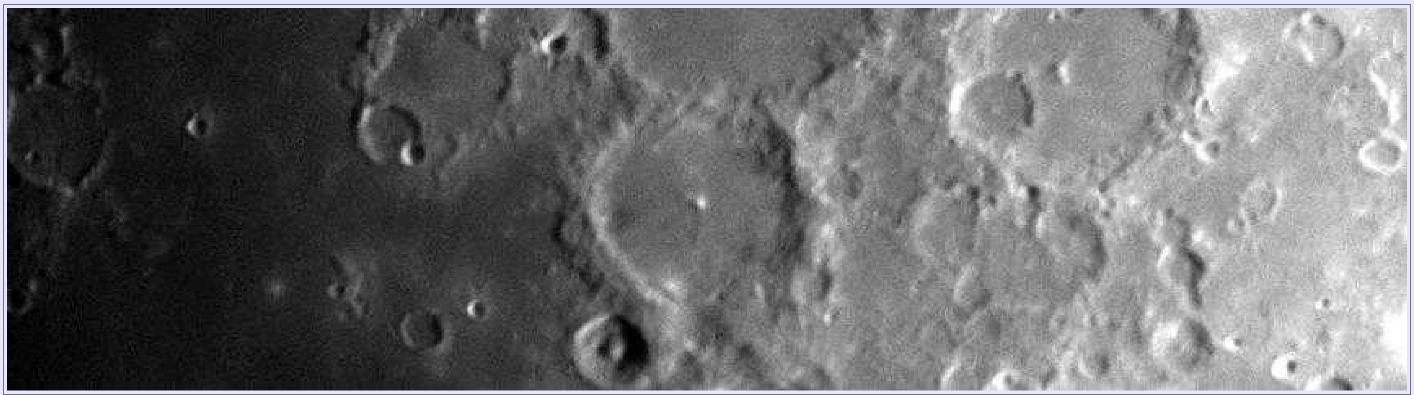

Figure 5. Alphonsus as imaged by Ivan Walton on 2023 Nov 22 UT 00:31, orientated with north towards the top.

Although it is not possible to see whether the central peak is fluctuating in brightness from one image, Ivan's image (Fig 5) is useful in that we see that the central peak is almost point like and so, presumably under variable atmospheric seeing conditions, the Gaussian shaped point spread function will blur it more and make the centre less bright – distributing the light sideways into the extended seeing disk. Also, it is noted that the 2004 report was made with a small telescope. I will therefore lower the weight to 1.

Deslandres and Lansberg: On 2023 Nov 24 respectively UT 16:36 and 18:00 Valerio Fontani (UAI) imaged these regions under similar illumination to when the Soviet Luna V lander and rocket stages crashed into the Moon and the resulting impact clouds were allegedly imaged through Earth-based telescopes:

ALPO/BAA request - in 1965 May 12 UT 19:10 the Soviet Lunar 5 probe crashed into the Moon (by accident). There are reports of an ejecta cloud, though strangely three locations are given, two of which are based upon telescope observations at the time. We would like you to image the surface of the Moon in the vicinity of these three craters: Copernicus, Deslandres and Lansberg, so that we can compare to photographs which were supposed to show the ejecta cloud back in 1965.Please email any images to:
a t c @ a b e r . a c . u k

Reference: Ksanfomality, (2018) Luna-5 (1965): Some results of a Failed Mission to the Moon Cosmic Research, Vol 56, No. 4, pp276-282.

The attempt to replicate the Penzel photograph of an expanding cloud from the carrier rocket impact, near Deslandre crater (See Fig 6) was not a great success – something similar happened when we tried this with earlier observations in the Jun/Jul newsletter. The region covered by Valerio (Fig 6 – Right) is smaller, and again I cannot place it in the Penzel image. In the bottom of the Penzel image you can quite clearly see Tycho crater though.

