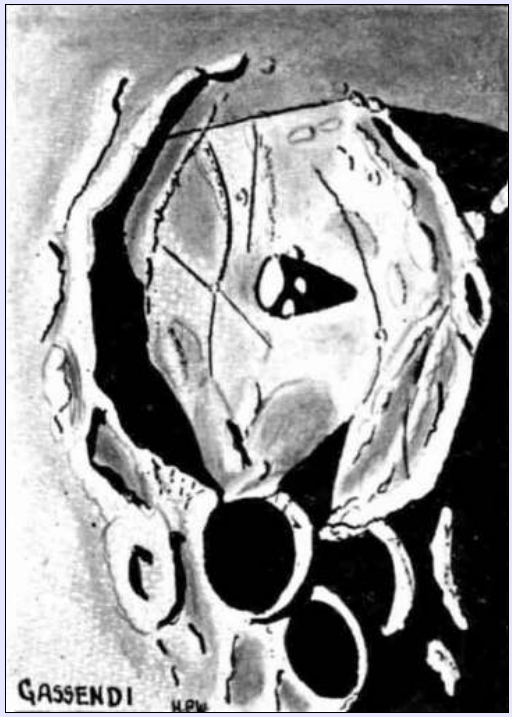
From the Director.



A sketch of Gassendi from 1926 Dec 15 made
by H.P. Wilkins, using a 12.5" reflector, x400.

It has been a month since the last editorial and an awful lot of things have happened. The passing of Queen Elizabeth II came as quite a shock to us all - somebody who has been head of state for as long as I can remember and synonymous with being British. This has affected us in many ways, with everyone having various memories, from different eras. As a tribute, I thought it would be nice to have a look through the lunar section archives and the BAA Journals to see what was happening lunar-wise in the year of her birth. According to the BAA Journals, there was much discussion over the origin of lunar craters, with a debate between Mr A.C. Gifford and Mr H.G. Tompkins, with the former promoting meteorite impact origin, based upon the studies by Foote, Gilbert and Barringer (after whom Meteor Crater in Arizona is named) whereas the latter BAA member was more into a non-impact origin. A more controversial topic, by modern standards, was F. J. Sellers theory about glaciation of the lunar surface.

I then decided to take a look and see what observations were being made, but surprisingly could not find many

in the Lunar Section archives. This is perhaps best explained on p323 of the BAA journal No, 9, Vol 25, where the director, Walter Goodacre comments:

"The hope expressed in the last report that the recent discussion on the origin of the lunar formations would lead to a revival of observing the Moon's surface, has not, so far, been realized. The lunar details are now so well revealed in the many photographs in existence that only those who possess telescopes of considerable size can reasonably hope to add to our knowledge of the finest details. This fact and the persistent bad weather of the past winter fully account for the dearth of communications received by the director. Walter Goodacre, Director".

Something similar happened shortly after the Lunar Orbiter and Apollo era. Fortunately despite obtaining higher and higher resolution images, we have shown that we can still do some amazing science and geology with existing earth-based telescopic images, sometimes used in conjunction with spacecraft images.

One obvious observation I came across though was a sketch of Gassendi crater made by a past director H.P. Wilkins. It is not to the same standards of Elger, but at least shows that some amateurs were still active in 1926. There was also one TLP report on record for that year: Melikhov (Russia) saw some light bands in Plato change their form – though the month, day and UT are not given for this entry in the Cameron catalogue. Not surprisingly, for such a vague report, Cameron gives this a low weight of 1.

Changing the subject, as you will remember last month I was actively encouraging you to use the NASA JPL Horizons web site in order to look up the RA and Dec of the Artemis-I Moon rocket and hopefully be able to track it, at least part of the way, to the Moon. As things turned out, the launch attempts were scrubbed and the arrival of Hurricane Ian forced a hasty retreat back to the safety of the large Vehicle Assembly Building to ride out the storm. Whether it launches in Oct or Nov we shall have to wait and see. But if it does launch before the next circular, do please try to capture some images of it in flight and send them into us. Again to follow it use the following web site: https://ssd.jpl.nasa.gov/horizons/app.html#/ and if you feed in your longitude, latitude and height above sea level, a given date and time range, specify apparent RA and Dec output, and then feed in a Target Body name of: "Artemis I" (note Roman Numeral for "1"), hopefully it should produce the RA and Dec (you must select these) of the spacecraft that you can point your scope at.

Tony Cook.

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Correspondence Received from Members.

The Occultation of 6th magnitude ZC 2524 on 8th August 2022.
By Peter Anderson.

Lunar Occultations are usually a brief affair lasting a mere few hundredths of a second. Occasionally, if the star is a very close double, a stepped disappearance or a very short fade of a few tenths of a second may be observed. In fact I had observed and written about a long, half-second fade of SAO 158294 that occurred just a month earlier on 8th July. After some investigation into that case, it seems quite likely that the component stars, originally four arc seconds distant when first recorded by John Herschel in 1836, drew together from our line of sight to be undetectable as separate stars when later observed between 1977 and 2003, including myself in 1996. Then they slowly drew apart, becoming separated by some 0.2 arc seconds by 2022, and this distance was not enough to resolve in the telescope, but quite enough to produce the obvious observed fade.

This present case ZC 2524 (SAO185474) is quite different. The star disappeared at 07hrs 39min 45.55sec UT leaving behind a faint companion that disappeared 1.2 seconds later. This was not in accordance with the predictions that placed the distance between the two components at 3.46 arc seconds with the second event to occur 8 seconds later. When the observations were processed, the Observed – Calculated (O-C) results were very ordinary, including the result for the primary star that had been a very careful observation. Thus there were two issues, the result for the primary and the incorrect data for the companion star. The occultation predictions referenced are produced for the purpose of timing these occultations. In the case of companion stars they attempt (if known), to predict the supposed orbital position at the time for which the prediction is generated. For example in this case, after discovery in 1991, this process resulted in a predicted separation of 2.15" for a 2009 event and 3.46" for the current 2022 predictions.

The calculations for the time of the occultation of the secondary are then based on the offset distance and Position Angle (PA) relative to the primary and expressed as a number of seconds earlier or later. The predicted figures are suspect and I suggest that the variation was likely not detected observationally by earlier observers because of the very close proximity to the primary star and the two and the half magnitude difference that would make it difficult to observe.

In my case the primary star had been occulted only 0.15 seconds after the predicted time and so should have produced a good result..Further, the companion star being occulted 1.2 seconds later was obviously much nearer to the primary than the predictions placed it. I determined to make some enquiries. On the internet I found the November 1991 'Occultation Newsletter' published by IOTA, the International Occultation Timing Association, an authority in the field:

Page 120 records the discovery by Hal Povenmire, a well known grazing lunar occultation observer, of this companion star visible when the primary was occulted during a grazing event on 15th September 1991. He discussed this with David Dunham, a leading researcher. Povenmire placed the companion at about mv 8.6 (my estimate agrees) and mv 8.55 is the precise catalogue magnitude. The position angle he estimated was around 160 degrees and the separation 'several tenths of an arc second.' A distance of probably less than one arc second, and certainly not the presently predicted 3.46 arc seconds is more compatible with my observation, so the matter certainly needed further investigation.

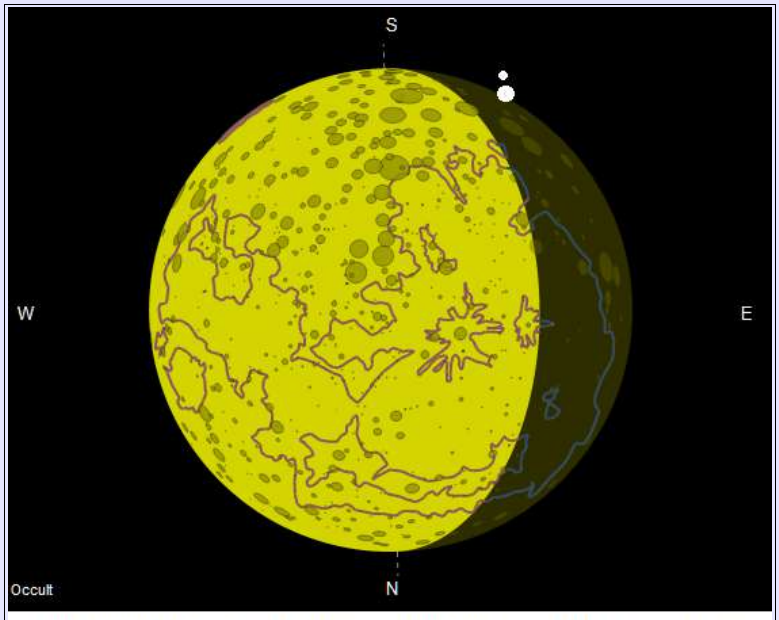
Such further research was conducted and David Herald, developer of the 'Occult' prediction and reduction program, then investigated and located the code that had caused the problem and implemented a fix. David also advised of the entry in the WDS (Washington Double Star catalogue)

listing a separation of 0.3 arc seconds at Position Angle (PA) 191° for the companion in 1991. This distance, direction, and magnitude listed are consistent with Povenmire's 1991 estimate. (Curiously the current predictions still show this same angle of PA 191°.) This separation of the stars had increased to 0.4 arc seconds and PA 178° by 1998. Therefore with the passage of time, the relative location of the companion slowly changed in separation and position due to orbital motion.

The end result of David Herald's labours was that my O-C (observed minus calculated) variation for the primary dropped from an unacceptable -278 milli arc seconds (mas) to -22 mas. In explanation, a + symbol means an early event and a – symbol signifies a late one. Anything over 100 mas usually requires further investigation and anything over 200 mas raises a red flag.

My observation of the secondary star was more problematical. This observation was not as accurate and the orbital motion of the star as yet not fully established. The observation produced an O-C of -117 mas for its disappearance 1.2 seconds later. This is very acceptable in the circumstances as the original equivalent figure had been nearly -700 mas.

So the problems have been successfully addressed. My thanks goes to the IOTA Regional Collector, David Gault (Australia) and especially David Herald. This was a very unusual case and it was only with perseverance and dedication by all that the mystery was solved. For those wishing to observe for themselves, there are unfortunately no further favourable lunar occultations of this star until 2028!



Simulated relationship of The Moon and the Star ZC 2524 (SAO 185474) as observed from Taylor Range Observatory, 2022 August 8 th, 7:39:45 UT

Note from Tim Haymes.
Thank you for another double star observation. It is always interesting to read the full story. I had a look in the Occult Database, and the most recent observations in 2009 preceding Peter's were made by video cameras and reported with "no double star effects".

Since Peter Anderson is a visual observer, skilled observations by eye and stop-watch are still relevant today as they were over a decade ago.

The occulted star is in Sagittarius: HIP 85783
The Occultation News Letter (Heritage Project) lists the issue reporting the "New Binary" here:
https://iota-es.de/onheritage/ON_Vol05_No05.pdf "A New Bright Binary Star"

The Triesnecker and Hyginus rilles at sunset.
By Bill Leatherbarrow.

In the small hours of 17th September 2022 the Triesnecker and Hyginus rille systems were well presented under low evening illumination when, for once, seeing conditions here in Sheffield were good (Fig. 1).

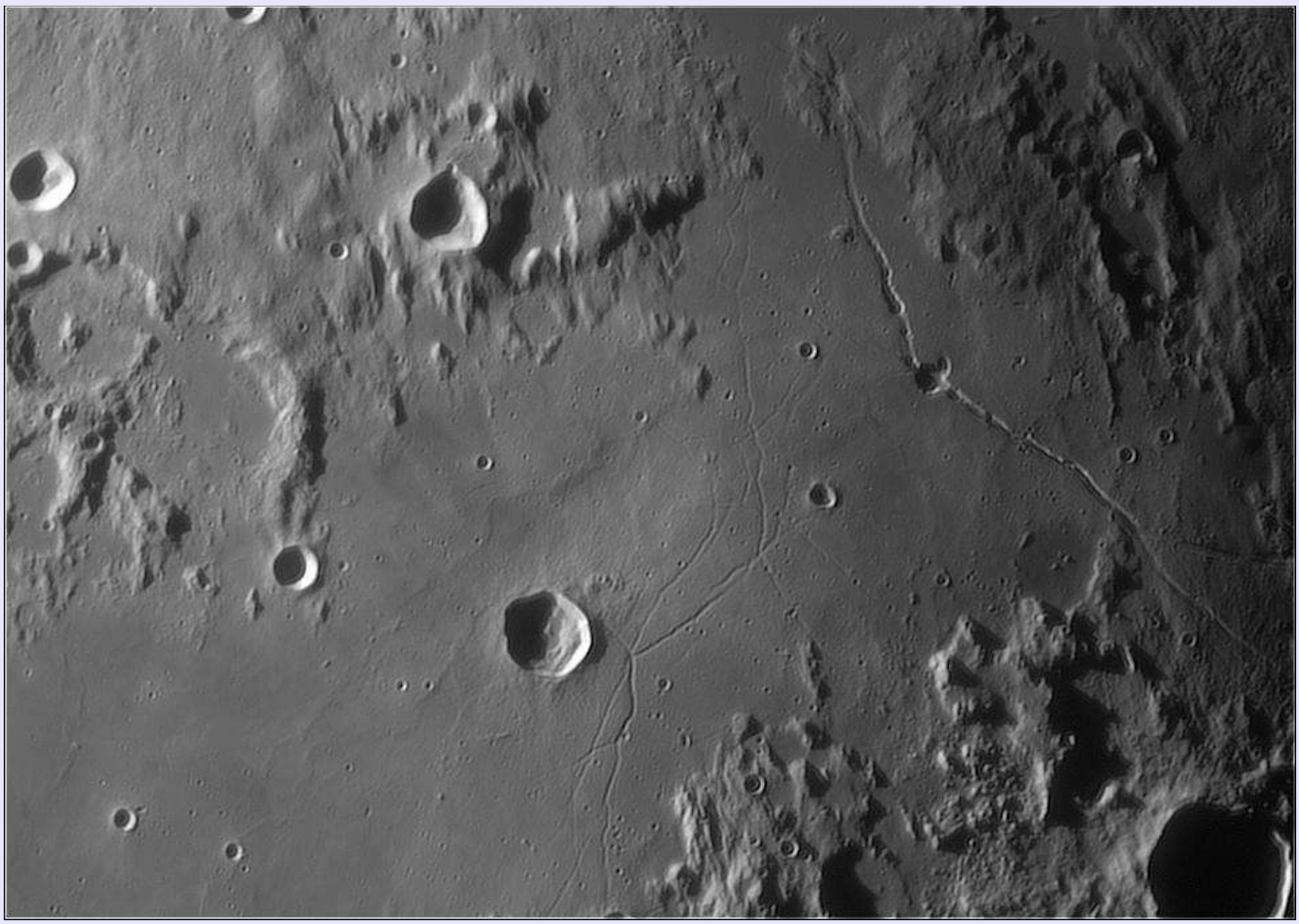


Fig 1: Triesnecker and Hyginus rilles, 17 September 2022, 05.03 UT, colongitude. 168.2, OMC300 Mak-Cass (Bill Leatherbarrow)

This area is noted for offering much evidence of volcanic activity in the Moon's past, most notably in the form of pyroclastic deposits and in the rimless volcanic collapse pits along the Rima Hyginus. Hyginus itself is also clearly a volcanic caldera rather than an impact crater.

But there is also evidence of volcanic activity near Triesnecker. Low solar illumination reveals the presence of what appears to be a large sausage-shaped depression immediately to the N-NW of Triesnecker itself. Almost certainly this was caused by the withdrawal of sub-surface magma from a chamber beneath the mare surface, resulting in the slumping of the surface layers. It is likely that this in turn created surface tensions which possibly caused fracturing of the surface to produce the complex Triesnecker rille system.

For comparison I attach (Fig. 2) a further image, taken back in 2018 under conditions of local sunrise over Triesnecker. This clearly shows the depression north of Triesnecker.

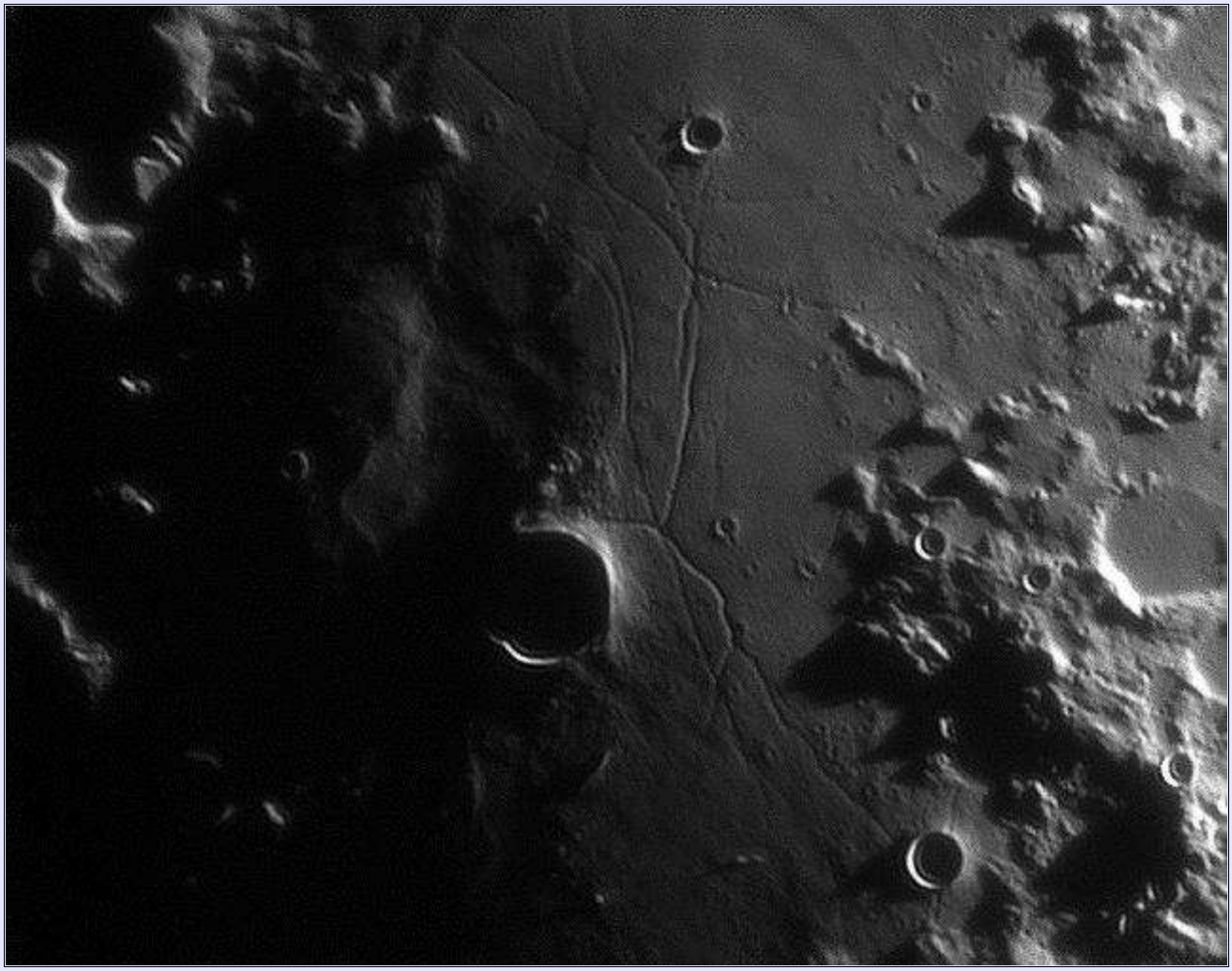


Fig. 2: Triesnecker 22 April 2018, 20.02 UT, colongitude 357.5, OMC300 Mak-Cass (Bill Leatherbarrow)

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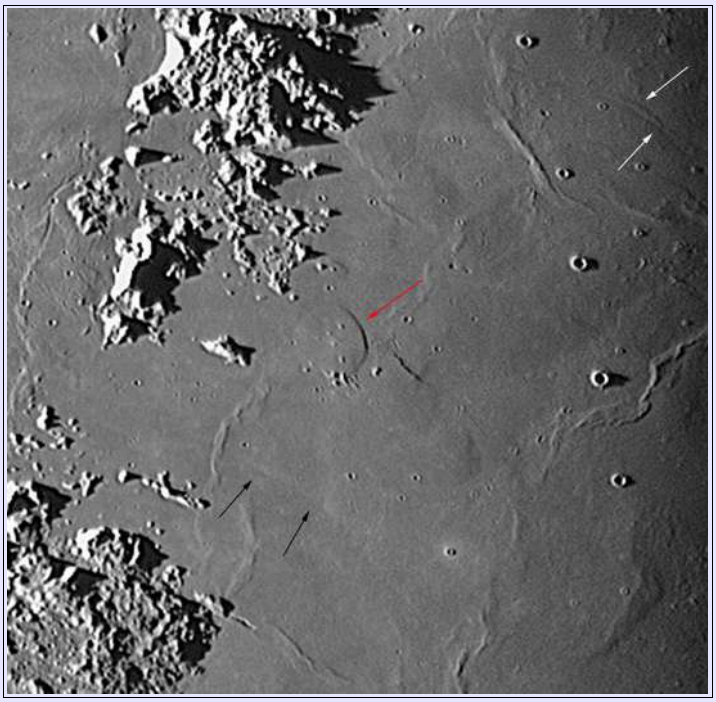
Searching for new elusive rilles.
By K.C Paul.

In 2011 December issue of Sky and Telescope , Dr. Charles Wood in his “Explore the Moon” column stated that "Backyard moonwatchers and lunar scientists tend to have different interests. The scientists are most interested in how and why things happened: in ages, compositions, and processes. Observers tend to be most interested in lunar geography: identifying features and perhaps searching for challenging craterlets or rilles. But often, amateurs have a chance to look in on lunar research discoveries for themselves." I totally agree with his points of view. As a moon observer for so many years, recently I devoted most of my observing time to look for elusive rilles on the moon.

As you all know, space probes had already imaged every inch of the moon in great detail. It seems that it is not realistic for an amateur to discover delicate rille on the moon. However, with the fast development of CCD imaging and software technology, amateur now can acquire good quality of high resolution moon image under oblique lighting angle. This kind of images may be missed or overlooked by space probes. Recently, LROC-QuickMap has launched a new experimental ACT Layers. Under this ACT Layers, a powerful new tool called TerrainHillshade is really a great help to confirm the existence of any elusive rille discovered by moon observers from their moon photos. It works by adjusting the light source position including zenith and azimuth, any elusive rille will show up as a real rille in front of your eyes. Not long ago, by using TerrainHillshade, my finding of Rimae Kan in north-western part of Mare Sernitatis is further confirmed (see LSC, TLO august 2022 issue). Recently, I had found two elusive rilles near Ina and in Mare Serenitatis. Again the existence of these rilles is confirmed by using TerrainHillshade. In the following, I want to share with you my experiences to discover these elusive rilles.

An elusive rille in the south-western part of Mare Serenitatis

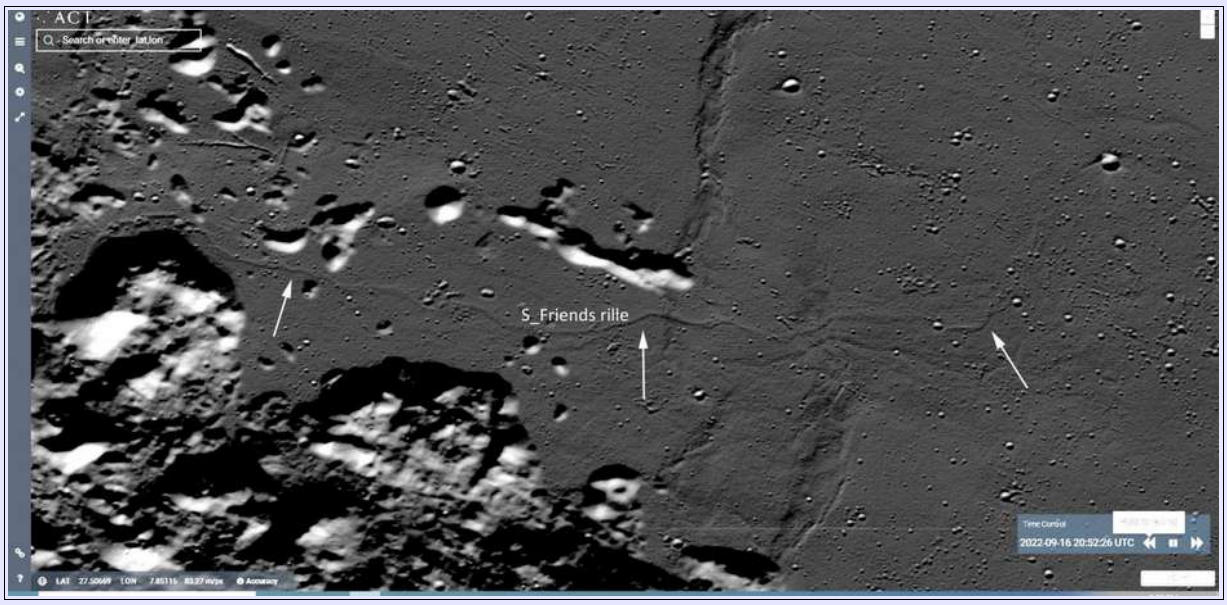
Below is a photo taken on 16Sep2022, 20h49m UT with a 250mm f/6 newtonian reflector prime focus with QHYCCD290M



Rimae Kan is indicated by white arrows, valentine dome is by red arrow, a suspected streak is indicated by black arrows. It is this streak that causes my attention. I wonder if it is a real rille or just an illusion caused by light-shadow effect. Then, I immediately open the LROC-QuickMap to check if a rille is existed.

