Director: Bill Leatherbarrow

LUNAR SECTION CIRCULAR

Vol. 56 No. 11 November 2019

FROM THE DIRECTOR

Since my return from the USA I have had no favourable opportunities to observe the Moon. On the rare clear nights the Moon has been frustratingly low in British skies. If there is a bright side to this situation it lies in the chance it affords to catch up with some reading. Two books on matters relating to the Moon have particularly caught my interest: Oliver Morton's widely reviewed work *The Moon: a History for the Future* (London: Economist Books, 2019) and Derek W. G. Sears biographical study *Gerard P. Kuiper and the Rise of Modern Planetary Science* (Tucson: University of Arizona Press, 2019). Morton's book has been widely praised for the judicious way it balances scientific and cultural approaches to the history of humankind's relationship with our satellite. It is a thoughtful and imaginative contribution to lunar literature. Sears's study is the first book-length biography of the father of modern solar system science, and it pays much attention to Kuiper's pioneering efforts in professional lunar cartography and his role in establishing the Lunar and Planetary Laboratory at the University of Arizona. It is a great story and one that has a particular resonance for the Lunar Section of the BAA, since past members Ewen Whitaker, D. W. G. Arthur and Alan Lenham were among the first recruits to Kuiper's team. Both books are highly recommended, although it is unfortunate that despite the key role played by Whitaker in Sear's account, his name is inexplicably missing from the index.

On the matter of oversights, I must apologise for the error in the time attributed to Bob Stuart's Messier image on page 7 of the last LSC. This was given as 10.12 UT, whereas it should of course be 01.12 UT.

Later in this issue you will find a contribution from our Lunar Domes Coordinator Raf Lena, describing a suspected dome in the Sinus Iridum/Promontorium Laplace area. There is an urgent need for confirmatory images of this feature, and I would urge Section members to pay particular attention to the region over the coming lunations.

Maurice Collins's Moon Science website has been relaunched at a new address: https://mauricejscollins.wixsite.com/moonscience

Maurice comments that he has tried to bring back some of the content of the old site and has included the 3D Moon rock images and LROC WAC images. He may update it from time to time and hopes that we find it useful

Finally, may I remind readers about our other Lunar Section publication, *The Moon: Occasional Papers*. This is intended to be a publication outlet that fills the gap between the LSC and the BAA Journal. So if you are considering writing something that is perhaps too long for inclusion in the LSC, but not suitable for a Journal paper, do consider submission to *The Moon: Occasional Papers.* Past issues are available for inspection and download from the Section website at:

https://britastro.org/downloads/10024

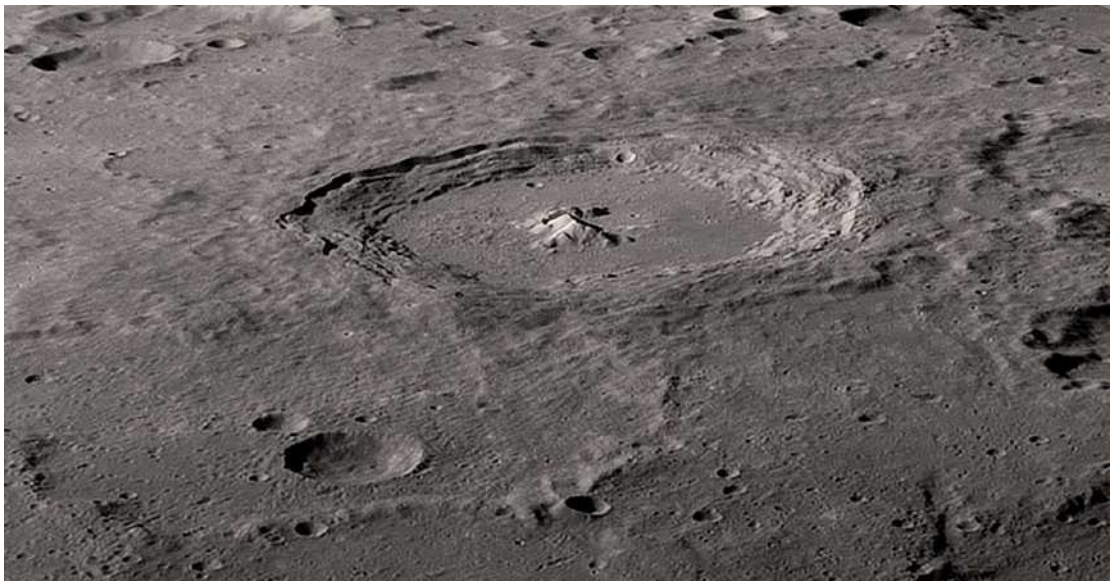
Bill Leatherbarrow

OBSERVATIONS RECEIVED

Since the last issue observations have been received from the following members:

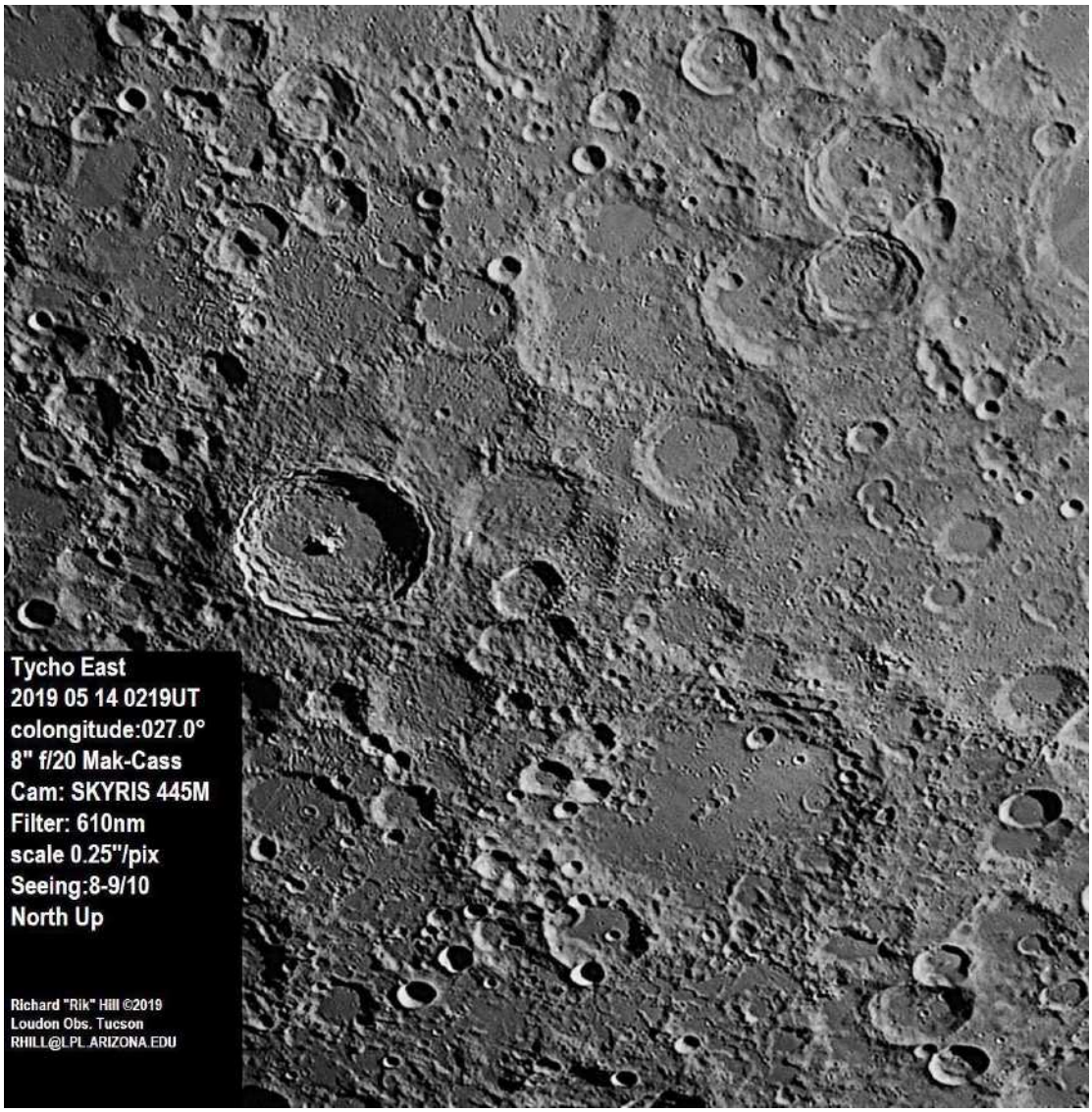
Leo Aerts (Belgium), Peter Anderson (Australia), Maurice Collins (New Zealand), Dave Finnigan, Rik Hill (USA), Ken Kennedy, Rod Lyon, Mark Radice, and Bob Stuart.

Leo Aerts has sent in the following outstanding study of the crater Pythagoras, using a C14 on the early morning of 22 September 2019:



Leo suggests, quite reasonably, that for this image he might have been working close to the limits of the C14's resolving power. Now, there's a challenge for C14 owners!

Rik Hill observed the area around Tycho on 14 May 2019 and has just submitted the following image and notes:

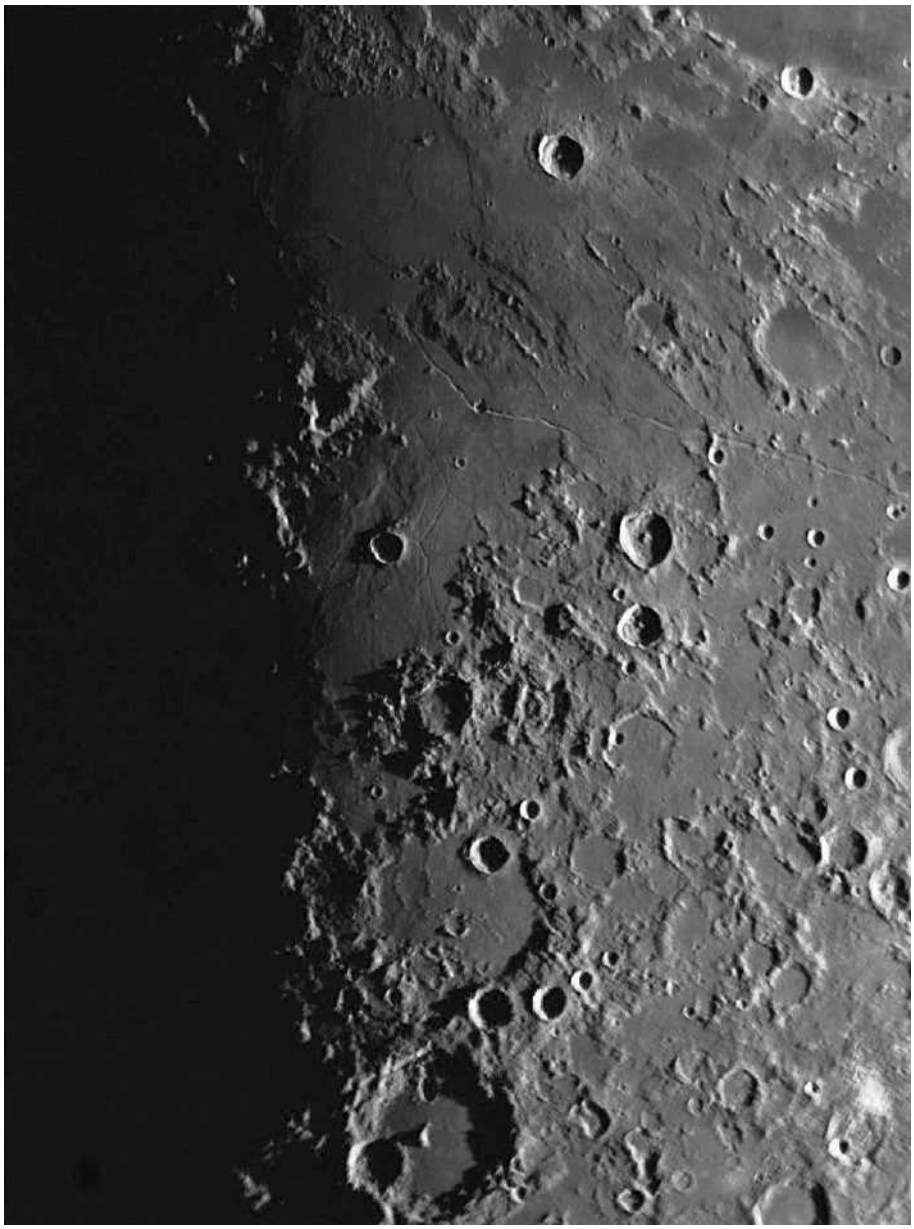


The area around Tycho is so busy that you have to study it in pieces. Here we start at Tycho (88km dia.) on left of center and look to the east (right). One of the first things we run into is below and east of Tycho and is the largest named crater in this image. Maginus (168km) is an oft overlooked crater lying between the spectacular Tycho and magnificent Clavius (just off the southern edge of this image). Between Tycho and Maginus is the crater Street (60km). Then below and to the right of Maginus is a sideways Mickey Mouse formed by three craters. The larger crater in this trio is Deluc (49km). From Tycho going east we see Pictet (65km) almost adjacent and further is Saussure (56km) with an interesting flat bottom. Above this last crater is another large one, Orontius (126km), with a triplet of craters just east of it. These are in order, Huggins (66km), Nasireddin (54km) and above it Miller (77km). Notice the central peak in this last crater and the material flooded into the southern floor up to that peak. Nasireddin has some nice terraced walls to enjoy and a curious merge of three craters just outside the southeastern wall. But by far the most interesting terraced walls are in

the crater due north of Tycho near the top edge of this image. This is Ball (43km) on the southern edge of Deslandres, just outside the northern edge of this image.