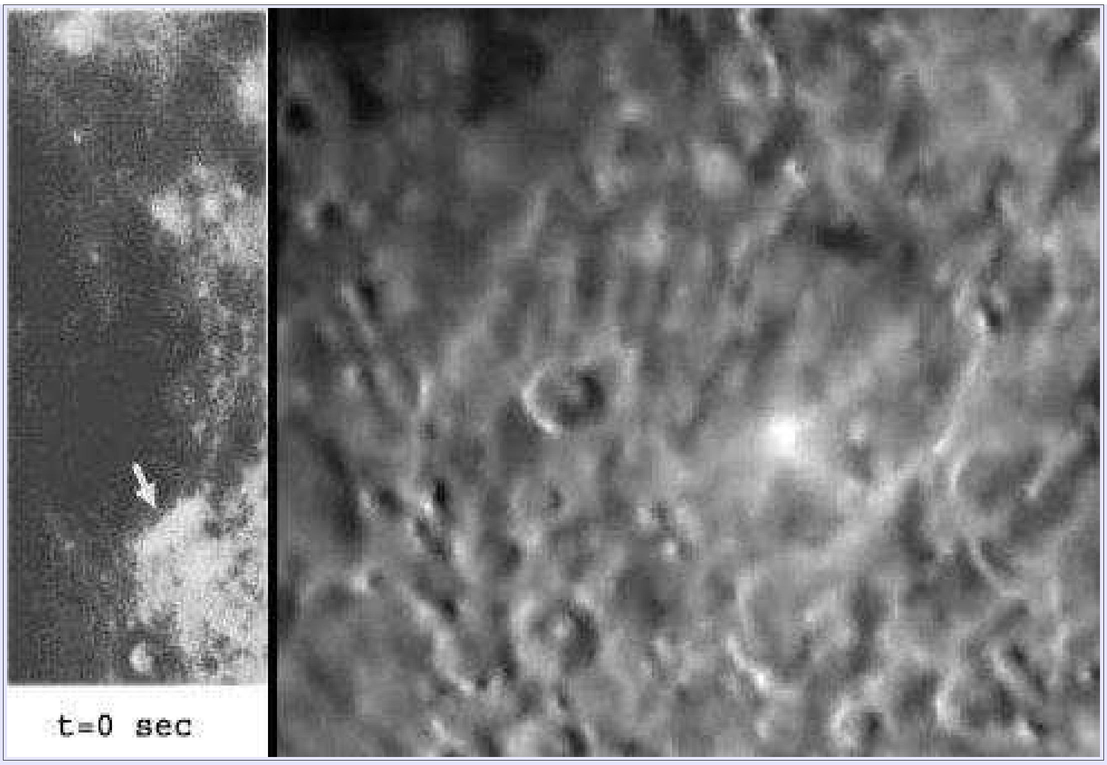

Figure 6. Deslandres crater and surrounds with north towards the top. (Left) Photograph taken by Penzel on 1965 May 12 from a paper by Geake and Mills: Possible Physical Processes Causing Transient Lunar Phenomena Events, Physics of the Earth and Planetary Interiors, 14 (1977) p299-320. (Right) An image taken by Valerio Fontani (UAI) on 2023 Nov 24 UT 16:36 – this has been blurred and degraded a bit to make it a bit more compatible with the resolution in the Penzel photograph.