Above image: Under normal view no rille is detected. (credit:quickmap.lroc.asu.edu)

In this normal view, no rille is detected but only a group of craterlets packed together and the power of my telescope cannot resolve them. Thus, a streak is seen instead. The next step is to open the 'TerrainHillshade' tool. I carefully and patiently adjust the values of both the zenith and the azimuth to see if magic has happened. It takes quite a long time to reach the resulting view. The streak is only a group of craterlets but to my surprise a real linear rille to the south of the streak pops up into my eyes. It is a long and narrow rille with overall length 123 km and average width is about 0.65 km. The rille starts from a tiny craterlet in the east and winds through the plain and ends somewhere north of crater Santos-Dumont. Finally, I took a screenshot and process it in Photoshop to increase the contrast and brightness so that the rille is well-displayed.

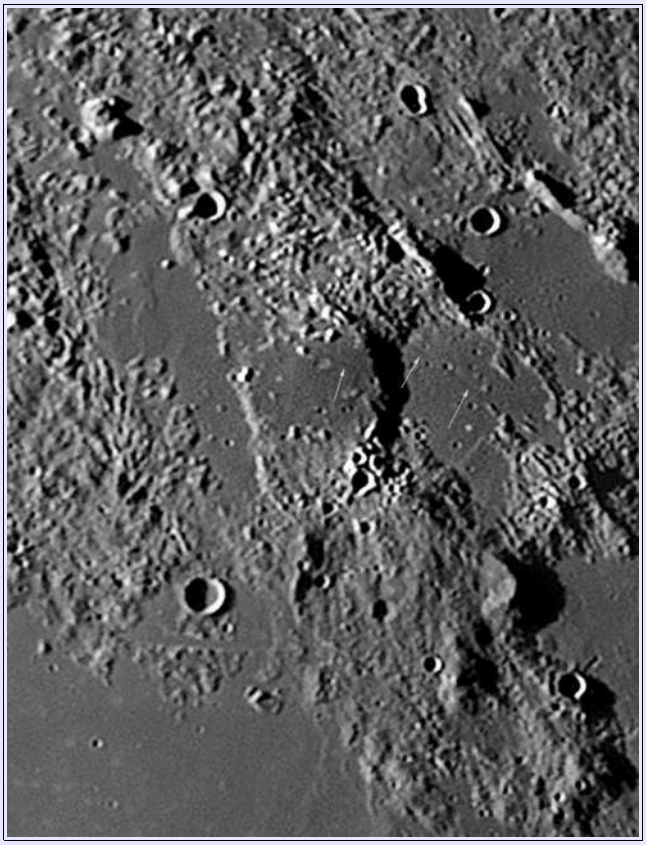


Above image : Under TerrainHillshade mode the rille pops up. (credit:quickmap.lroc.asu.edu)

For better communication among observers, I follow Danny Caes practice to name unofficially this rille as S_Friends rille to honour those guys that founded the second largest astronomy club 50 years ago in Hong Kong, China. I myself am also one of the founding members.

An elusive rille north-east of Ina in Lacus Felicitatis.
Below is a photo taken with 250mm f/6 newtonian reflector and 2.5X barlow and QHYCCD290M on 9December 2017, 22h02m UT.

When I review this old photo several days ago, I notice there is a rille-like feature just barely seen north east of

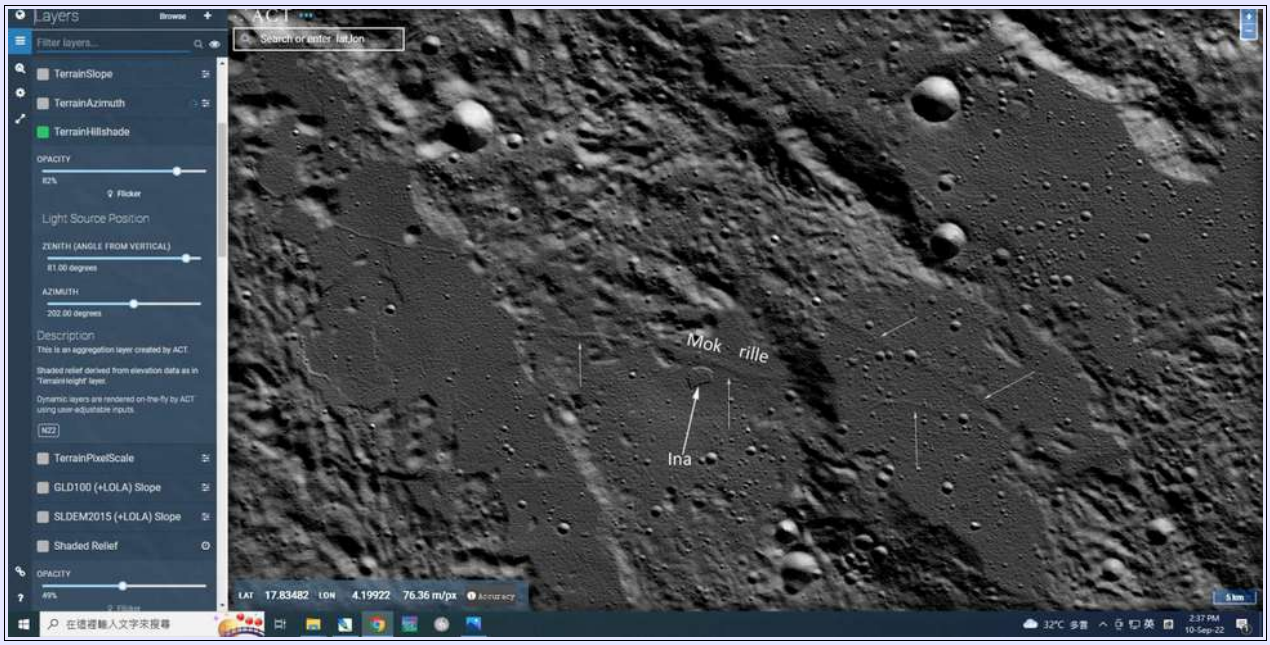


Ina. Another short rille is clearly seen in Manilius E. The 'TerrainHillshade' tool is employed to testify if the rille is really existing. Under normal view, a short streak is barely spotted north east of Ina but I cannot be sure if it is a real rille. Under 'TerrainHillshade' mode, the rille is clearly seen with certainty. It runs diagonally from

north-west to south-east across the plateau where Ina is located. The length of the rille is about 55 km with an average width about 1 km. Again, I name this rille unofficially as Mok rille in honour of my best friend who is also a keen moon observer.

Conclusively, amateur moon observers still have great opportunity to discover some elusive features on the moon if a good tactical plan is employed.

Above image : Under normal view, no rille is detected. (credit:quickmap.lroc.asu.edu)



Above image : Under TerrainHillshade mode the rille pops up. (credit:quickmap.lroc.asu.edu)

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Short Story 'Expedition 3' by Ivor Clarke.
Our thanks to Ivor who wrote in to alert us to the fact he has written a short story entitled *'Expedition 3'* which can be read in last November's issue of The Journal of the Coventry and Warwickshire Astronomical Society (Mira)* of which Ivor is the editor. The story involves an expedition through the lunar highlands and visits to a number of well known features, and is sci-fi with a geological slant. But when you read *'Expedition 3'* bear in mind that someone *may* be able to write a factual account of such an expedition within the lifetime of many of you. Please use the link below to read and enjoy the story.

*https://www.covastro.org.uk/_files/ugd/4d3647_eaae40eeed9044e0a39c4d32409945c2.pdf

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Lunar Occultations October 2022.
By Tim Haymes.

Time capsule: 50 year ago: in Vol 7 No.10-11
[With thanks to *Stuart Morris* for the LSC archives]

*Mr K Gayner (Bristol) has written to observers in USA, South Africa, and Sociedad Astronomica del Ve Valparaiso regarding the formation of a World Communications Network (W.C.N) with a view to sharing unusual occultation phenomena. Such observations can be forwarded to other groups in the Network.

*Miss Botley notes fades from literature; 1908 Feb 11, Zeta Tau ; 1880 Apr 11, Zeta Cancri

[Note: The WCN aim was similar to an email list server. In todays systems the Planoccult or Lunoccult list servers would be equivalent. Similar information is shared on https://groups.io/g/UKoccultations and https://groups.io/g/IOTAoccultations/ although range of topics is much wider.]

Observations
Uranus Reappearance at the Dark Limb, September 14th at 22.3 h UT.
Circumstance for the lunar occultation of Uranus were listed in the LSC last month. Predictions for Greenwich and Edinburgh were in the *Handbook*
I have received correspondence from Peter Tickner (Reading) and David Briggs (HAG).
Peter experienced some technical problems and local horizon obscuration. David Briggs asked about predictions times at Clanfield using Occult software.
David Strange (NLO) was more successful with the 50cm Connaught Telescope at Norman Lockyer Observatory, so too was Andrew Paterson. Both have posted observations on the BAA Forum.
https://britastro.org/observations/observation.php?id=20220915_102013_8cc27e9043b30174
https://britastro.org/observations/observation.php?id=20220915_111623_e3c3c6fefb5023d7

Alex Vincent recorded the RD with a small refractor. The image has been stretched by the Editor to reveal the planet in difficult conditions.

Thank you for sharing your observations – Tim Haymes.

Mr. P Anderson

Peter Anderson (Brisbane, Australia) reports a visual observation of the 6th magnitude double star ZC 2524 on August 8th, 2022. Peter has been a member of the BAA since 1969. His description of the event will be included elsewhere in the LSC.

Partial Solar Eclipse

The Moon "occults" the Sun on October 26th 0955 UT (Mid phase). See the HBAA page 14.
Venus is 1 deg to the NE and unlikely to be seen without special optical aid.
From the latitudes of South Africa, Venus is occulted by the Moon, but there is no solar eclipse.

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

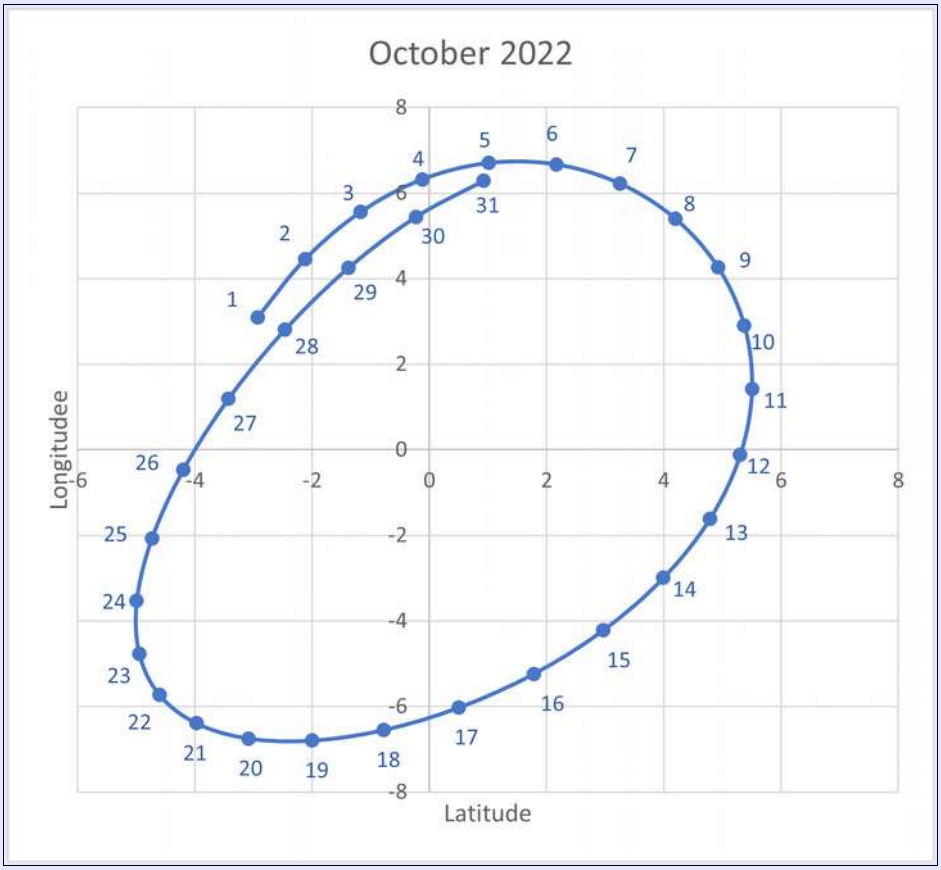
Oxford: E. Longitude - 1 18 47.1, Latitude 51 55 40.3.
To magnitude r8.3 Moon altitude >7 degrees.

yy	mmm	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Az	CA o	Notes
22	Oct	2	18	30	6.5	D	186842	F3	8.2	8.0	47+	87	-8	9	189	88S	
22	Oct	3	18	33	4.3	D	188248	K2	8.5	7.6	59+	100	-9	10	176	46S	
22	Oct	5	20	32	48.6	D	190504	F3	8.0	7.8	80+	127		18	177	65N	
22	Oct	5	21	49	10.9	D	190533	K5	8.9	8.0	81+	128		17	195	80N	
22	Oct	5	23	11	5.9	D	190556	K1	7.0	6.4	81+	128		12	214	41N	
22	Oct	5	23	57	59.5	D	3178	A0	6.2	6.1	81+	129		8	224	41N	
22	Oct	6	21	4	12.3	D	3314	F5	8.7	8.4	89+	141		23	171	88S	
22	Oct	7	0	33	7.9	D	165221	G0	7.8	7.5	90+	142		14	222	17S	
22	Oct	7	19	18	50.5	D	3442	F5	7.9	7.6	95+	153		17	132	37N	
22	Oct	7	22	48	53.8	D	146738	G0	8.9	8.6	95+	155		30	185	78S	
22	Oct	8	2	17	19.2	D	146786	K4	7.4	6.7	96+	156		14	238	89S	
22	Oct	8	2	45	0.2	D	3478	G5	6.4	5.9	96+	156		11	244	64N	
22	Oct	11	22	1	10.9	R	93080	F5	8.1	8.0	95-	155		35	112	74S	
22	Oct	11	22	20	27.7	R	403	B9	5.8	5.8	95-	155		38	116	68N	omicron Ari
22	Oct	11	23	30	10.5	R	93101	K0	8.1	7.6	95-	154		46	135	32S	
22	Oct	12	0	14	41.2	R	413	K0	6.7	6.0	95-	154		51	150	50S	
22	Oct	12	4	4	32.7	R	423	F5	6.3	6.1	94-	153		44	234	74N	
22	Oct	12	21	5	11.6	R	93485	A0	8.1	8.0	90-	143		23	87	55S	
22	Oct	12	21	58	43.0	R X	4603	A0	8.3	8.2	90-	143		31	98	71N	Dbl* dT 0.6s
22	Oct	12	21	58	43.2	R X	4604	A0	8.1	8.1	90-	143		31	98	70N	Dbl* dT -0.4s
22	Oct	12	22	14	31.5	R	93498	K5	8.7	7.8	90-	143		34	101	80N	
22	Oct	12	23	3	20.7	R	520	F5	7.5	7.2	90-	142		41	111	61N	
22	Oct	13	3	38	47.7	R	76101	K0	8.1	7.6	89-	141		56	212	80S	
22	Oct	13	4	15	8.0	R	534	A0	6.1	6.1	89-	141		52	226	71N	22 H1 Tau
22	Oct	13	20	42	49.0	R	76588	M*	7.0	6.1	83-	132		15	72	75S	
22	Oct	14	0	6	14.3	R	676	B8	7.2	7.0	82-	130		46	112	81S	
22	Oct	15	0	47	59.6	R	809	F5	8.4	8.1	74-	119		46	107	8S	
22	Oct	16	0	58	24.4	R	78218	B9	8.3	8.3	65-	108		41	97	84N	
22	Oct	16	3	6	5.9	R	78300	B9	8.3	8.3	65-	107		58	131	63N	
22	Oct	16	3	22	56.4	R	78309	A0	7.4	7.4	65-	107		60	137	83N	Dbl*
22	Oct	16	4	59	27.5	R	78361	K7	8.6	7.8	64-	106		65	183	67S	
22	Oct	16	5	24	26.7	R	78377	G5	8.8	8.2	64-	106	-11	65	196	45N	
22	Oct	16	23	25	12.4	R	79122	K2	7.6	7.0	56-	97		19	71	79S	
22	Oct	17	0	9	16.6	R	1089	K0	6.7	6.1	56-	97		25	79	45S	
22	Oct	17	0	45	54.0	R	79164	G8	7.4	6.9	56-	97		31	85	81S	Dbl* dT +0.1s
22	Oct	17	2	55	4.5	R	79243	K1	7.3	6.7	55-	96		50	113	13S	
22	Oct	17	3	10	36.8	R	1105	G7	6.5		55-	96		52	117	75N	Dbl*
							1105 is double: AB 7.00 7.70 0.20" 236.1, dT = -0.32sec										
22	Oct	17	4	12	15.7	R	1108	G8	7.0	6.5	55-	96		60	137	22N	Dbl*
							1108 is double: ** 7.7 7.7 0.10" 90.0, dT = +0.22sec										
22	Oct	17	5	34	12.6	R	79304	K2	8.1	7.3	55-	95	-10	65	175	76N	
22	Oct	17	23	15	32.3	R	1211	A1	6.3	6.3	47-	87		10	62	81N	4 Cnc
22	Oct	17	23	26	39.7	R	79874	K7	8.5	7.7	47-	87		11	64	73S	
22	Oct	17	23	33	53.6	R	79886	K0	8.6	8.1	47-	86		12	65	30S	
22	Oct	17	23	48	49.5	R	79888	K5	8.2	7.5	47-	86		14	68	77S	
22	Oct	18	3	3	35.9	R	79980	G8	7.3	6.8	46-	85		43	105	67S	
22	Oct	18	4	14	46.8	R	80004	G5	8.9	8.4	45-	85		53	123	50N	
22	Oct	19	0	6	1.4	R	1330	G5	7.8	7.5	37-	75		8	64	62S	Dbl*
22	Oct	20	2	54	24.9	R	1444	K0	7.8	7.1	27-	63		22	89	41S	

Key:
P = Phase (R or D), **R** = reappearance **D** = disappearance
m = Miss at this station, Gr = graze near this station (possible miss)
CA = Cusp angle measured from the North or South Cusp.

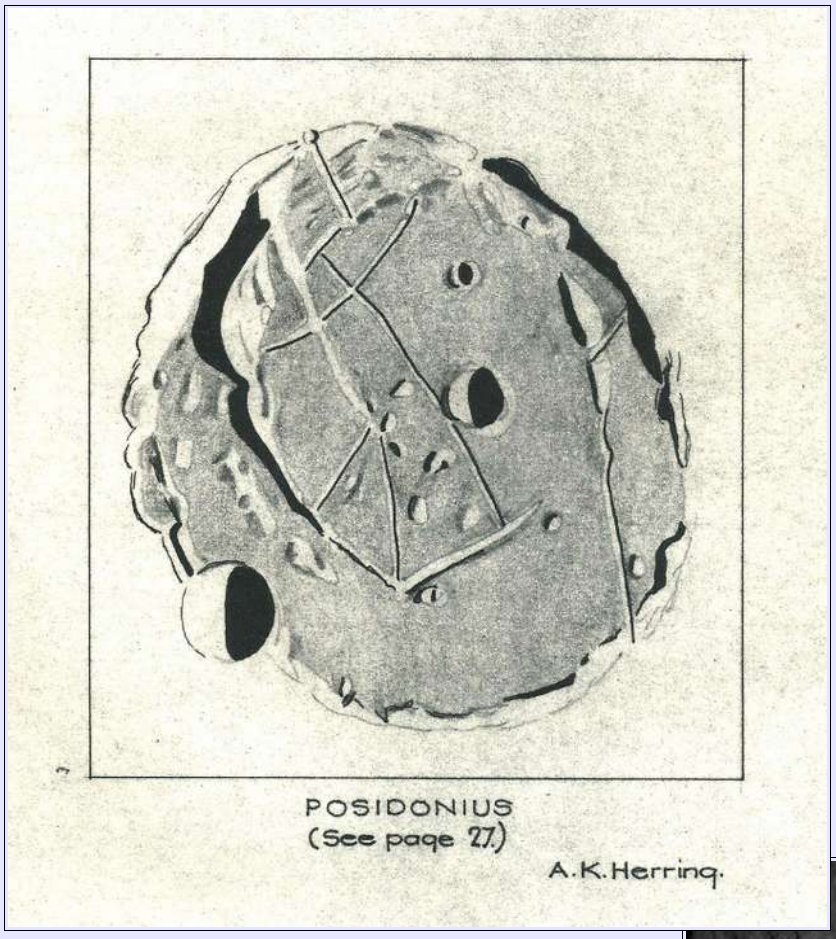
Mag(v)* = asterisk indicates a light curve is available in Occult-4
dT = For a wide double star, the *estimated* time difference (step) is given in seconds.
Star No:
1/2/3/4 digits = Robertson Zodiacal catalogue (ZC)
5/6 digits = Smithsonian Astrophysical Observatory catalogue (SAO)
X denotes a star in the eXtended ZC/XC catalogue.
The ZC/XC/SAO nomenclature is used for Lunar work. The positions and proper motions of the stars in these catalogues are updated by Gaia. Please report timings to Tim Haymes in the Occult4 data format.

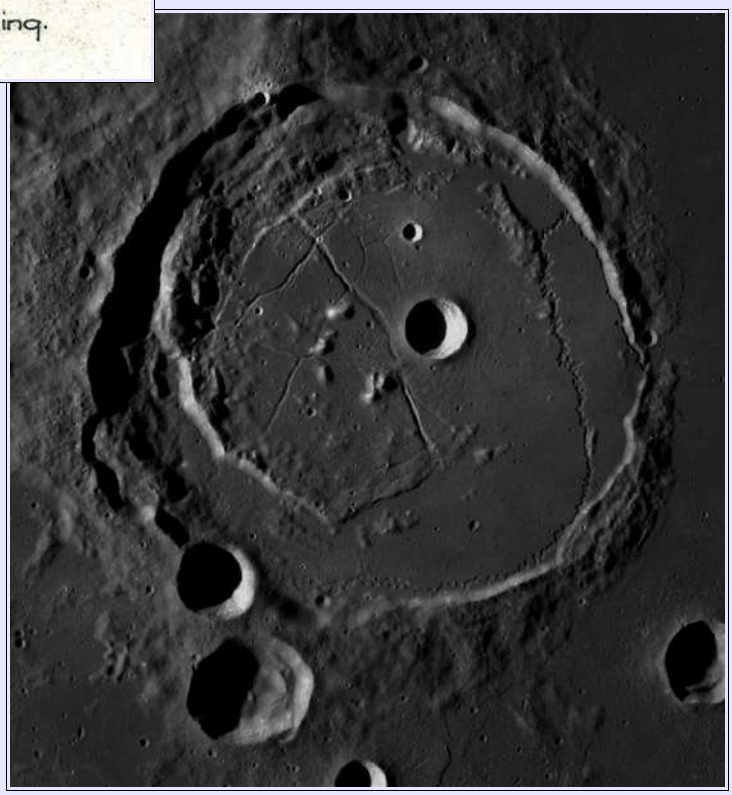
Detailed predictions at your location for 1 year are available upon request. Ask the **Occultation Coordinator**:
tvh dot observatory at btinternet dot com
Those interested in Grazes (only) – please indicate your travel radius in Km, and your home post code or nearest town. An aperture of 20cm will be used unless advised to the contrary.



Libration chart for October 2022.

Something from the past.





The drawing by Alika.K. Herring shown above featured on the cover of 'The Moon' Vol.6, No.2 January 1958. It was made using a 12.5 inch reflector on September 13th 1957 at x228. It is interesting to compare the detail recorded here with the WAC image shown alongside. Despite the differing illumination, you can see that the correspondence is quite impressive, despite there being one or two differences such as where Herring shows the sinuous rille on the western floor apparently traversing the northern rim. The sinuous rille itself does *not* cut the rim but there are unrelated linear features that do traverse the rim that could have led to this impression (North is down in both images).

Images/drawings submitted by Members.

The Miyamori Valley.