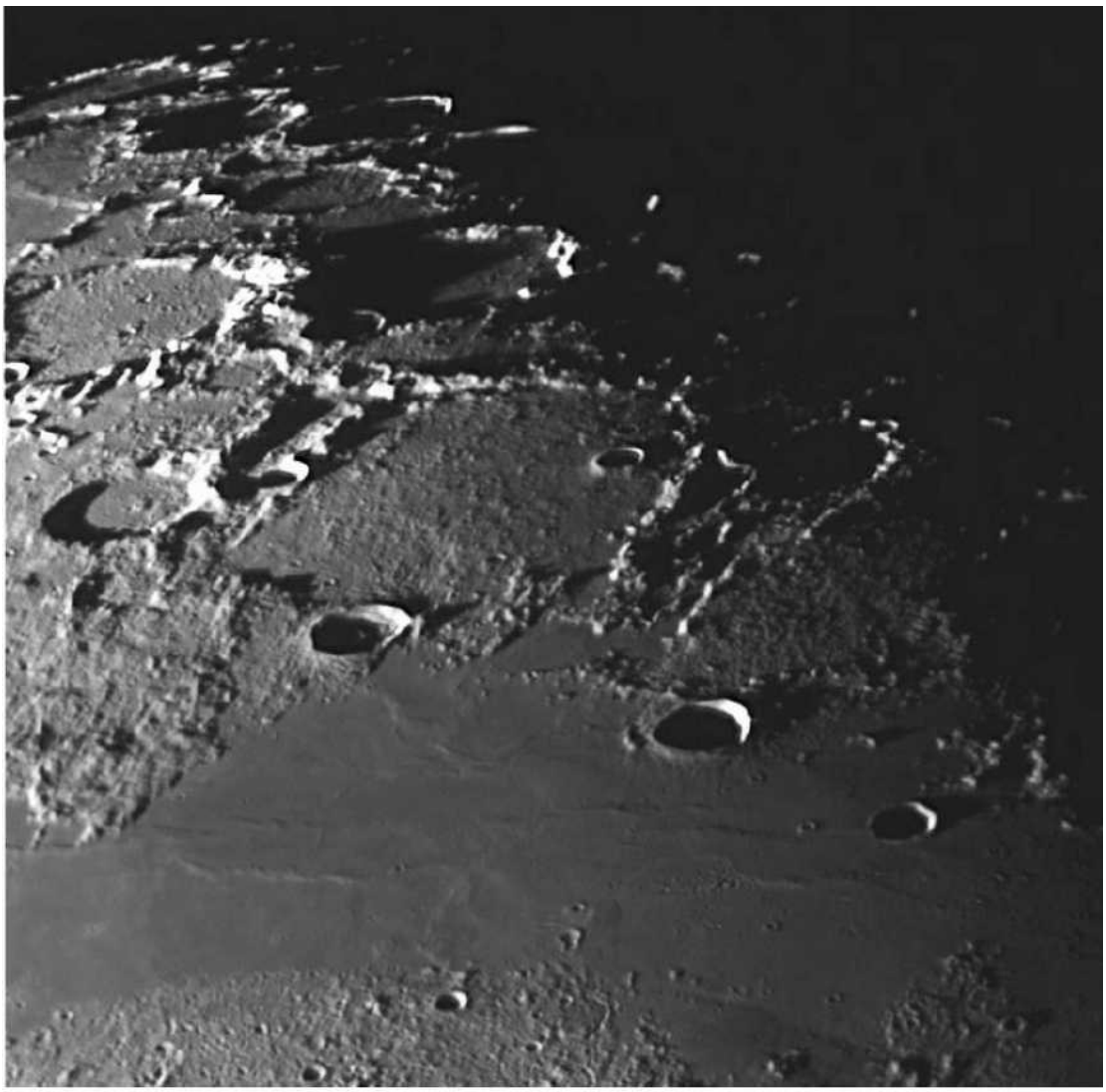
Notice over this whole image there is a splattering of secondary craters from 5km diameter on down beyond the resolution limit of this image (about 1.5km). Many of these were created in the Tycho impact around 100 million years ago, while most the rest of the large craters in this image range from 3.8-4.5 billion years in age. Many of the secondary craters form alignments or streams pointing back at Tycho like the horizontal one in the middle of the image and the one radiating away from Tycho at about 10 o'clock. The more you look, the more you'll see.

Ken Kennedy is a past-Director of the BAA Aurora Section and was an active member of the Lunar Section back in the 1970s. He has returned to lunar imaging using his 8-inch SCT, and we feature here his fine image of the Hyginus and Triesnecker region, captured on 11 May 2019.

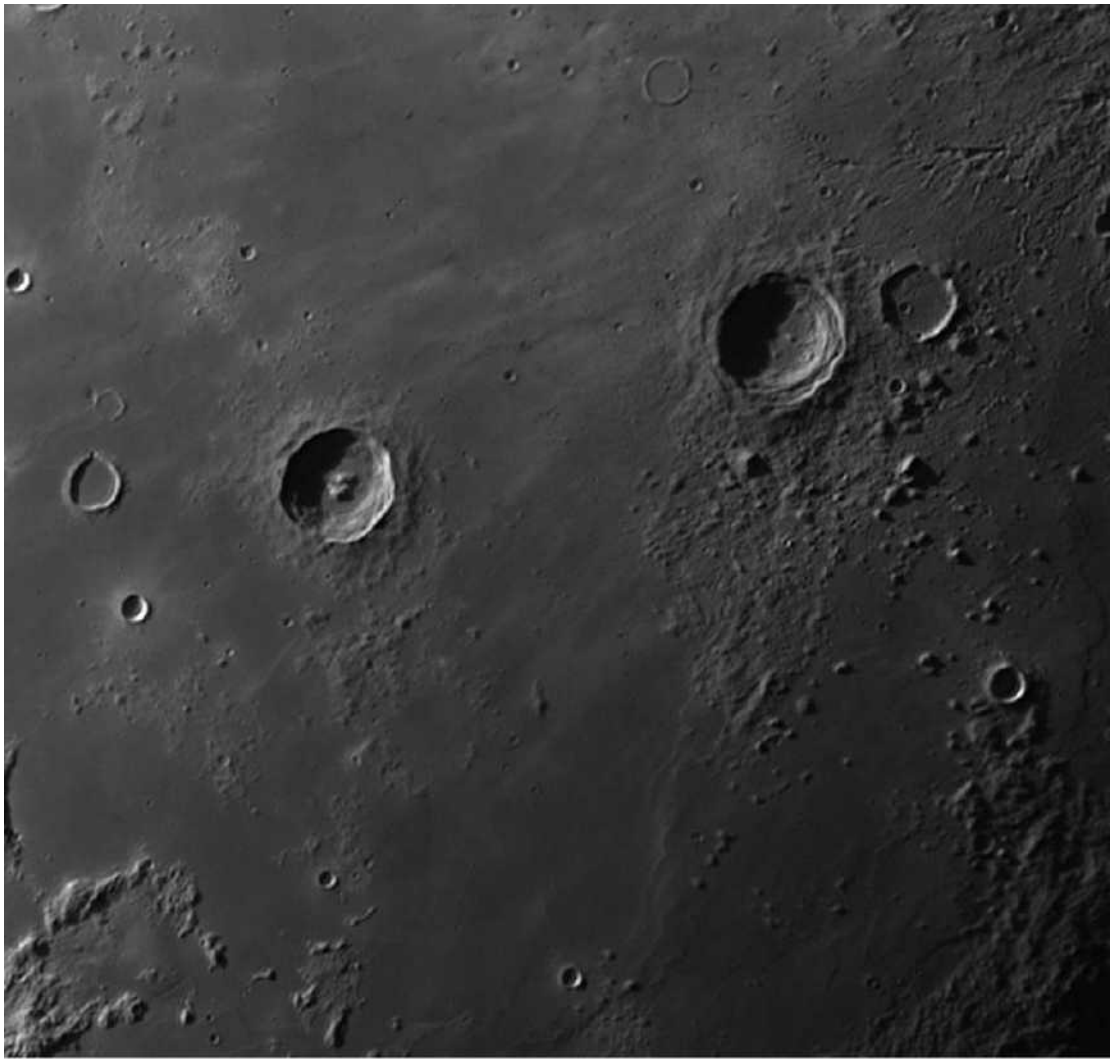


Rod Lyon managed a series of fine images under good seeing conditions on the mornings of 20 and 22 October 2019. He was using a 12-inch SCT and the highly regarded ZWO ASI224MC planetary camera. This is a colour sensor, but it also functions as a very sensitive mono camera when used with a red or near-IR pass filter.

Here are two of Rod's images:

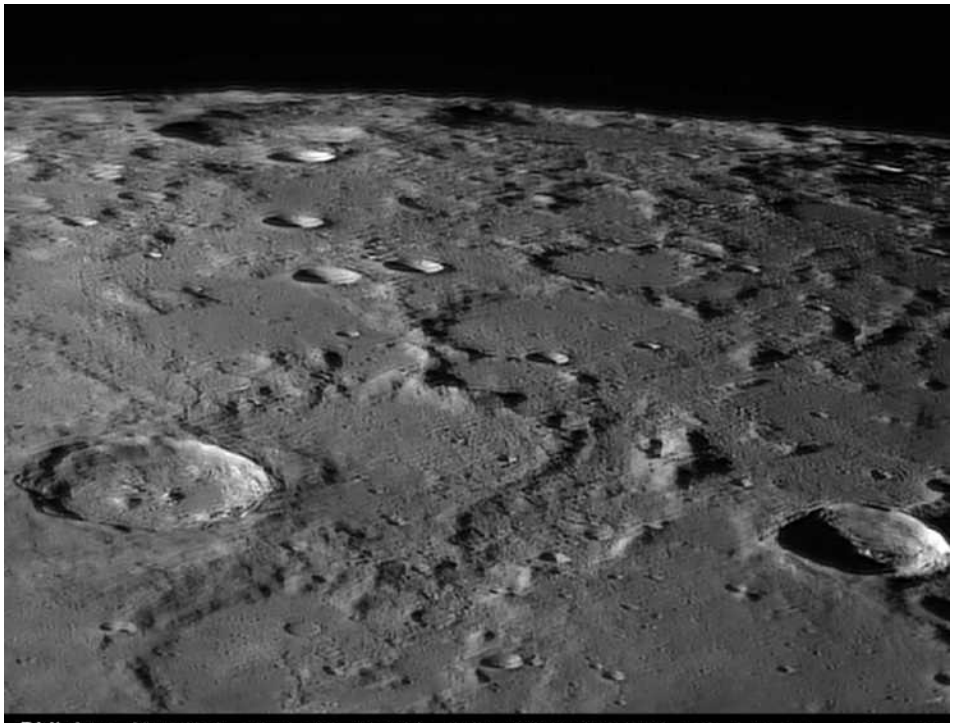


W. Bond at sunset 2019.10.20 - 07.40 UT
300mm Meade LX90, ASI 224MC Camera, with Pro Planet
742nm I-R Pass Filter. 1,000/5,000 Frames. Seeing: 7/10

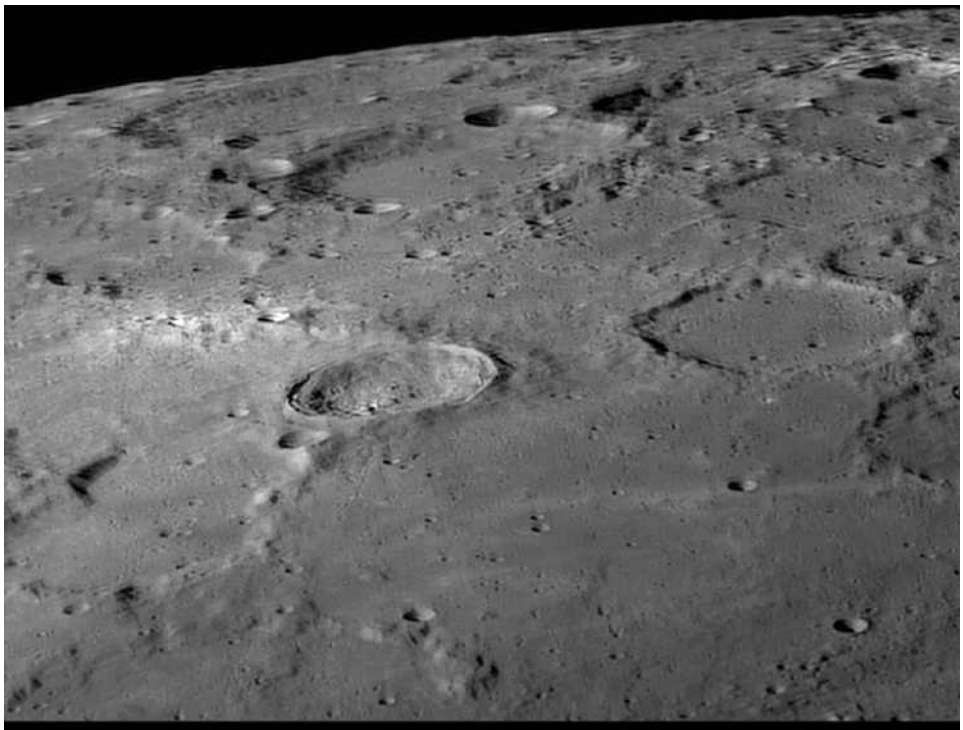


Reinhold & Lansberg 2019.10.22 - 06.48 UT
300mm Meade LX90, ASI 224MC Camera, with Pro Planet
742nm I-R Pass Filter. 1,000/5,000 Frames. Seeing: 8/10.