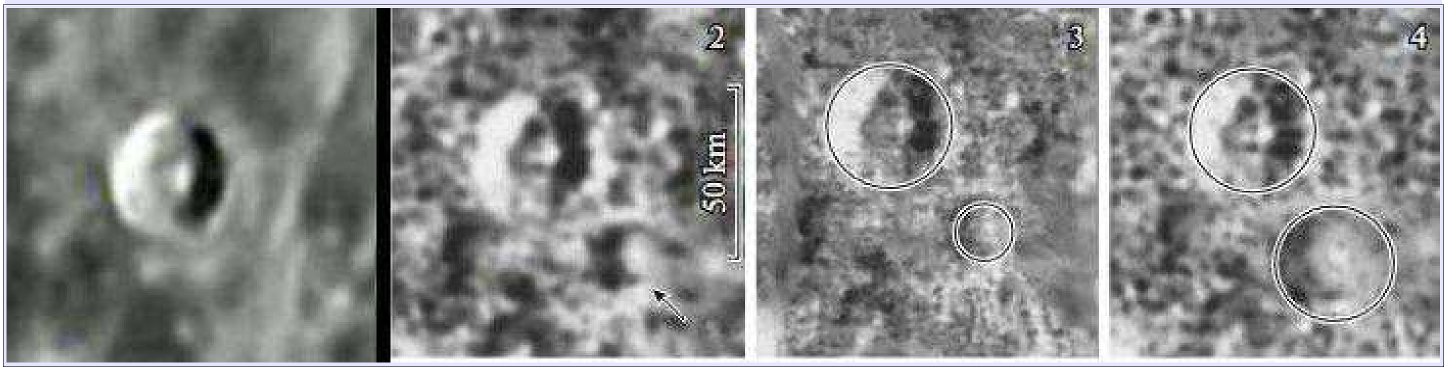

Figure 7. Lansberg crater orientated with north towards the top. (Far Left) An image taken by on 2023 Nov 24 UT 18:00 by Valerio Fontani (UAI) – image has been degraded in resolution, and contrast stretched to match those in the Ksanfomality paper (See Ref below). (Left) From p280, Fig 4: image 2 from (see Ref below) – arrow points to a possible impact side of the Lun 5 lander. (Right) From p280, Fig 4: image 3 from (see Ref below) – circle indicates possible impact cloud of Luna 5 lander. (Far Right) From p280, Fig 4: image 3 from (see Ref below) – circle indicates possible impact cloud of Luna 5 lander.

Another one of Valerio's images (Fig 7 – far left) corresponds to the region where the lander was supposed to have impacted, near Lansberg crater (See Fig 7 – Left). Again the images from 1965 are pretty grainy compared to the modern day image. What you need to do is to find recognizable bright and dark points in the 1965 images and compare to what you see in Valerio's image. Although the purported impact cloud (arrowed) looks promising, and it does not appear in the 2023 image, there are lots of other examples of bright and/or dark small scale features that do not appear either. So we need to be very careful interpreting the Ksanfomality images. As we have had two attempts at this now, I will adjust the constraint in the Lunar Schedule web pages to include similar viewing angles (topocentric libration) in case this helps interpretation in future.

Aristarchus Area: On 2023 Nov 24 UT 18:58 Les Fry (NAS) imaged this area under similar illumination to the following reports:

Aristarchus, Schroter's Valley, Herodotus 1881 Aug 07 UT 00:00? Observed by Klein (Cologne, Germany, 6" refractor, 5" reflector) "Whole region between these features appeared in strong violet light as if covered by a fog spreading further on 7th. Examined others around & none showed effect. Intensity not altered if Aris. placed out of view." NASA catalog weight=4. NASA catalog ID #224.

1954 Aug 11 Herodotus. Observed by Haas (Las Cruces, NM, USA) "Temporary greyness seen in interior shadow." ALPO/BAA weight=3

On 1955 Oct 28 at UT00:00? Kozyrev (Crimea, Soviet Union, 50" reflector) detected in Aristarchus Fraunhofer lines in UV spectra that were much narrower than in the solar spectrum. This indicated luminescent glow which overlapped contour(?) lines. Greatest after Full Moon, but fluctuated monthly with no indication of solar activity effect. The Cameron 1978 catalog ID=621 and the weight=5. The ALPO/BAA weight=5.