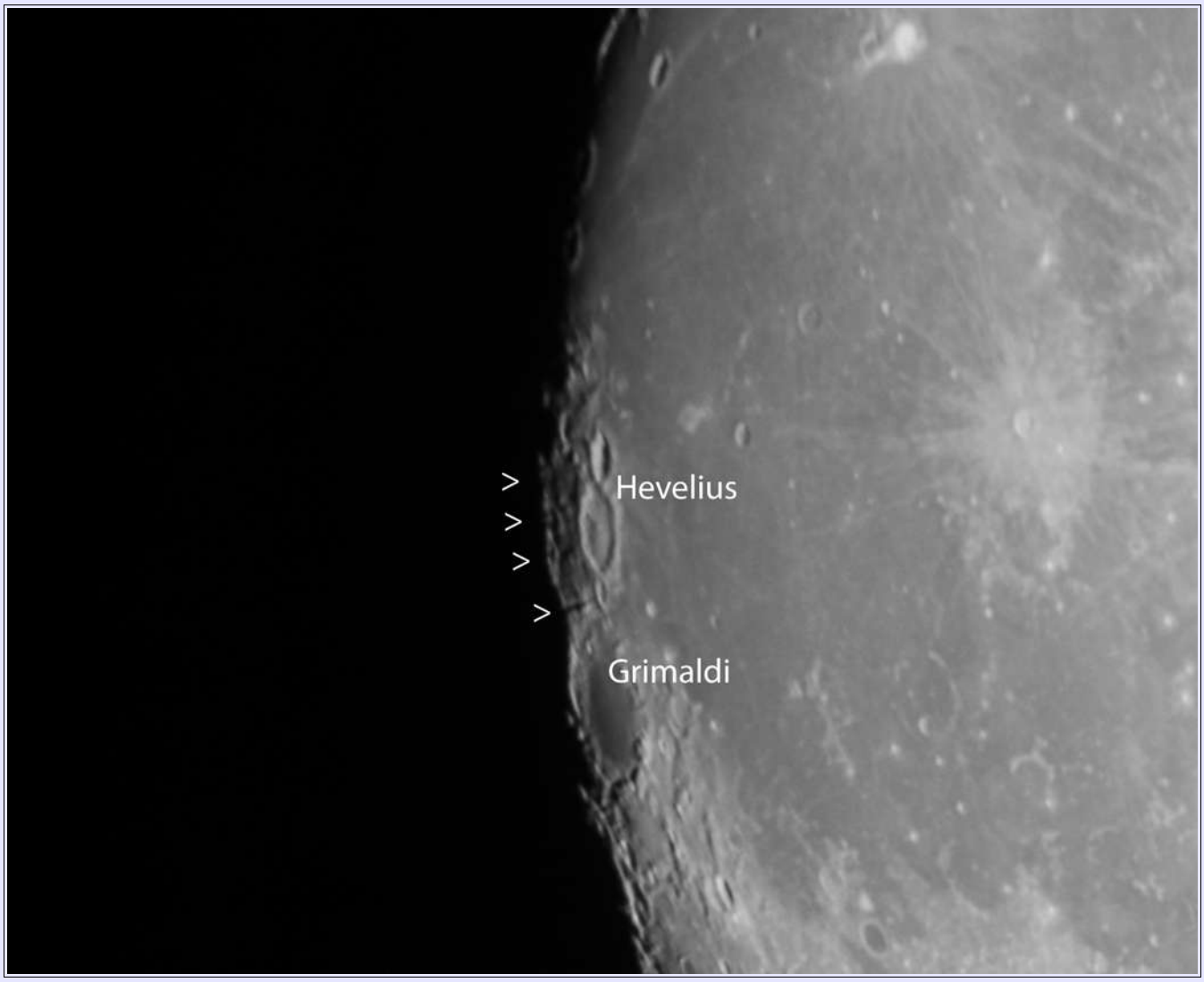


Image taken by **Mark Radice** using a Williams Optics 90m Megrez from a beach in the Spanish Mediterranean.

Mark commented that his daughter spotted a number of linear features emerging from the terminator to the west of Hevelius. He has marked these with arrows in the image above, and the senior members of the section will recognise the southern one as being the Miyamori Valley, a popular target for observers in the 50's and 60's but with a much longer history of observation*. But what are the other features that he identifies, which appear to be *at least* 5 and possibly 6 more linear features trending in the same direction? The feature immediately north of the Miyamori Valley may correspond to a tongue of Orientale ejecta that has streamed out of Ricciolli, and the next one up to a 300m high discontinuous south facing scarp. The others however do not have any obvious counterparts in the imagery, but Mark's image clearly shows them. The fact that they are parallel to the Miyamori Valley which itself is radial to the Orientale Basin suggests that they are related to that basin, and may therefore represent tectonic features in the form of faults and possibly ejecta features in the form of crater chains or streams of ejecta which constitute the Hevelius Formation. Bearing in mind the aperture of Mark's instrument, this goes to show just how critical timing can be in detecting subtle lunar features.

*Longshaw N., 'Miyamori's Valley, in myth and reality: a re-examination of the observational history of the Miyamori Valley', J. Brit. Astron. Assoc., 118(6) (2008).
Longshaw N.,A note on drawings of the 'Miyamori Valley' by T. G. E. Elger (1836-1897) J. Brit. Astron. Assoc., 119 Vol. (5) (2009).

Palus Putredinis.

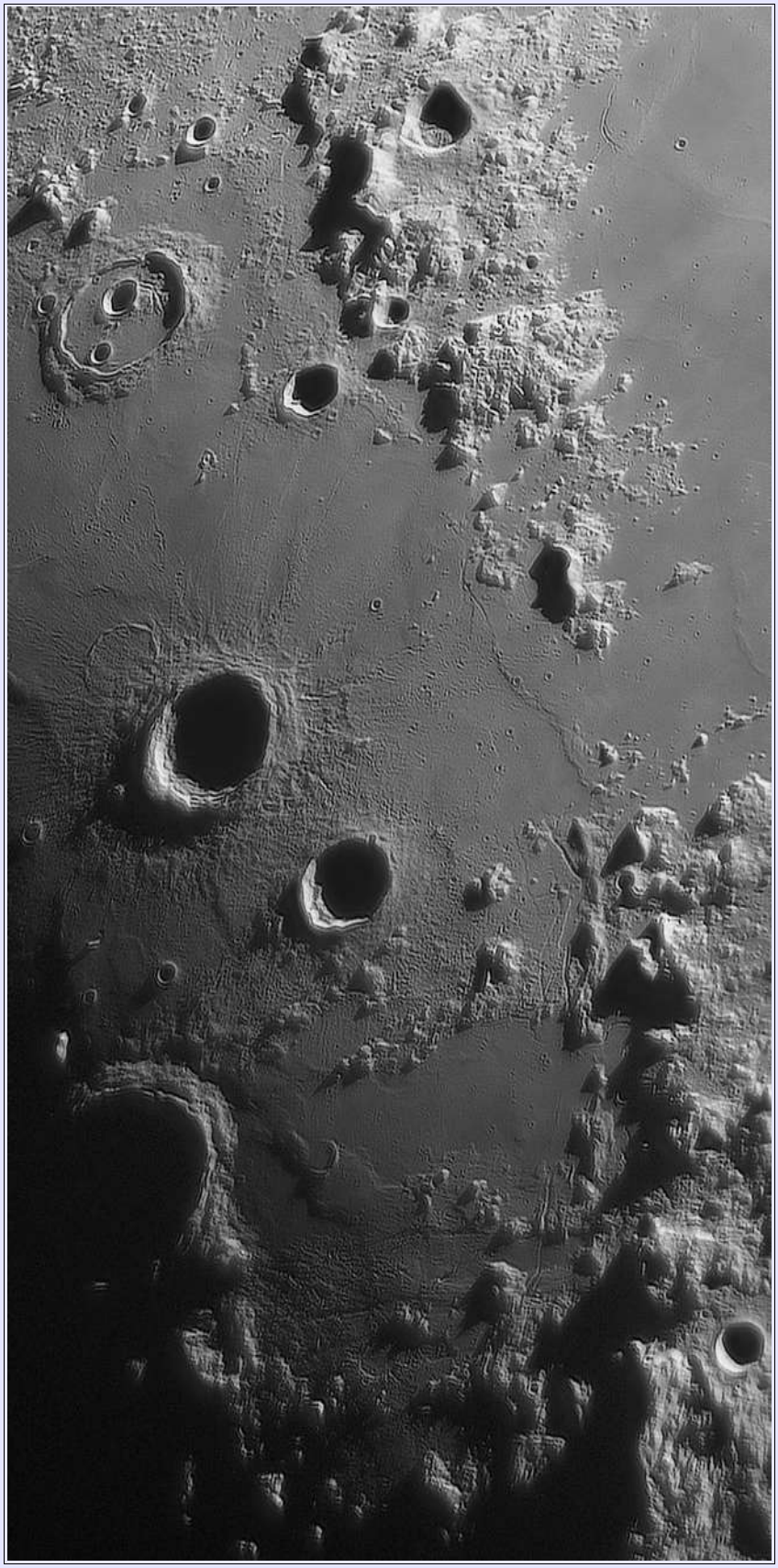


Image by **Leo Aerts** in good seeing on the May 8th 2022 using a Celestron 14" SCT, Ir filter and ASI 290MM camera.

This is another incredibly detailed study by Leo of the eastern margin of Mare Imbrium. Note the structure in the ejecta surrounding Aristillus and in the surviving ejecta blanket of Archimedes to the south-east of the crater rim.

From Torricelli to Apollo 11.

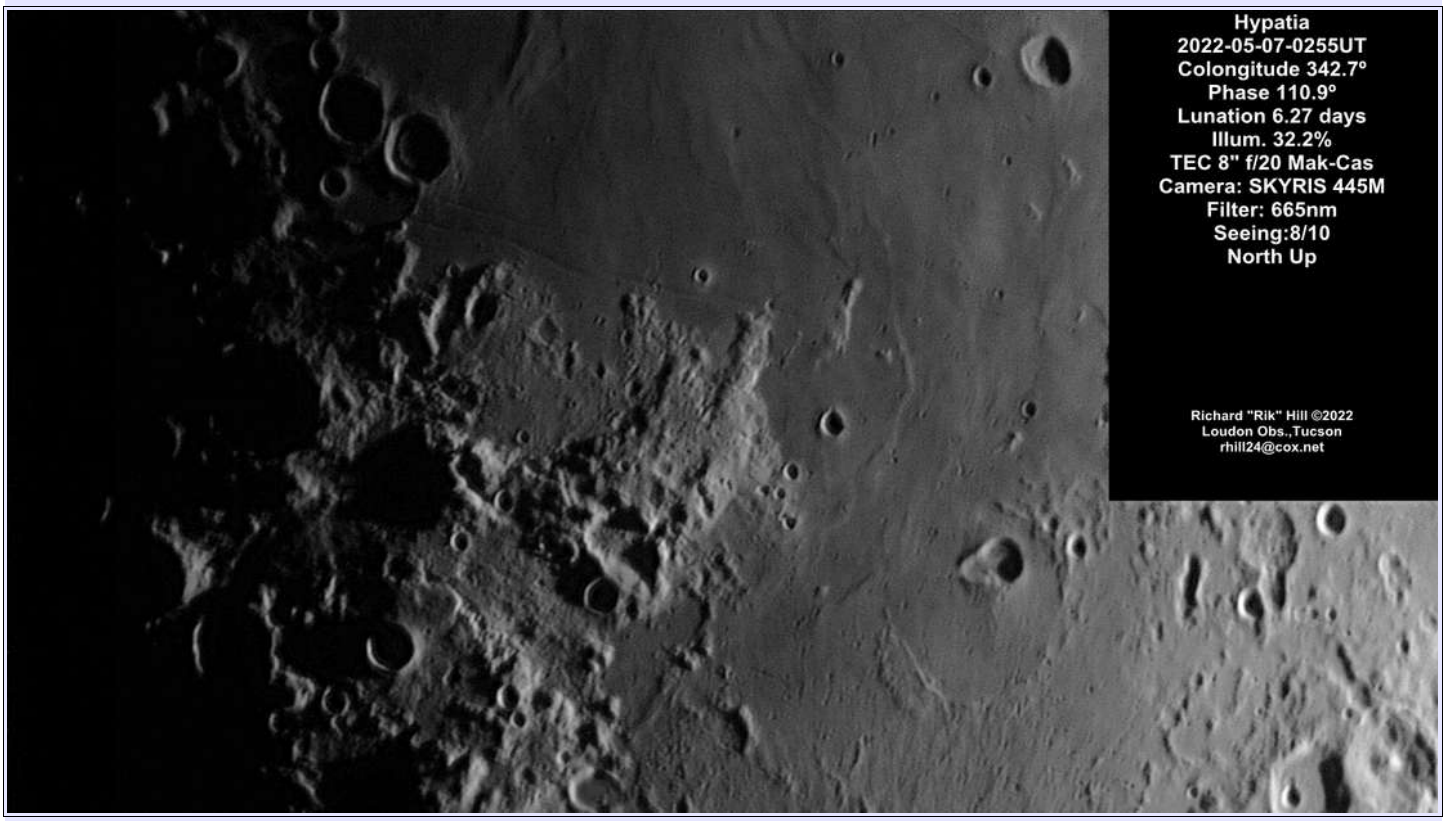


Image taken by **Rik Hill** of a 6.3 days old moon and is a montage of parts of two stacked 1800 frame AVIs stacked with AVIStack2 (IDL) combined with Microsoft ICE and further processed with GIMP and IrfanView.

Rik Comments: North of Theophilus is Sinus Asperitatis a flat region at the bottom of this image that contains the interesting pear-shaped crater Torricelli (23x31km) below and right of center. This crater has been a favorite of mine for many years sitting as it does on the north side of a much larger ghost crater some 75km diameter. It is the merging of at least 2 craters of Imbriam age (3.2-3.8 billion years old) filled with ejecta from surrounding impacts. On the opposite side (left) of the Sinus is another odd shaped crater that points more or less south. This is Hypatia (28x41km) also of Imbrian age, also overlain by ejecta materials. Notice the sideways "V" shaped shaft of light from sunlight streaming in through the break in the western wall. It's fun to watch these kind of light shows as they change rapidly with time.

North of this region is Mare Tranquillitatis and the site of the Apollo 11 Base. Two large craters on the left side of this are Sabine (31km) south and Ritter (32km) north. They make it easy to find the "Tranquility Base". Between these two craters and Torricelli is the small crater Moltke (7km) and between Moltke and Sabine is a large system of rilles named Rimae Hypatia. These are not the thin cracks like the Triesnecker rimae, but rather are grabens where a block of land drops down between two roughly parallel faults. In this case we have two such grabens parallel to each other. Then in the upper right corner, near the label, is the crater Maskelyne (26km) another odd shaped crater but younger than most of the other craters we have pointed out, being of Eratosthenian age (1.1-3.2 b.y.o.) and so this one is not filled in by ejecta like the much older craters.

Longomontanus.

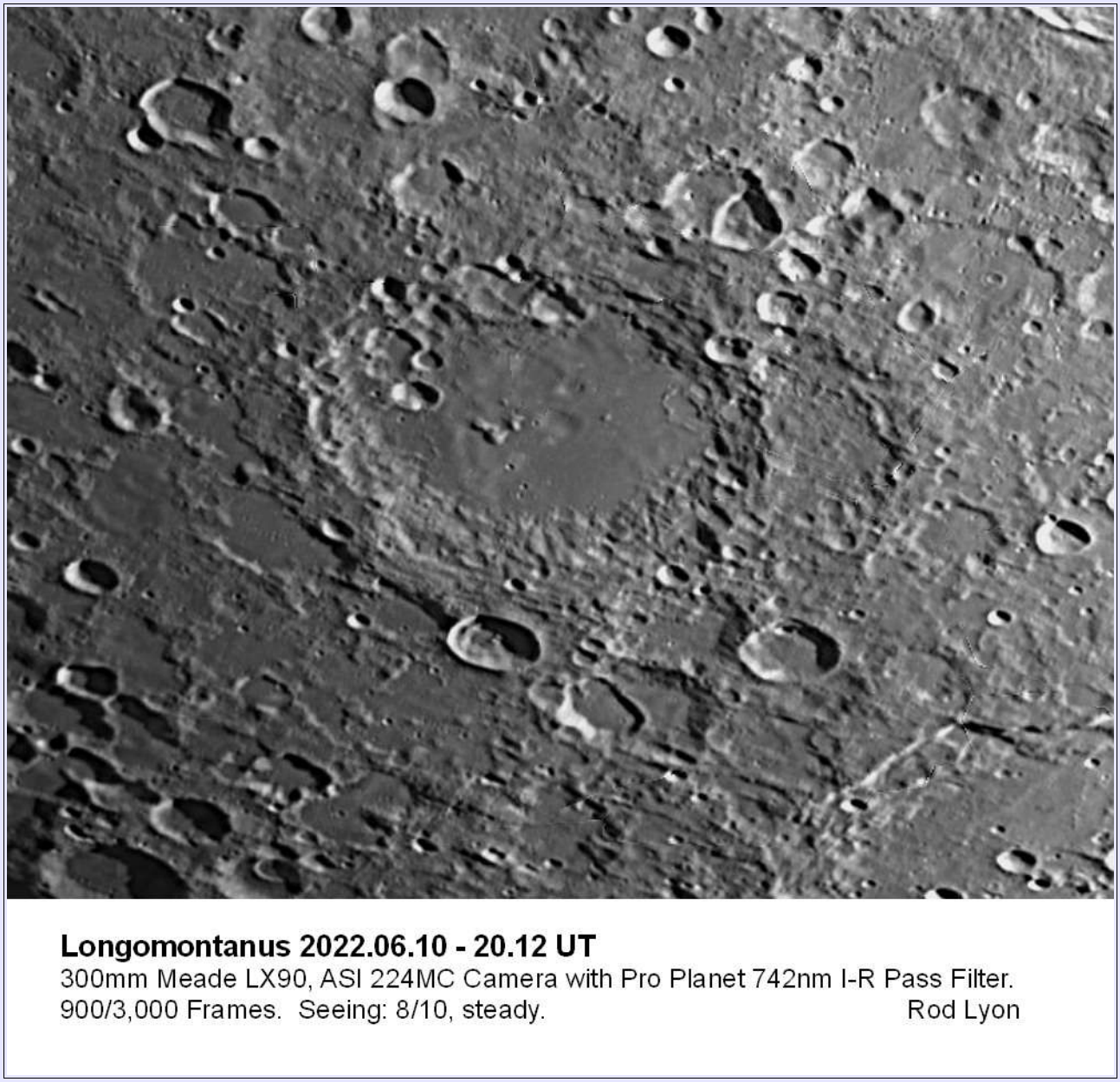


Image by **Rod Lyon** with details of equipment and time/date shown in the caption.

Editor Comments: The floor of the 145km diameter crater Longomontanus consist of smooth light plains that are interpreted to be basin ejecta, with the Orientale impact being the most likely source. Albedo differences across the floor are related to rays from Tycho which is some 180kms away to the north-east (top right hand corner). The central peak is offset to the west of the crater centre, and only the upper 600m or so protrude above the floor. Why some craters have offset central peaks is something of a mystery – it may be related to the original impact or subsequent modification, but here there is not much in the way of evidence to suggest which of these factors played a part in this case. A number of Floor Fracture Craters (FFC) have offset central peaks, and in these cases it is possible that the crater floor, including the central peak actually detached from the basement as magma forced its way upwards from within the crust. The separated crater floor could then potentially be displaced, carrying the central peak with it. Here however there is no evidence that Longomontanus was a FFC, so this explanation would not apply.

Cruger-Sirsalis basin.

Image by **Alexander Vandenbohede** – details of equipment and time/date as shown.

Alexander comments: Cruger-Sirsalis basin: The view shows clearly the post-basin basalt within Cruger and Rocca A, Lacus Aestatis and the areas northeast of Cruger. Along the limb, the northern part of the Orientale basis is in view with Montes Cordillera, inner and outer Montes Rook, Lacus Autumni and Lacus Veris.

Editor Comments: The Cruger-Sirsalis basin is in the region of 700kms in diameter, though as with most other ancient Pre Nectarian basins it is difficult to determine the outline on the present lunar surface. Data from the GRAIL gravity probes clearly shows a multi-ringed basin with the mare filled crater Cruger lying just to the south of the basins geometric centre. The central part of the basin is depressed, and from the gravity data it appears that the denser lunar mantle has risen towards the surface as the overlying crust was removed during basin formation. Bearing in mind that the basin is Pre-Nectarian in age, so around 4.5to 3.9Ga, crater counting suggests that the most recent episodes of volcanism date to *only* some 1.4Ga, indicating a prolonged period of geological activity. There has obviously been a fair amount of volcanic activity and as Alexander comments numerous areas of mare like basalts are evident, with the floor of Cruger being the most prominent one.

This image also shows the crater Sirsalis and the older Sirsalis A which it partially overlaps, as well as the small bright crater Sirsalis F just to the south. This latter crater just nicks Rima Sirsalis (which can be seen running approximately parallel to the bottom of the image) but its neighbour, the older Sirsalis J sits right on top of the rima. Oddly enough when I have viewed this area telescopically the older Sirsalis J appears to have a higher albedo halo surrounding it than its younger neighbour. This odd impression may however just be a result of bright ejecta from Sirsalis F being drapes over Sirsalis J. Between Cruger and Grimaldi a chain of Orientale secondaries including Damoiseau B and C can be seen.

Snellius.

Image by **Bob Stuart**, details of equipment and time/date shown in caption.

The 85km diameter Snellius which can be seen below the centre of the frame has its southern floor draped in ejecta from Petavius. The ejecta forms ropy tendrils that obscure most of the crater floor, with only a small part of the original floor visible to the north. Bob's image also captures Vallis Snellius which trends in a SE to NW direction and is radial to the Nectaris Basin, the south-eastern quadrant of which is just visible in the top left corner. This would indicate that Vallis Snellius is related to the Nectaris basin forming event and represents a crater chain or gouge produced by ejecta excavated from the impact site.

Rhaeticus, Godin and Lade.

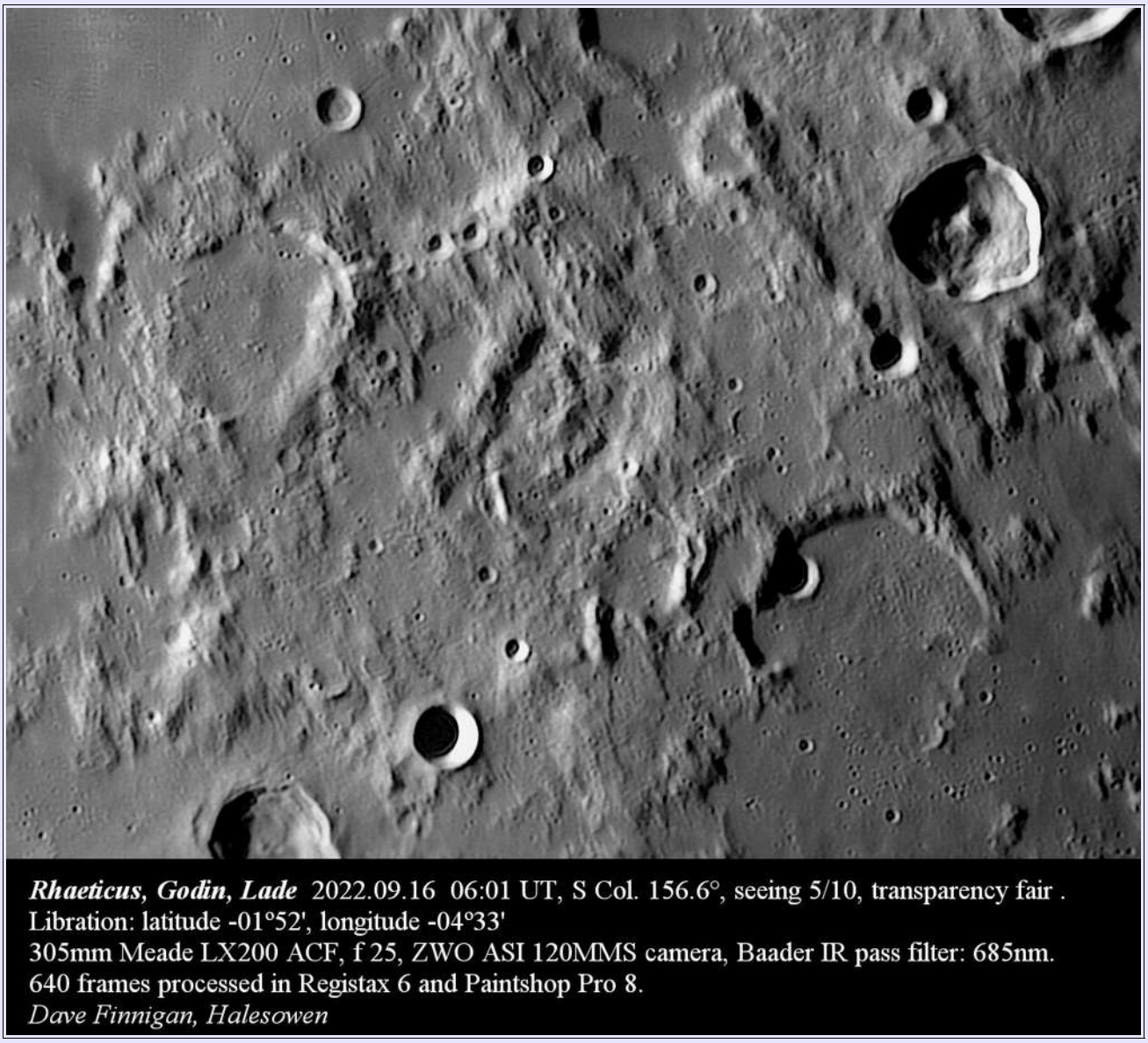


Image submitted by **Dave Finnigan** with details of equipment and time/date in caption.