A combination of good seeing and favourable libration allowed **Dave Finnigan** to take some excellent images of the Moon's northernmost regions of the morning of 20 September 2019. These are reproduced on the next page.

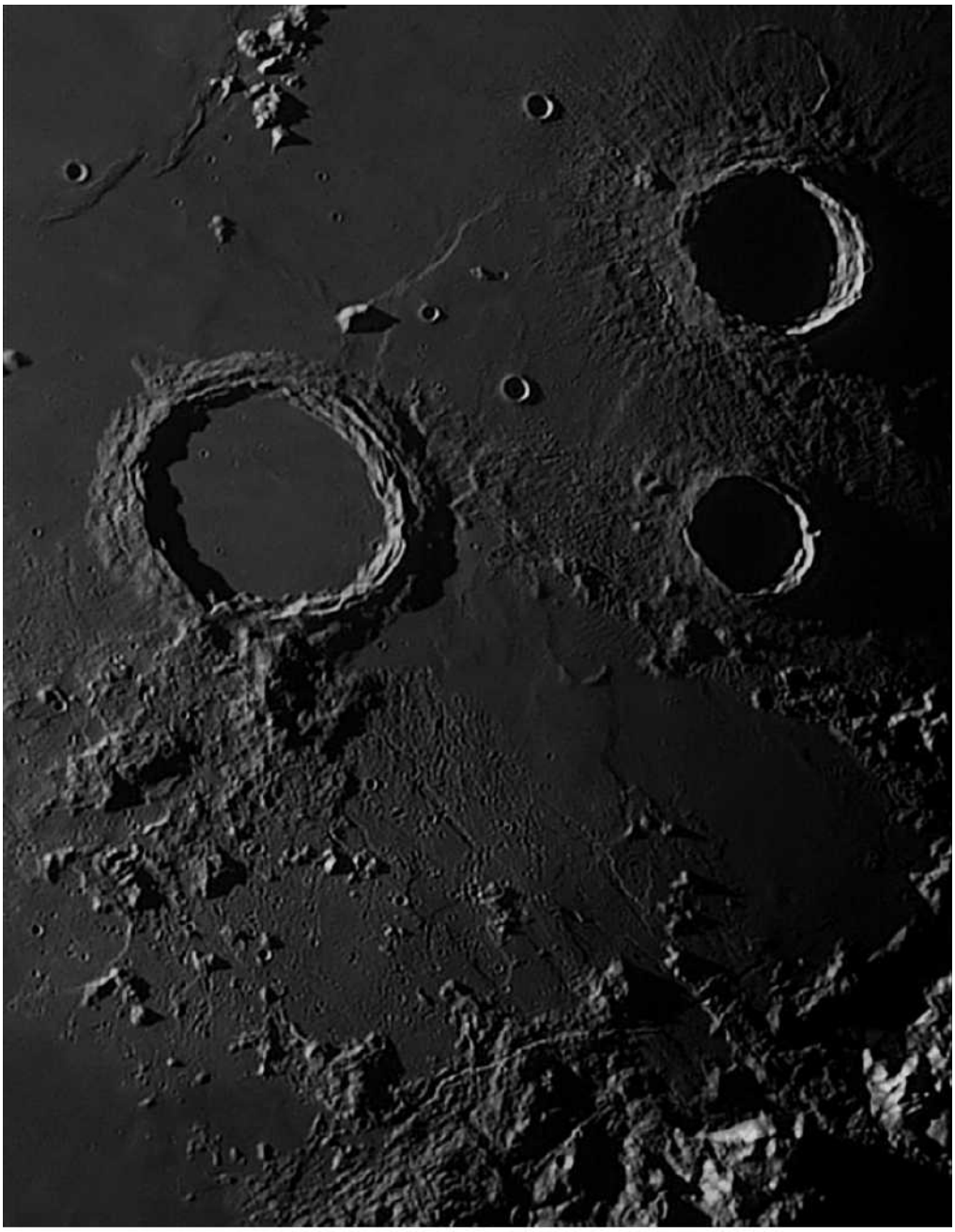


Philolaus, Mouchez, Sylvester, Hermite 2019.09.20 04:36 UT, S Col. 163.7°, seeing 6/10, transparency very good. Libration: latitude +04°47', longitude -07°01'
305mm Meade LX200 ACF, f 25, ZWO ASI 120MMS camera, Baader IR pass filter: 685nm.
640 frames processed in Registax 6 and Paintshop Pro 8.
Dave Finnigan, Halesowen



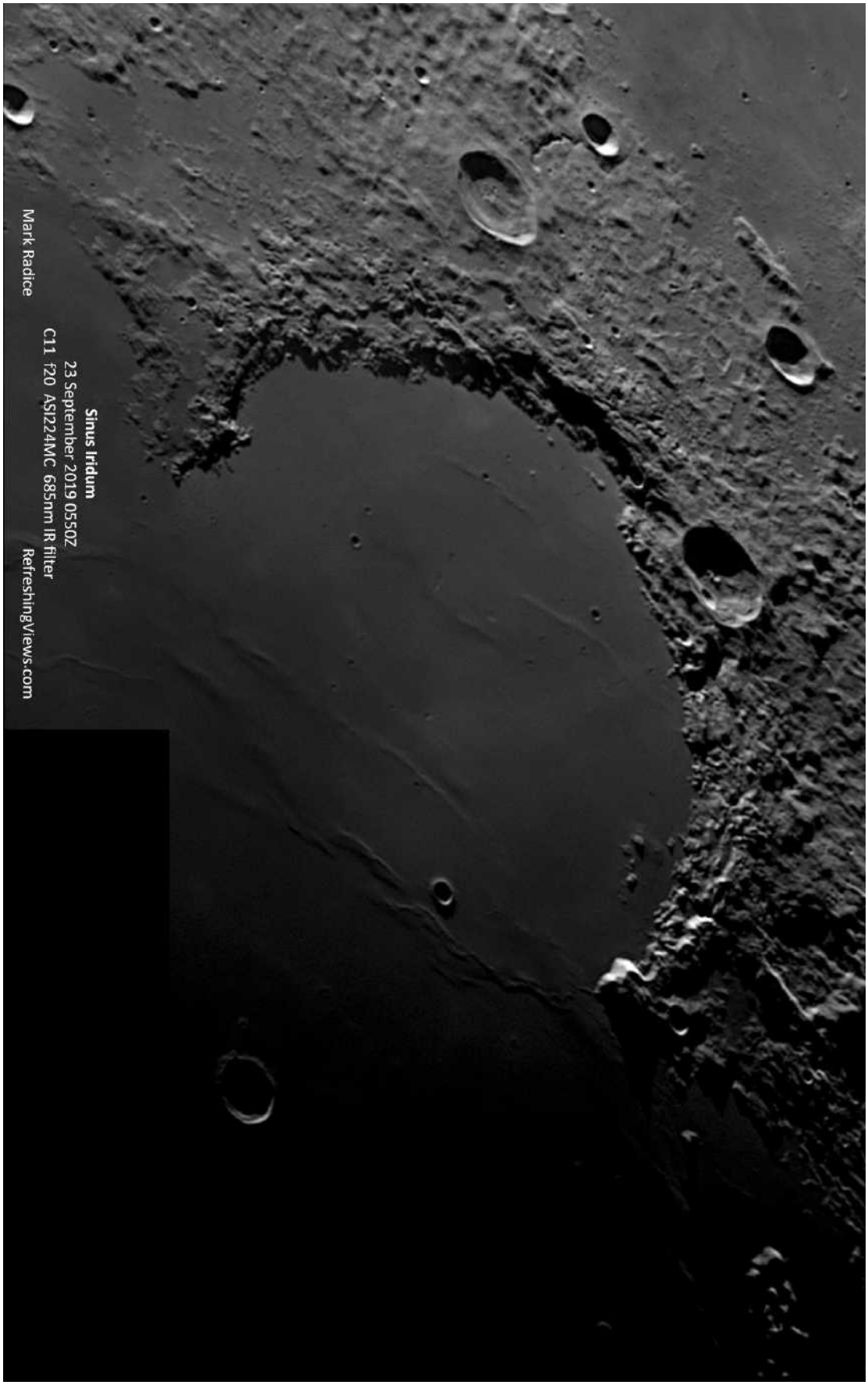
Carpenter, Pascal, Brianchon 2019.09.20 04:38 UT, S Col. 163.8°, seeing 6/10, transparency very good. Libration: latitude +04°47', longitude -07°01'
305mm Meade LX200 ACF, f 25, ZWO ASI 120MMS camera, Baader IR pass filter: 685nm.
640 frames processed in Registax 6 and Paintshop Pro 8.
Dave Finnigan, Halesowen

Mark Radice captured some excellent images of sunset over Archimedes and Sinus Iridum on the mornings of 21 and 23 September 2019, respectively. These were taken with a C11, x2 barlow, ASI224MC and a 685nm IR filter. 10k frames at around ~50% histogram captured with Firecapture, stacked the best 500 in AS3 and then wavelets sharpening in Registax.



Archimedes
C11 f20 ASI224MC 685nm IR filter
21 September 2019 0610Z

Mark Radice RefreshingViews.com


Sinus Iridum
23 September 2019 0550Z
C11 f20 ASI224MC 685nm IR filter
Mark Radice
RefreshingViews.com

LUNAR DOMES (Part XXXII): Possible lunar dome in Sinus Iridum region

Raffaello Lena

Lunar domes are the best evidence of volcanic activity on the Moon. Most have very low angles of inclination, only a few degrees at most. This makes domes similar to Earth's shield volcanoes formed by outpouring of magma from a central vent (effusive eruption) [1-3]. Notably, the detailed study of lunar domes is best based on images of the lunar surface acquired under oblique illumination conditions that allow for their measurement and for maximum detail. Maximilian Teodorescu, from Romania, has reported a possible dome, with a vent on the summit, located near Promontorium Laplace (Fig. 1). We term provisionally this volcanic construct as L1, to be consistent with previous classification with regard to the Sinus Iridum region. It lies at coordinates of 48.57°N and 26.37°W.

The suspected dome is clearly detectable only with oblique solar angle (Fig. 1), demonstrating that it must be imaged close to the terminator. In Fig. 1 the dome displays a curved edge with the shadow bending around it, showing that the centre of the structure is higher than the edges.

Another image of this region is shown in Fig. 2.

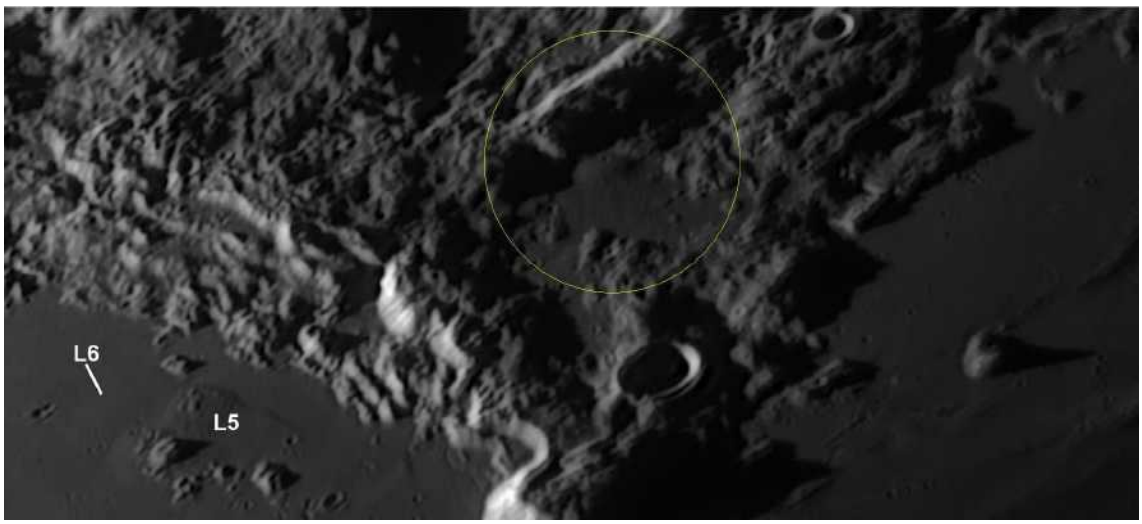


Figure 1. Image by Teodorescu taken on September 23, 2019 at 02:30 UT using a 355mm Newtonian telescope and ASI 174MM CCD camera. The suspected dome - termed L1 - is marked with a circle. Two domes, termed L5 and L6, have been previously described by Lena et al. [3].

A possible vent of 1km diameter is present on the summit. According to the LOLA DEM the vent has a depth of 90 ± 10m. The dome has a diameter of 7.6 ± 0.2km and a height of 100 ± 10m determined in E-W direction, resulting in an average flank slope of 1.5° ± 0.1°. Note that the most elevated part of the surface section covered by the DEM (in N-S direction) has a height of 230 ± 20 m, resulting in a slope of 3.4° ± 0.3°. A 3D reconstruction of the examined dome, obtained using WAC mosaic draped on top of the global WAC-derived elevation model GLD100 is shown in Fig. 3.