Aristarchus 1976 Sep 05/06 UT 18:45-01:35 Observed by Prout (England?, 12" reflector, S=III-II), Foley (England, 12" reflector), Moore and Spry (Sussex, England, 12" reflector) "Viol. hue on crater on W. wall, especially NW corner seen by Prout & 2 Foleys. Moore & Spry did not see colour. All obs. noted that the crater was dull <Tycho pr Proc. At 2140h all noted it was brighter & now brightest on Moon. Colour disappeared at 2143h (30-40% incr in bright.)" NASA catalog weight=1 for Prout and 5 or all other observers. NASA catalog ID #1449.

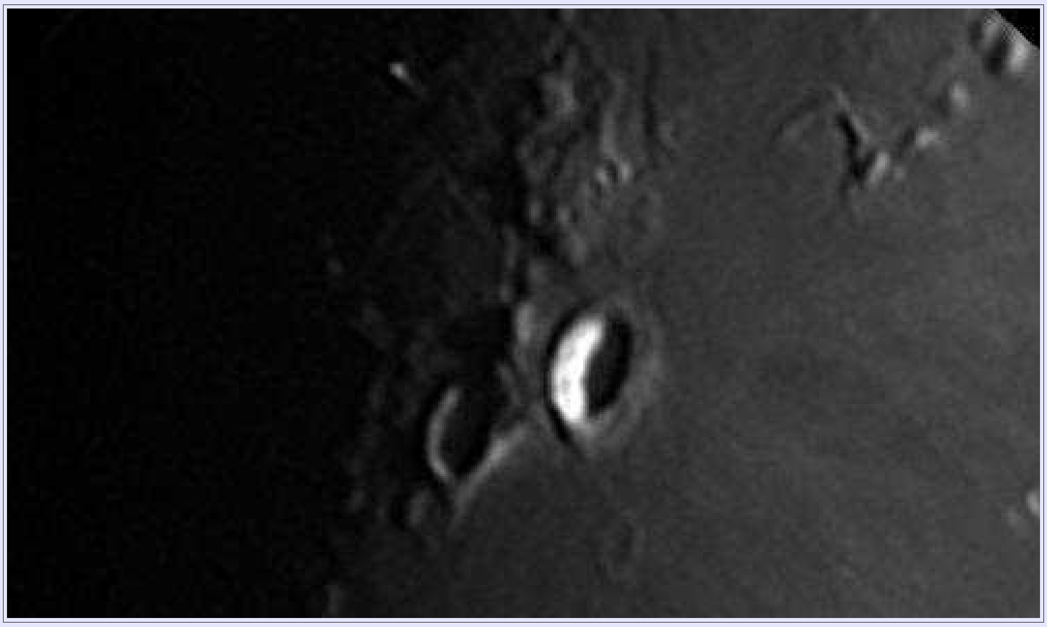

Figure 8. Aristarchus on 2023 Nov 24 UT 18:58 as imaged by Les Fry (NAS) and orientated with north towards the top.

Although not a colour image, Figure 8 is a useful context image for the 1881, 1954, 1955 and 1976 TLP reports. I did check a contrast stretched version of the image to see if there was a temporary greyness in the shadow of Herodotus, as was reported back in 1954, but the image resolution and contrast is not sufficient to help with the interpretation. We shall leave the weights of these respective reports as they are for now.

Aristarchus Area: On 2023 Nov 24 UT 21:21 Chris Longthorn (BAA) imaged the area around Aristarchus under similar illumination to the following report:

Aristarchus Area 2004 Nov 22 UT 04:58-05:49 Observed by Gray (Winemucca, NV, USA, 152mm f/9 refractor, seeing 4-5, transparency 4-5, x114, x228) "Blinked Herodotus with Wratten filters Blue 38A and Red 25. The illuminated west crater wall stood out brilliantly in blue light, much more so than in white light. This was true also of Aristarchus. Red light did not increase contrasts in Herodotus any more than they were in white light.