Editor Comments: This image shows a very battered section of the lunar highlands with superimposed Imbrium Sculpture which takes the form of gouges and crater chains orientated radially to the Imbrium Basin. A small lunar dome can be seen towards the top left of the image on the southern shore of Sinus Medii, and set in an embayment which is named Rhaeticus L. The dome, which is some 10kms in diameter is only about 160m high, so a walk up the flank to the rectangular summit crater would not leave you out of breath. You can see the dark volcanic halo surrounding the dome, and a close examination of the area reveals a number of Irregular Mare Patch (IMP) type features indicative of the venting of volcanic gasses from beneath the surface. The peculiar somewhat triangular outline of Godin might suggest some form of tectonic control where faults and fractures were preferentially exploited during the impact event, much like Meteor crater in Arizona has a squarish shape which reflects the orientation of pre-existing lines of weakness. Something similar may account for the outlines of Ukert and Agrippa, which are far from circular.

You would think that an area such as this would be geologically dead, with nothing to disturb the surface apart from the odd impact, but the floor of Lade, just to the SE of Lade M (small crater on the NW floor) is contorted by a lobate scarp, showing that compressional tectonic forces have been active in the recent (in lunar terms) geological past. There is also a small cluster of 'micro-graben', again features produced by surface deformation. These features are thought to be in the region of <100 million years or so whilst the area shown might not be a hotbed of activity it is possibly not completely dormant.

Bullialdus

Image submitted by **Maurice Collins** and taken on 2022-07-08 at 0549UT using a Meade ETX-90 and QHY5III462C camera.

Editor Comments: The the subject of this image, the crater Bullialdus is just emerging from shadow with the eastern glacis illuminated but the crater floor still in deep shadow. Mare Nubium shows a difference in surface tone with the generally higher titanium basalts being darker than basalts of a lower titanium content. Rima Birt which is discussed later in this newsletter can be seen just to the west of the double impact crater Birt. This is area has a relatively diverse geology for the moon, with rocks of a relatively high silica content forming both the heart shaped Wolf and the Lassell Massif just to the west of Alphonsus. These features pre-date the mare flooding within Mare Nubium and possibly represent an early phase of volcanism where the lavas produced were compositionally different to those which make up the younger surrounding mare basalts. The concentration of wrinkle ridges between Bullialdus and Rupes Recta, and which formed as the central part of Mare Nubium sank under the weight of the infilling basalts is quite striking under low angle illumination.

Stofler

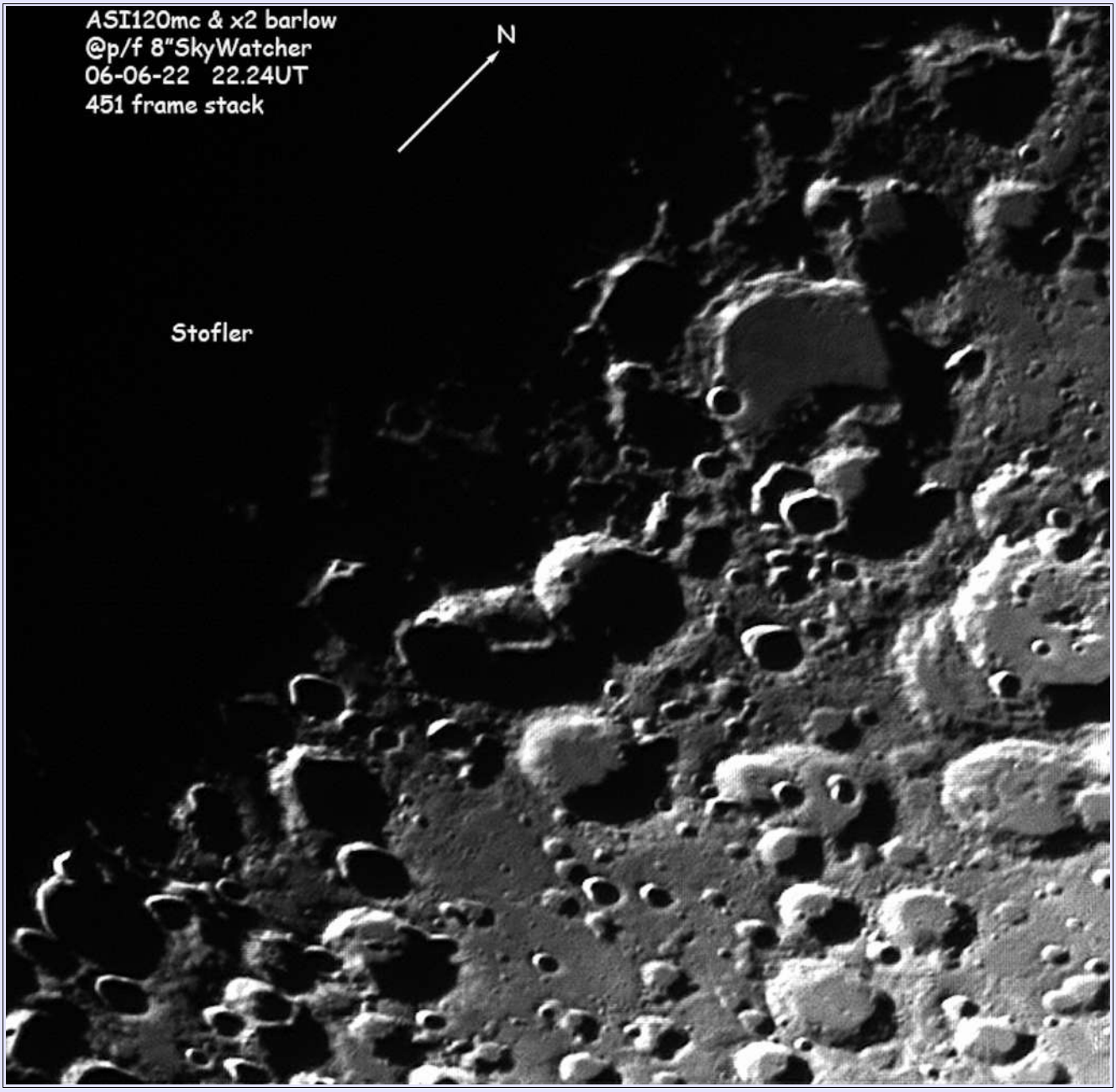


Image submitted by **Les Fry** with details of equipment and time/date shown in the caption.

Editor Comments: You can see from this image why the notion of a 'Lunar Grid', a global system of faults and fractures was seriously considered by many researchers in the past. Notice the straight shadow across the northern floor of Stofler which extends into Fernelius to the west and is *almost* lined up with the straight southern rim of Maurolycus to the east. Whatever is causing this shadow, it was included by V.A.Frisoff in his Selenogical Map showing Tectonic Grids, Crater Chains and Wrinkle Ridges in his Moon Atlas, published in 1961*. Though the concept of a 'Lunar Grid' is largely discounted, these features appear to be real but are quite subtle and require fortuitous illumination, such as in this image by Les, to become visible. It is possible that these linear structures relate to deep crustal fractures caused by large basin forming impacts in early lunar history, and that these still exert an influence as lines of weakness which are preferentially exploited during cratering events or during tectonic movements. I am sure that many of you will have seen these alignments during your observations – personally I am sure they reflect real geological structures and not chance alignments of unrelated surface features.

*"Moon Atlas" by V. A. Firsoff. The Viking Press, New York, 1961

Montes Tenerife - BAA Requested observation.

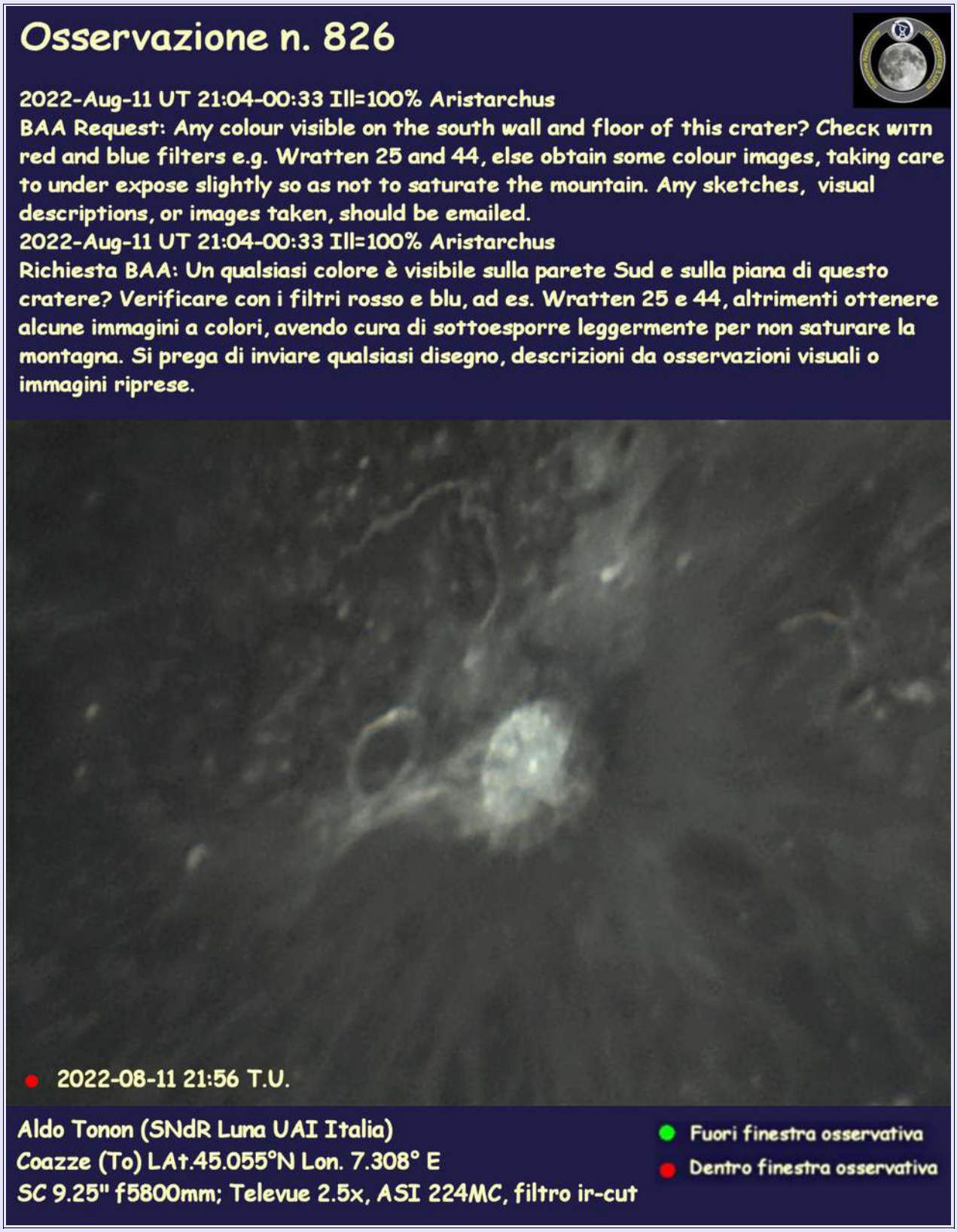


Image submitted by **Aldo Tonon**. Details of the equipment used and time/date as shown in caption.

Montes Tenerife - BAA Requested observation.

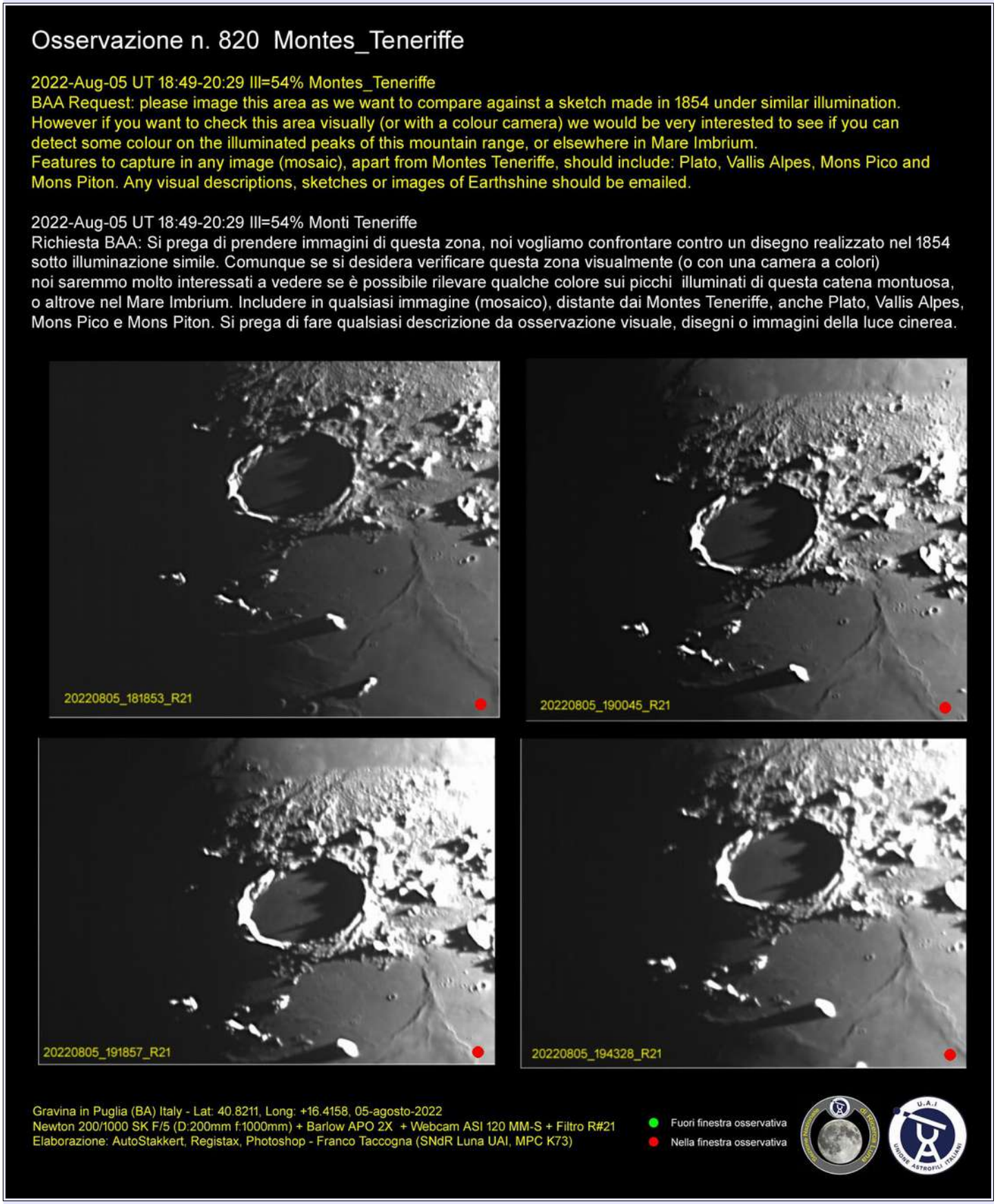


Image submitted by **Franco Taccogna.** Details of the equipment used and time/date as shown in caption.

Lunar Domes (part LVIII): Dome near Plana G and Luther Y (P1)
by Raffaello Lena

In this fifty-eighth note I will describe a lunar dome near Plana G and Luther Y. It is located at 38.45° N and 24.85° E, and identified in earth telescopic image taken under strongly oblique solar illumination angle (Fig. 1, labeled as P1).

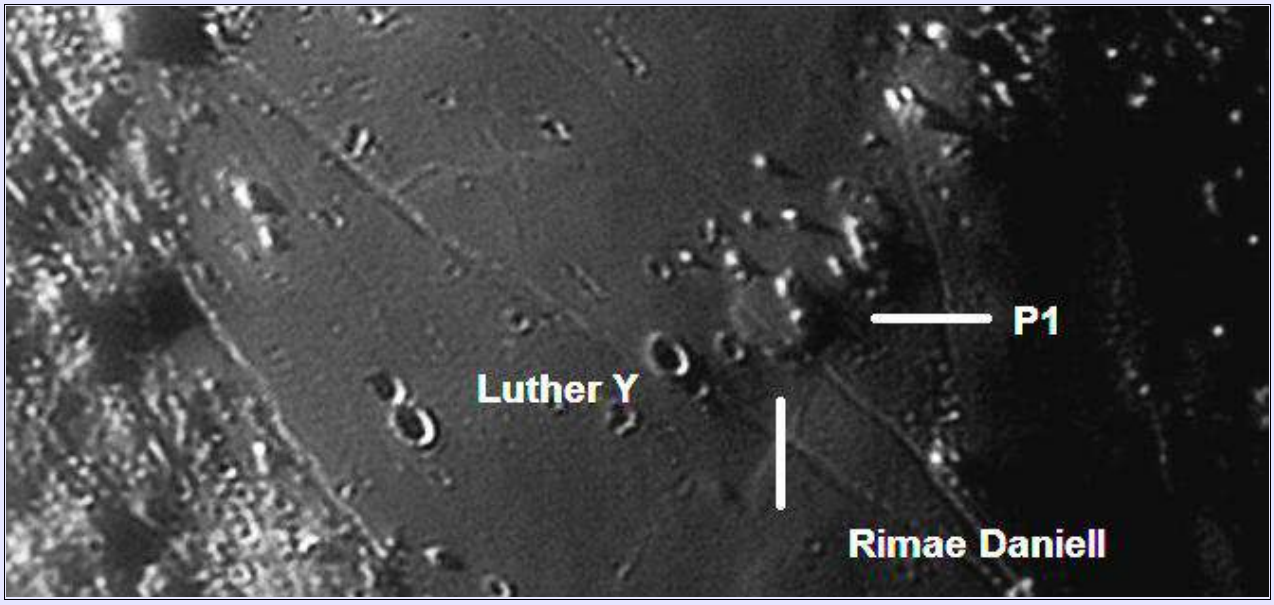


Figure 1: telescopic image by Paolo Lazzarotti acquired on August 19, 2011 at 03:40 UT (Gladius XLI Cassegrain with aperture of 400 mm f/16 and a Baader Zeiss 2x Barlow lens).

In the corresponding WAC imagery (Fig. 2) it displays small non-volcanic hills on the surface which are characterized by heights of not more than two hundred meters. Thus the dome P1 formed around pre-existing non-volcanic hills.

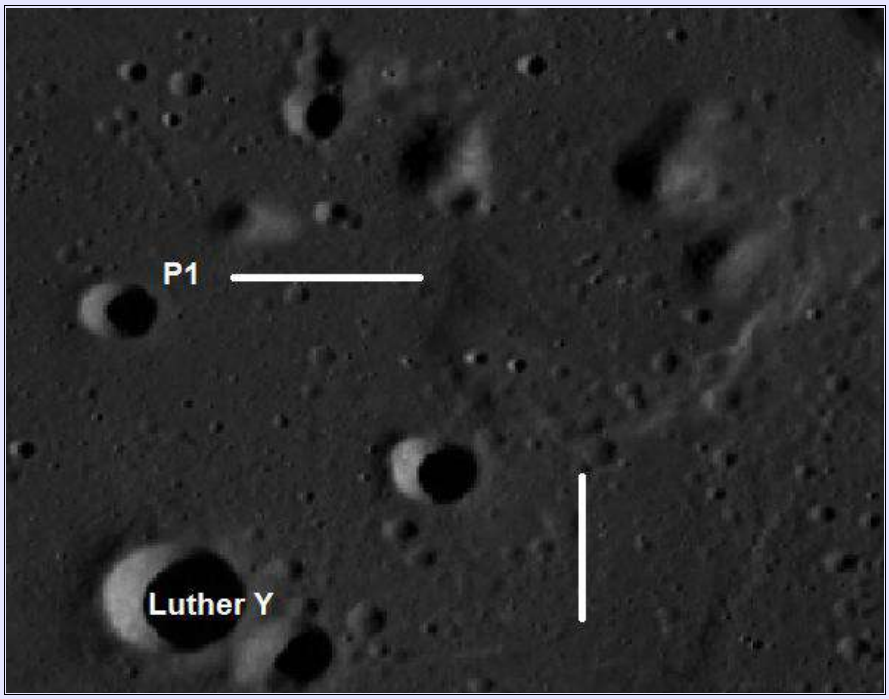


Figure 2: LRO WAC imagery. Dome P1.

Morphometric properties

Based on the LOLA DEM, the dome has a base diameter of 9.0km ± 0.1km and height of 175m ± 10m yielding an average flank slope ξ of 2.3° ± 0.23°. Assuming a parabolic shape, the feature's edifice volume is determined to 5.5km^3. The cross sectional profile of the examined dome is shown in Fig. 3. The 3D reconstruction using WAC mosaic draped on top of the GLD100 elevation model is shown in Fig. 4.

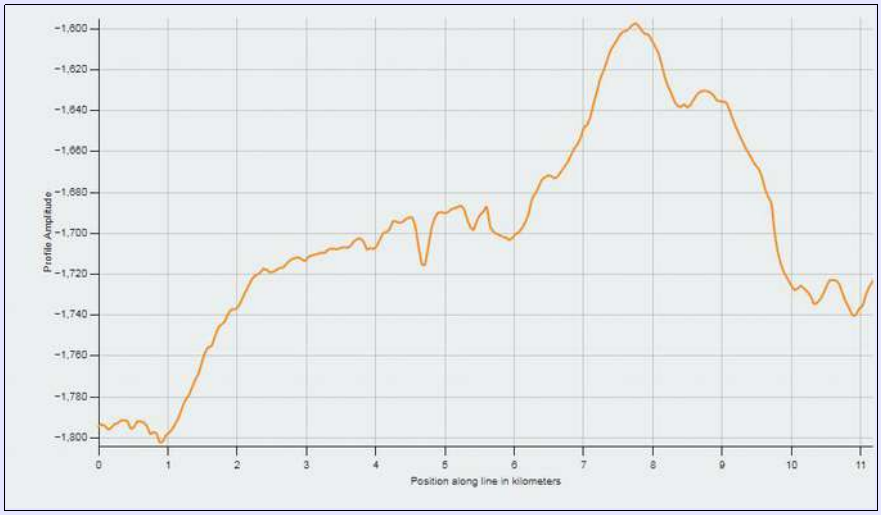


Figure 3: LOLA DEM. Cross-sectional profile in E-W direction of the dome P1.

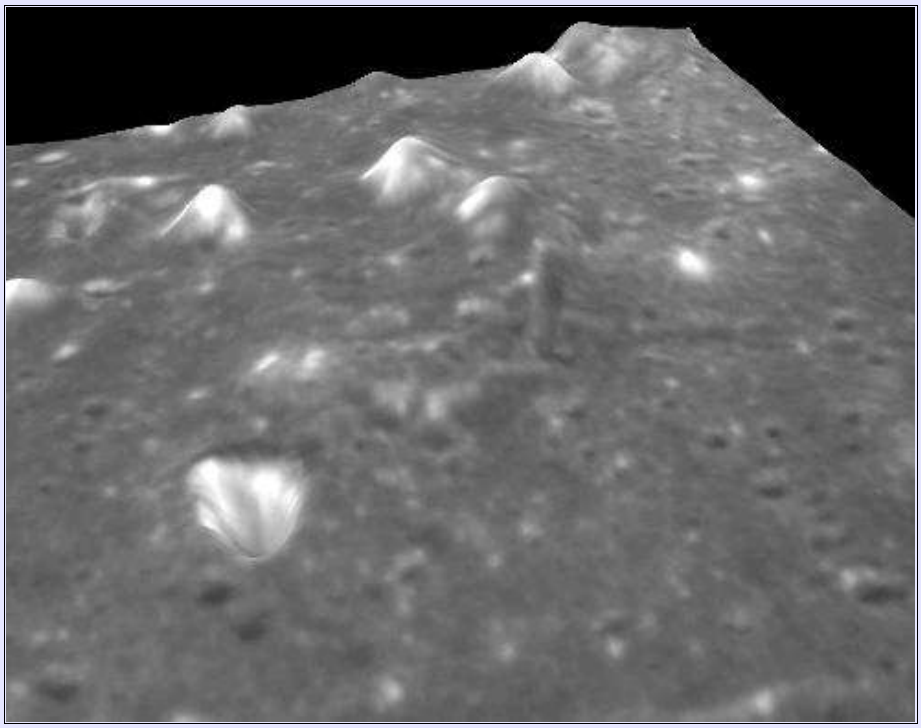


Figure 4: WAC draped on top of the global LRO WAC-derived elevation model (GLD100). The dome P1. The vertical axis is 7 times exaggerated.