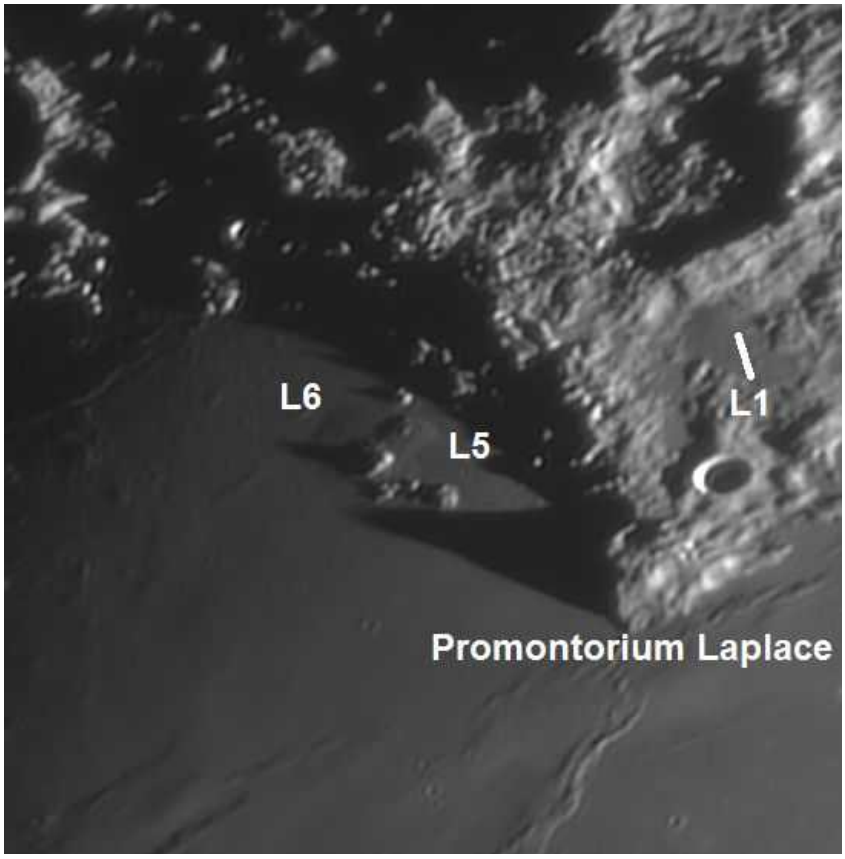


Figure 2. Image by Phillips taken on November 17, 2018 with a 254 mm Maksutov telescope.

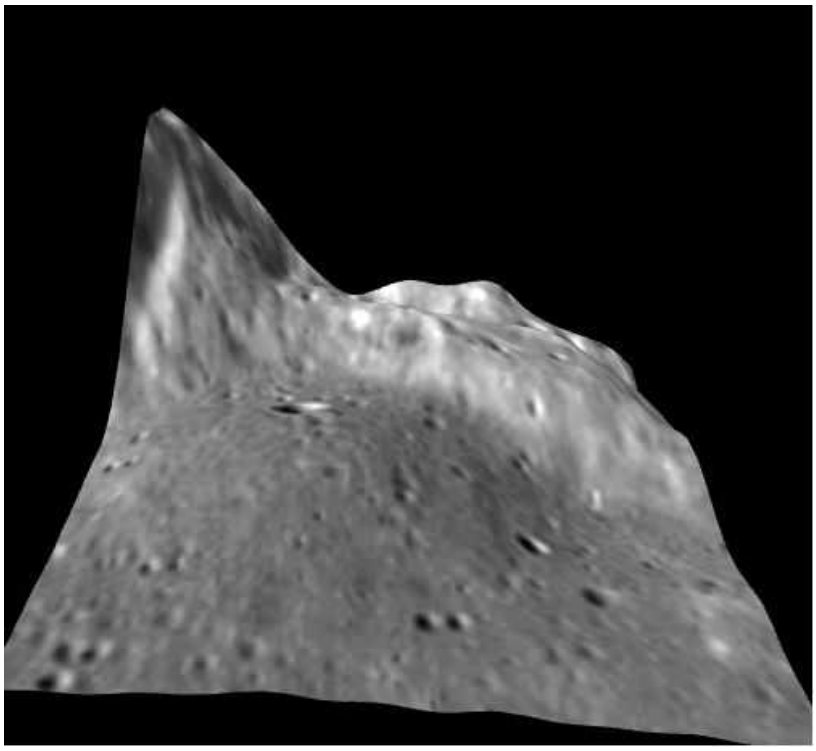


Figure 3. WAC draped on top of the global LRO WAC-derived elevation model (GLD100). The vertical axis is 7 times exaggerated.

Spectral data have been obtained using Chandrayaan-1's Moon Mineralogy Mapper (M^3), an imaging reflectance spectrometer that can detect 85 channels between 460 to 3000 nm. The spectrum of the dome (Fig. 4) displays a narrow trough around 1000nm with a minimum wavelength at 980nm and an absorption band at 2000nm, corresponding to a typical High-Ca pyroxene signature (Besse et al., 2014) and indicating a basaltic composition. The highland to the north of the dome displays a spectrum of more feldspar composition which lacks any observable mafic absorption feature in the range between 1000 and 2300nm.

Thus the dome consists of mare material, which contradicts the possible interpretation that this feature is merely an elevated deposit of hummocky material.

The spectral properties of major lunar minerals exhibit absorption bands that differ by their shape and position along the spectral domain. Pyroxenes (orthopyroxenes and clinopyroxenes) have two absorption bands, one centered near 1000nm and another near 2000nm. Olivine has a complex absorption centered over 1000nm, with no absorption at 2000nm. Therefore, olivine-rich lunar deposits are characterized by a broad 1000nm absorption band which is enhanced relative to the weak or absent 2000nm band (Fig. 5).

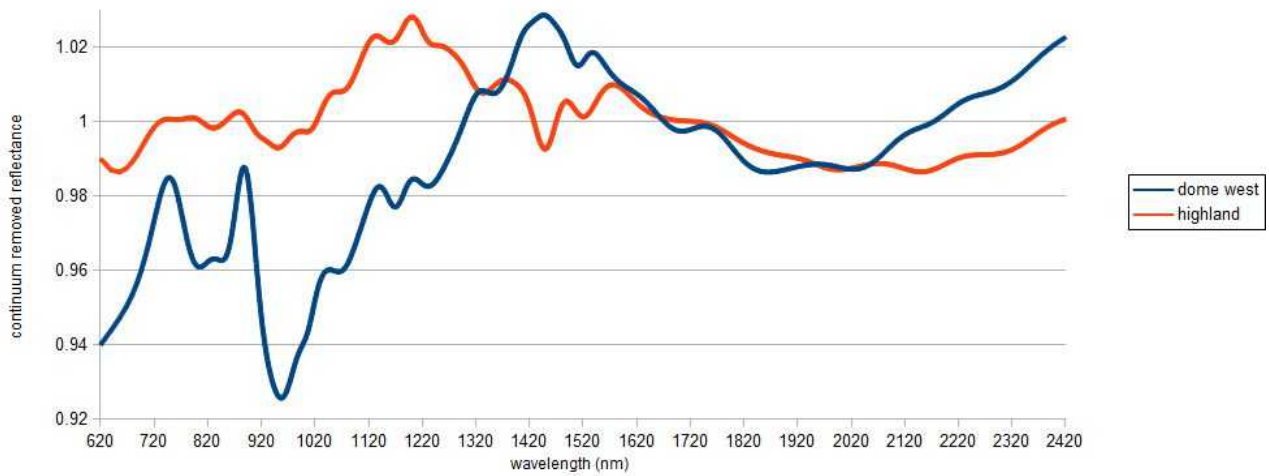


Figure 4. Moon Mineralogy Mapper (M^3) spectra of the examined dome identified by Teodorescu and the highlands north of the dome.

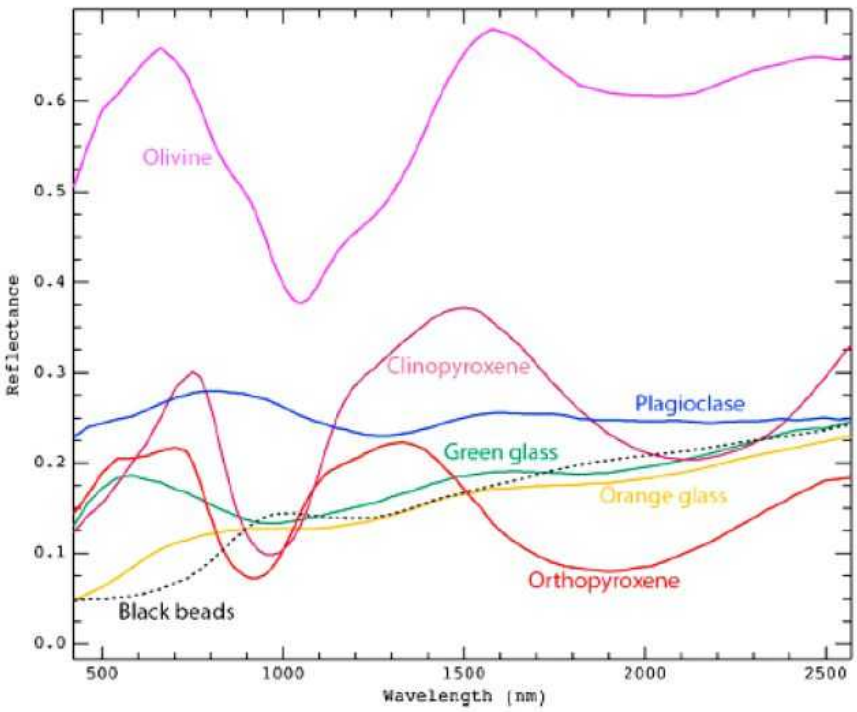


Figure 5. Spectral properties of major lunar minerals, including volcanic glasses.

Previous domes reported in Sinus Iridum, near Promontorium Laplace are Laplace 5 and 6 (Figs. 1-2).

Laplace 5 (L5) has a diameter of 9.0 ± 0.5 km, height of 125 ± 15 m with an average slope of 1.60° ± 0.10°. The edifice volume is determined to 3.7 km^3. Laplace 5 belongs to class B_2. Rheologic modelling indicates that it was built by lava of moderate viscosity of 2.4 x 10^5 Pa s, erupting at a high effusion rate of 110 m^3 s^{-1} over a period of time of 1.2 years. The second elongated dome, named Laplace 6 (L6), with a low average slope of 0.7° ± 0.10° is considered a putative intrusive dome, and modelling results indicate that it belongs to class In2 [3]. A map of this region is published in our lunar domes atlas (http://sinusiridumdomes.blogspot.com/).

I encourage more high-resolution imagery of this dome, which has not yet been characterized for morphometric and spectral properties. Please check also your past imagery and send any positive results to me for the ongoing study (raffaello.lena59@gmail.com).

References

[1] Basaltic Volcanism Study Project, 1981. *Basaltic Volcanism on the Terrestrial Planets*. New York: Pergamon Press.

[2] Lena, R., 'Lunar domes', chapter in *Encyclopedia of Lunar Science* ed. Brian Cudnik, 2015, Springer ISBN: 978-3-319-05546-6.

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

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

APOLLO 11 TAPES Kevin Kilburn

The late 1960s was the time when I was most interested in the Moon and all things Apollo and was a member of the British Astronomical Association's Lunar Section, then directed by Patrick Moore.

I lived with my widowed mother and younger sister near the centre of Ashton under Lyne, Greater Manchester, so the Moon and planets were the only things I could observe without being swamped by street lights. My mother was manager of a pub, appropriately called the Star Inn and we were able to rent a colour TV, for the pub of course, although it lived in my bedroom!

So I was pretty well prepared for Apollo 11. I recorded the TV coverage onto 150mm reel-to-reel audio tapes from the launch date, 16 July, until splashdown…and never listened to them, nor thought about them until early June 2019, when it was pointed out that the BBC had lost or over-recorded their studio TV coverage. I had four long-play, double-sided audio tapes.

Angel Li, assistant producer of *The Sky at Night*, made arrangements for me to send them to Steve Roberts, Senior Archivist at the BBC Archives in Perivale, who offered to digitise them for their own records and to send me back a USB stick with the recordings. This was his e-mail, 19 June:

The tapes really are of huge interest. The BBC Apollo coverage is a permanent fixture in any list of missing British TV material - and it's unlikely to ever change, as the live studio output it wasn't officially recorded on videotape at the time. As crazy as this seems, the videotape department was probably full just trying to record all the various incoming feeds from all over the world and didn't have capacity to record the BBC's own output. The tiny amount we have is some absolutely shocking quality amateur domestic reel to reel video that was subsequently transferred to 16mm film, but the majority of what it contains is purely the NASA pictures, which of course exist in much better quality anyway. As far as audio recordings, we previously had only 48 minutes of off-air audio of the BBC coverage from another source. Now thanks to you we have over eight hours!