Shadows in Herodotus appeared as black as the night west of the terminator and remained that way throughout the observing period. No TLP seen in Herodotus tonight. A possible TLP was seen to the west of Herodotus near the terminus of Schroter's Valley. It was noted at the beginning of the observing period that there were four very bright spots of light, one near the end of Schroter's Valley, the other three grouped together a little farther north. Although not far from the terminator they were definitely east of it. It was noted that all of them nearly vanished in the Blue 38A filter while Aristarchus and the rim of Herodotus gleamed brilliantly. At 5:19UT it was noted that the most brilliant of the four lights, the one near the terminus of Schroter's Valley, had faded almost to invisibility in white light. When first seen it had been brighter than Aristarchus. It remained very dim after this through the remainder of the observing period, and was unchanged at 7:35-7:49UT when I again examined the area. The other three bright spots remained brilliant and unchanged.". ALPO/BAA weight=3.

Figure 9. Aristarchus on 2023 Nov 24 UT 21:21 as imaged by Chris Longthorn (BAA) and orientated with north towards the top. Insert shows an enlargement of the Aristarchus region.

Fig 9 certainly shows that Aristarchus is very bright, so this is probably normal for what was seen in 2004. Also the crater west rim is its normal blue colour, though the west rim of Herodotus does not exhibit blueness. Only one bright spot can be seen in the Vicinity of Vallis Schroteri and this is clearly a mountain, or hill, poking out through the terminator shadow into sunlight. Any others present maybe off the edge of the image frame. We shall leave the weight at 3 for now, since although Aristarchus is normally bright and has a bluish cast, the same cannot be said for Herodoutus, and we can't say much about the four bright spots.

Plato: On 2023 Nov 26 UT 09:52-09:55 Maurice Collins (ALPO/BAA/RASNZ) imaged the whole lunar disk, but this included Plato under similar illumination and viewing angle to the following report:

Plato 1874 Jan 01 UT 20:00? Observed by Pratt (England?) "Unusual appearance" NASA catalog weight=1. NASA catalog ID #183. ALPO/BAA weight=1.

Figure 10. Plato on 2023 Nov 26 UT 09:52-09:55 as imaged by Maurice Collins (ALPO/BAA/RASNZ) and orientated with north towards the top.

Fig 10 certainly does not show anything unusual about the crater, so if there was anything odd in 1874, I am guessing that it had something to do with the craterlets on the floor of Plato as they were a popular topic back in those days. We shall leave the weight at 1 for now.

Aristarchus Area: On 2023 Nov 28 UT 23:19 Bill Leatherbarrow (BAA) imaged this region in colour under similar illumination (and for the 1970 report, similar viewing angle too) for the following two reports:

Figure 11. Aristarchus on 2023 Nov 28 UT 23:19 as imaged by Bill Leatherbarrow (BAA) and orientated with north towards the top.

1969 Jan 04 UT19:30-20:00 W.Deane (Hendon, UK, 2" refractor) observed a bright yellow spot just E of Aristarchus, stretching from the S. end of Montes Harbinger to the S. wall of Prinz. The ALPO/BAA weight=1. ALPO/BAA weight=1.

On 1970 Nov 14 UT20:10 J.Coates (Burnley Astronomical Society, 8.5" reflector, x102 and x204) saw a dirty green colour on the NW region of the crater, in patches, with a green area nearby. ALPO/BAA weight=1.

Bill's image illustrates the natural surface colours present in and around this region. For the 1969 report, although Fig 11 does not include Montes Harbinger, it does include sufficient terrain just to the east of the partly buried Prinz crater, such that that if a natural yellow cast to the surface was present here it should show up. It does not however, therefore what was seen by Deane, remains unexplained, though the aperture of the scope, 2", was rather small – so the weight of 1 seems appropriate. For the Coates report from 1970, there is simply no dirty green on the NW of the crater rim in Bill's image, and as the scope used in 1970 was a respectable 8" reflector, the colour is difficult to explain. We shall therefore leave the weight at 1 for now.

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 .

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Items for the February circular should reach the Director or Editor by the 25th January 2024 at the addresses show below – Thanks!