A scarp separates the eastern flank of P1 from the surrounding mare plain. The eastern parts of P1 are higher than the centre with the maximum elevation reached at the eastern flank (Fig. 4).

Age estimation

P1 lies in a region mapped as Im_2 unit, which denotes *Imbrian* mare material. In the corresponding USGS geologic map (https://www.lpi.usra.edu/resources/mapcatalog/usgs/I705/150dpi.jpg) the Im_2 unit is described as

extensive mare unit, similar to *Eratosthenian mare*, but having higher albedo and density of craters. Thus P1 represents a mare dome of *Imbrian* age (likely of *Late Imbrian* epoch occurred between 3.8-3.2 billion years ago). The surface of P1 appears strongly degraded with several impact craters which have likely modified the original surface of the older domical structure.The identification of possible source vents is inconclusive, and is suggested as candidates on the basis of subdued morphology of some features. However, many effusive lunar domes do not display a summit vent at all when their associated conduits are plugged by the ascending lava [Lena et al., 2013].

Most hills located in the examined region are recognized as *Alpes Formation*, which represent material ejected from Imbrium basin (Fig. 5). According to Scott [1972], in the USGS geologic map I705 the *Alpes Formation* is characterized by irregular to subround domical hills generally < 5 km in dimension. These hills display a blue colour in the Clementine color ratio image (cf. Fig. 6). Murl et al. [2015] have identified *Alpes Formation* from 800 to 1000 km to the north, east, and south of the edge of Imbrium basin.

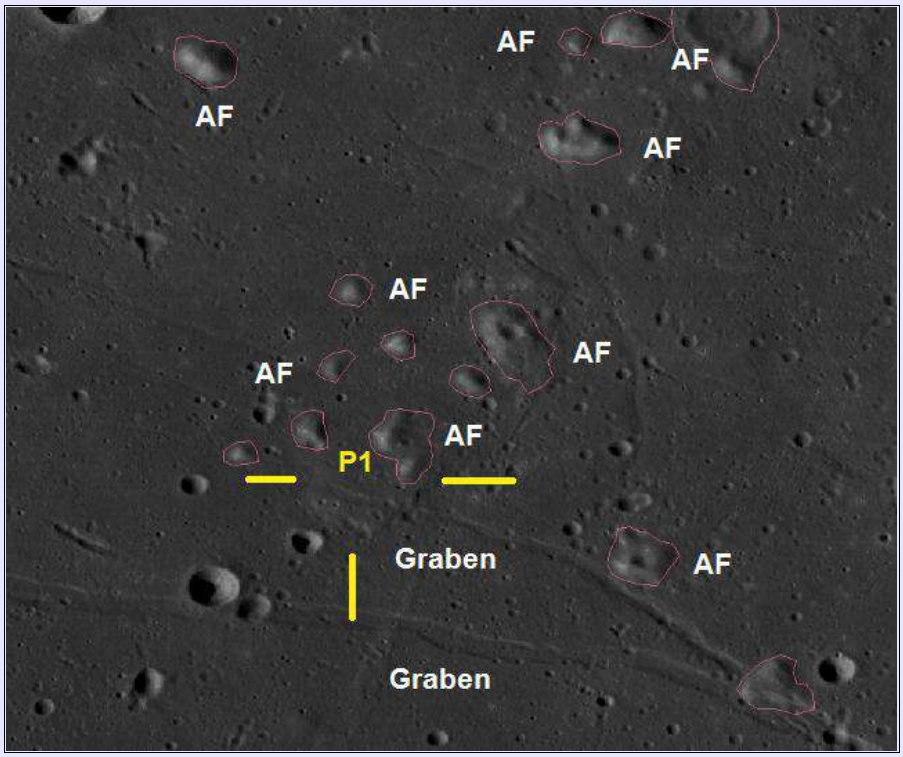


Figure 5: The dome P1 (yellow lines) cut by a graben and presence of rounded hills (Alpes Formation).

The southern summit of P1 is also bisected by a graben linked to the long Rimae Daniell localized in the examined region (Fig. 5).

Bulk Silicate Mineralogy

Based on the Diviner Lunar Radiometer Experiment the Christiansen Feature (CF), has been used to map this region. The examined dome has CF positions ranging from 8.3 to 8.36 µm. Average CF value of 8.16 µm is consistent with a mixture of plagioclase and some pyroxene, while the average CF values of *maria* basalts range from 8.3-8.4 µm [Greenhagen et al., 2010]. Thus it displays a basaltic composition. Lower CF values (8.16-8.25 µm) are indicating admixed highland component due to ejecta contamination originated by youngest impact craters (Fig. 11). The CF position occurs at shorter wavelengths for felsic and feldspathic compositions and longer wavelengths for mafic compositions.

Spectral analysis and composition

The extracted Clementine UVVIS data were examined in terms of reflectance at 750nm and R415/R750 and R950/R750 colour ratios. The color ratio image is obtained assigning the R750/R415, R750/R950 and R415/R750 into the red, green, and blue channels, respectively (Fig. 6). The Clementine UVVIS spectral data reveal a low value for the UVVIS colour ratio of $R_{415}/R_{750} = 0.560$ indicating a low TiO_2 content, and a weak

mafic absorption with R_{950}/R_{750} = 1.059, indicating a high soil maturity. In the color ratio image the lunar highlands are depicted in red (old) and blue (younger), while the *maria* are depicted in orange (iron-rich, lower titanium) or blue (iron-rich, higher titanium).

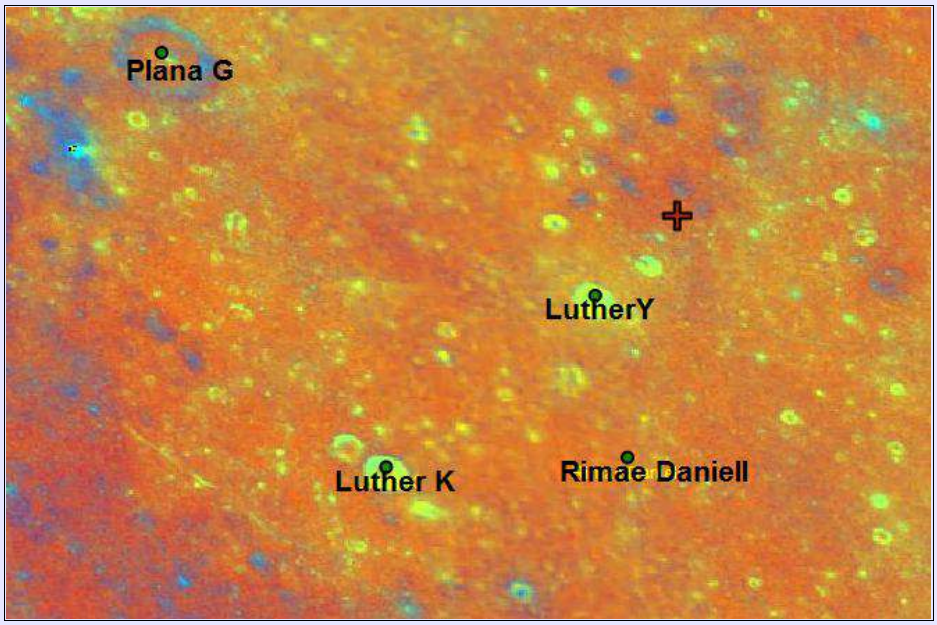


Figure 6: Clementine color ratio map of the examined P1 (marked with the symbol +) and nearby craters, obtained assigning the R_{750}/R_{415}, R_{750}/R_{950} and R_{415}/R_{750} into the red, green, and blue channels, respectively.

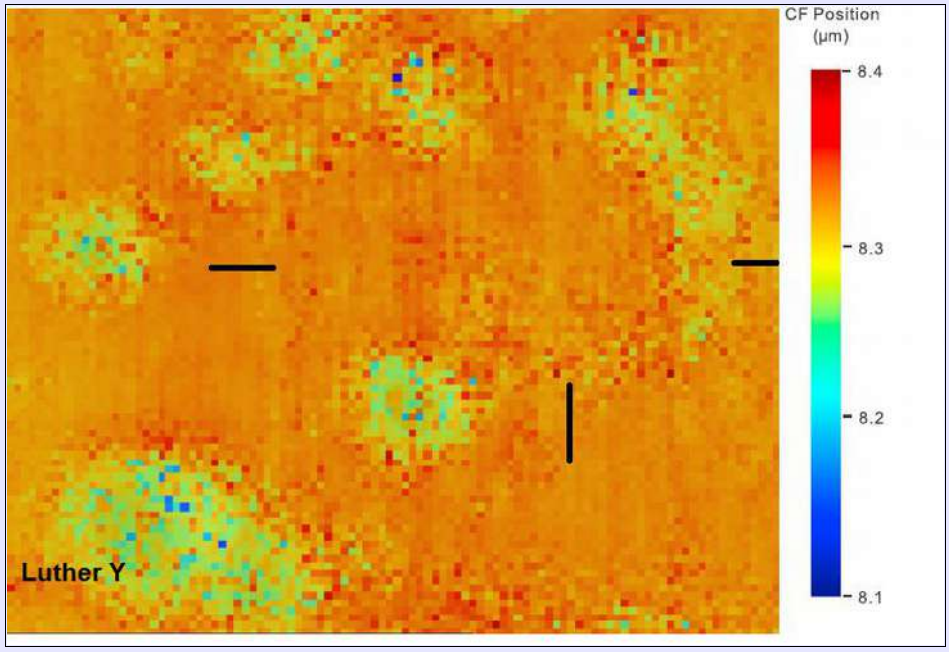


Figure 7: Diviner Christiansen Feature (CF) position map of the examined dome P1.

In Fig. 6, the dome summit is characterized by a different color (orange) respect to the small hills embayed from the dome and the ejecta of the nearby craters, which appear yellow. The absence of a spectral contrast between P1 and the surrounding surface, indicating that both consist of the same material (cf. Fig. 12) and the lacking of a spectral contrast suggest that P1 is most likely not a kipuka, an elevated "island" surrounded by the flooding mare lavas like Darney located in western Mare Cognitum, an elevated section of highland terrain embayed by mare lava [Nichols, 1974]. The M^3 spectrum of P1 (orbital period OP1B) displays a typical high-Ca pyroxene signature with a minimum wavelength at 1.020 nm and another strong absorption band at 2,160

nm (Fig. 13). The broad 1.000 nm absorption band would indicate also the presence of low Ca pyroxene and olivine signature, mixed with high-Ca pyroxene.

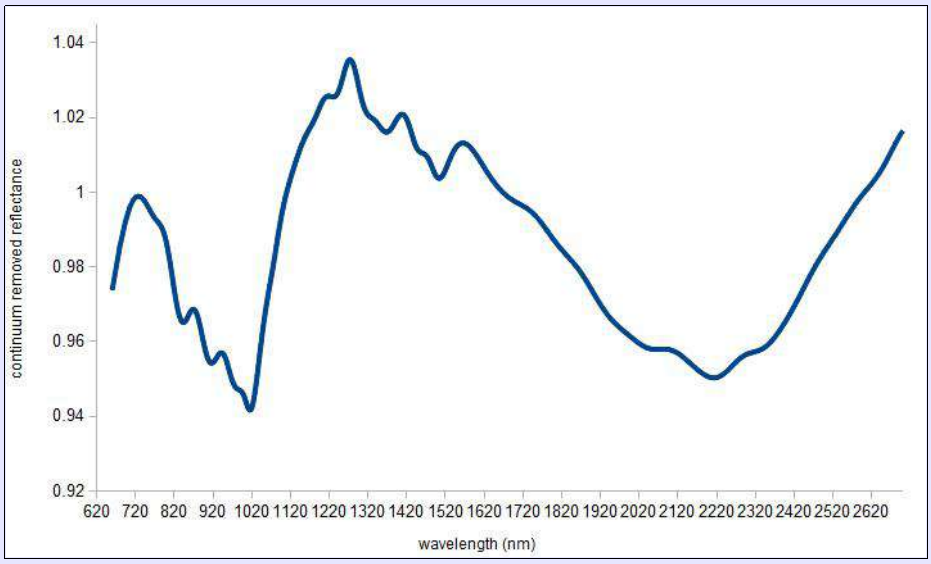


Figure 8: M^3 spectral analysis. Spectrum of P1- OP1B orbital period- continuum removed.

For the spectral study the Kaguya Multiband Imager (MI) have been used providing data in wt% of the minerals plagioclase, olivine, clinopyroxene (high-calcium pyroxenes) and orthopyroxene (low-calcium pyroxene) [Lemelin et al., 2016]. However the area of the dome P1 is partially covered by the Kaguya Multiband Imager data: thus the mineral abundance in wt% can be derived only for the eastern summit of P1 (Fig. 10), which is characterized by FeO content of 13.5 wt%. Similar values for FeO content are obtained in nearby mare units.

Furthermore the eastern summit displays plagioclase content of 40.0 wt%, orthopyroxene (low-calcium pyroxene) of 23.0 wt%, clinopyroxene (high-calcium pyroxenes) of 25.0 wt% (Figs. 9-10). According to the spectral data derived by Chandrayaan-1's Moon Mineralogy Mapper (M^3) the olivine content derived by Kaguya Multiband Imager amounts to 10.0-12.0 wt%.

Based on the derived FeO and TiO_2 content (13.5 wt % and 1.2 wt % in average, respectively), the main rock type is low-Ti basalt, with the presence of an olivine component admixed with pyroxene. The resulting maps derived using Mineral Mapper reflectance data confirm that the rounded hills (features 1-7 in Figs. 9-10) display a different composition consistent with a feldspathic composition excluding their eventual volcanic origin (e.g. lunar cones) being part of the *Alpes Formation*. The seven examined features display an average plagioclase content of 64.0-73.0 wt%, orthopyroxene (low-calcium pyroxene) of 9.0-12.0 wt%, clinopyroxene (high-calcium pyroxenes) of 10.0-12.0 wt%, and lower FeO content of the nearby mare units (Figs. 9-10).

Rheologic Model and Classification

The rheologic model [Wöhler et al., 2006; Wöhler et al., 2007; Lena et al., 2007: Lena et al., 2008, Lena et al., 2013] applied to P1 yields a low effusion rate of 100 $m^3 s^{-1}$ and a high lava viscosity of 1.1 x 10^6 Pa s. It formed over a period of time of about 2.5 years. The magma rise speed amounts to U = 5.9 x 10^{-6} m s^{-1} and the dike width and length to 65 m and 180 km, respectively. If it is assumed that the vertical extension of a lunar dike is comparable to its length L [Jackson et al., 1997], the magma which formed the dome originated in the upper lunar mantle, well below the crust. The dome P1 belongs to rheologic group R_3 and to class C_2 with a tendency toward class B_1 in the classification scheme of lunar mare domes [Lena et al., 2013], being characterized by very low R_{415}/R_{750} ratio indicating very low TiO_2 content (< 2.0 wt %) and shorten effusion time than class B_1. The southern summit of P1 is bisected by a graben linked to the long Rimae Daniell localized in the examined region (Fig. 5). This graben cuts the summit of P1 in its southern section suggesting that the rille is younger than the examined dome P1.

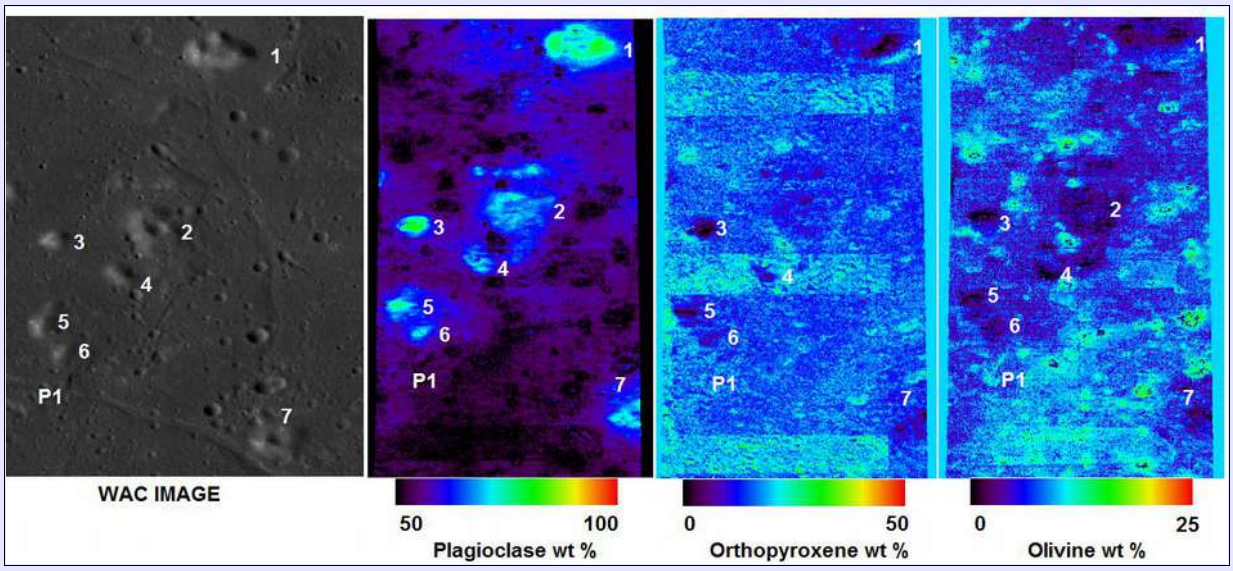


Figure 9: Kaguya Multiband Imager (MI) dataset and derived abundance wt% for the examined features (plagioclase, orthopyroxene and olivine).

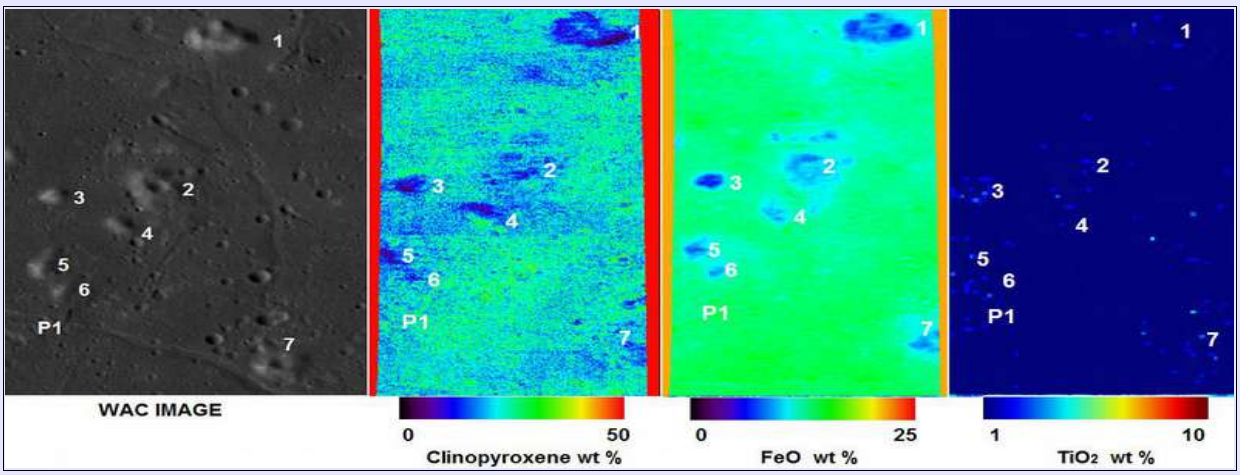


Figure 10: Kaguya Multiband Imager (MI) dataset and derived abundance wt% for the examined features (clinopyroxene, FeO and TiO_2).

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Rima Birt and Surroundings.
By Barry Fitz-Gerald.

I was interested to read Paul Abel's observations regarding Rima Birt in last months LSC, and have had a quick look at the spacecraft data to see what it can reveal about the area. He noted a slight orange colour around the elongate Birt E which forms the the northern end of the feature, and which also has a conspicuous dark mantle halo surrounding it.

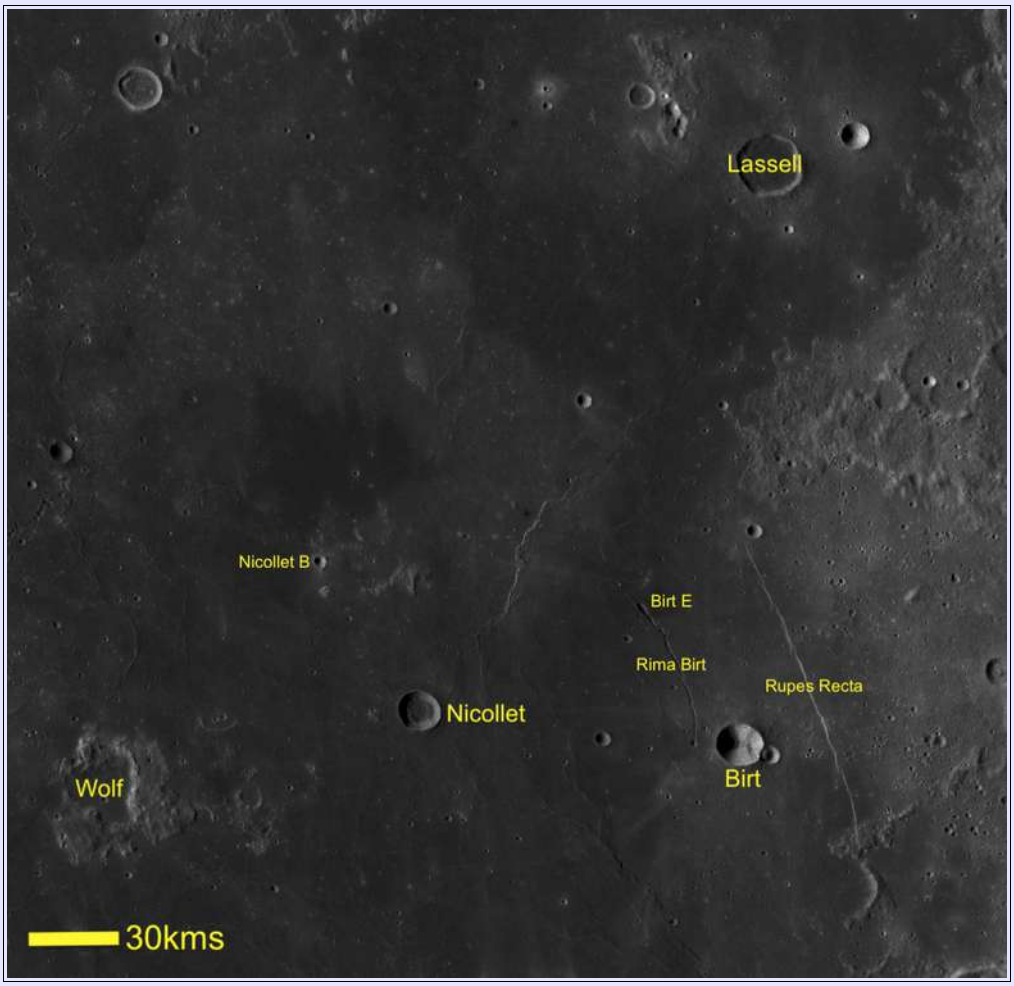

Fig.1 Rima Birt and its surroundings.

As can be seen in Fig.1 Rima Birt is on the eastern shore of Mare Nubium, with Rupes Recta to the east and the lava plains of the mare to the west. The rather peculiar Wolf complex appears to sit at the centre and lowest part of Mare Nubium, and the curve of Rima Birt appears to be somewhat concentric to the basin centre. This might suggests that the feature owes its origin to tectonic forces as opposed to a volcanic ones, and formed as a result of crustal fracture as the central part of the mare subsided. It is likely that this is is also the mechanism behind the formation of Rupes Recta, but here the curvature is much less marked.

Figs.2 and 3 show a more detailed view and a cross section of both of these features, and as can be seen Rima Birt lies on the elevated margins of Mare Nubium and not the flat mare surface itself – again suggestive of a tectonic as opposed to a volcanic origin. The offset in Rima Birt approximately half way along its length also suggests that it has its origins as a fault or fracture, as this sort of offset is often seen where a number of shorter fractures align, one after the other to produce one apparently longer fracture. Often the ends of these neighbouring shorter fractures overlap slightly, producing structures called 'relay ramps' and giving the composite fracture a rather jagged appearance. Examples of these ramps can be seen along Rupes Recta which indicated that it is not one continuous fault but a series of *almost* aligned shorter ones. This sort of mechanism would account for the offset in Rima Birt's course.

What is fairly obvious however is that Rima Birt has been heavily modified by subsequent volcanic activity as

its northern termination, the elongate crater Birt E is surrounded by a low albedo halo of probable volcanic origin. The stretch of Rima Birt to the south of Birt E appears to consist of a chain of confluent pits as opposed to a straight fracture as is the case with Rupes Recta. This is probably a result of collapse or drainage of materiel downwards away from the surface.