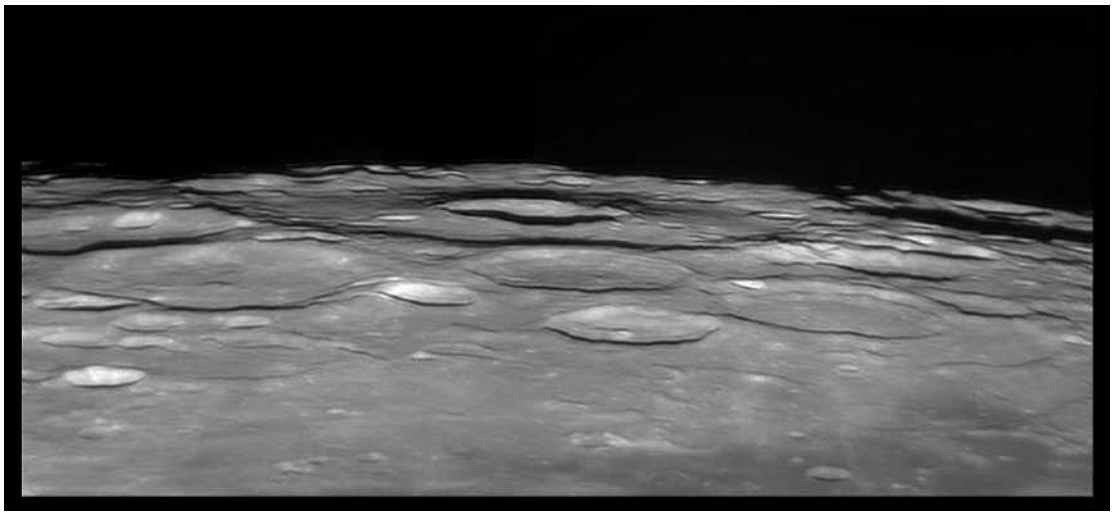
The recovered tapes were too late to be included in the 50th anniversary BBC programmes but I understand that one of the recordings was used in a BBC Radio 4 programme produced by BBC Scotland. By the way, the tapes also included TV coverage by ITN/ITV that was similarly lost.

The digital recordings, all 6Gb of them, are available at no cost, apart from a stamped return self-addressed envelope and a USB stick, to anyone who would like a copy.

Contact: kevinkilburn@sky.com

CRATER EINSTEIN: An observing opportunity Bill Leatherbarrow

In the small hours of the morning of 12 November 2019 the nearly full Moon will be sinking into the west in UK skies, but it will offer a rare opportunity to observe one of its largest and most elusive craters. Einstein is situated right on the Moon's western limb, in part beyond 90° W. This means that it lies in a libration zone and is only seen properly when the Moon's tilt is favourable in that direction. At 170 km in diameter it is hardly a shrinking violet, but most lunations it goes undetected, waiting for a conjunction of ideal libration and lighting to reveal itself to the Earth-based observer. For this reason there are very few good telescopic drawings or images of crater Einstein. Damian Peach's excellent capture from 2005, taken through a 9.25-inch Schmidt-Cassegrain, is probably still the best we have, apart from spacecraft imagery.



Crater Einstein (image by Damian Peach)

Previously (and unofficially) named Caramuel by H. P. Wilkins, Einstein was the subject of an intensive observing campaign by BAA Lunar Section members on 8 November 1965, and a full report was drawn up by David Allen and published as a paper in the BAA Journal for June 1966 (Vol. 76, No. 4). This was a reasonably favourable combination of lighting and libration.

Conditions on 12 November will not be quite as good for observers in the UK. Not only will the Moon be low, but much of the floor of Einstein will still be shadow-filled while the Moon is at an observable elevation. But it will still be worth getting up for, and I would be glad to have any drawings or images obtained.

Here's hoping for clear skies!

LUNAR OCCULTATIONS: November 2019 Tim Haymes

Yahoo! Group changes

The Occultations discussion group (UK) has been moved from Yahoo to groups.io owing to impending and drastic action by Yahoo not to support the Groups. This took a lot of group owners by surprise. Yahoo will be stopping all content from 1st December. Most groups see this as the death of Yahoo Discussion Groups in their present form.

Consequently I have moved as much content as I can (as owner) to https://groups.io/g/UKoccultations Yahoo members have been re-invited to join the new group. New members are welcomed.

Lunar Occultation observing in the UK

I would like to encourage all readers with the capability of timing total Lunar occultations by video (analogue and digital), to take part in the Section's observing program to time occultations. We have only three members that have contributed regular reports in the last year or so.

If there are any reports not yet sent to me, please do send them in. It's never too late! One of my small pastimes is to find and research unreported (timed) events and re-submit them if they are not in the global database accessed from Occult4 software. Please consider observing total and grazing occultations and sent reports to the sub-section. They will be gratefully received.

Moon in Gemini Nov 15/16th

The 88% illuminated phase will occult (reappearances) several stars near eta Gem, including eta for Southern counties. Mu Gem is also occulted. Anyone with high frame rate digital video (100-400 fps) could attempt the reappearance of both stars (no timing required) to see what is recorded on the light curve.

Set your clock by the Moon

Halley in 1683 proposed that a telescope could be used to time occultations as a means of deriving time at sea. *Now* we have such accurate lunar predictions and limb corrections the time of an occultation can be used to check our clocks to within a few frames of our video cameras. An accumulation of timings over say 6 months will produce a distribution of O-C values; the mean should be zero. If not, then there could be a systematic error in timing. I believe Dave Herald is formalising this approach as a method to check timings based on NTP and computer clocks which are more prone to errors than GPS derive time. Good idea Edmund!

Always expect the unexpected. Some timings reveal real errors which is why we observe - double stars, observer position (plate tectonics) and changes in lunar profile perhaps. We won't know unless we continue to observe and time occultations as accurately as we can.

2019 November predictions for Manchester (Occult4 by D.Herald)
Please Note: Predicted times are in UT

W. Longitude 002d 15′, Latitude +53 25′, Alt. 50m;

y	m	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Moon Az	CA o	Notes
19	Nov	1	17	26	36.6	D	2692	K3	5.5	4.6	24+	59	-8	11	200	59S	24 Sgr
19	Nov	1	17	35	33.9	D	186977	B9	7.6	7.5	24+	59	-9	10	202	31S	Dbl*
19	Nov	4	17	24	37.8	D	190162	K0	7.7	7.1	53+	93	-8	15	164	58S	
19	Nov	5	20	53	44.3	D	3243	G8	7.3*	6.8	63+	105		17	204	25S	
19	Nov	7	17	39	53.3	D	3480	F5	7.2	6.9	79+	126	-11	17	133	87S	
19	Nov	7	19	11	29.3	D	3484	G5	6.9	6.4	80+	126		25	155	57S	
19	Nov	7	21	41	26.9	D	3490	F8	7.2	6.9	80+	127		28	196	48N	
19	Nov	8	20	52	25.9	D	128739	A0	7.4	7.4	87+	138		33	171	36N	
19	Nov	9	0	35	51.0	D	60	K2	6.9	6.1	88+	139		22	232	84N	
19	Nov	10	2	30	45.6	D	109783	G5	7.3	6.7	94+	151		16	251	32S	
19	Nov	11	0	24	2.9	D	110253	F3	8.4	8.2	97+	161		40	211	57N	
19	Nov	11	1	39	25.6	D	110268	K5	7.4	6.5	97+	162		33	232	26N	
19	Nov	11	21	14	48.9	D	398	K0	6.5*	5.9	99+	171		40	135	81S	
19	Nov	11	21	53	0.8	D	401	A2	6.3*	6.3	99+	171		43	146	68N	85 Ari
19	Nov	13	2	43	27.8	R	523	A5	6.4	6.3	100-	173		43	231	75S	Dbl*
19	Nov	14	23	52	25.3	R	77118	A0	7.7	7.6	94-	151		50	132	54S	
19	Nov	15	4	24	46.1	R	77192	K0	8.5	7.9	93-	149		48	234	47N	
19	Nov	15	4	54	34.2	R	77202	F8	8.2	7.8	93-	149		44	243	80S	
19	Nov	15	20	7	42.9	R	928	K4	5.9	5.1	89-	140		13	70	62N	
19	Nov	15	20	48	14.0	R	939	M1	6.9*	5.8	88-	140		18	77	12S	Dbl*
19	Nov	15	22	3	17	Gr	946	M3	3.5	2.5	88-	139		29	** GRAZE:		nearby
19	Nov	15	22	3	17	GrX	85102		6.1	5.5	88-	139		29	** GRAZE:		nearby
19	Nov	15	22	5	7	M	946	M3	3.5	2.5	88-	139		29	91	13N	eta Gem (Dbl*)
19	Nov	15	22	5	7	M X	85102		6.1	5.5	88-	139		29	91	13N	
19	Nov	15	23	20	37.6	R	78174	F0	8.6	8.4	88-	139		40	108	46S	
19	Nov	15	23	29	21.6	R	78182	G5	7.4	6.9	88-	139		41	110	34S	
19	Nov	16	2	13	48.5	R	78277	B9	8.8	8.9	87-	138		58	163	82N	
19	Nov	16	2	46	1.0	R	976	M3	2.9	2.0	87-	138		59	177	82S	mu Gem
19	Nov	16	4	10	46.9	R	78352	A3	7.2		87-	137		56	212	65S	
19	Nov	16	4	29	1.9	R	78367	G5	8.1	7.6	87-	137		55	219	56N	
19	Nov	16	4	31	12.6	R	78369	F2	8.7	8.5	87-	137		55	220	50N	
19	Nov	16	5	58	53.9	R	78418	G0	8.7	8.5	86-	136		44	246	81S	
19	Nov	16	6	42	54.7	R	997	A0	7.0	7.0	86-	136	-8	38	256	90N	
19	Nov	17	1	45	27.4	R	79293	K0	8.9	8.3	79-	125		51	131	62S	
19	Nov	17	1	59	16.2	R	79297	M0	8.8	7.8	79-	125		53	136	72S	
19	Nov	17	2	13	35.8	R	79306	K0	8.8	8.1	79-	125		54	141	79N	
19	Nov	17	2	49	1.1	R	79330	K0	7.8	7.3	79-	125		57	154	63N	
19	Nov	17	5	29	48	R	1128	K5	6.8	5.9	78-	124		54	220	10S	
19	Nov	17	5	37	14.1	R	79409	K0	7.9	7.3	78-	124		54	223	15N	
19	Nov	17	23	42	14.0	R	80039	A5	8.4	8.3	70-	114		26	89	49S	
19	Nov	18	0	35	36.4	R	80063	G5	7.6	7.1	70-	113		34	100	88S	
19	Nov	18	1	8	14.8	R	80075	M0	8.6	7.9	70-	113		39	107	81S	
19	Nov	18	1	49	47.2	R	80094	K2	8.0	7.4	69-	113		44	117	74N	
19	Nov	18	1	50	24.3	R	80099	B9	8.1	8.2	69-	113		44	118	25S	
19	Nov	18	4	48	32.1	R	80176	G5	8.8	8.3	68-	111		58	180	23N	
19	Nov	19	0	44	0.5	R	98460	A3	8.4*	8.3	59-	100		25	92	40N	
19	Nov	19	0	47	53	R	1377	A3	7.0*	6.9	59-	100		26	93	16N	
19	Nov	19	1	33	4	m	98481	F0	7.9*	7.7	59-	100		32	102	6N	
19	Nov	19	4	39	44.4	R	98534	K0	7.7	7.0	57-	99		53	155	73S	
19	Nov	19	5	17	52.4	R	98546	G0	8.9	8.6	57-	98		55	170	76N	Dbl*
19	Nov	19	5	33	21.4	R	1392	G0	7.3		57-	98		55	176	78N	Dbl*
19	Nov	19	6	47	55.9	R	98575	G5	8.3	7.8	57-	98	-8	53	205	55N	
19	Nov	20	6	51	13.1	R	1520	F0	8.7	8.6	45-	85	-7	50	185	88N	
19	Nov	21	0	53	43.6	R	1612	F5	7.3	7.1	36-	74		4	79	83N	
19	Nov	21	1	48	3.2	R	99474	F8	8.4		36-	74		12	89	46N	
19	Nov	21	3	16	21.7	R	1622	K2	8.2*	7.6	35-	73		24	107	54N	
19	Nov	22	6	48	27.8	R	119272	F5	7.6*	7.3	23-	58	-8	37	151	54S	
19	Nov	23	3	22	25.1	R	1867	A3	7.5	7.4	15-	46		2	95	52N	
19	Nov	30	17	47	36.7	D	188858	G8	8.0	7.4	18+	50		9	210	67N	
19	Nov	30	18	9	25.5	D	188869	F8	8.6	8.3	18+	50		7	215	39S	
19	Dec	1	16	52	52.8	D	189827	A3	8.0	7.9	26+	61	-8	16	187	36N	
19	Dec	2	17	22	54.5	D	164632	G5	8.5		35+	73		19	183	34N	
19	Dec	2	17	26	58.0	D X	50839	G0	8.8	8.6	35+	73		19	184	87S	
19	Dec	2	17	49	16.0	D	164637	K2	7.5	6.8	35+	73		18	190	32N	
19	Dec	2	18	13	57.9	D	3191	A5	7.4	7.3	35+	73		17	195	46S	Dbl*
19	Dec	3	20	21	7.2	D	3323	A5	7.5	7.3	45+	85		16	216	84S	
19	Dec	4	17	47	51.5	D	3433	G5	7.7	7.2	54+	95		25	166	49S	
19	Dec	4	23	33	52.8	D	3458	K0	6.2	5.5	56+	97		3	250	88S	

```
19 Dec  5 18  7  1.3 D       5 K1  4.6  4.1   63+ 106     29 160  49N  3 Psc
19 Dec  5 21 30 58.8 D      18 K1  5.8  5.3   64+ 107     26 216  71S  Dbl*
19 Dec  5 22 26  0.3 D  128632 K2  8.3  7.7   65+ 107     20 229  70S
```