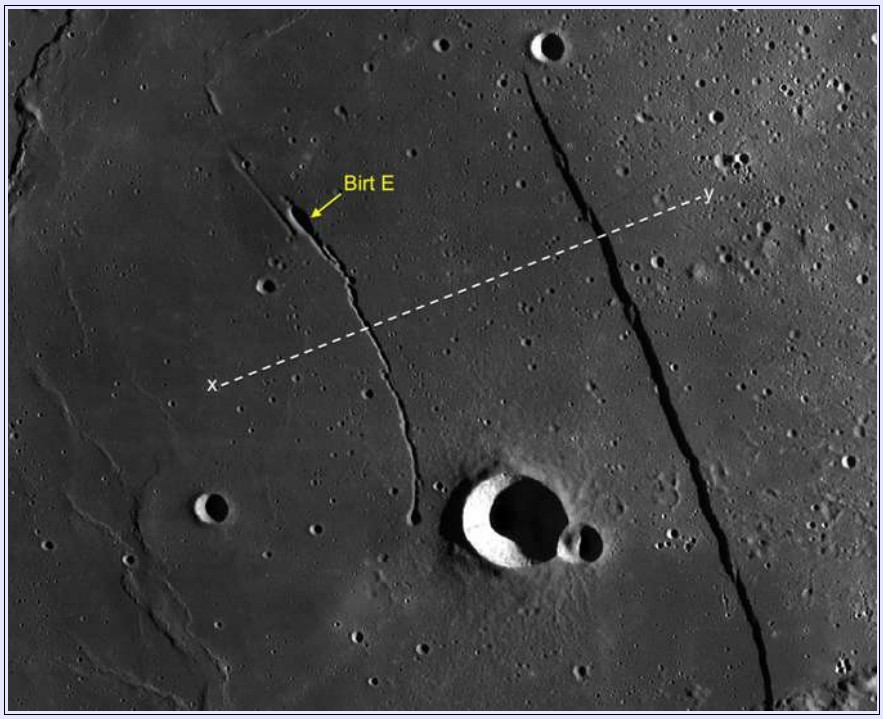

Fig.2 LRO WAC image of Rima Birt and Rupes Recta with the cross section along lie x-y shown below in Fig.3. Note how Rima Birt is composed of a chain of confluent pits.

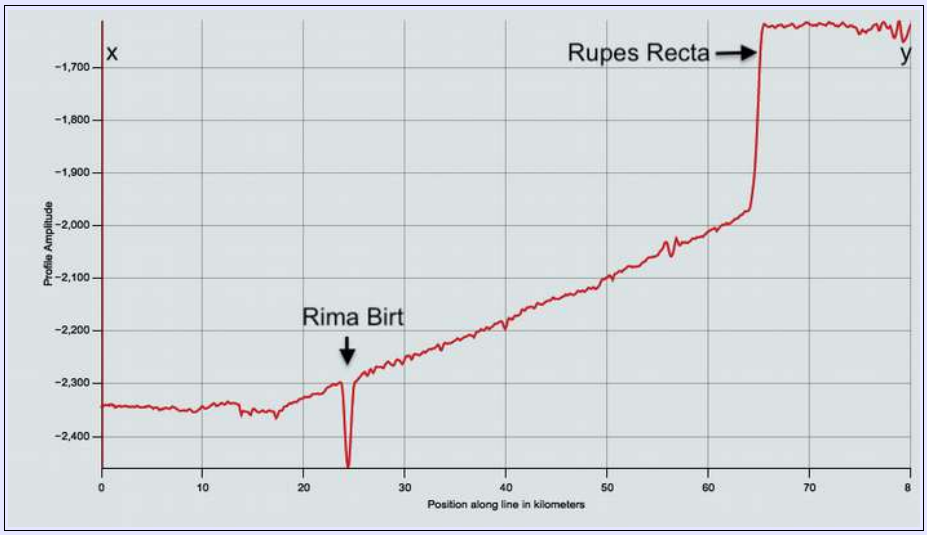

Fig.3 Topographic profile along line x-y shown in Fig.2.

Evidence for this volcanism can be seen in Fig.4 which is a Clementine UVVIS ratio image of the area, with the prominent orange colouration around Birt E indicating pyroclastic volcanic deposits, rich in the mineral olivine and volcanic glass, probably erupted in the form of a 'fire fountain'. This is, in all likelihood what Paul observed when he reported the slight orange colouration noted above. The extent of this orange material corresponds to the low albedo mantle surrounding the northern end of Rima Birt.

This shows that Birt E is a volcanic vent, whilst the remaining stretch of Rima Birt to the south is made up of confluent pits that formed by collapse and not volcanic eruption, as there is no significant indication of associated pyroclastic deposits, but smaller eruptions cannot be ruled out. The larger circular pit that forms the southern terminus of the rima *might* another vent, but it lacks the low albedo halo or orange colouration of Birt E, so could just be a collapse pit and not a volcanic feature. Of course, being so close to the crater Birt it may be that any volcanic surface deposits that were present might have been obscured by ejecta afrom the younger impact. This is despite the fact that this pit lies in Birt's 'Zone of Avoidance' where ejecta is sparser than elsewhere around the crater, but whilst being sparse it is probably not completely absent and so could obscure volcanic material beneath.

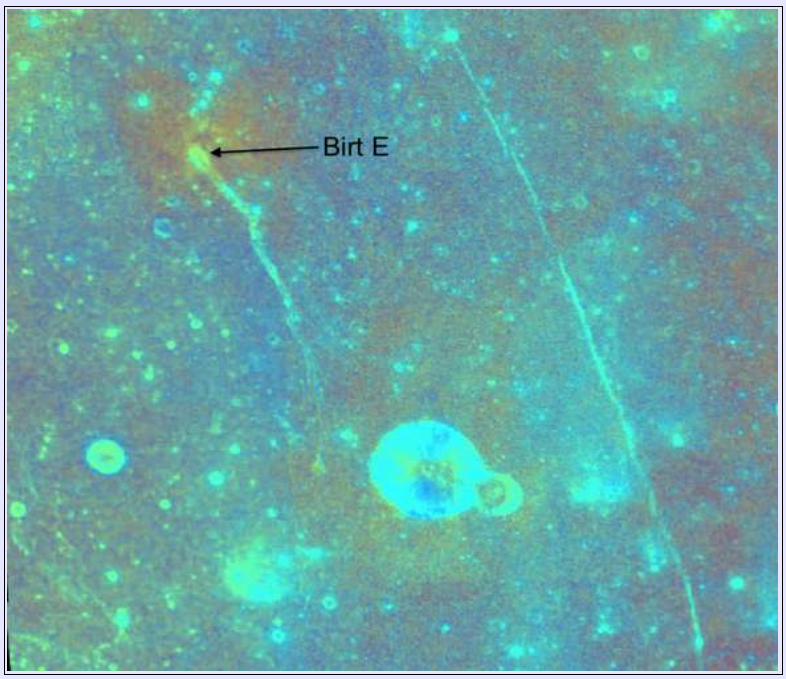

Fig.4 Clementine UVVIS ratio image of the Rima Birt area. The orange colouration surrounding Birt E is probably pyroclastic deposits rich in volcanic glasses.

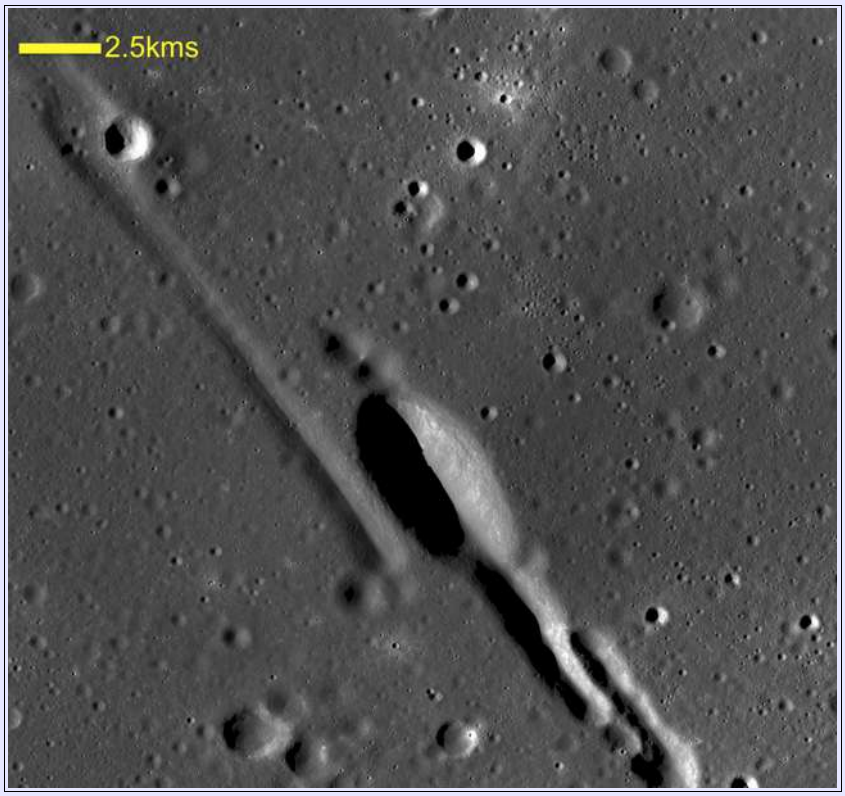

Fig.5 SELENE image of Birt E showing the shallower linear feature immediately to its west which may be a parasitic linear vent.

More evidence for the volcanic nature of Birt E can be seen in Fig's.5 and 6 which are a SELENE image of Rima Birt and a cross section profile taken over it. Fig.5 shows the 8km long and 600m deep Birt E, and also shows a much shallower linear 'rima' like feature immediately west of it which trends in the same direction as Rima Birt. This feature extends some 18 kms to the north beyond Birt E and varies between 30 and 50m deep before eventually petering out in the mare. Where this feature runs along side Birt E it has something of a V shaped profile which is typical of volcanic vents, and hinting at its origin as a parasitic linear vent, with the term parasitic indicating that it is a smaller vent feeding off a magma body that supplies a larger main vent.

Fig.6 is a topographic profile across Birt E (orientated diagonally lower left to top right in Fig.5) which shows that it sits atop a raised area some 16km in diameter and 150m high. This is probably the result of the accumulation of pyroclastic deposits which built up during the 'fire fountain' eruptions, with the thickest deposits accumulating around the vent itself. The parasitic linear vent can also be seen in the topographic profile, and what is immediately obvious is that it is on top of this raised area. This suggests that it became active *after* Birt E had been active for some time and had already built up a substantial depth of pyroclastic material around itself.

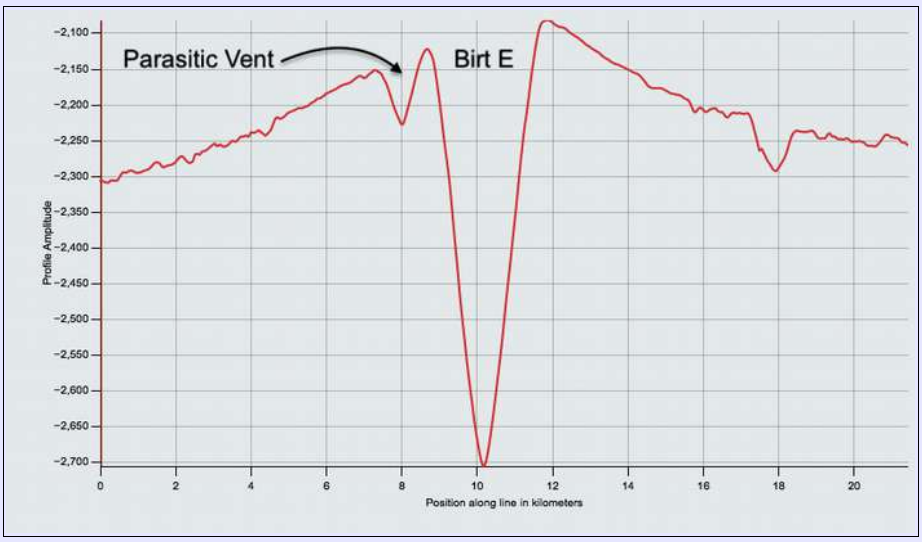

Fig.6 Topographic cross section over Birt E and the nearby 'parasitic vent'. Note the raised margins surrounding Birt E and the location of the 'parasitic vent' on top of this accumulated pile of pyroclastic mound.

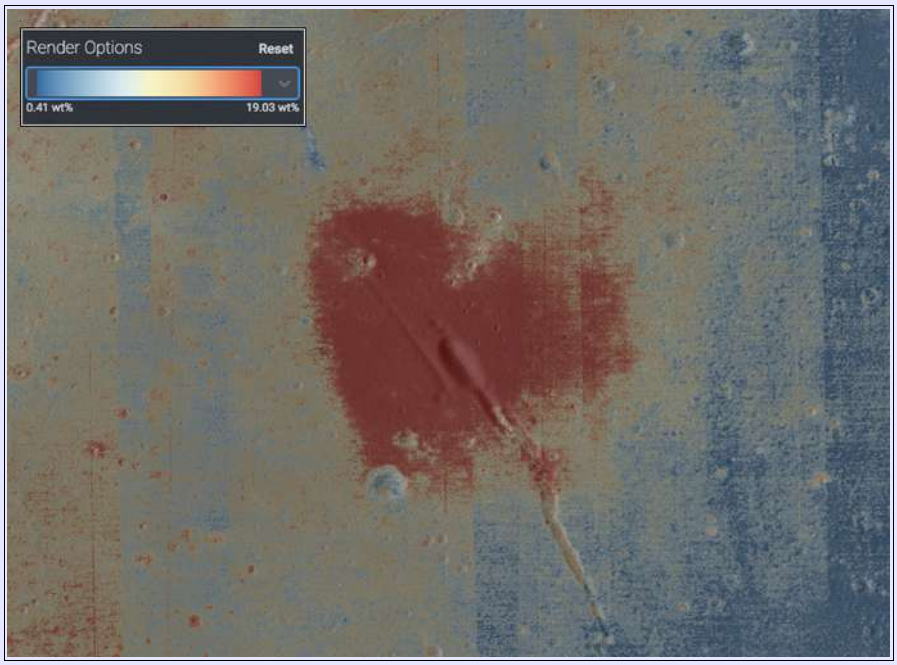

Fig.7 SELENE/Kaguya Mineral Mapper olivine abundance overlay from Quickmap showing deposits of olivine rich pyroclastic material surrounding both Birt E and the associated parasitic linear vent.

That this smaller 'parasitic vent' was the focus of its own volcanic activity is shown by the fact that it also has a halo of pyroclastic material associated with it, something which shows up quite well in Fig. 7 which is a SELENE/Kaguya Mineral Mapper olivine abundance overlay. The orange halos surrounding the northern end of Rima Birt is in that case probably a combination of thick primary deposits erupted from Birt E combined with later thiner deposit erupted from the 'parasitic vent'. The northern end of this 'parasitic vent' also has a raised margin where material has accumulated, but on a smaller scale (~60 to 80m thick) when compared to Birt E. These raised accumulations of pyroclastic material are visible telescopically as slight mounds as they were recorded as suspected domes by Raf Lena's GLR Group*

So, a geological potted history might go along the following lines. The filling of Mare Nubium by basalt lavas caused the central part of the mare to subside, producing compression within the basin, but tension and extensional forces around its edges. This caused the crust to fracture around the mare margins, which produced the smarm of faults that linked up to form Rupes Recta and smalles fractures that linked up to form what is now Rima Birt. The northern end of the fracture underlying Rima Birt became a conduit for magmas ascending to the surface, and when they erupted in a fire fountain they produced a vent – Birt E, whilst pyroclastic deposits accumulated around the vent margins to build up a broad mound. At the other end of Rima Birt a smaller vent may have become active – but as noted above evidence for this is open to debate. Meanwhile, along much of the length of Rima Birt the surface collapsed to produce the 'string of sausages' morphology we see – there may have been localised eruptions, but the evidence for this is not strong. Meanwhile, back at Birt E, a second vent became active as magmas invaded an adjacent fault and erupted near the summit of the mound surrounding the main vent. This linear parasitic vent was not as active as the main one, but still managed to accumulate a raised rim of pyroclastic deposits around its northern end. All this took place after most of the surrounding basalt lavas were erupted, so towards the end of the volcanic activity that accompanied the filling of Mare Nubium.

Acknowledgement:
LROC images reproduced by courtesy of the LROC Website at http://lroc.sese.asu.edu/index.html, School of Earth

and Space Exploration, University of Arizona.
Selene images courtesy of Japan Aerospace Exploration Agency (JAXA) at: http://l2db.selene.darts.isas.jaxa.jpDomes?

*http://www.fabiolottero.it/lac/94.htm

….....

Basin and Buried Crater Project.

Basins: Schiller-Zucchius.

Alberto Anunziato has sent in some work conducted by the SLA on a possible 3rd ring in this basin and comments: *"Paul Spudis in "The geology of Multi-Ring Impact Basins" (Table 2.2 on page 40) includes this basin in the list of basins with less than three rings"*. You can see the basin quite clearly in the LROC Quickmap GRAIL Crustal Thickness layer (Fig 1), but not the rings.

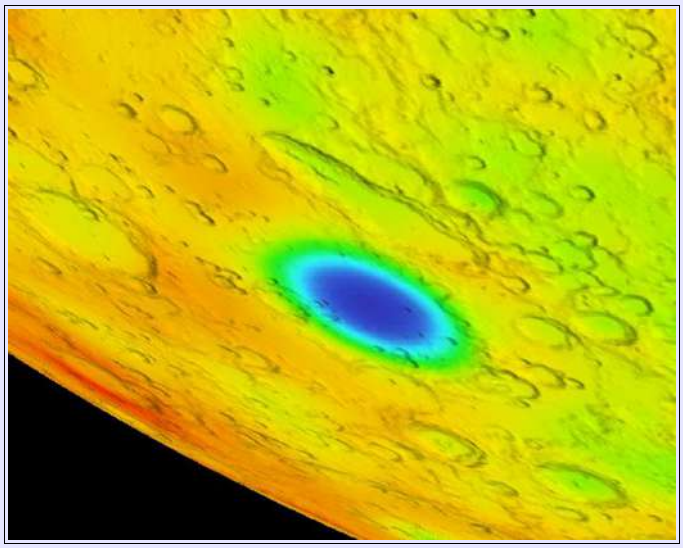

Figure 1. GRAIL Crustal Thickness Map – blue is thin and red is thick. From the LROC Quickmap web site.

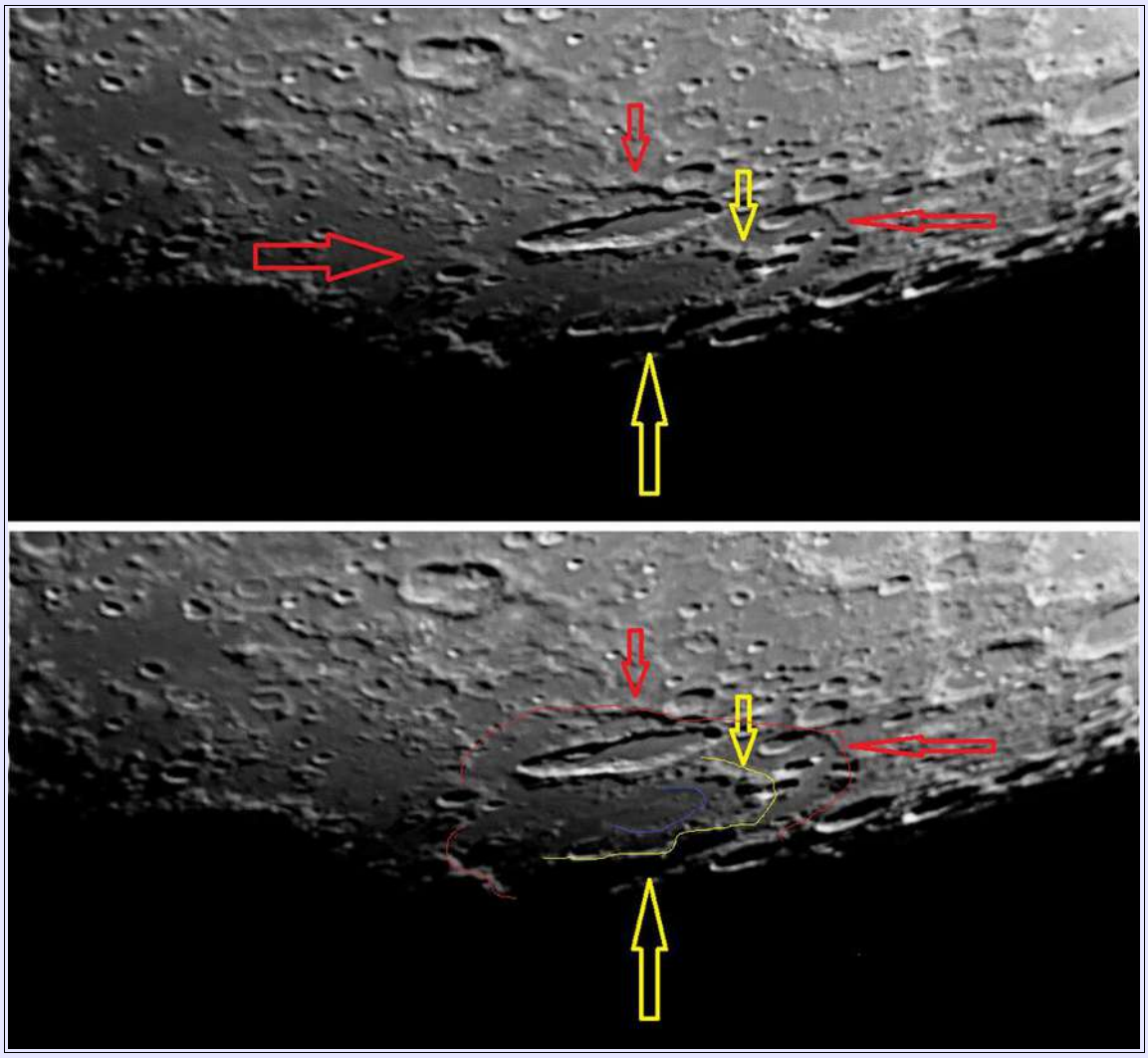

Figure 2. An Earth based SLA image of the Schiller-Zucchius basin. **(Top)** Two rings found by Spudis. **(Bottom)** Third possible ring (in blue) found by the SLA team, with coloured line depictions for the existing two rings.

Using an image that the SLA group took six years ago (Fig 2) of Schiller near the terminator, which passes through the edge of Zucchius opposite Schiller, they tried to depict the rings of this basin. Fig 2 (top) shows where the proposed two rings, according to Spudis are. Fig 2 (bottom shows an additional inner ring that the SLA group suggest might be an inner ring. The Lunar Wiki: http://the-moon.us/wiki/Schiller-Zucchius_Basin gives two ring diameters: 175 and 335 km. The proposed inner ring is of diameter 91 km, but it could also be a buried crater – however it does seem to be coincident with the centre of the Schiller-Zucchius basin. All three rings are more clearly seen in the slope Azimuth plot in Fig 3.

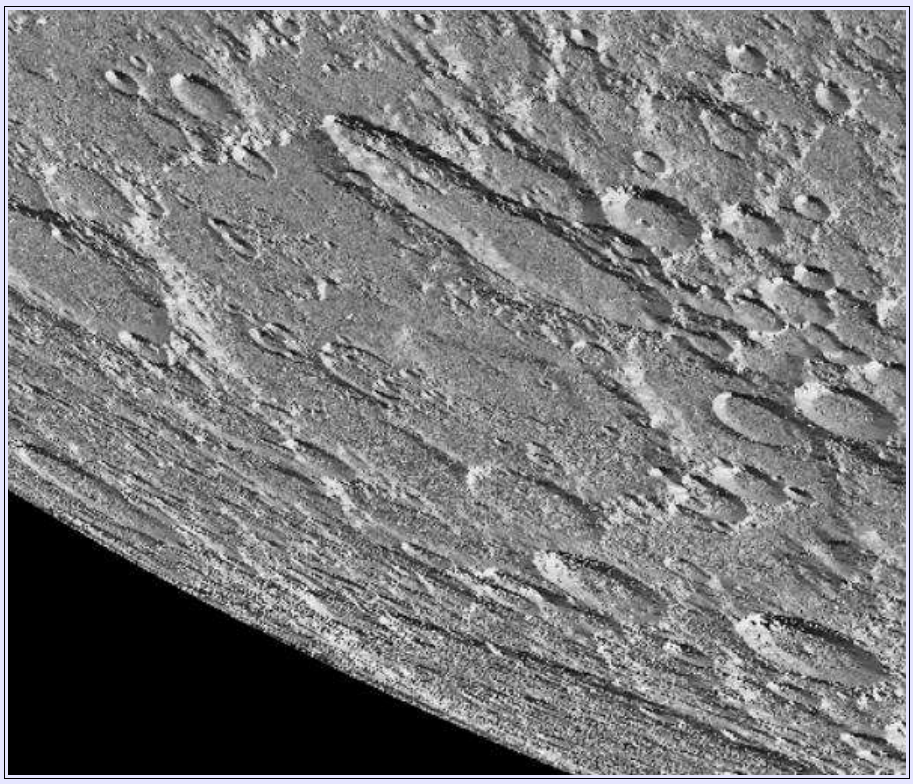

Figure 3. Azimuthal Slope Map - from the LROC Quickmap web site.

Buried Craters

Jay Albert (ALPO) emailed in the following: "*Found some possible buried craters. I looked through many of my old photos where I have previously suspected buried craters. Based on an article I read (I think by Chuck Wood) years ago, I had called them "ghost craters". I made copies of a few of these photos for this email and drew crude arrows pointing to features I thought might be buried craters. The photos dated before 2017 were made with my former 11" Celestron SCT and the ones after were taken with my 8" Celestron SCT. None of these arrowed features have names, although some of them have letter designations in Rukl while others have no designations at all.*"

In Fig 4a we have three craters arrowed. The centre one is at 35.0°E 11.2°S and is 25 km in diameter and has no IAU name nor in our catalog. It is the least well defined. The right most one has no IAU name and is not in our catalog either, but is located at 35.3°W 10.5°S and is 22.9 km in diameter. The left most one is the 2nd least well defined and again is not in our catalog and does not have an IAU name. This is 32.2°E, 10.8°S and 52.0 km in diameter. We will add these to our catalog.. This is 32.2°E, 10.8°S and 52.0 km in diameter.

In Fig 4b the arrowed area does not seem to have a buried crater at its tip 19.6°W, 23.5°S, but a little further east we have Wolf T located at 18.9°W, 23.4°S with a diameter of 27.1 km.

In Fig 4c two candidate ghost/buried are arrowed. The upper buried crater turns out to be PFC 35 from the ALPO/BAA buried crater catalog. The lower arrowed crater is not in the ALPO/BAA catalog, nor has an IAU

name, so we will add this to the catalog with a position of 27.4°W, 16.6S and a diameter of 37.4 km.

In Fig 4d the arrowed ghost crater here turns out to be Maraldi D and is 66.5 km in diameter, so we do not need to add this to our buried craters list.

So this is not a bad haul on a fishing trip for buried craters, four out of the seven candidates that Jay found are unknown (uncatalogued) and will be added to our database in the next few days!

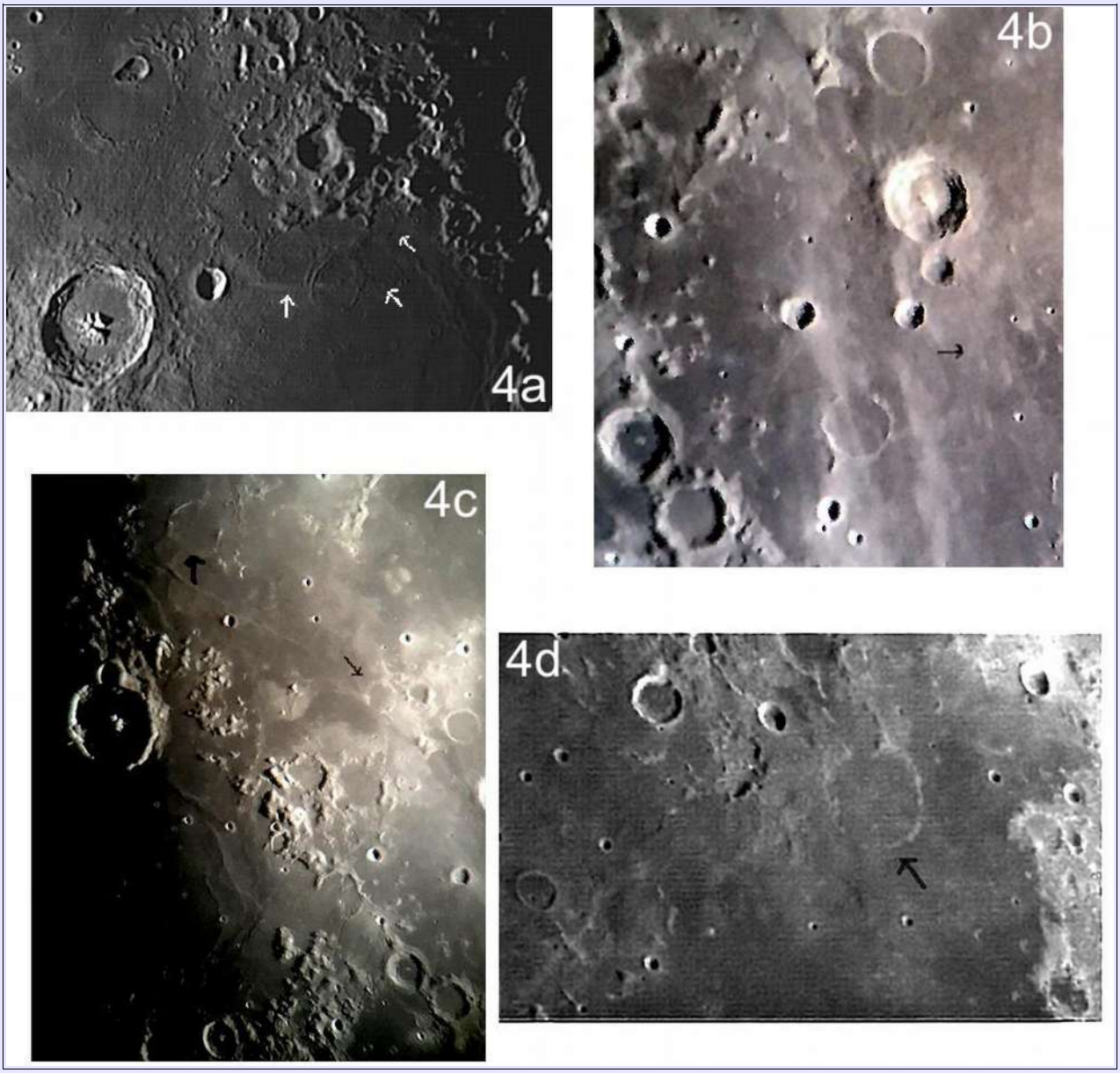

Figure 4. Images sent in by Jay Albert (ALPO) with arrows pointing to candidate buried/ghost craters. **4a** Ghost Craters Daguerre, Torricelli R taken on 2012-11-03. **4b** Bullialdus taken on 2020-04-04 UT 01:04. **4c** Gassendi taken on 2020-04-04 UT 01:56. **4d** Ghost crater D from Rukl 25 taken on 2014-09-02 UT 01:40.

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.

Tony Cook.

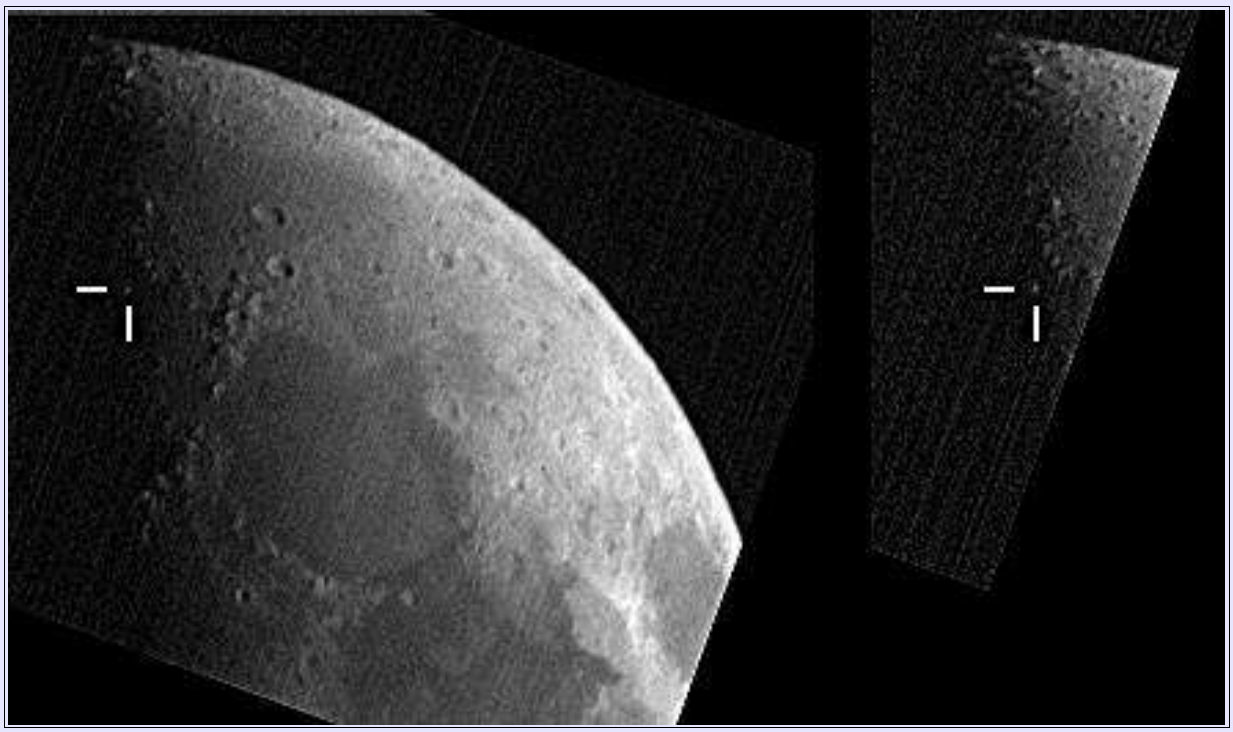

Figure 1. The Moon as imaged in part (1.5-1.7 microns – i.e., monochrome) of the Short-Wave IR waveband, by Tony Cook (BAA) taken on 2022 Aug 04 and orientated with north towards the top. These are both raw uncalibrated images (no dark current removal or flat fielding) however they have undergone separate contrast stretches to compensate manually for transparency variations between the two times and have also undergone sharpening. Note that the Xenics Bobcat SWIR camera used has a relatively small image size of 320x200 pixels. The tick marks show the location of Mons Piton. **(Left)** Taken at 19:29 UT. **(Right)** Taken at 19:40 UT.

TLP reports: One report was received from Trevor Smith concerning Mons Piton. We should not necessarily regard this as a TLP due to the Moon's very low altitude, but has been included here as it may explain some past TLP reports. On 2022 Aug 04 UT 19:41-20:10 BAA member, Trevor Smith (Codnor, UK), using a 16 inch Newtonian, x247, but under Antoniadi IV seeing conditions, found the mountain to be very bright, and further more red was seen around its eastern slopes. However an examination of the bright and contrasty Proclus crater revealed it to be relatively colour free compared to Piton. An additional examination of other features, north and south along the terminator (similar longitude to Mons Piton) revealed some tinges of colour, but not as strong as the red on Mons Piton. At 19:50 he examined the mountain with a yellow filter and found that it still showed red along the eastern side, other features along the terminator had no colour through this filter. Video images by myself (Newtown, UK) made earlier at 19:29 & 19:40 UT, (in the SWIR 1.5-1.7 microns) did not reveal Mons Pico as especially bright - but the resolution was poor. Uncalibrated images can be seen in Fig 1. A friend of Trevor's, phoned him up the next day to say that they had seen a mountain on the terminator exhibiting red on the 4th August – this is effectively an independent confirmation. Probably the redness can be explained by atmospheric spectral dispersion as the Moon was low, and strong colour was especially visible on Mons Piton as this is an exceedingly contrasty object on the terminator. Please do not read too much into the fact that the mountain was not bright in the SWIR camera images (Fig 1), as the wavelength being used was nearly 2.5x longer than in visible light, Rayleigh criteria resolution is nearly 2.5x worse than in the optical, and I still have to perfect image calibration – so you see raw images in Fig 1. In case you are wondering, why bother taking low resolution images at 1.5-1.7 microns, it is part of project to look for blackbody radiation from impacts on the dayside of the Moon.

Routine Reports received for August included: Jay Albert (Lake Worth, FL, USA – ALPO) observed: Adams, Agrippa, Aristarchus, Proclus, and Theophilus. Massimo Alessandro Bianchi (Italy – UAI) observed: Torricelli B. Francisco Alsina Cardinali (Argentina – SLA) imaged: Campanus and Mons Piton. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Fracastorius and several features. Anthony Cook (Newtown, UK – ALPO/BAA) imaged: several features in the Short-Wave IR (1.5-1.7 microns) and the Long Wave IR (7.5-15 microns). Walter Elias (AEA) imaged: Alpetragius, Alphonsus, Hercules, Maskelyne, Montes

Apenninus, and Plato. Trevor Smith (Codnor, UK – BAA) observed Mons Piton. Bob Stuart (Rhayader, UK – BAA) imaged: Atlas, Langrenus, Petavius, Snellius, Timaeus and Vendelinus. Franco Taccogna (Italy - UAI) imaged: Lassell, Montes Teneriffe and Plato. Aldo Tonon (Italy – UAI) imaged: Aristarchus and Descartes. Fabio Verza (Italy – UAI) imaged: Aristarchus. Ivan Walton (UK – BAA) imaged the lunar crescent. Luigi Zanatta (Italy – UAI) imaged: Aristarchus.

Analysis of Reports Received:

Aristarchus (the following is a report from July that got delayed): On 2022 Jul 12 UT 23:01 Walter Elias (AEA) imaged the crater under similar illumination to the following two TLP reports:

Aristarchus 1950 Jun 29 UT 05:20-05:41 Observed by Bartlett (Baltimore, MD, USA, 3.5" reflector x100, S=6, T=5) "Strong bluish glare on E..SE wall." NASA catalog weight=4. NASA catalog ID #529. ALPO/BAA weight=2.

Aristarchus 1973 Apr 16 UT 23:45 Observer Schlegel (52.5N, 9E) equipped with a 60 mm refractor, noticed that Aristarchus was extraordinarily bright. ALPO/BAA weight=1.

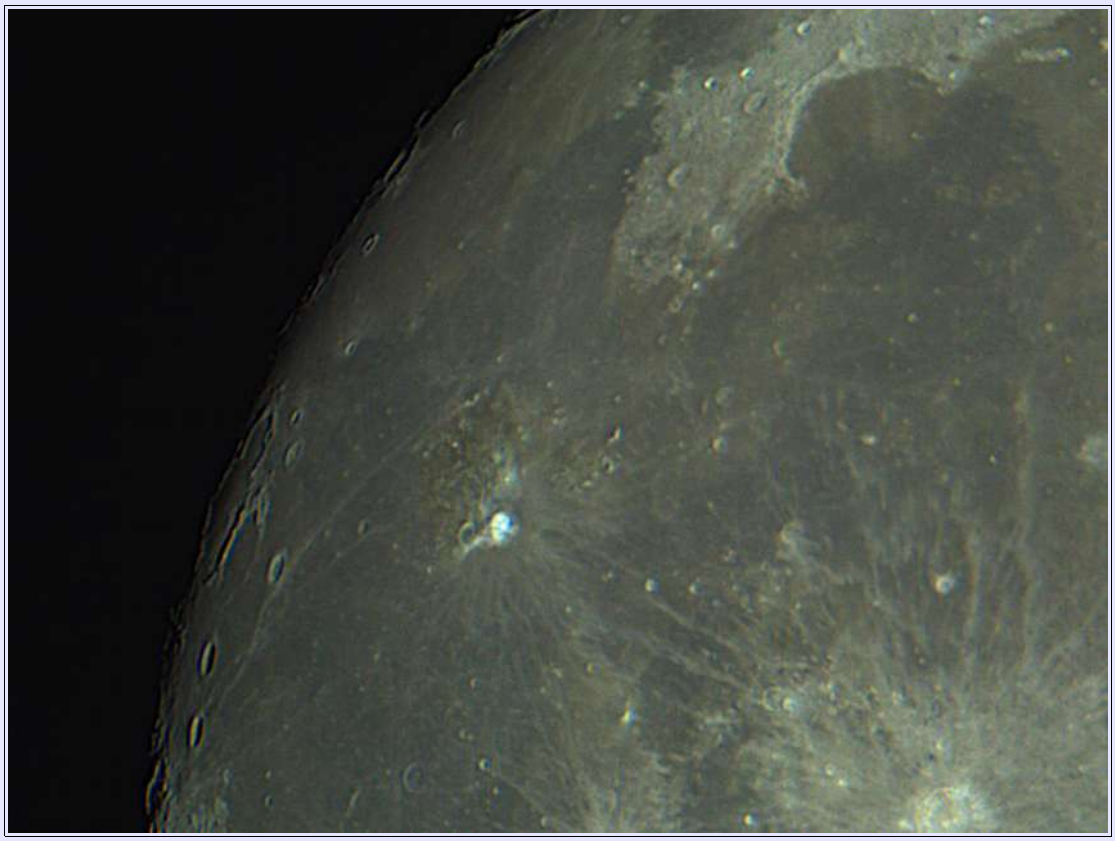

Figure 2. Aristarchus as imaged in colour by Walter Elias (AEA) on 2022 Jul 12 UT 23:01 and orientated with north towards the top. Colour saturation increased slightly.

Concerning the Bartlett report, we can clearly see (Fig 2) some blue glare on the E-SE wall. It maybe natural colour but it could also be atmospheric spectral dispersion as in Walter's image or a similar effect from Chromatic Aberration for the refractor that Bartlett used. We shall lower the weight from 2 to 1. Now moving onto the 1970 report, Aristarchus does indeed look somewhat bright, and to an inexperienced observer perhaps exceedingly bright. We shall therefore lower the weight from 1 to 0 and remove it from the TLP database.

Janssen: On 2022 Aug 02 UT 06:09-06:12 Maurice Collins (ALPO/BAA/RASNZ) imaged the whole Moon, but at sufficient resolution to examine this crater at similar illumination to the following report:

On 1983 Sep 11 at UT 23:52 K.P. Marshall (Columbia, 12" reflector, x268, seeing II), whilst sketching the crater Janssen noticed a tenuous red patch on the southern junction of the valley which joins Fabricius to A. Nothing resembling this found on nearby areas. The ALPO/BAA weight=2.

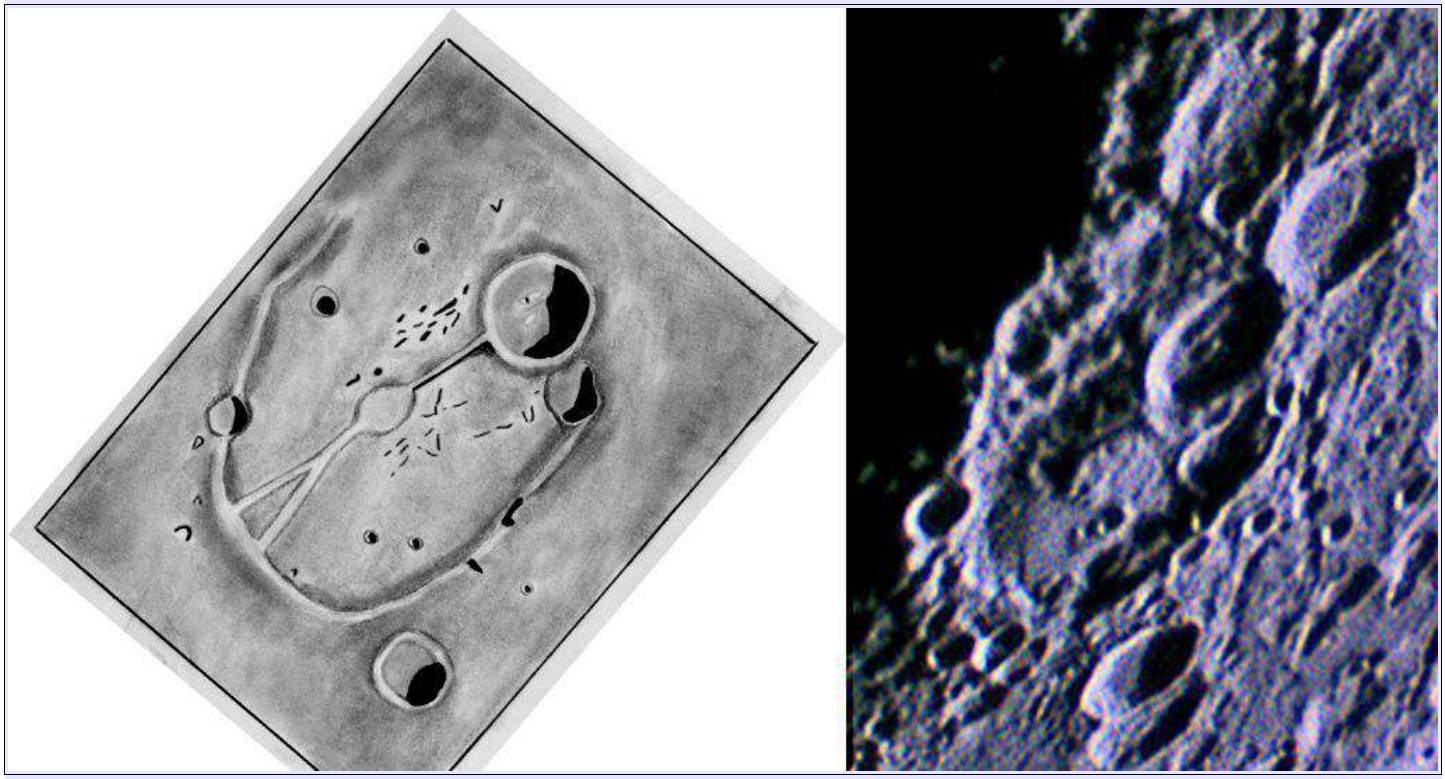

Figure 3. Janssen crater with Fabricius on its NE floor interior. Janssen A is located just south of Fabricius. Orientated with north towards the top. **(Left)** A sketch by Kevin P. Marshall (BAA) made on 1983 Sep 11 UT 23:53. **(Right)** A colour image by Maurice Collins (ALPO/BAA/RASNZ) taken on 2022 Aug 02 UT 06:09-06:12 with colour saturation increased to 70%.

In comparing Kevin Marshall's drawing to Maurice Collins' image (Fig 3), there appears to be quite a few inconsistencies in terms of crater sizes and amounts of shadow. One can speculate that the former could have been due to inexperience at sketching as the observer had only started submitting observations the BAA the year before. It is after all quite a complex crater to sketch for a beginner. The latter might be due to having the wrong date and/or UT as sometimes happens with observations away from the Greenwich meridian. Maurice's image, despite being colour enhanced, shows no sign of colour between Fabricius and Janssen A, which is interesting. Nevertheless the sketch inconsistencies suggests that we should lower the weight from 2 to 1 as a precaution.

Adams D: On 2022 Aug 05 UT 01:40-01:55 Jay Albert observed this crater under similar illumination to the following report:

Adams D On 2019 Sep 06 UT 21:44-22:20 T. Smith (near Great Yarmouth, UK, 90 mm Maksutov, x80, Seeing IV) saw a very bright spot on the SW. rim of Adams D - at first sight looked perhaps raised above the lunar background, but this was just due to its brightness. It was by far the brightest object on the NW quadrant of the Moon. In terms of brightness it was almost but not quite bright as Proclus, but only half the size of Proclus. No colour was seen to the spot. The spot was not emitting any false colour, there was no change in appearance, and there was no ray structure visible either. Observations ceased when the Moon got too low. ALPO/BAA weight=1.

Jay was using a Celestron NexStar Evolution 8" SCT (x226) with the Moon high up in the sky. The sky was initially mostly clear and slightly hazy, but thin cirrus clouds soon moved in with an increase in haze.

Transparency was initially 3rd magnitude but shortly dropped to 2nd magnitude and seeing was 7-8/10.

Jay noticed easily the very bright spot in the TLP description on the S rim of the crater. It was very bright indeed and quite comparable to the north wall of Proclus. He was able to confirm visually that the spot was the brightest object near the rim of that SE region of lunar disk. As Jay has now confirmed this normal appearance, we can assign a weight of 0 and remove the TLP from the ALPO/BAA database.

Plato: On 2022 Aug 05 Franco Taccogna (UAI) attempted the following Lunar Schedule request:

BAA Request: It has been noticed that a bright carterlet can appear very suddenly on the floor of Plato in between needle like shadows, during local lunar sunrise. This happens in the space of just a minute or so, and can look really quite dramatic. This effect was first spotted by Brian Halls on 2014 Oct 31 Please send any high resolution images, detailed sketches, or visual descriptions to: a t c @ a b e r . a c. u k .