Notes on the Double Star selection:

Doubles are selected from Occult 4, where the magnitudes of the pair are not more than 2 magnitudes different, the fainter companion is brighter than mag 9, and the time difference (dT) is between 0.1 and 5 seconds. **Please report double star phenomena.**

Key:
P = Phase (R or D), R = reappearance D = disappearance
M = Miss at this station, Gr = graze nearby (possible miss)
CA = Cusp angle measured from the North or South Cusp. Negative CA = bright limb
Dbl* = This is a double star worth monitoring.
Mag(v)* = asterisk indicates a light curve is available in Occult-4
Star No:
2/3/4 digits = Zodiacal catalogue (ZC) but referred to as the Robertson catalogue (R)
5/6 digits = Smithsonian Astrophysical Observatory catalogue (SAO)
X denotes a star in the eXtended ZC/XC catalogue

Detailed predictions at your location for 1 year are available upon request.
Occultation Subsection Coordinator: Tim Haymes
tvh.observatory@btinternet.com

LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME 2019 Nov

Tony Cook

Reports have been received from the following observers for Sep: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Alphonsus, Aristarchus, Atlas, Barrow, Bessel, Hase, Mons Piton, Rabbi Levi, and Torricelli B. Alberto Anunziato (Argentina – SLA) observed Agrippa, Aristarchus, Hahn, Plato, Proclus and Yerkes. Dietmar Büttner (Germany - BAA) observed Tycho. Jario Chavez (Columbia - LIADA) imaged Aristarchus, Bianchini, Gutenberg, Mare Crisium and several features. Maurice Collins (ALPO/BAA/RAS NZ) imaged earthshine, Petavius, and several features. Alexandra Cook (Spain) imaged the Moon. Pasquale D'Ambrosio (UAI – Italy) imaged the Full Moon. Valerio Fortani (Italy – UAI) imaged Bullialdus, the Full Moon and Torricelli B. Les Fry (Mid Wales, UK - NAS) imaged Montes Apenninus, Theophilus, Tycho, and several features. Kevin Kilburn (BAA) imaged several features. Nicoletta Minichino (Italy – UAI) imaged Torricelli B. Bob Stuart (Rhayader, UK – BAA) imaged Anaxagoras, Aristarchus, Arnold, Atlas, Briggs, Capella, Carpenter, Cusanus, Desargues, Endymion, Fracastorius, Hayn, Hercules, Janssen, Lacus Spei, Lavoisier, Macrobius, Messier, Meton, Newcomb, Oenopides, Philolaus, Pitiscus, Posidonius, Proclus, Reiner Gamma, Römer, Santbech, Schröter, Taruntius, Theophilus and the Full Moon. Franco Taccogna (Italy – UAI) imaged Campanus, Mare Frigoris, Montes Teneriffe, Tycho and several features. Aldo Tonon (Italy – UAI) imaged the Full Moon. Gary Varney (Pembroke Pines, FL, USA – ALPO) imaged Montes Apenninus and Triesnecker. Román García Verdier (Argentina - SLA) imaged the regions around Aristarchus, Plato and Proclus. Fabio

Verza (Italy – UAI) imaged Montes Teneriffe and the Full Moon. Ivor Walton (Codnor, UK - BAA) imaged Campanus. Marcello Zurita (Brazil – APA/BRAMON/SAB) videoed earthshine.

News: Readers may be interested to know that a giant 7 metre diameter model of the Moon is touring the Earth's surface at the moment! I stumbled upon it by accident when I visited Gloucester, UK and went inside the cathedral (see Fig. 1). It is a 1:500,000 scale map of the Moon and each cm on this model represents 5km on the Moon's surface. The artist's web site: https://my-moon.org/ tells you where it is likely to pop up next and it is not just confined to the UK.

Figure 1. The 'Museum of the Moon' inside Gloucester Cathedral on 2019 Oct 19, just prior to a rehearsal for a Wagner concert.

TLP reports: No additional TLP, other than the candidates discussed in the last newsletter, have been reported for September. However, concerning Kevin Kilburn's green/blue spot seen on Galvani G, I have a few additional things to say. The UT I quoted of 21:26UT was a typographical error on my part, and it should have read 23:26 UT. I thought that you might be interested in the colour version of his image and red, green blue colour separated components (Fig. 2). Although I suspect the flash is either a cosmic ray, or something to do with the camera Bayer filter, it is an interesting coincidence that it lines up with the ray crater inside Galvani B. I have therefore decided to raise the ALPO/BAA weight to 2. If any of you have experience with being able to remove Bayer filter patterns from the original image, I would be grateful if you could get in contact as I think this is the only way to prove that the flash might be cosmic ray related.

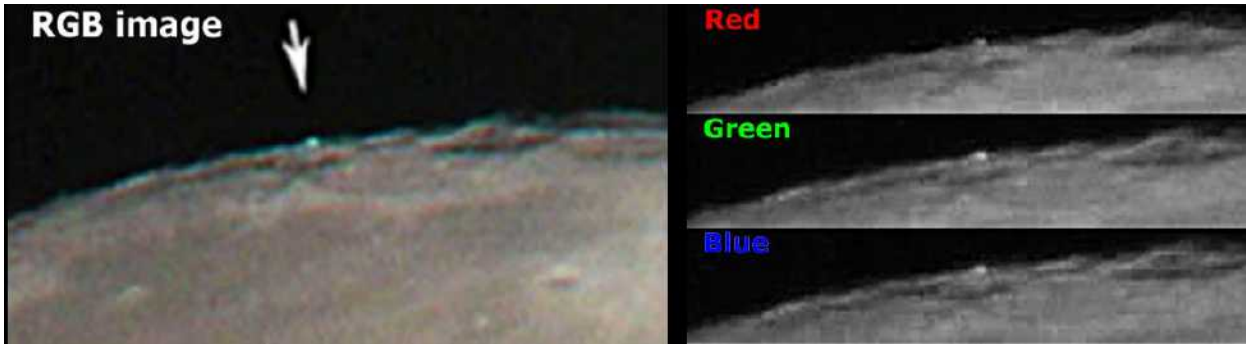


Figure 2. *The limb of the Moon in the vicinity of Galvani B with north towards the top right.* ***(Left)*** *RGB image taken by Kevin Kilburn on 2019 Sep 13 UT 23:26 with some sharpening and colour saturation increased – an arrow points to a blue-green spot.* ***(Right)*** *Colour separated red, green and blue components.*

Routine Reports: Below are a selection of reports received for Sep that can help us to re-assess unusual past lunar observations – if not eliminate some, then at least establish the normal appearance of the surface features in question. Note that some observations sent in have not been used in this newsletter because they do not cover repeat illumination predictions. However they will be kept in our database and used as reference images should a TLP be reported under similar illumination in the future.

I am now in the throes of a heavy teaching workload at University, and so although trying to list as many observations as possible, I will not be providing, much in the way of analysis. Instead, readers of this newsletter, are invited to read the original TLP descriptions and judge for themselves whether these repeat illumination observations explain what was originally seen. When I get some freedom in a month, or two's time I will reassign weights, if necessary, to the original TLP reports.

Earthshine: On 2019 Sep 02 UT 07:36 Maurice Collins (ALPO/BAA/RAS NZ) imaged (Fig. 3) the night side of the Moon under similar phase and similar topocentric libration to the following reports:

[REF 01] *On 1970 May 08 at UT 23:00-23:30 Celis (Quilpue, Chile, 3" refractor, x60, atmosphere turbulent) observed in the Aristarchus region a clear line(?) and several star-like points. Cameron suspects atmospheric effects due to low altitude and turbulence? The Cameron 1978 catalog ID=1259 and weight=1. The ALPO/BAA weight=1.*

[REF 02] *On 1989 Apr 09 at 02:13 was seen to be not very bright in binoculars, despite visibility of Earthshine in general as being exceptional. Darling confirmed this at 02:31UT, though it was quite bright in a 17" reflector, but Herodotus could barely be seen. Weier claimed to be able to see Aristarchus with the naked eye. At 02:08 the brightness was found to be 5.0 for several measurements. The observing team ware from the Maddison Astronomical Society, WI, USA. The Cameron 2006 catalog ID=359b and he weight=3. The ALPO/BAA weight=2.*

Figure 3. *Earthshine as imaged by Maurice Collins on 2019 Sep 02 UT 07:36 and orientated with north towards the top. The colour saturation has been increased to 70%. An enlarged view of Aristarchus is shown in the inset in the bottom right.*

Curtis: Jario Chavez (LIADA) 2019 Sep 04 UT 00:03 imaged (Fig. 4) the Mare Crisium region which included the usually bright spot east of Picard mentioned in the following report, and under nearly similar illumination (±0.5°):

[REF 03] *On 1877 Jun 15 at UT 20:00 Birt (England, UK) observed a bright spot east of Picard. The reason why this was regarded as a TLP, according to Cameron was that it was supposed to be faint or invisible. The Cameron 1978 catalog ID=193 and the weight=3. The ALPO/BAA weight=3.*

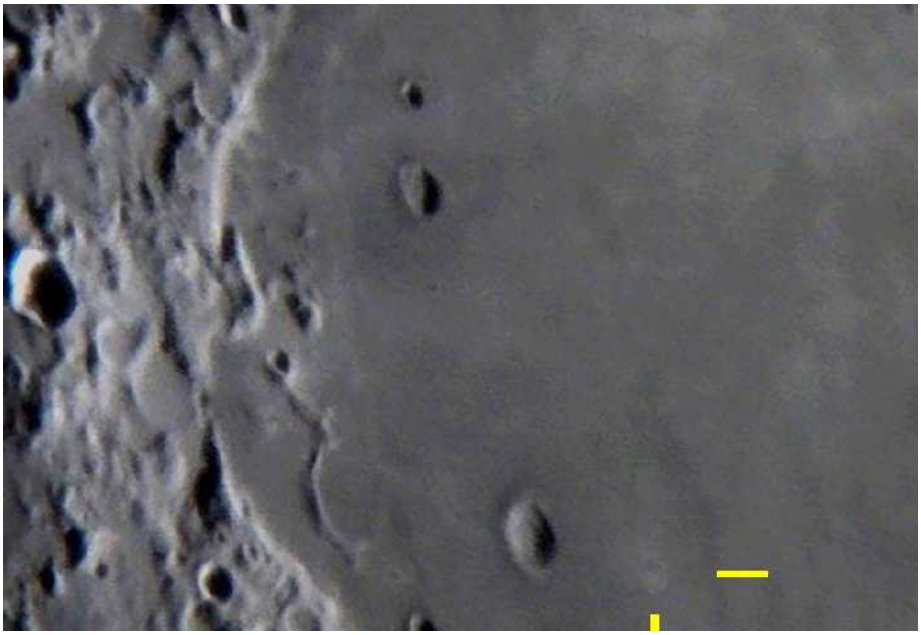


Figure 4. *A normally bright spot (Curtis crater) east of Picard in Mare Crisium, as imaged by Jario Chavez (LIADA) on 2019 Sep 04 UT 00:03 and orientated with north towards the top.*

Barrow and Bessel: On 2019 Sep 06 at 01:15-01:35 and 01:45-02:05 respectively, Jay Albert (ALPO) observed visually these two craters under similar illumination (±0.5°) to the following two reports:

[Ref 04] *Barrow 1972 May 19 UT 20:17 M. Burton (UK, 13.5-inch Cassegrain reflector, x180, seeing IV-III, Transparency: Fair) noted that the E. side of the crater wall was brilliant. There was also a luminous streak across the floor from E-W. No colour was detected using a Mon Blink device. ALPO/BAA weight=1.*

[Ref 05] *Bessel 1877 Jun 17 UT 22:30 Observed by Denett (England? 2.75" reflector) "Thought he could detect a minute pt. of light shining out of dark crater. (no high peaks in Bessel to catch light.)" NASA catalog weight=3 (average). NASA catalog ID #194. ALPO/BAA weight=3.*

For Barrow, Jay noted that 'The W (IAU; TLP description states E) side of the crater was brightly lit. I also saw the "luminous streak" running E-W across the floor. The sunlight appeared to be coming through a gap or low point in the E wall and extended all the way to the W wall. I checked Rukl chart 4 and noted no complete gap in the E wall, however there was a lower area with a small craterlet which could have been the area where the sunlight could penetrate the E wall and light up the strip across the floor. While photo #10 in the *21st Century Atlas of the Moon* (Wood & Collins) was taken at a higher solar angle, it does show how light comes through this lower area with a smaller amount of shadow on each side. Accordingly, the bright W wall and luminous streak would appear to be normal at this LTP's solar angle.'

For Bessel he found: 'Seeing at 5/10 dropped rapidly to 4/10 or less during this observation as the Moon dropped lower over the roof of my house. I intermittently caught brief glimpses of what appeared to be a minute, faint light spot at the edge of the shadow on the crater floor at the base of the bright W wall. I used 290x, then 226x

and viewed from 01:45 to 02:05UT when poor seeing ended the lunar portion of my observing session.'