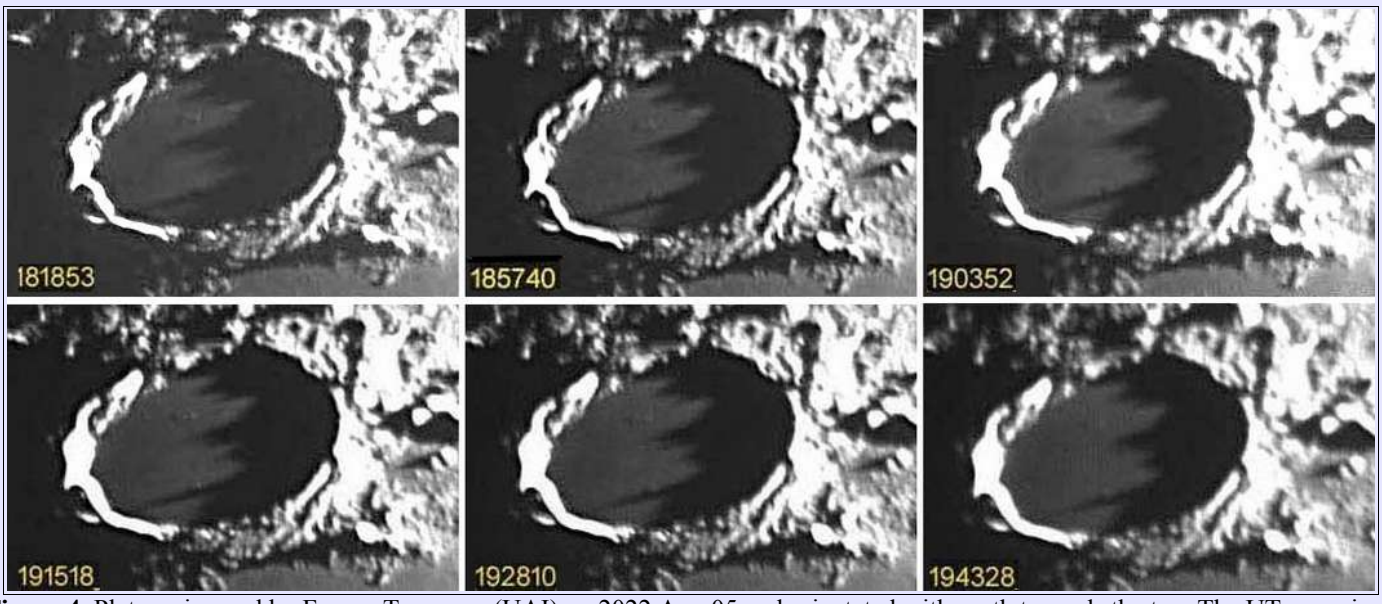

Figure 4. Plato as imaged by Franco Taccogna (UAI) on 2022 Aug 05 and orientated with north towards the top. The UTs are given in each image as a yellow number: hhmmss

It is interesting that the southern craterlet that emerges from the southern shadow spire, seems to be at its brightest at 19:15:18 UT but has faded a bit at about 19:43:28 UT – however this maybe seeing related. Franco included some LTVT simulated shadow plots (not shown here) by Aldo Tonon and Bruno Cantarella, which agreed with the shadow locations in the images very well.

Maskelyne: On 2022 Aug 05 UT 23:15 Walter Elias (AEA) imaged this crater under similar illumination to the following report:

2 deg S of Maskelyne (29E, 1N) 1969 May 25 UT 01:15-01:56 Observed by Jean, Barry, Bernie, (2) Madison (Montreal, Canada, USA, 4" refractor)"Very vis. pink patch red as seen thru a yellow filter. Photo of bright red spot nr. Mask. (confirm. -- Apollo 10 watch)" NASA catalog weight=5. NASA catalog ID #1145. ALPO/BAA weight=3.

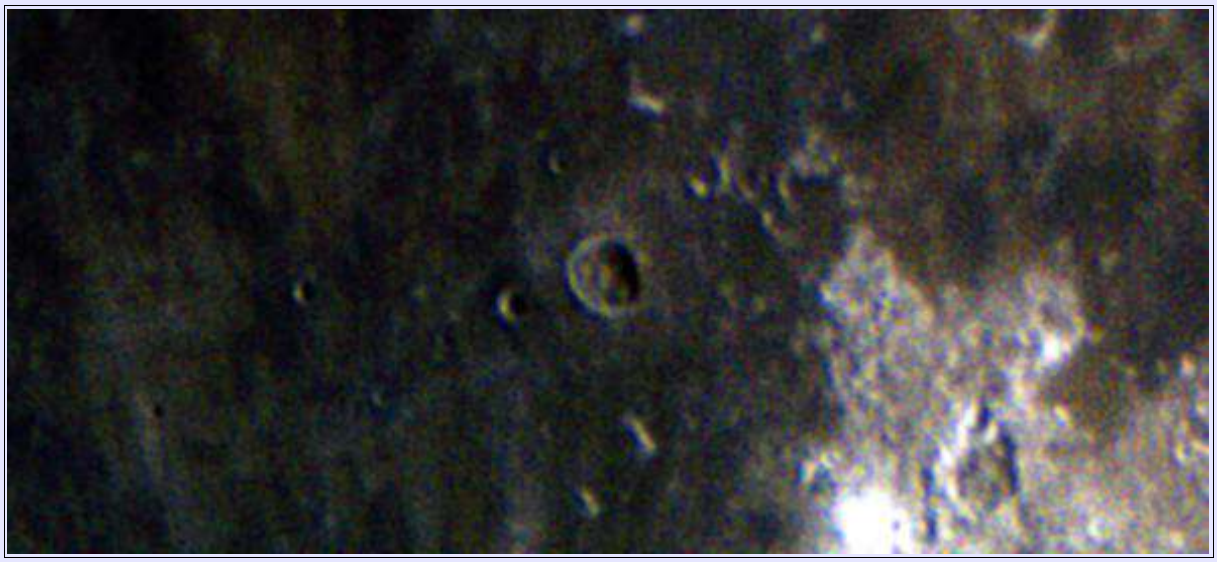

Figure 5. Maskelyne as imaged by Walter Elias (AEA) on 2022 Aug 05 UT 23:15 and orientated with north towards the top. The image has been cut out from a larger image, colour normalized, had it colour saturation increased to 80%, then Gaussian blurred to remove some noise.

If there was any pink or red spot due to lunar minerals then it should show up near the centre of the bottom edge of Fig 5. However, all we see here are a couple of elongated mountain peaks. Normally the Jean TLP reports are given low weights in the Cameron catalog as there was deemed to be a quality issue, however Cameron gives a weight of 5 as independent observers were involved and a photograph is mentioned. Alas we do not have a copy of the photograph in our archives. Looking at the scanned copies of the Cameron catalog cards, it mentions that the TLP was during the Apollo 10 mission watch by amateur astronomers (though only Jean's name is mentioned) and the TLP call came through to the Smithsonian, who were a communication hub for TLP reports in those days. As a precaution the ALPO/BAA weight is set at a level of 3 and we will keep this for now.

Campanus: On 2022 Aug 08 UT 00:22 Francisco Alsina Cardinali (SLA) imaged this crater under similar illumination to the following report:

Campanus 2014 Jan 11 UT 22:00-22:30 S.Bush (UK, 6" SCT, x180, seeing average) made a sketch of the Campanus and Mercator craters. He found that the central peak of Campanus difficult to resolve and the floors of both craters were devoid of detail. Mercator was the lighter shade of the two floors. Earlier at 19:47 UT M.Brown (Huntingdon, UK) imaged this region and using Registax resolved details on the floors of both craters, though Mercator clearly was slightly lighter in floor shade and had less detail on its floor than Campanus. The most likely explanation was that it was just seeing effects blocking the visibility of detail - this of course is less of a problem for a Registax used on the CCD image. However just to be sure this observation is being given an ALPO/BAA TLP weight of 1, to encourage visual observers to attempt this observation under similar illumination and seeing.

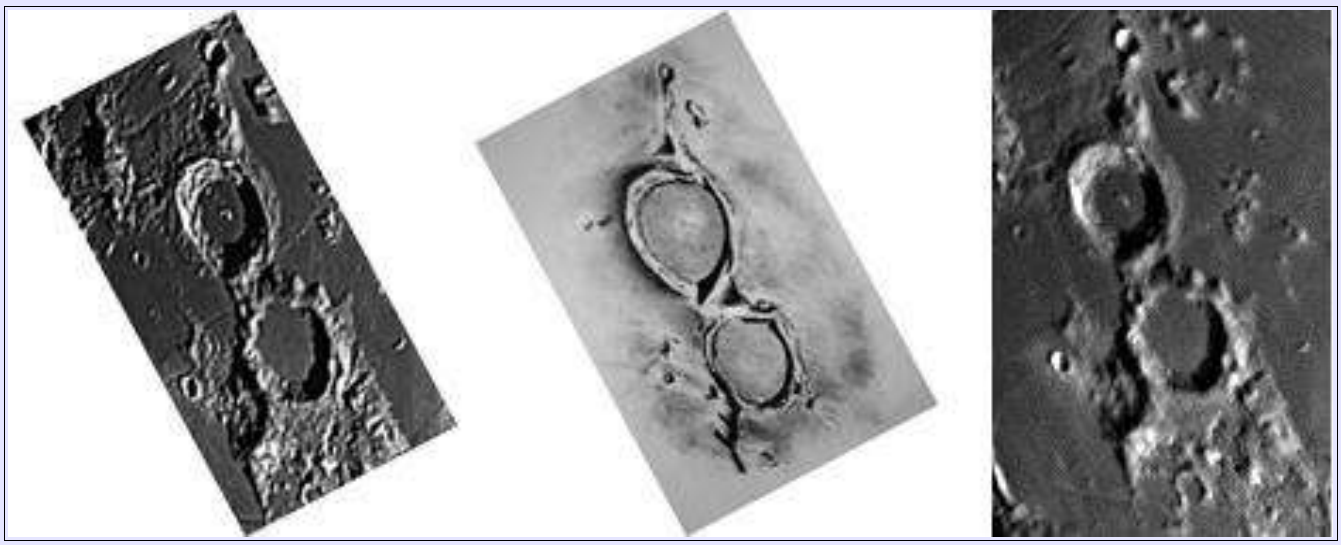

Figure 6. Campanus and Mercator with north towards the top. **(Left)** An image by Mike Brown (BAA) taken on 2014 Jan 11 UT 19:47. **(Centre)** A Sketch by Steve Bush made on 2014 Jan 11 UT 22:00-22:30**. (Right)** An image by Francisco Alsina Cardinali (SLA) made on 2022 Aug 08 UT 00:22.

Francisco's image (Fig 6 – Right) is interesting as the central peak is slightly less visible (due to resolution) than Mike Brown's image (Fig 6 – Left). This adds some weight to the theory that the Steve Bush TLP report may have had something to do with image resolution and atmospheric conditions at the time. I note that in Steve's sketch, although geometrically correct with most detail, the shadows are not as thick as they are in the images. Could this infer a date error? What we really need are some visual observations under different seeing conditions on the predicted day and a day later to test these theories out. For now, we shall leave the weight at 1.

Aristarchus: On 2022 Aug 08 UAI observers. Fabio Verza and Luigi Zanatta, imaged this crater for the following lunar schedule request:

ALPO Request: On 2013 Apr 22 Paul Zellor noticed that the two closely spaced NW dark bands in Aristarchus had some (non-blue) colour to them. Can we confirm his observation of natural colour here? Ideally you should be using a telescope of 10" aperture or larger.
Please send any high resolution colour images, detailed sketches, or visual descriptions to:
a t c @ a b e r . a c. u k .

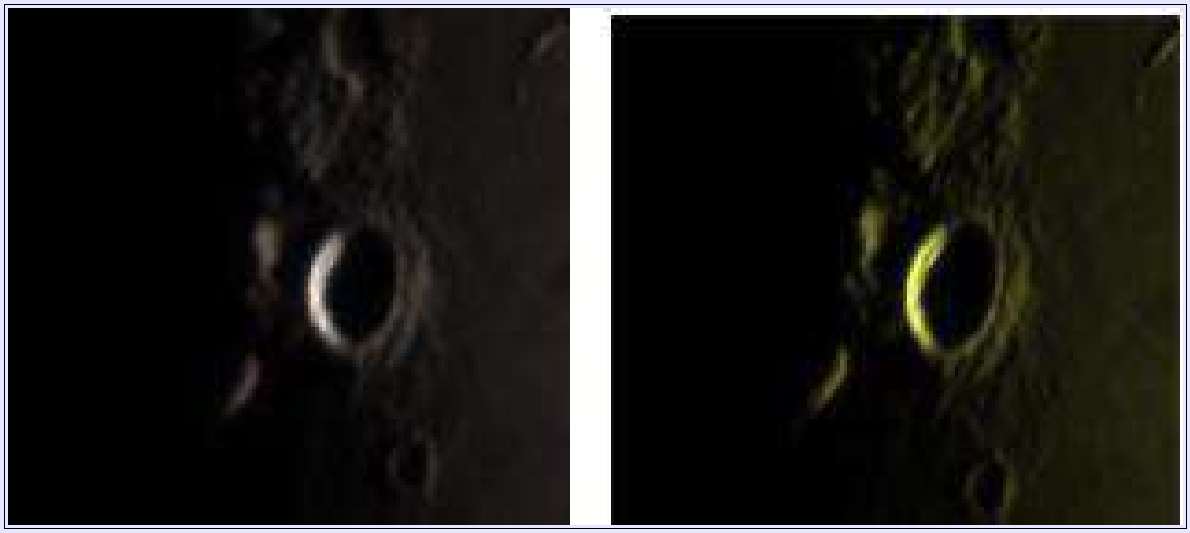

Figure 7. Aristarchus as imaged in colour on 2022 Aug 08 and orientated with north towards the top. (Left) Taken Luigi Zanatta at 20:29UT. (Right) Taken by Fabio Verza at 20:32 UT.

Neither images (Fig 7) show a couple of dark banks on the NW, nor any colour in that region, Fabio's image has a slight yellow cast to the whole crater and surrounds – this appears to be because the start level on the blue channel is above the shadow background, unlike the red and the green channels which show the full blackness of the shadows. In view of the fact that we cannot see what Paul Zellor saw, we shall leave the weight at 1 for now.

Torricelli B: On 2022 Aug 10 UT 20:50-21:11 Massimo Alessandro Bianchi observed visually this crater according to the following lunar schedule request and repeat illumination predictions for:

ALPO Request: How well can you see this crater in red and blue light? If possible, use Wratten 25 and 38A filters. If you do notice the crater is more difficult to see in one filter than the other, could it be because one filter is denser than the other? Check this out on other filters too to verify this idea. Email any visual descriptions, sketches, or images to: t o n y . c o o k @ a l p o - a s t r o n o m y . o r g

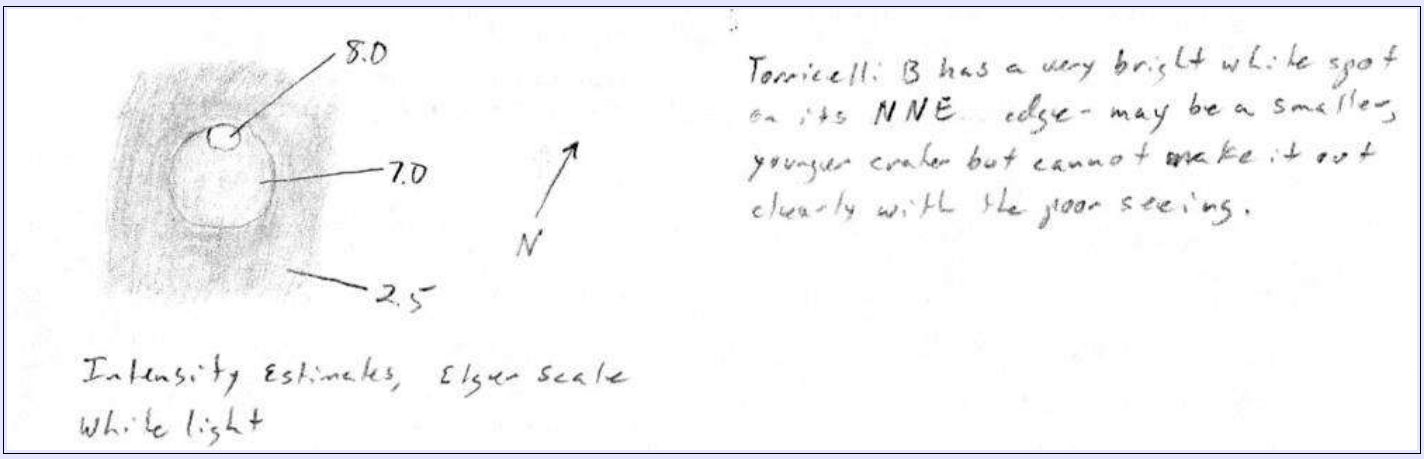

Figure 8. A sketch of Torricelli B made by Robin Gray (ALPO) on 2002 Sep 20 UT 05:30-07:20.

This actually refers to a TLP report from 2002 Sep 20 (See Fig 8 for the original sketch), but which we had taken off the TLP list and put on the lunar schedule list to check out: *"On 2002 Sep 20 Robin Gray (Winnemucca, NV, USA) found Torricelli B to be more difficult to see through a blue Wratten 38A filter than through a red Wratten 25 filter. This effect though might have had more to do with respective filter densities rather than an actual TLP. The ALPO/BAA weight=0."*

Massimo was using a Vixen VMC 260L Mak-Cass. 260 mm f/11.5 - Mag. 428x - Seeing III – Transparency 5th magnitude, but the sky had some cloud. Observing in white light and with Meade 4000 filter set: Red 25A, Dark Blue 38A, Green 58 and Yellow 12. By switching views through the red and blue filters the crater appeared darker in the dark blue filter. This was undoubtedly due to the filter being denser as it affected other features too. Massimo then co pared Torricelli B to Moltke in red, blue, green and yellow filters: *"I noticed that with the dark blue filter alone **Torricelli B** appeared noticeably less bright than **Moltke**, while with the other filters the difference in brightness between the two craters was much less noticeable, perhaps only a little more pronounced with the red filter than with the yellow and green"*.

I think that we can take this off the lunar schedule website now as the effect repeated.

Plato: On 2022 Aug 14 UT 04:21 Bob Stuart (BAA) imaged Timaeus, but the frame included Plato. This was just 3 min outside the observing window for ±1.0° similar illumination and topocentric libration for the following report:

On 1975 Feb 27 at UT21:26-23:32 P.W. Foley (Wilmington, Dartford, Kent, U.K., 12" reflector) picked up a colour Moonblink blink (brighter in blue) in Plato crater at 21:36, 22:15 and 23:32UT extended from 11 - 3 o'clock along entire area inside the crater - the effect was particularly diffuse

and obscure, despite the surrounding localities being sharp. The effect was seen visually and was continuous. A check was made on star images and these were found to be very sharp and not pulsating, thus indicating good atmospheric conditions. This is a BAA Lunar Section report. The ALPO/BAA weight=3.

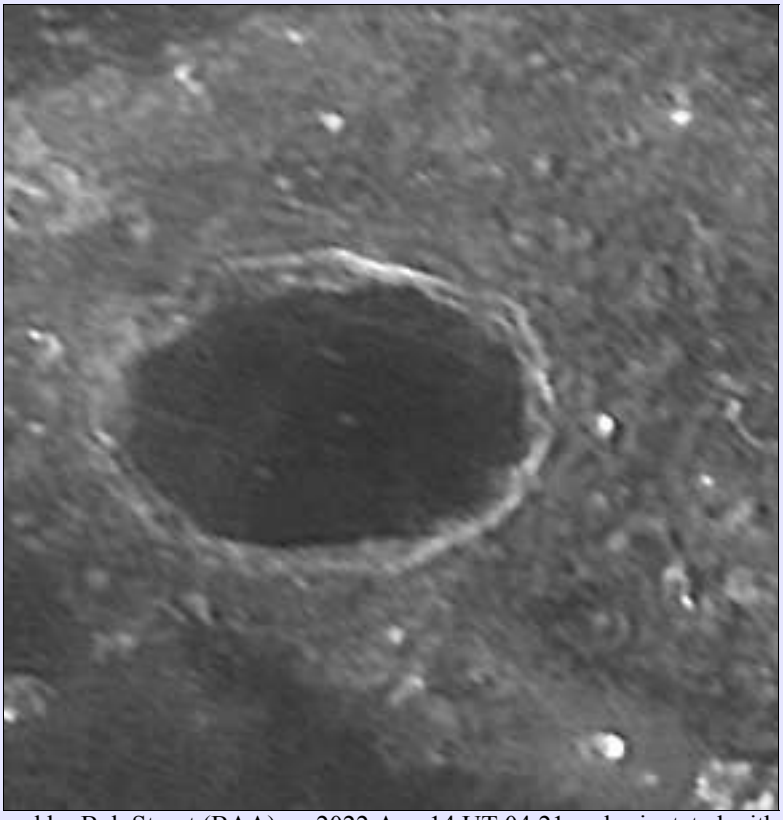

Figure 9. Plato as imaged by Bob Stuart (BAA) on 2022 Aug 14 UT 04:21 and orientated with north towards the top.

The location of Foley's reported TLP (he used coordinates with north at the bottom) would have been along the inner southern rim. Although Bob's image (Fig 9) is in monochrome and in yellow light rather than blue, this is what Plato would normally have looked like on the night that Foley observed. Note that there is a dark line on the floor just inside the southern rim, but being a monochrome image, there is no way to know if this would have been dark in blue light as well. As Foley checked star images for atmospheric spectral dispersion, and used a Moon Blink device (this can eliminate the effects of atmospheric spectral dispersion), we shall keep the weight at 3 for now.

Earthshine: On 2022 Aug 25 Ivan Walton (BAA) imaged the crescent Moon under twilight conditions to cover the following Lunar Schedule request:

BAA Request: Please try to image the Moon as a very thin crescent, trying to detect Earthshine. A good telephoto lens will do on a DSLR, or a camera on a small scope. We are attempting to monitor the brightness of the edge of the earthshine limb in order to follow up a project suggested by Dr Martin Hoffmann at the 2017 EPSC Conference in Riga, Latvia. This is quite a challenging project due to the sky brightness and the low altitude of the Moon. Please be very careful around sunrise so as not to be observing once the Sun has risen. Do not bother observing if the sky conditions are hazy. Any images should be emailed to: a t c @ a b e r . a c . u k

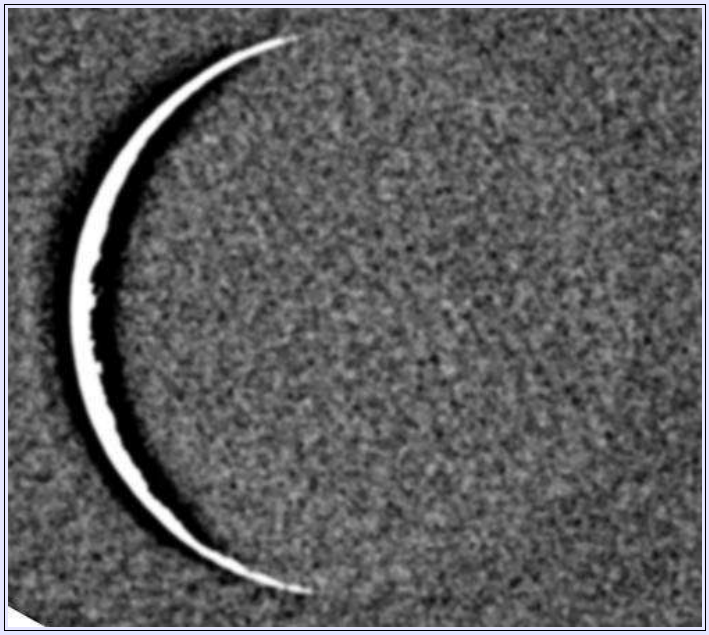

Figure 10. Earthshine as imaged by Ivan Walton (BAA) on 2022 Aug 25 UT 05:44. This has been significantly contrast stretched and then Guassian blurred to bring out the earthshine. North is towards the top.

Although Fig 10 is somewhat noisy as it was really geared in exposure to show detail on the crescent, you can see the limb of the Moon. If you blur your eyes the eastern limb does have a slightly bright band around it, but I think this is too thick to be the effect that Prof Hoffmann was interested in and it is probably noise related or something to do with the processing by the camera as is evident by the ringing effect on the bright limb.

General Information: For repeat illumination (and a few repeat libration) observations for the coming month - these can be found on the following web site: http://users.aber.ac.uk/atc/lunar_schedule.htm . By re-observing and submitting your observations, only this way can we fully resolve past observational puzzles. To keep yourself busy on cloudy nights, why not try "Spot the Difference" between spacecraft imagery taken on different dates? This can be found on: http://users.aber.ac.uk/atc/tlp/spot_the_difference.htm . If in the unlikely event you do ever see a TLP, firstly read the TLP checklist on http://users.aber.ac.uk/atc/alpo/ltp.htm , and if this does not explain what you are seeing, please give me a call on my cell phone: +44 (0)798 505 5681 and I will alert other observers. Note when telephoning from outside the UK you must not use the (0). When phoning from within the UK please do not use the +44! Twitter TLP alerts can be accessed on https://twitter.com/lunarnaut .

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

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BAA LUNAR SECTION CONTACTS:

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