NW Mare Vaporum: On 2019 Sep 07 UT 01:58 Gary Varney (ALPO) imaged (Fig. 5) the Triesnecker area, and covered some of the NW area of Mare Vaporum, at similar illumination (to within ±0.5°) to the following report:

[REF 06] *Mare Vaporum 1969 Apr 24 UT 19:34 Observed by Bentley (England, 8" reflector, x320, S=E) "NW part of mare obscured for 4 min., gradually thinning." NASA catalog weight=3. NASA catalog ID No. 1123. ALPO/BAA weight=2.*

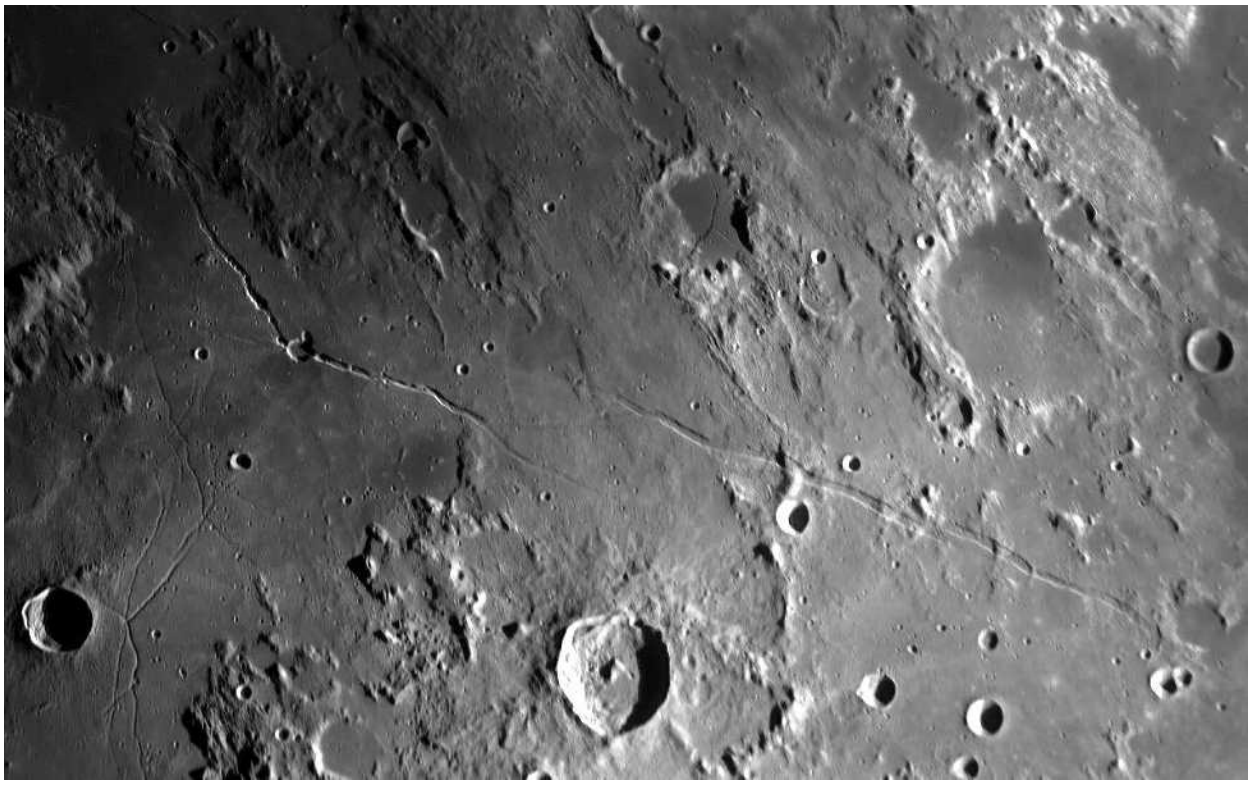


Figure 5. *The Triesnecker area of the Moon as imaged by Gary Varney (ALPO) on 2019 Sep 07 UT 01:58.*

Montes Teneriffe: On 2019 Sep 07 between UT 17:41 and 18:14 Fabio Verza (UAI) and Franco Taccogna (UAI) obtained a series of images (See Fig. 6) that overlapped with a Lunar Schedule website request for the following:

[REF 07] *BAA Request: please image this area as we want to compare against a sketch made in 1854 under similar illumination. However, if you want to check this area visually (or with a colour camera) we would be very interested to see if you can detect some colour on the illuminated peaks of this mountain range, or elsewhere in Mare Imbrium. Features to capture in any image (mosaic), apart from Montes Teneriffe, should include: Plato, Vallis Alpes, Mons Pico and Mons Piton.*

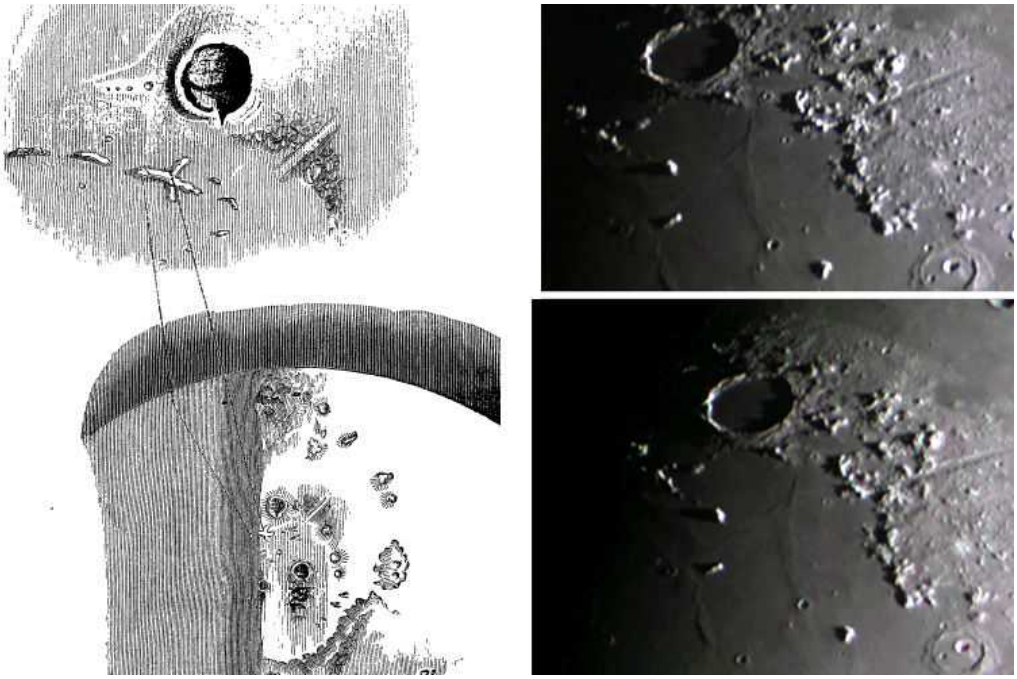


Figure 6. *The Montes Teneriffe area orientated with north towards the top.* ***(Left)*** *A couple of sketches from the Monthly Notices of the Royal Astronomical Society from 1885 Vol. 15, p.163 depicting on 1854 Dec 27 UT 18:00-23:00 an observation of Hart and others (Glasgow, Scotland) of '2 luminous fiery spots on bright side on either side of a ridge, contrasting color. Seemed to be 2 active volcanoes. Ridge was normal color. Spots were yellow or flame color. Never seen before in 40 yrs. of observing'.* ***(Top Right)*** *Colour image by Fabio Verza (UAI) taken on 2019 Sep 07 UT 17:41 – colour normalized and colour saturation increased to 50%.* ***(Bottom Right)*** *Colour image by Franco Taccogna with red, green and blue channels captured respectively at 18:11, 18:13 and 18:14 UT. These were then registered together, colour normalized and then had the colour saturation increased to 50%.*

Full Moon: On 2019 Sep 13 several UAI observers imaged the whole lunar disk close to Full Moon in order to see which were the brightest features. Table 1 below shows a selection of features and in the last column the mean digital number value i.e. the higher this is the brighter (higher albedo) the feature has:

UT:	19:33	20:38	21:23	22:02	Mean
Observer:	**Taccogna**	**Tonon**	**D'Ambrosio**	**Fontani**	**DN**
Censorinus	241.2	199.5	213.5	173.3	**207**
Spot near Hell	213.8	210	213.8	185.4	**206**
Proclus	197.5	206.6	213.5	182.6	**200**
Aristarchus	188.8	177.7	208.4	170.4	**186**
Tycho	171.9	166.6	196.5	175.4	**178**
Menelaus	154.4	160	184.3	161.5	**165**
Copernicus	115.3	133.2	181.2	157.6	**147**
Kepler	104.7	128.8	168.5	151.1	**138**
Plato	54.1	76.3	111	72.3	**78**

Table 1. *CCD brightness values of different craters as measured in images by UAI observers on 2019 Sep 13.*

Hahn: On 2019 Sep 15 UT 02:51 Alberto Anunziato (SLA) managed to obtain an image (Fig. 7) of the crater Hahn following a Lunar Schedule web site request:

[REF 08] *BAA Request: On 2012 Jan 09 UT 21:01-21:08 Hahn crater was imaged by Nick Hazel (Beverley, Yorkshire, UK, Nikon D7000 with 70-300 zoom at max, with 2x teleconverter, at f9, 1/320 sec, ISO 400 - tripod mounted, mirror up), A series of images were taken. The 21:06 one showed a grey column cutting across the central floor of the crater from the west and then bisecting the eastern rim. All detail inside is completely invisible. Some (but not all) of the other images showed a more blurred view of this feature. It is possible that this was a seeing ripple effect, or just the natural appearance of shadings on the Moon at this time, however we would like to capture images of this area to be sure. Small aperture telescopes or telephoto lens similar to Nick's can be used. Try switching the tracking off to see what effect motion blur has during the exposure - to see4 if this replicates the effect.*

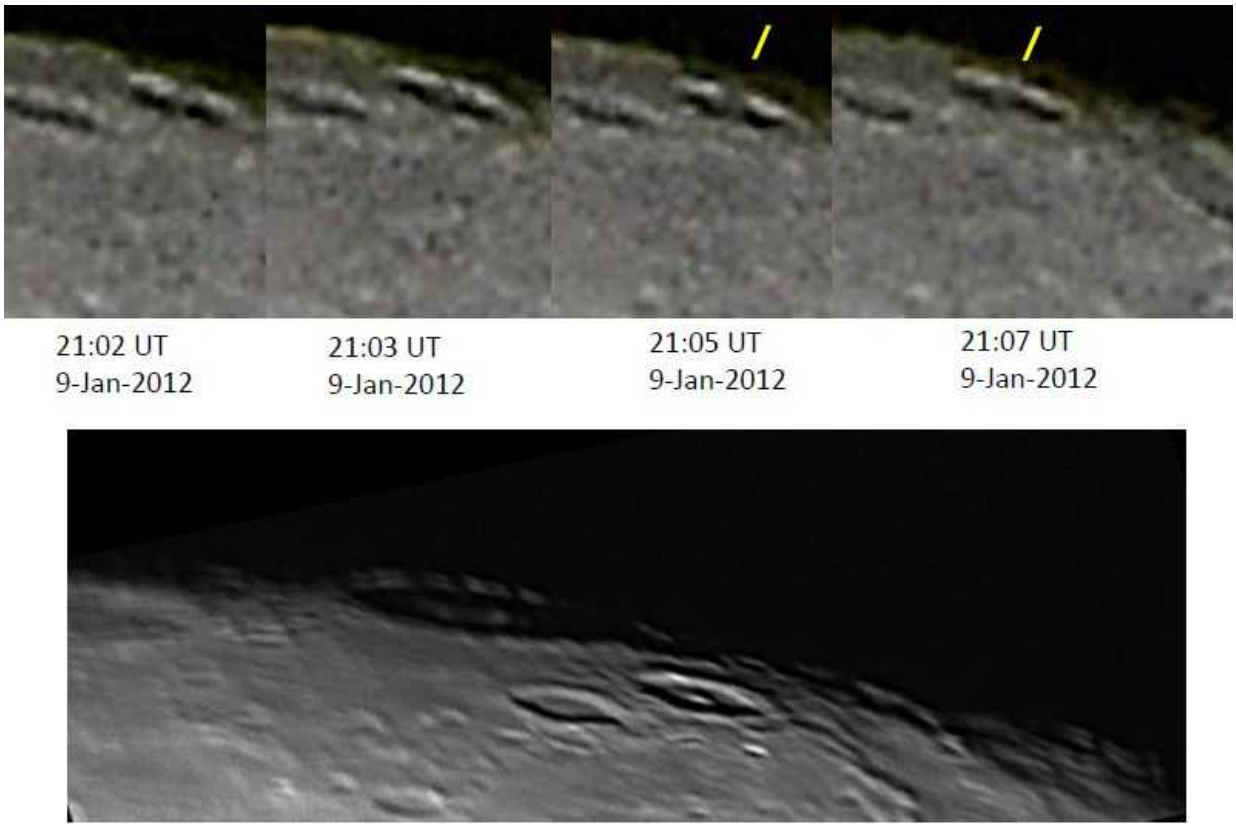


Figure 7. *The crater Hahn and surrounding area, with north towards the top left. (**Top**) Image sequence by Nick Hazel, taken with a tripod mounted D7000 DSLR camera for the dates and UTs given. (**Bottom**) An image by Alberto Anunziato taken on 2019 Sep 15 UT 02:51 taken with a 180 mm reflector equipped with a ZWO ASI120MC camera.*

Alberto's image (Fig. 7 – bottom) is much sharper than the 2012 DSLR camera images (Fig. 7 – top), and shows no sign of the plume effect. The simplest explanation for the 'plume' is that it was just image data compression noise or a bird or insect flying past the Moon; otherwise some significant volume of absorbing material would be needed between the eastern crater rim and us. We shall keep the weight at 1 for now and encourage similar DSLR images to see if we can check out the compression noise effect.

Plato: On 2019 Sep 07 UT 21:34 Les Fry (NAS – see Fig. 8) was just 3 minutes outside a repeat illumination (to within ±0.5°) observing window for the following report:

[REF 09] *On 1975 Apr 19 UT 21:09 P. Foley (Kent, UK), detected blue in Plato on east. Fiton at UT20:45 found blue along the south wall at the east (IAU?) end, which was very bright white. Blueness extended towards the large landslip at the east of the formation. Immediately north of the landslip, where the bright wall curves first westwards, then again northwards, red could be faintly detected, followed by a very faint blue. All other parts of the formation were normal. Examination with a Moon blink device revealed no colour blink. J-H Robinson also found blue, with red on the west wall (exterior?). By 21:30UT Fitton found Plato to be normal and so was Proclus, though he did find Epigenes (bright crescent of east wall only) slightly blue to the N.W and red to the S.E. Mare Crisium was normal. Prominent spurious colour seen on Venus, but it was low in the sky, with blue to the north and red to the south. However, J.H. Reading, managed to see the north east floor blurred and slightly blue from 22:45-23:00UT. These reports are BAA observation. The ALPO/BAA weight=2.*

Figure 8. *Plato located at the centre of this monochrome image and orientated with north towards the top. Taken on 2019 Sep 07 UT 21:34 by Les Fry (NAS).*

Promontorium Agarum: On 2019 Sep 15 UT Román García Verdier imaged (Fig. 9) the Mare Crisium area under similar illumination and topocentric libration, to within ±1°, to the following report:

[REF 10] *In 1958 Aug 20 at UT 20:00? an unknown observer noticed that Promontorium Agarum appeared filled with fog or mist. The Cameron 1978 catalog ID=510 and the weight=3. The ALPO/BAA weight=2.*

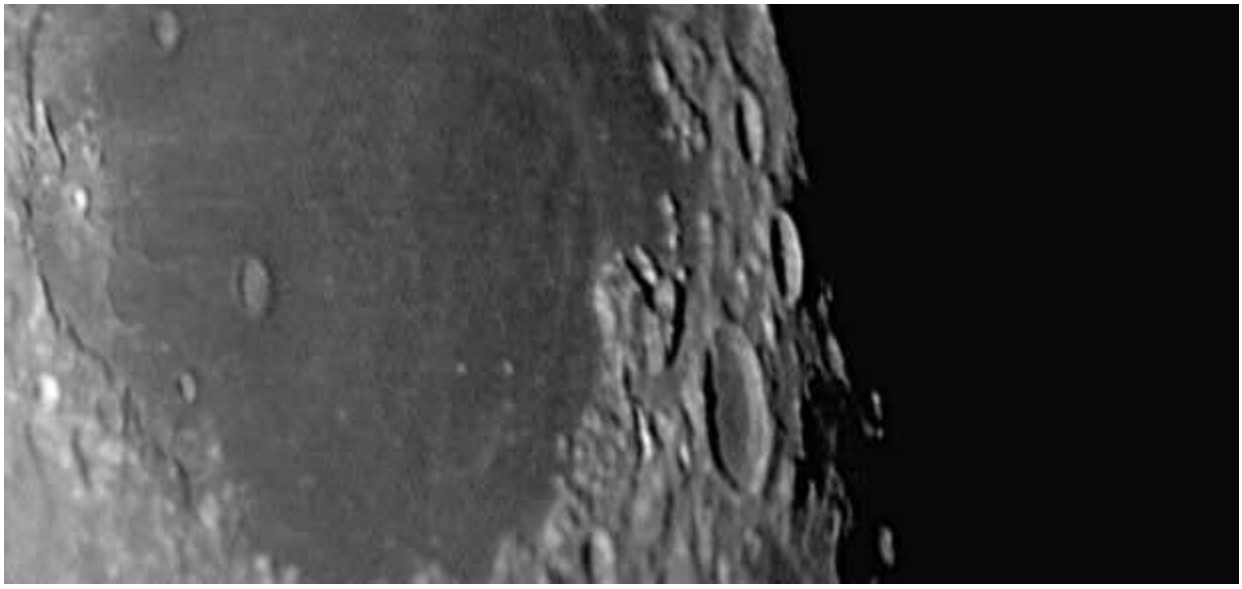


Figure 9. *Promontorium Agarum located at the centre of this image and orientated with north towards the top. Taken on 2019 Sep 15 UT 03:44 by Román García Verdier (SLA).*

Torricelli and Torricelli B: On 2019 Sep 16 UT 20:45, 21:10 Valerio Fontani (UAI) and Nicoletta Minichino (UAI) at 21:12 UT, imaged (Fig. 10) this area under similar illumination (to within ±0.5°) to the following report:

[REF 11] *Torricelli B 2002 Oct 23/24 UT 23:25-23:52 Observed by Clive Brook (Plymouth, UK, 60 mm OG x120 + prism) "Observed that Torricelli was very diffuse and Tor B showing shadow? observer considered a shadow perhaps a little surprising this far from the terminator. Nothing unusual seen by M. Cook at 23:52UT or by A Cook at 00:40-00:52 and indeed other craters did appear to have shadows this far from the terminator? so perhaps only unusual aspect of the original observation that could not be checked due to poor seeing by the latter observer was the fuzziness. The ALPO/BAA weight=1.*

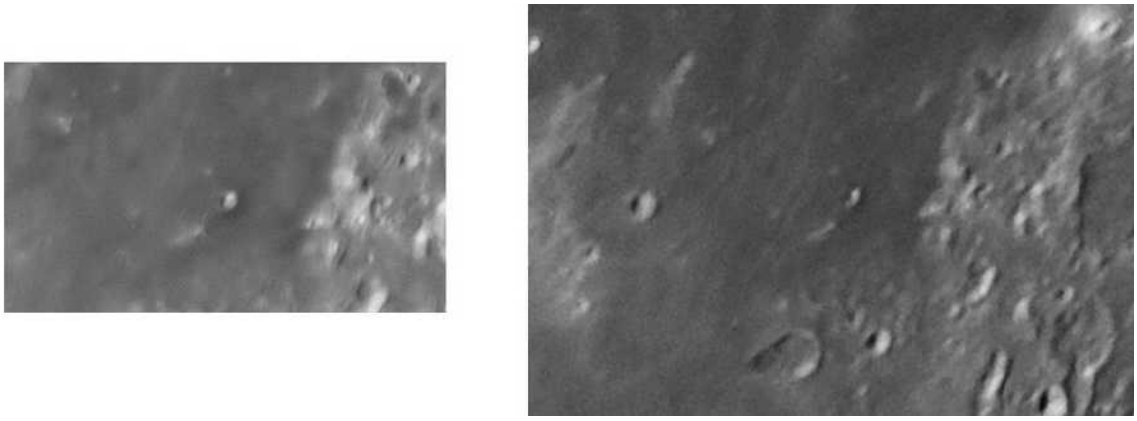


Figure 10. *Images of the Torricelli B region orientated with north towards the top, taken on 2019 Oct 16.* ***(Left)*** *Image by Valerio Fontani (UAI) taken at 21:10UT with Torricelli B at the centre.* ***(Right)*** *image by Nicoletta Minichino (UAI) also with Torricelli B at the centre and the sideways key-hole shaped crater Torricelli at the bottom*

Atlas: On 2019 Sep 17 UT 01:34 Bob Stuart (BAA) imaged Atlas and Hercules in monochrome (Fig. 11), just 3 minutes outside the ±0.5° similar illumination window of the following report:

[REF 12] *Atlas 1969 Aug 01 UT 03:36-04:00 Observed by Pither (Nottinghamshire, England) NASA catalog reports: "Eng. moon blink in crater at 0336h close to E. wall, NE of central feature. Oval in shape & dirty brownish color & hazy. Started fading at 0345h but may have been due to dawn, Neg results on other features, (Apollo 11 watch)." 12" x450 reflector used. NASA catalog weight=3. NASA catalog TLP ID No. #1195. ALPO/BAA weight=3.*

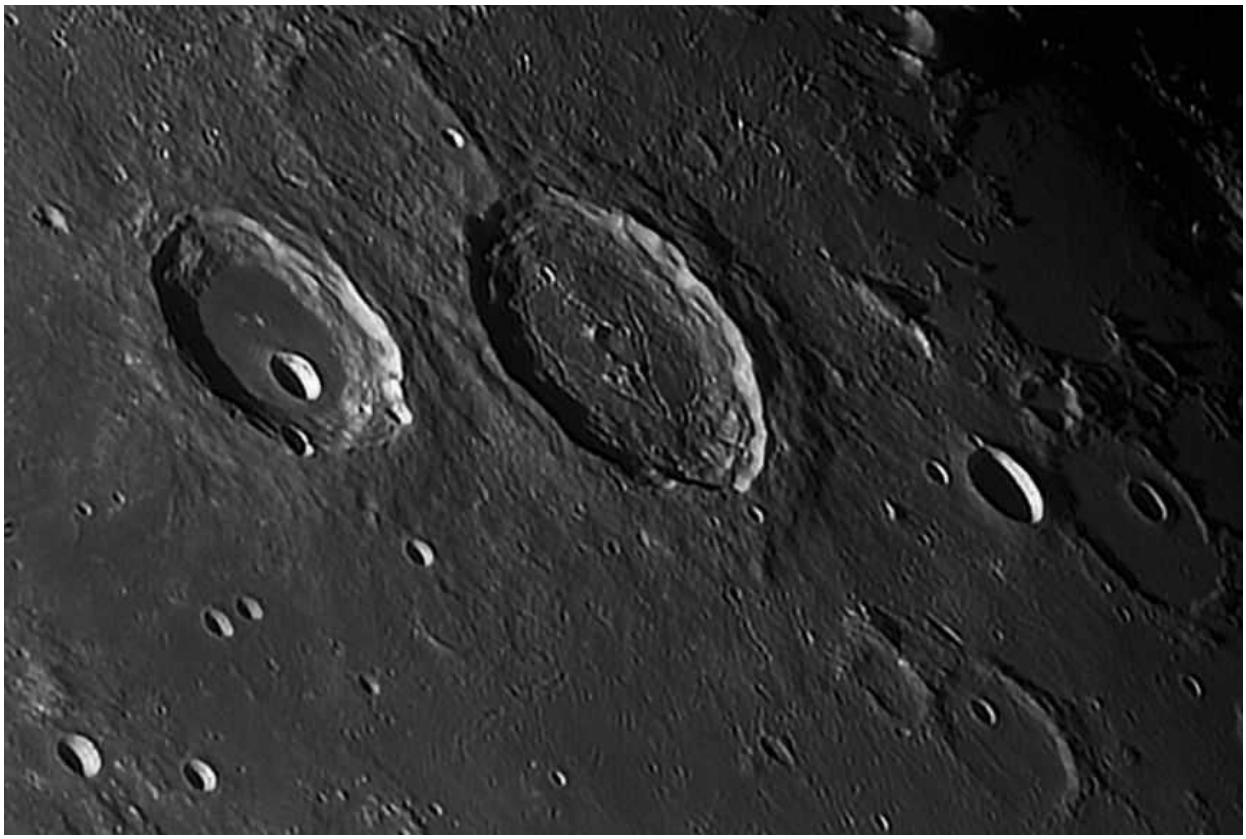


***Figure 11**. Hercules and Atlas as imaged in monochrome by Bob Stuart (BAA) on 2019 Sep 17 UT 01:34. North is towards the top.*

Tycho: On 2019 Sep 22 UT 02:45-03:39 Dietmar Büttner (BAA) observed visually sunset over Tycho, but was not aware that 3 hours earlier the lunar schedule web site had requested:

[REF 13] *On 1996 Feb 12 at UT 07:30-08:27 J. Sandel (Caycee, SC, USA) noted a contrast effect inside Tycho at sunset. At 07:30UT there was a slight, but definite illumination of small areas of the crater floor west of the central; peak. Also seen by T. Ferrel(Lawrenceville, GA, USA, SCT C8). This was oval in shape and grey in colour - Ferrel noted some diffuseness. It brightened over 30 minutes. At 08:11UT a definite brightness fade noted in Tycho's central peak. The crater floor had increased illumination of entire crater floor. ALPO/BAA weight=3.*

Dietmar noted that Tycho was completely on the day side of the Moon, with the crater's floor fully in shadow, and its eastern inner wall brightly sunlit. More specifically time wise:

02:45 UT: central peak seen as a very weak sunlit point; at the limit of visibility.

03:03 UT: central peak a little bit brighter than before, central peak no longer just a point, but also a little bit extended; but again, at the limit of visibility.

03:31 UT: central peak now seen as a weak/very weak sunlit point, again a little bit extended; at the limit of visibility.

03:39 UT: central peak seen as a sunlit point; at the limit of visibility, but it was also noted that the shadow inside the crater partly not fully black, but slightly greyish. As a comparison the shadows in other nearby craters were completely black!

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

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